MODERN WIRELESS

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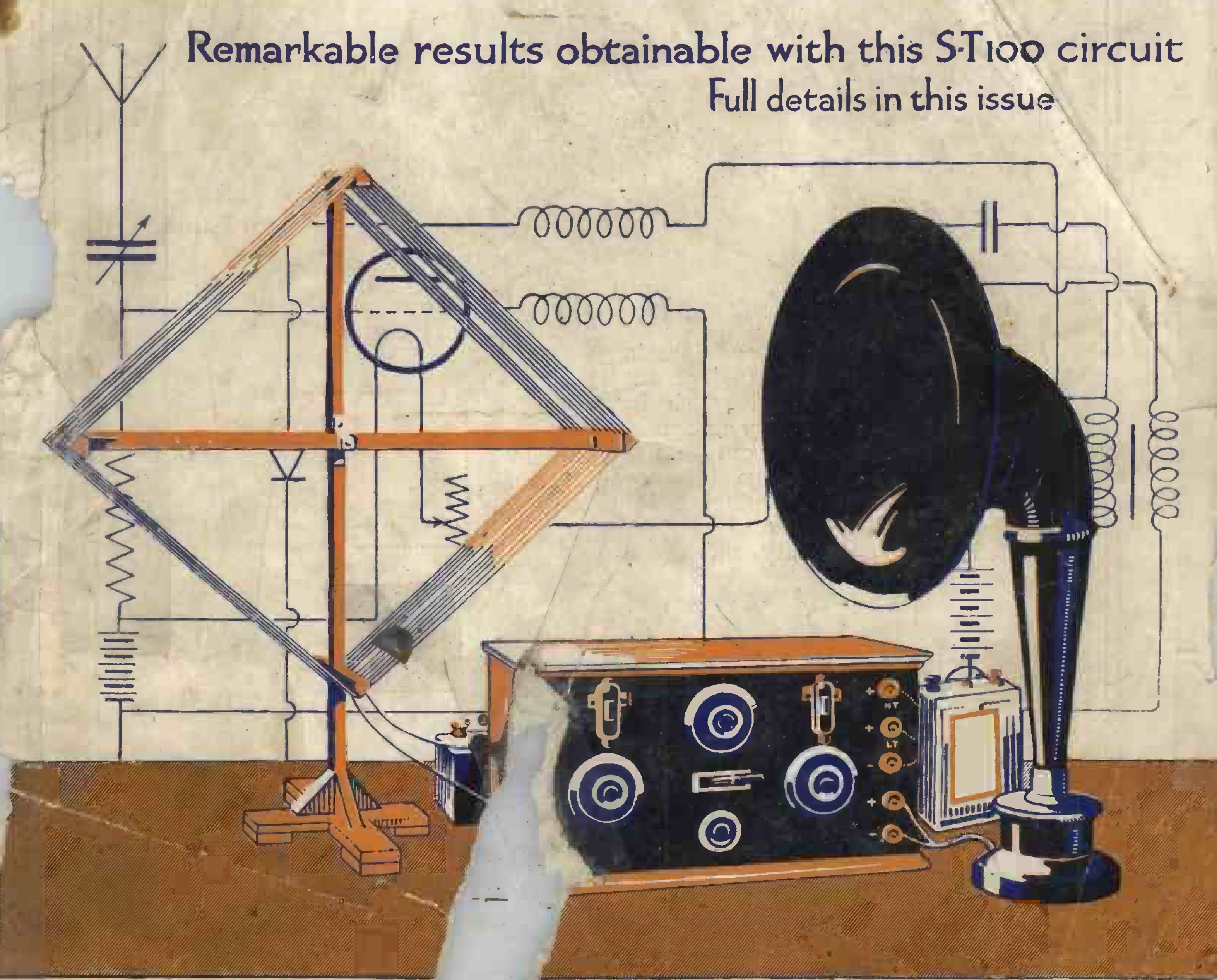

No. 5

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T[illegible]URE OF ATMOSPHERICS by O. F. Brown, M.A. B.Sc.
Aerial [illegible] Making a Long-wave Valve Receiver. A Broadcast Receiver Emplo[illegible]tion. How to make a Compact Crystal Set. New Ideas. Practical [illegible] in Passing. Above and Below the Broadcast Wave-lengths.

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Editorial

AT this time of strife and contention in the wireless world, it were perhaps well if we could stand back a little from some of our problems and try to see them from a broader view-point. Take, for example, the question of the relative rights and privileges of the broadcast listener and the experimenter, which has been worn somewhat threadbare in the discussion of the licence problem.

We must remember that the matter is not so simple as one might imagine after reading some of the superficial pronouncements in the Press; it is not merely an antagonism (real or imaginary) between the type of individual who is interested in reception from the entertainment point of view alone, and another type who wants to play with a toy set of his own construction, and demands various apparently unreasonable concessions upon the strength of it. The true experimenter is *not* a person whose ambition in life is to be allowed to make unpleasant noises with a reaction set whose function he does not understand, but rather he is the equivalent in the wireless world of the independent researcher, who is the backbone of British science, and to whom so many discoveries are due.

The great value of the amateur investigator lies in the fact that he is free to pursue problems which do not promise to lead him to results of commercial value, in a way that is impossible to the professional who is employed by a wireless company. Such investigation, of course, is of great scientific utility, since it has led workers in the past, and will no doubt lead them in the future, to stumble upon many important discoveries.

To illustrate this point we will take an example which will seem less hackneyed, perhaps, than the familiar instances from the history of wireless: the gas industry of the present day is largely built upon two inventions, namely, the Bunsen burner, which enables gas to be used on the large scale for heating boilers and so forth, and the incandescent mantle, by whose aid it is enabled to compete with electricity as a source of light. Now, both these inventions were of an accidental nature: the first was devised by a chemist who wanted a burner which would allow him to heat his glass vessels without covering them with a deposit of soot, while the second was also due to a chemist, who was carrying out some rather academic investigations into the properties of what are known as the rare earths. These substances are chiefly the oxides of various metals of rare occurrence, such as cerium and thorium, and what the investigator found was that certain of them possessed the characteristic of becoming incandescent at quite low temperatures, which discovery led, before long, to the construction of the first "incandescent mantle."

It is interesting to note in passing that some of these rare earth metals have the peculiarity of giving a copious emission of electrons at relatively low temperatures, and this property is made use of in the manufacture of "dull emitter" valves, whose filaments are coated, in some cases, with thoria.

We believe it to be but just to say that the majority of experimenters are thoroughly imbued with the spirit which prompts a man to be continually testing new devices, trying to think of new and better ways of doing things, and attempting to discover the why and wherefore of unexplained phenomena, which is the basis of all true scientific research.

Let us therefore speak of the genuine experimenter with due respect, and realise that he is the leaven in the wireless lump.

* * *

At the time of going to press the licence question shows no signs of an early settlement and the ill-effects of the prolonged uncertainty are becoming more and more marked. The "pirates" are growing case-hardened in their piracy, many of the general public are coming to the conclusion that it is useless to hope for a solution and are therefore abandoning their interest in wireless, while the continued uncertainty of the position is having a most serious effect upon the industry, and has already thrown some thousands of workers out of employment. Surely it is time something was done?

* * *

Our readers will note the appearance in this issue of a number of new features with pictorial headings: these new sections will now appear each month, and will be supplemented by others as occasion requires. In connection with these new features we would direct the reader's attention to the page headed "We ask for your criticism," where he will find provision for the expression of an opinion upon these and other innovations. The page in question, by the way, is a significant indication of our endeavour to interest our readers in our constant efforts to improve "MODERN WIRELESS" and extend its usefulness yet further. We wish the readers of this magazine to realise that we are continually striving to make it more attractive, interesting, instructive and useful to them, and that they can help us by letting us know what they really want.

* * *

Following upon the recent addition to our staff of a number of well-known wireless authorities, we have pleasure in announcing that the Editorial forces have been further strengthened by our being joined by Mr. Percy W. Harris, whose qualifications are, no doubt, familiar to all our readers. He was at one time Editor of the *Wireless World* and more recently of *Conquest*, but he is perhaps most widely known as the author of "*The A B C of Wireless.*" "*Broadcast Receivers and how to Use Them*," and other works. In welcoming Mr. Harris, we can say, on his behalf, that it is his intention to uphold and enhance the reputation possessed by "MODERN WIRELESS," among all those interested in wireless in this country.

* * *

We would direct the attention of those of our readers who take a serious interest in experimental work to the article in this number entitled "The Measurement of Signal Strength." This contribution should do much to remove the common impression among amateur workers that methods employing exact measurement are too complicated and costly for them, and to convince them that the use of some such method is essential, if much of one's work is to be of real value. While we may not agree entirely with the dictum "Science is measurement," yet there are many occasions in wireless investigation when a whole series of experiments may break down and fail to give information of any real value simply because the results given at some stage were not submitted to rigid measurement, but were estimated in some crude way which brought in all the possibilities of error pertaining to the fallible human senses.

* * *

Among the special beginner's articles in this issue, the discussion of the best methods of making a good earth connection should prove of great help to those readers who are installing their first receiving set (and possibly to others of greater experience also!). The importance of obtaining a good low-resistance connection to earth is difficult to over-estimate, and yet the matter is often very carelessly attended to by the novice. With all sets which do not employ reaction, such as crystal receivers, the quality of the earth connection has a great effect, not merely upon the loudness of the received signals, but upon the sharpness of tuning obtainable with the set.

Wireless Towers & Masts

By C.F. ELWELL, Fell.I.R.E.; M.I.E.E.

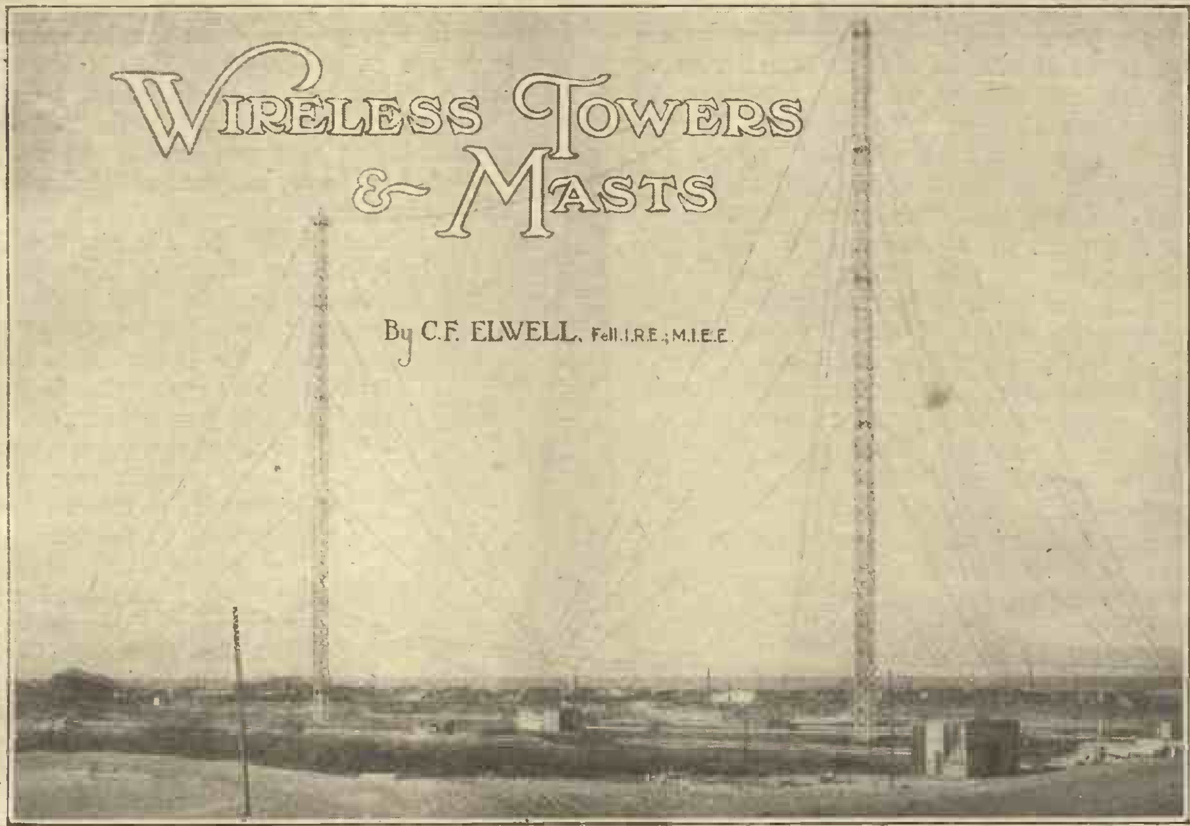

Fig. 5. Two 300-foot wooden masts at San Francisco.

SINCE the advent of Broadcasting, the number of aerials to be seen on every hand has multiplied enormously. Some of these aerials are fastened to natural supports, such as chimneys, trees, etc., but the majority have one or more poles to support them, and as the aerial which may be erected is strictly limited in size, these poles are never of any great height. It is also true that many of them would succumb to the first really good windstorm, but the enthusiastic amateur would soon put his poles up again, if he did have the misfortune to have them blown over, and no great harm would have been done.

This interesting article has been specially written for "Modern Wireless" by an engineer who has erected some of the highest masts in the world.

But for transmitting stations, especially those devoted to the transmission of intelligence to the Colonies and other countries, the masts or towers necessary to support the large aerials required, if considerable distances are to be spanned, must be high and substantial. If one of these should fall down as the result of a storm, it would be a serious matter, since it would take several months before another could be erected in its stead. The object of this article is to describe a few of the various forms which wireless masts and towers may take, and to point out some of the salient factors.

First, a definition of the word "tower" would not be out of place. The word "tower" is applied to all those structures which, by virtue of being constructed with a large base and a small top, are self-supporting, in that no stay-wires or other supports are necessary for the stability of the structure.

One of the best known "towers," and at the same time, the highest tower in the world, is the Eiffel Tower in Paris. (*See* Fig. 1.) Although not constructed as a wireless tower, it has been put to that use. It was constructed from the designs of M. A. G. Eiffel, a French engineer, for the Exposition held in Paris in 1889. Its height is 985 feet, or exactly 300 metres, and in order that such a high tower should be able to stand without any external support, its base was made to cover about 2½ acres. To be exact, the four legs are spaced 328 feet apart. These four legs are inclined, and at a height of 187 feet from the ground the first platform is encountered. Its area is 5,860 sq. yds. From the first platform the tower proper is square and tapers gently. At an elevation of 378 feet above the ground there is a second platform with an area of about 300 sq. yds., and at an elevation of 905 feet there is a pavilion capable of holding 800 people. There is also a wide promenade from which a wonderful view of France may be obtained upon a clear day. An aerial consisting of six wires is attached to this platform and the other ends of these six wires are anchored at a considerable distance from the base. The wires are of steel because the authorities of the city of Paris insist upon the use of this material in order to avoid the possibility of a wire or wires breaking and falling into the street below. This aerial is connected to the famous Eiffel Tower transmitting station.

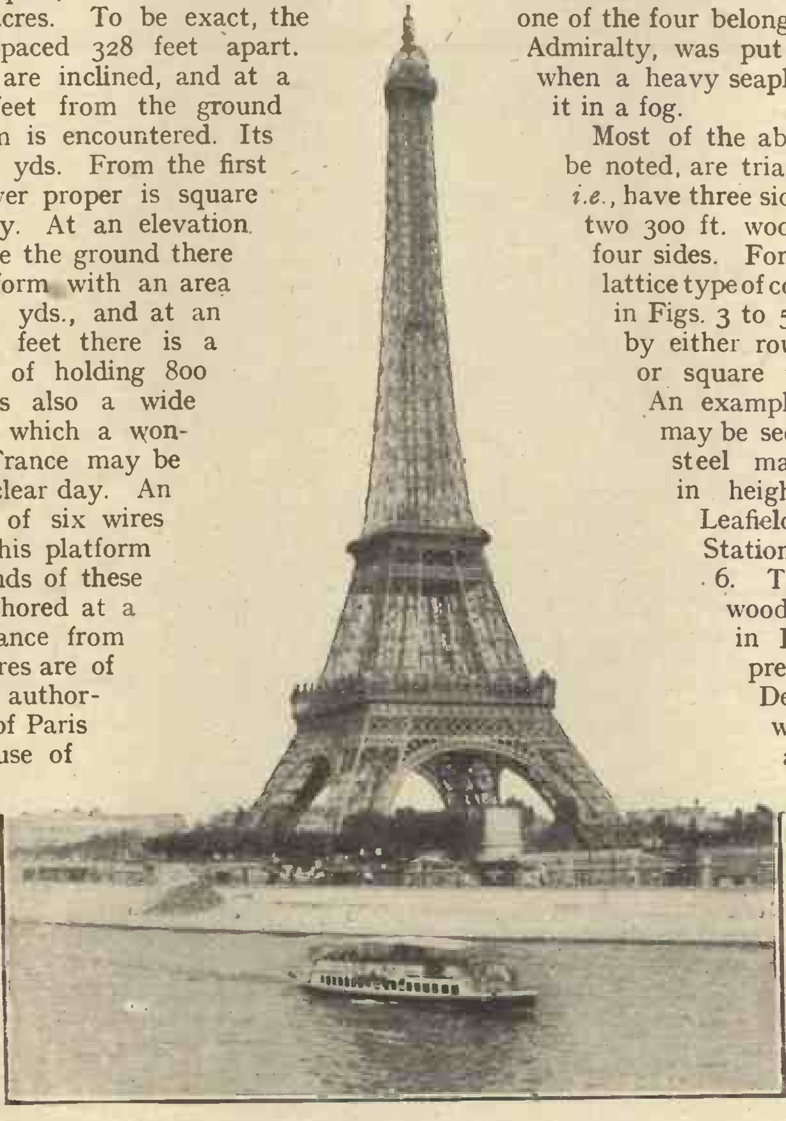

Fig. 1. A view of the Eiffel Tower taken from the Seine.

The tower in Fig. 2 is 200 feet in height, and has been increased in height to 230 feet by means of a wooden extension. This tower is one of two at the Royal Air Force Station at Malta. The above examples should make it quite clear what is meant when a wireless tower is mentioned.

Now, the word "mast" defines a structure which depends for its stability upon one or more sets of stay-wires or ropes. Masts may be constructed either of wood or steel, and some examples of each type will be shown.

The British Post Office Station at Northolt is shown in Fig. 3. The three wooden masts are each 446 ft. in height. Fig. 4 shows to what a severe test a similar mast, being one of the four belonging to the British Admiralty, was put during the war, when a heavy seaplane collided with it in a fog.

Most of the above masts, it will be noted, are triangular in section, *i.e.*, have three sides. Fig. 5 shows two 300 ft. wooden masts with four sides. For lower masts the lattice type of construction shown in Figs. 3 to 5 may be replaced by either round steel sections or square wooden sections. An example of the former may be seen in the tubular steel masts, each 305 ft. in height, employed at Leafield, Oxfordshire, Station, shown in Fig. 6. The square type of wooden mast is shown in Fig. 7, which represents the Lyngby, Denmark, Station, where the masts are 180 ft. in height.

For masts up to 180 ft. in height round wooden poles have been largely used, and these may consist of one, two or three pieces, according to the height. Finally, for short poles steel tubing of small diameter may be employed.

The foregoing illustrations give an idea of some of the various forms which wireless towers and masts may take in practice. A few words as to the type of engineering problems these towers present may not be out of place. The chief load on a mast, or tower comes from the pressure of the wind upon its exposed surface. This pressure is proportional to a constant depending upon the proportions of the front surface exposed

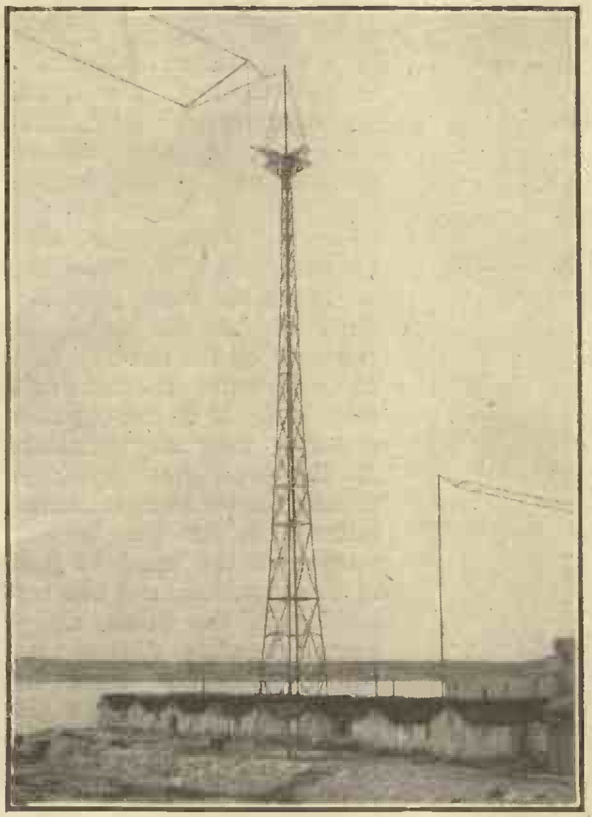

Fig. 2. 200-foot tower at Malta.

to the wind; to the square of the velocity of the wind, and to the area of the surface exposed to the wind. More exactly $P = KV^2A$, where P is the pressure in lbs. per sq. ft.; K is a constant varying in value from ·0029 to ·0066; V the velocity of the wind in miles per hour, and A the area of the front face in sq. ft.

In the case of a tower this wind pressure would tend to blow it down by overturning it, if the base of the tower were not sufficiently large, and if the feet of the tower were not attached to blocks of concrete sufficiently heavy to resist the uplifting movement.

In the case of a mast, sets of three or four stays, consisting generally of steel wire rope, are attached to the structure at various elevations. These stays are anchored to masses of brick, stone or concrete. Each of these stays must be sufficiently strong to resist the sum of the forces due to the wind pressure upon half of the section of the mast above and half the section of the mast below the point of attachment of the stay. As the wind may blow from any direction, three or four stays arranged at intervals of 120° or 90° must be provided.

The points of attachment of stays constitute points of support to the structure as a whole, but the structure between stay points behaves as a uniformly loaded beam supported at the ends only. It also behaves as a long column, which means that if its length be excessive compared to its section, it will have large stresses set up in it. The designer of a mast of any given height must then decide, first, upon the lengths of the unsupported sections, *i.e.*, the number of stay points. Once having settled this, and the cost of the mast will depend upon whether there are to be few or many, the minimum size of the section of the mast can be determined.

If the mast to be designed is a high one the sections can readily be upwards of 100 ft., and this makes it necessary to use sides of the structure of from 5 to 8 ft. If the number of stays be quite few, as at Nauen, where only 4 sets of stays support the 860 foot mast, the side of the section of the mast can readily become as large as 22 ft. The larger the side of the mast exposed to the wind, and the larger the half sections above and below the stay point, the greater the force due to the wind which the stay must resist, and the larger the wire rope

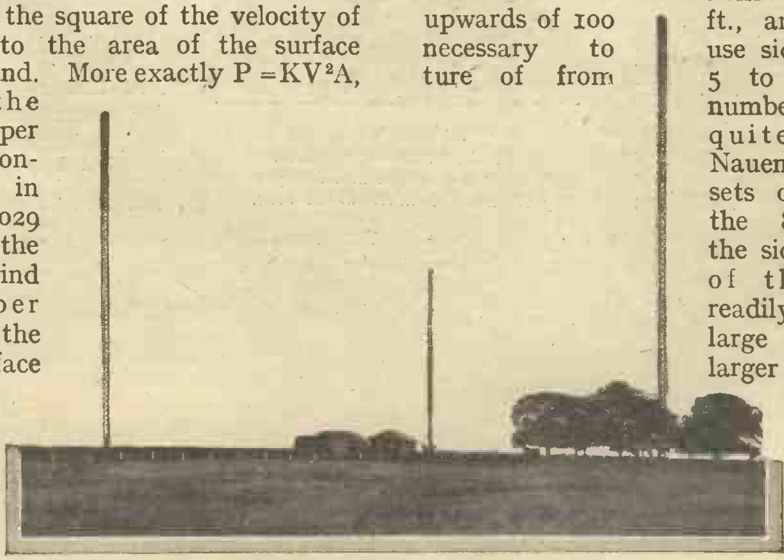

Fig. 3. Three wooden masts, each 446 feet high, at Northolt.

forming the stay must itself be.

In the higher masts the increased section of the mast brings its own particular problems, in the form of the bracing which binds the corner columns of the mast. These corner columns take the loads in the masts, the principal of which are due to the wind pressure, the dead weight of the mast structure, the beam action and the long column action ; the unsupported sections both of the columns and of the bracing are subject to the same laws as the length of the sections between stay points.

The wind upon the stay-ropes themselves must not be neglected in high structures, or in structures with so few stays that the stay-wires become of large diameter. The stay-ropes must be broken up into insulated sections for electrical reasons, and these present serious problems, when the stays are excessively large.

So far nothing has been said about the load imposed by the aerial, which the mast or masts are to support. If the masts are high and spread considerable distances apart, as at St. Assises where the masts are 1,320 ft. apart, or at Rome, where they are 1,000 ft. apart, the aerial can represent a very large pull exerted horizontally at the top of the mast. By using special devices a large part of these horizontal pulls can be transformed into vertical loads in the columns. The same wind pressure which increases the load upon the mast, increases the load upon the aerial. If the wind on the mast be in a certain direction the two loads may add. If in the opposite direction they may subtract. As the mast must deflect in a wind, the tendency is, in the latter case, for the bottom portion of the mast to lean in one direction and the top portion in the other, introducing bending stresses, for which allowance must be made. If large stresses are not to be introduced in the base of the mast, the bottom must be pivoted, and if this pivot must be electrically insulated, as is often specified, a further problem is introduced. The above will serve to show that the design of wireless towers and masts calls for a certain amount of skill and judgment, if a really safe structure is to be erected at a reasonable cost.

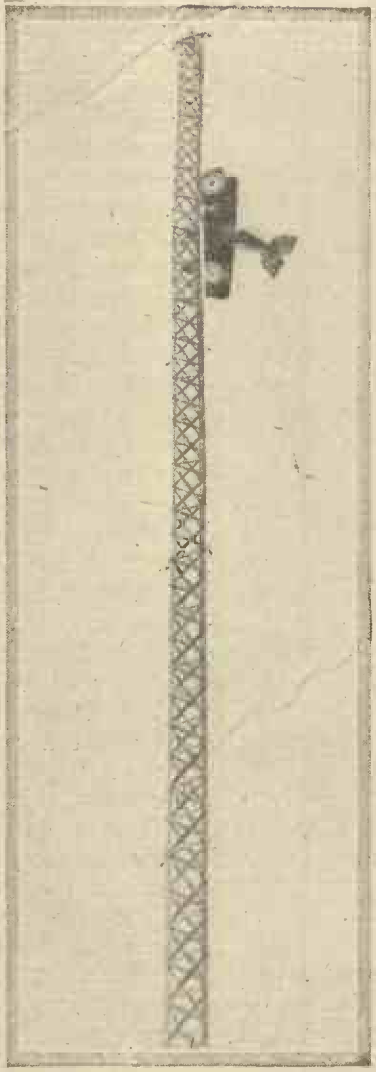

Fig. 4. A testimonial to the mast! The result of a collision between a seaplane and the 440-foot wooden mast at Horsea.

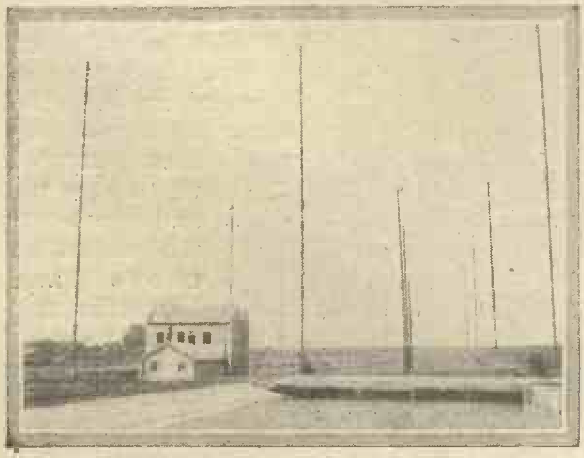

Fig. 6. Showing the ten steel masts at Leafield.

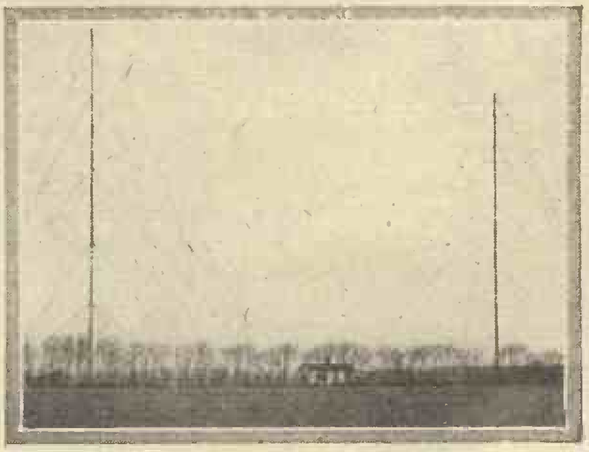

Fig. 7. 180-ft. wooden masts at Lyngby, Denmark.

THE NATURE OF ATMOSPHERICS

By O. F. BROWN, M.A., B.Sc., Secretary of the Radio Research Board.

This article will be found to contain a most fascinating account of recent research upon the atmospheric problem, upon which it throws a new light.

IT has been evident for some time that the main limitation imposed on the development of radio-telegraphy as a commercial proposition for communication over long ranges is that due to the interference of atmospherics. It would be difficult to estimate how much time and how many thousands of pounds have been spent in attempts to eliminate such interference. Hitherto all attempts have ended in comparative failure. At the most an hour or two has been added to the daily period during which two stations could communicate without atmospherics delaying traffic.

The Radio Research Board from its formation naturally decided to give this problem the fullest possible consideration. It was evident from the examination of the various devices which had been tried for the elimination of atmospherics that all the investigators in this field were handicapped through the fact that practically nothing was known of the nature of the atmospherics. No reliable data were available of their duration, intensity, origin, or the directions from which they came, and the methods developed for elimination were based entirely on guesses as to these fundamental facts. Sometimes it was assumed that atmospherics were aperiodic impulses, and at other times that they were strongly damped trains of waves.

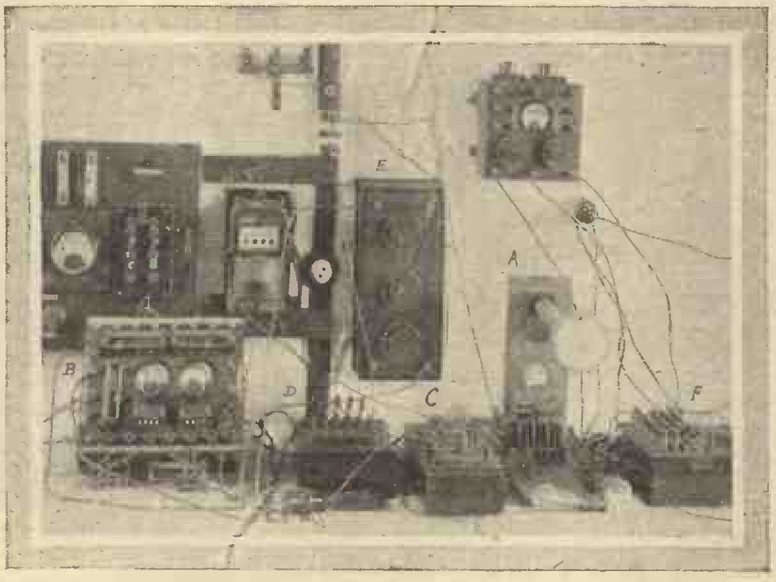

Fig. 5. Showing the apparatus employed at Aldershot. A. Cathode Ray oscillograph. B. Amplifier. C. Time base oscillator. D. Condensers. E. Resistance box. F. Source of artificial atmospherics.

The Radio Research Board therefore decided to leave the problem of elimination severely alone for the moment, and a research station was equipped at Aldershot under the direction of an Atmospheric Sub-Committee of the Board, with Mr. R. A. Watson Watt as superintendent, solely to investigate the fundamental nature and origin of atmospherics.

The difficulties to be faced were realised to be very great, mainly due to the lack of an instrument for measuring brief electrical impulses. What these difficulties were can best be realised from a closer consideration of the problem. Let it be supposed for a moment that an atmospheric consists of a complete solitary wave the length of which is 100,000 metres. Such a wave impinging on an ordinary antenna system would introduce in it an electric impulse lasting only 1/3000 of a second. But if the antenna circuit, as is normally the case, is only feebly damped, the current in it would not necessarily stop at the end of this period—just as a bell goes on emitting a sound long after the blow which produced the vibration has ceased. We thus see that, even if a reliable indicator of the currents and voltages produced in the aerial system was available, the interpretation of its record would be difficult, since it could not generally be determined which part represented the "electrical blow" of the atmospheric, and which part the electrical free vibration of the antenna; for the damping of the free vibration excited depends only on the characteristics of the aerial, and not on the characteristics of the cause of excitation.

Another difficulty was the absence of an instrument which, while sensitive enough for atmospheric work, was completely satisfactory as a faithful recorder of transient currents and voltages, such as an atmospheric would produce in an aerial system. Independent suggestions were made both by Mr. Watson Watt and by Dr. E. V. Appleton, who was working on similar lines at Cambridge, that a solution of the problem might be found in the development of a sensitive low voltage cathode ray oscillograph. While both these workers were engaged in the production of such a tube an oscillograph of the type required was put on the market by the Western Electric Company. Dr. Appleton

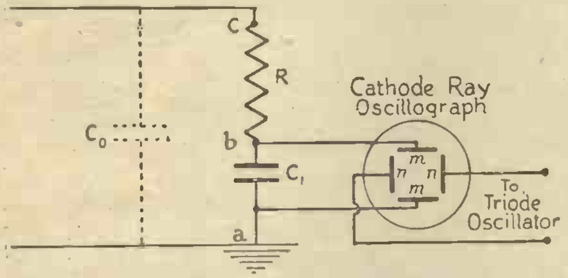

Fig. 1. Showing the method of applying the oscillograph to the semi-aperiodic aerial circuit.

and Mr. Watson Watt collaborated in experimenting with this American tube at Aldershot, and it was immediately seen that the tube provided just the instrument that was required for the investigation of atmospherics. Results obviously of the greatest importance were at once obtained, and these have been published already in a communication* to the Royal Society, and the diagrams and results reproduced here are taken from that paper.

As has already been pointed out, the electromotive forces produced in an aerial by an electromagnetic impulse such as an atmospheric may be regarded as consisting of two parts: (1) a "forced vibration" which follows the variation of electrical amplitude of the incident wave, and (2) a "free vibration" having a form which depends only on the electrical constants of the aerial, *i.e.*, its capacity, inductance and resistance. In order to study the form of the atmospheric it is necessary to design the aerial system so that the duration of the "free vibration" is small compared to that of the "forced vibration." Fortunately this is possible in the case of atmospherics because the period of the atmospheric vibration happens to be long (of the order of 1/1000 sec.), and in practice it was done by inserting a suitable ohmic resistance in series with the aerial circuit. The insertion of such a resistance changes the free vibration into a "free aperiodic" disturbance, and the resistance chosen was of a value to cause the "free aperiodic" disturbance to have a duration of 1/100,000 second. Thus in the case of an atmospheric lasting much longer than 1/100,000 second, it can be safely assumed that the electromotive forces in the antenna actually follow the form and intensity of the atmospheric.

Since it is not usually practicable to measure the whole of the electromotive force in the aerial system, a variable condenser C_1 (*see* fig. 1) was inserted in series with the aerial, and the potential across this condenser was measured. The total electromotive force in the aerial was found by multiplying the value obtained for the E.M.F. across C_1 by $\frac{C_1 + C_0}{C_1}$. The complete diagram of connections is shown in fig. 2. The apparatus can be considered as consisting of four parts: (*a*) the aerial system; (*b*) a triode voltage amplifier; (*c*) the cathode-ray oscillograph; (*d*) a device for the local generation of impulses of known type. The details of the apparatus are given in the paper in the Proceedings of the Royal Society already referred to. The amplifier used consisted of a single Western Electric triode (Type 102 DW), giving an amplification ratio of about 15 without distortion.

The cathode-ray oscillograph as already stated was of the pattern recently put on the market by the Western Electric Co. As in other similar oscillographs a stream of electrons from a heated filament are shot through a narrow tubular anode, maintained in this case at 400 volts positive with respect to the filament. These electrons form a narrow beam which with care can be brought to a focus on a screen which is coated with a sensitive fluorescent material. In the Western Electric tube a gas is introduced between the

* *On the Nature of Atmospherics (I.), Watt and Appleton, Proc. Roy. Soc. A 103, p.*

filament and anode, which becomes ionized by the passage of the electrons. The positive ions produced remain in the centre of the beam and attract the negative electrons, and so have the effect of preventing the beam from spreading. The spot on the screen is so made to come to a sharper focus.

As shown in the diagrams the magnified atmospheric impulses charge the plates *mm*, and introduce a vertical deflection of the beam of electrons in the tube. A horizontal deflection of the beam of electrons is produced by applying to the plates *nn* an alternating difference of potential from a triode oscillator having a range of frequency of 100 to 15,000 per second, so that the variations with time of the electric field due to the atmospheric are traced out. The tube is of such sensitivity that a deflectional sensitivity of

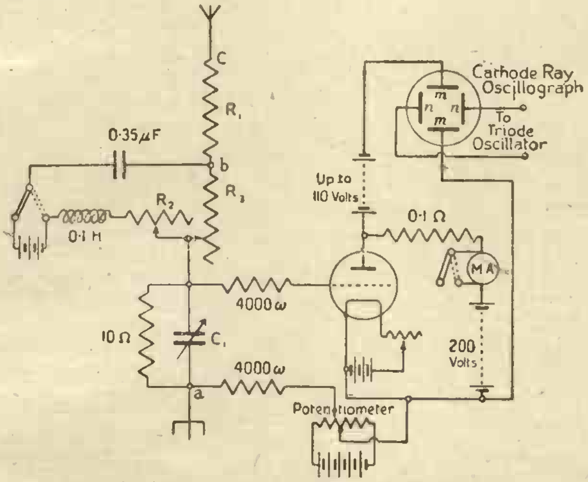

Fig. 2. The complete circuit of the apparatus.

1 millimetre per volt is easily obtained, so that the sensitivity to the amplified disturbances reaches 15 millimetres per volt.

The local generator of "atmospherics" consists of an arrangement for discharging a condenser through a known inductance. Its object is to check the records given by the instrument in the case of known forms of disturbance, and to afford a means of calibrating the instrument.

The experiments with the apparatus described are being continued at Aldershot, but the analysis of some 600 typical atmospherics has been completed. These 600 can be divided roughly into two equally numerous classes: (1) aperiodic impulses in which the change of field was in one direction only; (2) quasi-periodic oscillations in which the change of field due to the atmospheric was first in one direction, with a return to the initial state followed by a change of field in the other direction.

The general form of the most commonly occurring types is shown in fig. 3—(*a*) and (*b*) representing aperiodic and (*c*) and (*d*) quasi-periodic disturbances. The disturbances of type (*a*) were found to be twice as frequent as those of type (*b*). The most frequently recurring duration of an atmospheric of the aperiodic class was found to be 1,250 microseconds (·00125 seconds), but values as low as 100 microseconds, and as

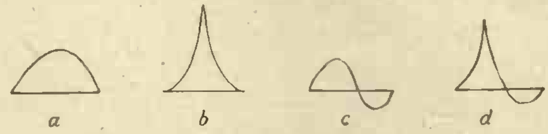

Fig. 3. Common types of atmospherics.

high as 55,000 microseconds (1/20 second) were observed. The mean change of field strength was ·125 volts per metre, and in seven to one of the atmospheric disturbances observed the discharge tended to carry negative electricity towards the earth in the receiving antenna. In many cases the rates of growth and decay of the atmospherics were similar, but in a few cases the rate of growth was too rapid to be observed. In much previous theoretical work it has been customary to assume an infinitesimally short growth period. The Aldershot results show that such an assumption is entirely incorrect in at least 80 per cent. of the cases observed.

In the case of the quasi-periodic disturbances, the most frequent duration was about 2,000 micro seconds. The half wave of greater amplitude occupied the same time as the half wave of less amplitude in only a small number of the cases observed, and on the mean it was found to last about 1·7 times longer than the smaller half-wave. The mean field strength observed was about 0.128 volts per metre. The disturbances observed were of many different types, but the most common was that shown in fig. 3*d*.

Fig. 4 shows a selection of typical observations. The horizontal line represents the time base, and the ordinates give the voltages of the atmospherics at any instant. As already explained, the time base is given by an alternating e.m.f., and it is not possible in any one case to state with certainty in which direction this e.m.f. is acting. In fig. 4*a* therefore it cannot be definitely stated whether the first alternations of the atmospheric impulse are small, and followed by the two large ones, or whether the two large alternations are followed by the small ones. In other words it is impossible to be certain whether the diagrams should be interpreted from the left or the right. In the experiments which are now being carried out this ambiguity has been removed by an ingenious device due to Dr. Appleton.

In fig. 4*c* the first half period of the atmospheric reaches a zero value on the extreme limit of travel of the time base, which then reverses, so that the second half wave appears below the first instead of appearing as a continuation as in fig. 4*d*, and as it would do if the time base had had a longer period of oscillation.

In fig. 4*f* is shown an example of one of the more complicated forms observed. In this and many other cases ripples of short period and of amplitude equal to about 10 per cent. of the main amplitude, are observed impressed on the main form. The durations of these ripples correspond to wave lengths of some 10,000 to 45,000 metres, so that on such long waves atmospherics of radio frequency may be expected to occur and to cause strong interference with signals.

In fig. 4*g* is shown an extremely powerful aperiodic atmospheric whose rate of growth was too rapid to be recorded. It will be seen that the electric force falls from an amplitude of 4 volts at the middle of the time base to 1 volt in a quarter of an oscillation of the time base, and that the applied time base e.m.f. then executes several complete oscillations before the electric field due to the atmospheric falls from 1 volt to approximately zero.

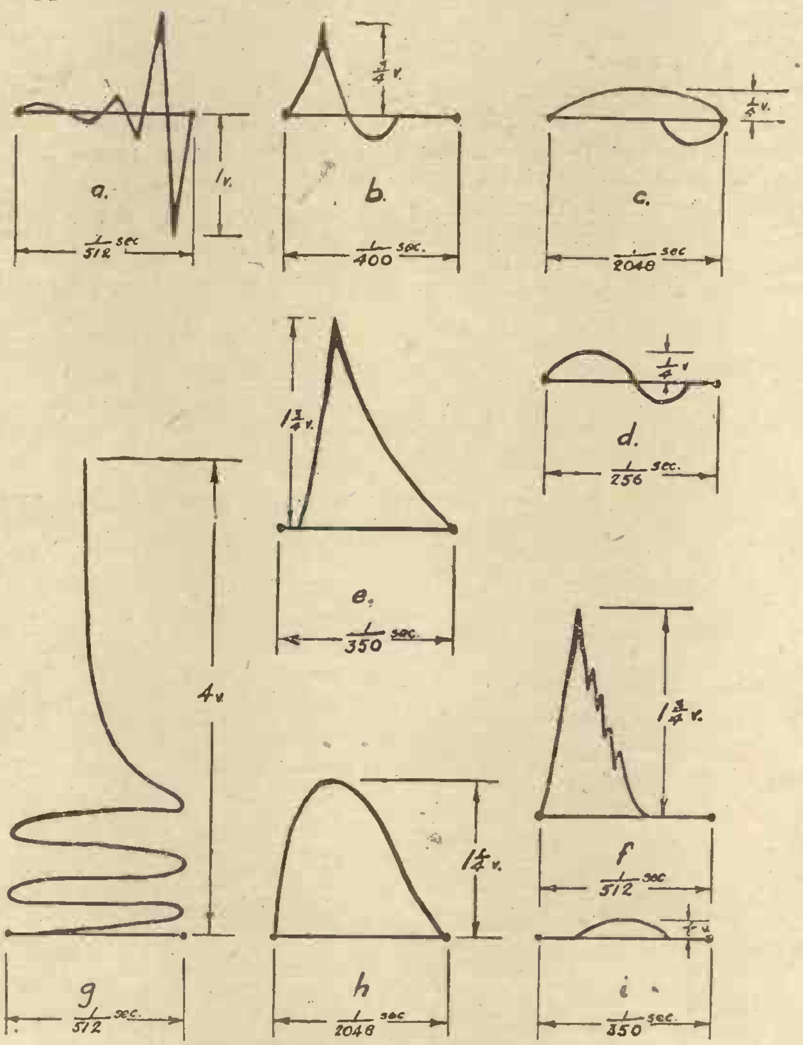

Fig. 4. Oscillograms of a number of typical atmospherics.

The brilliant work of Watt and Appleton which has been described is obviously of the highest importance. Not only does it constitute an immense advance in our knowledge of the phenomena, but it explains the failure of the many attempts at elimination of atmospherics, and at the same time indicates possible new lines along which the problem of elimination can be attacked. It is clear that different methods of elimination will have to be tried at receiving stations situated in different parts of the world according to the type of atmospheric which proves on investigation to be most common. The form of apparatus for elimination which will probably be found most satisfactory appears to require an aperiodic antenna system, followed by a series of filters cutting out all frequencies below the lowest radio frequencies to be received, with, in the case of long waves, selective arrangements for dealing with the effect of the "ripples" referred to above.

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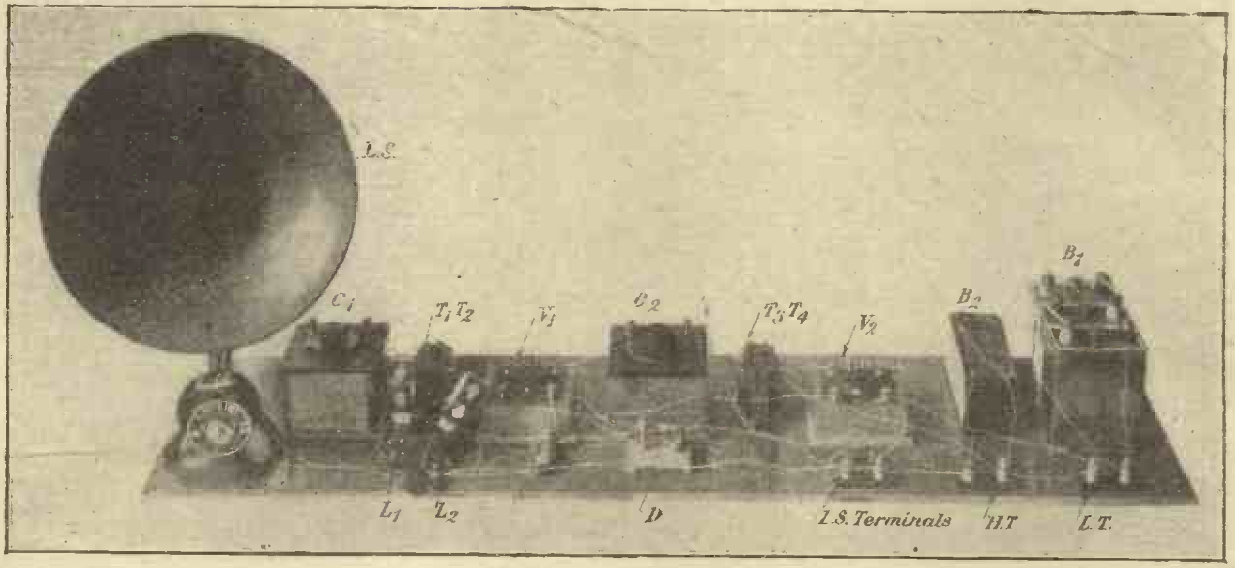


Fig. 1. The actual apparatus used in the origination of ST100.

A SUPER-SENSITIVE TWO-VALVE RECEIVER

By JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E.

A description of the new ST100 Circuit which has created such a great amount of anticipatory interest. The arrangement described is exceedingly sensitive and will receive broadcasting on very small aerials and over long distances.

SUPERLATIVES have become so common that I hesitate to describe the arrangement either as novel or super-sensitive. As regards novelty, we always have the type of person who has been using something like that for years, and, as regards super-sensitivity, one is competing with the man who hears all the Broadcasting Stations in the country on one valve on a loop aerial.

I have no desire to emulate the exploits of either type. Nevertheless, the arrangement about to be described is one which unquestionably gives very good results. We hear so much of super-sensitive circuits, and yet so little of such sets in use. Three and four-valve sets, apparently, have still to be used to obtain good results on a loud-speaker, and yet here is a two-valve circuit which will enable broadcasting to be heard 100 yards from a loud-speaker at a distance of about 15 miles from a broadcasting station.

Different sizes of aerials have been tried, and at this distance signals are quite audible in a room when using a loud-speaker, and an aerial of only from 8 ft. to 16 ft. long, suspended from wall to wall in the room. Similar results are obtainable with a 2 ft. 6 in. square frame aerial. Such results are quite good as the generality of circuits go.

As regards purity of signals received, no circuit could excel in this direction. One of the disadvantages of the ordinary Armstrong super-regenerative circuit is that the modulation of the incoming signals is impaired, and the signals are often made rather mushy. Moreover, the Armstrong super-regenerative circuit is not efficient on wave-lengths much above the broadcasting band, whereas the ST100 will work on any wave-length, and will also give excellent results with continuous wave signals.

Another point in connection with the Armstrong super-regenerative circuits is that they do not work except on small frame aerials. The experimenter is, therefore, compelled to work on a much smaller antenna than he could possess. Although the ST100 will work quite well on a frame aerial—as well, in fact, as an Armstrong super-regenerative circuit (except, perhaps, over very long ranges), yet the signal strength will vary with the size and height of the aerial. The

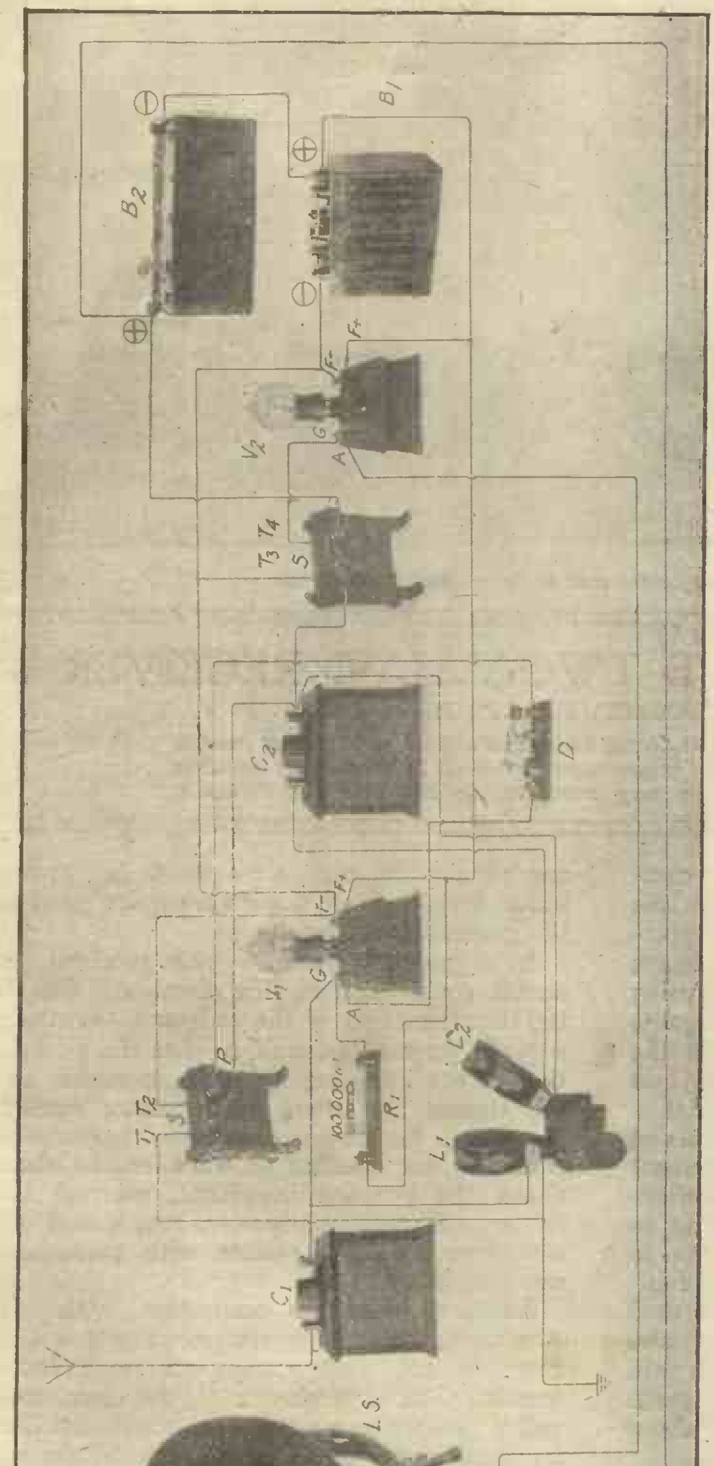


Fig. 2. Showing the connections of the various components. The terminals S of T_1 T_2 are preferably shunted by a .0003 μF condenser.

better the aerial, the louder the results obtained. This is a very distinct advantage, because no one is particularly anxious to use a 2-ft. frame aerial for reception when he can arrange an effective indoor aerial or one out of doors. Even in flats a much better aerial may be obtained than a 2-ft. frame, and with this circuit it is possible to take advantage of whatever aerial can be erected.

As a receiver for portable purposes, it is ideal. I have for my own use a complete two-valve receiving outfit which packs into a fairly large attaché case. The batteries are all self-contained and dull-emitter valves are employed. With such a circuit, it is possible to receive 2LO, not only on telephone receivers, but on a loud-speaker, up to 20 miles on even the smallest aerial.

Although it is more than likely that a number of experimenters have obtained equally good results, yet the number must be extremely small, and the apparatus they use must be tricky to work, or else the majority of listeners-in would have adopted their arrangements.

I can say with confidence that the arrangement here described is capable of being reproduced by any beginner with perfect confidence that excellent results will be obtained. The circuit, unlike many other super-sensitive circuits, is very stable. It does not produce howling noises, and undesirable capacity effects are absent, except perhaps when working on a very small frame aerial.

The Circuit.

Figure 3 shows one form of the ST100 circuit. There are several possible modifications of this arrangement, and these modifications will be described in future issues of MODERN WIRELESS and *Wireless Weekly*.

It will be seen that between the aerial and earth we have a variable condenser C_1, a resistance R_1, a six-volt accumulator B_1 and the secondary T_2 of a step-up iron-core transformer T_1 T_2. The condenser C_1 has a maximum capacity of 0·0005 μF, or 0·001 μF. The advantage of using the smaller capacity is that a finer vernier adjustment is obtainable. The resistance R_1 has a value of from 50,000 ohms to 100,000 ohms; the latter value was actually used on the set described. The resistance used was supplied by the Mullard Radio Valve Company. The transformer T_1 T_2 is an ordinary intervalve transformer. The two transformers used in this set were actually those manufactured by Radio Instruments Limited, but I have no reason to suppose that other types would not be suitable.

The grid and filament of the valve V_1 are connected across the resistance R_1. The two valves used in the set described were Ora valves, but here again other types would probably give just as good results. In the anode circuit of the first valve is an inductance coil L_1 which, in the set described, was a No. 50 Igranic de Forest honeycomb coil. Any equivalent inductance, of course, could be used. The other end of L_1 is connected to one terminal of the primary T_3 of an intervalve transformer T_3 T_4. One end of this primary T_3 is also connected to one terminal of the primary T_1 of the intervalve transformer T_1 T_2. The other end of T_3 is connected to the positive side of the high-tension battery B_2, which has a value of 100 volts. Lower voltages may be used, but the same volume of sound in the loud-speaker LS is not obtainable.

As regards the loud-speaker itself, both an Amplion and a Magnavox gave excellent results. I do not in any way desire to specify individual types of apparatus, but it is always of interest to some readers to know the actual apparatus used. Telephone receivers could, of course, be used instead of a loud-speaker.

Across the anode of the valve V_2 and the lower terminal of T_3 is connected a fixed condenser C_3 of 0·002 μF capacity. This fixed condenser was supplied by the Dubilier Company. Across the anode of the valve V_1 and the top terminal of the primary T_1 of the intervalve transformer T_1 T_2, is connected a crystal detector, D. A piece of Hertzite, on which rested a light spring of No. 36 bare copper wire, was used for most of the experiments, but different crystal detectors were found to give good results. The Hertzite combination is very sensitive and reliable, but was inclined to be microphonic, the set responding to the slightest vibration, producing crackling noises in the loud-speaker. A zincite-bornite detector, while not always as sensitive, is rather more robust.

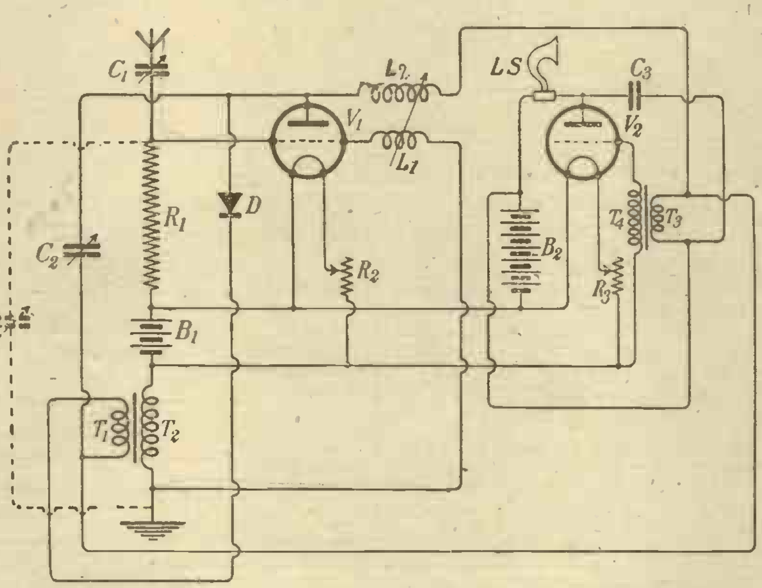


Fig. 3. The new circuit. This diagram was actually taken from a set in use without any attempt at simplification. The winding T_2 is preferably shunted by a 0·0003 μF condenser.

Across the anode of the valve V_1 and the lower terminal of the primary T_1 is connected a variable condenser C_2 having a maximum capacity of about 0·0005 μF, or 0·001 μF; the actual value used with this set was 0·0005 μF. This was found suitable for receiving 2LO, and would also tune the set up to almost 600 metres.

Across the grid and the earth is connected a fixed inductance coil L_1, which may either be a No. 50 or No. 75 Igranic honeycomb coil. Any equivalent coil, of course, of other make could be used. The correct value of the coil L_2 is important, and preferably different sizes should be tried. Nos. 25, 35, 50 and 75 should preferably be kept on hand. For general purposes it will be found that a No. 50 will give satisfaction.

The inductance coils L_1 and L_2 are coupled together if a reaction effect is desired, but they may be kept separate without much decrease of signal strength. Whether the coils are coupled together or not, the connection to the coil L_1 should be reversed, in order to see which way round gives the loudest signals. Whenever any alteration or adjustment in the circuit is made, the two condensers C_1 and C_2 should be slightly readjusted.

If the coils L_1 and L_2 are connected in a two-coil or three-coil holder, it is possible to have the coils either wide apart or coupled to each other.

The Arrangement of the Component Parts

Figure 1 shows the arrangement of the different component parts. It will be seen

positive filament terminal and a filament socket on the valve holder, the positive terminal on the panel should be treated as if it were the negative.

There is no need to mention the make of the valve panel and coil holder, as various types have been tried, and there is no difference in the results obtained.

Operation of the Set

The operation of the set presents no particular difficulty. The coupling between L_1 and L_2 should normally be loose, and the condensers C_1 and C_2 varied until signals are heard. The crystal detector, of course, should be carefully adjusted beforehand. The filament

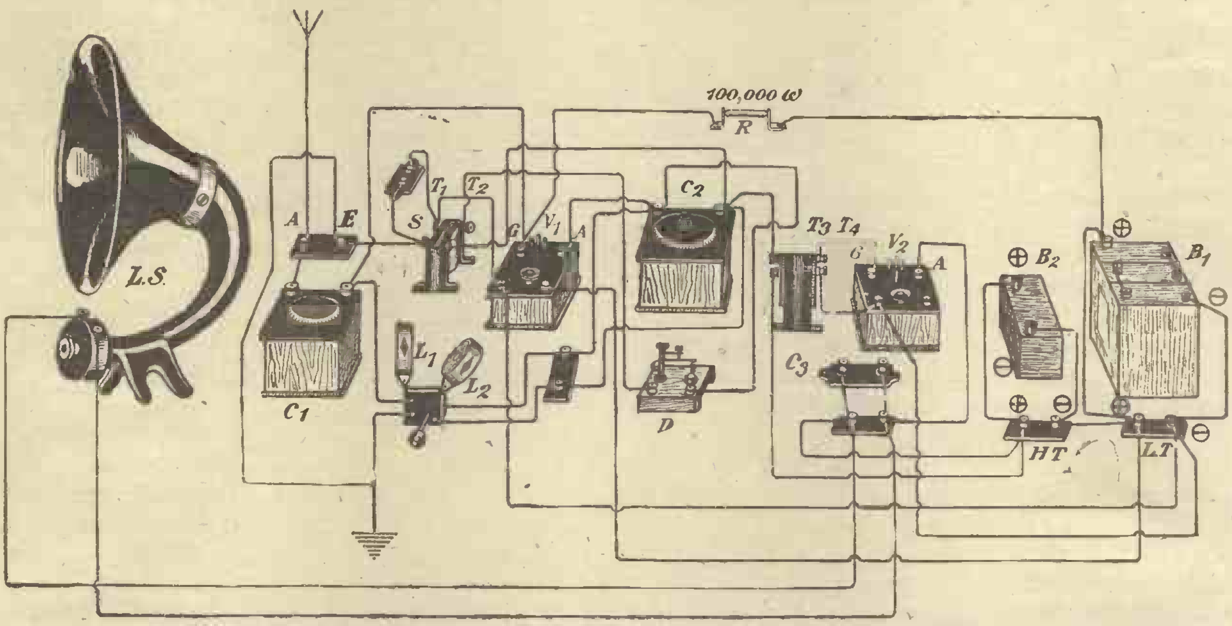


Fig. 4. A pictorial representation of the connections of the apparatus. It should be noted that the small fixed condenser of .0003 μF capacity across the secondary terminals of the transformer T_1 T_2, although not shown in the other figures, is desirable with most types of transformer.

that they are mounted on a board, at one end of which is the high-tension battery, and at the other the loud-speaker.

