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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.

THE B.B.C. TRADE MARK: WHAT IT STANDS FOR TO-DAY.

INVESTIGATIONS which we have carried out recently disclose the fact that there is a very general misunderstanding amongst the public as to what is the real significance of the B.B.C. trade mark on wireless apparatus.

In order that the present significance of this trade mark can be explained, it is necessary to trace its history from the date of the inception of the Broadcasting Company. Those who at that time were interested in broadcasting will remember that the Post Office licence to use a wireless set was issued on the condition that the set used should be marked with the B.B.C. trade mark, which, in those days, signified

(1) That the set was of a non-radiating type approved by the Post Office;

(2) That it was manufactured by a member of the British Broadcasting Company, and was *ipso facto* of British manufacture.

When the separate constructor's licence was issued, that was also conditional on the principal parts used being of British manufacture and bearing the B.B.C. mark.

Subsequently this method was proved to be impracticable, and the Post Office system of testing the sets for non-radiation was discontinued. At no period has the B.B.C. stamp been a guarantee of quality, and to-day the mark has comparatively little significance.

Under the Trade Marks Act of 1905 special trade marks are permitted by the Board of Trade to be used where any association or person undertakes examination of any goods in respect of origin, material, mode of manufacture, quality, accuracy, or other characteristic, and certifies the result of such examination by a mark used in connection with such goods. In the case of the B.B.C. trade mark, the only significance of the mark is that it indicates that the apparatus is of British manufacture and produced by a firm which is a member of the B.B.C.

Since any *bona fide* British manufacturer of wireless apparatus is eligible for membership of the B.B.C. without examination as to the standard of quality of his products, the trade mark must not be regarded as implying any standard of quality.

It would be interesting to know what would be the attitude of the Board of Trade if this trade mark had been applied for now instead of at a time when it actually had an important significance, and was virtually used under the authority of the Post Office. It might be argued that the B.B.C. is not conforming to the conditions under which such trade marks are granted to an association, and is, in consequence, not entitled to authorise the use of this mark by its members.

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LOUD SPEAKERS
A Review of Modern Practice

By N. W. McLACHLAN, D.Sc. (Eng.), M.I.E.E., F.Inst.P.

THE subject of loud-speakers and associated auxiliary apparatus is now so extensive that only a few later date models can be examined in a cursory manner. Before doing this it is necessary to have some sort of working hypothesis regarding the portions of the electrical circuit leading up to the loud-speaker. For simplicity we shall assume the input to the loud-speaker is such that, so far as the receiver is concerned, each audio-frequency from 40 ~ to 4,000 ~ is given equal prominence, *i.e.*, the amplification-frequency input to the power valve is uniform over this range. For example, a detector without reaction, followed by a good resistance-coupled speech amplifier with low-impedance power valve (D.E.5, L.S.5, or D.E.5A), will fulfil the requirements very nearly.

Sound Intensity from Loud-speakers.

Another hypothesis is required to cope with the "loudness level" or degree of intensity from the loud-speaker. If we listen to a band or an orchestra, the quality or timbre of the music depends upon our distance from the band. Starting near the band-stand, let us walk away to a distance. The lower tones will become weaker with reference to the higher tones, until at a certain distance they will be almost inaudible. Thus the "pitch" of the music appears to get higher the further we get away. A similar effect can be obtained with a pianoforte. This phenomenon is due to the varying sensitivity of the human ear, which appreciates high tones much more readily than low tones. Now suppose a loud-speaker is reproducing in a room of average size so that ordinary conversation can be carried on without serious difficulty. The intensity will be very much less than that of a military band in the broadcasting studio. Moreover, the low tones may be inaudible or very weak if the reproduction is perfect. Although the intensity from the loud-speaker is relatively small, we like to hear the low-toned instruments even on the soft passages. Thus, with uniform amplification from 40 ~ to 4,000 ~, the lower tones must be augmented by giving the loud-speaker a good bass register. Under these conditions the bass tones would be too prominent when reproducing the playing of an orchestra *at its normal strength*, even if there were no distorting influences elsewhere.

Apart from the variation in quality with loudness—due to the physiological peculiarities of the ear—the chief trouble in loud-speaker design is to avoid resonance and get sensitivity. There is no loud-speaker on the market which is devoid of resonance. In fact, to secure sensitivity, it is essential to employ resonating components, *e.g.*, reeds, diaphragms. To the critical ear, even though the air damping is high, the resonances are detectable on speech particularly, and they rob an orchestra of the individuality of its instruments, *i.e.*, there is a certain amount of blurring particularly in the neighbourhood of the resonant frequencies, especially if these occur in the lower register. The resonances of various types of loud-speaker occur at different frequencies, with the consequence that no two of these instruments sound alike. In spite of these apparently depreciatory remarks, which are actually based on musical taste, loud-speaker reproduction can be made very pleasant. We have already stipulated the type of amplification on which these remarks are based. It may not be out of place to say that, for similar reproduction with various types of amplifier, the characteristics of the loud-speaker would require to be altered accordingly. For example, a normal bass on the uniform amplification scale would become over-prominent with heavy reaction. In fact, the time is approaching when overall performance curves of amplifiers will be required, so that we can see what is happening at various points on the audio-frequency scale.

Loud Speakers.—

Loud-speakers can be divided broadly into two main classes :—(*a*) with horns ; (*b*) without horns, these usually having some form of large or small stiff diaphragm. The horn type is the more common at the present time, but the diaphragm type is slowly but surely making its appearance.

Horn Type Loud-Speakers.

The horn types of loud-speaker are well known. Here we have a small resonant diaphragm or reed and diaphragm which is coupled to the air or loaded by a horn. The shape of the horn, the thickness of the diaphragm, the shape

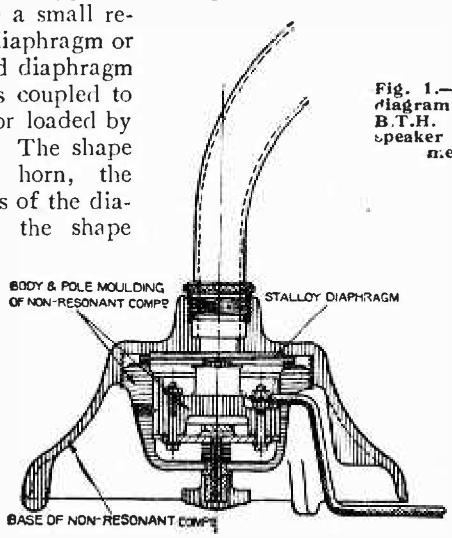

Fig. 1.—Sectional diagram of the B.T.H. loud-speaker movement.

of the various air cavities behind and in front of the latter, affect the tone of the loud-speaker. Stated in other words, they determine the various resonances. The air in the horn is a prolific resonating column, especially at large amplitudes, and the result is to cause blurring of the lower tones so that they merge together. The general characteristic of a loud-speaker with the usual length of horn is a weak bass, and a prominent register above middle C. Put in an exaggerated way, contraltos become sopranos and 'cellos become violins. The weak bass is due partly to the short horn, but chiefly to the relatively high resonance of the diaphragm.

The customary procedure in designing horns is to make the opening follow a logarithmic law. For best results the horn should be long and straight. Taking a horn three to four feet in length, there is a pronounced resonance on the low notes which is very marked at large intensities when listening near the mouth. At some distance away—in the open—the resonance almost disappears. This is due to the relative insensitivity of the ear to low tones when the overall intensity is sufficiently reduced.

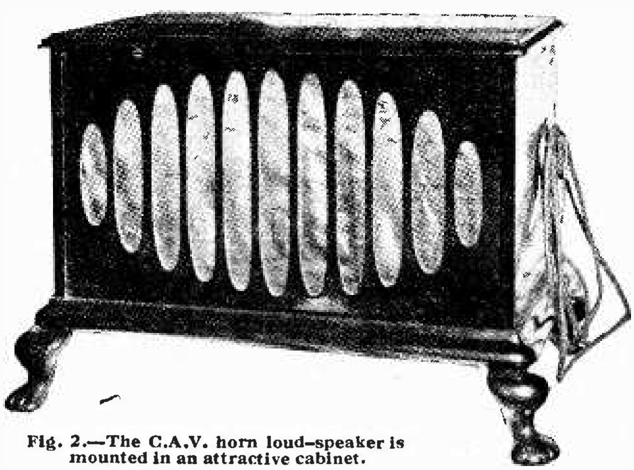

Fig. 2.—The C.A.V. horn loud-speaker is mounted in an attractive cabinet.

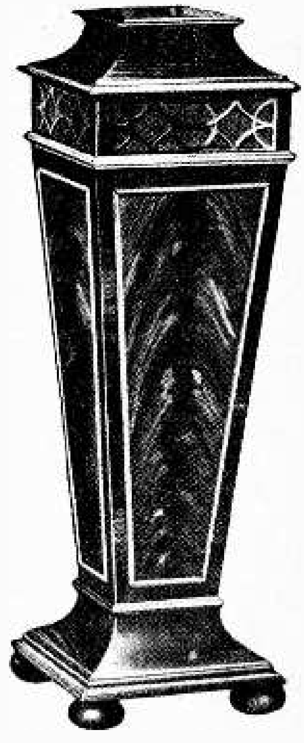

Fig. 3.—The A.J.S. Pedestal loud-speaker

Several new types of speaker have been put on the market recently with a modified type of horn. Sometimes the horn is camouflaged by an artistically designed box, whilst in the latest "Amplion" model, known as the "Radiolux," the horn is truncated at a small diameter section, and the smaller hole in the upper or flare portion filled up. The flare is then reversed to act as a reflector. The curves of both horn and reflector are specially shaped to give the best results. A number of the new horn type instruments are shown photographically in Figs. 1 to 4, whilst in Figs. 5 and 6 are given sectional photographs of the "Radiolux," showing the peculiar construction.

Diaphragm or Hornless Loud-speakers.

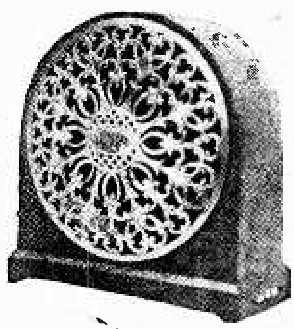

Fig. 4.—The Amplion "Radiolux" loud-speaker.

Coming to hornless types of loud-speaker, a large number of interesting problems present themselves. The peculiarity of the reproduction problem is simply that all musical sounds originally depend upon the resonances of one or more vibrating members ; whilst in reproducing these the loud-speaker must exhibit the minimum of inherent resonances. The aim in reproduction at normal loudness level is to get the air pressures in the studio and in the private dwelling, or wherever the reproduction is taking place, identical. As indicated already, the bass requires a little boosting when the overall intensity is brought down to room level.

Before beginning the subject of moving diaphragms which characterise the hornless type of loud-speaker, there are three salient points to which attention must be directed.

(1) Every diaphragm, whatever its shape, every piece of metal, wood, and the like, has a resonance frequency. Music or speech consists of a series of impulses of varying

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amount, and each impulse calls forth the various resonances of the component parts of the loud-speaker in a degree depending on the nearness of the frequencies of the impulse (when the steady state is reached) to the resonances of the speaker. A similar argument applies to air cavities associated with the loud-speaker. This accounts for local coloration in acoustic reproduction, apart from the influence of room resonances, echo, and the like.

(2) When a force is applied to a particular point of

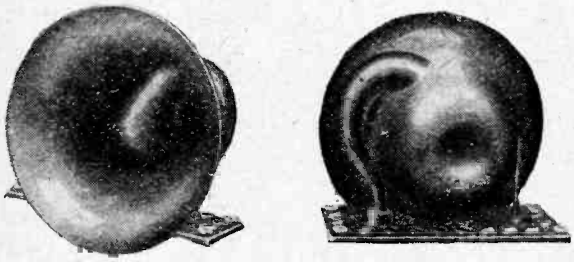

Fig. 5.—Two views of the sound conduit of the "Radiolux" loud-speaker.

any mass, *i.e.*, the distribution is not proportional to the mass, *e.g.*, the point of a conical diaphragm or the centre of a circular one, its effect is not immediately felt at every part of the diaphragm. The push or pull exerted by the force travels along the diaphragm with finite velocity, equal to the velocity of propagation for the particular type of diaphragm. This velocity is governed by the elastic coefficients of the diaphragm, *e.g.*, depends on the shape and material. The influence of this "finite" velocity is detectable by the human ear unless the diaphragm is very small.

(3) When a diaphragm open at both sides is executing vibrations, the air at one side is compressed, and that on the other side is rarified, and *vice versa*. The difference in pressure is such that the air rushes round from front to back to equalise. The effect at the higher audio fre-

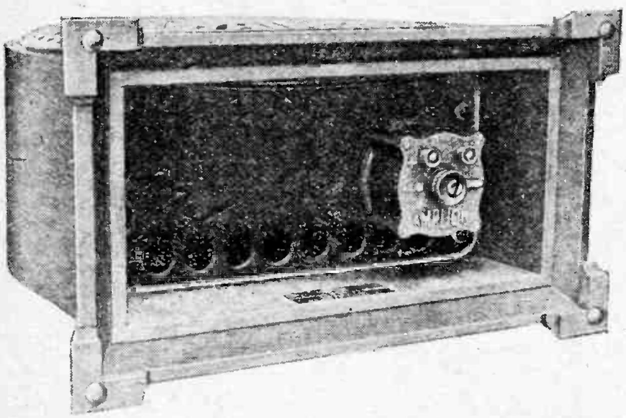

Fig. 6.—View under the base of the "Radiolux" loud-speaker, showing position of adjustable movement.

quencies is not marked, for the pressure at the front has altered from + to − before the air can rush round to the back (with velocity of sound). But at the lower frequencies a partial equalisation of pressures occurs, and the energy radiated is considerably reduced. The equalisation is never complete owing to the time taken for the pressure wave to travel round the diaphragm, *i.e.*, owing to the phase shift.

Diaphragms.

A loud-speaker can be made by connecting any vibrating reed type of movement to any kind of diaphragm. The results will depend upon conditions, *e.g.*, whether the diaphragm is large or small, and whether it has free or fixed edges. The shape and composition of the diaphragm is immaterial so far as emitting some kind of sound is concerned. For example, it might be a paper cone, a paper pyramid, a dining-room table, a plate-glass window, a pianoforte sound board, a paper sphere, or, in fact, *any object with adequate rigidity*. When we are strictly tied down to conditions, we cannot take the movement and fix it to any accessible piece of furniture and then proclaim that a good loud-speaker has been invented. The conditions to be satisfied are good reproduction and a respectable degree of acoustic efficiency. (Strictly speaking, electro-acoustic efficiency never did comply with the rules of decency.) A somewhat analogous case is found in constructing an efficient inductance

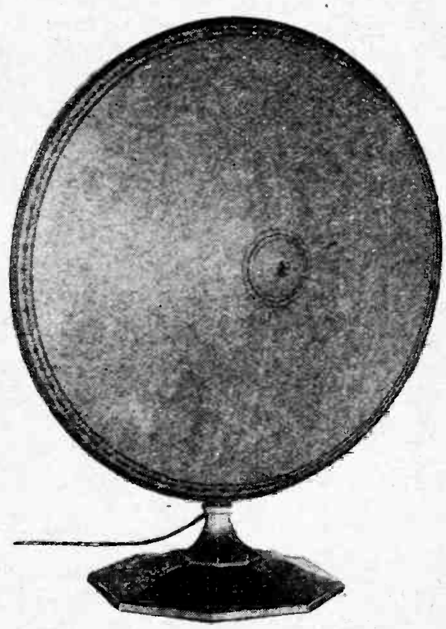

Fig. 7.—The Western Electric "Kone" loud-speaker.

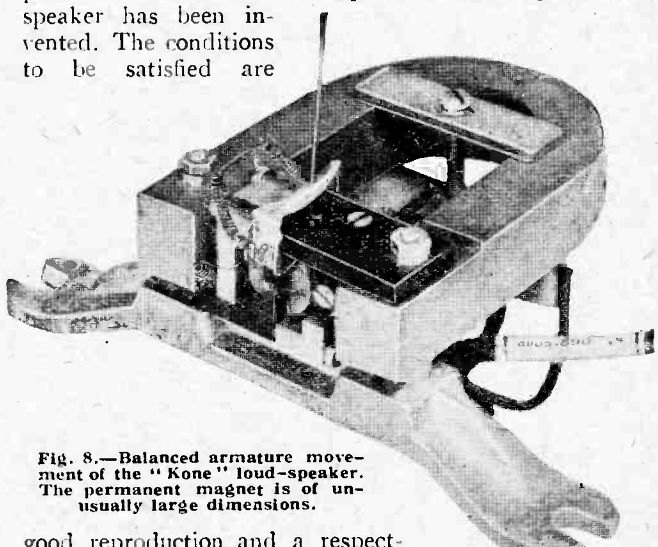

Fig. 8.—Balanced armature movement of the "Kone" loud-speaker. The permanent magnet is of unusually large dimensions.

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from a coil of wire.. So long as the wire is not wound non-inductively, it is immaterial in what tangle it exists, for an inductance of sorts will be obtained. But when the condition to be satisfied is that the ratio L/R shall be a maximum for the given length of wire, the problem resolves itself into scientific design. So it is with the loud-speaker diaphragm.

Taking the case of a diaphragm symmetrical about some plane or axis, we have examples in the "Primax" pleated diaphragm, the Western Electric "Kone," the Radio Communication Company's "Audalion," which cylindrical,

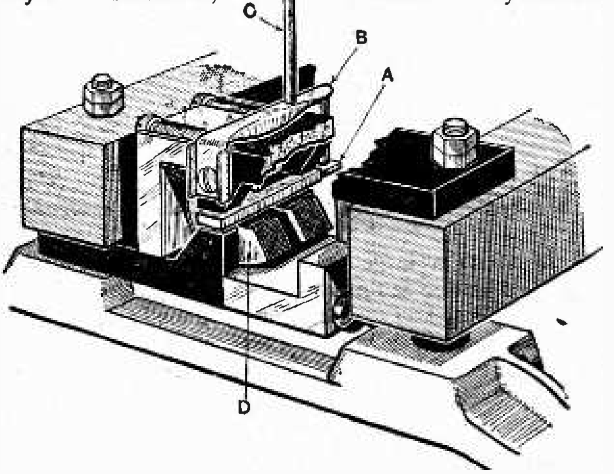

Fig. 9.—Sectional diagram of the "Kone" loud-speaker movement. Vibrations of the armature A corresponding to variations of current in the speech coils D are transmitted through a short metal rod to a spring lever B. The rod C is attached to the apex of the cone diaphragm.

and the General Electric Company of America's small cone with a baffle. These are illustrated diagrammatically in the title of the article and in Figs. 7, 17, 13, and 14 respectively. The action of a diaphragm depends (1) upon its diameter, (2) its shape, (3) the fixing or freedom of its outer edge, and (4) the material of which it is made. Taking the case of a diaphragm 12 to 18 inches in diameter with a *fixed* edge, we can imagine the pleated arrangement or the cone to be replaced by a disc diaphragm of varying thickness having identical elastic properties. Strictly speaking, the cone cannot be represented thus at high audio-frequencies, *i.e.*, short acoustic wavelengths, but with a wide-angle cone the error is not worth worrying about here.

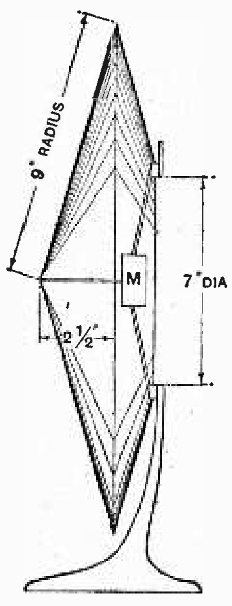

Fig. 10.—Leading dimensions of the "Kone" loud-speaker.

Having got an equivalent diaphragm, it is easy to see that it has a fundamental resonance frequency with overtones depending on the stiffness at different radii. Furthermore, there will be complex modes of vibration as in ordinary diaphragms, with, of course, the differences due to the peculiarities of the design. For example, the stiffness of a pleated diaphragm is much greater at the centre than at the periphery. When the movement or reed mechanism is fixed to the centre of the diaphragm we get two tightly coupled mechanical resonating systems, with a new set of resonance frequencies dependent upon the characteristics of the diaphragms when free and upon the degree of coupling.

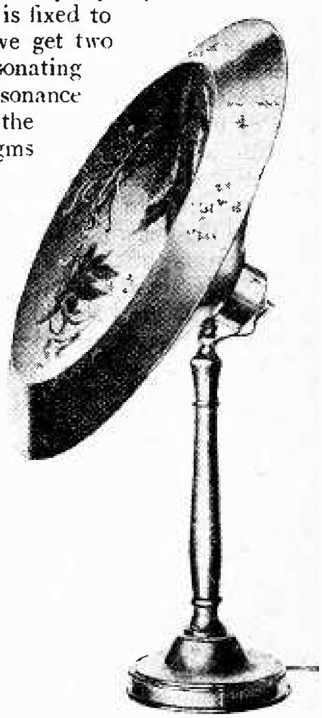

Fig. 11.—Another example of the cone method of construction—the Sterling "Mellovox."

The fact that the diaphragm is fixed at its edge and that in general a mass is situated there in the form of a ring, means that all the flexural waves, except perhaps the very short ones, which travel from the centre due to vibrations of the reed, reach this ring and are reflected therefrom, thus yielding standing waves and promoting resonances at certain frequencies. In this way the loud-speaker can be made more sensitive at the expense of quality. The vibration of the diaphragm is damped to an extent by the resistance (inertia) of the air to motion of its mass, but the damping falls short of the critical value for aperiodicity. When the edge of the diaphragm is free or freely supported, the reflection of the flexural waves from the edge is much less than before, and the resonance is determined by that of the diaphragm *alone* (its value in free space just as a disc coin—say a penny—vibrates when dropped) and the reed of the movement. The result is usually—when the movement is fixed—a decrease in volume due to lack of reflection. It should be noted, as remarked previously, that the cone does not move as a whole. With the usual type of reed and a cone 10 to 18 inches in diameter, having a free or fixed edge, there will be weak low tones. These are augmented by the use of a baffle, as shown in Fig. 12, but they must be inherent in the system, or there will be no tones to augment. The free edge is the better proposition of the two, owing to reduced resonance. The general pitch level of the reproduction is determined in this case largely by the natural frequency of the reed. For good low tone reproduction the natural frequency should be low. But this usually means a lack of efficiency owing to the

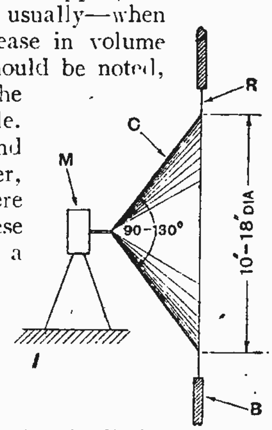

Fig. 12.—Typical example of the "free-edge" cone principle of construction. The cone C of cartridge paper from 5 to 10 mils thick is supported in a sound baffle B from 2 to 4ft. square by a thin sheet rubber ring R. The cone is driven through the medium of a short thin rod by a magnetophone or reed type movement M.

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design of the movement necessitated. Nevertheless, it is possible to get quite satisfactory results. Just as the impedance of a loud-speaker must be designed to give the best results with a certain type of valve, so must the mechanical impedance of cone and movement be suited to each other. In other words, the leverage of the cone relative to the fulcrum or fixing of the reed and the stiffness of the reed must be matched.

With a really large diaphragm, say 36 inches in diameter, the baffle is almost unnecessary and there is good radiation of the low tones, but care must be exercised in the general design not to reduce the high tones at the expense of the low ones. The cone should be very stiff for its mass and at the same time the mechanical transmission losses should be low or the high frequencies will be attenuated considerably. For example, consider the vibrations of the reed at 3,000 ~. These are

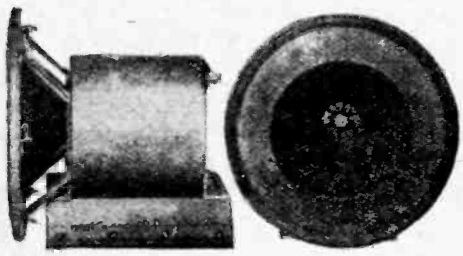


Fig. 13.—Movement and diaphragm of the small cone loud-speaker produced by the G.E.C. of America.

transmitted to the point and travel down the cone at a definite velocity, meanwhile causing motion of the air *en route* and making the cone emit a note of 3,000 ~. Whilst travelling down the cone, the energy is attenuated due to transmission losses, and if these are large enough, the damping may be so great that the amplitude of the vibrations is reduced to a small value quite near the vertex. This contingency must be avoided in the design. On the other hand, a certain amount of damping is desirable to curb prominent resonances, but it is advisable to obtain this in the form of useful work done on the air, rather than in diaphragm transmission losses.

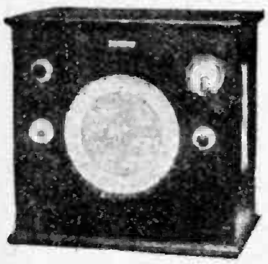


Fig. 14.—Small cone loud-speaker and amplifying unit of the G.E.C. of America. The front of the cabinet, which is perforated at the sides and back, acts as a sound baffle.

Some New Types of Diaphragm Speaker.

After these preliminary remarks, we are in a position to examine some of the latest diaphragm types of loud-speaker. Taking the "Kone" type of the Western Electric Co., the diaphragm consists of a conical member of large solid angle, to the edge of which is glued a truncated cone, as shown in Fig. 10. The paper is of a brown hue, and is specially prepared to avoid paper rattle and to withstand climatic conditions. The conical portions are made in the usual manner with a seam. The hole in the truncated portion is bound by a metal ring, this being secured to a metal

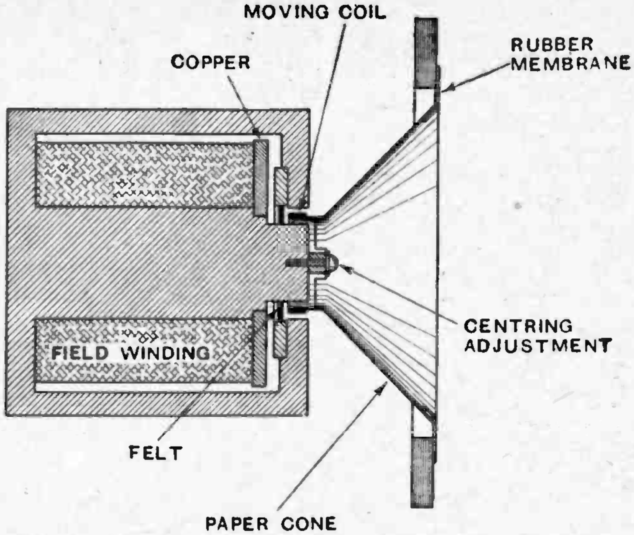


Fig. 15.—Section of the driving mechanism of the small cone loud-speaker.

stand in which a large foot is incorporated. There is also a small handle at the back for lifting purposes. The movement is based on the Baldwin telephone arrangement, and consists of a magnetically balanced reed between the polar extensions of an exceptionally large permanent magnet. The reed is connected by a lever mechanism to a long rod which projects through the point of the cone, thus obtaining the correct conditions for maximum efficiency. The complete movement is mounted on the same framework as the diaphragm. At the point of the cone a thumbscrew is used to secure the rod, which is connected to the vibrating reed.

The system is obviously a resonant one, and there are major resonances at a high and at a low frequency. The upper resonance is chiefly due to the reed, whilst the lower one is due to the diaphragm. The shape resembles a Helmholtz resonator and the frustum portion acts partially as a baffle and partly as a flexible support, thus promoting certain resonances in the lower register. In practice the resonances do not evince themselves by a blasting effect, but merely give the acoustic output a certain degree of coloration. An interesting experiment can be performed by using a reflecting surface either in front or behind the cone. Assume the point to be outwards and the back to be 12 inches from a wall, push the speaker gradually (not too slowly) towards the wall. The ear will detect an apparent rise in pitch. This is due to interference of the low tones reflected from the wall with those radiating from the front of the cone, *i.e.*, to partial pressure

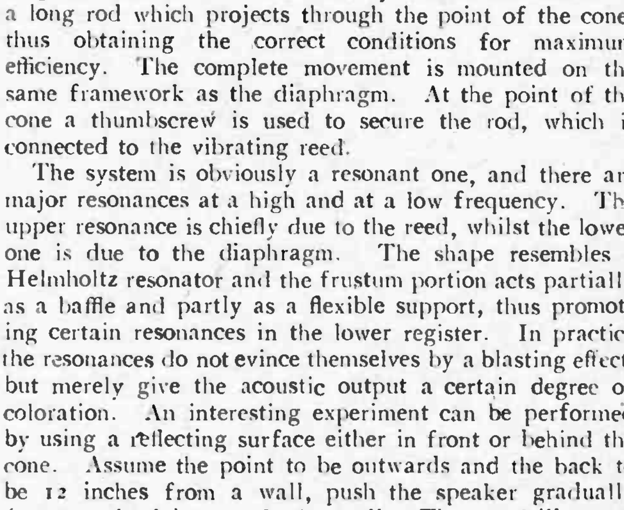


Fig. 16.—The "Blatthaller" loud-speaker with baffle removed, and (right) a sectional diagram of the magnet pole pieces, showing positions of strip conductors.

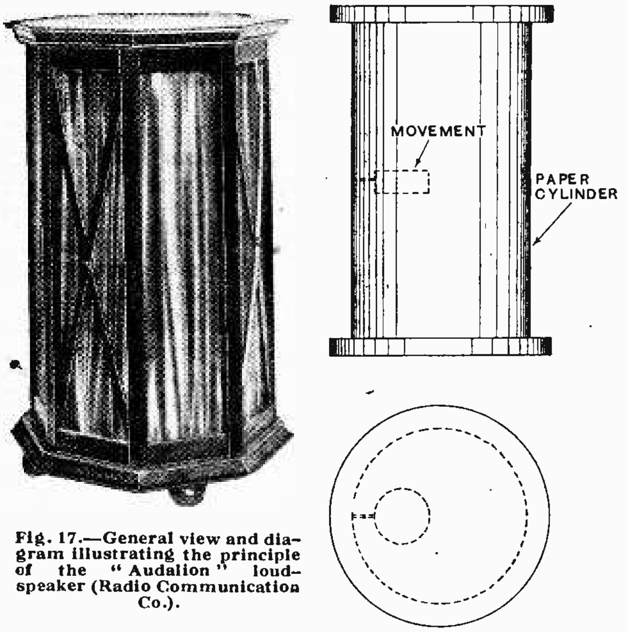


Fig. 17.—General view and diagram illustrating the principle of the "Audalion" loud-speaker (Radio Communication Co.).

equalisation on the low tones, and is akin to a small cone without a baffle. Thus if a diaphragm type loud-speaker is too low pitched, the remedy is simply to place it near the wall or to fit some wooden or other reflecting surface of adequate size behind it. If a reflector of the "iris" type with expanding hole were gradually brought over the point of the cone, it would ultimately become a baffle. This flexibility of tone is of great advantage, especially if reaction or a series of very selective circuits is used, thereby attenuating the higher audio-frequencies. Of course, if the low tones are weak, a reflector will have little or no effect.

The next type of loud-speaker is that of the General Electric Co., Schenectady,[1] and it is shown in Fig. 15. Here a paper cone about 6 inches in diameter with a central angle of 90 deg. is supported at its periphery by a flexible rubber ring, so that the natural frequency is of the order of 50 ~ per second or less. A portion near to the apex of the cone is removed, and a cylindrical coil is attached which moves axially in a pot type of electromagnet, the magnetising power being about 50 watts. The coil has a light centering system to avoid rattling against the pot. The arrangement is designed to avoid resonances, but the free resonances of the cone itself, apart from its support, still remain and there may be other resonances of mechanical parts. This instrument is really a happy mixture of several old ideas. First, the free (or nearly so) suspension of the cone or rigid element was used in the original Bell telephone, where a flat iron diaphragm was mounted in the middle of a flexible membrane, leaving the outer edge free. Then S. G. Brown used an aluminium cone, both in headphones and loud-speakers, supported at its periphery by thin paper. In later models the support and cone are in one spinning. This prevents the air getting to the back of the cone and acts as a baffle. The pot and coil arrangement, with flat wood sounding board, was used by Sir Oliver Lodge in 1898.[2] The scheme of Fig. 15 was found to be lacking in low tones, and a baffle was used as in Fig. 12 to avoid pressure equalisation on the two sides, as discussed previously. In the actual model the baffle takes the form of a box with perforations in the sides. The box, however, is bound to contribute its quota of resonance, especially at large intensities. A photograph of the box is shown in Fig 14. In practice the loud-speaker is manufactured as a composite unit with power and rectifying valves for working off the A.C. mains. The D.C. voltage available on the power valve is about 420. The electromagnet is used not only to supply a steady field for the moving coil, but it also serves as a choke for smoothing the A.C. To avoid a ripple being superimposed on the steady field, the magnet is surrounded at its working face by a thick copper band, shown in Fig. 15.

So far as performance is concerned, I have carried out a series of experiments and find the reproduction thin and high-pitched without a baffle. The baffle augments the low tones and the general intensity in a remarkable degree. At ordinary room levels the low tones are weak—owing to the insensitivity of the ear, as explained above—but at large intensities such as obtain in the studio or for public address purposes, the low tones are good on a proper amplifier. Reproduction of the rather irritating high harmonics of the violin are unmistakable, and there is no doubt concerning the pedal notes of the grand organ (Shepherd's Bush transmission).

The general mechanism of this speaker is interesting. There is practically no restoring force and the coil is operated by the push and pull exerted between the field of the magnet and the alternating field due to speech and music currents in the moving coil. The opposing forces are (1) the dynamic inertia of the moving system, (2) the air damping, this being the useful component

(1) "Proceedings, A.I.E.E.," September, 1925. The photographs in Figs. 13 and 14 are reproduced from the "A.I.E.E. Journal."

(2) Brit. Patent Spec., No. 9712, 1898.

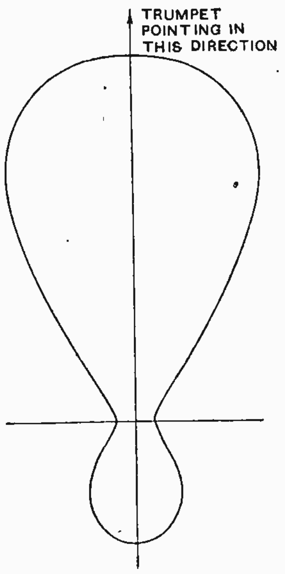


Fig. 18.—Rough sound distribution curve for a typical horn type loud-speaker.

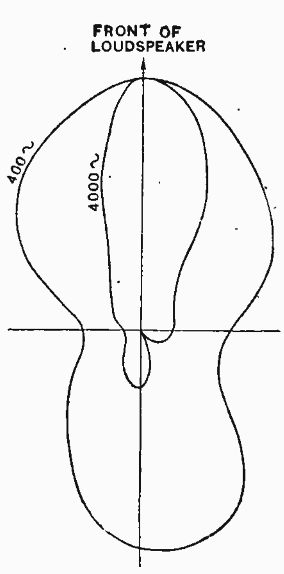


Fig. 19.—Polar curves of sound distribution round the G.E.C. small cone loud-speaker at frequencies of 400 and 4,000 cycles.

Loud Speakers.—

in doing acoustic work, (3) the force equivalent to electrical mechanical energy losses in the coil system.

At the lower frequencies the cone (6 inches diameter) may be taken to move as a whole, *i.e.*, like a piston. As the frequency increases, however, a point is reached when flexural waves appreciably appear, that is to say, the cone ceases to move as a whole and there is a phase difference between the motion of different parts of the cone due to the finite velocity of propagation of energy from the truncated vertex. Under these conditions the radiation of acoustic energy is complex, for the vertex may be causing a rarefaction whilst some other section of the cone is causing a condensation, and so on. The larger the diameter of the cone, the lower the frequency at which flexural action appears. There is clearly a band of frequencies between the two extremes, *i.e.*, at which the cone moves as a whole (the energy propagation not being sensibly flexural), and that at which the energy propagation is almost entirely flexural.

To avoid flexural propagation as far as possible, it is necessary that the force shall be uniformly distributed over the diaphragm, *i.e.*, the force distribution shall be in accordance with the mass at any section. An example of this is to be found in the Gaumont loud-speaker. A conical piece of thin rubber is wound with thin insulated wire and immersed in a magnetic field at 90 deg. to the slant side of the cone. The reaction between the alternating current in the coil and the field of the magnet is such that each turn of wire is urged backwards or forwards with a force proportional to its length, *i.e.*, f/m is constant, assuming a uniform field distribution. One of the difficulties with this type is the fact that the sound has to pass through holes in the pole faces of the magnet at back and front, which tends to cause muffling. When the Gaumont cone is of reasonable size, say 3 to 4 inches in diameter, a baffle can be used as in the previous type of speaker.

The next type of instrument is by Messrs. Siemens and Halske, and is designated the "Blatthaller." In principle it is identical with the G.E.C. of America and Gaumont loud-speakers, and is virtually a combination of the two—at any rate, so far as operation is concerned. To a flat plate of a material named "Cellon"—probably one of the inflammable cellulose-celluloid family—is fixed a band shaped copper conductor edge on. The cellon, which measures about 8in. × 8in., is held in place at its edges by felt at the centre of a wooden baffle just over 3ft. square. The baffle serves the same purpose as we have already described. The poles of a powerful electromagnet are in close proximity to the copper band. The arrangement is shown diagrammatically in Fig. 16. The magnet is fed with direct current at 110 or 220 volts and the energy expenditure is said to be 600 watts. This seems an extremely large amount, but may be due to the long air gap. It compares very unfavourably with a cylindrical coil—cone type—which only requires 30 to 50 watts, and it seems as though a young power station has to be in attendance on the outfit. Using a condenser microphone and a resistance-capacity amplifier, the uniformity of reproduction between 100 ~ and 5,000 ~ is good, whilst the intensity increases (relatively, of course) below 100 ~. There is said to be an absence of upper tones so that the brilliancy of 'cello and violin is impaired, and, furthermore, the letter "S" is imperfectly reproduced. This latter means, presumably, an absence of the characteristic hiss of the "S" thus making it sound like the letter "F." The effect can be readily demonstrated by cutting off the high tones from any ordinary loud-speaker by the aid of a condenser. The paucity of higher tones would appear to be due to (1) the ratio $\frac{\text{stiffness}}{\text{mass}}$ of the moving system being too small; (2) to transmission losses down the diaphragm and probably losses at the felt. The diaphragm may have a relatively low resonance due partially to its loading by the copper band reducing the frequency of the upper cut off point.

Another aspect is the ratio of the resistance of the band circuit to its inductance. For good reproduction of the upper tones, the ratio R/L should be fairly high, so that the current through the band is approximately equal at all frequencies. It is impossible, of course, without further information to diagnose exactly the cause contributing to the attenuation of the high frequencies. There is just a possibility of its being in the microphone-amplifier system due to accidental reaction.

As with the coil-driven cone, the general intensity of the "Blatthaller" must be of the same order as the original which is being reproduced to obtain the proper aural balance of tones throughout the acoustic register. This is not merely of theoretical interest, but with a good loud-speaker it is of prime importance and deserves a good deal more attention than has been shown hitherto. The best plan is to try an experiment and find out.

The principle of the Radio Communication Co.'s "Audalion," which is due to Dr. Lee de Forest, is illustrated in Fig. 17. A paper cylinder free at one longitudinal edge and at both ends has the mid-point of its other edge fixed to the reed of a balanced movement. The instrument is mounted rather like a stool with silk panels. This helps to curb the inrush of air from outside, which would reduce the low tones. The vibration of the reed is transmitted to the cylinder and makes the ends move relatively to one another. The cylinder, acting as a diaphragm, moves in such a manner that its radii at different points increase and decrease, thus varying the air pressure along the curved surface and radiating sound fairly uniformly in all directions in a horizontal plane. The distribution depends upon the frequency of vibration. The paper is specially prepared to avoid rattle and to withstand climatic conditions.

Energy Distribution and Acoustic Interference.

On the subject of energy distribution in a horizontal plane, *i.e.*, the polar curve, some remarks may be of interest. The distribution is really represented by a series of surfaces since energy is propagated in every direction, but at the moment we are really interested in the horizontal distribution as we are in D.F. work. Everyone knows the focussing effect of a horn, which is often a nuisance. A rough polar diagram of a horn type in a large open space to avoid reflection from near-by boundaries is shown in Fig. 18, whilst that of a G.E. Co. instrument is portrayed in Fig. 19. It should be

Loud Speakers.—
observed that the distribution is different at 400 ~ from that at 4,000 ~. The energy in the latter case is chiefly in front of the cone. This may have been due in part to a shadow cast by the mechanism at the rear of the cone.

These curves were taken with the loud-speaker in a room, and although a correction was made, there may be boundary effects incorporated. The interpretation of such curves is simply that the quality from the speaker is a function of the polar position, *i.e.*, it varies as we walk round the instrument. This is characteristic of any diaphragm type of loud-speaker, and modifications are introduced by boundaries which may cause standing waves. An excellent example of the latter is to be found when the broadcast tuning note is sounding. By moving the head to and fro the intensity and the quality of the note varies. The intensity varies due to interference between the direct rays and those reflected from the walls, etc., whilst the quality variation is due to the note being complex, *i.e.*, a number of frequencies are present and the interference points for the different frequencies occur at different places in the room. It is also of interest to state that with a cone, say 18 inches in diameter, interference zones can be traced down the cone (best in free space). This is due to the fact that an air wave starting from, say, the point is out of phase with one starting some distance down the cone. The phase displacement arises from the velocity of propagation of vibrations down the material being greater than that of the air pressure from the point (velocity of sound about 1,100ft. per second). Thus at, say, a frequency of 1,500 ~, giving a half wave-length of about 4.5in., the pressure about this distance down the cone, due to the air wave from the point, will be of the order of 180 deg. out of phase with that due to motion of the cone at this position, *i.e.*, the pressures will be + and − and interference will occur. The precise spot giving a 180 deg. phase difference depends clearly on the relative velocity of the flexural wave and air wave down the cone. Interferences are readily audible if the head is placed successively in the proper positions.

Calls Heard.

Extracts from Readers' Logs.

Basingstoke, Hants.
Adriatic :—UNTT (U.S.S. "Scorpion"). Mosul :—1DH, GHH. Palestine :—BSR. Turkestan :—RNRL. Java : —ANE. Canada :—1AR, 2CG. Cuba :—2BY. Porto Rico :—4RL, 4OI, 4KT. Mexico :—1AA, 1B, 1K, 9A. Brazil :—BZ1AF. Argentine :—CB8.
C. F. Scruby.
(0-v-0.) 25-45 metres.

Stockholm.
September 20th to October 3rd.
Great Britain :—2SZ, 5DH, 6MP, 5MO, GCS, 2AO, 5AT, 2XY. U.S.A. : 1CMF, WIZ. Belgium :—E2 K2. France : 8ÉS, 8ÉÉ, 8SSM, 8VU, 8GI, 8WTG, 8YNB, WF. Holland :—PCF, OPM, OKW, OCS, PB3, PCMM. Italy :—1MD, 1GN. Sweden :—SMLZ, SMTH, SMTX, SMYU, SMYV.
I. Sven-Nilsson (SMVI).

Dublin.
September 24th to 28th.
Belgium :—E2, K2, P7, R2, T2, Z9, 4GB, 4RE, 4RS. Holland :—PB3, PCMM, OBX, OHB, OKG, OSV, 2PZ. Italy : — 1AU. Yugo-Slavia : — Y7XX. Russia : — SOK. Sweden : — SMXU. France :—8AG, 8BV, 8CO, 8DTD, 8GI, 8HU, 8HLL, 8IX, 8JAB, 8MAR, 8NA, 8PGL, 8SSM, 8TOK, 8YNB. Great Britain :—2EL, 2FO, 2NB, 2PO, 2TO, 5HX, 5LF, 5MO, 5PM, 5QT, 5RQ, 5SZ, 5ZU, 6DO, 6MU, 6OH, 6YU, GFD. Miscellaneous :—AGA, NW4X, KXH.
(0-v-1.) D. O'Dwyer.

Lowestoft.
September 18th to October 6th.
Great Britain :—2BDY, 2DA, 2TO, 2VR, 2XO, 5HX, 5RQ, 5UP, 5UW, 5YK, 6DO, 6KY, 6MX, 6OH, 6YU. France :—8CQ, 8DD, 8GRA, 8NNN, 8NA, 8PRD, 8PS, 8PPV, 8RAT, 8SU, 8VO, 8VU, 8WIN, 8YB. Holland :—NOAX, NOBR, NONAA. Belgium :—BE2, BU3, BX9. Switzerland :—H9RNA, H9LA. Spain :—EAR2I. Italy : I1AU, I1ER, I1GB, I1L. Germany :—K18, KJ5, KK4, KK7, KQ5, KY7. Unknown : INCC. P. L. Savage.
(0-v-1.) All below 100 metres.

Sheffield.
October 22nd to 25th.
Holland :—OPM, PCMM. France :—8GRA, 8VO, 8JA, 8NA, 8JX. Italy :—1AY. Belgium :—W3. Miscellaneous : KK7, FW, EAC9, BUSU.
A. S. Williamson.

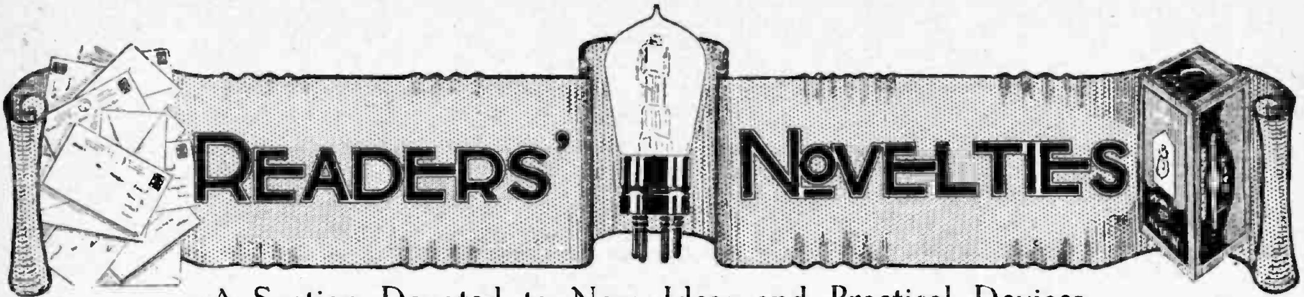
Braintree.
New Zealand :—2AC, 2AE, 2AQ, 2XA, 1AO, 1AX, 3AM, 4AA, 4AL, 4AG, 4AK, 4AR, 4AS, 4AV, 4AC, NRRL, NUMM, NISP, NISR. Australia :—2CM, 2YI, 2LO, 3BD, 3BQ, 3EF, 5BG. Argentine :—BA1, CB8, DE2, DH5, FB5, FA2, PA2, AF1. Brazil :—1AB, 1AC, 1AD, 1AF, 2SP, RGT. Porto Rico :—4SA, 4KT, 4RM, 4RL, 4WO, 4NF, 4OI, 4VL. Mexico :—1AA, 1N, 1F. Java :—ANE. Yugo Slavia :—7XX. Iraq :—1DH. Czecho-Slovakia :—OK1. Algeria : 8ALG. Norway :—NW4, LA1. Russia : RDW, NRL.
D. Woods (2ANZ).
(0-v-1.) 30-40 metres.

Ilford.
October 1st to 14th.
Great Britain :—2GY, 2SP, 2APS, 2APV, 5AT, 5BY, 5DH, 5OC, 5TG, 6AH, OCS, GCS. France :—8KMA, 8LDR, 8OM, 8PAX, 8SZ, 8VO, 8VU, 8XHP, FW. Holland :—0PM, 0WB, 0ZA, PCU, PCLL. Italy :—1AS, 1AU, 1BP, 1BS, 1ER, 1SA, 1YB. Czecho-Slovakia : — 1OK. Spain : — EAC9, EAR1O. Sweden :—SMUF. Africa :—OCDJ, OCTU. Argentine :—LPZ. Java : ANE. C. E. Largen.
(0-v-1 Cowper.) All on 30-90 metres.

TRANSMITTERS' NOTES AND QUERIES.

General Notes.
In reply to innumerable queries from amateur transmitters regarding a complete list of British and Foreign Experimental stations, we may state that the "Wireless Annual for Amateurs and Experimenters," which will shortly be published, will contain all the known call-signs, names and addresses of licensed amateurs in Great Britain, France, Holland, Germany, Sweden, Finland, Italy, Spain, South Africa, India, Australia, New Zealand, Argentine Republic, Brazil, Chile, and Mexico. An official list of amateur radio stations in the United States can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., price 25 cents, and those in Canada from the Department of Marine and Fisheries, Ottawa.

Addresses of Stations Wanted.
We shall be glad if any of our readers can give us the QRA's of the following stations (in some cases it is inadvisable to publish the names and addresses, but any replies indicating that publication should be withheld will be communicated, in confidence, to the enquirers) :—
G2AWL, G2DA, G2EX, G2ZA, G5GB, G6KY, G6LH, GB1 (India), GA1BS, G2P AAA (Montevideo), A1 or 1A (Argentine), A3EF, A4RT, BZRGT, C2AX, CZOKJ, EAR31, E1RE, E3XU, FW (calling LPZ on 43 metres). F8MS, F8TK (on 37 metres), F8VO, KK4, KOL, KXH, K4EA, K5PF, NK1, NOXQ, NPB7, NPC7, OBL, PCLL, P1AJ, PR2MK, Q2BY, V1E, V8VX, XR8, YCB (or CBY, sending English Press on 40 metres at 0900 and 2100 G.M.T.), ZP3, Z4AV, Z4CG, 2SSK, 3AD.



A Section Devoted to New Ideas and Practical Devices.

CIRCUIT SWITCHING.

The diagram shows an interesting system of connection for obtaining four distinct circuits without the use of switches in a two-valve receiver.

Plug-in coils are used for the tuned circuits throughout, and are mounted in two variable coil holders. One of these is a two-coil holder, and carries the aerial coil L_1 and L_2 when used as a reaction coil in the left-hand position in the circuit diagram. The other is a three-coil holder which carries L_2, when used as the primary winding of the H.F. transformer in the right-hand position in the diagram; L_3 the secondary winding of the transformer; and also the reaction coil connected in the plate circuit of the detector valve. The four circuits obtainable with this system of connections are as follow:—

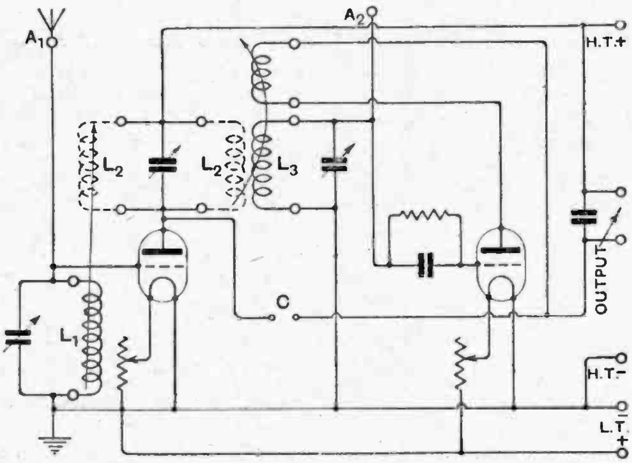
(1) *Crystal Receiver.*—For this circuit the first valve is withdrawn and the aerial is connected to A_1. L_2 is inserted in the left-hand position, and the crystal detector is connected at C. L_2 then acts as the secondary circuit of a coupled tuner with the crystal C and the output terminals connected across it.

(2) *Crystal and H.F. Amplifier.*—For this circuit the connections are the same as for the crystal receiver, and the first valve is inserted and provided with H.T. and L.T. current.

(3) *H.F. and Detector with Reaction.*—The second valve is inserted and the crystal withdrawn from the terminal C. The coil L_2 is then transferred to the three-coil holder, where it occupies the right-hand position in the circuit diagram, and functions as the primary winding of the H.F. transformer. Reaction is coupled to the secondary winding L_3 of this transformer.

(4) *Single-Valve Receiver with Reaction.*—The first valve and the coil L_2 are withdrawn, and the aerial is transferred to the terminal A_2. The coil L_3 then functions as the A.T.I. of the receiver.

In changing from one circuit to another it may be necessary to change the value of some of the coils; thus fewer turns will be required for L_3 when it operates as an A.T.I. than when used as the secondary winding of the H.F. transformer. Similarly, fewer turns will be required for the reaction coil when it is coupled to the H.F. transformer.—G. S. T.



Four-circuit two-valve receiver.

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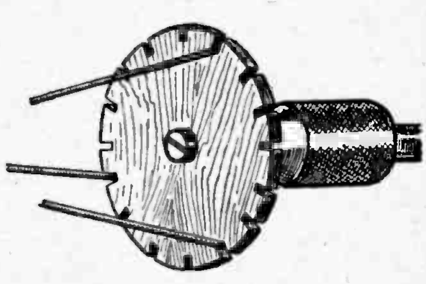
STRANDED WIRES.

Stranded wires for inductances and aerials give, when properly designed, a higher efficiency than single solid wires. It is not always possible, however, to obtain wire of suitable diameter which has been properly insulated.

Many types of stranded aerial wires, for instance, are wound with bare copper strands. To obtain the full benefit from stranded conductors it is necessary that each strand should be perfectly insulated from the others. For aerial wires, enamel insulation is best, but most of the enamelled and stranded aerial wires available are of rather heavy gauge, and if only a short aerial is required may present an unsightly appearance owing to the fact that the total weight of the aerial is not sufficient to straighten out kinks.

Stranded wires are quite easily wound with the hand drill attachment shown in the diagram. A light wooden disc is provided at the edge with a series of slots into which the wires to be stranded are inserted. The ends are bound round the screw passing through the centre of the disc at the back. It is best to use as large a diameter as possible for the disc. If a small diameter is used the twisting will be irregular. With a device of this kind it is possible to wind cables with very thin enamelled wire, which are extremely flexible, and, besides giving a high electrical efficiency, present a good appearance when erected as an aerial.

It is interesting to note that the



Winding stranded aerial wires.

following numbers of wires will twist up into a cable of round section:—3, 7, 19, 37, 61, 91, 127, etc. An alternative method of winding is to build up the cable with three strands containing three wires each, and so on.—W. P.

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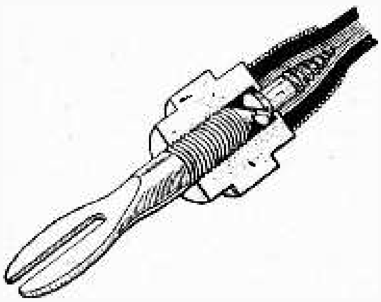
SPADE TERMINAL CONNECTION.

It is essential that the leads from the L.T. supply battery should be heavier than usual when valves of the 2-volt type are used in a receiver. This is particularly necessary with power valves such as the D.E.6, which consume a comparatively heavy current. Unless the L.T. leads are thicker than usual, there will be a considerable drop in voltage, and the emission from the filament will be insufficient. Rubber-covered ignition cable is excellent for the purpose, but the diameter of the wire core often prevents its insertion in the base of the spade terminal.



Spade terminal connection for heavy cables.

The diagram shows how the difficulty of making connection to these terminals may be overcome. Instead of clamping the wire in the base of the terminal, an ordinary wood screw is inserted in the manner indicated in the diagram, and is then screwed into the centre of the stranded core of the cable. A single layer of binding wire ensures a firm joint which will not easily pull off. The method is similar to that often used to make connection to sparking plugs or the brush connections of magnetos.—S. J. B.

Valves for Readers.

For every practical idea submitted by a reader and accepted for publication in this section the Editor will forward by post a receiving valve of British make.

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REINARTZ CIRCUIT CONNECTIONS.

The circuit diagrams show how a single-valve receiver with loose-coupled tuning and reaction may be converted to the Reinartz system of connections.

The following additions to the "straight" circuit are necessary in order that the connections may be easily changed. A single-pole double-throw switch is connected in the reaction circuit, and terminals are provided at L for a radio-frequency choke coil. The auxiliary aerial terminal and series aerial tuning condenser are also connected at A_2. The circuit (*a*) in the diagram shows the connections for the simple reaction circuit. The aerial is connected at A_1, and the switch is placed in the right-hand position. The terminals at L are left open. In circuit (*b*) the aerial is transferred to A_2, and the A.T.I. is removed. Then, with the switch in the left-hand position and the choke coil inserted at L, the Reinartz system of connection is obtained. The aerial tuning condenser now provides capacity reaction.—J. S.

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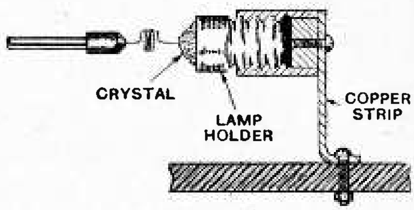
CRYSTAL CUP.

A very convenient experimental mounting for crystal specimens is provided by the screwed metal base of a flash lamp bulb.

Having removed the glass and plaster of Paris from the base, the crystal is set in the usual way with Wood's metal. Screw lamp holders



Flash-lamp bulb cap as crystal cup.

can be obtained for a few pence, and one of these should be mounted on a right-angle bracket made from thick brass or copper strip. Not only can the specimens be rapidly changed by this method, but the electrical contact provided by the screw thread is much better than with other methods.—W. H. C.

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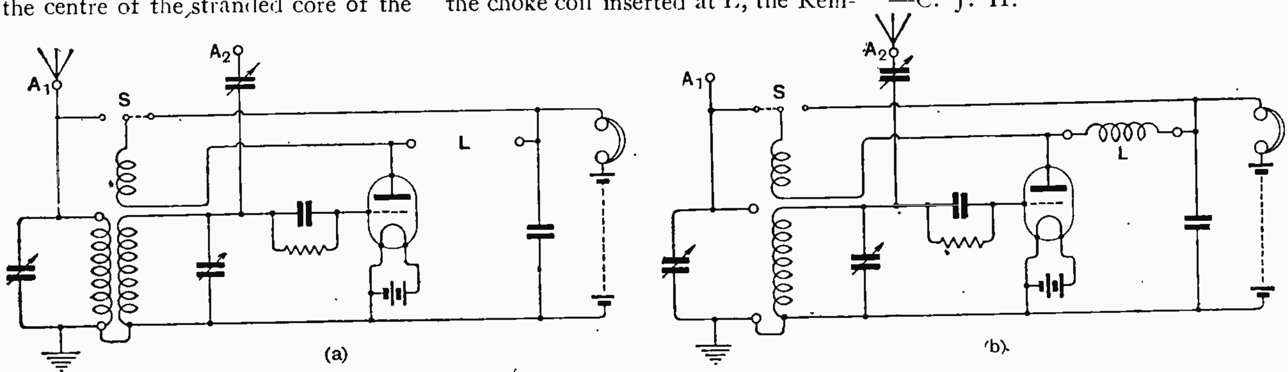
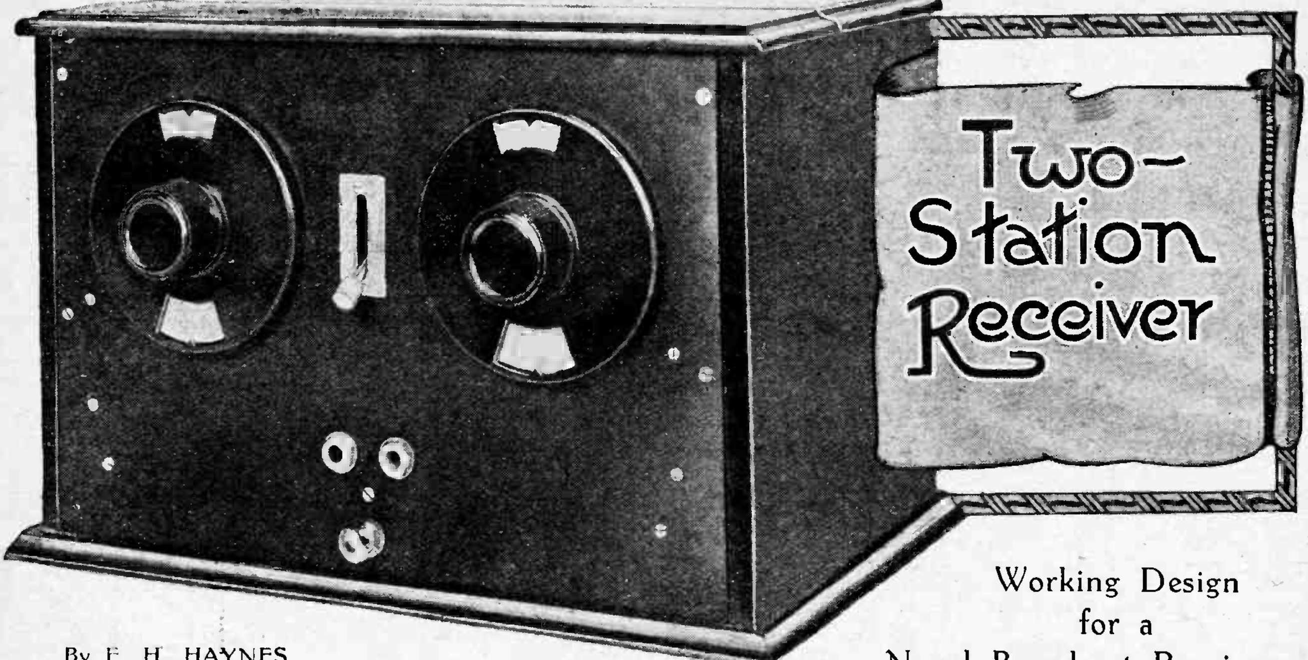
MARKING TERMINALS.

In experimental work it is frequently necessary to check the wiring at the back of a receiver panel, and a good deal of time and trouble will be saved if all the terminals are marked at the back as well as the front of the panel. This will entirely avoid the confusion which often occurs owing to the fact that the positions of all the terminals are reversed when viewed from the back.—C. J. H.



Circuit connections of a single-valve receiver arranged to give (a) a simple reacting single-valve set with coupled tuner and (b) a modified Reinartz circuit.



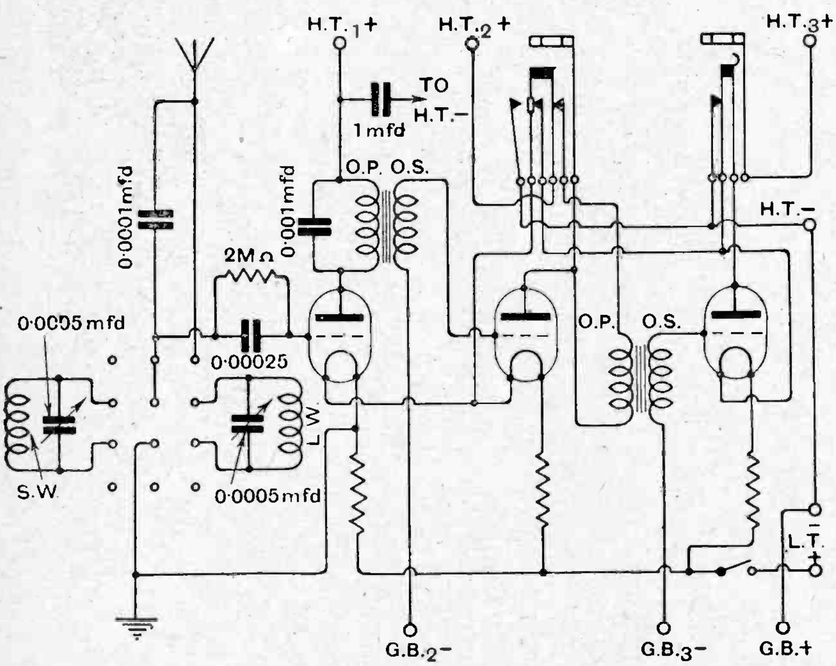
Working Design for a Novel Broadcast Receiver.

By F. H. HAYNES.

SPECIFICATION.

(1) The receiving set is intended entirely for broadcast reception, and a circuit arrangement is adopted which will permit of the tuning adjustments being indicated on the dials. (2) Three valves are employed, connected as a valve detector, with two low-frequency amplifiers, the second amplifying stage being removed from the circuit by inserting a plug to which the loud-speaker is connected into a break-jack

(3) The tuning circuits are duplicated and can be tuned to any wavelength by means of plug-in coils, and either of two transmissions can immediately be received by means of a two-way switch. (4) All component parts are standard, including the cabinet, and only average skill is required to assemble and wire them.

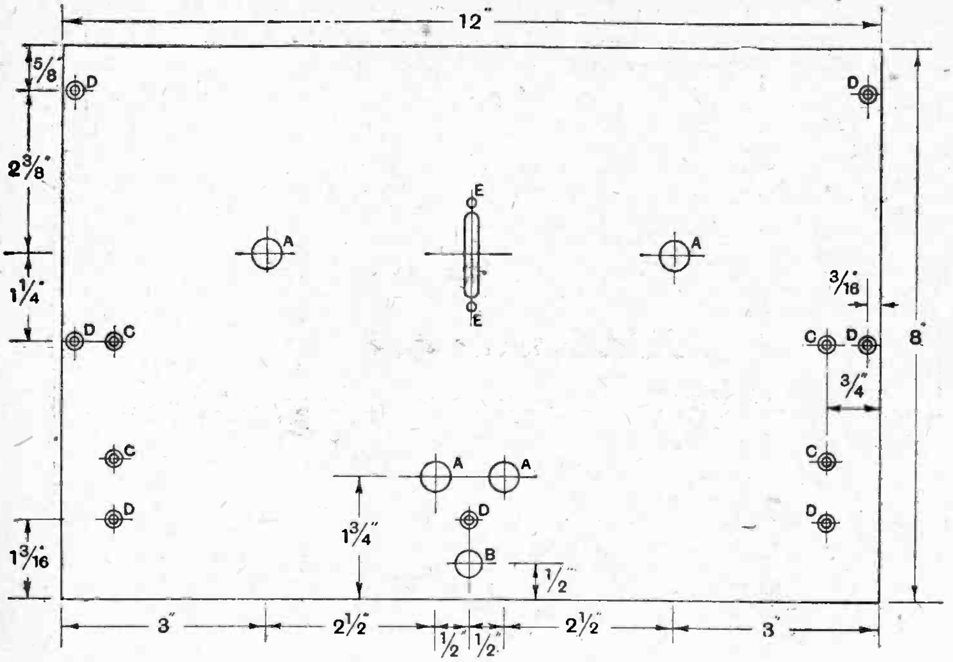


The tuning apparatus is duplicated, providing a choice of two transmissions by the action of a two-position switch. The additional contacts on the change-over switch may, if desired, be connected to fixed reaction coils arranged near the long and short wave tuning inductances. By means of plugs and jacks, one of the amplifying valves may be removed from circuit.

THE majority of listeners require little more than the transmissions from the local station with provision to switch over to the high-power station for an alternative programme. Apart from the experimental long-range reception undertaken by many listeners, there exists a need for a set in addition to the experimental equipment which can be relied upon to produce good and consistent reproduction of the local and high-power transmissions.

The Disadvantages of Reaction.

For these requirements the set will obviously differ in many respects from the typical amateur receiver with its numerous controls and difficult tuning adjustments. In the first place reaction is omitted, at once removing the difficulties of critical reaction adjustment to control self-oscillation as well as rendering calibration of the set possible. The varying position of a reaction coil in the proximity of the tuning coils produces variations in their inductance values. Thus, when reaction is used, it is not possible to provide a tuning chart show-



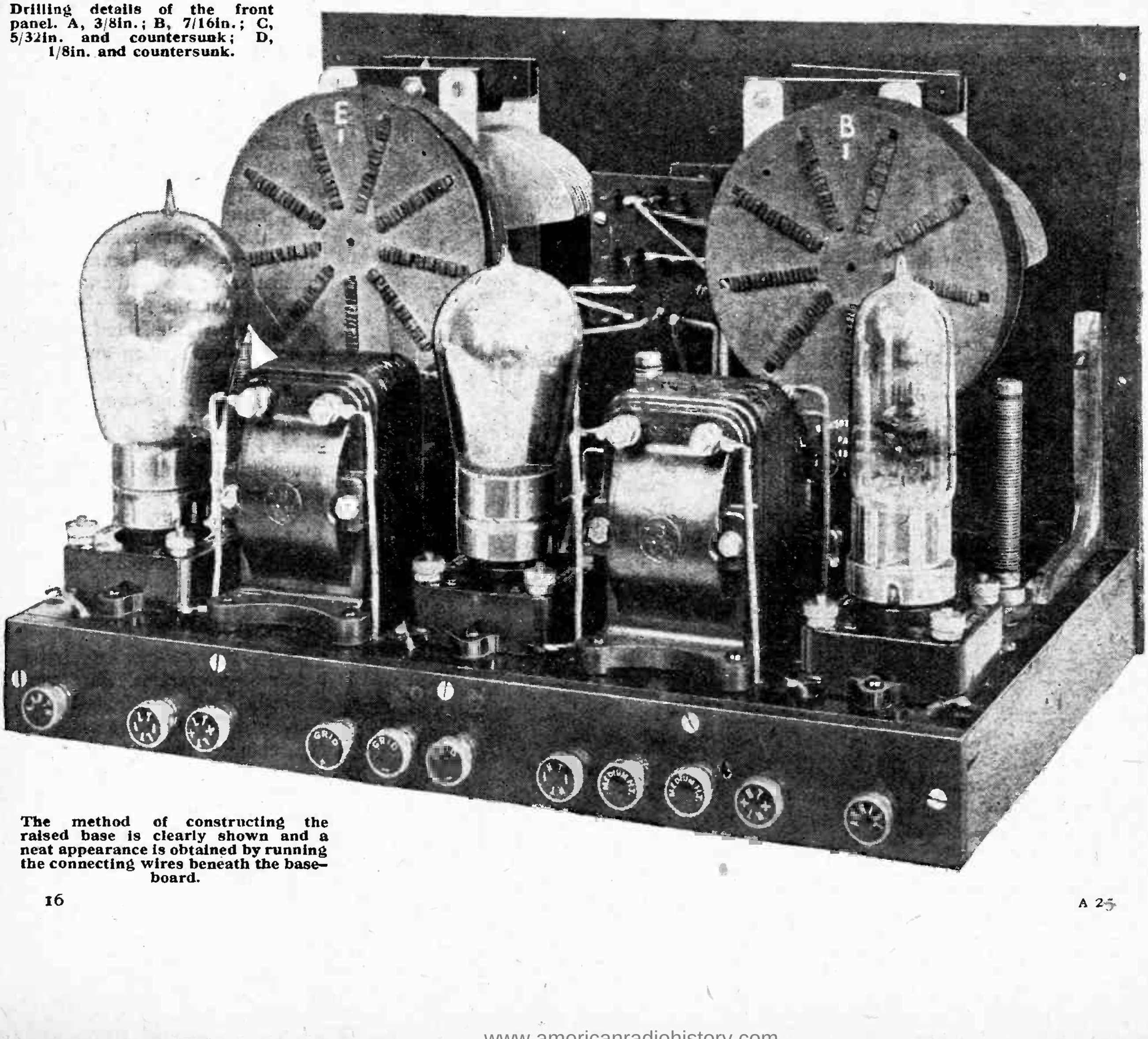
Drilling details of the front panel. A, 3/8in.; B, 7/16in.; C, 5/32in. and countersunk; D, 1/8in. and countersunk.

ing the calibrated positions at which certain stations may be tuned in.

With a good outdoor aerial not only is reaction definitely not required up to distances of 20 miles from a local station, but its use introduces a most undesirable form of distortion. Yet, again, and most important of all, is the fact that the set is not capable of contributing to the interference set up by oscillation. It must be remembered, however, that where an oscillating set will produce loud though distorted signals on almost any sort of aerial, a good outdoor aerial is necessary for a non-oscillating receiver such as this.

Range of Reception.

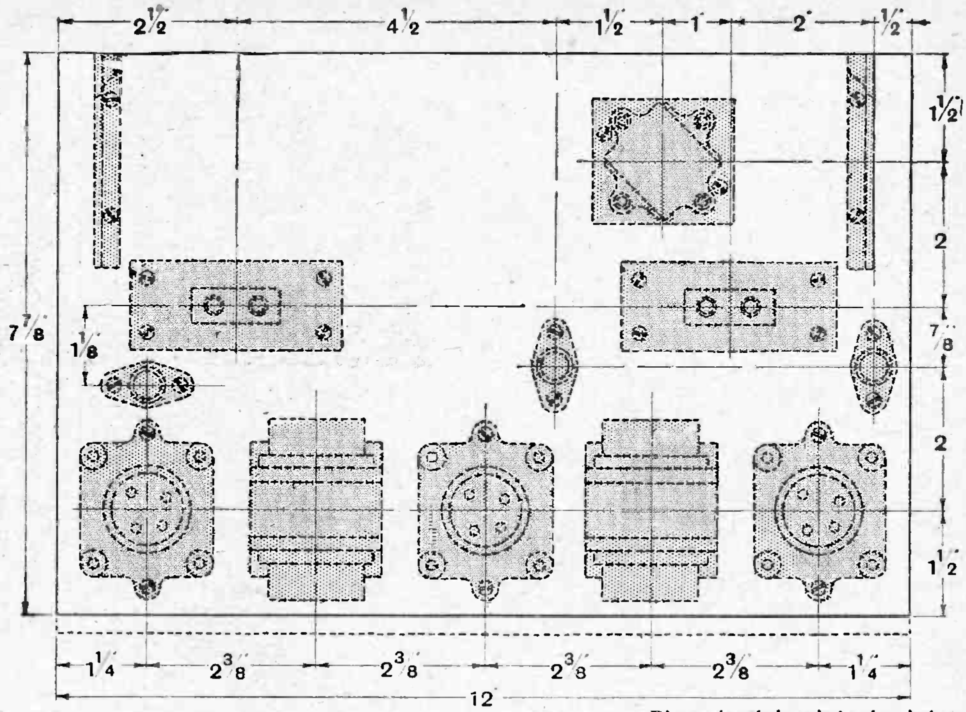
Depending very much upon locality, the range of reception



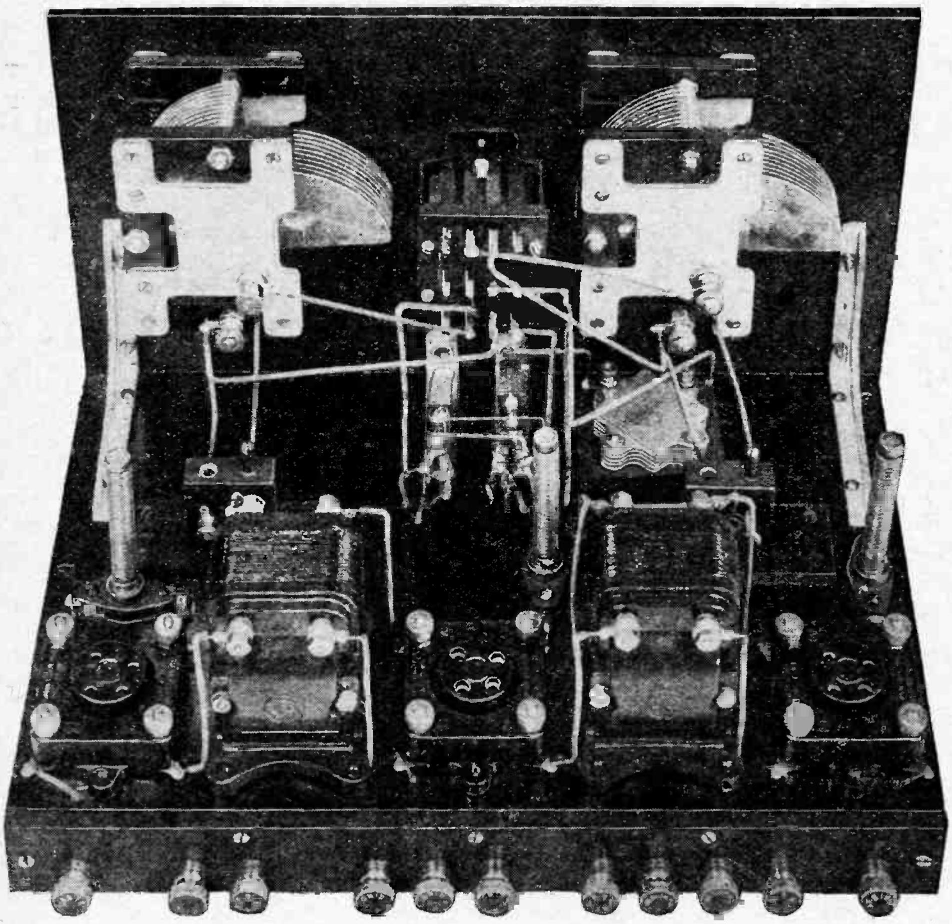
The method of constructing the raised base is clearly shown and a neat appearance is obtained by running the connecting wires beneath the base-board.

Two-Station Receiver.—of this receiver at a conservative estimate may be put as 25 miles from a main station, 20 miles from a relay station, and 125 miles from Daventry. Within a radius of these distances consistent loud-speaker reception can be relied upon.

With the wide difference of wavelength between the high-power and local stations it is necessary to completely change the value of the tuning inductance, and the comparatively small extra cost of fitting an additional condenser provides also for bringing in the two transmissions without tampering with the tuning adjustments. The set is, virtually, two tuners making use of a common power amplifier.



Dimensional drawings showing the relative positions of the various components.



The general layout of the component parts can be clearly seen in this view. The valves and coils are arranged in positions which are accessible through the lid provided to the cabinet.

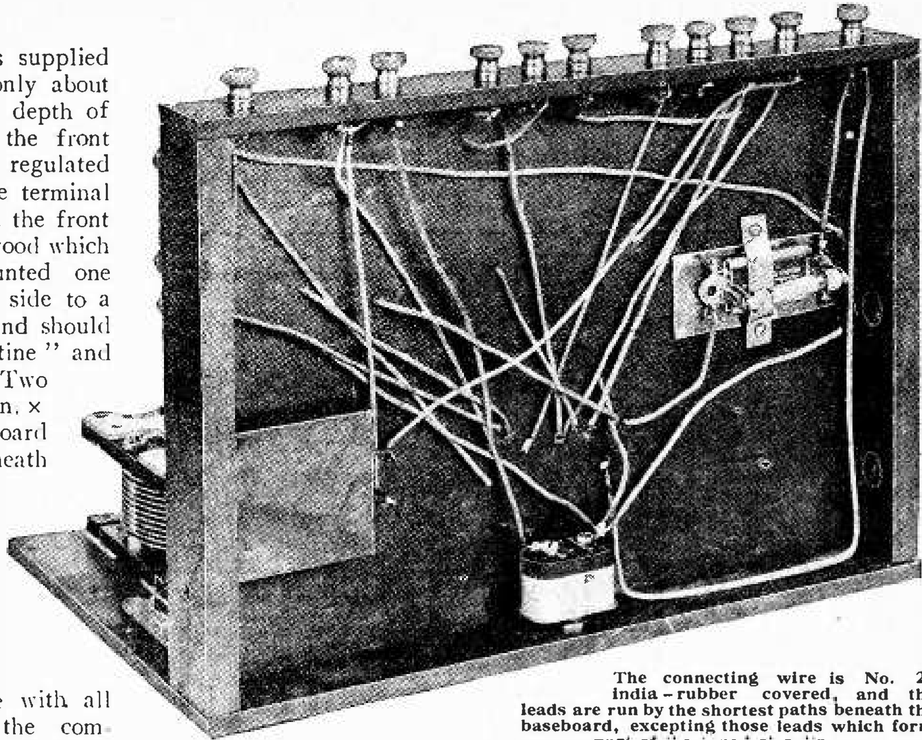
The Amplifier.

The most convenient method for switching the second amplifier out of circuit is by means of a telephone plug and break-jack, and it will be observed from the circuit diagram that in the process of disconnecting the last valve the grid and plate potentials of the first amplifying stage are unaffected. This is not the case when switching is carried out by means of a double-pole change-over switch. Hence, the levers and adjustments on the front of the instrument, if labelled to indicate their purpose, require no further manipulating instructions. A key switch is shown connected in the filament current supply.

Constructional Details.

With the cabinet to hand before construction is commenced, both panel and terminal strips, which are made in ¼in. ebonite, can be carefully

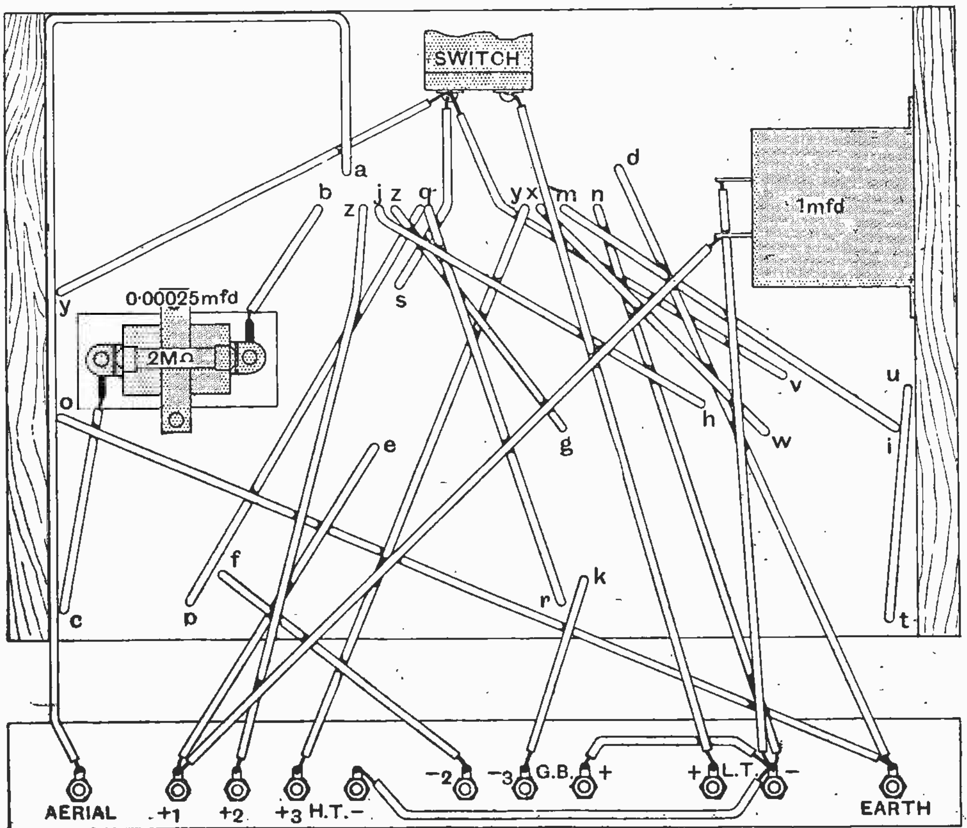
Two-Station Receiver.—
fitted. The baseboard which is supplied with the cabinet must measure only about $\frac{1}{8}$in. less than the total internal depth of the cabinet as measured from the front edge, and it must be carefully regulated by filing or planing, so that the terminal strip and panel appear flush with the front and back edges. The strips of wood which are supplied as filets are mounted one along the top and one on each side to a distance of 5in. from the top, and should be held in position with "Seccotine" and small brass wood screws. Two wooden strips of soft wood 1in. × $\frac{1}{2}$in. batten the ends of the baseboard and provide accommodation beneath the board for the battery switch, H.T. battery bridging condenser, grid condenser, and leak and the battery current distributing leads, as well as most of the wiring of the L.F. amplifier. This form of wiring, as well as being very much easier than using No. 16 wire with all connections directly between the components, separates the leads in the high-frequency circuits from the remainder of the wiring.



The connecting wire is No. 20 india-rubber covered, and the leads are run by the shortest paths beneath the baseboard, excepting those leads which form part of the tuned circuits.

The terminal strip should be screwed in position and carefully adjusted to make a good fit, after which the various components can be attached to the baseboard in the positions shown. The use of blued screws is recommended for holding down the components, and later the heads of the screws appearing on the front panel may be treated with bronzing solution, which will greatly add to the appearance of the finished set.

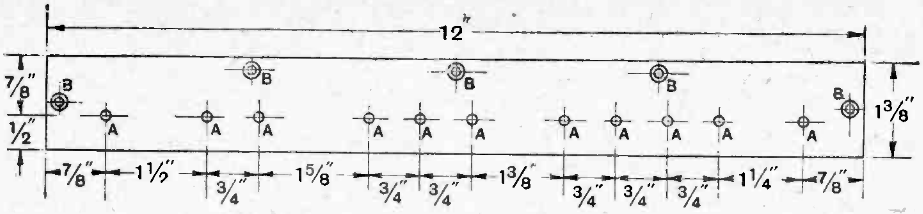
All the holes shown in the wiring diagram should be drilled in the baseboard before the wiring is commenced, and many of the leads can be run before the front panel is placed in position. The wire used is No. 20 tinned, with a vulcanised india-rubber covering and in the high-frequency circuits it is arranged in the usual manner of stiff wiring, whilst the battery and amplifier leads are taken by the shortest paths beneath the baseboard. Wiring up should prove quite easy by following precisely the practical wiring diagram. The ends of the wires, which, when bared, appear to be



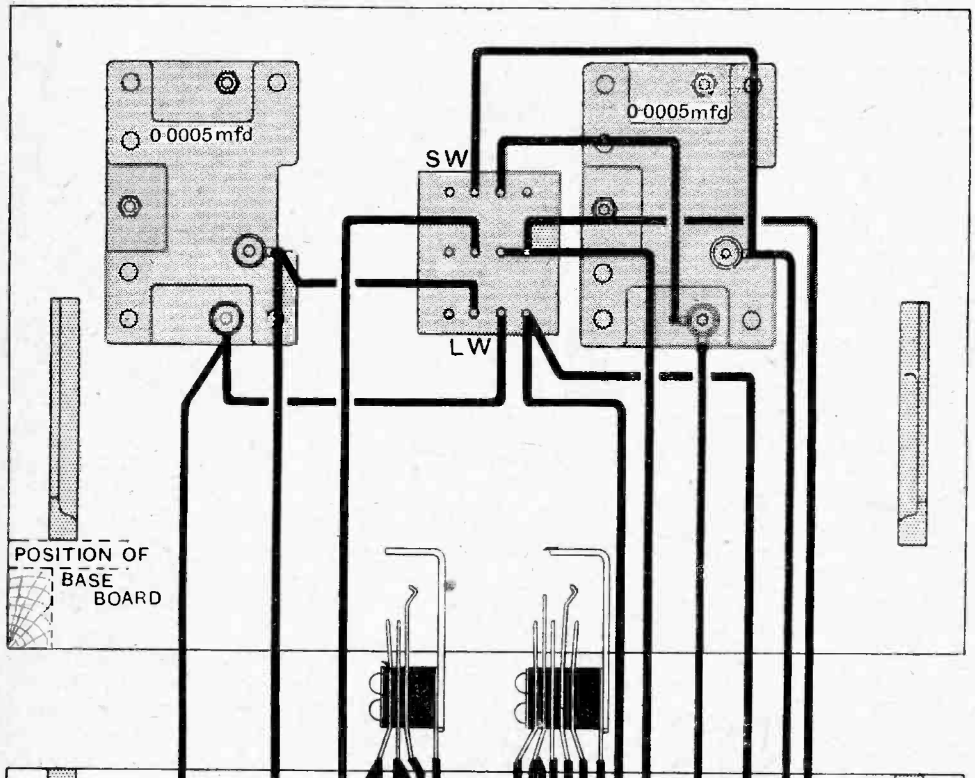
In conjunction with the diagram on the next page, the actual path taken by the various leads beneath the panel is shown.

Two-Station Receiver.—corroded by the action of the india-rubber, must be scraped bright before attempting to solder.

The front panel is rubbed down after all the holes have been drilled, and a good ap-



The terminal strip is drilled with 5/32in. holes for the terminals and countersunk ⅛in. holes for the securing screws.



Although the introduction of switches complicates the circuit diagram the wiring up will be found quite easy by following this diagram, which shows the exact points between which wires are run on the front panel and baseboard.

pearance is obtained by rubbing lengthwise along the panel with a movement parallel to the edges, instead of endeavouring to produce the usual matt finish. Cast aluminium brackets are employed to hold the panel and baseboard at right angles, and these may need some slight adjustment by filing, while three 1in. screws pull the panel up in close contact with the base.

If it is the intention to fit 4in. "Indigraph" dials as shown in the accompanying illustrations, it is necessary specially to order the "Ormond" condensers, and a type is available in which an additional $\frac{3}{16}$in. in length has been added to the brass spindle so as to engage with the grub screws and the dials.

On Test.

Little need be said as to the performance given by the receiver. When connected up to a typical broadcast aerial which, by the way, was arranged in a loft and situated twelve miles to the north of London, the transmissions from both London and Daventry were received at exactly similar strength. Good loud-speaker reproduction was obtained with two valves, whilst the third valve was, perhaps, required on the afternoon transmissions from 2LO on reduced power.

Ship signals were tuned in at good strength, using a suitable coil, and, other than Radio Paris (SFR),

LIST OF PARTS.

Cabinet, with baseboard for panel, 12in. × 8in., type No. 400 (Ashton and Mander, Albany Works, Trenmar Gardens, Willesden, N.W.10).
Polished ebonite for panel, 12in. × 8in., and terminal strip 12in. × 1⅜in., ¼in. in thickness.
2 3in. cast aluminium brackets, with screws and nuts (A. J. Dew & Co., 33-34, Rathbone Place, Oxford Street, W.1).
3 Benjamin valve holders.
3 Fixed "resistors" (Burndept type 734 for D.E.5 valves).
2 B.T.H. intervalve transformers. 1st stage 4 : 1 and 2nd stage 2 : 1 if last valve is D.E.5. 2nd stage may be 4 : 1 with last valve D.E.5A.
Grid condenser, 0·00025 mfd. and combined leak 2 megohms.
Primary bridging condenser, 0·001 mfd.
2 Coil holders for base mounting (Goswell Engineering Co., Ltd., 12a, Pentonville Road, London, N.1).
1 Fixed capacity condenser, air dielectric, 0·0002 mfd. (Ormond).
2 Variable condensers, 0·0005 mfd. (Ormond), with spindles extended, $\frac{3}{16}$in.
2 Jacks (Ashley Wireless Telephone Co., 69, Renshaw Street, Liverpool), types No. 4 and No. 5.
1 Telephone plug (Ashley).
1 Mansbridge condenser, 1 mfd.
1 Key switch (Igranic).
2 Indigraph dials, 4in. (Igranic).
11 Terminals (Belling & Lee, Ltd., Queensway Works, Ponder's End, Middlesex), earth, L.T.—, L.T.+, grid+, grid— (2), H.T.—, medium H.T. (2), H.T.+ and aerial.
1 3-pole changeover switch. A 4-pole switch is shown fitted in set so that fixed reaction coils can be attached to the tuning coils if required and switched across. Lever type, nickel plated (Wilkins & Wright).
4 doz. ½in. × No. 4 brass screws, round headed and blued or black finish.
6 yards No. 20 tinned and indiarubber-covered connecting wire (Ripaults, Ltd., King's Road, St. Pancras, London, N.W.1).
A few miscellaneous brass screws with countersunk heads.
French polish and linseed oil for baseboard.

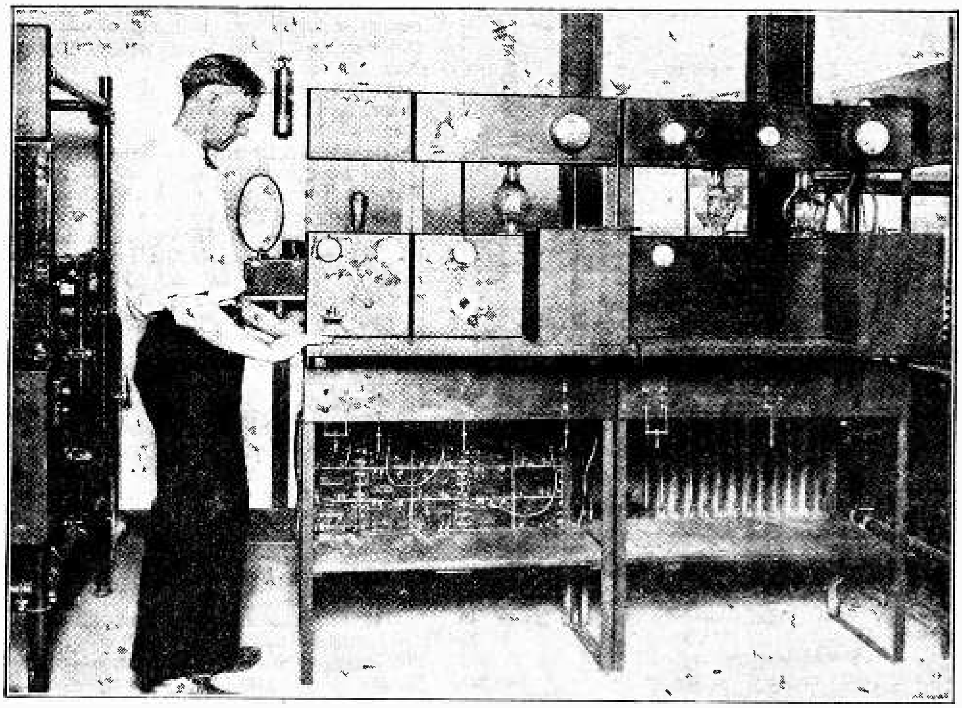
working on 1,750 metres, which could be faintly heard at intervals in the Daventry transmissions, signals from other broadcasting stations were neither heard nor expected.

Connected to a two-wire or long single-wire aerial, the Igranic 50 coil or Gambrell "B" will tune to an optimum wavelength of about 300 metres. On small aerials a 75 coil or Gambrell "C" will be required. On the long wave side a 200 coil or Gambrell "E" should be inserted for reception from Daventry.

WAVELENGTH CONTROL AT KDKA.

OSCILLATING quartz crystals are being widely adopted in the United States to control the wavelength emitted by broadcasting stations. The crystal has been in experimental use for months at KDKA, but only on the short wave set. The 309.1 meter broadcasting set has now also been equipped with one of the crystals, and after a test period the crystal will be regularly used on this set for broadcasting all the KDKA programmes.

That the tests have been entirely successful is evident from the following extract from a report issued by Mr. C. W. Horn, the superintendent of the wireless operations of the Westinghouse Company: "While the Bureau of Standards has checked the KDKA 309.1 meter set wavelength 165 times in the last twenty-one months, as noted in the July, 1925, Radio Service Bulletin of the department, and found that it was never more than 0.1 per cent., or one kilocycle, off its assigned frequency, which is quite a record when one considers the length of the period in which the measurements were taken and the times measured, it still is inaccurate when compared to the new method of crystal control now governing the frequencies of the short wave set and holding it automatically to a certain frequency without possibility of variation."



Crystal oscillator and amplifying equipment at KDKA.

CURRENT TOPICS

News of the Week in Brief Review.

LURED FROM WORK.

The Venezuelan Government is reported to have imposed a temporary ban on the import of receiving sets for the reason that broadcast reception entices people from their work.

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BROADCAST EDUCATION IN VIENNA.

A Radio High School has been instituted in Vienna for the purpose of transmitting educational courses in music, art, and languages.

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SILENCE.

The observance of a "silent night," recently adopted in Chicago, is being copied in Denmark, it having been decided to close the Copenhagen and Ryvang stations for one evening each week. Listeners in the neighbourhood of these stations will thus have regular opportunities for exploring the European ether without risk of local interruption.

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MARCONI'S SHORT WAVE SUCCESS.

Votaries of the ultra-short wave had cause for rejoicing on October 23rd when Senatore Marconi, speaking at the Caxton Hall, Westminster, announced the gratifying results obtained in 15-metre experiments between this country and the Argentine.

Using this wavelength and a power of only one-fifth of a kilowatt, Senatore Marconi and Captain H. J. Round found that it was not only possible, but easy, to communicate with the Argentine in hours of daylight. Nothing could be done on 15 metres at night.

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DUBLIN'S WIRELESS EXHIBITION.

Special excursion trains from all parts of Ireland will be converging on Dublin on Wednesday next, November 11th, when a Wireless Exhibition on a large scale will be opened at the Mansion House under the direction of the newly constituted Wireless Society of Ireland.

The Exhibition will remain open until November 14th, and it is hoped that during the four days the postal authorities will conduct tests from the new Dublin broadcasting station.

There is now every indication that the Free State is at last embarking on a progressive broadcasting scheme, which will receive the warm approval and encouragement of all who believe in the tremendous potentialities of the new art.

ENTHUSIASM IN AUSTRIA.

More than 160,000 broadcast receiving licences have been issued in Austria since June 30th.

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NEW SWISS STATION.

A high power broadcasting station is under erection at Munchenbuchsee, Switzerland, with a transmitter similar to that at Rome. The studio will be installed in the Kursaal at Berne.

LIFEBOAT WIRELESS. The White Star Line wireless-equipped lifeboat which was on view at the Manchester Wireless Exhibition last week. The boat is seen starting on its trip from Liverpool to Manchester *via* the Manchester Ship Canal.

RADIO ASSOCIATION DINNER.

The Duke of Sutherland will preside at a dinner to be held by the Radio Association at the Hotel Cecil on November 19th. Among the guests expected are Senatore Marconi, Lord Wolmer, and Mr. J. C. Reith.

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SHORT WAVES FROM NAUEN.

The high power station at Nauen, in Germany, now transmits news bulletins on wavelengths of 26, 27, 47, 70, 76 and 100 metres. The station is somewhat lavishly supplied with call signs and may be heard transmitting as POF, POW, POX, POY and POZ.

MUSIC FROM ESTHONIA.

Although a small State, Esthonia rightly insists on a place in the European ether. A broadcasting station is now being installed at Reval to work on a wavelength of 350 metres.

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SIAM CALLING.

The first important wireless entertainment to be given in Siam was recently transmitted from Bangkok by the army signal corps. The programme consisted of cavalry band selections and news items provided by the *Bangkok Times*. There were five receiving stations: Hua Hin, Ayudhys, Korat, and at two of the Royal palaces. The experiment lasted for three hours, and is said to have been quite satisfactory, the programme being heard by all the receiving stations.

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NEW APPOINTMENT.

We are interested to learn that Mr. A. H. Morse, A.M.I.E.E., Mem.I.R.E., has been appointed New York representativ of Messrs. The Radio Communication Co., Ltd., whose business is largely concerned with the establishment of commercial wireless stations and ship equipment. Mr. Morse will also, we understand, represent the interests of the Radio Press, Ltd., in New York.

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WIRELESS LICENCE PROSECUTION.

The first prosecution under the recent Wireless Licence Act came up before the South London Police Court on October 23rd, when Henry Hazlewood, a wheelwright, was summoned before Mr. Ratcliffe Cousins with having installed and worked a wireless receiving apparatus without a licence. Hazlewood pleaded guilty.

Evidence was given by Mr. Harold Pearce, assistant solicitor to the Post Office, that a complete and effective receiving set had been found on the defendant's premises. It was the first prosecution, but the Post Office had no desire under the circumstances for a substantial penalty.

Mr. Ratcliffe Cousins bound the defendant over in £5 under the Probation of Offenders' Act for six months.

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FIVE KILOWATTS AT PRAGUE?

A jump in power from 550 watts to 5 kilowatts is shortly to be made at the Prague broadcasting station, according to a report from that city. During alterations the present plant will be transferred to Presbourg.

SWEDISH BROADCASTING.

Sweden now possesses twelve broadcasting stations, of which seven are for relay purposes. The relay stations transmit the programmes from Stockholm.

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SHORT WAVE TESTS.

Mr. D. Sinclair (G2OC), of Morven, Shepperton-on-Thames, advises us that he is continuing his test transmissions on 23 metres (C.W.) which were begun on October 1st. Up to the present the number of reports received has been disappointing. Transmissions take place on Saturdays from 3 to 5 p.m. (G.M.T.) and on Sundays from 7 to 7.45 p.m., with an interval between 7.15 and 7.30. Reports by wireless, as near to 25 metres as possible, immediately after the transmissions will be very welcome. Reports by card would also be gladly received.

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MUSIC ON THE CANALS.

Many of the Venetian gondolas, it is reported, are now fitted with broadcast receivers. The programmes from Rome and Vienna are picked up at good strength. Readers may recall that, in the early days of broadcasting, when receivers were banned on the canals of Venice, an exciting police raid resulted in the discovery of many clandestine listeners.

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POPULAR LECTURES ON WIRELESS.

A course of ten lectures on Wireless Telephony, with special reference to broadcast reception, will be given on Friday evenings at 8 p.m., at the Norwood Technical Institute, Knight's Hill, West Norwood, S.E.27, by Mr. J. F. Stanley, B.Sc. (Hons.), A.C.G.I. The first lecture of the series will be given on November 20th next. Facilities will be given for practical experiments and the discussion of individual difficulties.

Applications for admission should be made to the Principal of the Institute, Mr. L. N. Coombs, B.Sc., from whom particulars of fees and a syllabus of the course may be obtained.

It is proposed to form a West Norwood branch of the Radio Society of Great Britain. Arrangements will be made for members to experiment and test out their apparatus provided they are students of the Institute.

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NEW USE FOR BROADCASTING.

The latest wireless story hailing from America concerns a foreign vagrant who was recently apprehended by the New York police and interrogated as to his credentials. But he spoke an exceedingly strange tongue.

The police interpreters were nonplussed and an *impasse* was reached when several professors of modern languages admitted themselves beaten. At this juncture the idea occurred that broadcasting might be of service. Listeners to the nearest broadcasting station were accordingly acquainted with the circumstances, and the luckless individual was instructed to speak into the microphone. The distressing appeal was heard by a fellow-countryman, with the result that the captive was identified as a Laplander. His explanations satisfied the police, and he was allowed to depart.

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AMERICA'S BROADCASTING PROBLEMS.

Next Monday, November 9th, will see the opening of America's Fourth National Radio Conference, to be held at Washington. The Conference has been called by Secretary Hoover for the purpose of discussing matters affecting radio communication in the United States from the viewpoint of the general public.

Practically every wireless interest will be represented, including broadcasting stations, radio magazines, and newspapers, amateurs and broadcast listeners, commercial stations, trade associations, and Government departments. The Institute of Radio Engineers and other important organisations will also provide representatives.

As might be expected, the problem of interference is among the most important to be discussed.

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CHANCE FOR SOUVENIR HUNTERS.

In his inaugural speech at the opening of the Manchester Wireless Exhibition on October 27th, Captain P. P. Eckersley made a touching reference to the loss of his hat, which he had left in the L.M.S. train. It is said that a number of souvenir collectors disappeared immediately.

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BROADCAST LESSONS PRIZE.

The Schools Radio Section of the Radio Society of Great Britain is offering a prize of £5 to the school boy or girl who submits before November 28th, 1925, the best essay on "The Value of Broadcast Lessons." The competition is open to any school boy or girl throughout the country, and there is no entrance fee, the only conditions being that :—

1. The essay must be certified by head teacher or parent that it is the unaided effort of the scholar.
2. The essay must not contain more than 200 words.
3. The name and age of the scholar must be given in full.
4. The name of the school and the town in which it is situated must be stated.
5. All competitors must accept the decision of the judges as final.
6. All essays must be written on foolscap.
7. All entries must reach Mr. R. J. Hibberd, St. Paul's School, Dorking, by November 28th, 1925.

The winning scholar will have the opportunity of broadcasting his or her essay from 2LO and 5XX.

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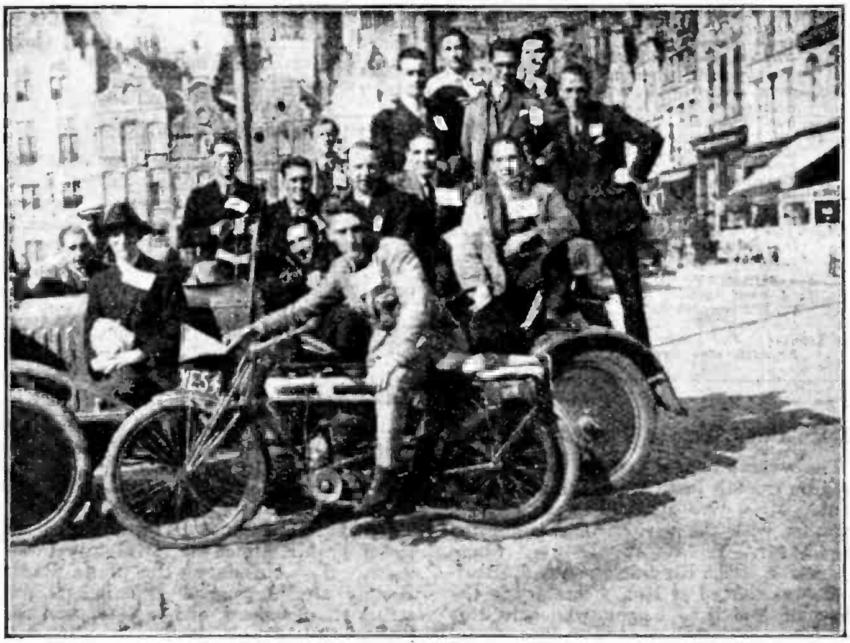
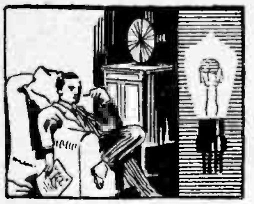
WESTERN ELECTRIC CHANGE.

On October 31st the Western Electric Co., Ltd., of London, became known as "Standard Telephones and Cables, Ltd." The registered and executive office remain at Connaught House, Aldwych, W.C.2.

An announcement has already appeared in the Press of the sale to the International Telephone and Telegraph Corporation of the International Western Electric Co., by the Western Electric Co., Incorporated. Under this new ownership, the International Western Electric Co. will in future be known as the International Standard Electric Corporation, and will continue to hold exclusive licences under the foreign patents of the Western Electric Co., Incorporated, in the telephone and telegraph field, and will also continue to act as the exclusive distributors outside of the United States, Canada, and Newfoundland, for all Western Electric manufactures.



A BELGIAN FIELD DAY. Members of the Reseau Belge photographed while on an autumn excursion to Malines. The Reseau Belge includes practically all the best-known Belgian transmitters



NEWS FROM THE CLUBS:

Secretaries of Local Clubs are invited to send in for publication club news of general interest. All photographs published will be paid for.

Lewisham and Bellingham Radio Society.

Experiences of reception during the summer months were related by various members on October 13th. It was generally agreed that results obtained in DX work and with loud-speakers were superior to those of the previous summer, a fact which was attributed to the benefits obtained from the Society's lectures and demonstrations.

The second of a series of lectures on "High Frequency Amplification" was delivered by Mr. R. Stanley on October 20th. In this lecture attention was drawn to the effects of different methods of winding transformers.

Arrangements are being made to hold a whist drive in the near future for members and their friends.

An attractive syllabus has been arranged for the winter months, an interesting item being an exhibition of valve sets, to be held on November 24th.

Particulars of membership may be obtained from the Hon. Secretary, Mr. C. Tynan, 62, Ringstead Road, Catford, S.E.6.

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Inland Revenue Radio Society.

"Measuring Instruments for Radio Work" was the title of an interesting talk given at Somerset House on October 16th by Mr. L. Bland-Flagg (2GO), of Messrs. The Sifam Electrical Instrument Co. The principles employed in designing the various types of instrument were carefully explained, and useful information was given regarding their application. A lively discussion followed, a large proportion of those present taking part. The next meeting of the Society will be held at 2, South Place on Friday, November 6th at 6 p.m., when Mr. D. G. Dyne, B.Sc., will lecture on "Direction Finding—Methods and Difficulties."

Hon Sec.: Mr. W. J. Tarring (5TG), Room C2, York House, Kingsway, W.C.2.

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West London Wireless and Experimental Association.

General regret will be felt at the news that this well-known Association is closing down owing to the absence of public support and the illness of the hon. secretary, Mr. Cotton. We hope that the cessation of activities may be temporary only and that Mr. Cotton may soon be restored to health.

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Nottingham and District Radio Experimental Association.

The President of the Association, Mr. R. Pritchett, B.Sc., delivered an informative lecture on "The Flewelling Circuit" on October 14th.

The lecturer described the circuit as the germ of something worth following up; at present it was still to be regarded as one of the freak variety. Questions and a discussion concluded a very interesting evening. On October 21st the members were privileged to visit the laboratories of Dr. Rigby, the lecturer, who gave an instructive talk and demonstration on "X-Rays." Members had the opportunity of seeing the penetrating effects of X-Rays and of feeling the soothing and stimulating effects of short doses of high-frequency treatment.

Hon. Secretary: Mr. M. Allan, 71, Burford Road, Nottingham.

FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 4th.

Institution of Electrical Engineers (Wireless Section).—At 6 p.m. (Light Refreshments at 5.30). At the Institution, Savoy Place, W.C.2. Inaugural address by Major B. Binyon, O.B.E., M.A. (Chairman).

Golders Green and Hendon Radio Society.—At 8 p.m. At the Club House, Willifield Way, N.W.11. Fourth Lecture: "Fundamental Principles of Radio Reception." By Mr. Maurice Child.

THURSDAY, NOVEMBER 5th.

Walthamstow Amateur Radio Society.—Lecture: "Reception on 45 Metres" (with demonstration). By Mr. E. Nickless, M.I.E.E. (2KT).

FRIDAY, NOVEMBER 6th.

Sheffield and District Wireless Society.—Lecture: "Music in Relation to Wireless." By Mr. T. A. W. Blower.

Inland Revenue Radio Society.—At 6 p.m. At 2, South Place, London, E.C. Lecture: "Direction Finding—Methods and Difficulties." By Mr. D. G. Dyne, B.Sc.

MONDAY, NOVEMBER 9th.

Swansea Radio Society.—Comparison and Demonstration of L.F. transformers of various makes. By Mr. H. Morgan.

TUESDAY, NOVEMBER 10th.

Ilford and District Radio Society.—Lecture: "Superhets." By Mr. Ashton Cooper (5TR).

Lewisham and Bellingham Radio Society.—Experimental Evening.

Sheffield and District Wireless Society.

The seventh annual general meeting was held on the 9th inst., when the new president, Mr. W. Burnet, was elected, together with the various officers for the year. Mr. T. A. W. Blower, whose address is 129, Ringinglow Road, Sheffield, was elected as Hon. Secretary in the place of Mr. R. Jakeman who held this office for the last two years. The annual balance sheet was submitted and shows that the Society's finances are in a healthy condition.

The first of a series of elementary classes was held on October 16th, when the fundamentals of magnetism and electricity were dealt with by Mr. L. H. Crowther. These classes are being followed up by experimental work bearing upon the subject-matter of the previous class and should prove a very useful and interesting feature.

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Croydon Wireless and Physical Society.

An interesting talk on H.T. supply was given by Mr. G. W. Hale at the Society's last meeting. The speaker referred to the inconvenience of high-tension batteries when used with power valves and emphasised the desirability of obtaining H.T. from the electrical mains. In cases where no main supply was available he advocated the use of H.T. accumulators.

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

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Manchester Radio Scientific Society.

The Society's Annual General Meeting was held at headquarters, 16, Todd Street, on October 14th, when officers were elected for the winter season.

Meetings are held every Wednesday at the above address. Prospective members should apply for particulars to the Asst. Hon. Secretary: Mr. J. Morris, Junr., John Morris and Son, Ltd., Cross Lane, Salford, Manchester.

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Bolton and District Radio Society.

A large gathering of members and friends attended the Society's last meeting, at which Mr. Hankey, Assistant Engineer of the B.B.C., gave an interesting lecture on "Radio Ramifications." Alderman Steele, the Mayor of Bolton, occupied the chair.

Hon. Secretary; Mr. J. Grimshaw, 70, Church Road, Smithills, Bolton.

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Malta Radio Society.

At a meeting of this Society held at the "Unione Cattolica 'San Guiseeppe,'" Valletta, on October 17th, Mr. R. F. Galea delivered a very interesting lecture on "The Three-Electrode Valve." Further instructional lectures are to be given by Mr. Galea at fortnightly intervals. The objects of the Malta Radio Society are to conduct experiments, instruct the members, and to safeguard the interests of all concerned.

Those desirous of joining the society should communicate with the Secretary at No. 73, 73a, Sda. San Francesco, Floriana.

THE MANCHESTER EXHIBITION.

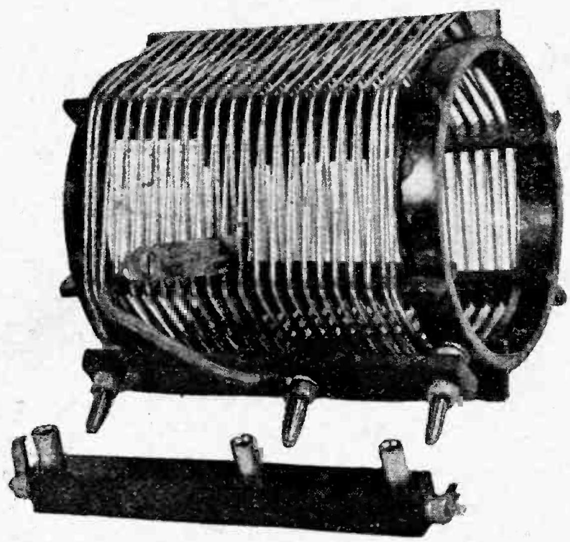
Items of Interest to be Seen on the Stands.

As much of the apparatus to be seen on the stands has already been discussed in detail in connection with the recent London exhibitions descriptions will only be made of sets and components now appearing for the first time.

THE Second Wireless Exhibition to be held in Manchester was promoted jointly by the Manchester *Evening Chronicle* and the Manchester and District Association of Radio Societies.

Over 180,000 visitors paid for admission to the Exhibition last year, and the attendance on the opening day indicated that these figures may be beaten this year before the Exhibition closes on Saturday, November 7th.

Although many of the exhibits are substantially the same as those already shown at the London exhibitions,



The Baltic low-loss coil. The winding, which is about 4in. in diameter, consists of 40 turns, giving an indutancce of 98·5 microhenries, with a natural wavelength of 31·5 metres, and when bridged with a parallel capacity of 0·00055 mfd. a wavelength of 425 metres is produced.

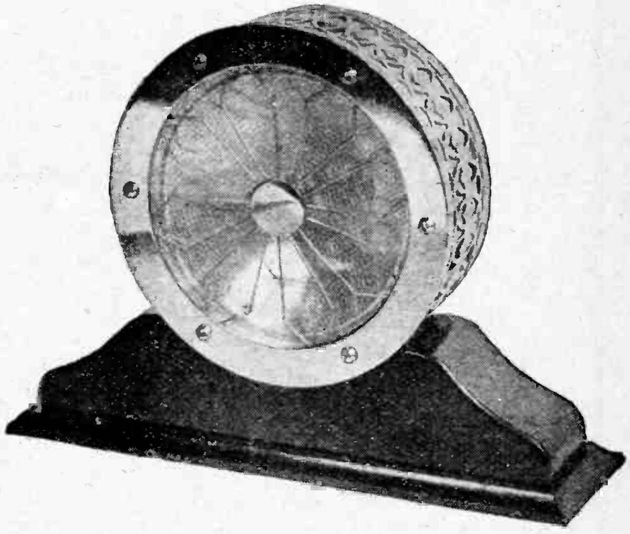
new apparatus is to be seen at the stands of certain of the firms from the Midlands and the North who are now exhibiting for the first time. In addition, there are no restrictions with regard to the inclusion of apparatus of foreign manufacture, and as a result the amateur is showing a keen interest in the design of apparatus developed abroad.

There was a packed hall when, in a few well-chosen words, Sir Joseph Nall, M.P., introduced Capt. P. P. Eckersley. In his address Capt. Eckersley, after dwelling at length on the future aspect of wireless, emphasised the importance of employing high-grade receiving equipment to appreciate the real public service rendered by the British Broadcasting Company, and he explained that both as regards range and selectivity great advances are still needed in the design of British wireless receiving apparatus.

Primary Battery for Filament Heating.—It would seem that the introduction of dull emitter valves has merely brought about an economy in filament current consumption from the accumulator battery, and has not, to any great extent, been met by the development and substitution of primary batteries for filament heating.

The Darimont battery manufactured by Darimont Electric Batteries, Ltd., of Abbey Road, Park Royal, London, N.W.10, has, however, been designed expressly for wireless purposes, and an assurance that it is capable of satisfactory and economical performance can be obtained from an examination of the curves produced under varying conditions of discharge. The cells are made in four sizes, and the largest, type B15, has a capacity of about 60 ampere hours, determined at a constant discharge rate of about 0.25 ampere. The internal resistance is shown to be about 0.4 ohm, and the mean potential is about 1.4 volts. Thus it is possible, using, say, two Mullard "Weco" valves, to obtain 130 hours' use, and at moderate cost the cell can be recharged by replacing the inactive electrolyte. A cell of smaller type, described as the B5, can be employed for the filament heating of, say, a three-valve set fitted with A.R.06 valves. Three cells connected in series will be needed, giving 120 hours' service. Again, a single valve receiver, employing a Marconi DE3 valve and working from three of the lowest-priced Darimont batteries, type B2½, will give 225 hours' use, and can be reconditioned for the cost of a shilling.

Pyrex Glass Insulators.—Aerial insulators constructed from Pyrex glass with grooved surfaces and shaped so that the aerial and halyard pass through holes in the ends, are shown by Messrs. N. V. Webber and Co.,

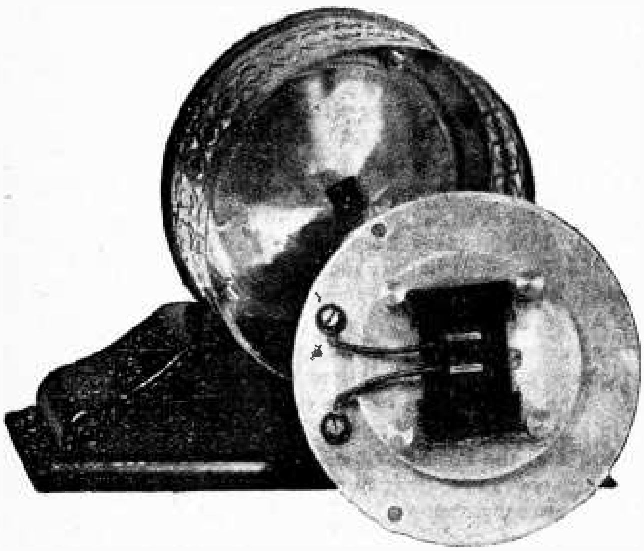


Beco hornless loud-speaker.

The Manchester Exhibition.—

Ltd., a firm specialising in the manufacture of amateur transmitting station equipment, as well as receiving apparatus of special design for use on short wavelengths.

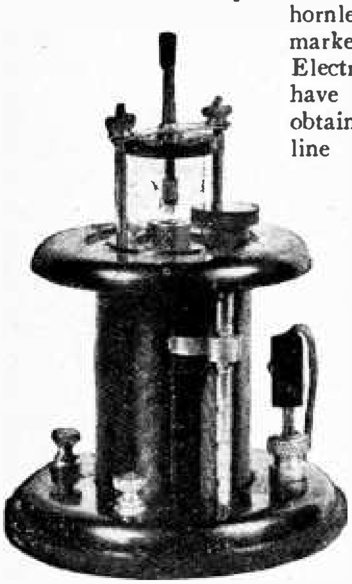
The range of apparatus exhibited includes an absorp-



Interior view of the Beco loud-speaker, showing the magnetic system and the conical aluminium diaphragm.

tion transmitting wavemeter, heterodyne, and buzzer wavemeters, a series of meters including thermo-ammeters, solenoid and pancake type transmitting inductances, and short wave receiving sets and components.

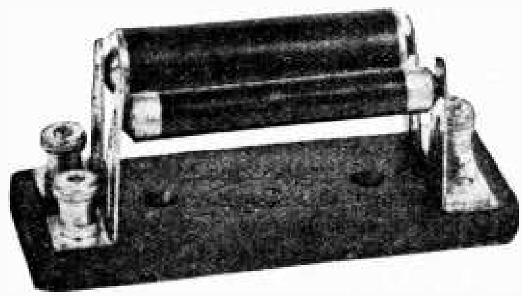
Hornless Loud-speaker.—In putting the "Beco" hornless loud-speaker on the market, Messrs. the British Electrical Sales Organisation have endeavoured to not only obtain a more pleasing outline than the usual trumpet



Goltone crystal receiving set. By means of a plug and socket switch the wavelength can be extended for reception on wavelengths up to 1,850 metres.

Cell in glass container used in building up the Oldham high-tension battery.

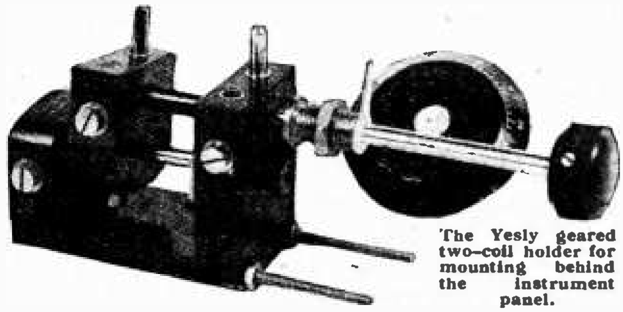
model, but have aimed at eliminating resonance effects as far as possible, with a view to maintaining original sound quality. The general construction consists of a thick aluminium back plate carrying an adjustable electromagnet with polarising bars. The diaphragm is a stiff aluminium cone less than 0.002in. in thickness, rigidly clamped at the rim between thick aluminium rings. A suppleness is provided around the edge by means of a groove in the diaphragm, and this, resting on wool packing, is probably responsible for the avoidance of reson-



The Yesly combined grid condenser and leak. Three terminals are provided so that it can be used in circuits where the leak does not directly bridge the condenser.

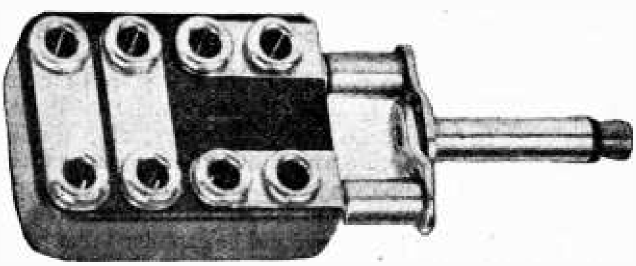
ance. Moderate in price, it is obtainable either with a nickel plated, oxydised silver or copper finish.

Low Loss Tuning Coils.—On the stand of the Wellworth Wireless Company, 8, Withy Grove, Manchester, is an interesting set of Baltic inductance coils of



The Yesly geared two-coil holder for mounting behind the instrument panel.

attractive design. Referring to the 60-turn coil, the wire is supported by means of slotted strips carried on rings, and the unusual feature is that the slots are alternately cut to different depths, so that successive turns do not lie side by side. The self-capacity is thus reduced, thereby limiting the dielectric losses and producing a coil of extremely low ohmic resistance, which will lead to improved selectivity and range. This coil has an inductance of 200 microhenries with a natural wavelength of only 60 metres. When bridged with a parallel capacity 0 00055 mfd., the wavelength becomes 630 metres. The

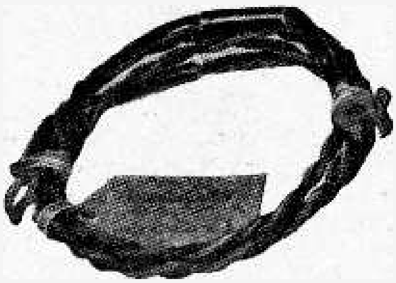


The Baltic universal telephone plug is arranged for connecting a number of pairs of telephones in series or parallel and the socket itself is removable from the plug.

The Manchester Exhibition.—

range of coils, which are all interchangeable, includes five coils smaller in size.

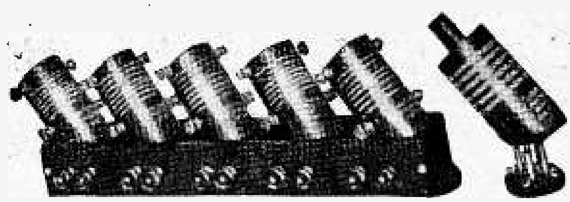
Belden Battery Cords.—To overcome the difficulty of connecting up a number of leads from the low and high tension batteries, the Belden battery cord consists of a length of braided cable carrying the necessary conductors. Five leads are laid up in the form of cable, in different



Useful battery connector made up complete with tags by Ripaults Ltd.

colours, so as to give easy identification, and the provision of an additional wire in order that two high-tension potentials may be obtained is a most useful feature. The cord is 6ft. in length and of durable construction.

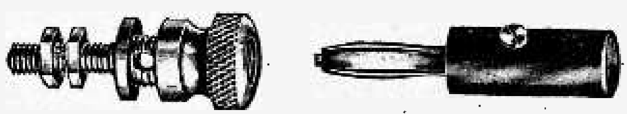
Other products shown by the Standard Insulator Co., Ltd., 41, Rathbone Place, London, W.1, include insulated sleeving in various sizes and colours, Belden frame aerial wire consisting of sixty strands of No. 42 wire



The Liberty supersonic set of units for use in super-heterodyne receiver construction comprises four matched intermediate transformers, filter circuit and units for long and short wave oscillators.

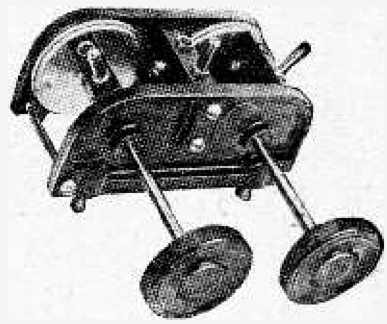
with a silk-finished braided covering, enamel insulated wire, resin cored solder, the "Midget" vernier knobs for critically controlling instrument dials, terminal tags in brass, copper, and tinned copper of varied sizes and shapes, and ebonite loud-speaker horns of attractive outline and good, clean finish.

Large-capacity H.T. Batteries.—Messrs. Ripaults, Ltd., King's Road, St. Pancras, London, N.W.1, have evolved a new and improved type of battery specially designed to meet the increasingly heavy demands upon the source of H.T. supply, due to the adoption of multi-valve sets and power amplifiers. A special feature of the design is that the individual cells are interchangeable, thus permitting of the replacement of any particular cell which may become faulty. The battery is supplied in two sizes of 45 and 90 volts. As battery manufacturers, Messrs. Ripaults are showing a wide range of square type Leclanché cells of large capacity suitable for filament heating. Some useful battery leads with tags are also shown, together with indiarubber-covered wire in sizes Nos. 16, 18, and 20 S.W.G., useful for instrument wiring.



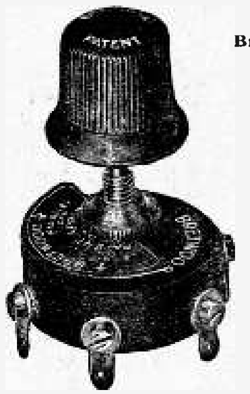
The Triparte terminal manufactured by Ward & Goldstone, Ltd. Connection can be made either by spade or tag connector as well as by plug, for which a socket is provided in the head of the terminal.

Superheterodyne Kit.—Among superheterodyne equipment of British manufacture, the "Liberty" Supersonic Units provide all the necessary tuning circuits. The



The Lotus geared coil holder for inside baseboard mounting shown on the stand of Garnett, Whiteley & Co., Ltd

windings are arranged in grooves on ebonite formers, and coupling between the various stages is kept to a minimum by tilting the coils in the familiar fashion employed in neutrodyne sets. Intermediate transformers are carefully tuned, and the outfit includes the filter circuit and long and short wave oscillator inductances. The units possess a good instrument finish. The Radi-arc Electrical Co., Ltd., Bennett Street, Chiswick, London, W.4, are also exhibiting the "Liberty" superheterodyne receiver, which makes use of the unit equipment. It is supplied in two models, employing either five or eight



Bretwood series parallel aerial switch.

The midget friction adjuster for providing critical adjustment of an instrument dial made by the Standard Insulator Co., Ltd.

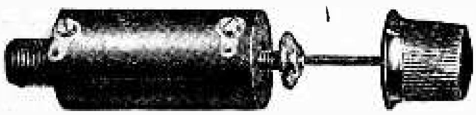
valves. The frame aerial with which it operates is rotated by means of a link action connected with an instrument dial, and, by means of a compass fitted to the base of the frame aerial, it becomes possible to indicate the directional settings for the various stations.

Compact Variable Condenser.—Bretwood, Ltd., 12 to 18, London Mews, Maple Street, London, W., are now manufacturing a variable condenser, which occupies a space of less than 1in. in depth beneath the instrument panel. The moving plate, which revolves between treated

The Manchester Exhibition.—

mica discs, is clamped in position by means of two spring plates, one of which forms the fixed plate of the condenser. Being compact, this variable condenser lends itself for use with the transformer equipment of supersonic heterodyne receivers, and a tunable intervalve unit is shown on the stand. Another useful component is the Bretwood anti-capacity switch, in which smooth contact is made to the segments of a small disc by means of phosphor-bronze balls pressed in position by means of springs.

A Popular Crystal Set.—It is doubtful if, with the many elaborate types of crystal receivers, the range of reception exceeds to any noticeable extent the signal strength obtainable from a simple solenoid with sliding contact. To provide a complete crystal receiving set at the lowest possible price, Messrs. Ward and Goldstone, Ltd., of Pendleton, Manchester, make use of this principle. The contact between wire and slider, which must be perfectly reliable, is made by means of a pair of contacts which traverse the coil by the operation of a knob and quick-acting screw. Provision is made for the reception of Daventry by means of a plug and socket switch. The more elaborate sets manufactured by this firm include a series of low-priced cabinet type receivers built on sound lines and employing standard circuits. A terminal connector is also of interest, for it provides for either spade or tag connection, or the plug with which it is provided may be made use of. A series of fixed condensers is also shown which can be mounted in a variety of ways, and are provided with detachable tags for supporting a leak resistance when required. When a grid leak is required to be mounted so that it does not bridge the condenser, a clip in suitable mounting is supplied.



The new type Bretwood filament resistance.

Another useful device is the "Protex" fuse for fitting to an accumulator battery to prevent damage by short-circuit.

New Geared Coil Holder.—The unusual feature in the new "Yesly" coil holder for behind the panel mounting is the use of very fine toothed gear wheels for providing the necessary critical adjustment. As several teeth are thus always engaged, backlash is practically eliminated. The position of one of the holders is adjustable to allow of the use of coils of varying thickness. The degree of coupling between the coils is indicated by a pointer moving over a stationary circular scale, and, in addition to a standard one-hole fixing, a pair of screws are fitted to more rigidly attach the holder to the panel if required.

Wireless Gramophone Combination.—In an exceptionally attractive cabinet of mahogany of Sheraton period design, Messrs. Halliwell and Good, Ltd., 9-13, Miller Street, Manchester, have combined a four-valve receiving set with a high-grade electrically operated gramophone. When the instrument is used as a gramophone there is nothing to indicate that the cabinet is used as a receiving set. The receiver itself is a straightforward four-valve set with a tuned anode high-frequency amplifier, constructed with high-grade components.

"The Wireless World" stand at the Manchester Exhibition. Visitors are afforded an opportunity of examining a very wide range of wireless literature covering every branch of the subject.

WHAT IS BEING SAID.

NO CUSTOMS DUTIES.

"Sitting in my home in Geneva, I am in contact at one moment with the musicians and thinkers of Scandinavia and at the next with those of Italy and Spain. Another slight turn of the condenser dials brings to my ears the voice of a Czech or a Parisian. There are no Customs duties on speech or the music which is borne on the ether.

"Here, then, is an opportunity for the peoples of Europe such as has never before existed—an opportunity to learn how much they possess in common and how much may be lost and has been lost through ignorance born of isolation. The broadcasting companies realise that it is their duty to see that the medium in their hands is developed to the uttermost in the service of mankind and that no time shall be lost in the process."—A. R. Burrows, in *International Language*.

A HINT TO TOWN LISTENERS.

"If you think that by moving the reaction coil a fraction of an inch closer to the aerial coil you are going to get better signals, when already the set is right on the dividing line between the silent point and oscillation, remember that by so doing you are going to distort your reception, which will become woolly and muffled. Remember also that many hospitals are listening, and that if you did move the reaction coil that fraction of an inch the resultant oscillation would be distinctly irritating to the patients, whose nerves may be very highly strung as the result of some recent operation or shock."—T. Francis Barrett, in R.S.G.B. Talk from 2LO.

VALVES WE HAVE TESTED

SOME POWER VALVES.

THIS week we have four valves to report on, and they are all power valves—that is, valves which the makers say are suitable for power amplification and for use in the last stage of an audio-frequency amplifier.

What characteristics do we expect a power amplifying valve to have? First, such valves are expected to deal with a certain amount of power, as distinct from those valves which are essentially used as voltage amplifiers. We should therefore expect the valves to have a large emission and to have a grid-volts, anode-current characteristic which extends well to the left of the zero grid-volts point. In other words, they will have a fairly low anode impedance and amplification factor. The anode impedance in particular is a very important thing, for, to get the maximum output from the valve for a given input, the impedance of the valve and the apparatus connected to the anode should be approximately equal. With loud-speakers of normal design and wound to a resistance of about 2,000 ohms, a suitable impedance for the valve would be 5,000 to 10,000 ohms. Certain loud-speakers—for instance, the new "Kone," of the Western Electric Co.—are wound to a lower resistance than the average loud-speaker, and should therefore be connected to a valve of lower impedance. The resistance of the "Kone" is 750 ohms, while its average impedance is 5,000 ohms, and the makers suggest that it be connected to a valve having an anode impedance of about 5,000 ohms.


The Ediswan P.V 6D.E, of The Edison Swan Electric Co.—a 2-volt power valve.

Secondly, for a given impedance, the voltage amplification factor of the valve should be as high as possible, and thirdly the emission should be obtained with the smallest expenditure of power in the filament consistent with long life.

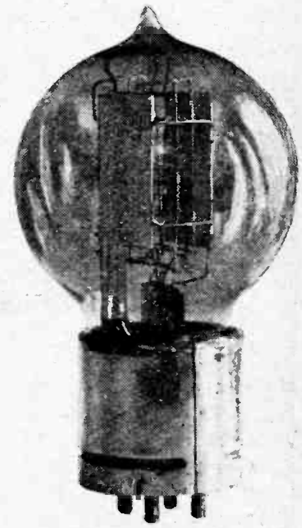
Another factor of importance is the working anode voltage. Is it preferable to design the valve to work from a supply of, say, 120 volts, or from a higher voltage such as 200-240? If the valve is to deal with big grid voltages—say, 10-15 (20-30 volts total swing)—and a valve working off a low anode voltage is preferred, that valve will probably have an impedance of about 3,000 ohms, and an amplification factor of 2 to 3. Further, dry cells will not last very long, and a battery of secondary cells will have to be used. If electric mains are available, however, there is no doubt that a valve designed to take an anode voltage of 200-240 is an excellent proposition.


The P.M.4, a Mullard power valve.

The Ediswan P.V.6D.E (2-volt Valve).

The first of the valves tested was the Ediswan Electric Co.'s power valve, designated P.V.6D.E. This valve differs slightly from the earlier models of this type, improvements having been made to the construction. The shape of the anode and grid have been changed from cylindrical to the oval box type, and the filament is of V pattern. Reference to the illustration will show that the valve is of the pipless pattern, while the cap is of moulded ebonite. A green line is marked on the cap to indicate the anode pin.

The valve is packed in a box on which is printed the specification of the valve, and we are pleased to note that such things as the emission, amplification factor, working slope, normal impedance, and filament efficiency are clearly given.


A Western Electric Co. power valve—the P.A.4.

Tested in our usual manner, we obtained the results given in the accompanying table, from which it will be seen that the valve is a good one of its class. The tests were made with a filament voltage of 2.0, and it was found that the emission was barely sufficient when working with an anode voltage of 110. This valve would work extremely well in the first stage of an audio frequency amplifier with a good coupling transformer of high ratio (6 : 1).

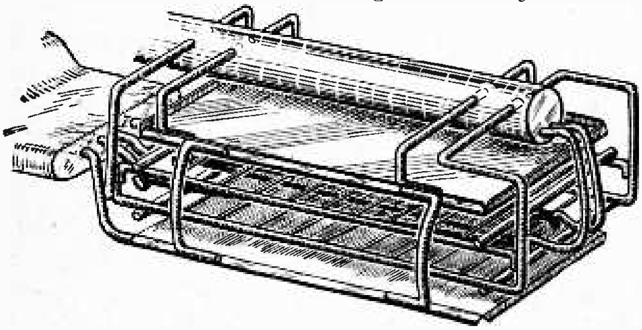
In the last stage it might be overloaded with really powerful signals, but would certainly supply the maximum power with which an average small loud-speaker will satisfactorily deal.

The Mullard P.M.4 (4-volt Valve).

A specimen valve of this type, which, we are told, is a product of the combined Philips and Mullard organisations, was secured for test. The makers state that this valve is suitable for use in all stages of audio frequency amplifiers and for the operation of loud-speakers. Rated at 3.8 volts, 0.1 amps for the filament, and 30 to 100 anode volts, we found the filament efficiency re-

Valves we have Tested.—
markably good at 57 *m*A per watt with 3.8 volts on the filament. On test the average amplification factor, as stated in the table below, was found to be 8.3 with an impedance of about 15,000 ohms. Both these values are rather higher than those given by the makers in their advertising literature for average valves, but even so the valve may justifiably be said to be perfectly suitable for working into a small loud-speaker provided ample anode and grid volts are used.

When used in the first stage of an audio-frequency amplifier, an anode voltage and grid bias of 50 and −2 respectively would be right in normal circumstances. A coupling transformer of 4 : 1 ratio, of good design, would be satisfactory.



Construction of the P.A.4 valve.

The Western Electric P.A.4.

This is a power valve designed to work off a 4-volt filament accumulator and to have an anode voltage of up to 160. Fitted to a base of the usual American type, the electrodes are of rather unusual construction. A stout glass support is used as an anchor for the stiff wires provided to hold the filament, grid, and anode in position. The filament is of "M" shape, while the grid and anode take the form of two sets of flat surfaces on either side of the filament, as may be seen from the sketch above. This valve is obviously one designed to handle power, for the elements are of large size, and, while the spacing of the parts is considerable, the areas are sufficient to result in a valve having very good characteristics. The glass bulb is quite clear, and, so far as we know, no "Getter" is used in the exhausting process.

We must confess that a valve which is pumped hard in what is, perhaps, the old-fashioned way, appeals to us. The results of our tests are given in the accompanying table, from which it will be seen that the average anode impedance of the valve tested was 6,700 ohms, while the amplification factor is roughly 5.6. This valve is obviously one which will handle a good deal of power, as with 160 volts on the anode, the correct grid bias is about − 14 volts. In our experience a valve of these or similar characteristics should always be used in the last stage of an amplifier if really good loud-speaker results are to be obtained. The valve is one which can be strongly recommended.

The Marconi L.S.5.

This valve is, of course, not a new one, but it is such an excellent valve, from the point of view of long life and performance, that one was tested in order that the results might be given, and readers' attention once again drawn to a good power valve.

The valve is rated at 4.5 volts, 0.8 ampere, for the filament; working anode voltage 60-400; total emission, 60 milliamperes; impedance, 5,000 ohms; and amplification factor, 5. On test we found the impedance to average 5,300 ohms, while the amplification factor varies between 5.2 and 5.4. From the figures given, it will be seen that the valve will handle a good deal of power without distortion, and those who use the electric mains as a source of current for the last valve of their receiver might well consider the advantages of a valve such as the L.S.5. Used in a transmitter, this valve may be permitted to dissipate 10 watts on the anode without harming the valve in any way.

EDISWAN P.V. 6 D.E.

Filament voltage 1.6. Filament current 0.395 ampere.
1.8. 0.42 „
2.0. 0.445 „
Total emission, 10 milliamperes. Filament efficiency, 11.2 mA. per watt at 2 volts.

Anode Voltage.	Anode Current at Zero Grid Volts. Milliamperes.	Actual Anode Current. Milliamperes.	Grid Bias. Volts.	Amplification Factor.	Anode Impedance. Ohms.	Slope. mA. per Volt.
110	7.15	4.7	−7	5.3	12,000	.44
85	6.0	3.8	−4½	5.6	12,200	.46
61	3.95	2.4	−3	5.6	13,500	.42

MULLARD P.M. 4.

Filament voltage 3.6. Filament current 0.11 ampere.
3.8. 0.12 „
Emission 26 milliamperes at 3.8 volts on filament.
Filament efficiency 57 mA. per watt.

Anode Voltage.	Anode Current at Zero Grid Volts. Milliamperes.	Actual Anode Current. Milliamperes.	Grid Bias. Volts.	Amplification Factor.	Anode Impedance. Ohms.	Slope. mA. per Volt.
97	6.9	2.33	−5	8.6	13,950	.61
85	4.89	2.08	−4	8.3	14,450	.57
73	3.8	1.79	−3	8.3	15,400	.54
61	2.78	1.52	−2	8.3	16,400	.51
48	1.74	1.27	−1	8.3	18,500	.45

WESTERN ELECTRIC P.A. 4.

Filament voltage 3.6. Filament current 0.82 ampere.
3.8. 0.86 „
4.0. 0.90 „

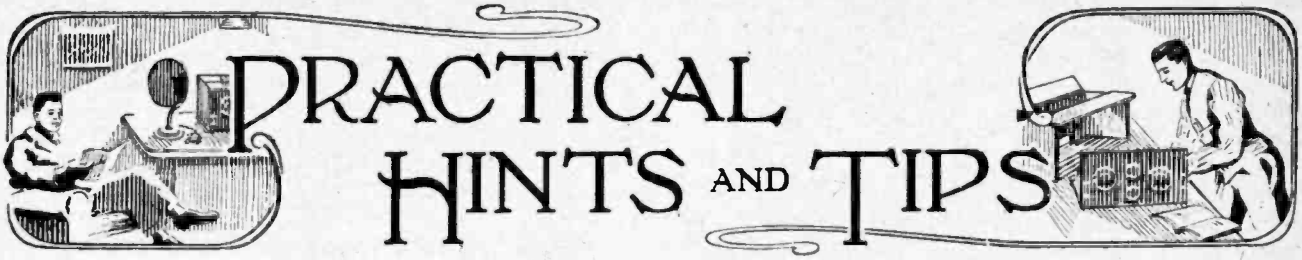
Anode Voltage.	Anode Current at Zero Grid Volts. Milliamperes.	Actual Anode Current. Milliamperes.	Grid Bias. Volts.	Amplification Factor.	Anode Impedance. Ohms.
163	21.6	9.1	−14	5.3	6,500
152	20.0	8.8	−12	6.0	7,000
140	18.1	8.7	−10	5.6	6,700
128	16.4	8.6	− 8	5.6	6,700
116	14.2	8.4	− 6	5.6	6,700
94	10.4	6.7	− 4	5.6	7,100

Grid current + 1.5v.

MARCONI L.S. 5.

Filament voltage 4.5. Filament current 0.79 ampere.

Anode Voltage.	Anode Current at Zero Grid Volts. Milliamperes.	Actual Anode Current. Milliamperes.	Grid Bias. Volts.	Amplification Factor.	Anode Impedance. Ohms.
197	31.0	13.2	−16	5.4	5,300
186	28.5	12.4	−15	5.5	5,300
175	26.0	11.6	−14	5.3	5,300
164	23.5	11.0	−12	5.2	5,500
153	21.2	10.8	−10	5.2	5,500
142	18.8	9.8	− 9	5.2	5,500



PRACTICAL HINTS AND TIPS

A Section Mainly for the New Reader.

SOME TUNING PROBLEMS.

WHILE untuned intervalve H.F. couplings do not give anything approaching the degree of efficiency which may be obtained from a well-designed tuned transformer or tuned anode circuit, they possess certain advantages, not the least being the fact that they do not introduce the need for an additional control, thus simplifying the process of searching for distant stations. Although it may seem that a knob more or less should not make much difference, experience will show that it is difficult to find a weak signal, the exact wavelength of which is unknown, if there are more than two critical controls.

Speaking generally, from the operating point of view, one may divide sensitive receivers into two categories: those with, say, two fine controls which may be simultaneously adjusted by using both hands, and those with three or more main adjustments, where, for obvious reasons, this simultaneous tuning of the circuits cannot be carried out. The procedure to be adopted in operating these two classes of receiver is essentially different; in the case of the latter the tendency is to depend on previous calibration of the dials.

The former class is headed by the superheterodyne, and includes various types of receiver with or without one tuned H.F. stage. In the second category will, of course, fall the popular neutrodyne with two tuned H.F. valves, which has become almost the standard in America. The tuning of each individual stage and of the aerial-grid circuit is not excessively sharp, but the selectivity of the instrument as a whole is extremely high. Once calibrated, the tuning of such a receiver to a given wavelength does not present any great difficulty, but it is certainly not the best type of set to use when searching at random for signals.

It would really seem advisable to pay more attention to local conditions when designing receivers; the high degree of selectivity obtained by the inclusion of three tuned circuits is hardly necessary at a distance of some twenty or thirty miles from a station of average power. A set with, say, a couple of controls, while it will possibly be less efficient, from the point of view of overall amplification, will probably be more likely to yield good results from the point of view of the average listener.

Of course, where one is faced by the problem of eliminating a powerful near-by station, the position is entirely different, and, short of adopting the supersonic principle, it is almost essential to take advantage of the "filtering" effect of a multiplicity of tuned circuits.

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SEMI-APERIODIC H.F. TRANSFORMERS.

In view of the foregoing, it will be seen that conditions may arise where the use of one or more stages of untuned H.F. amplification is likely to be of advantage. While the amplification is disappointingly small (about three per stage at 400 metres is a good average), there is the advantage that few additional complications are introduced, and that no artificial stabilising is necessary. If a good design of transformer is used, the valve is by no means a "passenger," and even the small degree of amplification obtainable can be of great value.

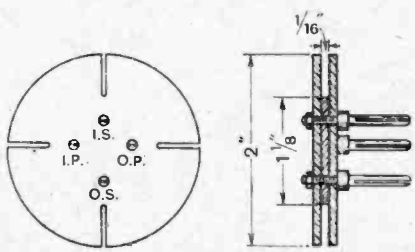

Fig. 1.—A typical H.F transformer bobbin.

Suitable transformers, giving fair amplification over the 300-500 metre waveband, may be wound on ebonite plug-in formers, as shown in Fig. 1. If difficulty is experienced in obtaining these formers ready made, they may be constructed from discs cut from ⅛in. sheet ebonite. Commencing at the pin marked I.P. (in primary), 115 turns of No. 45 S.S.C. resistance wire are wound into the groove, together with a single thread of finest sewing silk, to provide additional spacing. The end of this primary winding is brought out through the slot and soldered to the O.P. pin. A few turns of silk are wound on for insulating purposes, and then the secondary winding, in the same direction, and with a similar number of turns, and also spaced by a silk thread, is wound on, beginning at I.S. The external connections giving best results with this type of transformer are:—I.P. to plate, O.P. to + H.T., I.S. to grid, and O.S. to – L.T. It will almost invariably be found that a coupling condenser of 0.0001 mfd. capacity connected between I.P. and I.S. will improve results.

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ANODE CAPACITY REACTION.

A simple method of reacting into the grid circuit of a detector valve following a transformer-coupled high-frequency amplifying valve is shown in Fig. 2. Owners of sets incorporating this system of amplification, and without any form of controllable feed-back, will find that this is probably the easiest and simplest method of introducing regeneration.

In this case, of course, a proportion of the H.F. component of current in the anode circuit of the detector is deflected through the anode coil of the H.F. amplifying valve, *via* the reaction condenser, inducing voltages into the secondary winding, and thus on to the grid of the detector valve. It is, of course, essential that the windings of the transformer should be in the right direction, and it may be necessary to reverse one of them.

The reaction condenser (R.C. in the diagram) will generally be extremely small; its value depending on the constants of the circuit and the amount of damping present.

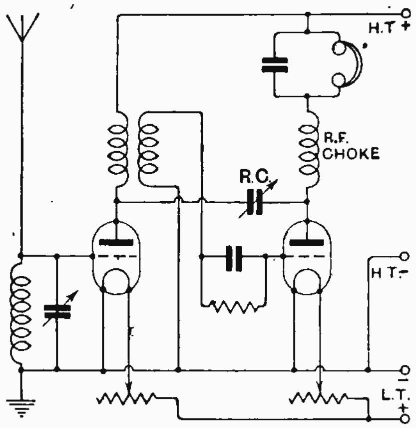


Fig. 2.—Capacity-controlled reaction.

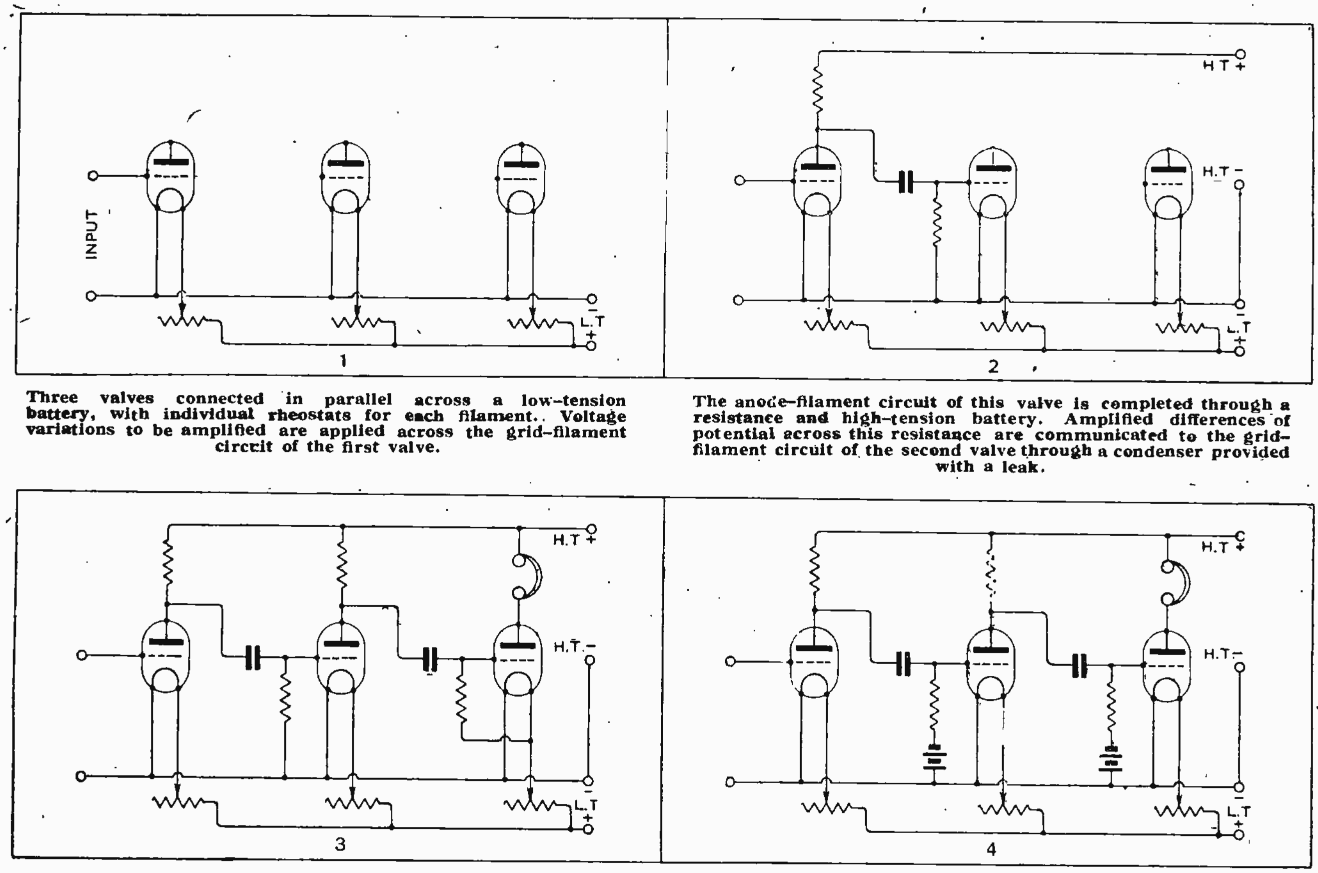
Generally speaking, any of the vernier condensers now available, with a maximum capacity of something in the neighbourhood of 0.00005 mfd., with a low minimum, will be found suitable. As is usual in circuits of this description, the high-frequency choke in the anode circuit of the detector valve acts as an impedance to oscillatory currents.

This form of capacity reaction will generally work best where transformers having a 1 : 1 ratio are used; in the case of receivers employing couplings with a small number of primary turns, control is seldom really smooth, and a larger reaction condenser may be necessary.

DISSECTED DIAGRAMS.

No. 4.—A Resistance-Capacity Coupled Cascade Amplifier.

For the benefit of those who have not yet acquired the simple art of reading circuit diagrams, we are giving weekly a series of sketches showing how the complete circuits of typical wireless receivers are built up step by step.



1. Three valves connected in parallel across a low-tension battery, with individual rheostats for each filament. Voltage variations to be amplified are applied across the grid-filament circuit of the first valve.

2. The anode-filament circuit of this valve is completed through a resistance and high-tension battery. Amplified differences of potential across this resistance are communicated to the grid-filament circuit of the second valve through a condenser provided with a leak.

3. The same procedure is repeated in the case of the plate circuit of the second valve and the grid circuit of the third valve, except that the leak is connected to give a positive grid bias for detection; 'phones in the output circuit.

4. Here the amplifier is modified to deal with low frequencies. Coupling condensers and leaks of suitable values are used, while grids are biassed negatively. The last valve will be of a type capable of handling a considerable amount of power.

Broadcast Brevities

SAVOY HILL TOPICALITIES

By Our Special Correspondent.

The Prince.

When the Prince of Wales broadcasts a message to the nation from the twenty-one stations of the B.B.C. on November 10th, in connection with Poppy Day and Earl Haig's British Legion Fund, it will be the second time that the microphone has been installed in His Royal Highness' study at York House, St. James's Palace.

oooo

Four Miles of Lines.

As on the previous occasion, viz., October 7th, 1922, it is expected that the Prince will sit at his writing desk in his study and speak into the microphone, which will be connected by about four miles of telephone line with Savoy Hill and the 2LO transmitter.

oooo

No Test Necessary.

It will hardly be necessary to make a special test beforehand, as the five tests made in 1922 showed the ideal distance at which to work in order to obtain the best results. His Royal Highness possesses a broadcasting voice of really exceptional quality, and perfect transmission should, therefore, result.

oooo

Armistice Day.

Programmes for Armistice Day anniversary, November 11th, are now being prepared. 2LO will broadcast the sounds from a spot in the neighbourhood of Whitehall, where a microphone is to be installed. One of the most moving of the musical tributes to the fallen, conducted by its composer, will also, it is hoped, be transmitted, as well as a drama specially written by Captain Reginald Berkeley, entitled, "The White Chateau." The hospitals ball will be relayed from the Albert Hall in the evening.

oooo

At Manchester.

The Manchester station will broadcast the Armistice ceremony from Albert Square, and in the afternoon will give listeners a programme worthy of the occasion, under the title of "Blow out, you Bugles, over the Rich Dead!"—the first line of one of the now famous sonnets written by Rupert Brooke in 1914.

oooo

Other Stations.

Edinburgh will relay from 8 to 10 p.m. the Remembrance Day Concert from Usher Hall, where Earl Haig, Earl Jellicoe, and the Lord Provost of Edinburgh will be among the speakers. Nottingham will broadcast the ceremony from the Market place, Nottingham; Leeds, the Cenotaph service from outside the Town Hall; and Stoke, the service from the Victoria Hall, Hanley.

oooo

Frequencies.

The extraordinary quality of a note is that it can be heard as such over an enormous gamut of frequencies. The lowest note we can hear is of the order of 16 a second, a note coming to us from the largest pipe of an organ. The highest note we can hear may be of the order of 15,000 vibrations a second. This note seldom comes to us fundamentally, but really is common to our experience in "overtones" from violins and other stringed instruments.

oooo

The Engineers' Task.

The audible gamut which the engineers at the Oxford Street station had to consider in a practical sense was from, say, 30 a second up to 10,000. A piano scale is from about 30 up to 4,000, but the character of the higher notes would be somewhat lost if we could not hear the "overtones" up to 10,000.

oooo

System Changes.

To secure faithful and smooth response over the whole gamut, adjustments were made in the five transformers with which the plant is equipped. The amplification system was rearranged to bring the electric impulses to the same value as given directly by the ordinary microphone; and the result is that the reproduction of the lower notes is only about ten per cent. and of the higher notes about twenty per cent. below perfection.

oooo

The Microphone—New Style.

The microphone of the future may probably be shaped like a man's head,

LOUD-SPEAKERS IN THE MAKING. An interesting corner of the Sterling Works, Dagenham, showing the processes of shaping and assembling Mellovox loud-speaker diaphragms.

the pick-up device being placed on either side and fulfilling much the same function as the human ears. Experiments along these lines may call for the pooling of resources by the wireless expert and the professor of anatomy.

oooo

An Incorrect Story.

A story is going the rounds that the B.B.C. profits are being swollen unduly by the royalties on sets. One newspaper writer quoted the figures contained in the Supplementary Agreement between the Postmaster General and the B.B.C. dated October 1, 1923, as showing that the royalty received by the B.B.C. on a two-valve set is 17s. 6d.

oooo

The Explanation.

That was perfectly true eighteen months ago and the Postmaster General justified the payment of royalties to the B.B.C. on the ground that even with the increased contribution from fees of fifteen shillings for a constructor's licence and ten shillings for the B.B.C. licence, it was doubtful if the revenue of the company would be sufficient to provide adequate programmes without a substantial contribution in the form of royalties on the sale of sets by the manufacturers who formed the company. Hence the Supplementary Agreement stipulated for the continued payment of such a contribution, but on a scale approximately fifty per cent. lower than that stipulated in the original Wireless Broadcasting Licence dated January 18, 1923. This reduction should, he said, enable a cut to be made in the cost of receiving sets.

oooo

Only One Licence Fee Now.

The arrangement underwent a change in 1924, and at the Annual General Meeting held on June 19 in that year, the Chairman of the Company announced that a proposal had been made to the Post Office that from July 1, 1924, there should be one uniform licence fee of ten shillings, so that whether a listener were buying a complete set or making up his own set from parts, he should pay the same fee. In addition, all tariffs were abolished from the same date. With the abolition of tariffs and the discontinuance of the approval of sets by the Post Office, the only restriction remaining was that against the use of foreign parts, and even that restriction was removed at the end of the year. The B.B.C. therefore get nothing at all from royalties.

oooo

Suicide of a Mouse.

The tiny mouse who committed hari-kari by getting himself electrocuted on the plates of one of the main condensers at Daventry and thereby held up broadcasting for twelve minutes, may have thought that he was making history; but the incident can be treated as a less intelligent repetition of that for which a Sheffield mouse was responsible some months ago, when it stopped transmission by chewing the moving coil of the microphone at the Sheffield relay station and "got away with it," whilst the Daventry mouse paid the penalty.

FUTURE FEATURES.

Sunday, November 8th.

LONDON AND 5XX.—Full Performance of "Hassan." De Groot and Piccadilly Orchestra.

BIRMINGHAM.—Bells of Birmingham Cathedral.

BOURNEMOUTH. — Rev. Studdert Kennedy at Holy Trinity Church.

GLASGOW.—"A World Requiem."

oooo

Monday, November 9th.

LONDON.—Chamber Concert of Hungarian Music. Speeches at Lord Mayor's Banquet, relayed from the Guildhall.

BOURNEMOUTH. — An Hour of Musical Comedy.

CARDIFF.—"Modern and Gay."

NEWCASTLE. — Pianoforte Recital by Harold Samuel

oooo

Tuesday, November 10th.

LONDON.—H.R.H. the Prince of Wales, A Poppy Day Message on behalf of Earl Haig's Fund.

BIRMINGHAM.—Dramatised Stories.

oooo

Wednesday, November 11th.

LONDON AND 5XX.—Simple Armistice Day Service, relayed to other stations. London Wireless Orchestra, conducted by Sir Edward Elgar.

BIRMINGHAM. — Armistice Programme.

NOTTINGHAM. — Armistice Service from the Great Market Place.

oooo

Thursday, November 12th.

LONDON.—Mass Telepathy. Revue by Donald Calthrop.

MANCHESTER.—Instrumental Hour: Solo Pianoforte, Irene Scharrer, Solo Violin, Bessie Spence.

BELFAST.—Station Dance Band.

oooo

Friday, November 13th.

LONDON.—"The Valkyrie," relayed from Manchester Opera House. Pianoforte Recital by Vladimir de Pachmann. George Robey.

SHEFFIELD.—Birthday Night.

EDINBURGH.—Annual Dinner of the Stevenson Club, relayed from North British Hotel.

oooo

Saturday, November 14th.

LONDON AND 5XX.—Talk by Capt. P. P. Eckersley: "Technical Improvements." Staff Birthday Concert.

2LO Improvements.

Experiments with the London station transmitter are rapidly approaching completion, and all the improvements which have been effected will shortly be incorporated in the apparatus at other main stations, as may be found necessary.

oooo

Perfect Reproduction.

These experiments affect the devices which convert sound to electrical vibrations, and the engineers have been working for several months past with the view to perfecting the apparatus at the transmitting end so that when it is associated with a perfect "reproducer" a reproduction undetectable from the original may be obtained.

oooo

Licence Figures.

A list of the monthly statistics of receiving licences in force from January, 1924 until April, 1925 appeared in these columns some months ago. It may now be brought up to date, as follows:—

May	1,371,581
June	1,387,933
July	1,379,275
August	1,422,603
September	1,464,674

The drop in the figures for July is explained by the fact that the number of new licences during the holiday season did not equal the number of licences surrendered.

oooo

Valuable Experiments at 5GB.

Experience has been considerably widened by the use of different types of transmitter working on the shorter waves at 5GB, the Chelmsford experimental station, about which I wrote a fortnight ago. A good deal of information has also been gleaned on the subjects of shielding by steel frame buildings of long distance reception, night distortion and so on. For these purposes, power varying between three-quarters of a kilowatt and three kilowatts has been used.

oooo

Ten Kilowatts.

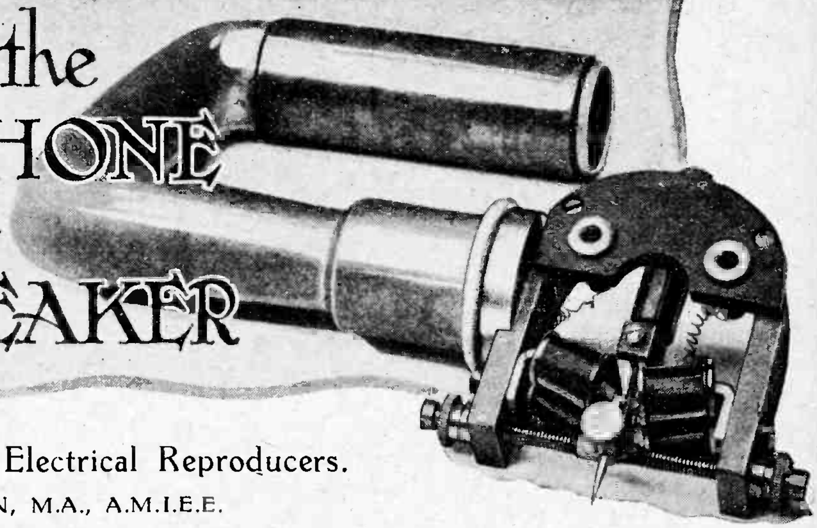
An important object of the tests has been to find out the potential daylight range of a ten kilowatt station so far as crystal and single valve set owners are concerned. Close observation has been kept on harmonics, to see whether such a station would be likely to interfere with other wireless services; the possibility of jamming on the fundamental wavelength has also been investigated. It is too early to discuss the results, which will be submitted to the Post Office as soon as the tests are complete, but the facility afforded for the carrying out of the experiments is a concession which cannot be over-estimated.

oooo

High Power at Hilversum.

The Daventry station will have to look to its laurels in the near future as a formidable rival is looming ahead in the shape of the new Hilversum station. The latest news indicates that this refurbished Dutch station will employ a power of 25 kilowatts.

Putting the GRAMOPHONE on the LOUD SPEAKER



Constructional Details of Electrical Reproducers.

By R. P. G. DENMAN, M.A., A.M.I.E.E.

REMARKABLE as the progress of the "Talking Machine" has been since the invention of Edison's tin-foil phonograph in 1877, it could not (until quite recently) be denied that the reproduction of broadcast music had come closer to perfection in five years than had the gramophone in fifty. This state of affairs is hardly surprising when we consider the difficulties involved in acoustical measurement and research, and the almost mystical attitude towards such matters which was taken up in consequence of these difficulties. Some semi-religious beliefs, for instance, as those that "sound always rises," or that the acoustic properties of an auditorium are affected by suspending a few wires from the roof, were quite common only a few years ago, and if it is true to say that "Science is Measurement" then Sound in its practical applications was a very inexact science indeed.

Recent Developments in Acoustics.

To-day all this is being altered. Partly owing to the facility with which electrical measurements can be made, and partly to the tremendous concentration of research on the electrical transmission of speech and music, a great deal of practical knowledge concerning the behaviour of sound in an electrical form has been acquired, and much of this, by a fortunate and most remarkable analogy, is available exactly as it stands for the solution of purely acoustical problems.

The introduction of this knowledge into gramophone technique, together with astonishing advances in recording (due to the use of microphones and amplifying equipment), is about to bring the gramophone into its own. In the meantime it is possible, by straightforward electrical means, to obtain from any gramophone, results comparable to the best studio broadcasts. When the B.B.C. began early this summer to transmit gramophone records with the aid of an electromagnetic reproducer designed by Capt. H. J. Round, a considerable improvement over the usual gramophone tone was observed, and the author began experimenting with a view to playing his own records electrically through loud-speakers. Various reproducers based on Capt. Round's design were very skilfully constructed for him by Mr. J. B. Woodroffe, of 93, Harwood Road, S.W.6, and two of them are illustrated in Fig. 2. Fig. 1 shows the principal features of these reproducers. It will be seen that the permanent magnetic flux-path is from the two ends of the horse-shoe magnet, through the soft iron pole-pieces P and the reed R to the central south pole. The reed is provided with a needle-holder at its lower end, and the whole device is mounted on a plug for connection to an ordinary gramophone tone-arm, which acts merely as a support.

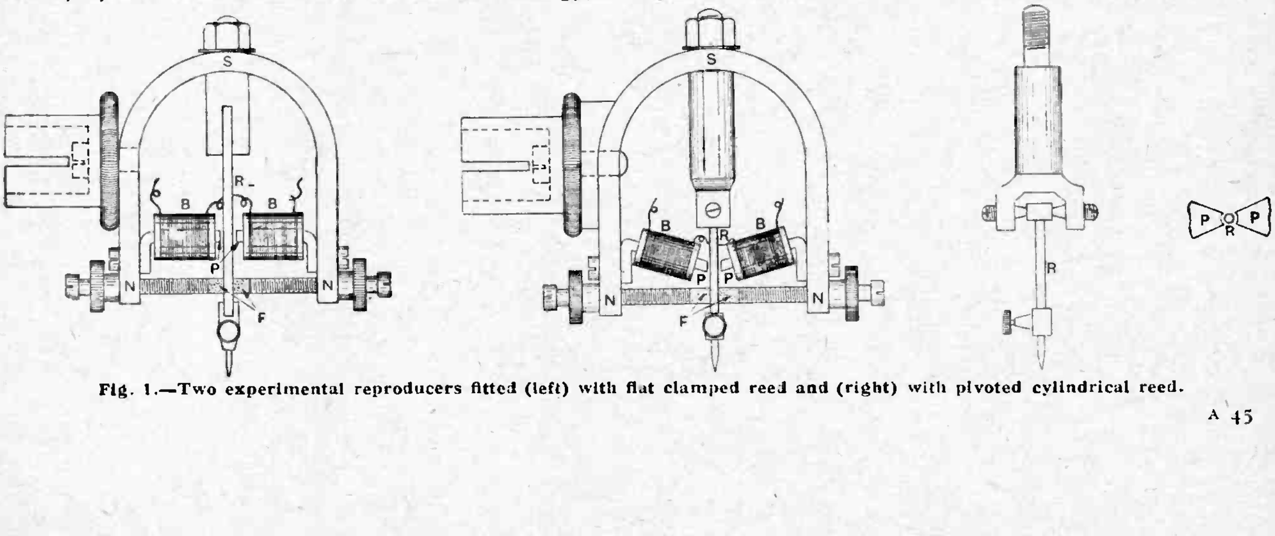


Fig. 1.—Two experimental reproducers fitted (left) with flat clamped reed and (right) with pivoted cylindrical reed.

Putting the Gramophone on the Loud Speaker.—

When the needle engages with the record-groove, it imparts to the reed transverse vibrations. These superimpose, on the steady flux through the telephone bobbins B, an alternating flux proportional to the product of the frequency and amplitude of the record-wave. An e.m.f. is therefore set up in both of the windings, which are connected up in series in such a manner as to make these two e.m.f.s additive. The bobbins may be of either high or low resistance, with a volume-control consisting of a variable shunt resistance, and a suitable transformer to step-up the voltage before it is applied to the grid of the first amplifying valve.

In order that there may be no sustained resonance effect from the reed, it is necessary that it should be mechanically damped; while the greater the mass and stiffness of the reed, the greater must be the damping if transient free vibrations are to be quickly checked. The elasticity can be made very small by pivoting the reed, as shown in the diagram at the right of Fig. 1, but if the mass is too much reduced, the sensitivity is lowered by the consequent reduction in size of the iron circuit, and greater amplification will be required in spite of the decreased damping, which is then permissible.

For reasons such as these, it has been found that the reproducer shown at the left of Fig. 1, with its massive reed, is more efficient than that shown at the right-hand side of the figure. In designing another on these lines, however, the author would retain the pivotal arrangement of the later model, which appears to work admirably.

The mechanical damping is carried out in Capt. Round's original patented design by means of adjustable rubber feet F. It has been found that a system of "grease" damping answers very well, a single application of Fluxite giving permanently good results. Of course, the heavier the damping, the greater will be the reaction (and therefore wear) on the record, so this should not be carried further than is necessary.

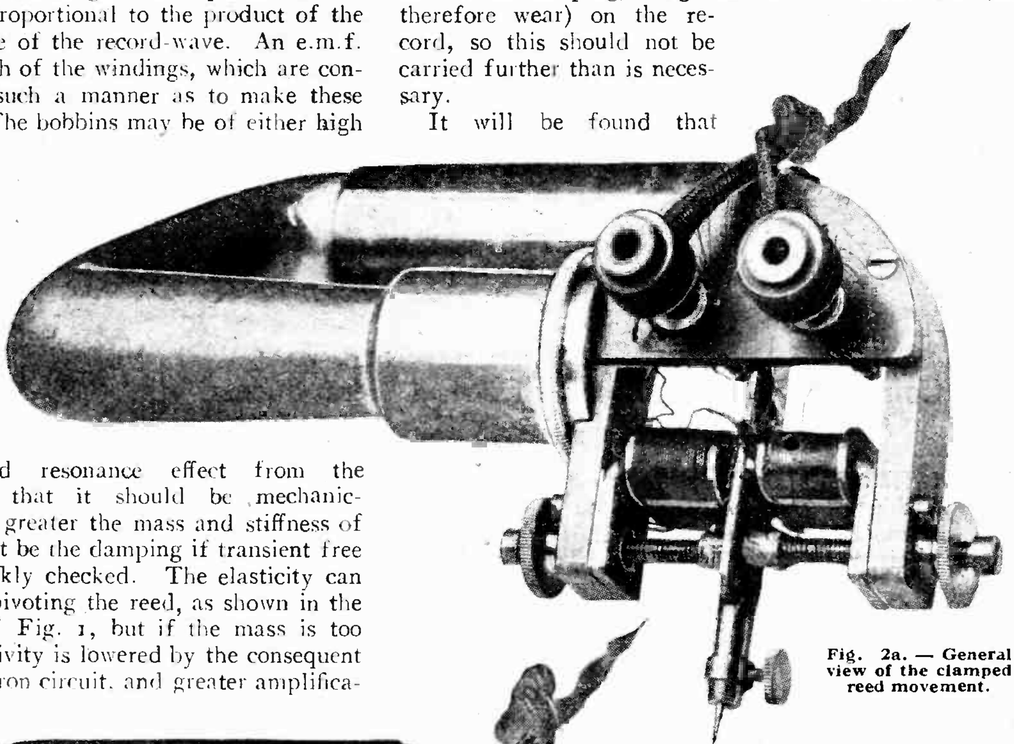


Fig. 2a. — General view of the clamped reed movement.

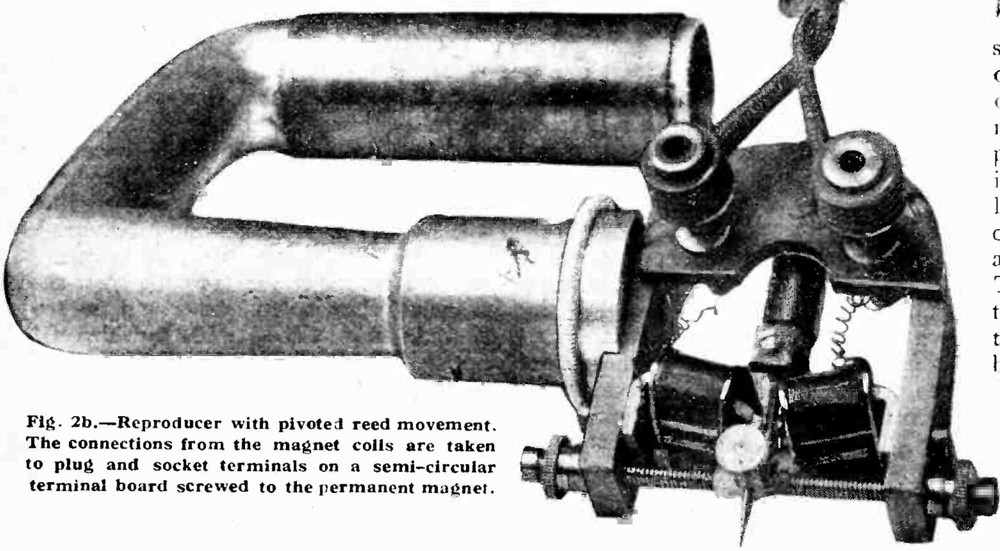


Fig. 2b.—Reproducer with pivoted reed movement. The connections from the magnet coils are taken to plug and socket terminals on a semi-circular terminal board screwed to the permanent magnet.

It will be found that signals of approximately crystal strength are produced in telephones connected with one of these reproducers. The tone-quality is such that results will be limited only by the degree of distortion present in the amplifier and loud-speakers. That is to say, that when the amplification is such that the volume appears to be five or six times as great as that of an ordinary gramophone, there will be no distortion traceable to the reproducer.

With regard to a suitable amplifying equipment, it should be remembered that in the case of the electrically made records, frequencies of one hundred cycles per second are genuinely present. If, therefore, it is desired to preserve these most satisfying tones, the easiest way to do it will be to make use of resistance coupling. I should like to state my personal belief that at present there are no horn-type loud-speakers on the market that are capable of doing justice to these deep tones.

It will be found that nearly all loud-speakers give too much prominence to some frequencies within the region

Putting the Gramophone on the Loud Speaker.—

of 900-2,000 cycles, and a better response characteristic is often obtained if these frequencies are partially subdued. This can easily be done by means of a simple shunt circuit if resistance-coupling is used. All this apparatus is naturally far more elaborate than an ordinary gramophone, but this is offset by the fact that almost all of it can be used as the low-frequency portion of a broadcast-receiver, and the user will, therefore, enjoy a double reward for careful design. Fig. 3 shows the connections of the amplifier used by the author, certain switches having been omitted. Usually all six valves are employed for gramophone reproduction, giving great volume, but for broadcast reception with an input of fair crystal strength, four valves are, of course, ample.

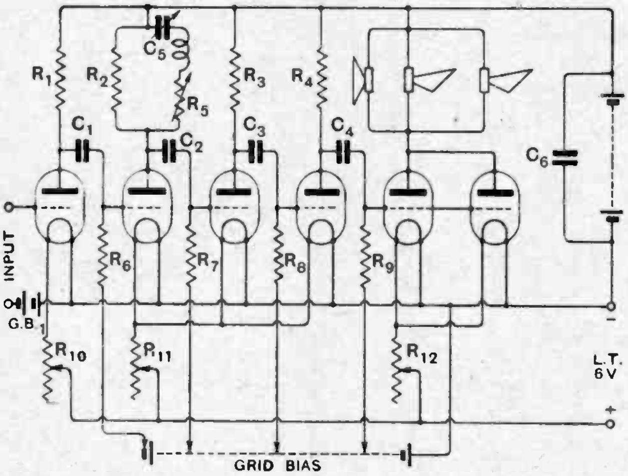


Fig 3.—Circuit connections of an amplifier specially designed for the electrical reproduction of gramophone records.

Referring to Fig. 3, the valves used are as follows: V_1 and V_2, D.E.5b; V_3, D.E.5; V_4, L.S.5; V_5 and V_6, L.S.5a, with grid bias of 6, 6, 18, 20, and 50 respectively, the last two valves being in parallel. The H.T. voltage is 250 and is furnished by a set of Hart accumulators.

Wire-wound anode resistances are used, "Polar" units being suitable. In the case of the D.E.5b valves, 80,000 ohm resistances are to be preferred, but these are unnecessary for the other valves, the anode impedance of which is small. The 0.005 coupling condensers C_1, C_2, C_3, C_4 are quite capable of passing vigorous low tones of the order of 100 cycles, provided that the leak resistances are kept high (2 megohms). However, now that 0.1 mfd. mica condensers can be obtained cheaply (T.C.C. Co.), it would perhaps be worth while to use these.

The tone-control circuit is shown connected across the second anode resistance. If an inductance of 1 henry (preferably air-core) is used, and if values between 0.01 and 0.04 mfds. are tried for C_5, some frequency between 1,600 and 800 can be selected as the lowest point in the amplification curve to correspond with the main peak in the loud-speaker curve. The dip which is thereby given to the amplification curve can then be widened so as to extend some way above and below this frequency, by a suitable choice of value for R_5. About 5,000 ohms will very possibly be found satisfactory, but this resistance should be variable.

A Possible Source of Distortion.

Incidentally, so much energy is present in these middle frequencies that, in taking the natural course of increasing the input strength to compensate for reduced volume, there is some danger that the user may unknowingly overload those valves which precede the tone control stage. A milliammeter is therefore useful.

Some difficulty may be found in stabilising this amplifier, and the only way to do this is either to space it out well, or else to screen each stage. The best plan is to start with a bench circuit and to find out by trial what is necessary. If the leads from the gramophone to the amplifier are of any length, they should be shielded.

In conclusion, electrical gramophone reproduction may be said to offer the following attractions:—

(1) Remarkable tone quality as compared with gramophones hitherto obtainable.

(2) Very much increased volume, coupled with full control, without degradation of quality due to the use of fibre or thin steel needles for pianissimo effects.

(3) Simultaneous reproduction of records in two or more rooms of a house (or hospital, etc.).

The construction of the powerful high-grade amplifier necessary to attain these results would often be justified even if it were only to be used for broadcast reception. Very little extra expense is then called for to produce a combination set capable of providing real musical entertainment irrespective of broadcasting hours. The detailed design of such a set must be left to the reader's personal taste.

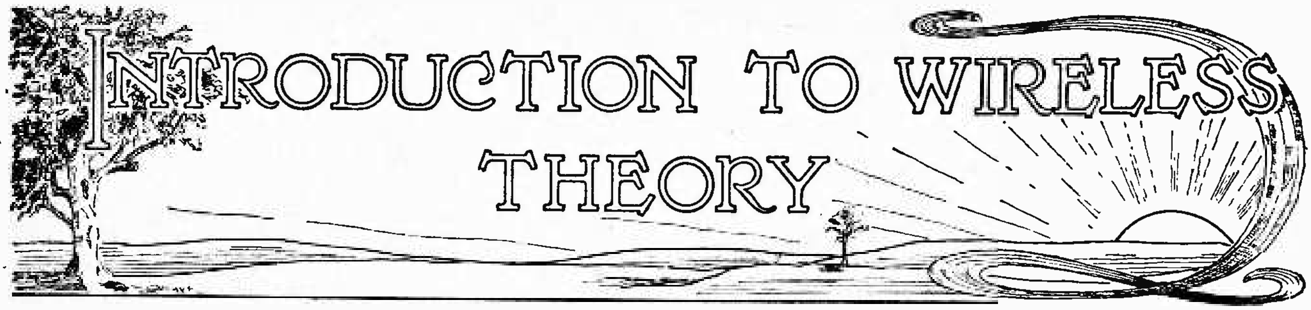
A BROADCAST NOVEL.*

FOR the production of this "thriller"—there is no more appropriate name for it—the author has made a skilful selection of propitious ingredients. There is an arch-villain—an overwhelming Russian, with a saving passion for music, who is no better than he should be—contending with the exponents of virtue and honour in the persons of a young Englishman and his fiancée, a humorous German aviator, a stricken Russian professor and his wife, and other well-intentioned individuals.

The *motif* of the story—the rescue of the Russian professor and his wife from the Soviet régime in Petrograd—is well sustained in impossible passages made possible by the skill of an experienced pen. Interest develops when the English hero, with his German friend, embarks on a flight of rescue into Russia with a parachute drop at the end of it. Excitement reaches a pitch during a scene in the broadcasting studio at Savoy Hill, London, in which the villainous emissary of the Soviet Government, having acted as pianoforte accompanist to the hero's fiancée, is rude enough to use the microphone for the purpose of communicating with his friends in Russia. The hastily spoken words are heard by a Soviet wireless station; whereupon the lives of the hero and the Russian professor and his wife are hardly worth the price of a mug of *vodka*. Dogged virtue wins through, however, and the escape is duly effected. A tragedy at the end of the story comes as a genuine surprise.

"Broadcast" is an excellent tale for a leisure hour, and can be warmly recommended to the broadcast listener whose accumulator has run out. E. C. T.

* "Broadcast"—A Novel. By J. D. Mackworth. (London: Longmans, Green & Co. Price 7s. 6d. net.)



INTRODUCTION TO WIRELESS THEORY

Series and Parallel Connections of Batteries and Resistances.

By N. V. KIPPING and A. D. BLUMLEIN.

Previous sections of this article have dealt with Ohm's Law and the transformation of power and energy into heat in electrical circuits. The present article deals with primary and secondary batteries and the nature of positive and negative potential. Series and parallel connections are also explained in a manner that can be easily understood by the beginner.

SO far very little has been said about batteries. The exact action of a battery is a complex electro-chemical process which is only of interest to the specialist, but it is necessary to have some idea of their electrical properties.

As we have said, a battery is not a store of electricity. It is a store of electrical energy When this energy is exerted, it takes the form of an electromotive force driving a current round a circuit of which the battery forms a part. This energy is not used until the circuit is closed; the bigger the current which the e.m.f. forces round, the greater the power taken from the battery, and the faster the energy of the battery is used up. There is a limit to the energy which a battery can give out, and when this limit is reached, the battery becomes "used up," and must be re-energised, either by renewing the chemicals of which it is made or, in the case of accumulators, by recharging electrically. Batteries are divided into two groups known as primary batteries and secondary batteries. One unit of any type of battery is called a cell. Accumulators are secondary cells, and all other types are primary cells.

In secondary cells it is possible to renew the chemicals by an electrical process called "charging" the accumulator, which consists in forcing a current through the cell in the opposite direction to which it normally tends to flow—in fact, pumping electrical energy back into the cell. For this reason an accumulator is sometimes called a storage cell.

All cells consist of two conductors separated by a chemical, and if these are suitably chosen, an e.m.f. will exist between the two conductors; the terminals of the battery are attached to these conductors. The value of this e.m.f. is usually round about 1 to 2 volts, and not much more than this can be obtained from one cell. The value of the e.m.f. across any cell depends upon the chemicals of which it is made; it remains practically constant until the energy of the cell is nearly all expended, after which, with further use, it falls rapidly to zero. With an accumulator the e.m.f. is normally about 2 volts, and it is harmful to use the cell so much that the e.m.f. falls below 1.8 volts. At this point, or before, the accumulator should be recharged.

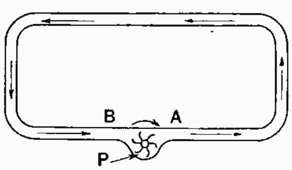


Fig. 1.—The distribution of pressure in this hydraulic circuit is analogous to the distribution of potential in the electrical current shown in Fig. 2.

The most common type of primary battery is known as a dry cell, and consists of a zinc and a carbon conductor separated by sal ammoniac (NH_4Cl). The e.m.f. of the dry cell is about 1.5 volt.

Although the e.m.f. of the cell is more or less constant, the energy which the cell can store depends on the amount of chemical it contains, a large cell being able to exert its e.m.f. under the same conditions for a longer time than a small cell of the same type.

A characteristic of accumulators is their very low internal resistance. This has the advantage that the voltage of an accumulator drops very little when normal currents are flowing through it, but has the disadvantage that, when short-circuited, an extremely large current is forced through the cell, causing serious damage to the electrodes (or plates). An accumulator, therefore, must never be short-circuited. There is, in fact, a limit to the current which may safely be passed through any given accumulator, and this value is always specified by the makers. A dry cell has in general a higher internal resistance, so that the effect of short-circuiting is not so serious. It is, nevertheless, to be avoided, as it results in a waste of energy.

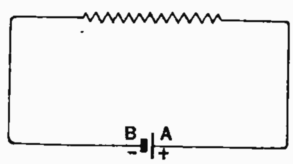


Fig. 2.—The current in the circuit external to the battery flows from A, which is a point of positive or high potential, to B, a point of negative or low potential.

The care of accumulators is an art in itself, and is a subject which does not fall within the scope of this series of articles.

We now come to the consideration of positive and negative potential, and we can again make use of the pipe and paddle analogy of Fig. 1 to determine the meaning of these terms.

Suppose the paddle is being turned so as to force the water round the pipe in the direction of the arrows; then

Introduction to Wireless Theory.—

the water in the section of pipe A to B flows in this direction because it is being pushed at A and pulled at B. That is to say, it is flowing from a point of high pressure to a point of low pressure, as water always does in a plain pipe. In the short section of pipe AB containing the paddle, however, the water is flowing from the point of low pressure B to the point of high pressure A, because the paddle is forcing it to do so. The essential feature of a water system is that water will flow from a point of high pressure to a point of low pressure, unless it is forced by a pump to do otherwise.

This leads us to a similar idea in electrical circuits. In Fig. 2 current is forced round the circuit A to B from the point of higher potential A to the point of lower potential B, but current flows through the cell itself from B to A because it is forced to by the e.m.f. of the cell. This point of higher potential A is known as the positive (+) side of the cell, and B the negative (−), because the A terminal of the cell is always at a higher potential than B. Current, then, always flows from positive to negative in parts of a circuit which contain no driving e.m.f., but from negative to positive through the cell or battery or other device which is driving it.

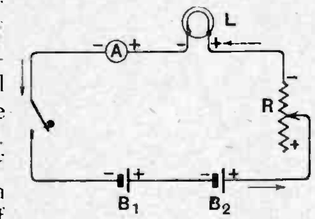


Fig. 3.—Simple electrical circuit. The lamp L is rated at 3 volts and 6 watts, and the two cells have each an e.m.f. of 2 volts.

Positive and Negative Potential.

When the science of electricity was first studied, it was not possible to find definitely the direction in which a current was flowing in any particular circuit. It was possible to find whether the currents in two wires were flowing in the same direction or in opposite directions, without saying which way they were actually going. A convention was therefore adopted by which current in a wire connected to a dry cell was said to flow from the carbon to the zinc electrode. The carbon was called positive and the zinc negative, and the positive or negative side (polarity) of all other cells was made to agree with this convention. All batteries consequently have their terminals marked + and −, so that one may know which is the side of higher potential.

Unfortunately, the convention adopted was later found to be the reverse of fact, for when electrons were discovered they were found to flow in the opposite direction to that assumed This does not really matter to the wireless engineer, except in the case of thermionic valves; any difficulty arising can be avoided by assuming electrons to be negative electricity, which will, of course, flow in the reverse direction to the arbitrary positive electricity. With this assumption of the possibility of negative electricity, the old convention still holds and is always used. In writing the conventional sign for a cell, the long thin stroke should be made to represent the positive side, and the short thick stroke the negative pole.

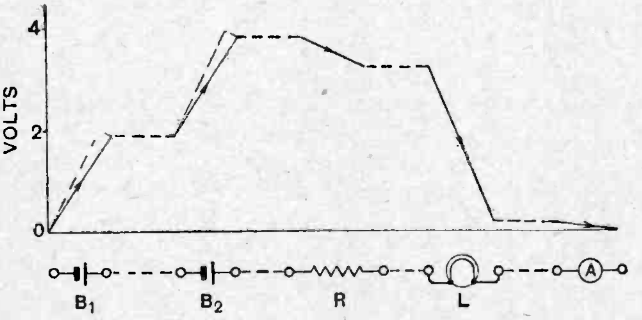


Fig. 4.—Potential gradients in the circuit of Fig. 3 illustrated graphically.

We now know enough to understand easily a good deal of what happens in a simple circuit. Let us take, for example, the circuit shown in Fig. 3.

Potential Gradient.

In Fig. 3 is shown an arrangement by which a 3-volt, 6-watt lamp can be lit from two 2-volt accumulators. A switch is used for opening or closing the circuit, A is an ammeter for measuring the current, and R is a rheostat. By connecting the positive of one accumulator to the negative of the other, the two e.m.f.'s add together, because obviously the current in the circuit is getting two "pushes" of 2 volts, which is the same as one "push" of 4 volts. If R were short-circuited or omitted from the circuit, nearly the full e.m.f. of the battery would be across the lamp L, as the resistances of the battery itself and the ammeter are extremely small. We know that the lamp will then have too great a current through it, as it is designed to work with a potential of 3 volts across it. The current which should pass through the lamp is $\frac{6}{3} = 2$ amperes, and we can make use of this fact to adjust matters in the circuit. The simplest way of doing this is to put the rheostat R in the circuit and to adjust it until the ammeter reads 2 amperes.

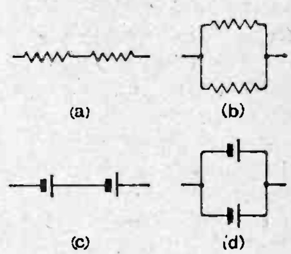


Fig. 5.—Resistances and batteries in series—(a) and (c), and in parallel—(b) and (d).

In Fig. 3 the terminals of the battery and of R, L, and A are marked + or −. The current, as we have already stated, flows from + to − in the resistance part of the circuit, and from − to + in the battery or driving part of the circuit, as shown by the arrows. It is easy to think of this as current flowing down-hill through resistance, but being pushed uphill by a battery. This gives us the idea that there is a falling of potential round the resistance part of a circuit, and a raising of potential through a battery, and, because of this, P.D.s round a circuit may be looked upon as a series of hills, up or down according as the P.D. is across a battery or across a resistance. These imaginary hills are referred to as potential gradients.

Fig. 4 is intended to explain this idea of potential gradient, and illustrates what happens in the circuit of Fig. 3. The dotted lines indicate connecting wires, which, having negligible resistance, cause practically no potential drop. Following the current round from the switch, the potential gradient is uphill through the

Introduction to Wireless Theory.—

two cells, and then downhill through R, L, and A, as these are resistances. The drop across A is only slight, as its resistance is small.

It will be noticed that the + side of each part of the circuit comes at the top of the corresponding slope, and this serves to remind us again of the direction in which current flows through batteries and resistances.

The difference of height between the beginning and the end of each slope represents the difference of potential between the beginning and the end of the corresponding part of the circuit. There must be as much downhill as there is uphill, otherwise we should not arrive at the same level as that at which we started.

The dotted lines on the first two up gradients show more exactly the form of the up-slope, because the e.m.f.

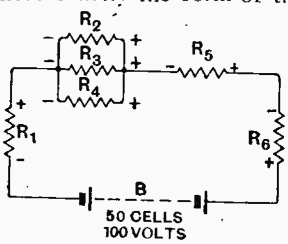


Fig. 6.—In this circuit the resistances R_2, R_3 and R_4 are connected in parallel, the unit so formed being connected in series with the remaining resistances R_1, R_5 and R_6.

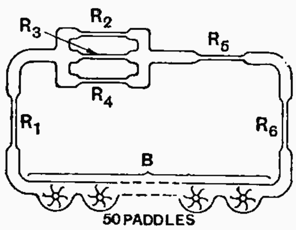


Fig. 7.—Hydraulic analogy to the circuit of Fig. 6.

of each cell raises the potential a full 2 volts, but a little of this is effectively lost in the small internal resistance of the cell.

Whenever a potential gradient is downhill, electrical power is leaving the circuit, and when the gradient is uphill, power is being put into the circuit.

The lamp of which we have spoken in this example might very well be a 3-volt, 2-ampere filament of a valve, and the circuit shown represents the circuit which might be employed to light it from two 2-volt accumulators.

Series and Parallel Connections.

There are two ways of connecting together units of a circuit to form a single unit. These arrangements are called "series" and "parallel." Fig. 5(*a*) shows two resistances in series, (*b*) two resistances in parallel, (*c*) two batteries in series, and (*d*) two batteries in parallel. In Fig. 5(*b*) and (*d*) the black spots indicate that wires are connected together at those points.

In drawing a number of batteries connected in series, it is usual to omit the wire in between adjacent batteries to save time. In Fig. 6, for example, it would be totally unnecessary to draw fifty or so accumulator cells separately, so only a few are shown with a note of the e.m.f. of the whole number in series. In Fig. 6 we really have four resistance units in series, one of them consisting of a group of three resistance units in parallel.

From Fig. 7, which is a water pipe equivalent of Fig. 6, we can easily see what is going to be the effect of connecting resistances in series and parallel. Clearly two narrow pipes in series will hold back the flow of water more than will one narrow pipe. In fact, the resisting effects of narrow pipes in series are added together. Similarly, the resistance of electrical resistances in series add together, the combination having a resistance equal to the sum of all the component resistances.

The resisting effect of a combination of resistances in parallel, however, is obviously less than that of any one of them singly; in Fig. 7 the combination of R_2, R_3, and R_4 results in a larger path for the water than would be provided by any of these alone, because the flow of water splits up between the three pipes. In Fig. 6, therefore, the resistance of the combination of R_2, R_3, and R_4 in parallel is less than the resistance of any of them alone. It is clear that we could find one pipe which would provide just as much resistance to the flow of water in Fig. 7 as is given by R_2, R_3, and R_4 in parallel. Similarly we can always obtain a single electrical resistance equivalent to any combination of resistances in parallel. If R is this equivalent resistance then

$$\frac{1}{R} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

This may be extended to any number of resistances in parallel.

We can further see from Fig. 7 that the push of the fifty paddles in series adds up; in the same way, in Fig. 6 the e.m.f.'s of the fifty 2-volt cells all add up, giving a total e.m.f. of 100 volts. By this means any desired e.m.f. can be obtained by suitably connecting the cells.

It will be noticed from Fig. 5 that when the same kind of units are connected in series, they are connected − to +. When in parallel they are connected − to − and + to +. It is important when connecting cells in parallel not to make a mistake with the − to − and + to + arrangement. If this is accidentally reversed, we have the arrangement of Fig. 8(*a*), which is really the same as Fig. 8(*b*), and consists of two cells connected in series and short-circuited.

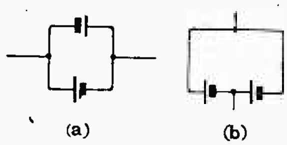


Fig. 8.—Cells incorrectly connected in parallel, resulting in the complete discharge of both cells.

Connecting cells in parallel does not give us any advantage in the way of an increase of e.m.f. It merely serves to give us a battery capable of storing a larger amount of energy; it is often better to use several cells in parallel than to use a single cell if we want to force a large current round a circuit. For example, if we have a supply of 2-volt accumulators with a maximum safe current of 2 amperes, and we require a supply of electrical energy at 2 volts and 10 amperes (20 watts), we must connect at least five cells in parallel. The current flowing round the circuit will then split up, so that not more than 2 amperes flow through each cell.

Cells or batteries of largely unequal voltage should not be connected in parallel, as if they are the battery of higher e.m.f. will force current through the battery of lower e.m.f., so that, although the rest of the circuit may be open, the battery of higher e.m.f. will be continuously discharging and so wasting its store of energy.

In lighting systems, lamps are usually arranged in *parallel* with a generator, so that any lamp may be switched off without all the remainder going out.

The Reader's GUIDE TO LOUD-SPEAKER TYPES.

There are at the present time so many different types of loud-speakers, and the number has been so largely augmented in the past few weeks, that we think the following list will be of interest and assistance to readers as including practically all loud-speakers which are at present available, with a brief description of each type and the price at which they are sold.

The classification is under the name of the makers in alphabetical order, as this appears to be the most convenient form for reference.

ACROPHONE, LTD., Graisley Works, Church Lane, Wolverhampton.
"CURFEW," Model A. Metal horn, black enamel (2,000 or 4,000 ohms) £3 15 0
"CURFEW," Model B. Metal horn, imitation wood (2,000 or 4,000 ohms) £4 10 0

ASHDOWN, H. E. (BIRMINGHAM), LTD., Perry Bar, Birmingham.
"ASHDOWN." Metal horn £4 0 0

ASHLEY WIRELESS TELEPHONE CO., 67, Renshaw Street, Liverpool. (Sole distributors for A.T.M. Telephones and Loud-speakers.)
"CLARITONE," Senior model. Metal horn (2,000 ohms) £5 0 0
"CLARITONE," Junior model. Metal horn (2,000 ohms) £2 15 0

BERCI, M., 329, High Holborn, W.C.1.
"BULLDOG," larger size. Metal horn £1 1 6
"BULLDOG," smaller size. Metal horn £0 15 9

BRANDES, LTD., 296, Regent Street, W.1.
"BRANDOLA," metal horn 12in. diameter (2,000 ohms) £4 10 0
"TABLE TALKER," metal horn 10in. diameter (2,000 ohms) £1 10 0

BRITISH ELECTRICAL SALES ORGANISATION, Australia House, Strand, W.C.2.
"BE-CO." Hornless, 5in. diaphragm, nickel plated .. £2 12 6
"BE-CO." Hornless, 5in. diaphragm, oxydised copper or silver £2 15 0

BRITISH L.M. ERICSSON MFG. CO., LTD., 67-73, Kingsway, W.C.2.
"SUPERTONE," Senior. Metal horn (2,400 ohms) .. £3 15 0
"SUPERTONE," Junior. Metal horn (2,000 ohms) ... £1 19 6

BRITISH THOMSON-HOUSTON CO., LTD., Crown House, Aldwych, W.C.2.
"B.T.H." Model C1. Metal horn (2,000 ohms) £2 10 0
"B.T.H." Model C2. Metal horn (2,000 ohms) £5 0 0
"B.T.H." Model C5. Table lamp type £5 0 0
"B.T.H." Model C8. Straight horn 11½in. dia ... £1 15 0
"B.T.H." Model D. Electro-dynamic type £9 10 0
"B.T.H." Model E. Hornless (2,000 ohms) £6 5 0

BROWN, S. G., LTD., Victoria Road, North Acton, W.3.
TYPE H1. Metal horn (120 ohms) £5 5 0
TYPE H1. Metal horn (2,000 ohms) £5 8 0
TYPE H1. Metal horn (4,000 ohms) £5 10 0
TYPE H3. Metal horn (2,000 and 4,000 ohms) £3 3 0
TYPE H4. Metal horn (2,000 ohms) £1 10 0
TYPE H.Q. Metal horn (120 ohms) £5 15 0
TYPE H.Q. Metal horn (2,000 ohms) £5 18 0
TYPE H.Q. Metal horn (4,000 ohms) £6 0 0
TYPE Q. for halls or outdoor use (120 and 4,000 ohms) £15 15 0
TYPE C. cabinet type (120, 2,000 and 4,000 ohms) .. £6 6 0
"CRYSTAVOX." Metal horn (combined amplifier and loud-speaker) £6 0 0

BULLEN, W., 272, Green Street, Upton Park, E.7.
"BULLPHONE." Concert Grand. Metal horn. Art Lacquer £4 5 0
"BULLPHONE." Concert Grand. Metal horn. Plain black £3 3 0

BURNDEPT WIRELESS, LTD., Aldine House, Bedford Street, W.C.2.
"ETHOVOX." Wooden horn, 15in. dia. (120 and 2,000 ohms) £5 5 0
"ETHOVOX." Metal horn, 15 in. dia. (120 and 2,000 ohms) £4 10 0
"ETHOVOX" Junior. Metal horn, 11½in. dia. (120 and 2,000 ohms) £2 2 0

CABLE ACCESSORIES CO., LTD., Tipton, Staffs.
"REVO" Senior. Metal horn (2,000 and 4,000 ohms) £4 0 0
"REVO" Junior. Metal horn (2,000 ohms) £2 8 0
"REVO" Baby. Metal horn (2,000 ohms) £1 5 0

CLEAR-HOOTERS, LTD., Highgate Square, Birmingham.
"ENTERTAINER." Metal horn, 12in. dia. (120, 2,000 or 4,000 ohms) £2 10 0

CROMWELL ENGINEERING CO., 81, Oxford Avenue, Merton Park, S.W.20.
"ALLISON." Metal horn, 14in. dia. (120 ohms) £4 10 0
"ALLISON." Metal horn, 14in. dia. (2,000 ohms) .. £4 12 6
"ALLISON." Metal horn, 14in. dia. (4,000 ohms) .. £4 15 0
Oak horn, 15in. dia. £1 extra.
Mahogany horn, 15in. dia. £1 5s. extra.

DENT & CO. & JOHNSON, LTD., Linwood, Paisley.
"LINWOOD." Type P. Metal horn £5 0 0
"LINWOOD." Type C. Concert model £10 0 0

EDISON SWAN ELECTRIC CO., LTD., 123-125, Queen Victoria Street, E.C.4.
"TELEVOX." Metal horn (with tone control) (2,000 ohms) £5 5 0
"DULCIVOX." Metal horn (2,000 ohms) £2 2 0

ELECTRICAL MANUFACTURING & PLATING CO., Hampton Wick, Kingston-on-Thames.
"CELESTION." Hornless in oak or mahogany cabinet (3,000 ohms) £6 10 0
"CELESTION." Hornless in walnut cabinet (3,000 ohms) £6 15 0

FALK STADELMANN & CO., LTD., 83, Farringdon Street, E.C.4.
"PURAVOX." Standard model. Metal horn £4 0 0
"PURAVOX." Junior model. Metal horn £2 8 0
"PURAVOX." Miniature model. Metal horn £1 5 0

FELLOWS MAGNETO CO., LTD., Cumberland Avenue, N.W.10.
"VOLUTONE." Metal horn (2,000 ohms) £4 10 0
"JUNIOR." Metal horn (2,000 ohms) £1 10 0

FLEET RADIO STORES, 143-144, Fleet Street, E.C.4.
"FLEET." Metal horn. 17s. 6d., £1 10s., £2 15s., and £5 0 0

FULLERS' UNITED ELECTRIC WORKS, LTD., Chadwell Heath, Essex.
"SPARTA." Type A. Metal horn (120, 2,000 or 4,000 ohms) £4 15 0
"SPARTA." Type B. Metal horn (with tone control) (120 ohms) £5 15 0
"SPARTA." Type B. Metal horn (with tone control (2,000 or 4,000 ohms) £6 0 0
"LITTLE SPARTA." Metal horn (120, 2,000 or 4,000 ohms) £2 15 0

The Reader's Guide to Loud Speaker Types.—

GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, W.C.2.
"GECOPHONE." Ebonite horn (1,000 or 4,000 ohms) (adjustable) ... £5 0 0

GENERAL RADIO CO., LTD., 325, Regent Street, W.1.
"ARISTOCRAT." Metal horn (in cabinet) ... £5 5 0
"PLEASURE TIME." Metal horn ... £3 10 0
"HEARTHSIDE." Metal horn ... £1 15 0

GENT & CO., LTD., Faraday Works, Leicester.
"TANGENT." Concert model. Metal horn (2,000 ohms) ... £5 0 0
"TALL BOY." Metal horn (2,000 ohms) ... £5 0 0
"BABY TANGENT." Metal horn (2,000 ohms) ... £2 2 0

GRAFTON ELECTRIC CO., 54, Grafton Street, W.1.
"GRELCO." Metal horn (2,000 ohms) ... £2 10 0

GRAHAM, A. & CO., St. Andrew's Works, Crofton Park, S.E.4.
"AMPLION." Concert Grand Model. Oak bell, 26in. dia. (250 or 2,000 ohms) ... £14 10 0
"AMPLION." Lecture hall Model. Oak bell, 23in. dia. (120 or 2,000 ohms) ... £10 10 0
"AMPLION." Concert Table Model. Oak bell. 19in. dia. (250 or 2,000 ohms) ... £8 10 0
"AMPLION." Swan-neck Model. Oak bell. 14½in. dia. (120 and 2,000 ohms) ... £6 0 0
"AMPLION." Standard Model. Oak bell. 14in. dia. (120 and 2,000 ohms) ... £5 5 0
"AMPLION." Junior Model. Oak bell (120 or 2,000 ohms) ... £3 5 0
"AMPLION." Junior Model. Metal horn. 10in. dia (120 or 2,000 ohms) ... £2 10 0
"AMPLION" Junior, straight metal horn, 8in. dia. (120 or 2,000 ohms) ... £1 7 0
"AMPLION DRAGONFLY." Metal horn, 5½in. dia. (120 or 2,000 ohms) ... £1 5 0
"RADIOLUX AMPLION." Cabinet type (mahogany) £8 8 0
"RADIOLUX AMPLION." Cabinet type (metal) smaller size ... £4 15 0

HOUGH, J. E., LTD., Glengall Road, Old Kent Road, S.E.15.
"EDISON-BELL," hornless (3,000 ohms) ... £2 2 0

MARCONIPHONE CO., LTD., 210–212, Tottenham Court Road, W.1.
"PRIMAX" hornless, with pleated diaphragm (2,000 ohms) ... £6 0 0
"PRIMAX" hornless, Statuette model (2,000 ohms).. £20 0 0
"MAGNAVOX," metal horn, 14in. dia. (120 ohms)... £5 5 0
"AUDIOVOX," metal horn (2,000 ohms) ... £4 10 0
"BABY," metal horn (2,000 ohms) ... £2 10 0
"AMPLIVOX." Combined amplifier and "Baby" loud-speaker ... £5 19 0
"DINKIE." Metal horn, 7in. dia. (2,000 ohms) ... £1 10 0
"MELLOVOX," hornless (cone diaphragm) (2,000 ohms) £2 8 0

RADIO INSTRUMENTS, LTD., 12, Hyde Street, New Oxford Street, W.C.1.
"R.I." Metal horn, 14in. dia (2,000 ohms) ... £5 5 0

RADIO EQUIPMENT CO., 5, Dyers' Buildings, Holborn, E.C.1.
"R.E.C. AMBASSADOR." Large size ... £4 15 0
"R.E.C. AMBASSADOR." Small size ... £2 2 0

RADIO COMMUNICATION CO. LTD., 34–35, Norfolk Street, Strand, W.C.2.
"AUDALION." Hornless (cylindrical type diaphragm) £7 7 0

ROTHERMEL, R. A., LTD., 24–26, Maddox Street, Regent Street W.1.
"BURNS." No. 205B. Metal horn ... £5 10 0
"BURNS." No. 205D. Pyralin horn ... £6 10 0
"REMO." Metal horn ... £3 7 6

SERENADA MANUFACTURING CO., 22, Paper Street, E.C.1.
"SERENADA." Model No. 50. Non-metallic horn 14in. dia. ... £4 4 0
"SERENADA." Model No. 30. Non-metallic horn, 12in. dia. ... £3 3 0
"SERENADA." Model No. 25a. Non-metallic horn, 10in. dia. ... £2 10 0

SIEMENS BROS. & CO., LTD., Woolwich, S.E.
"SIEMENS." Metal horn (120 ohms) ... £2 2 6
"SIEMENS." Metal horn (2,000 ohms) ... £2 4 0
"SIEMENS." Metal horn (4,000 ohms) ... £2 5 0

STELLA PRODUCTS, LTD., 31, Wybert Street, N.W.1.
"STELLA." Metal horn ... £3 10 0
"LITTLE STELLA." Metal horn ... £1 15 0
"WEMBLEY." Metal horn ... £1 2 6

STEVENS, A. J., & CO., LTD., Walsall Street, Wolverhampton.
"A.J.S." Standard. Wooden horn (2,000 ohms).. £4 15 0
"A.J.S." Standard. Metal horn (2,000 ohms).... £4 0 0
"A.J.S." Junior. Metal horn ... £1 15 0
"A.J.S." Cabinet type ... £4 15 0

SUPERLAMP, LTD., 197, Old Street, E.C.2.
"SONGSTER DE LUXE." Metal horn ... £0 15 6

TELEPHONE MANUFACTURING CO., LTD., Hollingworth Works, Dulwich, S.E.
"TRUE MUSIC." Concert grand type. Metal horn, 15½in. dia. (4,000 ohms) ... £6 10 0
"TRUE MUSIC." Standard type. Metal horn, 10in. dia. (4,000 ohms) ... £5 0 0
"TRUE MUSIC." Junior Type. Metal horn, 6in. dia. (4,000 ohms) ... £2 10 0
"TRUE MUSIC." Minor. Straight metal horn, 8in. dia. (4,000 ohms) ... £1 1 0

VANDERVELL, C. A., & CO., LTD., Warple Way, Acton, W.3.
"C.A.V." Standard type. Metal horn (120 ohms). £4 5 0
"C.A.V." Standard type. Metal horn (2,000 ohms) £4 10 0
"C.A.V." Standard type. Metal horn (4,000 ohms) £5 0 0
"C.A.V." Junior. Standard type. Metal horn (2,000 ohms) ... £2 15 0
"C.A.V." TOMTIT. Standard type. Metal horn (2,000 ohms) ... £1 7 6
"C.A.V." Hornless. (2,000 ohms) ... £5 5 0

WARD & GOLDSTONE, Pendleton, Manchester.
"GÖLTONE." Concert grand type. Metal horn, 14in. dia. (2,000 ohms) ... £4 0 0
"GÖLTONE JUNIOR." Metal horn, 9in. dia. (2,000 ohms) ... £1 10 0
"GÖLTONE MAVIS." Metal horn, 7in. dia. (2,000 ohms) ... £1 5 0

WESTERN ELECTRIC CO., LTD., Connaught House, Aldwych, W.C.2.
Model 44002. Metal horn (320 ohms res., 2,000 ohms impedance) ... £7 7 0
Model 44005. Metal horn (320 ohms res., 2,000 ohms impedance) ... £5 5 0
"KONE." Model 44007. Hornless 18in. diaphragm (750 ohms res., 5,000 ohms impedance) ... £6 6 0

YOUNG, A. M., & CO., Bordesley Street, Birmingham.
"RONDAR." Metal horn (2,000 ohms) ... £3 0 0

TRADE NOTES.

The Rothermel Corporation.

Messrs. R. A. Rothermel, Ltd., inform us that owing to expansion of business the radio section has now been taken over by the Rothermel Corporation of Great Britain, Ltd. The management and policy will be in no way affected.

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Electrical Trades' Benevolent Institution.

The Rt. Hon. F. G. Kellaway will be the principal guest at the Electrical Trades' Benevolent Institution Festival Dinner at the Trocadero Restaurant this evening (Wednesday).

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The A.J.S. Choke.

We regret that this component was inadvertently referred to as the A.J.S. transformer on page 360 of *The Wireless World* of September 16th. The company does not manufacture transformers, all their sets being choke coupled.

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The M.P.A. Receiver.

In connection with the description included in the issue of October 14th of the exhibits of the Wireless Exhibition held at the Royal Horticultural Hall, the receiving set described on page 506 should have been styled with the initial letters "M.P.A.," and not "M.A.P." as shown. This set is a product of the M.P.A., Ltd., 62, Conduit Street, Regent Street, London, W.1.

DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Current Transformer. A transformer with its primary winding connected in *series* with one of the mains, the secondary being connected to an ammeter or other measuring instrument or apparatus.

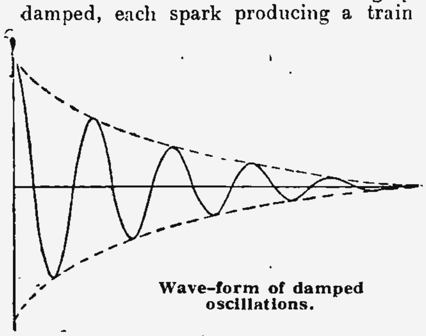
C.W. Abbreviation for *continuous waves.*

Cycle. The sequence of values attained by an *alternating quantity* in passing through one complete set of its positive and negative values. See ALTERNATING CURRENT.

Cymometer (Fleming's). A *wavemeter* in which both the inductance and the capacity are varied simultaneously by the operation of one handle. Such an arrangement allows one to read off directly the *oscillation constant* of the circuit.

D.

Damped Oscillations. Oscillations which rapidly decrease in *amplitude* and die away. The oscillations in a spark transmitter are more or less highly damped, each spark producing a train of oscillations which rapidly die out. The ratio of the amplitude of one half-wave to that of the next in a train of damped oscillations is called the "damping." See also LOGARITHMIC DECREMENT.


Wave-form of damped oscillations.

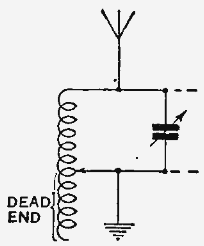
Damping. A term implying the rate at which an oscillation dies away or decays. See DAMPED OSCILLATIONS and LOGARITHMIC DECREMENT.

D.C. The usual abbreviation for *direct current.*

D.C.C. Abbreviation for "double cotton covered."

Dead Beat Instrument. A measuring instrument in which the pointer comes to rest at its final position without previously oscillating backwards and forwards about that position.

Dead Ends. Where only part of a tuning coil is used in an *oscillating circuit* the idle portion is called a "dead end." If the *self-capacity* of this dead end portion of the coil should tune it to a frequency approximating to that of the oscillations in the useful portion of the coil, a serious loss of energy will occur. It is bad practice to use a coil in this manner if it can be avoided.



Dead end turns.

Decrement. See LOGARITHMIC DECREMENT.

Decremeter. An instrument for determining the *logarithmic decrement* of *damped oscillations.* The current in a circuit tuned to resonance is compared with that in another circuit detuned by a known percentage.

De Forest Coil. See HONEYCOMB COIL.

Degree of Coupling. See COEFFICIENT OF COUPLING.

Detector. That part of a wireless receiver which *rectifies* the high-frequency oscillations, or by any other means renders them capable of producing audible sounds in the telephones. See RECTIFICATION.

Detector Valve. In a valve receiver, that valve whose function it is to *rectify* the high-frequency oscillations. See RECTIFICATION and VALVE DETECTOR.

Detuning. The act of tuning an oscillatory circuit to a frequency which is slightly different from that of the oscillations being dealt with.

D.F. Station. Abbreviation for "Direction Finding Station."

Diagram of Reception. A polar curve in which the sensitivity of a receiver is represented by the lengths of vectors drawn in the directions from which the signals are received. See DIRECTION FINDER.

Diaphragm. The thin flexible disc as used in a telephone transmitter or receiver, capable of responding to the sound vibrations.

Dielectric. An insulator capable of withstanding considerable electric pressure or voltage without breaking down and allowing a discharge to pass through it. The insulating medium between the plates of a condenser.

Dielectric Absorption. See ABSORPTION.

Dielectric Coefficient or **Dielectric Constant.** See SPECIFIC INDUCTIVE CAPACITY.

Dielectric Hysteresis. The loss of energy in a *dielectric* when it is subjected to an alternating voltage. See ABSORPTION.

Dielectric Strength. The capacity of a *dielectric* to withstand an electric pressure without a discharge taking place through it, usually measured in volts per centimetre required to break it down. The dielectric strength varies considerably according to the circumstances under which the test is made.

Difference of Potential. See POTENTIAL and POTENTIAL DIFFERENCE.

Diode. A two-electrode valve or Fleming valve.

Direct Coupling. An *inductive coupling* in which the two circuits are metallically connected, thus providing a continuous path through the two coils.

Direct Current. A *current* which flows in one direction only round a circuit. By direct current it is usually understood that the current is a steady one, as opposed to a unidirectional pulsating current. A direct current is commonly called a continuous current. Cf. ALTERNATING CURRENT.

Direction Finder. A wireless receiver for determining the direction from which signals are proceeding. The actual directional properties are possessed by the aerial system, the receiver itself differing very little from the ordinary type, except that it must be carefully screened in order that signals are not picked up by the tuning coils, etc., other than *viâ* the aerial.