It is important to keep all connecting wires as far apart as possible.

Figure 4 shows a pictorial wiring diagram, illustrating how different component parts may be used.

For the sake of convenience, I employ two valve panels, each of which is fitted with four terminals and a rheostat. Sometimes the filament terminals are marked positive and negative and the rheostat connected in the positive lead. The experimenter should unscrew the panel and see to which lead the rheostat is connected. If it is between the

rheostats R_2 and R_3 should also, of course, be varied, as an alteration of these often results in a great change in signal strength. By coupling L_1 to L_2 a reaction effect is obtained, but the Postmaster-General's regulations regarding the use of this reaction should be observed.

When small aerials are employed it will be found that the condenser C_1 should be connected directly across aerial and earth, in which case the condenser should be taken from its present position and the leads which went to it joined together. The dotted line in Figure 3 shows the alternative position of the condenser C_1.

If signals are heard but cannot be accurately tuned out on both sides of an adjustment of the condenser C_1, different coils should be tried in place of L_1, and also the condenser should be tried in the alternative position shown in the dotted line.

When small aerials are used the dotted line circuit should be employed, and it will be found that the inductance L_1 should be a No. 50 Igranic coil.

When reaction is permissible and it is used, the coil L_1 may be made to couple more tightly with L_2, and a readjustment of the condensers C_1 C_2 will be found necessary. It may also be necessary to adjust the filament rheostat. If the reaction is tightened too much, a buzzing noise will probably be produced, and the reaction should immediately be reduced by lessening the coupling between the coils. The circuit, generally speaking, is remarkably free from undesirable low-frequency oscillations, and, in this respect, differs from many other circuits having specially sensitive qualities. If the buzzing is to be prevented the resistance R_1 may be reduced to, say, 70,000 ohms or 50,000 ohms.

It will be found that the set, arranged as described, is very stable and the speech obtainable from it is very pure. A minimum number of adjustments are provided, and the circuit is very reliable. At the same time, it is not desirable to deviate materially from the instructions given here, as otherwise the set will howl loudly. One of the main advantages of this circuit is that a natural tendency to howl is suppressed without sacrificing signal strength.

We shall be pleased to hear from the large number of readers who will try out this circuit. Any difficulties or questions regarding it will be dealt with by the Radio Press Information Department, and a special series of articles dealing with the circuit and its developments, and also with any problems raised by correspondents, will begin in the June 13th issue of *Wireless Weekly*.

THE FILAMENT RESISTANCE

ALTHOUGH the part which it plays in the theory of operation of a receiver is a minor one, the filament resistance is a component whose efficient performance has much to do with the ease and convenience or otherwise of the manipulation of the set.

It is not, as a rule, worth while to make one's own filament resistances, since very good ones can be purchased extremely cheaply. To ensure the purchase of a satisfactory type there are a number of points to be borne in mind; besides insisting upon the presence of various desirable electrical and mechanical features, one must remember to see that the resistance is suitable for the particular use to which it will be put. For example, if it is to control the filament supply of a group of, say, three valves, it must be capable of carrying a current of two amperes without overheating, whereas if it is to control one valve only it need not have nearly so large a current-carrying capacity, but it must have a considerably higher resistance, to give the required amount of regulation to permit of a single four-volt valve being run from a six-volt accumulator.

The other important points to note in buying a rheostat are chiefly concerned with the maintenance of a steady smooth contact on the resistance element during adjustment, since the quietness or otherwise of operation of the rheostat depends upon this feature. The moving contact-arm should press firmly but not too heavily upon the resistance wire, and it must pass smoothly and without chattering over the turns of the winding. A weak point in many resistances is the unsatisfactory nature of the connection to the contact-arm; this connection should be steady and reliable and *not* of the loose and erratic nature which results from the utilisation of the contact between the bearing of the spindle and the spindle itself (and hence with the moving arm).

SHIPS THAT PASS AND THE TIME THEY KEEP

An interesting description of the methods employed in obtaining the correct time at sea.

APART from the decrease of danger at sea and the message traffic from shore to ship which now is conducted on high-speed station lines, modern navigation owes much to wireless.

Out of sight of land a navigating officer takes the usual observations with the sextant. This, however, would be useless without an accurate standard of time on which to base the calculation of position. For this purpose the most accurate clock extant is used—the chronometer. Nevertheless, it is not perfect, for it varies slightly from day to day according to temperature and circumstances.

Before the inception of wireless telegraphy it was necessary to "rate" the chronometer. Periodically, it was taken ashore and tested against local standards of time and the result entered on a card to the effect that a gain or loss of, say, 0·5 of a second was registered every twenty-four hours.

From this the navigating officer could calculate, daily adding or subtracting a growing error to reach the mean time at Greenwich. Moreover, in tramping or making long circuitous voyages opportunities occured to "take the time" from a time ball or flag at a coastguard or meteorological station. The procedure being to hoist a flag or ball a few minutes before a pre-arranged time and drop it on the stroke; this was watched from the ship and the chronometer rating adjusted accordingly.

These methods were subject to a certain amount of error. There were too many re-transmissions. In the case of the coastguard station, the time had to be transmitted over the telephone or telegraph from the observatory to the coastguard, a slight loss in transmission here. The operator at the end of the wire at the moment of time shouted to his assistant; down came the flag. The officer on the ship watching through glasses and noting the dropped flag shouted "time." Another officer noting the shout recorded the time by the chronometer.

Some days the whole sequence would work well, others slowly, never the same. To allow a fraction of a second for transmission therefore would mean the admittance of guesswork into the scheme. Furthermore, checks could only occur when in port or in sight of land. This meant probably a few weeks' run on one check. Truly, comparisons could be made with passing ships; but a ship carrying a recently checked chronometer implied a recent departure; within a few hours the doubtful mariner would make his own observations. On the other hand, ships in mid-ocean were similarly placed regarding checks; a comparison only could be made and discretion exercised as to its utility.

When wireless time signals came along mariners seized upon so convenient a method with celerity. Ships on regular routes need hardly be without a check for more than twenty-four hours these days. The Eiffel Tower wireless station in Paris gives out a daily series of time signals which are recorded and appreciated from Greenland's icy mountains to Aden's arid rock, and at far spots equidistant from Paris and situated in the South Atlantic on the one side and Russia on the other. When a mariner passes out of Eiffel's range there is often another station available. On the North Atlantic, for instance, the wireless station at Arlington, U.S.A., fills the bill.

A wireless wave is propagated with the speed of light—186,000 miles per second. A ship receiving time signals over three thousand miles therefore, will be $\frac{1}{62}$ of a second late, which error is ignored, of course. So far as actual transmission is concerned no greater speed is required. The personal element remains, but this is reduced to a minimum by familiarity with the system. We will take the station mentioned above. Every ship's operator is conversant with the system adopted by Eiffel Tower; it has been the same for years. The operator knows how many dots and dashes and pauses occur before the long dash, the cessation of which denotes "time."

When the wireless room is not adjacent to the chartroom on a ship the regulations demand that a telephone be carried connecting the two. Again, the time signals are sent out from Paris by a clock control, not by hand. The whole sequence takes place as follows:

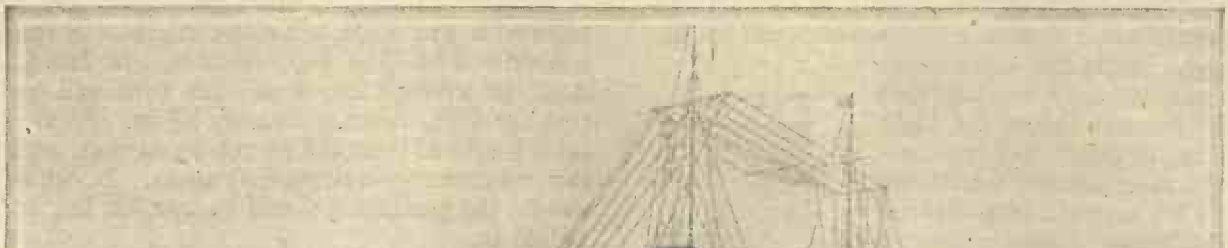
The navigating officer asks the wireless officer to record the time signals at a certain hour. As the time approaches, both take up their respective positions, the former watching the second hand of the chronometer in the chartroom, the latter at the wireless instruments tuned in for Paris.

The familiar preparatory signals are ticked automatically dead on time by the Paris control. The wireless man follows attentively until the signals reach a point a few seconds before time, at once he presses the telephone push ringing the bell in the chartroom, thus the navigating officer is warned. The bell is kept ringing then until the operator hears the anticipated dot or dash denoting the hour, simultaneously he removes his finger from the bell push. The time of the cessation of the bell in the chartroom is noted on the chronometer, thus completing the reception.

After a few minutes the operator 'phones the chartroom with the information regarding the conditions under which the observation was made; if the signals were perfectly clear and reliable; if they were broken up somewhat by atmospheric disturbances, and so on. Three or four consecutive transmissions can be checked one against the other and a very accurate rating emerges therefrom, giving the officers responsible for the safety of the ship a feeling of confidence in the chronometer. It would be folly to compare the old system with the new. It is doubtful if a better could be devised.

Any wireless amateur possessing apparatus capable of being tuned up to 2,600 metres can receive the time signals from Paris anywhere in the United Kingdom. Watch, clockmakers and jewellers have already taken advantage of this system; scarcely a district remains where a tradesman does not give correct time by wireless.

F. A. B.



A complicated aerial system. The U.S. battleship "Texas" with her multiplicity of aerials.

ON THE USE OF A SIMPLE FORMULA FOR MAXIMUM INDUCTANCE.

By Sir OLIVER LODGE, D.Sc., F.R.S.

The first of a series of instructive articles on some mathematical aspects of wireless which have been specially written for "Modern Wireless."

A NEW and remarkably simple expression for the inductance of a coil, wound so as to give to that inductance a maximum value for a given length of wire, is that it equals the length of wire employed multiplied by three times the number of turns. Or in symbols,

$$L = 3nl.$$

This is such a simple expression that it ought to be useful; but its applicability depends entirely on the proper conditions being satisfied. The coil must be of the right shape and size to accommodate the wire in the form of a ring of proper dimensions. We can imagine ourselves possessed of a number of bobbins, all of the right shape but of different sizes, and may suppose that we have to choose the right size, in order to give a required amount of inductance with a covered wire of given thickness—that is to say, so many turns to the inch. Or we may consider that we have to decide on the wire suitable for winding a given bobbin in order to give the required inductance.

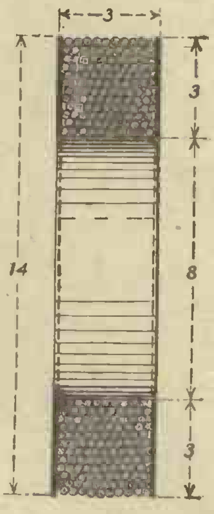


Fig. 1. Showing how the dimensions of the bobbin are measured.

When I say that the bobbins are to be of the right shape, I mean that they must all have the same proportion between their dimensions and the size of the channel in which the wire is going to be wound. If the channel is 3 of any unit, say $\frac{3}{8}$ in. square, the mean diameter of the coil will be $\frac{11}{8}$ in.; or, more completely, the external diameter will be $\frac{14}{8}$ in., and the internal diameter $\frac{8}{8}$ in.; that is to say, the diameter of the bobbin, measured with a pair of calipers to the bottom of the channel, will be just 1 in.

In passing from one bobbin to another this proportion is to be maintained. Each bobbin will be just like another magnified. They will then be all of the right shape for maximum self-induction. And by suitably choosing the wire you can get any inductance you like.

The number of turns that can be wound on a given bobbin will depend on the size of the channel; which, as we know, is to be of a square section. For a given size of channel the number of turns is known. Thus, suppose the wire is of such a thickness that 20 turns lie in an inch, and suppose the channel is $\frac{1}{2}$ in. wide and deep. It is obvious that we shall get 100 turns on it, 10 layers of 10 turns each.

The bobbin being of the right shape, if the channel is $\frac{1}{2}$ in. wide, the mean diameter of the bobbin will be $\frac{11}{3}$ of $\frac{1}{2}$ in.—that is, 2 in. less $\frac{1}{6}$. And the average length of each turn will be roughly 6 in., more accurately $5\frac{3}{4}$ in. So the total length of wire will be 100 times that, and the inductance 300 times that again. In other words, the product $3nl$ will be 172,800 in., or 14,400 ft.

If this is somewhere near the value required, well and good. But if it is much too small, we can either choose a thinner wire for the same bobbin, or select a bobbin of larger size. A small change in the thickness of the wire will make a considerable difference in the inductance. For instance, halving the thickness will increase the inductance sixteen-fold. A small increase in the linear dimensions of the bobbin, retaining the proportionality (as we must), will likewise make a great difference in the inductance.

By the use of thin wire the bobbin can be kept quite small, even for very considerable inductances. Suppose each layer of wire in a certain channel consists of 30 turns; the total number of turns will be 900, and the length of wire that is to be used will be the required inductance length divided by 2,700, since that is three times the number of turns. That sort of arithmetic enables us to select a suitable wire for a given bobbin.

Another mode of writing the expression $3nl$ is $6\pi n^2 r$, where r is the mean radius of the bobbin ; which is very nearly $19n^2r$. Thus if the external diameter of a bobbin were 7 cm., and its internal diameter 4 cm., so that the mean radius is $\frac{11}{4}$ cm. ; and if 225 turns of wire are wound in its channel, being 15 to each layer of covered wire 1 mm. thick; then (since $19 \times \frac{11}{4} = 52$) the inductance will be $52 \times (225)^2 = 2{\cdot}6325$ million cm., or 26·3 km.

The simple formula $3nl$, or its equivalent $19n^2r$, will apply to any ring or disc coil of fair aperture for which $\log \frac{8r}{R}$ is not far from 3·5.

For a thin disc or cylindrical coil of breadth b the geometric mean distance of its wires from each other is—

$$R = \tfrac{1}{4}b,$$

and for a disc coil $\quad b = \frac{1}{2}(D - d)$
while $\quad r = \frac{1}{4}(D + d)$
(where D is the external and d the internal diameter of the disc),
so $\quad R = \frac{1}{8}(D - d)$.

Thus the term of which the logarithm has to be taken in the expression for L is—

$$\frac{8r}{R} = 16 \times \frac{D+d}{D-d}\ ;$$

and the natural log of that will be—

$$2.77 + \log \frac{D+d}{D-d}.$$

So if

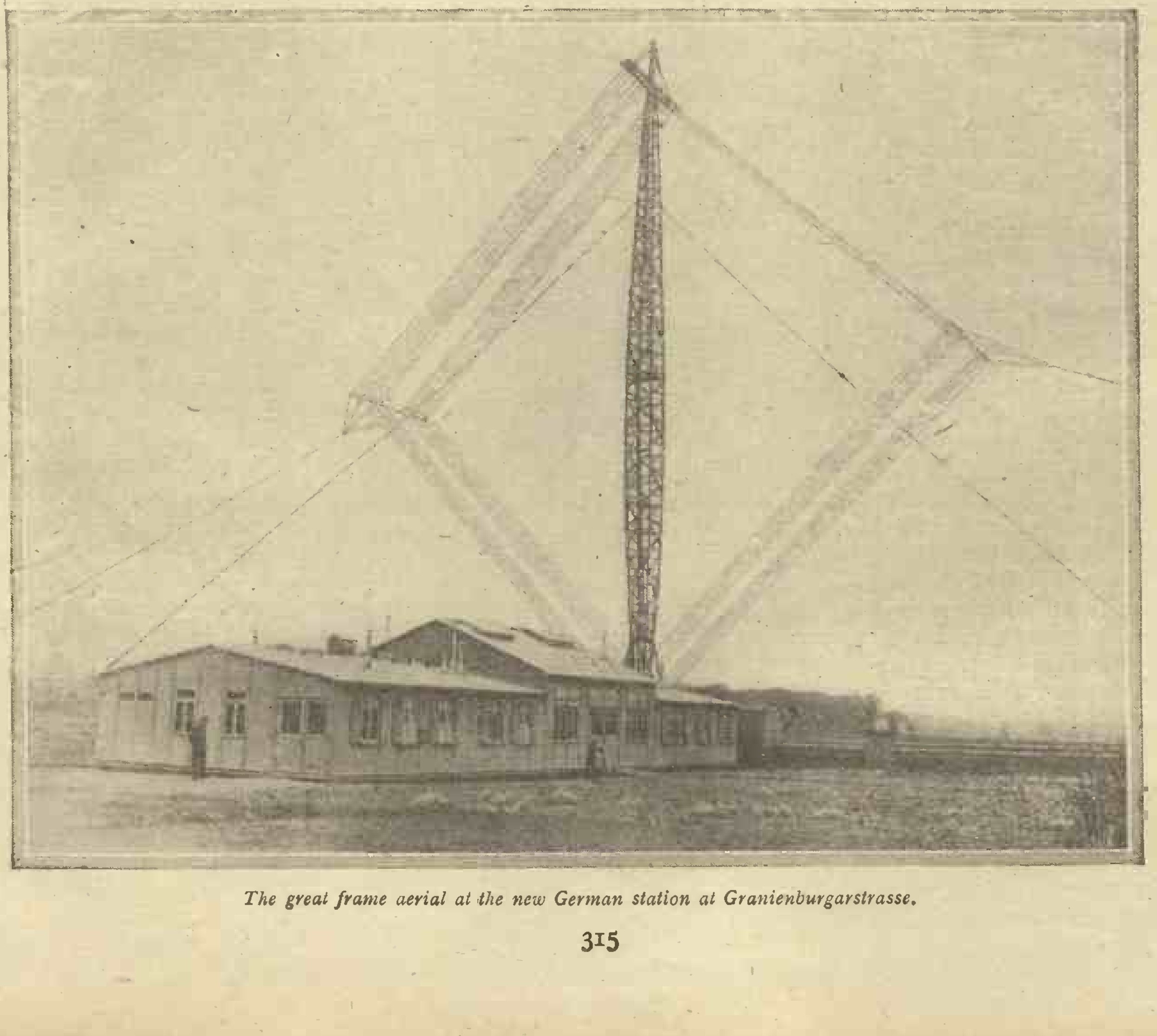
$$\frac{D+d}{D-d} = 2.1,$$

it would be just right ; that is to say, $\log \frac{8r}{R}$ is just about $3\frac{1}{2}$. This would mean that the outside diameter of the disc coil would be about three times the internal (or aperture) diameter.

We have now incidentally justified the reckoning of the inductance of any disc coil as

$$\pi n^2 (D+d) \left(\log \frac{D+d}{D-d} + 0.77\right);$$

where the 0.77 represents our 2.77 with 2 subtracted from it. If the breadth of the winding is equal to the breadth of the internal aperture, this result is $3nl$.



The great frame aerial at the new German station at Granienburgarstrasse.

WIRELESS OPERATORS AND THEIR CAREERS—IV.

The Senior Operator.

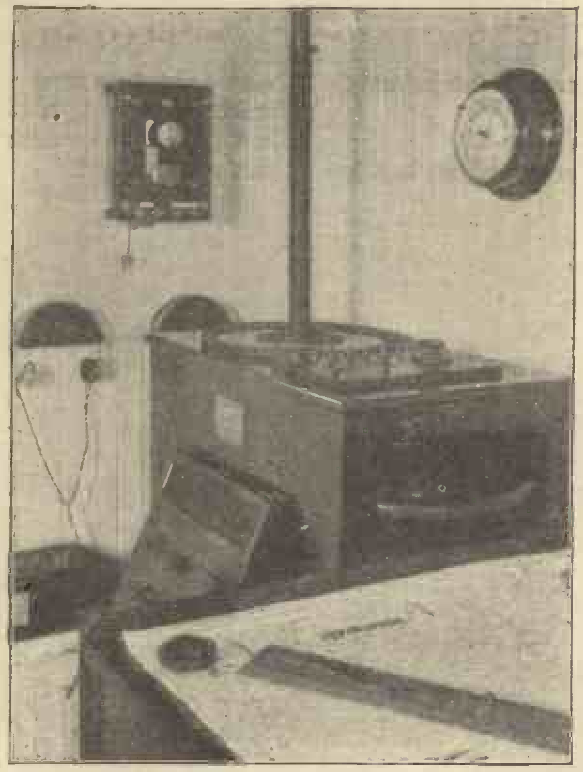
By TRAFFIC MANAGER.

This month's instalment of this illuminating series of articles contains a very clear account of the duties and responsibilities of the senior operator.

(Continued from page 231.)

THE operator in charge of a ship station is in the peculiar position of having to serve three masters. He is primarily under the command of his captain, but he is also responsible in many ways to the shipowner and to his wireless employers. Although this may appear anomalous, in actual practice cases of conflict are extremely rare.

The Post Office also keeps a watching eye on operators by reason of the fact that the postal authorities are responsible for interpreting and enforcing the regulations agreed to by the periodical international radio conferences, of which more will be said anon. These regulations are in turn embellished by the wireless companies, who arrange for their own particular traffic services within the limits prescribed.



Complete Direction Finder Equipment installed in Chart Room, S.S. "Cairnross" (Messrs. Cairns, Noble & Co.).

The first and most important thing to be borne in mind by an operator-in-charge is that a captain rules supreme on board his own ship. His instructions must be obeyed at all costs, no matter how much they may conflict with standing orders or official routine.

Most captains nowadays are thoroughly familiar with operators' duties, but occasions do still arise when they instruct their operators to act contrary to regulations. Such contingencies can generally be met by the exercise of a little tact on the part of the operator, who should point out the undesirability of having the ship reported for irregular working in the case of transmission, or of having to account to his wireless company for unauthorised reception.

If the captain still persists, his instructions must be carried out, but a careful note should be made in the log *at the time*, stating that the irregularity was duly pointed out. If the violation is a serious or protracted one the operator should write a letter to the captain in duplicate confirming the instructions received, and stating that they are being duly observed, and the duplicate of the letter should be posted to the wireless company under cover of a further letter explaining the circumstances which gave rise to it.

There is no possible excuse for an operator disobeying his captain's instructions—to do so generally spells the end of his seagoing career, for it furnishes ample ground for refusing discharge, in which case no other shipping company will allow him to sign articles.

Trouble of this nature in the past has, in most cases, arisen in connection with the reception and publication of private news bulletins transmitted to ships actually subscribing to the service. But it should now be possible for ships fitted with modern equipment to receive ample English news of a general nature in any part of the world from the "free" official bulletins without intercepting services from which they are not entitled to benefit.

Captains generally treat operators very well, particularly if they work hard and do not over-estimate the importance of their own position on board. There are a few captains who, for some obscure and unjustifiable reason, abhor operators generally, but they are exceptions and are well known to the wireless companies.

Having emphasised the operator's position *vis-à-vis* the captain, we will now proceed to deal with his miscellaneous duties under the following broad headings :—

(1) Discipline and wireless companies' regulations.
(2) Working regulations.
(3) Handling of traffic.
(4) Counting and charging of messages.
(5) Accounts and book-keeping.
(6) Care and maintenance of apparatus.
(7) Inspections.
(8) Taking over and handing over stations.

Discipline.

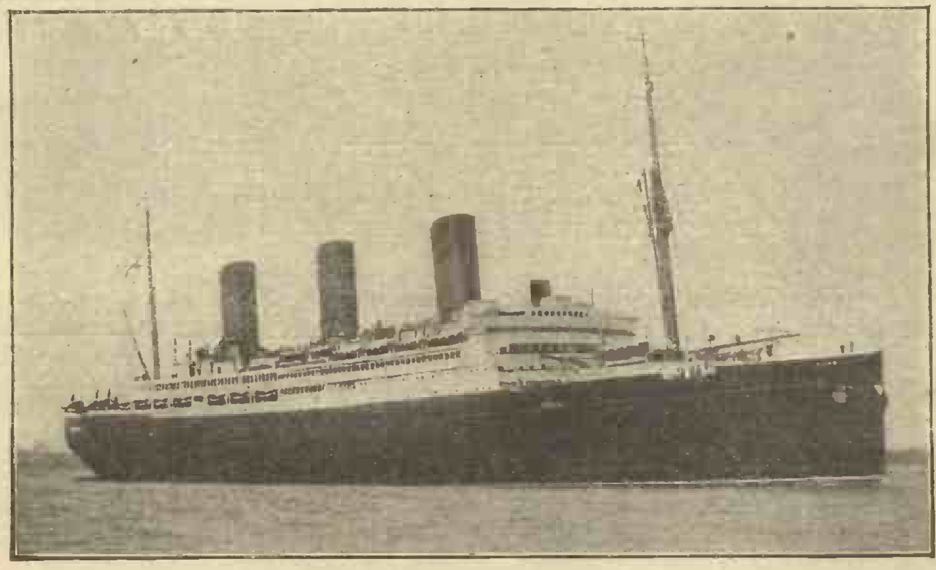
The nature of service maintained at a ship station must to a large degree depend upon the discipline of the wireless staff. The best operator is always a strict disciplinarian ; this does not necessarily mean that he is a tyrant to his juniors; in fact, he is generally liked and admired by them.

The best good fortune that can befall a junior, particularly during his first few trips, is to be placed under the care of a strict senior who organises and systematises the work of his station, allocates it fairly, and who insists on even the more simple duties being carried out thoroughly well.

The discipline of a station is reflected in the log book, in the messages, in the abstracts in the bundling of returns, in the performance and condition of the apparatus, and particularly in the appearance of the wireless cabin. Perusal of a ship's voyage returns after they have been checked gives a very reasonable indication of the kind of discipline maintained on board, and the resulting impression is generally confirmed upon receipt of the report from the inspector visiting the ship.

The general points requiring emphasis in connection with wireless staff discipline are as follows: The watch-keeping hours should be laid down and strictly adhered to. If the senior finds it necessary to take over when a junior is on duty, the latter should also remain at the instruments in order to benefit from an observance of the work done.

Definite daily duties should be allocated to be performed at specific times and in a particular manner. The senior should not only see that these duties are carried out, but he should also check the work in order to assure himself that it is satisfactory. If not, he should take the trouble to explain exactly where it falls short, and, if necessary, demonstrate a satisfactory performance.



An ideal home for operators: the R.M.S. Berengaria.

Everything on the station from pencil to tool-chest should have a definite location so that each member of the staff will know where to lay his hands on anything required. No tools, message pads, or other articles should be found lying about the floor or tables at any time. This applies equally to articles of clothing in the living quarters—the senior should always see that his junior's quarters are orderly.

Inward messages should be delivered promptly, whether for bridge or public, and outward messages, if not sent off immediately, should be placed on a firm clip in correct order of transmission.

An operator going off watch should hand over a clean sheet. By this is meant that he should have his log entered up and signed off, all inward and outward messages completed and filed, all messages for delivery sent out, and all stationery and equipment which he had been using put back in its proper place.

It is very important that there should be no laxity on the part of the wireless staff in the observance of ships' discipline and etiquette. Nothing is more calculated to create a bad impression than late attendance at inspections and boat drill. The senior operator should make a point of ascertaining the times of such functions and the proper stations for his staff, and should see that his juniors turn out neatly and properly dressed and well up to time.

In the case of boat and fire drills, the proper procedure is for the senior operator to stand by his apparatus whilst his juniors take up their boat stations, but in some cases the captain insists on all operators attending the boats. A ruling on this point must always be sought at the commencement of a voyage. All operators should be punctilious in the matter of saluting the captain on deck and in saluting the officer of the watch when they step on the bridge. It should be remembered that in the latter case the rank of the officer is immaterial—if an apprentice happens to be on the bridge when the senior operator arrives, he is entitled to take what is termed the "bridge salute."

The hours of attending meals should be definitely laid down by the senior and strictly adhered to.

The most frequent causes of complaint against operators arise from undue familiarity with passengers. On ships where operators are allowed to join in deck games with passengers, the senior should see that recreation is not carried to extremes. Juniors, particularly new ones, are apt to spend time on deck when they should be sleeping; this should not be allowed, for no man can carry out his duties properly unless he gets sufficient rest. To sleep on duty is an unforgivable offence that is calculated to discredit the profession.

Passengers should, under no circumstances, be entertained in the wireless cabin. If the captain allows them to enter the cabin they should be treated with the utmost courtesy, and their visit made as interesting as possible without interfering with the work of the station, but they should not be encouraged to spend their leisure hours in conversation with the operator on watch.

(To be continued.)

A USEFUL TABLE.

The accompanying table should prove useful to all those who wind their own coils, since it enables them to ascertain very readily how many turns of wire will be required to fill a given former, or alternatively, how long a tube must be obtained to accommodate a certain number of turns. The table indicates the turns per inch of various gauges and coverings of wire: Suppose it is desired to know how many turns of No. 30 double cotton covered wire go to the inch. Look in the column headed "D.C.C." opposite 30 in the "S.W.G." column and read off 44.

S.W.G.	S.C.C.	D.C.C.	S.S.C.	D.S.C.	ENAMELLED.
18	18	17	As for enamelled	19	20
20	24	22		25	26
22	26	25		32	33
24	35	30		39	42
26	42	36		47	50
28	48	39		56	61
30	53	44		66	72
32	64	50		75	83
34	70	54		85	98
36	86	63		102	122

A COMPACT AND EFFICIENT CRYSTAL SET FOR BROADCAST AND TIME-SIGNAL RECEPTION

By A. D. COWPER, B.Sc., M.Sc., Staff Editor.

This very practical article will be found to give full details for the construction of a crystal set with several novel features.

A CRYSTAL broadcast receiver is required to tune over a limited range of wave-lengths only; within these narrow limits the maximum possible signal strength is naturally desired, with an amateur's aerial, and at a distance of a score of miles at most from a powerful station—so powerful, relatively speaking, that the question of interference by other legitimate transmissions hardly arises. The problem of efficient design, therefore, is a very different one from that of a Morse receiver working with a long-distance station and on long wave-lengths, although the latter would appear to have influenced the designers of many of these essentially short-wave radio-phones.

The biggest problem, however, is presented by the very varying electrical characteristics of different amateurs' aerials — the vast range of electrical capacity they offer, quite apart from their merits as to height, screening, etc. This range is estimated by the Post Office officials to stretch from .0002 to .0006 microfarads or more; even if the aerial itself is high and single-wire, a long lead-in will sometimes load it up so as to approach the latter figure.

Design of the Tuner.

Hence a comparatively large range of inductance value, or else a big tuning condenser in the apparatus, are called for, in spite of the small wave-length range to cover. The large condenser spells great inefficiency on these low wave-lengths. In order to get a large *inductance* range, generally one of two methods is adopted in broadcast receivers. Either a tapped inductance, with slider or many-point switch, is adopted—involving "dead-end" and other serious losses—or else a variometer is used, when, for the sake of an excessive inductance range, and appearance, crowded fine wire is generally the rule.

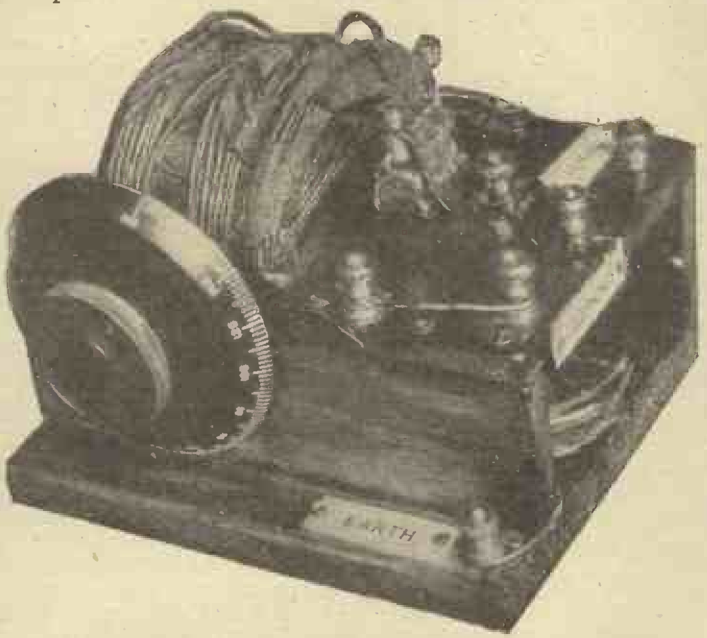


Fig. 1. The completed receiver.

Careful and repeated measurements have shown me that the use of wire of any size below No. 18 or 20 involves avoidable losses through excessive high-frequency resistance (which is a very different thing from the ordinary ohmic resistance), and crowding of the wire, especially when small and enamel-insulated, brings in excessive "distributed capacity," all of which cuts down signal strength.

Since variometer tuning is far the most efficient for a short-wave receiver, the problem of design reduces itself to the question of getting enough of No. 18 D.C.C. wire on to a variometer so as to obtain the range of inductance required to tune amateurs' aerials from 350 to 425 metres, *i.e.*, a range of from some 60 to nearly 250 microhenries.

If this be worked out, it is found that the variometer required becomes rather formidable in size, and carries a great deal of wire which is seldom properly utilised.

Accordingly, a compromise is suggested here: use a very compact variometer with only 48 turns of No. 18 D.C.C. in all, to give the necessary tuning range on any one aerial, allowing for extreme variations, and bring up the total inductance by a small loading-coil separate from the variometer, adjustable to these extremes and to the local broadcast wave-length. In this way the apparatus can be kept compact, no more wire is used than is really necessary, and avoidable losses are reduced to a minimum. The resulting signal strength, with a good crystal setting and a moderately efficient aerial in the suburbs of a broadcast centre, will be a revelation to those who are familiar only with the average old-fashioned tuner, designed originally for long-distance Morse. An Eiffel loading coil, tapped for approximate adjustment to 2,600 metres, is also provided.

General Arrangement.

A wooden-ball rotor rotates on a horizontal axis inside a cardboard stator tube, the latter externally wound with two-pile winding.

The variable loading-coil, in the form of a simple narrow loose-wound slab-coil, is placed so as to be effectively part of the stator winding. A small panel carries the perikon crystal detector, of

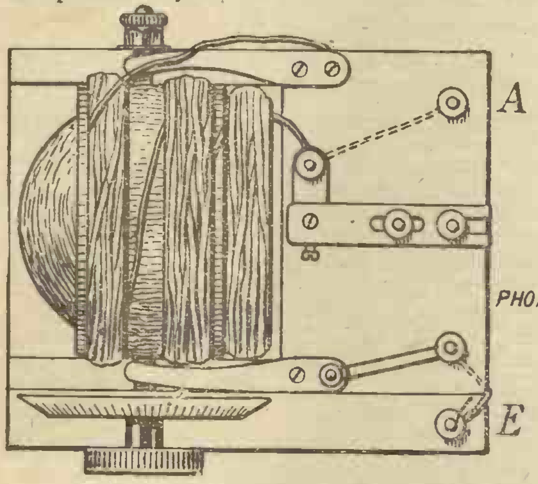


Fig. 2. Plan of the set, showing the arrangement of the parts.

simple and sturdy form, and the contact brushes for the rotor connections.

The Eiffel loading-coil is a tapped double-slab wound with No. 32 enamel wire on a cardboard former, and lies under the panel. It is normally bridged by a shorting strap when receiving broadcast telephony.

Materials:

Wood: base-board, 5½ by 4½ by ½ inch; two sides, 5½ by 1⅜ by 1/16 inch; cross-pieces, two, 3 by ½ by 1/16 inch.
Panel: well-dried varnished or paraffined wood; ebonite; fibre, etc., 3⅝ by 2½ inch, ¼ inch thick.
Rotor: hard wood ball, 2⅞ inch diameter, 1⅞ inch thick.

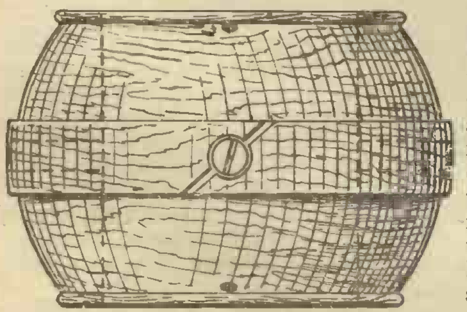


Fig. 3. The variometer rotor, showing the position of the screw which holds the ends of the two windings.

Stator: cardboard tube, 2⅞ to 3 inch inside diameter, 1⅞ inch long.
Wire: 1/3 lb. No. 18 D.C.C.
1 oz. No. 32 enamel.
Knob and Scale; Brass Bush.
7 terminals; two small crystal cups; 2 small brass screws with nuts; zincite and bornite crystals; Wood's metal; ½ foot No. 2 B.A. screwed rod; brass scrap, 1/16 to 3/32 inch thick; a dozen No. 2 B.A. nuts; washers; small brass screws; cardboard; tape; shellac, varnish, etc.

Cost of materials will amount to about 10s.

Construction.

Base.—The two side-pieces are nailed to the base-board, so as to leave a shelf ⅜-inch wide in front, as shown in the plan. The two cross-pieces are nailed on, with a gap of 1⅜-inch (into which the stator fits) between. The central one will require to be cut away a little to make room for the loading coils subsequently.

Panel.—This is marked out and drilled as shown in Fig. 2, to take the six terminals, three screws for the contact brushes, and four small screws fixing it to the frame. If made of dry wood (which answers perfectly if properly prepared) it must be well-baked and shellacked (or paraffined) before using. Fibre also should be baked and varnished first.

Variometer.—The rotor is of the hard-wood turned form which has appeared recently in many of the wireless accessories shops, selling at a few pence, and is quite efficient for the purpose, if well-dried and varnished. If the purchased article is not available, any wood-turner can make one of hard wood in a very short time, from the dimensions given.

The rotor is drilled No. 2 B.A. tapping-size at opposite ends of a diameter, for the stub-axles of No. 2 B.A. screwed brass rod, each 2 inches long; these are screwed in, and locked by nuts inside. One carries the bush, ebonite scale and knob; the other a nut and lock-nut. Small holes are drilled just within the rim of the rotor for the lead-wires, and a deep notch, with a screw in a large counter-sunk hole, for making the joint between the two halves of the winding, are provided in the centre rib.

To wind.—The end of the No. 18 D.C.C. wire is passed through the small hole behind the rim of the rotor, and made fast to one axle-end within. The wire is then wound on up the slope, 12 turns, taking great care to make it lie evenly. The end is made temporarily fast to the screw in the centre-rib; then the other half of the ball is wound in precisely the same manner, starting from the narrow rim and working up the slope, but, of course, winding up in the opposite direction. The end is brought to the junction-screw, and the joint made securely (best soldered, with a very hot iron) and

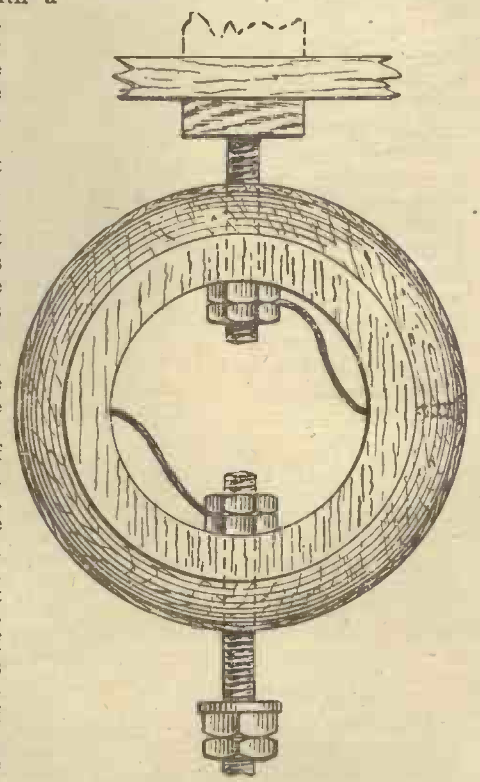


Fig. 4. The rotor with its axles fitted.

tucked down into the counter-sunk hole. The rotor is then given several coats of thick shellac varnish, being baked well between coats.

The cardboard tube is cut to size, and the two opposite holes for the axle of the rotor made; also two small holes for lead-wires close

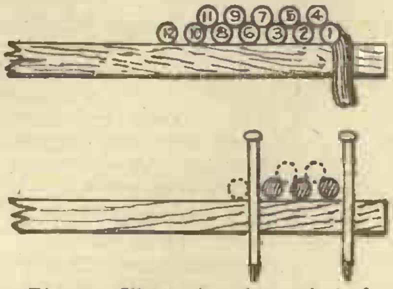


Fig. 5. Illustrating the method of winding the variometer stator.

to the ends. The two-pile winding is then carried out as follows (see Fig. 5): With one end of the wire passed through and secured in the small hole at the edge of the tube, three turns are wound on of the No. 18 D.C.C., then two rows of say 5 pins each are put into the thick cardboard to prevent sideways slipping of the wire; the latter is then carried back and wound in the grooves between the 1st and 2nd, and between the 2nd and 3rd turns; then No. 6 turn is made on the tube, the wire carried back (close to the last point of transfer), and No. 7 laid between Nos. 3 and 6; and so on for 12 turns, the last being directly on the tube. The inner row of pins has, of course, been shifted back at each two turns. A little experimenting will make this quite easy. After the 12th turn, the wire is carried diagonally across the middle empty belt of ½-inch, and an exactly similar winding of 12 turns put on the other side and in the same direction. The end is passed through the small hole in the rim and secured temporarily.

With the aid of a bodkin, tape is then carried under and round the two windings at a few points, and the ends tucked under to make all secure; the stator is then varnished and baked like the rotor.

The variometer can then be put together, the stub-axles being screwed in from the outside and locked by nuts inside the rotor, the wire-ends being secured between two nuts. The bush, knob, scale, on the one, and two nuts on the other, can be placed on best with a little shellac on the threads to prevent working loose.

Contact Brushes.—These are made of springy sheet brass, cut to the shape and size and bent slightly as shown in the figure. If bent up into a channel-form for part of their length, they will be stiffer. It is very important that they make good *firm* contact with the axles on which their ends rest;

Fig. 6. One of the contact brushes of the variometer.

much trouble with variometers is traceable to bad electrical contacts here.

They are drilled for the two fixing screws as shown, and they should be tried in with the variometer in place at this stage, to get them the right shape, and also to see if they clear the variometer stator windings; the shallow notches for the axle-bearings are also made now.

Crystal Detector.—The well-tried Perikon (zincite-bornite) combination is recommended here, for every-day (and often unskilful) usage. Fancy-named and fancy-priced artificial galenas may give greater signal strength at a few points *for a time*; but these rapidly deteriorate with use, and it soon becomes a matter of anxious search for a reasonably good point, while the perikon will stand much abuse, and can be simply scraped with a knife for fresh points when worn. Some may prefer to purchase a finished detector unit which can be mounted direct on

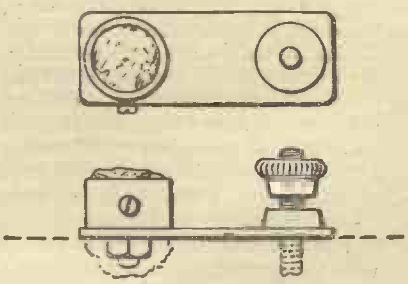


Fig. 7. Showing the parts of the Perikon detector.

the little panel; if galena and cat-whisker combination be the choice the existing whisker had better be scrapped and replaced by a less brutal one of several turns of springy No. 36 copper or very fine brass wire.

For the simple and sturdy detector described, a strip of springy sheet brass, 3 by ½ inch, is drilled and slotted as shown, and bent up to shape. One crystal cup is secured by a small screw to the end. Another short strip, 1¼ by ½ inch, is drilled, and the other crystal cup screwed to it as shown. The crystals are then secured into the cups with Wood's metal, and the whole mounted on the panel, which is recessed by a large drill to receive the head of the screw under the lower cup. The aerial terminal is connected to the lower cup terminal by a wire under the panel.

Eiffel Loading Coil.—As many are interested in the time-signals sent out from the Eiffel Tower daily, a loading-coil is included in the design which will bring these in

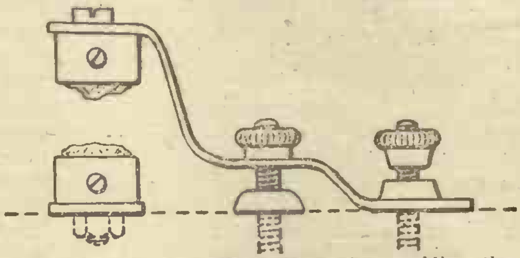


Fig. 8. Showing the method of assembling the detector.

when the shorting strap is removed. While no continuously-variable tuning device of effective range is available in this little set, the power of FL is so great, and his tuning so flat, that very approximate tuning by a tapped coil suffices.

The coil is wound of No. 32 enamel wire in the form of a double slab, on a simple cardboard former. Three discs of shellacked cardboard, about 1/16 inch thick and 2¼ inches diameter, with two of 1 inch diameter about ⅛th inch thick, each with a hole for No. 2 B.A. rod in the centre, are required. These are clamped together by nuts on the rod as shown, and the wire wound on in the resulting channels. The end is passed through a pin-hole in one cheek, 200 turns are wound in the first groove and the wire passed through a diagonal knife-cut in the centre cheek to the bottom of the second channel, protected by a split ring of waxed paper where it passes down into the groove; then another 150 turns are wound, a loop brought through a slit in the end-cheek for the first tapping, then 25 turns, a second tapping, and so on, tappings being made at Nos. 350, 375, 400, and end at 425 turns. The coil is secured in position under the panel, after the right tapping has been determined by actual trial on FL's time signals (between 11 and 11.7 p.m., summer time), by the No. 2 B.A. rod, and a nut in a counter-sunk hole under the baseboard. (With a twin 40-foot aerial, not very high, the 400 tapping was best; on a standard P.M.G. 100-foot single, or a small high aerial of low capacity, the 425 is called for; while a low double aerial, or one loaded up with a long lead in, badly placed, may do best with the 375 or even 350.)

Broadcast Loading Coil.—This is a simple slab coil, loosely wound with the No. 18 D.C.C., in a temporary former consisting of two rough wooden cheeks bolted on the faces of a wooden disc, about $2\frac{1}{4}$ in. diameter and $\frac{1}{16}$ inch thick. The end of the wire is passed out through a hole in one cheek, and

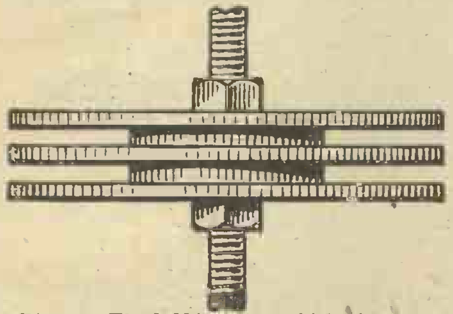


Fig. 9. The bobbin upon which the long-wave coil is wound.

some 16 turns are wound on, as evenly as possible, but not necessarily very tightly; the former removed, and the loose coil of wire taped up, heavily shellacked, and baked. It is mounted in position between the variometer stator and panel-edge, the middle cross-strip being recessed to receive the lower edge. The starting end is connected to the crystal-cup terminal, and the other to the starting end of the stator winding, so that the direction of winding is the same in both coils.

Assembly and Trial.

The whole can be now assembled. The panel is screwed down in position, and the contact brushes fixed, so as to bear hard on the axle-ends. The stator is sufficiently locked in by these, if it is a good fit between the sides; these latter will probably have to be notched away somewhat to make room for the piled stator windings. The further end of the stator winding is secured under the fixing screw of the brush on the side opposite the scale; the

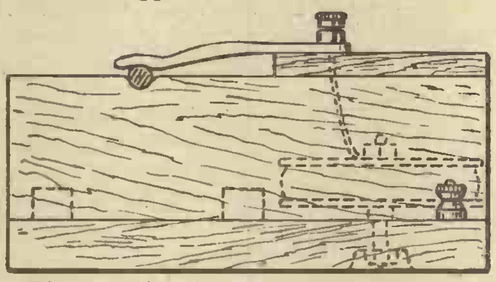


Fig. 10. Side view of the receiver, showing the position of the long-wave loading coil.

starting end of the Eiffel coil is secured to the other brush-terminal, and a shorting strap is provided between the latter and the nearer phone terminal; the latter is connected by a stout wire to the "earth" terminal on the shelf. With a single dry cell, or old flash-lamp battery, and phones (or galvanometer, if available), the circuit aerial-loading-coil-stator windings - brush - rotor-windings-brush-earth is tested for continuity, and for any noises while rotating the moving portion.

The crystals are then brought into gentle contact by screwing down the knob of the adjusting screw; phones are connected, and a buzzer brought near. This may be any kind of a small induction coil, electric bell with bell and hammer removed, etc., and should be clearly audible in the phones as a continuous scratching or buzzing noise when a foot or so away, without any metallic connection, if the crystals are set correctly. If unsuccessful, fresh points of contact should be sought. Without a buzzer of some sort, attempting to get signals on a crystal set is like a game of blind man's buff, and largely futile with a new experimental set.

When good signals are obtained with the buzzer, the aerial and earth can be connected, and an attempt made to pick up the broadcasting at the regular times. If with a well-set crystal only feeble signals are heard with the rotor right round in the maximum position (windings in the same direction as those of the stator) with a very small high aerial on, *e.g.*, Birmingham's 420 metre wave, the effect of adding a few turns to the broadcast loading-coil can be tried. Only under very exceptional circumstances would it be found necessary to cut the latter down (*e.g.*, very big and low double aerial on Cardiff's wave). There should be a well-defined maximum away from either extreme position of the rotor.

When successful reception of broadcasting has been made, the Eiffel transmission can be tried; having determined by simple trial which of the tappings is best, permanent connection is made with this tapping to the earth side, and the Eiffel coil bolted in place under the panel.

The crystals, if undisturbed, will rarely need attention, but if moved from place to place the contact surfaces may be spoilt by mechanical shocks, so the top crystal should be raised in this case. They will last indefinitely then.

No great advantage is found with extremely high - resistance phones on these powerful local transmissions: ordinary 4000 ohm phones suffice. The signal strength depends, of course, on the height, etc., of the aerial used. At a dozen miles it should be at any rate 40 (shunted phones scale, just audible being 1, ordinary crystal reception 10 to 20, on this scale). On account

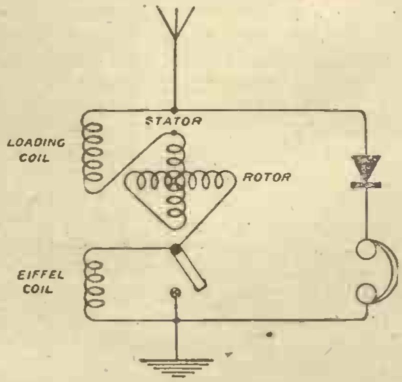


Fig. 11. The circuit of the receiver.

of the proximity of so much comparatively poor insulating material as wood and cardboard, and the damping effects associated therewith, the optimum possible with the No. 18 wire used is not obtained in this little receiver.

"DIRECTIONAL WIRELESS"

J. ROBINSON, M.B.E., Ph.D., M.Sc., F.Inst.P.

(Continued from p. 236)

A further instalment of this interesting series containing a description of the method of direction-finding invented by Dr. Robinson.

2. Multiple-Loop Direction-Finders.

THE elementary principles involved in both the working and design of a single-loop direction-finder have now been considered and the way prepared for a description of the various methods which have, from time to time, been devised for utilising the above fundamental principles to the best advantage for accurate direction-finding.

The single-loop direction-finder under certain conditions and when skilfully operated is very accurate, but it suffers from two main disadvantages, the importance of which, however, alters with the purpose for which the direction-finder is required. Firstly, even with large amplification, the range of a small loop to any but high-power transmitting stations is limited, not only on account of the generally small amount of energy absorbed by a loop, but also because it is necessary for accuracy to work about the minimum position, *i.e.*, that position of the loop where energy absorption is a

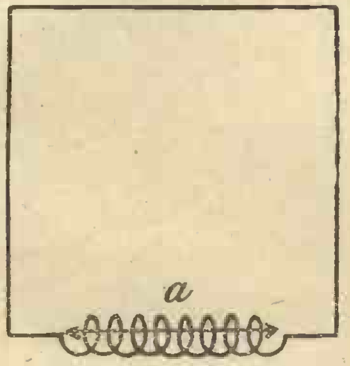


Fig. 13.—Single loop and coil to illustrate the Bellini-Tosi method.

minimum and signals just die away. Secondly in certain circumstances, such as in aircraft and other noisy places, accuracy in judging the point about the minimum at which signals just go out and just come in is rendered impossible owing to the extraneous noises drowning the already weak signals and so giving a false indication of minimum.

Although historically the development of the wireless direction-finder did not proceed along these lines, we will now consider various methods in which the above disadvantages of a single loop have been counteracted.

1. Bellini-Tosi Method of Direction-Finding.

In this system of direction-finding, which came into practical use before the days of the three electrode valve and ampli-

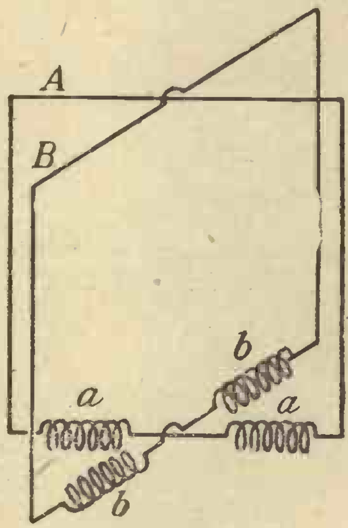


Fig. 14.—The Bellini-Tosi arrangement of loops and field coils.

fication, the small absorbing power of a convenient loop aerial is overcome by the use of fixed loops having a large area, so employed however that the convenience in manipulation of a small loop is still retained. We have already seen that for a given inductance value the Area Turns, on which energy absorption depends, are a maximum with a loop of such an area that the inductance required is obtained with a single turn, and while in the days of the crystal a loop of this nature was capable of quite useful work at short ranges, with modern amplifiers the receiving range is considerable, even to low powered transmitters.

A single loop has definite directional properties, but in order to utilise these it is necessary to rotate the loop about a vertical axis. How then can fixed loops be utilised for direction-finding purposes? In order to explain this we will go back to our original rotating loop and consider a loop having a single turn

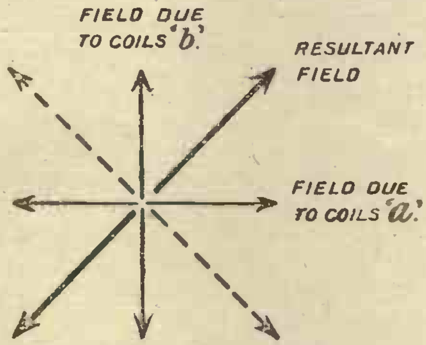


Fig. 15.—Showing the direction of the resultant field of the two coils.

but provided with an additional inductance coil "a" in its lower horizontal side, this coil rotating rigidly with the loop, as shown in Figure 13.

When a current is caused to oscillate in this loop by a passing electromagnetic wave the current will set up an oscillating magnetic field along the axis of the inductance coil, directed first one way and then the other as indicated by the arrows. The strength of this field will be a maximum when the loop is pointing to the transmitting station and will be zero when the loop is at right-angles to the station, but the point to notice is that the direction of the oscillating field will always lie along the axis of the inductance coil, *i.e.*, the field will rotate with the loop as the latter is rotated. Suppose now that a second loop aerial of the same size and with a similar coil "b" is fixed at right angles to the original loop and so as to rotate with it. The axes of the two inductance coils will also be at right angles and it is assumed that they are so arranged that the magnetic fields produced in each can combine. To effect this symmetrically it will be necessary to have each coil in two equal parts, the arrangement being shown in Figure 14, from which it will be seen that each loop is electrically independent.

It is obvious that if loop A is pointing directly to the transmitting station loop B will be at right angles to it, and therefore while the maximum magnetic field is produced along the axis of the inductance coil "a" there will be no field produced along the coil "b." If, however, the two loops are turned through 45 degrees, in a clockwise direction for example, each loop will absorb an equal amount of energy and consequently magnetic fields will be produced in each of the two inductance coils, of equal intensity but oscillating at right angles to each other. These fields will combine and produce a resultant field directed as shown in Figure 15. It should be noted that the direction of the field produced in either of the coils at any instant depends on the direction from which the wave strikes the loop concerned, hence the direction of the resultant field must always bear a definite relation to the position of the transmitting station with regard to the two loops. In other words, had we turned our loops 45 degrees in an anti-clockwise direction the resultant field would have been directed as shown by the dotted arrow in Figure 15. We thus see that when the magnetic fields due to two loops mutually at right angles are caused to combine, the direction of the field produced is no longer confined to the axes of the inductance coils but is directed in the direction along which the exciting electromagnetic waves are passing the loop system. It is obvious that if the converse case is taken, *i.e.*, two loops at right angles fixed in position, and a transmitting station making a circular journey round them, the direction in space of the resultant magnetic field of the coils at any instant will depend entirely on the position of the transmitting

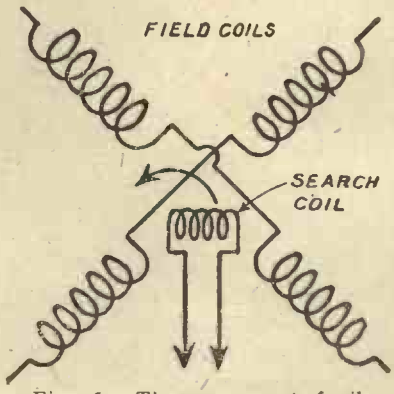


Fig. 16.—The arrangement of coils used in the radio-goniometer.

station in relation to the loops, the field as it were acting as an invisible indicator always pointing to the source of the passing electromagnetic wave.

The principles of a fixed loop direction-finder have now been considered, but it yet remains to explain how the direction of the resultant field can be found, and so how the indication of direction is obtained. The ordinary laws of electromagnetic induction will once again come to our aid, the solution in this case being the provision of a small coil which can be rotated in the resultant field of the two coils connected in the loop aerials. Now when the axis of the small coil lies along the direction of this field the maximum electromotive force will be induced in the coil by the oscillations of the field, while when the axis is at right angles to the field no electromotive force at all will be induced. If now we connect our amplifier-receiver to this small rotating coil an indication of the direction of the field will be obtained in the telephones, the signals being the loudest when the axis of the coil lies along the field, no signals being heard when the axis is at right angles.

A direction-finding system is thus arrived at, the chief characteristics of which are large fixed loop aerials combined with a small rotating coil, *i.e.*, we get the largest possible energy absorption without sacrificing convenience or ease of handling.

That part of the system comprising the two inductance coils mutually at right angles together with the small rotatable coil is known as a radio-goniometer, shown diagrammatically in Figure 16, the two right angle coils being termed the field coils and the rotating coil, as its function implies, the search coil.

The actual indication of direction is given by means of a pointer fixed to the operating handle of the search coil moving over a fixed circular scale divided in degrees.

In the foregoing discussion it has been assumed all along that the system as a whole has been correctly tuned, but a little consideration must now be given to this and kindred matters upon which the accuracy of this system is dependent.

In the first place, as regards tuning, three separate oscillatory circuits are concerned, namely, the two loop aerials with their field coils, and the circuit containing the search coil. Each of these circuits is tuned separately by means of a condenser as shown in Figure 17, the aerial tuning condensers "c" being connected between the two halves of each field coil for reason of symmetry while the search coil has a condenser "d" shunted directly across it, to the terminals of which the amplifier receiver is connected.

Now in tuning the loop aerials it is essential that they should be tuned to exactly the same wave-length even though this may mean they are not exactly in tune with the wave to be received. This operation is known as balancing and the accuracy of the system as a whole depends to a great extent upon the accuracy with which this is carried out. Further, it is obvious that the current strength induced in each loop aerial, considered separately, must be the same for an equal wave intensity and similar angle of striking the aerial. For this reason the two aerials should be of the same size and have the same resistance to high-frequency currents.

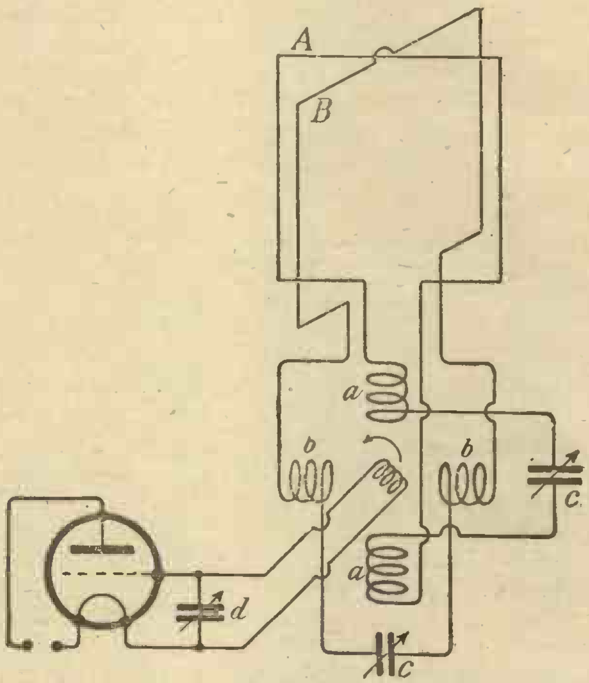


Fig. 17. The complete circuit of the Bellini-Tosi apparatus.

Considering now the operation of the system, we must again refer to the curve in Figure 5 (MODERN WIRELESS No. 2) which showed the relationship existing between sound intensity and the angle of a single loop with regard to the direction of the incoming waves. Two maxima and two minima are shown for one complete rotation of the loop, and it was then explained that accuracy in direction finding with a single loop could only be obtained by working about the position of minimum signal strength. If now a curve is plotted showing the change of signal strength with angular position of the search coil in relation to the direction of the resultant field, a result very similar to the curve in Figure 5 will be obtained. This means that while the maximum signal strength is obtained when the plane of the search coil is at right angles to the field, the most rapid change in signal intensity is obtained when the coil is near the zero position. Thus the ultimate effect of two fixed loop aerials combined in a radio-goniometer is equivalent to that obtained with a single rotating loop.

The pointer on the radio-goniometer should be so fixed in relation to the plane of the search coil that when the latter is in the position for zero signals the pointer will indicate on the scale the direction of a line passing through both the direction-finding station and the transmitting station concerned. As in the case of a simple loop, the line only and not the absolute direction is obtained with the simplified Bellini-Tosi system described. The method of adjusting the search coil in order to fix the position of zero signals is carried out in a manner already described and consists in noting the scale readings where the signals just become audible on either side of the minimum, the zero then being on the line bisecting the angle so obtained.

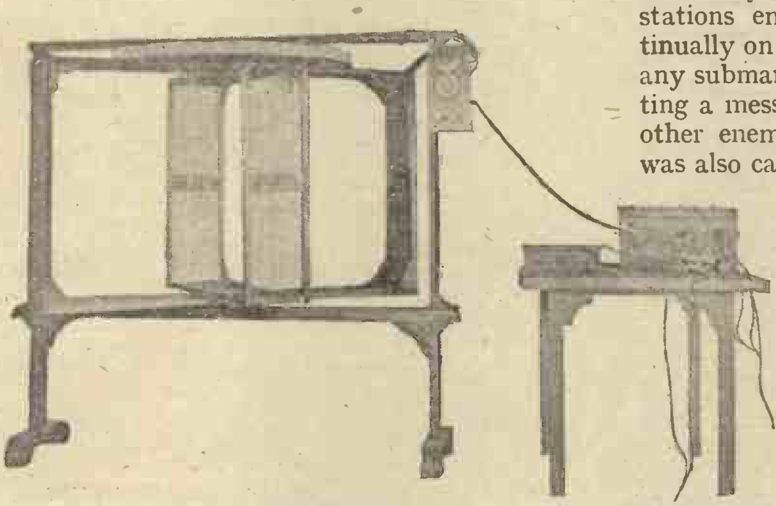


Fig 20.—A complete direction-finding equipment working on the Robinson system.

It will be gathered that the tuning and balancing processes necessary to the system just described render it unsuitable for many purposes where quick bearings on different wave-lengths are required, as in ships and aircraft for navigational purposes. A modification of the Bellini-Tosi method has therefore been devised for this special class of work in which the balancing of the aerials is rendered unnecessary, the tuning being carried out solely by means of a condenser across the search coil. A preliminary calibration of the aerial system is of course essential, but having once been set this remains correct for practically all wave lengths. This system is known as the Aperiodic Aerial System and is rendered possible by the use of extremely tight coupling between the field and search coils in the radio-goniometer. A tightly coupled system of this nature although composed of three separate circuits will behave in its reaction to a tuning condenser as though it was a single circuit. Diagrammatically this modification is obtained simply by omitting the two aerial tuning condensers "c" in Figure 17.

Coastal direction finding stations on the Bellini-Tosi principle were used extensively during the war for the navigation of our ships. They were also used for detecting the positions of enemy submarines, the direction finding stations employed on this work being continually on the alert to D.F., as it was termed, any submarine that happened to be transmitting a message either to its own country or to other enemy ships. A similar class of work was also carried out by certain stations of this type in connection with the attacks by enemy aircraft on this country. We all know how messages were sent out from headquarters plunging definite parts of the country into darkness, sometimes an hour before any Zeppelin or aeroplane was heard. This was rendered possible by two or three direction-finding stations keeping a continuous watch on all transmissions taking place from suspicious aircraft, and thus keeping a central headquarters continuously informed of the bearings of any aircraft operating over the North Sea. This case offers a good illustration of the fact that wireless communication can at the same time prove both a help and a hindrance to certain military purposes. In order that the Zeppelins themselves should know their own positions it was necessary for them to transmit to certain direction finding stations situated in Germany, where again a central station was employed to plot the position and retransmit this information to the airship.

For ordinary commercial purposes stations on this system of direction finding are now in use around the coasts of many countries, enabling ships to be navigated in safety even during dense fogs. The method of position finding adopted at these stations is similar to that used during the war for detecting the positions of submarines and aircraft. In certain cases ships themselves are fitted with the direction finding gear, being then able to find the direction of any wireless station within range and so plot their positions independent of any assistance from coast stations.

We have now considered a system of direction-finding which does not suffer from the first disadvantage pertaining to small rotating loop direction-finders, but which, however, for certain purposes, must still suffer from the second or minimum signal disadvantage. The inaccuracy introduced when trying to fix a minimum position amidst a lot of extraneous noise, as in aircraft, has been discussed, and the next direction finder it is proposed to describe is one in which accuracy is obtained without a corresponding loss in signal strength. In other words, the direction along which a transmitting station lies can be obtained at the same instant as signals from that station are being read. This method was originally designed for use in aeroplanes during the War and is now usually known as the Robinson direction-finding system.

2.—Robinson Method of Direction-Finding.

In this system also two loop aerials fixed rigidly at right angles are used, but in this case the loops are connected in series and are not independent circuits. Tuning is therefore a simple matter, the aerial circuit being completed through a condenser across the ends of the two aerials and to which the amplifier, receiver is connected.

A diagram of this system is given in Figure 18, where it will be noted a switch "A" is shown, by means of which the connections of one of the aerials may be reversed in the circuit. The required direction is found by rotating the loops about a vertical axis and it is usual therefore to employ small loops having a number of turns on each. It should be stated, however, that in certain cases, as for instance when the loop aerials are wound on the wings of an aeroplane, large loops can be employed, though it is then necessary to turn the aeroplane bodily in the air when taking a bearing.

We will call one loop the "main" coil and the other the "auxiliary," this latter being the loop directly connected to the reversing switch.

Now the two loops are in series and the signal strength produced in the telephones will principally depend on how these coils are connected together through the reversing switch. That is to say, whether the switch is in such a position that the energy absorbed by the auxiliary coil will assist or oppose that of the main coil.

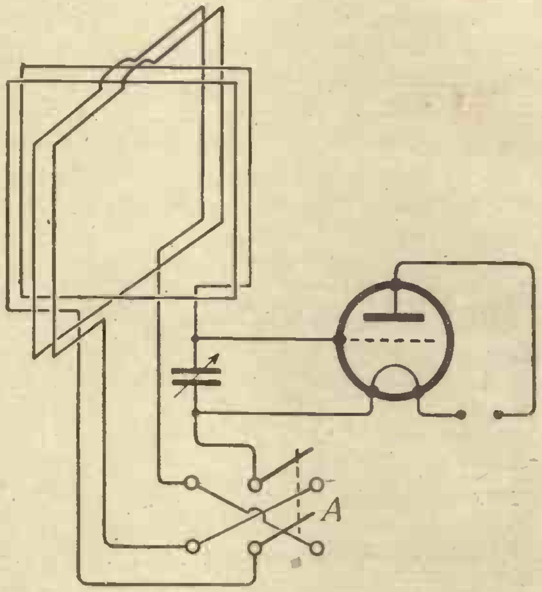


Fig. 18.—Connections of the two frames used in the Robinson method of direction finding.

Let us examine a case where the main coil is pointing directly to a transmitting station. An electromotive force of a certain maximum value will be produced in this coil, but there will be no absorption of energy by the auxiliary coil which could either oppose or assist the electromotive force produced in the first coil.

In the above case the signal strength will be unaltered by a change over of the reversing switch. Suppose, however, the main coil is slightly displaced from the previous position. Energy will now be absorbed by the auxiliary coil, and in one position of the switch this energy will assist the energy of the main coil and produce a louder signal, while in the reversed position the energy of the main coil will be opposed and the signal strength reduced.

Here then is the principle on which this method of direction finding depends. The direction of the transmitting station is indicated by the direction along which the main coil is pointing when no change in the signal strength can be observed on moving the reversing switch from one side to the other.

As briefly described above the question will at once arise as to how one is to know which is the main coil, as it is obvious that similar equality of signal strength would be obtained if the so-called auxiliary coil had been pointing to the station, the main coil then acting as the auxiliary. This ambiguity would not arise in practice for various reasons, which are beyond the scope of this article, but as a definite safeguard an additional switch is added to the system by means of which the auxiliary coil can be cut out of the receiving circuit altogether, thus leaving the main coil as a single loop aerial. Before taking an accurate bearing therefore, the main coil alone is used and roughly aligned on the transmitting station by rotating the coils until loud signals are heard. When this position is found the auxiliary coil is switched in and an accurate bearing obtained by making small adjustments in the orientation of the loops until equal signals are heard with the reversing switch in either position. In order not to upset the tuning when switching out the auxiliary coil a very small balancing coil of similar inductance value is at the same time switched into the circuit. This coil will absorb no energy, but will dispense with any necessity for retuning when switching over. A diagram of the whole system is given in Figure 19, and an example of a complete ground station in Figure 20. In this photograph the main coil is shown pointing towards the reader, the actual bearing of this coil being read on the large circular scale against a pointer fixed to the supporting frame.

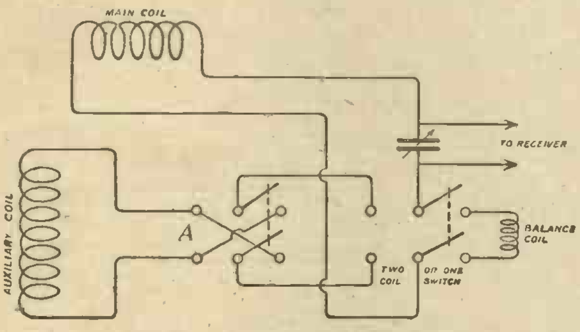


Fig. 19.—Showing the use of a compensating coil.

In the diagram it will be noticed that the auxiliary coil is shown with more turns than the main, and this brings us to the question of the accuracy of the system.

Although when obtaining a bearing the main coil is in the position for maximum signal strength and therefore in its most insensitive position as regards directional indications, the auxiliary, on which the change of signal strength on reversing the switch depends, is in its minimum and therefore most sensitive position. In other words it is the auxiliary coil which is indicating the direction while the main coil is producing signals. The accuracy of the system must therefore depend on the rapid increase in the energy absorption of the auxiliary coil as it is moved slightly from its true zero position, and it will be obvious that this increase can be made the more rapid as we increase the number of absorbing turns on the auxiliary coil. For aircraft purposes it is not usual to have more than from 2.5 to 3 times the number of turns on the auxiliary to those on the main coil, though for ground purposes where extreme accuracy is required this ratio can be increased.

The system just considered, though in general necessitating the use of very sensitive amplifiers, has successfully overcome the second disadvantage of the systems previously described. When used in aircraft for navigational purposes the utility of the system has been amply proved, and it might be mentioned that this system was used by the American Naval Air Service when the N.C. 4 was successful in crossing the Atlantic.

In this flight a particularly interesting example of the use of wireless direction-finding occurred shortly after the flying boat had left the Azores. The magnetic compass had become inoperative, with the result that the boat missed two of the ship stations placed for its guidance, and was in danger of becoming entirely lost. The direction of the next ship station was however obtained by the wireless direction-finder, and by working on this direction the flying boat was enabled to proceed towards the ship and so regain its correct course.

The principal systems of direction-finding in practical use have now been described, and in the following articles it is proposed to deal with some of the many modifications and refinements that are being continually invented. Mention must also be made of various defects and errors, for the removal of which experiments are still being carried on.

(To be continued.)

MY EXPERIENCE WITH DUAL AMPLIFICATION

By A. G. DORMER.

An article containing some very useful practical instructions for the construction of a simple dual amplification receiver.

ONE frequently hears the question asked by the owner of a crystal set: "How may I most efficiently add a valve to my set?" and by the owner of a valve set: "How may I use my valve to its best advantage, since I find that without reaction my results are little better than a crystal?" Having experimented with various valve and crystal combinations, I think that these two questions are ably answered by the two words—"Dual Amplification." After experimenting with this latter class of circuit for some time, with more or less success, mostly the latter, I have no misgivings in advising either of the above querists to adopt the circuit given here. It will be noticed that this circuit only differs from that given in Mr. Voigt's article, in MODERN WIRELESS for February, in that I have replaced the tuned transformer with an aperiodic coupling from valve to crystal, and that a 5-1 step-up transformer is put in the L.F. input section.

Use of an Untuned Valve to Crystal Coupling.

For the valve to crystal aperiodic coupling, I used an ex-Army H.F. transformer; the primary and secondary being wound on an

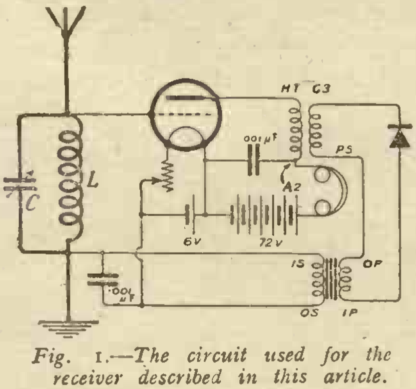


Fig. 1.—The circuit used for the receiver described in this article.

ebonite bobbin in alternate slots—four of each. I recommend that, as these transformers are wound with No. 40 D.S.C. wire and there are 400 turns in each slot, you buy one of these from one of the many dealers in ex-disposal apparatus, as they are fairly cheap compared with the trouble of winding them, unless you possess patience and dexterity, far in excess of my own, for handling this fine gauge wire. If you do desire to wind your own, or can get a friend to do it for you, full particulars of how to do so will be found in E. Redpath's book, *Wireless Telegraphy and Telephony.* Experiment by reversing one of the windings of the transformer by changing over the leads to crystal and L.F. transformer until the best results are obtained. The markings on my transformer and their connections to the rest of the circuit are shown in the diagram. While experimenting with the H.F. transformer and crystal detector you can leave the L.F. transformer out of the circuit until you get the best results, when it may be inserted with an increase of 30 per cent., or more, on the L.F. efficiency of the circuit. The connections I have found best for the L.F. side are also shown in the diagram.

Crystal Detector and Tuner.

A word about the crystal detector. Buy, make or otherwise obtain, an enclosed detector with the finest and lightest adjustments you possibly can, for your results in distance and signal strength hinge entirely upon the nicety of the adjustment of the contact wire on the crystal. Also it is essential that the contact wire is connected next to the L.F. transformer as I have shown. The values of the two blocking condensers are not critical, although the values of mine are marked in. Experiment here and see if you can better your results with different values. L and C can be any tuning arrangement you happen to have on hand suitable to the wavelength you wish to receive; mine being basket coils and a variable condenser as shown.

Advantages of the circuit.

The advantages of this class of circuit are:—

1. Simplicity of tuning, only one control for the whole circuit; that is the A.T.C.

2. Strength of signals are equal to, if not slightly in excess of, those got with the normal single valve reaction circuit, with total absence of parasitic noises connected with valve rectification and reaction distortion combined. With a good crystal nicely adjusted, the circuit is as stable and simple to operate as a single valve detector circuit less reaction, and you also know that your valve is earning its upkeep in "juice" by performing two functions well. These points combine to make a circuit which, when better known, amateurs will swear *by*, certainly not *at*, for telephony at least.

Results obtained.

The set which I am using now was finished 20 minutes before Mr. J. Scott-Taggart was due to give his speech from 2 LO recently, yet with this slight acquaintance with its working I was able to receive the speech in S.E. London uncomfortably loud on the 'phones. So you need not fear critical adjustments. Since then 2 LO's items, musical, vocal and speech, have been clearly audible the length of two rooms away from the 'phones, which were merely hung up and no horn attached. London amateurs also come in quite loudly, and this is using an inefficient aerial 60 ft. long, 21 ft. high, single wire T, badly screened for half its length. In conclusion, I would like to express my indebtedness to Mr. Voigt for his valuable advice and assistance given to me while experimenting on this class of circuit, he having introduced me to it.

We hope to publish in our next number full instructions for the construction of an extremely compact and efficient portable set employing a somewhat similar circuit to that of Mr. Dormer.

THE MEASUREMENT OF SIGNAL STRENGTH

By A. D. COWPER, B.Sc.(Lond.), M.Sc., Staff Editor.

The experimenter is often rather apt to consider that measurement methods with their great advantages are beyond his reach: this contribution is intended to show that such is not the case, by describing an extremely simple and inexpensive method of measurement of signal strength.

A GREAT deal of the uncertainty and very unscientific confusion that exists in people's minds and also, alas, in radio literature, as to the efficiency of various types of tuning devices, intervalve couplings, different varieties of valves and crystals—to say nothing of relative powers of different transmissions—all this would vanish if a uniform standard of signal strength, and what that implies, a simple and quick method of measuring the same, were widely known and practised. Unfortunately, a good deal of the romance of radio gossip would also vanish, for wireless enthusiasts, like fishermen, are rather notoriously addicted to drawing the long bow (or, should one say, the lofty aerial?). Many of these tales of marvellous signal strength, phones-on-the-table, signals audible in the next room with the door shut and a brass band in the street, etc., etc., will not provide half such interesting material for after-meeting gossip if expressed in units and decimals! With the regular uniform transmissions of the broadcast stations and with the thousands of enthusiasts listening-in night after night all over the country, we have now a quite unprecedented opportunity for genuine investigations into many of the problems that trouble radio engineers—to mention only one, that elusive subject of "fading"—given a rapid, approximate method of determining signal strength which could be regularly practised by any amateur who is interested in helping to solve these problems, and which would provide a most powerful weapon for tackling many of them. Apart from such general utility, a quick and relatively accurate method of measuring and comparing signal strength is one of the most useful aids the wireless experimenter can have, to improve his own apparatus and increase the efficiency of his reception. Without measurement, development of amplifying circuits, comparison of different circuits, etc., is the merest guesswork.

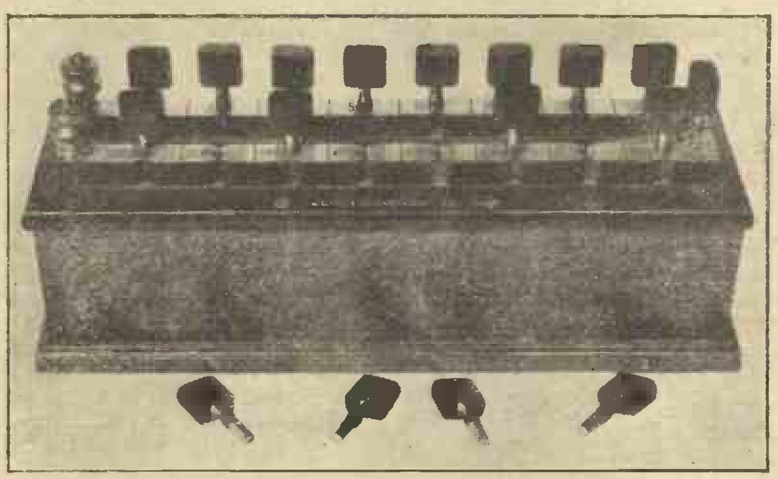


Fig 1. A suitable type of resistance box for signal strength measurements.

Many will have come across—and not a few will have been puzzled by—the old relative scale of signal strength, "R 7," "R 9," etc., used in military telegraphy, and by the "old timers." This was a purely guesswork scale with some relative value so long as merely feeble Morse signals were in question. The scale ran something like this: R 1, barely audible; R 3, weak; R 5, readable; R 7, strong; R 9, clear and strong. It will be seen that the widest possible latitude was left for the individual observer's judgment; what would be R 5 to one careful observer would be R 9 to another anxious to impress his hearers, and R 3 to a poor operator. With the advent of broadcasting and the era of loud-speakers the standard of R 9 has to be expanded to cover a range of several thousand, as will be seen later, and the whole scale becomes almost meaningless and hopelessly inadequate.

Elaborate methods of accurately measuring the strength of the impulses received in the receiving instrument have been worked out by ingenious radio engineers, with elaborate and delicate instruments, which are beyond the means and powers of most amateur experimenters; with such we are not concerned here, though any who have troubled to listen-in into the small hours of Sunday mornings may have heard the experimental operators of certain commercial test stations wearily reading pointless paragraphs or intoning lists of disconnected words, followed by a bored request for report of "signal strength and modulation," indicating that these are in daily use by the professionals.

Fortunately, however, we have a well-established method for measuring rapidly the signal strength as received in the phones, which requires the minimum of apparatus, adds practically nothing to the complexity of the set, is always ready for use at a few seconds' notice, and is extremely simple while being quite sufficiently accurate, relatively, to serve for real scientific investigations. This is the method of "shunted phones." If the telephones are "shunted" by a resistance connected across the terminals, some of the alternating current that gives rise to the sound heard (as well as some of the usual continuous current) will pass by via this resistance, so that less will pass through the windings of the telephones and the sound heard will decrease in intensity. The lower the value of the "shunt," *i.e.*, the less resistance it offers to the current, the larger the proportion of the current that will by-pass through it, and the lower the intensity of the sound heard. If the shunt is reduced to a sufficiently small value, so much of the current will be by-passed that the sound in the phones will fall in intensity below the intensity of sound which can be heard by the ear even in an ordinarily quiet room—below the "threshold intensity," and will accordingly be completely lost.

The method then consists in choosing by trial so low a value of shunt that this very nearly occurs, *i.e.*, until the sound is only "just audible" in the phones. The signal strength is then calculated from the value of this shunting resistance. The apparatus required, then, is merely a box of resistances, or a potentiometer-type of adjustable resistance with a range of from about the (nominal) resistance of the phones used, to unity. This can be kept permanently wired across the phone terminals, and is then available literally at a second's notice to measure the relative strength of the signals received.

It will be seen at once that the method is only relative—that is all it is claimed to be. The results depend to some extent on the characteristics of the phones used, upon the personal equation of the operator, and particularly on this "threshold intensity" of sound in the operating room. A noisily ticking alarum clock, traffic noises, especially other persons moving about and whispering—these all introduce difficulties and sometimes gross errors, but with careful intelligent use and reasonable attention to the matter of getting some uniformity of degree of silence (*i.e.*, threshold value) in the room while making measurements, quite uniform and comparable results can be obtained, and from day to day.

The calculation is simple: if S stands for the signal strength to be measured, R the "impedance" (in ohms) of the phones used—which we take here as identical with their direct current resistance (it is, of course, not strictly so, but for the purposes of relative calculations can be taken as such without introducing any serious systematic error), and S_R the value (in ohms) of the shunting resistance across the phones which just brings the signal strength down to the lowest distinctly audible; then

$$S = R + S_R/S_R.$$

For example, if the ordinary 4,000 ohms phones are used, we take R as 4,000 ohms for the purposes of our calculation; if we found that on putting a shunt of 400 ohms across the phone terminals the signals faded to the lowest audible limit, we would say that the signal strength on the scale was

$$S = \frac{4{,}000 + 400}{400} = 11.$$

If by adding, *e.g.*, a note magnifier, we find that we can plug out in the shunt only 100 ohms and still just hear the signals, we have

$$S = \frac{4{,}000 + 100}{100} = 41.$$

(Showing incidentally a measured amplification ratio of about 4 : 1.) When near the loud speaker stage, we may find that signals are still above threshold intensity—just audible—with only 4 ohms across the phones: then similarly $S = 4{,}000 + 4/4 = 1001$. Nominally, a "non-inductive resistance" should be used—one wound so as to have as little self-inductance as possible; but for ordinary resistances this is so small in comparison with that of the phones that it can be ignored.

Hence a potentiometer type of variable resistance can be used in an emergency for the lower values. As it is not possible to gauge the very high values—above 1,000—with any great accuracy, a 300 ohm potentiometer can be pressed into service to cover a range from about 100 up to loud-speaking, provided that its total resistance is known, and by counting the turns other resistances can be marked off on it. For the lower range of signal strengths (1—100 or so) a few single resistances can be made of insulated resistance wire, simply doubled on itself at the middle and wound on "non-inductively" on small bobbins, starting with the loop end of this doubled wire, as resistance coils are usually wound. To give a convenient range, values required will be: 1,000, 500, then on the potentiometer marks at 300, 200, 100, 50, 40, 30, 20, 10, 7, 5, 2 ohms. Signal strengths corresponding are: 5, 9, 14, 21, 41, 81, 101, 134, 201, 401, 572, 801, 2,001.

A further refinement in the form of a dial-

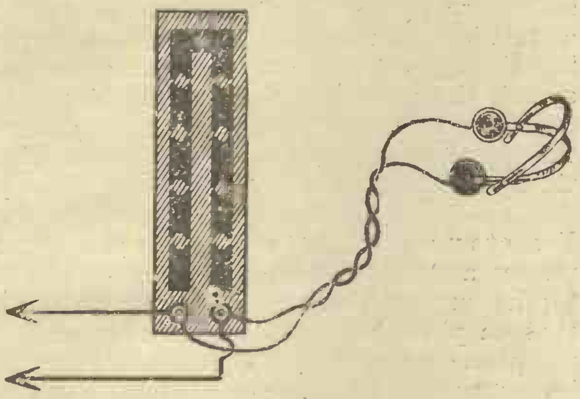


Fig 2. Showing how to connect up the box of resistances. The arrows indicate connections to the telephone terminals of the set.

fitted box of resistances of the right figures to give whole round numbers for the signal strengths and scales marked accordingly, to save all calculation, or a potentiometer-type of variable resistance-coil wound with graded sizes of wire for greater ease in setting and reading off, will occur to experienced experimenters. Also the idea of incorporating the device permanently into a receiving set, in place of having it as a separate unit outside with loose leads to the phones. Of course, if the ordinary "Post Office box" or "Wheatstone Bridge" type of boxed resistance coils with plug adjustment happens to be available—such as are commonly used in elementary physics, laboratories at schools, etc., it can be used without any alterations or adjustments and is immediately available for other purposes when required.

Naturally, a very quiet room must be chosen for such work, and anything likely to disturb or raise irregularly that "threshold value" of sound must be avoided. And it must be attempted to determine upon some uniform interpretation of "minimum audible"; *e.g.*, in musical transmissions, whether loud notes are to be excluded; and in speech (the best subject for obvious reasons), whether an indistinct murmur or just intelligible speech is the minimum.

The applications of this method, which takes only a few seconds in a fairly quiet environment to get comparable results, and does not interfere otherwise with the enjoyment of the transmitted matter, are so obvious in many branches of radio experimentation that it is not necessary to more than hint at a few of them. Many others will undoubtedly develop as the method becomes more widely practised. Examples are such as determining the practical relative efficiency of different tuning devices; loss of signal strength with different degrees of coupling; efficiency of H.F. and L.F. intervalve couplings; relative efficiency of different crystals and of valve-crystal couplings; rectifying efficiency of different valves, etc., etc. It becomes possible to measure amplifying power, instead of guessing it vaguely.

A few figures, published elsewhere in connection with another topic, may be worth repeating here. Ordinary moderate crystal reception of broadcasting, such as that with which most unskilled beginners content themselves, with the phones clamped tightly to their ears in as quiet a room as possible, is about 10 on the scale. Reasonably good is from 20 to 40; above 80 it becomes something to show envious friends. But actually it is possible to get values from 200 up to 400 or more, on a good aerial, a first-class tuner, and good crystal within a few miles of a powerful station; this begins the "phones-on-the table" stage of the single-valve set. A moderate degree of loud speaking for a small room is at 1,000; signals begin to be uncomfortable on the headphones here. Real loud speaking runs from 2,000 up to 4,000, and as far beyond as you like with power amplifiers, etc. Another useful simile is the "dry biscuits" stage—when you can enjoy both these delicacies and the music in the headphones simultaneously, at some 400 on the scale.

A USEFUL RECEIVER FOR WAVES OF FROM 1,000 TO 30,000 METRES

This article describes how a sensitive receiver embracing the wavelength band of all the high-power transatlantic stations may be readily constructed by the experimenter.

In designing this instrument, several essentials had to be borne in mind; the chief consideration from the experimenter's view point is, of course, first cost, and the most useful method in which one can arrange the necessary circuits to produce the maximum results. The writer did not wish, either, to have a large and cumbersome device in a wooden cabinet, and the instrument described here is both flexible and compact.

The wavelength range specified is sufficient to include all the distant stations which one may want to listen to, and the arrangement of two H.F. valves followed by one stage of L.F. (after rectification) is one which produces excellent loud-speaker signals on even an indifferent aerial.

Materials Required.

The essential parts for the construction of this instrument are :—

- An ebonite panel 12 inches by 5 by ¼ inch;
- An ebonite panel 12 inches by 4 by ¼ inch;
- 4 sets of valve fittings;
- 2 variable condensers, 0.001 μF and 0.0005 μF respectively, 7 terminals;
- A low-frequency transformer;
- 2 coupling resistances, (100,000 ohms);
- 2 grid leaks (2 megohms);
- 1 filament rheostat;
- 2 small condensers 0.0003 μF;
- 2 condensers 0.002 μF,

and about 2 feet of ½ by ⅛ inch brass strip for mounting, together with wire, screws, nuts, shellac, solder, etc.

Construction.

The first thing to be taken in hand will be the two ebonite panels. They must be drilled and tapped as shown in Fig. 2, in which the upper one is the amplifier panel and the lower one the tuner panel. The illustration shows sufficiently clearly the sizes and positions of the different holes.

Before proceeding any further it will be as well to consider the principles upon which resistance-capacity coupled amplifiers work. The chief advantage of this type of instrument lies in the fact that it is remarkably efficient over a wide band of wavelengths without any adjustment being required; it is indeed, although very aperiodic in action, a much better amplifier for long wavelengths than the conventional pattern of semi-tuned transformer, and is also much more stable if extended to many stages.

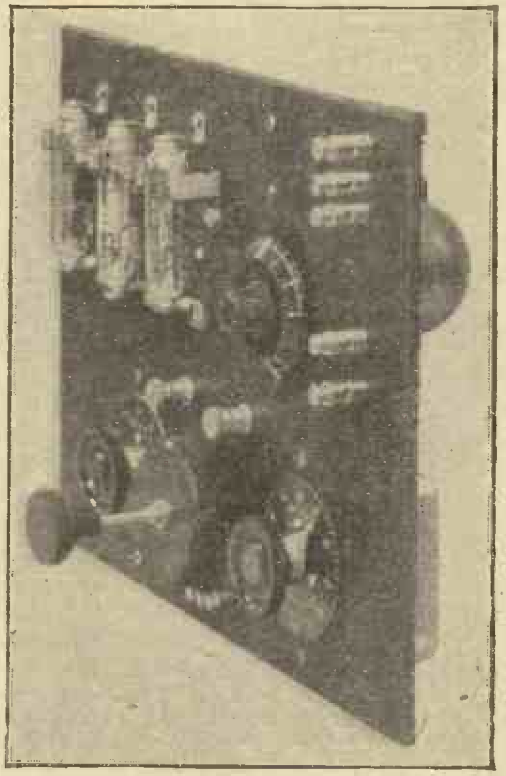


Fig. 1. The completed receiver.

The arrangement under consideration is a high frequency amplifier, but with only very slight alterations might be converted into a low-frequency amplifier. In this instance however, an L.F. stage is introduced in the form of an ordinary step-up intervalve transformer.

The non-inductive resistances (marked 100,000 ohms) are connected in the anode circuit of each valve, whilst coupling to the next valve is effected by means of the small condensers of 0.0003 μF. The high resistances (2 megohms) are for the purpose of keeping the grids of the respective valves at the correct negative potential, and their value is as a rule not critical. Two megohms proves experimentally to be a satisfactory value for the particular valves used.

Incoming high-frequency currents set up oscillations across the anode resistances, which permit the steady H. T. current to pass, and at the foot of these anode resistances we therefore find the rapid oscillations of the H.F. component, together with the steady D.C. voltage, communicated by the resistance to the grid of the next valve. As a matter of fact if L.F. impulses are present these are also amplified by this arrangement, so that the valves act both as H.F. and L.F. amplifiers to a certain extent; but the constants of the circuit are so chosen that H.F. impulses are dealt with in preference to those at audio-frequency.

Fig. 4 shows a back view of the amplifier panel and illustrates the disposition of the component parts, and Fig. 5 is a circuit diagram of the instrument. Fig. 3 depicts the brass side members for supporting the apparatus. The author is in favour of this panel construction for receivers, for not only is a very workmanlike appearance presented, but it is also easy to get at the connections should this be necessary for any reason.

To turn now to the actual construction of the instrument, it will be evident that it could, if desired, be entirely built up from raw materials. In this particular case special condensers and coils were employed, but there is no reason why the experimenter should not build his own and for this reason constructional details are given. The two variable condensers are of 0.001 and 0.0005 μF capacity respectively, and if made up should consist of 49 and 29 plates. Full data for constructing them were given in MODERN WIRELESS No. 4 to which the reader should refer. The actual tuner panel, Fig. 2, may be used as a basis for the assembly to be mounted on, and is indeed recommended as presenting a much neater final appearance.

The main tuning condenser is always in parallel with the aerial inductance, and thus if the reader can afford to buy two "Polar" condensers, the even tuning given by this device will be found very useful to obtain selectivity between the switch stops. The inductance may now be taken in hand, and as it is necessary to cover a wide range and yet not have too bulky a coil, the "slab" pattern is recommended. The relatively high self-capacity which these coils possess does not seriously lower the efficiency of the system on the high wavelengths this amplifier covers. Taking now the sizes of the aerial and reaction coils into consideration, we shall require a coil of $1\frac{1}{2}$ inches internal diameter wound with 1,500 turns for the aerial circuit, and one of the same diameter with 700 turns for the reaction coil. The aerial coil may be wound in the form of a slab coil with wire up to No. 34 s.w.g., and the reaction coil in a similar manner. If desired, the multilayer coils described in MODERN WIRELESS No. 4 might be employed, but unless the wire was rather fine their bulk would be considerable. In order to cover the requisite range of wavelengths, six tappings should be taken from the 1,500 turn coil at 300, 600, 900, 1,100, 1,300 and 1,500 turns. These tappings are taken to the wave selector switch which can be seen in the photograph and at B, Fig. 2, in such a manner that any number of turns between 300 and 1,500 may be included in circuit by rotating the switch arm.

The constructional details of this latter, which is of an unusual pattern (inasmuch as the reaction spindle passes right through the switch arm spindle itself) may be grasped from an examination of Fig. 6. The most convenient method for the experimenter to adopt when making this switch is to choose a piece of $\frac{3}{8}$ inch brass tubing having a $\frac{3}{16}$ inch centre hole, and to thread this for its entire length ($1\frac{1}{2}$ inches) on the outside. The switch arm knob may be tapped to suit, and a $\frac{3}{16}$ inch hole drilled through it to guide the reaction spindle. A $\frac{3}{8}$ inch hole in the panel will permit of the tube being inserted, and once the switch blade and contact studs have been attached as in Fig. 7, the necessary adjustments for distance and pressure may be made by means of the front and rear nuts (Fig. 7). This illustration also shows how a steel spring washer may be used to allow of delicate regulation of pressure being brought about.

In rear of the switch arm bush and fitting into a $\frac{1}{4}$ inch screwed hole in it is the extended bearing for the reaction coil spindle. This should be made from $\frac{1}{4}$ inch tube with a $\frac{3}{16}$ inch centre hole, as shown in Fig. 6, and while the length indicated is sufficient to give a firm bearing to the spindle, an extra $\frac{1}{2}$ inch might be allowed if desired. This whole structure rotates with the switch arm, as will be obvious from the drawings, and for this reason thin flat nuts should be used to lock the main switch arm bush in position; as it is not always very easy to obtain these nuts, they can be made by cutting an ordinary $\frac{3}{8}$ inch hexagon brass nut into sections with a thin hacksaw blade. The usual depth of a $\frac{3}{8}$ inch Whitworth hexagon nut is approximately $\frac{3}{8}$ of an inch, so that with care two $\frac{3}{16}$ inch nuts can be made from this. As a $\frac{3}{8}$th Whitworth nut has only 16 threads to the inch, no attempt should be made to cut 3 nuts, as there will not be enough thread on a $\frac{3}{32}$ inch nut to have a secure grip on the spindle.

The switch arm itself may be made from $\frac{1}{16}$ inch springy brass or phosphor bronze, and one leaf will exert sufficient pressure to ensure good contact. Care must be taken when buying contact studs to see that they are all of the

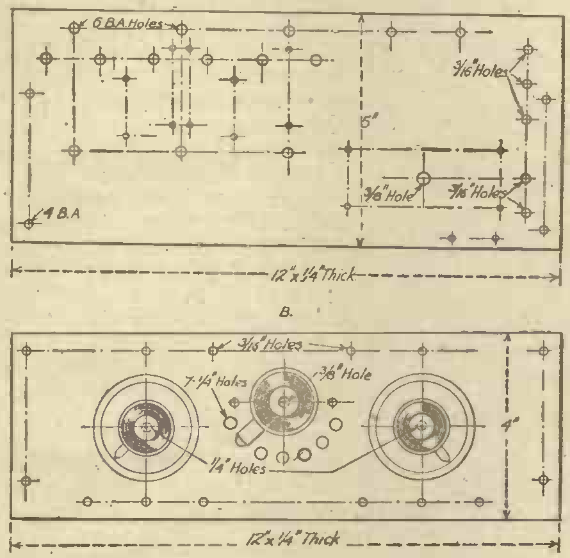


Fig. 2. Above, the panel of the amplifier, and below, the tuner panel, showing the position and size of the necessary holes.

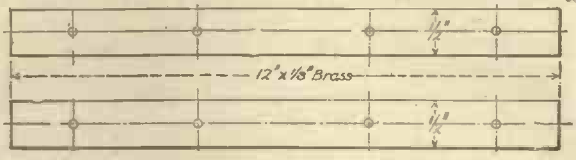


Fig. 3. The brass strips which support the components behind the panel.

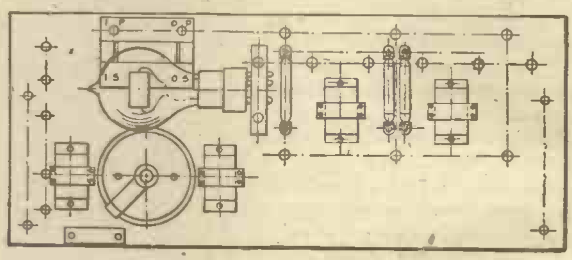


Fig. 4. Showing the arrangement of the parts.

same height, and a few more pence laid out on good studs is money well spent. The edge of the switch arm should be rounded off to provide a velvet-like contact, and with a little care this may easily be attained. The arrangements for mounting the main tuning coil to the panel will be clear from Figs. 7 and 8, and no further description is needed. The small ebonite supports can be varied to suit individual tastes, as the reader might have little blocks or scraps of ebonite by him which would serve equally well. The arrangement for mounting the reaction coil will also be clear from Figs. 7 and 8, which show the $\frac{1}{8}$ inch ebonite strips necessary to secure the coil to the spindle. Flexible wires should be soldered to this coil so as to prevent the leads from chafing through movement of the control, as the actual rod on which the coil is mounted (Fig. 7) is 8 inches long. This allows of a sufficient variation of reaction coupling over the whole band of wavelengths of the receiver.

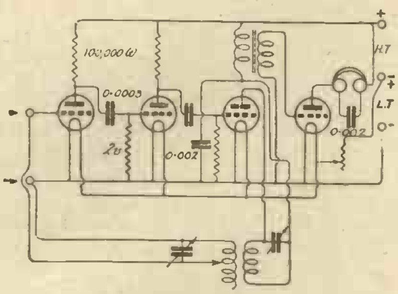


Fig. 5. The circuit of the receiver.

The next thing to be taken in hand should be the small fixed condensers through which coupling is effected between the valves, and the telephone and intervalve condensers. Small pieces of ebonite dimensioned as in Fig. 9, should be cut out and the following number will be required :—

4 pieces $\frac{7}{8}$ by 2 inches;
4 pieces $\frac{7}{8}$ by $\frac{7}{8}$ inch;
4 pieces $1\frac{3}{8}$ by $\frac{1}{2}$ inch;
all by $\frac{1}{8}$ inch thick.

Supplies of condenser vanes and foils may also be cut, and these will total :—

28 pieces copper foil $\frac{3}{4}$ by $\frac{3}{4}$ by $\frac{1}{64}$ inch (with tag);
38 pieces mica $\frac{7}{8}$ by $\frac{7}{8}$ inch by 0.006 inch thick.

The grid coupling condensers will each require 2 foils and 3 micas, and the telephone and intervalve condensers 12 foils and 14 micas each. The former have a capacity of 0.0003 μF, and the latter 0.002 μF. The exact method of assembling will be obvious from Fig. 9 and they should be secured to the back of the panel as shown in Fig. 4.

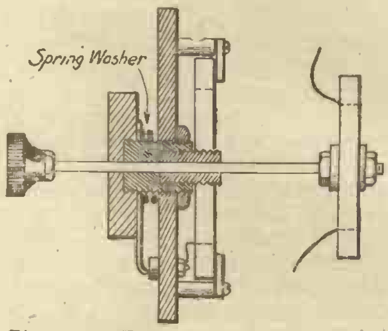


Fig. 7. The selector switch and reaction coil assembled on the panel.

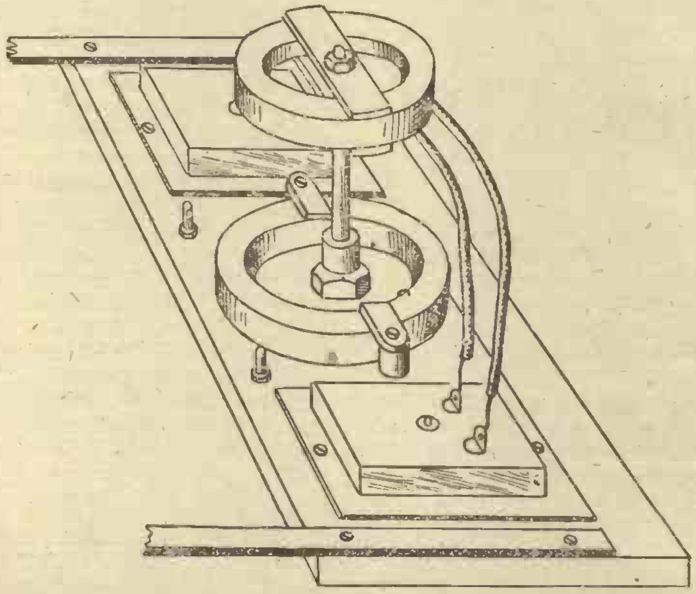


Fig. 8. Showing the arrangement of the tuning and reaction coils.

The anode coupling resistances could also be made, but as it is essential for the satisfactory working of the instrument that they should be absolutely constant in action and identical in value, it is really rather a false economy to make them up. For those, however, who wish to know how to make a really constant type of high resistance which is proof against atmospheric changes, the following details will be of use :—

A piece of thin cardboard such as a plain postcard should be first of all well dried, and then be

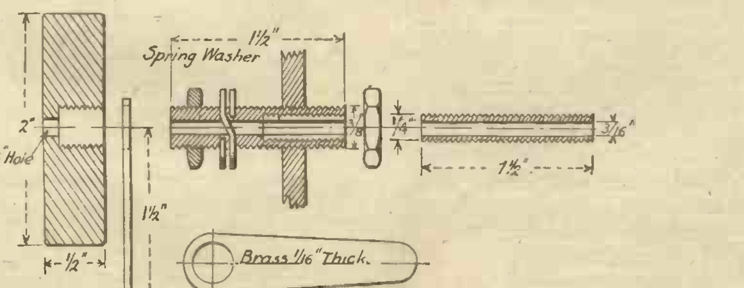


Fig. 6. Showing the construction of the selector switch (above) and the reaction coil spindle (below).

painted with a stiff hair brush with the following mixture: six parts of liquid Indian ink and one part fine dust obtained by shaving an "H" drawing pencil. The strip, having been coated, should then be thoroughly dried in a warm oven, and a piece 1½ inches long cut from it of a width to just wrap round a glass tube ½ an inch external diameter and 2 inches long. At the ends of this tube 2 clips made of thin soft brass strip should be attached, better contact with the coated strip being afforded by placing thin pieces of tinfoil under

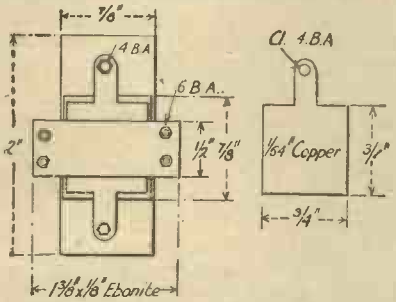


Fig. 9. Details of the condensers.

each clamp. The space between the clamps is then covered with two or three layers of silk tape or cord and shellacked; the coating should only be sufficiently thick to present an unbroken surface to the air when baked, and if this is not accomplished the first time another coat may be given. Do not let the shellac penetrate to the strip or the resistance will be altered. Anode resistances made as described will have a value of almost exactly 100,000 ohms, but should slight adjustment be necessary this can be done by moving the clips up and down the tube before the protective winding is put on. These resistances will be as constant as any commercial type of leak on the market, and are inexpensive to make. The construction of the intervalve L.F. transformer and the filament rheostat might be undertaken by the reader if desired, but in view of the present reasonable price of such components the small outlay will be well repaid if they are bought ready made. The filament resistance should be substantial enough to carry the load of 4 filaments without overheating, as otherwise trouble will result and the output from the receiver may diminish in volume. The method of attachment of these parts will be sufficiently obvious from the drawings. There now remains the question of the attachment of the L. F. valve, and in the writer's case this was mounted horizontally at the back of the panel, the bracket for supporting it being made from an odd scrap of ebonite in which four valve sockets were mounted. This should, of course, be of such a size that the bulb of the valve clears any parts (such as the filament rheostat) projecting from the rear of the panel.

The method of mounting the terminals and wiring generally should be noted, as the position of the components to a certain extent influences the working of the set. About 120 volts will be required on the anodes of the valves,

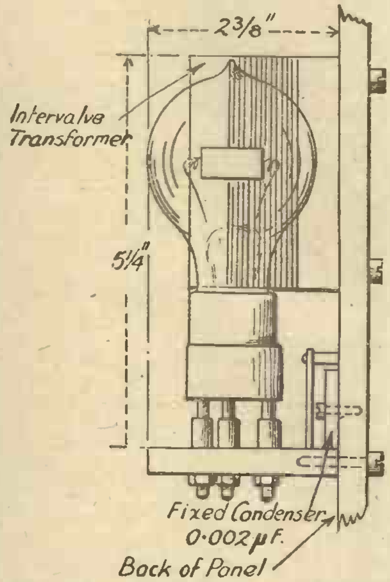


Fig. 10. Showing the method of mounting the R valve behind the panel.

including the V24's, and the amplifier will be found to yield loud signals at a distance of many feet from the 'phones and from some high power stations at several hundred feet from a loud-speaker.

A.L.M.D.

ABBREVIATIONS USED IN WIRELESS.

A.C.—Alternating current.
A.F.—Audio frequency.
A.T.C.—Aerial tuning condenser.
A.T.I.—Aerial tuning inductance.
C.—Capacity (in formulæ).
C.W.—Continuous wave.
D.C.—Direct current.
D.C.C.—Double cotton covered.
D.F.—Direction finding.
D.S.C.—Double silk covered.
E.M.F.—Electro-motive force.
E.M.U.—Electro-magnetic units.
E.S.U.—Electro-static units.
H.F.—High frequency.
H.T.—High tension.
Hy.—Henry (unit of inductance).
I.C.W.—Interrupted continuous wave.
L.—Inductance (in formulæ).
λ—Wave length.
L.F.—Low frequency.
L.T.—Low tension.
μF.—Microfarad (practical unit of capacity, sometimes abbreviated "mfd.").
M.—Metres.
M.A.—Milliampere (unit of current. One thousandth of an ampere).
Mhy.—Microhenry (one millionth of a henry, sometimes abbreviated "mic.").
R.C.—Reaction coupling.
R.F.—Radio frequency.
R/T.—Radio telephony.
S.C.C.—Single cotton covered.
S.I.C.—Specific inductive capacity.
S.S.C.—Single silk covered.
S.W.G.—Standard wire gauge.
T.T.—Tonic train.
W/L.—Wave length.
W/T.—Wireless telegraphy.
Ω—Megohms (unit of resistance.
ω—Ohms. One million ohms).

LOW-FREQUENCY AMPLIFIERS AND THEIR OPERATION

By JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E.

This article deals with the important question of low-frequency amplification and, as in the case of all these regular monthly articles on valves, the subject is dealt with both from a theoretical and practical standpoint, the two being reconciled.

LOW-FREQUENCY amplification has for its main object the strengthening of signals which already exist and which may be heard without amplification. The chief use, therefore, of low-frequency amplification is in the magnifying of signals which may be heard faintly, but distinctly.

As has been explained in a previous article, the chief value of amplification is in strengthening the incoming currents so that they may effectively operate thed etector. Once signals have been obtained sufficiently strong to work a pair of telephone receivers, the further strengthening is accomplished by one or two stages of low-frequency amplification.

The term "low-frequency," of course, is used because the signals in the 'phones may be heard and are to be distinguished as regards frequency from the high-frequency currents flowing in the aerial circuit. The terms "audio-frequency amplification" and "note magnification," are synonymous with low frequency amplification.

The Uses of L.F. Amplification.

Low-frequency amplification is, we might safely say, almost indispensable if signals are to be made sufficiently loud to operate a loud-speaker effectively. Another point in connection with low-frequency amplification is that it is useful in most cases where, even after several stages of high-frequency amplification, the results are not sufficiently loud. Several valves may be used for high-frequency amplification, but when more than three or four are so employed, troubles are likely to arise owing to the valves generating currents of their own accord, and it is therefore usual on specially sensitive circuits to use several valves as high-frequency amplifiers, one as a detector, and two or three as note magnifiers.

Those readers who only possess crystal receivers will, no doubt, welcome low-frequency amplification as a simple method of strengthening the signals they have obtained. A crystal detector followed by two low-frequency amplifying valves form a receiving set which will work a loud speaker quite well if the distance between the transmitting station and the receiver is comparatively short.

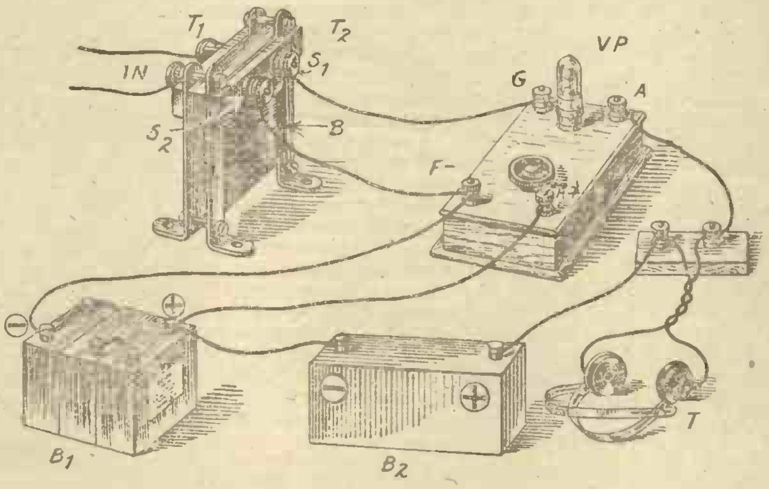


Fig. 1. A simple L.F. amplifier.

The chief advantage of a low-frequency amplifier is that, as it does not work on high-frequency currents, there is no necessity for tuning, and no adjustments of this part of the apparatus are necessary.

At the same time, it is important to understand the action of the note magnifier and to be able to correct any faults which may appear. These faults occur particularly when a loud-speaker is in use, and much of the distortion which is heard on a wireless receiver is due to insufficient attention to the low-frequency side of the apparatus. The very fact that no adjustments are necessary makes it all the easier for the experimenter to neglect it.

A Simple L.F. Amplifier.

Figure 1 shows a simple form of apparatus for amplifying low-frequency currents. In this figure T_1 T_2 represents what is known as an "input transformer." This transformer has a primary and a secondary winding. The primary consists of a relatively few number of turns wound round an iron core which passes through the centre of the bobbin B. The winding is wound on the bobbin B, and the ends are taken out to the terminals IN. These terminals are usually marked I.P. and O.P., in the commercial article the letters I.P standing for "in primary" and O.P.. for "out primary." There is no particular significance in the words "in" and "out," but they form a convenient method of labelling the terminals.

In many cases, the letter P is placed between the terminals, in which case the letter simply stands for "primary" which is the name given to this winding. Around the primary winding we have the secondary winding, which consists of very many more turns. The secondary winding has its ends brought out to the terminals S_1 and S_2. These terminals are sometimes marked I.S and O.S. on the commercial transformer, these abbreviations standing for "in secondary" and "out secondary."

A valve panel VP is shown in the drawing. This valve panel has four terminals on it, one, G, going to the grid of the valve, one A going to the anode, and two filament terminals marked F — and F +. A filament rheostat or variable resistance is connected between the terminal S_1 and one of the filament leads. Across the terminals F — and F + we have the six-volt accumulator B_1 which supplies the current to heat the filament of the valve. Between the terminal A and the positive terminal of the high-tension battery B_2 we have the telephones T. The negative terminal of B_2 is connected to the positive terminal of the accumulator.

It will be seen that one of the terminals of the secondary of the transformer T_1 T_2 is connected to the grid terminal on the valve panel and the other to the negative filament terminal. If now we connect the terminals IN on the intervalve transformer to the telephone terminals of a crystal receiver, we shall greatly amplify the signals which would have been heard in the telephones. Signal strength is usually increased by about seven times with an apparatus of this kind.

The Circuit Diagram.

Figure 2 shows the circuit diagram corresponding to the arrangement of

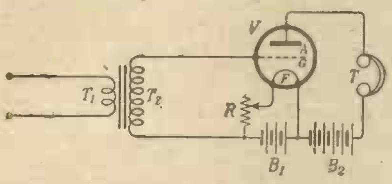


Fig. 2. The circuit diagram of the apparatus shown in Fig. 1.

Figure 1, while Figure 3 shows the amplifier applied to a simple crystal detector, which may be of any kind. All that we have to do is to connect the terminals YZ to which the telephones would normally be connected, to the terminals IN of the amplifier circuit and to connect the telephones in the anode circuit of the valve, and we shall obtain much louder results.

The arrangement to the right would be called a simple single-valve amplifier.

The operation of a circuit of this kind is as follows :—In the aerial circuit we have flowing oscillatory currents which are applied to the crystal detector, D. This detector only allows high-frequency pulses to flow through it in one direction, with the result that the condenser C is charged up with direct current, this current discharging through the primary T_1 of the step-up transformer T_1 T_2. The current flowing through the primary T_1 is therefore a pulsating one and is undirectional, that is to say, the pulse simply flows in one direction. When listening-in to broadcasting, the pulses through the primary of the transformer are continually varying in strength, but for the sake of explanation we will consider in the following pages that only one pulse is being studied.

Although the current through T_1 is a pulsating one, the current in T_2 will be alternating, and will change direction. This phenomenon is similar to that experienced in an ordinary spark coil. In the latter case there is a flow of current in the secondary winding when the primary circuit is made, and a reverse current, which is usually very much larger, when the primary circuit is broken. The potential differences or voltages across T_2 are very much greater than those across T_2, owing to the fact that the transformer T_1 T_2 is of the step-up type and acts in rather a similar manner to an induction coil, with which, of course, very high voltages indeed may be obtained from even a six-volt accumulator.

Since the grid in a three-electrode valve acts as an electrostatic control element, and as it is not necessary to have any appreciable energy in the grid circuit, the high voltages across T_2 will have the desired effect in obtaining the maximum control on the anode current of the valve.

It must not, of course, be supposed that the energy in the secondary of the transformer is any greater than that in the primary. All we have done is to increase the voltage and decrease the current. It must be remembered that it is voltage that you require on the grid of an amplifying valve. As we have previously stated in a course on valves appearing in *Wireless Weekly*, a dry battery of 10 volts would have just the same effect on the anode current of a valve as a 10 volt 20 kilowatt dynamo.

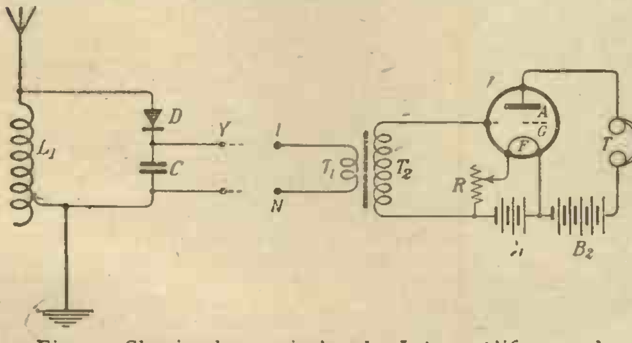


Fig. 3. Showing how a single-valve L.F. amplifier may be applied to a crystal receiver.

Graphical Representation of L.F. Amplification.

Figure 4 shows graphically the processes taking place in an amplifier of the type shown in Figure 2. The top line shows the pulse of current flowing through the step-up transformer T_1 T_2; the second line shows the alternating current produced in the secondary, and it will be seen that the amplitude of the E.M.F. applied to the grid is much greater than in the case of the current applied to T_2. The third line shows the amplified currents flowing in the anode circuit of the valve. It will be seen that these currents are also alternating, but are of much greater magnitude than the original ones.

Many students find it difficult to understand how there can be an alternating current in the anode

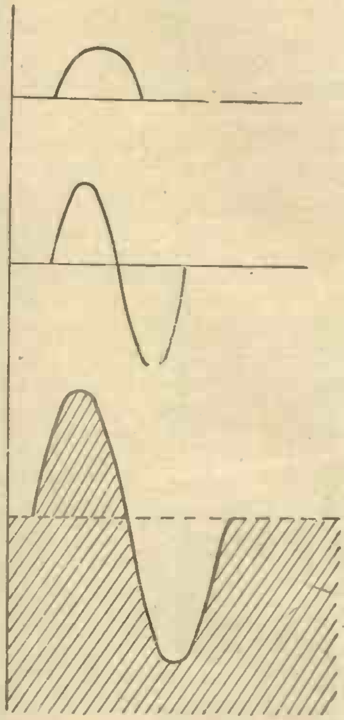


Fig. 4. Illustrating the actions taking place in a low-frequency amplifier.

circuit of a three-electrode valve when the valve itself will only allow a current to pass between filament and anode.

The current, as a matter of fact, is an alternating one superimposed upon the steady anode current flowing from filament to anode round through the telephones T and the high-tension battery B_2, back again to the filament. This steady current is increased and decreased according to whether the potentials on the grid are positive or negative, or increasing or decreasing. There is always a certain amount of anode current flowing round the circuit, but this amount is varied up and down, above and below the average value. For example, the steady anode current might be 1.5 milliamperes and the positive half-cycle might increase this value to 2 milliamperes, whereas the negative half-cycle of potential applied to the grid might reduce the anode current to 1 milliampere. If an alternating current were therefore applied to the grid, the anode current would fluctuate from 1.5 up to 2 milliamperes, then down to 1.5 and down further to 1 milliampere, then up again to 1·5, and so on.

The steady anode current does not concern us in the least in ninety-nine per cent. of the valve circuits we will deal with. If the telephones are connected directly in the anode circuit, as shown in Figure 2, there will be a steady flow of anode current through

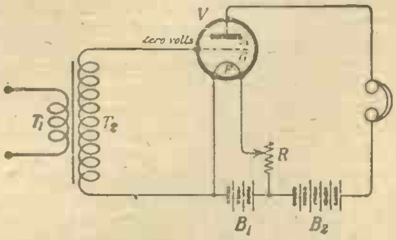


Fig. 5. A circuit in which distortion will occur in the amplification of strong signals.

the telephones, but this will not produce any sound. Telephones will only give forth sound when a current is suddenly switched through them or switched off, or is varying in any other way, provided this variation is neither too rapid nor too slow. As far as the telephones are concerned, a steady current has no effect and the phones are only interested in the variations of anode current. These variations, considered by themselves, really constitute an alternating current. To understand this a little better, we can consider various analogies.