One arrangement consists of two aerials placed at right angles to each other, known as the "Bellini-Tosi System." The two aerials are connected to an instrument called a *radiogoniometer,* which consists of two coils fixed mutually at right angles and a third coil rotatable within the fixed ones. The aerials are connected to the fixed coils and the receiving apparatus to the movable coil of the radiogoniometer. Suppose that a signal is proceeding from a direction in the plane of one of the aerials. Then loudest

Dictionary of Technical Terms.—
signals will be heard when the detector coil is brought into the same plane as the coil connected to that aerial. The instrument is usually calibrated so that minimum signal strength gives the direction of the station received.

In another form of direction finder a *frame aerial* is employed, and is rotated until maximum or minimum signal strength is obtained. By combining two direction finders at a known distance apart a wireless range finder can be made, operating on the principle of triangulation.

Directional Aerial. An *aerial* which is arranged to send out electric waves of much greater strength in one particular direction. An ordinary "inverted L" aerial gives greatest radiation in the plane of the aerial. The Bellini-Tosi aerial as used in a *direction finder* is a directive aerial. See WIRELESS BEAM.

"Dis." Colloquial expression for "disconnection" or "broken circuit."

Disruptive Discharge. A sudden passage of a spark due to the breakdown of the insulating medium between two conductors or dischargers which have been raised to potential difference higher than the insulating medium can withstand.

Distortion (of speech). The change of wave shape experienced by sound vibrations when subjected to the many transformations which they have to undergo in wireless telephony from the time they leave the speaker's mouth to the time they reach the ear of the listener.

Distributed Capacity. See SELF-CAPACITY.

Double Reaction. In a valve receiver employing a *high-frequency* amplifying valve before the *detector, reaction* is sometimes applied by separate *reaction coils* to the grid circuits of both the high-frequency valve and the detector valve simultaneously. This is known as double reaction. See REACTION.

Down Lead. The wire connecting the elevated portion of an aerial to the instruments. It includes the *leading-in wire.*

D.P. Abbreviation for "double-pole."

Drop of Potential, Pressure, Voltage, etc. The *difference of potential* between two given points on a conductor carrying a current, being the voltage required to drive the current through the *resistance* or *impedance* of that part of the circuit.

Dry Battery. A battery of *dry cells.*

Dry Cell. A primary cell of the *Leclanché* type in which the *electrolyte* is in the form of a plastic paste. The container is made of zinc and forms the negative pole of the cell.

D.S.C. Abbreviation for "double-silk-covered."

D.T. Abbreviation for "double-throw."

Dual Amplification. The attainment of both high-frequency and low-frequency amplification simultaneously by means of a single *thermionic valve.* A valve circuit used in this way is called a "reflex circuit." The received high-frequency oscillations are first amplified by the valve, then rectified by means of a crystal (or another valve), giving audiofrequency oscillations which are again fed back to the input side of the valve and so further amplified.

Dull Emitter Valve. A *thermionic valve* in which the filament is specially treated so that it is capable of giving good *emission* at comparatively low temperatures, thus economising in filament current. In one form the filament is coated with thorium.

Dumb Aerial. A closed non-radiating oscillatory circuit having the same oscillation frequency and effective resistance as the main transmitting aerial. During the sending of Morse signals the oscillator of the transmitter is switched over to the dumb aerial during the "spacing periods" between the dots and dashes, so keeping constant the load on the oscillator.

Dummy Aerial. See ARTIFICIAL AERIAL.

Duplex Radiotelephony. A system enabling transmission and reception of messages to be carried on simultaneously between two stations as on ordinary land telephone lines.

Dynamic Characteristics (of thermionic valve).—The characteristics of a valve taken under working conditions, *i.e.*, with alternating currents traversing the valve. Cf. STATIC CHARACTERISTICS.

Dynatron. A kind of *thermionic valve* in which the *electrons* given off by the filament strike the plate with sufficient velocity to cause the latter to emit secondary electrons, the actual plate current obtained being proportional to the difference between the number of primary electrons reaching it and the number of secondary electrons being re-emitted. Cf. KENOTRON and PLIOTRON.

Dyne. The unit of force in the C.G.S. system of units. It is the force required to give a mass of one *gram* an acceleration of one centimetre per second. The gravitational pull on a mass of one gram at sea level at the latitude of London is about 981 dynes, so that a gram weighs 981 dynes.

E.

"Earth." An electrical connection made with the earth. In the usual type of wireless receiver with an open aerial the high-frequency oscillations pass between the earth and the aerial through the main tuning arrangements of the receiver. For this purpose the resistance of the earth connection should be as low as possible. There are various methods of obtaining an efficient earth connection—for instance, by burying deeply and in a damp place as large a metallic "earth mat" as possible, or by burying a fan-shaped system of wires under the entire length of the aerial. The driving of a copper tube into the earth as an earth connection is not very efficient. Connection to the town water-pipes sometimes makes an excellent earth connection. Gas-pipes should not be used for this purpose, as the red-leaded joints are likely to offer an abnormally high resistance.

Earth Potential. On account of the large size of the earth its *potential* is considered to be fixed and is said to be zero. Any part of a circuit which is directly connected to earth is said to be at earth potential, or *zero potential.* Sometimes in connection with valve circuits any part of the circuit between which and earth there is no oscillating potential difference is said to be at "zero high-frequency potential," even though the mean or D.C. potential be not zero.

Eddy Currents. Name for the currents which are induced in the mass of solid conductors by varying magnetic fields. These currents usually circulate in "eddies" inside the conductor, and hence their name. They are responsible for a loss of energy which manifests itself as heat, and to minimise this loss the conductor in question is laminated, insulation being placed between the individual *laminations* to break up the path of the eddy currents, *e.g.*, the iron paths of all *alternating* magnetic circuits are laminated. See SKIN EFFECT.

Effective Value (of Current, E.M.F., etc.). The Root-Mean-Square value of current, E.M.F., etc. See ALTERNATING CURRENT.

Efficiency. The ratio of the useful output from any given piece of apparatus to the total input. It is usually expressed as a percentage and denoted by the Greek letter η ("eta"). See RADIATION EFFICIENCY.

Einthoven Galvanometer. A sensitive galvanometer in which a very thin filament of silvered glass is stretched between the poles of a powerful electro-magnet. The passage of current causes the thread to be deflected to one side, and this deflection is observed by means of a microscope when measuring steady currents. The instrument can be very effectively used for the recording of Morse signals by a photographic method.

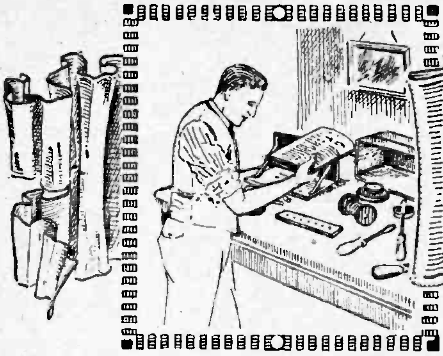
Electric Field. The space surrounding an electrified body, in which its effects can be detected. A place where electrostatic *lines of force* exist.

Electric Waves. See WAVES.

Electro-Chemical Equivalent. See ELECTROLYSIS.

Electrode. The conductor by means of which the current enters or leaves any given piece of apparatus. The term is used especially in connection with cells, valves and like apparatus. See ANODE and CATHODE.

Electrolysis. The decomposition of a compound into its constituent elements by passing a current through it when it is in solution or in liquid form. Faraday's Law of electrolysis states that the mass of a given element deposited on one of the *electrodes* is directly proportional to the strength of the current flowing and the time during which it flows. The mass in grams of the element deposited in one second by a current of one *ampere* is called the "Electro-chemical Equivalent" of the element.



READERS' PROBLEMS

"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Push-pull Amplifiers.

I am intending to construct a push-pull receiver-amplifier, somewhat on the lines of the instrument recently described in "The Wireless World," using bright-emitter general-purpose valves throughout. Before proceeding with the constructional work, however, I should be glad to know if any advantage would accrue from using the push-pull system in both stages of the amplifier. R.D.T.

Since the purpose of the push-pull system is to avoid distortion due to valve overloading in those cases where it is not possible to employ a power valve, it would only be of advantage to use the push-pull method in the first stage if it is anticipated that serious overloading would occur in the first stage of the amplifier. Since it is usually possible to avoid this in the initial stage of an L.F. amplifier by using a reasonable H.T. value together with commensurate grid bias adjustment, it is not advised that the push-pull method be employed in the first stage.

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Valve-Crystal Receiver.

I wish to construct a valve-crystal receiver in which range coupled with selectivity is the main consideration. It is particularly desired that reflex circuits with their seemingly inseparable low-frequency buzzes be eschewed. Can you recommend to me a suitable circuit? T.R.O.

The circuit which we give in Fig. 1 will be found excellent for the purposes of obtaining long-distance reception with a minimum of valves. The advantages of loose coupling and full magnetic reaction are incorporated, but at the same time the circuit is perfectly stable, reaction control being very smooth.

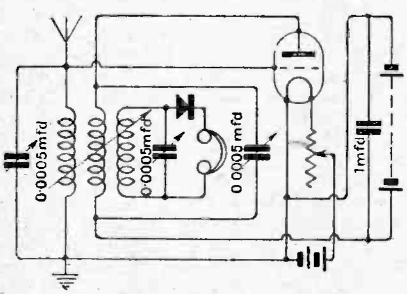

Fig. 1.—"Straight" valve-crystal circuit.

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H.F. Transformer Coupling.

I wish to construct a two-valve receiver (1-v-0) in which the tuned transformer method of H.F. coupling is employed, but I wish to employ plug-in coils for primary and secondary in order to obtain selectivity. Please indicate a suitable circuit. N.R.D.

We give in Fig. 2 a circuit on these lines as requested. Each plug-in coil comprising the H.F. transformer should be tuned by a separate condenser. This circuit will give considerably less selectivity, but at the same time will be more stable than a more conventional circuit using loose coupling in the aerial circuit, the reason being the same in both instances, namely, the damping caused by the direct coupling in the aerial circuit and in the grid circuit of the detector valve by the grid current due to the method of detection employed.

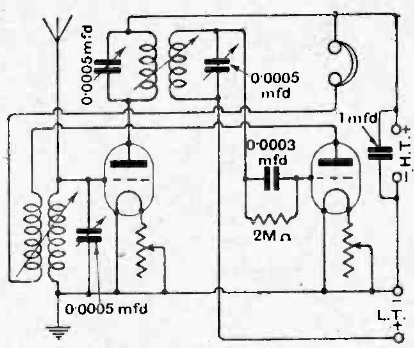

Fig. 2.—Two-valve receiver (H.F. and det.) with tuned transformer coupling.

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Life of Dry Cells.

Is it true that the life of a dry cell is in direct proportion to the amount of current drawn continuously from it? K.N.M.

This is, of course, quite untrue, the actual facts being that as the current drawn from any given cell increases its useful period of life falls off out of all proportion to the steady current increase. When using dry cells of even large, specially prepared types, it is advisable to restrict the current flow to ¼ ampere at the outside limit if it is desired that the life of the cell be of economical duration.

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Neutrodyne Transformers.

I am greatly interested in the type of H.F. transformers described in your article in the two-valve neutrodyne unit, and wish if possible to introduce them into a 1-v-0 receiver which I am building, but do not intend to make use of the neutrodyne principle, since only one H.F. stage will be used. Will you please criticise the enclosed circuit which I suggest? The reaction coil would be wound in a ball at one end of the second transformer, and it is understood that fifteen turns will be used on each primary. R.J.P.

We are afraid that trouble is likely from the point of view of stability, and we are of opinion that it would be far better to neutralise the H.F. stage in the manner suggested in our article, and thus make sure that perfect stability is achieved. In this manner a very effective receiver would be produced which would be both sensitive and selective, and at the same time perfectly stable. The neutralisation process should present no difficulty in a receiver of this type, it being carried out in accordance with the instructions given in the article referred to.

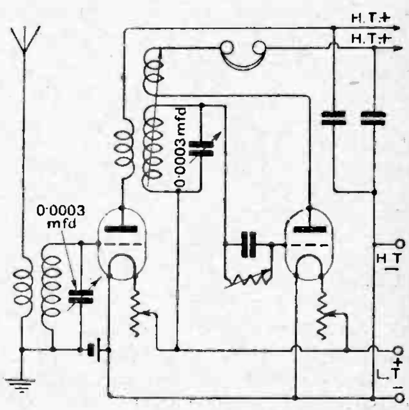

Fig. 3.—The circuit referred to by our correspondent (R. J. P.).

Converting Four-electrode Valves.

I have a number of four-electrode valves in my possession. Can you tell me how to connect these up in circuit so that they function as three-electrode valves? T.D.R.

The best method of accomplishing your purpose is to connect together the plate and the outer grid, and when connecting up in circuit to treat these two combined electrodes as the anode of a three-electrode valve, the inner grid then functioning as a normal grid.

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Amplifying after D.E.Q. Valves.

I am using a D.E.Q. valve as an anode rectifier in order to avoid distortion, but I notice that the quality of reproduction from the loud-speaker is only really good when the detector valve is followed by a stage of choke amplification, the tonal qualities being remarkably "thin" even when a very expensive form of low ratio transformer is used. Can you explain this? T.H.D.

The reason for this is, of course, quite clear. It must be remembered that this particular valve has a very high impedance, approximately three times that possessed by the ordinary type of "R" valve, which the low ratio transformer is intended to follow, and the primary of the transformer, although having a reasonably high impedance, does not possess a high enough value of this inestimable quality to render it suitable for connection in the plate circuit of a valve of the type mentioned. The result is that the lower musical tones are not amplified to the same extent as those of higher frequency, and the absence of these lower tones produces an impression of "thin" tone somewhat difficult to define. A good quality choke having a higher impedance than the primary of even the best low-frequency transformer gives considerably more even amplification of all frequencies and produces an effect more pleasing to the ear. It is advised, therefore, that a high impedance choke-coupled stage be used after the detector valve, followed by a suitable low impedance power valve, after which a transformer-coupled stage may be used with perfect confidence.

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Dull Emitter Valves.

I have frequently read in the various technical journals various methods of restoring the emission to an accidentally overrun dull-emitter valve, such as "flashing" and running the valve for a time with the H.T. battery disconnected. Can you inform me whether this method applies equally to all types of dull emitter? N.R.L.

This method applies to all valves of the thoriated filament type, the operation causing fresh active material to come to the surface of the filament, the aforementioned active material being, of course, imprisoned in the interior of the filament. In the case of coated filaments, however, there is obviously nothing in the interior of the filament to bring to the surface, and so this method falls to the ground. Actually, the effect of over-running the filament of a coated filament valve is different from that of over-running a valve having a thoriated filament. In the latter case, of course, the emission is at once seriously reduced, but it can, at any rate, be partially restored by adopting various expedients. In the former case, however, the effect is not to immediately reduce the emission but to shorten the life of the emission so that the valve's emissive properties come to an end far sooner than they would had the valve not been overrun at any time.

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Superheterodyne C.W. Reception.

I notice that when using my superheterodyne receiver I am unable to receive C.W. signals unless my intermediate amplifier is oscillating, and then only long-wave C.W. signals having a wavelength commensurate with the natural frequency of the intermediate amplifier. Surely this is incorrect, and I should be able to hear C.W. signals on the short wavelengths to which the frame aerial is tuned, since my first detector valve is in a state of oscillation, it being a combined oscillator and detector valve? R.H.T.

This is an error into which many readers fall. As is well known, in order to receive C.W. signals it is necessary for a source of local oscillations to be provided which are only very slightly different in frequency to the incoming frequency in order to produce an audible beat note. Now, in the superheterodyne receiver we either make use of a separate oscillator valve or a combined detector and oscillator valve in order to produce a beat note which is above the audible frequency range, hence the name of the receiver. It is obvious, then, that if we are intending to receive C.W. signals it is necessary to provide a second oscillator valve coupled to the grid circuit of the second detector valve in order to produce an audible beat note. The reason for long-wave C.W. being received when the intermediate amplifier is in a state of oscillation is that a beat note is formed between the incoming long wave signals picked up direct by the intermediate amplifier and the local oscillation set up by the amplifier itself.

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Earthing Variable Condensers.

There seems to be some conflict of opinion as to whether the moving or the fixed plates of a variable condenser should be connected to the earth terminal in the case of a condenser connected in parallel with the aerial tuning coil. Will you therefore give some enlightenment on this point? T.B.D.

In the case of all modern type condensers, where the fixed electrodes are completely insulated from the metal end plates, it is necessary for the moving electrodes to be connected to earth in order to avoid hand capacity effects. Since the two end plates and the whole of the moving plates, including the shaft, are in electrical connection, it will be found that if the method we suggest is adopted the end plates, being at earth potential, will act as a shield between the hand and the fixed plates, which are at higher potential. In the case of condensers of an older pattern, where the metal end plates are in electrical connection with the fixed plates, no hard-and-fast rule can be given, as hand capacity effects are apt to arise either between the hand and the metal shaft or the hand and the end plates. In most cases, however, where the old pattern of condenser is in use it will be found best to earth the fixed vanes.

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Anode Resistances.

I find that wire-wound anode resistances are very expensive to buy. Please give instructions for winding one of these instruments at home. R.E.H.

It is first necessary to obtain a 3in. length of ebonite rod, two inches in diameter, the rod having eight slots 0.1in. wide and about a quarter of an inch in depth cut in it. Wind thirty turns of No. 47 D.S.C. resistance wire in the first slot, and then a similar number on the second slot in the same direction. It is now necessary to return to the first slot and wind the same number of turns in the opposite direction, and then perform the same operation with the second slot. Then, again reversing the direction, return to the first slot and proceed as before, afterwards dealing with the next pair of slots in the same manner, and so on. This process is undergone in order to make the resistances as non-inductive as possible. The actual amount of wire wound in each slot depends, of course, on the value of resistance required, which should not be less than 40,000 ohms at the least, and in the case of very high impedance valves, such as the D.E.Q., will be as high as 250,000 ohms, 80-100,000 ohms being the best average value to use. The resistance of No. 47 S.W.G. Eureka wire is 214 ohms per yard.

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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.

A B.B.C. OBLIGATION.

IT is a matter of pride and congratulation that British broadcasting has been established on a stable basis which enables it to count upon a permanent existence without any cause for anxiety in so far as the financing of the organisation is concerned. In this respect, British broadcasting is probably in a position superior to that of any other country, and has no need to resort to the various expedients practised by other broadcasting organisations having no secure source of revenue for their support.

In America, as we know, most of the stations are owned by concerns which obtain publicity, direct or indirect, by virtue of this ownership; in South Africa definite contracts are accepted by the station organisers, who undertake to make direct advertising announcements which are sandwiched in between the programme items.

One very important factor which was taken into account when the British broadcasting organisation was set up was the recognition of the absolute necessity of avoiding all need to have recourse to the use of the microphone for purposes of advertising. It was recognised from the first that no systematic censorship of broadcasted matter could be undertaken except by the B.B.C. officials themselves, but the right to interfere if any unsuitable matter was introduced into the programmes was reserved to the Post Office. We believe that this right has been very rarely exercised by the Post Office, which in itself is a tribute to the tact and discretion of the B.B.C. officials. In the licence under which the B.B.C. operates, it is definitely laid down that no "paid for" advertising matter may be broadcast, and this regulation certainly protects the public from what might become a most distressing infliction. But we believe that the public care little whether or not advertising matter broadcast is paid for—the main concern is that the microphone should not be contaminated with advertising matter at all.

Whilst we appreciate that it is sometimes difficult to draw a hard and fast line between what may be construed as advertising matter and what is not, yet we are afraid the B.B.C. is not quite so strict in the observance of the principle of no advertising as the public would wish. There have, of late, been several instances where gratuitous advertising has been granted by the B.B.C. which has been of direct commercial value to the parties so privileged, whilst an outstanding example of advertising which has always been a matter of comment is the extraordinary publicity which is given to the official organs of the B.B.C., the *Radio Times* and the *Radio Supplement*. These journals, whilst they are owned by the B.B.C., do also provide a very substantial revenue to commercial concerns interested in their production, and it is very questionable whether the public does not resent the constant references made to these journals in microphone announcements. That the tendency of the B.B.C. is to become more lax in the matter of censorship of advertising is a matter which is beyond dispute, although, so far as we are aware, no wider discretionary powers have been granted to the Company.

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British broadcasting has been established on the basis of no advertising. It is to be hoped that the B.B.C. will not fail in this trust by permitting the establishment of advertising precedents which may lead to the gradual introduction of publicity broadcasting in the future.

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LOW-LOSS COILS.

Help to Find the Best.

THE term "low-loss" coil was, we believe, first used about eighteen months ago by a writer in the American Magazine Q.S.T. At that time very little investigation had been carried out into the electrical properties of tuning coils, but once the term "low-loss" had got into print the imagination of numerous writers was fired by these words, which acquired an almost magical significance. Low-loss coils became the craze, and coils of all sorts of unusual shapes and sizes were illustrated and described in wireless papers.

Amateurs and then manufacturers were not slow to realise that some of the new coils brought out were better than many of those in general use, with the result that to-day there are many varieties of home-made "low-loss" coil and many on the market that are given the same alluring description. A large proportion of the tuning coils offered for sale at the present time, and for that matter, condensers, valve holders and other component parts as well, are described as being of the "low-loss" variety. Such is the game of "follow the leader" that is being played in wireless to-day.

When Losses are Important.

The boom in "low-loss" components came at a time when a good deal of attention was being directed towards the problem of selectivity, and when amateurs and others were beginning to realise that the most careful use of reaction failed to give the results so much sought after. Then again the question of good quality was being gone into, and it was gradually recognised that neither good quality nor real selectivity, nor even maximum signal strength could be secured by using tuning coils and condensers with relatively bad electrical characteristics in receivers of conventional types. An improvement could nearly always be effected by replacing coils prepared without much regard to their design by others having really low losses.

The Laboratory Test.

It must, however, be understood that not all coils *described* as "low-loss" have small electrical losses, for it would appear, judging from the scarcity of reliable data on the subject, that many of the coils put forward are the result of their authors' own personal prejudices and fancies. We have coils of thick wire and of thin wire; some are wound on a tube and others on a former of skeleton construction, while some coils have their turns spaced and others are tightly wound. Certain amateurs prefer basket coils, others the so-called basket weave cylindrical coil; some like wire insulated with a double cotton covering, while others prefer an enamel-coated wire. Then again long coils of small diameter find favour in some camps, whilst the short coil of large diameter is recommended in others.

When these coils are put on test in the laboratory, it is found that nearly all of them are better than the types in vogue prior to the "low-loss" era, but it is also found that the best coils vary a good deal amongst themselves, coils of certain construction being far superior electrically to others of the "low-loss" type.

Taking Part in a Laboratory Experiment.

As a result of this state of affairs there are at the moment hundreds of amateurs who are so keenly interested that they have devoted considerable thought and time to the subject, and not a little ingenuity has been displayed in overcoming the many practical difficulties which have cropped up. A good deal of the work has been done by the "hit and miss" process, for comparatively few even amongst professionals have the equipment required for determining the electrical properties of coils really accurately.

> **LOW-LOSS COIL TESTS.**
>
> *Send us your idea of the best coil and so participate in the collection of valuable data. An award of five pounds will be made for the best coil, whilst every reader will benefit from the publication of results.*

An Invitation to Readers.

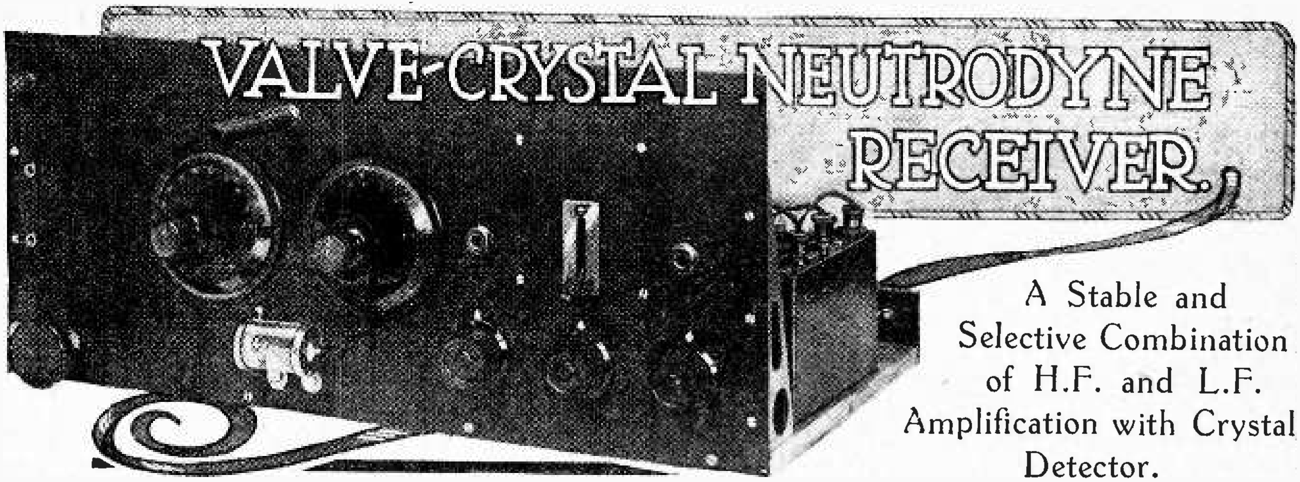
In order to collect valuable data for the benefit of our readers, we invite all who are interested in the subject to send to us a coil for a careful test to be carried out in our laboratory. The coils should be of a size normally used for tuning over the broadcast band of wavelengths, say between 250 and 550 metres. These coils will all be tested for high-frequency resistance at a frequency of 750 kilocycles (400 metres), and the resistance values so obtained will be expressed in terms of ohms per millihenry.

Details of the Scheme.

The coils sent in for test should be addressed to the Editor and carefully packed. Each coil will be given a number, details of their construction noted, and after test in the manner described above returned to their owners *with full details as to the results of the tests made in the laboratory*. When the tests have been completed, short descriptions of the coils with their electrical characteristics will be published, the coils being identified by their number.

Such complete data on tuning coils as will be obtained from these tests cannot fail to be of immense interest; not only will those amateurs who send in coils benefit, but all our readers will derive a very considerable amount of knowledge from the carefully collected results which will be published. The results so obtained will, of course, be of far more interest and of greater usefulness than if the coils were all made by one man. By inviting our readers to co-operate with us in investigating the "low-loss" coil question we, in effect, concentrate the attention of a number of thinkers on the subject.

To add to the interest of readers in this opportunity of working with us, an award of five pounds will be made to the reader sending in the coil which proves to be the most efficient.



VALVE-CRYSTAL NEUTRODYNE RECEIVER.

A Stable and Selective Combination of H.F. and L.F. Amplification with Crystal Detector.

By H. F. SMITH.

ALTHOUGH the crystal rectifier is generally admitted to perform its function in an extremely effective manner, it must be conceded that there is a tendency to regard its use after a high-frequency amplifying valve (or valves) as an almost certain and unavoidable source of instability and flat tuning. As far as the great majority of valve-crystal receivers are concerned, it must be admitted at once that this attitude is completely justified. The trouble really lies in the method of connecting the crystal to the H.F. part of the circuit; rectifiers of this type have a comparatively low resistance and, consequently, when connected across an oscillating circuit, take from it a considerable amount of energy, with the result that the circuit is heavily damped and a large build-up of voltage across it is prevented. The matter is further complicated by the fact that the effective resistance of an individual crystal varies enormously at different points of contact, and with varying degrees of contact pressure. If this were not so, it would be fairly easy to design a stable coupling.

A three-valve and crystal receiver designed for medium range, high-quality loud-speaker reproduction and long distance headphone reception. The crystal detector is connected in a somewhat unusual manner, in order to minimise its damping effects on the high-frequency circuits.

A wiring supplement for this receiver accompanies this issue.

Advantages of Crystal Rectification.

In spite of these drawbacks, the combination of valve and crystal can claim many supporters, who assert that, compared with other rectifiers, it is only equalled for distortionless detection by the valve operating on the bottom bend of its characteristic-curve, the latter having the disadvantage that much larger input amplitudes are necessary for equal results. While not wishing to join issue in this matter, which, as regards the last-mentioned alternative, at any rate, is distinctly controversial from a practical point of view, the writer would say that the crystal is unlikely to introduce distortion if properly used, and that, provided the difficulties mentioned can be overcome, its use has several distinct advantages.

In the receiver to be described the problem of eliminating damping has been solved by the simple expedient of arranging the circuit so that practically no current flows in the output circuit from the crystal, which acts here as a voltage rectifier. As no current is being taken by the crystal, it exerts little or no damping effect, and consequently can be adjusted without upsetting the constants of the tuned circuit across which it is connected.

Referring to the diagram given on the wiring supplement, it will be seen that the aerial circuit, which is normally untuned, can be loosely coupled to the grid inductance. Interchangeable coils are used, in order that the set may cover a wide band of wavelengths. Provision is made for optional tuning of the aerial circuit by plugging in an external variable condenser across the coil; "Clix" sockets are provided for this purpose. It is intended that for work on the 300-500 metre band this condenser will normally be dispensed with, but for long-distance reception of Daventry, Radio-Paris, etc., its use will be found to be of advantage.

In both the wiring plan and circuit diagram on the sheet accompanying this issue, the same lettering is used to indicate the various components.

The values are as follow:—C_1, C_2, 0.0005 mfd.; C_3, 0.0001 mfd.; C_4, C_6, 0.01 mfd.; C_5, C_7, 0.001 mfd.; C_8, C_9, 1 mfd.; R_1, R_2, 1 megohm.—N.C., neutralising condenser.

The H.F. valve is coupled to the crystal by means of a "neutrodyne" transformer similar in construction to the type recently described in this journal.[1] In this case, however, the extra capacity of wiring involved in the provision of an arrangement for interchanging the transformer may be tolerated, and the coils are fitted with a mounting carrying five pins, which fit into a suitable holder on the baseboard.

The crystal is connected across the tuned secondary winding of the transformer, and voltages rectified by it are applied across the grid-filament of the first L.F. valve through a large condenser, C_4. A leak is provided in order that charges may not accumulate, and the grid is negatively biassed to prevent the flow of

[1] See *The Wireless World*, Oct. 21st, 1925, page 531.

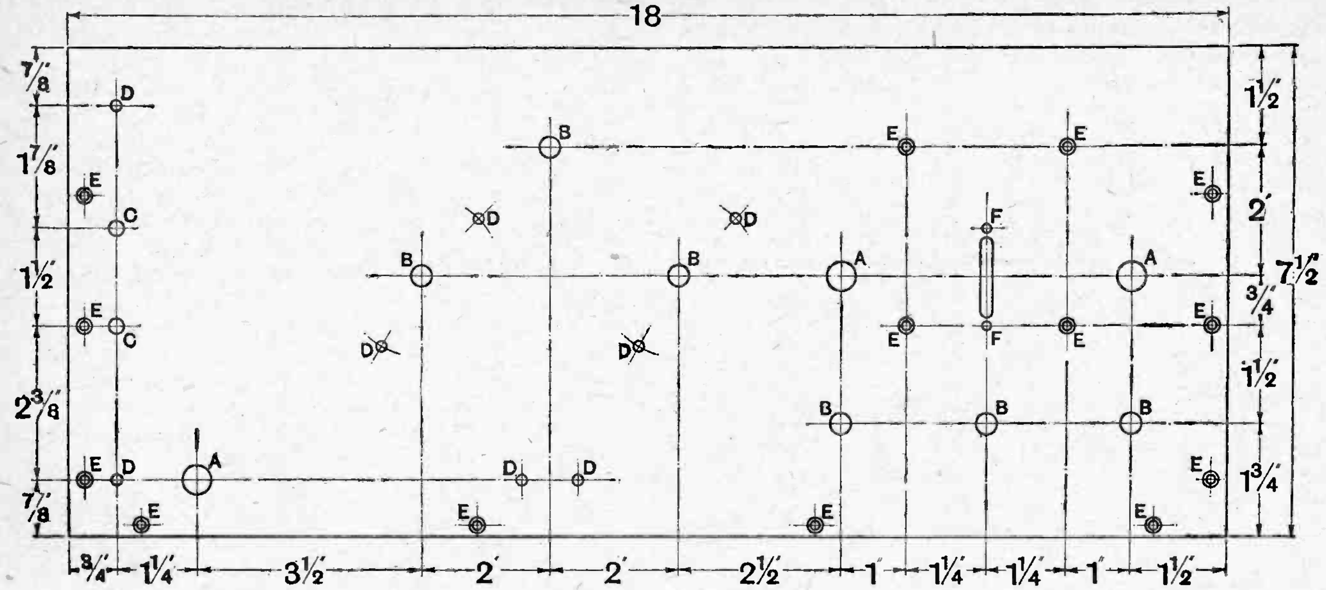


Fig. 1.—Drilling details of front panel. Sizes of holes are as follow: A, 7/16in. dia.; B, 5/16in. dia.; C, 7/32in. dia.; D, 5/32in. dia.; E, 1/8in. dia. coun.ersunk for No. 4 wood screws; F, 1/8in. dia.

currents in this circuit when positive voltages are applied. To prevent the application of unrectified H.F. voltages which may pass the crystal to the grid, an H.F. choke and by-pass condenser C_3 are included in this circuit. It may be said here that this condenser seems to be of doubtful utility, except in the case of very strong signals, and its inclusion is sometimes, in fact, definitely prejudicial to the smooth operation of the set when on the point of oscillation. The need or otherwise for this condenser depends on the characteristics of both the valve and the crystal, and the constructor is recommended to omit it until the set has been put into operation, and then carefully observe the effects of its inclusion. It may sometimes with advantage be connected between the grid side of the H.F. choke and negative L.T. rather than in the manner shown.

The two L.F. valves are coupled by means of the conventional arrangement of choke and condenser. A

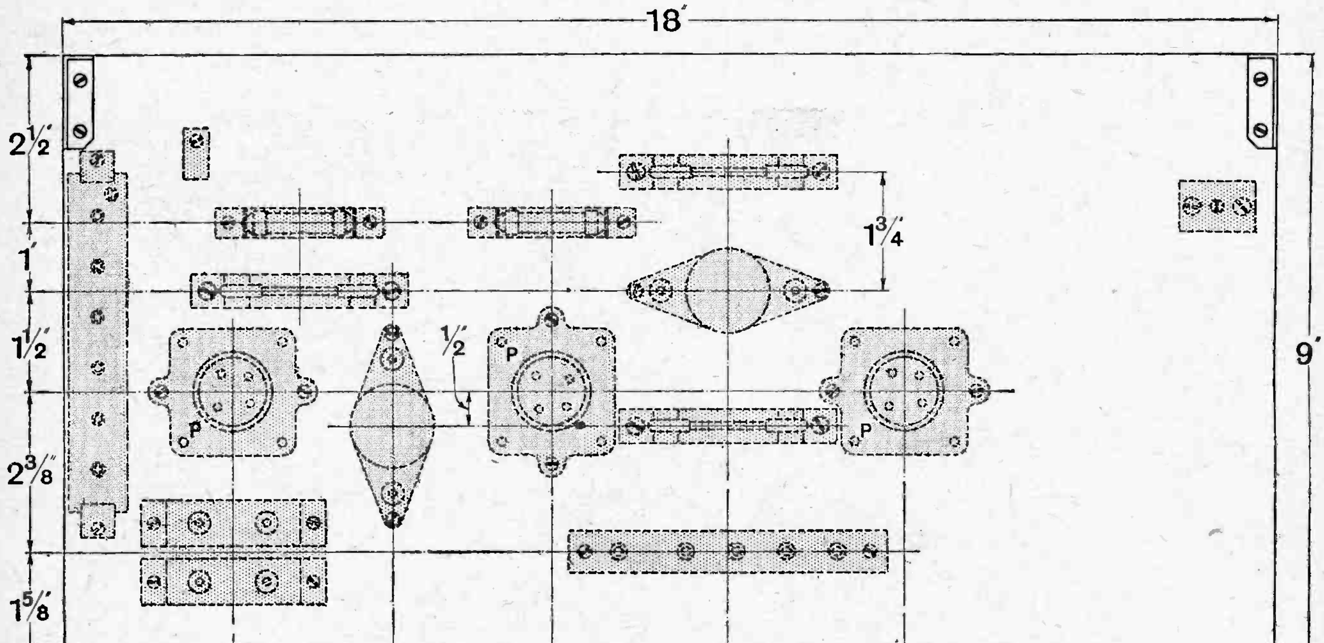


Fig. 2.—Layout of the baseboard.

Valve-Crystal Neutrodyne Receiver.—

switch is included, and, when the lever is "up," serves to connect the output of the first L.F. valve to head telephones, which are plugged into the jack J_1, at the same time cutting out the filament of the last valve. The loud-speaker is inserted in the jack J_2, and is connected when the switch is "down." The use of these plugs and jacks is by way of being a luxury, and they may if required be replaced by pairs of terminals. It is, however, sometimes very convenient to be able quickly to change the 'phones to the output of the last valve when receiving weak signals.

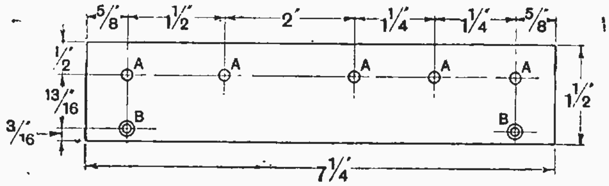


Fig. 3.—The terminal strip. A, 5/32in. dia.; B, 1/8in. dia., countersunk for No. 4 wood screws.

Constructional Details.

The set is assembled from ready-made parts, with the exception of the neutrodyne transformers and their holder. The method of construction of these components is clearly shown in the photograph and in the sketches in Figs. 4 and 5.

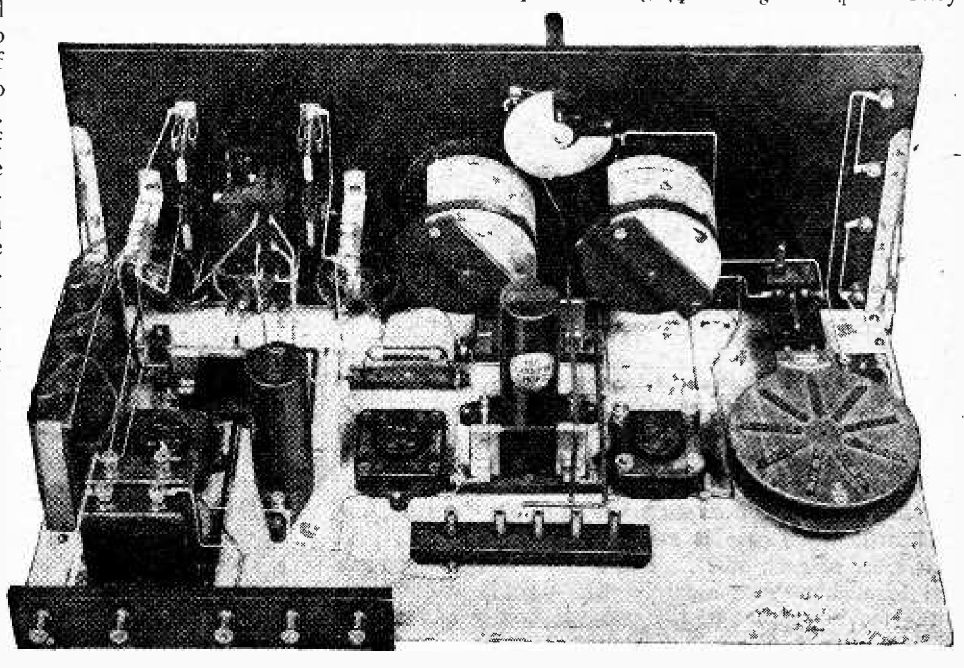
The short wave transformer has a secondary winding of 75 closely wound turns of No. 24 D.S.C. wire on an ebonite tube, commencing one inch from the end. The primary winding is put on over the secondary, and has 40 turns of No. 30 D.S.C. wound in the same direction, and spaced from it by ten small wooden strips (match sticks were used in the transformer illustrated). The end of the wire is secured by a binding of thread. A tap is taken at the centre of the winding, and connects to H.T. +. Actually, therefore, there are only twenty turns of primary, the other half of the winding being used for neutralising. The coil is fitted with a base, made from an ebonite strip $4\frac{1}{8}$in. × $\frac{5}{8}$in. × $\frac{1}{4}$in., carrying five valve pins. The coil is secured to the base by a one-inch 6 B.A. screw, passing through a distance piece of ebonite tube $\frac{5}{8}$in. long, at each end. The pins are fitted with soldering tags to which are joined the ends of the windings in the manner shown in Fig. 4. It should be noted that one of the pins is set out from the others in such a way as to minimise the risk of short-circuiting the H.T. battery if an attempt is made to enter the base into its holder incorrectly.

This transformer will adequately cover the 300-500 metre waveband.

The long wave transformer is made on slightly different lines, and its construction is illustrated in Fig. 5. Three ebonite discs of $2\frac{3}{8}$in. diameter and two of $1\frac{1}{8}$in. diameter, all $\frac{1}{8}$in. thick, are drilled with four holes, spaced for convenience in the usual valve socket formation. Slots are cut in each of the outside discs to take the commencing ends of the windings. A centre hole $\frac{3}{16}$in. diameter is drilled in each disc, and they are all clamped together with $\frac{3}{4}$in. 6 B.A. screws. Soldering tags are fitted on the "plate" and "grid" screws for the connections to the secondary winding, and on the "filament" screws for the primary. The secondary winding consists of 325 turns of No. 30 D.S.C. wire, while the primary, with the same number of turns of similar wire, is tapped at the 175th turn from the start for connection to H.T. positive. This tapping is made by bending back the wire on itself, and leading it out through a small hole drilled in a suitable position through a cheek of the former. The ends of each winding are brought out through similar holes. Both windings are in the same direction.

These coils are mounted on a base exactly similar to that used for the short-wave transformer, by means of a brass angle piece, a length of 2 B.A. threaded rod, and two ebonite tube distance pieces and nuts. Reference to the diagram will show that the foot of the brass angle piece is secured to the base by the nut of one of the contact pins. Care should be exercised in making the connections to the coils; in Fig. 5, I.P. refers to the inner (commencing) end of the primary winding, O.P. to the outer end of this winding, while I.S. and O.S. refer respectively to the ends of the secondary.

The valve legs to receive these transformers are mounted on an ebonite strip measuring $4\frac{3}{4}$in. × $\frac{5}{8}$in. × $\frac{1}{4}$in. They



The receiver viewed from the back, with grid coil removed to show wiring of aerial and earth terminals and extra condenser sockets. The holder for the H.F. transformer is clearly shown.

Valve-Crystal Neutrodyne Receiver.—should be most carefully spaced to the dimensions given in Fig. 5. A soldering tag, long enough to project just beyond the edge of the strip, is held by a nut on the underside of each socket. The strip is screwed down to the baseboard by two wood screws, passing through tubular ebonite distance pieces, ¼in. long.

The terminal strip is made from a piece of ¼in. ebonite sheet, of dimensions as shown in Fig. 3, where details for drilling are also given. It is secured by screws to the back edge of the baseboard.

The assembly of the remainder of the apparatus calls for little comment, as the drilling of the panel, mounting of components, and wiring, are very clearly shown in the wiring supplement and diagrams. Before screwing together the baseboard and panel, it is as well to put on a few wires in the less accessible positions. No. 16 tinned copper wire is used throughout for connecting up, some few leads being covered with insulating sleeving where there is a risk of short-circuiting. Following the usual practice, low potential earth and filament wires are kept down on the baseboard, while care is taken to carry plate and grid leads clear of each other. Two small ebonite blocks are used to anchor down securely the flexible connections to the moving socket of the two-coil holder and to the tapping plug on the grid bias battery.

A design for a suitable cabinet is indicated in Fig. 6. In this matter the constructor may, of course, be guided by personal preference. It is intended that screws be passed through the panel into the wooden fillets shown; three or four more screws are also put through the baseboard into the bottom of the cabinet.

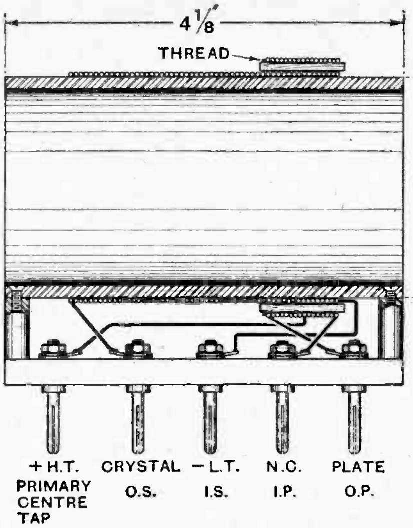


Fig. 4.—The short wave H.F. transformer shown in section. Connections of the winding to the pins and the ultimate connections to the remainder of the circuit are given.

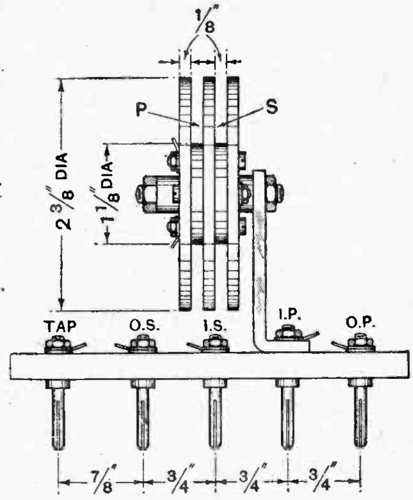
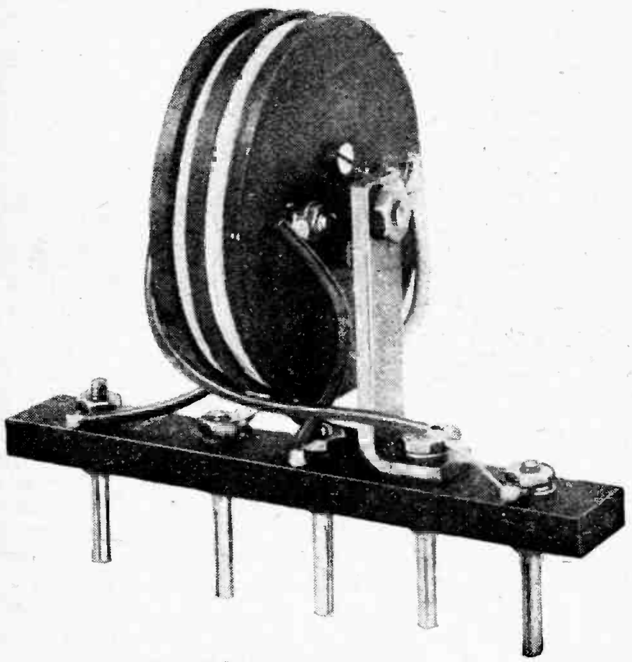


Fig. 5.—The long wave H.F. transformer. The markings correspond to the connections between the pins and the windings.



The long wave H.F. transformer.

Operation.

The "neutrodyne" transformer is designed for valves of moderately low impedance (not more than 20,000 ohms). A valve of this type should, therefore, be used in the H.F. socket (nearest the coil holder). The next valve should be of the high-magnification type, while the last should be capable of handling sufficient power to operate the loud-speaker.

The following combinations have been used with satisfactory results :—High frequency :—B.4, D.E.5, D.E.4, S.P.18 (Red Spot). First L.F. :—D.E.5B., D.F.A.4, S.P.18 (Green Spot). Second L.F. :—B.4, D.E.5, D.E.4, S.P.18 (Red Spot). Other valves with similar characteristics would be suitable. For short range loud-

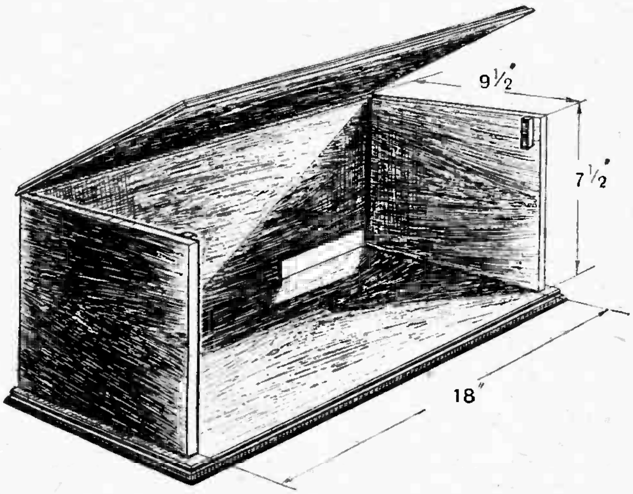


Fig. 6.—Cabinet for the receiver. Note slot cut out of the back to accommodate the terminal strip.

LIST OF COMPONENTS.

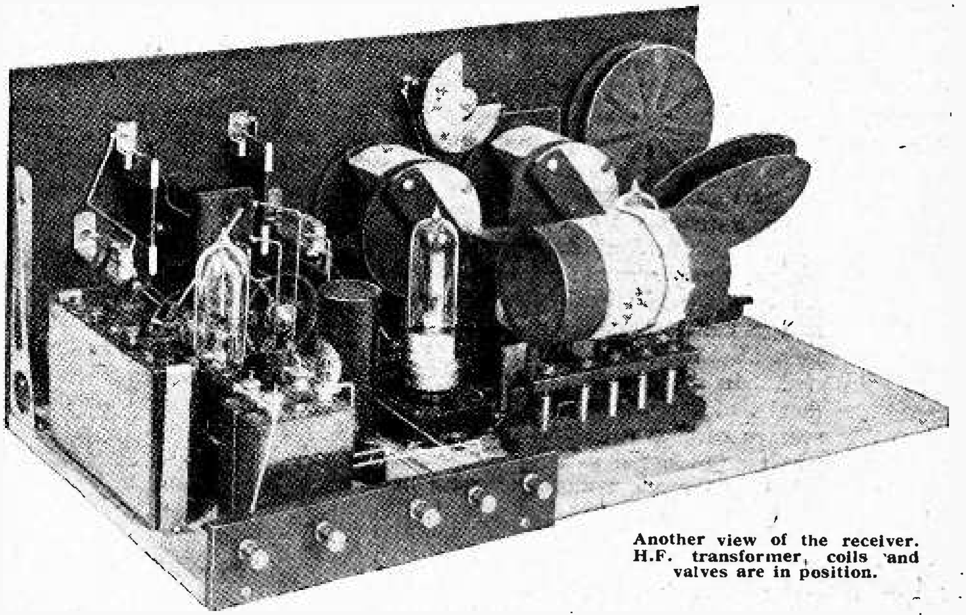
Ebonite Panel, 18in. × 7½in × ¼in. (Britannia Rubber Co.).
Baseboard, dry mahogany, 18in. × 9in. × ⅜in.
3 Filament rheostats (Ashley).
2 Panel brackets (A. J. Dew & Co.).
1 2-coil holder (Newey).
2 "Clix" sockets.
2 Variable condensers (Dubilier 0·0005 mfd.).
1 Neutrodyne condenser (Collinson's Precision Screw Co., Ltd.).
3 Valve holders (Benjamin).
1 Crystal detector (G.E.C. "Unit").
1 Fixed condenser, 0·0001 mfd. (McMichael).
2 Fixed condensers, 0·001 mfd. (McMichael).
2 Fixed condensers, 0·01 mfd. (McMichael).
2 Grid leaks, 1 megohm (Dubilier).
1 Grid bias battery, 9 volts, tapped every cell (Hellesen's).
1 Choke, H.F. (Lissen).
1 Choke, L.F (Lissen).
1 Switch, D P.D.T. (Wilkins & Wright).
2 Single open jacks (Ashley).
2 Condensers, 1 mfd. (T.C.C.).
Ebonite tube, 4½in. long, 2¼in. diameter, ⅛in. wall.
No. 30 S.W.G., D.S.C. wire.
No. 24 S.W.G., D.S.C. wire.
Odd pieces of ebonite, screws, tags, terminals, connecting wire, etc.

speaker work with moderate volume a general-purpose valve may be used in the second position, although those of the types specified are preferable. Grid bias on this valve (applied through the grid leak resistance R_1) should be about 1½-3 volts negative and on the last, 4½ to 6 volts with normal H.T. voltages. A suitable value would be 100-120 volts on the L.F. valves, which are provided with a common supply, and about 60 volts on the H.F. amplifier.

For the shorter wavelengths a "C" Gambrell coil in the grid circuit (fixed holder) and one of the same make, size "a" or "a_2," in the aerial socket, were found to be satisfactory. The short wave H.F. transformer is inserted in its holder, and the crystal adjusted, varying the tuning condensers until a signal is heard. With a moderately loose aerial coupling the valve will burst into violent oscillation as the circuits are brought into tune. The neutralising condenser should now be adjusted until this oscillation ceases. Again retune the grid and anode circuits by rotating the controls, and, if necessary, re-adjust the single plate condenser, until a state of stability is reached. This will not be found difficult. Once neutralised, the set should be stable over the whole of the tuning range.

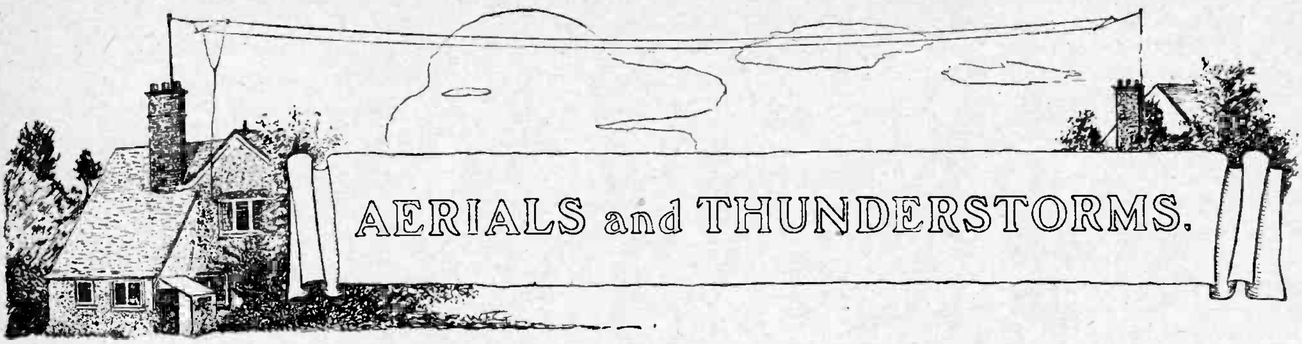
During these preliminary tests the condenser C_3 should be removed or disconnected. The effect of replacing this, or changing its position, as already suggested, should be tried. In this receiver, reaction control is obtained by a slight adjustment of the neutrodyne condenser, causing the valve to approach the oscillation point through imperfect balancing. If this control is not smooth, and oscillation commences with a violent "plop," the leads to the crystal detector itself should be reversed. The detector should not be adjusted except when the valve is well off oscillation. Any sign of instability when carrying out this adjustment is a fairly certain indication that the by-pass condenser C_3 should be either discarded or its connections changed in the manner suggested. The catwhisker should be very light and springy.

The small points referred to in the preceding paragraph will be found to cover the only difficulties likely to arise in putting the set into operation, and are easy to overcome, even for a beginner. They are, of course, intimately connected with the need for eliminating any "loading" of the H.F. valve anode circuit—the basis of the design of the receiver.



Another view of the receiver. H.F. transformer, coils and valves are in position.

Due to the comparatively low overall L.F. amplification obtained by the coupling methods used, it can hardly be said that the instrument as described is really suitable for real long-range loud-speaker reception, but the range on telephones is excellent, and under average conditions more than adequate loud-speaker volume is obtainable. For maximum range an external tuning condenser of about 0.0005 mfd. capacity should be plugged into the "Clix" sockets X and Y. If the coupling between aerial and secondary coils is tight, it will be found that the set will not oscillate; balancing is, therefore, unnecessary. Up to quite considerable distances, however, Daventry may be received without going to the trouble of tuning the aerial circuit.



AERIALS and THUNDERSTORMS.

Electric Charges Induced in an Aerial by Atmospheric Electricity.

By PROF. E. V. APPLETON, M.A., D.Sc.

It is natural for anyone possessing a wireless receiver with an outside aerial to be interested in the electrical processes taking place in the aerial system during a thunderstorm. Many people think an outside aerial is a source of great danger when local lightning is present, while others are of the opinion that the aerial acts somewhat in the same way as a lightning conductor or disperser of atmospheric electricity, thus behaving as a kind of safety valve device. Very few of these people are aware that researches have been carried out at Cambridge and elsewhere (mainly by Professor C. T. R. Wilson) on the electrical field of thunderstorms, which have given us comparatively accurate information relating to the magnitudes of the electrical effects of charged thunderclouds. From these data the magnitudes of the electrical charges in an ordinary aerial may be very simply calculated. In this article I propose to discuss some of the details of the effects of atmospheric electricity on an average wireless aerial, and it will be seen that the ordinary type of aerial used by listeners is, if properly earthed, by no means a source of great danger during a thunderstorm.

The Mystery of Fine-weather Electricity.

It will help us a good deal in our study of the electrical state of the atmosphere during a thunderstorm if we consider first the simpler case of ordinary fine-weather electricity. On fine days it is found that the earth's surface is charged electrically negative. At the same time, the atmosphere contains both positive and negative ions, with, however, a preponderance of positives. Thus the negatively charged ground is, all the time, attracting the positive ions downwards, and repelling the negative ions upwards. The positive ion current travelling to the ground tends to neutralise the negative charge there, and, since both quantities can be measured, we can estimate how long it would take for the positive current to neutralise the negative earth's charge. The result is a surprising one, for it is found that only a few minutes are required. But we know from experience that no such rapid neutralisation of the earth's charge takes place. The charge on the earth's surface in the fine-weather regions remains negative and fairly constant. We therefore conclude that there are other agencies at work, which tend to replenish the earth's negative charge, and the most important problem of atmospheric electricity is to determine this agency. I shall mention later what seems most probable the solution of the mystery, but for the time being we shall merely assume the permanence of the earth's charge as an experimental fact.

The Earth's Electric Field.

The charge on the earth in fine weather is such that the potential increases about 100 volts in each metre from the ground. Thus, if we consider the horizontal portion of an ordinary aerial, 10 metres high, we see that it is situated in a part of the atmosphere at which the undisturbed potential is 1,000 volts above the ground. Many students of electricity find in such a statement a problem of great difficulty, for they are unable to see why such a large potential difference should not produce excessive currents in the good conducting metallic aerial. But a little consideration shows that only very minute currents should flow down such an aerial in the normal case. We can understand this point most easily by reference to the diagram of Fig. 1, where an aerial with a horizontal portion AB is shown earthed at C.

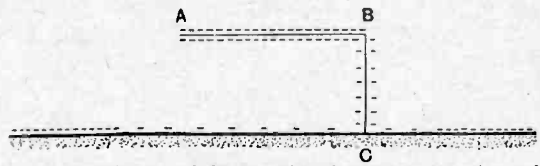


Fig. 1.—Distribution of the negative charge on an aerial and surrounding ground during fine weather.

In the first place, it should be noted that, since the aerial is earthed, it really becomes electrically part of the earth and thus has its appropriate negative charge. The distribution of this negative charge on the aerial and surrounding ground is shown in Fig. 1. Let us suppose, as suggested above, that AB is situated 10 metres above the earth's surface, in which case the undisturbed potential at AB would be 1,000 volts above that of the earth. This does not mean that the potential in the wire AB is 1,000 volts, for, since the aerial is connected to the earth, its net potential must be zero. We thus see that, since the earth's electric field produces a positive potential of 1,000 volts at AB, a negative charge sufficient to charge the wire 1,000 volts negative must be situated on the wire to make the total potential zero. Recognising this, we can calculate how

Aerials and Thunderstorms.—
much negative charge is collected on the aerial in fine weather. If Q is the charge (negative) on the aerial, C its capacity, and V the potential due to the earth's field at AB, then

$$Q = CV.$$

In our example, C would be about 0.0003 mfds., and V would be 1,000 volts, so Q would be 0.3 micro-coulombs.

Now, although such a quantity does not seem very large, it is equivalent to the charge on many square metres of ground, so that, as shown in Fig. 1, the aerial really shields the ground underneath and round about it, the appropriate negative charge being on the aerial itself.

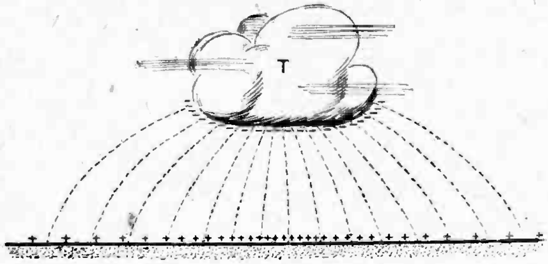


Fig. 2.—Positive charge induced on the earth's surface by a negatively charged thundercloud.

We thus see that, although the horizontal portion of the aerial holds enough negative charge to charge it (in the absence of the earth's field) to 1,000 volts, the whole system is really at the same potential (*i.e.*, zero), and so no current should circulate in it. I ought, however, to add that the negative charge on the aerial attracts the positive ions from the air, and the ordinary current from air to ground takes place *via* the aerial. This current does not usually amount to more than a small fraction of a microampere, and, being comparatively constant, does not produce any electrical effect noticeable in telephones.

Since the aerial shields the ground underneath it from the effects of the earth's field, it has been suggested by a recent correspondent to *The Wireless World* that this shielding influence may possibly have an influence on the growth of trees and plants situated under an aerial. This suggestion was based on the fact that strong electrical fields are found to have a beneficial effect on the growth of trees and plants. It seems, however, fairly well established by workers on the subject that the ordinary fine-weather fields are not of sufficient intensity to stimulate plant growth to any appreciable extent, but the effects of thunderstorm fields, which may be a hundred times as intense as those of normal fine weather, seem to present problems for further investigation.

The Electric Fields of Thunderstorms.

I now turn to discuss the behaviour of the charges on an aerial in the proximity of a thunderstorm. Here we are concerned with very large electric fields, usually of the opposite sign to that experienced in normal fine-weather regions; that is to say, the charge on the ground is usually positive and not negative. This positive charge is induced by the negative charges situated in the charged thundercloud. It is noteworthy that, in spite of the many researches that have been carried out on atmospheric electricity, we have to admit that there is no universally accepted theory of the origin of thunderclouds. We know that a thundercloud must act like a large electrical machine developing potential differences of the order of a thousand million volts, but we are not certain whether the machine is of the frictional type (like ebonite rubbed with flannel) or of the induction type (like the Wimshurst machine). But whatever may be the mechanism, the electrical effect at the ground is such as would be produced by a concentration of charges in regions of about 250 metres radius. When the electric intensity is sufficiently high a spark passes to the ground, or to another part of the cloud, or to the upper conducting layer. From the wireless standpoint we are interested in what happens in an aerial system when such a discharge takes place.

Conditions Preceding a Lightning Flash.

Let us consider the electrical conditions at the ground before the flash takes place. For definiteness let us consider a charge of negative[1] electricity concentrated at T (Fig. 2). Such a charge will induce a corresponding positive charge on the ground which will very much more than neutralise the normal negative charge which exists in fine weather. The positive charge will be densest immediately under the negatively charged cloud, and the density will fall off approximately as the cube of the distance from the centre of the system. To get an idea of the magnitude of the electric fields, let us take a typical example of a charge of 20 coulombs situated in the atmosphere at a height of 2 kilometres. Immediately under such a thundercloud we find the field to be 60,000 volts per metre, at 10 kilometres distance this is reduced to about 750 volts per metre, and at 100 kilometres it is reduced to about 1 volt per metre. We note that within, say, 5 kilometres of the thundercloud the electric fields are many times the normal amount, so that a thundercloud will have a very great influence on the charge on an aerial placed at that distance.

Let us consider a case in which an aerial is situated about 5 kilometres from a thundercloud which is about to flash. The electrical field will be of the order of 6,000 volts per metre. The charged thundercloud (Fig. 3) will hold a bound charge of positive electricity on the aerial. If we again consider a broadcasting aerial of 10 metres height and capacity 0.0003 mfd., this charge

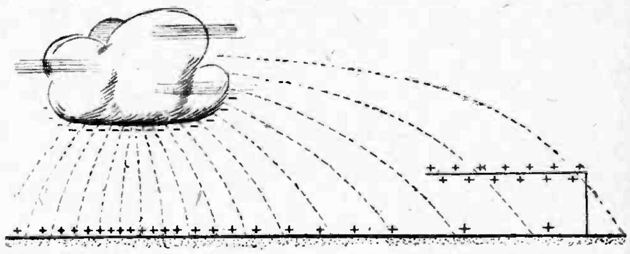


Fig. 3.—Distribution of induced charge on an inverted L aerial connected to earth.

[1] A negative thundercloud, such as is considered here, would send intense negative ionisation currents into the ground, and Professor C. T. R. Wilson has suggested that these ionisation currents may maintain the earth's negative charge.

Aerials and Thunderstorms.—
would be sufficient to charge a capacity of 0.0003 mfd. to 60,000 volts. Now consider what happens when the thundercloud discharges to the ground. There is no longer the inductive action of the cloud, and the positive charge on the aerial is set free and passes to the ground. But even if the discharge is as high as from 60,000 volts to zero, the quantity of electricity discharged is not large, so that no damage would be caused to the aerial system.

I now turn to discuss the case of an aerial, the lead-in

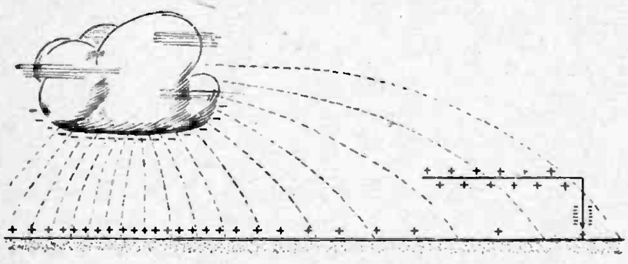


Fig. 4.—Negative charge induced on the upper electrode of a spark gap connected in the aerial down-lead.

of which is not earthed. In such a case I think it is common knowledge that one may obtain electric sparks both before and during the flashes. Let us consider this case with the aid of Fig. 4, where a thundercloud is shown influencing such an aerial. Here we see again that the negative charge of the thundercloud holds a bound positive charge on the aerial, but in this case the corresponding negative charge is driven to the end of the earth lead, where the electric force at the surface of the wire is often strong enough to cause sparking. When the lightning flash actually takes place, the aerial is usually left with a resultant charge, because of the different leakages of the two charges, and further sparking takes place.

Thus the above discussion shows that, if an aerial is properly earthed, no sparking will take place, and no damage will be caused due to the discharge of the electricity induced on the aerial by the thundercloud.

If the lightning actually strikes the aerial the case is obviously quite different. Here currents of the order of many thousands of amperes are involved, which are powerful enough to cause very great damage. But unless an aerial stands very much higher than the adjacent buildings (*e.g.*, as is the case in a commercial transmitting station) there does not seem to be any reason why an aerial should be struck in preference to surrounding objects. In order to get accurate data on this point I note that Professor C. L. Fortescue, of the City and Guilds Technical Institute, has been asking listeners and experimenters to send him complete accounts of the details of any cases of aerials struck by lightning. If accurate evidence is forthcoming, Professor Fortescue will be able to settle the question of risk for us, once and for all. But I think that, in any case, the risk must be very small.

BELGIUM'S WIRELESS HISTORY.

Broadcast Transmissions Before the War.

ALTHOUGH it is generally understood that the first broadcast concerts were transmitted from the Dutch station at the Hague, very little reference has been made to the fact that as long ago as 1914 regular Sunday evening transmissions of telephony were being made from the Belgian station at Laeken, Brussels, sending meteorological information and concerts which were often heard in the north of France. Prior to that date, in 1907, telephony experiments had been carried out between three stations, one installed at the Palais de Justice, Brussels, another in a balloon, and a third at Liège. The war brought to an end the transmissions from Laeken, and all receiving stations which existed at that time were taken over.

Early Transmission Attempts.

It was not until 1919 that one or two amateurs began again to construct apparatus in order to listen to the Eiffel Tower transmissions. In general, the public seemed to have forgotten the existence of wireless; but in November, 1923, the station "Radio Belgique" was established, and from that date wireless began to be adopted in Belgium and the number of crystal sets and even valve receivers increased considerably.

Commencing in 1920, one or two amateurs made attempts at transmission, and some of these have since become very well known, particularly P2. No system was adopted in the choice of call-signs, and these were selected more or less haphazard in Belgium until quite recently; in fact, the lack of organisation was so noticeable that it was generally accepted that unknown and mysterious call-signs were most likely to originate from that country.

The next step was for Belgian amateurs to group together and adopt call-signs consisting of a letter followed by the number "2," and a society was formed which adopted the title of "Reseau des 2." After a time all the letters were used up, and instead of adhering merely to a letter and the figure 2, letters followed by other figures were employed and the society was re-named "Reseau Belge." To-day, this organisation possesses more than 200 members, so that at present there are probably more amateur transmitters in Belgium, in proportion to the area of the country, than anywhere else. "Reseau Belge" undertakes a service of redistributing QSL cards amongst their members, but it must be remembered that there is still no official recognition of amateur transmitters in Belgium, and the activities are carried on more or less secretly. Quite a number of different amateur wireless societies have been formed in various parts of the country, and these work together harmoniously.

As regards broadcasting, it is proposed to construct two or three more large stations for broadcast transmissions. These will probably be at Brussels, Antwerp, and Liège, and arrangements will be made so that programmes can be relayed from one to the other.

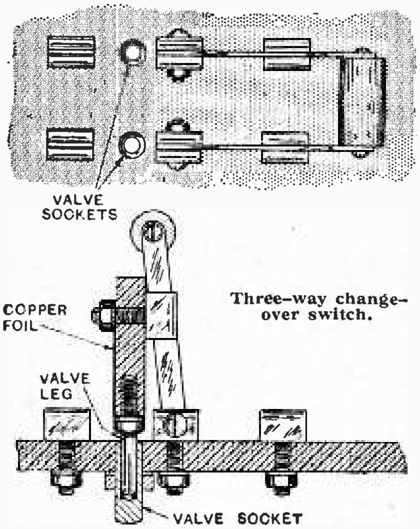
MARCEL OCREMAN.

NOVELTIES FROM OUR READERS

A Section Devoted to New Ideas and Practical Devices.

THREE-WAY CHANGE-OVER SWITCH.

An ordinary D.P.D.T. switch may be converted into a three-way change-over switch by means of the attachment illustrated in the diagram. This is quite easy to construct, and consists of a small ebonite panel carrying valve pins at one edge and provided on one of its faces with an additional pair of knife switch contacts mounted with a spacing corresponding to the distance separating the moving arms of the switch. The panel is drilled between two of the pairs of contacts in the change-over switch and flush fitting sockets are inserted, connections being taken from soldering tags on the underside of the panel. The auxiliary contacts and the valve pins are connected by narrow strips of copper foil. A sectional drawing showing the attachment in position is shown in the lower part of the diagram. The switch might be used to provide alternative connections to three loud-speakers, and there are innumerable other applications which will at once suggest themselves to the experimenter.—L. W. K.



Three-way change-over switch.

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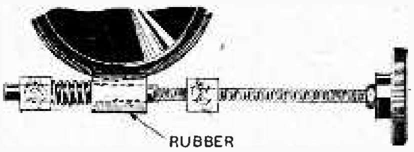
VERNIER CONTROL.

A condenser vernier adjustment which gives a very fine control over tuning is illustrated in the diagram. A short piece of thick-walled rubber tubing is fitted over a brass rod which slides in a hole in a square bearing pillar screwed to the panel at the side of the condenser dial. A similar pillar is at the other side of the dial, and carries a length of screwed rod to which is attached an ebonite knob. The rubber tubing is in contact with the edge of the condenser dial, and by screwing the rod forward against the pressure of a coil return spring, the vernier movement is transmitted to the dial through the friction of the rubber tube. Only a slight pressure is required in order to provide an effective drive, and the position of the bearing pillars should be adjusted so that the dial may be turned with ease. When the vernier movement is operated, the pressure of the coil spring causes the diameter of the tubing to increase slightly, and consequently a better grip is obtained.—H. D. E.



Vernier condenser adjustment

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CUTTING SHEET BRASS.

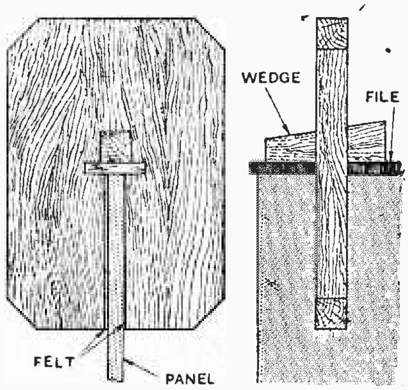
It frequently becomes necessary for the wireless constructor to cut sheet brass of thick gauge which cannot be conveniently cut with tinmen's shears. A hacksaw cannot be used in the ordinary way unless the brass is very stiff, otherwise the saw is apt to chatter and teeth are broken. By clamping the brass in the vice between two pieces of hard wood, the difficulty is overcome, as the support provided by the wood is sufficient to prevent all vibration due to the action of the saw. It is very often possible to dispense with the front piece of wood in order that scriber lines may be followed, but in this case the saw should be very carefully withdrawn on the back stroke.—M. R.

○○○○

FILING EBONITE.

In squaring up the edges of ebonite panels, many amateurs find difficulty in keeping the edge square with the face of the panel, when their attention is occupied with the task of keeping the edge perfectly straight.

The diagram shows how a wooden guide may be constructed to hold the file in such a way that it is impossible to deviate on either side when filing the panel. The slot is cut to fit the cross section of the file in the centre of a rectangular piece of wood, and from the centre of this slot another slot is cut at right angles extending to the edge of the wooden panel. The width of this slot should be made slightly greater than the thickness of the panel to be filed, and narrow



Guide for filing ebonite panels.

strips of felt should be glued to the inside edges to prevent marking of the ebonite panel. The handle is removed from the file, which is then fixed in position with a wooden wedge. Not only will this attachment enable the edge of the panel to be kept perfectly square, but the fact that the file is parallel to the top of the panel will greatly assist in producing a straight edge.—A. G. S.

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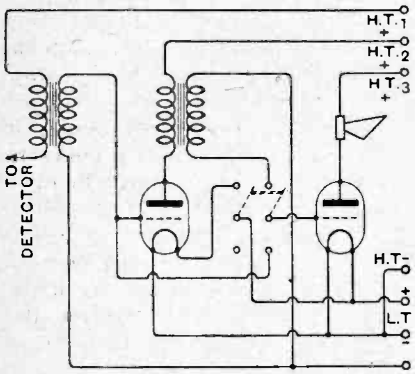
SWITCHING L.F. VALVES.

The system of connections indicated in the diagram enables the intermediate valve of an L.F. amplifier to be cut out of circuit without disturbing in any way the H.T. voltage applied to the detector or either of the amplifying valves. A D.P.D.T. switch is used to change the circuit, the left-hand set of contacts being



L.F. amplifier switching.

arranged to switch off the L.T. current to the last valve. The grid of the last valve is joined to the centre of the right-hand set of contacts, and may, therefore, be connected alternatively to the grid of the preceding valve or to the secondary winding of the second intervalve transformer. There is no need to remove the first L.F. valve, as the inter-electrode capacities are not likely to produce detrimental results at audio frequencies.—A. R. A.

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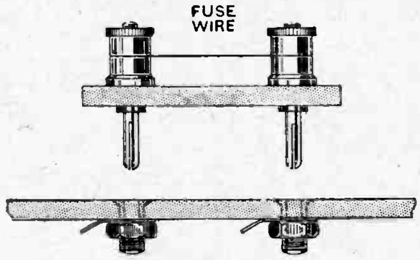
FILAMENT FUSES.

For experimental work where filament fuses are frequently being burnt out, it is convenient to build a small fuse unit which may be easily withdrawn from the panel for the renewal of the fuse wire. Two flush-mounting valve sockets are fitted to the panel, and the fuse wire is carried by two terminals mounted on a small ebonite panel with the same spacing as the sockets. The terminals are screwed on to valve pins in the manner indicated in the diagram. The method is particularly



Detachable filament fuse.

useful for valves of low current consumption where the fuse wire is of fine gauge.—G. J. S.

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TESTING FILAMENT VOLTAGE.

The fall of voltage across the filament of any individual valve in a receiver may be tested with an ordinary voltmeter without any special system of connections if the filament rheostats are connected in the following manner:—

Assuming that the rheostats are to be connected in the positive L.T. lead, the spindle, bush, and moving contact are connected to the positive end of the filament and one end of the resistance wire is joined to +L.T. Then, if the rheostats are of the one-hole-fixing type, the locking ring on the front of the panel will be joined directly to the positive end of the filament. To test the filament voltage of each of the valves, it is only necessary to join the negative lead of the voltmeter to −L.T., and then to touch each of the locking rings with the positive lead.—O. M. C.

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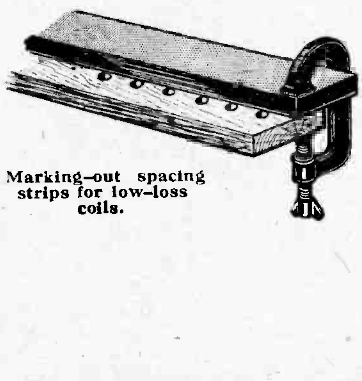
LOW-LOSS COILS.

When the positions for the holes in the spacing strips of a low-loss coil are marked out with dividers and a centre punch, difficulty is often experienced in keeping the centre punch marks in line. This may be done quite simply by clamping to the spacing strip an ebonite straight edge; then, by pressing the centre



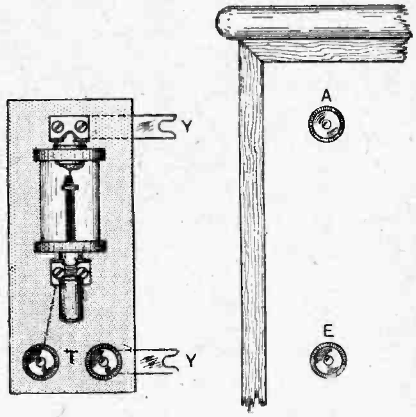
Marking-out spacing strips for low-loss coils.

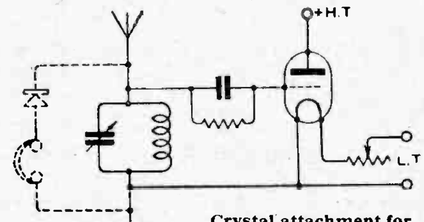
punch against the straight edge before making each centre dot, perfect alignment of the holes will be obtained.—R. S. C.

oooo

STAND-BY CRYSTAL SET.

The diagram shows the construction of a crystal receiver unit for use in conjunction with a valve set as a stand-by in the event of failure in the main receiver. The unit is built up on a narrow ebonite panel provided at each end with slotted strip connectors Y, which fit under the aerial and earth terminals of the receiver. A crystal detector and a pair of tele-





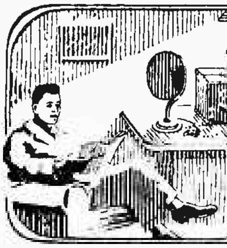
Crystal attachment for valve receiver.

phone terminals T are joined across the connecting strips, so that when the unit is attached to the receiver the crystal and telephones are connected across the A.T.I., as indicated in the circuit diagram.—W. A. D.

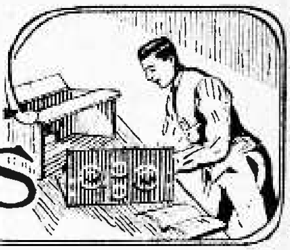
oooo

VERNIER CONDENSER.

If a vernier condenser is required in an emergency for experimental work and a special vernier condenser is not available, an ordinary variable condenser may be used by connecting in series with it a very small fixed condenser of, say, 0.00005 mfd. This combination is equivalent to a vernier condenser, because the small fixed condenser reduces the effective capacity of the variable condenser to about that of a single plate vernier.—E. L. S.



PRACTICAL HINTS AND TIPS



A Section Mainly for the New Reader.

CRYSTAL CONNECTIONS.

AMATEURS seem generally to pay far too little attention to the method of connecting a low-resistance crystal rectifier to an oscillatory circuit. It should be realised that in the transference of electrical energy the input resistance should balance the output. This will not be the case if the crystal is connected across the average circuit, tuning over the broadcast wavelengths with a comparatively small variable condenser. The crystal will, on account of its low resistance, tend to take energy from the circuit more quickly than it is supplied. High damping and inefficiency will result.

A well-known method of overcoming this difficulty is to tap the detector across only a portion of the tuning inductance. The voltages applied to it will be lower, and consequently the amount of energy taken from the tuned circuit will be less, effecting a reduction of damping. This reduction of damping can obviously not be carried beyond a certain point, unless signal strength is to be reduced. The best tapping point for the crystal is only to be found by experiment.

Another and less commonly used scheme for obtaining the same effect is to reduce the voltage applied to the detector by using a larger condenser than usual for tuning the coil. In Fig. 1(*a*) is shown the circuit diagram of a practical loose-coupled crystal receiver incorporating this arrangement. It will be seen that both inductance and capacity are variable, and for any given wavelength there will be one combination which will give the best results. In practice, however, it will hardly be necessary to provide a continuously variable inductance, as is indicated in the diagram, a crystal set generally being used on a more or less fixed wavelength. The correct value of inductance is not really critical, and, by the interchanging of coils and adjustment of capacity to suit, it is fairly easy to find the best value. Many specimens of artificial galena crystal (to which mineral all these remarks more particularly apply) require a capacity, on the broadcast wavelengths, of something in the neighbourhood of 0.001 mfd. It will be found convenient in many cases to connect a fixed capacity in parallel with the variable condenser, as shown in the dotted lines in the diagram.

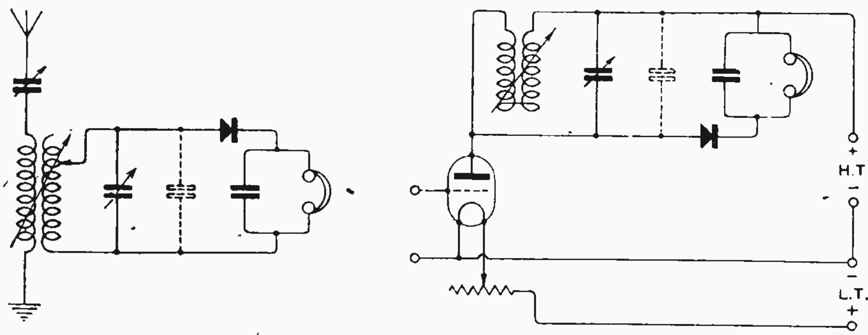


Fig. 1.—Reduction of damping in crystal circuits.

The foregoing applies equally to the coupling between a high-frequency valve and crystal detector. It may be said, in fact, that the reduction of damping is of much greater importance here than in the case of a plain crystal set, as, under modern conditions, selectivity is almost essential in a receiver designed for long-distance work; if heavy damping is present, it cannot possess this quality to the fullest possible extent. The circuit diagram of a suitable arrangement is given in Fig. 1(*b*). If the variometer is of the standard type designed for aerial tuning, it will generally be necessary either to remove a few turns from both rotor and stator, or to connect the windings in parallel instead of in series. Of course, a plain coil may be substituted for the variometer, as in the case of the plain crystal receiver, the latter alternative giving, however, a very limited tuning range.

The arrangement possesses another very great advantage, inasmuch as the value is automatically stabilised, provided that the capacity used to tune the anode circuit is sufficiently great. The fact that a large condenser across the anode tuning coil, with a consequent reduction of voltage build-up across it and therefore a reduced tendency towards "feed-back" to the grid, will give stability is well known, but, under ordinary conditions, where the grid-filament circuit of the succeeding valve is connected in parallel with the condenser, the amplification obtainable is reduced to an excessive degree.

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NEUTRALISED TUNED ANODE COUPLING.

Prospective constructors of neutrodyne receivers are often deterred by the difficulty of constructing the special transformers necessary; also by the fact that it is rather a problem to arrange for the interchanging of these transformers in cases where a wide band of wavelengths is to be covered. While the use of correctly designed transformers with suitable valves will probably give better results from the point of view of selectivity and amplification, the tuned anode has the advantage that ready-made plug-in coils may be used, and these, of course, may be interchanged for the various wavelength ranges which it is desired to receive. A circuit diagram showing a practical adaption of this method is given in Fig. 2.

If perfect balancing or neutralisation is to be obtained over the whole tuning range of a given anode coil,

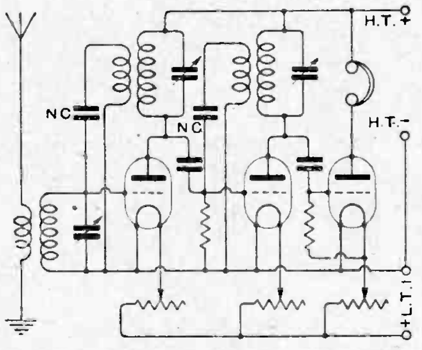


Fig. 2.—A neutralised H.F. amplifier.

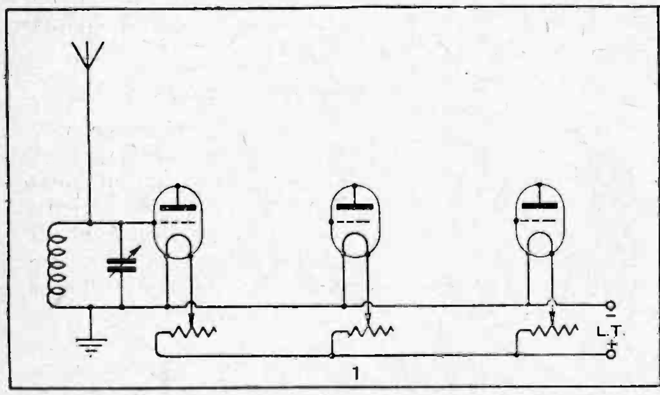
it is necessary that the inductance value of the neutralising coil should be of the same value, and that it should be tightly coupled to the anode coil. This is easily achieved by mounting the two coil sockets side by side; it is, of course, not necessary to make provision for variable coupling between the two inductances.

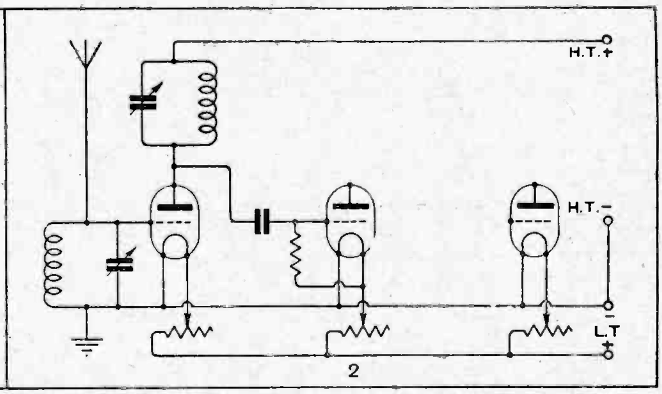
The usual precautions should be taken to prevent interaction between the various coils; and as they are somewhat larger than the usual neutrodyne transformers, extra spacing will probably be necessary. Adjacent coils should be arranged with their axes at right angles.

DISSECTED DIAGRAMS.

No. 5.—A Standard "1-V-1" Receiver—(H.F., Detector and L.F.).

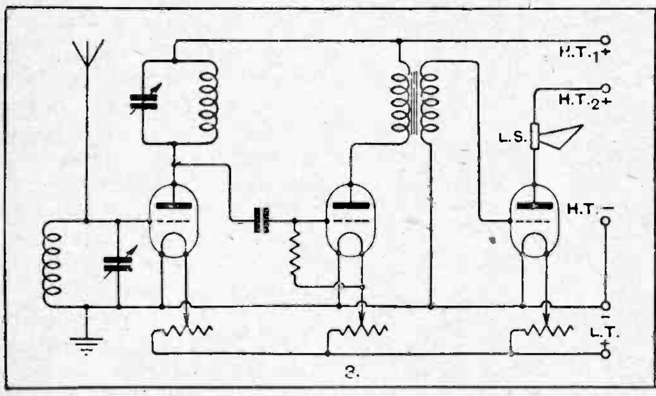
For the benefit of those who have not yet acquired the simple art of reading circuit diagrams, we are giving weekly a series of sketches showing how the complete circuits of typical wireless receivers are built up step by step.

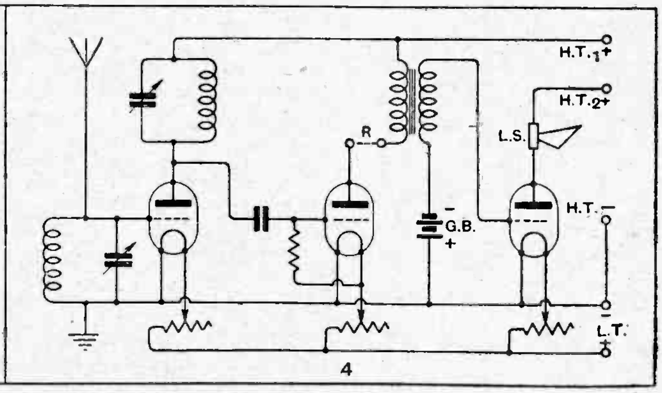




Three valves, connected in the usual manner across a filament battery, with rheostats in series with each filament Voltages built up across an oscillatory circuit, connected to aerial and earth, are applied between grid and filament of the H.F. valve, which has—

—connected in series with its anode a "tuned rejector" circuit, acting as a high resistance to oscillatory currents of the frequency to which it is tuned. Therefore, voltages are set up across it, and are applied to the grid of the dectector valve through the condenser, which, in conjunction with the leak, effects rectification.





The plate circuit of the detector valve is completed through the primary winding of an L.F. transformer, the secondary of which is connected between grid and filament of the L.F. amplifying valve. Magnified pulses in the anode circuit of this valve operate the loud-speaker.

Here a few refinements are introduced. Provision is made for the insertion of a reaction coil at R, while a fixed negative bias is impressed on the grid of the L.F. valve by the inclusion of a battery, G.B. Note that a separate H.T. terminal is provided for the last valve.

Mr. J. J. Walsh, T.D. Minister for Posts and Telegraphs, Irish Free State.

BROADCASTING IN IRELAND.

The Establishment of a New Station in Dublin.

By SCOTT HAYWARD.

The erection of the broadcasting station in Dublin having become an established fact—for the installation of 2RN is practically complete—it does not surprise those who have learnt to appreciate the zeal of the leading spirits in the Wireless Society of Ireland that a Wireless Exhibition should be organised in Dublin to synchronise with the period when it is anticipated 2RN will be testing.

Mr. G. Marshall Harriss, M.I.E.E., President, Wireless Society of Ireland.

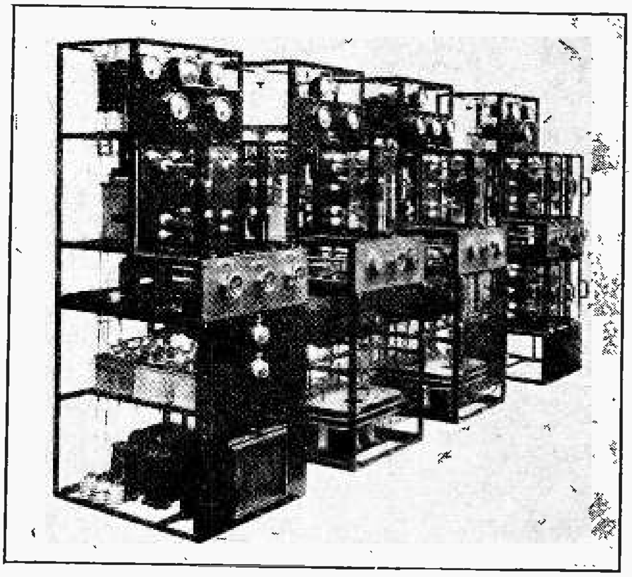
NOW that the joys of listening in are so soon to be the privilege of the masses, it will not be inappropriate to trace the development of broadcasting in Ireland, and *en passant* it may not be generally known that as far back as the year 1913 there existed in Dublin a small but enthusiastic body of wireless amateurs styled the Dublin Wireless Club. In those days the listener-in was unknown, just as broadcasting programmes were a development of the future. Wireless components and wiring diagrams were not available, and the amateur had of necessity to construct his own instruments, an undertaking which was also much more difficult then than in these progressive days of specialised products. Instead of the listener-in, by which I mean the listener who is merely interested in receiving the musical programmes, there existed a few enthusiasts who, on home-constructed apparatus, worked patiently to receive messages in Morse, with time-signals from the Eiffel Tower.

It was almost ten years later that broadcasting reception became popular in Ireland, and during the year 1923 two wireless associations were formed, the Northern Radio Association early in the year, and the Irish Radio Association in July. The first president of the former was Capt. J. Norman Inglis, one of the most enthusiastic wireless men in the British Isles, and of the latter the late Professor W. J. Lyons, B.A., A.R.C.Sc.(Lond.), who was one of the leading authorities on wireless matters in this country. During the time that there was so much dissatisfaction with the delay in establishing a Dublin broadcasting station, the late Professor Lyons once stated at a meeting that, though "Ireland might be late in the matter of broadcasting, it was better to be late, because broadcasting, from a technical point of view, was not perfect."

In the light of that statement, I am inclined to take a very optimistic view of the efficiency of 2RN when it "takes the air." The Radio Association of Ireland established branches in several parts of the country and became interested in the publication of a wireless journal as the Association's official organ.

Report of the Government Commission.

It was felt by many that an amalgamation of the Association with the old-established Dublin Wireless Club would have assisted largely in the extension of radio activity in the Irish Free State, but only quite recently was this accomplished, and on every hand I see evidence and hear expressions of opinion which go to show that the newly constituted Wireless Society of Ireland could not have been launched at a more opportune time.



The Marconi "Q" type transmitter installed at 2RN, the new Dublin station.

It was at the end of the year 1923 that the whole question of broadcasting in the Irish Free State was the subject of a White Paper prepared by the Minister for Posts and Telegraphs, which recommended briefly the formation of an Irish broadcasting company under Government supervision, and the importation of all apparatus through a clearing house to be set up by the company. The importation of wireless sets or components was to be confined to the Irish Broadcasting Company, which, through the clearing house, would collect a certain amount due on each apparatus as a contribution to broadcasting expenses.

A Government Commis-

Broadcasting in Ireland.—
sion was appointed, and in March, 1924, submitted its Report, recommending State control of broadcasting in the Irish Free State. On April 1st licences were issued by the postal authorities for listening in, and though there were no Irish stations "on the air," the fee was fixed at £1 per annum. These licences became renewable on April 1st last, and there was no change in the amount.

Formation of the Wireless Society of Ireland.

On May 1st, 1924, at a general meeting of the Radio Association of Ireland, Mr. G. Marshall Harriss, M.I.E.E., general manager of the Dublin United Tramways Co., Ltd., was elected president. Mr. Marshall Harriss is an enthusiastic experimenter, and has always been an asset to amateur organisation in Ireland. He held the office of president until the amalgamation of the Association with the Dublin Wireless Club, when he was elected president of the new Wireless Society of Ireland.

About this time the public was awaiting eagerly the submission of a broadcasting scheme for the Irish Free State from the Minister for Posts and Telegraphs on the lines recommended by the Dail Committee. Members of the Dail were plying the Minister with questions, and in June Mr. Walsh replied that he was unable to state when he would be in a position to submit to the Dail a broadcasting scheme, but that the matter, which involved a good deal of investigation and consideration, was receiving special attention, and that no time would be lost in framing the scheme.

In July the Irish Radio Association made an application to the Government for permission to broadcast the Tailteann Games, but this was refused, and it was felt by many that an admirable opportunity to do something of practical interest to radio enthusiasts at home and abroad had been lost.

Early in the following October the plans of the Minister for Posts and Telegraphs for the establishment of a broadcasting service in the Irish Free State were placed before the Ministry for Finance, and during this month also the B.B.C. station (2BE) at Belfast was officially opened by His Grace the Governor of Northern Ireland, who referred to the extraordinary present day popularity of wireless. With the establishment of 2BE, listeners in Ireland wherever situated displayed an increased interest in broadcasting, for radio knows no boundary, and the 2BE station programmes have always been popular in the south. Between January 1st and September 14th 1,423 licences had been issued in Belfast, and between September 15th (the day on which the station started experimental broadcasting) and the end of October, 5,289 were issued.

Details of the New Dublin Station.

Ever since then there has been a large increase in the number of licensees, and the stimulation of interest by possession of a crystal set resulted in an enormous increase in the number of valve receivers sold in Belfast.

At the end of May last the welcome news was sent forth that the Minister for Finance had agreed to the proposals of the Minister for Posts and Telegraphs for the establishment of broadcasting stations in the Irish Free State, and in June Mr. Walsh gave a public assurance that the erection of the Dublin station would be proceeded with at once, and a service inaugurated before Christmas. Since then everything has been plain sailing and the Minister's word has been kept.

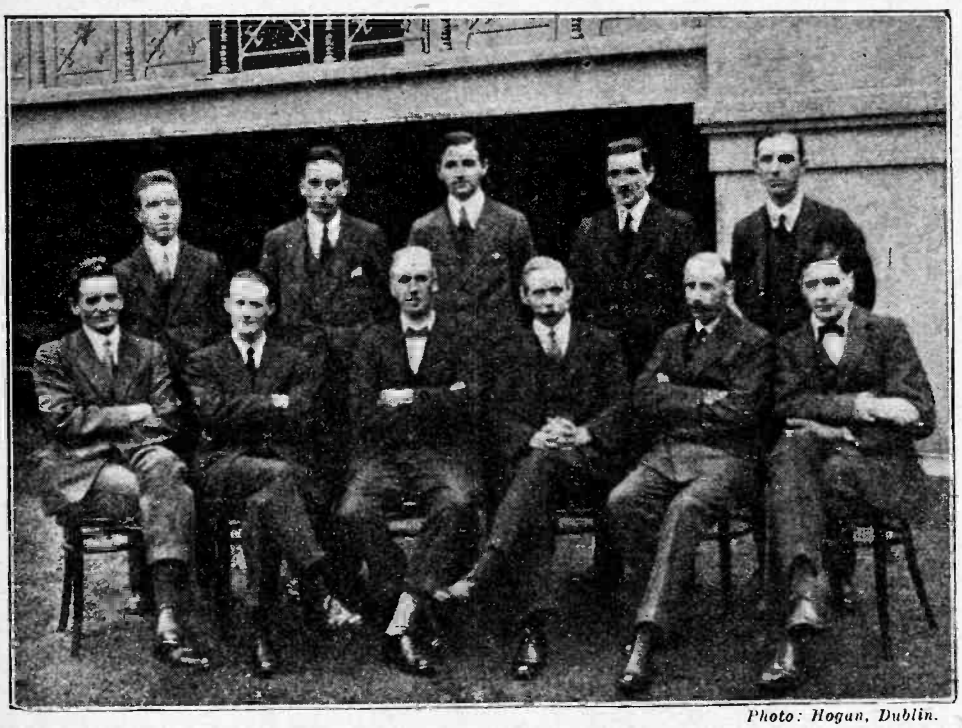


Photo: Hogan, Dublin.

Exhibition Committee of the Wireless Society of Ireland. Standing (left right): W. J. Byrne, J. Kitchen, — Jeffery, Hugh Butler, G. A. Pemberton. Sitting (left to right): W. A. Beatty, E. R. Jones, A. C. Bridle (hon. sec. Wireless Society of Ireland), Howard J. Duncan (Exhibition secretary), Joseph C. Mangan and G. Darnley Smith.

As stated in my opening remarks, the station is rapidly approaching completion. At the transmitting station in McKee Barracks (the old Marlborough Barracks), Phœnix Park, two masts, each 125ft. high, have been erected, and all the machinery is in place in the transmitting building. The transmitter is of the Marconi Q type, which is used at most of the British broadcasting stations. This set, which takes about 6 kW. at the input end, delivers 1,500 watts to the aerial. The installation has been carried out entirely by the Engineering Department of the G.P.O., Saorstat Eireann.

The studio is in Denmark Street, off Henry Street, Dublin. The call sign will be 2RN. The wave-length has now been definitely fixed within the broadcast band at 390 metres. While it is

Broadcasting in Ireland.—
almost certain that the service will be inaugurated early in December, it is anticipated that tests will be carried out at once, possibly during the holding of the Dublin Wireless Exhibition. At the time of writing the station director has not been appointed, and applications are being invited for the post. The musical director, Mr. Vincent O'Brien, and assistant engineer, Mr. W. A. Beatty, have had their appointments confirmed.

Now that local broadcasting in the Free State is upon us, I find in looking back over the past two years that it is surprising how great and widespread the interest in wireless has really been. Other countries where local broadcasting does not exist have been very slow to take up wireless, but a journey through the Irish towns will indicate that a few of our people—even if only one or two—in every town have valve receivers; indeed, I knew of several country installations at a time when I feel sure there were very few wireless sets in the metropolis. When the first rumours of local broadcasting were current—how long ago it seems—I well remember one Dublin trader whose wireless equipped motor van toured the country and did a tremendous amount of educational work. Another progressive trader I know has been a pioneer in outdoor demonstrations, and I sincerely hope these good people will shortly benefit by the new conditions. One often hears it said that a loud-speaker is no better than a bad gramophone, but it must be understood that no broadcasting stations existed in the Free State, and reception has therefore been over long distances. The loud-speaker is at its best when used on the local station, and that will soon be realised by the citizens of Dublin and district.

There exists in Great Britain and, indeed, in many other countries, an erroneous impression that Ireland is a poor country: that our people have no money to spend on quality products. This impression is just the reverse of the truth, for Ireland is an agricultural country only half populated, and under peaceful conditions, happily restored, the material prosperity of the people increases daily. Inferior products of any kind do not sell well in Ireland, and British merchant houses will be able to confirm my statement that the best quality goods are shipped across the Irish Sea.

Possibilities of Radio Development in Ireland.

The inauguration of a local broadcasting service will, of course, mean an immediate increase of many thousands of listeners on crystal receivers, but it will mean much more. We are an imaginative people, and in my opinion the extension of interest radiating from the broadcasting centres will be more rapid than in any other country in the world. The rural communities will grasp at the opportunity for amusement, as life is nowhere so dull as in an Irish country village, and is, I believe, in a measure responsible for much of the emigration for which we are famed. Farmers will without any great delay and in considerable numbers ensure that they are placed in a position to hear the programmes broadcast from the Dublin or Cork stations (the land line between Dublin and Cork is, I understand, being laid at once), and that will be but the beginning.

In considering the possibilities of radio development in Ireland, there is one great factor which must never be lost sight of—it is the larger Ireland beyond the seas. There is scarcely a family in our country without its member in the United States of America—if not a brother or sister, certainly a relation of some kind. And what is more natural than a desire to lessen the distance by radio. In my opinion wireless telephony will do more than any other science to bring together the various peoples of the world and prevent those misunderstandings which so often end in war. Its application in Ireland will have primary effect between this country and America. Twenty-five or even fifty guineas for a multi-valve set will never deter an Irish farmer from listening in to the land of his boy's adoption.

State Control of Broadcasting.

The broadcasting service in the Free State is to be State-controlled, and the Government has thus assumed a responsibility which will not sit lightly on its shoulders should it be abused. I believe the Minister responsible for this department is fully alive to the power he holds in trust for the people. Ireland's position in the world of nations makes it imperative that no individual or group should be allowed to misrepresent the national outlook. One of our greatest needs to-day is international publicity. Our country is something more than a "dot in the ocean," and broadcasting provides the means, as nothing else does, of informing the world that we are here ready to take and to give, ready to buy and to sell, ready to co-operate with the peoples of other lands for international peace and good will, ready with a culture all our own to contribute something to the advance of mankind.

To my mind one of the most difficult problems for immediate solution is that of programme selection. It simply teems with difficulties, but, nevertheless, we have men sufficiently competent to tackle the matter intelligently, and it shall be the privilege of most of us to aid and not hamper those whose arduous duties I hope to see rewarded by unprecedented success.

No time more fitting could have been chosen for the holding of a wireless exhibition in Dublin than the period during which the first Free State station is testing. As I write I am told that the final plans are complete. On November 11th Mr. J. J. Walsh, T.D., Minister for Posts and Telegraphs, will officially open the exhibition in the Mansion House, and I am satisfied that it will be attended by a success greater than the organisers ever anticipated.

The Mansion House is an historic building. The Round Room, in which the Wireless Exhibition is to be held, has from time to time been the scene of many great national demonstrations, and was built in 1821 on the occasion of the visit of George IV. of England. It is eminently suited to the holding of an exhibition of this kind, and is not unlike the Albert Hall, London, where the N.A.R.M.A.T. Exhibition was held recently. It is the largest single hall of the kind in Dublin.

Everyone is optimistic over this exhibition. There is a feeling that it will inaugurate a wireless boom, and it is only to be hoped that the industry will quickly become stabilised and thus cope more efficiently with normal requirements. The Wireless Society of Ireland is to be congratulated upon its enterprise.

Radio Ecco "T.E." and "T.Z."

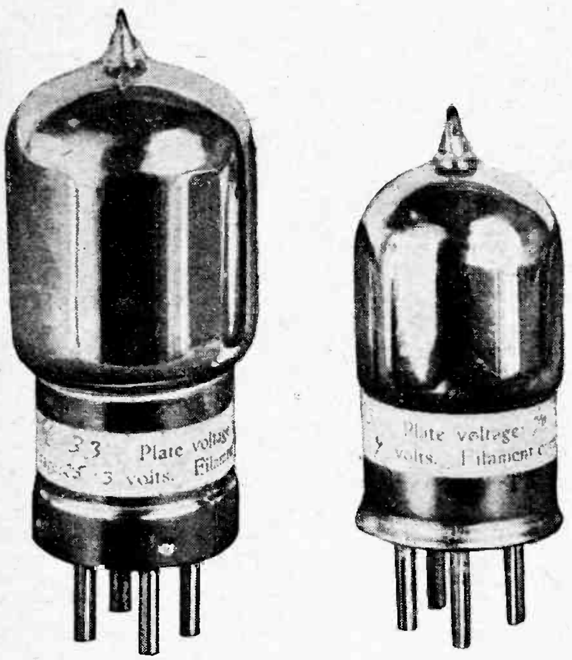
TWO forms of the above type valves have been sent to us for test.

The first, the Radio Ecco "T.E.," is rated as follows:—Filament volts, 3-4; filament current, 0.06-0.08; anode volts, 40-80. This method of giving a tolerance on both filament volts and current allows the manufacturer considerable latitude and tends against the production of uniform valves which, from the user's point of view, is perhaps undesirable.

Small Valves.

The valve under review is, outside the "Weco" valve class, one of the smallest we have seen, and from the top of the pip to the end of the contact pins measures only 3in., while its diameter is rather less than 1½in. The electrodes are mounted horizontally.

The results of our tests are shown in the table below, from which it will be seen that the amplification factor is particularly constant over the range tested, the anode impedance varying between 45,000 and 30,500 ohms, according to the anode potential and grid bias used.



Radio Ecco T.Z. Radio Ecco T.E.

The tests were conducted with a filament voltage of 3.0, the emission at this figure being 10.6 milliamperes. The filament current of the tested sample was somewhat above the rated value.

The "T.Z." Model.

The second valve to be tested, the Radio Ecco "T.Z.," is externally rather larger and measures approximately 3¾in. by 1¾in. The filament rating is 2.5 to 3 volts, filament current 0.18 to 0.2 ampere. Our earlier remarks on tolerances apply equally to the present case. The anode rating is 25 to 80 volts. Our tests were conducted at a filament voltage of 2, at which figure the emission obtained was 7.6 milliamperes. Increasing the filament voltage to 2.25 brought the emission up to 14 milliamperes, the filament efficiency, however, still being lower than that of the "T.E." valve.

Comparing the figures for the two valves as given in the tables, it will be noticed that the impedances and amplification factors are very similar, and, as would be expected, both valves gave very similar performance on circuit. Both types may be considered as useful general purpose valves, their characteristics (other than the filament) being comparable with those of the "R" type.

RADIO ECCO "T.E."

Filament volts, 3.0. Filament current, 0.10 ampere.
Emission (total) milliamperes 10.6. Filament efficiency, 35.3 milliamps. per watt.

Anode Volts.	Anode Current, Milliamps. Zero Grid.	Grid Volts.	Anode Current, Milliamps.[1]	Amplification Factor.	Anode Impedance.
40	0.6	−1.0	.34	10.5	45,500
50	0.9	−1.5	.46	10.0	41,700
60	1.2	−2.0	.57	10.0	37,200
70	1.55	−2.5	.73	10.0	32,000
80	2.0	−3.0	.92	10.0	30,500

[1] Anode current when grid is biased to the value of Col. III.