If a person stands still on the earth, he is whizzing through space at the rate of many thousands of miles per second in a certain direction. If now he walks towards the east his speed through space will have increased, the total speed being the sum of his own walking speed and the actual speed of rotation of the earth. If, however, instead of walking east he walks backwards towards the west, his progress through space will be slower.

Let us imagine for a moment that the man walks backwards and forwards along a road directional towards east and west. An observer outside the earth would not consider that the

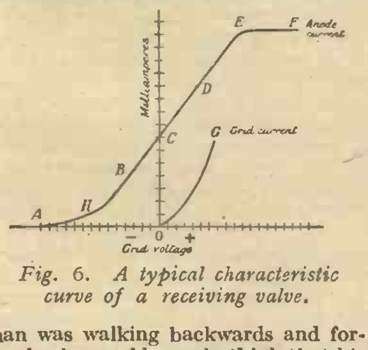


Fig. 6. A typical characteristic curve of a receiving valve.

man was walking backwards and forwards ; he would merely think that his general speed through space was varying. For a time he would seem to be going through space at a quicker rate and at other times at a slower rate. So, in the same way, the student often queries the fact that the currents in the anode circuit of the valve are alternating. He says they are direct currents, and that they are direct currents which increase and decrease but always flow in the same direction.

This is really quite correct, but the observer outside the earth would also be correct in assuming that the man on the earth was not walking backwards and forwards but was merely slowing up in his general journey through space. We on the earth, however, who might be watching the man, would consider that he was walking backwards and forwards, because to those of us on the earth it is the only movement which is of any real and relative importance. Similarly, as far as the telephones are concerned, the currents flowing through them are ones which go backwards and forwards.

We may picture a ship being tossed up and down on the surface of a sea five miles deep. The seasick person on board the ship is not at all concerned with the five miles of water beneath him. He is only concerned with the relatively small up and down movement of the surface of the sea. So in much the same way, the telephones do not worry about the steady anode current but only about the variations above and below the average flow of current.

A rather far-fetched analogy might also be of some help at this stage. Consider that you are placed at the top of a huge spring, the bottom of which rests on the ground. The top of the spring is given a tap and you move rapidly up and down. While you are bouncing up and down, someone begins to lift the spring rapidly upwards. As far as you were concerned, you would still be moving up and down and it would be little consolation to know that you were really always moving upwards but not quite at the same speed all the time.

Distortion Effects.

One of the principal advantages of the three-electrode valve as an amplifier is that it will reproduce very accurately the currents applied to it on a larger scale, the reproduction being perfect, provided the apparatus is properly employed. Every little fluctuation and change in the current to the amplifier is reproduced on a larger scale in the output or anode circuit of the valve.

If we speak into a megaphone, louder results are obtained, but the quality of the voice is not preserved. There is a considerable amount of distortion, and although the words may be understood, yet there is a considerable loss in the quality of the voice. A harsher result is obtained and the megaphone is therefore not an ideal sound magnifier.

The three-electrode valve, however, if properly used, will magnify varying electrical currents with great faithfulness. It is proposed to explain how this faithful reproduction may be obtained and how easy it is to lose it.

Unless precautions are taken, different syllables of the voice when receiving broadcasting, for example, may be made softer than others and the quality of the speech or music may be greatly impaired.

There are two principal sources of distortion in a low-frequency amplifier, quite apart from distortion which is produced as a result of badly designed or badly made transformers. These two causes are (1) grid damping, (2) asymmetrical amplification.

These expressions will be explained in simple terms.

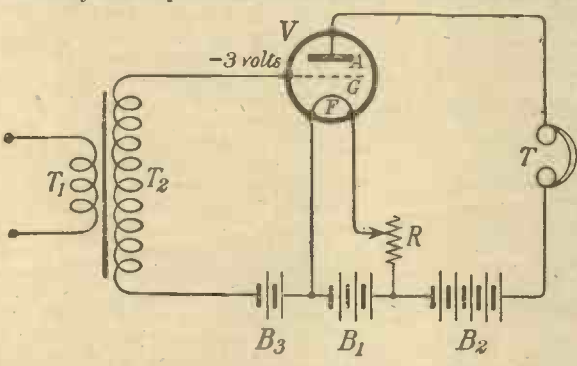


Fig. 7. Showing the use of grid cells to prevent grid damping.

Grid Damping.

Figure 5 shows a simple amplifying circuit in which it will be seen that the secondary T_2 of a step-up transformer T_1 T_2 is connected across the grid of the valve and the negative terminal of the filament accumulator B_1. This sort of circuit, although quite suitable for use when the signals are weak, is not at all so when strong signals are being amplified, in other words when the grid potentials are measurable in volts.

Two effects are noticeable. One is that the degree of amplification is not as great as it might be, and the other is that distortion effects are obtained.

Both these disadvantages result from the establishment of a grid current when the grid is made positive by the positive half-cycles of the alternating current supplied by T_2. When the grid is made negative, the anode current is decreased, and, of course, no electrons flow to the grid which, being negative, would repel them.

When, however, the grid is made positive by the positive half-cycles in T_2, the grid acts in the same way as an anode, and not only causes an increase of electrons to the main anode but diverts a few to itself. This number is relatively very small, but it has quite an important bearing on the efficient

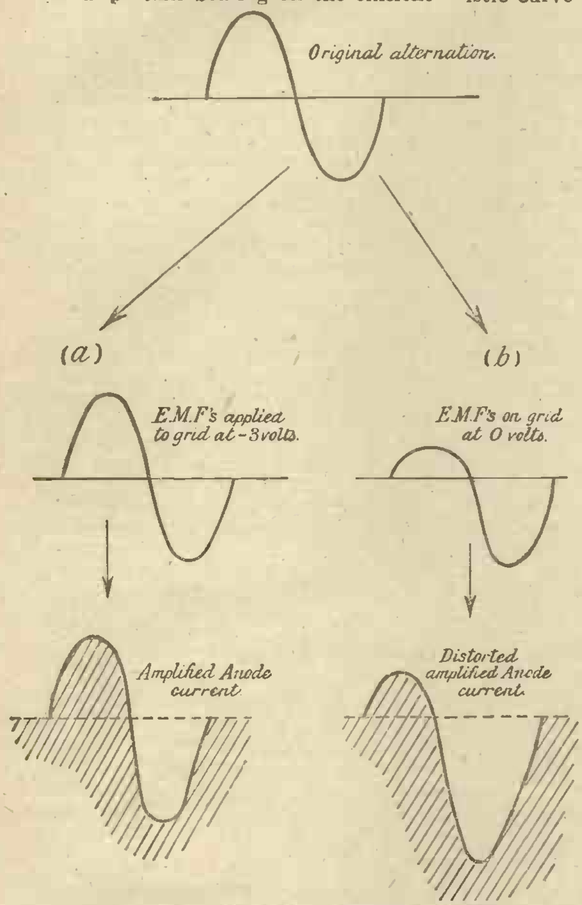


Fig. 8. Illustrating the production of distortion and its prevention.

operation of the valve when amplifying strong signals. The moment the grid becomes positive, electrons are attracted to it, and these electrons flow from the filament to the grid and round through T_2 back to the filament. The filament and grid path has be-

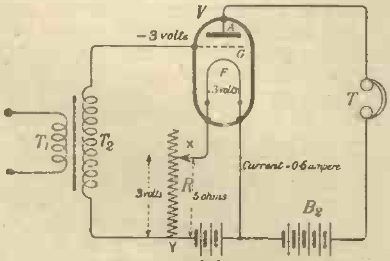


Fig. 9. Illustrating a method of applying a negative voltage to the grid without the use of grid cells.

come conductive and we get just the same effect as regards the positive half-cycles as if a resistance had been connected across T_2. The shunt resistance effect is absent during the negative half-cycles.

Figure 6 shows a typical characteristic curve of a three-electrode valve. The horizontal axis represents grid voltage while the vertical axis represents milliamperes of current. The curve A B C D E F is the curve illustrating the effect of grid voltage on anode current and the vertical axis in this case is a measure of the anode current.

The filament current and anode voltage have been so chosen that a characteristic curve of the kind shown is obtained. The operating point, when using the circuit of Figure 5, is represented by the point C.

It will be seen that the effect of one volt positive on the grid is an increase of anode current which approximately equals the decrease produced by − 1 volt. When, however, the potentials affecting the grid are supplied from, say, the secondary winding of an input transformer, although the positive and negative half-cycles might originally be equal, yet, when they are applied to the grid, the positive half-cycle never reaches its full value owing to the establishment of a grid current. Thus, although the negative half-cycle might be − 1 volt, yet the positive half-cycle might be only + ¾ volt.

To show the effect of the grid current more clearly, a separate curve O G has been drawn, and this represents the grid current for different positive values of grid voltage. When the grid is made negative, it will be seen that there is no grid current. This, of course, is because the grid and filament of the three-electrode valve act exactly like a Fleming valve, the conductivity of the filament-grid path being unidirectional. When, however, the potential of the grid rises above zero, a grid current begins to flow and this rapidly increases. Only a portion of the grid current curve is shown; this is quite enough to indicate that there is always a tendency for positive potentials supplied to the grid to be damped out.

Preventing Grid Damping.

In order to prevent the effect of the establishment of a grid current, it is desirable to connect one or two grid cells in the grid circuit. In Figure 7 we have an arrangement exactly similar to Figure 5 except that a battery B_3 of 3 volts is included in the grid circuit in such a direction as to make the grid negative.

We would be now working at some such point as B on the characteristic curve A B C D E F of Figure 6. When amplifying weak signals, such a point would be quite suitable; although, generally speaking, a little too close to the lower bend H.

Figure 8 shows the effect on the anode current variations of the two circuits in Figure 5 and Figure 7 respectively. At the top of Figure 8 we have an original complete alternation. To the left we see this alternation applied to the grid of the valve, which is maintained at a negative potential of 3 volts.

It will be seen that the positive and

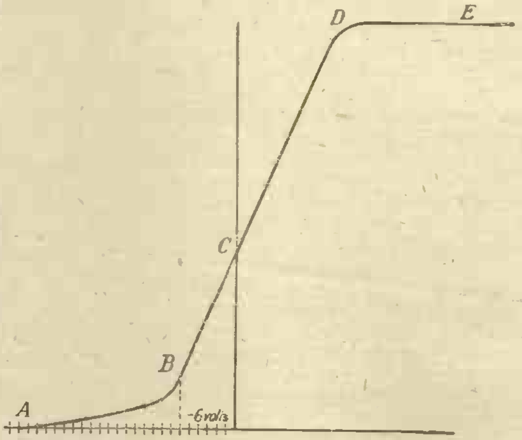


Fig. 10. Showing the production of distortion by working at the lower bend of the characteristic.

negative half-cycles remain equal, as the grid now does not become positive and no grid current flows. The result of this is, as shown lower down, the anode current variations are amplified reproductions of the original alternations.

The right-hand side of Figure 8 shows what happens when the original alternation is applied to a circuit of the Figure 5 type in which grid damping may take place. The E.M.F.'s on the grid (normally at zero volts) are now no longer undistorted. The positive half-cycle will be smaller than the negative half-cycle owing to the fact that it is damped out, due to the production of a grid current. This difference between the positive and negative half-cycle is reproduced on an even larger scale in the anode circuit. Distortion is reproduced in the anode circuit, and signal strength is also decreased, as this strength depends upon the sum of the positive and negative half-cycles.

The importance of having a negative potential on the grid of an amplifying

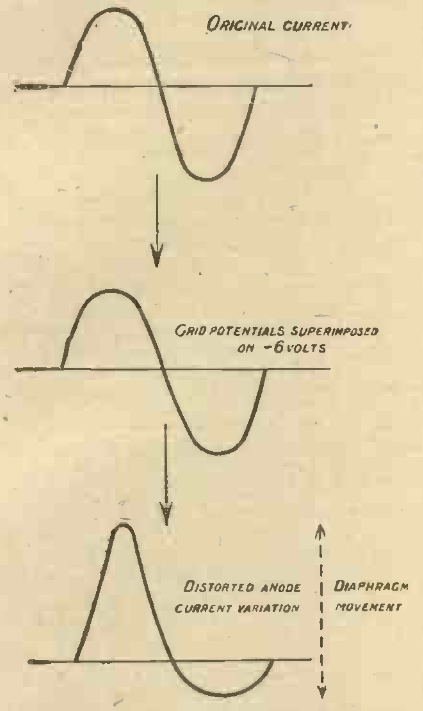


Fig. 11. The effect upon the anode current of an unsuitable grid voltage.

valve is not appreciated when the valve in question is only amplifying weak currents, as these do not produce an appreciable grid current. The greater the voltages applied to the grid, however, the more noticeable does the effect become; and when power amplification is being carried out, it becomes imperative to have a battery in the grid circuit.

An Alternative to the Grid Cells.

The provision of grid cells is a great inconvenience, and if the voltages to be amplified are not more than about 3 volts, the method shown in Figure 9 may be adopted.

It will be seen that the filament rheostat R, instead of being connected in the positive lead to the filament, is joined between one leg of the filament and the negative terminal of the 6 volt accumulator B_1. We can consider the current from the 6 volt accumulator as being an electron current flowing from the negative terminal, through the used portion of R, through the filament and back to the positive terminal.

Since electrons are flowing through the resistance from the point Y to the point X, the point Y is negative in respect to X. If we assume that the used portion of the resistance R has a value of 5 ohms, and the current through the filament is 0.6 ampere, we will see that the point Y is 3 volts negative with respect to the point X, and therefore the grid G, which is connected through T_2 to Y, will be at − 3 volts with respect to the negative side of the filament. By this stratagem therefore, we have given the grid a normal operating voltage of − 3 volts without having to use an inconvenient grid battery.

The arrangement of Figure 9 is recommended for all low power amplifiers; especially those using one or two valves. It is to be noted that when dealing with grid or anode potentials we always treat the negative side of the filament as being at zero potential, all other potentials being treated with reference to this point.

Anode Current Distortion.

Having established the fact that a negative potential on the grids of amplifying valves is desirable, it is now proposed to consider the effect of these negative potentials in other directions.

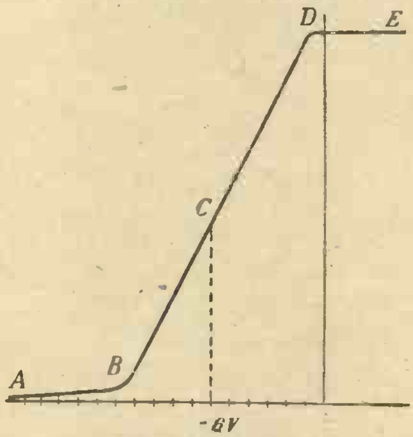


Fig. 12. Showing the adjustment of the grid potential to prevent distortion.

In the first place, the application of a negative potential to the grid of a three-electrode valve means that the normal current flowing through the valve is reduced. For example, the saturation current through the valve might be 3 milliamperes but the anode current with the grid at, say, − 6 volts might be only half a milliampere. If strong currents were applied to the valve to be amplified, the positive half-cycle might be fully reproduced and might cause the anode current to rise from half a milliampere to, say, 2½ milliamperes, but the negative half-cycle, on the other hand, could not possibly reduce the anode current to less than zero. The result would be that while the positive half-cycles were fully reproduced, the negative ones would be distorted and not fully amplified.

We can explain this effect more conveniently by referring to the characteristic curve of Figure 6.

In this curve if the normal operating point is B (corresponding to − 3 volts) it is quite clear that if fairly large voltages are applied to the grid, the representative point will travel round the bend H and the decreases of anode current, due to negative half-cycles, will not be as great or as faithfully reproduced as the positive half-cycles.

Figure 10 shows a characteristic curve A B C D E with the operating point at, say − 6 volts. As shown in Figure 10, we are now operating at the lower bend where obviously distortion must occur, and yet, if we were desiring to amplify currents of 6 volt amplitude it would be necessary to use − 6 volts; on the grid. The question therefore is: how can we prevent distortion and insufficient amplification while still keeping a negative potential on the grid?

The solution is in the adjustment of the anode voltage and filament current; but, before dealing with this, let us consider another graphical demonstration of the ill effects resulting from the application of a negative potential to the grid without a corresponding change in anode voltage.

Figure 11 shows in the top line the original currents; in the second line the grid potentials superimposed on the − 6 volts on the grid, while the third line shows the anode current variations.

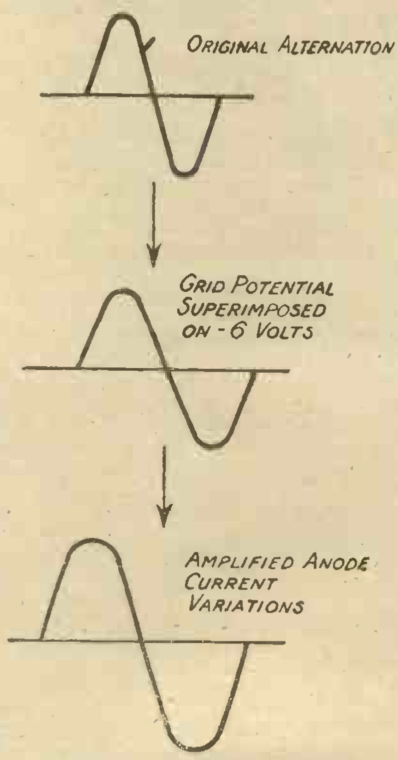


Fig. 13. Amplification without distortion.

It will be seen that the second line shows no distortion due to grid currents, this being, of course, because there is a normal *bias* of − 6 volts on the grid. Although there is no distortion due to grid currents, there is a very bad distortion due to operating the valve near the lower bend on its characteristic curve. The third line shows that while the positive half-cycle is fully developed and perfectly

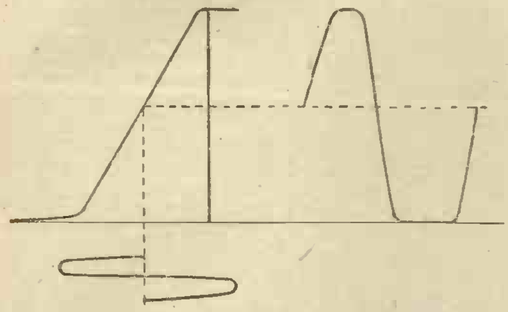


Fig. 14. Illustrating the flattening of the peaks of the anode variations.

reproduced, the negative half-cycle is distorted and insufficiently amplified.

A similar, but reverse, effect is obtained if we operate the valve too near the saturation bend on the characteristic. In this case it is the positive half-cycles that are insufficiently amplified and are distorted.

The Solution.

We considered above the case where the normal current through the valve was only ½ ampere, while the saturation value or the total electron current emitted from the filament was 3 milliamperes.

Under these conditions the negative half-cycles cannot be fully amplified. The valve, when acting as an amplifier, should pass a current between filament and anode having a value equal to approximately half the total current which it is possible to obtain at a given filament adjustment. Thus if the total electron current which it is possible to obtain through a

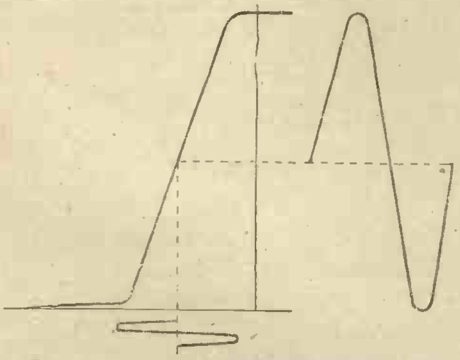


Fig. 15. Distortionless amplification obtained from a longer characteristic curve than that of Fig. 14.

valve with the filament at a certain brightness is 3 milliamperes, then the grid potential and anode voltage should be so adjusted that the current through the valve is 1½ milliamperes. We can obtain this value either by a positive potential on the grid and a low anode voltage or a negative potential on the grid and a high anode voltage; this is only what one would expect. If we place – 6 volts on the grid, the normal current flowing between filament and anode would be cut down and, to bring it back to its normal desired value of 1½ milliamperes, it will be necessary to adjust the anode voltage to a higher value so as to counterbalance the repelling effect of the grid.

Stated in a few words, when it is found necessary to give the grid a negative potential to prevent the establishment of grid damping, it is necessary to readjust matters by increasing the anode voltage.

To many it will be a simpler matter to explain why this is necessary by

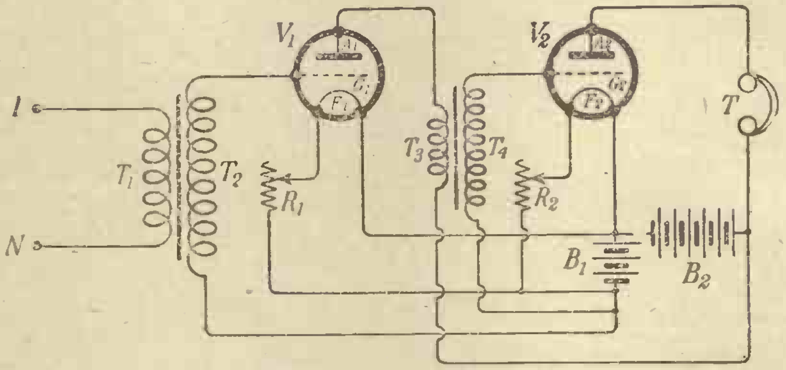


Fig. 16. A simple two-valve low-frequency amplifier.

the aid of characteristic curves. If a series of characteristic curves are drawn for different anode voltages, it will be found that by increasing the anode voltage the curve is moved to the left. The curve, of course, starts more to the left because if the anode voltage is increased a higher negative potential on the grid is necessary to bring the anode current to zero, the starting point of the curve.

The trouble about the curves in Figure 10 is that although – 6 volts may be necessary on the grid, it is impossible to work the valve under the conditions shown in Figure 10 owing to the fact that we are operating the valve at the lower bend of its characteristic curve. To bring the operating point to about the middle point of the curve, which is the best position, it is necessary to move the characteristic curve bodily to the left, and we do this by suitably increasing the anode voltage. If this is done, we get a characteristic curve similar to that shown in Figure 12. A potential of – 6 volts on the grid now brings us to the point C, half-way along the curve between B and D. This is the best point for amplifying; not only will there now be no distortion due to working too near a bend in the characteristic curve, but there will be no grid damping effect, as the potential on the grid is – 6 volts.

Figure 13 shows how the amplification this time is carried out without any distortion or incompleteness.

The Length of the Characteristic Curve.

Although we may be working the valve under the ideal conditions shown in Figure 12, yet this does not necessarily mean that there will be no distortion when receiving strong signals. There will certainly be none when the amplitude of the currents to be amplified is not greater than 6 volts in the case of the Figure 12 curve If, however, the applied voltages ar greater than this, the representative point will travel round both the bend D and the bend B in the characteristic curve. The result will be that there will be distortion owing to the flattening of the half-cycles, and the full degree of amplification will not be obtained.

Figure 14 shows in a very clear manner how, although the grid potentials may be of sine wave form, yet the anode current variations have flattened peaks.

There is a very distinct limit to the amplification which may be obtained with a single valve. The maximum amplification is obtained when the grid potentials vary the anode current between the lower bend and the saturation value. Obviously, the incoming potentials cannot vary the anode current appreciably more than this. If we desire a high power output, we must make the possible current variation larger. This is done by increasing the anode voltage and the filament current. The steady anode current, under normal conditions might, instead of being 1½ milliamperes, be 10 milliamperes, the maximum variation being between zero and 20 milliamperes. It is not, of course, desirable to overload a valve (in other words, cause the grid potentials to vary the anode current,

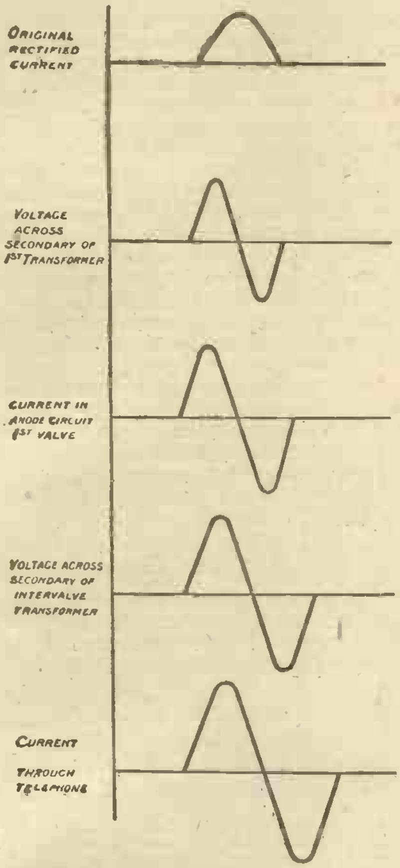


Fig. 17. *Illustrating the actions taking place in a two-valve L.F. amplifier.*

at least between zero and the maximum value) as otherwise distortion occurs at the bottom and upper bends of the characteristic curve.

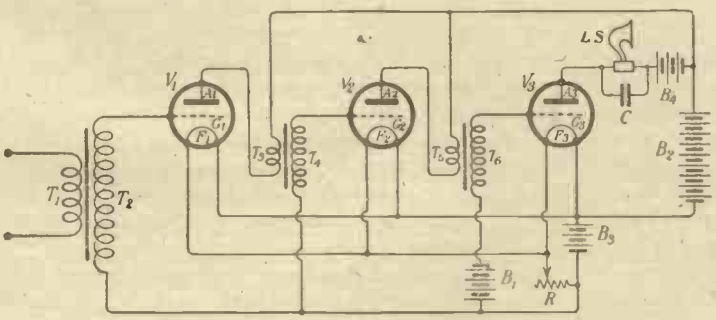


Fig. 18. *A three-valve amplifier with an additional battery for the third valve.*

Much distortion in wireless receivers using loud-speakers is due to overloading the valve, which causes the distortion shown in Figure 14.

Put in another way, we have to increase the length of the characteristic curve, so that the representative point may travel up and down without having to pass round either bend.

Figure 15 shows a new characteristic curve obtained by increasing both the filament current and the anode voltage. In many cases, if much power is to be obtained, a larger valve will have to be used. It will be seen that if we apply E.M.F.'s of large amplitude to a valve operating under the Figure 15 conditions, there will be no distortion, whereas, if the same E.M.F.'s were applied to a valve operating under the Figure 14 conditions, much distortion and inadequate amplification would occur.

It will be seen from Figure 15 that, when larger anode voltages and filament currents are used, a corresponding increase in the negative grid bias will be necessary, and it is no longer possible to use the device of Figure 9. This latter may be good enough in the case of one or two-valve low frequency amplifiers, but, where a real power amplifier is used, a separate grid battery has to be provided. This grid battery does not, to all intents and purposes, run down, as the grid, being negative, does not allow an electron current to flow round the grid circuit.

Two-Valve Amplifiers.

Coming to practical circuits for amplification, Figure 16 shows a simple two-valve amplifier which will be found perfectly successful.

Figure 17 shows the different stages of amplification. In the first place, the currents applied to the terminals I N have their voltage stepped-up by the step-up input transformer T_1 T_2; the stepped-up voltages applied to the grid of the first valve V_1 cause amplified currents to flow through the primary T_3 of the intervalve step-up transformer T_3 T_4. The voltages of the currents through T_3 are now stepped-up and are applied by the secondary T_4 across the grid and filament of the second valve V_2. The amplified currents in the anode circuit of this valve now operate the telephone receivers.

Power Amplifiers.

Frequently, when operating loud-speakers, it is desirable to use three stages of low-frequency amplification, and Figure 18 shows such a circuit. In Figure 18, a battery B_3, having an appropriate value, is connected in the grid circuit of the third valve V_3 in the anode circuit of which is the loud-speaker LS. The actual value of the battery B_1 is a matter of experiment. It will also be seen that in Figure 18 we have an additional battery B_4 in the

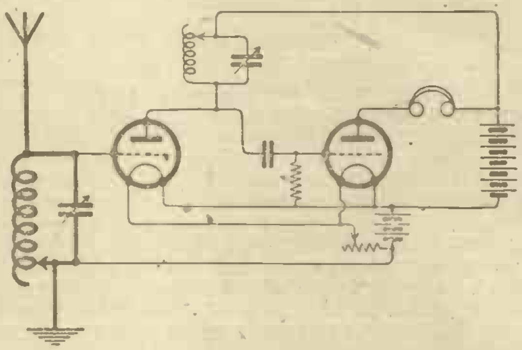


Fig. 19. *A simple two-valve receiver.*

anode circuit of the last valve, but not in the anode circuit of the first two valves. The object of the battery B is to increase the length of the characteristic curve as explained above, the filament current being simultaneously increased.

A fairly reliable rule is to make the grid bias battery have an E.M.F. of about $\frac{1}{15}$th of the anode voltage. It is, however, a matter entirely of experiment, as different valves have diffefent amplification factors.

In Figure 18 a condenser is connected across the loud-speaker terminals. This condenser may have a value of from 0.002 to 0.02 μF, or even higher. It will be found that a condenser across the loud-speaker terminals will make the tone more mellow in most cases.

Miscellaneous Notes.

There are several remarks which might be made in connection with low-frequency amplification which would only apply to special cases. It is proposed to give only a few of these here.

Some low-frequency amplifiers, due to improper design of the transformers, tend to oscillate of their own accord. To lessen this tendency it may be found necessary to connect the grids through their transformer windings to the negative side of their filaments. By doing this, a certain amount of damping is introduced which, while harmful in other directions, helps to stop self-oscillation.

In some cases, it is found an advantage to connect 0.002 μF condensers across the primaries of all the transformers. Sometimes, to prevent self-oscillation, all the cores may be joined together and connected either to earth or to the positive terminal of the high-tension battery. All these palliatives should not be necessary in the case of good intervalve transformers.

Another recommendation is to try connecting 100,000 ohms resistances across one or more of the secondaries of the transformers. This will often improve the tone of the speech when the latter is being received by wireless.

If there is a tendency to self-oscillation, the first thing to do is to try reversing the connections to one of the transformer windings. By doing this, any natural reaction in the apparatus will be counteracted.

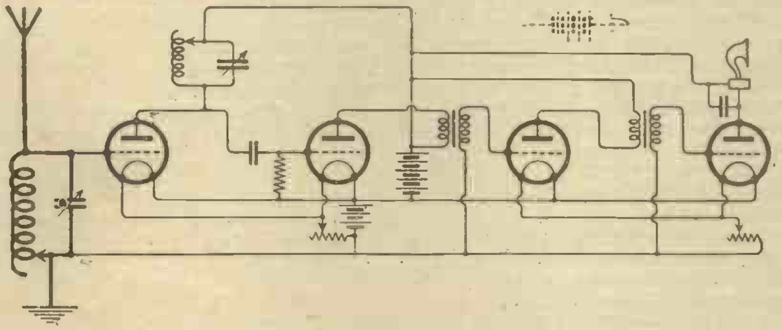


Fig. 20. The circuit of Fig. 19 with two L.F. valves added.

Adding Low-Frequency Amplifying Valves.

Many beginners who, having constructed a valve set, desire to add one or more low-frequency amplifying valves, are often at a loss to know exactly what to do.

The rules are very simple :—In the first place, it is important always to connect the high-tension battery next to the filament, the negative terminal of the high-tension being connected to the positive of the low-tension. This should be done, not only on the receiving circuit, but on the amplifier circuit.

The next thing to do is to connect the primary of the input transformer of the amplifier to the terminals to which the telephones would have been connected in the original circuit. The same filament accumulator and high-tension battery used on the existing receiver may also be used on the new complete extended circuit.

Figure 19 shows a simple receiver to which, we will suppose, it is desired to add two low-frequency valves so that a loud-speaker may be employed. We will suppose that the Figure 16 low frequency amplifier circuit has been decided upon. All we have to do is to use the existing filament accumulator and high-tension battery and to connect the primary of the input transformer T_1 T_2 in the place of the telephones of the Figure 19 circuit.

The new arrangement is now shown in Figure 20. A condenser has been shown connected across the loud-speaker, which is used in place of the 'phones illustrated in Figure 16.

Conclusion.

It is hoped that the above general remarks will assist experimenters to obtain the best results from their low-frequency amplifying equipment.

:: :: An Important Announcement. :: ::

It is with great pleasure that we are able to announce that Mr. Percy W. Harris, a former Editor of the *Wireless World*, and more recently editor of *Conquest*, will join the staff of MODERN WIRELESS and WIRELESS WEEKLY, as from the 1st of June.

Mr. Harris is the author of "A.B.C. of Wireless," "Broadcast Receivers and How to Use Them," "Practical Wireless Sets for All," "Crystal Receivers for Broadcast Reception," and other works. His name has become a household word amongst all experimenters, and his services will henceforth be at the disposal of the 106,000 readers of MODERN WIRELESS AND WIRELESS WEEKLY.

As publishers, we have done everything possible to strengthen our organisation. It is only because we are the largest publishing house devoted solely to wireless interests that we have been able to gather together the principal writers in the country. We want our readers to realise that here, at Devereux Court, all the energy, skill, and experience of a strong editorial staff are being placed at their disposal. Our whole efforts are directed to producing thoroughly reliable, up-to-date and instructive wireless information. The reputation of the Radio Press, Limited, and also of its individual members, depends solely on our wireless publications.

The boom in wireless has tempted general publishers, without any experience whatsoever of wireless, to launch out into the new field. It is our intention, for the benefit of new readers, to point out periodically the advantages of buying publications which bear the hall-mark of authority. Only by us having a strong editorial staff can readers feel that confidence which is so essential. Perhaps a little more has to be paid for the privilege, but it is well worth while.

A Plea for the Standardisation of Radio Terms.

To the Editor of MODERN WIRELESS.

SIR,—The present seems an opportune time to bring before the wireless members of the public a plea for the standardisation of the terms of the subject in which they are interested.

With the advent of broadcasting and the many thousands of listeners-in, there will surely be a large number of them who will turn their attention to the technical side of their pastime.

It is in their interest as well as in that of the older experimenters that this plea is brought forward.

There is a multiplicity of terms in wireless which all mean the same thing, and now appears to be the time to plead for a reform in this direction ; to have one term and one only for each item, whether it be the name of an instrument or that of some physical phenomenon.

We have recently had brought before us the first movement in this reform ; this movement being the change of name of the Wireless Society of London to the Radio Society of Great Britain. This change is significant, and if one may be permitted to digress for a moment from the chief object of this letter, the two changes in the name should be emphasised. These changes are from " Wireless " to " Radio " and from " London " to " Great Britain." To take the latter first, this indicates that the Society felt the need of following the progress of the times by making the Society a universal one. This is further emphasised by the creation of a new class of membership, that of Associates, members who are interested in wireless from the broadcasting point of view.

The change from " Wireless " to " Radio " is also important. The word " wireless " (as was pointed out in a daily paper last year) has a negative sound (in the same way as " horseless " carriages, as motors were originally called). The Society, in order to keep abreast of the times, felt that the name should be changed to one not having a negative implication. They decided on the name " Radio " (as was suggested by the present writer in the daily paper referred to above), and it is here suggested that " wireless " be allowed to fall into oblivion, " radio " taking its place entirely.

It is not possible, with the limited space at the disposal of the writer, to deal at length with the many cases of several names being used for the same thing, but let it suffice to cite the following :—

Radio frequency, high frequency.
Audio frequency, low frequency.
Thermionic tube, valve, vacuum tube, thermionic valve.
Atmospherics, statics, X's.
Tuning coil, inductance.
Rectifier, detector.
Reaction, reactance.
Aerial, antenna.
Secondary battery, accumulator, storage battery.
Anode, plate, sheath.
Amplify, magnify.

I would suggest that modern radio experimenters should decide from such a list as the above to use only one name for each item, in order to avoid the present multiplicity of terms.

I would also suggest that the first name in each group in the above list is the most suitable and should therefore be used. Some of my reasons for this are—

There are some high and low frequencies with which the radio experimenter is never troubled ; therefore I suggest radio and audio frequency.

A crystal acts as a valve ; therefore I suggest thermionic tube in order to distinguish between ordinary rectifiers and thermionic ones.

" Static " implies at rest, but atmospherics never are.

Inductances are used for other purposes than for tuning only.

Crystals and thermionic tubes do not " detect " radio signals. The signals are there and do not require " detection." What they want is to be " rectified."

" Reactance " is usually associated with " capacity" in the form of radio-frequency coupling. " Reaction " should be used to describe the " boosting-up " process.

" Aerial " is the accepted English term, and is easier to say than " antenna."

A secondary battery neither " accumulates " nor " stores " electricity.

The anode of a thermionic tube is not the only " plate." in a radio set.

" Amplify " is usually regarded to refer to the process which goes on before rectification, and " magnify " that which goes on after rectification.

This letter will have achieved its object if it has succeeded in pointing out the evils of present-day radio nomenclature, and those which will accrue from the modern interest in radio if newcomers to the science coin names for objects which have already many more names than is at all necessary.

The opinions of readers on this subject would be very interesting.

RAYMUND W. EDWARDS.

Tamworth, Staffs.

A GLOSSARY OF TECHNICAL TERMS USED IN WIRELESS TELEGRAPY AND TELEPHONY

(*continued from p.* 254.)

Damping

See Decrement

Decrement

A measure of the rate of decrease of damped oscillations. Defined as the ratio between the amplitude of one oscillation and that of the next, or as the log of this ratio.

Detector

A device to convert the energy in oscillating currents into some form perceptible to our senses. Particularly used in connection with the very weak currents forming received signals. All detectors in common use are rectifiers. Suitable types are :—

Detector, Crystal

Utilises the fact that contacts between certain crystalline substances and metals or one another have rectifying properties. Favourite substances are : Bornite, Carborundum, Chalcopyrites, Copper Pyrites, Galena, Graphite, Molybdenite, Silicon, Tellurium, Zincite, q.v. Very sensitive, but in some cases hard to adjust, though other types are easy. The best types give excellent results. Sometimes need readjustment after powerful atmospherics.

Detector, Electrolytic

A detector now seldom used, depending on the polarisation of a minute electrode in an acid solution. Sensitive, but easily upset by strong signals or atmospherics. Potentiometer needed.

Detector, Magnetic

Now obsolete. Depends on demagnetising action of oscillations on iron. Reliable but insensitive; needs circuit of a different type to those suited to most detectors.

Detector, Valve (Fleming)

Depends on rectifying effect of bend in plate current curve.

Detector, Valve (3-electrode)

Either as above or by accumulation of charge on grid condenser. See special handbooks on the valve. As a pure rectifying detector without retroaction the valve is not greatly superior to the crystal.

Dielectric

The name applied to the insulator between plates in a condenser. Sometimes extended to cover any insulator subjected to electric stress. Important properties are :—

Dielectric Constant, or Specific Inductive Capacity

The property which gives similar condensers different capacities according to the dielectric used.

Dielectric Hysteresis

A source of loss due to the fact that some of the energy stored in a dielectric when a voltage is applied to it is not given out again.

Dielectric Strength

The voltage which a dielectric of a given thickness will stand without breakdown. Not to be confused with surface or solid insulation resistance. (See Resistance.)

Dynatron

A special type of valve having a negative slope of characteristic, so that it will produce oscillations without retroaction.

Earth

In wireless, a short name for the earth connection used in most cases. Often used by analogy to indicate the connection to a counterpoise, even if this is insulated from earth.

Earthing Switch

Placed between aerial and earth, to connect them directly together when the apparatus is out of use.

Electromotive Force (E.M.F.) or Voltage
The electrical analogue of pressure. Measured in volts.

Electron
The ultimate unit of electricity, usually believed to be also a fundamental unit of matter. Apparently the only "material" object capable of moving at speeds approaching the velocity of light. The foundation-stone of all valve theory. Believed to have a diameter of $\frac{2}{10^{12}}$ mass of $\frac{3}{10^{29}}$ oz., and electric charge of $\frac{1 \cdot 5}{10^{19}}$ Coulomb.

Endodyne
See Heterodyne.

Ether
Originally postulated in support of the wave theory of light, in reply to the question "What is it that undulates?"
In the light of later philosophy, it would appear that it is not necessary to demand that there must be "something that undulates," and it is possible that the whole supposition of an ether will be dropped.

Farad
Unit of capacity.

Field
That part of space which comes under any particular influence which is being considered. In wireless work fields are either magnetic, in the neighbourhood of any conductor carrying a current; or electric, in the neighbourhood of any part at a potential differing from that of earth or neighbouring parts.

Filament
In wireless, used for the cathode of a valve, owing to its construction, which is that of the filament of an electric lamp.

Filter
A circuit specially arranged to cut out undesired signals or atmospherics while admitting those to which it is tuned. The ordinary coupled circuits, or course, form a filter, strictly speaking, but the term is mainly applied to special circuits, usually only employed in large stations.

Filter, Note
A filter circuit designed to operate at audio frequencies.

Frequency
In alternating current work of all kinds, the number of "cycles" or double reversals per second. Generally, the number occurring per second of any regularly repeated event.

Frequency, Audio
A group of frequencies which in air waves give, if regular, musical notes. Roughly understood in wireless work to range from about 200 to 5,000 or thereabouts.

Frequency, Beat
See Heterodyne.

Frequency, Fundamental
Used in referring to circuits such as aerials, which have several "natural" frequencies. In this case the lowest frequency (longest wave-length) is the fundamental, the others being Harmonics. (q.v.)

Frequency, Group
In damped wave work, the number of wave trains per second, as distinct from the frequency of the actual wave itself. Usually in the "Audio" Group.

Frequency, High
Naturally, a comparative term. Used in Wireless to define radio frequencies of 10,000 to 1,000,000 or more in contrast with audio frequencies.

Frequency, Low
Used in a similar loose manner to "High" Frequency, but, of course, with contrary meaning.

Frequency, Natural, of a circuit
That to which the circuit is tuned.

Frequency, Radio
Frequencies of the order actually radiated in wireless work. Connected by a simple formula with wave-length. Frequencies in use range from 10,000,000 (30 metres) to 10,000 (30,000 m.).

Galena
A native lead sulphide (PbS) used as a detector in combination with graphite. Sensitive, but irregular and easily upset. Also used with a copper wire. Very light contact. Appearance: Greasy black or grey metallic lustre.

(To be continued.)

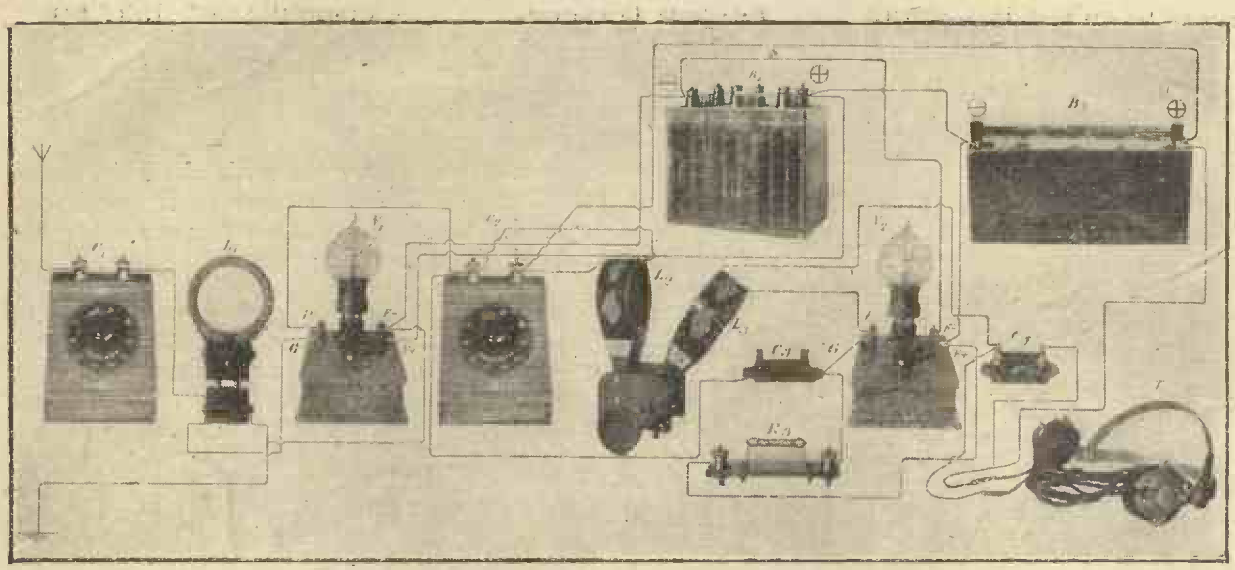


Fig. 1. Showing a suitable arrangement of the parts, and the method of connecting them up. The parts may be indentified by comparison of their lettering (which is repeated below for the sake of clearness) with figure 2.

C_1 L_1 V_1 C_2 L_2 L_3 B_1 C_3 R_3 V_2 C_4 B_2 T

A BROADCAST SET EMPLOYING REACTION.

By G. P. KENDALL, B.Sc., Staff Editor.

This article has been specially written in response to very numerous requests for instructions for assembling a simple broadcast receiver possessing variable reaction.

IT is proposed in this contribution to describe a very simple type of two-valve receiver employing reaction in such a way that there is not much risk of radiation. Instructions will be given for the assembly of the complete set from ready-made components, and also for the construction of a number of the parts.

This set is fairly simple to operate, and is capable of giving very good results; upon an average out-door aerial it should receive a number of the broadcasting stations, and with the addition of a third valve as a low-frequency amplifier should operate a loud-speaker up to a distance of about 50 miles.

Circuit.

A diagram of the circuit of the receiver is given in Fig. 2, while Fig. 1 shows the actual connections of the components.

As will be seen, the first valve V_1 functions as a high-frequency amplifier of the oscillations in the aerial circuit and reproduces them upon a larger scale in the circuit L. C_2, across which the rectifying valve V_2 is connected.

Reaction is arranged between the plate circuit of the rectifying valve and the "tuned anode" circuit by virtue of the coupling between L_3 and L_2. This form of reaction does not lead to serious re-radiation if used with reasonable care, and though it has not all the advantages of reaction upon the aerial circuit, it gives a good deal of amplification, and increases the sharpness of tuning to a marked degree; it is possible with this set to tune out a local station and receive a more distant one with little interference.

Aerial Tuning Arrangements.

The variable condenser C_1 should preferably have a capacity of ·001 μF, although one of ·0005 μF can be used at a slight sacrifice of convenience. This condenser may either be bought or may be made up very cheaply from a set of parts according to the directions given upon page 244 of MODERN WIRELESS for May.

The coil L_1 may be either a home-made one, or a purchased duo-lateral or other plug-in coil. Its size must depend to some extent upon the dimensions of the aerial, but for one of average height and length a No. 50 will be correct.

If it is desired to use a home-made coil, a set of three basket coils may be wound with No. 24 d.c.c. wire having 35, 50 and 60 turns each. These coils should cover the broadcast waves upon any size of aerial, and should be mounted so as to be interchangeable in circuit. This may conveniently be done by mounting them in the manner described in the article entitled "A Simple Tuner" upon page 269 of the May number of MODERN WIRELESS, and making use of one of the sockets described therein.

Perhaps the most easily made tuning coil is one with tappings to studs of a switch: the coil may consist of a single layer of No. 22 d.c.c. wire, 4 inches long, upon a 3-inch diameter cardboard tube. Six roughly equal tappings will suffice. The coil should be shellacked and well baked, after which it may be enclosed in a wooden box upon whose lid the rotary switch is mounted (for constructional details of such a box and switch see page 216 of the April number).

Valve Panels.

Any form of panel which possesses the necessary valve socket, filament resistance and terminals may be used, but great care should be taken not to buy by mistake a "valve detector panel," which would be found to contain also a grid condenser and leak.

Home-made panels can, of course, be used; such as those described upon page 217 of the April number.

Grid Condenser.

This component should be purchased if the best results are desired, and it is worth while to obtain one of reliable make. Its capacity should be the usual ·0003 μF.

Grid Leak.

This component, also, is better purchased, since its value is important (2 megohms). It may desirably be mounted between two clips upon a strip of ebonite 3 inches long by 1½ inch wide, and provided with two terminals, as shown in Fig. 3. The necessary brass clips to hold the leak may be obtained from most dealers in accessories.

Plate Circuit Tuning and Reaction.

The condenser C_2 should have a capactiy of ·0005 μF, and can be home-made or purchased complete, as preferred. The coils L_2 and L_3 may be Nos. 50 and 75 duo-lateral coils respectively, mounted in a coil holder as shown to permit of variations of the coupling between them.

Instead of two purchased coils, a pair of basket coils having 70 and 80 turns may be wound with No. 30 d.c.c. wire and arranged flat upon the table, variations of coupling being obtained by sliding one over the other.

Telephone Condenser.

This component may be purchased so cheaply that its construction is scarcely worth while. Its capacity may suitably be ·002 μF.

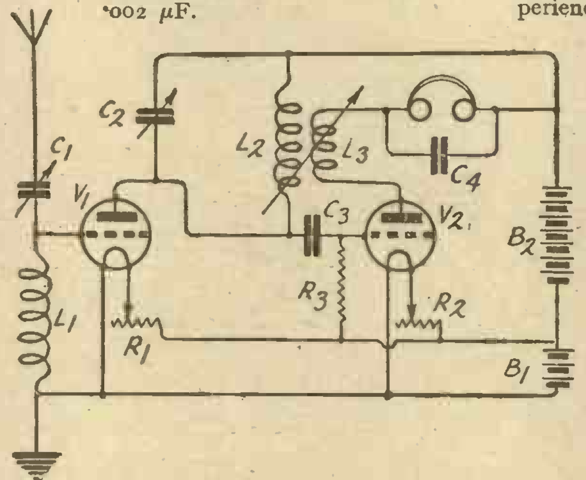


Fig. 2. The circuit of the receiver.

Batteries.

With all sets employing reaction it is important that the battery supply should be as steady as possible, in order that the critical adjustments may not be upset by changes in voltage during working.

The high-tension battery, therefore, should be of good quality, and of a voltage suited to the valves in use; 45 volts may be used with Ora valves, whereas better results will probably be obtained with 60 volts if R valves are employed.

The accumulator should also be of good make, and must be kept in the best of condition by careful treatment. A suitable size for this battery is 6 volts 50 ampere-hours, though one of a larger size can be used if desired. For sets of this type which require a very steady and smooth discharge from the accumulator the "block" type of battery seems very suitable.

Operation of the Set.

A little difficulty may be experienced at first in tuning-in a given station, since it is necessary to get both the tuned circuits L_1 C_1 and L_2 C_2 adjusted to the desired wave-length before the signals can be heard properly.

When the first attempt is made turn up the valve filaments fairly brightly, place the coils L_2 and L_3 at an angle of about 45 degs. (or slide them right apart if baskets are used) and proceed to vary the two condensers until sounds are heard. The best way to do this is generally to vary one of them slowly and the other rapidly from side to side. If no signals are picked up, try a different sized coil in the aerial circuit.

When the desired signals have been tuned-in bring the reaction coil L_3 up towards L_2, making slight readjustments of C_2 as you do so. The sounds should grow louder and louder, and finally become distorted and mixed with howling noises when the set commences to oscillate; stop just short of this point to obtain the best reception. If bringing the coils together does not produce an increase of signal strength, reverse the connections of the reaction coil L_3.

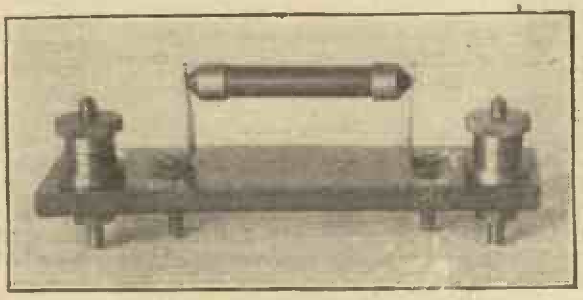
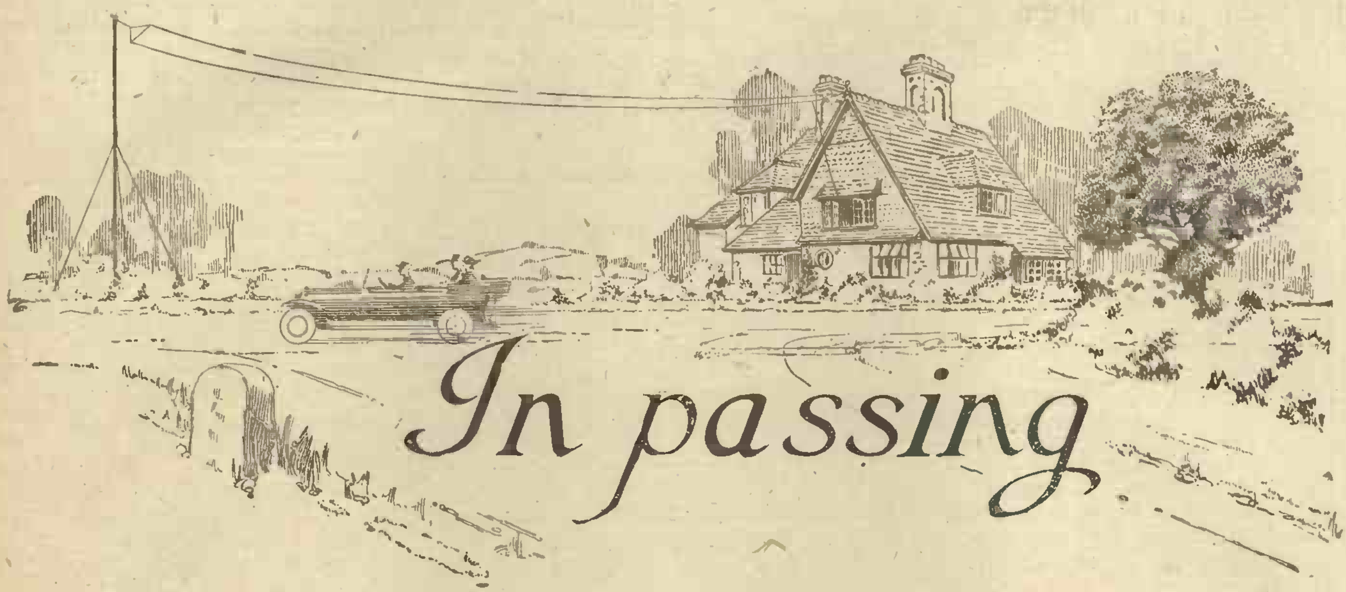


Fig. 3. Showing a suitable method of mounting the grid leak.

Addition of Low-Frequency Valves.

If it is desired to operate a loud-speaker from the set one or two low-frequency amplifying valves must be added, according to the distance of the nearest broadcasting station. Up to about 50 miles three valves should suffice when used with an out-door aerial, but at greater distances another low-frequency stage will be necessary.

The method of adding low-frequency valves to a set of similar type was fully explained in MODERN WIRELESS for May in the article upon page 265.



In passing

Infinite Variety.

WIRELESS, like marriage, horse - racing, shove - ha'-penny, company promoting, eating cheap oysters and other pastimes of the age, owes its fascination largely to its glorious uncertainty. You never quite know what is going to happen. You have, for example, inveigled an enthusiastic, skilled and highly critical friend into your den so that you may let him hear what really can be done with a home-made set; there *may*, upon your switching on, be a flow of clear, delightful sound from the loud - speaker. What, however, is far more likely to occur is a flow of naughty words from you, the loud-speaker choosing to enact for the time its alternative *rôle* of low-mumbler, or even remaining ingloriously mute. Directly the said friend has taken his departure the thing will begin to work as it has never worked before, filling the house with the sweetest strains. You will report this on the morrow and will discover what an utterly loathsome thing a cynical smile can be.

It is said that amateur photography has wrecked more friendships since its inception than has any other cause. This is possibly true, for photography has had a long run. It is many years since our grandfathers set this ball rolling by producing the caricatures of one another's bewhiskered features that now provoke unseemly mirth when we turn over the pages of ancient albums. But wireless bids fair to outdo photography as a separator of lifelong friends. When a man enters your house for a demonstration you feel that he is the best fellow in the world. Five minutes later when he is trying to be funny as you conduct your weary search for the source of trouble your esteem begins to ebb away. As you close the door upon him you know that no more utterly despicable creature walks upon two legs. And when a few nights later you go to his place prepared to have your revenge and are baulked thereof by the perfect working (for the only time in its career) of his set, you long for the good old days when such scurvy varlets were taught good manners by the efficacious and extremely satisfying process of cleaving them to the brisket.

Seeing Life.

Again, if you take a medley of valves, coils, condensers and transformers and wire them together in a novel fashion you may find that you have invented a super-super circuit which gives to a lone valve the voice of six. Or by mistaking IP for OS in a moment of aberration you may discover that tungsten burns in a vacuum with a very pretty purple light. Calculations, however, will show that this discovery is not of commercial value, since the illumination, though most effective, and hailed with enthusiasm by any of the younger members of your family who are present, is rather on the costly side. Still, you may console yourself by reflecting that, if only for a brief period, you have been amusing yourself at the rate of fifteen shillings a second, which represents an annual outlay that would make even Rockefeller turn pale. Surely this is seeing life.

A Joyous Demonstration.

One of the most joyous wireless surprises that I have ever seen occurred not many days ago in the showrooms of a great emporium, into which I had wandered to escape from the rain. The demonstrator was a youth beautiful to behold, and with an easy languid manner that made those who were being shown something of the mysteries of wireless feel that in him at any rate familiarity with its working had bred something akin to contempt. One dear old lady explained that she was very nervous about having all that electricity lurking in her drawing-room like a roaring lion seeking whom he may devour. The youth smiled indulgently and explained in a patronising and rather bored way that such a thing as a shock was an utter impossibility. "You see," he said, "I can touch any of the terminals and nothing happens." Two delicate fingers rested gently now on this pair and now on that. Only one pair remained untried. The fingers hovered over them, descended, touched. Adonis leapt like a startled gazelle, biting back a wicked word . . . You have probably discovered that quite a useful shock can be obtained from the output terminals of the note-magnifier. In this case a power valve was working the loud-speaker!

A Valve Tip.

Has it ever occurred to you that no two valves, even if they are of the same make and pattern, can ever be exactly alike? Each, as a matter of fact, differs slightly, it may be very slightly indeed, from every other. It may happen that the distance between plate and grid is a trifle less in one than in another, or that the filament is a wee fraction of an inch longer. One valve may be dead hard, whilst another contains a small residuum of air. And there are other tiny differences that must always be present no matter how careful or how highly standardised is the system of manufacture.

The moral of all this is that we should not be content to stick any valve into any holder of the set and leave things light-heartedly at that. Some valves will work anywhere with apparently equally good results. But usually if one buys a series of five for the set, one of them will be found to give results as a rectifier that are just a little better than the others can produce. Find the best rectifier first—it is the most important valve in the set—then test the others to see which of them do best as high-frequency amplifiers and which on the "note-mag." side. There is a great difference sometimes here. If the leads of any valve are placed closer together than usual in the "pinch" it will not as a rule do well on the H.F. part of the set.

Watch H.F. Valves.

The reason is this. There is capacity between all current-carrying leads. It may be a very tiny capacity indeed, but in the valve its presence will have results, especially if it gives rise to a capacity coupling between grid and plate circuits. The very rapidly oscillating currents with which the H.F. valves have to deal pass through any sort of condenser with consummate ease. Hence if the valve provides a path of this kind for them owing to the crowding of leads in the pinch, impulses from the plate circuit will be fed back into the grid circuit. Here they may build up, just as they do in circuits with reaction coupling, until oscillation sets in. A valve of this kind may give you all kinds of unnecessary worry if you fit it to a H.F. valve holder. You may indeed, if you don't happen to know of this little propensity, conduct for days a profane search for the cause of the oscillation that is giving rise to distortion. You may change grid leaks and grid condensers, alter your wiring, remake soldered joints—and all the time the culprit is a slightly abnormal valve which simply needs to be changed over to the L.F. side. Here it will do little harm, for low frequency oscillations require a larger capacity in order to be able to pass with any kind of ease.

Good Staff Work.

There was once a song that was all the rage at the music-halls. It described in a nasty jeering way what happened when father, filled with the noblest motives of economy, essayed himself to lay the carpet on the stairs. He whacked his thumb, he laid the carpet all askew, he left his pliers and the screwdriver beneath it and had to take it up again to recover them; he had, in fact, every kind of horrid adventure, to the intense joy of the juvenile members of his family. That father I think was foolish. He made his effort in holiday time when the young were at home from school. He was simply asking for it. The father of to-day has a different job, with even greater possibilities of humorous situations attached to it, for it is obviously his business to see to the raising aloft of the family aerial. The wise man, strange as it may seem, is now he who deliberately selects holiday time for the event. No youngsters can wax enthusiastic about stair carpets, but there is never one of them who does not long to see the aerial hauled to the masthead. Paterfamilias can, if he so chooses, labour with pick and shovel to dig a mighty hole, burn his fingers with the soldering iron, coil the mazy tangles of the aerial round him until he looks like a demented snake charmer, and perform all the antics that are traditionally expected of him. But if military experience has taught him anything, now is his chance of enjoying a really "cushy" staff job. He repairs to the garden armed with a deck chair and a pipe. He shows his offspring exactly where to delve and spurs them on with encouraging words. He directs them in the method of handling the wire, deriving no small amusement from their embarrassment as they wrestle with it. He remains cool; they do not. He avenges the father of days gone by who laid the carpet on the stairs.

THE LISTENER-IN.

THE IMPORTANCE OF A GOOD EARTH

A part of the installation much neglected by the beginner is the earth connection. In this contribution the writer explains the importance of obtaining a low-resistance connection to earth, and details some of the best methods of achieving this end.

It is surprising to notice how little attention many wireless people pay to the earth. One finds quite often that though care has been lavished on the aerial and on the set itself, the earth is of the most elementary order. There seems to be an idea that anything will do for an earth. Nothing could be more erroneous. The highest and best insulated of aerials used with a first-class set will give only mediocre results unless the earth is as good as it can be made.

It the earth is a poor one an enormous amount of resistance is introduced, and the effect which results is analogous to that caused by fitting an exhaust pipe of too small diameter to the engine of a motor car, in which case back pressure is set up owing to the fact that the gases cannot escape freely after having done their work, and the engine works badly. In the receiving set a poor earth is a source of pronounced damping, and somet mes of a tendency to fall into self-oscillation that is most difficult to control.

Probably the commonest of a' kinds of earth in use to-day is a water pipe inside the house. This is quite satisfactory so long as certain conditions are fulfilled. The lead from the set should consist of stout well-insulated stranded wire—7/22's, or better still 7/18's—it should be as short and as straight as possible, and its end should be attached to the pipe in such a way that sound connection is made. The best method

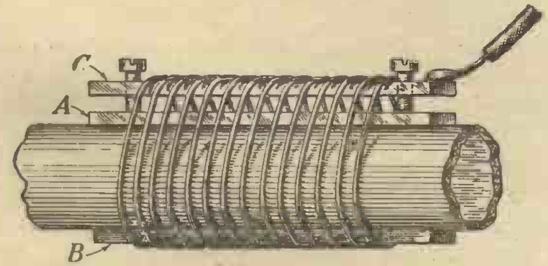


Fig. 1.
A good method of attaching the earth lead to a water-pipe.

is to solder the two together: failing this the earth wire may be soldered to one of those copper clips sold by garages for making radiator connections, and the clip tightly clamped on to a well-scraped section of the pipe. A third method is shown in Fig. 1. The pipe having been thoroughly cleaned, the brass strips A and B., whose purpose is to protect the pipe from injury, are laid upon it. A third strip C, provided with two 2 B.A. screws is then placed on A and wire is bound tightly round the whole. The earth-lead is soldered to C. By turning down the screws, which tightens the wire bindings, a very firm contact can be obtained. Always choose a *main, cold-water* pipe. Hot-water pipes and those which lead upwards to the cistern are of very little use, since they may make no actual connection with earth.

A gas pipe does not make a satisfactory earth, since the joints are sealed with a compound which offers a good deal of resistance. All indoor earths have one great drawback: they give very little protection from the effects of thunderstorms. If an earth inside the house is used for ordinary working, there should also be one outside, to which the lead-in may be shorted when lightning is about. The possibility of an aerial's being struck is remote, but it is as well to take no risks.

For the outdoor earth, which will be found by far the best if a reasonably short earth-lead can be used, the chief requirement is that it should make good contact with the largest possible area of damp soil, Pumps, iron pillars, pipes that go underground, and many other ready-made connections may be pressed into service with satisfactory results. A coil of wire, a length of wire netting, an old spring mattress or a sheet of roofing iron buried three feet or so will all do well as artificial earths. Whichever is used it should be buried immediately below the aerial wires. The earth lead should be unstranded at its end for some distance, and each of its wires soldered to a different part of whatever metal connection is used.

An earth that I have found most satisfactory in use is illustrated in Fig. 2. It consists of an old bucket, or a disused zinc bath—a 7lb. biscuit tin with its paper covering removed makes quite a good substitute—with a few very small holes bored in its bottom and sides. The vessel itself is half-filled with finely broken coke, which, being strongly hygroscopic, serves to collect and retain

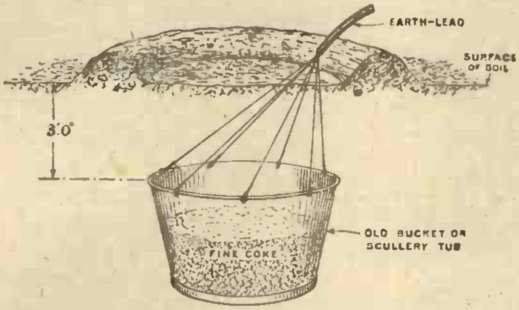


Fig. 2. A very good type of earth connection.

moisture. The contrivance, with the strands of the earth lead soldered to its rim as shown, is buried about three feet below the surface, the surplus soil being piled up round the edges of the hole when filled in so as to form a kind of crater. In dry, hot weather this hollow is filled with water every now and then, which ensures that the buried vessel makes contact with damp soil. The coke provides an inner moist connection whilst the water which leaks away through the holes wets the soil around and below. Such an earth will give good service for a very long time, though it is as well to dig down to it every six months or so in order to make sure that the iron has not rusted away at the places where the soldered joints with the wires are made.

To get the best results from outdoor earths they should be duplicated, which seems to lessen to some extent the directional effect of the aerial, and may make a considerable improvement in the reception of very weak signals. Fig. 3 shows a bird's eye view of an arrangement that will be found good. Here the earths are arranged in the form of a triangle. There might also be a water-pipe connection within the house, though it is not recommended that it should be used at the same time as the outdoor ground connections. For some reason it seems that indoor and outdoor earths do not work well in parallel : that, at any rate, has been my own experience, as well as that of many enthusiasts with whom the question has been discussed.

The last type of connection to be considered is not, strictly speaking, an earth at all, since it makes no contact with the ground. It is known as a counterpoise or capacity earth. Aerial and earth form between them the "plates" of a large condenser of small capacity. In the normal arrangement the lower plate is the ground itself. Though this is the most satisfactory system for general purposes, there are places in which it cannot be used with good results ; this applies particularly to localities in the near neighbourhood of tramways, electric railways and high power cables provided with an earth return. In such cases the performances of the wireless set often suffer serious interference from parasitic noises provided by stray earth currents.

The counterpoise earth provides an artificial lower plate for the condenser formed with the aerial wires, and thus largely, if not entirely, eliminates interference from such sources as those mentioned. Those who live in places where parasitic noises which cannot be traced to any fault in the wiring of the set or to the batteries are of constant occurrence, would do well to give it a trial if a clear space beneath the aerial is available.

One form of counterpoise consists of what is really a second aerial, slung between the masts at a height of only a foot or two from the ground. As it is important with a counterpoise that the capacity of the lower element

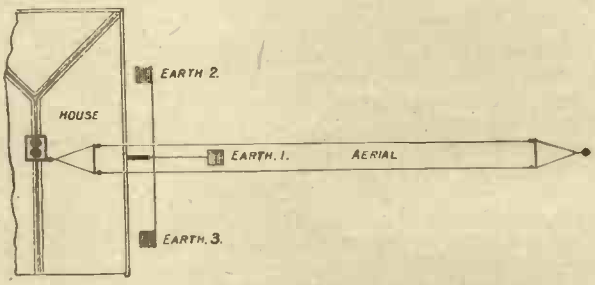


Fig. 3. An arrangement of three earth connections which gives good results.

should be at least as great as that of the upper, it should contain at the minimum as many wires as the aerial itself, and the strands of the former should be as thick as those of the latter. The counterpoise must be insulated as carefully as the aerial, and the earth-lead should be taken to it in the same manner as the lead-in, an insulating tube being used to keep it from contact with the walls and wood work of the house. R.W.H.

Above & below the Broadcast Wavelengths

A new feature which will appear regularly.

MOST wireless enthusiasts who are engaged upon anything like serious experimental work elect sooner or later to specialise either in short-wave or in long-wave reception. Exactly where short waves end and long ones begin is difficult to say, but the dividing line may be taken at 1,000 metres for all practical purposes. There are probably four short—or medium—wave receiving sets in this country for every one designed specially for dealing with the lower frequencies ; a fact which is not surprising when we consider that amateur transmissions are permitted only on short waves, and that probably three quarters of the telephony available for testing purposes is to be found below 500 metres. It used to be thought that the range of short-wave transmissions was very limited ; but the recent transatlantic tests made by amateurs in this country in co-operation with their fellow enthusiasts in America have shown that amazing results can be achieved with power that is almost incredibly small. American broadcasting stations such as WJZ and WDY are now so regularly received here that, whereas only a few months ago we regarded the feat as little short of miraculous, we now question the efficiency of any moderate sized set with which it cannot be achieved when conditions are favourable. If you are one of those who can occasionally sit up till 3 o'clock in the morning you will find listening for American C.W. amateur transmissions a most interesting variation of the usual programme. On good nights one can usually pick up several of them, and their signals come in with quite respectable strength. Those who live near London or in the South Midlands will find as a rule that they can do little or nothing in this direction until after 2 o'clock, for both Northolt and Leafield are usually at work up to this hour, or a little later, and the "mush" of their harmonics causes so much interference that signals are effectively blotted out.

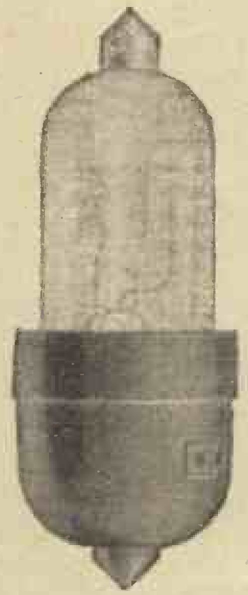


Fig 1. A specially designed valve for short wave work : the Mullard "Ora B."

Valves for Short-Wave Work.

For very short-wave work the ordinary 4-pin type of valve is not quite suitable, owing to the capacity which exists between the leads where they pass through the narrow "pinch" of the valve, as well as between the prongs and the legs of the holder. Two makes of valve have been designed to eliminate so far as possible these capacities, which are liable to set up unwanted oscillations owing to the coupling thus provided between grid and plate circuits. The first is the V24 series of "test-tube" valves, which have neither pinch nor prongs. The filament leads run from top to bottom of the bulb, being attached to metal caps at either end. Those from plate and grid run at right angles to them, passing through opposite sides of the bulb to another pair of caps. V24 is an amplifying valve, the rectifier of the same type being "QX." The two are also made with low temperature filaments and slight modifications in design as D.E.V. and D.E.Q. The Mullard Valve Company, too, makes special short-wave valves. The first of these is the "Ora B," which is the well-known "Ora" provided with an "end to end" filament mounting. The lower end of the bulb is provided with a little black helmet-shaped cap furnished with three small metal bosses. Those at the sides are connected to grid and plate, the third, at the point of the cap, making connection with the lower end of the filament. The other end of the filament is attached to a boss at the top of the valve. Another Mullard anti-capacity series consists of the "S.3" and "S.5," both recent designs. They are of the same shape as the "Ora B," though smaller in size. "S.3" is an amplifier, whilst "S.5" is a specially designed rectifier which requires no grid leak or condenser.

A Circuit for Short-Wave Reception.

Every experimenter who has had much experience of the difficulties of really short-wave reception knows that it is necessary to modify somewhat the standard circuits before they can be used efficiently on waves shorter than, say, 200 metres.

Various special circuits have been devised for use upon short wave-lengths, and one of the more successful ones is illustrated in Figure 2. This circuit is capable of giving quite good results in moderately skilled hands, and has been used for the reception of American amateur transmissions with fair success.

The condensers C_1 and C_2 should have a capacity of .0003 μF, and the coils L_1 and L_2 may consist of tubes 3 inches in diameter and 4 inches long, wound full with No. 22 d.c.c. wire, and provided with five roughly equal tappings

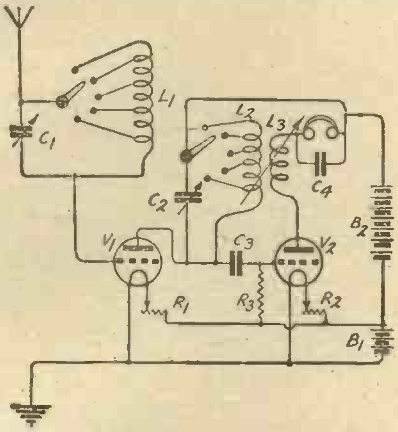


Fig. 2. A freak circuit for short-wave reception.

to the studs of two switches. The reaction coil L_3 should be arranged to slide inside L_2, and may consist of a tube $2\frac{1}{2}$ inches in diameter and 2 inches long, wound full of No. 28 d.c.c. wire.

All the other components employed may have standard values.

Aircraft Telephony.

For testing purposes towards the higher limit of short waves nothing is more useful than the telephonic transmissions which are always in progress between aerodrome and aerodrome, and between ground and 'plane on 900 metres, for they take place during the day, when little other telephony is available. The most important stations in this country are Croydon, Lympne, Pulham and Manchester, but distant transmissions can be obtained from Le Bourget, St. Inglevert and Rotterdam, the last of which comes in as a rule with great strength. 'Planes themselves may often be picked up, and it is an interesting experiment to see how far one can be followed after its departure from Croydon.

Intervalve Couplings for Long Waves.

For long-wave reception the best form of coupling for the high frequency amplifiers is undoubtedly the resistance-capacity method. Tuned-anode coupling becomes rather unwieldy over about 4,000 metres, owing to the size of the inductance coils needed, and if two or three stages coupled in this way are in use there is liable to be strong inter-action between their inductances unless kept some distance apart. Resistance-capacity coupling possesses amongst its other merits that of being extremely cheap to construct, for the only parts necessary are a non-inductive resistance, a .0003 μF condenser and a grid leak with an average value of 2 megohms. It is also very handy to use since no tuning of the anode circuits is necessary. This method does not as a rule give good results below 1,000 metres, though there are amateurs who swear by it even for broadcasting reception, but on the long waves it is all that could be desired.

Use a Loose-Coupler for Long Waves.

A very selective type of tuner will be found necessary when work is done on wave-lengths in the neighbourhood of 12,000 metres, for here a perfect babel of signals is always to be heard. With most tuners of the ordinary two-coil type it is quite impossible to pick out the desired transmission and to tune out the others. It will be found a great advantage when working on these crowded bands to make use of a three-coil tuner whose use does enable one to select one transmission and to silence the rest, by weakening the coupling between primary and secondary.

It is often extremely difficult to identify the long-wave commercial stations, for they send messages of great length and do not always give their call signs at the beginning or end of them. Many of them, in fact, seem to do so only when signing on or off, or when calling up a station with which they have not been previously working. Sometimes the nature of the messages intercepted give one a clue, but as a rule all that one can do is to go on recording in the hope that sooner or later a call-sign will be given. It is, at any rate, extremely good morse practice.

Advantages of using an external Heterodyne on Long Wave-lenghs.

The use of a local oscillator to produce continuous waves for beat reception of C.W. does not appear to be so commonly found in experimental stations in this country as might be expected. Possibly this is largely because autodyne reception, that is, the introduction of local oscillations produced by one of the valves in the actual receiver itself, is so easy to use. On the shorter wave-lengths where the frequency is abnormally high and the heterodyning frequency is therefore not much different from that of the incoming oscillations, the advantages of local heterodyning are not by any means so pronounced, as the detuning of the circuit necessary to produce the beat is only very slight.

The principle underlying the method usually called heterodyne reception is to introduce into the incoming oscillations locally generated high frequency oscillations having a frequency difference from the incoming waves of a sufficient amount to produce a beat note lying within the bounds of audibility. This can be shown by means of the following example: Supposing that the frequency of the incoming wave was 30,000 per second, which corresponds to a 1,000 metre wave-length. If we generate locally a high-frequency current having a frequency of 29,000, we obtain a beat note of 1,000 per second. This is within the limits of audibility and is indeed rather a low note as compared with speech frequencies which rise as high as 5,000 per second, but it will serve to illustrate the principles of heterodyne reception.

The greater the difference in frequency necessary to produce the beat note, the greater, unfortunately, the loss in efficiency in the circuit resulting from detuning, and the longer the received wave-length the worse matters become. For this reason a local oscillator may be used with advantage, as it does not in any way lower the strength of the incoming C.W. signal.

USEFUL ADDITIONS TO THE SET.

An interesting contribution showing how to fit and use measuring instruments, and explaining the advantages to be derived from their employment.

"KNOW thyself," was a saying of a Greek philosopher of old: "Know thy set," might well become the motto of everyone who makes wireless a hobby, and does not regard his loud-speaker merely as a kind of glorified gramophone horn which will deliver music when certain switches are turned on.

Wireless is, as a matter of fact, such an entrancing pastime that few people are content for long to turn knobs or to move handles without having any idea of what happens when they do so. Jones may buy a set merely as a source of entertainment, he may even swear at the time that he does not, and never will, care twopence how it works; but you will find this same Jones within a few short weeks discoursing quite learnedly of capacity effects or of the merits of rival circuits.

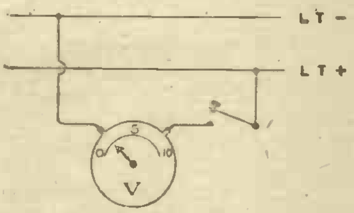


Fig. 1.—Showing how to connect a voltmeter in circuit.

The value of measurement.

Those who really wish to know their sets will discover that a vast amount of pleasure and of profit is to be derived from the use of measuring instruments. Your accumulator appears to run down very rapidly; is the charging station not giving it its full share? An ammeter will tell you what amount of current the set consumes. If you know the rate of discharge and log the hours that the battery is in use, you can soon find out whether you are receiving fair treatment or not. Is the new high-tension battery standing up well? Connect the voltmeter for guidance as to its condition, and the milliammeter for information concerning the strain that your set puts upon it.

The voltmeter measures the pressure or the potential supplied by a battery. It should be connected, as shown in fig 1., in *shunt*, that is directly across the positive and negative leads; but as its internal resistance may be low, we cannot have it permanently wired up to the battery, for if we did the current would rapidly drain away, and the plates of the accumulator would be damaged. It will tell us all that we want to know without doing any harm if we merely throw it into action for a second or so, and we must therefore provide some kind of switch, as shown in the figure, to act as a cut-out.

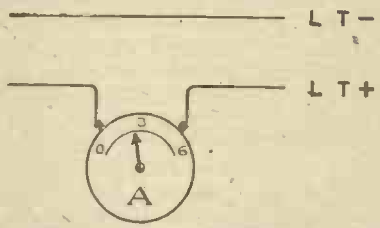


Fig. 2.—The connections of the ammeter.

The ammeter, which records the rate of flow of the current, is wired in *series*, and not in shunt; fig. 2 shows how this is done. It is important that current should pass in the proper direction through the instrument. Its terminals will usually be marked + and − respectively. They should be wired as shown.

The most useful type of voltmeter for the wireless set is that which gives double readings. There are three terminals: the middle one takes a common lead for both high-tension and low-tension batteries, and the other two are for the big and small voltages respectively. One way of connecting it to the set is given in fig. 3. If the left-hand switch is closed, current from the plate battery will pass, and the voltages will be read from the upper row of figures The other switch can admit current from the accumulator, the lower figures giving the correct reading in this case.

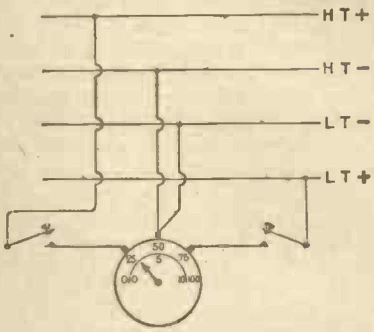


Fig. 3.—The connections of a double-reading voltmeter.

For measuring the rate at which current flows in the plate circuit the ammeter would be of no use, since few valves pass normally more than three or four thousands of an ampere, and the consumption of the whole set will rarely exceed one hundredth of an ampere. For this purpose we require a milli-ammeter, which measures in thousandths of an ampere. It is of course only a most delicate form of ammeter, and it is connected up (fig. 4) in the same way.

Fitting Instruments to the set.

Fig. 5 shows how a most useful instrument board may be fitted to the set. It contains an ammeter reading from 0 to 6 amperes, a double-reading voltmeter showing 0 to 10, or 0 to 100 volts, and a milliammeter whose range will usually be 0 to 100 milliamps. The instruments may be mounted most conveniently in one box, provided with terminals for H.T. +, H.T.−, L.T. +, and L.T.−. For the two switches required for the double-reading voltmeter, nothing could be better than small-sized bell-pushes—to obtain the voltage reading of either battery one simply presses the appropriate button down for a second, its subsequent release automatically breaking the circuit. What is the use of the

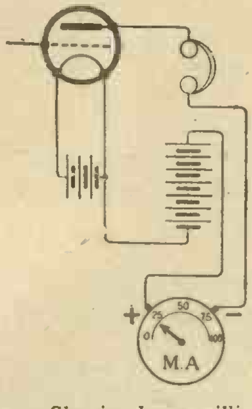


Fig. 4.—Showing how a milliammeter is connected to measure plate current. Note that the reading shown is an exaggerated one.

instrument board when it has been fitted up? Well, we can employ it in a multitude of ways besides those mentioned. We can for

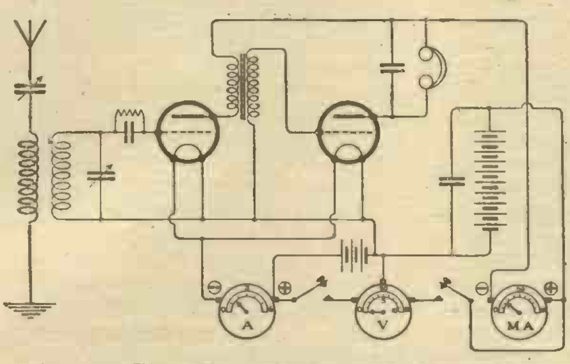


Fig. 5.—The complete set of instruments fitted to the receiver.

example check the current required by any particular make of valve. Suppose, for instance, that you have just bought a new valve whose advertised requirements are ·75 amp.; switch it on by means of its rheostat, leaving the other valves unilluminated, and the ammeter will at once show what current is passing. In the same way you can test old valves by its help, spotting any whose senile filaments are consuming more than a fair ration of current.

The ammeter will also enable you to see whether you are putting too heavy a strain on your accumulator. If the battery is to have a long life, the normal discharging rate should not exceed about one-fifteenth of its *actual* capacity. You have, say, a three-valve set with a 6-volt, 60 ampere-hour accumulator. The "60 ampere-hours" are usually intermittent rating, the actual capacity of the battery being about one half of this. The rate of discharging, then, should not be above one-fifteenth of 30 amperes, or two amperes. Your ammeter will tell you just what you are doing.

If the set begins to fall off in power, the low-tension button of the double-reading voltmeter is pressed to ascertain whether the accumulator is running down, and failing to give its full pressure. The fault may of course be that of the plate battery, whose condition is revealed by pressing the other button. Perhaps your set shows a tendency to become a little noisy after half an hour's working.

You might hunt for hours for the cause of this if it were not for the voltmeter. Read the voltage of the high-tension battery when you first switch on, and take it again when the noises begin to occur. You will probably find a considerable drop has taken place. The battery is nearing the end of the days; it picks up when left standing, and shows quite a respectable voltage when first called upon, but after a little while hydrogen gas begins to collect faster than the depolariser can disperse it. Up goes the internal resistance, the voltage falls away and becomes irregular, and noises are set up.

The milliammeter will assist you to discover the critical high-tension voltage. Watch its pointer as you move the wander-plugs, and notice what effect an increase or decrease of voltage has on the current that passes. You will find with many valves that a point can be reached beyond which no increase of anode potential makes much difference to the current flowing.

None of the instruments described need be expensive. Voltmeter and ammeter are quite simple devices, and various satisfactory kinds are on sale at prices that will not be a heavy tax on the pocket. The double-reading voltmeter costs rather more, from £1 1s. to £3 being average prices. The milliammeter is a more complicated instrument than any of the others, and a new one runs to about £3.

Some excellent double-reading voltmeters and milliammeters are, however, to be found in the stocks of many firms who deal in Army and Air Force surplus goods, and these can be obtained at very reasonable figures. R. W. H.

News of the Month

WE learn that work is being commenced upon the new South Coast broadcasting station, as to whose site there has been so much speculation. After a great deal of careful experiment the B.B.C. engineers have fixed upon Bournemouth as being the location best suited to their purpose. A second new station is also to be erected in the north of Scotland.

* * *

Our readers will note from the list of new call-signs upon another page that a number of "sixes" have now been issued to British experimenters. We wonder if this fact explains the phenomenally loud signals reported by various listeners-in as being of American origin ?

* * *

Another project of the B.B.C. which is now being proceeded with is the erection of a "relaying" station at Sheffield. Musical programmes will be sent to this station by land lines and transmitted with a power of about 100 watts, and it is expected that this arrangement will provide a satisfactory solution of the problem of covering the West Riding of Yorkshire.

* * *

One of the latest applications of wireless telephony is its use upon a large scale upon lightships and lighthouses round the British coasts. The installation upon the North Goodwin lightship is already completed and ten other ships are being fitted. The wave-length upon which these stations will work has not been announced, but it seems probable that they will use 300 metres, since one of their functions is to communicate with ships and handle traffic relating to distress messages.

* * *

Quite one of the most important events of the month from the broadcast listener's point of view was the opening on May 1 of 2LO's new studio at 2, Savoy Hill, Strand. This studio is the most carefully designed and constructed broadcasting room in the country, and seems to have effected an improvement in the quality of the transmission. It is 40 ft. in length, 20 ft. wide, and 11 ft. high. Most elaborate precautions have been taken to eliminate resonance effects, and something like five tons of canvas have been used in draping walls and ceiling. The result is so perfect that one seems to be speaking in the open air, and visitors tend to raise their voices.

* * *

The Marconi Company has appealed against the decision of the Court of Appeal which recently upheld the judgment of Mr. Justice Lawrence that a Mullard valve did not infringe Marconi patents Nos. 28413/13 and 126658. They intend to take the case to the House of Lords.

* * *

The appointment of Mr. Percy Pitt as Musical Controller of the B.B.C. makes it desirable to explain that this new office does not imply that Mr. Stanton Jeffries has been superseded. Mr. Pitt would, perhaps, be more accurately described as Consultant Musical Adviser. He will advise the company upon all matters of general musical importance, and will provide an operatic night once a fortnight, a string quartet once a week, and a male voice quartet twice a week. He will also develop the musical part of the Sunday programmes.

* * *

Extensive changes are being made at the great German station of Nauen, with a view to increasing its power and capabilities. Special arrangements are being made for the projected Buenos Ayres service, which is expected to be working very soon, and separate aerials have been built for handling the American, African, Asiatic, and European traffic.

* * *

It is officially announced that the station at Fort George, Guernsey, has been taken over by the Air Ministry. This station was until recently used by the Post Office for ship and shore traffic.

* * *

An interesting series of experiments has been carried out at the Manchester broadcasting station, upon the use of the photophone as a microphone instead of the conventional carbon type. The photophone is a form of microphone which controls the current flowing through a group of selenium cells by means of a speech-modulated beam of light. Some of the results obtained appear to have been remarkably good.

* * *

It is expected that by the time these lines appear the new Mexican high-power station at Chaputecpec will be in operation. The station will conduct services with Lyons, New York, London, and Berlin, and should be within the reach of a good three-valve set employing reaction.

* * *

Broadcasting in foreign countries has made considerable progress during the month. A service very similar to that of the B.B.C. has been inaugurated in Sweden, Norway is making preparations for one, and in India a protracted series of negotiations between the interested parties has begun. In Australia a committee has investigated the broadcasting possibilities, and has presented a report to the Wireless Board and the Federal Government. No definite proposals for a service have yet been made in New Zealand, but regulations have been drawn up laying down the conditions under which broadcast transmission and reception will be licensed.

* * *

A wireless service between France and Algeria has been commenced. Transmission is carried out from the Lyons station each day at 8.30 a.m. and 1 p.m. (G.M.T.).

* * *

When the British steamer *City of Victoria* was on fire in mid-Atlantic, many New England listeners-in were enjoying an opera broadcast from a station in Boston. The SOS calls which came from the burning ship interrupted the opera and broadcasting closed down for a quarter of an hour. Later messages indicated that the fire was under control and that the ship was proceeding to St. Michaels, the Azores, under her own steam.

* * *

The "Express Service Company" of Berlin has commenced a daily service of broadcast commercial and financial news from the Königswusterhausen station. Subscribers rent from the company a receiving set, and also pay an annual fee for the service.

* * *

In reply to a question by Sir Burton Chadwick, the Postmaster-General has written a reply stating that the total expenses of the Leafield and Cairo stations are estimated at about £36,000 and £49,000 per annum respectively. In addition to the Egyptian service, Leafield station is used for the transmission of Press telegrams to Halifax, Nova Scotia, India, ships at sea, and for the broadcasting of British official communiqués.

The revenue derived by Leafield amounts to £24,000 for nine months, or £32,000 for the whole year. The Cairo station has collected £4,700 for nine months, which amounts to about £6,200 for the whole year. The whole revenue from the two stations therefore amounts to about £40,000, whereas the total expenditure is £85,000.

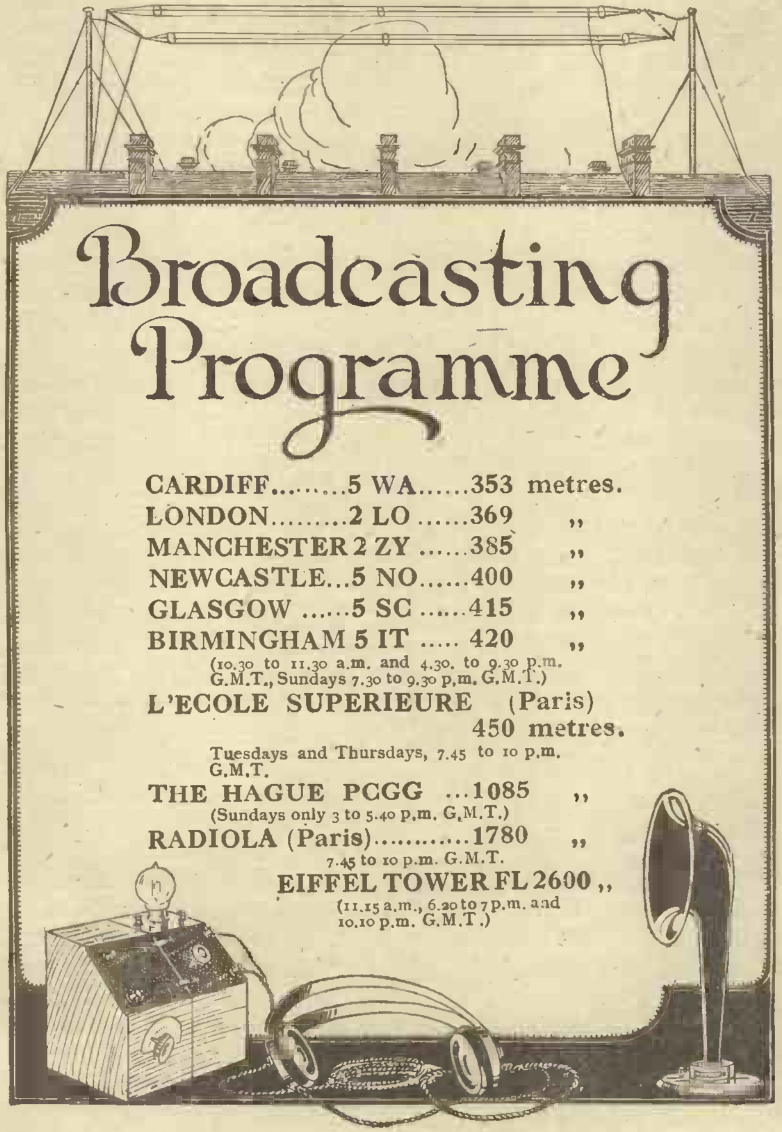
The loss on this service therefore amounts to about £46,000.

* * *

The G.P.O. has decided to permit ships to use their wireless sets in the harbours and estuaries of Great Britain. An exception is made, however, in the case of naval harbours and the Port of London above Barking Reach. Messages must be of an urgent nature, and must be transmitted with a minimum of power to the nearest Post Office coast station.

* * *

We learn that the Government of Greenland has commenced the erection of a high-power station for communication with Europe.



THE ERECTION OF AN AERIAL

By R. W. HALLOWS, M.A., Staff Editor.

Every experimenter wishes sooner or later to erect a really good aerial, and the essentially practical notes contained in this contribution should prove most helpful in the attainment of that desirable end.

WITH the exception of those whose dwellings are such that use must perforce be made of frames and other indoor contrivances, every owner of a wireless set is faced sooner or later with the problem of erecting a really good outdoor aerial. One may be content for a time with a makeshift arrangement of poles, broom-handles and bell wire, which suffices to bring in the transmissions of a nearby broadcasting station, but this stage in one's wireless career does not last long. To be able to receive one broadcasting station may satisfy during the first few weeks of ownership; a burning desire to be able to get the next station succeeds; next one is not happy until every British station can be received. This is followed by a yearning for telephony from France and Belgium, and finally one longs to hear the strains of WJZ or one of the other big American stations.

To make the set, of whatever kind it may be, thoroughly efficient, a good aerial is essential. From a wireless point of view the most important qualities in an aerial are height, length and good insulation. Other considerations, which, though they do not directly affect reception, are of the greatest importance from other standpoints, are that the aerial should be safe—it must not be forgotten that third party risks exist; that it should not be unsightly, and that it should not occupy too much space.

Before we can decide upon the type of aerial that it will be best to erect, we must first see what can be fitted into the space at our disposal. Height we can usually obtain so long as the garden is not crossed by low telegraph or telephone wires; but length is a different matter. Our object must be to get as near as possible to the maximum permitted length of 100 feet, which means usually a span of 90 feet with a 10-foot lead-in. We cannot stretch the garden, but we can often contrive to obtain an extra yard or two by slinging the aerial diagonally instead of straight across it. If, however, we are bothered by telephone wires we may have to sacrifice a little in order that our aerial may be as nearly as possible at right angles to them; if it runs parallel, or at a small angle to them the effects of induction may be a great nuisance. Nature already provides us with plenty of annoyance with her atmospherics, so let us avoid artificial interference if we can.

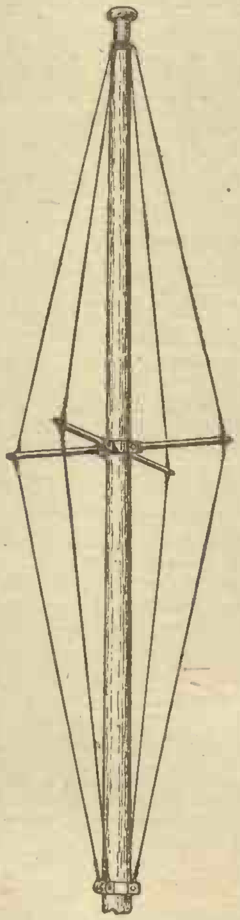


Fig. 1.—A "trussed" pole.

If the full 100 feet is obtainable a single-wire inverted L aerial will be found quite satisfactory: the advantages of this type are that it is cheap to erect, needing no spreaders, comparatively little wire, and only two pairs of insulators; it is also very light, which means that poles need not be massive. For very short wave reception the single-wire aerial is hard to beat, owing to its small capacity. The twin-wire kind has greater capacity, but a smaller inductance value; it is, however, by far the most usual of all aerials, and as it gives general satisfaction we shall not go wrong if we let our choice rest upon it. The only other type commonly used is the T aerial, which is often adopted owing to restrictions imposed by the amount of space available. The important point with this aerial is to see that the lead-in comes from its exact mid-point. Each arm of the T forms a separate aerial: if the two are equal they can be tuned perfectly, but if one is longer than the other sharp tuning cannot be done, since each has its own natural wave-length equal, very roughly, to four and a half times the distance from its farthest point to the aerial terminal of the set.

The direction in which the aerial must run is governed in the majority of cases by the shape and extent of the garden, but if one can make a choice, it is advisable that the aerial should be on a line joining the house and the station whose transmissions are mainly relied upon. Both L and T aerials have slight directional properties, though in the latter they are much less pronounced than in the former.

The best wire to use is undoubtedly enamelled cable consisting of a number of strands of silicon bronze. The metal has a considerable tensile strength, and the enamel coating protects it from the corrosive effects of soot and rain. Those who live near the sea should always use enamelled wire, since the bare variety suffers rapidly in a salt-laden atmosphere. Enamelled 7/22s will be found an excellent investment for all purposes.

Next comes the choice of the mast. There will be only one as a rule, since in nine cases out of ten the lead-in end of the aerial is supported by some part of the house. Here there is a wide variety. Certain firms specialise in hollow steel masts made in sections which can be fitted together like the joints of a fishing rod. These have the advantage of lightness, and they are immensely strong. It must not be forgotten, however, that any metal object acts as a deflector of ether waves; hence, unless some means can be devised of insulating it from earth, a steel mast may have a damping effect upon reception. Other

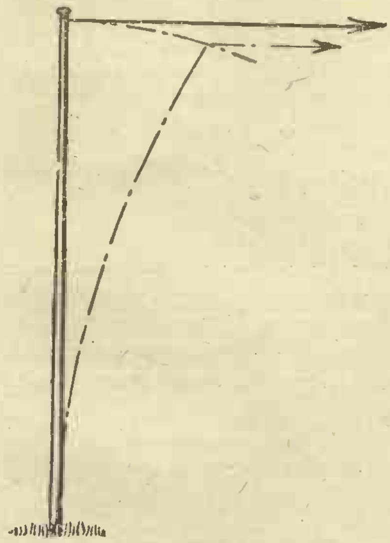


Fig. 2.—Showing the effect of a horizontal pull upon an unstayed pole.

firms make lattice-work masts of wood, which are excellent in every way; light, strong, easy to erect, and offering little resistance to wind. They have the further advantage of being quite pleasing to the eye.

The majority of wireless enthusiasts choose a plain spar of some kind. A good straight fir or larch pole that has been well seasoned, is hard to beat. It is not perhaps generally realised that quite a light pole can be used if it is trussed, as shown in fig. 1. Any piece of wood will stand a fairly heavy load applied

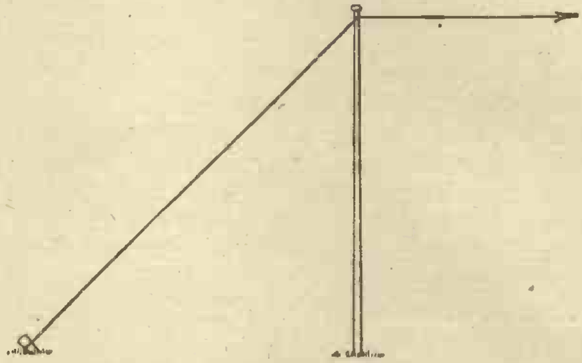


Fig. 3.—The effect of a stay in counteracting the pull of the aerial.

vertically. You can lean hard on a walking-stick, for example, though you could break it easily if it were held horizontally between the hands. If you lean on a walking-stick you will find that it will stand a comparatively enormous strain provided that pressure is

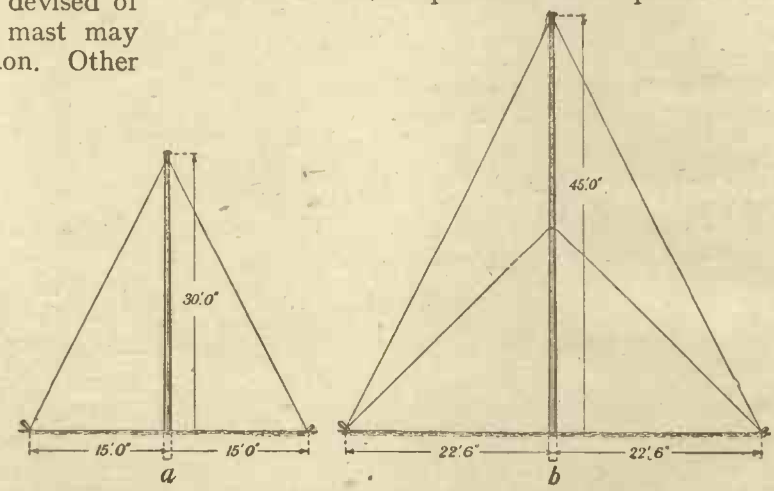


Fig. 4.—Methods of staying to be adopted with masts of different heights.

applied in a perfectly straight line downwards; if, however, the stick is slanted a little it at once begins to bend, and if the pressure is continued it will eventually break. Directly a spar begins to bend or buckle, its strength is greatly reduced.

In an untrussed and unstayed aerial mast the strain is largely horizontal (fig. 2), tending to bend the mast and make it assume the position shown by the dotted lines. Trussing will do a good deal to counteract this strain, by preventing the mast from buckling; but the best way to deal with it is to stay the aerial, as shown diagramatically in fig. 3. Here the resultant force is more or less perpendicular, thus throwing the strain in the direction in which the mast can best stand it. Masts up to 30 feet in height will do quite well with a single set of stays, which should be attached to a ring placed close to the top. If the height is greater it is advisable to rig a second set between the pegs which hold the first and a ring placed round the middle of the mast (fig. 4). In any case the distance from the foot of the mast to the pegs should be at least half its height, and the back stay should be directly in line with the aerial wires in order to take the strain which they impose.

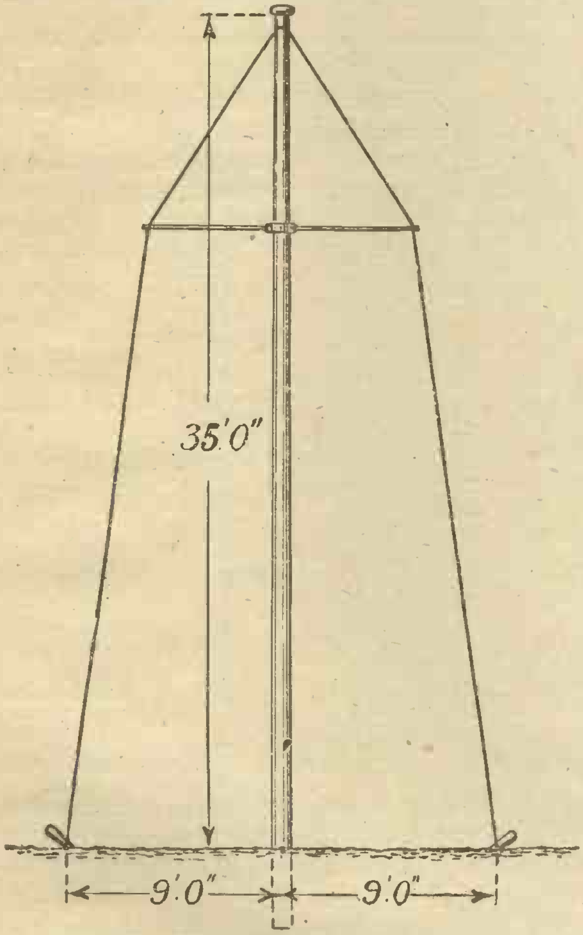


Fig. 5.—Where space is limited cross-trees may be used.

Many people will not have sufficient space at their disposal to give the stays their full spread. Those who are so situated can get over the difficulty by making use of crosstrees, as shown in fig. 5; by this method the distance from foot of mast to peg can be reduced to one quarter the height of the spar. When two spars, firmly bound together with iron rings

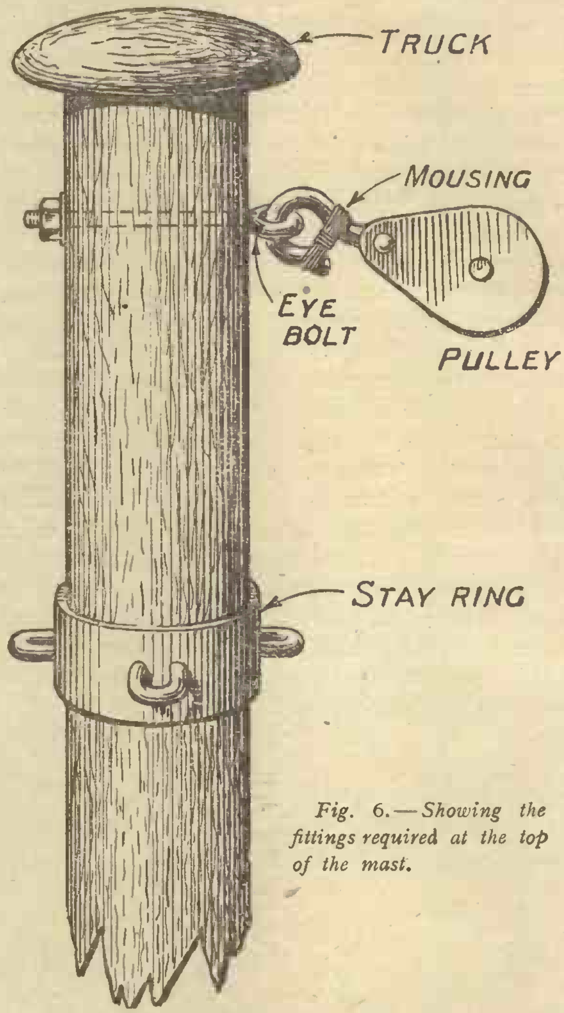


Fig. 6.—Showing the fittings required at the top of the mast.

and whipped at the joint with wire, are used as mainmast and topmast, each should have its own set of stays.

Before we can proceed to the erection of the earial we must furnish the top of the mast with its necessary fittings, as seen in fig. 6. The truck prevents moisture from entering the grain of the wood. The eyebolt should be of $\frac{1}{2}$-inch or $\frac{3}{8}$-inch galvanised iron. The pulley, either of galvanised iron or of aluminium, is secured to the eye of the bolt by a "mousing" of wire. The stay-ring can be purchased ready-made, or made to order by a local blacksmith. At the lower end of the mast, about 4 ft. from the ground, we shall require a cleat for securing the halyards. Both stays and halyards are best made of galvanised iron cabled wire, since ropes contract to such an extent when wet that breakages may occur unless one remembers always to slacken them off when rain is likely. We shall require four stout pegs 3 ft. 6 in. long, to serve as attachments for the stays.

All our provisions having been made, we are now ready to erect the mast, of whatever type it may be. There are three main ways of fixing its lower end; we may bury it deeply and use stays only to ensure rigidity, or we may seat it in a shallow hole and stay well, or we may make use of a wooden stepping, and leave the entire mast above ground. My own mast is a stout scaffold pole 33 ft. in length, sunk 4 ft. into the ground. Though no stays at all are used, it is as rigid as could be desired, and it has withstood successfully the violent gales that raged during last winter. The second method's chief advantage is that it allows one to make full use of the height of the mast. The third is by far the best of all, since the spar is not in contact with the soil, and, therefore, is not so liable to rot.

The stepping, illustrated in fig. 7, takes the form of a kind of trestle built of 2-inch timber. The uprights (a, a,) are bolted to a block of

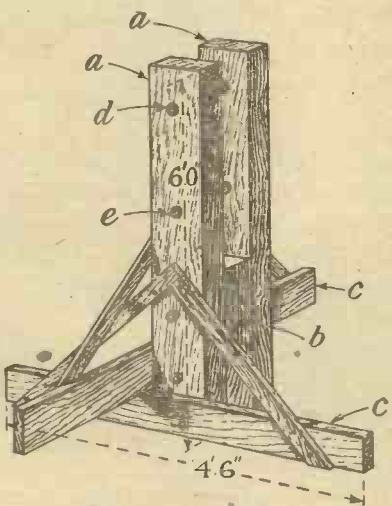


Fig. 7.—Stepping for the foot of the mast.

wood (b), whose diameter is slightly larger than that of the foot of the mast. The cross-pieces (c, c), 4 ft. 6 in. in length, serve to give the whole a good grip of the ground. The stepping is buried in a yard-deep hole, so that three feet of the uprights remain above ground. The mast is pivoted to a bolt (d) and when raised is locked in position by a second bolt (e). Anything that has to be buried, whether stepping or mast foot, should first be given two dressings either of hot tar, or of some preservative such as solignum.

For a mast which is erected without a stepping, a hole of from three to five feet in depth must be made. It is advisable not to make the hole of greater diameter than is absolutely necessary; it will be found easy to keep it fairly small if the soil is loosened with a crowbar and removed by means of a ladle such as builders use.

Once hole or stepping is ready the raising of the mast will not be found nearly so difficult a job as might be anticipated; in fact, unless it is of very great height it is quite unnecessary to use any kind of tackle. The heavy 33-ft. spar previously mentioned was erected by three people without any of these aids, the whole job from beginning of making the hole to the hauling up of the aerial wires, occupying less than one and a half hours.

The mast, with stays and halyards attached, is laid on the ground with its butt towards stepping or hole. If a stepping is used the end is raised and pushed between the uprights until the pivot bolt can be inserted and made fast. When the mounting is in a plain hole, the butt is moved until it is within a short distance of the far side of the hole. One man then uses the back stay as a steadier, whilst two others go to the top end of the pole. These two lift it and walk inwards raising the mast as they go, just as workmen raise a ladder. As soon as it is upright, two steady it with their hands whilst the third fills in the hole for about a foot. One man can then act as steadier, the second shovelling earth round the pole; the third man moves about at some distance away, watching the mast carefully and telling the others what to do in order to keep it straight. In the case of a stepped mast, all that has to be done when the pole is upright is to insert and secure the second bolt.

The method of filling in the hole round the butt or stepping is important. Fig. 8 gives a diagramatic representation of what should be done. At the bottom of the hole is placed a large flat stone or a block of tarred wood for the butt of the mast to rest on. A quantity of smallish stones is then shovelled in, followed by a layer of earth, which is rammed down hard. Next come alternate layers of large stones and rammed earth until the hole is full.

The pegs are driven in in their proper places, and the next job is to attach the stays to them. The best way of attaching stays to pegs is to splice the end of each wire round a small

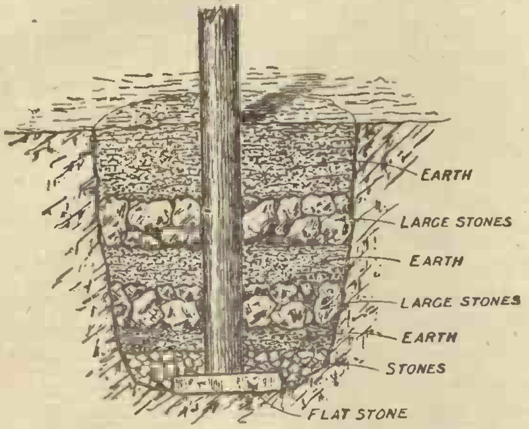


Fig. 8.—Showing how to fill in round the base of the mast with layers of earth and stones.

"thimble," to which is fastened a short piece of rope provided with a runner (fig. 9). Where the soil is of a loose kind pegs will not obtain sufficient hold, and it will be necessary to contrive anchorages consisting of lengths of stout timber provided with ring bolts, and buried a couple of feet below the surface of

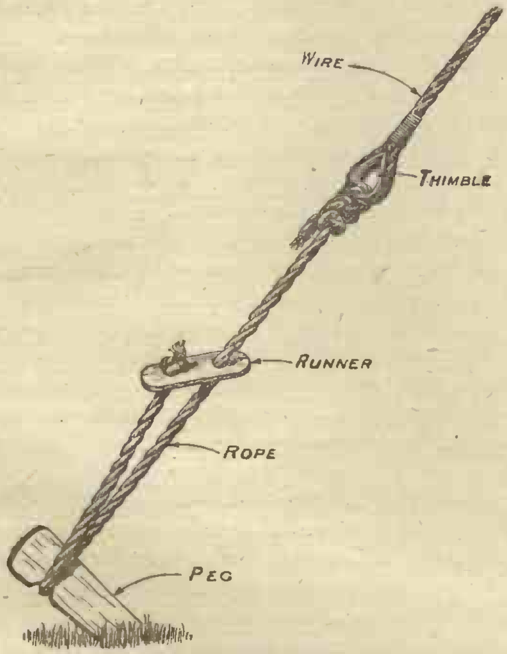


Fig. 9.—Runner for tightening stay ropes.

the ground. A still better method is to use concrete slabs with ring bolts cast into them. Once the mast is up we can proceed to make the attachment at the house end. For this purpose nothing is better than a short pole clamped to a chimney stack. The most effective way of doing this is to have a pair of iron clips made by the blacksmith, but a method which answers quite well is shown in fig. 10. Stout wire is used for fixing, and a strainer at each binding allows the necessary tension to be obtained. Wooden cushion pieces protect the brickwork from being damaged by the wires.

In many cases, however, either a cautious landlord or the fact that chimney stacks are not sufficiently sound, renders these methods impossible. The support may

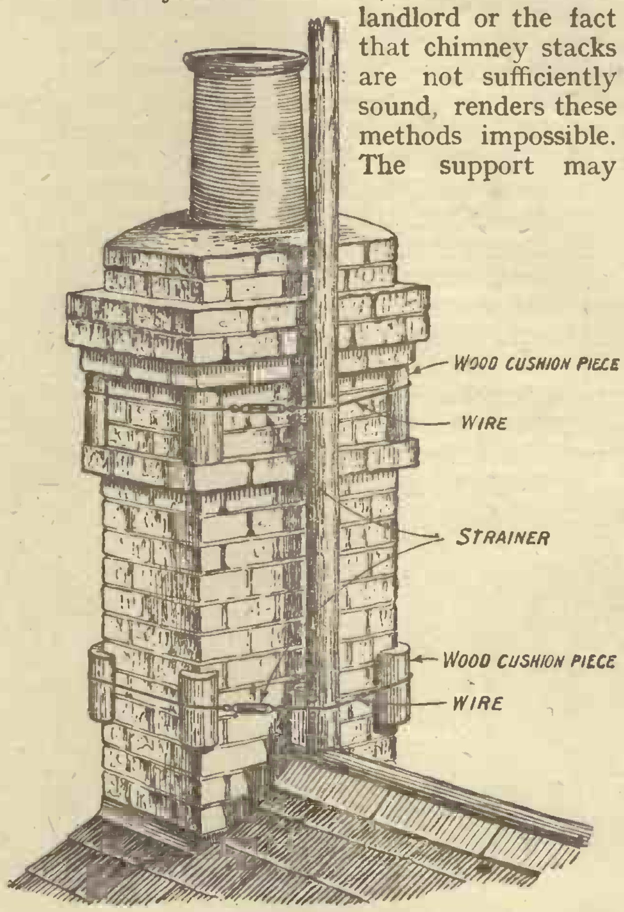


Fig. 10.—A good method of attaching a pole to a chimney.

then be a side-pulley fixed to the brickwork of the house by means of those useful little appliances rawl-plugs. Quite short halyards will do here, and the cleat for securing them may be screwed to the outside woodwork of a window frame.

The supports at both ends being now ready, we can tackle the job of making and erecting the aerial. For spreaders—it is presumed that twin wires are to be used—bamboo is by far the best material, owing to its strength and lightness. The function of spreaders should be to spread, and not to take a pulling strain. If we attach our wires firmly to the ends of the spreaders they will tend to bend inwards owing to the pull upon them. A better method is shown in fig. 11. A hole is bored with a hot iron at either end of the spreader near a knot, and the wire connecting a pair of insulators is passed through each; a second wire passes over the spreader, which has thus a little play and takes no direct pull. Spreaders should be at least four and a half feet in length if any benefit is to be derived from using twin wires. Fig. 10 also shows a good arrangement for the bridle.

Two spreaders having been made up as described, one end of each wire should be attached to the insulators of one of them. The wires should then be paid out whilst a friend holds the spreaders to keep them taut. Their far ends should next be passed through the insulators of the other spreader, and sufficient wire drawn through to make the down leads. The wires are now fastened roughly with string. You and your helper then raise the spreaders breast high and the wires are adjusted until they are of exactly equal length. They are then made fast and the running end of the wire is brought back to the standing part and secured to it with a tight binding of copper wire, into whose turns a little solder is run to make all firm. The bridle of the far end of the aerial is now fastened to its halyards and hauled up, your helper holding the other end and keeping the wires taut enough to prevent their kinking. Next, the bridle of the lead-in end is secured to its halyards, and hauling up is done gently, the spreader being steadied by means of the down leads.

The actual lead-in should consist of a length of heavily insulated 7/18s, such as electricians use for wiring power circuits. This wire costs only about sevenpence a yard, and it is quite as good as the stuff usually sold for leads-in at about three times the price.

The two down leads may run to within a foot or two of the point of entry into the house, so long as they are well away from the walls of the building. About four inches at the end of each of them and the same amount of the heavy insulated cable should be unstranded, each strand being separately scraped

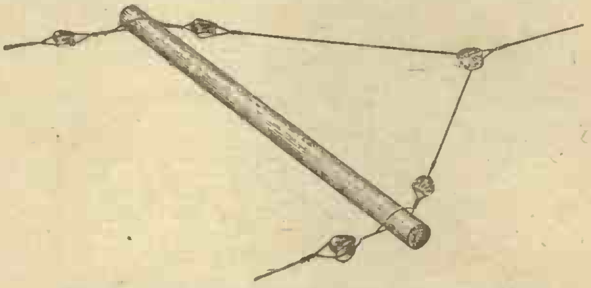


Fig. 11.—The best method of arranging spreaders.

clean and bright. Two strands of each down lead and two of the lead-in are then twisted tightly together with pliers, the remaining strands being wrapped one by one round the joint, which is finished off by running in plenty of solder.

It is most important that the down leads should not be so slack that they can sway to and fro when a wind is blowing. If they are too long they will swing at one moment near the walls of the house, at the next away from them. The result will be a varying capacity to earth, which will give rise to the weirdest effects in telephones or loud-speaker.

The halyards at both ends of the aerial should be long enough to allow the wires to be lowered to within one's reach. Attachments can thus be examined from time to time, and insulators can be given a periodic cleaning, which does much to preserve their efficiency. In large towns they rapidly collect a coating of dust, soot and grime, which is far from being a non-conductor. Its presenee will often bring about just the kind of mysterious reduction in signal strength that leads one to dismantle large portions of the set in a vain effort to discover the cause of it.

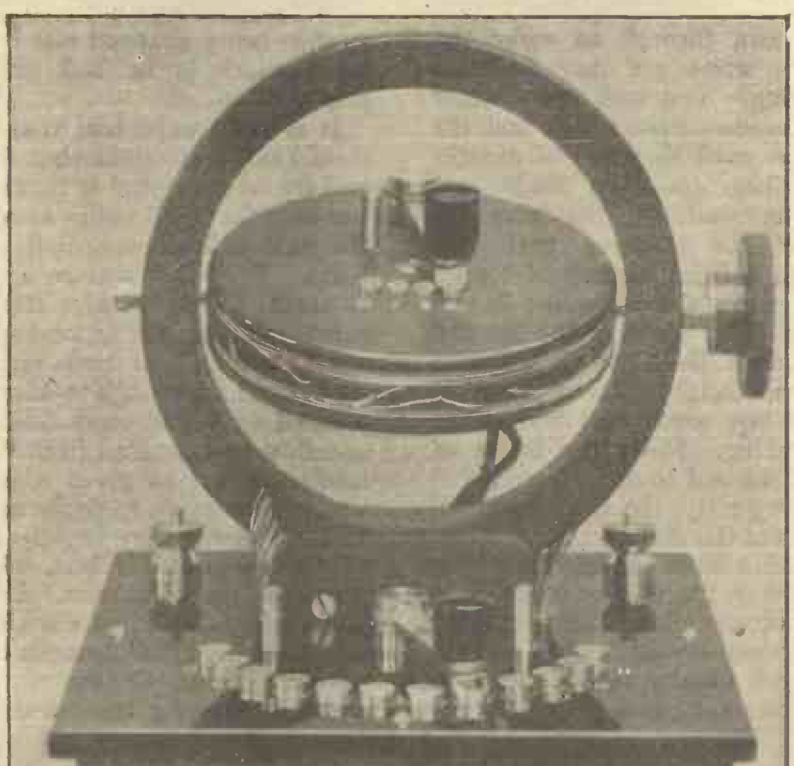
Tested by Ourselves

A Universal Tuner

THE Economic Electric Company, Ltd., have submitted for examination and test a compact tuner with swinging reactance of the vario-coupler type, and with tappings and selector switch covering a range of from about 330 to 2,240 metres on an average aerial, using a .001 μF condenser in parallel.

The convenience of having the whole of what is really the most interesting range of wavelengths comprised in one tuner, and the exceeding ease with which changes can be made within this range, will appeal to many experimenters. The swinging reactance proved, on trial, to be exceedingly handy, and capable of fine adjustment; three tappings are taken in this reactance, so that the most favourable combination is easily found. With these features, "searching" becomes the easiest thing in the world; the valve can be kept oscillating steadily and quietly, while the whole range of wavelengths is searched in the minimum of time and with the minimum of adjustments. In the course of our test, using a single soft valve with 30 volts on the plate and a fairly good suburban aerial, The Hague concert was readily picked up, coming through with quite satisfactory and enjoyable intensity; the fine adjustment of the reactance coupling being noticeably useful in such a case. On a test transmission, out of Broadcast hours, the London station gave loud signals, both on the fundamental wave and the first harmonic below, and amateurs could be tuned in with ease.

The tuner has a high-class instrument-maker's finish, and there is evidence that care has been taken to obtain smoothness of action of switch-handles, etc., so as to produce an instrument of



H. 480. The E.E.C. tuner whose performance is discussed on this page.

good efficiency and permanent value.

The makers point out that the instrument can be used also as an inductively coupled tuner or as a variometer, by slight alteration of external connections.

A Crystal Detector.