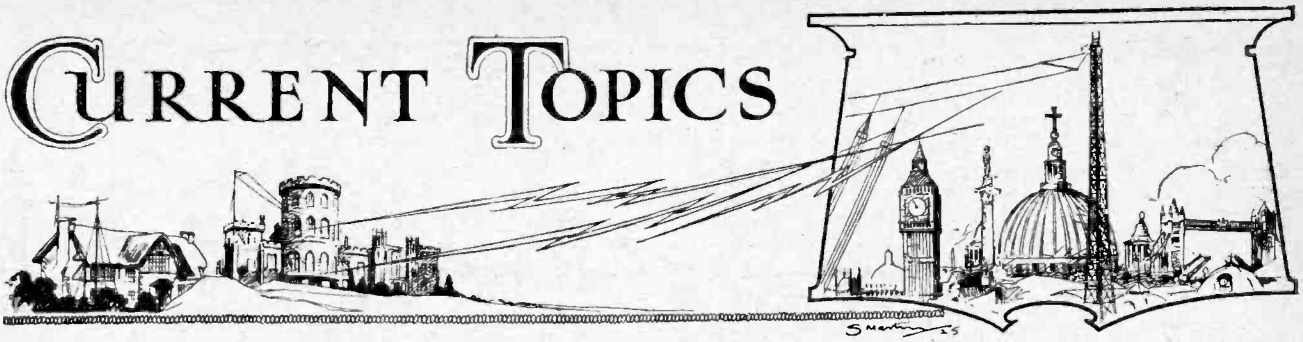
RADIO ECCO "T.Z."

Filament volts, 2.0. Filament current, 0.195.
Emission (total) milliamps. 7.6. Filament efficiency, 19.5 millamps. per watt.

Anode Volts.	Anode Current, Milliamps. Zero Grid.	Grid Volts.	Anode Current, Milliamps.[1]	Amplification Factor.	Anode Impedance.
40	0.6	−1.0	.36	11.4	50,000
50	0.84	−1.5	.43	11.0	49,000
60	1.12	−2.0	.54	10.5	43,500
70	1.44	−2.5	.65	10.5	37,800
80	1.8	−3.0	.8	10.5	35,500

[1] Anode current when grid is biased to the value of Col. III.

CURRENT TOPICS



News of the Week in Brief Review.

DUBLIN'S WAVELENGTH.

The wavelength of the new broadcasting station in Dublin will be 390 metres, according to an announcement by the Irish Free State Department of Posts and Telegraphs.

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AMATEUR WIRELESS RECOGNISED BY THE LEAGUE.

Amateur radio has undoubtedly taken another step forward with the official recognition by the League of Nations of the International Amateur Radio Union. It will be remembered that the Union was set on a firm basis at the Paris Amateur Conference in the spring of this year, Mr. Hiram Percy Maxim being appointed International President and Mr. Gerald Marcuse (G2NM) International Vice-President.

SUBAQUEOUS BROADCASTING.

A successful experiment in submarine broadcasting has been conducted off the coast of Heligoland. A diver descended with a microphone, and his description of what he saw on the bed of the North Sea was heard by listeners in Hamburg, 100 miles distant.

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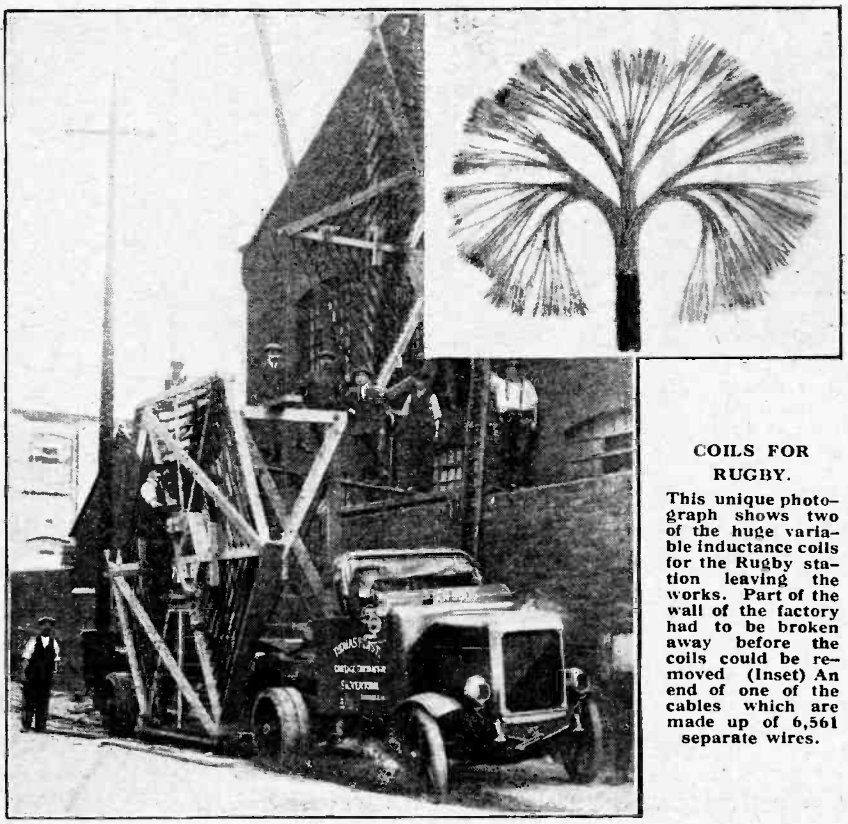
JAPAN AND WIRELESS DUMPING.

The Japanese Finance Department is considering the advisability of placing wireless goods among the list of articles coming under the "Luxury Tariff," says a Tokio message. Should this plan materialise, many manufacturers of the cheaper grades of wireless apparatus in the United States and Great Britain will find the market closed to them, for the "luxury tax" imposes a duty of 100 per cent.



COILS FOR RUGBY.

This unique photograph shows two of the huge variable inductance coils for the Rugby station leaving the works. Part of the wall of the factory had to be broken away before the coils could be removed (Inset) An end of one of the cables which are made up of 6,561 separate wires.

THE I.R.E. IN CANADA.

The famous American Institute of Radio Engineers will, it is understood, shortly establish a section at Toronto. At a recent meeting in that city it was pointed out that there are 250 engineers in Canada engaged in the construction and design of wireless apparatus.

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ADVERTISEMENTS FROM DUBLIN STATION?

As the day draws near for the opening of the Dublin broadcasting station, conjecture is rife in certain circles as to the probability of advertising appeals being broadcast. Those who assume that revenue will be gained in this manner are considering the further question of whether the station will transmit direct advertising announcements or merely broadcast "prestige" in the manner of our American friends.

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WIRELESS IN ENDURANCE FLIGHT.

Aircraft wireless proved its worth during the recent prolonged flight of three men in a French hydroplane. The route undertaken covered a 1,500 mile circuit of the Western Mediterranean, and throughout the 18 hours occupied by the flight wireless communication was maintained with France.

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AMERICAN RADIO CORPORATION'S DEFICIT.

For the second successive quarter the Radio Corporation of America has reported a deficit which, for the quarter ended September 30th, amounted to $358,000.

The expected revival in the demand for receiving sets will, it is hoped, result in an improved report for the current quarter.

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CANADIAN WIRELESS UNIVERSITY.

A "University of the Air" has been established by the Manitoba Agricultural College, in conjunction with the Manitoba Telephones System broadcasting station in Winnipeg. A series of diploma courses was instituted by the College on November 1st, all instruction being given by wireless. Examinations will also be conducted by radio, and those students who are successful in passing will be given diplomas. It is expected that many students throughout Western Canada will avail themselves of this means of supplementing their education.

JAPAN LOOKS AHEAD.

The Japanese Department of Communications, realising the ever-present risk of earthquakes, storms, and fires, is experimenting in the direction of linking up wireless apparatus with the telephone lines of the Empire.

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NEW D.F. ANTENNA SYSTEM.

The s.s. "Cairngowan," owned by Messrs. Cairns, Noble and Co., has been fitted with the new Marconi "fixed frame" direction finder. The advantage of the new type of installation is its economy of space in comparison with the ordinary type. Neither triatics nor posts are required to suspend or extend the aerial loops, the whole aerial systems being contained in an open teak frame approximately eight feet high by four feet square.

The "fixed frame" direction finder is already installed on several of the Cunard fleet and on a number of other vessels.

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A "SUPERHET" LECTURE.

A striking indication of the interest which the general public is taking in superheterodyne reception is afforded by the announcement that a lecture entitled "The Superheterodyne in Theory and Practice" is to be given in the Palm Court at Selfridge's, Oxford Street, on Friday next, November 13th, at 7.45 p.m. The lecturer will be Mr. A. E. Bowyer-Lowe, who has made a special study of the subject. Admission will be free, and tickets may be obtained from Selfridge's Radio Department.

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ESPERANTO IN LONDON.

The London Esperanto Club announces that it has opened its autumn session at St. Bride's Institute, Ludgate Circus, E.C.4, where classes and meetings are held every Friday evening from 6.30 to 10 p.m. The Hon. Secretary is Mr. L. N. Newell, 166, Brixton Road, S.W.9.

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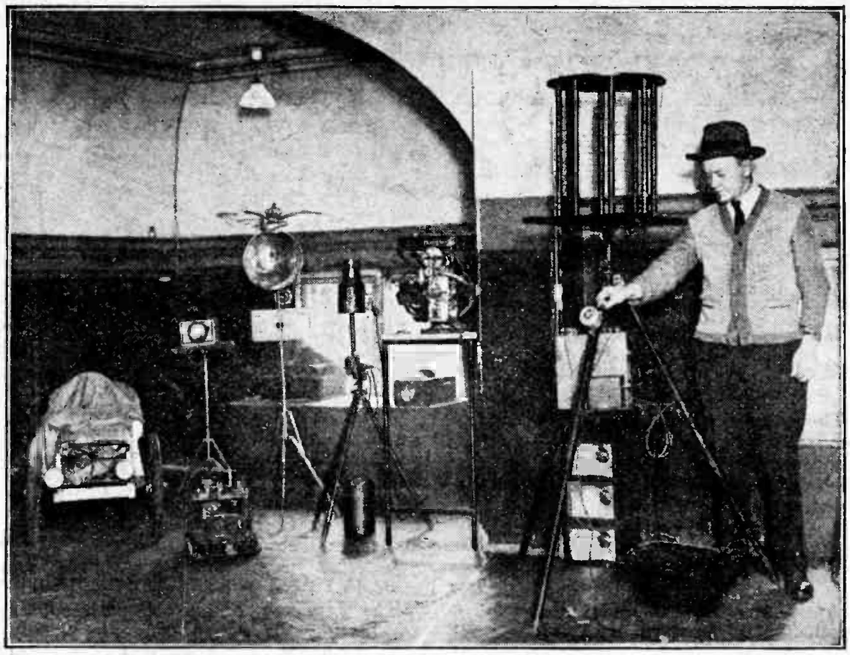
THE ST. DUNSTAN'S REPORT.

The Tenth Annual Report of St. Dunstan's, just issued, serves to remind us of the noble and unostentatious work which is still being conducted by this wonderful organisation in helping war-blinded men to surmount the difficulties with which they are faced.

Of striking interest are the many letters published in the Report from the men of St. Dunstan's themselves. They tell of fine achievement, of problems bravely faced and overcome, and, above all, they give proof of the real happiness the war-blinded men find in their post-war lives of physical darkness.

Wireless has been, in recent years, taken up by the men of St. Dunstan's with the greatest enthusiasm, as is only natural when one considers that it is perhaps the only pastime which puts the sighted and non-sighted on an absolute equality. The men receive every possible form of assistance from Headquarters in the installation and manipulation of their wireless sets, and possess in their Chairman, Captain Ian Fraser, M.P., a radio expert of acknowledged authority and influence.



INTERFERENCE ELIMINATED? Captain Alban Roberts who has invented a wireless device which, he claims, is invulnerable to interference. In a demonstration before Air Ministry officials, Captain Roberts successfully overcame interference from a transmitter in the same room as his own apparatus.

CANADIAN CONCERT FOR ENGLISH EARS.

Readers who on the night of November 6-7th picked up a musical transmission on 291 metres between the hours of 11.30 p.m. and 1.30 a.m. were listening to a special anniversary programme from CNRA, Monckton, Canada. The concert was specially intended for listeners in the British Isles, and it is hoped that readers who heard the transmission will report the fact to the Canadian National Railways, 17-19, Cockspur Street, London, S.W.1.

A similar transmission from this station last February evoked several hundreds of reports from British listeners.

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BROADCASTING IN MADRID STREETS.

Citizens of Madrid, it appears, enjoy the doubtful privilege of being able to hear the transmissions of the local broadcasting station when promenading in the streets. The only avenue of escape would appear to be down the back alleys, the principal thoroughfares being patrolled by a truck fitted with a multi-valve receiver and four loud-speakers. A microphone is also installed, so that during periods when the Madrid station is closed down public announcements can be made from the truck.

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PRAISE FOR NRRL.

Lieutenant F. H. Schnell, the American amateur who has accompanied the U.S. Fleet on its Pacific cruise for the purpose of conducting short wave experiments, has been publicly thanked for his services by Admiral R. E. Coontz, Commander-in-Chief of the U.S. Fleet.

NRRL, the experimental station controlled by Mr. Schnell on board the "Seattle," succeeded, day and night, without a break, in communicating with American amateurs and the Navy short wave station at Bellevue, D.C., during the entire cruise. The importance of this accomplishment is shown by the fact that the fleet visited Hawaii, the various South Sea Islands, Australia and New Zealand.

When relieved from his naval duties, Lieut. Schnell will resume his work as Traffic Manager of the American Radio Relay League at Hertford, Conn.

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JAPANESE PARLIAMENT TO BE BROADCAST?

The delicate question of whether Parliamentary debates can be considered suitable fare for a broadcast programme is agitating the minds of the Japanese Government. A petition for the installation of a microphone in the Imperial Diet building has been put forward by the officials of the Tokio broadcasting station, who express the hope that it may be possible to broadcast the winter debates for the edification of the public.

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NEWSPAPERS AND BROADCASTING.

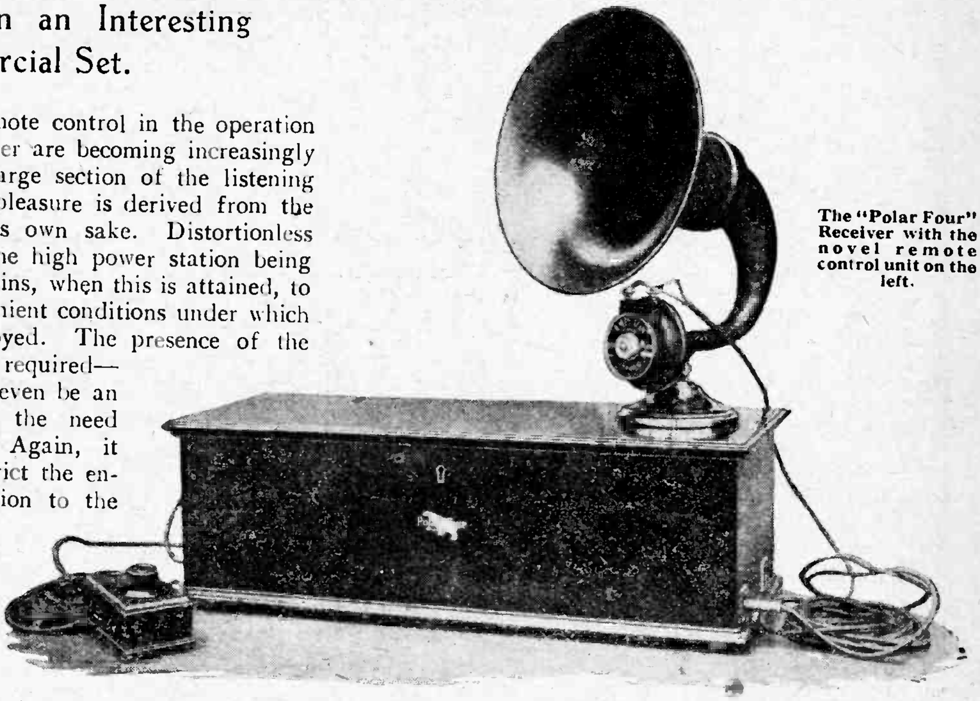
Lord Burnham, who is President of the Imperial Press Union, entertains no doubts as to the reciprocal benefits which broadcasting and the Press can confer upon each other. In a recent interview at Sydney, Australia, Lord Burnham stated that he had found that the brief broadcast news bulletin, in announcing happenings of importance, roused public curiosity, with the result that newspapers were bought for the purpose of learning details.

The prime necessity is, of course, that the broadcast message should *precede* the newspaper report; a "stale" broadcast bulletin is boring in the extreme.

NEW REMOTE CONTROL RECEIVER.

Some Notes on an Interesting Commercial Set.

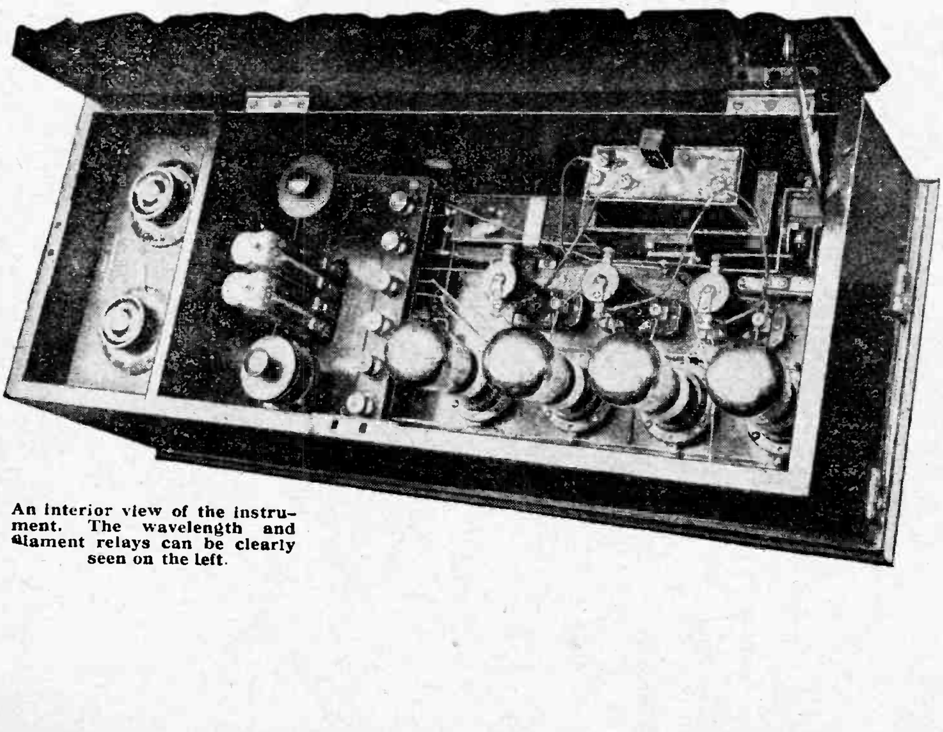
THE advantages of remote control in the operation of a broadcast receiver are becoming increasingly recognised by that large section of the listening community whose principal pleasure is derived from the broadcast programme for its own sake. Distortionless reception of the local and the high power station being the *desideratum*, it only remains, when this is attained, to seek the best and most convenient conditions under which the programme can be enjoyed. The presence of the actual receiver may not be required—to the most sensitive it may even be an unwelcome distraction—and the need arises for remote control. Again, it may not be desirable to restrict the enjoyment of broadcast reception to the limits of one room, and in such a case remote control avoids the necessity of transferring the set from one part of the house to another.



The "Polar Four" Receiver with the novel remote control unit on the left.

The "Polar Four" receiving set, the latest production of the Radio Communication Company, which was shown at the recent Albert Hall Exhibition, is the outcome of careful consideration of the points mentioned. As its name implies, the receiver contains four valves—a detector and three L.F. amplifying valves—and is designed for use with either a high or low resistance loud-speaker. Polar resistance capacity coupling units are employed throughout in the low-frequency stages. The principal feature of novelty in the set is the provision of an ingenious though robust and reliable remote control device capable of lighting the valves, adjusting for volume, and selecting alternative transmissions from the high power or the local station. A movable dial and a switch suffice to control these operations.

The set consists of two tuned circuits with reaction, one circuit covering ranges from 270 to 500 metres, the other circuit tuning between 1,320 and 2,900 metres. Prior to connecting up the remote control device, the two circuits are tuned to the local and high power stations respectively, when they may be left without further attention.

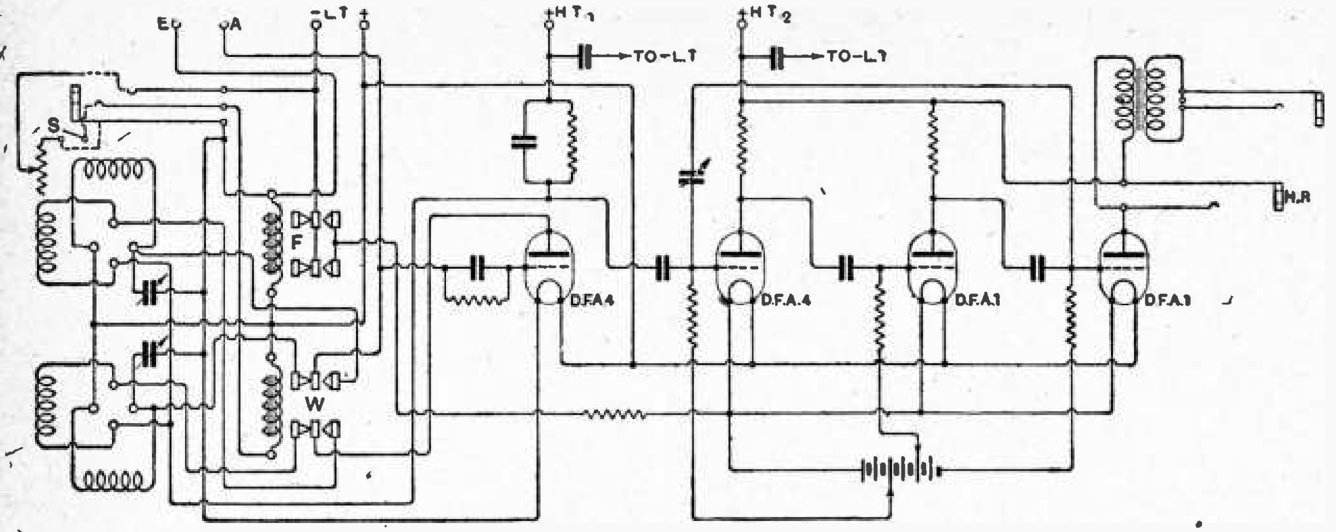


An interior view of the instrument. The wavelength and filament relays can be clearly seen on the left.

The Remote Control Unit.

The remote control unit is attached to the main set by flexible wiring, but provision can also be made for connecting up with a house-wiring system. The control unit consists of a rheostat, operated by an engraved knob and dial. A slight turn in a clockwise direction actuates a relay in the set which switches on the L.F. valves to their normal temperature and the detector only dimly. The control then acts as a filament resistance in controlling the brightness of the detector valve so that signals can be adjusted for volume.

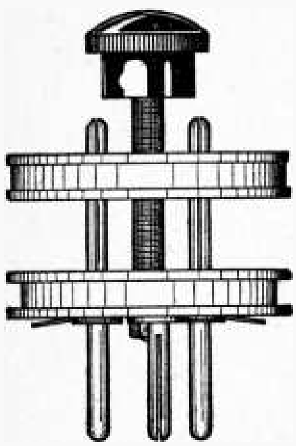
The control also embodies a switch, with indicator, which permits the listener to change over from one tuned circuit to the other without touching the set.



Theoretical diagram of connections in the "Polar Four" receiver

The Four Valves.

A word as to the most suitable types of valve used in the "Polar Four" may be of interest. For the detector and first L.F. stage D.F.A.4 valves are employed in order to secure as great an amplification as possible while the amplitude of the signal is small. D.F.A.1 type valves are used in the second and third stages, to obviate grid current troubles with the greatly increased amplitude. The use of only two types of valve has the advantage of being economical as regards spares.



The Polar coil unit which provides variable reaction

The grid condenser rectification is so arranged that it can be eliminated by a shorting bar across the grid leak when the receiver is installed near a broadcasting station. In this way distortion is minimised.

Such a receiver is of exceptional value in the case of hospitals, and it is interesting to note that a "Polar Four" has been installed in the London Homœopathic Hospital. The remote control device and change-over switch are installed in the matron's room.

Referring to the diagram of connections, relay F controls the filaments and is actuated by the current passing through the detector valve in series with the coil of the relay and the rheostat, which is fitted in the remote control box and connected between the top and bottom contacts of its jack. The switch S is also in the control box, and when it is closed actuates relay W and connects the appropriate tuned circuit and reaction coil to the set. If the circuit is traced out it will be seen that the upper contacts of relay W are connected to the aerial closed tuned circuits while the bottom contacts are joined to the reaction coils and to the anode of the detector valve.

"THE WIRELESS DIARY AND NOTE BOOK, 1926."*

Although the habit of preserving a lengthy journal of life's little happenings is no longer fashionable, the practice of keeping a brief record of daily events was never more pronounced than to-day. The diary habit is a good one.

An ideal diary, however, is not a mere receptacle for facts and fancies; it should provide useful and pertinent information likely to be required by its owner. The wireless enthusiast, be he expert or beginner, desires handy information of a highly specialised character, and it is to suit his needs that "The Wireless Diary" is annually produced.

"The Wireless Diary and Note Book, 1926," follows worthily in the footsteps of its predecessors, with the difference that it includes several important new features. Among these may be mentioned the valuable table of Valve Data, supplying operating particulars for all the best-known British valves, and, under "Wireless Notes and Circuits," practical and theoretical details regarding neutrodyne and super-neutrodyne receivers. This section also embraces a mine of progressive information concerning the installation of aerials and earths and the operation of valve receivers.

A word must also be said for the excellent directory of experimental transmitters. The list has been brought entirely up to date and contains not fewer than 1,200 call signs and addresses.

The diary pages are clearly arranged and each leaf contains a valuable wireless maxim. Nor must we forget to mention those useful pages at the end ruled and printed for receiver tunings.

For the wireless enthusiast who is searching for a "guide, philosopher and friend" during 1926, the "Wireless Diary" can be warmly recommended.

* "The Wireless Diary and Note Book, 1926." 75 pages. Cloth edition, 1s., postage 1½d. In leather case, with pockets, pencil, and season ticket window, 2s. 6d., postage 2d. (London: *The Wireless World*, Dorset House, Tudor Street, E.C.4, and Messrs. Charles Letts and Co.)

Simple Acoustic Measurements On Loud Speakers & Telephones

Application of the Rayleigh Disc to the Measurement of Sound Intensity.

By E. MALLETT, M.Sc., M.I.E.E.

WATCH the leaves falling off the trees. They do not fall with their edges towards the ground, but rather are always trying to get their flat surfaces downwards, and the well-known fluttering motion results. Make a hole at the middle of one side of a postcard near the edge, thread a piece of cotton through it, and hold the postcard up by the cotton. Now move the hand slowly horizontally. The card will be found to move round so that its surface is facing the movement, even though at first it was edgeways on. If the movement is reversed in direction, the same thing happens. If, instead of moving the card through the air, it is suspended by the thread in a draught or air current (Fig. 1), it will turn round so as to become broadside on to the draught.

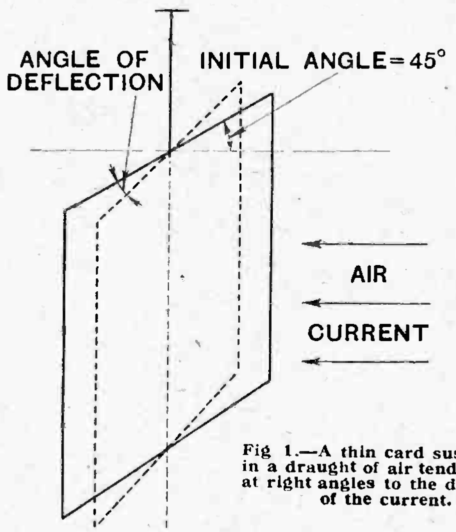


Fig 1.—A thin card suspended in a draught of air tends to set at right angles to the direction of the current.

If the suspension, instead of being cotton, is made elastic by using, say, a very fine wire, and the card is at first half-way round to the direction of the air current, then the turning movement produced by the current will be opposed by the forces brought into play as the wire is twisted, and if the air current is steady a steady position will be taken up at which these two couples balance. This position will depend upon the strength of the draught—that is, upon the velocity of the air current, and the stiffness to turning of the suspension; and for small movements from an initial position at an angle of 45 degrees to the current, the angle turned through by the card will be very nearly proportional to the square of the air velocity.

If the air current is reversed in direction, but kept the same strength, the angle turned through is exactly the same and in the same direction.

Once calibrated, therefore, such a card would give a means of measuring the velocity of any steady air flow. Also, since the deflection is in the same direction if the air current is reversed, it would measure a pulsating or alternating air flow if the alternations were sufficiently rapid for the card to be unable owing to its inertia to follow them, giving, since the movements are proportional to the square of the velocity, an angular deflection proportional to the mean square of the velocity.

Principle of the Rayleigh Disc.

The reason for the tendency of the card to move to a position broadside on to the stream will probably be understood by considering the stream lines of flow round the card. These are illustrated in Fig. 2, where the card is looked at from above. A is the up-stream edge of the card, B the down-stream edge, and C the centre from which the card is suspended. In order to pass the card the stream must divide, part going round the edge B and part round the edge A, and it is fairly evident that the point of division P will not be at the centre C, but somewhere as shown between A and C, so that the stream

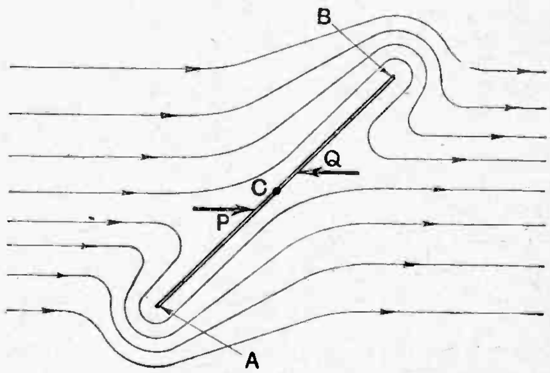


Fig. 2.—Forces acting on a card suspended in an air current at an angle of 45 degrees.

Simple Acoustic Measurements.—

lines that have partially to turn back to flow from P to A will have a shorter distance to travel than those which flow from P to B, and are only diverted in direction without any backward movement. Similarly, on the downstream side of the card, the centre of reunion will evidently be at Q between C and B. Now, the stream, on meeting the card, will evidently produce forces all along its surface, but it is not difficult to imagine that these forces will be greatest at P, where the full flow of the stream is stopped, while at Q the force of reaction will be greatest, as there the stream commences, as it were, its full flow again after the interruption of the card. So that the centres of the forces produced will be at P and Q, as shown by the thick arrows, and it will be seen that the effect of these will be to tend to produce a turning of the card so as to make it face the stream. Moreover, if the stream flow be reversed, the stream lines will remain the same with all the light directional arrows reversed, and a little consideration will show that the heavy arrows indicating the forces will be unchanged, so that the turning is precisely the same.

Discovery of the Rayleigh Disc Effect.

These facts had been known for many years, but it was Lord Rayleigh who first applied them to the measurement of sound waves. He was making an experimental investigation of the absolute value of the ohm, and was using a small magnet mounted on a small circular disc suspended within a practically air-tight box with glass sides. A coil rotated round the box and set up mechanical vibrations, which at low speeds caused no trouble, but at higher speeds caused the disc to be set into violent motion. Sounding a bell near the box or lightly tapping it also caused the disc to deflect. The actual reason for the deflection was ultimately proved to be the creation of sound waves within the box by the mechanical vibration, which, since a sound wave is constituted by a forwards and backwards movement of the particles of air conveying it, act in the same manner as the alternating air current envisaged above. Lord Rayleigh applied the disc, therefore, to the measurement of sound waves by suspending it at the mouth of a resonator or in a resonating tube, and the device is consequently always known as a Rayleigh disc.

The Rayleigh disc is usually used in a resonating tube,

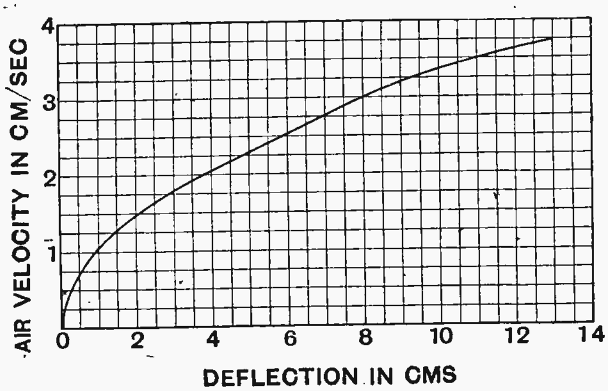


Fig. 3.—Calibration curve for Rayleigh disc.

where the velocities are very much magnified and a far more sensitive device results than if the disc were in the open sound field. But for making actual measurements opposed to using the device as an indicator, there is a disadvantage in the resonating tube because of its reaction on the sound source and distortion of the sound field. Discs quite sensitive enough for investigating the field of sound round a telephone receiver or a loud-speaker without any resonating tube can, however, be made. The disc itself is most conveniently a thin flat or concave galvanometer mirror, so that the angle it turns through can readily be ascertained by reading the deflection of a beam of light falling from a fixed source on to the disc and reflected thence to a scale. The suspension gives more trouble. It must be perfectly elastic so that, after a deflection, the disc returns to its original zero

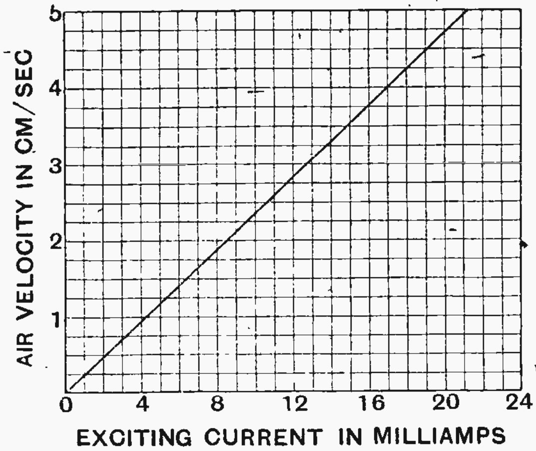


Fig. 4.—Curve showing relation between the air velocity and exciting current for a telephone receiver mounted in a resonator tube.

position, and it must give only a very small torque on being twisted as the forces available are very small; quite a loud sound of pitch upper C will give on a disc of ½ cm. diameter a torque of only five-hundredth of a dyne-cm., which is less than the weight of a millionth of an ounce, acting with a leverage of one inch. Glass was the material eventually adopted, in the form of a very thin fibre. This was made in the same way that C. V. Boys made quartz fibre. One end of a glass rod of about a sixteenth of an inch diameter was fixed to a support on the table, and the other end to the end of an arrow. The glass rod was heated almost to the melting point at the middle by a bunsen burner, until, in fact, the heated part appeared to be on the point of dropping off, when the arrow was shot from its bow along the table, leaving in its wake, stretched out along the table, a very thin fibre of glass.

Calibration of the Disc.

The fibre thus made was fixed to the mirror by means of sealing wax, and the other end was fixed to a support which could be rotated to give any desired initial position. It was calibrated in a steady air stream through a 5 cm. diameter tube, by placing it at the middle of the tube close up to the end. With a suspension length of 40 cm. and a distance from disc to scale of 48 cm., the

Simple Acoustic Measurements.—
calibration curve shown in Fig. 3 was obtained. This curve agrees well with that required by theory.

It is assumed that this direct air current calibration holds also for the alternating air current of the sound

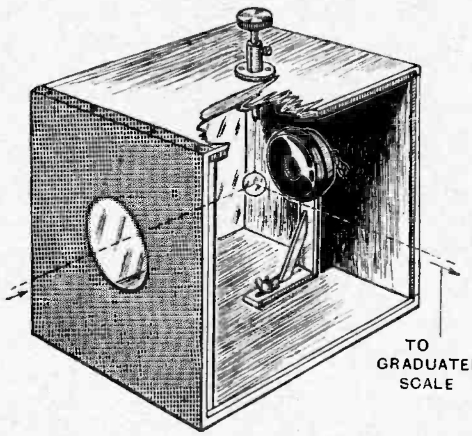


Fig. 5.—Experimental arrangement for testing telephone receivers.

wave, an assumption which does, perhaps, call for direct experimental proof. But there seems to be no reason why the same calibration should not hold, provided that the diameter of the disc is small compared with the wavelength of the sound. A sounding having a wavelength of half a centimetre would have a frequency of 66,000 cycles per second, so we should be quite safe at all acous-

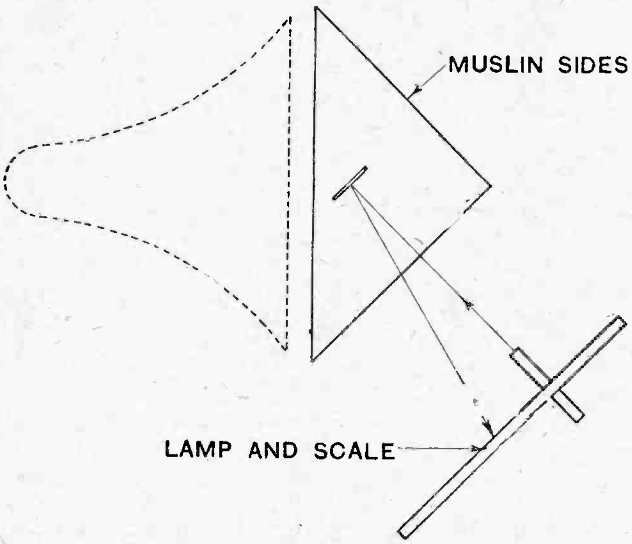


Fig. 6.—Method of setting up the apparatus to test loud-speakers In this case a screening box of triangular section is used.

tical frequencies with a half-centimetre disc. In fact, we could probably increase the diameter of the disc say to three centimetres and still be safe, and such a large disc, made, say, of aluminium with a small mirror at its centre, would be very useful at larger distances from a sound source on account of its greater sensitivity. It would, with the same suspension, be 216 times as sensitive, and, instead of our lowest reading being 0.5 cm.sec., we should be able to read 0.0025 cm.sec. The reason for the increased sensitivity is that the deflecting torque on the disc is proportional to the cube of the disc diameter.

Now the simplest acoustical test we can make on a telephone receiver is at a fixed frequency to find out how the sound output varies with the electrical input, or to draw a curve of the air velocity against the exciting current. Such a curve is shown in Fig. 4. This was taken with a telephone receiver fixed in the end of a tube, at a frequency corresponding to the natural frequency of the tube, so that from one point of view the

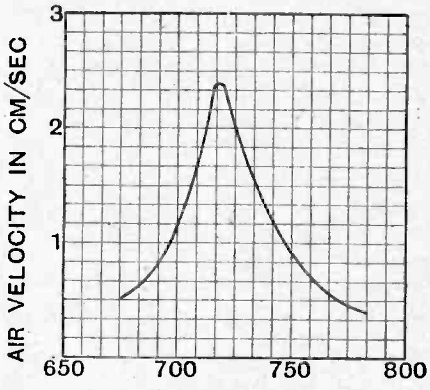


Fig. 7.—Air velocities produced by a telephone receiver when supplied with the same value of current at different frequencies.

arrangement was half-way between a telephone receiver and a loud-speaker, and from another it was an electrical organ pipe.[1] The tube was mounted in a large box heavily lined all round with loose cotton waste to avoid reflection effects, with the disc suspended at the mouth of the tube. A beam of light from the usual electric lamp arrangement for galvanometers stuck into one side of the box fell on to the disc and was reflected on to a translucent scale let into another side of the box. The box served also to protect the disc from draughts, which it is very necessary to do.

Loud-Speaker Tests.

It is seen that the air velocity is directly proportional to the exciting current, and this may be considered as being the first essential of any telephone device. Curves such as these should be taken on the loud-speaker under

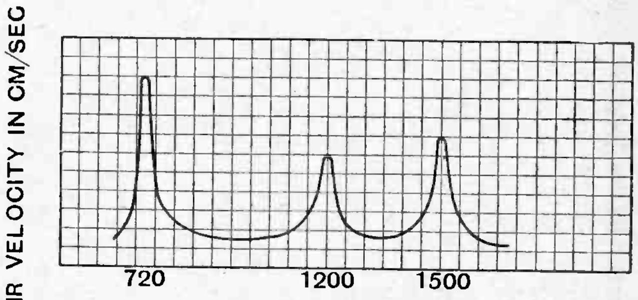


Fig. 8.—Typcial telephone characteristic, showing the principle resonance at a frequency of 720, and subsidiary resonances at 1,200 and 1,500.

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[1] See E. Mallett and G. F. Dutton, J.I.E.E., Vol. 63, pp. 502-516, May, 1925.

Simple Acoustic Measurements.—

test at a number of frequencies spread over the acoustic range. To avoid the padded box, we have arranged such an experiment for telephone receivers in the manner indicated in Fig. 5. The telephone is mounted in a box with glass sides. The disc is suspended from the top of the box in front of the telephones. The side of the box opposite the disc and receiver is removed and replaced by a piece of thin muslin. A cheap pocket-handkerchief washed to get rid of its dressing serves very well. The muslin has a small glass window let

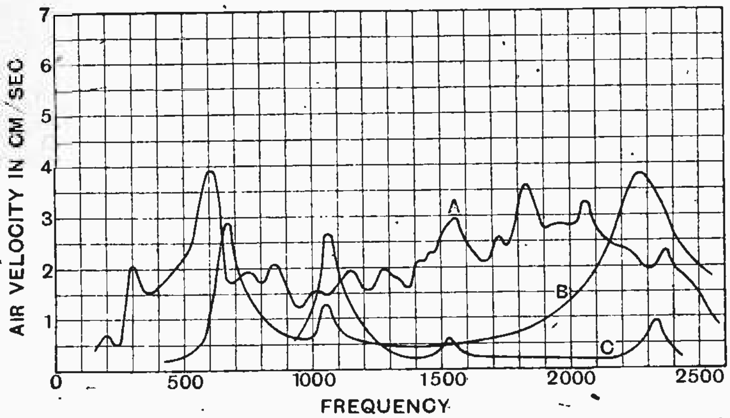


Fig. 9.—Frequency characteristics of a horn type loud-speaker. A, at the mouth of the horn; B, at the mouth of the nozzle with horn removed; C, at the diaphragm with nozzle removed.

into it for the beam of light. The object of the muslin is to protect the disc from draughts, while causing no sensible reflection of the sound wave from the receiver.

Frequency Characteristic Curves.

For loud-speakers, some such arrangement as that in Fig. 6 would probably be suitable. Here a triangular-shaped box with the sides all muslin is shown in plan. The disc is suspended from a suitable top, and a glass microscope slide is let into one side to allow a beam of light from a lamp and scale to enter and leave.

The next experiment that will be made is one to find the relative response of the telephone when excited with the same current, but at different frequencies. A telephone receiver tested in this way gave the curve in Fig. 7, displaying the well-known marked resonance due to the telephone diaphragm. The curve covers only the fundamental resonance. The higher mode resonances, if the frequency is carried further, will produce other resonant humps, as indicated in Fig. 8.[1]

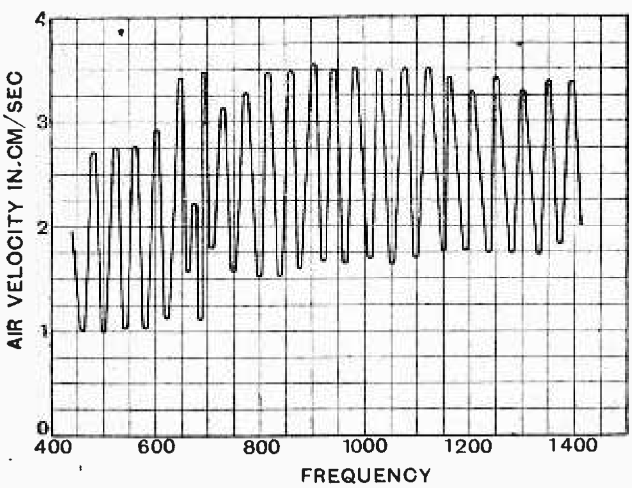


Fig. 10.—Resonance curve of the loud-speaker of Fig. 9, with a 15ft. tube 3/4in. in diameter substituted for the horn.

Loud-Speaker Resonances.

With a loud-speaker these resonances are far more complicated. Not only are there the resonances of the diaphragm or reed or spring control of the armature, but also there are the resonances of the horn or of the large paper diaphragm. These resonances cause the various curves to overlap, so that it is difficult to separate them out and say what is the cause of each. Fig. 9 gives an interesting set of curves taken by Dr. Dutton when a senior student at the City and Guilds Engineering College. Here the exciting current was 2.8 milliamperes. Curve A gives the air velocity at the mouth of the horn at frequencies from 150 to 2,500. It will be seen how complex a curve this is. The only sort of regularity that can be detected is some sort of peak every 100 cycles, which corresponds roughly to what would be expected from the horn. With the horn removed, and air velocities measured at the nozzle on which the horn fits, the very much simpler curve B was obtained, with resonances deter-

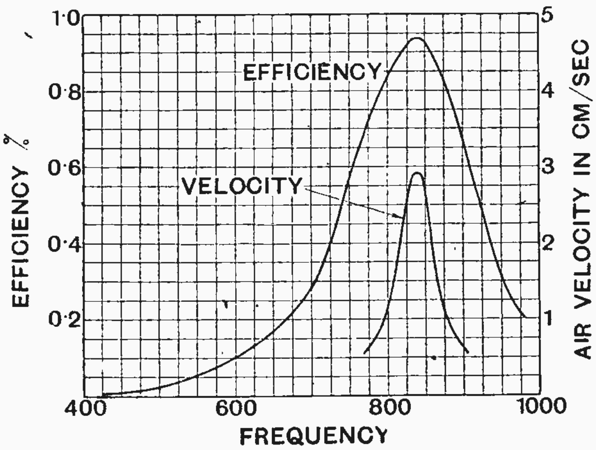


Fig. 11.—Variation with frequency of the air velocity and efficiency in a telephone receiver.

mined by the reed and diaphragm system, and by the short length of tube constituting the nozzle. With this tube removed, together with a plate that fitted close to the diaphragm, curve C resulted.

Another interesting curve is given in Fig. 10. A ¾in. tube 15ft. long was fitted to the nozzle of the loud-speaker instead of the horn, and sound velocities were measured at the end of the tube. Here, except at 700 cycles, corresponding to the fundamental of the dia-

[1] See *The Wireless World*, p. 374, June 25th, 1924.

Simple Acoustic Measurements.—

phragm system, the resonances are very uniform at a frequency apart of 40 cycles, corresponding to the overtones of a pipe 15ft. long closed at one end.

As to what weight to give these curves in the estimation of the loud-speaker it is difficult to say. On the face of it, if different frequencies are produced with amplitudes proportional not only to the different currents, but depending also on the frequency, distortion must result. But it seems to be well established that a considerable amount of such distortion can be tolerated. In fact, according to the figures given, not only curve A of Fig. 9, but also the curve of Fig. 10, should give no trouble on this account; but whereas the loud-speaker of curve A certainly gives good results (a musical friend described the reproduction as "perfect"), the sound of the tube was always present in the arrangement of Fig. 10. Transient or shock effects must evidently be taken account of, and a complete test of a loud-speaker must include an examination of the sound waves emitted by sudden alterations of current through it. This may quite possibly be the dominating factor in the behaviour of the instrument.

Efficiency Considerations.

The complete test of a loud-speaker should include efficiency tests, that is to say, the overall efficiency from electrical power input to acoustical power output, carried out at various frequencies. But here the difficulties are very great. The electrical power input can be measured fairly easily by the three-voltmeter method, using a valve voltmeter with grid bias sufficient to prohibit any grid current. But the measurement of the acoustical power output is a far more difficult matter. The power in the sound wave for unit area that the wave crosses is equal to the product of the particle velocity, the alternating pressure, and the cosine of the phase angle between the two. The considerations are similar to those in measuring the power in an alternating current circuit. And to find the whole power from a given source we must in imagination enclose the source in a surface, find the distribution of power over the surface, and, finally, sum up the whole power as the sum of the product of each element of the surface area and the power across it. This in general would present very considerable difficulties, in fact, it is probably quite safe to say that at present it is quite impracticable—how, for instance, would one measure the phase angle?—but if the distribution of the sound field follows a known law, the power may be calculated from a single reading of the Rayleigh disc. In the case of the telephone receiver, for instance, as soon as the wave has proceeded four centimetres from the diaphragm it has become a spherical wave; the pressure and velocity and phase angle are the same over any spherical surface drawn with the centre of the diaphragm as centre, and these quantities vary in a known manner with the radius of this sphere. In this way the curve of Fig. 11 was obtained for the efficiency of our ordinary telephone receiver working into the open air, and for comparison there is also shown the variation of particle velocity with frequency. For details as to how this efficiency curve was obtained reference must be made to the paper by the writer and Dr. Dutton referred to previously. It is, however, of interest to note how inefficient the ordinary receiver is; at its best frequency it is less than 1 per cent.

Now the problem is how to extend these efficiency determinations to the loud-speaker. Preliminary tests have shown that close to the horn, going across its mouth, there are wide variations in sound intensity; at some frequencies, in fact, nodal lines appeared, at which there was no sound at all. But, however complicated the sound distribution round the loud-speaker is, even though as indicated by the nodal lines, at some parts the movement of the air particles is actually of opposite phase to that at other parts, at a far enough distance the wave will become spherical and from measurements at one point it will be possible to deduce the power. The distance will be considerable, probably several yards, and the measuring device must be more sensitive than the one described—possibly a Rayleigh disc in a resonating tube would prove suitable—and unless the experiment is conducted in a large open space the walls of the room must be well padded to avoid reflection. But it is an interesting experiment which we hope to carry out before long.

INTERFERENCE ON THE BROADCAST BAND.

The following letter regarding Northolt interference is of especial interest in view of our Editorial remarks of October 28th.

Sir,—In a recent issue you print a copy of a letter received from the Postmaster-General, addressed to Capt. Ian Fraser.

In this, I notice that the harmonics and "mush" have apparently been suppressed at the Leafield Wireless Station, and the P.M.G. states that similar anti-harmonic appliances have been fitted at Northolt. He does not say, however, at Northolt the interference has been eliminated, and from my own personal observation I am of the opinion that this has recently become aggravated, either through an increase of power or due to certain alterations which have been made.

The point I wish to emphasise, however, is that the impression the P.M.G. gives is that the interference has been satisfactorily dealt with.

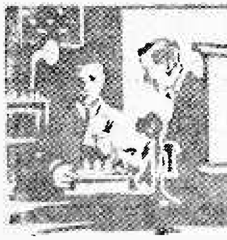
May I point out that later on in the same month I received a letter from the G.P.O. on the subject of Northolt interference, in which the following paragraph appears :—

"Observations taken in the London area show that the arc transmitter at the Northolt station may still be a source of disturbance to sensitive receiving apparatus when endeavour is made to receive *distant* stations, but that no interference from the Northolt station with the reception of the *London* programme is experienced, even when the sensitive receiving apparatus is used."

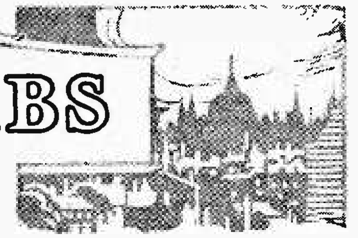
Further comment in this letter states that all possible steps have been taken to eliminate interference.

There is no doubt that Northolt is a source of great annoyance to all users of valve sets who desire to listen in to other B.B.C. stations, and I do suggest that with the great facilities that the G.P.O. have at their command it should be possible to effect the necessary improvements, which will without doubt earn the gratitude of thousands of London "listeners-in."

Finchley, N.3. A. H. BRACKENSEY.



NEWS from the CLUBS



Secretaries of Local Clubs are invited to send in for publication club news of general interest. All photographs published will be paid for.

Bristol and District Radio Society.

The current number of the *Monthly Bulletin* of the Transmitters' Section opens in a minor key with the Editor's cry: "What is the matter with you all anyway?" Enthusiasm is apparently lacking in the Bath, Newport, Weston, and Burnham districts. It is to be hoped that the Editor's spirited appeal for increased activity will not pass unheeded.

A healthy tone pervades the pages of this interesting *Bulletin*, which contains articles on the work of the International Amateur Radio Union, the Lecher wire system of wavemeter calibration, and "Short Waves over Atlantic Rollers."

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Golders Green and Hendon Radio Society.

Owing to the indisposition of Mr. Maurice Child, the third lecture on "Fundamental Principles of Radio Reception" was postponed from October 21st to November 4th. Arrangements have fortunately been made to include the full series of Mr. Child's lectures in the present session.

On October 21st Mr. J. Bird, B.Sc., gave an instructive lecture on "H.T. Supply," discussing in a very interesting manner the respective advantages and disadvantages attending the use of dry cells, H.T. accumulators, D.C. and A.C. mains, and motor generators and converters.

Hon. Secretary: Mr. J. W. T. Crewe (2AKS), 111, Prince's Park Avenue, N.W.11.

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Ilford and District Radio Society.

Captain West, Chief Research Engineer of the B.B.C., was the Society's guest and lecturer on October 27th, choosing as his subject "Some Problems and Aspects of Wireless, and Line Relaying for Broadcast Purposes." The lecture might be considered as a sequel to that of Captain Eckersley before the same society some time previously.

Captain West explained the efforts of the B.B.C. to place the listener as far as possible in the same position as the microphone in the studio. Difficulties in S.B. transmission were more easily overcome in the U.S.A. than over here owing to lack of funds in this country; in the U.S.A. tests were made at various points along the trunk lines employed, and this necessitated expenditure. Extraneous and induction noises in the land lines had to be drowned out by a step-up method of amplification along the route using a single-valve amplifier at points where the interference approached the strength of signals transmitted to the broadcasting station. FFU, the French spark station, was mentioned as a notable offender, being received at equal strength on 20 metres as on 600.

FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 11th.

Radio Society of Great Britain.—Informal meeting at 6 p.m. at the Institution of Electrical Engineers, Savoy Place, W.C.2. Discussion on "Crystal Detector Design" to be opened by Mr. A. Hindertich.

THURSDAY, NOVEMBER 12th.

Walthamstow Amateur Radio Society.—Jumble Sale.

FRIDAY, NOVEMBER 13th.

Radio Experimental Society of Manchester.—Lecture: "A new Method of Low Frequency Amplification," by Mr. J. Hudson.

Sheffield and District Wireless Society.—Elementary Class. Discussion: "Ether Waves, continuous, damped, and modulated."

MONDAY, NOVEMBER 16th.

Swansea Radio Society.—Lecture: "The Manufacture and Uses of Condensers for Radio Purposes" (illustrated with lantern slides).—Dubilier Condenser Co., Ltd.

Lewisham and Bellingham Radio Society.

The Transmission Section of the Society held a meeting on October 27th, when Mr. C. Bartle (2LT) gave a comprehensive lecture on the general principles of transmission. Various methods were carefully described, and consideration was given to the Reinartz and Culpitts transmitting circuits. The vexed problem of suitable H.T. supply also received careful attention, and much useful information was provided concerning the choice of rectifiers and transformers.

Joint Hon. Secretaries: Mr. C. E. Tynan, 62, Ringstead Road, S.E.6. Mr. J. A. Clark, 35, Boones Road, Lee, S.E.13.

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Manchester Radio Scientific Society.

At the Society's meeting on October 21st the announcement was made that a workshop had been obtained in Booth Street, off Oxford Street, in which members could carry out experiments and constructional work. The meeting concluded with an animated and instructive discussion upon the function of the grid in the thermionic valve.

Hon. Secretary: Mr. Geo. C. Murphy, Meadow View, The Cliff, Hr. Broughton, Manchester.

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Northampton and District Amateur Radio Society.

Mr. R. G. Turner, Chairman of the Society, provided an interesting lecture on October 26th on the subject of improving reception from the Daventry broadcasting station.

While emphasising the satisfaction which could be obtained with a home-made crystal set costing a few shillings, the lecturer reminded his hearers that the amateur who wished to extend his knowledge should invest in valves. In adding valve amplification to a crystal receiver it was essential, in purchasing a transformer, to consider whether a low or high resistance crystal was in use. The former required a high step-up transformer, while the latter required a transformer of the low step-up type.

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North Middlesex Wireless Club.

A highly successful meeting was held on October 28th, when Mr. A. L. Kirke, of the Engineering Staff of the B.B.C., delivered a lecture on "Distortionless Reception of Broadcasting."

The lecturer first explained, by a series of interesting diagrams, what exactly is meant by "distortion." It was shown that musical sound is made up of a number of elements, and that distortion occurs when the relative strengths of these component parts are altered.

Valves, transformers and loud speakers were each in turn subjected to examination and criticism, and helpful suggestions were given as to how they should be employed to the best advantage.

A gratifying feature of the meeting was the presence of a number of visitors.

Hon. Secretary: Mr. H. A. Green, 100, Pellatt Grove, Wood Green, N.22.

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Woolwich Radio Society.

The current number of "The Oscillograph," the live little monthly published by this society, reflects the enthusiasm of the members in no uncertain manner.

From the Editorial Notes we gather that the date of the Annual Address by the President (Mr. Bartle) draws near and that speculation is rife as to the President's choice of subject. The Presidential Address is looked forward to with interest each year owing to Mr. Bartle's skill as a lecturer and the practical experience upon which he is able to draw.

A small contingent of Woolwich members recently attended the "At Home" held by the Streatham Radio Society. The feature of the meeting was an excellent lecture by Mr. Minhalla on the subject of distortion in broadcast reception; the interest of the speaker's remarks may be judged from the fact that his audience remained absorbed in the subject for two hours.

Broadcast Brevities

SAVOY HILL TOPICALITIES

By Our Special Correspondent.

New S.B. Arrangements.

Various dates have been given for the coming into operation of the new S.B. scheme, but these dates, I am told, are inaccurate. An enormous amount of work is entailed in the construction of the sub-relay station at Leeds and several weeks will elapse before the scheme is ready to be put into operation. The particulars of the new arrangements have already been given in full in *The Wireless World*, and the actual date of their completion will be announced in these columns in due course.

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Continental Broadcasts.

There have now been two experimental transmissions of extracts from continental programmes—one on October 16, and the other on October 29—but I understand that the B.B.C. engineers are far from being satisfied. This is a healthy sign, as it gives promise of greater effort and better results in the future.

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Excellent Results.

The general excellence of those stations which Keston succeeded in receiving on October 29 is regarded as greater than on the first occasion. The Beethoven Quartet from Munster was rather thin, but was well balanced. Hilversum (Holland) was transmitting a stirring martial air, but Elberfeld, the other German station tuned in, was much interrupted, and although Malmo had been received earlier in the evening with exceptional clearness, it interfered with reception when Brussels was picked up. Subsequently, after many quests for stations on which there was no interference, Voxhaus (Berlin) and Stuttgart were tuned in and were particularly good.

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S.O.S.

While the latter was being received there was a background of Morse signals, an S.O.S. message from a ship in distress; and this is believed to have been the signal of the ship "American Merchant" which was then standing by a Dutch steamer in distress North of the Azores. The distress signal was picked up by Portpatrick in the S.W. corner of Scotland, which station notified that it was dealing with the matter.

The Value of Wireless.

In the midst of their entertainment, therefore, listeners, who understand had a practical illustration of one of the boons conferred on shipping by wireless.

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San Sebastian.

Several attempts to reach San Sebastian, which had prepared a special programme for English listeners, resulted in shrieks of the shrillest and noises of the noisiest, as if two or three stations were battling for supremacy in the ether. Although San Sebastian was thus eliminated from the programme it is hoped that the station authorities there will not be discouraged by this initial failure, and that their good-will may be shown later when another European broadcast is undertaken by Keston.

A Blind Programme

St. Cecilia's Day, November 22, will be signalised at 2LO by a special blind programme, as she was the Patron Saint of the blind as well as of music Captain Ian Fraser, M.P., will act as announcer in connection with some of the items and will also broadcast a talk. Blind singers, pianists, cornetists and chorus will take part as well as blind readers. The programme should have a particular appeal to all listeners, especially in view of the blessings which broadcasting has showered upon those among the vast invisible audience who are similarly afflicted.

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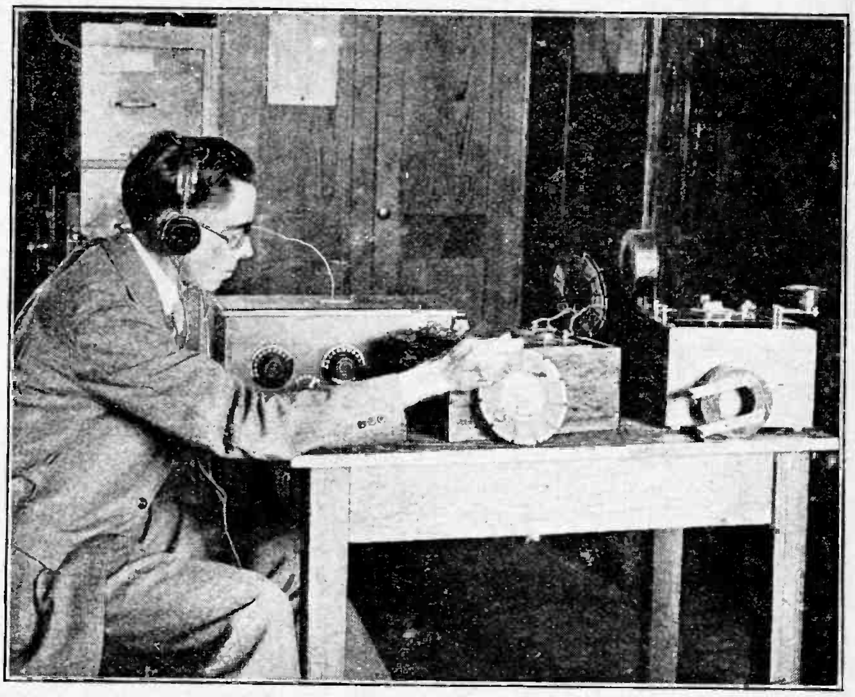
The Birthday Week.

Mr. George Graves is the latest addition to the special gala week programme referred to in this page last week. The inimitable Baron Popoff will broadcast



TESTING BROADCAST FREQUENCIES Considering the extraordinary number of broadcasting stations in America it is not surprising that interference presents a difficult problem. Mr. M. S. Stroek, of the U.S. Bureau of Standards, is seen in the photograph with a device of his invention for checking the frequencies of distant stations Doubt exists as to whether stations digress from their allotted wavelengths some special features at 10.30 p.m. on November 9. On the following day Mr. Lionel Tertis, the famous viola player and the equally well-known pianist, Lamond, will be in the programme.

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Mr. Donald Calthrop.

Mr. Donald Calthrop, who has recently joined the B.B.C. Dramatic staff, has arranged for the broadcast of his revue "Lend me your Ears." This transmission will take place on November 12.

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Thought Reading.

On the same evening the mass telepathy broadcast is expected to take place and the plea of the notabilities who are to attend at Savoy Hill for the purpose of reading the minds of listeners will be a silent and earnest appeal to people in their own homes to lend their thoughts rather than their ears.

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Mr. C. B. Cochran.

Mr. C. B. Cochran will appear before the microphone on the evening of November 14, when he will give a talk on his career as a showman.

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Programme Critics.

It is a sign of the times that some complaints have been made within the past few days as to the quality of broadcast programmes. They never are as good as they were, but the critics, unlike the dormice, wake up as the winter season approaches.

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Where they are Worse.

Apropos their complaints, I am told that the B.B.C. has just received a letter from Mr. Bransby Williams, from which the following is an extract:—

"The programmes here are frightfully monotonous—all bands, piano solos, violin solos, and no character."

He wrote from Washington, D.C.

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Dismantled Aerials.

The map of London and other big towns has been undergoing curious alterations of late; at any rate, so far as the suburban back gardens are concerned. This is apparently due to the fact that many listeners are determined not to pay for the enjoyment that they derive from broadcast, and are consequently pulling down their aerials by the score. A curious effect is produced by the sudden disappearance of poles which heretofore leaned at all angles and varying heights in whatever direction one looked; but probably after a time these aerials will make their reappearance, when erstwhile listeners find that they cannot do without their necessary sets.

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More Licences.

In the meantime, it is encouraging to learn on official authority that in many districts the number of licences has gone up by 100 per cent. during the past month and on balance it will probably be found by the end of the year that there is an aggregate increase of no mean proportions.

FUTURE FEATURES.

Sunday, November 15th.

LONDON.—4.15 p.m., Lucille La Verne in a Short Recital.

BIRMINGHAM. — Birthday Programme.

BOURNEMOUTH.—Picture. "Anno Domini — The Flight into Egypt."

CARDIFF.—First Concert of the Cardiff Musical Society, relayed from the Park Hall, Cardiff.

MANCHESTER.—3.30 p.m., A Russian Programme.

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Monday, November 16th.

BIRMINGHAM.—10.30 p.m., Short Recitals.

BOURNEMOUTH.—8 p.m., "John Citizen at Home."

CARDIFF.—A Varied Programme.

NEWCASTLE.—9.15 p.m., "Radio Radiance."

GLASGOW.—8 p.m., The Sonatas of Beethoven.

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Tuesday, November 17th.

LONDON.—8 p.m., "Winners."

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Wednesday, November 18th.

LONDON.—10.30 p.m., The Week's Feature.

CARDIFF.—8-9 p.m., "The Spirit of Welsh Music."

MANCHESTER.—8 p.m., A Yorkshire Night.

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Thursday, November 19th.

MANCHESTER.—8.45 p.m., "Schubert."

NEWCASTLE.—8.30 p.m., Schubert Anniversary Concert.

GLASGOW.—8.30 p.m., "Bach."

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Friday, November 20th.

LONDON.—9 p.m. Offenbach Follies.

BIRMINGHAM.—8.30 p.m., Children's Concert.

BIRMINGHAM.—9.15 p.m., "Radio Radiance."

NEWCASTLE.—8 p.m., Symphony Concert.

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Saturday, November 21st.

LONDON.—8 p.m., "Donald Calthrop's At Home."

MANCHESTER — Grand Opera, "Romeo and Juliet" (Gounod), relayed to 5XX.

ABERDEEN.—Scenes from "The Lady of the Lake" (Macfarren).

A Radio Ghost.

A ghostly story has reached the B.B.C., which seems to be six weeks or so in advance of the season for which it is intended. Nevertheless, it was just as well that it were told quickly.

A lady living in a 16th century house in an isolated situation was awakened at 2 o'clock one morning last week by the sounds of music which filled her bedroom. She has no receiving set and cannot suggest a possible explanation. There is no central heating and she assumes that some agency exists in the house which would take the place of a detector and a loud-speaker.

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Chaliapine.

A bit of secret history is worth recording apropos the appearance of M. Feodor Chaliapine, the renowned Russian basso, at 2LO last week.

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An Objection.

When he was last in America M. Chaliapine, who was approached by the broadcasting companies, pointed out that it was wrong of the American listener to expect to hear him for nothing; in fact, the whole system of supplying broadcast entertainment in America without charge was wrong. He suggested, therefore, that a special tax should be levied on listeners when he or any other great artist sang for broadcasting.

oooo

A Solution.

When he was at Savoy Hill M. Chaliapine remarked that his idea was being carried out in a rather different but more effective way by Great Britain. He regarded the ten-shilling licence fee as a clever means of dealing with the question of the listener's liability; better, indeed, than that which he propounded to the American broadcasters. And that is why he consented to broadcast to British listeners.

oooo

Blue Distemper.

The engineers at Savoy Hill have been greatly perturbed by the invasion of gentlemen with paint brushes, and the reason is this; a room with whitewashed walls had been set aside for experiments in echo effects; but one day, during the absence of the engineers, some vandal made his appearance and added a coat of blue distemper to the walls, with the result that all the resonance has been destroyed. And now the engineers fly in a temper when one mentions blue distemper.

oooo

The Oxford Studio.

The broadcasting studio in Magdalen Street, Oxford, will be opened on November 26, at 9.30 p.m., when a special transmission will take place of distinguished speakers connected with the University, and well-known singers. The rest of the programme on that evening, with the exception of the time signal and news bulletin, will be relayed from Oxford.

INTRODUCTION TO WIRELESS THEORY

Magnetism and Electromagnetic Induction.

By N. V. KIPPING and A. D. BLUMLEIN.

The present section of this article deals in a simple manner with the phenomenon of magnetism in iron and steel, and then leads up to a consideration of the magnetic effects produced by an electric current.

These articles have been specially written from the point of view of the beginner, and previous sections have dealt with current, voltage, resistance and power in electrical circuits.

AT this stage it is necessary to make a few remarks about magnets and magnetism.

Everyone is familiar with the ordinary horse-shoe magnet. A magnet need not necessarily be this shape, but may be of any form—for instance, bar-shaped. It is well known that a magnet will attract small iron objects, and that it is the ends of the magnets which seem "strongest" in this attraction. The ends of a magnet are therefore called the "poles." One pole is called the north pole and the other the south pole.

If a bar magnet is hung up on a thread so that it can turn about as it pleases, it will tend to set so that its north pole points northwards, so that we see there is a definite difference between the N. and S. poles. In fact, if two magnets were suspended near one another, we should soon see that the like poles of the two magnets repelled one another, but that the unlike poles attracted one another. It is worth while to remember this simple rule—that "like poles repel, but unlike poles attract."

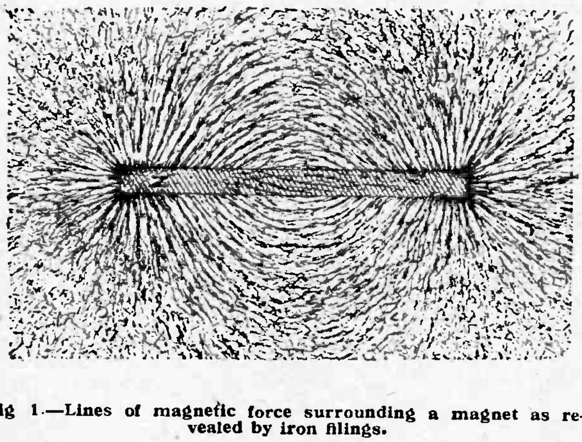


Fig 1.—Lines of magnetic force surrounding a magnet as revealed by iron filings.

Now, if we put a piece of paper over a magnet laid on the table and drop iron filings on the paper, we find that the filings arrange themselves in a pattern on the paper. Fig. 1 is a photograph of the pattern which iron filings took when scattered over paper covering a bar magnet. The outline of the magnet under the paper has been marked in the figure. We see from Fig. 1 that the iron filings have arranged themselves in lines, and these lines are called magnetic lines of force, and it is these lines of force which are the real basis of magnetism.

Lines of force flow out from the N. pole of a magnet back into the S. pole, and flow along from S. to N. inside the magnet. This is very like current flowing in a circuit. The current flows through the battery from – to +, and along the rest of the circuit from the + side of the battery back to the – side. The magnet takes the place of the battery, and the air takes the place of the wire in the circuit.

Substances are called magnetic or non-magnetic according as they are good or bad conductors of lines of force, or magnetic flux as it is called. Iron, steel, cobalt, and nickel are the only elements which are more magnetic than air, all these four being very similar magnetically, and are very good conductors of magnetic flux. Certain alloys, also, are good conductors of magnetic flux.

Magnetic Lines of Force.

Any area through which magnetic lines of force pass is called a magnetic field. As we have said, lines of force find it easier to pass through a magnetic substance than through a non-magnetic substance, and consequently if a magnet is in a magnetic field, lines of force try to pass through it. In doing so, they tend to pull the magnet in line with themselves, so that a magnet which is free to move, points along the lines of force of the magnetic field it is in. That is why the N. pole of a magnet points northwards, because a weak magnetic field exists round the earth, the lines of force running in a south to north direction. If the magnet is not free to move, some of the lines of force go out of their way to pass through it, so getting an easier path than through the air, which is comparatively non-magnetic.

Fig. 2 gives us the idea that magnetic lines of force are elastic. They try to pull the magnet through which they are passing in line with them. If a piece of magnetic material, not already a magnetic, is put in a magnetic field, it becomes magnetised due to the lines of force passing through it. Soft iron is very easily

Introduction to Wireless Theory.—

magnetised, but loses nearly all its magnetism as it is removed from the magnetic field. Steel, on the other hand, is very hard to magnetise, but retains nearly all its magnetism. That is why "permanent magnets" are made of steel.

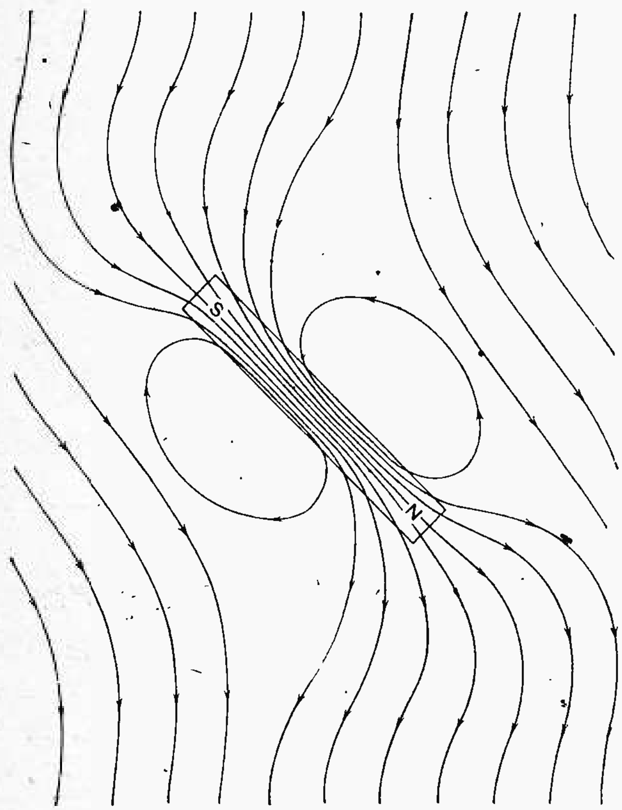


Fig. 2.—Lines of force in the earth's magnetic field distorted by a bar magnet.

Except for one thing, a magnet is very like an electric cell, the difference being that a magnet does not "run down." Unless its magnetic properties are spoilt by external means, a magnet goes on being a magnet for ever. Fortunately, we do not have to rely entirely on natural magnets for obtaining magnets in one or other of their many forms; if we did, the world would soon run out of magnets. We can very easily convert electrical energy into magnetic energy. These two forms of energy are, in fact, very closely linked up with one another.

Principle of the Electro-magnet.

If a battery is forcing a current along a wire, and we place a compass needle near the wire (a compass needle is, of course, a small magnet), we find that the needle sets in a certain direction depending on its position relative to the wire, and the direction in which the current is flowing in the wire.

In Fig. 3 is shown a wire, carrying a current, which passes vertically through a piece of paper. Several compass needles are arranged round the wire, and it is seen that these needles point round a circle. If no current were passing down the wire, the needles would all point northwards. This means that the fact that current is passing down the wire makes a difference to the magnets, because they try to set along lines of force. We are led to conclude, then, that there must be circular lines of force round the wire.

Whether the lines appear to go clockwise or anticlockwise round the wire in Fig. 3 depends on whether the current is flowing down or up the wire. If, then, we bend the wire of Fig. 3 back again through the paper in the reverse direction through the square hole, the lines of force will cancel out. If we bend it round in a circle as in Fig. 4, it is easy to see that the lines of force will concentrate in the centre, as in the middle the direction is always the same. If the wire is wound in a coil, we can get a much stronger concentration of lines of force through the middle, and this is the arrangement adopted to get what is called an electro-magnet. The coil need not necessarily be straight, but may be wound in a horse-shoe shape. Electro-magnets have a soft iron bar, called the core, through the middle of the coil, as soft iron is easily magnetised. When current is passed through the coil, the core becomes a magnet; very powerful magnets may be made in this way, and are often used for lifting heavy masses of iron and steel. Such a lifting magnet is shown in Fig. 5; the iron and steel can be released by turning off the current from the coil, as the soft iron core does not retain much of its magnetism.

Induced Currents.

We have seen that a magnetic field can be produced from an electric current. Conversely, an electric current can be produced from a magnetic field, but with this difference—that a steady magnetic field can be produced from a steady current, but a steady current can only be produced by a continually varying magnetic field. If we have a coil of wire, two ends of which are connected to a voltmeter, and we plunge a permanent magnet through the middle of the coil, we shall observe that there is momentarily an e.m.f. induced in the coil.

An e.m.f. is produced whenever magnetic lines of force cut across a wire, and, as the magnet is plunged through the coil, each turn of wire is cut by the lines of magnetic force. While this cutting is actually happening, an e.m.f. is produced. Now, after the cutting of lines of force has taken place, it is clear that the lines must be hooked round the wire across which they cut; in other words, a linkage has been formed between the magnetic lines and the coil. "Linkage," then, is the

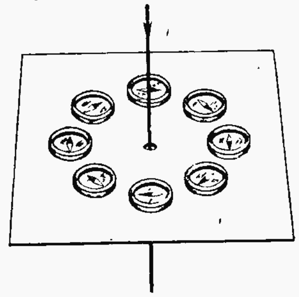


Fig. 3.—Small compass needles arranged to give an indication of the magnetic field surrounding an electric current.

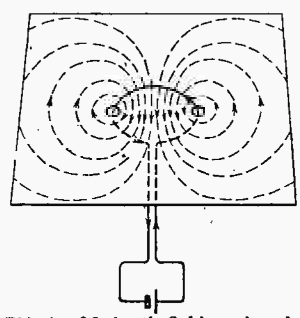
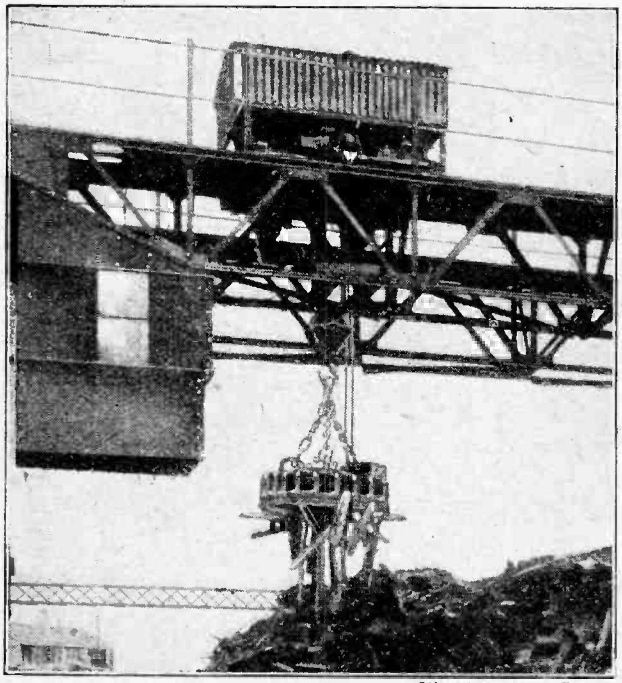


Fig. 4.—Magnetic field produced by an electric current flowing in a single turn of wire.

Introduction to Wireless Theory.—

word used whenever magnetic lines are hooked round or linked with a wire in an electric circuit. Whenever a linkage is changed, an e.m.f. is produced.

Let us consider the arrangement of Fig. 6, in which the large coil of wire is connected in series with a battery and a switch, and the small coil is connected across a sensitive voltmeter that will read voltages in both directions. The small coil is arranged inside the large coil. If the switch is closed, we know that a magnetic field will grow up round the wire of the large coil, and in doing so some of the lines of force will cut through and link with the small coil. While this cutting is taking place, we shall obtain a momentary reading on the voltmeter. If we now open the switch, the magnetic field dies down, and the small coil is again cut by the lines of force as they shrink, and another momentary voltmeter reading can be observed, but this time in the opposite direction. If a sensitive ammeter is substituted for the voltmeter, we shall find that a current is produced in



[*Courtesy: G.E.C., Ltd.*

Fig. 5.—A powerful "Witton-Kramer" electro-magnet employed in a steel works and capable of handling 2,500 tons per hour. The power consumed is 7 kW., and its lifting capacity in the case of solid ingots is between 10 and 20 tons.

the small coil when the linkage is changed, and that its direction depends on whether the linkage is building up or dying down. This current is, of course, produced by the voltage we have already observed.

Now the current which flows in the small coil will itself set up a magnetic field round the coil. The lines of force constituting this field always tend to oppose the change in lines of force which originally produced them. When the switch is closed, the lines of force built up by the current produced in the small coil oppose the building up of the lines of force due to the large coil. When the switch is opened, the lines of force due to the small coil tend to oppose the dying down of the lines of force from the large coil.

This is why the voltmeter reading in the experiment was found to be in opposite directions for making and breaking (closing and opening) the circuit.

This rule is known as Lenz's law, or familiarly as "the law of general contrariness." The law is that induced currents always flow in such a direction as to try to oppose the change that produces them. In the circuit we have been considering, this effect results in a lag in the building up and dying down of current.

Suppose we remove the small coil of Fig. 6, and, as before, close the battery switch. As soon as current flows, a magnetic field begins to build up round the coil. This field is itself linked to the coil that produces it, and, as the current increases, so the linkage increases. As the linkage changes, it produces an e.m.f. in the coil (quite apart from that due to the battery), which tends to oppose the e.m.f., which is causing the changed linkage, *i.e.*, the e.m.f. of the battery. This means that the building up of the magnetic field is retarded by the opposing e.m.f. If the coil were connected in any circuit in which the current was switched on or off, it would have the effect of making the increase and decrease of current slower.

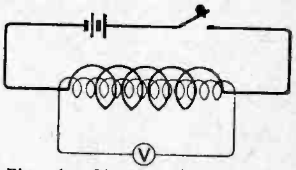


Fig. 6.—Simple circuit illustrating the principle of the induction coil.

This property of a coil of wire is called self-induction, and the degree to which a wire exhibits the lag effect is called its self-inductance.

Any arrangement of coils in which one coil is effected by the current in another is called a mutual inductance; the coils in Fig. 6 are a case in point.

If a rheostat replaces the switch in Fig. 6 so that we can vary the current in the large coil at will, we shall have an arrangement with which the change of linkages to the small coil can be controlled. Whenever the current in the large coil is changed we shall obtain an e.m.f. in the small coil, but we shall find that if the rheostat is only adjusted slowly, the e.m.f. produced will be small, and the quicker we change the current the larger will be the e.m.f. The induced e.m.f. depends, then, on the rate at which the linkages are changed. If we open and close the battery circuit very quickly, we shall have the fastest changes in linkage which can be obtained, and by this means the greatest e.m.f. can be induced in the small coil. This fact is made use of for producing high voltages, and the combination of coils used (fundamentally the same as those in Fig. 6) is called an induction coil.

In practice, the coils are wound over an iron core, and are given very many turns. Obviously, much more linkage of lines of force will occur with coils of many turns than with a straight wire, and as the iron core provides an easier path for the lines of force, the magnetic flux is increased by its presence.

We now know of two properties of an electric circuit which control the current which flows when a battery is connected to it. These are resistance, which determines what the final current shall be; and inductance, which controls the rate of growth of the current. All circuits have inductance to some extent, as well as resistance, but unless the circuit contains coils of wire, its

Introduction to Wireless Theory.—
inductance is, as a rule, absolutely negligible. Circuits of negligible inductance are said to be "non-inductive."

To get a better idea of the effects of inductance, consider an engine pushing some trucks. If the trucks are light, the engine can start and stop them quickly, but if they are heavy it can only start and stop them slowly. In fact, it would be dangerous to try to stop them very quickly with a heavy load, such as by running into buffers. This is like a battery pushing current round a circuit. If the circuit is practically non-inductive, the current builds up very quickly, but if the circuit contains a large inductance, the current may take some seconds to build up to its full value. It would be very dangerous to try to stop the flow of current quickly in such a circuit by opening a switch, as the rapid change of current would produce a very high voltage, corresponding to the large forces brought into play when the train hit the buffers. Such high voltages might lead to dangerous results. It is these induced voltages which are responsible for the flash that is sometimes seen when an electric switch is opened, as they are large enough to force a current across the very high resistance of the air gap which has been formed. Inductance acts as a lagging device tending to stop any rapid change in current. To fix the idea of inductance permanently in our minds, we have a good excuse to return yet again to the water analogy, in which a paddle forces water round a closed pipe. Inductance in a pipe corresponds to the weight of the water in the pipe. When the paddle starts to rotate, it begins to force the water round; the rate of flow does not immediately reach its final value, but builds up at a rate which is controlled by the total weight of water present. The reverse happens when the paddle is stopped, the water continuing to flow for a little time.

(To be continued.)

TRANSMITTERS' NOTES AND QUERIES.

General Notes.

A Belgian amateur, B4KR, works on 90 metres from 2030-2100 and from 2210-2225 G.M.T. on Thursdays and Fridays and from 1500-1530 G.M.T. on Sundays. QSL cards will be welcomed and may be sent *via* Mr. L. J. Davis, 6, Lindisfarne Avenue, Leigh-on-Sea, Essex.

With reference to our note concerning broadcast telephony from KW1, which appeared on p. 521 of our issue of October 14th, we are informed that the correct call-sign is K1W.

Mr. Hugo Francke (SMUK), Villa Hasselbo, Saltsjöbaden, Sweden, is transmitting on 42, 50 and 60 metres, and will welcome reports.

Mr. F. Bödigheimer (KK4) Südwestdeutscher Radio Club E.V., Frankfort a/M, would like to get into touch with British transmitters.

Communications intended for amateur transmitters in Holland may be sent *via* QRA Bureau, Dutch Section, I.A.R.U., c/o Mr. R. Tappenbeck, Hoogduin, Noordwijk-aan-Zee, Holland.

We regret two errors on page 579 of our issue of October 28th. The correct address of Mr. G. A. Massey (6YQ) is "Holmleigh," Hillside, Prestatyn, North Wales, and with reference to the transmissions from Mr. W. E. Coxon (A6AG), the times should read :—midnight and 6 p.m. G.M.T.

A Personal Note.

The growing interest taken in the "Transmitters' Notes and Queries" is shown by the ever-increasing volume of correspondence which reaches us. We take a keen personal interest in this correspondence and welcome it as one of the most exhilarating items of our day's work. At the same time, we must ask our readers to remember Mr. Hilaire Belloc's couplet in "The Moral Alphabet."

"E stands for egg—the moral of this verse
Is applicable to the young, be terse."

Terseness, however, does not imply the excessive use of those abbreviations (mainly of transatlantic origin) which are invaluable when used legitimately as a kind of shorthand for speeding up Morse transmission, but are obviously out of place, and occasionally confusing, in written correspondence.

Stations Identified.

We have received from various correspondents, to whom we tender our thanks, the following QRA's, which will probably be of interest not only to those transmitters who specifically asked for them but to others of our readers :—

H9WWZ, H9AD, H9BA.—Communications may be sent via "Journal le Radio," Lausanne.

NOWB, NOWC, NO11, NOMQ.—Communications may be sent under cover to D. Mollenis, 148 Barchman Wuytierslaan, Amersfoort.

Q2MK.—R. V. Waters, Galiano No. 29, Havana, Cuba.

RBA1.——— Carlos Calvo, 1357, Buenos Aires.

F8DIP is the low-power call of F8DI, R. Martin, 63, Bd. de la République, Nîmes.

Calls Heard.

Extracts from Readers' Logs.

Orkney Islands.

October 14th to 19th.

Great Britain :—2AM, 2EL, 2IN, 2FF, 2WA, 2XY, 5LF, 5MO, 5PM, 5VL, 6AH, 6IV, 6RY, GCS. France :—8DP, 8EE, 8FN, 8GI, 8GW, 8IX, 8NNN, 8PAX, 8RRR, 8TOK, 8VO, 8YOR, 8ZB. U.S.A. :—1AK, 1ALP, 1APD, 1CXL, 1EF, 4AGQ, 8DON. Belgium :—4AU, K3. Holland :—OAM, OAX, OCZ, OPM, PCUU, PB3. Italy :—1AS, 1AU. Sweden :—S2ND, SMUF, SMTX, S2NL. Norway :—LA1A, LA4X. Miscellaneous :—FW, FEAEF, SHNF, VIRT, NTT, NOT, WIR, IDO, BX9, 4KR, 6PU. J. Sutherland.
(0-v-1.)

Birmingham.

October 8th to 15th.

U.S.A. :—1AFO, 1BZP, 1CH, 1GA, 1GB, 1YB, 2BL, 2ZV, 2XU, 3NU, 4TV, 9DMJ. Spain :—EAR2I, EAR3I. Germany :—KW4, KW3, KK4, KQ7. Miscellaneous :—H9WW2, SMZ5, SMTG, NOF3, NPB3, CSOK1, CSAAL, Z4AG, Z2AC, Z2AE, PR, 2MK, ANE, FW, NOT (working NTT). B. Smith.

Sutton, Surrey.

Australia :—2CM, 3BQ. New Zealand :—2AC, 4AG. Argentine :—AF1, BA1, CB8, FG4, IH2. Brazil :—1AB, 1AC, 1AF, 2SP, RGT. Mexico :—1B. Bermuda :—BER. Porto Rico :—4OI, 4SA, 4RL, 4UR. U.S.A. :—4AS, 4ASK, 4ER, 4RM, 4TV, 5ZAI, 9BN, 9BRG, 9CXX, 9AOT, 9XN, NVE. Canada :—1AR, 2BE, 2BG, 2FO. Java :—ANE. India :—GB1. Mosul :—1DH. E. J. Erith.
(0-v-0.) All on 40 metres.

Muswell Hill, N.10.

Great Britain :—2BZ, 2IY, 2JB, 2VX, 2XO, 5BW, 5CS, 5CT, 5HJ, 5HT, 5NJ, 5RY, 5UP, 5UV, 5ZA, 6BF, 6CI, 6DX, 6IM, 6IZ, 6UT, 6VH, 6VP, 6YF, 6YG, 6TX, 6ZK. France :—8CT, 8OU, 8VW, 8SSK, 8GB, 8JL. Sweden :—SMVR, SMUV, SMNX. Belgium :—B4, 4US, 4YZ. Irish Free State :—IIB, 7OR, 7ER (?). J. Hum.
(0-v-1.)

Glasgow.

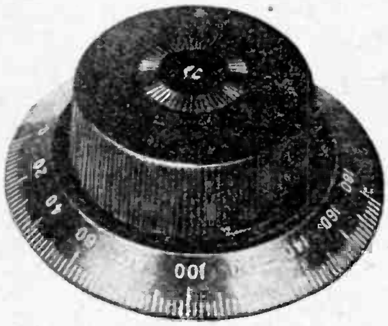
Great Britain :—2AZ, 2VL, 2BDG, 2PO, 2UN, 5BY, 5LB, 5DK, 6WG, 6QB, 6VP. France :—8JY, 8JAB, 8LDR, 8NB, 8NS, 8RG, 8RA, 8SPR, 8NA, 8PAX, 8CAX, 8RG, 8KR, 8CA, 8WK, 8KI, 8GN. Holland :—OGN, ORO, OPX, OPM. Spain :—EAR6. U.S.A. :—2BDY. Germany :—KY1, KY2, KY3, KY5. Italy :—1AU, 1AS. Belgium :—4RE. Miscellaneous :—NFD.
H. R. Boyle (G6YT).
(0-v-1 Reinartz.)

New Apparatus

A Review of the Latest Products of the Manufacturers.

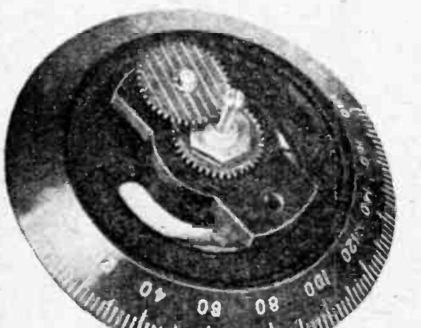
THE PELICAN ULTRA VERNIER.

The fitting of an instrument dial which itself incorporates the reduction gearing for providing fine adjustment is possibly to be preferred to the use of condensers and other components in which the actual reduction gear is contained in the operating mechanism. The Pelican ultra vernier

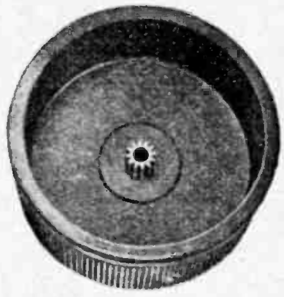


Pelican ultra vernier dial.

dial, which is of British manufacture throughout, has been carefully designed so that it can be attached to the spindle of almost any type of condenser; it does not depend for its action upon a friction contact with the surface of the instrument panel. The gear wheels, forming a reduction gear of about 10 to 1, are carried on a small platform which is held in position either by means of a bracket held under the one hole fixing of the condenser or by means of a small screw through the panel. The boring of the hole for this screw together with the driving home of the grub screw and replacing the cap is all that has to be done in fitting the dial. The centre hole provides for mounting on an instrument fitted with a $\frac{1}{4}$in. spindle, and an adapter is supplied so that the dial can also be fitted to a $\frac{3}{16}$in. spindle. The dial itself is $3\frac{3}{8}$in. in diameter, a serviceable and attractive size, and is obtainable with a scale divided into 180 divisions. Two models are available with numbers engraved suitable for vertical or horizontal reading respectively. The mouldings employed are of a particularly clean finish and the milled operating knob is of a convenient size for obtaining the necessary light grip needed in critical tuning.



The reduction gears of the Pelican dial are substantially set up and cleanly cut.



Underside view of the Pelican ultra vernier operating knob, showing the small pinion which engages in the reduction gearing.

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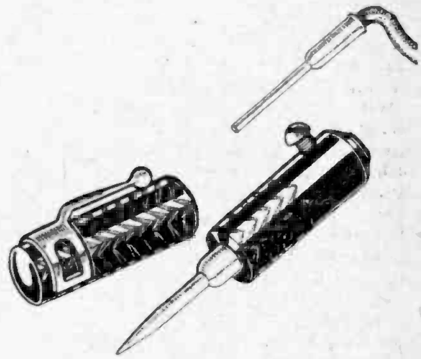
THE RAPINET FAULT FINDER.

Testing for breaks and faulty connections in multi-valve receiving sets is usually carried out by means of a battery and testing galvanometer. In the amateur station, however, a galvanometer is not always available. For easy testing Rapinet Ltd., 39, Groton Road, Earlsfield, London, S.W.18, have introduced a device which can be used in conjunction with telephone receivers.

In appearance it closely resembles a short fountain pen. It is well finished in ebonite, polished and knurled and fitted with a pocket carrying clip. Its action is quite simple, a small electrolytic cell being carried in the portion to which the testing spike is attached. To test a circuit for continunity, therefore, one of the telephone tags is inserted in a hole provided at the end of the tester and the other telephone tag is held in contact with one of the points in the circuit across which the test is to be applied. The brass wander pin of the tester is then brought into contact with other points in the circuit on test and continuity or high resistance contacts are at once detected by the intensity of the sound produced in the telephone receivers. The experimenter who makes a practice of carrying this useful testing device will find it indispensable for rapidly locating breaks in circuit wiring.



The Rapinet fault finder, designed for carrying in the pocket, locates breaks in instrument wiring when used in conjunction with a pair of head telephone receivers.

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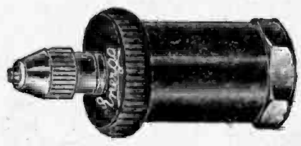
NEW TYPE SWITCH.

A new type of switch intended for connection in battery leads is produced by Energo Products, Ltd., 1, St. James's Street, London, E.C.1. In principle the switch is entirely original. When it is connected in an instrument lead the rotation of one of the milled ends lifts the internal contact so as to break the circuit. This is a device well worth fitting in filament and H.T. battery leads where switches are not provided.



Energo break switch for connecting in an instrument lead.

DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Electrolyte. The liquid through which the current flows in a *primary, secondary*, or electrolytic cell.

Electrolytic Detector. A *rectifier* for receiving wireless waves depending for its action on electrolysis. A fine platinum wire just dips into an *electrolyte* consisting of a 10 per cent. solution of sulphuric acid. A local battery is connected across the detector, and by electrolytic action the platinum wire becomes covered with minute bubbles of hydrogen, and limits the current to a very low value. The incoming oscillations destroy the hydrogen coating and allow a momentary current to flow from the local battery.

Electrolytic Rectifier. See Nodon Valve.

Electromagnet. An iron core rendered highly magnetic by passing a current through a coil wound round part of it. This magnetism is only temporary, almost entirely disappearing when the current is switched off.

Electromagnet, Alternating. See Alternating Electromagnet.

Electromagnetic Component. See Magnetic Component

Electromagnetic Induction. The production of an E.M.F. in a circuit by a changing of the magnetic field linked with that circuit. The "induced" voltage is proportional to the rate at which the magnetic field changes. If the product of the number of lines of magnetic force and the number of turns through which it is linked with the circuit (i.e., the number of "line linkages") varies at the rate of 10^8 per second, the E.M.F. induced in the circuit will be one *volt.* See Inductance.

Electromagnetic Microphone. A special microphone used for broadcasting purposes where the highest quality reproduction is required. A very light coil is suitably suspended in a magnetic field. The motion of the coil set up by the sound vibrations causes corresponding E.M.F.'s to be induced in it. Since these E.M.F.'s are very small, they have to be greatly amplified, a special amplifier being used for this purpose.

Electromagnetic Units. The C.G.S. system of absolute units based upon the electromagnetic properties of electricity, and upon which in turn the practical units (volts, amperes, etc.) are based. Cf. Electrostatic Units.

Electromotive Force (E.M.F.). That which tends to drive an electric *current* through a circuit. It is the electrical "pressure" which drives a current through a circuit against the *resistance* or *impedance* of that circuit. Thus a cell is capable of producing a current in a suitable circuit connected to its terminals because it possesses an E.M.F. The practical unit of electromotive force is the *volt*, which may be defined as the pressure required to drive a steady current of one *ampere* through a resistance of one *ohm.* (See Ohm's Law). See Potential and Potential Difference.

Electron. The smallest charge of negative electricity which is believed to be capable of existing by itself. According to the electron theory, an atom of matter is made up of a number of electrons in motion round a positive nucleus, the nature of the atom depending on the number of electrons composing it. The electron theory further explains an electric current as a transference of electrons from one atom to another in the conductor, or, in the case of a current through a vacuum, as an independent stream of electrons. In a *thermionic valve* a stream of electrons is emitted by the heated filament, this stream constituting the *plate current* passing between the plate and the filament through the vacuum.

Electrostatic Adhesion. When the surface contact resistance of two substances is high, and when a *difference of potential* is maintained between them, adhesion takes place on account of electrostatic attraction. Two substances, such as agate and metal foil, allow of very great electrostatic adhesion, even when moderate potential differences are employed. This property is made use of practically for operating loud-speaking telephones, relays, etc., being known as the Johnsen-Rahbek effect.

Electrostatic Capacity. See Capacity.

Electrostatic Component (of wireless waves). That part of the *radiation* produced by the oscillating potential in a transmitting aerial. See Waves (electric). Cf. Magnetic Component.

Electrostatic Coupling. The arrangement of two circuits so that the one will affect the other through the medium of a *condenser, i.e.*, by electrostatic action. Cf. Inductive Coupling.

Electrostatic Field. See Electric Field.

Electrostatic Units. The C.G.S. system of absolute units based on the unit charge of electricity in *electrostatics.* The unit charge is that quantity of electricity which will exert a force of one *dyne* on an equal quantity at a distance of one centimetre.

Electrostatics. The science which deals with electricity "at rest," *i.e.*, charges, potentials, etc., without current or flow of electricity.

E.M.F. Abbreviation for *electromotive force.*

Emission. Refers to the rate of emanation of *electrons* from the filament of a *thermionic valve*, and is measured in milliamperes as the plate current. Usually denotes the maximum electron current the filament is capable of giving at the normal temperature.

Empire Cloth. Linen or silk cambric impregnated by a special process with linseed oil and used as an insulating material.

Endodyne. A wireless receiver for *beat reception* of *continuous waves* in which the source of local oscillations is an actual part of the receiving apparatus. (Also called "auto-heterodyne" and "self-heterodyne.") Cf. Heterodyne.

Energy Amplification. The ratio of the actual energy output to the energy input of a given *amplifier.* This is under certain conditions proportional to the square of the *voltage amplification.*

Equal Heterodyne. The operation of a *heterodyne* receiver in such a manner that the local oscillations and those due to the received signals are of approximately equal *amplitude.*

Erg. The unit of work in the C.G.S. system of units. It is the work done by a force of one *dyne* acting through a distance of one centimetre. 10^7 ergs = 1 joule.

Ether (also spelt Aether). The medium which is supposed to fill all space, and by means of which light, heat, wireless waves, etc., are propagated through space. All etheric vibrations, such as light, radiated heat, electric waves, X-rays, etc., travel through the ether at the enormous speed of 300,000 kilometres per second, or 187,000 miles per second.

Dictionary of Technical Terms.—

Ether Waves. The propagation of energy through space is said to be effected by vibrations or waves in the "ether," and these disturbances or "pulsations" in the ether are termed "ether waves." Not only wireless waves, but light, radiated heat, X-rays, etc., come under this category. See WAVES (electric).

Eureka Wire. A wire made of an alloy of copper and nickel used for resistance purposes. The *specific resistance* is about 49 microhms per cm. cube. The chief usefulness of the alloy lies in the fact that the resistance is almost unaffected by change of temperature, the *temperature coefficient* being almost zero.

Excitation. The setting up of oscillations in an aerial system. See SHOCK EXCITATION.

F.

Filter Circuit. A combination of inductances, capacities and resistances arranged to select (or reject) by *resonance* certain desired (or undesired) frequencies, *e.g.*, a *wave filter*.

Fixed Resistor. A resistance of constant value connected in a circuit in order to limit the current. A fixed resistor is sometimes connected in series with the ordinary filament *rheostat* in a valve circuit which is designed to work either with ordinary *bright emitter* valves or with low current *dull emitter* valves. For use with the bright emitter the fixed resistor is *short circuited*.

Fading. The occasional weakening of signals which is experienced when receiving at certain wavelengths from a distant transmitting station, even though the power output from the transmitting station remains constant. The phenomenon is probably due to atmospheric changes.

Farad. The unit of *capacity* in the practical system of units. For definition see CAPACITY.

Fan Aerial. An aerial comprised of a number of wires radiating fan-wise from the apparatus.

Faraday's Law (of induction). The E.M.F. induced in a circuit is proportional to the rate of change of the magnetic lines of force linked with that circuit. See ELECTROMAGNETIC INDUCTION.

Feed-back. Another term for *regeneration* or *reaction*.

Field. Term denoting the region where magnetic or electrostatic lines of force are present, or in dynamos the system of magnets and windings producing the useful magnetic flux.

Field Strength. The intensity of a magnetic or electrostatic *field* measured in lines per unit area of cross-section of the field. Defined as the force in dynes exerted on a unit pole or unit charge respectively.

Filament. The fine wire in an incandescent lamp, *thermionic valve*, etc., which glows to incandescence; usually made of tungsten except in special cases. See DULL EMITTER.

Filament Control. Refers to the arrangements for varying or controlling the filament current of *thermionic valves*, etc., usually by means of *rheostats*.

Filament Resistance. The variable resistance used for regulating the current through the filament of a thermionic valve.

Flat Tuning. The reverse of sharp tuning. Conditions under which the signal strength remains fairly constant over a considerable range of the tuning condenser or inductance. The reason for this may lie either at the transmitting station or in the receiver, and in the latter case it is usually accounted for by excessive resistance or *self-capacity* (or both) in the receiving inductance.

Fleming Valve. A two-electrode *thermionic valve*, *i.e.*, one containing *plate* and filament only, without the presence of a *grid*. The first type of thermionic tube used for the reception of wireless signals. Not capable of producing oscillations.

Flux. A term used to denote the total number of *lines of magnetic force* passing through any given part of a *magnetic circuit* or space. Sometimes also applied to electrostatic lines of force.

Flux Density.—The number of *lines of magnetic force* per unit area of cross-section of a *magnetic circuit*, sometimes called the magnetic induction, where the magnetic circuit is an iron one, and usually denoted by the letter "B." The expression is applied in a similar way to electrostatic fields.

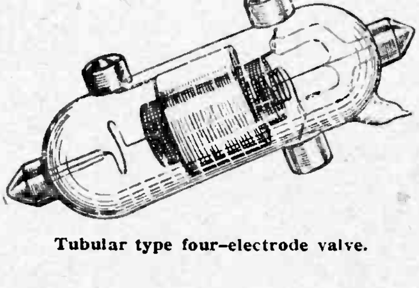
Forced Oscillations. Oscillations set up and maintained in a circuit by some external agency and usually of a frequency different from the *natural frequency* of the circuit in which they are produced.

Form Factor. The ratio of the *Root Mean Square* value of an *alternating quantity* to the mean value of a half wave. For a sine wave the form factor is 1.11, and is higher for peaked waves.

Former. The supporting frame or tube upon which inductance coils are wound.

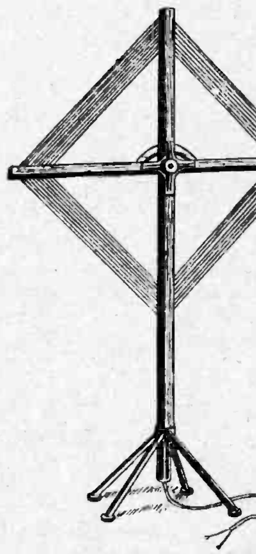
Foucault Currents. See EDDY CURRENTS.

Four-electrode Valve. A *thermionic valve* in which two *grids* are interposed between the *plate* and the filament. Used in special circuits, especially for obtaining simultaneous high-frequency and low-frequency amplification with the same valve. This arrangement differs somewhat from the ordinary *dual amplification* with a three electrode valve in this respect: whereas in the former case the high-frequency and low-frequency components are fed into the valve through two separate grids, in the latter both sets of oscillations are applied to the same grid.



Tubular type four-electrode valve.

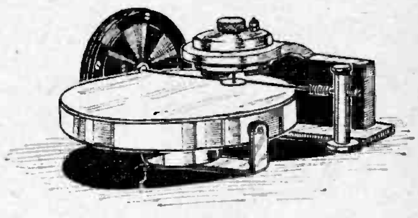
Frame Aerial. A portable, compact form of receiving *aerial* consisting of one or more turns of wire wound on a supporting frame. Since the aerial consists of a closed loop it picks up only the *electromagnetic component* of the wireless waves being received. The received signals are strongest when the plane of the coil is turned in the direction of the transmitting station, and such an arrangement is therefore very suitable for direction finding. See DIRECTION FINDER.



Portable frame aerial.

Free Oscillations. Oscillations at the *natural frequency* of the circuit in which they occur, unassisted by any external source. Cf. FORCED OSCILLATIONS.

Frenophone. A kind of loud-speaker in which the *diaphragm* is mechanically operated by the pull of a friction brake on a drum or flanges of a rotating member. An ordinary electromagnetic arrangement varies the pressure applied to the friction brake, the actual energy operating the diaphragm being drawn from the rotating part.



The "Frenophone" loud-speaker movement.

WHAT SHALL I BUY?

A Glance Through the Winter Catalogues.

Readers requiring copies of the catalogues dealt with on this page should apply to the manufacturers direct. The postal address is given in each case.

ONE of the most emphatic signs of winter's approach is afforded by the annual shower of wireless catalogues descending upon us as the days grow shorter This year's supply is more than usually copious, which speaks well for the sound state of the British wireless trade.

It is impossible, in a brief review, to provide more than a summary of the salient features of the winter programme as revealed in the catalogues, but enough may be said to show that the wireless enthusiast, whether broadcast listener or amateur experimenter, has a very wide choice of sets, accessories and components.

Valve Receivers.