From the Economic Electric Company, Ltd., we have also received a new and very simple form of crystal detector, embodying features, however, which are not often found amongst the multiplicity of patterns on the market. In this the crystal is fixed, in the ordinary manner, in a small cup, but the latter is held in a spring clip, quite firmly, so that it can be slipped out at any time to renew the crystal. The cat's whisker is also readily removable, and can be replaced by a crystal cup when the two-crystal type of detector is used (*e.g.*, Perikon). The latter cup screws in place, so that the greatest latitude is given for adjustment and replacement of the sensitive elements.

On trial, the smooth, sure action, and absence of all spring and back-lash in the moving arm of the holder, were noticeable; the best spots in the crystal could be found with ease, and the pressure finely adjusted. The pressure on the ball-joints can be readily adjusted, so that there is no need for looseness to develop in use.

The finish of this little instrument is attractive, and although the price is quite moderate, it is certainly one of the best mechanisms for its purpose that we have had through our hands.

A FEW NOTES ON THE CARE OF BATTERIES

Some useful hints for battery users.

THE general amateur newly adapting himself to a valve set has in all probability very little knowledge of the rudiments of the high and low tension batteries, and maybe will find, if the necessary precautions are not taken, after inviting one or two friends round to listen to a vocal or instrumental transmission from 2 LO, that one or other, or perhaps both of his batteries are run down. The writer experienced similar trouble when he first started dabbling in wireless, but he learned his lesson. It is hoped that the following notes will prove of some assistance to readers of MODERN WIRELESS.

When dealing with the accumulator or storage type of battery, try to bear in mind that:

The charging voltage must always be greater than the nominal voltage of the battery; how much greater depends on the charging current required and the resistance of the battery and leads.

You should never try to get more ampere-hours out of a battery than are put into it.

You should never let the solution fall below the tops of the plates.

If the solution gradually evaporates, make up with pure distilled water only.

If the solution leaks away or is spilled, make up with fresh solution, but be careful not to have this too strong. Its specific gravity (S.G.) should be equal to that of the acid remaining in the accumulator.

When connecting up batteries for a charge, be careful to see that the positive of the battery is connected to the positive of the leads, and negative to negative.

You should avoid the use of cells of different sizes in series, or parallel.

When putting a battery on charge, if possible, always have in series with it a fuse, which will blow with double the normal charging current.

You should try to keep your batteries in such a condition that all the cells start gassing simultaneously on charge.

Portable batteries: It is advisable to periodically remove batteries from their wooden cases, and see that the sediment is not "shorting" any of the plates at the bottom of the cells, and that the solution covers the tops of the plates.

When a battery is not in use give it a short charge at least once in every ten days.

High tension batteries: The writer has found that if you want to get the best out of your H.T. battery, presuming it is of the dry-cell type, you should try to memorise the undermentioned hints.

Do not test your H.T. battery with a low-resistance voltmeter, because every time this is done a big strain is thrown on the battery and current is wasted.

Do not connect tappings from your battery to the consecutive studs of a rotary switch. The action of the switch will "short" each cell, or each three cells in succession as it passes over the studs. Wander plugs provide the best means of using varying voltages. If you must use a rotary switch, then insert a "dead" stud between each live one.

Never insert a fixed condenser into your set without first testing it for a "short." It may be the one across the H.T. leads, in which case the battery may be run down before the fault is discovered.

To prevent possible damage, it is a very good plan to insert a flashlamp bulb in series in the H.T. circuit. In the event of a "short" the bulb will fuse and break the circuit.

In a receiving set making use of two or more L.F. amplifying valves, it is an advantage to put an extra 60 volts across the plate of the last valve. This should always be done when using a loud speaker.

H. A. S. G.

THE USE OF ALTERNATING CURRENT FOR RADIO TELEPHONY TRANSMISSION.

By ALAN L. M. DOUGLAS, Staff Editor.

An article describing several efficient methods of utilising an alternating current supply to produce steady high-voltage direct current for the anode feed of telephone transmitting circuits. Details of a practical and constructional nature are put before the experimenter interested in radio telephony.

THE good fortune which attends the experimenter in the transmission of speech by wireless who has an alternating current supply on his premises is rarely appreciated to the full. Success in radio telephony is materially assisted by the provision of a reliable and sufficient source of anode current for the transmitting valves, and in a general way the higher this H.T. voltage is, the greater measure of usefulness will the transmitter possess.

The great majority of experimenters along these lines do not appear to realise the necessity for a high voltage supply, and a considerable number are under the impression that danger attaches to the use of pressures in excess of 200 volts or 300 volts. This latter statement, of course, is perfectly correct if we assume that much current strength is "behind" the voltage, but in the case of any apparatus described in this article the total power is not in excess of 30 watts; this, at 1,000 volts, for example, only signifies a current strength of 30 milli-amperes, or a fraction of the current taken by an ordinary flash-lamp bulb. Short circuits and similar disasters, therefore, do not have devastating effects, although one is well advised to avoid actual contact with the circuit oneself. The shock obtainable from 30 watts at 1,000 volts is comparable to that to be had from a telephone magneto rotated at a considerable speed; that is to say, unpleasant, but merely sufficient to act as a warning to be more careful. It must, however, be considered a source of danger to come in contact with voltages in excess of 500, and this should be borne in mind.

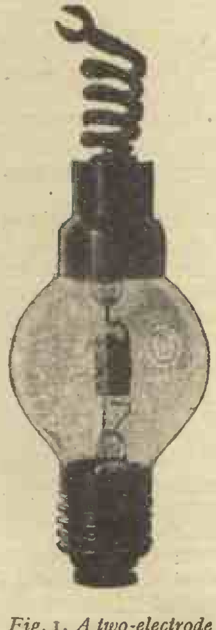


Fig. 1. A two-electrode valve for rectification of H.T. supply.

Now let us consider what sort of supply of alternating current we have. The majority of domestic A.C. lines are fortunately favoured with single-phase current; three-phase supplies require special rectifying apparatus and associated circuits, and do not come within the scope of this article. Alternating current at low voltages is generally supplied at a frequency of 50 or 100 periods. Occasionally we meet with 25 cycle supplies, when the source of current becomes more of a curse than a blessing. Such a low periodicity cannot be satisfactorily rectified in such a manner as to produce anything like a steady final voltage, and although it may be used for continuous wave transmission, it produces such a distressing hum in the speech as to render it practically useless for this latter purpose. We will therefore confine our investigations to 50/100 cycle A.C. supplies.

It is, of course, generally known that alternating current cannot be supplied directly to the anode circuit of transmitting valves, no matter what its frequency, as one-half of the oscillation is always suppressed and therefore we get an interrupted continuous current in the aerial. This is permissible possibly for certain classes of telegraphic communication, but cannot be of any use for radio-telephony. We must therefore rectify this current before it can be put to practical use. Before, however, considering the methods of doing this, it will be necessary to transform or step-up the line voltage to a suitable value for the particular valves in use. One of the greatest advantages of alternating current lies in the ease with which one can raise or lower the voltage or current strength in a simple and relatively inexpensive manner. We know, of course, that in the case of one coil of wire inductively coupled to another coil, if we pass a steady current through one coil we shall find no current flowing in the other coil; but if the first circuit is made or broken, then there will be a transference of energy between the coils, and current will flow in the second coil momentarily.

If the coils are called A and B respectively, and if the circuit in A is continually interrupted, an identical intermittency of current will be exhibited in B. If B consists of many more turns of wire than A, the ratio of intensity of current in B will be proportional to the ratio of turns of wire between B and A; and if an iron core is introduced into coil A, the effect is further enhanced.

It will therefore be seen that steady or direct current could not be stepped-up by such an arrangement, but if an interrupter were in the D.C. circuit then a step-up of potential would be obtained. This is the principle of the induction coil, and if the interrupted D.C. is replaced by alternating current, then we have the principle of the transformer; the reversal of flow of current in coil A producing a similar change in coil B, although slightly out of phase with A. Transformers for radio telephony take many forms; it is necessary to have a superficial knowledge of the construction of such

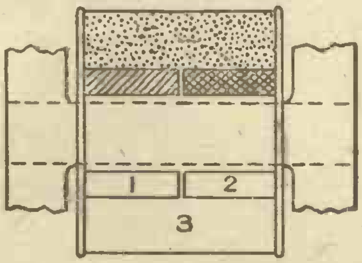


Fig. 2. Section of a transformer for H.T. and L.T. supply of a transmitter.

transformers to be able to fully appreciate the high-tension supply circuit.

If we examine one it will be evident that there is a closed core of apparently considerable size, made of soft iron laminations which, on close inspection, will be found to be all insulated from electrical contact with each other. This core has a central limb or leg upon which is a winding of relatively heavy wire. This is the primary circuit.

Upon this winding, and suitably insulated from it, will be found either one, two or three other windings. These may be arranged as in Fig. 2 or as in Fig. 3. They are all secondary windings, but one or two of them will be found to consist of a few turns of thick wire, whilst the remaining one will have a great quantity of fine wire. These windings are arranged to supply, if desired, two separate and well insulated 6-volt outputs, the fine wire one giving from 600/1,500 volts with a much smaller current output. This latter winding is the one with which we are most concerned.

As the step-up of voltage is directly proportional to the ratio of turns between the primary and secondary coils, this governs to a great extent the size of the transformer. Should the primary voltage be as low as 10, let us say, large potential variations are set up across the secondary, and the necessity for special insulation to withstand this strain is more pronounced than in the case of a transformer where the applied voltage is 250 or 100.

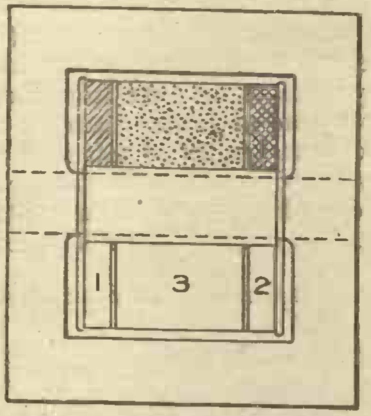


Fig. 3. A transformer with a different arrangement of windings.

A larger carcase is also required to accommodate the greater number of turns of wire. For radio-telephony, the windings should be provided with a centre tap, the reason for this being referred to later on. Two secondary windings should be chosen, one supplying 6 volts and the other from 1,000 to 1,200 volts. The output may conveniently be 18 watts for the 6-volt winding and 30 watts for the high-voltage winding. This means that in a transformer with a centre tap we shall have a winding for 1,000/1,200 volts on each side of this tapping point.

Before passing on to the rectifying circuits associated with this transformer, a certain amount of control over the output voltage of the apparatus may be exercised by the provision in the primary input of an iron-cored choke coil inserted in one of the leads. The core should be capable of being withdrawn from the coil, and is to be well insulated from the winding of the choke. Assuming the input to be 100 volts 50 cycles, a suitable choke coil to give as wide a range of control as convenient would be constructed as follows:

Examine Fig. 4. It will be seen that there s a brass tube 10 inches long by 1 inch bore.

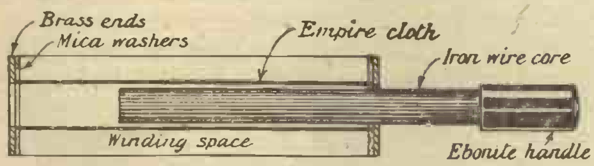


Fig. 4. Showing the construction of a variable iron-core choke.

This should have end-plates of brass sheet $1\frac{3}{4}$ inches diameter soldered on, after fitting two thick mica washers to their inside faces as indicated. The tube must then be well wrapped with thin cartridge paper soaked in shellac, and it is absolutely essential to see that the washers of mica fit over this so as to carefully insulate the tube from the winding.

An iron core of $\frac{3}{4}$-inch diameter should be prepared from lengths of soft iron wire, and this, if wrapped closely with fine iron wire as indicated in Fig. 5, will form quite a rigid member. An ebonite tube will be driven over

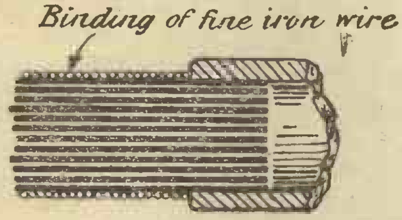


Fig. 5. Details of the core of the choke-coil.

one end to act as a handle, and the core should be of such a length as to be inserted right into the brass tube. This latter must now be wound full of No. 16 s.w.g. d.c.c. wire, and it will be advisable to shellac each layer as it is put on. A baseboard of convenient but simple shape, as indicated in Fig. 6, must now be made, and a groove to accommodate the core should be cut along its entire top surface. The completed choke may be secured to the base by means of brass straps at each end, as in Fig. 7, slots having been cut for the end discs and the groove widened to accommodate the whole coil. A strip of mica or presspahn is to be placed under each strap as shown, to avoid any possibility of short circuits.

Let us now examine how we are going to convert the high-tension alternating current supply into direct current. The two-electrode thermionic valve or vacuum tube is the medium most suitable for this purpose, although a three-electrode valve may be used if the grid and plate circuits are joined together exter-

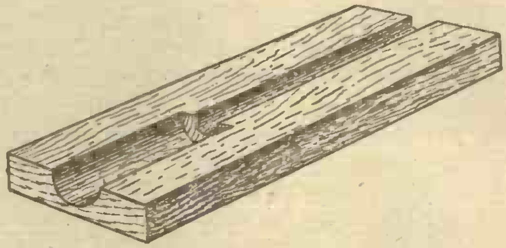


Fig. 6. The baseboard of the choke-coil.

nally by means of a wire. It will be convenient at this point to note the process by means of which rectification is effected. Look at Fig. 8: here we have a two-electrode valve A having associated circuits arranged as in the diagram. A large condenser C is connected between the filament-anode circuit and must be capable of withstanding several times the working pressure. A convenient value for this condenser is 5μF.

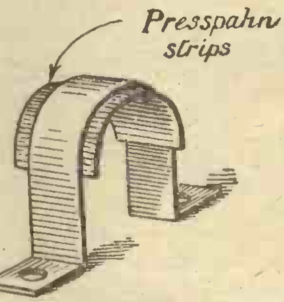


Fig. 7. Brass strap to hold the choke to the baseboard.

When the flow of alternating current is such as to make the anode positive, there will be a flow of electrons through the anode-transformer circuit to the right-hand plate of the condenser C. The cycle change making it negative will stop this electronic flow, so that no current flows in the anode-transformer circuit. This process, being continually repeated, causes the right-hand plate of C to become charged to a high negative value, and as no electrons can pass between the two condenser members the left-hand plate will be at a positive potential all the time.

As C is of relatively large capacity, it performs the function of a reservoir across the output circuit OP, and, in consequence, the demand upon it being small (a matter of milliamperes), we obtain almost pure direct current at OP. There is, however, a distinct A.C. ripple and this must be filtered out. Before passing to a consideration of this process, however, it will be seen that only one half of the wave has been rectified. To obtain satisfactory telephony on 50 cycle A.C. under

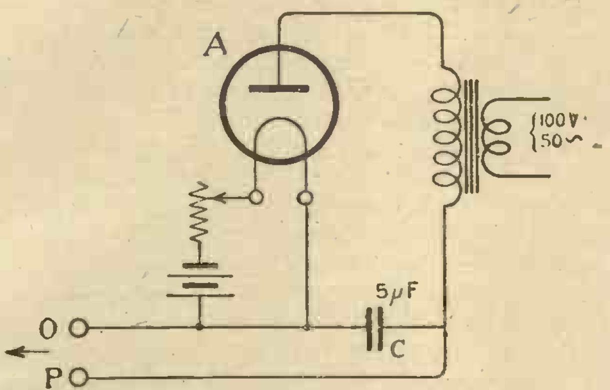


Fig. 8. A simple circuit for rectifying A.C.

such conditions would be very difficult, and therefore we should make use of *both* halves of the wave for practical purposes. This may be accomplished, as indicated in Fig. 9, by means of a rectifying valve in each output of the transformer. It will be readily seen from this diagram that the condenser G is kept continuously charged by each valve alternately as in the circuit already mentioned, and this is known as full-wave rectification. The use of the centre tapping is now obvious.

In Fig. 8 the filament is shown as being heated by an accumulator; the other secondary winding of the transformer may be used with advantage for this purpose, and a scheme of connections employing this is indicated in Fig. 10. A similar arrangement will also be noticed in Fig. 9, depicting full-wave rectification.

A.C. should not be used to heat the filaments of the transmitting valves if of as low a frequency as 50, as an undesirable hum will be set up in the receiver which will interfere with the speech. The lowest permissible frequency for this purpose would be about 1,000 cycles, and even at this value an efficient filter circuit should be provided. Well insulated accumulators are to be preferred in all apparatus for radio-telephony.

It will now be necessary to examine a suitable filter circuit to eliminate the greater portion of the A.C. ripple from the rectifying valves. It will be appreciated that, as this is at the frequency of the supply current, 50

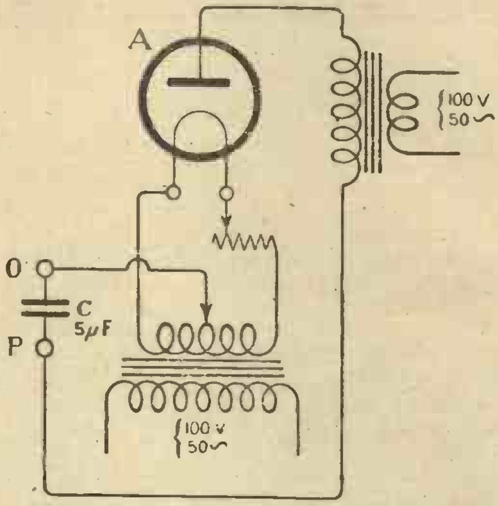


Fig. 10. Showing a rectifying valve with A.C. filament supply.

cycles will set up a distinct hum in any listening receiver. It is possible by suitable arrangements to almost entirely eliminate this noise even at such a low frequency. Fig. 11 shows an arrangement in the output of the rectifying system employing an iron-cored

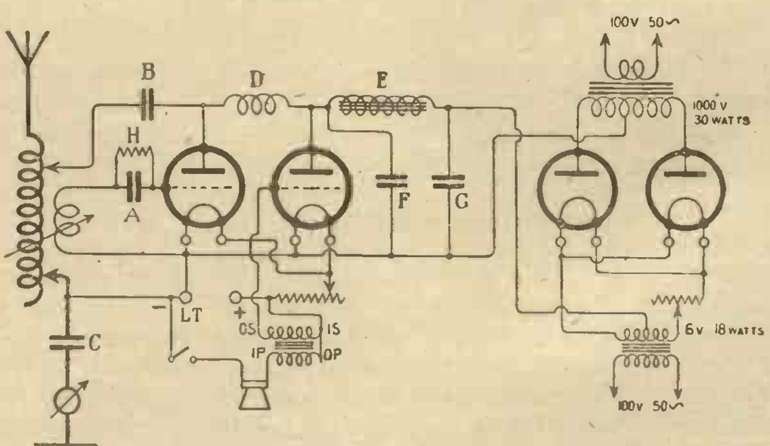


Fig. 9. Complete circuit of a transmitter showing full-wave rectification.

inductance and condensers of 2 and 5 μF. This inductance may have a value of 1 Hy., and can consist of ½ lb. of No. 36 s.w.g. s.s.c. wire wound upon an iron wire core 2 cms. in diameter. This will, of course, have to be very carefully insulated. An iron core inductance of this nature offers a very high resistance to pulsating currents of an A.C. nature

The potential variations across the choke will be of a relatively high order, but across the

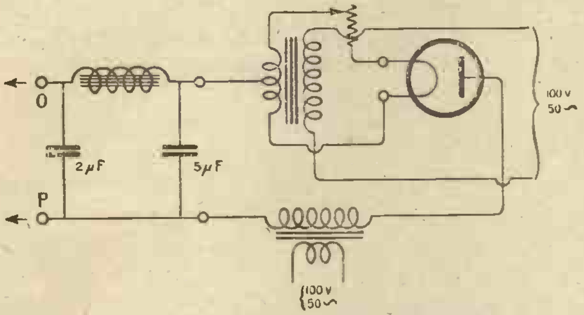


Fig. 11. A filter circuit for smoothing the rectified A.C.

condensers they will be only of a magnitude of a volt or two. We therefore obtain an A.C. ripple or wave of only 2 or 3 upon our steady voltage of 1,000, which can be discounted for all practical purposes.

Fig. 9 illustrates a complete radio telephone plant suitable for the experimenter, designed along the lines just described. It is possible for alternating current to be applied directly to the anode circuits of the transmitting valves, but the frequency would require to be over 1,000 and the valves would have to be arranged in such a manner as to utilise both halves of the wave to be in any way efficient. Such an arrangement cannot be conveniently used for radio-telephony.

In conclusion, let it be said that alternating current, if rectified and correctly filtered, is a much more satisfactory source of supply for transmission than direct current, and in general the domestic line supplies are very steady and do not cause fluctuations in the emitted carrier wave. Transformers should be worked well within their load capacity, and a voltmeter connected across full-wave rectification should be regarded as indispensable.

Experimenters in telephony transmissions should bear in mind that when handling A.C. at high voltages the greatest care should be taken to ensure good insulation, and transformers should only be purchased from firms specialising in their manufacture. Care should be taken that the pattern selected is suitable for the periodicity of the supply mains to be utilised. A typical rectifying valve is shown in Fig. 1.

BOOK REVIEW

"Wireless Licences and How to Obtain Them."

By E. REDPATH (Assistant Editor of "Wireless Weekly"). (Radio Press, Ltd., 1s.).

Although this book is extremely topical, in the sense that it deals with one of the burning questions of the day, we believe that its usefulness will long outlast the present licence controversy. It deals in a very illuminating manner with every type of licence, and the keen experimenter will find the chapters upon the experimental licences (transmitting and receiving) of especial helpfulness, for in these chapters an attempt is made for the first time to explain to the applicant exactly what he must know and what he must be able to do before he can expect to be granted either of these licences. The author deals with the question, of which he has evidently made an exhaustive study, in an extremely clear and painstaking manner, and shows not merely what knowledge is necessary, but also how that knowledge may be acquired.

We think the book should go far towards the clearing up of the many popular misconceptions about licences, and should be in the hands of everyone who intends taking a practical interest in wireless matters.

Practical Notes

HOW TO MAKE A FRAME AERIAL

A MOST useful addition to one's receiving equipment is a good frame aerial, with its extremely sharp tuning and strong directional properties. To those who live within a few miles of a broadcasting station the frame is probably the best solution of the problem of interference by the local station when attempting to receive one of those more distant, and it is well worth while to devote a little care to the construction of a good one.

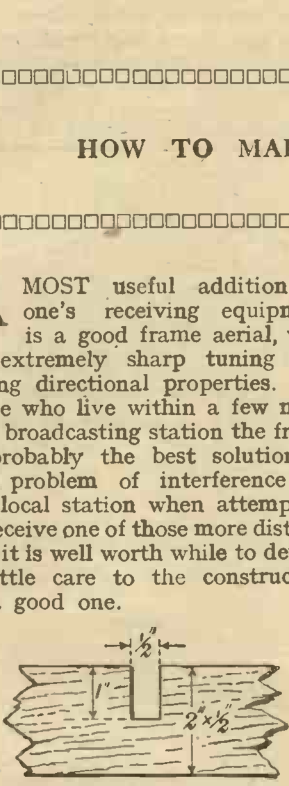


Fig. 1. Showing the dimensions of the notch to be made in each arm of the cross.

Wavelength Range.

The design of a frame aerial to cover a given range of wavelengths is outside the scope of this contribution, but it may be as well to remind the reader that the matter is not a very simple one, and that in making frames he should adhere fairly closely to dimensions which he knows to be correct, such as those contained in various published tables. The range of wavelengths covered by the frame whose construction is described in the lines which follow is approximately 350–600 metres when used with a tuning condenser of .001 μF capacity. (If it is desired to use it upon the broadcast band only, a capacity of .0005 μF is sufficient.)

Materials Required.

For the construction of this very simple frame aerial the following materials should be obtained:

2 pieces of wood 2 in. by ½ in. by 3 ft. long.

1 piece of wood, 2 in. by 2 in. by 2 ft. long.

1 piece of wood, 9 in. by 9 in. by 1 in. thick.

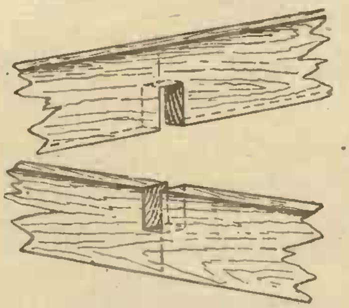


Fig. 2. The two arms with notches ready for placing together.

4 vulcanite or celluloid combs with coarse teeth. These combs should be 6 in. long and fairly robust, to withstand the necessary drilling.

1 piece of ebonite, 4 in. by 2 in. by ¼ in. thick.

1 lb. of No. 18 enamelled copper wire.

2 terminals, varnish, screws.

Construction.

The first proceeding is to "halve" together the two 3 ft. pieces of wood so that they may be joined together to form a cross upon which to wind the wire. The operation of halving consists in cutting in the centre of each piece a square notch ½ in. wide and 1 in. deep, as shown in fig. 1, so that when the notches of the two pieces are placed together the result is as shown in Fig. 3. Those who are unfamiliar with the method may have the work done for them by the local joiner for a trifling sum.

To each end of these pieces of wood must next be fixed one of the combs. This is best done by means of two screws passing through holes

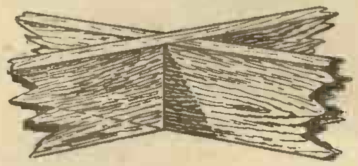


Fig. 3. Showing the two wooden arms halved together.

drilled near the ends of the comb. This is clearly shown in Fig. 5, which also indicates that the comb is to be attached obliquely so that there shall be no tendency for the turns of the winding to slip out from between the teeth in which they will presently be placed. In fixing the combs take care also that they are all attached so that their teeth project upon the same side of the cross when assembled.

Next, fasten the two arms of the cross together by means of a small nail through their point of intersection and proceed to mount them upon the pedestal, which is composed of the 2 ft. length of 2 in.-square wood attached by means of a screw to the centre

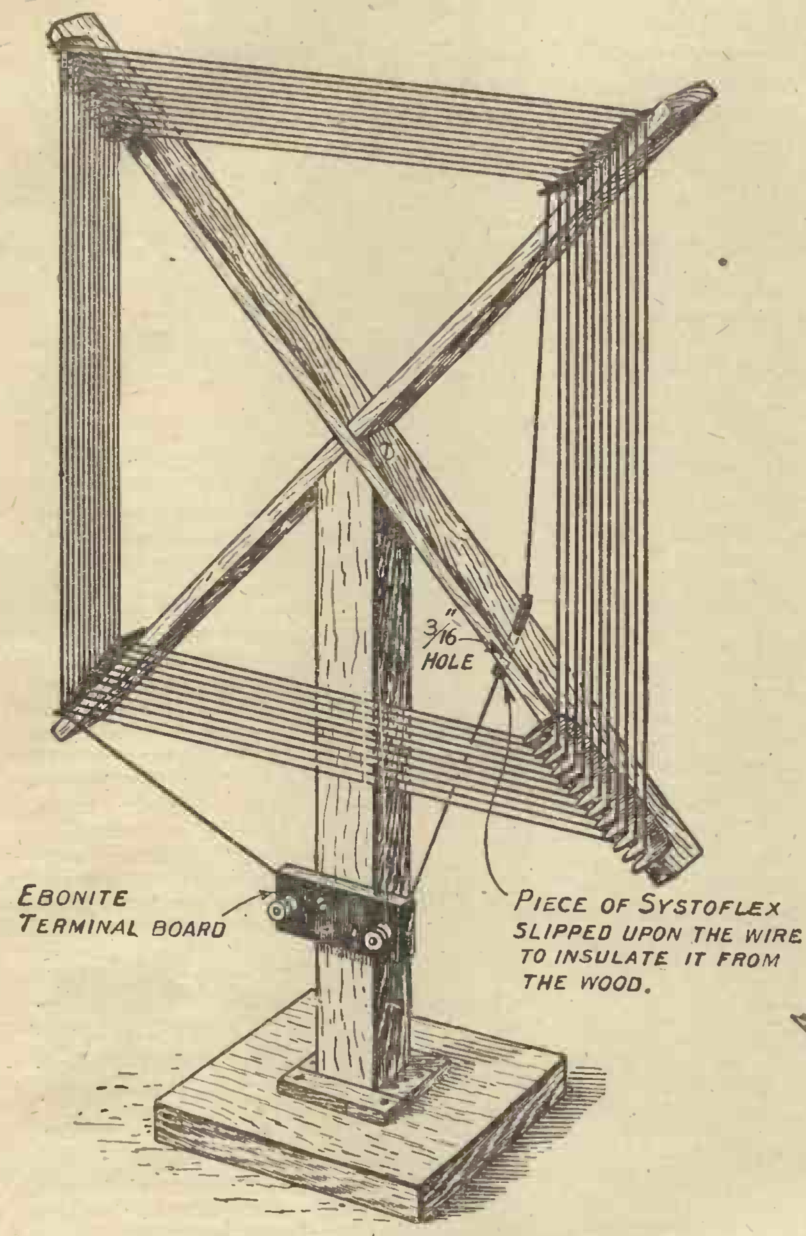


Fig. 4. The completed frame.

of the square piece of 1 in. thick board. Fig. 6 should make these details plain without further explanation.

Now drill the piece of ebonite with two holes for terminals and two for screws, attach the terminals (see Fig. 7) and screw it to the upright support of the frame as indicated in Fig. 4. This completes the actual construction, and the woodwork should next be given a coat of varnish and allowed to dry before putting on the winding.

Winding.

First drill a $\frac{3}{16}$ in. hole in the position indicated in Fig. 4 in one of the wooden arms of the frame, then thread the end of the wire through a short piece of systoflex (or rubber) tubing and pass it through the hole. Scrape the end bright and screw it down under the back nut of the right-hand terminal (Fig. 4) and adjust the piece of systoflex so that it slieves the wire

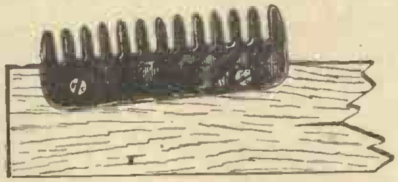


Fig. 5. Method of attachment of the combs.

where the latter passes through the hole in the wooden arm. Now take the wire round the frame, slipping it into the teeth of the combs at each corner, and keeping it tight. In this way wind on 12 complete turns, separating them

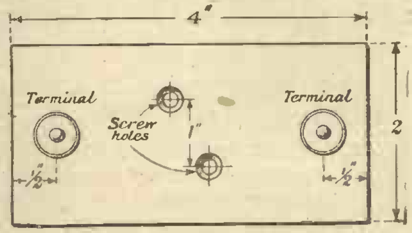


Fig. 7. The terminal block.

say, three or four teeth, depending upon the coarseness of the combs; the aim should be to space the wires about ½ in. apart. On the completion of the 12 turns fasten the finishing end of the wire under the left-hand terminal, and the frame is complete.

G. P. K.

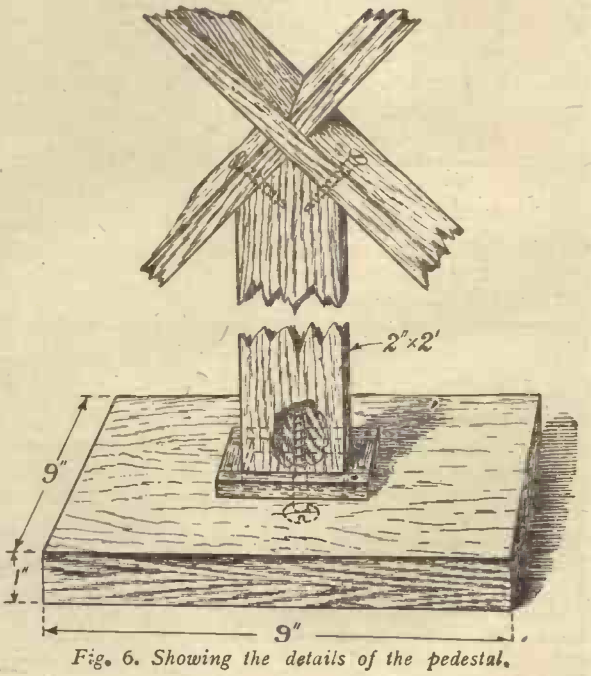
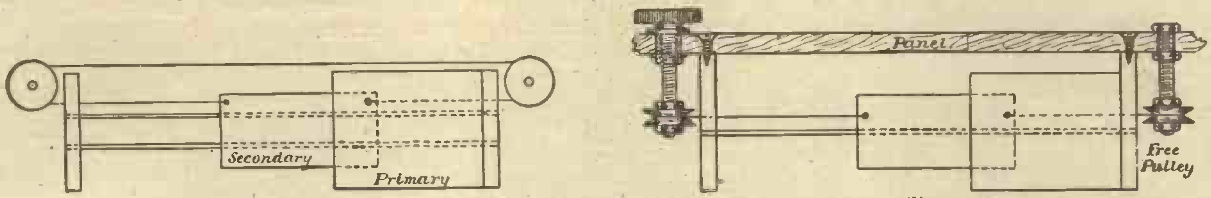


Fig. 6. Showing the details of the pedestal.

A SIMPLE PANEL CONTROL FOR SOLENOID COILS

IN mounting solenoid coils into a case the problem presents itself of sliding one coil in and out of another for variations of coupling. It is convenient to mount the coils horizontally, so that tapping leads to stud switches may be kept short. If the control, such as a quick thread screw or a movable rod fixed to the inner coil, is fitted on the side or front of the case it may be awkward to get at, while the only method of reaching the inside of the case is then to remove the bottom. The arrangement to be described allows of control from the top of the case, and leaves the panel free for lifting out when required. In addition, it provides a very smooth and fine variation of coupling.

It is assumed that the inner coil is mounted to slide freely on one or more supporting rods. At opposite ends of these rods and at one side of the coils are mounted two small grooved pulleys, about ½ in. diameter, one of which is free to turn on its axle. The other is fixed on one end of a screwed rod, the upper end of which projects through the panel and carries a suitable knob for turning. A length of fine hard twine or silk (undressed fishing line is excellent) is secured to opposite ends of the inner coil and passed tightly round the pulleys, a double turn being taken round the control pulley to obviate slipping. Fig. 8 should make the working of the device quite clear. The panel may be marked to indicate the direction of turning for "tight" and "loose" coupling. A. V. D. H.



(*a*) (*b*)

Fig. 8. Plan (a) and elevation (b) of the device for varying the coupling of panel-mounted solenoid coils.

A SIMPLE METHOD OF ADJUSTING THE TENSION OF SLIDER CONTACTS

IT is in many cases a troublesome matter to obtain a satisfactory adjustment of the slider bar to give the correct contact of the plunger upon the turns of the tuning coil. Not merely is it necessary to ensure that the plunger shall make satisfactory contact at all points on the coil, without pressing upon it so heavily as to injure the winding, but also the slider bar must be arranged exactly parallel to the winding. A very simple method of overcoming this difficulty should be made quite plain by the accompanying figure. The terminal is first screwed into the coil supports. A "thackeray" washer or spring of suitable thickness is then placed over the screw; next, the slider bar is put into position and a terminal head screwed on. By carefully adjusting the nuts of the terminals at each end of the coil, a very satisfactory contact can be obtained without difficulty. H. B.

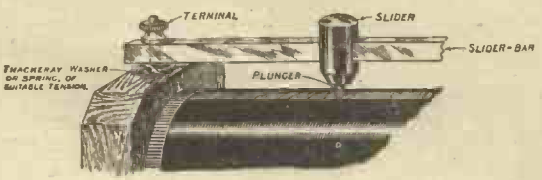


Fig. 9. The tension adjuster in position.

AN AERIAL INSULATOR

IT is surprising how many amateurs who, though they constantly design and construct good apparatus, do not turn their attention to the often most neglected part of a receiving set—the aerial. The important part of an aerial is, of course, the insulation. If the insulators are not good during all kinds of weather, one cannot expect the aerial, however well situated, to be really efficient.

The accompanying illustrations show a type of home-made insulator which possesses the advantage of being easily made without any sacrifice of efficiency, and which is a better insulator, particularly during wet weather, than most other types.

Fig. 10 is a cross-sectional view, where A is an ebonite rod; B the cover which protects the upper portion of the rod from rain; C an "eye hole" screw; D a metal washer; E a leather washer; and F paraffin wax. In construction the first article to obtain is the cover, as the dimensions of the rest depends on its size. The cover is an ordinary small tin box inverted. The majority of smaller boxes are made with a cardboard body and a tin base. These are quite suitable providing the cardboard has been well saturated in paraffin wax. The rest of the material can then be obtained.

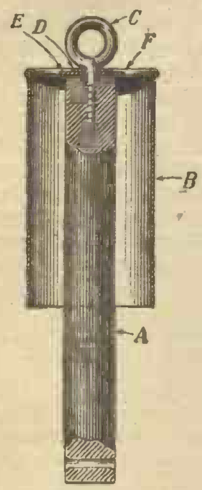


Fig. 10. Section of the insulator.

Take the ebonite rod and drill a hole in the centre of one end, slightly smaller than the thread on the "eye screw," and another is bored cross-wise through the rod at the other end. A hole is bored in the centre of the base of the tin box. The "eye hole" screw is then passed through the hole in the metal washer, the leather washer, and the tin box, and is screwed tightly into the ebonite rod until the cover is held firm.

When completed the top of the cover is heated, and hot paraffin wax is poured into the depression until level with the edge. This prevents any tendency to leakage of wet around the "eye hole" screw.

A. J. L.

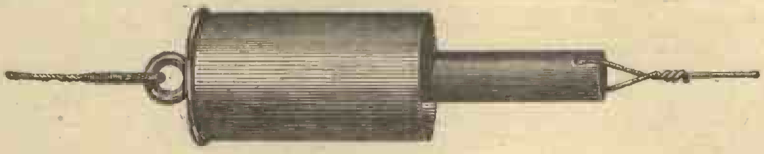


Fig. 11. The completed insulator.

AN EASY METHOD OF COIL MOUNTING

One of the greatest obstacles in the way of the experimenter who wishes to wind a set of multi-layer coils for his own use seems to be the difficulty of mounting them upon plugs to fit the standard coil holders.

The method which he usually tries first is that employing a fibre or leather band passing round the coil and having its ends secured under the two screws provided upon the coil plug. By the time he has fully realised what a difficult business it is to tighten up those screws without letting the band slip a little and become slack, his enthusiasm for home-made coils will probably have evaporated.

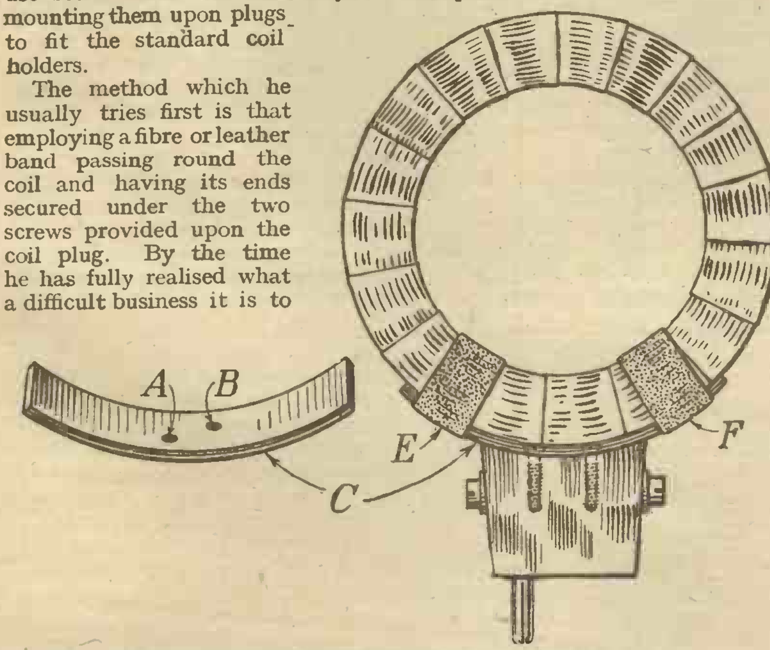


Fig. 12. Showing the method of attaching the coil to its plug.

The method of attachment illustrated in the accompanying figure will be found a satisfactory solution of the difficulty, which can be employed by anyone possessing quite simple tools.

The curved ebonite strip C is cut from a piece of tube having very roughly the same diameter as the coil to be mounted, and should be about 2½ inches long by ¾ inch wide. Two holes (A and B) are drilled in the positions shown with a 3 B.A. drill, and *slightly* countersunk, so that the heads of the screws which will pass through them may not project. Two corresponding holes are now drilled and tapped with a 4 B.A. thread in the plug.

Next, attach the ebonite segment C to the plug by means of two 4 B.A. brass screws ½ inch in length, as is shown in the diagram. Assuming that the coil has already been prepared for mounting by binding in the usual manner with Empire tape, the next step is to place it in position upon the plug and attach it firmly thereto by binding tightly round both coil and ebonite segment with sticky black insulating tape at the points E and F.

If the appearance of the two black bindings is disliked, they may be covered with a turn or two of Empire tape, secured in position by means of Chatterton's compound at start and finish.

G. P. K.

A VALVE AND EYE PROTECTOR.

MOST experimenters will have discovered by painful experience that to sit for any length of time operating a set equipped with the valves of the usual type, whose filaments have to be heated to dazzling whiteness, means that the eyes are apt to become strained by the glare. Some form of eye protector is therefore desirable.

Those who have eyes so strong that they are not affected by the bright light, or those who are fortunate enough to be able to use the expensive dull emitters, which work with filaments barely red hot, need no such shield. But they must often feel the need of something that will shield their treasured valves from the onslaughts of the housemaid's mop and duster. Valves are so easily broken, and they cost so much to replace!

The little device, a description of which follows, kills both birds with one stone, for it acts both as an eye shield and as a valve protector. It will be found easy to make and a great boon when fitted to the set.

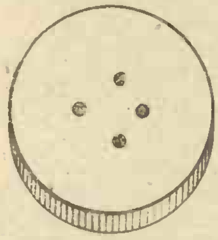


Fig. 13. The base of the valve protector.

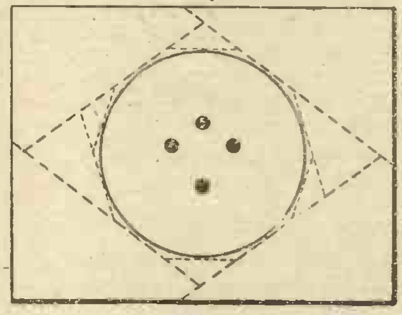


Fig. 14. Showing how to cut out the ebonite circle.

The base consists of an ebonite disc (Fig. 13) slightly larger in diameter than the fattest part of the bulb of the valve for which it is designed. Even if you have no lathe the disc can be made from $\frac{3}{16}$ inch ebonite quite satisfactorily with a tenon saw and a file. Saw-cuts are made as shown by the dotted lines, and final trimming is done with the file. The four holes are made with a $\frac{3}{16}$ inch drill so that they are an easy fit for the pins of the valve.

The disc should be made a tight fit for a standard size of cardboard tubing big enough to clear the bulb comfortably. A piece of this tubing about an inch longer than the valve is now cut off.

To mount the eye and valve protector, slip the pins of the valve through the holes in the disc, then push the valve home in its holder. Then slide the tube over the valve and push it down until it is firmly held by the disc.

The tube may be provided with a cardboard top fixed in place with seccotine. In this case it is advisable to make a window in the tube so that you can see whether the filament is glowing. The window should be covered with a little strip of celluloid painted blue so as to cut off the glare. R. W. H.

HOW TO MAKE A DOUBLE-POLE CHANGE-OVER SWITCH.

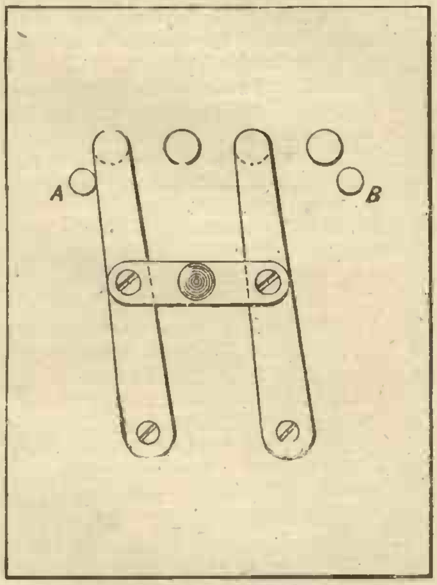


Fig. 15. A plan of the switch showing the stops A. and B.

A SWITCH of this type has many uses in a wireless set. It can be used as an aerial-earth switch, a series-parallel switch for the condenser, or a stand-by-tune switch, and for a number of other useful purposes.

A general view of the switch is shown in Fig. 15. The base is of ebonite, $\frac{1}{4}$ in. thick. A piece 3 in. by 4 in. is required. This should be squared up, and then marked out and drilled as shown in Fig. 16. Into the four smaller holes, four contact studs, $\frac{1}{4}$ in. diameter by $\frac{1}{4}$ in. high, are screwed. These can be bought quite cheaply from many advertisers in this journal.

The switch arms, of which there are two, are cut from $\frac{1}{16}$ in. spring brass to the dimensions of Fig. 17. The narrower ends should be bent round slightly as shown, in

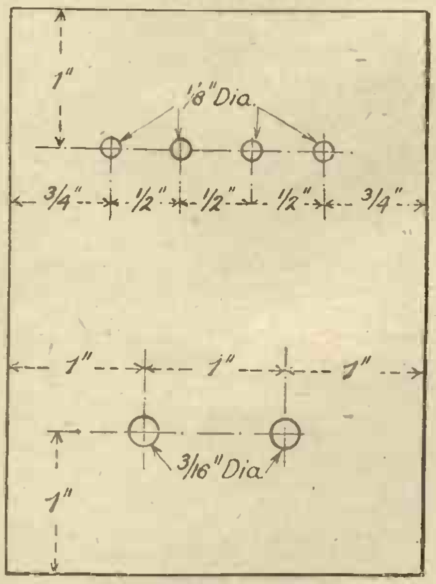


Fig. 16. Showing the dimensions of the base.

order to make a sure contact with the studs. The holes at the other end are tapped 2 B.A. and 1 in. pieces of rod, threaded 2 B.A., are screwed into them, so that the ends of the rods are flush with the surface of the switch arm. To prevent them from unscrewing,

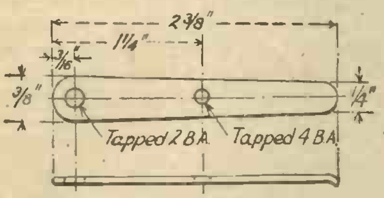


Fig. 17. Dimensions of the moving arms of the switch.

the ends should be soldered to the switch arms. Two washers, 3 in. diameter and ¼ in. thick are next made. Failing these, enough ordinary 2 B.A. washers could be used to raise the switch arms ¼ in. from the panel. This is not so neat, however.

It only remains now to make the piece for connecting the two switch arms. This is of ebonite, and is shown in Fig. 18. In the centre of it can be fixed a knob of any convenient size or shape. The connecting piece is fixed to the switch arms by screws which enter the holes tapped 4 B.A., shown in Fig. 17. These screws should have their ends riveted

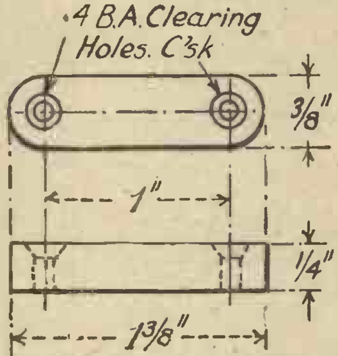


Fig. 18. The ebonite bar connecting the two moving arms.

or soldered underneath the switch arms, to prevent unscrewing. The connecting piece should allow the arms to move freely.

To complete the switch, the washers are slipped over the rods which were screwed into the switch arms, and the rods are then passed through the 3/16 in. holes in the base; 2 B.A. nuts and washers are then screwed on under the base. The nuts should be locked with two more nuts; failing this, they should be soldered to the rods, to prevent unscrewing. If necessary the switch-arms should be slightly bent to ensure good contact with the studs in both positions of the switch.

Fig. 19 shows the completed switch. The stops for the switch arms may be studs ⅜ in. high, or merely pieces of rod, screwed into the base. They should be placed so that the switch arms are stopped when they are exactly on the correct studs.

In wiring up the switch, the wires can be soldered directly to the studs and switch arm spindles on the underside of the base, but if desired, six terminals could of course be added.

The resulting switch, on account of its many uses, should appeal to all experimenters.

W. E. M.

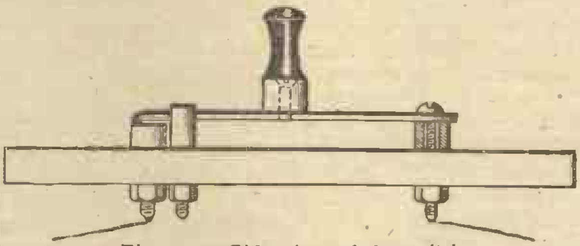


Fig. 19. Side view of the switch.

SOLDERING FLEX LEADS.

Of all the little jobs that we are called upon to do when making repairs or alterations in the wireless set, that of soldering flexible leads is probably the worst done by the majority of experimenters. Yet it is really a very easy business if it is tackled in the right way.

There are of course two sorts of flex. The ordinary type consists of a number of strands of thin bare wire cabled together and provided with one or more layers of insulation. The other kind also contains numerous fine wires, but instead of their being bare each is separately insulated. Those who use the Mark III. tuner will be familiar with the Litzendraht windings of its inductances, which are made in this way.

Now, whichever type of flex you may be dealing with it is important that *all* the strands should be soldered. This is particularly of moment in the case of "Litz," for if any strand is broken or left out of the joint, serious high frequency losses will result.

With ordinary flex it is easy to scrape off the outer covering, and then to unwind the inner layer of silk which covers the wires. But Litzendraht cable is a different proposition altogether. To endeavour to bare each of its forty or more strands by hand is a task that is beyond the patience of most people. The best method is to singe this insulation, taking care not to use more heat than is necessary; it can then be rubbed off with the fingers.

Once the wires are bared they should be twisted together as tightly as is possible without breaking them; they must then be dressed with fluxite. Into an iron teaspoon put a quantity of small chips of solder and melt in the flame of a spirit lamp. When the solder runs plunge the twisted end of the flex into it, and withdraw. It will then be found that the strands are firmly bonded together with solder. It is the simplest matter to solder them thus united to the terminal or valve pin to which they belong.

R. W. H.

RADIO SERVICE BULLETIN

Notes and Amendments from the U.S.A. Bureau of Navigation.

Information from the Berne Bureau.

Egypt.—Radiograms can be exchanged between vessels and Syria by means of the Alexandria radio station. The rate is the same as the rate for Egypt increased by an additional rate of 30 centimes per word.

Italy.—The Italian Government points out the fact that ship stations frequently transmit the same radiogram to two Italian coast stations on different dates. The Italian Government enters the radiogram twice on their accounts. In order to prevent inconveniences and the loss of money resulting therefrom, they have requested that operators of ship stations never omit the indication "duplicate" in their radiogram. The Italian Government holds that in case the word "duplicate" is omitted the ship station should be required to pay twice the coast and telegraph rate.

Brazil.—The coast station at Fernando de Noronha is open to PG service. Rate is 60 centimes per word, minimum 6 francs per radiogram.

Sweden.—Beginning February, this year the rates of Swedish coast stations were reduced to 30 centimes per word, minimum 3 francs per radiogram.

Greece.—Beginning February 13, last, the station at Vari was opened to PG service, call letters SXB. This station replaces the station Athens No. 2.

Turkey.—Turkey has neither ship nor coast stations open to PG service. This country will not accede to certain regulations regarding the accounts for radiograms originating from foreign vessels in the harbour of Constantinople.

Storm and Weather Forecasting on the Atlantic Ocean.

The need for and value of a weather forecasting service for the benefit of ships in mid-ocean, and especially along the routes between the United States and Europe, has been long recognised, but there has been inherent difficulties which prevented the inauguration of a service of this character. Chief among these difficulties has been the impracticability of collecting promptly and accurately current weather observations which are essential to such a system. For many years the United States Weather Bureau has been issuing twice daily forecasts of wind and weather as far east as the Grand Banks for the benefit of ships leaving North Atlantic ports and bound east. Lack of observations over the ocean areas has prevented the extension of these forecasts to cover the eastern sections of these routes. Radio now renders the collecting of observations and the disseminating of the forecasts to ships, regardless of their position in the lanes, a quite feasible matter. The co-operation of shipmasters in supplying the observations and the organising of a forecasting system are now the essential factors in providing a service that is destined to be of inestimable value to navigation interests on the oceans. An experimental service of this character had been projected and was in readiness for trial when the outbreak of the great war put a stop to the arrangements.

It is apparent that a forecasting service for ships in mid-ocean cannot be conducted from any station located on continental shores, and no island in the American-European lanes is advantageously located for the purpose. The ideal arrangement would be for more "floating islands"—ships anchored at selected positions—with trained meteorologists and forecasters on board, to serve as collecting stations where the weather reports would be charted and the forecasts disseminated on fixed schedules. This is not possible of realisation in the near future, and possibly may never be practicable. Shore stations cannot be utilised because of the volume of radio transmissions which would interfere with the prompt reception of ship observations, and a still greater deterrent is that only a comparatively few ships have radio equipment sufficiently powerful for a sending range of more than a few hundred miles, and reports could not be received from those any considerable distance at sea.

The most practical solution of the problem at the present time is the use of ships travelling the lanes with more or less regularity on which the work can be conducted collaterally and without interference with the ships' radio traffic. Moreover, international co-operation and considerable expenditures are required for an exclusive project of this kind, and the present conditions of world finance would take it out of the range of consideration at this time.

However, it is practicable to accomplish very effective results under existing conditions and with very little cost if the free and sympathetic co-operation of vessel masters and radio operators can be procured. The practicability of the scheme already has been demonstrated by the French training ship *Jacques Cartier* during the past year on the occasion of its several trips between French and American ports. This ship has among its corps of instructors Professors Coyecque and Adeline, who are experienced meteorologists and forecasters. They employed the weather observations taken at various points in the United States and Canada, which are regularly broadcast at 10.30 a.m. and p.m. (75th meridian time) from the naval radio station at Arlington (NAA), and similar observations from European stations broadcast on schedule from the Eiffel Tower, supplemented by observations obtained through the courtesy of ships that were accosted. These reports were charted, and forecasts prepared therefrom were transmitted in English and in French to ships within its range. An average of about six ship reports an hour were assembled. This was a very gratifying accomplishment when it is considered that no publicity had been given to the project and vessel masters in general were not informed regarding the work.

The *Jacques Cartier* will continue this work. The United States Weather Bureau is deeply interested in the pioneer project which it is believed will lay the foundation for extensions in forecasting services which will ultimately prove of great economic value to ocean transportation interests. The co-operation of vessel masters in responding to the calls from the *Jacques Cartier* for weather reports will go far toward making this experimental work a success. On an average, there are about 300 ships of 5,000 tons or more displacement on the Atlantic routes between Europe and North America every day, and with co-operation on the part of ships of all nations a sufficient number of observations may be procured to issue reliable forecasts for a period of 24 hours or more in advance, which will be made available free of cost to all vessels within the range of the *Jacques Cartier.*—*From the United States Weather Bureau.*

Application for Radio Call Letters.

Applications for radio call letters for vessels newly equipped with wireless apparatus should be filed with the collectors of customs at the various ports at the time application is made for the official number and signal letters and not before such time. When the official number has already been assigned, the application for radio call letters should give the number, and, in case a vessel has had a former name, the name should be given. All particulars regarding the hours of service, class of service, rates, etc., should be reported without delay in order that the data may be published in the Radio Service Bulletin and furnished to the International Radio-telegraph Bureau at Berne. When it is very inconvenient to apply to the collector of customs, application may be made to the radio inspector in the district where the vessel may be.

Information from the Hydrographic Office.

Free medical advice to seamen by radio.—To the list of United States Public Health stations and the United Fruit Co.'s hospitals offering free medical advice to vessels at sea by radio has been added the United States Marine Hospital No. 14, at New Orleans, La. Calls upon the hospital may be made through the naval radio station at New Orleans, La., by vessels in the region of the Gulf of Mexico. Call signal NAT.

International Ice Patrol Service.—For the purpose of carrying on the International Ice Observation and Ice Patrol Service provided for by the International Convention for the Safety of Life at Sea, London, 1913-14, the U.S. Coastguard cutters *Tampa* and *Modoc* have been detailed for this service.

The object of the Ice Patrol Service is to locate the icebergs and field ice nearest to the transatlantic steamship lanes. It will be the duty of the patrol vessels to determine the southerly, easterly, and westerly limits of the ice, and to keep in touch with these fields as they move to the southward, in order that radio messages may be sent out daily, giving the whereabouts of the ice, particularly the ice that may be in the immediate vicinity of the regular transatlantic steamship lanes.

During the months of March, April, May, and June, and as much longer as necessary, these two vessels will obtain fuel and other necessary supplies at Halifax, N.S. They will alternate on patrol, making alternate cruises of about 15 days in the ice region, the 15 days to be exclusive of time occupied in going to and from base. The movement of the vessels will be so regulated that on the fifteenth day after reaching the ice region the vessel on patrol will be relieved by the second vessel, if possible, at which time the first vessel will proceed to base, replenish her fuel supply, and return in time to relieve the other vessel at the end of the latter's 15-day cruise. It is important that the patrol be continuous, and the vessel on patrol will not leave her station until relieved by the other vessel unless it is absolutely necessary to do so.

Having located the ice, the patrol vessel will send the following daily radiograms. All time in radiograms will be in 75th meridian time: (*a*) At 6 a.m. and 6 p.m. (75th meridian time) ice information will be sent broadcast for the benefit of vessels, using 600-metre wave length. This message will be sent three times, with an interval of 2 minutes between each. (*b*) At 8 p.m. (75th meridian time) a radiogram will be sent to the Hydrographic Office, Washington, D.C., through the nearest land radio stations, defining the ice danger zone, its southern limits, or other definite ice news. The telegraphic address of the Hydrographic Office is "Hydrographic, Washington, D.C." (*c*) Ice information will be given at any time to any ship with which the patrol vessel can communicate on 600-metre wave length.

Ice information will be given in as plain, concise English as practicable, and will state the following order: (*a*) Position of patrol vessel. (*b*) Location and description of ice. (*c*) Other data.

While on this duty, the patrol vessel will endeavour by means of daily radio messages to keep ships at sea advised of the limits of the ice fields, etc.

The ice patrol vessel's radio call letters are KFOG.* They will use a wave length of 600 metres when communicating with passing vessels.

The radio messages from the patrol ships will be given publicity by the Hydrographic Office, as follows:

(*a*) By radio broadcast from—

Station.	Seventy-fifth meridian, standard time.	Wave length (metres).
Arlington	10.30 a.m.	5,950, C.W.
	9.55 p.m.	2,650, spark.
Annapolis	5 p.m. ..	17,145, C.W.
Boston ..	11 a.m. .. / 5 p.m. ..	1,620, spark.
New York	10.30 a.m. / 5 p.m. ..	1,832, spark.
Norfolk ..	10.45 a.m. / 4 p.m. ..	1,851, spark.
Ice-patrol ship ..	6 a.m. .. / 6 p.m. ..	600.

(*b*) All reports of ice are published in the Daily Memorandum and the Weekly Hydrographic Bulletin.

NOTE.—The work of the U.S. Coastguard cutters engaged on ice patrol duty will be greatly facilitated if the principal transatlantic steamship companies instruct the masters of their vessels to report the following data by radio to the patrol vessels: (*a*) Icebergs or obstructions sighted, giving date, time, latitude, longitude, and direction of drift if an iceberg, together with the temperature of the water at the time. (*b*) Surface temperature of the sea water every four hours when between latitudes 39° N. and 48° N., and crossing longitudes 52° W. and 44° W. when bound either east or west, and giving the latitude and longitude, course, and speed at time of each observation. These data will facilitate the plotting of a temperature curve which will be useful in locating the branches of the Labrador Current.

* This is a special call for the vessel actually on patrol and must not be confused with the regular call letters of the vessels.

Radio interference with messages from the ice patrol vessels.—The ice patrol vessels send out information daily relative to the ice conditions at 6 a.m., 6 p.m., and 8 p.m. (75th meridian time). It is therefore requested that masters and others will instruct their radio operators to desist, as far as practicable, from operating at the above times.

Violation of Article 46 of the International Convention.

Attention of all radio operators is invited to the above-cited article of the International Convention service regulations, as the bureau has received a number of reports of violations of this regulation. The article is herewith quoted for the information of all concerned:

"The exchange of correspondence between shipboard stations shall be carried on in such a manner as not to interfere with the service of the coastal stations, the latter as a general rule being accorded the right of priority for the public service."

975 Metres to be used in Turkish Waters.

The United States Shipping Board has informed this office that by agreement of the Allied Communication Officers the wave length of 975 metres is assigned to United States naval vessels operating in Turkish waters. This wave length and no other is used by United States vessels. In view of this fact, it is believed that the difficulties which have appeared from time to time will disappear. The station at Constantinople does not call, receive, nor send on any wave length other than 975 metres.

Wave Lengths used by Devizes Radio Station.

The difficulties which have been experienced at the Devizes station in the reception of long-distance radiograms from ships are found to be increased by the fact that the wave length used by ships frequently differs appreciably from the wave length nominally used for communication with Devizes, viz., 2,100 metres C.W. Recent observations showed that the wave length actually used varied from 2,080 to 2,180 metres.