The seeker after high quality reception will find much to interest him in the Marconiphone Catalogue, Publication No. 423, which illustrates and describes a complete range of receivers, amplifiers, components and accessories. From the same office (210-212, Tottenham Court Road, W.1) an attractive brochure is issued dealing with Sterling radio sets and component parts. A pleasing catalogue produced by the Reigate Radio Co. (Leigh, Reigate, Surrey) contains illustrated descriptions of a range of cabinet receivers, while other makers whose catalogues deal specially with this class of instrument are R.F.H. Radio Co. (John Bright Street, Birmingham) and Jonathan Fallowfield, Ltd. (61-62, Newman Street, W.1). The latter firm makes a speciality of a "Corner Cabinet" set. Two artistic catalogues issued by Metrovick Supplies, Ltd. (4, Central Buildings, Westminster, W.1), deal respectively with the Cosmos Five-Valve and Three-Valve Sets, the former publication also giving illustrated particulars of a rich array of cabinet receivers. The well-known "Gecophone" series of receivers, including a Six-Valve Superheterodyne (General Electric Co., Ltd., Magnet House, Kingsway, W.C.2), is covered in an interesting manner in Booklet B.C. 3772, while another catalogue describes the Efescaphone range of sets (Falk, Stadelman & Co., Ltd., 83-89, Farringdon Rd., E.C.1). Last but not least is a well-prepared catalogue relating to the well-known "Duodyne" range of Peter Curtis, Ltd. (75, Camden Rd., N.W.1).

Crystal Sets.

With the development of high power broadcasting the crystal set owner still occupies a prominent place, a fact not overlooked by manufacturers, if we may judge from the sales literature on the subject. Felix Thaud's Ferro Silicon crystal, for which startling claims are made, receives treatment in a leaflet issued by the sole distributors in this country, Russell Laboratories (Hill Street, Birmingham). Practically all the leading makers include crystal sets in their range of broadcast receivers, and one example, the Cosmos Crystal Set (Metrovick Supplies, Ltd., 4, Central Buildings, Westminster, S.W.1), has an attractive catalogue to itself.

Loud Speakers.

The prospective purchaser of a loud-speaker is catered for in several artistic catalogues. A notable example is that of the Western Electric Co. (Standard Telephones & Cables, Ltd., Connaught House, Aldwych, W.C.2), in which the new Kone loud-speaker is illustrated and described. In the General Radio catalogue (General Radio Co., Ltd., 235, Regent Street, W.) particulars are given of several types of loud-speakers, including the "Aristocrat" cabinet model. The well-known "Sterling" loud-speakers (Marconiphone Co., Ltd., 210-212, Tottenham Court Road, W.1) are dealt with in an attractive brochure which also embraces a number of useful amplifier units. An interesting variety of instruments is covered in the C.A.V. leaflet (C. A. Vandervell & Co., Ltd., Warple Way, Acton, W.3) dealing with the "Tom-tit," "Junior," "Standard," and "Hornless" models.

Superheterodyne Kit.

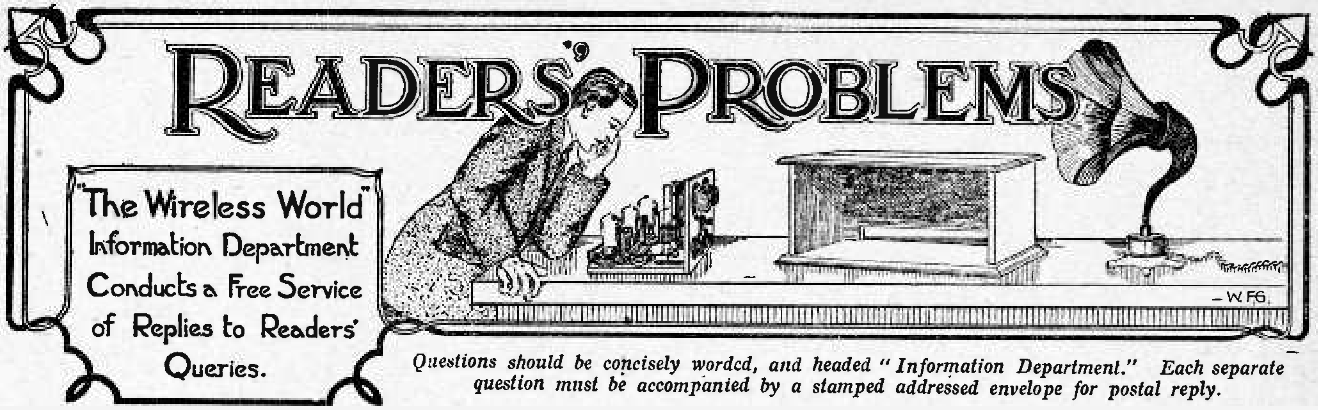
"Superhet" enthusiasts will be interested in the pamphlet issued by L. McMichael, Ltd. (Wexham Road, Slough, Bucks), dealing with the M.H. Tuned Supersonic Units. A blue print accompanied our copy, providing a diagrammatic plan for the arrangement of the supersonic parts in a 7-valve superheterodyne receiver. Publication No. 6182 of the Igranic Electric Co., Ltd. (149, Queen Victoria Street, E.C.), gives an illustrated description of the Igranic Supersonic Heterodyne Receiver Outfit, which includes every part necessary for the construction of a six-valve instrument.

Wireless Tools.

"Special Tools for Radio Users" is the title of a leaflet dealing with the highly useful range of Rockwood Tools (Rockwood Co., Ltd., 147, Queen Victoria Street, E.C.); and setting forth recent reductions in the price of "Spintite" wrenches. A valuable list for reference is issued by Macready's Metal Co., Ltd. (7, Baron Street, N.1), tabulating many and various grades of tool steels.

Components and Accessories.

A survey of all the catalogues covering this field would require far more space than can possibly be spared. The desirable practice of issuing a general accessories and components catalogue, suitable for ready reference, is followed by many well-known firms, including Autoveyors, Ltd. (84, Victoria Street, S.W.1); Efesca Products (Falk, Stadelmann & Co., Ltd., 83-93, Farringdon Road, E.C.1); Goswell Engineering Co., Ltd. (95-98, White Lion Street, N.1); F. Yates & Son, Ltd., (144, Church Street, Kensington, W.9); and Bordesley Electrical Accessories Co., Ltd. (162, High Street, Bordesley, Birmingham).



Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Valve Protection.

I propose to insert a high resistance in the common H.T lead of my receiver in order to safeguard my valves in the event of any accidental short-circuiting of the wiring at the back of the panel. It occurs to me, however, that this resistance, being common to all valves, is liable to act as a coupling and so cause instability. Is this so? H.J.P.

Undoubtedly a resistance of this type is apt to cause instability, and it is necessary to shunt the resistance with a fixed condenser of large capacity, which by offering a low-impedance path to the H.F. and L.F. pulsations will effectively prevent voltages being set up across the ends of the resistance.

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A Selective Single-Valve Receiver.

Please give me a diagram for a simply operated and really selective single-valve receiver. R.H.B.

In order to attain a reasonable degree of selectivity without resorting to a variable loose-coupled circuit, the wiring diagram given in Fig. 1 will be found very efficient. The secondary can consist of 55 turns of No. 20 D.S.C. wound on a former 3½in. in diameter and about 4in. in length. The primary, consisting of 15 turns, can be wound over the secondary winding in the manner described in the article on the "Two-valve

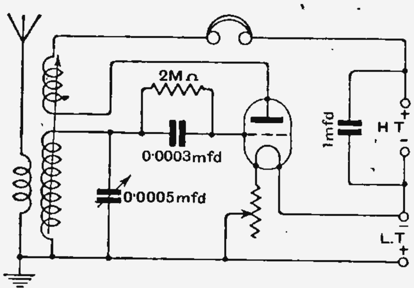

Fig. 1.—Selective single-valve receiver

Neutrodyne Unit" in the October 21st issue of this journal. The reaction coil can be wound on a piece of tubing 2¼in. in diameter and 1½in. long, suitably mounted at one end of the secondary coil.

Advantages of Using H.F. Chokes.

I am constructing the four-valve selective receiver described in your issue of June 3rd, but do not wish to use an H.F. choke. Is this component really necessary? B.P.L.

Whilst, of course, the receiver will still function if this choke is not employed, it will be found very advantageous to use it in order to prevent the H.F. component of the current in the plate circuit of the detector valve from entering the L.F. amplifier. By preventing this happening a noticeable improvement will occur. There is, however, no need to purchase a special choke. A 250-turn basket coil will be quite suitable, provided that it is arranged so that no magnetic interlinkage takes place with the aerial tuning coil.

oooo

Correct Values of H.F. By-pass Condensers.

What is the correct value of the fixed condenser which it is necessary to shunt across the primary of the first transformer in a receiver consisting of a regenerative detector followed by two stages of L.F. amplification, and would any advantage be derived from the connection of a fixed condenser across the primary of the second transformer? H.T.L.

The purpose of this condenser is to by-pass the H.F. component of the current in the plate circuit of the detector valve, and therefore this condenser should be of such a value that it will adequately pass the frequency corresponding to the longest wavelength within the tuning range of the receiver. In the case of the B.B.C. and lower wavelength Continental stations, this value need not exceed 0.0005 mfd., but if Daventry and the long-wave Continental stations are to be received a 0.001 mfd. condenser should be used. If the value used is too small it will be difficult to achieve smooth reaction effects, whereas if a value unnecessarily large is used a detrimental effect will be produced on the quality of reproduction, although this depends to some extent upon the characteristics of the transformer in use. No advantage will be obtained by using a condenser across the primary of the second transformer, since H.F. current should not be present in the plate circuit of the first L.F. valve.

The Four-valve Combination Receiver.

In a recent reply to a querist (October 21st) you referred to "The Wireless World" Four-valve Combination Receiver. Can you inform me in which issue of your journal constructional details were given regarding this receiver? K.N.R.

This receiver has not appeared in any issue of *The Wireless World*, but is published in book form, it being No. 4 of *The Wireless World* series of constructional booklets, and is entitled "The Four-Valve Combination Receiver," by W. James. Full constructional details are given, together with wiring diagrams printed in four colours. The book may be obtained at a cost of 2s. 2d., post free.

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Obtaining Good Quality from the Local Station.

I wish to construct a crystal receiver followed by two stages of L.F. amplification with the object of getting the maximum quality of loud-speaker reproduction from the local station. Do you advise two stages of resistance coupling? F.B.G.

We do not advise that you attempt to use a stage of resistance coupling immediately following a crystal rectifier. It

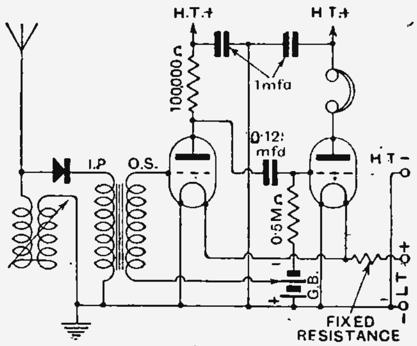

Fig. 2.—Crystal receiver and two-valve amplifier for high quality reception.

is preferable to use a good type of transformer, which may have a ratio as high as 8 to 1. The first L.F. valve may then be followed by a stage of resistance coupling. We illustrate a suitable circuit diagram in Fig. 2.

Noises in a Resistance-coupled Amplifier.

Recently I constructed a three-valve resistance-coupled L.F. amplifier. The instrument has given perfect satisfaction for several weeks. Recently, however, faint crackling noises developed in the instrument, which gradually increased in intensity. Suspecting the H.T. battery, I renewed this, and also carefully examined all connections, but the trouble is still persistent. Can you suggest a possible remedy? H.A.R.

From the symptoms which you mention it appears that you are making use of the "graphite" type of anode resistances. These instruments, whilst giving perfect results at first, are apt to cause crackling noises after a few weeks' use, owing to partial disintegration of the resistance material by the comparatively large steady anode current which they are called upon to carry. It is advisable to use none but wire-wound anode resistances in amplifiers of this description. These components can either be purchased ready made or constructed at home in accordance with details recently given in this journal.

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A Long Range Receiver for the High-power Station.

I wish to build an efficient receiver solely intended for long-range headphone reception of Daventry and Radio-Paris. The main objects are long range, simplicity, and good quality. Please indicate a suitable circuit. J.T.R.

We illustrate in Fig. 3 a circuit which should meet your requirements. Long range is assured by the use of two H.F. stages in addition to magnetic reaction. Simplicity is assured by the use of a resistance-coupled H.F. amplifier. which is quite efficient on the wavelengths of the station which you mention, purity being maintained by the use of resistance coupling in the single L.F. stage used. By the use of plug-in coils, of course, the receiver is quite suitable for use on higher wavelengths up to the maximum in use.

Lack of Efficiency in H.F. Amplifiers.

I have been receiving very good results from stations at moderate distances by the use of a detector valve with reaction. Recently, desiring to extend my range, I added a stage of high-frequency amplification to this receiver, but find that not only is my range not extended, but I cannot tune in some of the distant stations which I received before adding the H.F. stage. Can you explain this paradox? T.R.O.

This is by no means an uncommon state of affairs. There are probably two main reasons for it. The first is that it is not impossible that the efficiency of your H.F. stage is not as high as it might be. Many so-called H.F. stages are so badly designed that the valve acts virtually as a "passenger." Secondly, it must be remembered that tuning is much more difficult, there being an additional tuning control on the receiver, and consequently the operator does not get the same percentage of efficiency from the instrument as he does from the plain detector with reaction. It may definitely be said that high-frequency amplification is one of those things which is best left alone unless carried out really efficiently. An inefficient H.F. stage in inexperienced hands is a hindrance rather than a help in searching for distant stations.

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Operating Loud-speakers from Single-valve Receivers.

Can you give a suitable single-valve frame aerial circuit suitable for operating a loud-speaker? I live in close proximity to a broadcasting station. D.G.V.

Speaking broadly, it is not possible to obtain satisfactory loud-speaker reproduction from a single valve, no matter how closely situated to a broadcasting station, and a stage of L.F. amplification is called for. Of course, it is possible to obtain "loud-speaker" reproduction from even a crystal receiver at very short range, but such demonstrations leave much to be desired. You are advised to construct the "Two-valve Frame-aerial Receiver" described in our issue of September 9th, which will be quite suitable for your purpose.

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Choosing a Valve for Dual Amplification Purposes.

I have constructed a single-valve crystal reflex receiver, but am at a loss to know whether to purchase an H.F. valve or an L.F. valve, since the valve will be called upon to carry out both these functions. Can you assist my choice? A.R.G.

In reflex receivers of all types it is by far the best plan to purchase a general-purpose valve for use as a dual amplifier, since these valves are designed to give reasonable efficiency as either H.F. or L.F. amplifiers. In cases where these are unobtainable, however, it is far better to purchase an "L.F." valve rather than an "H.F." valve. It must be remembered that the permissible grid voltage swing on a so-called H.F. valve is usually small, and distortion is apt to arise when this valve is called upon to deal with the L.F. input.

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Reducing the Number of Valves in a Superheterodyne.

What is the smallest number of valves it is possible to use in a superheterodyne receiver? R.G.B.

Theoretically it would be possible to construct a two-valve instrument, the first valve being a combined detector and oscillator, the second valve acting as the secondary detector. Provided that regenerative effects were obtained on the long-wave side of the instrument, by inserting a reaction coil in the plate circuit of the second valve and arranging for it to be variably coupled to the grid coil, a certain amount of useful amplification would be obtained. In actual practice, however, it may be said that a minimum of four valves must be used. Complete constructional details of such a receiver, which is remarkably efficient, were given in the August 26th issue of this journal.

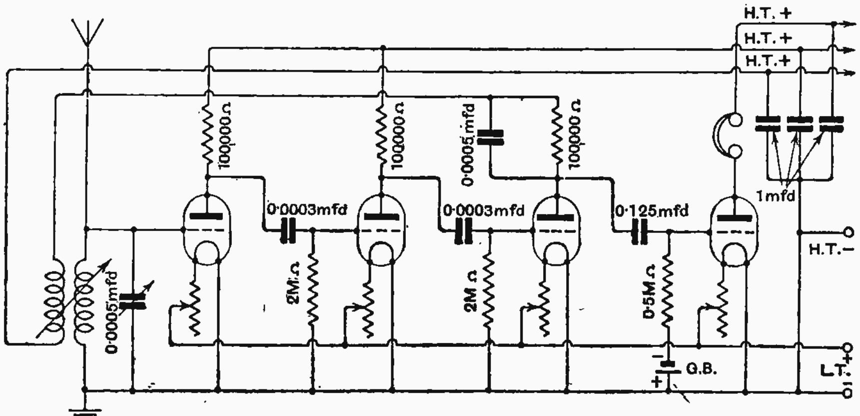

Fig. 3.—Four-valve receiver specially designed for the reception of Daventry and Radio-Paris.

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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.

ARTIFICIAL INTERFERENCE.

EACH successive winter, since broadcasting started, great strides have been made in the reception of distant stations, and one country after another has been linked up through the skill of amateurs in the reception of far-away stations by means of sets sufficiently selective to exclude interference, and so make such long-distance reception possible.

Already this year the amateur of this country is equipped with more selective and sentitive apparatus than has ever been the case before, and, naturally, better results in the way of reception records may be anticipated.

Apart from the amateur, the manufacturer has also recognised the interest which now attaches to distant reception, and has produced this year for the first time sets which are suitable for this purpose. Long-distance reception, however, cannot be entirely satisfactory from every point of view until steps are taken to eliminate the unnecessary interference which at present takes place from various causes. First amongst the interfering causes must be put the actual heterodyning of one station with another, which often makes reception of either station impossible. This trouble, it is hoped, will be eliminated when the recommendations of Geneva for a limitation of the number of stations have been put into force. It is, at all events, satisfactory to know that the necessity for improving upon this state of affairs has been so fully recognised at the Geneva Conference.

CONTENTS.

Next we have the interference caused by ship and shore stations, some of which work on wavelengths within broadcasting bands. A good deal has been done recently in this country towards limiting the marine traffic within the broadcast bands, and it may be hoped that the example will be followed by other stations, particularly certain coast stations in France, which are a frequent cause of trouble.

In long-distance reception the interference caused from oscillating receivers is very marked, but, just as every Britisher respects the common interests of his neighbours in other directions, so it may be assumed the wireless user will exercise caution in the use of his apparatus as he gradually acquires the knowledge of how interference is caused and how it may be avoided.

Lastly, and before dismissing the question of the contributing causes to artificial interference, it is impossible to avoid a further comment upon the attitude adopted by the British Post Office. In a recent editorial we referred to the interference produced by the Post Office arc transmitter at Northolt. Satisfactory long-distance reception to-day is rendered hopeless over a large area around Northolt, and although this has been repeatedly brought to the notice of the Post Office, no hint is given that anything is being done to effect a remedy.

When it is remembered that the Post Office receives a sum equal to one-third of the total revenue of the B.B.C. from licences, the public is surely entitled to expect that the Post Office will equip their stations with satisfactory apparatus.

"All Europe" Broadcast Receiver.

WIRING SUPPLEMENT ACCOMPANIES THIS ISSUE.

How to Build a Six-Valve All-Wave High-Frequency Set.

By W. JAMES.

MANY readers have constructed a neutrodyne receiver to one of the designs prepared by the author. Nearly all of these, however, have been of the type having a limited tuning band, such as 200-550 metres, and there are many advantages which are secured by this form of amplifier; for instance, single-layer coils, which are recognised as being electrically superior to other types, are used. The construction of such a set is a relatively simple matter; only a few inexpensive parts are required and the design can be such that the amplifier is very effective. Judging from the numerous letters received, this type of receiver is a great favourite, for apart from the fact that the amplifier is a non-oscillating one, the selectivity and range of a correctly made neutrodyne receiver is such that most of the B.B.C. stations and many of the Continental ones can be tuned in at good strength by a novice.

There are, however, many stations broadcasting on wavelengths above and below the 200-550 metres band. Many of them transmit quite good programmes and use, in many instances, a power in excess of the power used by the stations working on the intermediate wavelengths, so it was thought that a design for a receiver for tuning over all wavelengths would be welcome.

Features of the Set.

A receiver which could be used for the reception of all broadcast stations within range was therefore prepared. It was found convenient to use tuning coils and transformers of the plug-in type in the particular arrangement finally adopted, and to compensate for the slight losses unavoidably introduced by the coil mountings and the style of winding employed as compared with the single layer type of coil, a third stage of high-

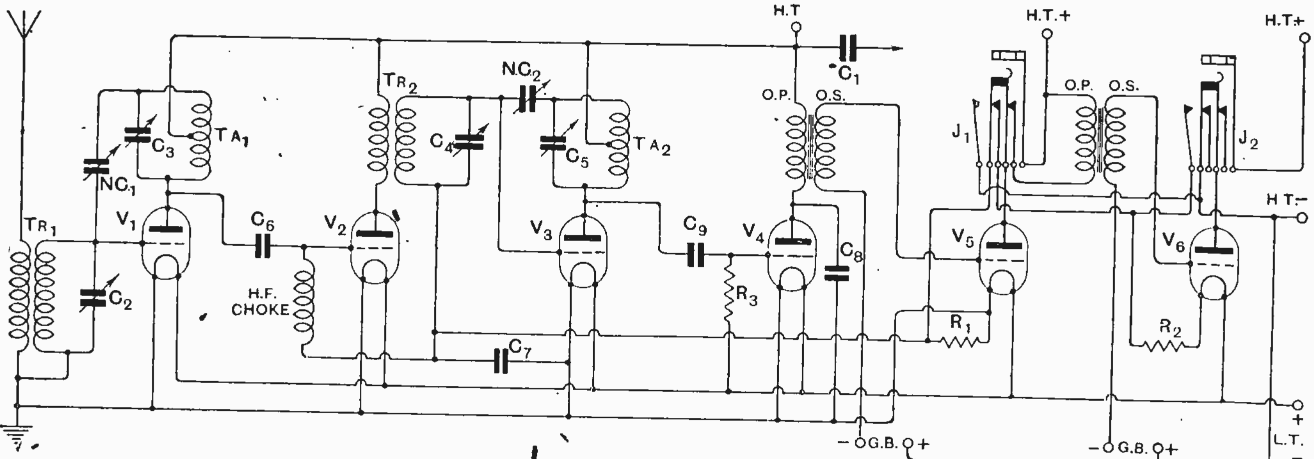

Fig. 1. The circuit diagram. Two H.F. transformers, Tr_1, Tr_2, and two tuned anode circuits, TA_1, TA_2, are used. C_2, C_3, C_4, C_5 = 0·0005 mfd.; NC_1, NC_2, neutrodyne condensers; C_6, C_9 = 0·00025 mfd.; C_7 = 0·005 mfd.; C_1 = 2 mfds.; C_8 = 0·0005 mfd.; R_1, R_2 = fixed resistors; R_3 = 1 megohm grid leak.

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frequency amplification was added. The addition of the third stage made the over-all selectivity and degree of amplification superior to that obtained with an amplifier using carefully made single-layer coils of the type so

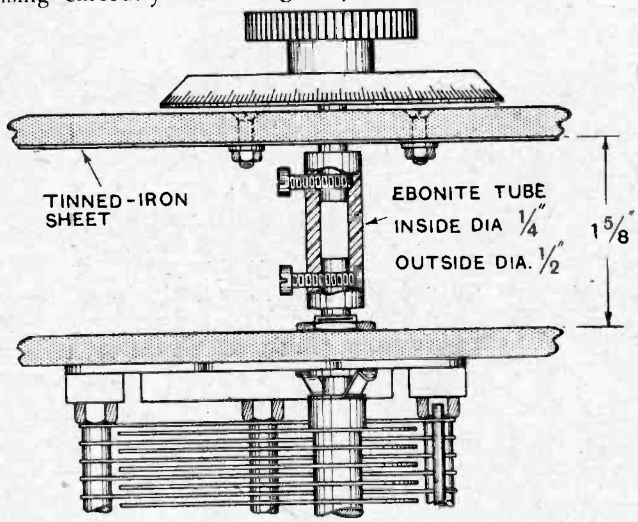


Fig. 2. Details of the method of mounting the tuning condensers and of fixing the ebonite distance pieces.

well known in the more usual two-stage high-frequency amplifier, while the addition of another circuit requiring tuning barely adds to the time taken in tuning a neutrodyne set of conventional design using but three tuned circuits.

Although the plug-in type of tuning coil is employed in the set, it is not suggested that the receiver is well suited for the direct reception of short wavelength transmissions. It is, therefore, proposed to employ the set as it stands to receive signals from stations on the normal broadcast band and on the longer wavelengths. Short frequency magnifiers. Jack switching is used, the last audio-frequency valve being cut out when the plug connected to the telephones or loud-speaker is put in the left-hand jack, while the filament circuit is broken when the plug is removed from either jack.

The Circuit Used.

From the diagram of connections of the set it will be seen that two of the valves are tuned anode coupled, while there are two tuned transformers. At the input end of the amplifier is a high-frequency transformer having a tuned secondary circuit; this transformer couples the aerial to the grid of the first valve and is purposely made with a small number of turns in the primary to give a degree of selectivity found desirable by experiment. The first valve is coupled to the second by a tuned anode circuit, a coupling condenser, and a high-frequency choke coil. If the circuit is examined, it will be noticed that the positive connecting wire from the anode battery is joined to a point between the ends of the coil and not to the end of the coil

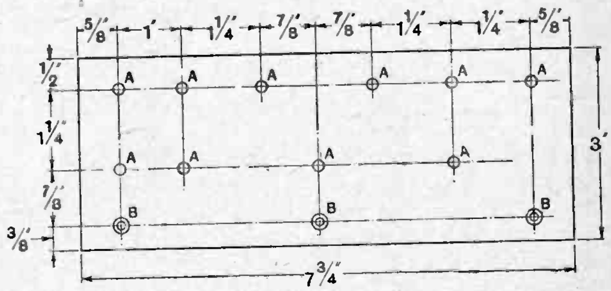
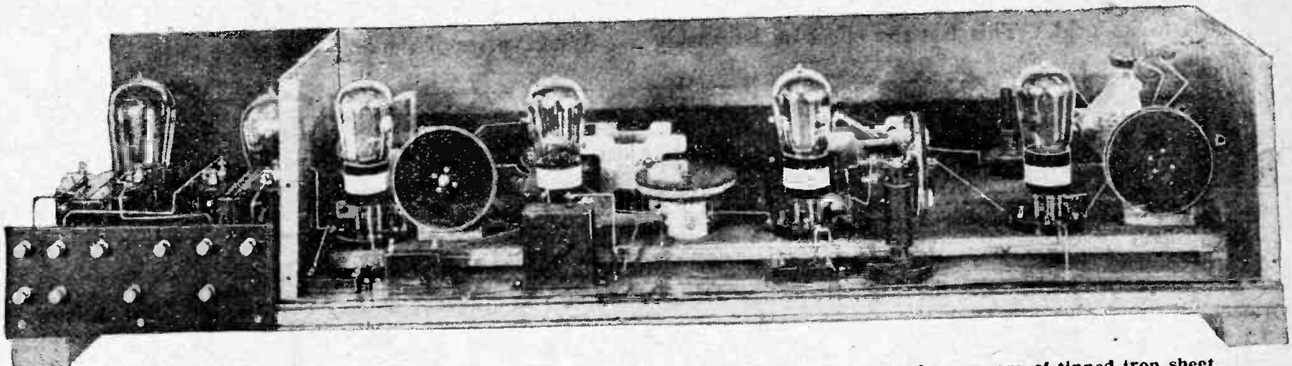


Fig. 3. The terminal strip. A, 5/32in. dia.; B, 1/4in. dia. and countersunk for No. 4 wood screws

remote from the anode of the valve as is usually done. This coil is tuned by a condenser connected across the ends of the coil; these ends are also joined to the anode of the valve and to one side of a balancing condenser. By



Rear view of the set with the back removed to show the parts. The two ends which can be seen are of tinned iron sheet

wave signals are to be received by connecting a wave-changer of one or two valves, as desired, to the input of the receiver; then with the amplifier adjusted to a convenient wavelength such as 5,000 metres, it is only necessary to tune the aerial circuit and the oscillator to receive short wave signals. Those who wish to try a super-heterodyne receiver on the normal broadcast wavelengths will be able to do so by suitably tuning the oscillator.

The set has six valves, three being used as high-frequency amplifiers, one as detector, and two as audio-frequency amplifiers ...

adjusting the balancing condenser marked NC_1 in the diagram, a setting can be found such that the first valve will not oscillate, the precise capacity of the balancing condenser at the correct setting depending upon the position of the point to which the anode battery is connected and the capacity between the anode and grid circuits.

Coming now to the second valve, its grid has a negative bias determined by the fall in voltage over the fixed resistance R_1, this bias being applied to the grid through the H.F. choke coil. In its anode circuit is the primary

LIST OF MATERIALS USED.

3 0·0005 mfd. tuning condensers (Ormond).
1 0·0005 mfd. tuning condenser (Utility).
6 Valve holders (Bowyer-Lowe Company).
3 Valve holders (Aermonic).
1 Valve holder (Athol).
1 Neutrodyne condenser (Gambrell).
1 Neutrodyne condenser (Colvern).
1 0·005 mfd. fixed condenser (Dubilier).
2 0·00025 mfd. fixed condensers (Dubilier).
1 0·0005 mfd. fixed condenser (Dubilier).
1 2-mfds. fixed condenser (T.C.C.).
1 1-megohm grid leak (Darco).
1 "Ideal" transformer, ratio 2·7-1 (Marconi).
1 "Ideal" transformer, ratio 6-1 (Marconi).
1 H.F. choke (Cosmos).
2 Six-point jacks (C. F. Elwell, Ltd.).
2 Plugs for jacks (C. F. Elwell, Ltd.).
2 Fixed resistors with holders (Burndept Wireless)
1 Ebonite strip 26in. × 2in. × ¼in.
1 Ebonite strip 7¾in. × 3in. × ¼in.
1 Piece of hard wood 26in. × 2in. × ½in.
1 Panel of ebonite, wood or three-ply wood, 36in. × 7in. × ¼in.
Quantity of ¼in. ebonite for plug-in coils.
Valve pins.
10 No. 4 B.A. terminals.
Quantity of tinned iron about 20-24 gauge.
2 Clix sockets and plugs.

winding of an inter-valve coupling transformer, the number of turns being such that the valve does not oscillate. Here, again, the correct number of turns in the primary is found by experiment, but the size of the secondary winding is approximately equal to that of the tuned anode coils.

designed to carry the current for the first five valves, while R_2 has a value suitable for the sixth valve. The value of these resistances will depend on the valves used and the voltage of the filament heating battery.

Provision is made for the connection of grid bias batteries to the two audio-frequency valves, while the fall

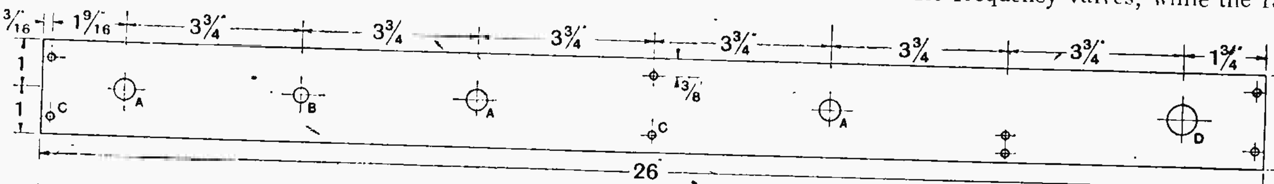


Fig. 4. Details of the ebonite strip for carrying the tuning and the balancing condensers. A, holes to take spindles of Ormond tuning condensers; D, for the Utility tuning condenser; B, for the Colvern balancing condenser; C, ⅛in. dia. for No. 4 fixing screws to brackets.

in voltage over the fixed resistor R_1 is utilised as the bias for the valves in the high-frequency amplifier. When valves such as DER and DE6 are used, there is no need for fixed resistors, as the fall in voltage through the wiring will reduce the voltage of a two-volt accumulator to a suitable value for heating the valves. A dry cell should, in this instance, be used to give the grids of the second and third valves a negative bias.

Connected to the anode of the third valve is another tuned anode circuit with a tap for the H.T. battery and with a balancing condenser; but this condenser is arranged to be suitable for giving control over the reaction effect produced by tuning the anode circuit TA_2. Hence, in practice the condenser may be adjusted if desired to such a value that the effect of tuning the anode circuit is to reduce the effective resistance of the tuned circuit connected to its grid. This has the effect of increasing

When valves of the 60mA class are to be employed and

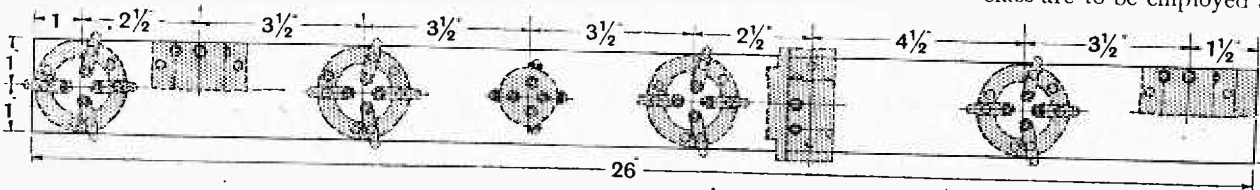


Fig. 5. Arrangement of parts on the valve platform.

the sharpness of tuning of the high-frequency transformer TR_2 and also increases the signal strength.

In the high-frequency amplifier part of the receiver we therefore have two sharply tuned circuits, TR_1 and TR_2, and two circuits not so sharply tuned; also two stages TA_1 and TA_2, which amplify very well, and one stage TR_2 which does not amplify to quite the same extent as a tuned anode stage. The over-all characteristics of the amplifier are, therefore, a high degree of amplification and selectivity; the selectivity being fixed experimentally.

Turning now to the remainder of the set, it will be noticed that no variable filament rheostats are used, but two fixed resistors are employed, R_1 and R_2. R_1 is

a four-volt filament battery is used, the fixed resistor R_1 should be of such a value that it will reduce the voltage by 1·1 volts.

Special Features.

It was found when experimenting at a place about four miles from the London B.B.C. station that this station was received direct by the coils of the amplifier; even when the first three coils were removed from the set this station could be heard when the tuned anode circuit TA_2 was tuned to the wavelength. A case of tinned iron was therefore made with the idea of preventing the coils of the amplifier receiving the local station direct and was found to be quite effective, provided it was earthed and had

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a lid which fitted fairly well. Having to make a tinned iron screen is rather a nuisance, but is well worth the trouble to those who live within a mile or two of a transmitting station, especially when rather large tuning coils are employed.

A further feature of the set is the means adopted to prevent hand capacity effects. Both sides of the tuning condensers TA_1 and TA_2 are at a high-frequency potential to earth, and hand effects are troublesome unless precautions are taken. In the set illustrated it will be noticed that four tuning condensers are supported on an ebonite strip fixed inside the set. Short lengths of ebonite rod are fastened to the spindles of the condensers and the dials are fixed to short brass rods let in the ebonite rods. These condensers have a capacity of 0·0005 mfd. for the reason that large capacities help to give selectivity. In the case of the two tuned anode circuits, the selectivity of the circuits under given conditions increases with the capacity of the tuning condensers, while by using large tuning condensers across the secondaries of the two transformers, the coils are relatively small for a given wavelength and their losses correspondingly less than if larger coils and smaller tuning condensers were used. It is not intended that the whole range of the tuning condensers should be used. The working range should be from 180° down to about 30°.

Construction of Parts.

The construction of the ebonite strip carrying the tuning condensers and the two neutralising condensers will be gathered from the drawings of Figs. 4 and 2 and the photographs. This work is not difficult, but should be done carefully if the condensers are to work smoothly after assembly. Details of the short ebonite rods fitted to the spindles of the tuning condensers and to the brass rods fastened to the dials are shown in Fig. 2. The strip is held in position by three brackets of strip brass, which must be very carefully shaped or the spindles will rub when the strip is fitted to the base and panel.

Fig. 5 shows the arrangement of parts on the wooden strip, which is used merely as a support to raise these parts above the base board. The parts include the valve holders for the valves and for the tuning coils, and one coupling condenser of 0·00025 mfd. All three aermonic valve holders are fitted to a piece of wood measuring 2¼in. × 1in. × 1in.

(To be continued.)

QUALITY OR DISTANCE?

Changing Demand in the United States.

By CARL H. BUTMAN.

THE trend of development in broadcast receiving sets in the United States for the coming season, based principally upon the demands of listeners, is towards tone quality and faithfulness of reproduction; simplicity in operation, selectivity, and appearance follow approximately in the order given. Most new sets guarantee loud-speaker operation, and some do not require antenna and separate batteries. An analysis of the products of 73 manufacturers shows that the latest practice is to provide for loud-speaker volume in the majority of cases, the exceptions being mostly crystal receivers. Out of a total of 391 sets examined, all but 58 depended upon outside aerials, these fifty-eight using loops or being adaptable to either aerials or loops. Loops are in general use for superheterodynes. Although 189 of the sets were listed as three-dial receivers, and 132 were two-dial arrangements, 70 receivers operated with a single control, showing a growing tendency towards simplicity in manuipulation, which appeals especially to the non-technical user.

Another tendency is towards the elimination of unsightly horns, the new cone and cabinet types of reproducers being favoured; wood is replacing many metallic substances in loud-speaker production.

A number of really portable receivers are now on the American market, some of them being entirely self-contained. Other portables are in prospect, which indicates increased use of radio out of doors. Apparently few re-radiating sets are being produced.

There are indications that the tendency in design is towards types which make for harmony in the living rooms. On the other hand, it appears that there is a marked decrease in the interest in distance, and entertaining programmes from good stations nearer home seem to be accepted rather than transmission from a long distance. Some manufacturers believe that by 1926 there will be few interested in DX compared with the great numbers a year or two ago. The demand for volume has died down markedly, chiefly because this requirement has been met in most sets and is no longer a novelty. Prices are gradually falling off; this decline began late in 1924, and costs still seem to be dropping rapidly.

The Passing of the Regenerative Set.

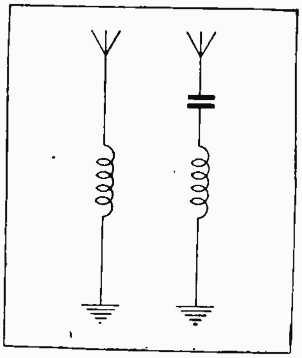
A survey based on sales of manufactured sets by large retail stores in New York and Chicago, conducted by the retailers, indicates that interest in regenerative sets is practically gone. The reflex, which was next in popularity with the regenerative set in 1922, began to lose its status early in 1924. The neutrodyne achieved an important place in 1924 and held it until 1925, when it began to recede from favour on the appearance of the superheterodyne. If the present survey were based upon production instead of sales, the neutrodyne would be second in popularity to-day, but simple radio frequency is first now amongst constructors, and the superheterodyne second, the latter having practically maintained its position since its appearance on the market late in 1924. "Supers" are losing their popularity among the home-made sets, following a rapid rise to first place in preference during 1924; neutrodynes are holding considerable interest, even though they fell off sharply in 1924.

IMPROVING SELECTIVITY.

Practical Methods of Adapting Existing Sets for Reducing Interference.

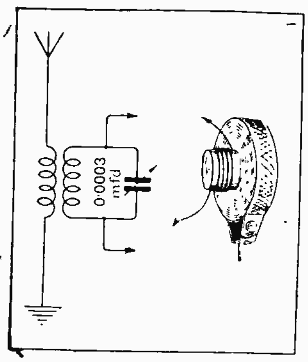
By F. H. HAYNES.

IT is while listening to the Radio Paris station to the accompaniment of the transmission from Daventry and key clicks from Kidbrooke, or receiving the local station with Morse signals in the background, that the problem of eliminating interference presents itself. A highly selective set is not required, however, for local reception, and any endeavour to produce exceptional sharpness of tuning will render the working of the set more difficult and probably bring about a reduction in signal strength.



A variable condenser connected in the aerial lead sharpens the tuning of the aerial circuit, reduces jamming, and usually brings about an increase in signal strength, though if used with an oscillating valve set renders oscillation control erratic.

The selectivity of a set represents its ability to tune to a given wavelength, and, within narrow limits, to produce no response to transmissions taking place on adjoining wavelengths. Selectivity is dependent upon two properties of the receiving apparatus. Firstly, as is well known, various combinations as to the size of the tuning coil and the setting of the tuning condenser may be used for bringing in a particular signal, and it is the relationship between the capacity of the condenser and the inductance of the coil that controls the limits of the band of wavelengths to which the set will respond. The other factor is resistance. This can be present in a variety of ways, and tends to reduce the amount of energy in the tuned circuits. Thus, wire of too fine a gauge in the inductances or excessive capacity between the turns of the wire set up across an unsatisfactory insulating material, a poorly designed tuning condenser, a leakage path across the tuned circuit, or the dissipation of energy by transference to adjoining conductors.

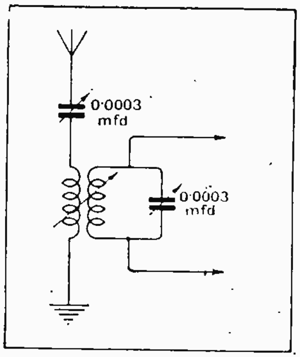


When a plug-in coil is employed with a parallel connected condenser to tune the aerial, selectivity can be improved by converting the circuit to a loose-coupled arrangement in the manner shown in this diagram.

Selective Crystal Sets.

The simplest form of crystal set consists of a coil of wire with sliding contact to serve as the variable inductance with crystal and telephone receivers connected across it. Better sets are tuned not by critically varying the inductance, but by connecting a variable condenser either in the lead to the aerial or across the tuning coil. Of the three arrangements, the most selective is that employing the tuning condenser in the aerial lead, and the addition of a condenser to an existing set is usually all that is required to eliminate the greater part of jamming by ships in coastal areas.

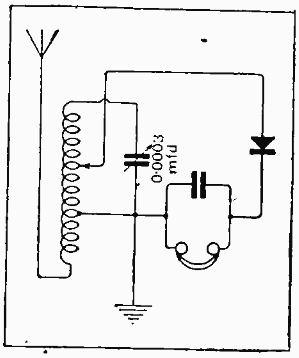
The sharpness of tuning is indicated, in this instance, by the very critical adjustment required to tune in or detune from the transmission, though the movement of the instrument dial should not always be taken as an indication of good selectivity, for the change in wavelength which results as the dial is moved is dependent upon the ratio of the factors governing wavelength, inductance and capacity.



A highly selective receiving circuit with separately tuned aerial and closed circuits, and variable coupling between the coils.

The next step that can be taken without structurally altering a receiver is to transfer the connection which joins the tuning coil to the crystal detector from the end of the coil to a point midway along it. If a plug-in coil is used for tuning this can be achieved by substituting a home-made basket coil fitted with a short flexible lead from its centre point. This is joined up with the lead to the detector which formerly connected with the coil. Some reduction in signal strength may be brought about by the change, for the detector no longer picks up the maximum available potential which is developed across the ends of the coil, but, on the other hand, as the comparatively low resistance crystal is not sapping so much energy from the tuned circuit the oscillating currents derived from the aerial may build up to greater amplitude.

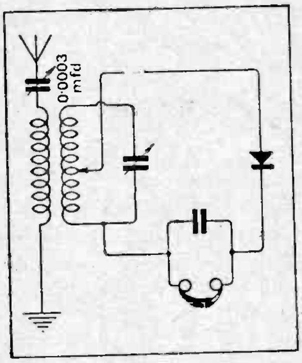
The cutting down of the amplitude by the shunt crystal circuit is referred to as damping, and selectivity is improved by any process which tends towards bringing about a reduction in the damping.



This is virtually a loose-coupled circuit in which the loss of selectivity brought about by connecting the crystal and telephones across the coil tuning inductance is limited by making use of a tapping point on the coil.

Loose Coupling.

The resistance of the aerial is always greater than that of a closed circuit consisting of a tuning coil bridged with a tuning condenser.

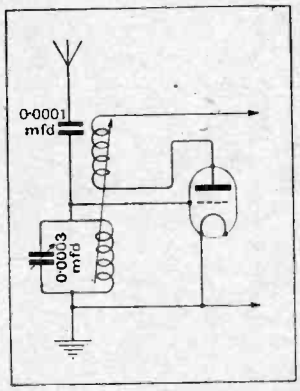


Selective crystal circuit in which two tuning adjustments are provided, as well as a tapping point on the coil.

An obvious method of improving selectivity is to excite a sharply tuned closed circuit by linking it in to the magnetic fields set up around the turns of wire used for aerial tuning. The nearer the two coils are together, assuming that the axis of the coils lie parallel, the greater will be the transference of energy not only from the aerial to the closed circuit coil but *vice versa*. It is this re-transference of energy back to the aerial that produces a curtailing of the energy oscillating in the closed circuit, bringing about a flattening of the tuning by damping.

Semi-Aperiodic Coupling.

The separate circuit tuner is therefore more selective than the direct circuit, and the less the coupling between the two coils the less the energy transference, with a resulting reduction in signal strength, but, withal, providing improved selectivity.



Reaction coupling sharpens the tuning by reducing the damping in the aerial circuit

Loose coupling is rarely adopted, as it introduces two additional tuning adjustments consisting of the tuning of an additional circuit and a control for regulating the extent of coupling between the two coils. If, however, the two coils are kept fairly close together and are suitably proportioned, tuning the closed circuit will also bring about a tuning of the aerial circuit and, thus, tuning can still be effected with a single control. This arrangement is referred to as an aperiodic aerial coupling (a term, by the way, which is not strictly correct, for to be truly aperiodic the aerial would have to possess merely the property of resistance), and is only slightly more selective than the simple circuit, though its adoption is often quite worth while.

Converting a Plug-in Coil Tuner.

Where a plug-in coil is normally used for tuning in conjunction with a tuning condenser which is connected across it conversion to loose coupling is comparatively easy. A single layer coil consisting of about 20 turns of No. 26 D.C.C. wound on a cardboard former and inserted through the hole in the centre of the plug-in coil, will provide an adjustable loose-coupled aerial winding. The best number of turns should be found by experiment, and will depend upon the size of the aerial. A small aerial will require a larger number of turns to produce a suitable optimum wavelength and provide a tighter degree of coupling than is desirable with a long flatly tuned aerial.

If the tuning coil consists of a single layer winding, cylindrical in shape, then the aerial inductance may consist of a 20 to 30 turn basket coil wound with No. 26 D.C.C. wire fitted into one end of the coil. Another method consists of over-winding the coil, though cardboard should be used as spacing between the windings in preference to paper or thin Empire cloth.

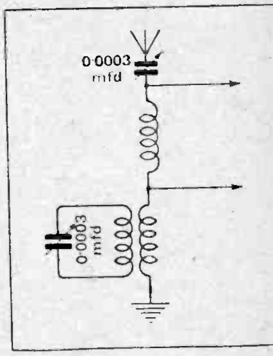
Selectivity by Reaction.

The various methods of producing selectivity in the aerial system, already described, are applicable in sets where valves are used for amplifying and detecting. The long-range oscillating set making use of reaction owes its sensitiveness to the boosting up of the oscillations in the aerial circuit by coupling with the amplified oscillations in the plate circuit of the valve. Consequently aerial circuit damping can be regulated to any extent by adjustment of the reaction coupling, and with the resistance of the aerial overcome through the amplifying action of the oscillating valve the tuning will be rendered exceedingly sharp. An oscillating valve set is a reasonably selective receiver.

The absence of interference when using a high-frequency amplifier in an oscillating condition is readily apparent. If, however, an attempt is made to stabilise the high-frequency amplifier by a potentiometer applying a positive grid bias flat tuning will result. Grid current produced by making the grid of a valve positive must therefore be avoided in tuned circuits if selectivity is to be maintained, and this applies when detection is brought about by a leaky grid condenser biassed from the positive side of the filament battery. The damping and loss of selectivity produced by grid condenser and leak detection may be reduced by including only a part of the tuned winding in the grid circuit. If a tuned anode H.F. amplifier precedes the detector valve, then the positive high-tension lead may be connected to the centre of the inductance instead of at one end.

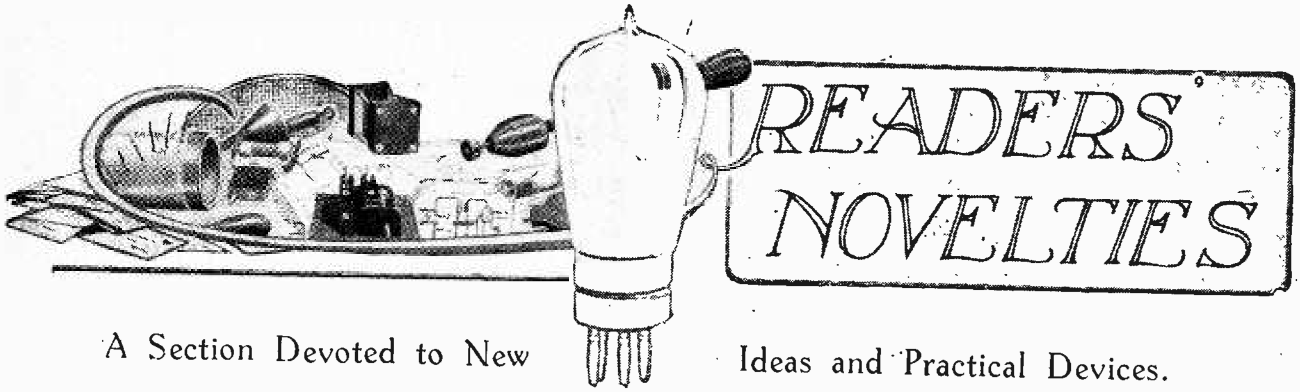
Rejector Circuits.

By coupling into the aerial circuit a tuned circuit, interference on a given narrow band of wavelengths can be obviated. For convenience of operation this coupled circuit, which may consist of a coil and condenser similar in size to those connected to the detector, is moderately tightly coupled with a coil connected in the earth lead of the set. The rejector circuit has the effect of considerably increasing the resistance of the aerial to oscillations of the particular wavelength to which it is tuned.



A wave trap increases the resistance of the aerial circuit on the wavelength to which the trap circuit is tuned, and is useful for reducing interference from a particular station.

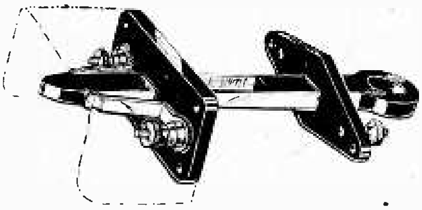
As an interference eliminator it is inferior to the tuned closed circuit of a loose-coupled set, yet is easy to manipulate.



A Section Devoted to New Ideas and Practical Devices.

LEAD-IN SWITCH.

A neat form of key switch for earthing the aerial system when the receiver is not in use is shown in the diagram. Two ebonite panels with square holes cut in the centre are fixed to the opposite sides of the window frame, and pairs of terminals and spring contacts are fitted on each panel. On the outside panel to which the aerial and earth leads are attached the spring contacts are of such a length that they press together when the shorting key is withdrawn, and so connect the aerial directly through to earth. The shorting key consists of an ebonite plug to each side of which is fixed a narrow brass contact strip. The contact strips are insulated from each other electrically, and, when the key is inserted, connect the aerial and earth leads through to the aerial and earth terminals of the set *via* the spring contacts on the two panels.



Key type lead-in switch

It will be seen that with this arrangement the person responsible for the operation of the receiver can carry the shorting key with him, so that no unauthorised person can use the set in his absence.—W. C. M.

oooo

REDUCING MICROPHONIC NOISES.

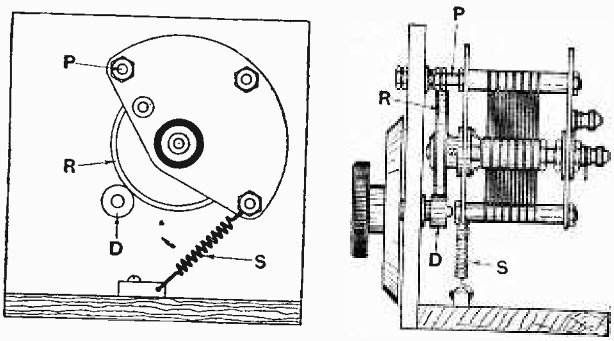
Wireless receivers which were constructed before the advent of dull-emitter valves are generally provided with rigid valve holders, with the result that irritating microphonic noises are experienced when the set is converted for use with dull-emitter valves. Instead of replacing the valve holders with others of special anti-vibration design, it is possible to overcome most of the trouble by raising the set as a whole from the table on resilient rubber feet. Solid rubber feet are unsuitable, as a large percentage of the vibration is transmitted through to the receiver. To be completely successful the rubber feet should absorb the whole of the vibration, and this condition will be fulfilled if sponge rubber is used. Small unburstable balls are now available, having a diameter of approximately $1\frac{1}{4}$in. Two of these should be obtained and cut in two with a sharp, wet knife. Four hemispheres of rubber so formed may then be fixed to the corners of the base with rubber solution.—G. E.

oooo

VERNIER CONDENSER.

Vernier condenser movements which depend upon a friction drive are frequently unsatisfactory owing to irregularities in the circumference of the tuning dial, or to the fact that it is slightly eccentric on the spindle. The method of mounting illustrated in the diagram effectively overcomes difficulties of this kind.

One of the securing bolts for the fixed vanes of the condenser is removed and replaced by a spindle P which passes through a bush in the front panel and is secured in position with lock-nuts and a spring washer. The dial of the condenser is replaced by a pulley R carrying in the groove a rubber ring of round section. This is bolted against the small drum D by a coil spring S. The condenser dial is made to actuate the drum D through a spindle passing through a bush in the front panel. It will be seen that any irregularities in either R or D will be compensated for by the spring S.—W. T. J.



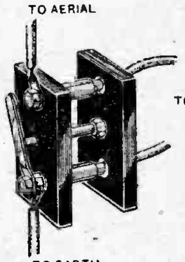
Vernier movement for condenser with compensated friction drive.

oooo

AUTOMATIC EARTHING SWITCH.

By withdrawing the terminal panel carrying the connections to the aerial and earth terminals of the receiver from the socket panel in the switch shown in the diagram, the aerial is automatically connected through to earth.

Ordinary valve pins and sockets are employed, and a spring contact strip is mounted at the back of the socket panel to which the aerial and earth leads are connected. A push-rod screwed to the centre of the panel carrying the valve pins passes through a hole in the socket panel, and raises the contact strip off the aerial terminal when the set is in use. The whole success of the device depends



Earthing switch.

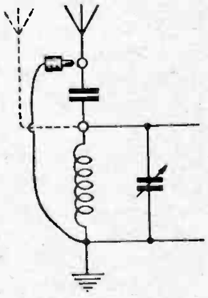
upon the construction of the spring contact strip. The material for this strip should be carefully chosen. The tip of the spring and the end of the aerial terminal socket should be tinned to provide a non-oxidising contact.—E. T. C.

oooo

AERIAL TUNING.

By means of the circuit arrangement shown in the diagram it is possible to connect the small fixed series condenser across the A.T.I. for the purpose of increasing the wavelength range.

A flexible lead with spade or one-plug connection is connected to the earth terminal, and when it is desired to connect the series condenser in parallel with the A.T.I., the aerial lead-in is inserted in the lower ter-



Connecting the series aerial condenser in parallel.

minal and the flexible one-plug connection is inserted in the upper aerial terminal.—A. H. M.

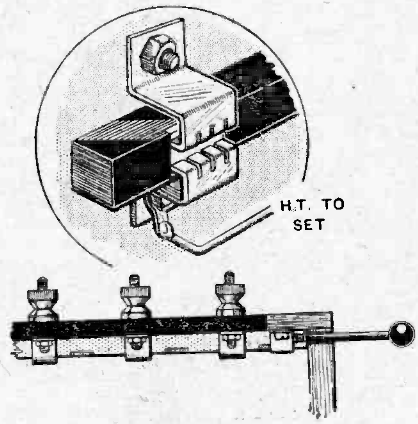
oooo

H.T. SWITCH.

When more than two tappings are taken from a H.T. battery to a multi-valve receiver, it is not sufficient to disconnect, say, the negative side of the H.T. battery in order to prevent leakage.

It frequently happens that a slight leakage is taking place at one of the intermediate tappings, which will result in the exhaustion of one section of the battery.

To overcome this difficulty, the switch illustrated in the diagram was devised. A long ebonite strip of square section carries on its upper surface a series of rectangular brass contacts let in flush with the surface of the ebonite. Spring contacts are arranged on opposite sides of the ebonite rod in such a manner that



Switch for disconnecting H.T. battery tapping.

they are connected together when the contact plates are pushed between them. The upper spring contacts are fixed directly to the terminal strip at the back of the receiver by the +H.T. terminals themselves, while leads are taken from the lower spring contacts to the appropriate points in the receiver circuit. The ebonite rod is actuated by a short brass rod passing through a hole in one side of the cabinet. The end of the brass rod is screwed and fits into a tapped hole in the end of the ebonite contact strip, so that the operating knob can easily be removed to permit the withdrawal of the receiver from the cabinet. With a switch of this kind, the H.T. battery is entirely isolated, and leakage currents external to the battery are eliminated.—E. E. B.

oooo

WIRE CLEANER.

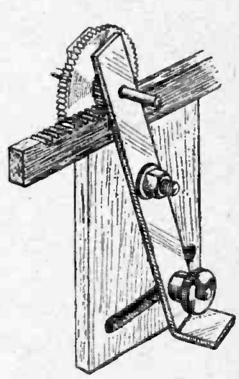
A very frequent operation in wireless work is the cleaning of the ends of connecting wires insulated with enamelled, silk, or cotton covering. A penknife is generally used for this purpose, and the cleaning operation will be greatly simplified if a small notch is cut near the base of the blade with a small three-cornered file. Not only are both sides of the wire cleaned at the same time, but the wire is prevented from slipping along the edge of the blade, and excessive wear of the remainder of the knife blade is avoided.—H. J. M.

oooo

GROOVING SPACING STRIPS.

A very convenient method of grooving wooden spacing strips for low-loss coils is indicated in the diagram.

Two brass strips pivoted on each side of a rectangular piece of wood carry a double pinion wheel, which may be obtained from an old alarm clock. The bottom ends of the brass strips are clamped by a screw passing through a radial slot in the wood. In order to insert the spacing strip, the brass strips are moved into a vertical position. With one end of the spacing strip underneath the small diameter pinion wheel, the brass arms are pulled to one side, thus forcing the teeth of the wheel into the wood. The whole of the top surface may then be corrugated by rotating the



Device for marking spacing strips.

larger diameter wheel with the fingers. If the material used for the spacing strip is sufficiently soft, the impressions obtained will be deep enough to maintain the turns of the coil in position; but if hard wood or ebonite is used, the depth of the grooves will have to be increased with a small three-square file.—F. V. N

HOW TO OBTAIN EFFECTIVE SCREENING.

Eliminating Interference Picked Up in the Components of a Receiver.

By R. L. SMITH ROSE, Ph.D., M.Sc., A.M.I.E.E.

FROM the manner in which the terms "screening" or "shielding" are used by many amateur and even some professional experimenters, it is evident that the principles of this art are very little, if at all, understood. It is not always appreciated, for instance, that there are two kinds of field which can be subject to screening, namely, radiation or wave fields and induction fields. Further, with each of these fields it is possible to screen either the electric or the magnetic fields or both.

At the present time, with the widespread use of highly selective receiving apparatus for broadcasting, the necessity of shielding some portion or portions of the apparatus from stray electric or magnetic fields has become a matter of great importance.

The author has had a wide and varied experience of screening, and this article contains the conclusions drawn from many instructive experiments.

To avoid misunderstanding it will be as well to define "screening" as the reduction of the strength of a field, whether electric or magnetic, over a given space with a view either of avoiding the introduction of some undesired signal or of overcoming some bad feature of the apparatus, such as a tendency to oscillation as a result of uncontrollable retroaction. The reduction of interference experienced on a multi-valve receiver is rendered simpler if, in addition to improving the selectivity of the tuned receiving circuits, the remainder of the apparatus, which may not employ sharply tuned circuits, is protected from the direct pick-up of signals. It is not always realised that in such a receiver the operator wearing head telephone can act quite effectively as an untuned aerial and so facilitate the pick-up of signals, wanted and unwanted. To secure freedom from interference, therefore, it is desirable to avoid this direct pick-up of signals by apparatus and operator, and one very effective method of doing this is to screen the receiver.

Electrostatic Screening.

Part of the misconception of the principles of screening has possibly arisen from the use of the term "Faraday cage" in connection with wireless. This term is only strictly applicable to the case of stationary electric fields such as exist, for example, in the neighbourhood of an ebonite rod charged by friction or between the terminals of a battery. If a hollow conductor is placed in such a field all the electric lines of force terminate on this conductor and there is consequently no detectable field inside. Probably the best illustration of this type of screening is the classical experiment carried out by Faraday, in which a large wooden cube of 12ft. side was covered with tinfoil and insulated by suspending it on silk cords. A large Whimshurst machine capable of producing a potential difference of several hundred thousand volts between brass balls, resulting in a spark two or three inches in length, was placed just outside the cage and one of its terminals was connected to the tinfoil. This machine was set in operation while Faraday was inside the cube with his most sensitive electroscope. No indication whatever was shown by this instrument, although it would certainly have given a deflection for an interior field giving a potential difference of a fraction of a volt. In other words, the electrostatic field inside the cube was reduced by the presence of the tin-foil screen to at least one-millionth of its strength just outside. In a similar manner, if the machine had been placed inside the screen, no detectable field would have been found outside. Subsequent experiments showed that it was not necessary for the screen to be continuous, and that perforated metal or wire gauze was quite as efficient for the screening of *electrostatic* fields. Since these fields are quite stationary, the screen becomes what is termed an equipotential surface, *i.e.*, all points on its surface assume the same potential, and by connecting any point to earth this potential is reduced to zero. In wireless apparatus, however, the only *electrostatic* fields present are those between the terminals of a battery or direct-current generator, and there is usually no point in screening these fields. The fact that it is sometimes necessary to screen a generator is explained by the presence of ripples on the nominally direct-current supply. In other words, these ripples represent an alternating current superimposed on the direct current, and the problem becomes one of screening an alternating field. In general, a screen placed in an alternating field has currents and potentials in it which are different at different points, and it is therefore an arbitrary point as to whether any improvement can be effected by connecting any particular point to earth, since this will not reduce the potential of the whole screen to zero.

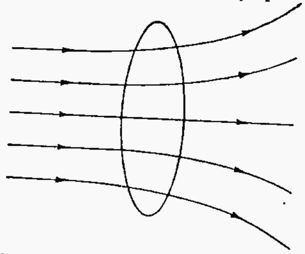


Fig. 1.—The magnetic field threading a conducting ring is opposed by the current which it induces in the ring.

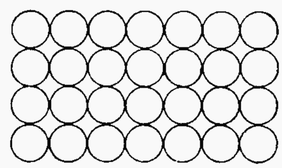


Fig 2.—A series of rings arranged to screen a plane area from a varying magnetic field.

Let us now consider the principles and modes of screening which may be adopted in the case of wireless apparatus.

Screening Magnetic Fields.

Suppose that we place a single closed loop of wire in an alternating magnetic field, as depicted in Fig. 1. The elementary laws of electromagnetic induction can

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be applied to such a case and show that the result will be the flow of an induced current in the ring, which in turn produces a secondary magnetic field inside the ring in a direction opposite to that of the primary field. In normal cases in which the loop is reasonably small for the wavelength employed, and its resistance is low, this secondary magnetic field will tend to eliminate the primary field within the ring, and to increase the field just outside the ring.

We have thus obtained a space within the ring which is "screened" from the effect of the original magnetic field. By placing a number of such loops side by side over a plane the dimensions of the screened area can be considerably increased. It will readily be seen that such a collection of loops can be replaced by a sheet of ordinary wire "rabbit netting." The efficiency of the screening will depend upon the stoutness of the wire and the mesh of the netting employed. Definite figures will be given later for several standard sizes of netting.

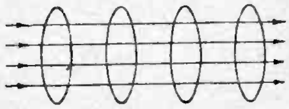

Fig. 3.—An arrangement of loops giving more effective screening for fields parallel to the axis of the loops.

Now the reduction of the field by such a sheet extends only to a comparatively short distance on either side of the plane of the loops, for the path of the secondary field is only parallel to the primary field while actually passing through the sheet. On either side it tends to curve back on its return path although the distance at which such curvature becomes serious increases with the size of sheet employed.

Now supposing that instead of placing several loops side by side, as in Fig. 2, they were placed one behind the other on a common axis as in Fig. 3. It is now evident that the screened space comprises a cylinder enclosed by the rings, but—and this is the important point—the rings are only effective in neutralising a magnetic field which is perpendicular to their planes. For a magnetic field parallel to the plane of the loops no currents are induced in them and hence no reduction of the field can result.

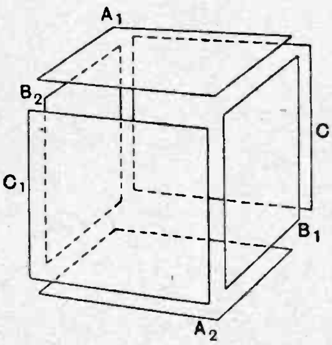

Fig. 4.—Six closed loops arranged mutually at right angles to screen a cubic space.

The efficiency of the screening of such a series of loops can be obtained experimentally by measuring the relative strengths of wireless signals inside and outside the screen.[1] The following results were obtained by the use of a frame coil receiver inside a screen constructed on a wooden framework of dimensions, 6ft. cube. With two loops of 6ft. sides arranged in parallel planes at a distance of 6ft. apart, the field at the centre of the cube was reduced by about 5 per cent., *i.e.*, the signal strength obtained inside the cube was about 95 per cent. of that obtainable when the whole screen was removed. As further closed loops were added in between these two extremes the field within become weaker and weaker until, when the cube was covered with 44 loops in parallel planes, the strength of field at the centre was only 10 per cent. of its value outside and well away from the screen. It is, of course, to be understood that such loops are only effective for magnetic fields at right angles to their planes, for a magnetic field parallel to the loop cannot induce an e.m.f. therein, and consequently no current will flow and no reduction or screening of the field will result. This point was quite well demonstrated in the above experiments.

A little consideration of this case will show that in order to screen a given space from an alternating magnetic field in any direction it is essential to have the space enclosed by a combination of three series of loops whose planes are mutually perpendicular to each other. Fig. 4 indicates a cube composed of three pairs of loops (A, B, and C) arranged mutually at right angles. In order to increase the dimensions of such a space each loop may be replaced by a sheet of gauze or netting.

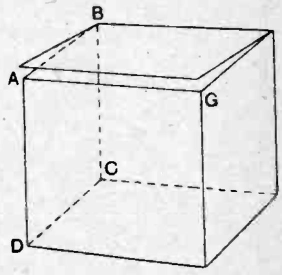

Fig. 5.—Faulty screen in which only the end surfaces are effective in screening fields perpendicular to A B C D.

The Screening of Large Spaces.

In the above manner one sees how a large space, such as a room or shed, can be shielded from an alternating magnetic field by surrounding it with a screen of wire gauze or netting. If, as is usual, the screen is made up with plane sides it is important that adjacent edges be well connected together, as otherwise one of the sets of loops becomes open-circuited, when its screening properties would disappear. For example, suppose a cube of netting is made up as in Fig. 5 with all edges efficiently joined or bonded except along AG. Then only the end surfaces of the cube are effective in screening fields perpendicular to A B C D, whereas by bonding the edge AG a very large number of intermediate loops is brought into action and the screening properties for such fields is much more efficient. This question of making adequate connection at all points which are to form part of conducting loops is found to be of the utmost importance in screening.

Reverting now to the experiments carried out inside a skeleton wooden cube of 6ft. sides, it was found that when this cube was completely covered with ordinary galvanised iron wire netting of 2in. mesh the field within was reduced to about 10 per cent. of its "unscreened" value for all directions of arrival of the waves. When the mesh of the netting was altered to 1in. the field strength was reduced to about 4 per cent. The actual value was found to vary slightly over the commercial range of wavelengths, the screen being most efficient at the shortest wavelengths as indicated by theory.

Here is a type of screen which is in a very practicable form for the purpose of screening whole sets of receiving

[1] These experiments were described in detail by Mr. R. H. Barfield in *Experimental Wireless* for July, 1924, p. 570.

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apparatus, for it is a comparatively simple matter to cover the whole of the inside of a receiving room with wire netting. For example, a wooden hut containing sets of receiving or measuring apparatus can be screened in this manner by simply lining the interior of the hut with wire netting. For most purposes the ordinary 1in. mesh size will be suitable, but if greater efficiency of screening is required the additional cost of the ½in. or even smaller size may be justifiable. The netting is simply attached as a lining to the interior (walls, floor, and ceiling) of the hut or room, no insulation being required. The netting on the floor can be conveniently covered with linoleum to save wear on the wire, and also to facilitate sweeping the floor. Care must be taken to board over the slits which will occur where adjacent strips of the netting meet, so as not to leave gaps in the conducting loops in any place. Windows can usually be covered over directly without any special modification. In the case of doors, the whole wall containing the closed door can first be covered and then the netting can be slit round the door to permit of its opening. Since these slits will form only part of the wall, they will cause practically no loss of screening efficiency, but as an additional precaution a simple kind of spring contact can be arranged to short circuit the gap at frequent points around the door when it is closed.

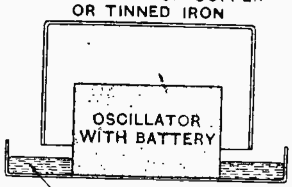

Fig. 6.—Experiment to show that screening is not complete until the screening box is completely closed

To give some idea of the efficiency of such a type of screen the following case may be quoted. A sensitive type of receiver used inside an unscreened hut with an ordinary Igranic coupling coil as the receiving frame gave adequate loud-speaker strength on the signals from a transmitting station about 12 miles away. When the receiver was placed inside a hut, screened with 1in. mesh netting in the manner above described, the signals were reduced to inaudibility in the telephones. Such an arrangement is of very great advantage in some experimental work in which it is necessary to be sure that *all* the signals are being picked up on the aerial or loop outside the screen, and that, contrary to the usual arrangement, no appreciable proportion is being picked up direct on the coupling coils of the tuner or upon the transformer or other coupling coils of the amplifier.

This in itself may effect the reduction or even the complete elimination of interfering signals on wavelengths adjacent to that to which the aerial circuit is tuned. Those experienced at direction-finding work will also appreciate the fact that the use of such a screened room prevents the operator, when wearing the telephones, from acting as an antenna and so contributing to the received signals.

The More Complete Screening of Smaller Spaces.

When, as frequently happens, it is required to reduce the field to less than 3 or 4 per cent. of its initial value, it is necessary to take many additional precautions. From the fact that the reduction of the size of mesh of the netting brought about a greater screening capability one would expect, if the netting were replaced by a solid sheet of metal, a very great reduction in the field strength inside. Although it is not usual to require to screen large spaces in this drastic manner, the writer can recall one instance of a commercial receiving station in which the whole of the apparatus, except the frame aerial, was in a room lined completely with solid copper sheets, all joints being well sweated over and an elaborate contact arrangement being used at the door. This, however, represented a rather extreme case in which it was necessary to eliminate interference from a high-power spark transmitting station only a few miles away.

Screening with Metal Sheets.

The essential principles of practically complete screening with solid metal sheets can be very nicely demonstrated by an experiment which can easily be carried out with the aid of a valve oscillator in the neighbourhood of a sensitive receiver. Take any form of low-power valve oscillator, operating from, say, a six-volt battery, and place it in a shallow iron tray, which is then filled with mercury to a depth of about half an inch. Next construct two metallic boxes, without lids, and of a size to just easily cover the oscillator and rest on the bottom of the tray (see Fig. 6). One of these covers should be made of tinned iron sheet of about 2X gauge, and the other of copper sheet of the same thickness. As the detector of the local oscillating field it is convenient to use a frame coil connected to a six-valve amplifier or to a supersonic heterodyne receiver. In either case some arrangement must be provided by which the set can be made to heterodyne the oscillations received from the oscillator in the tray as in the usual reception of continuous wave signals.

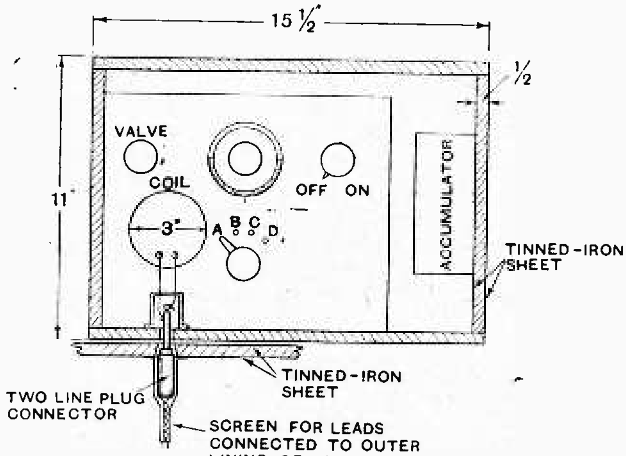

Fig. 7.—Sectional plan of screened oscillator, showing method of leading out telephone connections.

With its cover removed, adjust the oscillator to function on a suitable wavelength and tune in the resulting continuous wave on the receiver. It will probably be found that the resulting beat note is very loud and can be heard several yards from the telephones, even when the oscillator is placed at a distance of 100ft. from the coil receiver.

Now take the tinned-iron box and place it gradually over the oscillator in the tray of mercury. As the box

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begins to envelop the oscillator it will be found that the intensity of the beat note in the telephones rapidly decreases, and it will be desirable to move the oscillator and tray up to within a foot or two of the receiving coil. In this position the note in the telephones will still be distinctly audible so long as a gap remains between the open end of the box and the mercury; but, immediately this gap is closed and metallic contact is made over the whole of the open end of the box, the signal suddenly becomes inaudible. If the box is raised at one side only the signal suddenly reappears as soon as the surface of the mercury breaks contact with the metallic edge of the box. This effect is most marked and demonstrates in a very interesting manner the necessity for good metallic contact at all edges if anything approaching complete screening is to be attained. A word of warning is necessary to the experimenter here, to the effect that mercury has a very destructive action on solder, and the seams of the boxes should be carefully inspected at times to make sure that they are still adhering together. A more satisfactory job for experiments of this nature is to utilise iron boxes with the joints welded over.

Faulty Contact at Joints.

If now the iron box be removed and the copper box placed over the oscillator it will probably be found that the signal in the telephones can still be heard when the box is resting on the tray and its open end is immersed in the mercury to a depth of half an inch.

Similar results will be obtained if the oscillator is placed inside the box and a metallic lid is soldered down all round. Such experiments are rather laborious, but they are a good test of the skill of the tinsmith, since, in the case of the iron box, it will be found that a gap or a "dry soldered" joint as short as half an inch will make all the difference in the ability to detect an external field from the oscillator. These experiments show, therefore, that it is only possible to screen a valve oscillator completely by placing it inside a sealed box of tinned-iron sheet of sufficient thickness to prevent the direct penetration of the high-frequency magnetic field through it. In this respect iron is found to be far superior to copper, a result which is in complete accordance with theory. For, in this case, the screening action is due to eddy currents, and the magnetic permeability of the material enters into the formula expressing the reduction in field strength. Although it is very difficult to make quantitative measurements, it can be deduced that the somewhat drastic screening methods mentioned above result in a reduction of field intensity to about one-millionth of its original value. In certain cases of components for wireless receivers, such as coils or intervalve transformers, it is possible to place the whole component inside a small "tin" box with all joints soldered up, the insulated leads being brought out through the smallest possible holes. In many cases, however, it is naturally not very convenient to use screening boxes with either soldered-down lids or with mercury seals, and in the following section a description is given of several practical screening arrangements, which, while not giving perfect screening, provide a protection which is sufficient for most purposes.

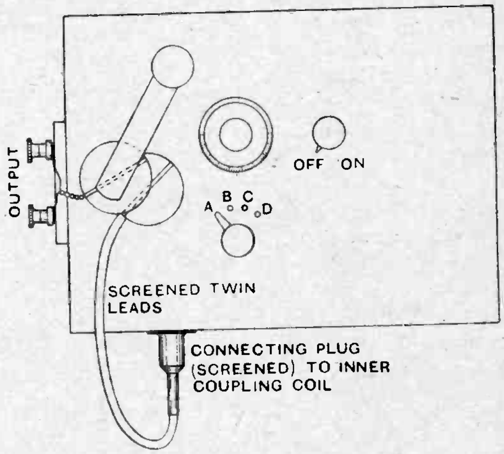

Fig. 9.—Exterior plan of the oscillator.

Practical Design of Screening Boxes.

One of the most satisfactory arrangements for a screening box is that in which the apparatus is contained in a box covered with metallic sheet, and this box is then fitted with a lid which envelops it to its full depth, and which is similarly covered with metallic sheet. The writer has applied this type of construction to the design of a screened oscillator which has given very satisfactory use with wireless direction-finders and signal intensity measuring instruments, but it will be evident that the same design may be applied to the screening of any other instruments. Experiments had already shown that the next best arrangement to a sealed box was the provision of a tightly fitting lid with deep overlap, making good contact with the box over a large surface. The details of the design can be seen from the drawings in Figs. 7, 8, and 9. Both the box A and lid B are constructed of ½in. five-ply wood, lined inside and outside with stout tinned-iron sheet of thickness 2X. A lid C of depth 2in. is provided to complete the inner sheet metal lining, and the outer lid B is a tight driving fit over the box A to ensure good metallic contact between the respective surfaces.

Ebonite connecting pieces are used between the control handles on the top of the lid and the variable condenser, and the switches for filament current and inductance tap-

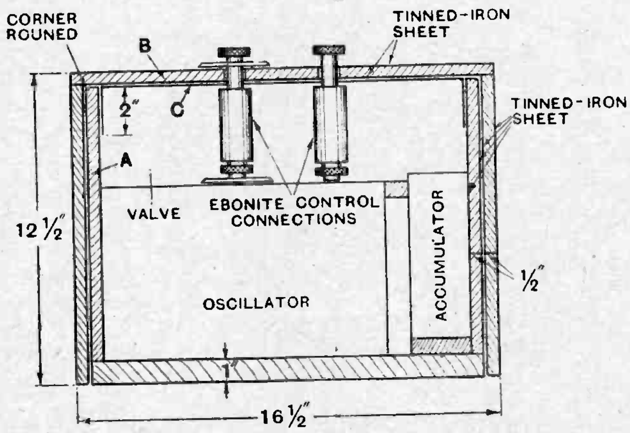

Fig. 8.—Sectional elevation of screened oscillator, showing control connections.

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pings within the box. Where they pass through the small apertures in the lid the controls are provided with metal bushes which make spring contact with the outer lining of the box. A separate coil is used within the box to couple to the oscillator inductances, and leads from this coil are brought out through the side of the box by a telephone jack and plug connection. The jack is mounted inside the box, as shown in Fig. 7, and the plug is pushed through holes in lid and box, which are only in alignment when the lid is in its final position over the box. The plug is screened by a metal shield in contact with the outer lining of the box, and the connections are taken through a metal-sheathed twin flexible conductor to a double D-shaped coil forming half the outer coupling. Leads from the other pair of D-shaped coils are taken to the output terminals mounted on ebonite at the side of the box (see Fig. 9).

Merits of the Design.

The following points may be emphasised in regard to this screened oscillator :—

(1) The entire control of the oscillator is obtained from outside, and it need never be opened except for inspection or replacement of either the valve or battery. A dull-emitter valve is used and operated from dry batteries, and a small hole is provided in the lid which enables the user to ascertain that the valve filament is incandescent.

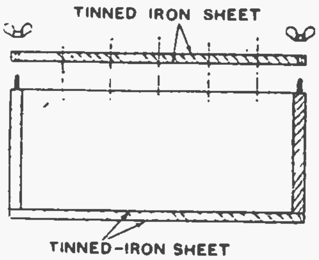


Fig. 10.—Screening box with close fitting bolted-down lid.

(2) The opening-up of the oscillator, when necessary, is a moderately simple operation. It entails the removal of the connection plug, control handles, and the two screening lids. Owing to the tight fit between the box and its lid, which makes for efficient screening, the user will appreciate the advantage of the fact that opening-up is not a frequent operation.

(3) Close metallic contact is obtained at all points in the paths by which the high-frequency currents require to flow in order to prevent the penetration of the oscillatory fields to the outside of the box.

(4) No part of the primary oscillator circuit is outside the inner metal lining. Leads from the secondary circuit, which is untuned, are brought out by a screened conductor to an astatic coupling coil arrangement. The other half of this astatic coupling forms the output circuit to the measuring instrument. This coupling forms a convenient means of varying the strength of the output oscillation.

For some measurement purposes it is desirable to be able to measure and control the value of the oscillatory current generated. For this purpose a heater and thermo-junction, preferably of the non-contact type, may be mounted inside the box, and connected in series with the condenser of the valve oscillator. Leads from the thermo-junction are brought out to a sensitive galvanometer through a plug and jack arrangement similar to that already described. Since these leads only carry direct current, little deterioration of the screening properties of the box will result from their use.

Screened Box with Bolted-down Lid.

One method of avoiding the somewhat clumsy properties of the enveloping lid design described in the last section is to use a flat lid, and bolt this down securely to the box. The box containing the necessary apparatus to be screened is lined with tinned iron sheet inside and outside. In this instance it is important to secure a very well-finished plane surface to the open end of the box, and except at the corners where they are unavoidable, no joints should occur along this edge. The sheets of tinned iron should be carefully bent over the box edge and sweated together with a good ¼in. overlap at a convenient point down the inside of the box. If desired, an inner, loosely fitting lid may be fitted to the box, as described in the preceding section. For the fitting of the main lid a number of No. 2B.A. screwed rods are let into the open edge of the box at distances of not more than four inches apart, as shown in Fig. 10. When they are fitted into position, these rods are all soldered to the covering of the box, being careful not to allow the solder to spoil the plane surface of the edge of the box. The lid of the box is simply a flat, well-made wooden panel, of ⅜in. to ½in. in thickness, and covered all over with tinned iron sheet. Great care must be taken to secure a good flat surface all round the edge where the lid is to make contact with the open top of the box. Holes are drilled at the requisite intervals at the edge of the lid to enable the latter to fit over the bolts fixed to the box. After placing the apparatus inside the box and arranging any external controls in the manner described in connection with the previous design, the lid is fitted over the box and screwed down with wing nuts, as shown in Fig. 10. The most important details to be attended to in the construction of this type of box are: first, securing an accurate fit between the surfaces of the lid and the top edge of the box; and, secondly, screwing down the lid tightly to make efficient contact with the box at every possible point. If an oscillator is placed within the box and a frame coil receiver set up in the neighbourhood, as in the experiments previously described, the effect of screwing down the lid can be experienced with some quite surprising results. When the nuts are slack the placing of a heavy weight upon the lid will give a very noticeable drop in the strength of signal due to the stray field from the box, illustrating the importance of securing adequate contact between the box and its lid at all points.

Screened Box with Spring Contact Lid.

While the type of box described in the previous section possesses excellent screening properties, and is very useful for many purposes in connection with wireless measurements, the operation of removing the lid is a somewhat long and tedious process. In some cases this disadvantage may be so serious that a more convenient arrangement may be sought, and one very practical alternative

How to Obtain Effective Screening.—
is illustrated diagrammatically in Figs. 11 and 12. This design is particularly applicable to the screening of whole sets of receiving apparatus, other than the loop or aerial, in order to avoid the direct pick-up of signal by the tuning or amplifying circuits, and so to enable the obtaining of, among other things, increased selectivity of the receiver as a whole. Now in screening apparatus from incoming signals it is as well to remember that, for all practical purposes, the magnetic field in the arriving waves is always horizontal. We have already seen that, in order to screen apparatus from the effects of such horizontal fields, it is necessary to employ sheets of metal or closed loops in vertical planes. If, then, we place the apparatus in a box with its opening at the top, only the four sides will form vertical screens, and we rely entirely upon the good contact made between the lid and the box in order to bring into action the large number of other vertical loops which are necessary in order to give adequate screening all over the box. If, however, the box is turned over on to its side it is evident that we have now available a large number of vertical loops quite additional to those formed by the vertical sides of the box. Such an arrangement, even without a lid, will thus give better screening from incoming signals than the same box with its opening at the top. Although, for the best results, it is still necessary to provide a lid and to make good contact between the box and lid, this is not now so vitally important as with the first arrangement. This fact can easily be verified by any experimenter by placing a small self-contained receiver, with no outside coil or aerial, inside a screened box and ascertaining the extent to which signals may be received with the box arranged in the various positions indicated.

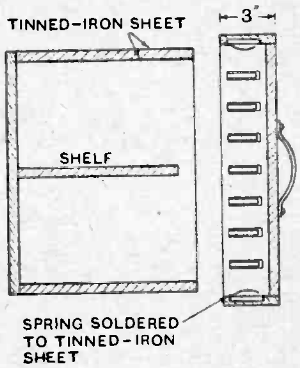


Fig. 11.—Screening box with spring contacts between the metal-covered lid and sides.

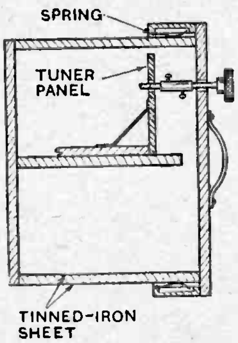


Fig. 12.—The lid in position showing arrangement of receiver controls.

Figs. 11 and 12 illustrate the design of a screening box, which makes use of the above principle, and is also fitted with a lid, which, while being easily detachable, is also provided with an efficient arrangement of spring contacts to add to the screening properties of the box. Although in Fig. 11 the wooden box is shown as completely covered with tinned-iron sheet, it would probably not be very serious if this covering were omitted from the inside. The box is seen to be provided with a shelf on which the receiver may be placed, while the batteries are situated below. The main portion of the lid is of ½in. deal, covered with tinned-iron sheet, while the sides are hollow, and should be arranged to give at least three inches of overlap when the lid is placed in position over the box. To provide adequate contact, springs of hard brass strip about ¼in. wide are fixed as shown at about 2in. apart all round the inside of the lid. The outer ends of these springs are soldered to the lid, while the other ends are free to move in slots as shown. If the whole of the metal work is carried out carefully the lid will be practically supported on the springs, which will make very good contact with the metal covering of the box. Fig. 12 shows a sectional view of the box with the lid in position, and also illustrates one method by which adjustments to the receiving apparatus may be carried out without removing the lid. A removable control handle is inserted through a hole in the lid about half an inch in diameter, and engages with a simple keying arrangement fixed to the spindle of the variable condenser or other component which requires adjustment. By this means the cutting away of the lid for the purpose of external controls is reduced to a minimum.

Mounting Coils in the Receiver.

In concluding this section a useful hint may be conveyed to the experimenter who is really desirous of reducing to the minimum the stray pick-up of signal e.m.f. on his receiving apparatus. Since, as mentioned above, the magnetic field in wireless waves is, for all practical purposes, horizontal, any coil or loop of wire forming part of a receiving circuit will have a maximum e.m.f. induced in it when its plane is vertical, and zero e.m.f. induced in it when its plane is horizontal. It is therefore advisable to arrange all such coils and loops of wire in a horizontal plane.

While this applies particularly to coupling coils, which are almost invariably arranged with the plane of the windings vertical, it should also be observed in regard to the remainder of the high-frequency circuit.

BOOKS RECEIVED.

"Elektrisches Fernsehen, Fernkinematographie und Bildfernübertragung." By Dr. W. Friedel. Pp. 176, with 153 illustrations.

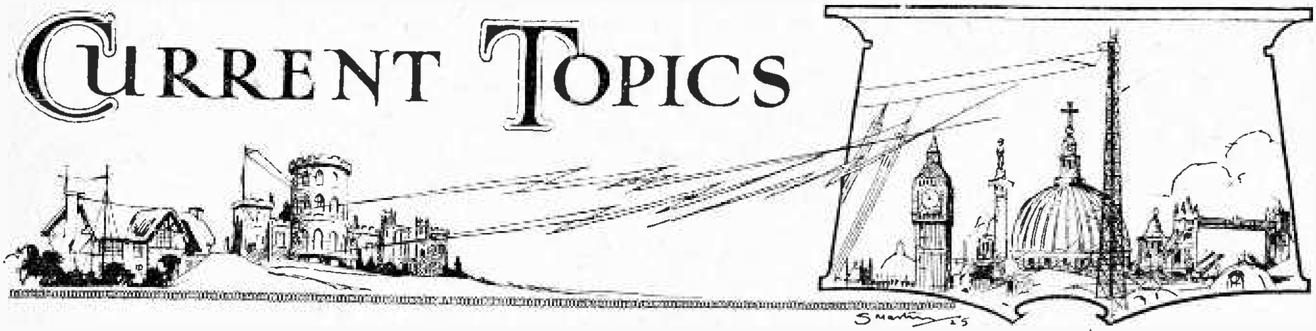
"Mikrophon und Telephon." By Dr. W. Mönch. Pp. 162, with 82 illustrations. Being Parts 2 and 3 of "Die Hochfrequenz-Technik." Published by Hermann Meusser, Berlin. Price each 8 mks.

"The White Château." A play broadcast by the B.B.C. on Armistice Night, 1925. By Reginald Berkeley. Pp. 79. Published by Williams and Norgate, Ltd., London. Price 1s.

"An A.B.C. to Wireless Entertainment." A guide to what you hear. Words of popular songs. Plots of opera, biographies of composers, etc. Compiled by Guy Hampnett. Pp. 71. Published by W. Foulsham and Co., Ltd., London. Price 1s.

"Broadcast." A novel. By John Mackworth. Pp. 285. Published by Longmans, Green and Co., London. Price 7s. 6d. net.

"L'Emission d'Amateur." By J. Labone. Second edition. Pp. 91, with 36 diagrams. Published by La T.S.F. Moderne, Paris. Price 5 francs.



News of the Week in Brief Review.

WIRELESS IN FRENCH HOSPITALS.

The value of a broadcast receiver in the hospital ward is being recognised in France, *Radio Toulouse* having opened a fund for the installation of receivers in local hospitals.

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LICENCES.

During September the number of British wireless receiving licences issued showed an increase of 41,500 over the preceding month, bringing the total number issued to 1,464,500. At the end of September, 1924, the number was 998,607.

oooo

PERUVIAN PRUDENCE.

The Peruvian broadcast listener, we understand, never thinks of calling his home a castle. This should save a certain amount of heartache, for the Government of Peru has decided to enforce tne wireless law calling for the inspection of all radio installations. A tax of one Peruvian pound per annum is levied on each set.

oooo

MORE POWER FROM BRESLAU.

Shortly increasing its power to 10 kilowatts, the Breslau broadcasting station is also to have a new aerial mast 325 feet high. Experimental transmissions under the new conditions will begin in the near future. Breslau will have a satellite in the Geliwitz relay station in Upper Silesia which will transmit Breslau's programmes with a power of 1½ kilowatts.

oooo

BROADCASTING IN THE RHINE DISTRICT.

A reminder of the pending withdrawal of the Allied troops from the Rhine area is furnished by the announcement that a powerful broadcasting station is to be installed at Cologne or Dusseldorf. A maximum power of 20 kilowatts may be employed.

oooo

A HERTZ MEMORIAL.

A monument to Heinrich Hertz, the illustrious physicist and first experimenter with electro-magnetic waves, has been unveiled at Leipzig by Dr. Schröter, of the Telefunken Gesellschaft. In the course of his address, Dr. Shröter announced the success of researches conducted in collaboration with Dr. Karolus which would increase the speed of transmission and reception of wireless pictures.

INVENTORS. PLEASE,

The Institute of Patentees, which has received from the War Office a long list of requirements, invites suggestions regarding secret wireless and the transmission of speech by light.

oooo

"BLACK-HEARERS" BEWARE!

An unpleasant epidemic is said to be spreading over Germany in the form of "licence-fatigue." Interest in the broadcast programmes was never greater than at present, but the Post Office officials report a definite decline in the number of licensed listeners. According to a *Times* correspondent, severe measures are likely to be adopted shortly in the punishment of offenders, who are known in Germany as "black-hearers."

LEAGUE RECOGNISES ESPERANTO.

Esperanto has been officially recognised by the League of Nations as a "clear" language for international telegraphy.

oooo

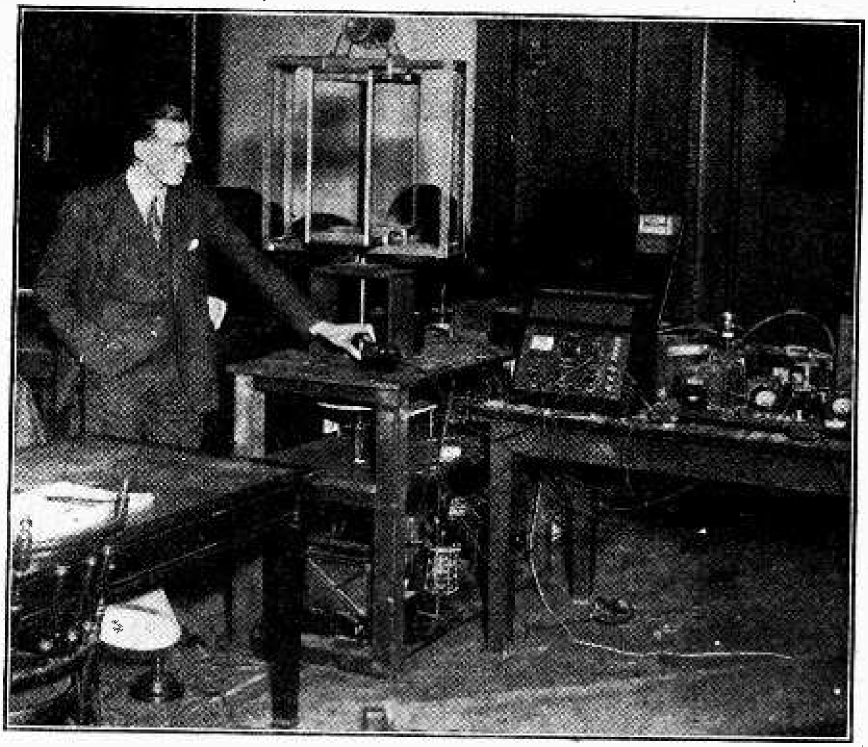
SHORT WAVES FROM HOLLAND.

Short wave experimenters will be interested to learn that transmissions on 42 metres are now conducted by the Dutch Colonial Ministry at The Hague, using the call sign PCUU. The Ministry of Posts and Telegraphs transmits on 25 metres with the call sign PCMM.

oooo

CANADA'S SPECIAL TRANSMISSION.

The special anniversary transmission from CNRA, Monckton, Canada, on the night of November 6-7th for the benefit



AUTOMATIC DIRECTION FINDER. Major Basil Binyon demonstrating his new D.F. instrument before the Wireless Section of the Institution of Electrical Engineers. The device automatically points in the direction of a distant transmitting station, and its value to navigators would thus be immense.

of British amateurs achieved a fair measure of success. Listeners at the Canadian National Railway's offices in London, Manchester and Southampton all reported reception, and the programme appears to have been picked up by a number of amateurs in different parts of the country.

oooo

AMATEUR AND AN S.O.S.

A Dublin wireless amateur named Buckley was instrumental in securing aid for the Cardiff steamer "Pencisely" which sent out an S.O.S. at midnight on Saturday, November 7th. Hearing the distress call Buckley telephoned to the Howth civic guards, who thereupon discovered the vessel drifting at the entrance to Dublin Bay. A tug brought her into harbour.

oooo

THE WIRELESS DOCTOR.

Medical diagnosis and advice by wireless is becoming a regular practice at sea. During the recent Atlantic hurricane, in which the American steamer "W. D. Anderson" sustained severe damage, the captain was seriously injured. There being no doctor on board advice was obtained by wireless from the medical officer of the "Mauretania."

LIFEBOATS AND SHIPS' WIRELESS.

That the use of wireless at sea does not lessen the need for an efficient lifeboat service was a point emphasised in the speech of Commander Steel at the recent annual meeting of the Dundee branch of the National Lifeboat Institution. It would have been as true to add that ships' wireless has increased the opportunities of life saving, and that the necessity for an efficient lifeboat service was therefore greater than ever.

factorily when a cat-whisker and telephones were added.

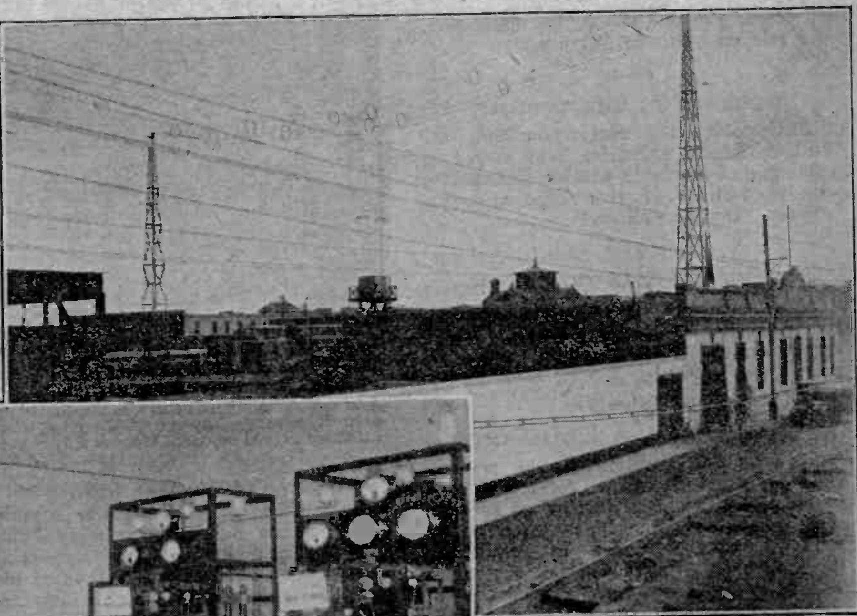
The case was adjourned for a fortnight.

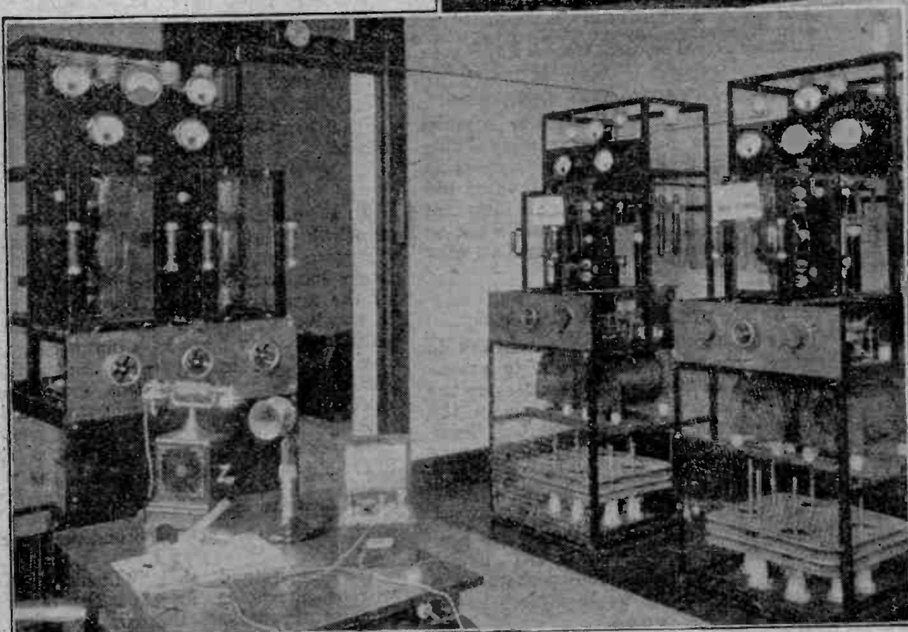
oooo

ANOTHER CALL SIGN AT NAUEN.

In view of the note in our issue of November 4th on the short wave transmissions from Nauen, the following information, kindly forwarded by the Director of Transradio fur Drahtlosen Ubersee-Verkehr, may be of additional interest.

A short wave transmitter at Nauen,





BROADCASTING IN PERU. Two interesting photographs of the newly opened station OAX at Lima. The upper picture clearly shows that Peru has nothing to learn in the construction of an excellent antenna system. The standard Marconi broadcasting equipment will be readily recognised in the lower photograph which was taken in the control room.

using the call sign AGA, works daily with the Argentine on a wavelength of 26 metres, transmissions beginning at 8 p.m. (G.M.T.), and usually continuing until 7 or 8 o'clock in the morning. In addition short wave tests are being carried out by the Telefunken Company from the same station with the call sign POF on 13 and 18 metres, and with the call sign POW on 28 metres. The last-named transmitters employ a power of 50 kilowatts, while AGA uses 10.

oooo

CARILLON CONCERTS BROADCAST.

Few musical instruments give a more faithful broadcast reproduction than the bell, a fact which has been proved on more than one occasion by the B.B.C. Readers may therefore be interested to learn that every Sunday evening a carillon concert is broadcast by WGY, Schenectady, New York, from the belfry of the Park Avenue Baptist Church. This carillon consists of 53 bells cast in Belgium, and is played by the noted Belgian carilloneur, M. Anton Brees.

British amateurs should listen on 380 meters between 12 and 12.30 a.m. (G.M.T.) on Mondays.

POST OFFICE WIRELESS PROSECUTION.

Before Mr. Mead at Marlborough St. Police Court, on November 12th, Mr. Robert Moffat Ford pleaded "Not Guilty" to the three charges of establishing a station, installing a wireless apparatus, and working it.

The defendant said it seemed hard that a private citizen had his premises forcibly entered by the police, and that he should have no opportunity of inquiring into and obtaining redress.

Mr. Edward Shaughnessy, assistant-engineer-in-chief to the G.P.O., said that the apparatus taken from Mr. Ford's house had been found to work satis-

LONDON'S WIRELESS LINK WITH THE ARCTIC.

Commercial messages may now be sent by wireless from London direct to

Aklavik, in the delta of the Mackenzie River and within 60 miles of the Arctic Ocean. This is rendered possible by the opening of the public wireless station at Aklavik, which constitutes the last link in a chain of four stations connecting the Arctic regions with Edmonton, the capital city of Alberta, over a distance of 1,700 miles. The intermediate stations are situated at Fort Simpson, on the Mackenzie River, and Fort Smith, on the Slave River.

Messages from London to the Arctic are telegraphed to Ottawa, whence they are wirelessed across Canada to Edmonton, and relayed north to Aklavik.

oooo

WIRELESS IN THE LIBRARY.

Anticipating the winter demand, the Fulham Public Libraries have issued a catalogue of available wireless books with careful outlines of the scope of every volume. Bravo, Fulham!

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BROADCAST ZEAL IN SWEDEN.

A year ago the number of broadcast receiving licences in Sweden amounted to approximately 6,000. There are now more than 75,000

oooo

ATMOSPHERICS AND A GUARANTEE.

Atmospheric conditions were responsible for a novel lawsuit recently heard in Montreal. The plaintiff sued for the recovery of the purchase price of a receiver, bought under a guarantee, claiming that the set did not function. The defendants, however, showed that a similar instrument had been operated with success in another part of the city, and maintained that the poor results obtained by the plaintiff were due to adverse atmospheric conditions.

The judge accepted this explanation, and the case was dismissed.

oooo

TACKLING THE CANADIAN HOWLER.

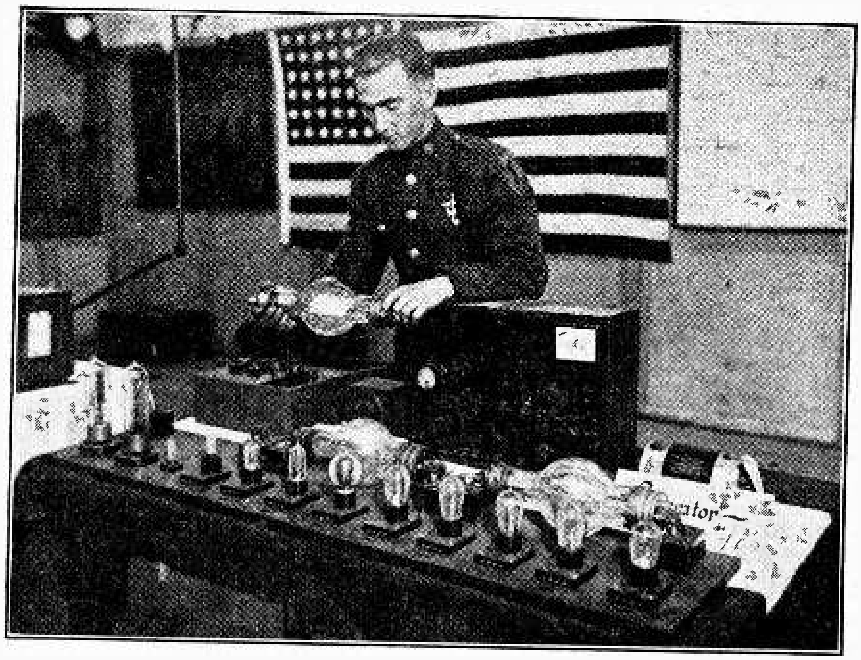
Fifty per cent. of the "preventable interference" to broadcast reception in Canada is caused through the incorrect use of regenerative sets, according to a special survey which has been carried out by the Canadian Department of Marine. A circular showing how re-radiation can be avoided has been distributed among Canadian broadcast listeners, and it is hoped that in consequence the local ether may soon become more commodious.

oooo

THE NORTHOLT "MUSH."

The continuance of the annoying interference from the Northolt wireless station to listeners who attempt to pick up distant transmissions has led a *Daily Mail* reporter to seek an explanation from the General Post Office.

Admitting the existence of Northolt's "mush," an official said: "The engineers are taking all possible steps, but it is not an easy matter. It is very difficult to know even the actual cause and how to eliminate it, but the engineers are doing all they can."



A GAMUT OF VALVES. A fascinating stand at the New York Radio Exhibition. This exhibit, arranged by the U.S. Army, showed every type of valve at present in use by the military signal service, from a tiny "peanut" to the largest 250 watt transmitting valve, taking 2,000 volts on the plate.

BELGIAN CONGO AND WIRELESS.

The building of a high power wireless station in the Belgian Congo is being strongly urged by *Le Soir* and other Brussels newspapers. It is pointed out that the cost would be as low as 300,000 fcs. The station would work on short waves and could be heard all over Africa.

oooo

ARBOREAL LOUD-SPEAKERS.

Rude shocks await country visitors to Sydney, Australia, who seek to escape the turmoil of the city by resorting to the municipal parks. Hidden high in the foliage of the trees, it is stated, loud-speakers have been installed which intone a string of exhortations to whomever comes within range.

The callow visitor is enjoined to respect the ground upon which he treads and constitute himself a guardian of public property. Finally, the loud-speakers warn him not to leave any waste paper.

oooo

RADIO GALE WARNINGS.

Attention is drawn to the value of wireless gale warnings to ships at sea in the report, just issued, of the Meteorological Committee to the Air Council for the year ended March 31st, 1925. Arrangements were made in September of last year for the addition of a note of the movement of pressure systems to the gale warnings issued by wireless. This service has been of extreme benefit.

The service of weather reports from British ships was well maintained. In the early part of the year arrangements were made, in co-operation with the U.S. Weather Service, for the re-transmission of reports from British ships in the Western Atlantic to Europe *via* a high power wireless station in the United States.

oooo

A B.T.H. FILM.

In a new film, entitled "Listeners-In," which has been released by the British Thomson-Houston Co., Ltd., a subtle brain has succeeded in infusing the idea of the merits of B.T.H. headphones into a number of typical screen situations such as an elopement in a motor car, the ravings of an irate parent, and a final reconciliation. Out of this material a convincing story has been constructed.

An interesting feature is the inclusion of a scene actually photographed in the 2LO studio whilst the orchestra was playing under the direction of Mr. Dan Godfrey. In another scene an announcer is shown in the act of broadcasting an "S.O.S."

We understand that "Listeners-In" will be shown at most of the leading cinemas throughout the country during the next few months.

LOUD-SPEAKER TYPES.

With reference to the "Readers' Guide to Loud-speaker Types" in our issue of the 4th inst., we have to correct a few of the particulars given therein, viz.:—

THE EDISON SWAN ELECTRIC CO., LTD. —"Dulcivox," in plain black finish, £1 17s. 6d.; "Dulcivox," in black and gilt (shaded), £2 2s.; "Dulcivox," in warm brown (shaded), £2.

FELLOWS MAGNETO CO., LTD.—"Volutone," £2 15s.; "Junior," 19s. 6d.

GENERAL RADIO CO., LTD.—The horns of these loud-speakers are of composition and not metal.

MEASURING ANODE POTENTIAL.

Common Sources of Error and How they may be Eliminated.

By W. J. TARRING.

A SHORT time ago an article appeared in a wireless periodical purporting to inform its readers how to measure accurately the working anode potential on a valve. The voltmeter recommended was a double-range moving-coil instrument with a resistance of at least 10,000 ohms on the high range. So far so good. It then proceeded to give the circuit shown in Fig. 1, and pointed out that the negative terminal of the meter should be connected to the negative filament leg. The latter advice is sound as in all valve measurements the negative end of the filament is taken as being the point of zero potential. The reading given by the voltmeter, however, will not be the working voltage of the valve.

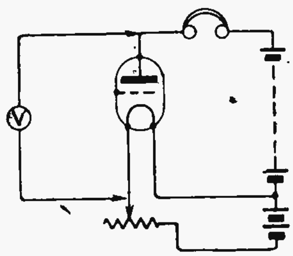


Fig. 1.—A simple and direct method of measuring anode potential, which is, however, subject to error when a voltmeter of finite resistance is used.

It would appear that the above method is in very common use, so perhaps the following remarks may be of interest.

First, let us see why the reading obtained is incorrect. In order to do this let us redraw the circuit of Fig. 1, both with and without the voltmeter, as in Fig. 2. R_a represents the impedance of the valve, R_t the resistance of the telephones, and R_v the resistance of the voltmeter.

Let us now assume that R_a is the same in both circuits in Fig. 2 (this may or may not be true in practice) and equals 36,000 ohms, $R_t = 2{,}000$ ohms, $R_v = 14{,}000$ ohms, and that there is a constant e.m.f. of 100 volts across the battery terminals.

False Readings—A Practical Example.

Now let us consider how this 100 volts is distributed round the two circuits, taking the simpler one first. From Ohm's Law we know that the current (I) flowing in the circuit is

$$\frac{E}{R_a + R_t} = \frac{100}{36{,}000 + 2{,}000} = 2{\cdot}6 \text{ milliamperes.}$$

The potential drop across R_a is given by

$$IR_a = 36{,}000 \times 0.0026 = 93{\cdot}6 \text{ volts.}$$

Turning now to the right-hand diagram in Fig. 2 the two resistances R_a and R_v are in parallel, and can be replaced by a single resistance of a value

$$\frac{R_a R_v}{R_a + R_v}.$$

Then from Ohm's Law again

$$I_1 = \frac{E}{\frac{R_a R_v}{R_a + R_v} + R_t} = \frac{100}{\frac{36{,}000 \times 14{,}000}{36{,}000 + 14{,}000} + 2{,}000}$$
$$= 8.28 \text{ milliamperes.}$$

and the voltage drop between the points X and Y will be given by

$$I_1 \cdot \frac{R_a R_v}{R_a + R_v} = 83{\cdot}5 \text{ volts.}$$

Thus there is a difference of 10 volts between the two cases.

So much for the theory—let us see how it works out in practice. A circuit as shown in Fig. 3 was arranged.

The resistance of the milliammeter was so small as to be negligible by comparison with the other resistances in the circuit. The telephones had a resistance of 2,000 ohms and the voltmeter 14,050 ohms. The valve was an R type, and was worked at 4.5 volts on the filament, so that the impedance should remain sensibly constant between 70 and 100 volts. The anode voltage—anode current curve is reproduced in Fig. 4.

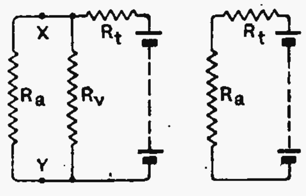


Fig. 2.—Analysis of the circuit in Fig. 1. The right-hand diagram shows the voltmeter disconnected.

Cause of the Reduction in Voltage.

It will be noticed that the curve runs practically straight between the above limits of voltage. Since the slope of the curve is a measure of the impedance of the valve, the assumption of a constant impedance is very nearly correct in this case.

The H.T. battery was tapped at about 100 volts, the exact value being unknown, and with both switches thrown to the left the milliammeter read 2.8 mA. From the curve it will be seen that this represents an anode voltage of 96 volts. S_2 was next thrown to the right to switch in the telephones, and the current dropped to just under 2.6 mA, which represents 90 volts on the anode. The voltmeter was then brought into circuit by means of S_1 and read 79 volts. The current increased to 7.7 mA—of this, from Ohm's Law, 5.6 mA was passing through the voltmeter, and the balance of 2.1 mA was due to the valve. 2.1 mA on the valve curve gives 79 volts, which affords a check on the voltmeter reading.

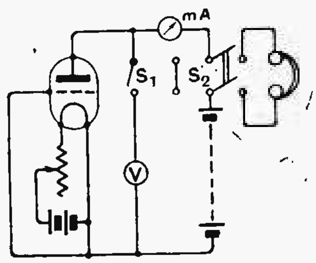


Fig. 3.—Experiment to illustrate the reduction in anode voltage due to the insertion of the voltmeter V.

Thus both in theory and practice the introduction of the voltmeter into the circuit results in a considerable reduction in the actual voltage on the anode. This reduction is, of course, due to the fact that when the

Measuring Anode Potential.—

larger current is flowing in the anode circuit the voltage drop across the telephones is correspondingly increased.

Having shown that the above method is unsound, these notes would be of little use unless a better method were suggested. There are at least two methods by which one can determine the true working voltage with the instruments usually available to the amateur. Both of them call for the use of a milliammeter and a voltmeter, and one requires a knowledge of the characteristics of the valve.

Estimating the True Anode Voltage.

First, then, let us consider what happens if we vary the anode voltage on a valve. From the curve of Fig. 4 it will be seen that, if the filament and grid voltages remain unchanged, the anode current varies with the anode voltage. The important point so far as we are concerned is that there is only one value of voltage for any particular current. Now let us use this fact. Suppose in Fig. 3 we switch the 'phones in and the voltmeter out we shall get a certain reading on the milliammeter which indicates a definite voltage on the anode. If now we short-circuit the 'phones and readjust the tapping on the H.T. battery until we get the same reading on the milliammeter we can be sure that we have the same voltage on the anode. The voltmeter can now be switched in, and the reading it gives will be the true voltage since the only resistance in the circuit is the composite one formed by the valve and the voltmeter.

This method, however, may not always be convenient, and then the second method may be useful. Suppose we are using the valve, of which the anode current—anode voltage curve is shown in Fig. 4, at the filament voltage at which the curve was taken, in a circuit such as Fig. 5, and that we know the amplification factor (m) of the valve is in this case 9.

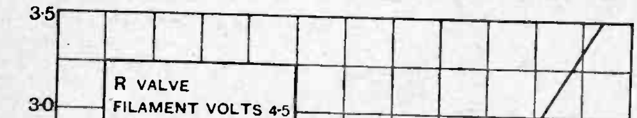


Fig. 4.—Anode volts—anode current characteristic of the valve used in thes e experiments.

The milliammeter will give us a certain reading. We cannot, however, obtain the anode voltage from this by reference to the curve as the bias on the grid has not been taken into account. Let us call the voltage on the curve corresponding to the milliammeter reading E_{a1}. If we can now determine the voltage on the grid E_g we shall be able to ascertain the true anode voltage from the formula

$$E_a = E_{a1} - (m \cdot E_g).$$

In order to determine the grid voltage the voltmeter should be across the terminals of the biasing battery. At first sight this would appear to be the wrong position as we should be ignoring the voltage drop across the resistance formed by the secondary of the transformer. However, the negative bias on the grid raises the filament-grid impedance of the valve to such a value that only a very small fraction of one per cent. of the biasing voltage is lost. It must be borne in mind, however, that the above remarks only apply when the grid is negative with respect to the filament, and this method would be unsuitable if a positive bias were applied.

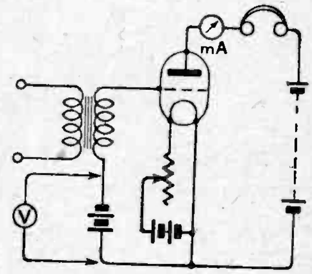


Fig. 5.—Circuit connections for measuring the anode voltage in terms of the grid voltage and anode current.

A numerical example may perhaps assist in understanding the latter method. Suppose our milliammeter gives a reading of 2.1 mA—this gives us a value of 79 volts for E_a, and suppose we find E_g to be -1.4 volts, then

$$E_a = 79 - (-1.4 \times 9)$$
$$= 91.6 \text{ volts.}$$

Effect of Internal Resistance in the H.T. Battery.

In these notes it has been assumed that the voltage across the H.T. battery remains constant irrespective of the current flowing through it. This is, of course, not the case, but, provided the battery is in good condition, any error so introduced would not be greater than the unavoidable experimental errors, and the results will be sufficiently accurate for most purposes.

In conclusion, it is hoped that these notes, in addition to explaining a popular fallacy, will encourage readers to get to know their valves, and thus be in a position to work them under the correct operating conditions.

HIGH POWER AT RIO.

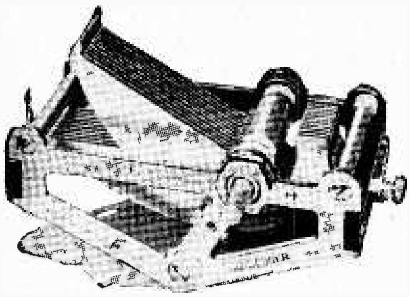
A Rio de Janeiro correspondent of *The Electrician* reports that a new high-power radio station has been opened on the Ilha do Governador in the Bay of Rio de Janeiro. The station, which is equipped with Telefunken apparatus, has a normal estimated range of 4,500 miles.

A Review of the Latest Products of the Manufacturers.

KARAS STRAIGHT LINE FREQUENCY CONDENSER.

A condenser of particularly attractive construction and finish and with plates shaped to provide straight line frequency tuning is supplied by R. A. Rothermel, Ltd., 24-26, Maddox Street, Regent Street, London, W.1. It is a product of the Karas Electric Co., of Chicago, and embodies many attractive features, being one of the very latest developments in a highly competitive and progressive market.

The accompanying illustration fails to show the many points of merit in the design of this instrument. The fixed and moving plates are of brass, bonded together at several points, and the frames, which are also of brass, are die-stamped and given a nickel-plated finish. By the use of cone-shaped bearings the moving plates turn firmly yet easily, and a spiral spring is used to ensure reliable contact with the terminal. The fixed plates are supported by the now usual method of employing a pair of ebonite strips carried between the end mounting plates. It is interesting to observe that one hole fixing is not employed, a better support probably being obtained by the use of the three screws which are supplied. No difficulty exists in drilling the instrument panel with the aid of a paper template.



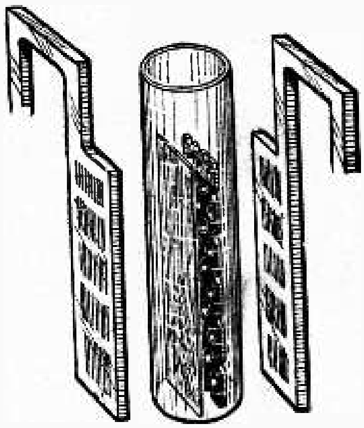
Karas "Orthometric" variable condenser.

oooo

MARS H.T. ACCUMULATORS.

The use of high-tension accumulators for operating multi-valve receivers is rapidly gaining favour, and various types of secondary batteries are now supplied.

The Mars accumulators obtainable from Fonteyn, Gilbert and Co., Ltd., 6, Blandford Mews, Baker Street, London, W.1, should interest the listener who is looking round for a secondary battery to replace his dry cell H.T.



A cell from the Mars H.T. accumulator, type "C."

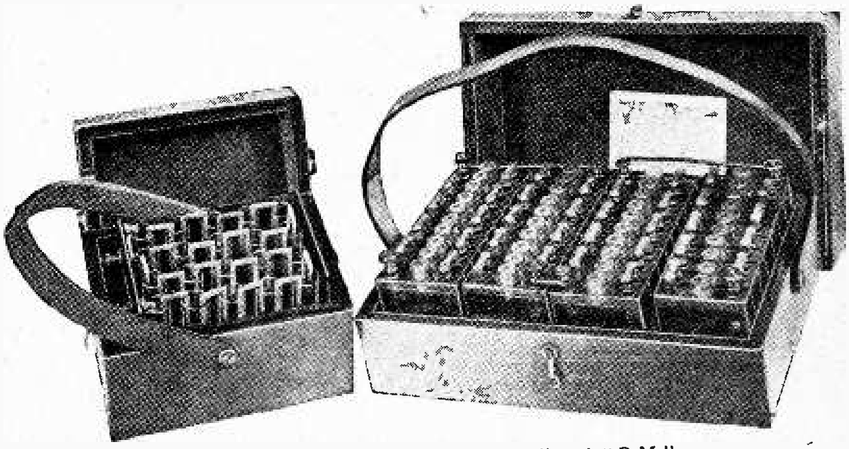
The accompanying illustration shows two models, the smaller one, type "C," which is made up with glass test-tubes, and the other, type "B.M.," which is made up in blocks of 20 volts. The glass containers of the "C" type are particularly tall, so as to reduce evaporation to a minimum, while spraying during charging is overcome by adopting the recommendation made in the pamphlet of instructions which accompanies the battery, to the effect that a layer of about ⅛in. of pure mineral oil should be added to float on the acid.

The elements are assembled together without soldering by an extension of the plates themselves, and the positive plate of one battery and the negative of the next are made in one casting. The frame, which is made of washable non-absorbent material which will not corrode, provides for keeping the battery in a clean condition. The battery can easily be taken to pieces and the framework washed down, thereby avoiding a low insulation being set up by an accumulation of acidulated moisture.

The "B.M." type consists of units of ten cells in a celluloid case with liberal spacing round the sides and the bottom of the plates. It is obtainable with a capacity of either two or four ampere-hours. A new departure consists of abandoning the usual form of vent and substituting a celluloid cone with a hole in the top, thereby limiting evaporation, providing an escape for the evolved gases, and extending the leakage path.

Both batteries are supplied in wooden cases so as to render them easily portable.

The type "B.M." was duly charged in accordance with maker's instructions and, as advised, discharged through a lamp resistance. The full ampere-hour capacity was maintained in the first charge, and by the appearance of the plates this battery promises to give good service.



Mars high tension battery, types "C" and "B.M."

NEW SIEMENS CELL.

A new type of cell has been evolved by Siemen Bros. and Co., Ltd., Woolwich, S.E.18, the well-known dry battery manufacturers, to be used as a unit in the construction of a large capacity primary high-tension battery.

One of the cells of the new type Siemens high tension battery with an unspillable electrolyte which can be replaced when the cell becomes exhausted.

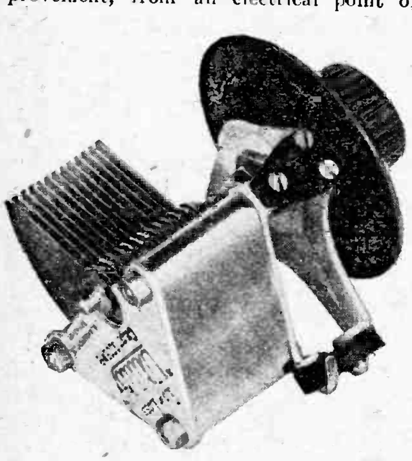
The active materials are contained in a strong glass tube measuring about $1\frac{1}{4}$in. in diameter and just over 5in. in height. The cell is really of the wet type, and a special feature is that it is rendered unspillable by the inclusion in the electrolyte of a glutinous material. The zinc is of liberal area, while the depolarising material is of the usual sack construction similar to that employed in dry batteries. After long use, when the battery eventually becomes discharged, it need not be discarded, but the exhausted electrolyte can be washed out and a further solution substituted, rendering the battery again active at a small cost.

oooo

UTILITY VARIABLE CONDENSER.

Messrs. Wilkins and Wright, Utility Works, Kenyon Street, Birmingham, manufacturers of the Utility change-over switch, have recently introduced a new model of variable condenser.

The particular point of interest is that the spindle carrying the moving plates is supported by a single bearing only; as a result the fitting of a bottom end plate is avoided, with a consequent improvement, from an electrical point of view, in the method of supporting and insulating the fixed plates. The single bearing is very liberal in length, giving ample support to the spindle, and end play is prevented by arranging a thread on both the spindle and the surface of the bearing on which it engages. This thread, which is, of course, very fine, increases the area of contact with the spindle, and good contact is further ensured by cutting away a portion of the bearing and clamping the piece thus removed on to the face of the spindle by means of a hard wire spring. Mechanically as well as electrically the condenser is very attractive, and it is offered at a moderate price.



Wilkins & Wright "Utility" variable condenser. It is provided with a single bearing of liberal length whilst a dust cover is fitted over the fixed plates.

oooo

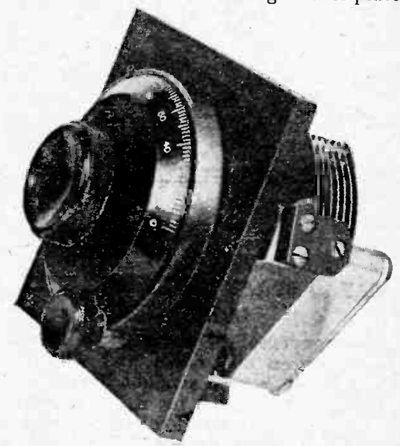
NEW GEARED DIAL.

Another recent product of Wilkins and Wright is a geared dial for use in conjunction with their "Utility" type condenser.

The various parts used in its construction are shown, and it will be seen to consist essentially of a small pinion operating through finely cut teeth on to the rim of a brass disc, from which the movement to the condenser spindle is transmitted through a three-limbed stamping carrying three steel balls. The brass plate rests on the balls, which travel over the face of the nickel-plated container to which the small driving pinion is attached. With the container stationary and clamped down to the panel, it will thus be seen that the rotation imparted to the condenser spindle is only half that applied to the brass-toothed disc, owing to the action of the balls travelling across the face of the stationary container.

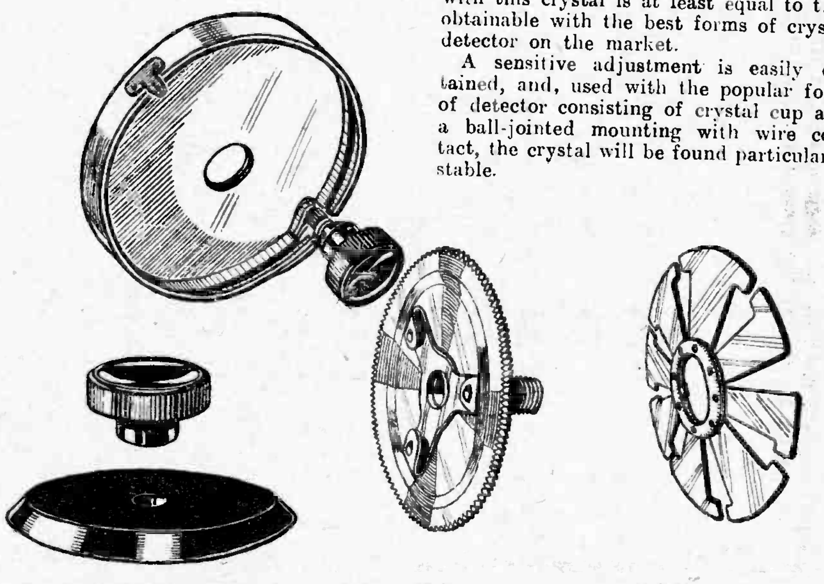
A friction slip action is arranged for rapid adjustment, and operates through a bronze spring stamping fitted with a ball race. The movement when operating through the main knob is particularly smooth, brought about by this ball-bearing movement, whilst a very fine tuning control is given by the smaller knob.

The metal parts are particularly heavy, the outside container being nickel-plated



Geared dial of Wilkins and Wright.

and provided with an indicator. The knob and dial are of attractive appearance and locked together on a fine thread on the large-diameter brass spindle.



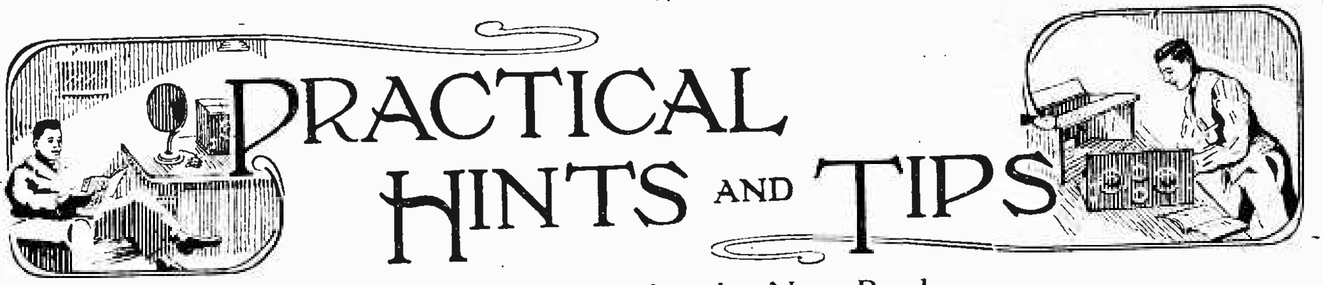
Component parts of the Wilkins & Wright vernier dial showing the friction spring plate with centre ball race and the interesting arrangement making use of three balls in a spring mount for producing an additional half reduction gearing between the condenser spindle and the toothed disc.

oooo

BRITICENT CRYSTAL.

This form of hertzite is being adopted by a number of manufacturers of crystal receiving sets, and is manufactured by the British Central Electrical Co., Ltd., 6 and 8, Rosebery Avenue, London, E.C.1. Owing to the difficulty of making definite tests on the performance of various specimens of detector crystal, it may be said that the signal strength given with this crystal is at least equal to that obtainable with the best forms of crystal detector on the market.

A sensitive adjustment is easily obtained, and, used with the popular form of detector consisting of crystal cup and a ball-jointed mounting with wire contact, the crystal will be found particularly stable.



A Section Mainly for the New Reader.

LOUD-SPEAKER VOLUME CONTROL.

It has become a fairly common practice to reduce excessive output volume in receivers embodying transformer-coupled L.F. amplification by the simple expedient of connecting a resistance of from a quarter to one megohm across the secondary winding of one of the transformers. This is certainly preferable to weakening signals by distuning or reducing filament and H.T. voltages, and has the advantage that the quality, of reproduction will be improved, except possibly where the very highest grade transformers are used. In some cases, of course, it is possible to obtain the desired intensity by switching off an L.F. valve, but it is so often found that, while one stage of amplification gives signals not quite loud enough, the addition of a second will overload the loud-speaker; hence the need of some finer form of control.

In receivers employing leaky grid condenser rectification there is the possibility of a considerable reduction of strength *before* detection without impairing quality, but both the crystal rectifier and the valve working on the bottom bend operate best from this point of view—in fact, from every point of view—when supplied with a fairly strong signal.

The question of volume control in the case of a resistance or choke-coupled amplifier is a much more difficult one; most of the adjustments which can be easily made will have the effect of changing tone rather than volume. Probably the best method to adopt is that used in the "Four-Valve Quality Receiver" described in *The Wireless World* for September 16th, 1925, where voltages applied to the grid are reduced by tapping this latter variably on to the leak, or, rather, on to the junction between two leaks in series, which amounts to the same thing. Alternatively, a non-inductive resistance may be connected across the loud-speaker itself. This resistance may be continuously variable, variable in steps, or fixed, in which case the correct value must be found by trial. The first method is to be preferred, as it will be easier to ensure that neither the last valve nor the loud-speaker itself are overloaded.

oooo

SWITCHING A RECEIVER.

It would seem advisable under modern conditions to simplify the elaborate system of switching low-frequency valves which has hitherto been so popular.

A choke-coupled 0-v-2 receiver, as shown in Fig. 1, is not likely adequately to operate a loud-speaker on less than the full number of valves, so switching is introduced in such a way that both telephones and loud-speaker are permanently connected to the receiver, the switch being wired so that when it is desired to listen on the headphones the third valve filament is extinguished and the output of the second valve is changed over.

It will, as a rule, be found easiest to tune in a distant station on the 'phones, and one stage of low-frequency amplification is, under ordinary conditions, quite sufficient for this purpose.

In the case of a receiver incorporating two transformer-coupled L.F. stages, the design of a satisfactory switching system will be influenced by various considerations. If the set is to be used in a locality where both L.F. valves will be necessary for operating the loud-speaker, the arrangement shown, with slight obvious modifications, is to be recommended. If, however, adequate loud-speaker volume is obtainable with the detector and one low-frequency amplifier, a somewhat more elaborate system will probably be necessary if this alternative is to be provided for. Unless power valves are used in both stages, it should be arranged that the loud-speaker is always connected in the plate circuit of the last valve, and that a suitable value of high tension is applied to the detector when the first L.F. valve is cut out.

oooo

IMPROVING "NEUTRODYNE" SELECTIVITY.

In spite of the high degree of selectivity obtainable from the conven-

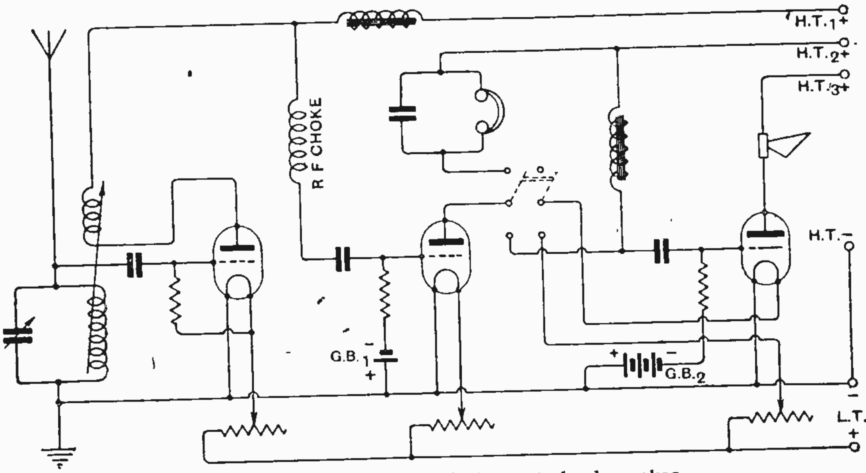


Fig. 1.—Switching from telephones to loud-speaker.

tional arrangement of two neutralised tuned high-frequency amplifiers, it is sometimes found that a powerful station in close proximity to the receiver will cause the aerial, and consequently the secondary coil, which is fairly tightly coupled to it, to oscillate at the frequency to which they are tuned, even if this differs to a considerable extent from the wavelength of the transmitting station.

Assuming that the grid circuit of the first valve is oscillating at its natural frequency, it will inevitably happen that the voltages across this circuit will be magnified when the H.F. transformers are brought into tune.

This trouble is due to what is called "shock-excitation," and may be most easily overcome by reducing the coupling between aerial and secondary coils. Signals from distant stations will be reduced in strength, but it is here that the real benefit of an efficient H.F. amplifier is appreciated, as by its use they can be brought up to audibility. Without the H.F. amplifier it is often possible to eliminate a very powerful near-by station, but only by reducing incoming signals from the distant transmitter to such an extent that they are no longer of sufficient intensity to operate the detector.

oooo

TESTING VALVE EMISSION.

The life of most modern dull-emitter valves is determined rather by failure of electron emission than by filament burn-out. The actual condition of a valve, as far as this is concerned, is best obtained by connecting a milliammeter in the anode circuit. This instrument is so seldom used, except by the experimenter, that the listener naturally regards its acquisition as a totally unnecessary expense.

All users of valve apparatus, however, require a voltmeter, and this, except in the case of the very cheapest type, will usually give a deflection when connected in a valve anode circuit, although it may be necessary in the case of general-purpose and high-impedance valves to positively bias the grid in order to get a reading.

It is suggested that, before a new valve is put into service, it is inserted in such a position in the set that measured values of high-tension, filament voltage, and bias, may be applied to it. The meter should then be inserted in a lead to the H.T. battery, and a note made of the voltages above as well as the deflection of the meter. It will thus be possible, at a later date, when the valve is under suspicion, to see if the emission has fallen off to any appreciable extent.

oooo

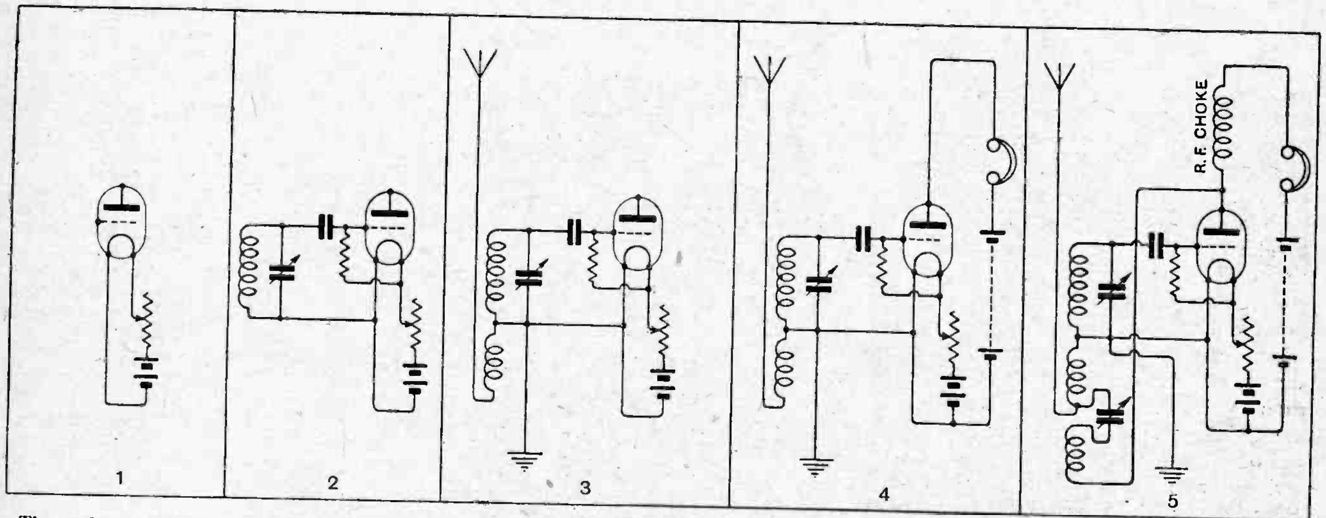
"DISSECTED DIAGRAMS."

It should be pointed out for the benefit of novices that the circuits shown in our series of "Dissected Diagrams" must not always be assumed to represent complete receivers. To avoid complications, and to make clearer the points in the progressive building-up of a receiver, various refinements are omitted. The Reinartz receiver shown below is, however, fairly complete, but in practice one would connect a large by-pass condenser across the H.T. battery, and another smaller one across the telephones.

DISSECTED DIAGRAMS.

No. 6.—A Single-Valve "Reinartz" Receiver.

For the benefit of those who have not yet acquired the simple art of reading circuit diagrams we are giving weekly a series of sketches showing how the complete circuits of typical wireless receivers are built up step by step.



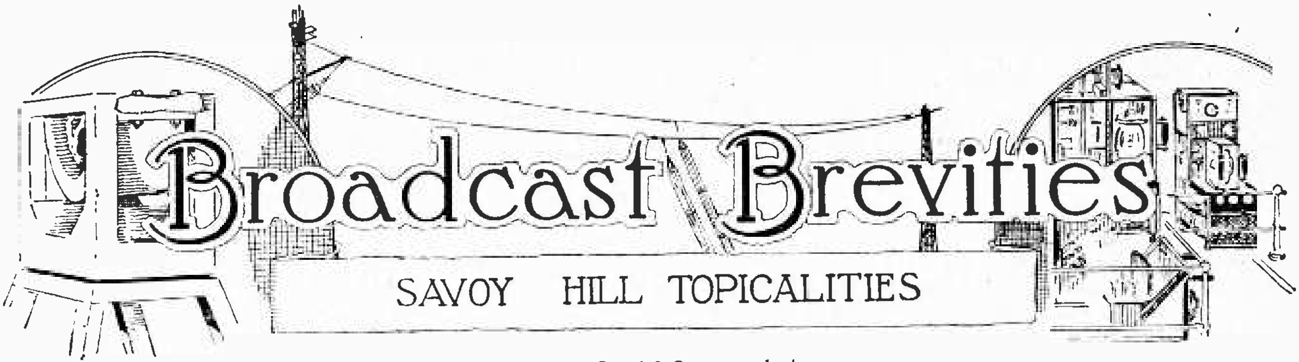
1. The valve, with its filament heated by a low tension battery through a variable resistance connected as usual in the positive lead.

2. An oscillatory circuit, with grid condenser and leak to give rectification, is connected between its grid and filament.

3. Aerial and earth are added. Note that this circuit is not separately tuned, and that the aerial coil consists of a few turns of wire wound continuously with the grid inductance.

4. The anode circuit is completed through telephones and high-tension battery, giving a practical receiver, but one having a very limited range. This may be improved enormously by the addition of reaction—

5. —as shown above. A choke is inserted in the anode circuit; amplified H.F. currents are thus deflected back to filament through reaction coil and variable condenser, inducing currents in the grid circuit.



By Our Special Correspondent.

Daventry Programme Changes.

The change in high-power policy which took place as from last week—does not signify a retrogressive step, despite assertions to the contrary on the part of uninformed writers. In future Daventry will transmit 2LO programmes regularly except on Thursdays, when it will have its own programme. On the face of it, this may perhaps be considered a change in the policy of alternative programmes, but in reality it does not indicate inconsistency.

oooo

Listeners Want London.

When the Daventry station opened last July some ten per cent. of the crystal users of the country were provided for the first time with the opportunity of hearing London programmes, *via* 5XX, on four evenings a week. For the rest of the time they heard Daventry's own programmes or those of some other station.

oooo

Not a Setback.

This policy has not met with the welcome which might have been expected; instead, this vast new body of 2LO listeners appear to have been attracted chiefly on the nights when 5XX transmitted 2LO programmes, and on judgment formed as the result of an analysis of listeners' letters regarding Daventry, it was decided that 2LO programmes were preferred.

oooo

Alternative Programmes.

This does not, however, mean that the policy of alternative programmes has suffered a setback, for I am told that the engineers are going ahead with the drafting of schemes for power development at other stations which will widen the field of alternative programmes not merely as from one high-power station like 5XX but from several main stations working on higher power than they at present use.

oooo

Morning Transmissions.

Daventry meanwhile continues its customary variety concert with the Radio Quartet and various artists from 11.0 till 1.0 each day. Experience has shown that these morning concerts are widely appreciated not only by the trade but by individual listeners who are able to listen at this time, such as night workers and the sick.

oooo

A Famous Band.

The Marsden Colliery Band, whose success will be remembered in carrying off the first prize at the recent Bands Festival at the Crystal Palace, and whose home is near Newcastle, are to give an hour's broadcast this evening (Wednesday). Their programme will be relayed from the Newcastle studio to London.

oooo

Long Distance Reception.

Reports of distant reception of 5XX are reaching me in large numbers. A Swedish correspondent tells me that his mother, a deaf old lady who resides about three miles from Leipsig, cannot hear the speech from the Leipsig station, but is able to hear both speech and music from Daventry.

oooo

5XX Heard Abroad.

5XX, according to the report of another correspondent, has also been received and transmitted by 6WF, the station at Perth, Western Australia; while the master of the s.s. "Maid of Athens," a small ship which carries no wireless installation, receives 5XX in the Mediterranean and the Black Sea on a Broadcast set.

oooo

New Studios.

Listeners may have noticed a new note in the reading of the news bulletin from 2LO in the past week or so. There has been a kind of gruffness which distorted the normally clear enunciation of the announcers. The reason is that the new Talk studio was brought into use on November 7th. Certain adjustments of the apparatus were found to be necessary in order to improve the tonal qualities of speakers. I am assured that everything is now all right; but some minor defects may have to be overcome in the same way when the new music studio comes into use.

oooo

Blind Artists.

The programme on Sunday next, November 22nd, will consist of items given entirely by blind artists, to commemorate the day that is dedicated to St. Cecilia, the patron Saint of music and of the blind. Since I announced in *The*

AMATEUR WIRELESS LIFE-SAVING SERVICE. An operator at one of the amateur stations which have been installed on the New York coast for the purpose of picking up distress calls from pleasure yachts. The messages are telephoned to the Coast Guard and Life-Saving Headquarters. Since this useful service was installed in the summer several lives have been saved in this manner.

Wireless World that Captain Ian Fraser, M.P., Chairman of St. Dunstan's, would be Master of the Ceremonies for that occasion, I have been given further details of this concert as follow:—

Mr. William Wolstenholme will play two groups of organ pieces in the Armitage Hall at the National Institute for the Blind, which will be relayed as part of the programme; and Mr. Sinclair Logan (baritone), Mr. Ronald Gourley (pianist), Mr. Ernest Whitfield (violinist), and Mr. Daniel Hunt (cornetist), will all contribute to the programme.

oooo

Braille Readings.

In order to show the difference between the reading from Braille of a man who has been blind from birth and a man who has been blinded in the War, and has therefore had only a few years of study, a demonstration will be given by Mr. Henry E. Dollett and Mr. Rupert Graves (late 3rd Toronto Regiment).

oooo

An Unfounded Rumour.

A statement recently appeared in a weekly wireless paper (not *The Wireless World*) to the effect that in spite of the building extension that has recently taken place at Savoy Hill, the accommodation is still inadequate and the B.B.C. is already considering removal to other premises. The old story that the Company has under consideration the purchase of Covent Garden Opera House, wherein broadcasting will take place, while around it a pile of magnificent new offices will be erected, has also been resuscitated. These rumours have no foundation in fact. B.B.C. headquarters will remain at 2, Savoy Hill.

oooo

Studio Parties.

A radio Saturday night will be held on November 21st. An informal party will take place in the studio that evening, with Mr. Donald Calthrop as the genial host. This will be the first of a series of Saturday night parties which will be the means of introducing all kinds of pleasing musical and other features.

oooo

An Unfortunate Accident.

Some ten million accumulators are in use in this country, and the one-in-ten-million chance has happened. It appears that a fire was caused in a Kentish cottage through the accumulator of a receiving set bursting into flames. A witness stated that he knew from experience that a short circuit generated heat in the wire, making it red hot. If such a wire fell on the celluloid container of the accumulator, it would cause it to burst into flames.

oooo

A Minimum of Danger.

A needlessly alarming attempt has been made to use this unfortunate accident as the occasion for magnifying the so-called dangers of the wireless receiving set. Dangers lurk around us in almost every phase of life. We do not refrain from travelling because of the perils of the road; and yet the percentage of danger is much more evident than in the simple receiving set.

oooo

Joseph Conrad Anniversary.

December 6th is the anniversary of the birthday of Joseph Conrad. Mr. H. M. Tomlinson will broadcast an appreciation of the great writer of sea stories on that day, and Mr. Ben Davies is to sing to listeners.

oooo

Life-Saving at Sea.

Accounts of some thrilling lifeboat rescues will be broadcast by Mr. William Adams, an old lifeboatman from Deal, on the birthday anniversary of Grace Darling (November 24th). Mr. Adams, who is seventy-six years of age, was for many years coxswain of the Deal lifeboat. He has been engaged in lifeboat work for about fifty years, and holds medals galore for life-saving, including one from the Italian and Esthonian Governments respectively, and also a gold watch and chain from the President of the United States. Mr. Adams' talk on his reminiscences will be "racy of the sea," and appropriate to the speaker.

oooo

Mussolini May Broadcast.

The B.B.C. hope to be able to make arrangements for a message from Signor Mussolini to be relayed by the Keston receiving station from Rome on Sunday, November 29th, when a Puccini recital is to be broadcast from the London studio as a tribute to the great Italian composer's memory.

oooo

Broadcast Plays.

The dramatic broadcasts which have been given recently from the studio show the need of explanatory assistance for the listener, to link up the plot. The explanation must, in the case of plays not specially written for broadcasting, be very ample if the listener is to be brought into that attentive frame of mind which will enable him to appreciate great works. Flecker's wonderful "Hassan" is a case in point. Probably thousands of listeners on that recent Sunday afternoon when this play was transmitted from the London studio, found it no easy matter to follow the story, in spite of the forceful and dramatic interpretations of Miss Cathleen Nesbitt, Mr. Henry Ainley, and the rest of a brilliant cast. There is much work for the dramatic department of the B.B.C. in future broadcasts of this character.

oooo

"The Mouse Contretemps."

Since we gave publicity to the tragic fate which overtook the mouse who succeeded in stopping broadcasting from 5XX for twelve minutes, the B.B.C. engineers have received much excellent advice on how to prevent a repetition of this contretemps.

A Leeds firm, however, did not waste time on mere words; they adopted the eminently practical course of sending along two dozen mouse traps, which have been used very effectively, a family of six having been caught in one night.

FUTURE FEATURES.

Sunday, November 22nd.

LONDON.—3.30 p.m., Saint Cecilia's Day: A Programme by Blind Artists relayed from the National Institute for the Blind. 9.15 p.m., Harry Purcell's Music.

BIRMINGHAM.—9.20 p.m., Radio Fantasy, "Echo."

BOURNEMOUTH.—9.15 p.m., Brahm's "Requiem."

CARDIFF.—9.15 p.m., Symphony Concert.

Monday, November 23rd.

LONDON.—8 p.m., Cecil Sharpe Commemoration Programme. 9.30 p.m., Opening of the Oxford Studio.

BIRMINGHAM.—8 p.m., Community Singing Concert, relayed from the Town Hall, Birmingham.

CARDIFF.—8 p.m., "The Importance of Being Earnest," a Comedy by Oscar Wilde.

NEWCASTLE.—10.30 p.m., Novocastrian Night, 1.

BELFAST.—8 p.m., Derry Night.

Tuesday, November 24th.

LONDON.—8 p.m., Wagner: Symphony Concert conducted by Albert Coates.

MANCHESTER.—1.15 p.m., The Brodsky Quartet, relayed from the Tuesday Midday Society's Concert at the Houldsworth Hall.

Wednesday, November 25th.

LONDON.—8 p.m., Round the Continent." 9.15 p.m., Speech by H.R.H. the Prince of Wales, in aid of the N.S.P.C.C.

BIRMINGHAM.—9 p.m., Chamber Music.

BOURNEMOUTH.—9.15 p.m., "Radio Radiance" (5th Edition).

NEWCASTLE.—9.30 p.m., "The Philosopher and the Lady," a Song Cycle by Easthope Martin.

Thursday, November 26th.

LONDON.—9 p.m., "Radio Radiance" (9th Edition).

CARDIFF.—7.55 p.m., First Concert, 28th Season, The Newport Choral Society, relayed from the Central Hall, Newport.

GLASGOW.—8 p.m. Empire Phono-Flight, No. 6, "India."

Friday, November 27th.

MANCHESTER.—8 p.m., Lancashire Talent Series, 1—A Contribution by Bolton.

ABERDEEN.—8 p.m., Mendelssohn Night.

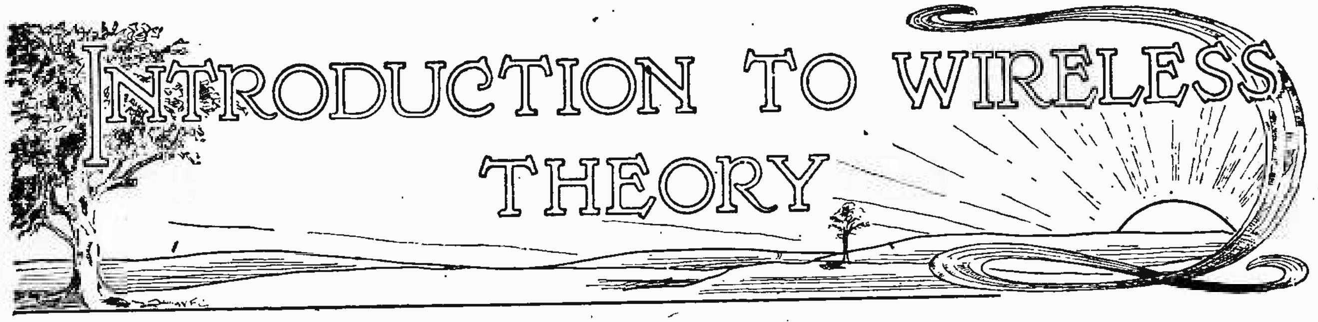
GLASGOW.—8 p.m., "The Pied Piper," by Richard Benyon.

Saturday, November 28th.

LONDON.—8 p.m., A Saturday Night Party: Donald Calthrop as Host.

BIRMINGHAM.—9 p.m., Ballad Concert.

BOURNEMOUTH.—8 p.m., Winter Gardens Night.



Electrical Condensers and Alternating Currents.

By N. V. KIPPING and A. D. BLUMLEIN.

WE have so far discussed two of the three fundamental properties of an electrical circuit which control the current which flows. These are resistance and inductance. The third is capacity, and to explain this we must introduce an elastic membrane into the pipe in the water analogy as in Fig. 1, in which the pipe is entirely blocked by the diaphragm.

Written specially for the beginner, these articles have dealt in previous issues with the elementary theory of direct currents and the magnetic phenomena associated with them. The articles of necessity cover only a limited field, but with the introduction which they provide it will be possible for the amateur to understand the more specialised articles which appear in this journal from time to time.

If the paddle is not rotated the elastic diaphragm will be flat, and will exert no pressure on the water, but if we start to rotate the paddle, the pressure exerted by it will stretch the diaphragm a certain amount in the direction in which the water tends to flow. When the paddle is first rotated the water flows during the moment in which the diaphragm is stretching, but as soon as the diaphragm is stretched as far as the pressure exerted by the paddle will force it, water ceases to flow altogether.

If the rotation of the paddle is then stopped the diaphragm, in restoring itself to its normal position, momentarily forces water to flow backwards round the pipe. If a pipe contains a diaphragm, water can only flow for the instant that the diaphragm is stretching or restoring itself. The greater the force exerted by the paddle, the greater will be the stretching of the diaphragm, and the greater will be the momentary rate of flow of water in stretching it.

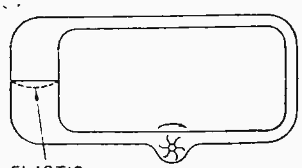


Fig. 1.—The action of an electrical condenser is analogous to that of the elastic diaphragm in the above hydraulic circuit.

The Action of a Condenser.

The important thing to remember about the diaphragm is that as well as its *total degree* of stretching, its *rate* of stretching depends upon the force exerted by the paddle, and that the rate of flow of the water, therefore, also depends on the force exerted by the paddle. When the diaphragm first begins to stretch, the rate of flow of water is considerable, but this grows less and less as the diaphragm reaches the limit of its stretch.

The electrical analogy for the small length of pipe containing the diaphragm is a condenser. The electrical property of a condenser is called capacity, and is determined by its dimensions and elasticity. An electrical condenser consists of two conductors separated by an insulating material, corresponding to the two lengths of pipe containing water, separated by the elastic diaphragm. It will be seen that the effect of the momentary flowing of water will be greater when the diaphragm has a large area and is thin, because its volume, or capacity, when stretched by a certain force will then be greater than for a thicker or smaller diaphragm. In the same way an electrical condenser will only have appreciable capacity if the two conductors are of large area, and are separated by a thin layer of insulating material. Electrical condensers are therefore made as a rule of thin sheets of tin or copper separated by waxed paper or mica, or in some cases by air. The sheets of metal are usually termed the plates of the condenser, and the insulating material is termed the dielectric.

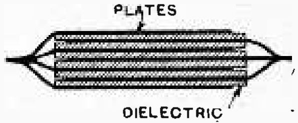


Fig. 2.—Construction of an electrical condenser.

If a condenser is connected across the terminals of a battery, current flows momentarily while the condenser is "charging," as it is called. If the battery is then disconnected and the condenser connected across a resistance or short-circuited, it will force current to flow in the reverse direction momentarily—or it will "discharge." In the case of short-circuiting a charged condenser a very large current is produced momentarily. If on disconnecting the condenser from the battery it is not short-circuited, the condenser slowly discharges through the high resistance of the air between its terminals, or through its own dielectric, which can never be made a perfect insulator.

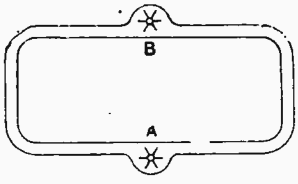


Fig. 3.—Hydraulic circuit illustrating the transfer of energy by direct and alternating currents.

The construction of a typical type of condenser is shown in Fig. 2, which is a diagrammatic view of a cut through a condenser. To obtain a large area of plate in a reasonable space the

ntroduction to Wireless Theory.—

interleaving arrangement shown is usually adopted. The capacity of a condenser is usually measured in micro-farads, abbreviated *mfd.*

So far the currents with which we have dealt have all been what are called direct currents (abbreviated D.C.). The other types of current which occur are called alternating currents (abbreviated A.C.). The best way to understand the fundamental difference between D.C. and A.C. is to imagine a water-pipe containing two paddles, each free to rotate as in Fig. 3.

Direct and Alternating Currents.

The real use to humanity of electrical energy, as of other kinds of energy, lies very largely in the fact that it can be conveyed from one place to another, either for signalling (telephones, wireless, etc.) or for power purposes (heating, lighting, traction, etc.).

Similarly, by means of the water in the pipe (Fig. 3) energy can be conveyed from A to B, or from B to A. If the paddle A is rotated continuously the flow of water produced will cause the paddle B to rotate continuously, thus transferring the energy applied to the paddle A to the paddle B, which may be used to drive something. This system of working corresponds to direct current working.

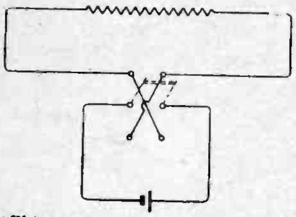


Fig. 4.—Switching arrangement for reversing the direction of current in a circuit

Now if the paddle A is not rotated continuously in one direction but is turned first in one direction, then in the other, and so on, then the paddle B will be caused by the flow of water to do the same. That is to say, an oscillating movement in the paddle A will produce an oscillating movement in the paddle B, which may then be used to drive something; its oscillating motion still represents a source of energy, as a mechanical device can be used to convert it to some more convenient movement. This oscillating means of transferring energy is analogous to alternating current working. It may not at once be obvious how this form of current which flows first one way then the other can be made use of; this will appear later, but it will be interesting to notice that a rubber diaphragm inserted in the pipe will not prevent the transfer of energy by the oscillating arrangement, although except for the first kick it prevents the continuous rotation arrangement. That is to say, A.C. can flow through a condenser although D.C. cannot. But this is rather out of place here, and is simply quoted to illustrate the essential difference between D.C. and A.C.

Frequency.

Besides alternating currents it is, of course, possible, in fact, essential, to have alternating e.m.f.'s (and voltages). An alternating current can be produced by the simple process of making the voltage of a battery alternate—that is, push first in one direction, then in the reverse direction—by means of a reversing switch connected to the battery and a wire as in Fig. 4.

In this figure the switch is of the type known as double pole, double throw (D.P.D.T.), so that the middle contacts may be connected either to the corresponding upper contacts or lower contacts. It will be seen that by changing the position of the switch the direction of flow of current through R will be reversed, as the battery connections to R are reversed.

It might be possible for a man to reverse the switch four times each second, but without machinery not much greater speed than this could be attained. This means that only A.C. of less than about two cycles per second could be obtained by this means. "One cycle" is short for "one complete cycle of events," which occurs

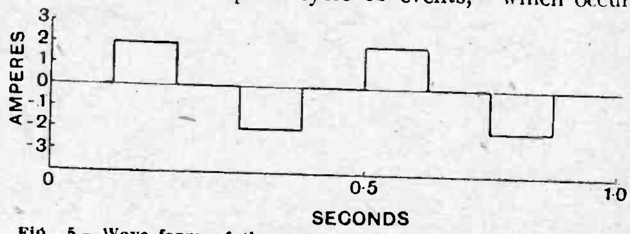


Fig. 5.—Wave-form of the current produced by the circuit in Fig. 4.

in this case when the switch has been closed and opened once on each side, so that only two cycles are completed when the switch has been closed and opened four times (twice on each side). When an A.C. goes through one cycle of events per second it is said to have a frequency of one cycle, or period, per second (abbreviated c.p.s. or p.p.s. and sometimes written ~). The arrangement of Fig. 4, then, could be used to produce a low-frequency A.C. in R, the frequency being about 2 ~.

Alternating Current Wave-forms.

In actual practice A.C. of a frequency of less than about 16 ~ is seldom used, although frequencies as high as several million c.p.s. and occasionally ten thousand million c.p.s. are employed.

In Fig. 4 the current flowing in R will be of a rather jerky nature, as each time the switch is closed the current

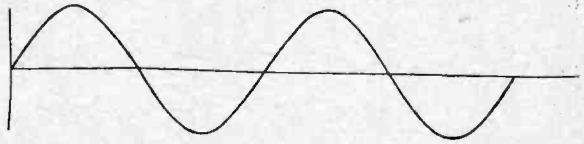


Fig. 6.—A more usual wave-form for alternating currents—the sine wave.

will rise very quickly to the value determined by the resistance of R and the voltage of the battery, and at this value it will remain constant until the switch is opened again, when it will immediately cease altogether till the switch is closed again in the other direction. In fact, the current will have the shape of Fig. 5, which is a graph of the current in R plotted against time, supposing the maximum current which flows to be 2 amperes. Fig. 5 gives a very clear idea of the shape of the A.C., as from it we can tell in what way it varied—or flowed in the two directions—as time went on.

Alternating currents do not usually have such a square shape (showing a jerky nature) as that shown in this picture, but have usually rounded corners, more like Fig. 6. For this reason we often speak of A.C. waves, or of the wave-shape of alternating currents and voltages. Fig. 6 shows that the A.C. there drawn rises slowly to

Introduction to Wireless Theory.—

a maximum in one direction, then slowly drops to nothing, and immediately rises slowly in the other direction, then drops again to nothing, completing the cycle, which it then immediately repeats. This is a state of affairs very often met with in nature. Things far more often fluctuate in this smooth manner than follow a jerky cycle. The tides are one example, the movement of a pendulum is another.

There is no need to enter into the detail of how alternating currents are commercially produced, but it may be said that the underlying principle of alternators (generators of A.C.) consists in the rotation of a coil in a magnetic field. The coil cuts lines of force first in one direction than in the other, and so alternating currents are induced in it. The wave shape is in general similar to that shown in Fig. 6.

(To be continued.)

TRANSMITTERS' NOTES AND QUERIES.

General Notes.

Mr. W. G. Dixon, the secretary, The British Section, International Amateur Radio Union, states that on October 15th signals from Australian 6AG were picked up at his station (5MO) near Newcastle-on-Tyne at 2.30 p.m. on 38 metres at good strength, and remained audible till 7.30 p.m.

The following stations have also been logged on several occasions between 2 p.m. and 5 p.m.:—PNP (Pekin) on 37.5 metres; PI1CW and NUQG (U.S.S. *Pillsbury*) in the Philippine Islands, on 38 metres and 37 metres respectively; and 2SZ (Mill Hill School) reports A3BD at 2 p.m.

On October 26th A6AG in Perth, West Australia, was heard at 3 p.m., making first contact with OA3E, South Africa. Members of the I.A.R.U. are asked to report any further stations observed during the afternoon, in order that a working schedule may be arranged with them. This has already been done in the case of the Philippine stations; the South African stations logged by 5MO are A4Z, A4B, A4L and A3E, which are only audible between 9 p.m. and 4 a.m., signals being strongest at the latter hour.

The number of Argentine stations heard in this country is rapidly increasing. Messrs. T. A. and F. C. Studley report that during the last few weeks they have heard CB8, A8, FG4, FF9, AA8, BA1, BG8, FC6, AD1, BD1, AF1, DB2, FA3, FB5, AE5, AS7 AF4, all at very good strength on an 0-v-1 receiver. They also heard Chilean 2RM when transmitting on only 3.5 watts.

Mr. N. G. Baguley (G2NB), 35, Castlegate, Newark, transmits on a wavelength of 9.2 metres on Thursdays at 10.30 p.m., and on Sundays at 11 a.m. for a period of half an hour (five-minute transmissions with five-minute intervals), and will welcome reports.

We also understand that he has established two-way communication with BER (Bermuda), working on a wavelength of 35.2 metres, and that Mr. Gerald Marcuse (G2NM), of Caterham, has worked with Mr. J. V. Brooks (7JB), of Hobart, Tasmania, at 7.25 a.m. G.M.T., which corresponds to 5.30 p.m. Tasmanian time.

Addresses of Stations Wanted.

We shall be glad if any of our readers can give us the QRA's of the following stations (in some cases it is inadvisable to publish the names and addresses, but any replies indicating that publication should be withheld will be communicated, in confidence, to the enquirers).

K4VL, NB7, NPAX, S2NO, G6YV, G5BG, G2EL, G5DK, CHRML, COS2, F8LZ, NOKG, NSTB, PCJJ, P1RK, S2CO.

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Stations Identified.

We have received from correspondents, to whom we tender our thanks, the following QRA's which will probably be of interest not only to those transmitters who specifically asked for them, but to others of our readers:—Italy; 1GW. Bruno Brunacci, via Evangelista Torricelli 1 Rome, (transmitting on 17 to 50 metres). Cuba; 2BY. F. W. Borton. Galiano 29. Havana.

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New Call-signs Allotted.

G5IR. H. Field, 62, Chertsey Road, Woking.

G5JO. L. Jones, 50, King Street, Cambridge (in place of 2ARY).

G5JD. J. L. Wood, Stanhurst, Burntisland, Fife.

G6MW. Lt.-Col. C. W. Thomas, Clifton House, Old Swinford, Stourbridge.

Calls Heard.

Extracts from Readers' Logs.

Harrow.

(Sept. and Oct.)

New Zealand: 1AX, 1AO, 2AE,, 2AC, 2AQ, 2XA, 3AM, 3AO, 4AG, 4AR, 4AK, 4AC, 4AL, 4AV, 4AS. Australia: 3BD, 3BQ, 3EF, 2DS, 2LO, 2YI, 2CM, 2GA, 2TM, 2BK, 2JW, 5BG, 6AG. Argentine: AF1, FG4, BA1, BD1, CB8, AF4, DB2, FA3. Brazil: 1AB, 1AP, 1AC, 1AF, 2SP, RGT. U.S.A.: 6VC, 6CF, 6CGW. Mexico: 1B, 1K, 1AA. Chili: 2LD. India: HBK. South Africa: OA4Z. U.S.A. ships: WAP, WNP, NVE, NISR (New Borneo), NISP.

(0-v-1.) F. C. and T. A. Studley.

Cambridge.

(Oct. 10th to 29th.)

Great Britain: 2YS, 5IV, 5PM, 5UO, 6BD, 6YU. U.S.A.: 4AV, 4LL, 4RM, 5YD, 6CTO. Brazil: 1AB, 1AF. Norway: LA4X. Italy: 1GW, 1BB. Spain: EAR20. Mexico: 1X, 1K. Morocco: MAROC. Sweden: SMRY. Argentine: AF1, BA1, BG8, CB8, DH5, DM9, FA3. Australia: 2CM, 2JW, 2TM, 2YI. New Zealand: 1AO, 1AX, 2AC, 2AE, 2BR, 2XA, 4AC, 4AR, 4AS.

(0-v-1 Reinartz.) All below 50 metres.

F. G. Turner.
(G. 2ANO.)

South Norwood, S.E.25.

Australia: 2CM, 4RT, 2YI, 3EF, 5BG, 3BD, 3BQ. New Zealand: 4AL, 2XA, 4AK, 4AG, 1AT, 2AC, 1AB, 2AE, 4AA, 4AR. Miscellaneous: RCB8, R2LZ, NRRL, WNP, M1DH.

(0-1-1.) 5-90 metres.

J. H. D. Ridley.
(G5NN.)

Mombasa.

(Aug. 26th to Oct. 1st.)

U.S.A.: 1PL, 1BYX, 1KA, 1ARH, 1ACI, 1UW, 1AAG, 1CMP, 1AAP, 1KMF, 1BZP, 1CMU, 1CAW, 1CMY, 1AXA, 2CFT, 2LU, 2BGI, 2WR, 2AGB, 2AHG, 2BEE, 2CXL, 2XBB, 2CR, 2APV, 2AHM, 2BBX, 2CXD, 3AFQ, 3ABJ, 4ASK, 4SI, 4DA, 5NJ, 5HE, 5SD, 5AA, 5EW, 5MS, 5VA, 5ZAI, 5BG, 5DQ, 5UK, 5JD, 6AFF, 6CGW, 6BUC, 8BEN, 8AVL, 8DAL, 8EG, 8BHM, 8SF, 8JQ, 8EQ, 8BRC, 8TX, 8BQI, NKA, NKF, WIZ, WQN, WQO, WIR. Great Britain: 2RZ, 2LZ, 5DH, 2IZ, GCS, GHH. Australia: 3BD, 5BG. Cuba: 2MK, 2BY. Italy: 1MT. Palestine: 6ZK. Sweden: SMYY. Java: ANE. Russia: RDW. Miscellaneous: 8FY, NOBQ, 1ANQ, 5ZAI, 9XN, W8PL, W1CEE, NPO, OCDB, 8BC, RFRL, MIDH, PCUU, OCDJ, N8ZF, OCML, RNRLL (?), MCHAF, 8FQ, 6YX, ERK1, FJL, XDA, 6XC, 1M, 9HH, NOHT, H1ER, AG3, FW, POF, 3AUV, WAP, WNP.

(0-v-1.) 35 to 50 metres.

L. J. Hughes.
(KY 1VP.)

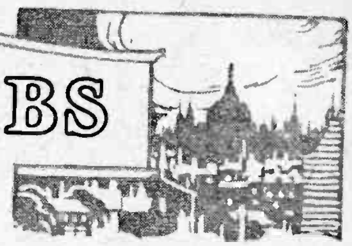
Lowestoft.

Oct. 7th to Nov. 1st, 1925.

British: 2AWL, 2DX, 2FO, 2JB, 2PO, 2VL, 5DH, 5GS, 5KO, 5WQ, 5XO, 6BD, 6QB, GCS, GHA (Malta). French: 8DK, 8DT, 8GW, 8IX 8QR, 8RA, 8TO, 8UDI, 8VX, 8WZ, 8ZB. Dutch: NOHB, OCTU, PCMM. Swedish: SMXG. Danish: D7ZM. Belgian: X3. Finnish: S5DF. Irish: 11B. Czecho-Slovakian: OK1. German: KXH, LPZ. Spanish: EAR 20. American: WIZ, WNM. Unknown: Y8. P. L. Savage

(0-v-1) All below 100 metres. (G2MA).

NEWS from the CLUBS



Secretaries of Local Clubs are invited to send in for publication club news of general interest. All photographs published will be paid for.

Sheffield and District Wireless Society.

In his Presidential Address, on October 23rd, Mr. W. Burnet, the new President, dealt with the aims of a wireless society, which should be to make wireless development as democratic as possible and to instruct and direct public opinion on the subject.

The speaker then dealt with the importance of radio measurements, in the perfection of which lay the design of the apparatus of the future. He considered that the ideal set for the public would be found to consist of three valves only, working with a frame aerial and obtaining current from the supply mains for both filament and plate. Such a set should combine simplicity, efficiency and high-class components.

Hon. Secretary : Mr. T. A. W. Blower.

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Hounslow and District Wireless Society.

The society is installing broadcast receiving apparatus at the Hounslow Hospital. To meet the expense involved a "Hospital Wireless Fund" has been started in the district.

Hon Secretary : Mr. A. J. Myland, 219, Hanworth Road, Hounslow.

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Lewisham and Bellingham Radio Society.

The humours and uncertainties of an impromptu debate were enjoyed on November 3rd, the lecture on "Low Loss Coils" having been postponed owing to the indisposition of the lecturer.

Members now have access to experimental apparatus, including a transmitter, and those in difficulty are able to go to the Technical Adviser for help.

Several members are actively engaged in collecting funds for the supply of broadcast receiving apparatus to the local Hospital.

Hon. Secretary : Mr. C. F. Tynan, 62, Ringstead Road, Catford, S.E.6.

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Streatham Radio Society.

Mr. W. K. Alford delivered an interesting lecture on "The Superheterodyne Receiver" at the Society's meeting on November 5th. Much valuable information was given regarding the correct values of coils and condensers to secure efficient working, besides many practical hints for the construction and operation of this deservedly popular receiver. Attention was also given to the various methods of intermediate frequency amplification. The lecture was followed by a keen discussion, in which many members participated.

Hon. Secretary : Mr. N. J. H. Clarke, 26, Salford Road, S.W.2.

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Hackney and District Radio Society.

The meetings of this Society are now held at "Holy Trinity Institute," Mayfield Road, Dalston, E.8 (close to Dalston Junction Station).

Greater facilities for experimenting are now available, and a programme of considerable interest is being arranged.

The Society meets every Monday night at 8.

Hon. Sec., Mr. G. E. Sandy, 114, Parnell Road, E.3.

FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 18th.

Golders Green and Hendon Radio Society.—At 8 p.m. At the Club House, Willifield Way, N.W.11. "Fundamental Principles of Radio Reception," by Mr. Maurice Child.

Nottingham and District Radio Experimental Association.—Lecture: "Long Distance Reception," by Mr. Fielder, of the B.B.C.

THURSDAY, NOVEMBER 19th.

Walthamstow Amateur Radio Society.—Lecture: "Transmitting and Receiving on Short Waves," by Mr. Williams, of the G.P.O.

Chelmsford Engineering Society.—Presidential Address by Mr. H. M. Dowsett, M.I.E.E., F.Inst.P.

FRIDAY, NOVEMBER 20th.

Sheffield and District Wireless Society.—Lecture: "Formulæ, and when they fail," by Mr. J. Hollingworth, M.A.

MONDAY, NOVEMBER 23rd.

Hackney and District Radio Society.—"Vest Pocket Lectures."

Swansea Radio Society.—Members' At Home Night.

TUESDAY, NOVEMBER 24th.

Lewisham and Bellingham Radio Society.—Exhibition of Valve Sets.

WEDNESDAY, NOVEMBER 25th.

Radio Society of Great Britain.—General Meeting at 6 p.m. (tea at 5.30). At the Institution of Electrical Engineers, Savoy Place, W.C.2. Lecture: "A Review of Short Wave Development," by Captain W. G. Miles.

Ipswich and District Radio Society.

The Secretary's report, read at the Society's annual meeting on Monday, November 2nd, was a record of another successful year, although during the period under review the attendances of the members had not been all that could be desired. Generally speaking, the activities of the club have lain in the direction of assisting those confronted with wireless difficulties. On several occasions appeals for help from listeners were received through the medium of the B.B.C., and all of these were satisfactorily dealt with.

Public meetings are to be a feature of the coming session, owing to the success realised at the last meeting of this kind, when Capt. Frost, of the B.B.C., was the lecturer.

The Society's President, Mr. F. Mellor, A.M.I.E.E., was re-elected for the ensuing session, and the Hon. Secretaryship remains in the hands of Mr. H. E. Barbrook, 55, Fonnereau Road, Ipswich.

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Wimbledon Radio Society.

A complete B.B.C. control room erected at the Society's headquarters was the centre of interest at a recent meeting when Mr. R. H. Wood, of the B.B.C. staff, gave an excellent lecture on "The Engineering Side of Broadcasting." Members were able to speak into the microphone whilst the various controls were operated, the effect being heard in a pair of telephones. The evening was also profitable in another respect, for Mr. Wood answered an enormous number of questions regarding modern broadcasting practice.

The Hon. Secretary, Mr. P. G. West, 11, Montana Road, Wimbledon, S.W.20, will be pleased to forward particulars of subscriptions, etc., to prospective members.

AN INTERNATIONAL CATALOGUE.

The value of this 68-page illustrated catalogue * to the progressive experimenter may be judged from the fact that more than 50 per cent. of its space is devoted exclusively to the latest American apparatus available in this country. In this respect it is probably unique, and on examination the catalogue shows that a source of supply now exists from which the British amateur can obtain practically all the best-known American apparatus, in addition to a vast selection of attractive but less familiar lines. The pages are strewn with the (American) household names of Bremer Tully, Haynes Griffin, Silver-Marshall, Connecticut and others, and the apparatus, if it does bear an exotic appearance, is no less efficient on that account.

The British section of the catalogue is thoroughly comprehensive, and covers the products of the leading manufacturers.

* *Catalogue*, 1926. Will Day, Ltd., 18 and 19, Lisle Street, Leicester Square, London, W.C.2.

DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Frequency. The number of complete *cycles* an *alternating quantity* passes through in one second. Sometimes called the "periodicity." See ALTERNATING CURRENT.

Frequency, Audio-, Fundamental, Group, High, Radio, Spark, and Supersonic. See AUDIO-FREQUENCY, GROUP FREQUENCY, etc.

Frequency Band. See SIDE BANDS.

Full-wave Rectification. *Rectification* in which both positive and negative half-waves of the alternating current being rectified are made use of. Cf. HALF-WAVE RECTIFICATION and see RECTIFICATION.

Fundamental Frequency. The *frequency* of the *fundamental wave.*

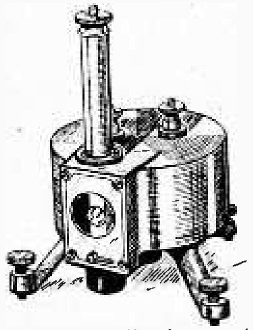
Fundamental Wave. It is well known that any *alternating quantity,* whatever the wave shape, can be resolved into a number of pure *sine waves* whose sum will give the wave shape in question. The principal sine wave obtained in this manner which has the same *frequency* as the original wave is called the "fundamental wave." The remaining sine waves whose frequencies are all multiples of the frequency of the fundamental are called "harmonics," and that harmonic which has three times the frequency of the fundamental is called the "third harmonic," and so on. In ordinary alternating currents, where both half-waves are of the same shape, no even harmonics are possible, only those whose frequencies are odd multiples of the fundamental frequency being present. However, in wireless work, where oscillations are produced by a valve or an arc, the two halves of the wave are not necessarily of equal shape, and therefore the even harmonics as well as the odd ones are usually met with. Sometimes the fundamental wave is called the "first harmonic."

Fuse. A safety device included in an electric circuit to protect it and any connected apparatus from damage should an accidental *short circuit* occur. The fuse is essentially a wire of lower current-carrying capacity than any other part of the circuit, and therefore when an excessive current flows this wire gets heated first and melts, thereby breaking the circuit and interrupting the current.

G.

Galena. A sulphide of lead (PbS) in natural crystal form commonly used as a *crystal rectifier.* Various artificially treated forms are found to be more efficient for rectifying purposes than the natural crystal. It is used in conjunction with a "catwhisker" or fine metallic point.

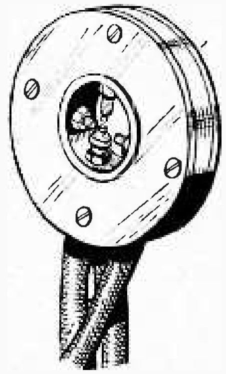
Galvanometer. An instrument for measuring currents, usually of small magnitude. See EINTHOVEN GALVANOMETER.



Suspended coil galvanometer.

Gauss. The unit of *field strength* or *flux density*; it represents a field strength of one line per square centimetre.

Generator. (1) Any machine for converting mechanical power into electrical power, such as a dynamo. (2) Any device for producing electrical oscillations from a non-oscillating source of electrical energy, *e.g.*, a valve oscillator.



Glow discharge microphone.

German Silver. An alloy of copper, zinc, and nickel used for resistance purposes. It consists of about 62 per cent. copper, 22 per cent. zinc, and 16 per cent. nickel, giving a *specific resistance* of about 27 microhms per cm. cube at 15 degrees Centigrade. Increasing the percentage of nickel gives a higher value of specific resistance.

Glow. See BLUE GLOW.

Glow Discharge Microphone. A microphone in which the current to be modulated passes in the form of a *glow* discharge between two electrodes. The modulation is produced by the direct action of the sound waves on the air through which the discharge is taking place.

Goniometer, Radio. See DIRECTION FINDER.

Grid. The wire spiral or wire gauze auxiliary electrode between the *plate* and filament of a three-electrode *thermionic valve.* See THREE-ELECTRODE VALVE.

Grid Bias. Refers to the potential which is imparted to the *grid* of a *three-electrode valve* with respect to the *potential* of the negative leg of the filament (usually taken as zero), *i.e.*, it is the number of volts by which the potential of the grid is above or below that of the negative end of the filament. When the potential of the grid is negative it is said to have a "negative bias."

Grid Circuit. That part of a valve circuit which is connected between the *grid* and *filament* of a *three-electrode valve.* Cf. PLATE CIRCUIT.

Grid Condenser. A condenser usually of fixed *capacity,* connected in series with the lead which joins the *grid circuit* to the *grid* of a *three-electrode valve.* It may serve one of two purposes: (*a*) To give a suitable negative bias to the grid of an oscillating valve, especially when used for transmitting purposes; (*b*) to produce a rectifying effect on the grid side of the valve, for which see GRID RECTIFICATION. See also GRID LEAK, GRID BIAS.

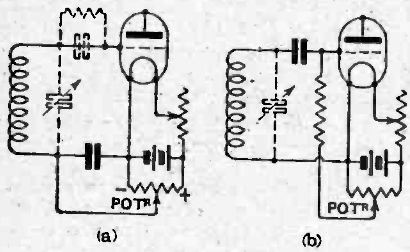
Grid Current. The current which passes between the filament and the *grid* of a *three-electrode valve.* When the *grid* of a *three-electrode valve* is given a positive potential with respect to the filament, it attracts and traps some of the *electrons* being emitted from the filament, so that in effect a current flows

Dictionary of Technical Terms.—

between the grid and the filament, this current being the grid current. If the grid potential is made zero or negative with respect to the negative end of the filament, it does not attract any electrons and no grid current flows. Grid current represents a loss of energy and is detrimental to sharp tuning, whereas on the other hand grid current is often made use of to prevent *self-oscillation* (see Grid Potentiometer) and forms the basis of *grid rectification*.

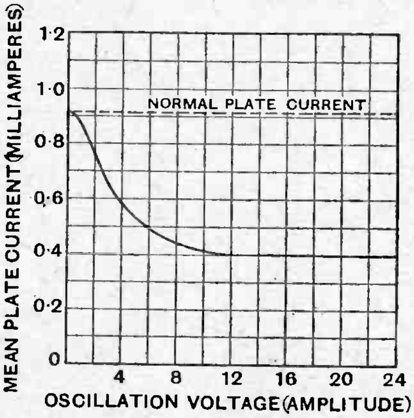
Grid Leak. A high resistance connected in parallel with the *grid condenser* in a valve circuit. It is included to prevent the *grid* from accumulating excessive static charges or to assist in the process of *grid rectification*. Sometimes the grid leak is connected between the grid and the negative or positive leg of the filament, or to the slider of a *grid potentiometer* connected across the filament battery. See Grid Rectification.

Grid Potentiometer. A *potentiometer* arranged to enable the grid potential or *grid bias* to be critically adjusted. The potentiometer is usually connected across the filament battery. If the grid circuit does not contain a *grid condenser* it is connected between the slider and the grid as shown at (a). If a grid condenser is included the connection to the potentiometer depends on the arrangement of the *grid leak*. If the grid leak is in parallel with the grid condenser, the connection will be the same as the case already considered. If the grid leak is not in parallel with the grid condenser, the connections must be as shown at (b), the leak being connected between the grid and the slider of the potentiometer. Variation of grid potential by this means is often employed for controlling the *self-oscillation* of a receiver which has a tendency to spontaneous self-oscillation, oscillations being damped out by the *grid current* which flows when the grid potential is made positive with respect to the negative end of the filament.



Alternative connections of grid potentiometer.

Grid Rectification. Refers to the method of using a *three-electrode valve* for the detecting of high-frequency oscillations, based on the *unilateral conductivity* of the grid to filament circuit inside the valve. A small condenser of the order of 0.0003 microfarad is connected in the grid lead, and the oscillations are applied to the grid through this condenser. Owing to the fact that current can flow from the grid to the filament and not in the reverse direction (see Grid Current), a charge of negative electricity is accumulated on the grid side of the condenser when an oscillating voltage is applied between the other side of the condenser and the filament, thus reducing the value of the *plate current*. It is necessary for this charge to leak away as soon as possible when the applied oscillation ceases, bringing the plate current back to its normal value. For this purpose a high-resistance leak, called a *grid leak*, is connected directly across the condenser or from the grid side of the condenser to one leg of the filament. Thus the average value of the plate current will vary according to the amplitude of the signal oscillation applied to the grid. This system is much more sensitive to weak signals than *anode rectification*. Compare Anode Rectification.



Typical grid rectification characteristic.

Ground. Another term sometimes used for "earth."

Group Frequency. The number of separate trains of waves per second in spark or *damped* wave transmission.

H.

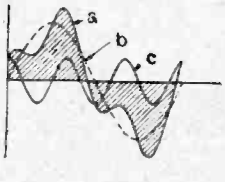
"H." The usual symbol for magnetic *flux density* in air, or *magnetising force*. See B-H Curve.

Half-wave Rectification. *Rectification* in which only the positive (or negative) half waves of the alternating current being rectified are made use of. Cf. Full-Wave Rectification and see Rectification.

Hand Capacity Effect. In some short-wave receivers the electrostatic *capacity* between the hand of the operator and various parts of the circuit may be sufficiently large to alter seriously the tuning of the circuit when the hand is moved and to make receiving difficult, if not impossible. Various devices are employed to eliminate this effect, such as extension handles to the controls, and *screening*.

Hard Valve. A *thermionic valve* which is exhausted to a very high degree so that there are very few molecules of gas left in the bulb. In a hard valve the *plate* to filament current inside the valve takes the form of almost pure electronic emission from the filament as opposed to partial conduction through *ionised* gas in a *soft valve*. The life of a hard valve is longer and the characteristics are more stable than those of a soft valve. Cf. Soft Valve.

Harmonics. The component sine waves in an irregular wave form (of alternating current, etc.), the frequencies



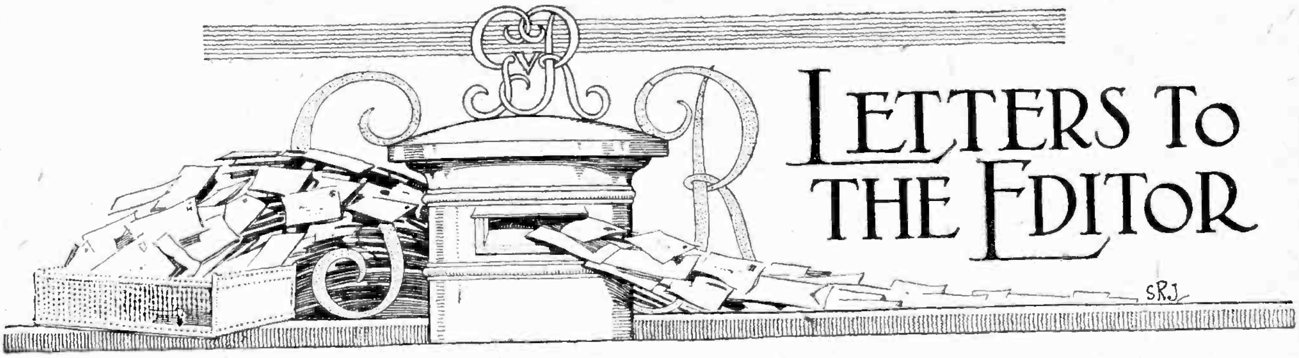
Resultant curve *a* produced by the combination of a sine curve *b* and its third harmonic c.

of which are some multiple of the main frequency. Any irregular wave form is equivalent to a *fundamental* sine wave, of frequency equal to that of the actual wave, and a number of "harmonics" whose amplitudes are usually less than that of the fundamental wave. That harmonic which has a frequency of, say, three times that of the fundamental is called a "third harmonic." For further explanation see Fundamental Wave.

Heaviside Layer. The upper rarefied stratum of the earth's atmosphere is supposed to be *ionised* and to be in consequence a more or less good conductor of electricity. This conducting layer is known as the "Heaviside layer," and apparently accounts for the transmissions of long-distance wireless signals round the curvature of the earth, the waves being reflected and refracted back to the surface of the earth when they strike the Heaviside layer at an angle, just as a beam of light is reflected from a mirror or refracted through a prism. The action of the sun has a marked effect on the height of the Heaviside layer above the surface of the earth, and this fact may account for the great difference in the strengths of day and night transmissions. It has been discovered lately that very short waves (below 30 metres) are more effective in daylight than during the dark hours, just the reverse effect as compared with medium and long waves, being thus at variance with the generally accepted theories of day and night transmission based on the changing of the Heaviside layer.

Henry. The practical unit of *inductance*, either *mutual inductance* or *self-inductance*. For definition see Coefficient of Self-Inductance and Coefficient of Mutual Inductance. See also Inductance.

Hertzian Waves. The electric waves employed in wireless telegraphy, etc.; named after Hertz, who first demonstrated their existence practically, although they had been previously predicted by Maxwell as a result of his mathematical investigations.



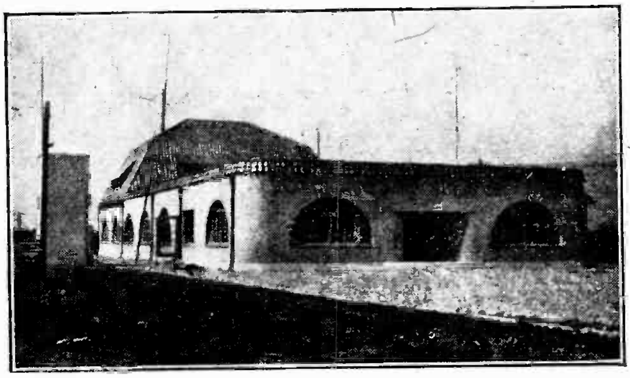
LETTERS TO THE EDITOR

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.

J-1AA TOKIO.

Sir,—I was very glad to find the report on page 222 in *The Wireless World and Radio Review*, August 19th, 1925, that the signals from the station J-1AA were picked up for the first time in your country by Mr. S. K. Lewer (G-6LJ), of West Hampstead. J-1AA is the temporary experimental short-wave station of the Department of Communications, and is not amateur, as



A general view of the Iwatsuki short-wave station (J1AA), controlled by the Japanese Department of Communications.

was stated in the above issue. The transmitters and receivers are at Iwatsuki Radio Receiving Station, Saitamaken, near Tokio (about 30 kilometres apart). As I have been engaging in the erection of the station and short-wave tests, I am sending you a brief description as follows :—

A.—Transmitters.

No. 1.—Wavelength, 40, 20, and 14.6 m.
Valves : One MT-4 (Marconi).
Aerial : Inverted L. Height 15 m., length 15 m.
Counterpoise : 3 wires each 3 m. long.
Radiation : 1.5 amps.

No. 2.—Wavelength, 36 m.
Valves : Two UV-204 (G.E.).
Aerial and counterpoise : Same as No. 1.
Radiation : 2 amps.

No. 3.—Wavelength about 5 m.
Valves : Two UV-203 (G.E.).
Aerial : 15 m. vertical copper tube.
Radiation : 1 amp.

B.—Receivers.

Wavelength : 5 to 100 m.
Circuit : Low loss grid and plate tuning.
Valves : Detector and one L.F. amplifier.

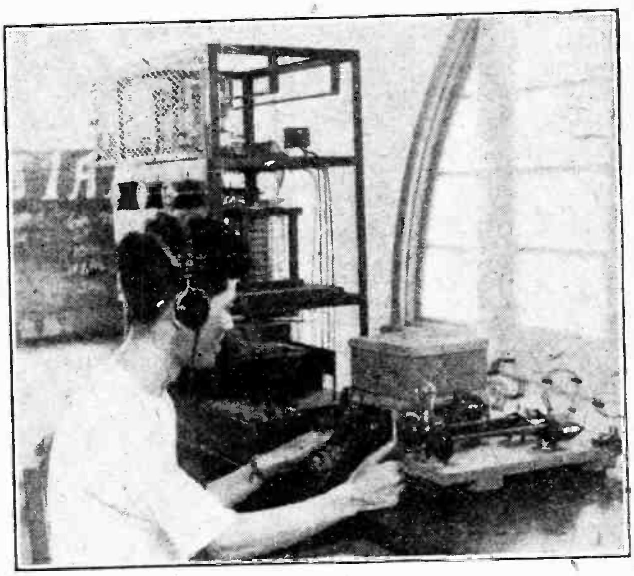
We started the short-wave tests in the beginning of this year. The longest distance communication was recorded during August with BA-1 at Buenos Aires, Argentine, this country being the farthest in the world from our land (about 18,000 kilometres).

Signals from all other Continents, Europe, Africa, Australia, and North and South America also reach us; as an example, 2BR and 2YT in your country, and 2NM, 2DSS, 2LZ, also 2XAF in daylight on 20 metres.

As our transmissions were picked up both in London and New York, I believe two-way communication on short wave should be possible, and that it will be done within a few months. J-1AA usually listens-in from 20.00 to 08.00 G.M.T. on 20 and 40 metres, so I should appreciate it if English amateurs would call the station in the Far East in the night.

The accompanying photographs of J-1AA will, I hope, be of interest.

D. ARAKAWA.
Radio Engineer, Department of Communications, Tokio, Japan.
October 10th, 1925.



An operator at J1AA.

PORTUGUESE SHORT-WAVE TRANSMISSIONS.

Sir,—The many experimenters in this country who are devoting their attention to the ever-increasing interest in short-wave work may like to know that several Portuguese amateurs are to be heard on about 50-60 metres.

The pioneer Portuguese amateur Station P1AB, already reported as having been logged in England on 5.263 kc. (57 metres) on October 25th at 23.00 G.M.T., is operated by Mr. Alvaro Contreiras, Editor of *T.S.F. em Portugal*, 50-66 Rua do Seculo, Lisbon, who will be pleased to receive direct, or

The operating room of the Iwatsuki station.

through myself, QSL cards or reports as to his QST transmitted between 23.45 and 1.00 G.M.T. on the 9th-10th instant.

As the call QST DE P1AB, sent at regular intervals, was to be followed by two words, probably expressive of greetings, in the Portuguese language, I should be extremely glad to know whether any English amateur has succeeded in logging same, even in a mutilated condition, in which case I should like to have details as to the strength of signals received, etc.

The writer would be equally interested to know whether any other Portuguese amateur stations, such as P1AA, P1AC, P1AE, P8AM, etc., have recently been heard or recorded in this country.

As it is frequently impossible to advise the technical press in time for publication of any intended calls to be made by the Portuguese transmitting stations, the writer will be happy to forward details of such transmissions, as soon as received from Portugal, to any interested amateur who will kindly send a stamped envelope to the address hereunder.

Requesting you to accept, and to convey to your readers, the heartfelt greetings from the amateurs of the "oldest ally of England," I wish your invaluable publication every success.

A. C. M. DE CARVALHO,
Representative of *T.S.F. em Portugal.*

25, Crewdson Road,
Brixton Road, S.W.9. November 10th, 1925.

NORWEGIAN LOW POWER TESTS.

Sir,—The following details of low power tests at my station LA1A may perhaps be of interest:

On October 31st, 1925, between 14.30 and 15.15 G.M.T., tests were carried out with Swedish SMWF, Stockholm, on power input 8.64 watts down to 0.24 watts My wavelength was about 42 metres. SMWF was using a 2-valve receiver and indoor aerial. The distance from here to Stockholm is about 1,000 kilometres. The results were as follow:

High-tension.	Anode current.	Input.	Strength.
240 volts	36 milliamps.	8.64 watts	R4.
180 ,,	26 ,,	4.68 ,,	R3.
120 ,,	14 ,,	1.68 ,,	R4.
60 ,,	4 ,,	0.24 ,,	R2-R3.

Particulars at my transmitting station during tests:—Circuit: Coupled. Valve: One LS5. High-tension: Dry batteries, units of 60 volts. Aerial: One wire, 30 metres long, 23-14 metres high. Counterpoise: One wire, 10 metres long, 2 metres above level.

Moen i Maalselv is situated in the Maalselv valley, 60 kilometres south of Tromsoe. (Location: Latitude 69° N., longitude 19° E.)

On November 1st, 1925, at 19.00 G.M.T., communication was established and tests carried out with English G6MP (Alton, Hants) on power inputs down to 2.1 watts on a wavelength of 40 metres. Strength, when using an input of 2.1 watts, was reported as R3-R4 on a 3-valve receiver. The tests were not completed when the northern lights appeared, followed by strong earth currents, completely wiping out the signals from G6MP, so I had to close down. The distance from here to London is about 2,200 kilometres. J. DIESEN (LA1A).

Moen i Maalselv,
Norway. November 2nd, 1925.

DX WITH THE PHILIPPINES.

Sir,—The following DX record will probably interest you. Yesterday afternoon between 2.30 and 4.0 p.m., G.M.T., I was in two-way communication with the Philippine Islands. This is the first two-way wireless communication between th country and the Philippines.

The station I was working with was Pi—IHR, at Fort McKinley, Manila, P.I., Operator Master Sgt. Angel D. Maningas, 12th Sig. Coy., U.S. Army.

QSL cards should be sent to Sig. Officer Hayden P. Roberts, Fort McKinley, Manila, Philippine Islands.

The remarkable part is that the communication took place in broad daylight, on the 40 metre band. His signals were very strong on two valves, and he reported my signals also strong and on a very steady pure C.W. note.

I was using about 400 watts power on two type T/250 Osram valves. F. A. MAYER (G2LZ).

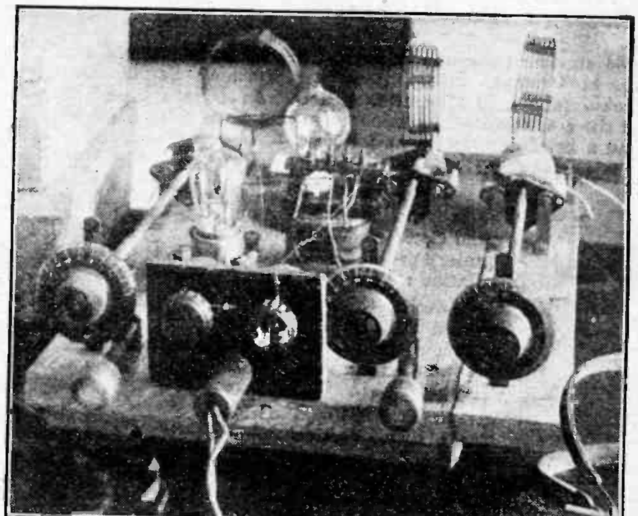
Wickford, Essex. November 10th, 1925.

INTERFERENCE FROM NORTHOLT.

Sir,—I noticed another complaint in the November 11th issue of *The Wireless World*, of the interference from the Northolt station. I have noticed for some time bad interference on 40 metres. Since it is exactly similar to that which I experience on the broadcast band I presume this to be due to Northolt. Since it is impossible to read any but the strongest signals (such as 5DH, the Post Office Research Station) I am seriously hampered in my study of the meteorological effects on long-distance reception.

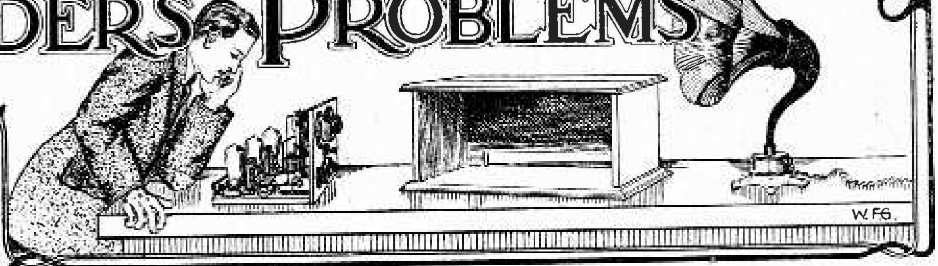
There must be many others who are being inconvenienced by Northolt, and while such a state of affairs exists short-wave progress will be retarded. Therefore it is not good enough that the Post Office should stop their improvements when only local stations can be received. E. J. ERITH.

Sutton, Surrey. November 11th, 1925.



The short-wave receiver, tuning from 15 to 100 metres, at Iwatsuki

READERS' PROBLEMS



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Charging Accumulators from A.C. Mains.

I wish to charge my accumulator from my house mains, which are A.C., by means of a step-down transformer and a chemical rectifier. Will you please give details of the construction of a suitable transformer and rectfier? T.R.B.

Since you do not, among other things, give us the voltage or periodicity of your mains, we can give no details of the transformer. In any case, efficient transformer design is by no means the simple matter which many people suppose, and it is often less expensive in the long run

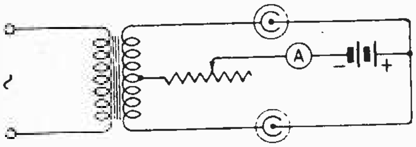


Fig. 1.—Connections of a full-wave electrolytic rectifier.

to purchase a transformer from a reputable firm. However, full details for the construction of small power transformers for all normal mains, voltages, etc., were given in the issues of this journal for August 27th and September 24th, 1924, and are also to be found in "Wireless Valve Transmitters," by W. James. With regard to chemical rectifiers, here again it is necessary to exercise great care. Speaking broadly, a voltage greater than 50 or 70 volts should not be applied to a rectifying coil, and if at any time a greater voltage is to be dealt with, it is necessary to connect a number of cells in series. Also, in the case of heavy currents, it may be more convenient to construct several small cells and connect them in parallel than to construct one cell of large plate area. Thus, in cases where a fairly heavy current at a comparatively high voltage is to be rectified, a series-parallel combination of cells might have to be used. The electrodes, which can be of lead and aluminium respectively, should have one square inch of surface to every 0.1 amp. of current, the electrolyte, which may consist of an almost saturated solution of ammonium phosphate having a volume allowance of three quarts per ampere. It is an excellent plan to pour a thin film of paraffin on the electrolyte surface in order to prevent evaporation and creeping of the solution. It is advised that full wave rectification be employed in conjunction with a centre-tapped transformer secondary, in accordance with the diagram shown in Fig. 1. It is well to point out that chemical rectifiers are somewhat malodorous and "messy," and it would be well to consider the employment of valve rectifiers, since these may now be obtained at a cost not greatly exceeding that of a bright emitter valve.

oooo

A Stable H.F. Circuit.

I wish to construct a receiver employing two H.F. stages using plug-in coils, but do not wish to make use of the neutrodyne principle. Can you give me a suitable circuit? C.E.K.

The circuit shown in Fig. 2 should be suitable for your purpose. The ordinary circuit employing two tuned anode circuits or two plug-in transformers is very unsuitable, since in the first place it is necessary to bias positively the grids to a considerable extent before stabilisation is brought about. This has the effect of very considerably reducing the H.F. amplification obtainable, and at the same time imposes a heavy load on the H.T. battery. A further disadvantage is that with two stages of H.F. carried out in this manner there are three condenser dials to adjust, in addition to the reaction coil. This renders "searching" very difficult. By adopting the method of using a choke-coupled stage in conjunction with a tuned anode stage stability is assured, although for those who wish it a potentiometer is included. It will probably be found, however, that in most cases this may be left over to the negative side. The H.F. choke may very readily consist of a plug-in coil, and on the B.B.C. band of wavelengths a 250-turn coil is quite suitable.

oooo

Simplifying the Construction of a Superheterodyne.

In the superheterodyne receiver described in your issue of July 29th I notice that two long-wave plug-in coils are used as a filter. This arrangement appears to be somewhat difficult in construction. Is there no alternative method? V.L.B.

Yes, it is now possible to obtain from the manufacturers of the intermediate transformers a suitable filter transformer specially designed to work in conjunction with the intermediate transformers used in this particular receiver.

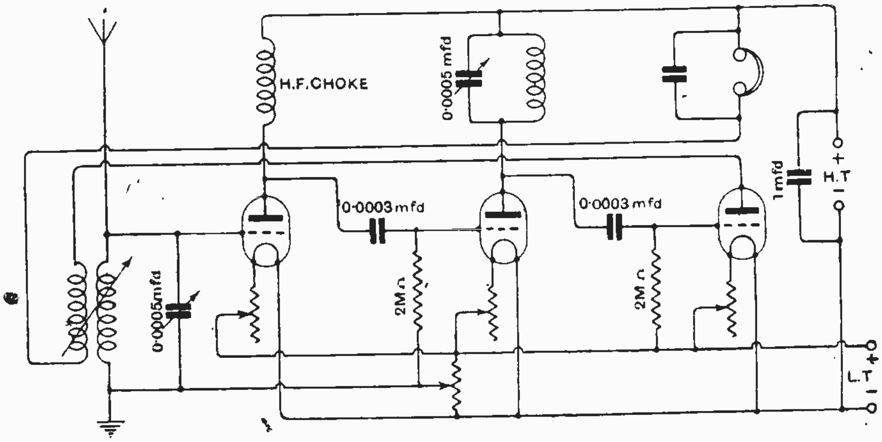


Fig. 2.—Tuned anode and choke-coupled H.F. amplification incorporated in a three-valve receiver.

Range of a Single-Valve Set.

What is the utmost range it is possible to obtain with a single-valve regenerative receiver? J.R.

This is by no means a simple question to deal with. From the point of view of reception of Morse signals, the possible range of a single-valve receiver of this type is practically unlimited, since communication has been carried out with the antipodes when using one of these instruments. In the field of telephony the range is greatly reduced, and although, of course, reception of distant broadcasting stations is of daily occurrence, it would be hazardous to give a greater range than 100 miles for consistent reception of telephony.

oooo

The Magnetic Detector.

I have recently been reading about the magnetic detector. Surely this instrument, owing to its constancy and ruggedness, would be ideal for use in the construction of a "foolproof" receiver designed for use at close range to a broadcasting station? G.J.H.

Unfortunately, although this instrument is undoubtedly the simplest and most trouble-free form of detector for use at short ranges when dealing with Morse signals, it causes distortion of telephony signals owing to its principles of operation.

oooo

"Low Loss" Switching in H.F. Circuits.

I have frequently seen it stated that switching on the H.F. side of a receiver is greatly conducive to inefficiency, but would like to be able to eliminate my H.F. valve when receiving the local station. Can you suggest an efficient method whereby this could be done, other than by using a three-coil holder? R.M.H.

Possibly one of the simplest methods of carrying out "low loss" switching in H.F. circuits is that shown in Fig. 3. The circuit diagram is more or less self-explanatory. The short-circuiting bridges are used for the purpose of bringing either one or both valves into service as required. Needless to say, it is necessary also to switch out the filament of the H.F. valve by means of the rheostat when working on detector only.

oooo

The H.T. Question.

Which source of H.T. would be the most reliable for me to adopt in conjunction with my superheterodyne receiver? I have D.C. mains at my house. H.T.A.

There are four courses open to you. Firstly, the use of dry batteries; secondly, the use of small wet primary cells; thirdly, the use of H.T. accumulators, and lastly the use of the mains. The initial cost of small-sized H.T. batteries is about 3d. per volt in the case of first-class batteries, those of inferior manufacture averaging 1½d. per volt. These batteries, however, would be of very little use from an economical point of view when used [in] conjunction with a superheterodyne receiver. The larger-sized H.T. batteries cost about 6d. per volt, but even the largest-sized ones would be uneconomical in the cases of certain types of superheterodyne whose anode current demands are large. Small wet Leclanché cells work out about 9d. per volt, and H.T. accumulators at 1s. per volt, and either type is suitable. With regard to the use of D.C. mains, it may be said that if the hum can be got out of them no better source of H.T. for L.F. amplifiers could be found. Providing that initial cost were no object it would probably be best to use large sized H.T. accumulators in all cases where a multi-valve receiver is to be used.

oooo

Controlling Loud-Speaker Volume.

Desiring to have a variable control over my loud-speaker volume, I constructed a unit consisting of a number of fixed condensers, which by means of a stud switch could be brought one by one in shunt with the loud-speaker windings. My idea was that part of the L.F. energy would be diverted from the loud-speaker windings through the condensers, and thus give me a control over volume. The only result, however, is very bad distortion. Can you explain to me where I have gone wrong? D.F.T.

The distortion which you have experienced was to have been expected, the effect of the condensers being to divert the higher musical frequencies from the loud-speaker, which has the effect of producing "muffling." The reason for this is, of course, that the impedance of a condenser varies inversely as the applied frequency. The correct method of controlling the volume of your loud-speaker would be to shunt it with a variable resistance, or alternatively to arrange to bring a number of fixed resistances in shunt by means of a stud switch.

oooo

Conditions Governing High-Impedance Valves.

Recently I have been using a two-stage resistance-coupled amplifier, the resistance being 80,000 ohms and the valves D.E.5B. Having the misfortune to burn out one valve, I substituted a D.E.Q. which I had by me. Although this valve has the same amplification factor as its predecessor, it appeared to give little or no amplification. Please explain the reason for this. T.B.D.

The reason for this is that, although the amplification factors of the two valves are identical, the impedance of the D.E.Q. valve is over three times greater than that of the D.E.5B. Consequently, in order to obtain the same volume and quality of reproduction from the former as from the latter it would be necessary to proportionately increase the value of the anode resistance, which would, of course, entail the use of a much larger value of H.T.

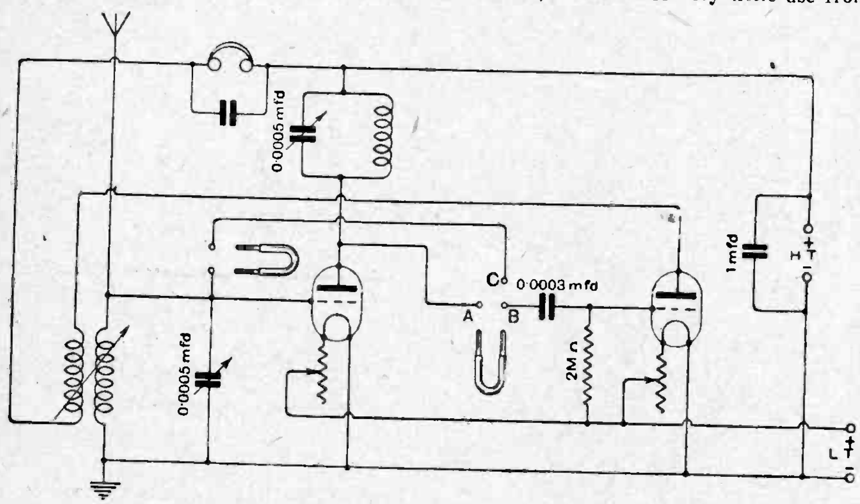


Fig. 3.—Switching H.F. receiver circuits.

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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.

WHAT TO DO WITH £125,000 A YEAR.

EVEN in these days £125,000 a year is a very substantial sum, and an amount which can produce very tangible results if expended judiciously. When it becomes common knowledge that such a sum, composed almost entirely of unearned income, has suddenly been added to the credit balance of a Government Department, it is natural that the public should be curious as to the purpose to which this windfall is being put, more especially so when the public are the contributors of the amount in question.

At the last Ordinary General Meeting of the British Broadcasting Company, held in July of this year, the amount derived by the B.B.C. from licences taken out during the preceding twelve months was disclosed, the figure being £488,881 2s. 11d., whilst the estimated revenue from this source for the following year was put down as over £500,000. This sum, as we know, has to meet the main expenditure of the broadcasting organisation, including the programmes, and is made up of the B.B.C. share of 7s. 6d. on each 10s. licence fee, the remaining 2s. 6d. going to the Post Office. As we pointed out last week, this means that an amount equal to one-third of the total revenue of the B.B.C. from licences is acquired by the Post Office without any particular effort on their part being made towards earning this income.

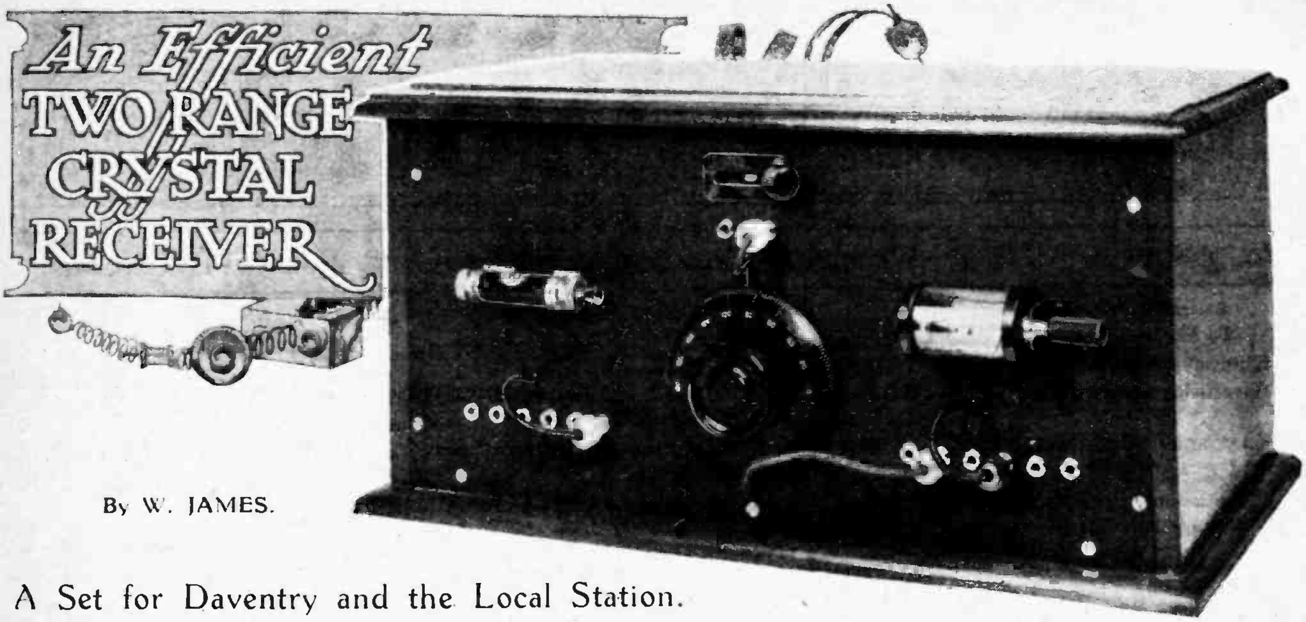
Assuming the revenue of the B.B.C. from this source to be as estimated by the Company for the current year £500,000, we find that the Post Office revenue is £125,000. Admitting there are expenses incurred which the Post Office might justifiably charge to broadcasting, we still find that the Post Office is deriving a net profit which cannot be far short of £100,000 a year.

If it is considered by the Broadcast Committee of Enquiry that 10s. a year is a reasonable licence fee to charge, then probably the existing division of this sum between the B.B.C. and the Post Office will stand, but the public will be entitled to know to what use this additional revenue is being put by the Post Office. As things stand at present, we have no assurance that the amount is not merely absorbed in the general exchequer of the Post Office, and we have not even the satisfaction of thinking that a substantial proportion of it reaches the wireless section of the Engineering Department of the Post Office to be expended on radio research and development. In fact, one might almost suppose that the poverty of this section has been amply demonstrated by the unwillingness to bring the equipment of such stations as Northolt into line with modern practice.

Many proposals could, we feel sure, be put forward as to how the Post Office might expend this annual sum. One suggestion, which we should like to see considered, is that it should be devoted to radio research and development on national lines. Already Great Britain is behind other countries in work of this nature, the reason being that Government wireless departments, in common with other national scientific organisations in this country, are seriously handicapped for lack of adequate funds.

CONTENTS.

An Efficient TWO RANGE CRYSTAL RECEIVER



By W. JAMES.

A Set for Daventry and the Local Station.

A CRYSTAL set is probably the simplest type of wireless receiver, but when properly used it gives results that, from the point of view of purity of reproduction, cannot be excelled by any other type of set.

The good quality obtainable is due to the electrical characteristics of the detector employed. This is not hard to understand if the electrical characteristics which can be obtained by experiment are examined, for it is found that when signals of above a certain strength are applied to the detector the rectified current (which is the current that passes through the head telephones and actuates them) is directly proportional to the strength of the applied signal. For signals below a certain strength the detector has a somewhat different characteristic, weak signals producing a disproportionately weak rectified current and therefore causing only a feeble sound in the telephones.

The signals radiated from a broadcast station vary in strength, not perhaps to so great an extent as the music which would be played in a concert hall, but still there is a variation in the strength, the loudest passages of music being of the order of four or five times as loud as the weakest. It is evident, therefore, that for the best results the strongest possible signals should be applied to the detector, as then the rectified current will more truly be a faithful copy of the original currents transmitted from the broadcast station. If the incoming signals tuned in on the crystal set are weak ones, the stronger notes will produce a louder sound in proportion to the weaker ones. The strength of the signal applied to the detector depends on a number of things. In the first place, it depends on where the set is installed and its distance from a broadcast station; secondly, on the effectiveness of the aerial and earth; thirdly, on the efficiency of the crystal receiver; and, fourthly, on the sensitivity of the head telephones.