The use of different wave lengths by the ships not only necessitates a continual adjustment of the receiving apparatus at Devizes, but also increases the probabilities of interference, and may even lead to a call from a ship being missed if the station is at the time listening to another ship which is using a different wave length.

It is accordingly proposed to arrange for Devizes to send out every four hours a long dash lasting a minute on a standard wave of 2,100 metres C.W., to enable the ships to check and adjust, if necessary, the wave length of the transmitter on board. It is essential that ships equipped with C.W.

apparatus be accurate in their adjustments. In order to avoid encroaching on the time available for the exchange of traffic, it is proposed to arrange for the standard wave to be emitted toward the end of the period of 10 minutes, viz., 35 to 46 minutes past the hour G.M.T., during which ships using long wave C.W. are at present required to keep watch on 2,400 metres. Devizes will as at present broadcast on 2,400 metres the call signals of the ships for which messages are on hand, and they will ask ships to "Stand by" until 44 minutes past the hour for the standard wave of 2,100 metres. This standard wave will be emitted at 0044, 0444, 0844, 1244, 1644, and 2044 G.M.T.

Capetown Time Signals Amended.

South Africa.—Cape of Good Hope.

Position.—On Slang Kop point. Lat. 34° 08′ 45″ S., long. 18° 19′ 17″ E.

Details.—Capetown W.T station broadcasts time signals daily as undermentioned and not at the times stated in the former notice. The signals, which are controlled from the Cape Observatory, are preceded by the usual warning signal, and comprise a series of 12 dashes (each of about three-quarters of a second's duration) extending over half a minute, divided up into five groups, a dash commencing at each of the following times:

G.M.T. (astronomical.)

h.	m.	s.	
8	59	30	Group I.
		32	
		34	
8	59	38	Group II.
		40	
8	59	44	Group III.
8	59	48	Group IV.
		50	
8	59	54	Group V.
		56	
		58	
9	00	00	

Each signal may be used as indicating the exact G.M.T. recorded above; the beginning of the last dash of the series corresponding exactly with 9h. 00m. 00s. G.M.T., corresponding to 11h. 00m. 00s. standard time.—*From Notice No.* 68 *of* 1923, *Admiralty, London, January* 10, 1923.

CALL LETTERS ASSIGNED TO COUNTRIES BY BERNE BUREAU.

Call letters.	Country.	Call letters.	Country.
AAA–AMZ	Germany.	OAA–OBZ	Peru.
ANA–APZ	Dutch Indies.	OCA–OFZ	Great Britain.
AQA–AWZ	Norway.	OGA–OIZ	Denmark.
AXA–AXZ	Poland.	OJA–OJZ	Finland.
AYA–AYZ	Venezuela.	OKA–OKZ	Czechoslovakia.
AZA–AZZ		OLA–OMZ	Netherlands.
B	Great Britain.	ONA–OTZ	Belgium (colonies).
CAA–CEZ	Chile.	OUA–OZZ	Denmark.
CFA–CKZ	Great Britain protectorates.	PAA–PIZ	Netherlands.
		PJA–PJM	Curacao.
CLA–CMZ	Spain.	PJN–PJZ	Dutch Guiana.
CNA–CNZ	Morocco.	PKA–PMZ	Dutch Indies.
COA–COZ	Great Britain.	PNA–PPZ	Brazil.
CPA–CPZ	Bolivia.	PQA–PSZ	Portugal.
CQA–CQZ	Monaco.	PTA–PVZ	Brazil.
CRA–CRZ	Portugal (colonies).	PWA–PWZ	Cuba.
CSA–CUZ	Portugal.	PXA–PZZ	Netherlands.
CVA–CVZ	Rumania.	Q	Reserved for abbreviations.
CWA–CWZ	Uruguay.		
CXA–CXZ	Spain.	RAA–RQZ	Russia.
CYE–CZZ	Mexico.	RRA–RZZ	
DAA–DSZ	Germany.	SAA–SMZ	Sweden.
DTA–DTZ	Danzig (Free State).	SNA–STZ	Brazil.
DUA–DZZ	Germany.	SUA–SUZ	Egypt.
EAA–EHZ	Spain (colonies).	SVA–SZZ	Greece.
EIA–EZZ	Great Britain.	TAA–TEZ	Turkey.
F	France (colonies and protectorates).	TFA–TEZ	Iceland.
		TGA–THZ	Greece.
G	Great Britain.	TIA–TOZ	Spain.
HAA–HAZ	Hungary.	TPA–TUZ	Norway.
HBA–HBZ	Switzerland.	TVA–TZZ	Netherlands.
HCA–HCZ	Ecuador.	UAA–UMZ	France (colonies and protectorates).
HDA–HEZ	Netherlands.		
HFA–HFZ	Kingdom of Serbia.	UNA–UNZ	Kingdom of Serbia.
HGA–HHZ	Siam.	UOA–UOZ	Austria.
HIA–HIZ	Dominican Republic.	UPA–UZZ	Italy.
HJA–HKZ	Colombia.	VAA–VGZ	Canada.
HLA–HNU	Spain.	VHA–VKZ	Australia.
HNV–HNZ	New Hebrides.	VLA–VMZ	New Zealand.
HOA–HZZ	France (colonies and protectorates).	VNA–VNZ	Africa.
		VOA–VOZ	Newfoundland.
I	Italy (colonies).	VPA–VSZ	Great Britain (colonies and protectorates autonomous).
J	Japan.		
KAA–KAY	Germany.		
KAZ	Danzig (Free State).	VTA–VWZ	British Indies (Persian Gulf).
KBA–KBZ	Germany.		
KCA–KCZ	Lettonia.	VXA–VZZ	Great Britain (colonies and protectorates).
KDA–KZZ	United States.		
LAA–LHZ	Norway.	W	United States.
LIA–LRZ	Argentina.	XAA–XDZ	Mexico.
LSA–LUZ	Great Britain.	XEA–XMZ	Great Britain.
LVA–LVZ	Guatemala.	XNA–XSZ	China.
LWA–LWZ	Norway.	XTA–XZZ	Great Britain.
LXA–LZZ	Bulgaria.	Y	Do.
M	Great Britain.	Z	Do.
N	United States.		

FIRESIDE PANELS.

THE convenience resulting from the fitting of such an accessory as a fireside panel repays one time after time for the trouble taken in constructing it. There is nothing more irritating than the confusion which occurs when a member of the family is endeavouring to attach his or her lead of the 'phones to a terminal which is already doing its utmost to sandwich together half a dozen others.

The great advantage of the panel system is that the receiving instrument as a complete unit can be placed in an adjoining cupboard or in some position which is convenient to the operator and yet will not offer any temptation to unauthorised persons to interfere with the action of the set.

In the majority of cases four 'phones each of 4,000 ohms resistance can be attached to the receiver, even a crystal set, without any perceptible diminution in the signal strength, and, what is more, the length of the telephone leads within reasonable limits makes little difference. This fact enables permanent panels to be fitted at convenient places in the room, the best place of course being on either side of the fireplace, as shown in Figure 1, and at the bedside in the case of a bedroom.

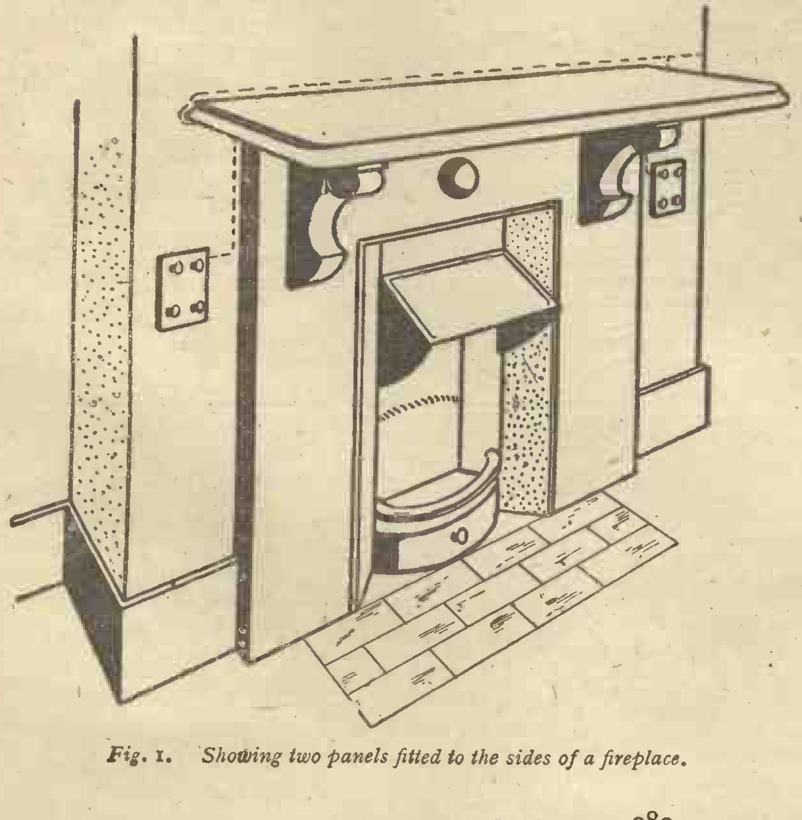


Fig. 1. Showing two panels fitted to the sides of a fireplace.

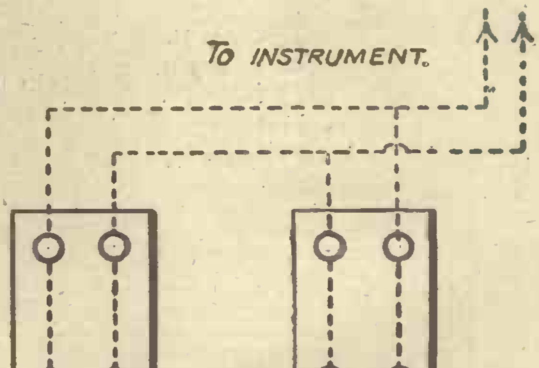


Fig. 2. Showing how to wire up the panels in parallel.

These panels are of ebonite $3\frac{1}{2}$ in. by 2 in. by $\frac{1}{4}$ in. thick, and the number used will vary according to requirements, but four are usually sufficient for one room. Figure 2 illustrates the method of wiring. H.J.T.

A NOVEL VALVE WINDOW.

MESSRS. C. F. ELWELL, Ltd., have placed upon the market an ingenious fitment for attachment to sets in which the valves are placed behind the panel. This device resembles a small opal bull's eye, about half an inch in diameter, enclosed in a neat nickel-plated casing.

To mount them, a hole of appropriate size is drilled in the panel opposite each valve. The windows are then pushed in, and it can be ascertained at a glance whether the valves are lighting up correctly without having to open the instrument case.

These windows form a handsome addition to any panel-front and do away with unsightly holes in the panel.

THE "CLAW-GRIP" CRYSTAL DETECTOR.

THE illustrations reproduced on this page show the essential features of a new form of patented crystal detector known as the "Claw-Grip," the name being derived from the shape and action of the member which secures the crystal.

As will be seen from the illustration of the standard vertical type, the claw consists of a two-pronged member which is attached to a screwed stud. A hollow knurled nut fits the latter, and as the nut is tightened, the claw is drawn into it, the action closing in the prongs of the claw upon the crystal.

The movement permits of the use of crystals varying in size, and even those of the most brittle character can be fixed and changed without suffering damage from flaking.

When the crystal is fixed in the claw, this portion is pushed into a sleeve which, in addition to possessing a certain amount of spring, acts as a register for the enclosing glass in some types.

Perfect electrical contact is ensured by the firm pressure of the claw prongs on the crystal, whilst the security of the fixture prevents loss of a "good" sensitive spot owing to vibration.

The other illustrations depict the "Claw-Grip" mounted as a detector of the double-crystal pattern; this range of detectors being designed to suit the varying tastes of users of the ever-popular crystal receiving set. R.T.

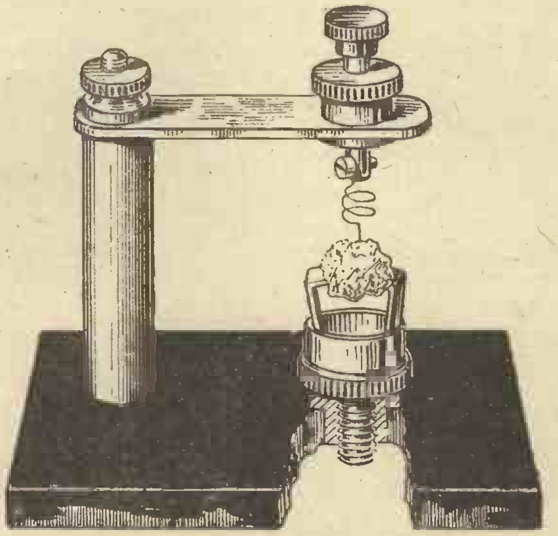


Fig. 3. A "claw-grip" detector of the cat-whisker type.

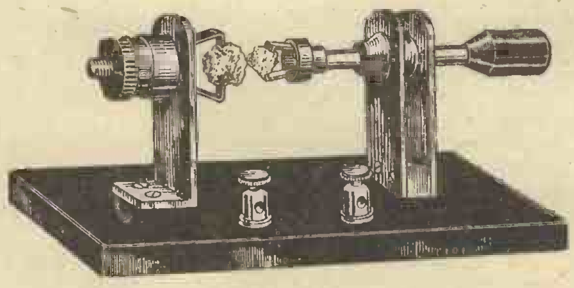


Fig. 4. A Perikon detector with "claw-grip" cups.

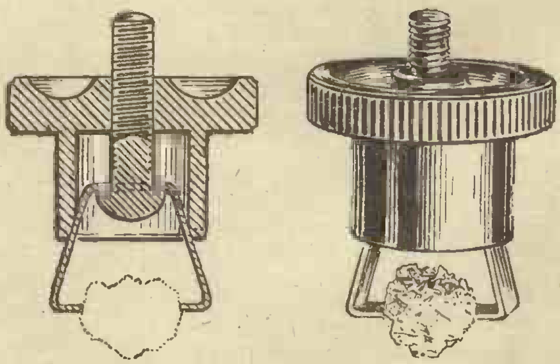


Fig. 5. Showing the mechanism of the "claw-grip" device.

A FOLDING H.F. TRANSFORMER.

A DRAWBACK which is sometimes found to be a characteristic of the transformer-coupled type of H.F. amplifier is that it lacks a means of adjusting its selectivity to the high degree which is essential to successful operation upon certain of the more crowded wave-lengths.

A good method of providing the desired selectivity is to construct the transformer in such a way that the coupling between primary and secondary can be considerably weakened; this generally involves the slight additional complication of another small variable condenser to tune the secondary, this complication being usually well repaid by the remarkable sharpness of tuning which results.

A transformer of this description is now upon the market (Leslie McMichael, Ltd.), and is illustrated in Figure 7. Another desirable feature embodied in this particular example is a second moving element which is composed of a reaction coil which acts upon the secondary winding, thus enabling one to use quite strong reaction coupling with little risk of radiation.

Fig. 7. The folding transformer.

A SLOW-MOTION KNOB.

THIS ingenious device is intended to take the place of the regulating knob on any variable condenser having a full 360° scale. By means of a chuck it will fit on spindles up to $\frac{3}{16}$in. diameter.

When the knob is turned, a special reducing gear is brought into action so that the movement of the condenser spindle is small in comparison with that of the knob. When the limit of fine adjustment has been reached, any further rotation of the knob in the same direction causes the mechanism to lock and the spindle then revolves at the same speed as the knob. In this way both coarse and fine action are combined in the one instrument, and a vernier adjustment can be obtained on any variable condenser for a fractional extra cost.

Fig. 8. The Vernier knob and dial.

CONVERTING A RHEOSTAT INTO A VARIABLE GRID LEAK.

HERE is a simple little device which will appeal to both experimenter and novice. A variable grid leak is a very useful compon nt and the construction of such an instrument as described below is simplicity itself.

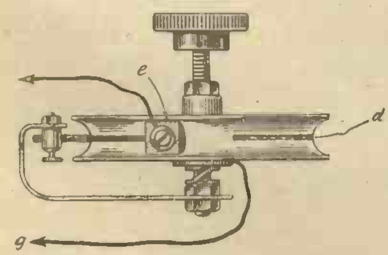


Fig. 20. Showing the details of the variable leak.

Obtain an ordinary filament rheostat (this should present no difficulties, since most of us have an odd one lying about the workshop) and remove the resistance spiral and brass arm. From a piece of spring brass cut out another arm slightly longer than the original one, bend it to the shape indicated in the diagram, and attach a small terminal to the other end in the approximate position shown.

Next obtain a carpenter's pencil or any other pencil having a large graphite lead, and fit this into the terminal as shown. When tightening up the clamping screw great care should be taken not to crack the lead, and there should be just sufficient tension on the spring brass arm to keep the lead pressed lightly against the groove in the ebonite former. Now revolve the arm several times round the former so as to make a good graphite line (*d*) round it, commencing and finishing at the holes which formerly accommodated the clamping screws of the spiral. Countersink one of these holes fairly deeply, and with another piece of pencil apply graphite freely in and around the recess. From several thicknesses of soft tin foil cut out a small wads, punch a hole through the centre and place it over the countersunk hole. Take one of the screws and washers previously removed, place a connecting wire under the screw head and screw this in position, pressing the tin foil wad firmly in the countersunk portion of the hole as shown at (*e*).

It is most important that this end of the graphite line makes good contact with the wad and screw. The other end of the line is, of course, left open.

The arrows (*f*) and (*g*) show the connecting wires for placing the instrument in circuit with the grid condenser of the rectifying valve, one terminating at one end of the graphite line and the other at the brass bush, which is kept in good contact with the spindle and arm by means of the usual spring washer. O. J. R.

Inventions at Home & Abroad

British Patents.

The following abstracts from Patent specifications recently published have been specially compiled for MODERN WIRELESS *by Mr. H. T. P. GEE, Patent Agent, Staple House, 51 and 52, Chancery Lane, London, W.C. 2, and at 70, George Street, Croydon, from whom copies of the full specifications, when printed, may be obtained post free on payment of the official price of 1s. each.*

191,358. **NEUMANN, O., and NEUMANN, A.**—The alloy used for making storage battery electrodes described in the parent Specification 184,762 is modified by the substitution of potassium for sodium, and the addition of tungsten. Potassium hydroxide is used instead of sodium hydroxide in the pastes of the cathode and anode and potassium bi-sulphate is substituted for sodium sulphate and zinc hydroxide in the cathode paste, to which is also added mercury sulphate. Thallous sulphate is added to and sodium sulphate omitted from the anode paste. (Addition to 184,762.) (February 15th, 1922. Convention date, January 5th.)

191,390. **BRITISH THOMSON-HOUSTON CO., LTD.**—The grid circuit of a thermionic oscillation generator comprises a leak resistance shunted by a condenser, and a tuned oscillatory circuit in which oscillations are generated independently of any retro-active coupling. Oscillation is normally prevented by a series condenser which interrupts the leak path and allows the grid to attain a considerable negative potential. Signals are sent by short circuiting this condenser, and allowing the valve to oscillate. The operation of signalling also closes the plate supply circuit. Alternating current is used for heating the filaments and for supplying rectifiers which energise the plate circuit. A pair of valves and a pair of rectifiers may be used, and the failure of the filaments of either is indicated by a lamp or an audible signal. (January 4th, 1923. Convention date, January 5th, 1922.)

191,402. **LOW, A. M.**—The circuits of different receiving stations are successively completed by contacts controlled by stop-watches, so that a transmitting operator equipped with a synchronously started stop-watch can, by choosing the time of transmission, send signals which will be heard at any one receiving station and not at the others. (June 22nd, 1917.)

191,404. **LOW, A. M.**—Coherers for wireless reception comprise a mixture of silver and nickel particles wholly or in part coated with the sulphides of the respective metals by heating them in an atmosphere of sulphur dioxide. When in use the particles may be enclosed in a glass tube and held between a fixed and an adjustable electrode. (August 10th, 1917.)

191,406. **LOW, A. M.**—Consists of using as an aerial, the stream of exhaust gases from an internal combustion engine, or other like stream of minute carbon or other particles. The exhaust pipe is insulated from the engine by a rubber tube and is attached to the earth through the supply transformer. (January 9th, 1918.)

191,485. **BRITISH THOMSON-HOUSTON CO., LTD.**—In an arrangement for preventing interference, a parallel oscillatory circuit and a series oscillatory circuit, both tuned to the disturbing wave, are included in the antenna circuit, electro-motive forces derived from both circuits being impressed upon a common receiving circuit. The elements of the two circuits are so selected that the potential drops across the two circuits are equal and in phase for interfering waves to which they are tuned, and the coupling is so arranged that these potentials oppose and neutralise one another in the grid circuit of the thermionic receiver. The desired signals, however, cause a different potential drop across the two circuits and produce an additive effect in the receiving circuit. (October 14th, 1921.)

191,550. **BURNHAM, W. W.**—An inductance coil is connected to its terminal carrying member by attaching oppositely extending arms to the member and winding tape or other binding material around the arms and the coil so as to bind the arms to the coil. (November 18th, 1921.)

191,618. **HINKLEY, V. J.**—Consists in having the fixed and moving electrodes of a variable condenser made in the form of screw threads, both electrodes being preferably formed of parallel helical plates of equal pitch. The movable electrode is carried by a threaded spindle having the same pitch as the plates. (January 17th, 1922.)

191,723. **BRITISH THOMSON-HOUSTON CO., LTD.**—Relates to magnetic modulators for controlling high-frequency currents of the kind described in specification 7151/13. In order to lessen the net inductive variation in the high frequency winding, when this is directly in series with the aerial system, the winding is split into two portions, which are wound in opposition. This method of control is particularly advantageous in short-wave transmission .(January 3rd, 1923. Convention date, January 12th, 1922.)

191,724. **BRITISH THOMSON-HOUSTON CO., LTD.**—Magnetic modulators of high frequency currents, particularly those of the type described in Specification 7151/13, are constructed with a laminated core built up from a continuous ribbon of magnetic material. (January 5th, 1923. Convention date, January 12th, 1922.)

191,756. **LOW, A. M.**—The armature of an electric relay is kept normally in vibration, so that the contact is not closed unless current passes for a predetermined time. (January 9th, 1918.)

191,757. **LOW, A. M.**—Photographs and other pictures are transmitted electrically by first producing the picture by a suitable process upon a movable conducting surface of conductivity varying with the light and shade, passing a current through a contact traversing the moving surface at the transmitting station, and using the resulting variable current to affect the colour of material stretched on a synchronously moving member at the receiving station. (January 19th. 1918.)

193,010. **LORENZ AKT.-GES., C.**—In order to prevent the amplification of undesirable frequencies, which give rise to "whistling" noises, a shunt circuit containing capacity and inductance is connected across the valve transformer windings. This circuit is tuned to the higher frequencies beyond the speech range, and consequently by-passes such energy and prevents its further amplification across the transformer. (January 10th, 1923. Convention date, February 11th, 1922.)

193,059. **PFIFFNER, E.**—In an electric condenser comprising a number of superposed elements, with metal coatings in intimate contact with the dielectric, coatings of like polarity are spaced apart, at least at their margins, in order to weaken the electric fields which may be formed at the margins of successive elements if the coatings do not exactly cover each other. The space at the margins may be filled with an insulating-mass, with a smaller dielectric constant than that of the condenser dielectric. (February 12th, 1923. Convention date, February 10th, 1922.)

193,060. **PFIFFNER, E.**—In electric condensers and other electrical apparatus in which conducting material rests on insulating material, electrical discharges at the edges of the conducting material are prevented by providing the conducting material with marginal extensions of high resistance. These extensions may be formed of a powdered resistance material, such as graphite, mixed with a binder, or they may be in the form of a thin coating of conducting material applied to the insulating material by chemical precipitation or by heat. (February 12th, 1923. Convention date, February 11th, 1922.)

193,072 **FOREST, L. de.**—Apparatus for recording sound photographically comprises a lamp to which high or super-audio frequency oscillating current is supplied, the intensity of the light being varied by and in accordance with the sound waves without varying any other characteristic of the light source, such as its size or shape. The sounds to be recorded affect a microphone producing alternating or pulsating currents, which, acting through an amplifier and a transformer connected to the oscillation generator, modulate accordingly the high-frequency currents passing through the lamp. Specification 157,441 is referred to. (August 16th, 1921.)

193,092. **BRITISH THOMSON-HOUSTON CO., LTD.**—In a thermionic "negative resistance" device arranged for the production of oscillations in the manner described in Specification 103,865, the electrode which emits the secondary electrons or "dynatrons" is maintained at an average negative potential. (October 14th, 1921.)

193,150 **BURNHAM, W. W.** In variable electric couples or inductance devices for wireless signalling, of the kind in which the inductive distance between two coils is varied by rotation of one coil about an axis external to the coil and lying in a plane through the coil and perpendicular to its axis, the moving coil is mounted on a supporting element axially rotatable by manual rotation of a spindle operatively connected to and parallel to the axis of the supporting element, and of sufficient length to avoid approach of the hand to the coils in operation. Any number of fixed and movable coils may be used. (November 18th, 1921.)

193,203. **BING WERKE VORM. GEB. BING AKT.-GES.**—The electrodes of a spark-gap suitable for a toy wireless set are disposed practically in contact with each other and are covered with a thin layer of badly conducting or insulating material, preferably varnish, enamel, or an oxide of magnesium, cadmium, or calcium. This allows a tension of only a few hundred volts to be used. The component parts of the toy sending and receiving set are mounted on a cardboard switch-board, the wiring being arranged underneath and being protected by a casing or box. (December 19th, 1921.)

193,241. **PAYNE, M., and JEAL, W. S.**—A storage battery consisting of a number of cells in series is provided with bi-polar electrodes each of which has a flange projecting at right angles at both sides of the electrode and extending beyond the surface of the active material, adjacent flanges being concave and convex. The negative side of each electrode is formed with a vent. The electrodes are separated by perforated rubber, etc., washers, tight joints between the washers and electrodes being obtained by wedges inserted between the outer electrodes and a container or by other means. The container may be filled with wax to keep the electrodes in position and devices may be provided to cut out one or more cells if required. (January 20th, 1922.)

193,339. **SOC. des ETABLISSEMENTS GAUMONT.**—In apparatus for the production and reception of sound, a diaphragm having disposed therein a wire coil is arranged in the air gap of a magnet so that the movements of the various elements of the surface take place in an oblique direction, i.e., neither in their own plane nor perpendicular thereto. The apparatus may be used as telephonic transmitter or receiver. (June 30th, 1922. Convention date, February 17th.)

193,379. **GES. Für DRAHTLOSE TELEGRAPHIE.**—A tuned circuit in the output path of a thermionic generator is coupled through an intermediate circuit to the heating circuit of the filament. Owing to the back-coupling, the electron stream from the filament is controlled in rhythm with the oscillations occurring in the tuned circuit. Preferably the two electrodes have large surfaces and are arranged close to each other, and the cathode is formed of a coiled wire having as small heat-capacity as possible. In this way a two-electrode valve will function as an oscillation generator. If a third electrode, or grid, is employed, the back-coupling from the tuned circuit is linked with both grid and filament. (November 7th, 1922. Convention date, February 14th.)

193,438. **WILSON, W. H.**—In a method of signalling adapted to reduce interference between stations, a type of radiation is used in which each half wave has a different length from that of the half waves before it and after it. Waves of this type may be used in wireless or wired wireless signalling and may be of audible frequency for use in alternating current telegraphy. (August 29th, 1921. Cognate application, No. 16305/22.)

193,387. **GES. Für DRAHTLOSE TELEGRAPHIE.**—A negative potential is applied to the grid of a thermionic generator by means of a resistance, shunted by a condenser, and inserted in the plate circuit between the cathode and the negative pole of the high-tension supply. The value of the resistance may be varied by keying, or through a microphone. (January 30th, 1923. Convention date, February 14th, 1922.)

193,525. **FROST, S. G.**—In a thermionic valve, a grid serves as the only or main support for a filament. (November 30th, 1921. Cognate application, No. 17265/22.)

193,566. **ONWOOD, A.**—Modulating-apparatus for wireless transmission of the kind in which the modulating-valve is connected in series in the plate circuit of the oscillation generator is so arranged that the filament of the modulator and the microphone or key are at earth potential. The specification also describes a panel mounting for the apparatus. (September 14th, 1922.)

193,628. **PRESTON, L. G., and HODGSON, B.**—The leading-in wires and metallic supports for the electrodes of a thermionic valve are shielded from the discharge so that conduction takes place wholly or almost entirely between the electrodes. (January 24th, 1922.)

193,629. **PRESTON, L. G., and HODGSON, B.**—The electrodes of a thermionic valve or other vacuum tube are fixed substantially rigidly with respect to each other and mounted resiliently in the envelope so as to allow play or movement between the electrodes and the envelope. (January 24th, 1922.)

193,690. **REES, H. P. P.**—A loud-speaking instrument is located within a casing of a valve receiver, and is adapted to be switched into circuit alternatively with the usual head-phones. The specification describes the wiring and mounting of a three-valve set. (March 7th, 1922.)

193,873. **AMERICAN RADIO and RESEARCH CORPORATION.**—Inductance coils with low distributed capacity and low energy losses for use, for example, in wireless receiving apparatus, comprise spherical skeleton supports having spaced curved arms and wire wound on the supports so that the turns engage each other at only a small number of points, the wires preferably passing in and out about opposite sides of the arms to form a basket mesh with the turns crossing between the arms. (February 26th, 1923. Convention date, February 24th, 1922.)

193,882. **TAGGART, J. SCOTT, and RADIO COMMUNICATION CO., LTD.**—In a wireless receiving system operating on the heterodyne principle, the local oscillations are set in operation, or are controlled in magnitude or frequency, by the received signals. The system may be used for eliminating interfering signals which are weaker or stronger than the desired signals, and for reducing interference from atmospheric and damped waves. (August 30th, 1921.)

194,007. **LORENZ AKT.-GES., C.**—In a method for increasing the frequency of an alternating current, an oscillatory circuit is charged by impulses from a generator circuit, the curve of energy output of the generator being so distorted that it lies for a prolonged part of each period along the zero line. The oscillatory circuit is tuned to an integral multiple of the generator frequency, and the total time of each impulse is limited to the time during which it is of like sign with the free oscillation in the oscillatory circuit. (December 9th, 1921.)

194,070. **POLLOCK, E.**—A combined transmitting and receiving set is so arranged that the receiving circuits are rendered insensitive during the period when transmission is taking place, thermionic tubes energised by the microphone current being variously employed to achieve this result. In certain cases, radiation from the transmitting-aerial can only occur when, and for as long as, the microphone is being spoken into. (January 14th, 1922. Cognate application, No. 1848/22.)

194,185. **SOC. ANON. le CARBONE.**—A galvanic battery consisting of zinc and carbon electrodes in an electrolyte such as a solution of ammonium chloride has the perforated zinc electrode arranged horizontally below the carbon in a porous vessel, a space being provided below the zinc to receive the zinc chloride formed during the action of the cell and so prevent it from coming into contact with the carbon electrode or electrolyte. (April 21st, 1922.)

American Patents.

(Patent 1,434,984. **HAROLD H. BEVERAGE, of Riverhead, New York, November 7th, 1922.**)

The present invention relates to radio receiving systems, and more particularly to a system which permits of the reception of signals coming from more than one direction upon a single antenna.

A long horizontal receiving antenna is made up of two conductors which are grounded at the ends. If this antenna is constructed with distributed constants of such value that the current wave therein travels at the same velocity or substantially the same velocity as the ether wave, the current wave in the antenna will gradually build up and become a maximum at the end farthest from the transmitting station. Currents produced at the end by ether waves travelling from that end toward the other will have substantially zero value at the one end and will increase to a maximum value at the other. In order to prevent reflection of the current waves flowing in the antenna from the ends, the ground connections are made through resistances having a value substantially equal to the surge impedance of the antenna.

(Patent 1,436,252. **RAYMOND A. HEISING, of East Orange, New Jersey, November 21st, 1922.**)

This invention relates to the production of modulated high frequency electromagnetic waves by varying the current or voltage supplied to an arc in accordance with signals; for example, sound signals.

A generator constitutes a source of direct current for supplying an arc circuit which comprises the anode-cathode path of an electron discharge device, a high-frequency choke coil, and the electrodes. The frequency of the discharges across the electrodes is controlled by the magnitude of inductance and capacity in the control circuit. An electro-magnet maintains a field across the space between the electrodes, which serves to extinguish the arc after each discharge. Connected to the grid and the cathode is the input circuit, comprising a resistance, shunted by the secondary of a transformer to which is coupled the primary, said primary being located in series with the controlling microphone or an equivalent device. The usual sources are provided for heating the cathode and maintaining the grid negative with respect thereto. The arc across the electrodes is included in the path to earth of the aerial circuit. With proper adjustments the radiated frequency will be an approximate sine wave of the same frequency as the frequency of the discharge across the electrodes.

(Patent 1,439,947. **LOUIS COHEN, of Washington, D. C., December 26th, 1922.**)

This invention relates to the art of electrical signalling, particularly receiving radio signals, and a system for use in practising the same.

The object of the present invention is to eliminate interferences in the reception of radio signals and thus insure greater reliability in radio communication.

In carrying this out, the incoming signals are acted upon by local oscillations which combine with them producing beats. The beat frequency current is then impressed upon a Wheatstone bridge, the constants of the arms of which are so adjusted as to produce zero potential across the bridging arm for the current of the beat frequency, and hence no current flows in it. The indicating instrument is coupled to two arms of the bridge and also to the bridging arms. By properly adjusting the couplings in the matter of direction and magnitude, a condition is obtained where the interference effects are balanced out, and the indicating instrument responds only to the signals which are to be received.

(Patent 1,440,432. **CHESTER T. ALLCUT, of Pittsburgh, Pennsylvania, January 2nd, 1923.**)

The object of this invention is to provide a receiving system for undamped signal impulses which embodies the heterodyne or "beat" principle of operation.

In a well-known type of receiving system for undamped signal impulses, reception is effected by heterodyning the receiving signal currents with those from a local source to cause the formation of beat currents.

Similar results may be obtained by combining the magnetic fields of the signal and local currents to form a resulting magnetic field of beat frequency and then causing the resulting magnetic field to control the impedance of a vacuum tube device.

The desired result may be obtained by employing a two-electrode vacuum tube, of well-known form, and surrounding the tube with magnetizing windings which are associated with wave-responsive apparatus and with a local source of high-frequency currents.

(Patent 1,435,009. **EDWARD W. KELLOGG and CHESTER W. RICE, of Schenectady, New York, November 7th, 1922.**)

This invention relates to radio receiving systems, and more particularly to a system which permits of the simultaneous reception of a plurality of signals at a single receiving station.

In carrying out the invention, use is made of a long horizontal receiving aerial made up of two conductors which are grounded at the ends. If this aerial is constructed with distributed constants of such value that the current wave therein travels at the same velocity as the ether wave, the current wave in the aerial will gradually build up and become a maximum at the end farthest from the transmitting station. If the velocity of the current wave in the aerial differs somewhat from that of the ether wave then for a certain distance the waves will add, but a point will finally be reached where one wave will be so far in advance of the other that the two will be in phase opposition. Interference will then occur and the current wave will start to decrease

(**MARIUS LATOUR, Paris, France** 1,447,793. March 6th, 1923.)

The present invention relates to improvements in circuit arrangements of radiotelegraphic receiving stations for the purpose of increasing the sensitiveness of the receiving and making possible the application of the principle of heterodyne action in the reception of Hertzian waves.

As well known, in the case of crystal detectors, the rectified portion of the current is proportional to the square of the alternating potential V acting on the circuit comprising the detector. On the other hand, if a potential V of a slightly different period is introduced into the receiving circuit it is found that the sensitiveness of the receiving increased with the potential V up to a certain limit.

It has been found advisable to increase V until the law of the square no longer holds good and up to a point beginning at which the rectified portion of the current is simply proportional to the potential applied to the detector. The increasing of V above this value will be useless.

The only difficulty that will be encountered in increasing V will be the presence of a permanent rectified current in the telephone. This permanent current will cause a permanent attraction of the diaphragm that may cause a lowering of the sensitiveness of the telephone. As a result of this, beginning with a certain value for V, the increase in sensitiveness corresponding to the increase of V will be concealed.

This disadvantage may be remedied in the following simple manner:

A simple expedient is to use telephones provided with magnets of a lower magnetization. Th permanent rectified current would only add its effect to the magnetism of the magnet to supplement its insufficiency and produce the necessary permanent induction under the diaphragm. It is also conceivable that we may operate without a permanent magnet and use only he rectified current for producing the necessary permanent induction.

(BYRON MACPHERSON, Roxbury, Mass. 1,446,650. February 27th, 1923.)

This invention relates to improvements in electrical condensers of the plate or sheet type, especially of the type wherein the condenser is divided into sections and the sections connected in series for high potential service, although not limited to series condensers; and the invention consists of certain improvements in the means for clamping the stack. This application is a continuation in part of application Serial No. 301,498, filed June 3rd, 1919.

The invention is especially applicable to the type of stack in which the two ends are at a difference of potential and is embodied preferably as an insulating clamp; that is, a clamp in which the two ends of the stack are connected by a member comprising insulating material. An advantage of this form of clamp resides in the fact that the capacity of the condenser remains constant with time and use.

The clamp comprises metallic end blocks or members engaging the ends of the stack, and a flexible band of insulating material connecting the members and drawing the same into clamping relation against the ends of the stack, these ends being at high potential differences.

(I. LANGMUIR, Re-issue Pat. 15,495. November 21st, 1922.)

A heterodyne receiving system is described, in which the vacuum tube serves both as a detector and as a source of oscillations, the frequency of which differs by a slight amount from that of the oscillations received by the aerial. The telephone in the plate circuit of the tube is coupled by a coil both to the input circuit and to the aerial, and thus serves to combine both sets of oscillations.

(J. ROBINSON, Pat. No. 1,435,941. November 21st, 1922.)

A radio compass is described in which there are two coils rigidly connected at right angles to each other, but rotatable as a unit about a vertical axis. The effect of these coils on a detector is perceived by telephones. For maximum effect on one coil, there is a minimum effect on the other, and the bearing of the distant source may be readily ascertained by noting the effect of disconnecting or even reversing one coil. When this coil is disconnected, an equivalent coil is inserted in its place so as to leave the circuits with substantially the same constants.

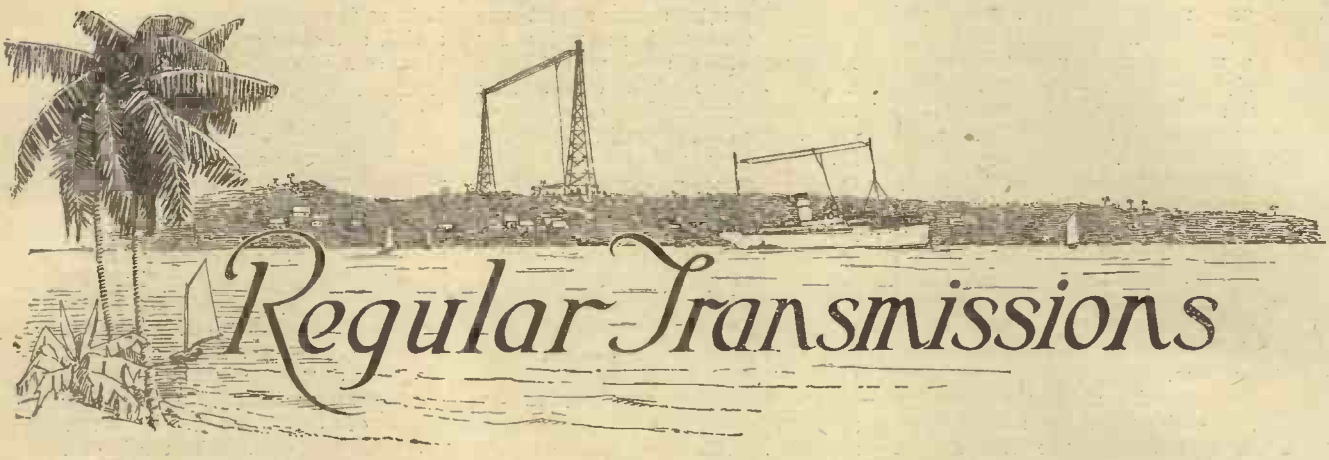
(E. C. HANSON and W. L. CARLSON, No. 1,437,240. November 28th, 1922.)

In order to detect minute values of energy, an arrangement is set up whereby variations in energy cause corresponding variations in frequency of an oscillating tube. When no energy is received, this frequency is set to be the same as that of another tube, and since the phone is responsive to the combination of both frequencies (which are above audibility), no response is received therein. However, upon reception of energy, the frequency changes and beats are produced in the phone.

Patents in the Irish Free State.

The secretary of the Institute of Patentees states, in connection with patents in the Irish Free State, that, pending legislation which is being considered, dealing with patents, trade marks and designs in An Saorstat, no action is necessary in regard to patents, etc., granted or approved before December 6th, 1922.

Where applications have been lodged, but a decision was not given by the Patent Office before December 6th, 1922, particulars should be furnished to the Ministry of Industry and Commerce (Department of Trade and Shipping), Dublin. Applications arising after December 6th, 1922, should be addressed to the above-named Ministry. In this connection, applications are received in the first instance, and their receipt is duly noted without payment of fees. The scale of fees requisite in such cases will be notified to applicants before the applications are finally dealt with.



Regular Transmissions

This list, though short, includes most of those stations actually heard in England.

TIME (G.M.T.)	CALL SIGN.	NAME OF STATION.	WAVELENGTH.
Mid-night	GBL	Leafield	8,750 C.W.
0005–0015	FL	Paris	7,000
0100	POZ	Nauen	12,000 C.W.
0100	ICI	Guglielmo Marconi (Coltano)	5,250 C.W.
0120	GBL	Leafield	8,750 C.W.
0200	GKB	Northolt	6,850 C.W.
0200	GFA	Air Ministry	4,100 C.W.
023c	UA	Nantes	9,200 C.W.
0300	HB	Budapest	4,250
0315	FUA	Bizerta	5,150 C.W.
0330	FL	Paris	6,500 C.W.
0400	UA	Nantes	9,000 C.W.
0430	FL	Paris	7,400 C.W.
0550	ICI	Guglielmo Marconi (Coltano)	5,250 C.W.
0600	GFA	Air Ministry	4,100 C.W.
0600	IDO	Rome	11,000 C.W.
0635	LP	Berlin (Königswusterhausen)	5,250 C.W.
0650	LP	Berlin (Königswusterhausen)	5,250 C.W.
0700	POZ	Nauen	—
0700	FL	Paris	3,200 C.W.
0715	FL	Paris	6,500 C.W.
0730	UA	Nantes	9,000 C.W.
0735	GFA	Air Ministry	1,680 C.W.
0740	SAJ	Karlsborg	4,300 C.W.
0750	BUC	Bucharest	7,500 C.W.
0800	EAA	Aranjuez	6,700 C.W.
0800	GFA	Air Ministry	4,100 C.W.
0835	GFA	Air Ministry	1,680 C.W.
0840	LP	Berlin (Königswusterhausen)	5,250 C.W.
0850	GFA	Air Ministry	4,100 C.W.
0850	LP	Berlin (Königswusterhausen)	5,250 C.W.
0855	STB	Soesterburg	1,680 C.W.
0904	YN	Lyons	15,000 C.W.
0915	GFA	Air Ministry	4,100 C.W.
0923–0930	FL	Paris	2,600 Spark.
0925	FL	Paris	2,600 Spark.
0928	FNB	Le Bourget	1,680 C.W.
0930	IDO	Rome	11,000 C.W.
0935	GFA	Air Ministry	1,680 C.W.
0958–1015	FL	Paris	2,600 Spark.
1000	FL	Paris	2,600 Spark.
1003	FL	Paris	3,200 C.W.
1028	FNB	Le Bourget	1,680 C.W.
1035	FL	Paris	2,600 Spark.
1035	GFA	Air Ministry	1,680 C.W.
1036–1049	FL	Paris	2,600 Spark.
1044	FL	Paris	2,600 Spark.
1050	FNB	Le Bourget	1,680 C.W.
1115	PCH	Scheveningen	1,800 Spark.
1128	FNB	Le Bourget	1,680 C.W.
1130	FL	Paris	2,600 Spark.
1135	GFA	Air Ministry	1,680 C.W.

TIME (G.M.T.)	CALL SIGN.	NAME OF STATION.	WAVELENGTH
1130–1205	FL	Paris	7,000 C.W.
1130–1300	FL	Paris	7,000 C.W.
1150	FNB	Le Bourget	1,680 C.W.
1155	POZ	Nauen	3,100 Spark.
1200	GBL	Leafield	8,500 C.W.
1200	ICI	Guglielmo Marconi (Coltano)	5,900 C.W.
1228	FNB	Le Bourget	1,680 C.W.
1230	UA	Nantes	3,400 Spark.
1235	GFA	Air Ministry	1,680 C.W.
1300	LY	Bordeaux	23,500 C.W.
1300–1415	FL	Paris	7,000 C.W.
1306	AN	Nimes	1,680 C.W.
1328	FNB	Le Bourget	1,680 C.W.
1335	GFA	Air Ministry	1,680 C.W.
1400	GFA	Air Ministry	4,100 C.W.
1440	GNF	North Foreland	600 Spark.
1415	UA	Nantes	9,500 C.W.
1425	OPO	Brussels	1,680 C.W.
1428	FNB	Le Bourget	1,680 C.W.
1430	YN	Lyons	15,000 C.W.
1435	GFA	Air Ministry	1,680 C.W.
1435	FL	Paris	6,500 C.W.
1500	FL	Paris	7,300 C.W.
1500–1600	FL	Paris	7,000 C.W.
1505	STB	Soesterburg	1,680 C.W.
1525	OPO	Brussels	1,680 C.W.
1528	FNB	Le Bourget	1,680 C.W.
1535	GFA	Air Ministry	1,680 C.W.
1625	OPO	Brussels	1,680 C.W.
1628	FNB	Le Bourget	1,680 C.W.
1635	GFA	Air Ministry	1,680 C.W.
1715–1800	FL	Paris	7,000 C.W.
1800	POZ	Nauen	6,500 C.W.
1800	FL	Paris	6,800 C.W.
1830	POZ	Nauen	9,000 C.W.
1830	STB	Soesterburg	1,680 C.W.
1900	OUI	Hanover	9,500 C.W.
1900	GFA	Air Ministry	4,100 C.W.
1945	CNM	Medicuna	5,000 C.W.
1900–1930	FL	Paris	7,000 C.W.
1955	LY	Bordeaux	23,500 C.W.
2000	GBL	Leafield	8,750 C.W.
2000	SAJ	Karlsborg	2,500 Spark.
2000	EGC	Madrid	1,600 Spark.
2015	LY	Bordeaux	23,500 C.W.
2015–2200	FL	Paris	7,000 C.W.
2030	EGC	Madrid	2,000 Spark.
2045	IDO	Rome	11,000 C.W.
2130	LY	Bordeaux	23,500 C.W.
2200	FL	Paris	2,600 Spark.
2230	UA	Nantes	9,500 C.W.
2235	FL	Paris	2,600 Spark.
2236–2249	FL	Paris	2,600 Spark.
2244	FL	Paris	2,600 Spark.

TIME (G.M.T.)	CALL SIGN.	NAME OF STATION.	WAVELENGTH.
2300	IDO	Rome	11,000 C.W.
2315	PCH	Scheveningen	1,800 Spark.
2330	POZ	Nauen	12,600 C.W.
Operating almost continuously :			
	FL	Paris	8,000 C.W.
	GB	Glace Bay	7,850 C.W.
	GBL	Leafield	8,750 C.W.
	GKU	Devizes	2,100 C.W.
	GLA	Ongar	2,900 C.W.
	GLB	Ongar	3,800 C.W.
	GLO	Ongar	4,350 C.W.
	GSW	Stonehaven	4,600 C.W.
	LCM	Stavanger	12,000 C.W.
	IDO	Rome	11,000 C.W.
	MUU	Carnarvon	14,000 C.W.
	OUI	Hanover	14,500 C.W.
	POZ	Nauen	12,600 C.W.
	UFT	Saint Assizes	15,000 C.W.
	WGG	Tuckerton	16,100 C.W.
	WII	New Brunswick	13,600 C.W.
	WQK	Long Island	16,460 C.W.
	WQL	Long Island	19,200 C.W.
	WSO	Marion	11,500 C.W.
	YN	Lyons	15,000 C.W.
	LY	Bordeaux	23,500 C.W.

British Coast Stations Working Continuously on 600 Metres : GCA Tobermory, GCB Lochboisdale, GCC Cullercoats, GCS Caister, GKR Wick, GLD Land's End, GLV Seaforth, GNF North Foreland, GNI Niton, GPQ Parkeston Quay, GRL Fishguard, GXO Crookhaven.

Continental Coast Stations Continuously Heard on 600 Metres : FFB Boulogne, OST Ostend, PCH Scheveningen.

WEATHER REPORTS.

Below are given the times of transmission of the most useful of the weather messages sent during the day. They are transmitted in morse at moderate speeds and their reception provides excellent practice for the beginner.

TIME (G.M.T.)	CALL SIGN	NAME OF STATION.	WAVELENGTH.
0630	FNB	Le Bourget	1,680 C.W.
0635	LP	Berlin (Königswusterhausen)	5,250 C.W.
0635	GFA	Air Ministry	1,680 C.W.
0645	LP	Berlin (Königswusterhausen)	5,250 C.W.
0650	FNB	Le Bourget	1,680 C.W.
0715	HS	Brussels	1,400 C.W.
0730	STB	Soesterberg	1,900 C.W.
0735	OXE	Lyngby	3,650 C.W.
0735	GFA	Air Ministry	1,680 C.W.
0740	SAJ	Karlsborg	4,200 C.W.
0750	LCH	Christiania	8,000 C.W.
0800	GFA	Air Ministry	4,100 C.W.
0830	GFA	Air Ministry	4,100 C.W.
0835	GFA	Air Ministry	1,680 C.W.
0900	POZ	Nauen	4,700 C.W.
0915	GFA	Air Ministry	1,400 C.W.
0930	LP	Berlin (Königswusterhausen)	5,250 C.W.
0935	GFA	Air Ministry	1,680 C.W.
1005	FL	Paris	2,600 Spark.
1035	GFA	Air Ministry	1,680 C.W.
1115	PCH	Scheveningen	1,800 Spark.
1130	FL	Paris	2,600 Spark.
1135	GFA	Air Ministry	1,680 C.W.
1150	FNB	Le Bourget	1,680 C.W.
1235	GFA	Air Ministry	1,680 C.W.
1315	HS	Brussels	1,400 C.W.
1330	STB	Soesterburg	1,900 C.W.
1335	OXE	Lyngby	3,650 C.W.
1335	GFA	Air Ministry	1,680 C.W.
1340	SAJ	Karlsborg	4,200 C.W.
1400	GFA	Air Ministry	4,100 C.W.
1435	GFA	Air Ministry	1,680 C.W.
1535	GFA	Air Ministry	1,680 C.W.
1550	LP	Berlin (Königswusterhausen)	5,250 C.W.
1635	GFA	Air Ministry	1,680 C.W.
1815	HS	Brussels	1,400 C.W.
1830	STB	Soesterburg	1,900 C.W.
1835	OXE	Lyngby	3,650 C.W.
1840	SAJ	Karlsborg	4,200 C.W.
1900	GFA	Air Ministry	4,100 C.W.
1920	FL	Paris	2,600 Spark.
1940	POZ	Nauen	4,700 C.W.
2000	GFA	Air Ministry	1,400 C.W.
2315	PCH	Scheveningen	1,800 Spark.

RECENT ADDITIONS TO OUR LIST OF EXPERIMENTAL CALL-SIGNS

Continued from page 249 of the last issue. *To be appended to our Wireless Directory.*

CALL.	NAME OF OWNER.	ADDRESS.
2 RN	D. D. Richards	"Mametz House," Bontnewydd Terrace, Trelewis, Glamorgan.
2 YW	J. H. F. Town	4, Eversley Mount, Halifax.
5 DG	C. H. Stephenson	Penn Manor, Wolverhampton.
5 KY	E. E. G. Allsopp	Ingle Nook, Wigginton Road, Tamworth.
5 LB	H. C. Foster	Hornby Castle, Lancaster.
5 ML	O. R. Healey	11, Glebe Road, Wallasey, Cheshire.
5 MR	N. P. Stoate	15, Winterstoke Gardens, Mill Hill, N.W. 7.
5 RP	H. I. Hughes	Hughes and Watts, Limited, Woodchurch Road, Oxton, Birkenhead.
5 SI	C. L. Naylor	43, Hill Crescent, Longden Road, Shrewsbury.
5 SQ	A. P. MacGrory	16, Main Street, Campbeltown
5 TQ	H. Rayner	Scite House, Hightown, Liversedge.
5 UC	J. Gardener	Lewis Road, Sutton, Surrey.
5 UO	R. L. Simmonds	61, Brightfield Road, Lee, S.E. 12.
5 VD	P. J. Wakefield	31, Station Road, Church End, Finchley, N. 3.
5 VK	B. Caldwell	"Caverswall," Lower Walton, near Warrington.
5 VT	G. C. Webb	10, Osborne Road, Stroud Green, N. 4.
5 VW	W. V. Harrington	51, First Avenue, Hoe Street Walthamstow.
5 WD	K. Ullyett	25, Harrington Road, Leytonstone, E. 11.
5 WM	J. B. Renshaw	"Wireless House," Old Chapel Street, Blackburn.
5 WZ	E. W. Hettich	1, King Street, Jersey.
5 XM	F. Eustance	92, Briardale Road, Mossley Hill, Liverpool.
5 XS	F. B. Thomas	7, Mornington Villas, Wanstead, E. 11.
5 XU	T. N. Lord	6, Trafalgar Terrace, West Park Street, Dewsbury.
5 YM	E. H. Robinson	Langmead, Pirbright, Surrey.
5 YQ	J. Gallocher	4, Havelock Terrace, Paisley.
6 AA	Durham and Northumberland Collieries Fire and Rescue Brigade	The Rescue Station, 854, Scotswood Road, Newcastle-on-Tyne.
6 AB Portable	Durham and Northumberland Collieries Fire and Rescue Brigade	The Rescue Station, 854, Scotswood Road, Newcastle-on-Tyne.
6 AG	W. H. Fortington	237, Dudley Road, Rotton Park, Birmingham.
6 BJ Portable	C. L. Solomon	10, Cavendish Road, Brondesbury, N.W. 6.
6 BQ Portable	J. L. Cannon	14, Woodcroft Avenue, Broomhill, Glasgow, W.
6 CW	D. Burne-Jones	"Gwalier," Rustic Avenue, Streatham, S.W. 16.

CORRECTION.

CALL.	NAME OF OWNER.	ADDRESS.
5 AN	W. J. Joughin	New Address :—158, Sumner Road, Peckham, S.E. 15.

WE ASK FOR YOUR CRITICISMS

In our endeavours to improve "Modern Wireless" at each fresh appearance, we are especially desirous of ascertaining what it is that our readers really want. If they will answer the questions upon this page they will help us materially in our efforts to produce the perfect Wireless monthly.

1. Do you prefer to have a 144 page book such as this on this kind of paper, or fewer pages on the quality of paper used for Nos. 1 and 2 of MODERN WIRELESS?

2. Do you prefer the large type in two columns or the smaller type in three columns which enables us to get more in?

3. What features do you like best in MODERN WIRELESS?

4. What author's writings do you prefer?

5. Place in their order of preference the articles and sections in this issue.

6. Do you prefer a large number of short articles or fewer long ones?

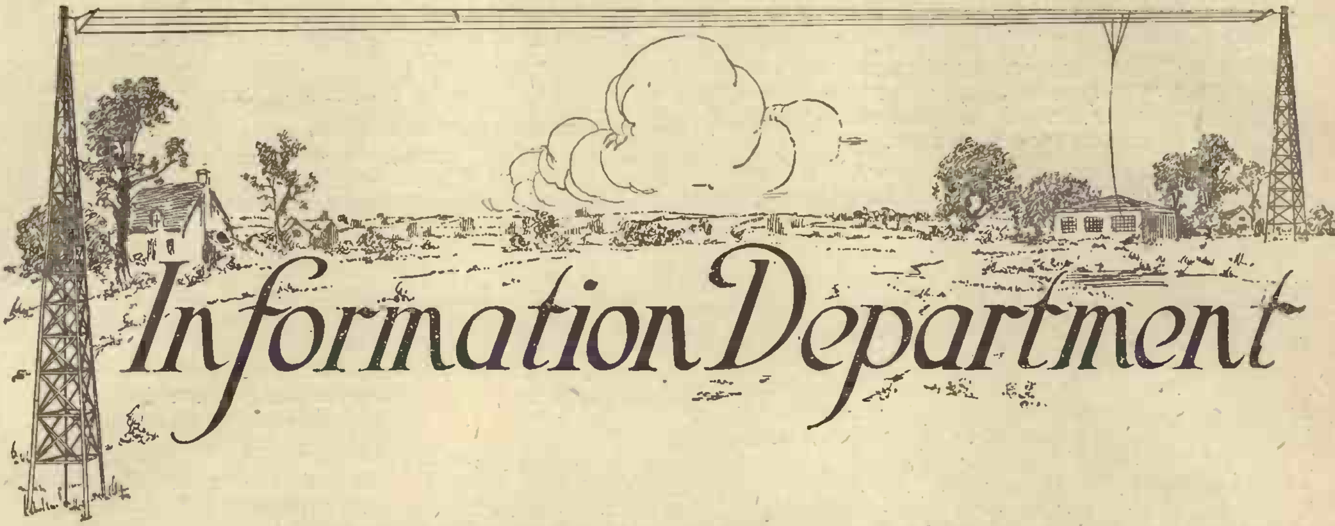
7. Have you any suggestions for articles or regular features?

8. Would you like us to start courses of instruction in MODERN WIRELESS, or is the interval of a month too long for such courses?

9. Any miscellaneous criticisms.

Post this in an unsealed envelope, stamped ½d., and addressed to

Editor, "Modern Wireless,"
Devereux Court, London, W.C.2.



Information Department

Conducted by J. H. T. ROBERTS, D.Sc. F.Inst.P., assisted by A. L. M. DOUGLAS.

In this section we will deal with all queries regarding anything which appears in "Modern Wireless," "Wireless Weekly," or Radio Press Books. Not more than three questions will be answered at once. Queries, accompanied by the Coupon from the current issue, must be enclosed in an envelope marked "Query," and addressed to the Editor. Replies will be sent by post if stamped addressed envelope is enclosed.

W. M. F. (Shorncliffe Camp) proposes to build a two-valve set comprising a rectifying valve and a low frequency amplifier, for the reception of 2LO. He wishes to know whether this would give satisfactory results in Folkestone.

The addition of a high-frequency valve on the lines of circuit ST 45 "Practical Wireless Valve Circuits," Radio Press, Limited, would greatly increase the pleasure you would derive from this set.

L. G. (Catford) has made up a four-valve set, using circuit ST 50, and obtains exceedingly good results. He asks if there is any way of transferring the telephone connections to various valves so that he can cut out unnecessary ones, by simply turning off the filament rheostat.

We are afraid you cannot disconnect valve circuits in this manner. Certain manufacturers have now on the market plug and jack systems which perform these various operations. A number of circuits have to be made or broken to vary the number of valves in circuits.

H. W. asks questions about the elimination of interference from neighbouring tramcars.

Several replies have recently been given in these columns to persons suffering from the same source of interference. We suggest you should use a frame aerial if at all possible, and careful screening of your apparatus in a metallic earthed screen may help. Referring to your question about the selenium cell, we are afraid we cannot give you any information on this subject, but you might experiment with a soot cell which produces somewhat similar results. This could be made by packing a piece of glass tubing having an internal bore of about 1 millimetre, closely with soot. The tube might be about 4 in. long.

D. C. (Wimbledon, S.W. 19) has a certain commercial pattern of receiver, and complains that whilst he is able to hear Continental telephony, he cannot cut out London and hear any of the other British broadcasting stations. He asks if we could help him.

The chief trouble with this receiver lies in the fact that it is not very selective on the lower wavelengths. We are afraid you will always experience this difficulty unless you remove the existing tuning apparatus and substitute an inductively coupled tuner in its place. This would probably produce the desired effect.

R. M. (Kingston) notices that when he places the switch arm of his tuner between contact studs, a loud humming noise is heard in the receiver which disappears when the instrument is again tuned. He asks, first, what is the reason for this? and, secondly, what is a low-frequency transformer, and what does it do?

(1) The humming noise you hear in your telephones is produced by earth currents which circulate through the apparatus when the aerial circuit is opened. The power wire you mention will probably be the cause of this noise.

(2) A low-frequency intervalve transformer is a device for magnifying the output from one valve so that when it is applied to the grid of the next it produces a much greater effect. By careful design this effect may be from 5 to 10 times greater.

E. T. B. (Ilkley) wishes to build a receiver to listen to the London broadcasting, but is not quite sure what sort of circuit would be most suitable.

A five-valve amplifier on the lines of circuit No. ST 51 "Practical Wireless Valve Circuits," Radio Press, Limited, would ensure satisfactory reception of this station at that distance. This is a very sensitive circuit and can be thoroughly recommended.