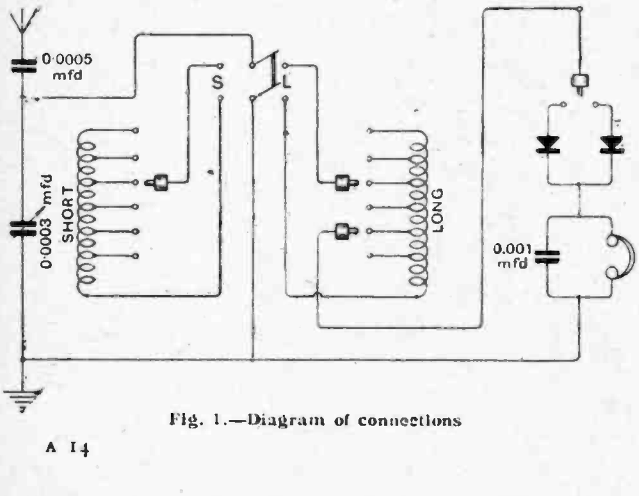


Fig. 1.—Diagram of connections

The Aerial and Earth.

We are concerned in this article with the crystal receiver itself, but, from what has just been said, it is evident that the signal strength heard in the telephones will depend on several other things. The arrangement of the aerial and earth are particularly important. It is advisable to employ a single-wire aerial, when possible 30ft. to 40ft. high and 60ft. to 70ft. long, with good insulators preferably of the long, thin type at each support. The down lead may be brought into the room through an insulator mounted in the centre of a pane of glass in one of the windows, or through an ebonite tube of large diameter fitted with terminals. It is, perhaps, unnecessary to say that the aerial should hang in a clear space with several feet between the aerial wire and such objects as roofs, gutters, trees, and walls. Great attention should also be paid to the earth. Clips secured to a water pipe form a fairly satisfactory earth connection, but in many instances it is worth while to construct a special earth. This may take the form of a sheet of copper 4ft. × 2ft., put vertically in the ground with the longer edge a few inches above the surface, an insulated copper cable being soldered to the earth plate and taken

An Efficient Two Range Crystal Receiver.—

by a direct path to the instrument. As a matter of interest, the rectified current obtained from the London station and from Daventry was measured on a microammeter when an earth such as just described was used, and also when an earth consisting of a large tin buried in the ground was connected. The micro-ammeter was connected in series with a pair of 4,000 ohms head telephones joined to the crystal set, and an average increase of 30 per cent. was noted when the copper plate earth was used.

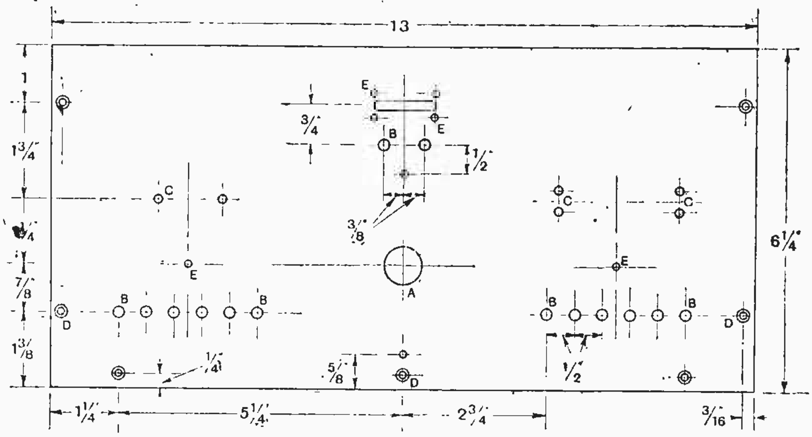


Fig. 3.—Details of the front ebonite panel. A, 11/16in. dia.; B, 3/16in. dia.; C, 5/32in. dia.; D, ⅛in. dia. and countersunk; E, ⅛in. dia.

Circuit Features.

Having stressed the fact that an efficient receiver should be used for the best results, we will now examine the circuit of the receiver and see what special features have been incorporated in its design. The connections are given in Fig. 1, from which it will be seen that in the aerial circuit is a fixed condenser, capacity 0.0005 mfd., and a variable condenser of 0.0003 mfd. The fixed condenser is in series with the aerial, while the variable condenser is connected in parallel with either of the two tuning coils. One of these coils is for short wavelengths, and the other for the longer wavelengths; when the switch is moved to the position marked "S" the short wave coil is connected to the aerial, while the long wave coil is completely disconnected. Moving the switch to "L" connects the long wave coil and cuts off the short wave coil. Both coils are tapped at a number of places, and it will be seen that the upper side contacts of the switch which can be connected to the aerial are joined to a plug. When the "short" coil is in use the left-hand plug can be employed to vary the amount of winding of this coil in circuit, and in the same way when the long wave coil is connected by putting the switch to "L" the right-hand plug can be used to vary the amount of this coil included across the aerial tuning condenser.

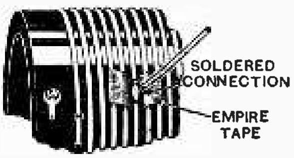


Fig. 2.—Method of tapping the coils.

Now, there is usually a certain loss in signal strength if the tuned circuit in use has a relatively large capacity across it. The coils are therefore so proportioned that for any aerial of reasonable size a point can be found for the adjustable tap such that the required broadcast station is tuned in with the variable condenser set near its minimum value. The exact effect of the ratio of the value of the parallel tuning condenser to the inductance of the coil in the circuit on the signal strength depends very largely on the constants of the aerial-earth system and also on the type of crystal detector and its connection to the circuit. When a station is tuned in with the condenser set at a small value the signal strength is, in the majority of cases met with in practice, seriously reduced by connecting the detector across the whole of the tuning coil. In addition, selectivity suffers. Provision has therefore been made to tap the crystal across part of the tuning coil, and for this purpose the crystal is connected to a plug which may be put in any of the taps on the coil. With the arrangement adopted we can get the utmost from our set because we can vary the ratio of the capacity connected in the aerial circuit to the value of the tuning coil used, and we

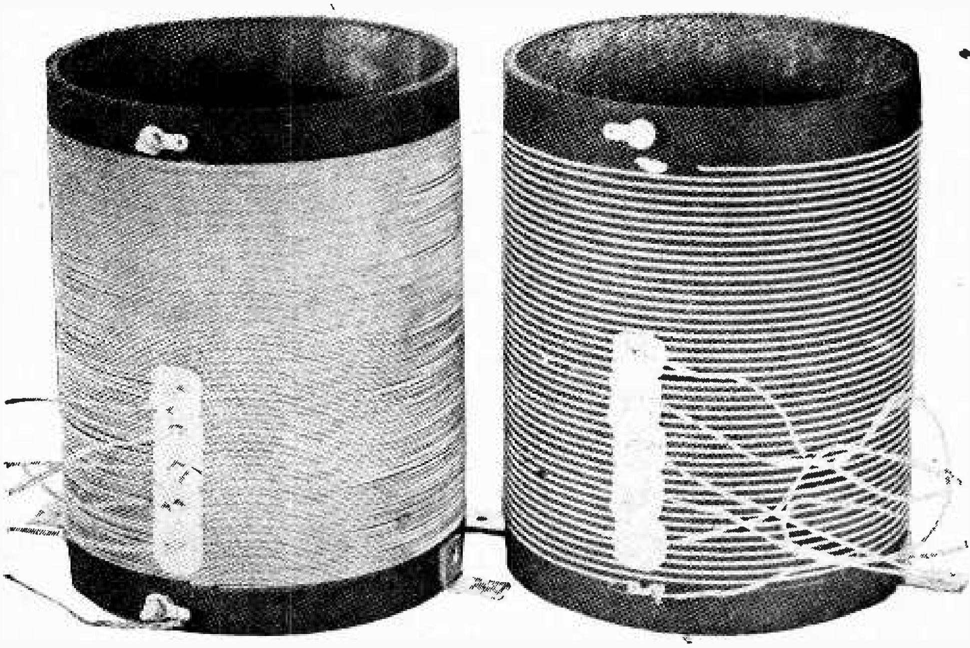


Fig. 4.—View showing the construction of the two tuning coils.

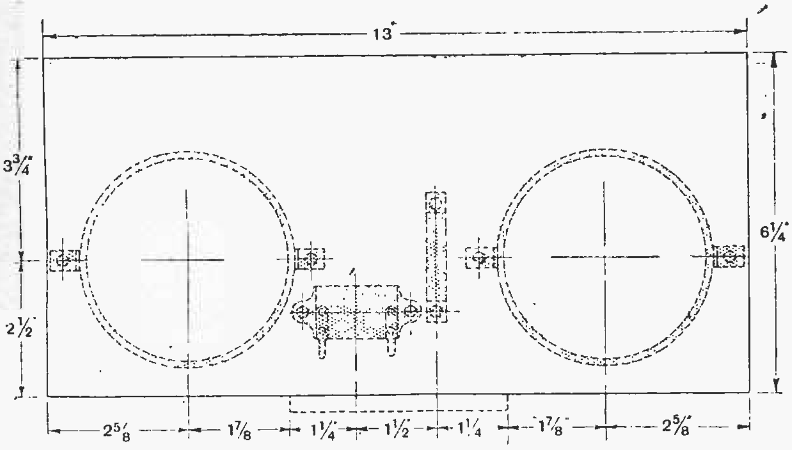


Fig. 5.—Plan view of the baseboard, showing the position of the parts.

can also connect the crystal across a portion of the tuning coil.

Two detectors are provided on the set with a simple arrangement of plugs and sockets to put either of them in circuit. One of these detectors is of the semi-permanent type, while the other is of the sensitive wire contact type.

Arrangement of Parts.

The set is quite a simple one to build and operate, and it will give a signal strength of greater intensity than an ordinary set in which the crystal is connected across the whole of the tuning coil and in which no provision is made for varying the constants of the tuner.

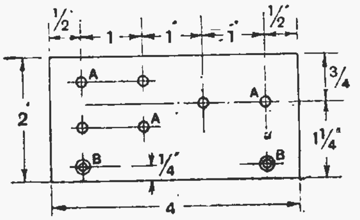


Fig. 6.—The terminal strip. A, 5/32in. and B, 1/8in. dia.

Changing from the lower to the higher wavelength is an easy matter, as only the switch has to be moved (to change the coils in circuit) and the connection plug of the crystal changed from a tap on one coil to one on the other. This system of switching prevents losses due to "end effects," and enables the best to be got out of the set on the short and the long waves.

The set is arranged in a cabinet like many valve receivers, as it was thought that some readers would like to add an amplifier which could be accommodated in another cabinet of similar size. A glance at the illustrations will show the general arrangement of parts adopted; there is an ebonite panel which carries the tuning condenser; a change-over switch; the crystal detectors; and the sockets connected to the crystals and to the tappings from the coils. A board is screwed to the bottom of the front panel and has mounted on it the two tuning coils, aerial fixed condenser, telephone condenser, and the terminal strip. On this strip are the aerial and earth terminals, and four others for the head telephones.

Construction of the Set.

The first part of the construction to be undertaken might very well be the tuning coils. These coils are both wound on ebonite tubes, 4in. in diameter by 5in. long, and are illustrated in Figs. 2 and 4. For the short wave coil wind on 55 turns of No. 22 D.S.C. copper wire to occupy a length of 4in. The turns will have to be spaced by approximately their own diameter to fill this winding length, and the ends can be terminated either by passing them through two holes or a 4 BA screw and nut can be put in each end of the tube and the ends of the wire soldered to tags held by these. The taps are made by raising the wire at the tapping point, placing a piece of empire tape under the wire, and then cleaning the wire at this place and soldering on a short length of any convenient flexible wire. Five taps are taken, the position of the taps being shown in the Figs. 1, 4 and 8.

The long wave coil is wound with 200 turns of No. 32 D.S.C. wire, to make a winding having a length of 4in. to 4¼in. Tappings are taken at the points shown in the diagrams. Both coils have small brass feet fitted to them, so that they may be screwed to the baseboard of the set.

For the panel a piece of ebonite 13in. × 6¼in. × ¼in. is required, and should be marked out and drilled according to Fig. 3, which shows the sizes of the holes to be drilled and their position. The contacts used to make connection with the coils and with either of the two crystal detectors are "Clix" sockets, and they are arranged in the positions shown in the illustrations. Those on the left-hand side of the panel are for the

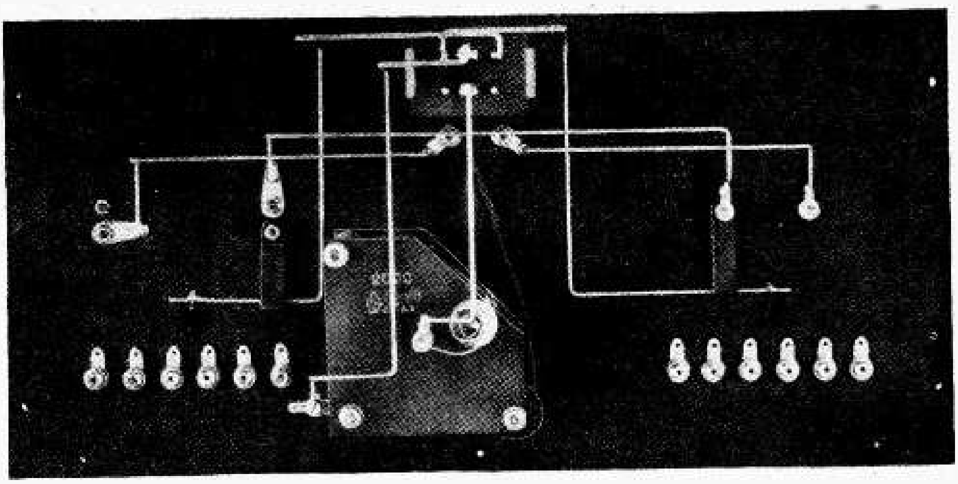


Fig. 7.—View of the panel with some of the wires in position. Notice the two ebonite cleats holding the two stiff wires to which the flexible wires are soldered.

An Efficient Two Range Crystal Receiver.— short wave coil and those on the right-hand side for the long wave coil.

When the panel has been drilled and the parts assembled it may be screwed to the baseboard, which measures 13in. × 6¼in. × ½in. Then the two coils, fixed condensers and the terminal strip can be secured and the set prepared for wiring.

Wiring and Testing.

Before wiring the set it is advisable to go over all the points to be soldered and clean them, also to examine the parts and see that they are likely to be satisfactory. In particular, see that the crystal detectors are likely to work well; with the particular type of wire contact detector used in the set illustrated, it was found necessary to clean the surface where the screws which pass through the panel make contact with the metal side pieces, as these were found to be covered with a form of black enamel which would have prevented satisfactory reception.

For wiring, No. 16 or 18 bare tinned copper wire may be used, short lengths being stretched and cut from the reel as required. Some of the wiring can be done with the panel removed from the base; for instance, the wires connected to the change-over switch and to the variable condenser and the wires connecting the detectors can all be put on. The connections to the plugs for the aerial and crystal circuits are of flexible wire and are soldered to stiff wires which are held by small ebonite cleats secured under the nuts which fasten the detectors. It will be noticed that the crystal detectors are connected by a length of flex having a plug on each end. This wire is also anchored by a small cleat, which is fixed to the baseboard by the lower side of the tuning condenser.

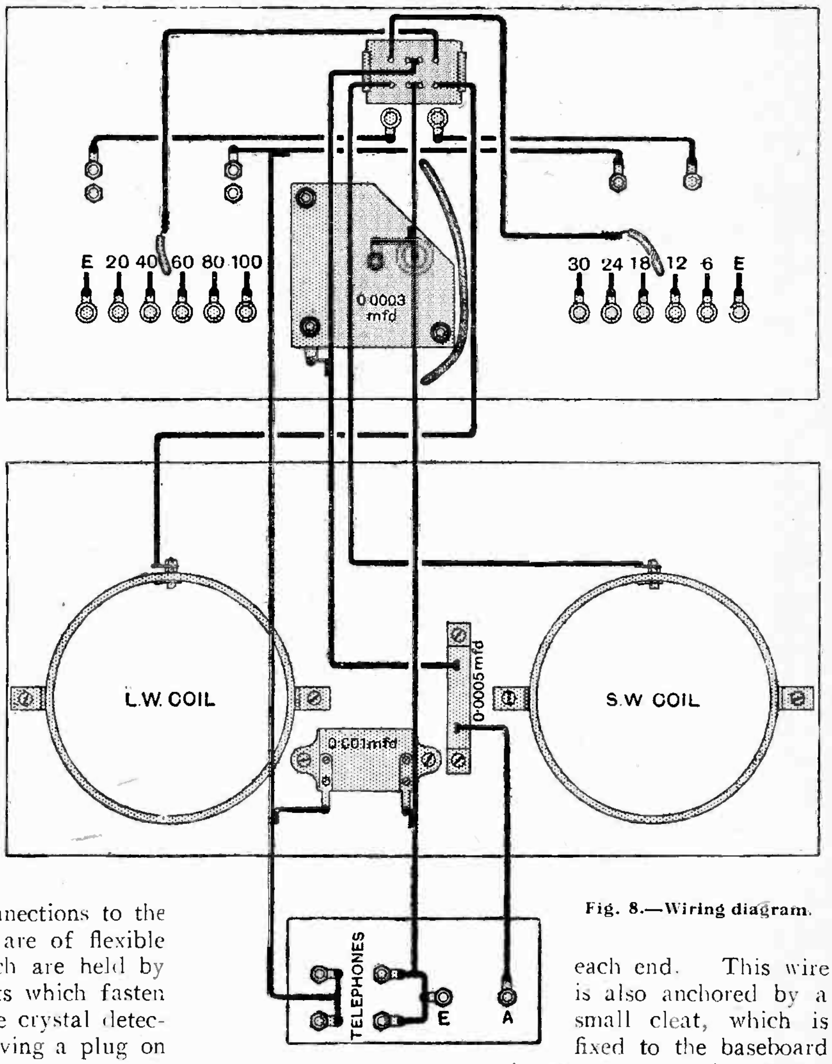


Fig. 8.—Wiring diagram.

Some of the wires connecting the parts on the baseboard can now be put on before the panel is finally screwed to the baseboard. It will be found that the wire from the aerial terminal to the fixed condenser in the aerial circuit can be put on, also the telephone condenser wires. The final wiring is that of the coils, which must be done with the parts screwed together, but as there is plenty of room this work is easily done.

Having finished the wiring and carefully checked it by the wiring diagram, the aerial, earth and telephones may be connected and tests

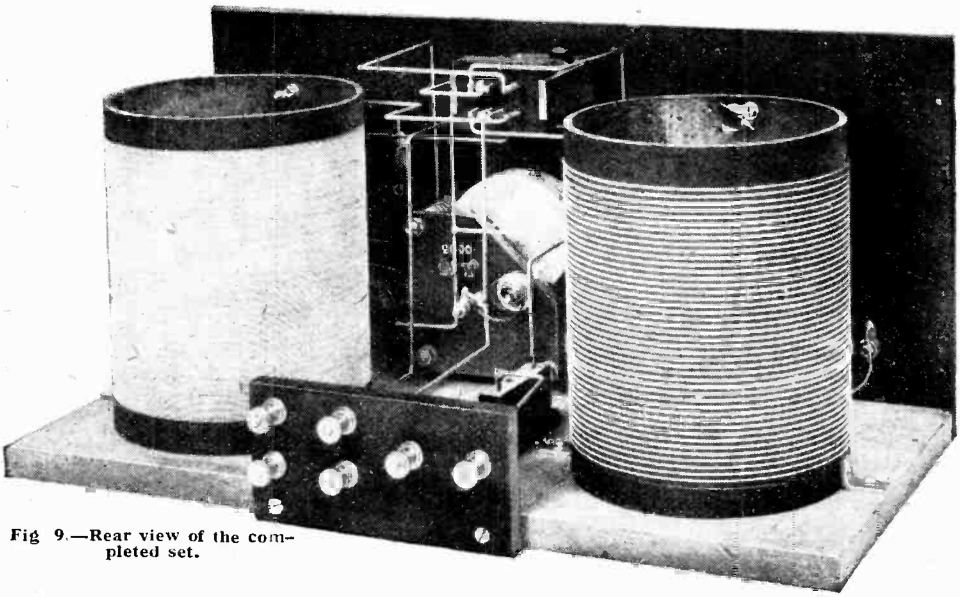


Fig 9.—Rear view of the completed set.

LIST OF MATERIALS USED.

- 1 Ebonite panel, 13in. × 6¼in. × ¼in.
- 1 ft. Ebonite tube, 4in. dia., ⅛in. wall.
- 1 Ebonite strip, 4in. × 2in. × ¼in.
- 1 Wood base, 13in. × 6¼in. × ½in.
- 1 Semi-permanent detector (Radio Instruments Ltd.).
- 1 Crystal detector (Burndept Wireless Ltd.).
- 1 0·0003 variable condenser (A. J. Stevens & Co.).
- 1 0·0005 fixed condenser (Dubillier).
- 1 0·001 fixed condenser (Dubillier).
- ½ lb. No. 22 D.S.C. copper wire.
- ½ lb. No. 32 D.S.C. copper wire.
- 1 Double pole change over switch (Burndept Wireless Ltd.).
- 14 Clix sockets.
- 4 Clix plugs.
- 6 No. 4 B.A. terminals.
- 1 Cabinet (Peto Scott, Ltd.).

made to see that the set is working properly. With the switch knob moved over to the left-hand side to connect the short-wave coil to the circuit, put the aerial tapping plug for this coil (which is the one on the left-hand side) into the socket on the extreme left-hand side; also put the lower plug contact from the crystal detector in one of the left-hand row of sockets and the upper plug in one of the sockets situated just below the change-over switch. Now set the detector and endeavour to tune in the local station by adjusting the tuning condenser; and when it is heard make adjustments to the position of the aerial tap and the crystal tap for loudest signals. To receive Daventry use the long wave coil and transfer the lower crystal plug to the right-hand row of contacts. It will be found that there is a best combination of tuning capacity and tuning coil and a certain position for the detector plug which gives best results from the point of view of signal strength and of selectivity.

As the effective resistance of the semi-permanent crystal is different to that of the wire contact detector, loudest signals in each case will probably be obtained with the crystal plug in a different socket.

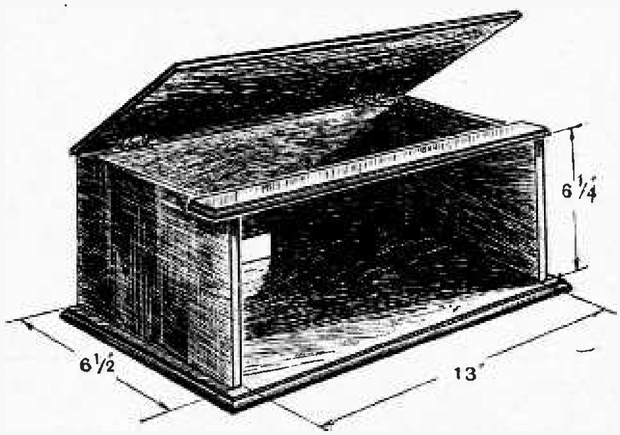


Fig. 10.—Sketch of the cabinet employed.

TRANSMITTERS' NOTES AND QUERIES.

General Notes.

Mr. G. F. Kitchen (5VP), 10, Beech Road, Epsom, is experimenting in directive transmission on 160 metres C.W., and will welcome reports.

The Belgian station E9 will transmit from January 1st, 1926, on wavelengths of 90 to 110 metres at the following times:—Sunday, 22.00 to 24.00; Monday, Thursday and Friday, 18.00-19.00; Saturday, 18.00-19.00 and 22.00-0100. Reports will be welcomed and may be sent *via* "T.S.F. Moderne," 9, rue Castex, Paris.

Mr. G. S. White (2GW), "Fiveways," Chippenham, Wilts, will shortly be transmitting on 163 and 440 metres, and will welcome reports.

Mr. W. H. Maycock (5SK), 61, Kirby Road, Earlsdon, Coventry, is transmitting on 45 metres and will welcome reports.

Cards for the Dutch stations OLL, OXX, ONL, OZN, PB3 and PB6 may be sent *via* Mr. F. C. Osorio (G2AJY), 65, Dartmouth Road, Cricklewood, N.W.2.

NOWC is transmitting on 46 metres. Reports, indicating weather and QSB, may be sent *via* Mr. C. de Beaufort, 120, Grosvenor Road, London, S.W.1.

The German station K4EA has now ceased operation, but reports of past reception may be forwarded *via The Wireless World*, and will be duly acknowledged.

K18, the Darmstadt Radio Club, is conducting experiments on wavelengths from 5 to 100 metres, and will welcome reports, which may be addressed to S. James Tyrrell, T. and R. Section, R.S.G.B., Prinz Christiansweg 19, Darmstadt, Germany.

Official Wavelength Stations.

The American Radio Relay League has arranged for official wavelength stations in the U.S.A. and other countries of the world, the English stations being 2NM (G. Marcuse, Caterham), and 20D (E. J. Simmonds, Gerrards Cross). There will be no regular schedules, but the stations will announce the wave they are using at the end of each transmission.

New Call Signs Allotted.

2JC.—G. Sykes, 13, Longford Street, Gorton, Manchester (in place of 2ADN).

5KR.—C. M. Thorpe, The Crossways, Rhuddlan, N. Wales.

5KU.—R. Pollock, 4, Glenhurst Avenue, N.W.5 (in place of 2APW), transmits on 45 metres.

6YV.—Stanley F. Evans, 3, Clarence Crescent, Whitley Bay, Northumberland (in place of 2BDY), transmits on 45 metres.

6YW.—T. P. Allen, 19, Ardgreenan Drive, Strandtown, Belfast, transmits mainly on 45 metres.

Misuse of Call Signs.

We have again received complaints about the illicit use of call signs, and understand that signals have been picked up purporting to have been transmitted from 6YF (Hampstead) and 6SV (Reading) on 196 metres, and from 6JV (Norwich) on 45 metres at times when the licencees of these stations were not operating. Our informant believes that this is the work of one transgressor in the neighbourhood of Muswell Hill, and if these remarks should meet his eye we would earnestly beg him to "play the game."

Mr. D. H. Johnson (6DW), Kingston Hill, informs us that he has definite information that his call sign is being used in or near Cheshire, and that if this continues he will notify the G.P.O.

Stations Identified.

We have received from correspondents, to whom we tender our thanks, the following QRA's which will probably be of interest not only to those transmitters who specifically asked for them, but to others of our readers:—

KXH Cards may be sent via Capt. E. H. Robinson (5YM), "Langmead," Pirbright, Surrey, who kindly undertakes to forward communications.

1 1GB G. Fracarro, Castel, Franco-Veneto, Italy.

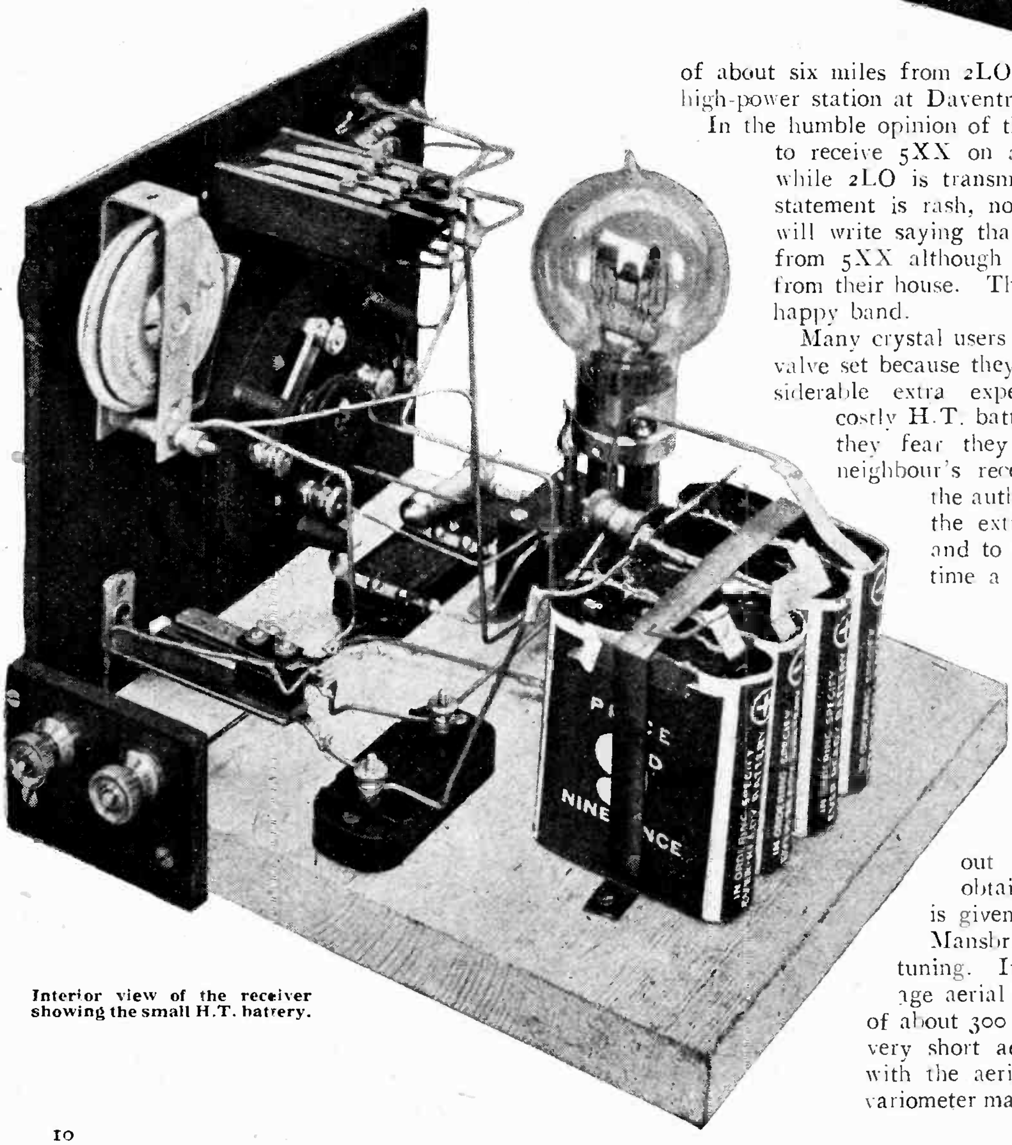
F 8IL M. Lamy, 2, rue de Provence, Paris.

FOUR-ELECTRODE VALVE RECEIVER.

A Simple Circuit for Broadcast Reception.

By H. ANDREWES, B.Sc., A.C.G.I.

AT the present stage in the development of broadcasting in this country there is great need, in the opinion of the author, for a receiver which will give a little bit more than the ordinary crystal receiver when used in close proximity to a B.B.C. station, will be a little more selective, and which at the same time will be simple to operate and cheap to build. With this object in view, the receiver to be described has been designed. Its primary object was to receive, at a distance of about six miles from 2LO, that station and also the high-power station at Daventry.



Interior view of the receiver showing the small H.T. battery.

In the humble opinion of the author it is not possible to receive 5XX on a crystal set near London while 2LO is transmitting. Of course, such a statement is rash, no doubt. Hosts of people will write saying that they get excellent results from 5XX although they can see 2LO's aerial from their house. The author is not among that happy band.

Many crystal users are loth to try even a one-valve set because they fear that this entails considerable extra expense, large accumulators, costly H.T. batteries, and possibly because they fear they may interfere with their neighbour's reception! In this receiver the author claims to have cut down the extra expense to a minimum, and to have produced at the same time a receiver which is not only selective, but very simple to operate.

The Circuit.

The circuit used is the well - known Numans oscillator, but the H.T. voltage may be adjusted so that regeneration without actual oscillation can be obtained. The circuit diagram is given in Fig. 1. A Dubilier-Mansbridge variometer is used for tuning. It is assumed that an average aerial is used, having a capacity of about 300 mmfd. With a longer or a very short aerial a condenser in series with the aerial or in parallel with the variometer may be necessary. Two ranges

Four-Electrode Valve Receiver.—

of the receiver are obtained by the switch S, which, on the higher range, places a 2,500 mmfd. condenser C_1 in parallel with the variometer, so that a wavelength of 1,600 metres may be obtained. An obvious criticism of this arrangement is that better results could be obtained by using a loading coil instead of a parallel condenser for the longer wavelength. But the author has found, after careful experiments, that if the H.F. resistance of the oscillatory circuit is kept low, by using a good variometer and mica condenser with this circuit, very little signal strength is lost by the arrangement; at the same time a very much more selective receiver is obtained. If a large ratio of inductance to capacity is used, it has been found that unless loose coupling is resorted to, in fairly close proximity to 2LO, interference occurs even on 1,600 metres, so that the arrangement described has been adopted.

Turning now to the actual construction of the receiver. The photographs show views of the finished receiver, and it may be noted that it is no larger than an ordinary crystal set. As will be seen, the main components are mounted on the front panel; connection is made by means of a strip of spring brass mounted beside the valve legs to the cap of the valve (the inner grid connection), thus avoiding a flexible connection as is normally used. As the grid leak is not connected across the grid condenser as is usual with a detector, a grid leak attachment is used.

H.T. Supply.

The H.T. battery is mounted inside the receiver at the back and may be readily seen. This consists of four dry cell flash-lamp batteries. The size of this battery is an important feature of the receiver, since 10-15 volts is all the H.T. necessary. Higher voltages, of the order of 30-50 volts, have been tried, but it has been found that superior results are obtained with about 12 volts. This adds considerably to the cheapness and simplicity of the set. As a matter of fact, quite good results may be obtained without any added H.T. at all by simply

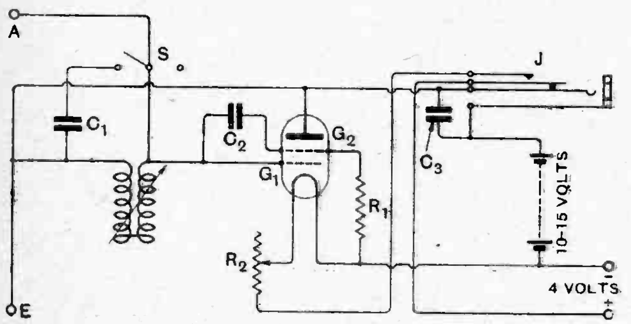


Fig. 1.—Circuit diagram. The connections are similar to those of the Numans oscillator.

connecting the 'phone lead from the junction to the positive of the low-tension battery. The value of C_2 is not at all critical, but 300 mmfd. is given as a good average figure. With the particular variometer used C_1 should not be less than 2,500 mmfd., and this figure should be adhered to fairly accurately. The value of R_1, the grid leak, depends largely on the particular valve used, and

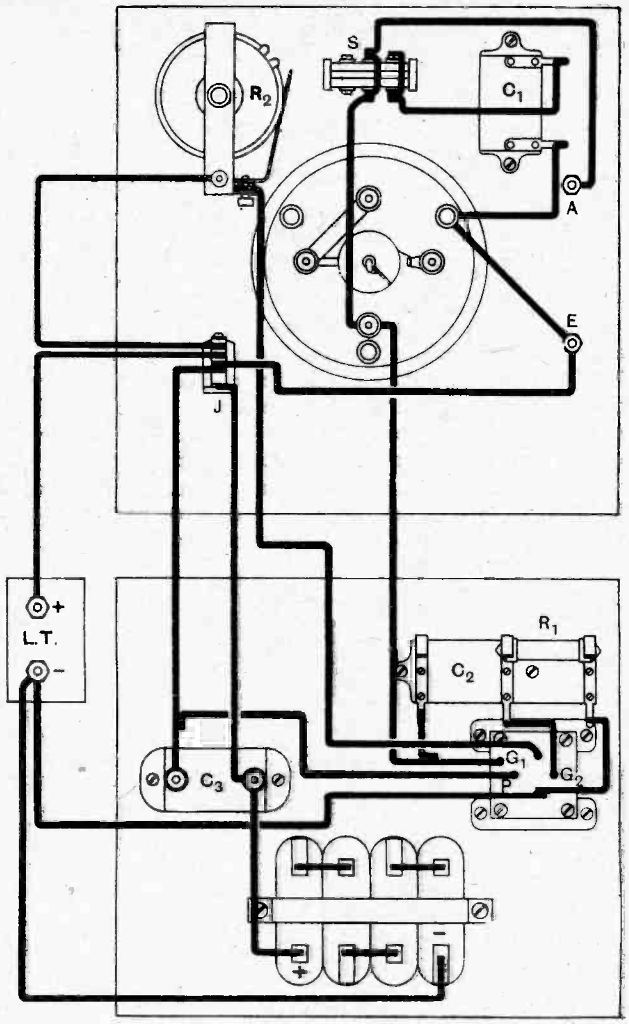


Fig. 2.—Practical wiring diagram.

will usually be found to be of a rather low value. The filament rheostat R_2 should be of a good make, as it will get rather more use than in the average set. A refinement would be, of course, to use one fitted with a vernier adjustment.

As regards operation of the receiver, this will be found to be quite simple. Tuning is, of course, "one knob," and "volume" is controlled by means of the filament rheostat. This last will be found to be quite critical, as it also controls regeneration. It is rarely necessary to run the filament at full brilliancy. It will be found quite a good plan to fit a wander clip to the + H.T. connection, and then adjust the H.T. voltage until the set will just not oscillate with the filament voltage adjusted correctly. The set will then be found to be quite "oscillation-proof" and simple to handle. If a tendency to howl is found, a lower value of grid leak should be tried.

The author thinks this is a set which will repay any trouble taken in making it, and one which will be found to possess a surprising degree of selectivity on both ranges.

A SIMPLE CRYSTAL SET FOR 5XX.

How to Use Carborundum without a Potentiometer.

By G. C. SHERRIN.

THE wireless community may be divided into three sections. There are the experts and engineers to whom we owe this wonderful invention of broadcasting; there are the experimenters of varying degrees of importance; and, finally, a vast host of people who are either quite content or most anxious to be able to hear the splendid programmes of music, entertainment, and intelligence provided for them at enormous cost throughout the day.

It is to this latter class that I propose to discover the very simple means by which their ambition may be realised.

When the British Broadcasting Co. erected their transmitting station at Daventry—a station which is many times more powerful than any of their other stations—they announced that programmes sent from it would be audible on crystal sets for a distance all round Daventry of a hundred miles; and, as the company have a great and growing reputation to maintain, it is probable that they meant exactly what they said.

Essentials of a Crystal Receiver.

But the listeners and would-be listeners have to do something on their part, and the question arises:—What is the right thing to do?

Three things are essential. They must

(1) Erect an aerial and earth connection;

(2) Buy a pair of telephones; and

(3) Make, cause to be made, or buy an efficient crystal set.

I propose to deal only briefly with Nos. 1 and 2, but a little more at length with No. 3, as it is undoubtedly in the choice of the set that the listener is most easily led astray.

(1) *The aerial* may consist of one line of stranded copper wire (known in wireless shops as "seven twenty two (7/22) copper aerial wire") raised to a height of 50ft. clear of trees and buildings (the regulation length being adhered to). Such is as good an aerial as the average listener is likely to obtain. Three insulators at either end are not too many.

If it is impossible for any reason to reach this height, approach it as nearly as possible. In crystal reception the height of the aerial is of the utmost importance, and it is well worth the extra cost that may be incurred in obtaining it.

The number of extraordinary aerials which one sees all over the country—aerials which must fill the heart of Mr. Heath Robinson with envy—only shows how little this very important point is appreciated.

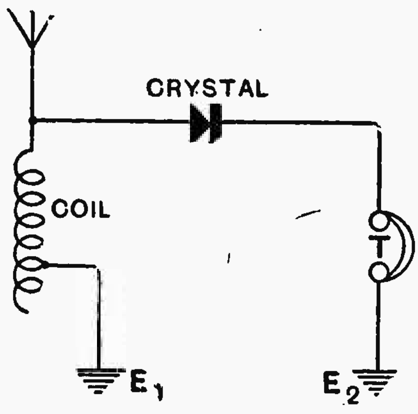


Fig. 1.—Circuit diagram of the receiver. E_1 is a galvanised iron pipe, and E_2 a brass rod. The cell formed by the two earth plates in contact with the soil provides the potential necessary for the carborundum detector, the crystal of which is connected to the aerial.

For the earth connection it is not necessary always to sink a deep hole and to bury sheets of metal; take six to ten feet of galvanised iron water pipe and drive it vertically into the ground until level with the surface.

(2) *Telephones.*—A cheap pair of telephones will generally give about one-half the loudness and clearness of a more expensive pair.

(3) *The crystal set* itself I have placed third in order of importance, not that it cannot entirely mar your endeavours to receive broadcast if constructed without a due sense of proportion, but because the essence of a crystal set is so simple that there is no excuse for incurring loss of strength in the use of it.

If we are satisfied to use a crystal set and to enjoy the programme of 5XX, which may be our only audible station, it is obviously unnecessary to have a set of ingenious complication capable of tuning in a hundred other stations which we cannot hear.

The duty of a crystal set is two-fold; firstly, it must tune the aerial to the required wavelength, and, secondly, it must rectify the aerial current so as to make it operate the telephones.

The tuning is done by connecting the aerial and earth to an inductance coil of exactly the correct length and size for the wavelength required; and the rectifying is carried out by passing a portion of the current through a suitable crystal.

The Tuning Coil.

There are many kinds of coils, but the one which in theory and practice is generally admitted to be the most efficient is a coil made by winding insulated wire upon a round cylinder. Suitable dimensions for a coil for the Daventry station are given in Fig. 2.

The cylinder, made of cardboard, is about 12in. high and 4in. in diameter. Double-cotton-covered wire of No. 24 gauge is tightly and closely wound in a single layer on the outside until about 300 turns have been wound on. When complete, the coil is cumbersome compared with the neat basket coils and duolateral coils sold in the shops, and in all probability it is its ungainly size which prevents it being embodied in commercial sets, but it must not be forgotten that you are going to listen to this coil, not to look at it.

A still better coil can be made with a cylinder 6in. in diameter, 12in. high, and wound with 220 turns of wire of No. 20 gauge.

A point of very much greater importance than is usually attached to it in the handbooks is that the coil must be

A Simple Crystal Set for 5XX.—
perfectly free from moisture. To ensure this the cardboard cylinder should be baked in a warm oven for ten minutes; while still warm it should be coated, inside and out, with shellac varnish, and again returned to the oven until the varnish is dry and hard. After this the wire may be wound on, and finally a thin coat of varnish applied to the wire to prevent the cotton covering absorbing moisture in a damp atmosphere. A gentle heat will dry off this last coat, and the coil is ready to fit to the aerial.

At last we come to the crystal rectifier. Without preamble, I am going to recommend the first crystal that was ever discovered as a rectifier, namely, *carborundum*. It is the hardest of all artificial substances. It withstands any amount of heat without deteriorating as a rectifier. It may be fixed into its cup with ordinary solder. It requires no catwhisker delicately poised upon a sensitive spot, but instead a piece of stiff steel spring clamped

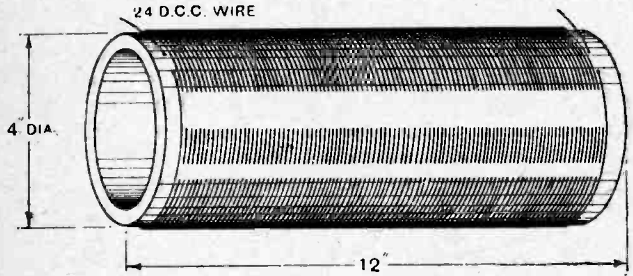


Fig. 2.—Dimensions of the aerial tuning coil.

firmly into contact with it. It is for all practical purposes a permanent detector. For listeners within fifteen miles of 5XX I do not know of any other crystal that will so well stand up to the work or give such volume of sound. Even at a distance of 75 miles a good sample is as sensitive as any other crystal, with the added advantage of its being unable to get out of adjustment, even as a result of lightning discharge.

But carborundum has a bad name; it is generally thought that it can only be used in conjunction with a battery and potentiometer; and how many people understand what a potentiometer is?

It is quite true that carborundum is practically useless for receiving weak signals unless a small voltage or potential from a battery is being applied to it to bring it up to its rectifying point; and the potential must be very small, for which reason a potentiometer must be used—an instrument by which the amount of potential can be very accurately adjusted.

There is, however, another and a simpler method of applying this potential. The essentials of any battery are a piece of zinc and a piece of copper, or carbon, immersed in an acid solution. If, therefore, we bury a small piece of copper (or brass will do) at a small distance from our galvanised or zinc-covered pipe which forms our earth, we shall have the essentials of a battery, the moisture in the ground acting as the acid solution. As the acid in the ground is small, the current produced will be small also, and will not necessitate a potentiometer. The arrangement of the set will therefore be like that shown in Fig. 1.

There are practically two earths, one for the aerial circuit and one for the telephone circuit, and a tiny current of electricity will flow from the brass rod *via* the telephone circuit to the detector, and thence to the main earth through the inductance coil. This little current will make the carborundum as sensitive as any other crystal, provided the pressure between the steel and the crystal is suitably adjusted.

Tuning.

Put on the headphones, bring the steel into contact with the carborundum, take the end of the earth wire which is connected to the galvanised pipe, and hold it in contact with the blade of a penknife. With the point of the blade pierce the cotton insulation of one of the lower turns on the coil, and 5XX should be audible. Now test in the same way various turns up and down the coil until signals are at their loudest. Having discovered the best position on the coil, clean off half an inch of the insulation, and solder a connection.

You have now a simple, efficient, and practically permanent set for 5XX, free from condensers, variometers, or any ingenious complication through which any possible loss of strength may occur.

It is important that the current from the double earth should flow the right way through the crystal; connect the aerial, therefore, direct to the carborundum.

If you have a local station audible in addition to 5XX, a similar treatment of the case is possible, but do not tamper with the 5XX coil; use a separate coil.

FUTURE POLICY IN BROADCASTING.

Mass Meeting of the Radio Society of Great Britain.

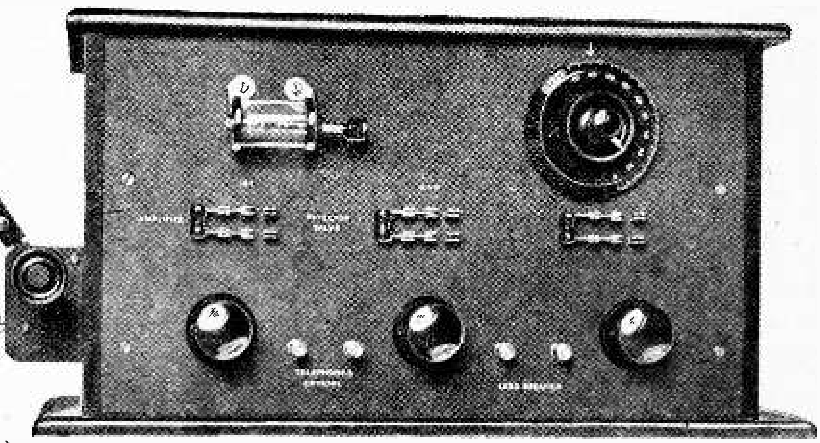
In view of the probability that the Radio Society of Great Britain will give evidence before the Broadcasting Committee set up by Government, the Society has arranged a gathering of unusual interest. This will be held in the Palm Court of Messrs. Selfridge's, Oxford Street, to-morrow (Thursday), and will take the form of a mass meeting representing some 15,000 persons. All members are requested to attend if possible, and representatives of the affiliated societies will be present.

The first part of the programme will be devoted to a demonstration of "Talking Motion Pictures," by Mr. C. F. Elwell, Fellow I.R.E., this being followed by a debate on a resolution: "That the present system of broadcasting, as represented by a single monopoly, is the best for this country." Among the participators in the discussion will be Messrs. H. Bevan Swift, H. A. Epton, D. S. Richards, C. H. Keeling, J. F. Stanley, R. J. Hibberd, Maurice Child, and L. F. Fogarty. The chair will be occupied by Dr. W. H. Eccles, Past-President of the Society.

Admission to this interesting meeting will be free by ticket, applications for which should be made immediately to the Secretary, Radio Society of Great Britain, 53, Victoria Street, London, S.W.1, or to the Secretary, Selfridge's Radio Society, 400, Oxford Street, London, W.1. The meeting will begin at 8 p.m.

A loud-speaker address system will be installed in the Palm Court by Messrs. Alfred Graham and Co., Ltd.

Three Valve Two Circuit Receiver



By M. D. SMITH.

Sensitivity Combined with High Quality Reception from the Local Station.

THE detector valve, followed by one or more amplifiers, has always been a great favourite with amateurs because of its ability to "get there"; at the same time it is easily controlled. In fact, most amateurs possessing a transmitting licence who go in for long-distance communication, use this circuit. As the writer has always favoured the crystal for quality reception of broadcasting, the two are combined in the set about to be described.

This set was designed to give good quality and at the same time good signal strength on a loud-speaker, at a distance of four or five miles from the local broadcasting station, with the minimum of trouble and risk of radiation. It was also required to receive other stations when the local station had closed down.

Choice of Circuits.

Therefore, it was decided to use two circuits. At first sight it would appear better, in view of the use of a crystal with this receiver, to have made the second circuit comprise one H.F. valve-crystal detector and one or two L.F. valves. As a matter of fact, I used this circuit for a considerable time, but in experiments with the detector valve this was found to be the more efficient of the two, possibly owing to the resistance and damping effect of the crystal. Of course, in these days of the ultra-short wave, the detector valve is certainly of more general utility.

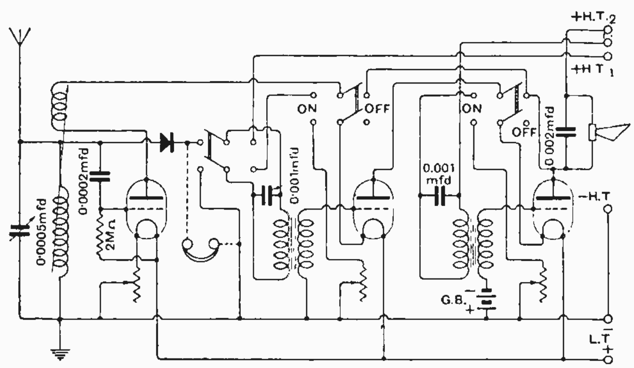


Fig. 1.—Diagram showing the switching arrangements for changing the circuit connections.

Fig. 1 shows the theoretical circuit diagram. The circuit employed on the local station is the crystal detector, followed by two L.F. valves. This can be changed to valve detector and one or two L.F. valves as desired for other stations. A good many sets now employ what is termed a volume control. This can be achieved in this set by reducing the number of valves in use. It is never satisfactory to dim the filaments or detune the set in order to reduce volume. It was found in actual practice that the crystal, and one L.F. valve, gave quite good results on a loud-speaker in London from the local station.

Switching.

Three double-pole, double-throw switches are used The first, seen on the left-hand side (front view) of the photograph, enables either a valve or crystal to be used for rectification, and connects the primary winding of the first intervalve transformer in series either with the reaction coil or crystal detector. The second and third switch in or out the second and third valves respectively. The filaments of these valves are switched on and off by merely changing over the respective switches; but, in order to avoid extra complication, the first valve filament is controlled by the rheostat, which has an "off" position. No main filament switch is employed, but the "off" position of the Burndept rheostats are again utilised. In this case the "off" position was arranged when the white spots on the knobs are at the bottom.

Construction.

The front panel is of ebonite, and is 14in. × 8in. × ¼in. This should be marked with a scriber (an old gramophone needle held in a suitable holder makes a good one) on the *back* of the panel, as in Fig. 2. Then it can be cut roughly to size and finished off with a file. A "Dreadnought" file, although a little more difficult to use, reduces the labour considerably. It should be used along the panel more than across it, when it will be found to cut rapidly and yet not clog like the ordinary file. When this is completed, the remainder of the panel can be set out as in Fig. 2. It needs to be done fairly accurately, especially the D.P.D.T. switch holes, for which a template can be obtained from the makers.

Three Valve Two Circuit Receiver.—

The crystal detector was bought ready mounted, but was removed from its base and fixed direct to the panel front. This base can be used as a template for marking the holes. Some of the wiring can be done before the panel is attached to the baseboard.

The baseboard is of mahogany 14in. × 9in. × $\frac{3}{8}$in., and can be varnished with a good quality shellac varnish in order to give a neat appearance to the set. It is attached to the panel by means of the brass strip shown in the photograph. The brass strip can be bent at right angles and then scribed and drilled. It will be found much easier to get the holes the same distance from the bend if this is done. The holes in the arm attached to the baseboard are countersunk. These brackets can then be fixed to the baseboard with $\frac{3}{8}$in. brass screws, care being taken to see that when the panel is brought up to them it comes up flush with the baseboard at the bottom.

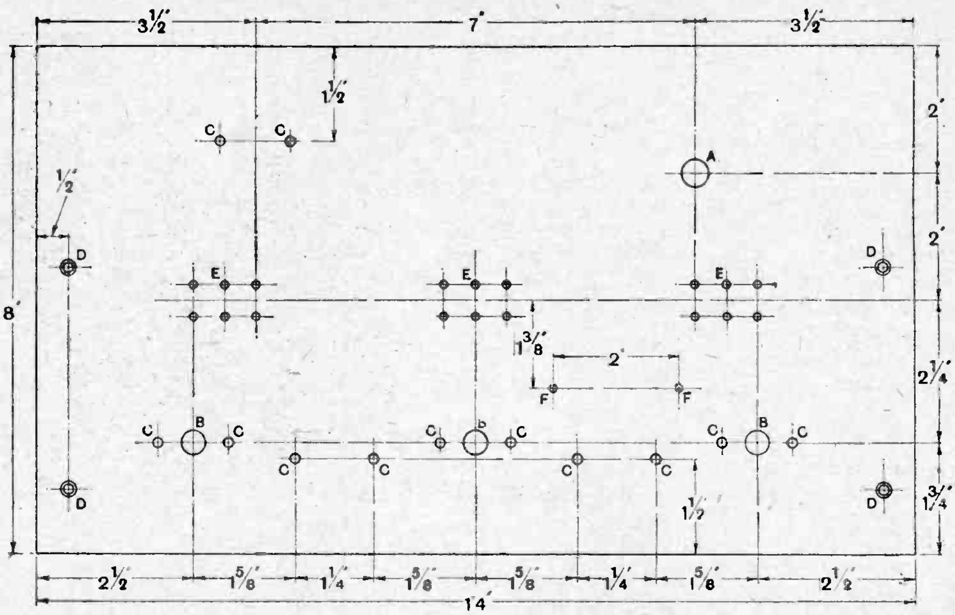


Fig. 2.—Drilling details of the front panel. Sizes of holes are as follow: A, 7/16in. dia.; B, 3/8in. dia.; C, 5/32in. dia.; D, 5/32in. dia. and countersunk for No. 4 B.A. screws; E, 1/8in. dia.; F, 7/64in. dia., tapped for No. 4 B.A.

The valve platform can next be made. The ebonite is 10in. × 2in. × $\frac{1}{4}$in., and the valve holders can be fitted in the position shown in Fig. 3. The two wooden supports measure 2in. × 2in. × $\frac{7}{8}$in., and are fastened to the baseboard by screws through from the bottom. Now make the terminal strip in Fig. 4, which is $7\frac{1}{2}$in. × $1\frac{1}{8}$in. × $\frac{1}{4}$in., and drilled as in Fig. 4. This can be screwed with $\frac{3}{4}$in. round-head brass screws to the baseboard in the place indicated in Fig. 3. The other terminal strip in Fig. 3 is 4in. × $\frac{3}{4}$in. × $\frac{1}{4}$in., and drilled as shown for four terminals. This is screwed to the baseboard, but has small wooden blocks under each end, measuring $\frac{1}{2}$in. × $\frac{1}{2}$in. × $\frac{3}{4}$in., the object being of course, to raise the terminals clear of the baseboard. The auxiliary H.T. terminal strip is made in exactly the same way, except that the ebonite is $2\frac{1}{2}$in. × $\frac{1}{2}$in. × $\frac{1}{4}$in., and the wood blocks are $\frac{1}{2}$in. × $\frac{1}{2}$in. × $\frac{7}{16}$in. The three valve sockets are used for this.

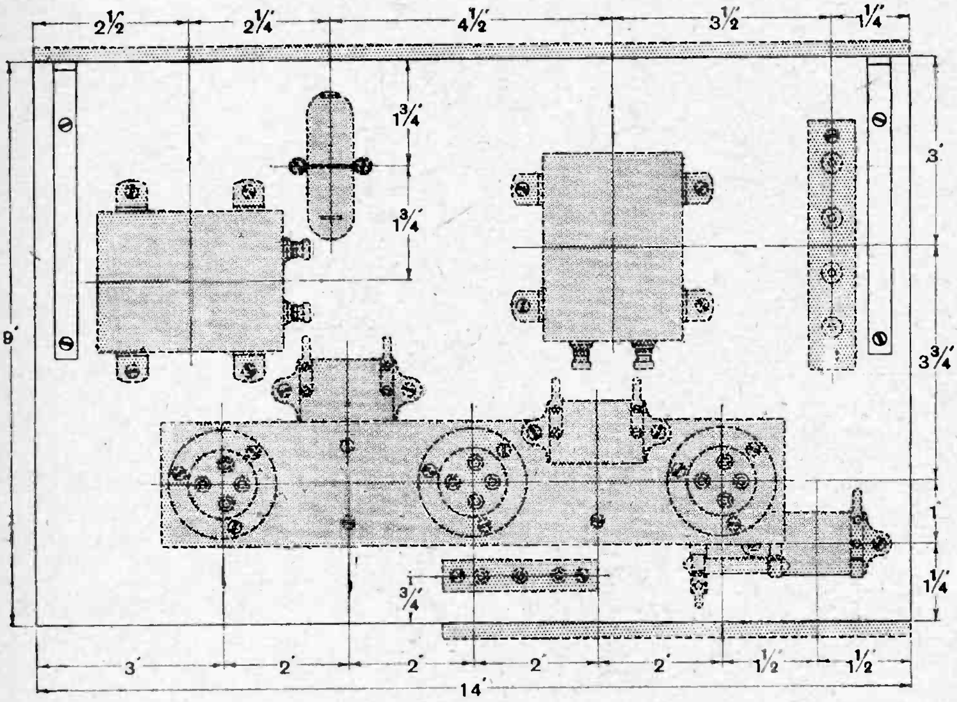
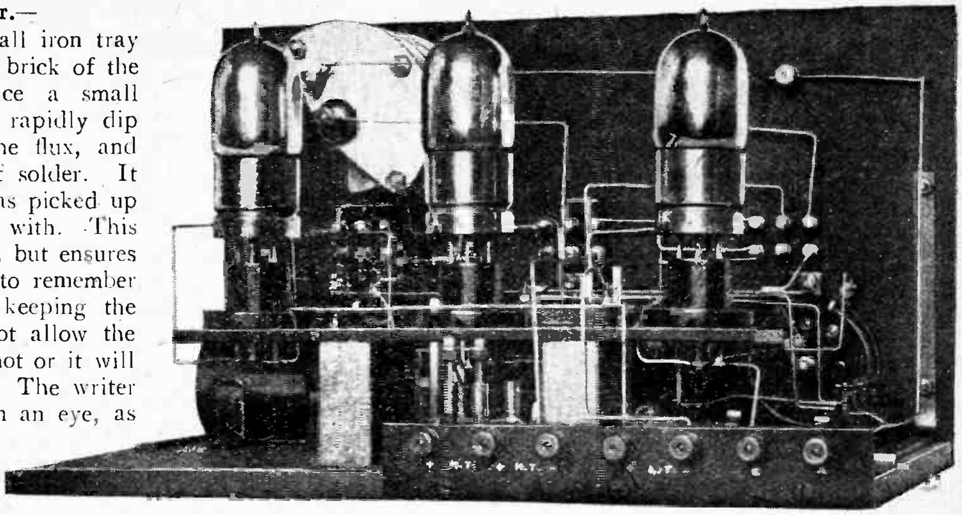


Fig. 3.—Layout of components on the baseboard and valve panel.

Wiring.

A word with regard to soldering may not be out of place here. The method advised in some text-books of holding the solder in one hand and the soldering iron in the other and applying both to the part to be soldered is, to say the least, a clumsy method, especially in the case of a wireless receiver which contains so many small parts to be soldered. A better way is to thoroughly "tin" the

Three Valve Two Circuit Receiver.—



The finished receiver ready for insertion in the cabinet.

iron, then obtain either a small iron tray (not a tinned tray), or even a brick of the hollow-sided variety, and place a small piece of solder on it. Then rapidly dip the point of the iron into the flux, and transfer to the small piece of solder. It will be found that the iron has picked up just sufficient to solder a wire with. This method is not only economical, but ensures a neater job. It is as well to remember that its success depends on keeping the iron well "tinned." Do not allow the soldering iron to become red hot or it will need to be retinned entirely. The writer always terminates the wires in an eye, as it was found not only to make a stronger connection, but also to hold the wire in position whilst soldering. Of course, tags can be used under the terminals, as they are liable to become loose when heated with the soldering iron.

Some difficulty was experienced in wiring up the valve

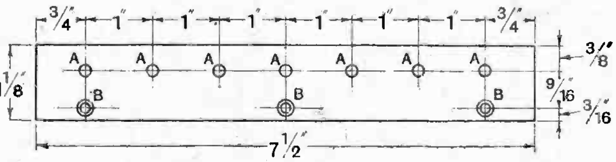
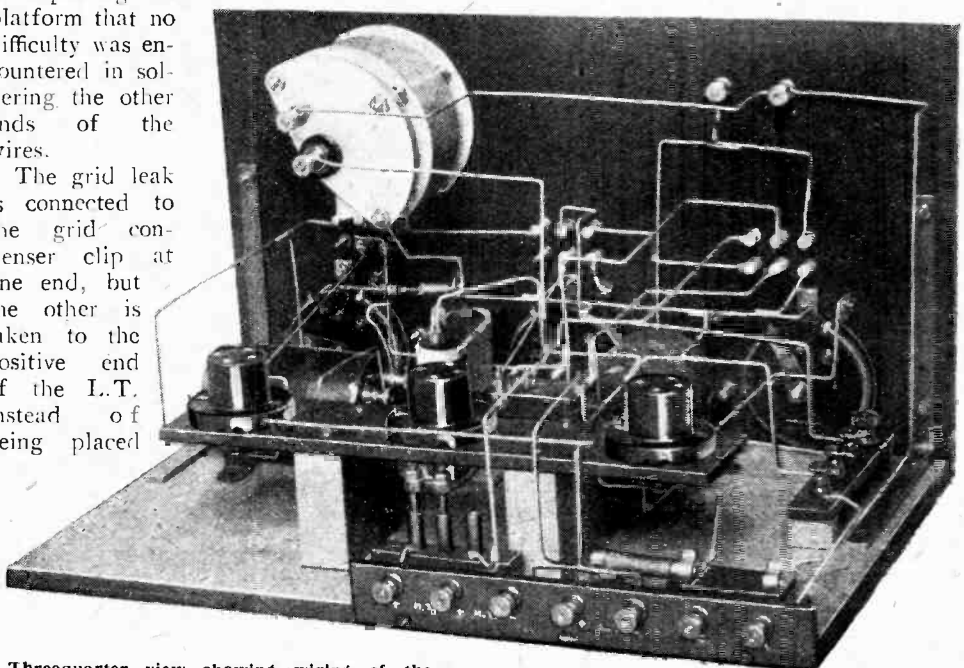


Fig. 4.—The terminal panel. Sizes of holes are as follow: A, 5/32in. dia.; B, 1/8in. dia., and countersunk for No. 4 wood screws.

holders, but this was overcome by bending all the wires to the correct length and shape, then removing the valve platform bodily, and soldering them on. It was found on replacing the platform that no difficulty was encountered in soldering the other ends of the wires.

The grid leak is connected to the grid condenser clip at one end, but the other is taken to the positive end of the L.T. instead of being placed across the grid condenser as usual. The writer has found that in general this method gives the best results with the dull emitter type of valves. This necessitates a clip being made. One end of the clip holds the grid leak and the other end is soldered direct to the positive L.T. terminal. The clip can be made of springy brass.

The grid battery is placed in the position shown in the general layout, and the two "Hovimo" connectors fitted. The two valve pins and nuts are attached to eyes made in the wires that go to the grid bias battery. If the set is wired with No. 16 S.W.G. tinned copper wire this will be found sufficiently stiff to keep the battery in position when the pins are plugged in, and at the same time allows the battery to be renewed easily if necessary.



Threequarter view showing wiring of the change-over switches.

The remainder of the wiring is comparatively simple, but it should be borne in mind that spacing and shortness of the wiring all go to make for efficiency. The grid wire of the detector valve is probably the most important of all. The coil holder requires to be carefully mounted on the end of the cabinet, and should be in such a position that the connecting wires are kept as short as possible when attached to the terminals inside the cabinet. These wires can be made of flex, and are passed through holes drilled in the end of the cabinet opposite the coil holder contact screws provided for the purpose. To the other ends spade terminals are fastened.

LIST OF PARTS REQUIRED.

1 Ebonite panel, 14in. × 8in. × ¼in.
1 piece of ebonite, 7½in. × 1⅛in. × ¼in.
1 piece of ebonite, 4in. × ⅜in. × ¼in.
1 piece of ebonite, 2½in. × ½in. × ¼in.
1 piece of ebonite, 1in. × ½in. × ⅜in.
1 piece of mahogany, 14in. × 9in. × ⅜in.
1 Variable condenser, 0·0005 mfd. (Ormond).
1 Fixed condenser, 0·0002 mfd. (Dubilier).
2 Fixed condensers, 0·001 mfd. (Edison Bell).
1 Fixed condenser, 0·002 mfd. (Edison Bell).
1 Grid-leak, 2 megohms (Dubilier).
1 Eureka Concert Grand L.F. transformer.
1 Eureka No. 2 L.F. transformer.
1 Vernier crystal detector (G.E.C.).
1 Two-coil holder (Polar Cam Vernier).
3 Valve holders.
3 Filament rheostats (Burndept Dual).
3 Double-pole double-throw switches (Radcom).
1 4½in. volt grid battery.
2 "Hovimo" battery connectors (Molback).
3 Valve sockets with nuts.
4 Valve pins with nuts.
11 Terminals suitable for spade connection.
4 Telephone terminals.
2ft. brass strip ⅜in. × ⅛in.
Quantity of No. 16 S.W.G. tinned copper wire.
Cabinet to suit.

H.T. Connections.

Normally, there are two positive H.T. connections, and the shorting plug can be left inserted in the middle socket, and the one connected to positive H.T.2 as shown in the wiring diagram, but if it is desired to put a different value of H.T. on the second valve as well as the other two, the shorting plug can be removed and a tapping taken to the middle socket. By shorting the middle socket to H.T.1 when three valves are in use, the same H.T. value is applied to valves 1 and 2, but extra to the last valve, thus two D.E.3s and a D.E.4 can be used. If when all is connected up, the set fails to oscillate, the reaction leads should be reversed. Of course, this must be tried out when broadcasting is not in operation. The crystal and L.F. circuit is the one intended for broadcast reception. It was found desirable at times to be able to use the crystal only. This can be done by inserting the 'phones in the terminals marked "Telephones Crystal." The advantage of this will be seen when testing pieces of crystal, etc.; or perhaps if only one accumulator is employed, the crystal can be used while it is being recharged.

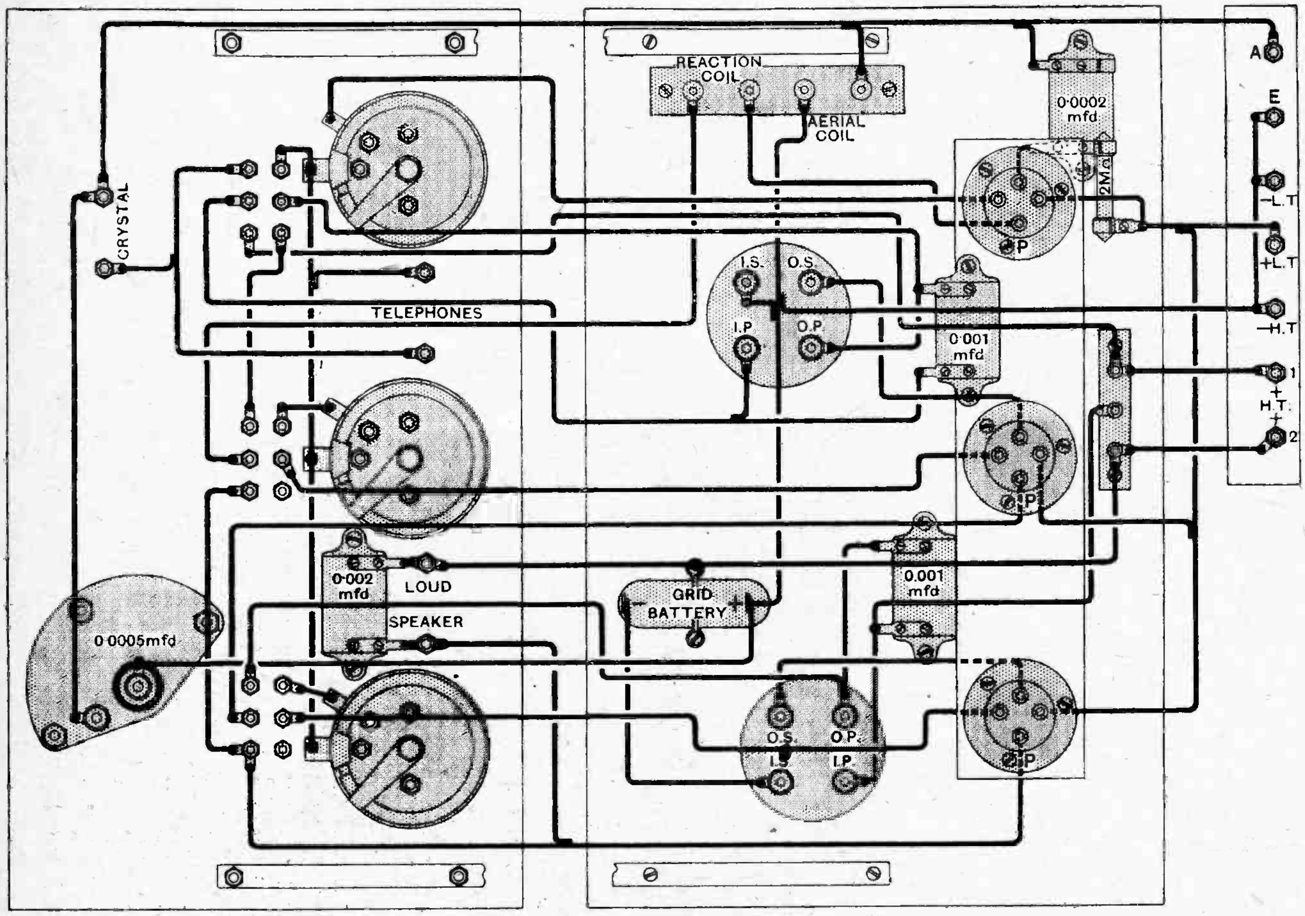
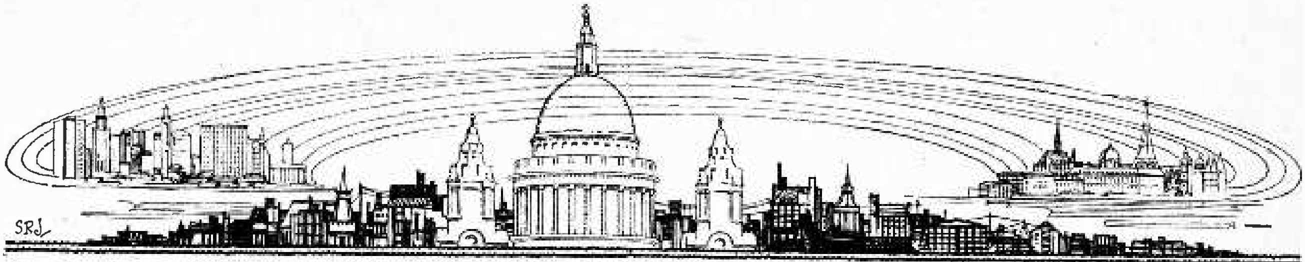


Fig. 5.—The complete wiring diagram.



CURRENT TOPICS

Events of the Week in Brief Review.

WIRELESS ON TRAINS.

The American Railway Association is experimenting with wireless telephony on goods trains to enable guards to converse with drivers.

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ANOTHER IRISH TROUBLE ?

Remarking upon the opening of the new Dublin broadcasting station, which will operate on a wavelength of 390 metres, the *Leicester Mercury* says that attention will doubtless be drawn to the injustice of Belfast having a longer wavelength than Dublin.

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BROADCAST PROGRAMMES ON THE 'PHONE.

A scheme whereby telephone subscribers would be able to pick up broadcast programmes is said to be under consideration in Holland. The subscriber would merely ring up his exchange, asking for "broadcast," and be switched through to the studio or a special receiving station.

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SHEFFIELD WIRELESS EXHIBITION.

Yesterday (Tuesday) saw the opening of Sheffield's first wireless exhibition, which is being held in the Artillery Hall, Edmund Road. The exhibition has been organised with the object of appealing to all wireless users, and particular attention has been given to the needs of the home constructor, for whose benefit a number of interesting competitions have been arranged. Prizes range from 10s. to £15, and entries include two-valve amplifiers, single valve receivers, and "whimsical and artistic" crystal sets.

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CANADIAN AMATEURS IN CONFERENCE.

Montreal has been chosen as the venue for a convention of Canadian wireless amateurs which will open to-morrow (Thursday) and continue in session for three days. Officially the gathering will be known as the Eastern Canada American Radio Relay League Convention.

A discussion on the various technical phases of amateur radio will be one of the principal items on the agenda, and much interest should be evoked by an address by Mr. F. H. Schnell, in which he will describe his recent experiences in operating the short-wave experimental station NRRL with the U.S. Pacific Fleet.

ESPERANTO CELEBRATIONS BROADCAST.

Special festivities at Stuttgart on December 5th in honour of Zamenhof, the inventor of Esperanto, will be broadcast from the "Suddeutscher Rundfunk."

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MUSICAL INSTRUMENTS.

A recent estimate indicates that 60 per cent. of the music stores in the United States stock wireless receivers.

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MUSIC ON THE MARCH.

A "radio band" featured in the inaugural procession of the recent Chicago National Radio Exposition. Military music played by a band at the broadcasting station KYW was received by a mobile station in the procession and diffused by loud-speakers so that the marchers were able to keep in step.

FLOATING RELAY STATION.

Isolated towns on the Ohio and Mississippi rivers will shortly enjoy the benefits of broadcasting. The Kodel Radio Corporation of Cincinnati has acquired a 37ft. cabin launch which will cruise on these rivers with a short-wave transmitter and will relay distant programmes.

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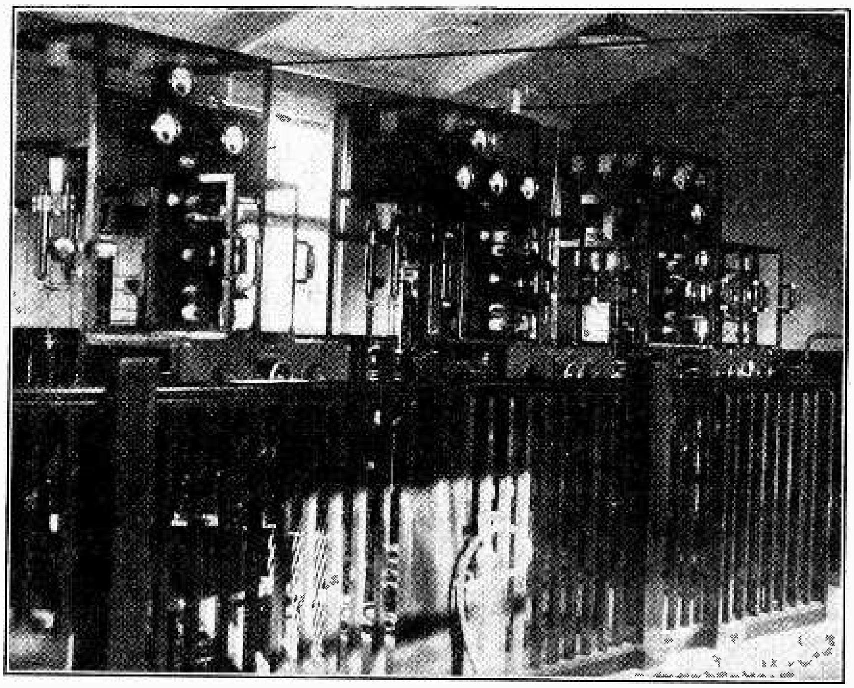
WIRELESS FOR SAFER AIR TRAVEL.

Emphasising the need for safer flying, in a lecture given before the Institution of Aeronautical Engineers on November 10th, Mr. M. L. Bramson stated that safety could be secured by the use of three-engined machines, increased wireless telephone communication between the machine and the aerodrome, improved altitude recorders and better direction finding apparatus.



FREE STATE BROADCASTING. A view in the transmitting room of the Dublin broadcasting station, which will open shortly.

NEWS FROM THE CLUBS.

We regret that pressure on our space this week compels us to hold over a number of interesting club reports until our next issue.

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RADIO ASSOCIATION ANNUAL DINNER.

The Duke of Sutherland occupied the chair at the annual dinner of the Radio Association, which took place at the Hotel Cecil on November 19th. Viscount Cecil of Chelwood, in submitting the toast of "Broadcasting," said that he regarded wireless as one of the most astonishing inventions that had ever been made in the history of the world, and, like other great inventions, it had come just when it was wanted. Mr. J. C. W. Reith (managing director of the British Broadcasting Co.), in his reply, asked Lord Cecil to use his influence to enable the company on December 1st to broadcast the proceedings in connection with the signing of the Locarno Treaty in London. With the co-operation of the broadcasting organisations abroad this historic event could be relayed throughout the Continent.

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TELEPHONY TO PORTO RICO.

A brief but interesting report of the reception of telephony from England reaches us from Senor Joaquin Agusty (4JE), of San Juan, Porto Rico.

On the night of October 31st Senor Agusty was in communication with Mr. Gerald Marcuse (G2NM), of Caterham, for more than an hour, during which Mr. Marcuse conversed with telephony, using perfectly good modulation. In spite of much atmospheric disturbance and interference, 2NM's speech was easily understood.

Our correspondent adds that this was not the first occasion on which he had heard telephony from Mr. Marcuse.

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ON HOLIDAY WITH A SUPER-HET.

We regret that an error occurred in the caption to Fig. 2 of the above article in our issue of October 21st. C_2 is a vernier condenser, while condenser C_3 has a capacity of 0.0005 mfds.

FREE STATE BROADCASTING. One of the masts of the new Dublin broadcasting station.

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NEW MARCONI DIRECTORS.

Sir Frederick J. Barthorpe, D.L., and Sir William Slingo, Engineer-in-Chief of the G.P.O. from 1912 to 1919, have been appointed to the board of Marconi's Wireless Telegraph Co., Ltd., in place of two retiring directors, Sir Charles J. Stewart and Mr. H. Morgan.

FORTHCOMING EVENTS.

WEDNESDAY, NOVEMBER 25th.

Radio Society of Great Britain.—General meeting. At 6 p.m. (tea at 5.30 p.m.). At the Institution of Electrical Engineers, Savoy Place, W.C.2. Lecture: "Review of Short Wave Development," by Capt. W. G. Miles of the Royal Marines.

Barnsley and District Wireless Association.—At 8 p.m. At Headquarters, 22, Market Street. Lecture: "The Care of Accumulators," by Mr. L. S. Dobson.

North Middlesex Wireless Club.—At 8.30 p.m. At Shaftesbury Hall, Bowes Park N. Loud Speaker Competition.

THURSDAY, NOVEMBER 26th.

Radio Society of Great Britain.—At 8 p.m. Mass Meeting in the Palm Court, Messrs. Selfridge's, London, W. See page 730.

Walthamstow Amateur Radio Society.—Lecture: "Heterodyne Wavemeters," by Mr. R. H. Cook.

FRIDAY, NOVEMBER 27th.

Sheffield and District Wireless Society.—Experimental Work. Measurement of Wavelength.

MONDAY, NOVEMBER 30th.

Swansea Radio Society.—Lecture by Miss Hawken.

Hackney and District Radio Society.—At 8 p.m. Discussion on Loud Speakers with comparative tests.

TUESDAY, DECEMBER 1st.

Halifax Wireless Club.—Lecture: "Distortionless Reception," by Mr. P. K. Turner.

Lewisham and Bellingham Radio Society.—"Demonstration with one valve, three batteries, and a junk box," by Mr. Riddle.

WEDNESDAY, DECEMBER 2nd.

Institution of Electrical Engineers.—At 6 p.m. (tea at 5.30). At the Institution, Savoy Place, W.C.2. Lecture: "The Performance of Amplifiers," by Mr. H. A. Thomas, M.Sc.

PROBLEMS OF AMERICAN BROADCASTING.

Mr. Hoover, the U.S. Secretary of Commerce, opened the fourth National Radio Conference on November 9th in New York. The problem of interference figured largely in Mr. Hoover's inaugural speech. Owing to the higher power now being used by American broadcasting stations, he said, the range of non-interference between stations using the same wavelength was decreasing. With only 89 wavelengths available for broadcasting, and more than 175 applications pending for new licences, the time had clearly arrived to abandon the policy of freedom of the air.

Observing that the policing of the ether traffic should obviously be a Federal responsibility, Mr. Hoover added that it would be preferable for local communities to decide who was to supply broadcast programmes, so that undesirable features might be eliminated. Advertising provided the broadcaster's principal revenue, but this should not mean that individuals and firms should monopolise a listener's set with details about their business and descriptions of their wares.

WIRELESS IN SCHOOLS. Sir Henry Thornton, the Canadian railway magnate now visiting this country, inspecting a wireless receiver made by the pupils of St. John's School, Ealing.

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FRENCH BROADCASTING CRITICISED.

A movement directed at improving the standard of French broadcasting programmes is being undertaken by the Société Française d'Etudes de T.S.F., the Radio Club de France, and the Association of Broadcast Listeners. In their indictment of present-day French broadcasting, the leaders of the new movement declare that the programmes more often than not are badly constructed, and do not compare in excellence with those of Britain and Germany.

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WIRELESS WINDOW DRESSING COMPETITION.

Prizes amounting to £50 have been awarded by the Radio Communication Co. in connection with the "Polar" Window Display Competition at the All-British Wireless Exhibition at the Royal Albert Hall. Competitors, it may be remembered, were required to judge twelve window displays, placing them in order of merit.

The prize-winners are as follow:—

FIRST PRIZE—£25.—Mr. L. B. Whisson, "Glenhurst," Linden Gardens, Leatherhead.

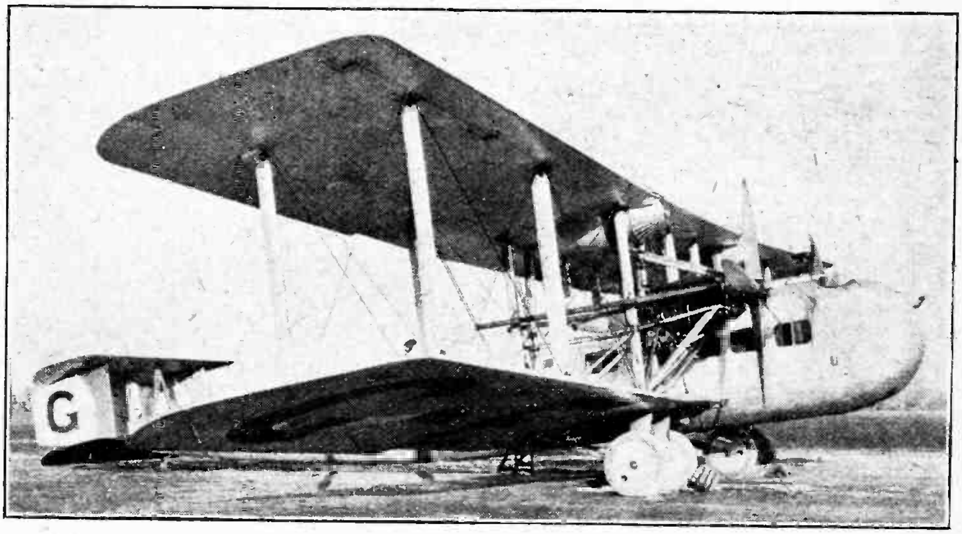
SECOND PRIZE—£15.—Mr. Thomas H. Wyatt, 24, H Block, Sutton Estate, Chelsea, S.W.3.

THIRD PRIZE—£10.—Master G. J. R. Bunn, 34, Barley Lane, Hastings, Sussex.

A CONCERT FROM THE AIR.

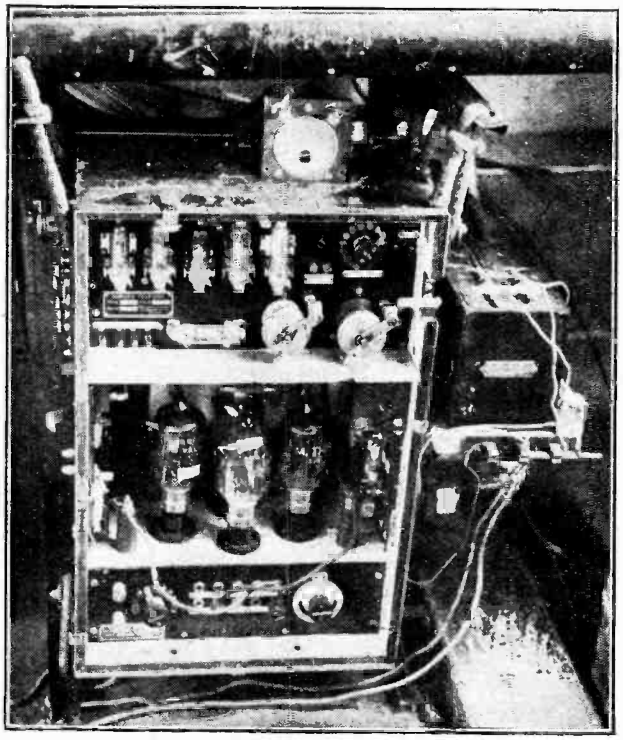
How the Aeroplane Broadcast was Carried Out.

By CAPT. A. G. D. WEST.



The Imperial Airways Vicker's Rolls-Royce Vanguard used for the air concert. It has a seating capacity of 20.

A BROADCAST transmission from an aeroplane is not a new idea, the B.B.C. having made previously two attempts to carry out programmes of this nature. But each of these was a speech transmission, and did not necessitate any modifications of the aircraft equipment for broadcast purposes. The latest idea has been to have a concert transmitted from the air, attempting to give music approaching studio quality. The B.B.C. were fortunate in having the co-operation of Imperial Airways, Ltd., in carrying out this experiment, this company supplying the necessary flying machines for the tests and for the concert itself. In all, ten flights were carried out by Imperial Airways for this purpose, of about an hour's duration each, so that the expense borne by this company was fairly heavy on account of the large amount of petrol consumed by these big aeroplanes. Thanks are due to Major Brackley, the Air Superintendent, for giving the B.B.C. every facility in this respect. Also we are greatly indebted to Mr. H. T. Sayer, the Marconi engineer in charge of the aircraft sets, for very valuable assistance in fitting the machines and in carrying through the experiments.



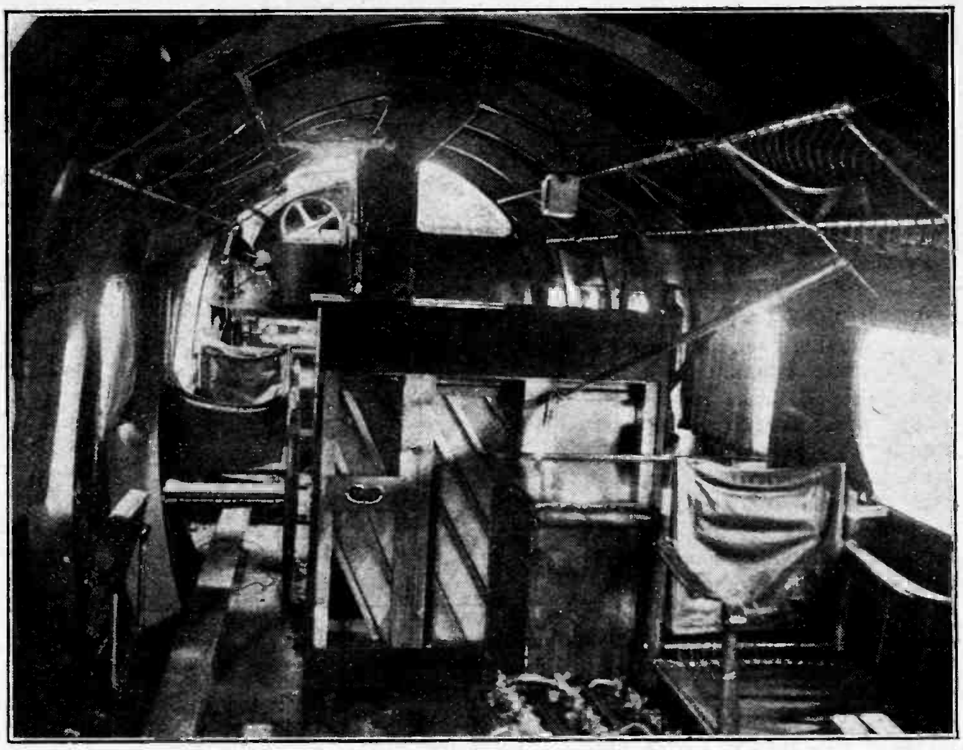
The partially modified transmitter used in the first tests.

The standard aircraft transmitter used by British machines employed in the cross-Channel services is the Marconi A.D.6 set. This consists of a choke control set with an oscillator, a control, and a sub-control valve, coupling between the latter being by a transformer. The H.T. is supplied by a wind-driven generator giving 1,500 volts at normal flying speed, with a floating six-volt battery for low-tension supply. There is also incorporated a five-valve receiver, taking its H.T. supply also from the generator, with change-over send-receive switches connecting up with the pilot's remote controls. This set, though extremely efficient for its own purpose—that is, long-distance speech telephony between air and ground—is not entirely suitable for broadcast purposes. The Marconi Company kindly lent one of these sets to the B.B.C. to be modified for our requirements. These modifications consisted first of all in removing the sub-control valve and circuit, the addition of extra control valves and of a special input transformer and a grid bias battery in accordance with the usual broadcast practice. The aerial and oscillatory circuits, designed to operate on 900 metres, were not touched.

First Experiments.

In the first experiments the oscillator valve was an M.T.5 (25 watt) valve, and the control system consisted of three M.T.5B.'s in parallel, taking feeds of 25 and 30 m/a respectively at 1,500 volts. This gave only a maximum permissible control of 50 per cent (*i.e.*, consistent with no blasting), corresponding to about 10 per cent average control. It was anticipated that this would be sufficient for the short range of transmission.

A Concert from the Air.—A change-over switch on the transmitter enabled the pilot's microphone or the cabin microphone to be used at will, the former being required to be brought into use for a demonstration of direction finding and communication with ground stations which was to be part of the transmission from the air. For the concert itself two microphones of a special carbon type were installed in the cabin, and a two-valve resistance-coupled amplifier to bring the strength up to that sufficient to operate the control system. It incorporated a strength control and also a galvanometer connected direct in the grid circuit of the control valves to indicate blasting.



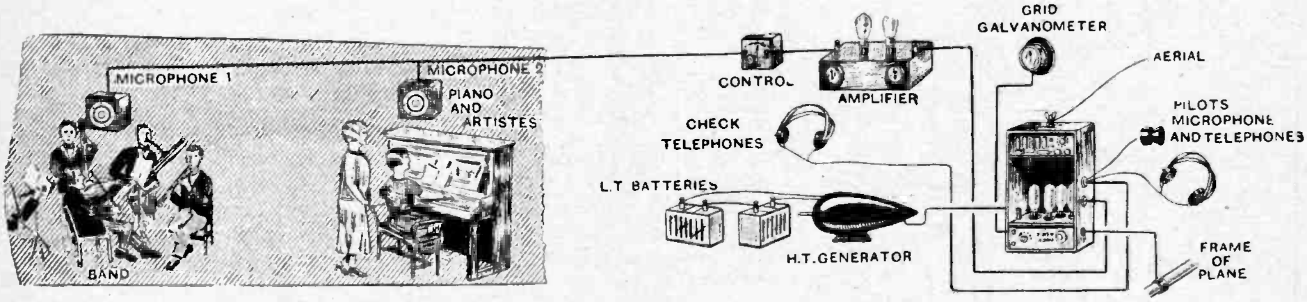
Inside of the cabin looking forward, showing the piano and one of the microphones.

Such a transmitter gave on the ground excellent studio quality, but when used in the air several difficulties presented themselves.

A first test using the microphones and amplifiers with music by some members of the 2LO orchestra was made in the cabin of a D.H.34 machine. The results were excellent when gliding down, but engine noise was predominant when climbing. A second test with the Savoy Orpheans was made in a Handley-Page, but in this case engine noise was very strong, and this, together with the vibration of the fuselage and the sound produced by the flapping of the outside canvas covering of the cabin, cut up the music very badly. The third and subsequent tests were made in the Vickers Vanguard, the largest passenger-carrying machine in the world, and it was found that excellent music could be transmitted when the engines were cut down to one-third full revolutions, the machine then rather hovering than flying or gliding. This limitation reduced the length of the concert to about twenty-five minutes, this being the maximum time taken to come down from 10,000 feet at this engine speed. It further cut down the air speed of the machine, and consequently the voltage generated by the wind-driven high-tension generator. As any drop in such voltage would result in a great loss of quality and strength, it was decided to install a motor generator inside the cabin, driven by large capacity low-tension batteries. The generator and smoothing system used was that actually installed two years ago at the Old Vic. theatre, when a short-wave transmitter sent opera to 2LO for re-transmission purposes. This generator maintained a steady voltage of 1,500, when running off 18 volts L.T. batteries.

Solving the Problems.

The difficulty of maintaining a voltage constant at all flying speeds was thus overcome, and, by means of interchangeable adaptors, it was arranged so that the transmitter worked normally from a wind-driven generator for the part of the programme consisting of a demonstration of position finding in which the pilot was to take part, and from the cabin generator for the concert part of the programme. Preparations were thus made anticipating successful transmission under the conditions of

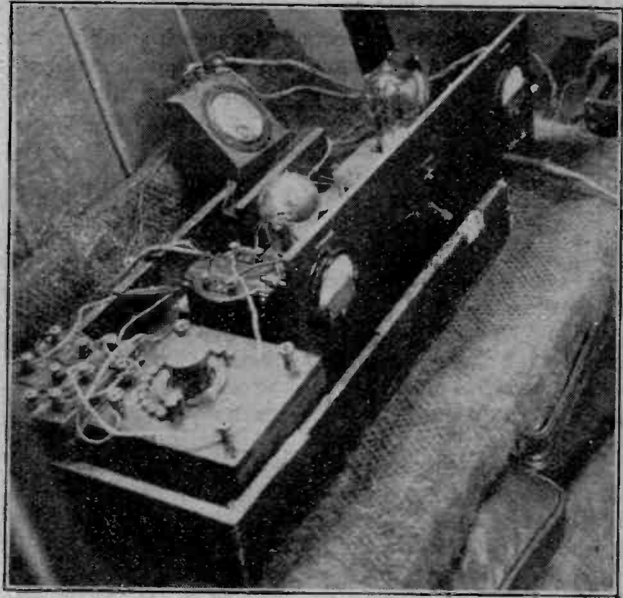


Schematic diagram showing the arrangement of the microphones and apparatus.

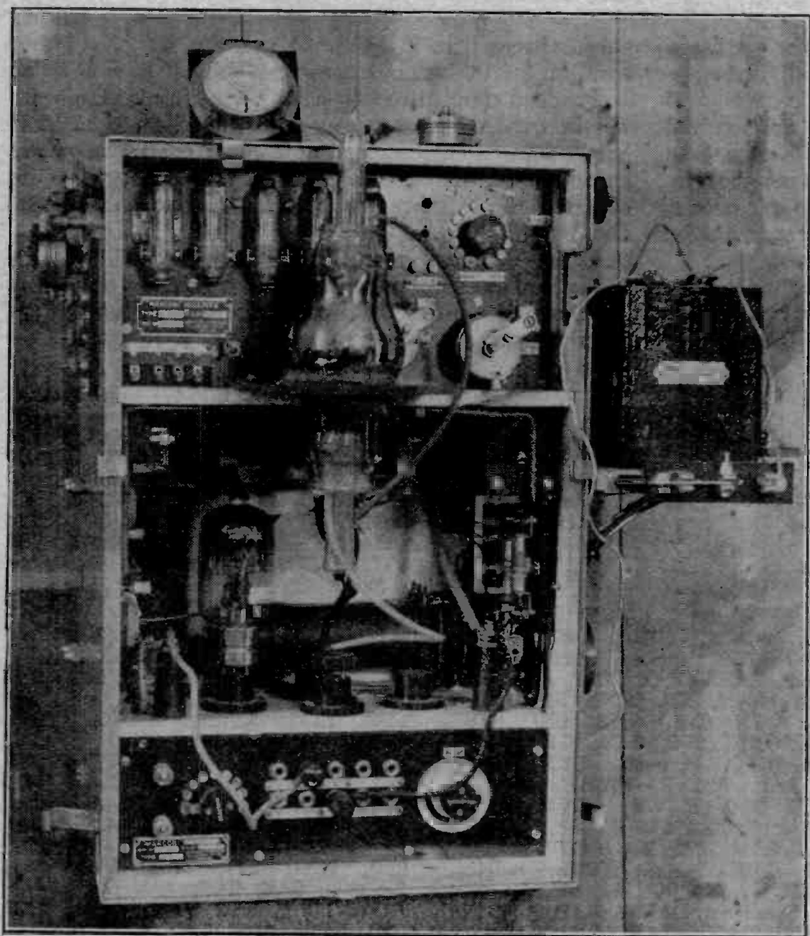
A Concert from the Air.—gliding down from 10,000 feet with engines cut down to one-third their maximum speed. Unfortunately, on the day on which the transmission was to take place (after being postponed from a previous date when a thick fog prevailed), the clouds were very low, at about 5,000 feet, and thus it was not possible for the machine to fly higher than this, as the concerts were taking place after dark, and the pilot had to keep Croydon Aerodrome in view all the time from the point of view of safety, as a slight ground mist was prevailing.

As the two concerts were to last for over a quarter of an hour each this necessitated, with a very heavy load on board consisting as it did of about twenty people, a piano, and heavy batteries to drive the generator, that the engine should be run between two-thirds speed and full speed to maintain height. It was found in a previous test under these conditions that the noise from the two Rolls-Royce 650 h.p. Condor engines, situated as they are within a few feet of either side of the cabin, was terrific, and it not only swamped music in the cabin but also cut up loud speech at a distance of more than three or four inches from the microphone.

As the engine noise tended continually to blast the control system of the transmitter, resulting in the retransmission of mainly noise and only faint sounds of music, it was decided at the last moment to make a complete alteration to the arrangement of the transmitter. First of all the microphones were bound up with several layers of cotton-wool. The object of this was to reduce the sensitivity of the microphone, thus cutting down engine noise and allowing the artists to come really quite close without blasting the microphone itself. Secondly, during the final test in the air the control system was completely changed, allowing a very much greater percentage in modulation consistent with quality, and giving a much greater margin, so that the engine pulsations by themselves should not blast the transmitter, thus cutting up the music transmitted. In place of the three valves previously mentioned one O/50 low-impedance valve was used as the main control valve, taking a feed of 42 m/a, and providing an average modulation of about twenty-five per cent. Reports on the test transmission, changing over from one control system to the other, showed that greatly improved results were obtained with the new system. The photographs show the appearance of the transmitter during the first tests and when finally modified for the transmission itself.



The speech amplifier control potentiometer and transmitter grid meter.



The modified transmitter as used in the actual concert.

Final Touches.

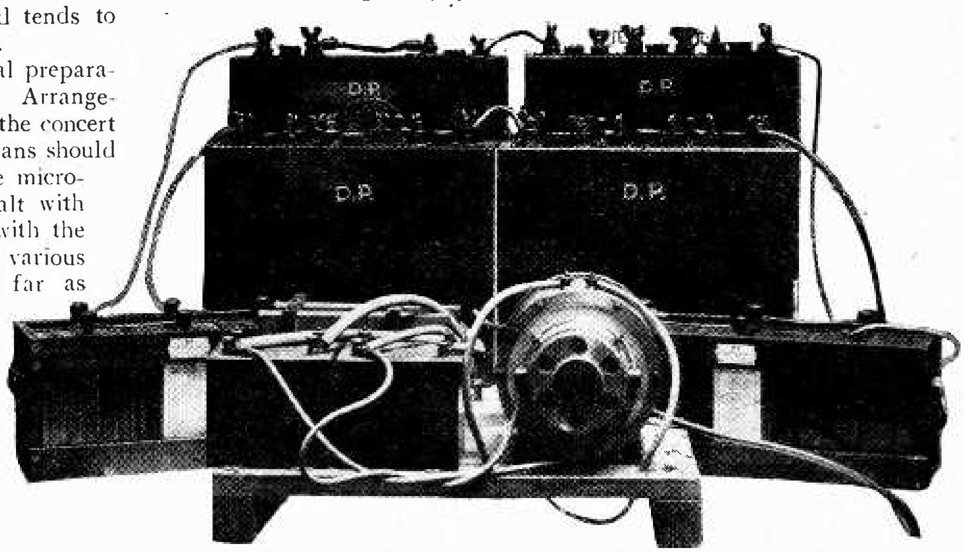
During the same test further final modifications were made which also tended to improve the quality. These consisted in the insertion of high-frequency chokes and double condensers with centre point

A Concert from the Air.—
earthed, in the lines connecting the speech amplifier with the input of the transmitter. An extra speech choke was also connected in series with the main high-tension supply, as the present speech choke in the transmitter is rather on the small side and tends to give a low-toned transmission.

This completed the technical preparations for the concert itself. Arrangements were made that during the concert the various artists and musicians should be as close as possible to the microphones. One microphone dealt with the orchestra, the other one with the artists and the piano. The various parts were balanced up as far as could be done.

It is interesting to note that during the concert in the air it was impossible for anyone else to hear actually what the announcer was saying or to hear the artists singing. Mr. Yearsley, of Messrs. Dix, Ltd., who provided the artists for the transmission, kept time throughout by signs; even the musicians themselves heard no other instrument but their own. It was really astonishing that under these circumstances any music at all was received at Keston and retransmitted; but it was received well, and, what was more, the engineers at Keston even sent it on to London in a better condition than they received it, as, by the careful use of a form of filter circuit, they were able to cut out a good deal of the engine noise and thus to purify the music that they received.

The maximum speed of the engines is 1,800 revolutions a minute, and if twelve cylinders fire every two revolutions the note of the exhaust is something of the order of 180 a second. This is, I suppose, the predominant frequency of the engine noise. This figure is confirmed by the fact that a beat note of one a second is produced when there is a difference of 10 r.p.m. in the speed of the engines (say, 1,800 r.p.m. and 1,790 r.p.m.). A simple calculation verifies it. Capt. Hinchliffe, the pilot, whose handling of the machine was very skilful, in view of the large dead (and live, especially the Savoy Orpheans) weight carried, managed most of the time to maintain height with an engine speed of 1,400-1,500 r.p.m., corresponding to a predominant note of 150 per sec. The filter operated to cut down the strength of frequencies round about this particular value.



High tension generator and batteries installed in the cabin.

Listeners on the ground had a much better idea of the music that was going on inside the machine than anybody actually there. It was therefore surprising that the retransmission was so good.

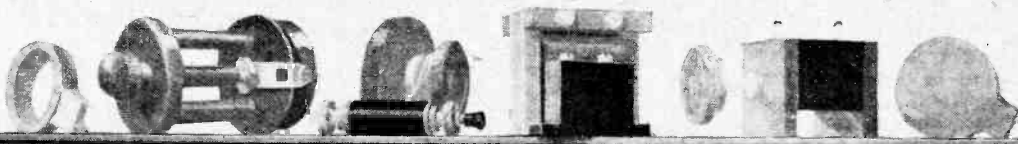
Calls Heard.

Extracts from Readers' Logs.

Manchester.
(October 12th to 28th.)
Great Britain: 2AO, 2CO, 2EL, 2FM, 2FO, 2OD, 2OJ, 5MO. 5ZU. 6YC. France: 8CH, 8CT, 8CV, 8CZ, 8DD, 8EE, 8FW, 8HHH, 8HSF, 8JA, 8JC, 8NA, 8NNN, 8PAX, 8PP4, 8RRA, 8TH. 8TK, 8TOK, 8UD, 8UDI, 8VV, 8VX. Italy: 1AA, 1BD, 1GB. Sweden: 8MXG. Germany: KXH, KJ5. Miscellaneous: BU3. BW3, FW, QROC, OCTU, NTT, IDO.
(0-1-1.) 30 to 90 metres. J. Barnes.

Horsens, Denmark.
(October 29th to November 8th.)
British: 2OJ, 2KT, 2CC, 2LZ. 2AO, 2AIN, 2OD, 2ZA, 2XV. 2SZ, 2AO, 2DX, 2NM (telephony), 2XY, 2WJ. 2RY, 2UF, 5MO, 5DH, 5DK, 5OC, 5XO, 5XY, 5SI, 5YK, 5NN, 5NJ, 5DA, 5LF, 5PM, 5FT, 5ZU, 5ID. 6VP, 6AH, 6RW, 6YC, 6GU, 6IZ, 6DO, 6OD, 6TD, 6TM, 6BD, 6YV, 6FH. French: 8GO, 8EB, 8PAX. 8HLL, 8TOK, 8QR, 8XH, 8VO, 8DGN, 8DTD, 8IL, 8JK, 8CA, 8VJ. 8GRA, 8PAD. 8XO. 8PC, 8DK, 8DN, 8DF, 8ZZ, 8LK, 8OFM, 8JD, 8JYZ. 8JF, 8RR, 8YOR, 8AIX, 8BGN, 8PKX. 8CS, 8WC. 8OWA, 8RBP, 8HU, 8RPX. Danish: 7ZM. Swiss: H9AD. H9XD. German: KK4, KK6, KK7, KY4. KJ2. Dutch: OAX, PC2, 9RNA, SNCC, PC7, STB, OGN, OII, ONB, ORO, OMS. OGG, OXX, 2PZ, PB3, OKV, OPX. OPM, OWC. Bermuda: BER. Brazil: BZ. 1AF, BZ1AB, BZ5AU. Swedish: SMUZ, 2CO, SMWF, SMVR. SMYV, SMTN, SMZZ. SMPF. SMVL, 5NF. 1MA, 2CA, SMUK, SMUV, SMXU, 2MM. 9HS, NLAB, F2ND. Belgian: G6, R2, S2. X9, U3, A1, W3, D1, 4RS, 5H. Spanish: EAR9, EAR10, EAR6, EAR22. Italian: 1AS, 1BD, 1GB, 1GN. 1YB. 1AU, ICX. 1SZ, 1FM, 1BB, 1AF. Jugo-Slavia: 7XX. Czecho-Slovakia: OK1. Canadian. C2AA. New Zealand: NZ4AA. NZ1AN. American: 1AAO, 8XW, 1CKP. 3LW, 1RR, 1ACI, 2AHM, 2AKB, 2AGY. 2CXL. 2MM. 2BGM, 1ARH. 2ZR, 2CKY. 1RF. 3HG, 2FD, 2ZV, 2CGJ. 3ATQ, 9EKY, 2XAF. NKF, NUTT. NTT, W1R, W1Z, WQO, N1SM. Others: OKH. 4LA. GHA, LA4X, GCS, FW. PCUU, 1RM, 4PA.
(0-v-1.) R. Kipling.

Coventry.
U.S.A.: 1AAO, 1APU, 1AFF, 1AY, 1AB. 1ARH. 1AIR. 1CAK, 1CKP, 1CRE, 1CMX. 1CMF, 1CLN, 1CH, 1EF, 1KA, 1LW, 1MY, 1PL. 1SI, 1XM. 1YB. 1ZA, 2AHM, 2AGO, 2CPA, 2CVJ. 2KR. 2WR, 2XAF, 3AMQ, 3CHG, 3JO, 4OA, 4TY, 6CGW, 8DME, 8GZ, 8SF. Brazil: 1AC, 1AB, 1AF, 1AV, 1AN, 1IA, 2SP, RGT. Argentine: AF1, CB8, DB2, DM9, FG4. Mexico: 1AA, 1K. India: HBK. Australia: 2LO, 2CM. 2YI. 3BQ, 6AG. New Zealand: 2AE. 2AC, 4AK. Various: NISR. NISP, NTT, NVE, NPP, NKF, GB1, LA1A. ANE, MAROC.
(0-v-1) on 30-40 metres.
Brian W. Warren (G6CI).



REVIEW OF APPARATUS

Latest Products of the Manufacturers.

OSCILLATING CRYSTALS.

Specimens of crystals specially intended for use in oscillating crystal circuits are now obtainable from Aneloy Products, Camomile Street Chambers, Camomile Street, London, E.C.3, under the name of the Aneloy Mineral Oscillator.

In order to assure the user that the specimens can be relied upon to produce oscillating effects, a laboratory test is applied to every specimen, and a statement endorsed with the signature of Mr. L. L. Barnes accompanies the crystal. Mr. Barnes will be remembered as a contributor to the pages of this journal of several articles describing practical methods of setting up oscillating crystal receiving sets.

The Aneloy oscillating crystal with laboratory test certificate.

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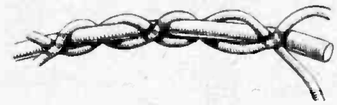
NEW WIRE FOR TUNING COILS.

The difficulty of providing spacing between the turns of wire when winding a tuning coil is overcome by employing the new "Air Space" wire recently introduced by Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex.

It is often exceedingly difficult to wind the wire with uniform spacing from turn to turn, and the result is achieved with this new wire by overwinding it with a double thread. Two threads are uniformly wound over the bare wire in opposite directions so that adjoining turns will remain spaced by a uniform distance.

There is little doubt that the spaced winding is one of the best methods to employ in the construction of tuning coils and this new wire, whilst providing the necessary pitch, maintains practically an air spacing from turn to turn. The thread, of course, only covers a portion of the surface of the wire, making it superior probably to any form of conductor with even a liberal thickness of cotton covering. The wire is obtainable in several gauges and either as a stranded or solid conductor.



An enlarged view of the "Air Space" wire manufactured by Belling & Lee, Ltd. The conductor is overwound with a double thread to provide spacing from turn to turn in the construction of inductance coils.

Coils wound with this wire, whilst possessing an attractive appearance, should possess lower self-capacity with lower dielectric losses than coils wound with cotton or silk-covered wire, resulting in an improvement both in signal strength and selectivity.

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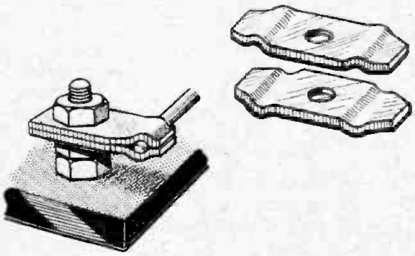
THE CLINCHER CONNECTOR.

Now that terminals are invariably nickel-plated it becomes difficult to make a soldered connection, and, moreover, soldering is not always desirable, as the stem of the terminal is liable to become overheated and loosened in the ebonite, while solder in the threads of the screw makes the removal of the back nuts difficult. Soldering tags can, of course, be employed. A better solution is, perhaps, to employ the small brass stampings now manufactured by G. H. Parker, of Muswell Hill, London, N.10. Made in both single and double types, several wires can be clamped together and soldering entirely obviated.



The Clincher Connector.

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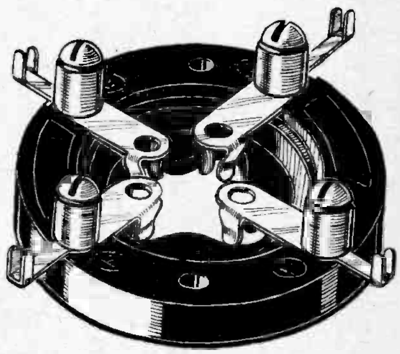
THE TONEX VALVE HOLDER.

An interesting form of low capacity valve holder is now produced by the Tonex Company of Blackpool. It consists of a clean bakelite moulding in the form of a ring upon which the contact pieces are mounted. The valve contacts are in the form of light clips, though a special feature (not shown in the accompanying illustration) is the finish applied to the contact faces which resemble the surface of a file and therefore ensure reliable contact.



Tonex valve holder.

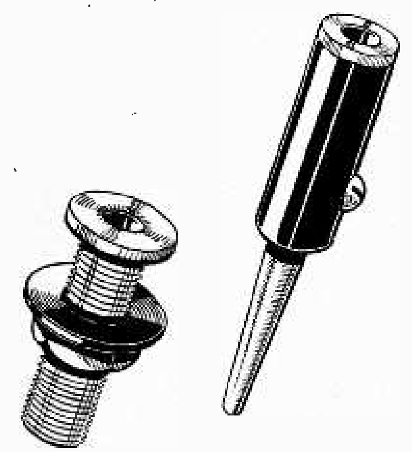
In mounting the holder on the instrument panel a hole 1¼in. in diameter is required to give clearance to an extension on the moulding on the underside, and the manufacturers appreciating that the making of this hole will be difficult to the majority of purchasers have made an arrangement with retailers to undertake this work without charge on presentation of a coupon which accompanies the holder.

It is doubtful if a valve-holder presenting lower capacity between its terminals can be produced while the file-like surface on the connectors will maintain the connecting pins of the valve in a bright condition.

TAPA PLUG AND SOCKET CONNECTER.

One of the first types of plug-and-socket connecter to be introduced was manufactured by W. J. Charlesworth, 88-89, Aston Street, Birmingham.

This connecter depends for a reliable contact between plug and socket upon



Tapa plug and socket.

the use of a tapered plug fitting into a tapering hole in the socket, and will therefore not work loose as in the case of a split pin, where the two halves close together after prolonged use. The insulated sleeving on the plug is made to match in colour a small disc which is inserted under the socket. All plugs are interchangeable, and connection is made with flexible wire by means of a screw or by soldering. The metal parts are given a nickel-plated finish.

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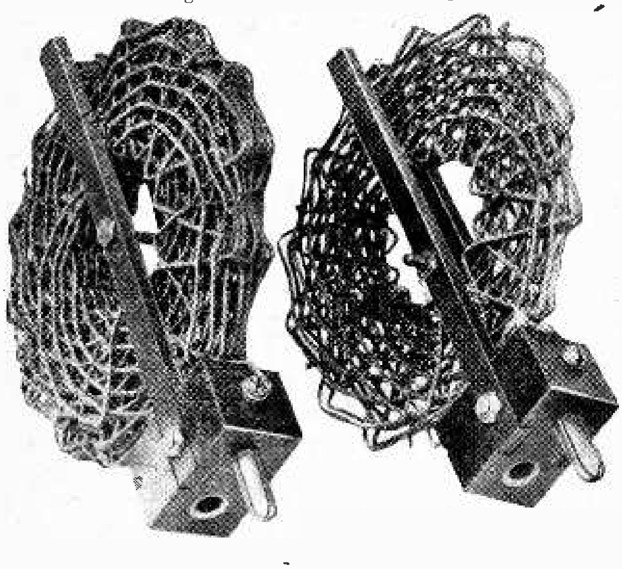
MARS COILS.

A set of coils of the rather unusual construction shown in the photograph has recently been submitted for test. The method of winding the coil results in a low value of self-capacity, whilst on test the high-frequency resistance was also found to be unusually low, a property that is probably accounted for largely by the fact that the wire used is stranded. The strands are of fine copper strip instead of the usual wire of circular section.

The manufacturers might to their advantage give a little more attention to the mechanical robustness of the coils, if this is permissible at the price at which the coils are marketed.



Mars tuning coils.

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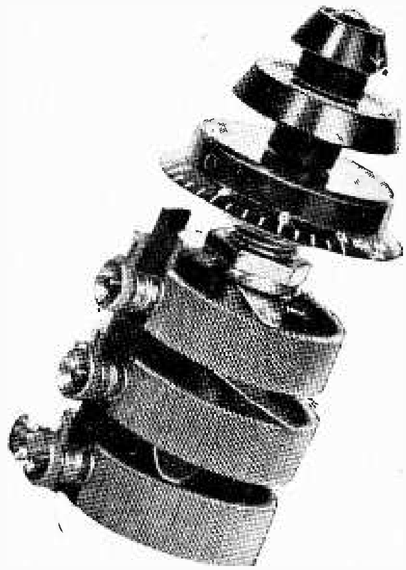
TRIPLE FILAMENT RESISTANCES.

Under the name of the Multistat, the Engineering Works (Electrical and General), Ltd., are manufacturing a component combining three filament rheostats and fitted with a triple concentric knob control. The obvious advantage of the arrangement is that only a minimum of panel space is occupied.



The Multistat Triple Resistance is a well finished component occupying very little panel space.

The design makes use of two hollow spindles with a third spindle passing through its centre. Behind the panel each spindle carries an arm held in position with a set screw which moves over the resistance winding, the latter being carried on a fibre strip. The metal parts are of nickel-plated brass and the resistances are wound with Eureka wire.

Judged from their clean finish it is probable that the operating dials are turned from ebonite rod and consequently present a much more attractive appearance on the face of the panel than the common form of moulded knob. One hole fixing is employed for attaching to the panel.

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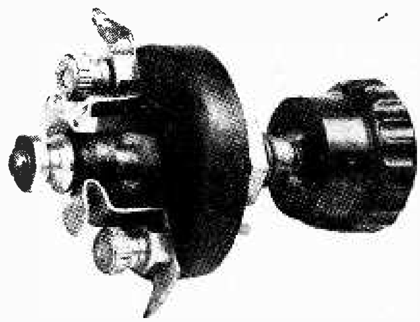
LAMPLUGH SWITCH.

It is common practice in receiver construction to fit a simple on-and-off switch to break one of the filament leads. Messrs. S. A. Lamplugh, Ltd., Kings Road, Tyseley, Birmingham, have introduced a switch for this purpose provided with one hole fixing and the knob operating as a plunger is depressed to break the circuit



A useful switch for breaking the filament battery circuit.

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TRADE NOTES.

Wireless Repair Service.

New repair premises for car and radio work are to be opened by Messrs. Peto and Radford on December 1st at 107a, Pimlico Road, London, S.W.1. The company will specialise in maintaining a prompt service.

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A Superheterodyne Demonstration.

No fewer than 19 broadcasting stations were picked up in Wilmslow, near Manchester, at a recent demonstration of the new Igranic six-valve superheterodyne receiver by engineers of the Igranic Co. Excellent loud-speaker reception was obtained in spite of a thunderstorm in the district.

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Wireless in London Hospitals.

During the past few months wireless receivers have been installed by the Oxford Wireless Telephony Co., Ltd., in seventeen London hospitals, largely as a result of generous contributions by readers of *The Daily News*. All the sets have been equipped with Osram valves, the U3 being used for rectifying purposes in hospitals where alternating current is available, and the LS5 as the amplifying unit.

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New Igranic Offices.

West of England readers may be interested to learn that Messrs. Igranic Electric Co., Ltd., have opened a new office at British Dominions House, Tramways Centre, Bristol.

HOW TO CHOOSE A CRYSTAL.

Appearance and Properties of Active Specimens.

By A. HINDERLICH.

IN choosing crystals attention should be paid first to the presence of impurities, and then to the nature of the surface. From the wireless point of view the mineral impurities in crystals are mostly non-rectifiers, if not actually insulators, and in choosing a specimen great attention should be paid to these foreign bodies lest they prevent proper electrical and physical access to the rectifying substance itself.

There are three types of surface to be met with in practice. For rectifying purposes, one that is *abraded* or artificially flattened by filing, etc., will be found practically useless. A true cleavage (separation along the natural surfaces of the crystal) is rarely met with, and is then found to be unsatisfactory. The type of surface wanted is a fracture, *i.e.*, a clean break across the natural grain of the crystal.

The crystals in common use may be grouped as follows:—

1. *Carborundum* (SiC) with steel.
2. *The Perikons:* Zincite (ZnO) and Cassiterite (SnO_2) with Bornite (Cu_3FeS_3), Copper Pyrites or Chalcopyrite ($Cu_2S.Fe_2S_3$), Tellurium (Te).
3. *The Catwhisker Group:* Silicon (Si), Galena (PbS), Iron Pyrites (FeS), Molybdenite (MoS_2) with almost any metal.

The outward appearance is no real guide to rectifying excellence, but a preliminary examination along the following lines will weed out a lot of doubtful specimens.

Substance.	Desirable Appearance.	Impurities to be Avoided.
Carborundum....	Metallic	Brightly coloured varieties often poor.
Zincite..........	Small pieces, deep ruby red. Large pieces, deep red to bright black with ruby gleams.	Orange patches, whitish, yellowish or orange veins. Dull black spots. Yellow zincite, white bloom.
Cassiterite.......	Rich black	Chocolate colour.
Bornite	Bright metallic, almost any colour.	Small embedded quartz crystals. Amethyst.
Chalcopyrite.... / Copper Pyrites..	Bright golden yellow, often tarnished.	Embedded quartz.
Tellurium	Silver white, metallic	Dull patches.
Galena..........	Lead white	—
Silicon	Bright lead-white ...	Dull patches.
Molybdenite	Bright lead-white ...	Green or yellow patches.
Iron Pyrites	Bright golden yellow	Dull patches.
Metals	Bright	Any sort of tarnish.

Durability.

Although crystal detectors are nominally loose-contact devices, an appreciable amount of wear is sure to occur in time. This will be least annoying if the two substances are approximately of the same hardness and care is taken that of the pair the one that is difficult to pick should be the harder, while the one that is easier to replace should be the softer. The following table of hardness numbers on Mohs' scale will serve as a guide:—

				Steel	7
				Iron Pyrites ..	6
		Cassiterite...	7	Silicon	5
		Quartz......	7	Copper	3
Carborundum..	9	Zincite......	4½	Gold (9ct.)	3
Steel	7	Chalcopyrite.	3½	Galena........	2½
		Bornite	3	Silver.........	2½
		Tellurium ..	2½	Gold (assay) ..	2½
				Molybdenite ..	1½

We thus see that for durability carborundum-steel is excellent. The Perikons seem good, but with bornite and chalcopyrite there is always the danger of uncovering a crystal of quartz embedded in the mass and damaging the zincite. With tellurium this danger does not exist. Silicon and iron pyrites are safe with any metal except steel, but with galena and molybdenite only soft silver or pure gold should be used ("pure 9ct. gold" is only 37½ per cent. gold and noticeably harder than pure gold).

Brittleness also affects durability. It must not be confused with softness. Thus carborundum is hard but rather brittle, while molybdenite is soft but not brittle. Allied to this is the question of transverse strength. Though every care should be taken to avoid side pressure or shear stress and bending stress, this is not always possible. However, no trouble should be experienced if thin splinters are avoided and due care is taken with the detector design. Molybdenite alone calls for special treatment.

Chemical Action.

Rectifiers are subject to two types of chemical action. The metals are liable to tarnish, *i.e.*, become coated with a film of oxide or sulphide, which may change eventually to sulphates or other non-rectifying substances. Either of these coatings requires removal before the substance is fit for use again, which in practice is often done unconsciously by scraping during adjustment of the crystal, so hastening the destruction of the crystal surface.

The trouble may be avoided, either by using a metal such as gold that does not tarnish, or better still by putting over the crystal a layer of thick non-acid grease such as vaseline. The latter has the additional important advantage of steadying a light catwhisker.

Excessive current causes peculiar effects, which generally result in loss of sensitivity. The trouble may arise from violent atmospherics, proximity of power circuits, or be inherent in certain reflex circuits. Carborundum and molybdenite are remarkable in their indifference to violent electrical shocks, the Perikons are not bad, but the catwhisker class are a continual source of annoyance in this respect.

CRYSTAL DETECTORS.

The Electrical Properties of Contact Rectifiers.

By F. M. COLEBROOK, B.Sc., D.I.C., A.C.G.I.

(Concluded from page 483 of the October 7th issue.)

In this the concluding section of the article the author deals with the application of crystal detectors to wireless reception.
The theoretical aspects of crystal rectification have been fully dealt with in the three previous sections of this article, which appeared in the issues of Sept. 2nd, Sept. 23rd and Oct. 7th.

IN considering the application of crystal detectors to the reception of wireless signals, some distinction is to be made between direct reception and receiving systems in which a crystal is used in association with one or more valves in such a way that the load imposed by the crystal on the receiving circuit can be reduced by means of retroaction.

Actually the distinction between these two cases is more apparent than real, for in each there is a definite upper limit to the high-frequency energy available for conversion into modulation-frequency or continuous e.m.f.s or modulation-frequency or continuous power. The case of direct reception will be considered first.

Direct Reception with Crystal Detectors.

To the best of the writer's belief the actual energy conditions of the reception of wireless signals on an aerial have not yet been fully worked out. There is, however, a certain amount of evidence[1] for the inherently probable view that the e.m.f. induced in an aerial by any given transmission is practically independent of the power absorbed by the aerial and the receiving system.

Under any given conditions the power consumed in the aerial can be divided into two parts: (1) the total energy losses in the aerial itself and the earthing system, (2) the total losses in the tuning and detector circuit. The line of division can be taken as passing through the aerial and earth terminals of the receiving set. The power absorptions in these two parts of the receiving system are not necessarily independent, but it is very probable that the maximum power will be consumed in the tuning and detector circuit when the two are equal. Though inherently probable, this is admittedly a matter on which further experimental evidence is desirable. Assuming for the present that it is so, then there is clearly an upper limit to the amount of power available in the tuning and detector circuit. The losses in the detector circuit can again be divided into two parts: (*a*) resistance and other losses in the tuning coils, and (*b*) the power absorbed by the detector circuit, *i.e.*, the crystal and telephone or other load. As between these two, however, there is no optimum distribution, *i.e.*, the best condition is when (*a*) is as small as possible. This latter condition means that the actual tuning coils and any condensers associated with them should be of low loss construction. This is, of course, a large subject in itself, and will not be further considered here.

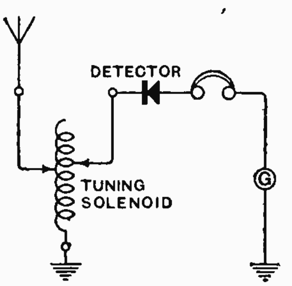

Fig. 21.—Crystal receiver for large signal amplitudes.

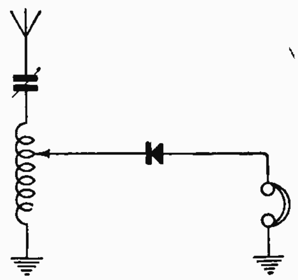

Fig. 22.—Circuit suitable for crystal reception of weak signals.

Coming now to the losses in the detector circuit itself, the nature and variation of these have been considered in some detail in the preceding sections. It should be clear that for the reception of speech or music modulated continuous waves there will be some best value of telephone resistance depending chiefly on the signal strength and the detector. Probable values have been indicated. There is, in addition, an optimum value for the power consumption in the detector circuit as shown above. The obvious way to realise or to approximate to this optimum condition is to vary the e.m.f. acting across the detector circuit. Practical methods of doing this have been described by the writer in previous papers in *The Wireless World*.[2] It will, perhaps, be well briefly to recapitulate these.

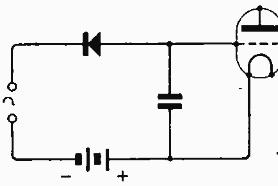

Fig. 23.—Crystal detector connected for potential rectification.

For moderately large signal amplitudes, using a detector of the galena type, *i.e.*, of fairly low internal resistance, and with telephones of 500 ohms or even 250 ohms resistance, the best arrangement is that illustrated in Fig. 21, the detector circuit e.m.f. being stepped down by means of the detector tapping illustrated, and the most suitable position being found by trial. In general, the lower the telephone resistance, the nearer will be the detector tapping to the earthed end of the coil. On the other hand, for distant reception, *i.e.*, for small signal amplitudes, it is probable that the series condenser arrangement shown in Fig. 22, with fairly high resistance telephones, 2,000 or 4,000 ohms, will be more suitable. This arrangement will also be more suitable for any detector, such as carborundum, which has a high

1 "Aerial Tuner Design," Medlam and Oschwald. *Experimental Wireless*, July, 1925.

2 "What Is The Best Circuit for Crystal Reception?", *The Wireless World*, April 30th, 1924.
"More About Crystal Reception," *The Wireless World*, April 23rd, 1924.

Crystal Detectors.—

internal resistance. The effect of the series condenser is to give a step-up of voltage across the inductance, thus increasing the power consumption in the detector circuit.

In the papers referred to the writer gave experimental curves illustrating the effect of varying the e.m.f. across the detector circuit, and confirming the general character of the analysis.

Before leaving this side of the subject it will be well to point out no very striking increase in apparent telephone intensity is to be anticipated as the result of improving the circuit conditions, unless they are very inefficient to start with. A physiological factor comes in here, *i.e.*, the law connecting sensation and stimulus. It seems to be generally agreed that sensation is proportional to the logarithm of the stimulus. This would mean that the acoustical output of the telephone has to be squared before the sound intensity is apparently doubled. However, improved circuit conditions may make all the difference between comfortable and barely sufficient sound intensity. In any case, there is a certain satisfaction in knowing that the reception is as good as can be obtained under the given conditions.

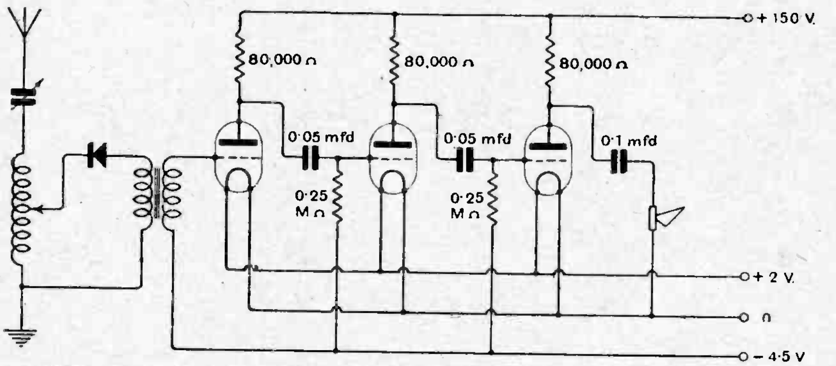

Fig. 24.—Practical circuit for a crystal receiver with resistance-coupled low-frequency amplifier.

Crystal in Association with Receiving Circuits. Crystal-valve Combinations.

This is, of course, a very extensive subject, and will probably be considered more fully in a later paper. There are, however, one or two points arising out of the present article which will be dealt with now.

The principal things to be borne in mind in the design of crystal-valve combinations are, first, that a crystal is most effective both as to sensitivity and freedom from distortion for moderately large signal amplitudes, *i.e.*, greater than about 0.4 volt; secondly, that the operation of a crystal detector involves the introduction of a certain amount of damping into any circuit to which it is connected, so that provision should be made for retroaction direct into the circuit associated with the detector.

A good example of a circuit arrangement which can be considered satisfactory in both these respects is that described by P. K. Turner in *Experimental Wireless* of July, 1925. This is a reflex arrangement in which the crystal is preceded by two stages of high-frequency amplification, the second stage being directly coupled to the aerial.

As far as the low-frequency side is concerned, the crystal can, of course, if desired, operate telephones directly as in ordinary crystal reception. As already explained, however, a crystal is particularly efficient as a rectifier of potential, by which is meant its employment in circuits in which the load is such as to reduce the rectified current to zero or to a very small amount. For this reason it is usually advantageous to use after the crystal a valve on the grid of which the rectified potentials are allowed to operate either directly, as shown in Fig. 23, or through the medium of a low-frequency transformer. A circuit of the second kind is shown in Fig. 24. This latter circuit, by the way, details of which have been described elsewhere by the writer,[1] is very satisfactory for obtaining good quality reproduction of loud-speaker volume at comparatively short distances (up to 15 miles or so) from a transmitting station.

The use of a low-frequency transformer in conjunction with a crystal is a matter which calls for a further comment. It might be thought that this would detract from one of the principal advantages derivable from the use of a detector, *i.e.*, freedom from distortion. This, however, is not the case, provided that the secondary of the transformer is on open circuit, as it will be if sufficient negative potential is applied to the grid of the valve to which it is connected. Under these conditions the transformer can be considered to act as a potential transformer, and the primary potential is practically the full rectified potential given by the crystal, since the impedance of the primary winding will be high compared with the effective internal resistance of the crystal. This latter is an essential condition for purity of reproduction, just as it is in the corresponding case of the association of the transformer with a valve. For use with a crystal the primary impedance need not be quite so high as for use in the anode circuit of a valve, and, therefore, for a given secondary winding a higher ratio is permissible. (This applies only to the use of crystals of compartively low effective internal resistance, such as galena, for which an 8 : 1 ratio is suitable.)

Space will not permit of a fuller discussion of the details of various possible crystal-valve combinations, but the principles considered above will be found to be of general application.

The Effect of Various Conditions of Operation on the Performance of Crystal Detectors.

Contact Conditions.—(*a*) *Galena.*—During the course of the experimental work involved in the investigation, an attempt was made to determine the effect, if any, of the nature of the contact metal or "catwhisker." The inherent variability of the crystal and the impossibility of reproducing exactly similar conditions for the various cases, made it very difficult to draw any very definite conclusions, but no pronounced effect attributable to variation of the contact metal was observed. It appeared that the effect of variation of the contact metal is, in any case,

[1] "Further Notes on Resistance Capacity Amplification," *Experimental Wireless*, Sept., 1924 (p. 712, Vol. I).

Crystal Detectors.—
less than the effect of variation of the actual point of contact.

An attempt was also made to determine the effect of contact pressure, but, for the same reasons, no conclusive results were obtained. It seemed, however, that this detector is not very sensitive to contact pressure provided the latter is not too heavy. The maximum pressure given, say, by a spiral spring of No. 26 or 28 copper wire of about $\frac{3}{16}$in. diameter is certainly not excessive.

One factor, however, which had an appreciable effect was the fineness of the point of contact. The measurements, referred to in this paper, were made with a contact consisting of a very finely pointed piece of silver foil, but it has since been found that an apparently even more effective contact can be made with a very sharp steel point soldered on to the end of a copper spiral. The point was prepared by taking the smallest size of needle obtainable and then sharpening the point of it on a wheel faced with the finest grade of emery paper. This may sound like painting the lily, but it will be found that the point of even a very small needle is not nearly as sharp as it can be made. Steel is probably the only metal which will give a sufficiently fine point of sufficient strength, but it is, of course, liable to surface oxidation or rusting. This can be prevented very effectively by immersing both the crystal and the contact in an oil bath of any light mineral oil. (The latter should be free from suspended particles, and provision should be made for excluding dust.)

(*b*) *Perikon.*—In this case very definite conclusions were obtained as to the effect of variation of contact pressure. It was found that a heavy contact pressure gave a very much greater no-load sensitivity with a maintained input e.m.f. An increase of up to 500 per cent. was obtained by increasing the contact pressure. With a high resistance load, however, the effect was reversed, and was smaller in magnitude, the rectified current decreasing by a small amount (30 per cent. or so).

These effects can be explained very simply in terms of the rectified e.m.f. and the effective internal resistance. The decrease of sensitivity with a high resistance load indicates that there is a small decrease of the rectified e.m.f., and the increase of the no-load sensitivity indicates a very considerable decrease in the effective internal resistance. An examination of the static characteristics corresponding to light and heavy contact pressures revealed the cause of these changes. It was found that with a heavy contact the conductivity of the crystal was considerably increased in both directions. This would lead to the decrease in the effective internal resistance, and also, in some cases, to the decrease in the rectified e.m.f. Further, it would tend to lower the input high-frequency resistance and the efficiency of transformation. This is consistent with the fact of experience that a fairly light contact is preferable for direct reception with a perikon detector, particularly for weak signals. It may be concluded that the holder for a perikon detector should be designed on fairly massive lines to secure rigidity, and should permit of the fine and smooth adjustment of the contact pressure.

Variation of Sensitivity with Radio-frequency.

All the measurements described were made at a constant radio-frequency corresponding to about 400 metres wavelength. The effect of variation of radio-frequency, all other conditions remaining constant, was determined, and was found to be exceedingly small. The greater part of the variation occurs from 300 to 10,000 metres, and it may be that this is due to a defect in the experimental method, though careful precautions were taken. In any case, the total effect is inconsiderable. (It might be mentioned at this point that the actual performances of both galena and perikon detectors, though showing quite good qualitative agreement with the form of the static characteristics, is not generally in quantitative agreement. This is probably a consequence of the fact that an appreciable time-lag is observable in the establishment of a current-potential equilibrium under static conditions.)

General Conclusions.

The chief merits of crystal detectors, apart from the practical considerations of cheapness, simplicity, etc., are their high intrinsic sensitivity and the purity of the reproduction of modulation obtainable with them. By the intrinsic sensitivity is here meant the output energy per volt of in-put potential. To obtain this high intrinsic sensitivity, however, the appropriate conditions of operation must be employed. These have been indicated above. Assuming these suitable conditions of operation, then the intrinsic sensitivity of a crystal is in general considerably higher than that of a valve. It must be borne in mind, however, that the actual effective sensitivity in a receiving system can be made much higher with a valve than with a crystal, since the proper use of a valve permits of the minimisation, by means of retroaction, of the damping effect of the detector on the receiving circuit. This does not mean that the energy efficiency of the process is greater for a valve than for a crystal, but that a valve can be made to increase the input energy, and so give a greater output energy than a crystal. For these reasons it can be stated that the most effective rectifying arrangement of all is one in which the energy regeneration afforded by a valve is combined with the high intrinsic sensitivity of the crystal.

CATALOGUES RECEIVED.

"Alfred Graham and Co." (St. Andrew's Works, Crofton Park, London, S.E.4.). Publication No. W.D.14, introducing the new "Radiolux" Amplion loud-speaker.

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"Billing Tool Co." (101. Clerkenwell Road, London, E.C.1). Abbreviated list of tools, including stocks and dies, lathes, and drills.

"J. Churly Cann, Ltd." (16-20. Farringdon Avenue, E.C.4). Price list of terminals, detectors, etc.

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"Baltic Co., Ltd." (Stockholm, Sweden). Catalogue of radio components.

"Rose Bros. Electrical Co., Ltd." (25, Milton Street, London, E.C.2). Price list of accumulators, dry batteries, switches, and wireless accessories.

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"A. F. Bulgin and Co." (9-11, Cursitor Street, London, E.C.4). Illustrated catalogue of "Decko" wireless products, also American components.

HINTS and TIPS for NEW READERS

A Section Devoted to the Practical Assistance of the Beginner.

THE USE OF A MILLIAMMETER.

NEXT to a double-scale voltmeter there is little doubt that a milliammeter is the most useful instrument which an amateur can possess. Unless it is proposed to use large power valves, such as the L.S.5 or D.E.5.A., an instrument reading up to not more than 10 or 15 milliamps. is recommended, otherwise it will be difficult to read accurately the small currents taken by high impedance valves on comparatively low anode voltages. The meter may conveniently be mounted on the panel, and in this position will be less liable to damage than if it is connected up externally.

The method of connection suggested in Fig. 1 will probably be found to be the most convenient. Provision is made here for inserting the milliammeter in the anode circuit of either the detector or last L.F. valve. A four-pole change-over switch is used, two of the contacts being arranged to complete the anode circuit of the valve from which the meter is disconnected by moving the switch.

When connected in the detector valve circuit the milliammeter will show, by a flicker of the needle, when the tuning circuit is brought into resonance with an incoming carrier wave. This visual indication enables the operator to make probably more accurate adjustments than would be possible by merely listening to the signal. A deflection of the needle will also show when the valve commences to oscillate, and will help in this way to prevent interference. If "bottom bend" rectification is used, it is possible to adjust grid and anode voltages for best results. When correctly adjusted, the anode current will be very low when no signal is being received, but will rise considerably when the set is tuned to a carrier wave. This gives a rough, but, nevertheless, useful indication of signal strength, and some idea of the comparative efficiencies of an H.F. amplifier preceding the detector may be obtained.

Changing over the milliammeter to the last L.F. valve will help in making suitable adjustments of grid bias and anode voltages. The deflection should remain constant when signals are being received; any movement will show that the valve is either overloaded or that the voltages applied are incorrect.

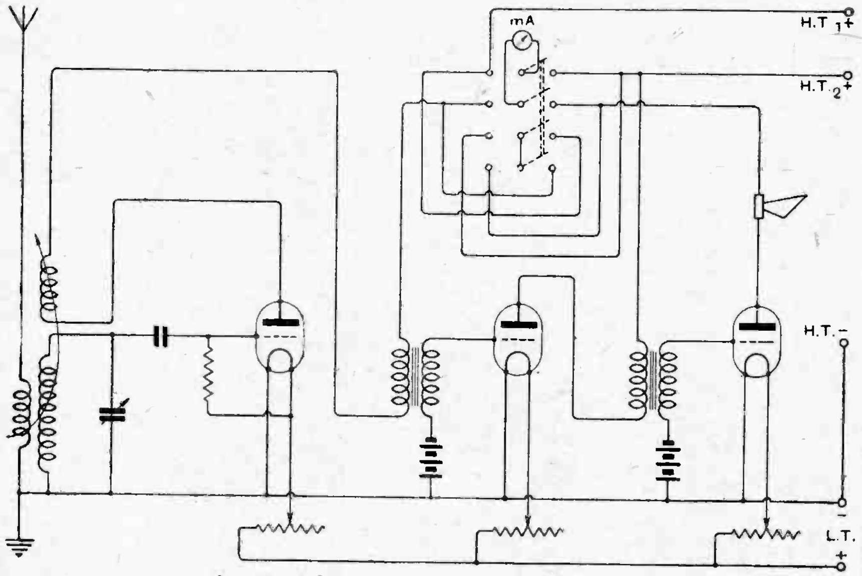

Fig. 1.—Connections for a plate milliammeter.

THE UNIT RECEIVER.

In the early days of broadcasting the unit set enjoyed a certain degree of popularity, and a favourite receiver consisted of a tuner, H.F. amplifier, detector, and note magnifier—four separate interconnected units in all. For some reason or other this arrangement is seldom used nowadays; perhaps because the space occupied is considerably greater than that required by an instrument built into a single container; also, perhaps, because the initial cost is slightly higher. At that time, however, there was certainly less need for a readily convertible type of set than there is at the present; receiver design is really largely a matter of intervalve couplings, and many of the modern alternative methods had not been developed, while amateur transmission and reception on the very short waves was unknown, and the need for the utmost possible degree of selectivity had not been felt.

Under present-day conditions it is obvious that there are many advantages in the unit system of set construction, and the experimenter who is lucky enough to be able to devote a fair amount of space to his apparatus would be well advised to give the matter careful consideration. The practical design of a suitable unit receiver, giving facilities for experimenting in a chosen line of work, and with sufficient flexibility for adaption will be found rather a difficult problem, but extremely interesting, and not incapable of satisfactory solution.

The set would probably include a 250-500 metre H.F. amplifier-detector, a long wave amplifier-detector, and a note magnifier, with, of course, an aerial tuning and coupling unit. With the addition of an oscillator these could be connected up as a superheterodyne, while an ultra-short wave detector could be used with the L.F. unit. The latter, with a plain crystal set, would provide one of the most effective and economical loud-speaker receivers for work on the near-by station.

It is recommended that a standard height of box be used to house the various units, with battery terminals arranged in a uniform manner for easy interconnection when working from common batteries. As different high-tension voltages will generally be needed on the various valves, as many separate terminals for the positive connection as seem necessary should be provided on each unit, and connected direct to the battery. The negative connection will, of course, be common to all.

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IMPROVING A CRYSTAL SET.

As has recently been pointed out in these notes, the efficiency of a crystal receiver may be increased by reducing the damping effect of the detector.

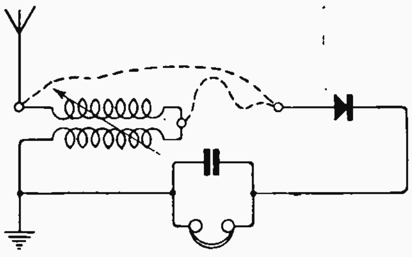

Fig. 2.—Alternative crystal connections.

In the case of the variometer-tuned set shown in Fig. 2, this way most conveniently be done by connecting the crystal and 'phones across only one winding of the variometer (either the rotor or stator). This is an alteration which may easily be tried, and will in the great majority of cases result in a very distinct improvement.

Some commercial variometers have their windings arranged in such a way that connection can only be easily made to include either a quarter or three-quarters of the total number of turns in the output circuit. In dealing with this type of tuner, the effect of making connection to each of these available points should be tried.

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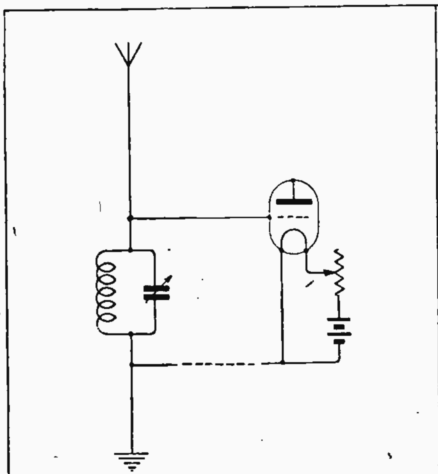
"UNTUNED" AERIAL CIRCUITS.

It should be realised that designers of "untuned" aerial couplings, which often consist of some 10-15 turns of wire wound in close proximity to a tuned grid coil, usually presuppose that the device will be used with an aerial of something approaching normal dimensions. With such a coupler, used on a very short aerial, it will be found that the transfer of energy to the grid coil is too small to be effective, and it will be necessary either to increase the number of primary turns or perhaps to connect the aerial direct to the grid end of the secondary inductance. In many cases, where the aerial is really short, the latter alternative is to be recommended, as the damping resulting from the direct connection will not be appreciable.

DISSECTED DIAGRAMS.

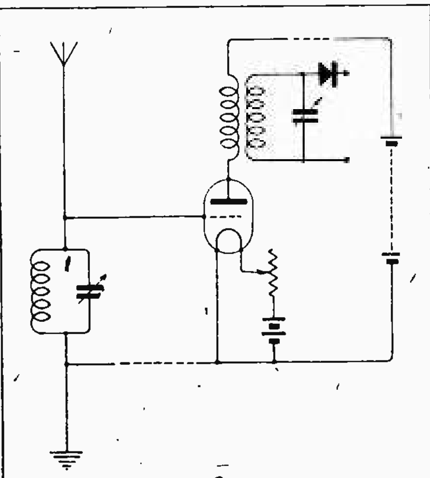
No. 7.—A Single-Valve Reflex Receiver.

For the benefit of those who have not yet acquired the simple art of reading circuit diagrams, we are giving weekly a series of sketches, showing how the complete circuits of typical wireless receivers are built up step by step.



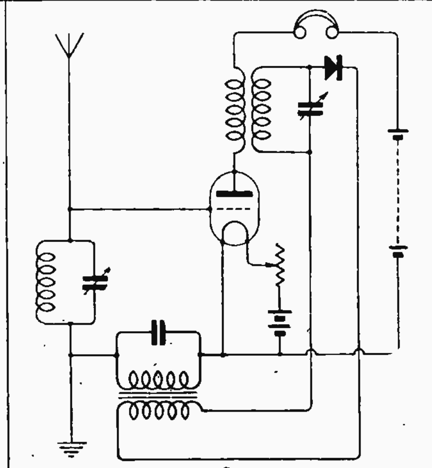
1

An oscillatory circuit, connected to aerial and earth. High-frequency voltages built up across it are applied to the grid circuit of a valve. The filament is heated by an L.T. battery, the external circuit being connected to its negative end.



2

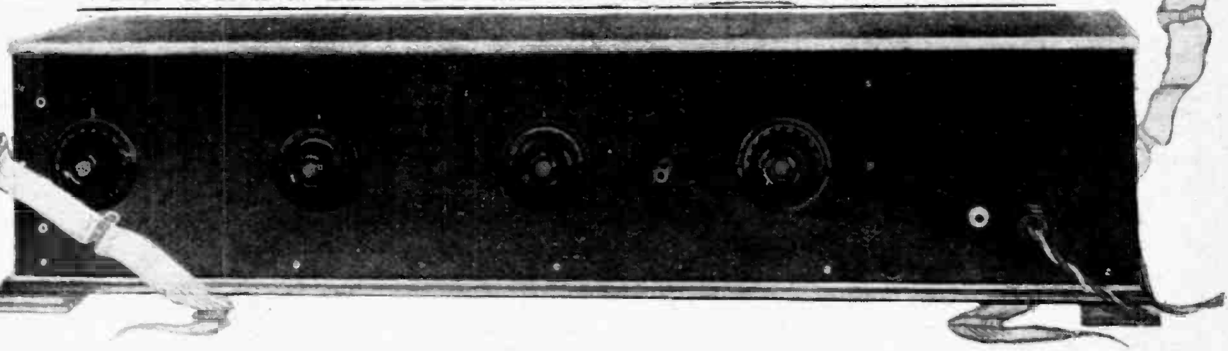
The plate circuit is completed through the primary winding of an H.F. transformer. Amplified currents are rectified by a crystal detector connected in the tuned secondary circuit. Rectified pulses are passed through—



3

—the primary winding of an L.F. transformer, the secondary of which is inserted in the grid circuit. Stepped-up, low-frequency variations are applied to the grid, are amplified, and operate the phones in the anode circuit.

"All Europe" Broadcast Receiver.



How to Build a Six-Valve All-Wave Set with Three High-Frequency Stages.

(Continued from page 689 of last issue.)

By W. JAMES.

Having made the valve platform and the strip holding the tuning and neutralising condensers we can turn our attention to the remainder of the set.

The receiver has a baseboard of wood 1in. thick, measuring 36in. long by 9in. deep, and a front panel, which can be of ebonite or wood as desired, measuring 36in. × 7in. × ¼in., which are fixed at right angles. Holes are drilled in the front panel to take the spindles attached to the ebonite distance pieces of the variable condensers and the shaft of the Colvern neutralising condenser, while two small holes are drilled on the left-hand side for "Clix" sockets, which serve as aerial and earth connections. On the right-hand side of the panel two large holes are made for the two jacks; these holes are clearly indicated in the drawing of the front panel of Fig. 2.

Turning now to the baseboard, it will be seen that mounted on it by three brackets is the strip carrying the tuning condensers. Further back from the front edge of the base is screwed the valve platform, while on the right-hand side are the low-frequency transformers, fixed resistors, and the two valve holders for the low-frequency amplifier. Between the valve platform and the back edge of the base is also mounted two bye-pass condensers and a radio-frequency choke, the choke being fixed on a small piece of ¼in. ebonite. The terminal strip is also screwed to the back edge of the base. These parts are arranged as shown in Fig. 3.

Screening.

Those who will use the set within a mile or two of a broadcast station are recommended to try screening the high-frequency portion of the receiver. The screening material is sheet tinned iron, No. 24 gauge, and is so arranged that when the lid is on the H.F. portion is totally enclosed in a metal box.

A sheet of tinned iron is first screwed to the back of the front panel and extends from the extreme left-hand side to between the detector and first L.F. valve, and is

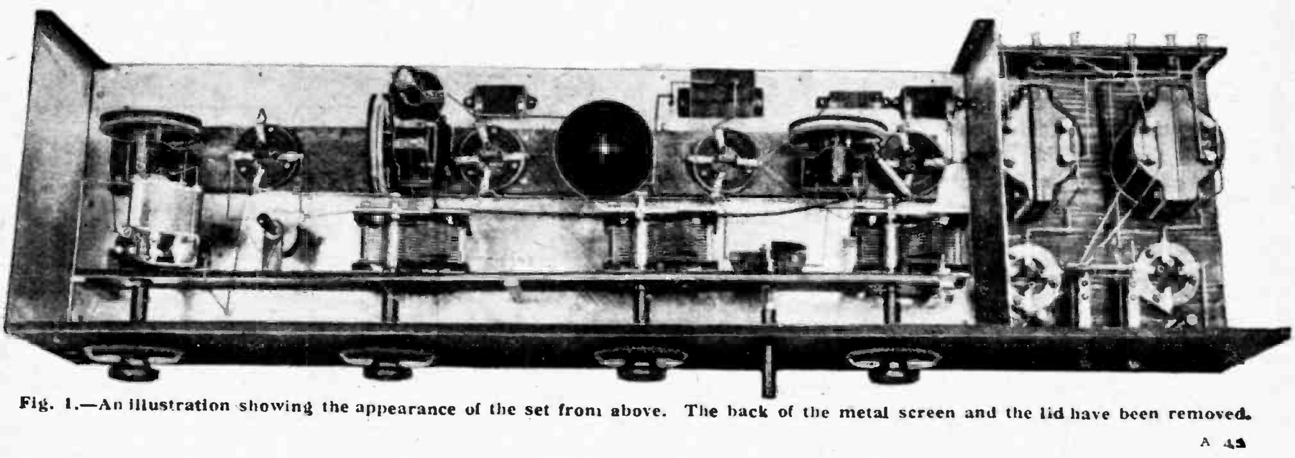


Fig. 1.—An illustration showing the appearance of the set from above. The back of the metal screen and the lid have been removed.

"All Europe" Broadcast Receiver.—
cut to the same height as the panel. Some of the fixing screws are placed at points where they will be covered by the condenser dials, and others are put at the edges of the sheet to hold it securely. The base is then covered with a sheet, which is bent over the front edge so that when the panel is screwed to the base a good contact is made between the metal on the panel and that on the edge of the base.

Two end pieces are now cut out and an edge about 1in. long is bent at right angles to the surface of the sheet on three sides—the bottom and two upright sides. These edges are for the purpose of holding the sides of the metal box, and the lower edges of the two end pieces are slipped between the sheet on the base and the wooden base itself, while the edges nearest the panel are pushed between the panel and the sheet on the back of the panel. Screws are then passed through the surfaces which are in contact. Besides holding the parts in position, these screws serve to make the contact between the different pieces a fairly good electrical one.

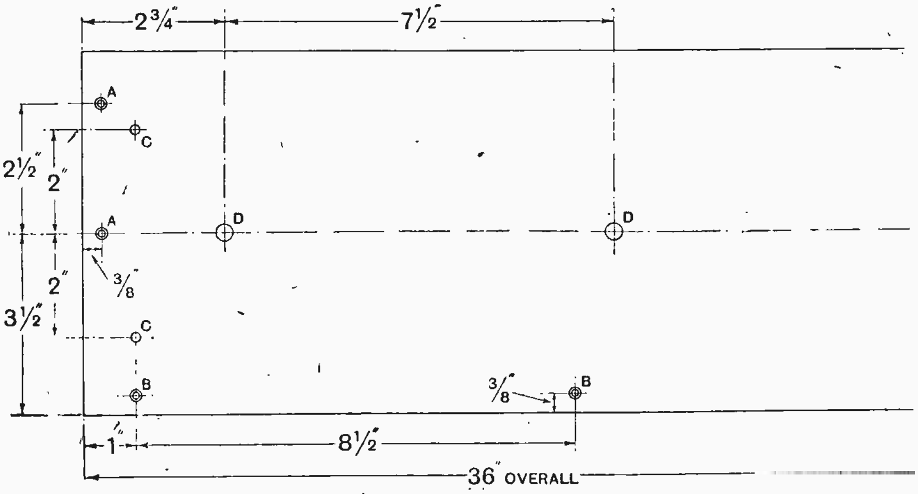


Fig. 2.—Details of the front panel. A, 1/8in. dia., countersunk for No. 6 B.A. fixing dia.; E, 3/8in. dia.;

If it is found necessary, the inside edges of the box can be soldered.

For the back, a piece of the tinned iron is cut to shape and drilled so that it can be screwed to the edges of the two ends. The bottom edge of the back is also bent over to form a strip about 1in. wide, which is put between the baseboard and the bottom sheet.

The construction is relatively simple, although it is none too easy to make a box which is square and fits nicely at the first attempt. The appearance of the screen without the back or top is clearly shown in the illustrations.

For the cover of the box, a piece of wood 37in. × 10in. × ⅜in. is used, and screwed to it is a sheet of tinned iron with its edges turned over about 1in. in such a way that when the cover is on the metal box is completely closed. A number of strips of wood are screwed to the lid to hold the tinned iron firmly in position.

To make the surfaces fit fairly tightly a number of 2BA nuts are soldered to the inner surface of the top edges of the box and screws are put through the cover and screwed up tight.

The H.F. Couplings.

The high-frequency couplings are made in the form of plug-in type transformers from circular pieces of ebonite, ¼in. thick and 3in. in diameter, the distance piece being 1in. in diameter; thus the transformers have a slot ⅛in. wide and 1in. deep. Four valve pins are arranged in the usual manner and are screwed to the back disc of the formers.

Two sets of these formers are required, one set being for the lower broadcast wavelengths and the second for the longer waves.

The short-wave coils are wound of No. 24 D.C.C. wire. For the aerial transformer 45 turns are wound on, the beginning of the winding being connected to the left-hand filament pin[1] of the transformer and the end to the anode pin. A few turns of thin string are then put on to separate the windings by ⅛in., and over this is put 10 turns for the aerial earth circuit. The beginning of this winding is connected to the right-hand filament pin of the former and the end to the grid pin.

The two tapped coils for the tuned anode circuits are

[1] Looking at the pins of the transformer with the anode pin in front.

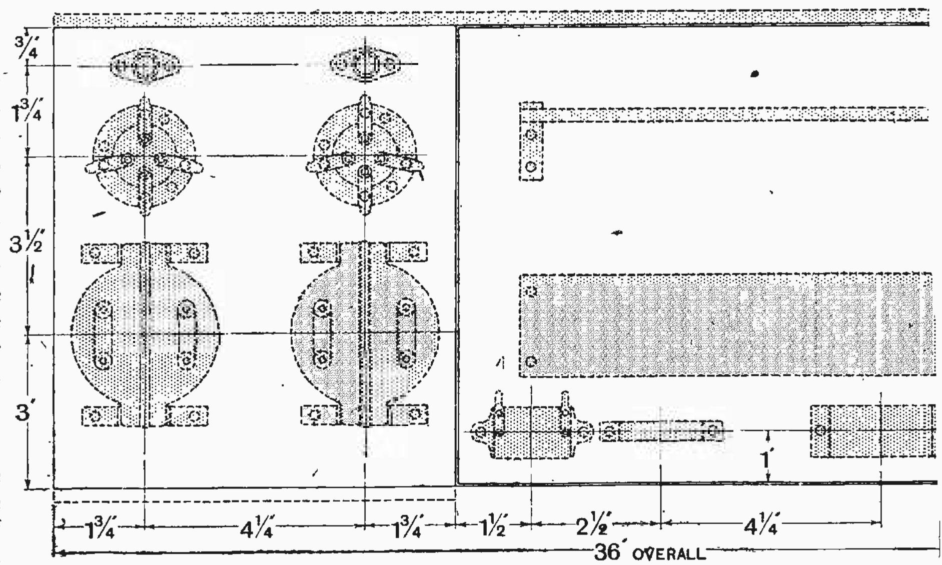
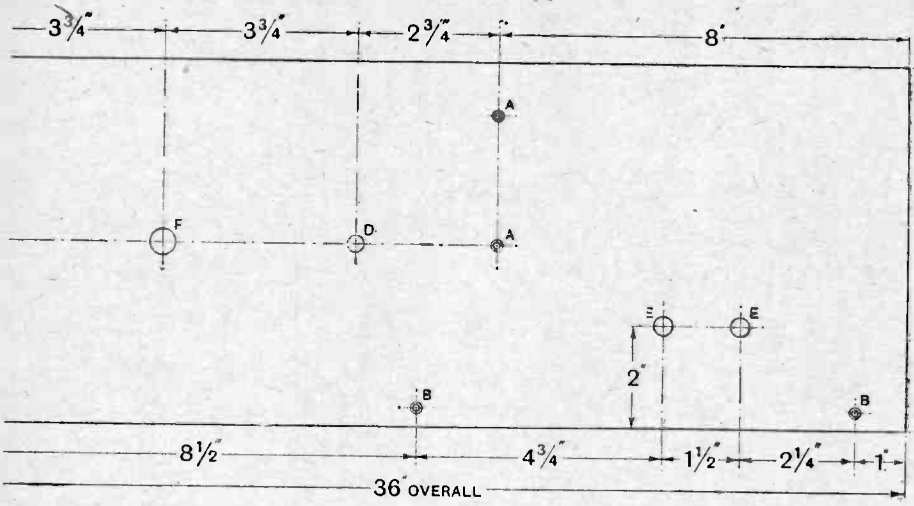


Fig. 3.—The arrangement of the



screws; B, 1/8in. dia., countersunk for No. 4 wood screws; C, 3/16in. dia.; D, 5/16in. F, 1/2in. dia.

wound with the same number of turns. Commence by joining the wire to the left-hand filament pin of the former; then wind on 28 turns and make a connection with the grid pin of the former; 14 turns are then wound on and the end taken to the anode pin. These windings, therefore, have a total of 42 turns of No. 24 D.C.C. wire, each with a tap at the 28th turn, counting from the beginning of the coil.

For the intervalve high-frequency transformer a winding of 42 turns is put on first for the secondary, the beginning being connected to the left-hand pin and the end to the anode pin. Over this coil is put a few layers of thin string to a depth of about ⅛in. and then a winding of 8 turns for the primary. The beginning of this outer winding is connected to the right-hand filament pin and the outside end to the grid pin.

For tuning over 900 to 2,800 metres, the coils are wound with No. 30 D.S.C. wire and are connected in the manner just described. The coils have the following number of turns:—

Aerial coil, secondary 245 turns, primary 50 turns.

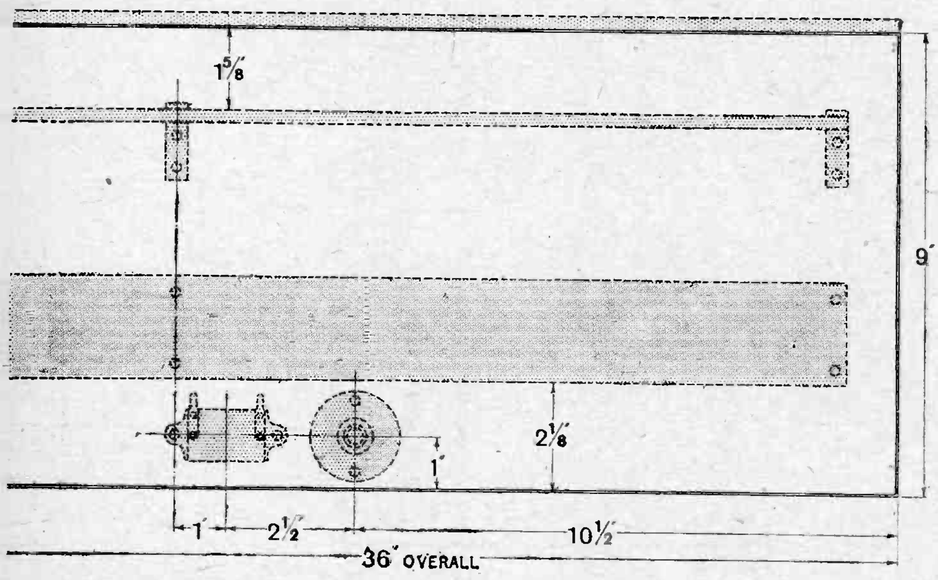
H.F. transformer, secondary 245 turns, primary 20 turns.

Anode coils, 245 turns. Turns tapped at 105th turn from the beginning of the winding.

Wiring.

This is a straightforward piece of work, as the circuit is not a complicated one. A diagram appeared as a supplement to last week's issue of this paper, and if it is closely examined, it will be seen that most of the wires in the high-frequency circuit are fairly short and have direct paths. These wires are of No. 22 tinned copper. Wire of this gauge is also used to connect up the jacks, as there is not much room for the heavier wire generally used in wiring low-frequency circuits.

It will be noticed that a few wires pass from the low-frequency part of the set through holes in the baseboard, along the underside of the baseboard, and are brought up through holes provided to the high-frequency portion of the receiver. These wires should be covered with insulating tubing to prevent them short-circuiting where they cross and where they pass through the metal screen. They are marked in the diagram by letters—thus, wire C in the L.F. side passes to wire C in the H.F. side, wire D joins wire D, and so on. The tinned iron screen should be earthed at several places, and it is advisable to earth the spindles of the tuning condensers which are secured between the dials and the ends of the ebonite distance pieces.



components on the baseboard.

Testing the Set.

Valves of the H.F. class may be used in the first, third, and fourth stages, a valve of the L.F. in the second stage and power valves in the two L.F. stages. Suitable valves are of the DE5B, DE5, and DE5A class, although valves of the 60 milliampere class are satisfactory in the H.F. stages. Fixed resistors of a value suitable for the valves in use should be inserted in the holders, and the grid bias, filament and anode batteries connected up. The best voltages for the valves will, of course, depend on the valves used. For the DE5 class of valve an anode voltage of 60 may be used on the first four, with 120 to 150 on the anodes of the two L.F. valves, which should have a grid bias of 4½ and 12 to 18 respectively, the last valve being a DE5A. If the combination of valves and filament battery voltage

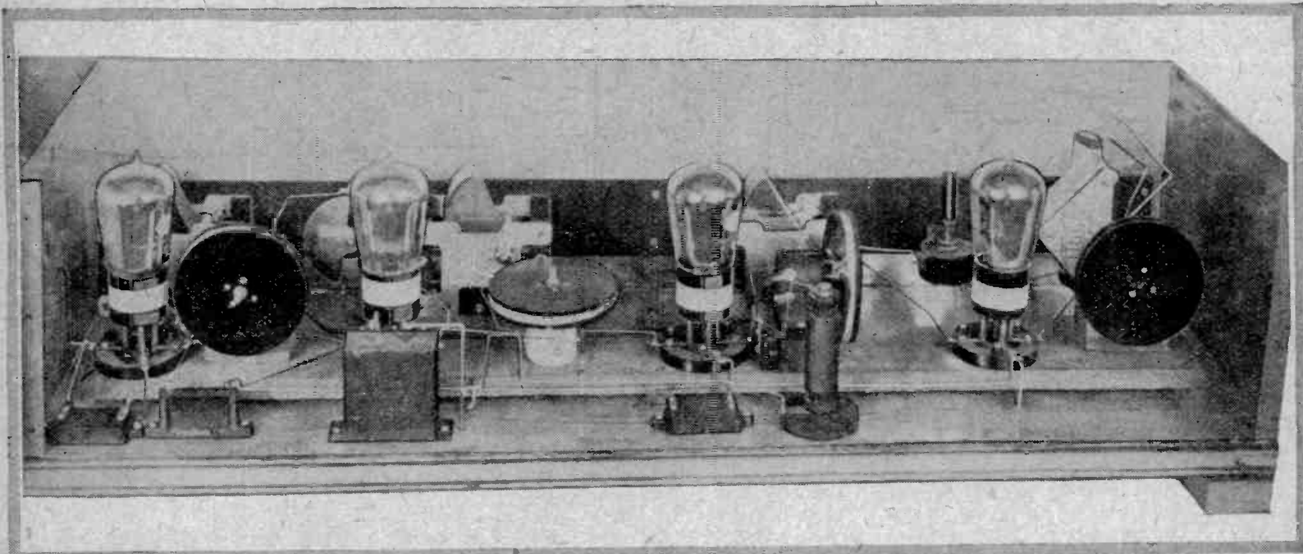


Fig 4.—View of the right-hand end of the set looking at the back. Most of the high-frequency amplifier can be seen.

is such that there is very little fall in voltage over the fixed resistor R_1, a 1.5 volt grid battery should be connected between point A and the condenser C_7 shown in the wiring diagram. If the wire coming from the filament battery to A is taken off the condenser C_7 and joined to the positive side of the grid bias battery, and the negative side of the battery is connected to C_7, the grids of V_2 and V_3 will have a negative bias of 1.5 volts plus the fall in voltage in R_1.

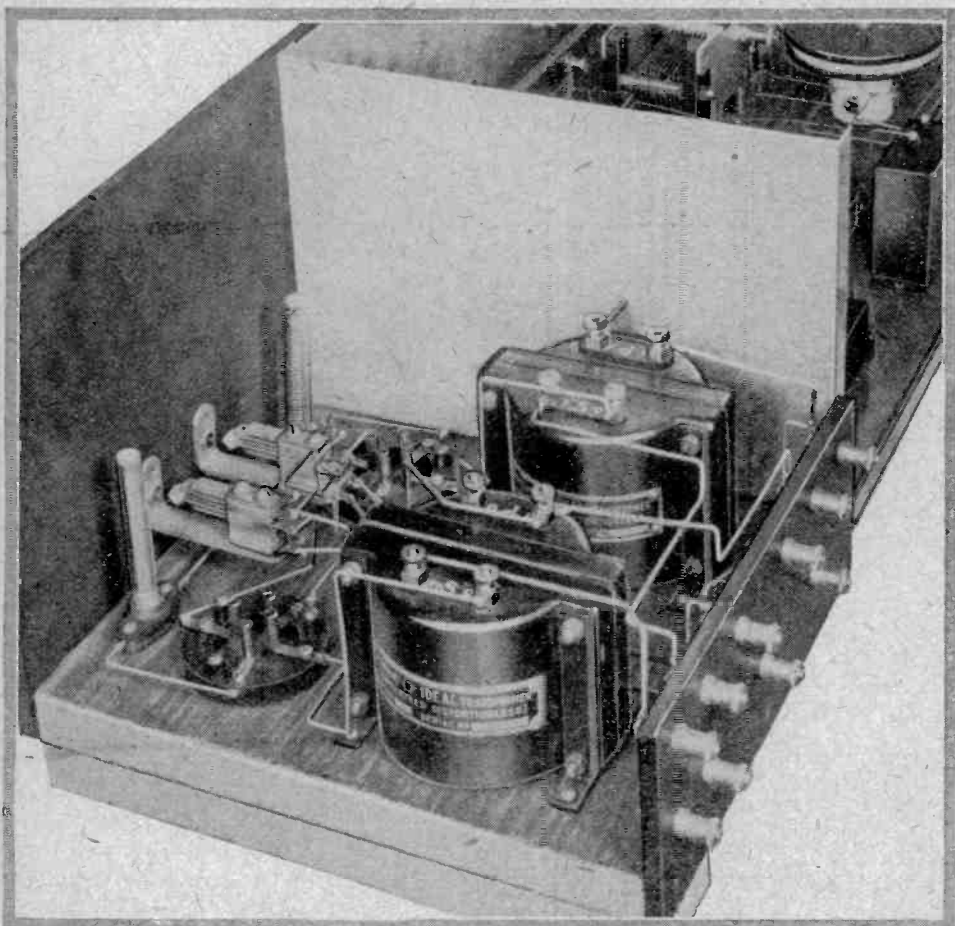


Fig. 5.—The audio-frequency amplifier portion of the receiver.

When first trying the set tune in the local station to find the settings of the dials of the tuning condensers, and then move each dial a degree or two at each step until a weak signal is tuned in. Adjustments can now be made to the neutralising condensers NC_1 and NC_2, and to the anode voltage applied to the high-frequency amplifier. It will probably be found that a fairly high anode voltage can be used, provided, of course, that the neutralising condensers are carefully adjusted.

Owing to uneven winding it might be found advisable to adjust the coils to make the condenser dials read alike. This is best done with the set tuned to a weak signal; and it will be found very much easier to tune in distant stations after this adjustment has been made.

Attention should also be given to the number of turns

"All Europe" Broadcast Receiver.—

in the aerial circuit and in the anode circuit of valve V_3. The values given are satisfactory ones, but it may in some instances be worth the trouble to find the most suitable turns for the particular aerial and the valves used. If the set is too selective the aerial can be connected directly to the grid of the first valve in series with a 0.0002 mfd. fixed condenser. This will broaden the tuning a little, but will, of course, reduce the wavelength range of the aerial circuit. Should it be found advisable to make the tuning a little sharper, the number of turns in the primary winding of the high-frequency transformer may be reduced by two or three turns, or the distance between the primary and secondary windings may be increased.

Necessity for High Impedance Valves.

Coils to tune to longer wavelengths can easily be made with wire of No. 30 to No. 36 D.S.C., the best position for the tapping on the two anode coils being found experimentally. It should be remembered that high impedance valves must be used in the two tuned anode stages if selectivity is desired. Should valves of the low impedance class be used, it will be found that the amplifier is not sufficiently selective for the purpose for which it was designed, and, further, it will be found difficult to stabilise the circuit.

If the utmost range is required it is advisable to employ an aerial rather less than 100ft. in total length and height. A good size would be about 35ft. high and 30ft. long, particular care being taken to see that it is as efficient an aerial as can be erected in the space available.

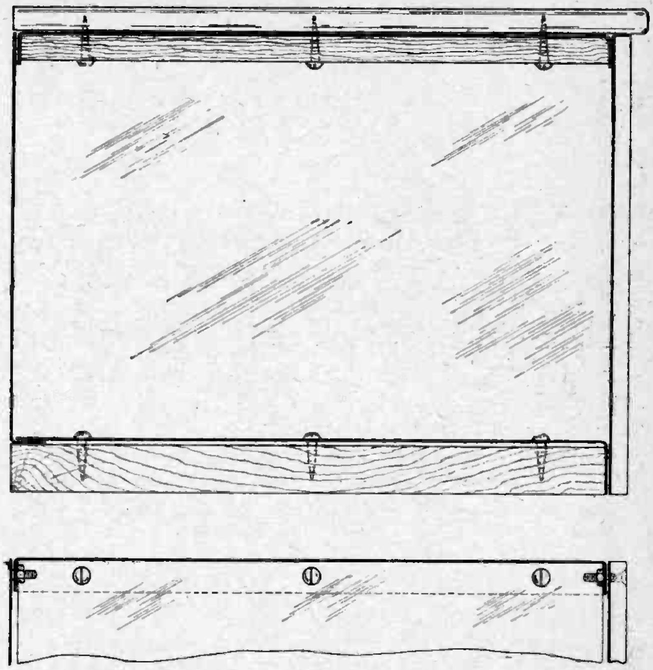


Fig. 6.—Details of the metal screen. The top drawing is a section across the set, while the bottom diagram shows the method of securing the end pieces of the screening box to the panel and the back.

LOW LOSS COILS.

THE invitation which we extended in our issue of November 11th to readers to send in to us their idea of the best coil has met with a very ready response, and coils of all shapes and sizes and great diversity of methods of winding have been received at our offices for test under the conditions which were set forth in our announcement.

Purpose of the Tests.

The object which we have had in view in suggesting this competition is to put to bed some widespread misconceptions regarding the qualities which go to make a low-loss coil. As we previously explained, not all coils described as "low-loss" have small electrical losses, and although the term "low-loss" is a very convenient one to use in describing an efficient coil, yet the term has been grossly misapplied so persistently that it is quite time that publication should be given to directly comparative tests.

We are particularly pleased that readers who have sent in coils have entered so fully into the spirit of the idea and expressed their sincere appreciation of being able to participate in these laboratory tests, which must of necessity be of the utmost interest to everyone concerned with the design of coils for highest efficiency.

> *LOW-LOSS COIL TESTS.*
>
> ***Send us your idea of the best coil and so participate in the collection of valuable data. An award of five pounds will be made for the best coil, whilst every reader will benefit from the publication of results.***

Closing Date for Entries.

No purpose will be served by having an unwieldy quantity of coils to test, and it has therefore been decided that no entries will be accepted which reach us after the date of our next issue, viz., December 2nd. It is thought that this will give sufficient time to all those who may be actually engaged in the construction of coils for the competition. We hope that all readers who have a coil to send us will do so in time, as we are anxious that the collection for test should be as representative as possible.

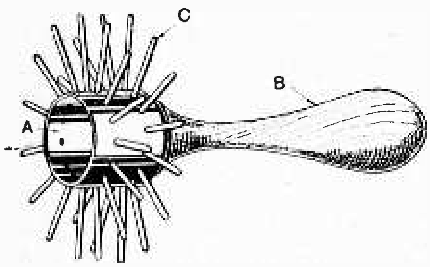
Coils sent in for test must be addressed to the Editor and carefully packed. Each coil will be given a number and details of its construction noted. After the test has been carried out, the coils will be returned to their owners with full details as to the results of the tests made in the laboratory. When the tests have been completed, short descriptions of a selection of the coils will be made and their electrical characteristics published, each coil being identified by the number, and not by the name of the owner.

As we mentioned in our first announcement, an award of £5 will be made to the reader sending in the coil which proves to be the most efficient, as it is thought that this will add to the interest of readers in our scheme.

Brain Waves of the Wireless Engineer.

Former for Winding Duolateral Coils.
(No. 239,944.)

The above invention by C. S. Hodson and A. A. Tarbuck, relates to a former for winding duolateral coils, and comprises a metal bush A having two equally



Duolateral coil former. (No. 239,944.)

spaced rows of holes drilled and tapped to take removable screwed pins C.

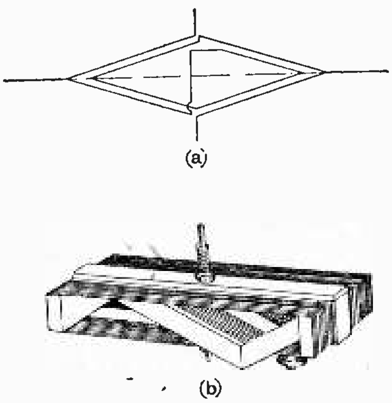
As shown, the bush contains 30 pins, fifteen on each side. A handle B is fitted into one end of the bush A for convenience in winding.

oooo

Variometer or Variocoupler.
(No. 239,561.)

The object of this invention, by J. C. W. Eastick, is to produce a variometer or variocoupler in which the essential parts—the rotor and stator—are of such a form that their length is more than twice the axial height.

A variometer of rectangular section is



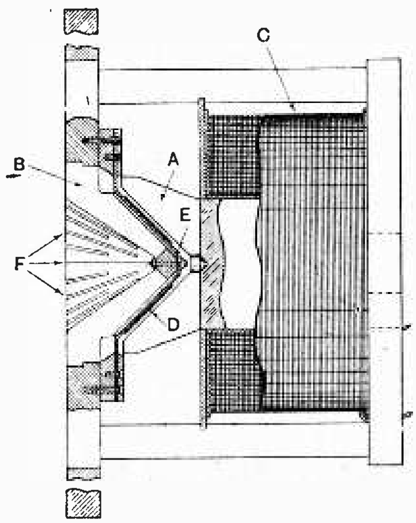
Variometer or variocoupler of special design. (No 239,561.)

shown at (b), and (a) shows a modification in which the stator and rotor are of more or less rhombic section, the diagonal length being greater than the axial length.

Hornless Loud-speaker.
(No. 231,421.)

The object of this invention by the British Thomson-Houston Co., Ltd., is to reproduce sounds with greater accuracy and fidelity.

According to the invention, a non-resonant baffle, of massive form or of a rigid material, is adapted to extend the path through the air between the two sides of the diaphragm to a length of at



The B.T.H. hornless loud-speaker. (No. 231,421.)

least the order of magnitude of one quarter of the wavelength of the longest useful sound waves. By this means the solid angle into which energy will be radiated from the diaphragm is decreased without the introduction of resonant effects, as occurs with the use of a sound horn.

One form of loud-speaker is shown in the diagram, in which a conical diaphragm is supported in an annular air-gap formed by the concentric pole-pieces A and B. The magnetic field is produced by the exciting coil C surrounding the pole-piece A. The coil D to which the actuating currents are supplied is secured to the diaphragm E, which may be of cloth or rubber.

One method employed successfully in constructing the diaphragm consists in painting a metal former with rubber cement, winding the coil over this cement, painting another layer of the cement over the coil, and then baking the whole to vulcanise the cement.

The pole-piece B is provided with a plurality of radial slots F to permit the escape of sound produced, and radial slots are formed in the pole-piece A for the purpose of venting adequately the air space behind the diaphragm.

The baffle may be conical or pyramidal, or may be a shallow box with open back facing the diaphragm and a small aperture in the opposite side.

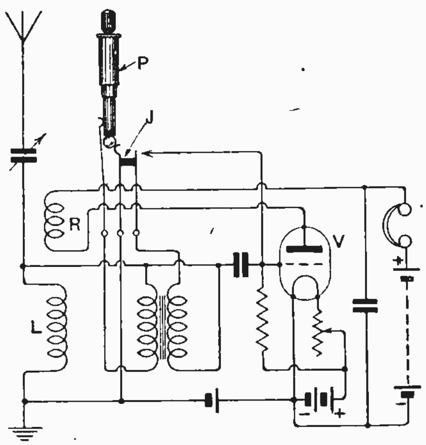
oooo

Receiver Improvements.
(No. 239,310.)

This patent by G. W. Hale and the Radio Engineering Co., Ltd., relates to a plug and jack switching arrangement for changing the function of a valve in a receiving set.

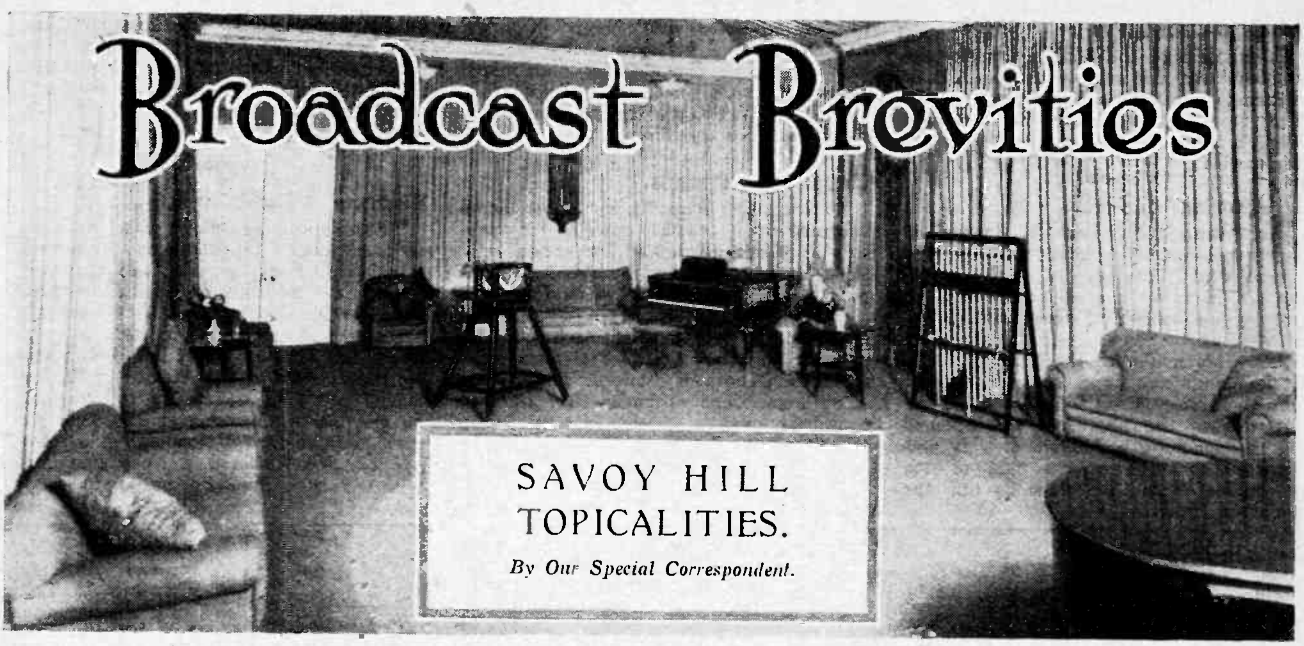
The figure shows a diagram of connections of one form of receiving apparatus in which a single valve detector with reaction may be made to function as a low-frequency amplifier by inserting the plug P containing a crystal detector into the jack J.

When the plug P is inserted in the jack J it will be seen that the crystal in the plug is employed for rectification and the valve V for low-frequency ampli-



Plug-and-jack crystal detector. (No. 239,310.)

fication, a reaction effect being also obtained by coupling the plate coil R to the aerial coil L. The invention may be applied to a conventional dual-amplification receiver, a multi-stage valve amplifier, or to a receiver working on the supersonic heterodyne principle.



Broadcast Brevities

SAVOY HILL TOPICALITIES.

By Our Special Correspondent.

2LO's New S.B. Board.

The new S.B. board at Savoy Hill was brought into use for the first time on the B.B.C. birthday night; but did not quite come up to the standard expected.

oooo

Greetings in the Vernacular.

You will remember that towards the conclusion of the two hours' programme provided by members of the staff, greetings were provided in the vernacular from all stations. First we had a message from the Bournemouth station; then Birmingham, which cutely reminded listeners that it was only a day younger than 2LO; then Cardiff, Leeds-Bradford, Manchester, Glasgow, Aberdeen (with the sound of bagpipes as a background to its spoken message of cheer), and so on down the list.

oooo

Engineers Disappointed.

The only disappointment in an otherwise successful evening was experienced by the engineers, who were ready and able to switch over from station to station practically without a pause. Nothing more than the changing of one plug was necessary. But, unfortunately, the arrangements for the quick-change broadcast were made hurriedly and the stations were not quite ready to follow each other without a break; and so pauses occurred which somewhat detracted from the novelty.

oooo

A Long Journey.

Nevertheless listeners travelled a goodish distance that night, what with Captain Eckersley broadcasting from Brussels, Mr. Percy Edgar in a humorous turn from Birmingham, and then the whole of the stations S.B.-ing to the British Isles.

FUTURE FEATURES.

Sunday, November 29th.

LONDON.—3.30 p.m., Puccini Programme.

BIRMINGHAM.—9.20 p.m., Special concert by the Station Orchestra. Madoc Davies (baritone) and Olga Thomas (solo pianoforte).

Monday, November 30th.

LONDON-BIRMINGHAM.—8 p.m., St. Andrew's Day.

MANCHESTER.—8 p.m., Light Symphony Concert.

ABERDEEN.—8 p.m., Scottish Programme.

Tuesday, December 1st.

LONDON.—8 p.m., Symphonic Syncopated Music.

Wednesday, December 2nd.

LONDON.—10 p.m., "Carmen" (Act. IV.). Performed by the B.N.O.C. Relayed from the Prince of Wales' Theatre, Birmingham.

CARDIFF.—8 p.m., The Spirit of Welsh Music.

NEWCASTLE.—8 p.m., Harlequinade.

Thursday, December 3rd.

LONDON.—7.30 p.m., The Hallé Orchestra relayed from Manchester.

NEWCASTLE AND 5XX.—8 p.m., "A Border Foray."

Friday, December 4th.

BIRMINGHAM.—8.30 p.m., An hour of Humour by John Henry and Blossom.

BOURNEMOUTH.—8 p.m., Herbert Bedford Programme.

DUNDEE.—8 p.m., "Rob Roy."

Saturday, December 5th.

BIRMINGHAM.—8 p.m., Choral Humour, "John Gilpin."

CARDIFF.—8 p.m., "Footlight Favourites."

Cold Storage Wireless.

Some interesting experiments have been conducted at Savoy Hill with a form of bottled wireless. The apparatus used was not the Vox Magnetophone, about which I wrote several months ago, but the Telegraphone, which is a development of the old cylindrical phonograph record. It was used for recording part of the broadcast performance from an aeroplane and will be brought into requisition in the next week or two, in connection with the public speeches of some eminent persons, in cases where the installation of a microphone is not desirable. While listeners may be prevented from hearing speeches at the moment that they are delivered, there will thus be no reason why they should not receive them within a few hours afterwards.

oooo

A Cathedral Broadcast.

The 300th organ recital at Gloucester Cathedral, to be given by Dr. Herbert Brewer, will be relayed to Daventry on December 9, from 8 to 9 p.m. Besides works by Handel, Bach, Gibbons, and Widor, to be played by Dr. Brewer, there will be violin solos by Mr. W. H. Reed and singing by the Gloucester Festival Chorus.

oooo

The Fall of Jerusalem.

December 9 also is the anniversary of the Fall of Jerusalem, one of the outstanding events of the Great War. The story of how a dilapidated looking old gentleman approached the British lines on that occasion and said to the Sergeant on duty: "I am the Governor of Jerusalem. Here are the keys of the city," only to be told, "Jerusalem? I don't want it," will be related from the London studio on December 9 by Sergeant Hurcomb, 19th Battalion, London Regiment.

Thank You, Engineers !

The success of the birthday week programmes was due mainly to the B.B.C. engineers; but their achievements do not seem to have attracted the attention which I feel sure listeners will consider they merited.

oooo

The Aeroplane Concert.

The transmission from an aeroplane was unquestionably a wonderful feat, and a good deal of money was spent on it. The air company spared no expense in assuring the success of their part of the performance. Some ten preliminary flights were made for the benefit of the wireless engineers, and each flight cost more than £25. I am told that when the first part of the broadcast was finished and the machine had descended, it was suggested that the second part of the programme should be omitted; but the engineers insisted that a second flight should be made and the programme completed. Their persistence and the patience of listeners were rewarded by the excellent music broadcast by the Savoy Orpheans from 8 to 8.10 p.m. — an hour later than the time originally arranged.

oooo

Canterbury Cathedral.

Then, the Canterbury Cathedral broadcast deserves special mention. Owing to the difficult acoustics in the Cathedral, speech on the microphone at more than seven feet in the choir is not at all intelligible. Three microphones were used in the Cathedral on Armistice night, and the results were doubtless appreciated by millions of listeners.

oooo

The "Co-Optimists."

For the broadcast of the "Co-Optimists" from His Majesty's Theatre only one microphone was necessary, and this was placed in the centre of the footlights. The exceptional clearness of the transmission was due to the fact that the Co-optimists worked in a setting of black velvet cloths hung on both sides of the stage and across the roof. This gave as good an effect as if the performance had taken place in the studio.

oooo

A Public School Concert.

The first of several broadcasts from English public schools will take place on December 21, when from Marlborough College will be relayed a concert provided by full orchestra and choirs of boys. The refrains will be taken up by an audience of 1,000. Sea chanties and school songs will be given by the boys with, we may be sure, all the zest of which schoolboys are capable.

oooo

Europe's Wavelengths.

Listeners are experiencing some inconvenience owing to the changes in wavelengths recently adopted by various stations, and I am asked by the B.B.C. to point out that Geneva is struggling with a most difficult task in trying to fix upon a system of wavelengths such as that referred to after the last Geneva Conference. Geneva is, indeed, finding out what tremendous obstacles they have to overcome owing to the circumlocution caused when all the departments in the different Governments have to give their sanction to an agreed plan.

THE B.B.C. AT RUGGER. A new photograph of the stalwarts who represent British broadcasting on the football field. Mr. Dan Godfrey, Junr., is seen in the centre, with Mr. Bishop on his right and Captain West on his left.

A Fool-proof Scheme Wanted.

The wavelength tests in September were arranged rather hurriedly. Before the new schedule of wavelengths is put into operation, the scheme will be made as watertight as possible, and it is better to suffer delay at this stage than run the risk of chaos when all stations get working on the wavelengths which are ultimately to be allocated to them.

oooo

Broadcasting in Holland.

Holland is taking a leaf out of the book of British broadcasting and is now giving a series of church service broadcasts. A committee of clergy and laity has been formed to take control and both morning and evening services will in future be broadcast.

oooo

A Clean Slate.

I have been shown up-to-date statistics of the engineering work at all the broadcasting stations (excluding 5XX), and am chiefly impressed by the comparatively clean record, so far as breakdowns are concerned—and that, after all, is a matter that interests the listener more than anything else; for irregular service would be worse than indifferent programmes.

oooo

Minimum of Breakdowns.

These statistics show that in sixty thousand hours of programme entertainment throughout the year, less than one-tenth of one per cent. of the time has been lost through breakdowns. The average percentage breakdown per week per station since January 1 last has been in the Northern area (twelve stations) .10, and in the Southern area (eight stations) .11. In the North, Manchester has been the most unfortunate station with a percentage of .26; Sheffield a close companion with .25, with Liverpool and Belfast tied at .18. In the South, Bournemouth had .25; Swansea .16, and Plymouth .15. London's percentage was as low as .08.

oooo

Life of a Valve.

Even the changing of a valve during broadcasting counts as a breakdown. The engineer estimates that a valve should have 800 - 1,000 hours' life; but it sometimes happens that a valve falls far short of expectations and a new valve has to be substituted in a hurry. Quick-change methods are adopted and the new valve is slipped into position by means of a carrier; but if an engineer should strike a bad lot of valves it would involve several successive changes and several minutes would be lost.

oooo

Big Ben in Odd Corners of the World.

Memories of England, home and beauty which are reawakened in the breasts of English travellers abroad by recollections of familiar scenes, are nowadays emphasised by the familiar sound of Big Ben's chimes, which can be heard even in caves and desert places, provided there is a receiving set available. Even foreigners are coming to form an attachment for dear old London by reason of the chimes from Westminster.

oooo

The Prince to Speak Again.

Listeners are to hear another broadcast by the Prince of Wales this evening (Wednesday), when, at 9.15 p.m., H.R.H. will make an appeal through 2LO and 5XX on behalf of the Society for the Prevention of Cruelty to Children.

DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Heterodyne Interference. *Interference* caused in the vicinity of a valve receiver in which *self-oscillation* is being employed and allowed to excite the aerial.

Heterodyne Reception. A method of *beat reception* by means of thermionic valves. By "heterodyne reception" it is understood that the local oscillations of slightly different frequency from the received oscillations are provided by a source quite independent of the receiving circuit proper. Sometimes called "separate heterodyne." See BEAT RECEPTION. Cf. ENDODYNE.

Heterodyne Wavemeter. A *wavemeter* which generates continuous oscillations of known wavelength by means of a *three-electrode valve* and used for the measurement of the wavelengths of *continuous waves*. The name "heterodyne" is employed because the oscillations of the wavemeter are tuned to those being measured by the beat method or *heterodyne* method. Sometimes called "C.W. wavemeter."

H.F. Abbreviation for *high frequency*.

High Frequency. *Frequencies* of alternating currents, etc., over about 10,000 cycles per second. The very wide band of frequencies employed in wireless telegraphy, etc., and ranging from about 12,000 cycles per sec. (25,000 metres) up to about 100,000,000 cycles per sec. (3 metres) are called "radio frequencies." Cf. AUDIO FREQUENCY.

High-frequency Choke. An air-cored untuned *choking coil* with a sufficient number of turns to offer a considerable *impedance* to the passage of *high frequency currents*, but offering a low impedance to low frequency currents or a low resistance to direct currents. See AIR CORE CHOKE.

High-frequency Amplifier. An *amplifier* which increases the strength of wireless signals at the frequency of the received waves, *i.e.*, before the signals are *rectified* by the *detector*. For methods of effecting high-frequency amplification see RESISTANCE-CAPACITY COUPLING, TUNED ANODE, and HIGH-FREQUENCY TRANSFORMER. Cf. LOW-FREQUENCY AMPLIFIER.

High-frequency Resistance. The electrical *resistance* offered by a conductor of solid cross section to the passage of a current is very much greater at high frequencies than at low frequencies. This is due to the fact that the high-frequency magnetic fluxes set up inside the conductor induce *eddy currents* which weaken the current at the centre of the conductor and strengthen it at the outer surface. Thus at high frequencies the *current-density* is greatest at the outer surface of the conductor, and for large size solid conductors there is practically no current at all in the centre part. For this reason large conductors for carrying H.F. currents are often made in the form of a tube. The phenomenon referred to in the foregoing is called "skin effect."

The H.F. resistance of a coil is not simply the H.F. resistance of the wire of which it is composed but is that equivalent resistance which accounts for all sources of energy loss. For instance, a certain loss of energy takes place due to *absorption* in the *dielectric* comprising the insulation and former and a still further loss due to radiation, and losses in neighbouring objects by induction. If W denote the total power loss in watts and i the *effective value* of the current, the effective high-frequency resistance is given by $R = W/i^2$ ohms.

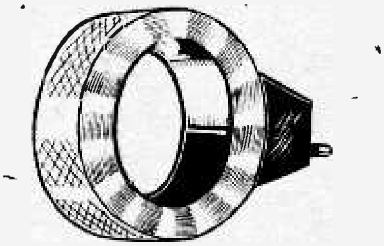
High-frequency Transformer. A transformer for coupling the three-electrode valves of a high-frequency amplifier in *cascade*, or in general an *oscillation transformer*. A high-frequency transformer used as an *intervalve coupling* is usually tuned by means of a variable condenser connected across either the *primary* or the *secondary winding*, so that a given transformer will only operate efficiently over a limited band of wavelengths. Some high-frequency transformers are provided with a number of *tappings* on both primary and secondary windings, so that by means of a multiple contact switch a very wide range of wavelengths can be obtained.

Instead of having a transformer with tapped windings it is often convenient and more efficient to employ a separate transformer for each band of wavelengths, such transformers being interchangeable in the circuit (see PLUG-IN TRANSFORMER). The action of a high-frequency transformer with the primary tuned is identical with that of the *tuned anode* coupling, except that the output voltage is applied to the grid of the next valve by *inductive coupling* instead of by means of a *grid condenser*.

High Tension. Refers to the *potential difference* or voltage which is applied between the *plate* and filament of *thermionic valves*. This voltage is large compared with the voltage necessary for driving the heating current through the filaments of the valves; hence the term *high tension*. Cf. LOW TENSION.

High Tension Battery. A battery of cells (usually dry cells) used in valve circuits to maintain the plate at a given potential above that of the filament, *i.e.*, the source of *high tension*. Sometimes called the "B" battery.

Honeycomb Coil. A multilayer coil wound in a manner to give a minimum value of *distributed capacity* for a given value of *inductance*. The turns are wound from side to side of a cylindrical surface by means of a special machine, and the finished coil has a cellular appearance, giving rise to its name. Sometimes called a De Forest coil after the inventor.



Honeycomb coil.

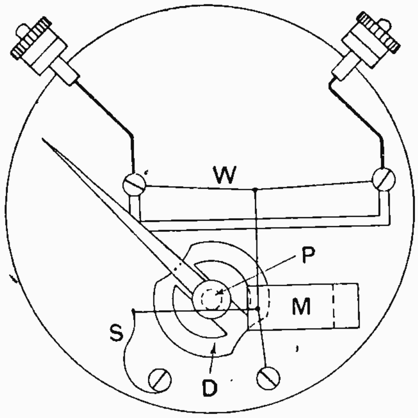
Horse Power. The practical unit of mechanical *power*, equal to a rate of doing work of 33,000 foot pounds per minute, and equivalent to an electrical power of 746 watts.

Horse Shoe Magnet. A permanent or electro-magnet of such a shape that the two poles are brought near together compared with the length of the *magnetic circuit*. Not necessarily the shape of a horse shoe.

Hot Wire Ammeter. An instrument for measuring current, depending for its operation on the heating of a wire by the current to be measured. The expansion or extension of the wire is made to operate the pointer through suitable mechanism. The temperature rise of the wire is roughly proportional to the square of the current, and

Dictionary of Technical Terms.—

therefore the instrument obeys the *square law.* The reading is independent of wave shape, and also of *frequency*, at all low and moderate frequencies; but at high frequencies errors are probable if the instrument is not of the highest quality, and it is always advisable to have it calibrated at the frequency at which it is to be used when reliable readings are necessary. The chief sources of error arise from the increased *high-frequency resistance* of the instrument itself, and, at very high frequencies, due to the by-passing of a considerable fraction of the current by condenser action, *i.e.*, through the capacity between the terminals of the instrument. Cf. THERMO-AMMETER.



Principle of the hot-wire ammeter. W, heater wire; P, pulley; S, control spring; D, damping disc; M, damping magnet.

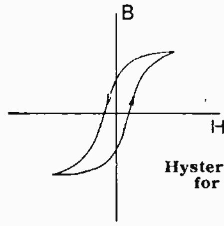
Howling. The occurrence in a valve receiving circuit of continuous oscillations of an audible frequency, especially where *audio-frequency amplification* is employed. These oscillations are produced by stray coupling between the output and input sides of the amplifier, and may be due to faulty laying out and spacing of the connections. Howling may sometimes be due to another cause altogether, namely, the starting and stopping of *high-frequency* oscillations in the *detector* circuit where grid rectification is employed in conjunction with *reaction.*

H.T. Abbreviation for *high tension.*

Hydrometer. Instrument for measuring the specific gravity of accumulator acid and other liquids.

Hysteresis (in iron). If the magnetic flux density B produced in a given piece of iron is found for increasing values of the *magnetising force* H, and then again for decreasing values of H over the same range, it will be found on plotting the two "B-H curves" from the two sets of readings so obtained that the curves will not coincide. In other words, the value of B is not only dependent on the value of the magnetising force, but also upon whether it was increased from a lower value or decreased from a higher value to the given value, *i.e.*, there is a sort of lag of the flux density produced in the iron behind the magnetising force producing it. This effect is known as "hysteresis." See HYSTERESIS LOOP.

Hysteresis Loop. If an iron *magnetic circuit* is subjected to an alternating *magnetising force, i.e.*, one produced by an alternating current and thus magnetising the iron alternately in both directions, the curve obtained by plotting the values of the *flux density* B in the iron against all the successive values of the *magnetising force* H over one complete *cycle*, is a closed loop

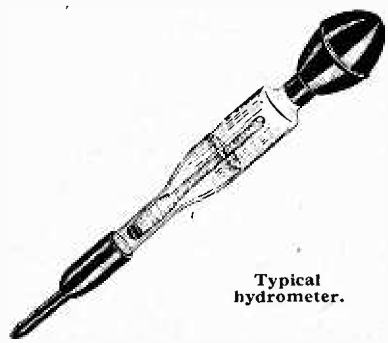


Hysteresis loop for steel.

similar in shape to that shown in the figure. This is known as the "hysteresis loop."

This hysteresis effect represents a loss of energy, and the area enclosed by the loop is directly proportional to the energy lost per cycle. The power lost in hysteresis is directly proportional to the frequency, and roughly proportional to the 1.6th power of the flux density. See HYSTERESIS.

Hysteresis Loss. The power in watts lost in iron subjected to an alternating magnetic field, due to *hysteresis* effects. See HYSTERESIS LOOP.



Typical hydrometer.

I.C.W. Abbreviation for *Interrupted C.W.*

Idle Current. That component of an *alternating current* which is 90° out of phase with the voltage and thus represents no power. It is sometimes called a "wattless current." See POWER FACTOR. Cf. POWER COMPONENT. See POWER IN A.C. CIRCUITS.

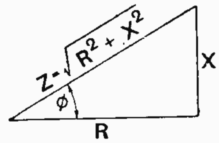
Impedance. The total opposition offered by a circuit to the passage of an *alternating current* and given by the ratio of voltage to current, being measured in ohms. The impedance of a circuit is due to the combined effects of *resistance, inductance*, and *capacity*. In general, for a series circuit, the impedance Z is given by $Z = \sqrt{R^2 + X^2}$ ohms, where R and X are the resistance and *reactance* respectively of the circuit, each measured in ohms. See ALTERNATING CURRENT CIRCUITS.

Impedance Coil. See CHOKE or CHOKING COIL.

Impedance, Internal (of valve). See INTERNAL IMPEDANCE.

Impedance Triangle. If R is the resistance of an *alternating current circuit* and X is its *reactance*, then the *impedance* is given by $Z = \sqrt{R^2 + X^2}$ ohms. These three quantities can be represented by the three sides of a right-

Impedance Triangle.



angled triangle, the two sides adjacent to the right angle representing R and X respectively, and the side opposite (the hypotenuse) representing Z. If ϕ is the angle opposite the side representing X, $\tan \phi = X/R$ (see ALTERNATING CURRENT CIRCUITS),

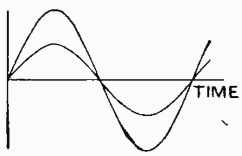
and $\cos \phi = \dfrac{R}{\sqrt{R^2 + X^2}}$ = the power factor.

Impressed E.M.F. The voltage or *difference of potential* which is applied to the ends of a circuit from some external source by direct connection, and not *induced* into the circuit by *electromagnetic induction.*

Impulse Excitation. Method of starting *high-frequency* oscillations in an aerial system or *oscillatory circuit* by a sudden surge, *e.g.*, a spark, and not by applying an oscillating voltage of the same frequency as that of the tuned circuit. Sometimes called "shock excitation."

In Phase. Two alternating quantities are said to be "in phase" if they have the same frequency and pass through their respective maximum and zero

Sine waves in phase.

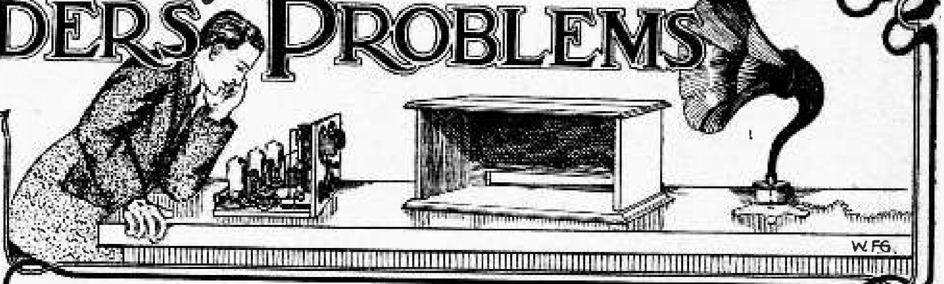


values at the same instants. The definition applies only where the two waves are of the same shape. See PHASE DIFFERENCE.

Induced Current. A current produced in a circuit by an *induced E.M.F., i.e.*, by a changing of the magnetic flux linked with the circuit.

Induced E.M.F. If the magnetic *lines of force* linked with a circuit are changed (increased or decreased) an *electromotive force* or voltage is produced in the circuit, being at any instant proportional to the rate at which the lines are changing. This is called an "induced E.M.F.," and it has a value of one volt when the *line-linkages* (product of magnetic lines of force and the number of turns of the circuit with which it is linked) are changing at the rate of 10^8 per second. See SELF-INDUCTANCE, and ELECTROMAGNETIC INDUCTION.

READERS' PROBLEMS



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

A Single Valve Receiver for Distant Reception.

A friend who has had remarkable success on distant stations with a one-valve receiver has given me the circuit of same, but before constructing the instrument I should like an opinion from you concerning the technical soundness of the circuit. Can an L.F. stage be used with it?

R.J.H.

This circuit is perfectly sound and reliable, and enjoys a considerable vogue amongst American enthusiasts. Its special merit is in the smooth control of

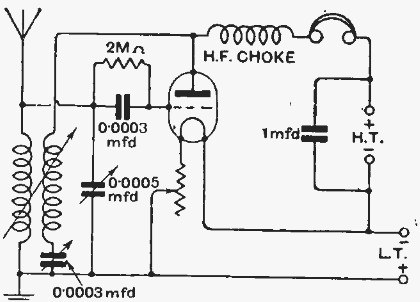


Fig. 1.—Combined capacity and magnetic reaction.

reaction, coarse adjustment being made by varying the position of the reaction coil, and a final adjustment being made with the reaction condenser. The benefits of this circuit are specially noticeable on the shorter wavelengths, where a comparatively slight movement of the reaction coil calls for considerable readjustment of the tuning condenser. It is, however, equally suitable for the higher wavelengths, very critical adjustment of reaction being possible, causing the circuit to be specially useful for distance getting. The moving plates of both condensers should be connected to earth, and then it will be seen that the last vestige of hand-capacity effect is eliminated, a fact which is greatly appreciated when tuning-in distant stations. It should, however, be noted that the efficiency or otherwise of this circuit depends on the efficacy of the H.F. choke, which should be very carefully chosen. It is possible to obtain from advertisers in this journal chokes which cover all wavelengths from the lowest B.B.C. wavelength up to about 4,000 metres. The aerial and reaction coils can be of the plug-in type. An L.F. stage can be added in the conventional manner, the primary of the transformer taking the place of the telephones.

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Using A.C. Mains for Filament Lighting.

I have 240-volt A.C. mains in my house, and understand that I can effect an economy by lighting my valves (four bright emitters) direct from the mains. Can you explain how I could accomplish this with a transformer and rectifier?

D.L.C.

No rectification is needed if using A.C. for filament ignition, which accounts for the simplicity and reliability of the method in contrast to use of A.C. mains for H.T. supply, where, of course, some form of rectifier is needed. You will need a small power transformer to step down the voltage from 240 to 6 volts, which can be obtained from advertisers in this journal for the price of a first-class L.F. transformer, a potentiometer and two 1 mfd. fixed condensers of the type used for shunting across H.T. batteries. We illustrate in Fig. 2 this apparatus used in conjunction with a conventional two-valve receiver; although, of course, it is equally applicable to any type of receiver. We shall need to include an extra terminal in our receiver and make a very slight alteration to the wiring. Negative grid bias is applied to the L.F. valve by a battery in the conventional manner, the positive side of this battery being connected *via* the extra terminal to the slider of the potentiometer instead of to L.T. –, as is customary. The reason for this is that we shall have A.C. passing through our filament, and it is evident that we cannot join this connection to "L.T. –" as usual, since both sides of the valve filament are constantly changing their sign, owing to the fact that they are heated by A.C.; consequently, if the grid return lead of either detector or L.F. valve were connected to either side of the filament as is customary, a hum would be produced, owing to the fact that the value of grid bias would be constantly and rhythmically changing. The same thing would happen if the H.T. – were connected to either side of the filament. Were it possible to tap the centre of the filament, we should find a point which in spite of the A.C. was always at constant potential, but we can obtain the same effect by shunting the transformer secondary with a potentiometer and adjusting the slider to the zero position, which will be about half-way along, and connecting all grid return leads and the H.T. – connection to this slider. This method of obtaining an artificial centre tap on the transformer secondary is preferable to having an actual centre tap on the secondary, since unless the transformer is very carefully made, the centre tap may not be the exact electrical centre of the secondary, and a hum will be produced in the loud-speaker. Since we have robbed the detector valve of the slight positive bias necessary for its operation, which it derives from its customary connection to the positive side

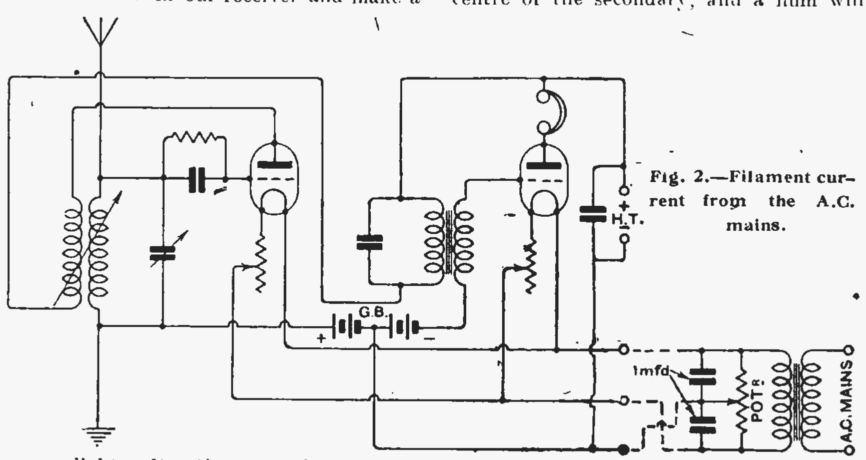

Fig. 2.—Filament current from the A.C. mains.

of the L.T. battery, we must compensate by using a tapped grid battery to *positively* bias the detector valve, whilst, of course, the L.F. valves require to be biased negatively. This method of lighting the valves is very economical, since even if the transformer is not noted for its efficiency, four *bright* emitters can be lighted at a cost of less than that entailed in illuminating one average household lamp of 30 watts or so, whilst owing to the absence of a rectifier the apparatus is remarkably trouble free. If we attempt to use A.C. mains for H.T., however, not only do we require some form of rectifier, but it is no longer permissible to use leaky grid rectification if good results are to be aimed at.

oooo

Self-oscillation.

Is it true that if a click is heard on touching the aerial terminal with a moistened finger the receiver is in a state of oscillation? I ask this because I hear a loud click whenever I do this at a time when my local station is in operation, although the reaction coil of my single-valve receiver is short-circuited. S.E.L.

It can be stated with certainty that if at any time a receiver is in a state of oscillation, and a moistened finger is touched on the aerial terminal, a click will be heard in the telephones. At the same time, the presence of a click when this operation is performed at a time when the local station is "on the air" is not necessarily indicative of self-oscillation.

oooo

Positive or Negative?

Can you inform me in which lead the filament resistance should be connected when dealing with H.F. valves? K.L.M.

The rule is the same as when dealing with L.F. amplifiers, namely, that the rheostat should be placed in the positive lead. In this way variation of the rheostat will have no effect on the mean grid potential of the valve. Actually, however, if a *fixed* resister is used it is not a bad plan to put the rheostat in the negative lead, since in this manner a little negative bias is given which is all to the good in an H.F. amplifier, and is beneficial to the life of the H.T. battery.

oooo

Volume from a Choke-coupled Amplifier.

I possess a three-stage choke-coupled amplifier, which I have built up from the best possible parts. Volume is very poor indeed, it being much less than that obtainable with a two-stage transformer-coupled amplifier. Can you suggest any likely fault? F.G.B.

Speaking broadly, the amplification obtainable from three stages of choke-coupled amplification is equivalent to that obtainable from two stages of transformer-coupled amplification, using the same type of valves in each case, provided that the choke connected in the anode circuit of the valve has an impedance at least two or three times the impedance of the valve

in the anode circuit of which it is connected. In this manner 90 per cent. of the amplification factor of the valve may be obtainable. Therefore, if general-purpose valves are used a choke having an impedance of 100,000 ohms over the main part of the audible frequency range will be suitable. A good value of inductance to aim at is 100 henries, which is obtainable by connecting the primary and secondary of an intervalve transformer in series. We would suggest, therefore, that the chokes you are using are not the best obtainable; possibly they are 20-henry chokes, which are mainly used in choke filter circuits following the output power valve in an L.F. amplifier.

oooo

Designing a Two-range Receiver.

I wish to construct a receiver employing plug-in coils throughout, which has an aperiodically coupled aerial circuit on the B.B.C. wavelength and a direct-coupled aerial on longer wavelengths. Can you suggest a suitable circuit? M.R.M.

We illustrate a suitable circuit in Fig. 3. The secondary coil on the broadcast band can consist of a No. 50 plug-in coil, the coupled coil being some such coil as a Gambrell A2 or a similar coil by other manufacturers. By providing two aerial terminals all switching is avoided.

Restoring Dry Cells.

I have a number of exhausted dry cells of the bell-ringing type which have done service with dull-emitter valves. Is there any method of recharging these cells? H.V.C.

It is, of course, quite impossible to recharge dry cells from the mains in the same manner as a secondary battery. However, it is possible to obtain many hours' additional service from the batteries by removing the paper labels, punching holes in them, and immersing them in jam jars filled with sal-ammoniac solution.

oooo

Using a Two-electrode Valve as a Rectifier.

I have in my possession a two-electrode valve, and wish to use it as a rectifier in a wireless receiver. Is a grid leak and condenser necessary? R.H.V.

No, it is not necessary to employ these components, since this type of valve rectifies by means of anode rectification, the positive half-cycle of current causing a fairly appreciable increase in the steady current flowing through the valve, the negative current having little or no effect in causing a proportional decrease.

oooo

Amplification Factor.

Please explain what is meant by the amplification factor of a valve. D.F.F.

The amplification factor of a valve represents the relationship between the change in the grid potential and anode potential necessary to cause the same change in anode current. Thus, assuming we have a valve in which it is necessary to vary the anode voltage twenty times the amount necessary to vary the grid voltage in order to bring about the same change of anode current, we may say that the valve has an amplification factor of twenty.

oooo

Aerial Insulation.

Is it preferable to use one very large insulator or to use two or three small ones in series? A.J.C.

It is preferable to use two or three small ones in series, since in this manner not only is the D.C. resistance increased, but losses due to leakage across the insulators by capacity effect, which may become serious in the shorter wavelengths, are lessened by connecting a number of small insulators in series.

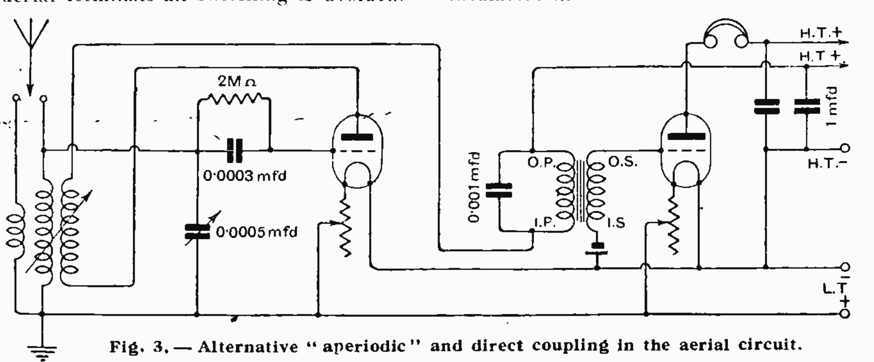

Fig. 3.—Alternative "aperiodic" and direct coupling in the aerial circuit.