G. A. (Bristol) has made up a two-valve set described in No. 3 " Modern Wireless," and wishes to know whether the size of aerial (sketch of which he submits) would be suitable for this receiver.

The aerial arrangement you show should be quite satisfactory. We suggest the lead-in be removed a little further from the wall of the house if possible, as it is rather long.

F. G. (Shoreham) has made the two-valve receiver described in No. 1 of " Modern Wireless," but does not get very satisfactory results. He asks various questions about it.

(1) When the variometers are in the position you mention they represent half the maximum inductance. The coils must oppose each other in order to attain the minimum wavelength.

(2) We do not think any useful purpose would be served by altering the circuit.

(3) You should hear the London broadcasting station with this set at the above address. The apparatus will require careful tuning, of course, and you must be patient with this.

R. E. H. (Surbiton) has some ebonite formers 2¼ in. diameter, ⅜ in. deep and with a 1 in. slot, and wishes to know how many turns of No. 40 S.W.G. enamelled wire should be wound on these formers to make high-frequency transformers covering wavelenghts of 800, 1,200, 2,500, 6,000 and 8,000 metres.

The primary and secondary windings should be wound together in the same direction in the same slot and both have the same number of turns, which will be as follows, for the respective wavelengths:—150, 200, 300, 500, aud 750 turns. The condenser you mention will be satisfactory for covering the intermediate ranges.

G. W. B. (Phillip Lane, N. 15) asks certain questions about the manufacture of wireless apparatus.

By manufacturing apparatus in the manner you suggest you are liable to get into trouble with several companies holding master patents on the apparatus you describe. We suggest you enquire through the usual channels as to what you may or may not manufacture.

W. F. W. (Stratford) states that in No. 1 of " Modern Wireless " a variometer is described, in conjunction with a two-valve circuit. He wishes to know whether this type of tuner would be suitable for a crystal receiver.

The variometer you mention is very suitable for crystal tuning.

R. M. V. (Moseley) asks for the size of former and number of turns required to tune to 450 metres, for an aerial circuit coil in a telephony transmitter using certain wire which is in his possession.

If the former is 3 in. in diameter, 75 turns will be sufficient. A suitable reaction coil for this might consist of 40 turns of No. 26 S.W.G. double silk covered wire wound on a 2½ in. former. We do not think your aerial is very suitable for short wave transmission, but you may get satisfactory results. In connection with circuit ST 66 the key might be placed in several different positions, but will be satisfactory if inserted directly in the earth lead. This key should be well insulated.

H. B. D. (Stroud) asks certain questions about a continuous wave transmitter.

If you will furnish us with further particulars of your requirements, we shall be pleased to advise you. We obviously cannot design a complete transmitter in these columns.

A. M. (Catford) asks whether certain numbers of plates for different condenser capacities are correct.

If the condenser is carefully built so that the movable plates go right inside the fixed plates, that is, so that the spindle is central with the hole in the fixed plates, the values you suggest are approximately correct.

H. T. I. (Birmingham) asks with reference to the Armstrong super-regenerative receiver described in " Wireless Weekly " No. 1 : (1) Data for building a condenser of 0.006 μF capacity. (2) Would basket coils be satisfactory for the coils E, C, and F?

(1) For the construction of the condenser you mention, you will require 12 foils, each 1½ in. by ½ in. The mica should have an overlap of at least ¼ in.

(2) Basket coils in the positions you mention would be quite satisfactory.

A. H. (Walthamstow) intends to construct the three-valve circuit described in No. 2 of " Modern Wireless," using certain apparatus in his possession, and asks (1) Whether the circuit would pass the Postmaster-General's regulations? (2) Whether it would be capable of receiving from all the broadcasting stations? and (3) What size " Igranic " coils would be required for the reception of PCGG ?

(1) If you are in possession of an experimental licence, you will be able to use this receiver. Otherwise you cannot do so.

(2) We think you should obtain satisfactory reception with this instrument from most broadcasting stations.

(3) If you mean what size of aerial and closed circuit coils to use, the aerial circuit coil should have 100 turns, the closed circuit coil 150 turns and the reaction coil, if used, 50 turns.

W. F. T. (Chislehurst) asks : (1) What is the best form of tuner for the reception of American or long distance telephony? and (2) Whether shunting the primary winding of a telephone transformer with a fixed condenser is really an advantage.

(1) Any reasonably selective type of inductively-coupled tuner will be satisfactory. For valve work we should recommend a three-coiler holder with the usual aerial and detector circuit coils and condensers.

(2) The presence of a fixed condenser in the position you mention is generally desirable, but sometimes weak signals are stronger when it is not there. It is generally of value where a loud-speaker is being operated from the transformer.

R. G. A. (Fife) wishes to know how many valves would be necessary for the reception of Continental telephony, and also the name of a suitable book dealing with valve apparatus, preferably on the unit system.

He also suggests that he might be building the variometer receiver described in "Modern Wireless," No. 1, and asks what sort of range he might expect with this set.

You would require at least two stages of high-frequency amplification, to obtain satisfactory reception from Continental stations at your home. A suitable book is "How to make a unit Wireless Receiver," Radio Press, Limited, which gives you full constructional details. With careful adjustment and the variometer set you mention, you might be able to hear 5SC. We do not think you would hear any other broadcasting station unless one were erected in Aberdeen.

A. L. (Cheadle) asks how he can add reaction to a certain receiver.

The second variometer produces reaction effects, which are quite as strong as is permissible for the reception of British broadcasting.

W. L. D. (Devon) asks questions about obtaining a situation.

We regret we are unable to deal with requests of this nature.

H. R. (Glasgow) is contemplating the construction of a certain set, and asks whether with it he could cut out 5SC and listen to English broadcasting stations.

We are afraid that as you are within 1 mile of 5SC you will have the greatest difficulty in cutting it out. If, however, a three-coil holder were used in place of the variometer you suggest, we see no reason why you should not hear London and Cardiff.

A. W. E. (Putney) encloses an advertisement from "Modern Wireless," and asks whether the instrument described in it is satisfactory.

We have not yet had an opportunity of testing the apparatus, but understand that it is very sensitive and quite satisfactory. It is of course quite feasible to produce the results stated if the apparatus is properly designed and handled.

R. R. G. (Seven Kings) is puzzled as to what is really the most suitable type of aerial, and submits three alternatives. He asks our advice.

If it is your intention to do reception only, then we suggest you adhere to a long single wire aerial as high as possible. You will then obtain satisfactory results from all classes of telephony transmission.

D. W. G. (Warwick) submits the following questions: (1) Does a variometer give great selectivity? (2) To what use could he put a variable condenser of 0.001 μF in a variometer circuit? (3) What would be the effect of connecting such a condenser across the aerial and earth terminal?

(1) A variometer if correctly designed is quite sharp as a tuning device.

(2) We do not think that you could find a satisfactory use for this condenser in your circuit.

(3) Placing the condenser in the position you mention would raise the minimum and maximum wavelength of the set considerably.

M. L. S. (Colchester) asks the following questions: (1) Is a fixed condenser of 0.001 μF of any use in the position of C_4, page 249, "Modern Wireless"? (2) If not, what is the correct value of C_4 and R_6?

(1) The condenser you mention is much too large for the position indicated in the circuit. (2) Condenser C_4 might have a value of 0.0002 μF, and the grid leak R_6 a value of from 1 to 5 megohms. The object of the resistances R_6 and R_7 in this circuit is to keep the grids of the two valves at the necessary negative potential. This could of course quite as easily be done by a potentiometer in the circuit, but the grid leak method is just as efficacious and very much simpler to use.

L. R. (West Kensington) has constructed an inductance as described in "Modern Wireless," No. 3, and finds difficulty in reconciling the number of tappings taken with the number of turns of wire on the former.

The fact that a definite number of tappings is given is not so important as that the tappings should be taken out at equal intervals. The number is not critical provided that the coil is tapped frequently. Your suggestion about the position of the variable condenser is quite sound.

H. J. E. M. (Leeds) refers to the explanation of a curious effect which has been brought to his notice, and asks our opinion.

This phenomenon is at present under investigation, and will be reported upon later in this publication.

T. W. F. (Stratford) asks certain questions about obtaining a licence.

"Wireless Licences and How to Obtain Them," Radio Press, Limited, will give you all the information you require. The official receipt for your 10s. postal order does not constitute authority to erect an aerial.

H. A. (Lincolnshire) proposes to build a two-valve receiver employing variometers, which appears in "Modern Wireless." The wavelength range of this instrument he states to be between 350 and 500 metres, but he wishes to extend this. He asks whether loading coils might be employed, or what alternative arrangement we can suggest.

If the range you desire to cover is not more than double the original range, the addition of small fixed or variable condensers of equal capacity across the variometers will produce the desired increase. If the range is greater, the variometers should be rewound with a finer wire, or loading coils may be used.

W. F. B. (Forest Gate) has made a two-valve variometer receiver, described in "Modern Wireless," No. 1, and asks certain questions about valves he has been recommended to use.

You mention three alternatives. The two valves you mention last would give most satisfactory results in this circuit, and should have a high tension battery of a value not less than 40 volts. Good results may often be obtained with as much as 70 volts.

W. W. F. (Birmingham) wishes to know the approximate range of the crystal receiving set described on page 173 of "Wireless Weekly," and also asks the wavelength of a coil with 170 turns of 23 gauge wire on a 3 in. diameter former.

The approximate range of this set is about 15 miles under favourable conditions. With reference to the coils, the actual wavelength of this would vary according to the type of circuit it was used in. The natural wavelength of such a coil on a P.M.G. aerial is in the neighbourhood of 800 metres.

F. W. H. (Fife) refers to the receiver mentioned on page 214 of "Modern Wireless," No. 3, and asks questions about the tappings.

See reply to L. R. (West Kensington).

D. A. (Bangor, Co. Down) is not quite sure what type of aerial will give him satisfactory reception from all the broadcasting stations.

Any well insulated aerial suitably exposed will give satisfactory results. The suggestion you make about a six-wire cage is quite sound, but as regards the use of gold or silver-plated wire, quite apart from the question of expense, this would be no better than bare copper wire. You should use enamelled copper wire of heavy gauge. We should not think that at your distance the directional effect of this aerial would be very marked.

C. E. B. (Hornsey) asks for a circuit diagram of the five-valve receiver given on page 80 of No. 2 "Wireless Weekly," as he does not think it sufficiently obvious. He also asks what voltage of high tension battery should be used with Ora valves.

(1) We do not thimk there is any difficulty in following out the circuit diagram, which is quite clear.

(2) This depends to a certain extent upon what function the valves fulfil. We do not recommend Ora valves for high-frequency amplification, but in other positions they may be used with from 45 to 70 volts on the anode.

H. E. F. (Herne Hill) asks questions about multi-layer coils.

If you will let us have more detailed information as to the sizes of coils you wish to construct, we shall then be able to advise you.

R. B. C. (Shenfield) proposes to construct the two-valve Broadcast receiver described in "Wireless Weekly," No. 4, and asks whether the introduction of variable condensers into the circuit would assist matters, and, if so, where they should be placed.

No useful purpose will be served by the use of variable condensers in this circuit, as the tuning adjustments are already sufficiently fine and are much more easy to operate than a variable condenser would be.

H. D. (Greenock) **asks the following questions: (1) From what valve reaction should be taken? (2) How can four variable condensers which he has in his possession be employed in this circuit? (3) Where could vernier condensers be most usefully employed?**

(1) The reaction should be taken from the anode of the detector valve.

(2) We do not think you could use four condensers of the capacity you mention successfully in this circuit.

(3) The two vernier condensers might be used as secondary circuit tuning condensers and reaction tuning condensers. You will, of course, realise that reaction into the aerial circuit such as you propose to use is not permitted on the broadcast band of wavelengths, that is, from 353 to 435 metres.

J. J. (West Hampstead) asks for the values of condensers shown in circuit No. 8, page 190, No. 3, "Modern Wireless." He also asks questions regarding a commercial type of reactance coupling.

(1) The circuit shown is efficient but not very selective. The condenser values might be C_1 0.001 μF, C_2 0.0002 μF, C_3 0.0003 μF and the telephone condenser 0.002 μF.

(2) We believe the instrument you mention is very satisfactory and is at the moment widely used.

R. L. H. (Palmers Green) has a circuit which refuses to oscillate. He asks our advice, after submitting particulars, and also wishes to know whether a loud-speaker can be made out of a microphone which he has in his possession.

We suggest that if the values of the inductances, condensers and batteries in the circuit are correct, the valves may be at fault. Reaction in a single valve circuit is generally very easily produced. You cannot satisfactorily employ the microphone in the way you mention.

R. F. (Glasgow) asks a number of questions about a single-valve Armstrong circuit.

We must adhere to our rule of answering three questions only at a time. We will deal with the three most useful questions in your remarks. (1) The 0.005 μF condenser may consist of 12 foils each 1½ in. by 1 in.

(2) A vario-coupler of the "Igranic" pattern will be quite suitable.

(3) A hard valve should be used such as a good "R" valve or a small transmitting valve.

T. (Renfrew) submits a circuit diagram of his apparatus, and asks: (1) Whether he could cut out 5SC. (2) Whether he should be able to receive American broadcasting. (3) Certain questions about switching.

(1) You should have no difficulty in tuning out 5SC at your distance with this apparatus.

(2) Under very favourable conditions you might possibly receive one or two of the American stations, although this reception must be regarded as rather in the nature of a freak.

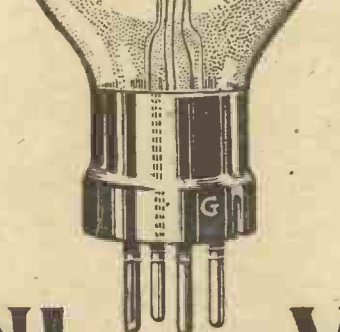
(3) Without having further particulars of what circuits you wish to control, we cannot show you where to insert switching devices.

J. R. M. (Barnet) asks: (1) For a diagram of a two-valve set with one high-frequency valve, using reaction. (2) For suitable sizes for basket coils to be used as anode and reaction coils for broadcast wavelengths. (3) Whether the same A.T.I. and secondary honeycomb coils which have been used with a single valve set would be equally efficient with the projected two-valve arrangement.

(1) The use of this type of reaction on the broadcast band of wavelengths is prohibited.

(2) Suitable sizes of basket coils for this purpose could be wound on a former having a diameter of 2 in. with 17 spokes, and would have 50 turns for the anode coil and 75 turns for the reaction coil.

(3) The same honeycomb coils that you have been already using could, of course, be used.



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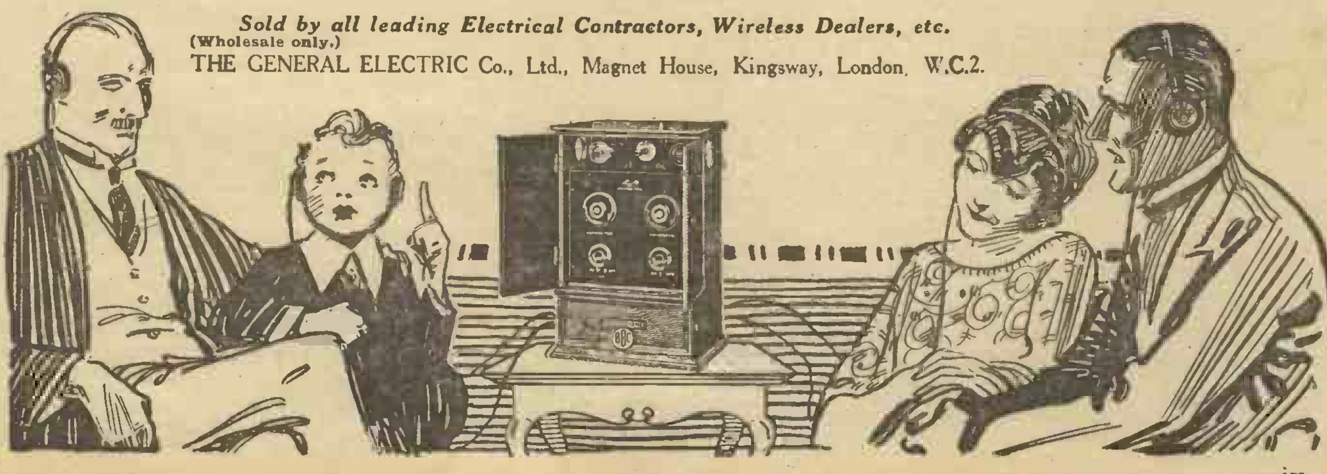

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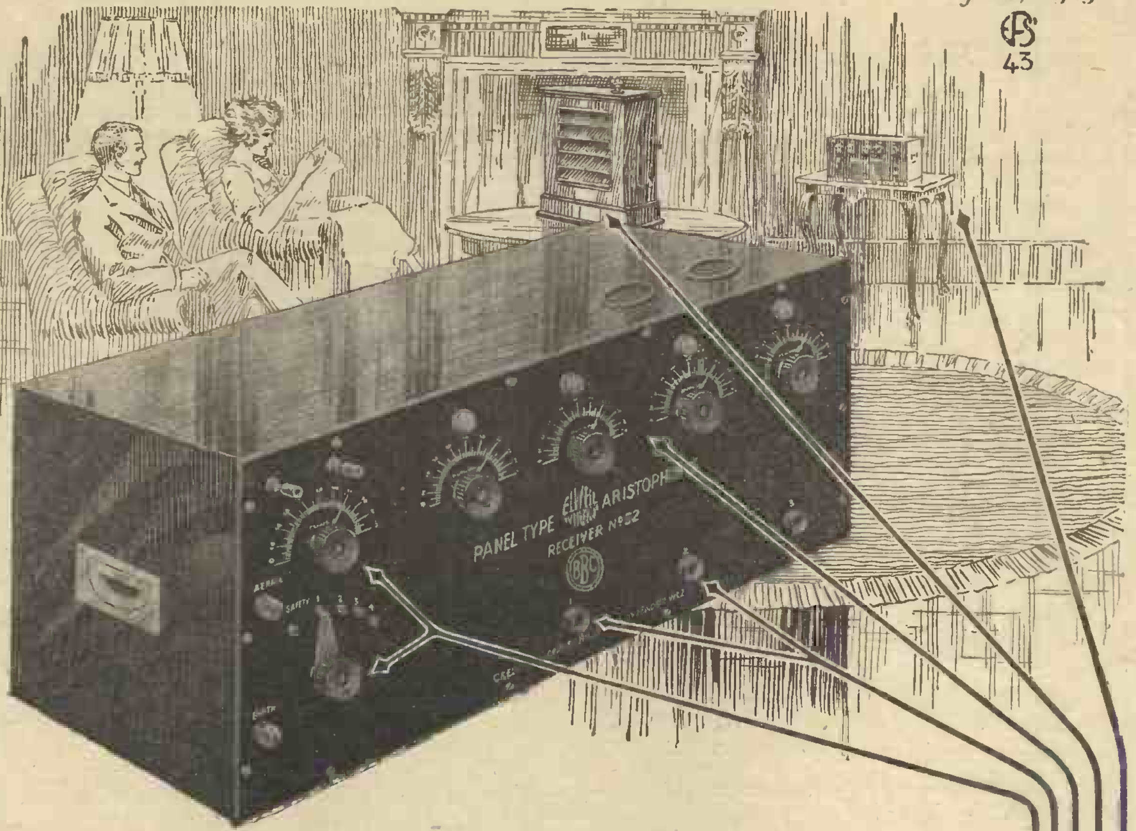

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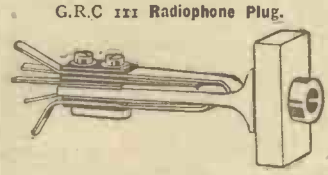
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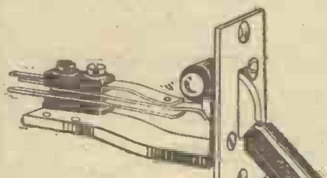
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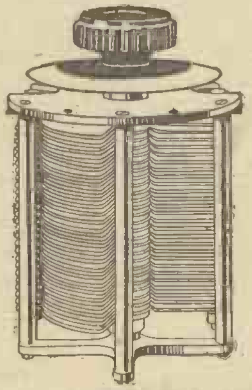
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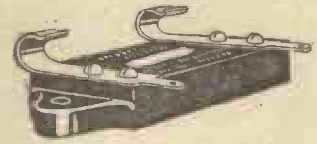
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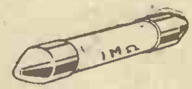
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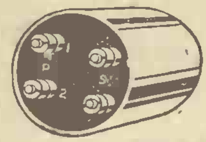
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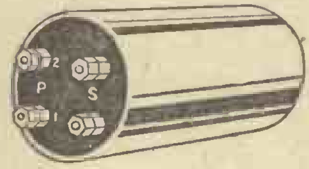
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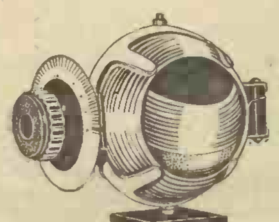
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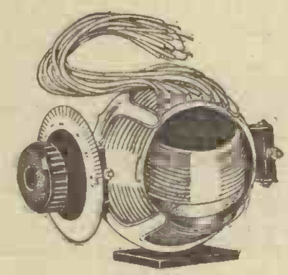
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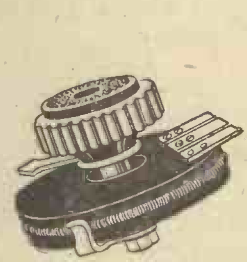
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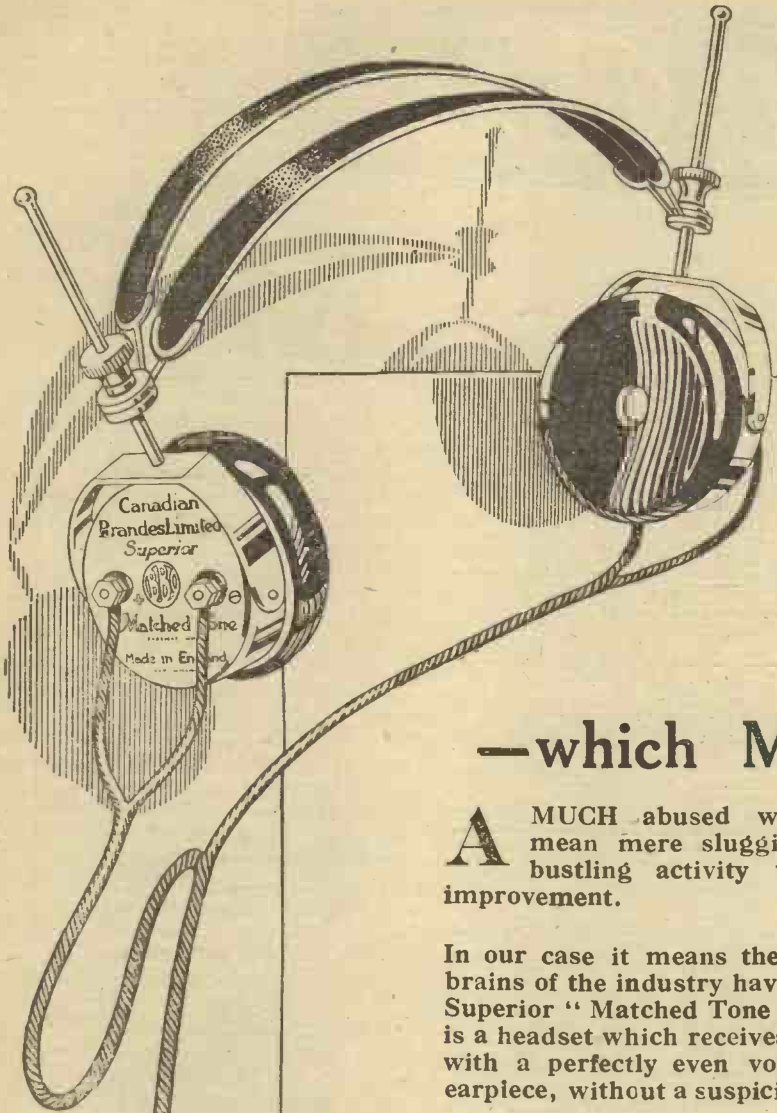

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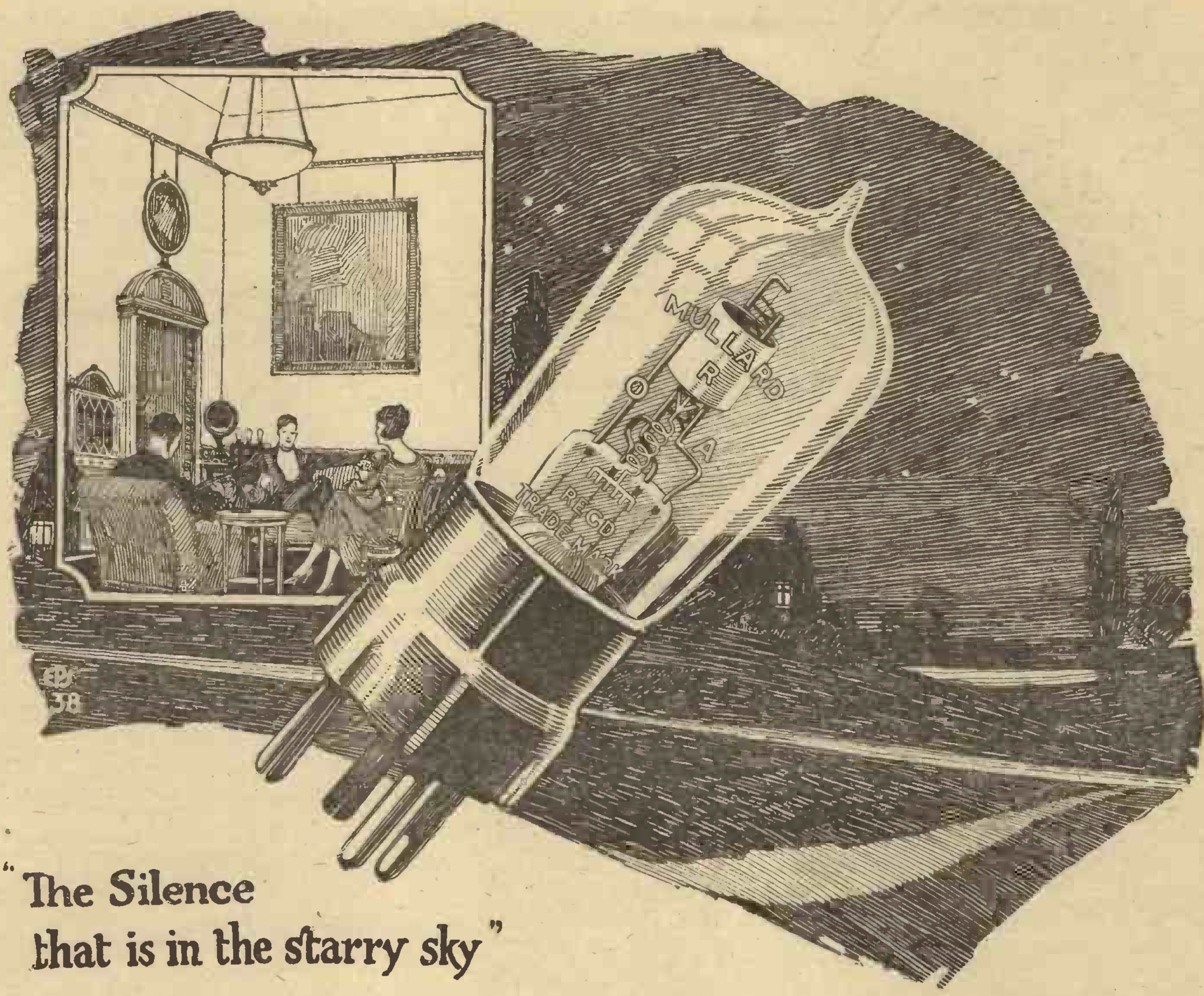
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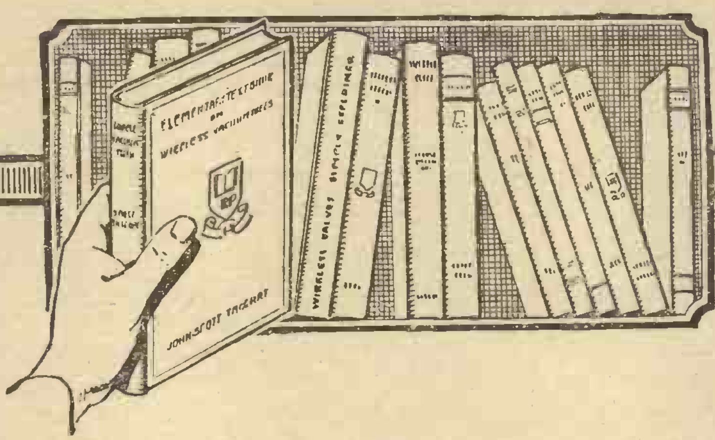

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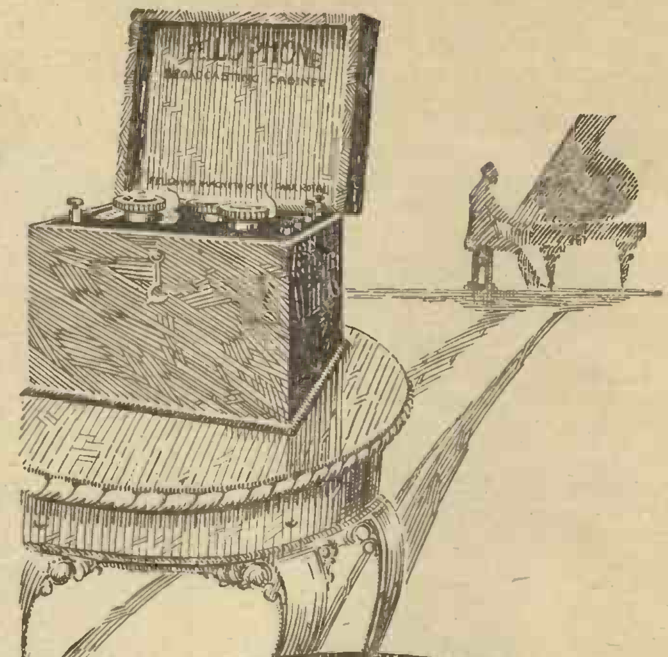

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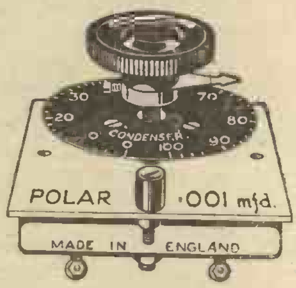
"POLAR"



Price 20/- mounted in polished wood case. 14/- for panel mounting. Postage 9d.

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FOR EXPERIMENTAL SET BUILDING.

Readers of MODERN WIRELESS who wish to construct any of the extremely interesting circuits described therein, are invited to consider the advantage and convenience of employing the following "Polar" units.

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Give uniform tuning over nearly twice the length of scale. Their design is correct theoretically while that of condensers hitherto available is opposed to uniformity of tuning. Our technical booklet supplies the reason.

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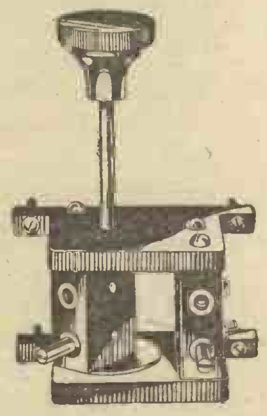

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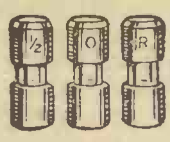
In addition to the usual quick movement, the movable coils have a slow fine tuning movement through an angle of about 10° in all positions. Hence, precise adjustments are rapidly obtainable after the coils have been brought roughly into position by quick movement.



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Quality counts as well as price, something "cheap" and "nasty" is of no use to anyone. See you get an article worth the amount asked for it.

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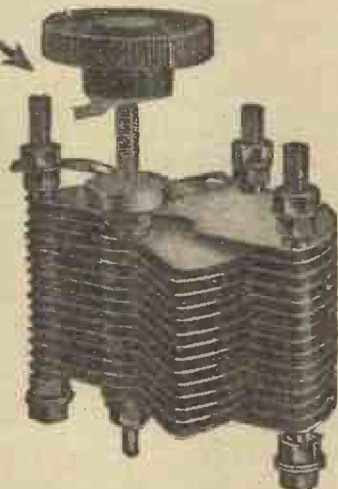
(Drilled Ebonite Ends for same 1/- pair.)

Approx. Capacity in Mfd.	No. of Plates.	PRICE.
·001	57	6/6
·0005	29	4/6
·0003	19	3/3
·0002	13	2/6
·0001	7	2/3
Vernier	3	1/9



COMPLETELY ASSEMBLED AS SHOWN.

·001	8/-
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·0003	4/11
·0002	3/11
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Vernier	3/3

If required to be sent by post, the charge for post and packing is 1/3 per Set extra. Orders only accepted on this condition.
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ALUMINIUM VANES 12 pairs 1/6
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My home-assembled Set

—the interesting experiences of an Amateur's first steps in Wireless

ALWAYS being fond of mechanics—in a mild sort of way—I fell an easy victim to the fascination of wireless. After reading one or two little books on the subject, I made up my mind to build up my own set. A timely article in a wireless paper describing a simple crystal set seemed to me to show just the instrument which would fill the bill.

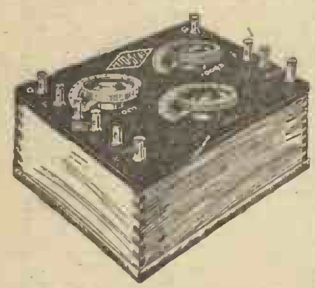
A Crystal Set.

It was simple and consisted of few parts—a great advantage to a novice—and could be constructed for a few shillings. I well remember the thrill experienced when I heard my first telephony on it—the excitement of other members of the household at hearing this "music through the air." But this set, good though it was, later on began to pall. My interest seemed to wane; I wanted to hear more than the nearest broadcasting station and the few amateurs in my neighbourhood. In short, I had tired of this crystal set and wanted a more ambitious valve receiver.

After looking around I found that to buy a ready-made instrument was far beyond my means, and constructional articles in the wireless papers seemed hard to understand and to require rather more skill in the use of tools than I possessed.

A Unit Valve Receiver in sets of parts.

There seemed no alternative until by chance I discovered just the type of receiving set I had in mind. It was in units—that is to say, it could be made to expand and more valves could be added just as often as one's purse permitted, until eventually a super-sensitive multi-valve receiver is obtained. Just like a certain expanding bookcase, in fact, "always complete, yet never finished." And the greatest advantage of all, perhaps, was that it was supplied in complete sets of parts all ready to assemble at home.

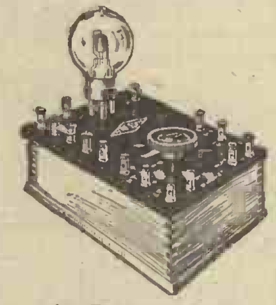


The Condenser Unit.

The manufacturers and designers of this clever set were the Peto-Scott Co., Ltd., of 64, High Holborn, London, W.C.1, and having found that they issue a little sixpenny booklet describing the whole system—as well as giving an interesting description of the whole principles of wireless—I lost no time in getting a copy and studying it.

Making a start with one Valve.

I found that I could make an excellent start—using the tuning coils from my old crystal set—with the Detector Unit (No. 4) alone. Having bought the complete set of parts for the modest sum of 17s. 6d., and followed the directions contained in a six-page illustrated instruction folder, a couple of hours' work gave me a complete valve unit. There were no holes to drill; all I had to do was to insert the parts as shown.

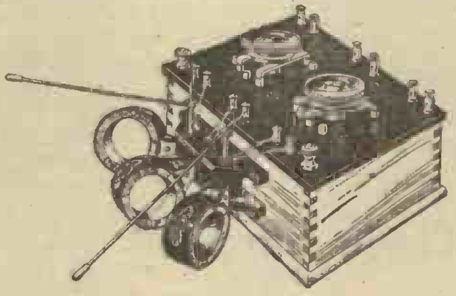


The Detector Unit.

Although my valve now gave me much better results than I had ever been able to obtain with my crystal set, I found that my primitive tuning arrangements had very serious drawbacks, therefore I decided that my next step would be to invest in a proper tuner.

A Tuner for all Wavelengths.

An outlay of £3 9s. 6d., therefore, procured for me all the requisite parts for a really first-class tuner in two units suitable for all wavelengths. The tuner unit itself is most ingenious. Besides a three-coil holder it has two rotary switches; one is for putting the condenser in series or in parallel with the primary coil, and the other is for "Stand by" or "Tune." The advantages of the former are probably very well known to you, but the latter may be as new to you as it was to me.



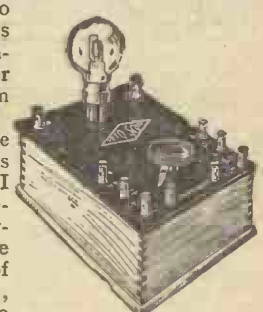
Tuner Unit.

It operates like this: When the switch is at "Stand by" the tuning is done on one coil only—the other one for the time being is not in use at all. The result is that the tuning is quite "broad" and non-selective. This has advantages; for instance, if you are searching for a station you can find it so much quicker on a non-selective circuit. Also, if you are listening to a couple of amateurs talking to one another, you can hear them both without having to re-tune each time, supposing they are not exactly on the same wavelength.

When the switch is at "Tune," you are operating two circuits at once and are able—by separating the coils and adjusting the condensers—to cut out all interference from near-by stations.

Every Broadcasting Station heard on this set.

I was now on the high road to success. These three units enabled me to pick up all the broadcasting stations with ease from London to Newcastle, as well as the splendid Eiffel Tower concerts from Paris.

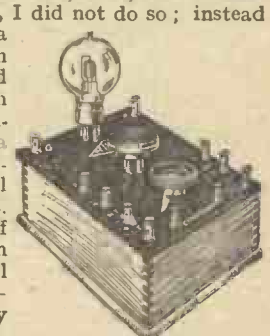


L.F. Unit.

In due course—and as funds permitted—I added a high frequency amplifying unit (at the moderate cost of but 13s. 6d.), enabling me to pick up The Hague, and a low frequency unit which gave me the necessary strength to use my headphones attached to an old gramophone horn as a loud-speaker.

Building the Set into an old Bureau.

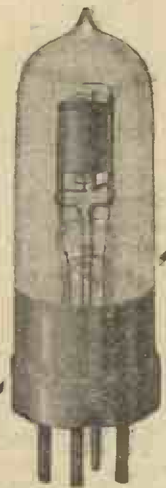
You will observe that I have said nothing about cabinets. Although I could have purchased suitable mahogany ones from Peto-Scott, Ltd., for as little as 3s. 6d. each, I did not do so; instead I bought at a local auction sale a fine old bureau which I am now converting as a suitable receptacle for all these five units. The result of my efforts, I am convinced, will be a three-valve set worthy of any home, and one which would have cost me probably three times as much had I bought it ready made. It will certainly be an investment I shall never regret.



H.F. Unit.

E. R. G.

EDISWAN VALVES



Noiseless — Sensitive — Robust

There is no better valve for wireless work than the Ediswan Type A.R. It is silent-working, sensitive and essentially strong. It gives high amplification, is very compact and extremely economical in current consumption.

This Valve—made by the makers of the world-famous Ediswan Electric Lamps—has been specially designed for operation on low plate voltages and is particularly recommended for amateur work.

We have had very considerable experience in the development and manufacture of the Thermionic Valve. The first experiments in connection with the investigation of the "Edison Effect" on which the working of a valve depends were carried out at our Ponders End Works by Prof. J. A. Fleming, who was then in our employ.

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Descriptive leaflets free on request.

Also manufacturers of complete Receiving Sets, Accessories and H.T. and L.T. Batteries.

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Everything wireless at Autoveyors

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Seven strand 25 gauge best tinned copper wire, heavily insulated with rubber, jute and braiding. This aerial wire does not require insulators, as its heavy insulation prevents leak, irrespective of contact with walls, trees or other supports. In fact, it will afford good reception laid on the earth.

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Provides an indoor antenna for efficient reception of broadcast telephony for those who are unable or unwilling to erect an outdoor aerial.

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These crystals are specially selected and carefully tested on long range telephony by experts. Every crystal is carefully cased and sealed.

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Iridia Platinum ...	1	3	Talite	2	3
Gold	1	0	Herzite	2	3
Silver	0	3	Zincite	2	0
Tungsten	0	3	Permanite	2	0
Aluminium	0	3	Tellurium	2	0
Nickel Chrome ...	0	3	Selenium	1	6
Nickel Copper ...	0	3	Molibdinite	1	6
German Silver ...	0	3	Iron Pyrites	1	0
Zinc	0	2	Bornite	0	6
Copper	0	1	Gelena	0	6
Brass	0	1	Carborandum	0	6
Steel	0	1	Silicon	0	6
Lead	0	1	Graphite...	0	3

FILTRONS (Patd.) 5/- each.

A variable Grid leak ensuring precision control of Detector Valves.

FILTRON COMBINATION (Pat.) 10/- each

A variable Grid leak coupled with a variable grid condenser. For those who desire the last word in accuracy and purity of rectification or R.F. precision capacity-resistance coupling.

"CHICCO" LIGHTNING and STATIC DISCHARGER (regd) 5/- each.

A protector for wireless receiving sets which may be fitted to any set in two minutes and needs no further attention. This lightning protector was the only device which proved constantly efficient in the equatorial tornado belts of Africa after several years' experience with innumerable designs.

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This loop aerial is constructed of 7.25 best tinned copper and insulated wire specially designed for outdoor, picnic or river use, 10s. each.

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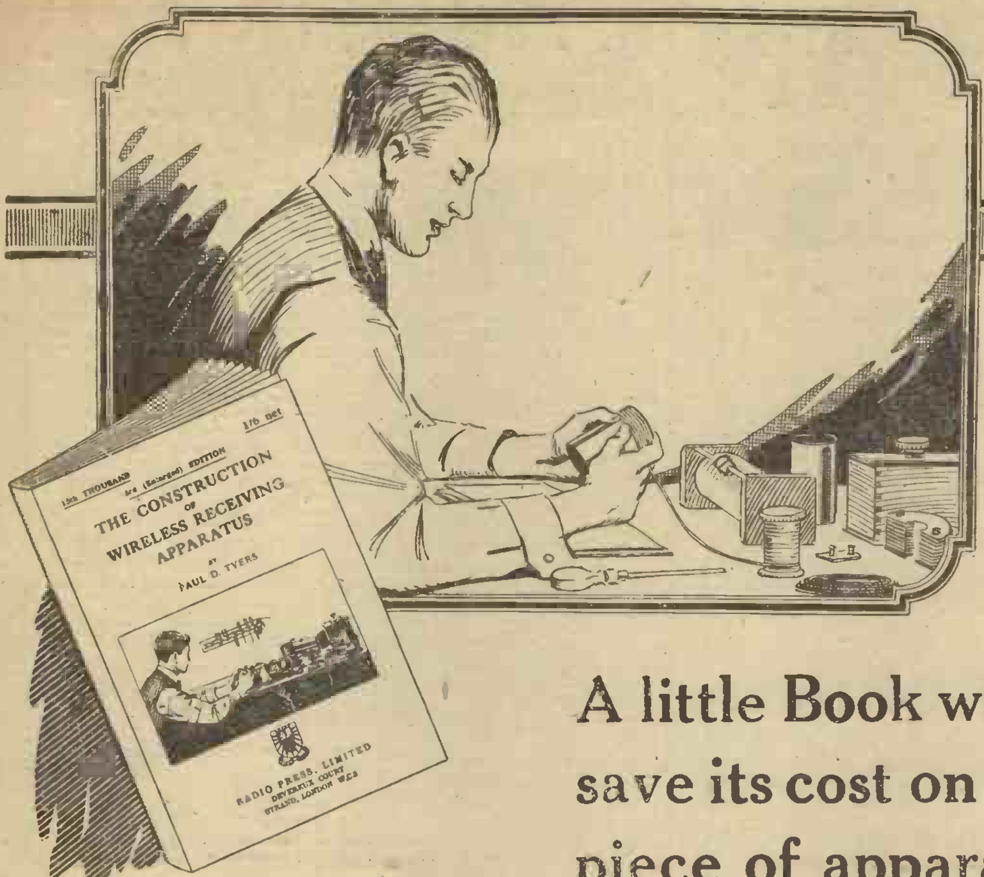
Write for Catalogue. The most comprehensive list in the Wireless Trade. Post free, 3d.



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Sold by all Booksellers and Newsagents or 1/7½ post free.

A little Book which will save its cost on the first piece of apparatus——

The construction of Wireless Receiving Apparatus

By P. D. TYERS.

Fifth Edition. 96 pages — RADIO PRESS WIRELESS LIBRARY No. 5.

Shows how to make

Anode and Grid Resistances, Filament Rheostats, Potentiometers, Basket Coils, Slab Coils, Solenoid Coils, Duolateral Coils, H.T. Batteries, Condensers, Crystal Detectors, L.F. Transformers, H.F. Transformers.

THERE are quite a number of Wireless components to be made without the use of special tools. This Book contains, for the first time, a collection of constructional articles which are essentially practical, and which will prove of special value to the Experimenter whose financial resources are limited. Such vital details as the gauge of suitable wire, number of turns, diameter of formers, etc., are given as the result of the Author's personal experience.

Nothing is described which has not actually been constructed and used.

If you are an Experimenter and take pleasure in building your own apparatus, you must certainly keep a copy of this useful little Book by you.

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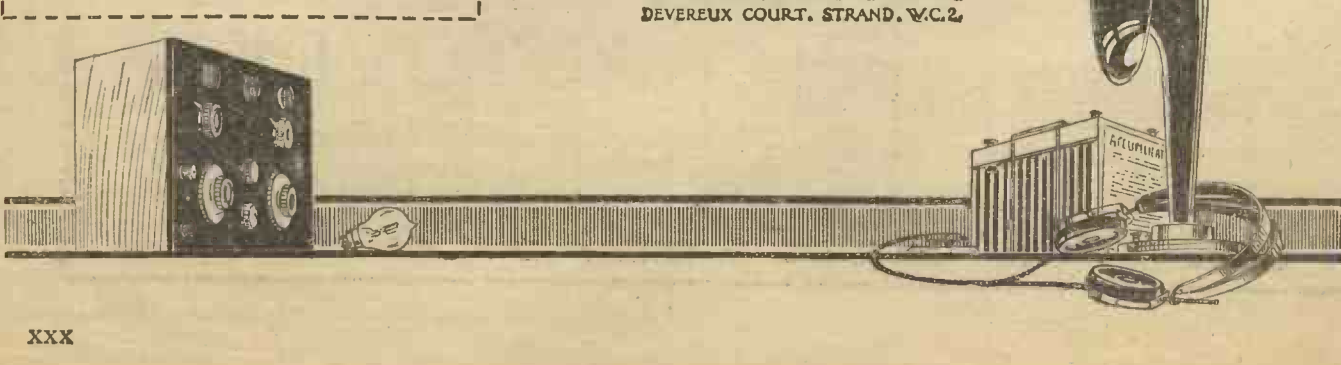
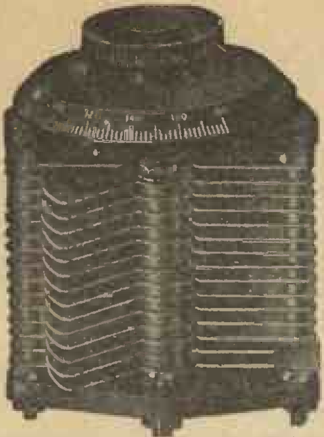


LETTERS OF APPRECIATION



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Prompt delivery Cash with Order.

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WIRELESS SUPPLY STORES,
HECKMONDWIKE.
Dear Sirs,—
Enclosed please find cheque. The quality and style of your Condensers, having been seen by my customers, **will doubtless lead to further orders** . . .
Yours truly, P. HANSON.

8, RUE DE GAND, OSTENDE.
Dear Sirs,—
With reference to previous correspondence, I have much pleasure to let you know the CONDENSERS have now arrived and **are very satisfactory.**
Yours faithfully, F. de MORTIER.

116, VERNON STREET,
PITSMOOR, SHEFFIELD.
Dear Sir,—
We thank you for the sample Condenser, which we have tested in the circuits we propose to use, and **it is quite O.K.**
Yours truly, BROOKES BROS,
Mechanical and Electrical Engineers.

WIRELESS SUPPLY STORES,
HECKMONDWIKE.
Dear Sirs,—
I beg to acknowledge receipt of the sample of your new model Condenser. **This model is certainly very good,** and will no doubt prove an **excellent line.** I enclose herewith cheque . . . .
Yours truly, P. HANSON.

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ASHTON-ON-MERSEY.
Dear Sirs,—
Please send me . . . I have been **recommended to your firm.**
Yours faithfully, L. TIDSWELL.

11, ALBERT GROVE, SOUTHSEA, HANTS.
Gentlemen,—
. . . . **The quality of your products is good and the price is very reasonable.**
Yours faithfully, J. H. C. HARROLD,
Radio Engineer and Lecturer.

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Dear Sirs,—
. . . We are keeping the sample in question, and are **highly** satisfied.
Yours faithfully, FRANCIS LAW, Ltd.,
Electric Light and Power Engineers.

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Dear Sirs,—
I have received the Condensers and am very pleased with them. **I want another Type A.II** for panel mounting.
Yours, T. J. JACKSON.

WIRELESS STORES,
HECKMONDWIKE.
Dear Sirs,—
. . . **I am very well pleased with the style and quality of your Condensers,** and feel that good business can be done to our mutual advantage.
Yours faithfully P. HANSON.

HACKNEY & DISTRICT RADIO SOC.
Y.M.C.A. HACKNEY.
Dear Sirs,—
I wish to thank you for the .0002 Condenser which you sent me a week ago, and which is O.K. I herewith have pleasure in enclosing £ . . . . for two more.
Yours faithfully,
H. A. EPTON, Chairman.

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Dear Sirs,—
. . Our Exhibition was a splendid success. . . YOUR RANGE OF CONDENSERS WAS VERY FINE, and I am prepared to retain them all for stock. . .
Yours faithfully,
P. HANSON.

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SOUTH SHIELDS.
Dear Sirs,—
Many thanks for Condensers received last week, which **are quite satisfactory.**
Yours faithfully, S. A. JEFFERIES.

62, DELPH STREET, WIGAN.
Dear Sirs,—
Received Condenser in good order, and am **quite pleased** with same.
Yours truly, H. CLAYTON.

203, CASEWICK ROAD,
W. NORWOOD, S.E.27.
Dear Sirs,—
I have pleasure in acknowledging receipt of Condensers, both in good condition.
Yours truly, R. W. BEST.

Everyone of which is authenticated by the name & address of Sender!
—Verb. sap.

In response to numerous enquiries we beg to state we manufacture Variable Condensers only.

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is an important factor when considering the price of inductance coils. The "Efficiency" Inductance gives you more metres per shilling in addition to its many other advantages. All the coils in the set are of the same dimensions and the air space between turns increases with frequency. The self-capacity and effective resistance are reduced to a minimum. Don't use a lot of reaction to overcome avoidable losses. Fit inductances in which the losses are negligible.

Condenser Max. Capacity.		.00025		.0005		.00075		.001		Price.
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Wave Length in Metres	A	105	275	110	385	115	460	120	525	5/9
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	D	340	880	360	1225	380	1460	400	1700	8/-
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	F	890	2300	945	3170	995	3800	1040	4350	10/3
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Complete Set .. .. £3 10s.

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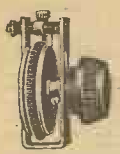
Embodied in "IGRANIC" RADIO COMPONENTS is all that is best in construction and finish.



Plain type rheostat.

FILAMENT RHEOSTATS
(Patent applied for).

These rheostats are supplied in two types, Vernier type for detector circuits, Plain type for amplifying circuits. Both types designed for individual valve control.
Price: With Vernier 7/-
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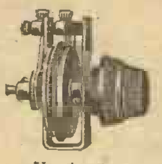
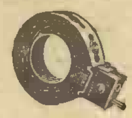


Vernier type rheostat.



Plug type Honeycomb Inductance

HONEYCOMB INDUCTANCES.

(De Forest Patent No.141344 Highest efficiency. Low distributed capacity. Low resistance. High self inductance. No losses due to dead ends. Coils supplied either standard plug or gimbal mounted.

Gimbal typ Honeycomb Inductance.

Type H.R. Variometer.

VARIOMETER.

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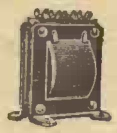

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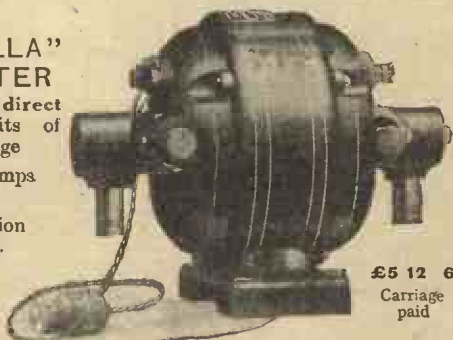

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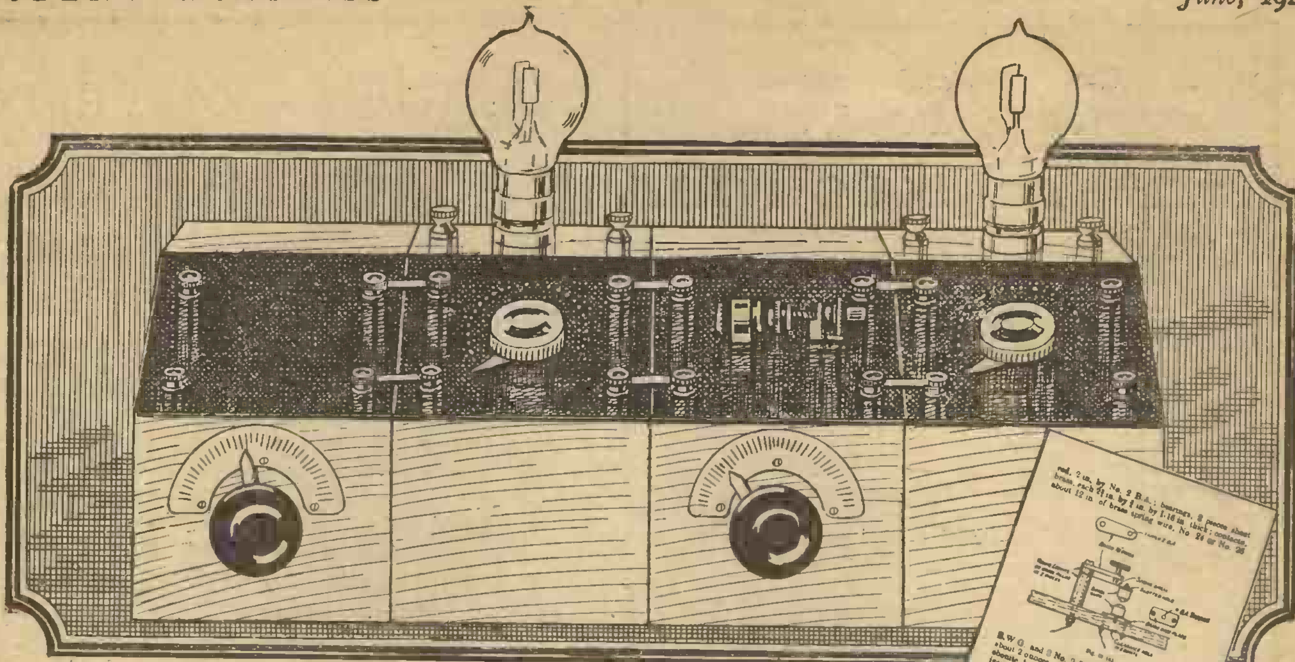

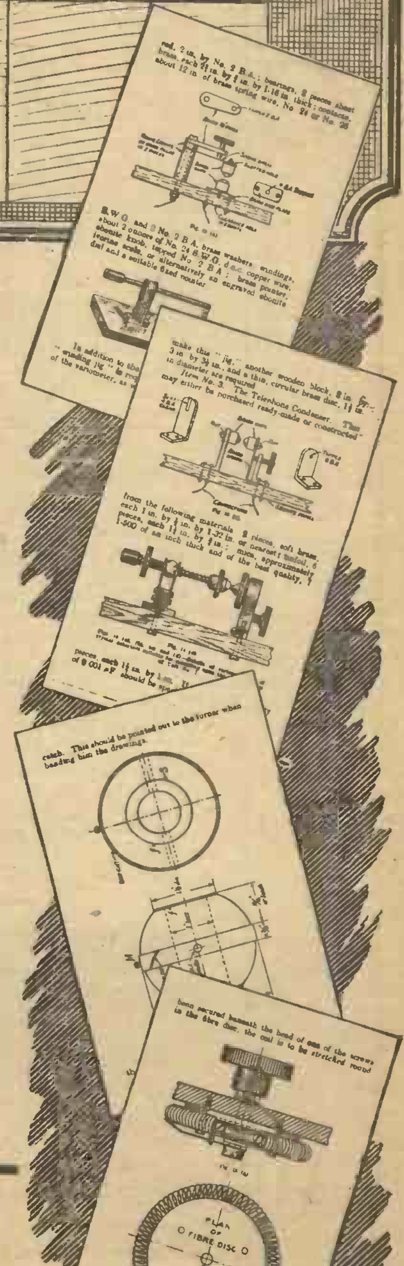

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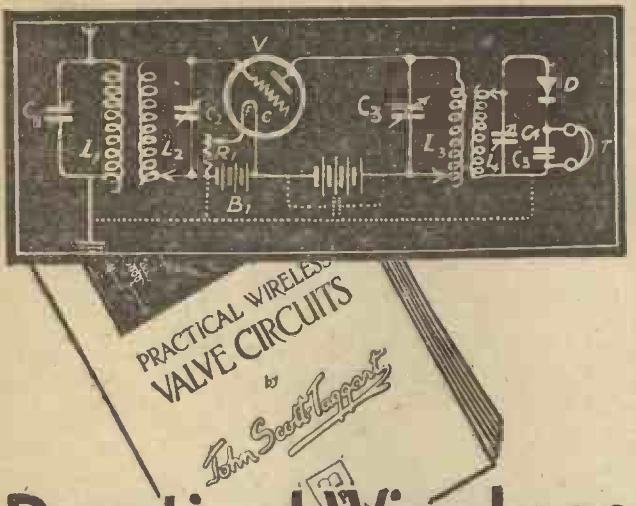

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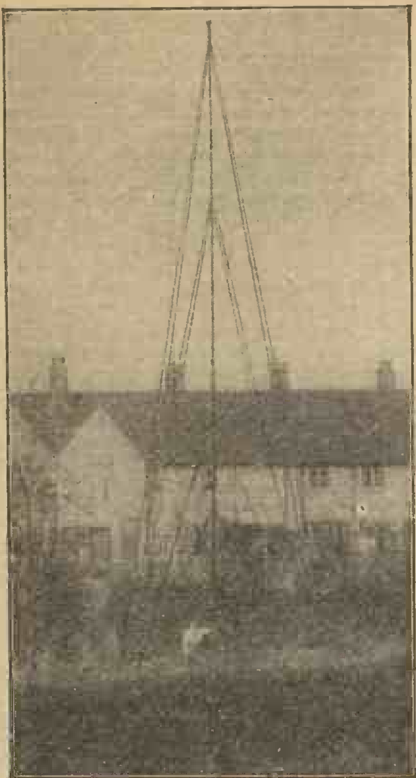

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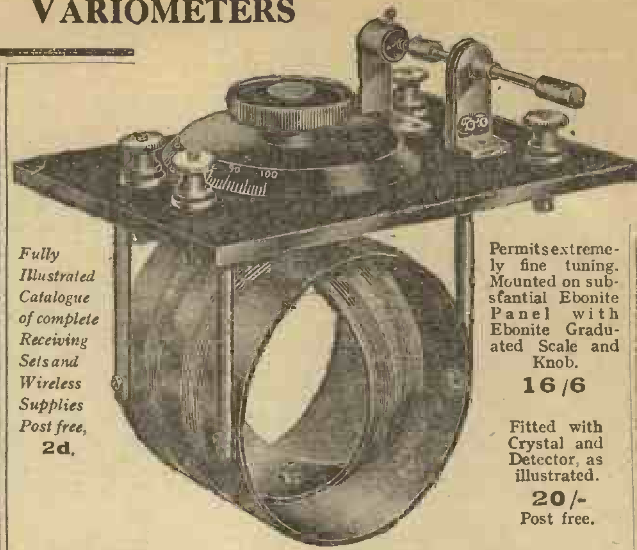

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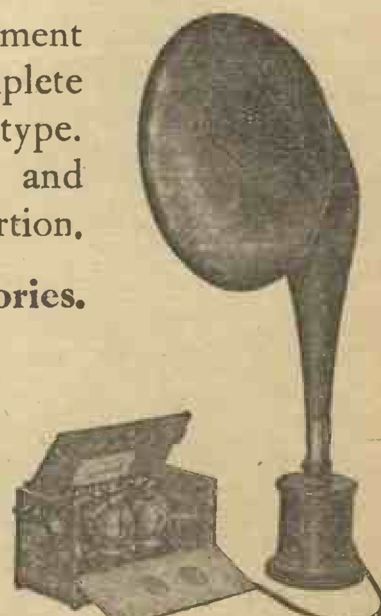

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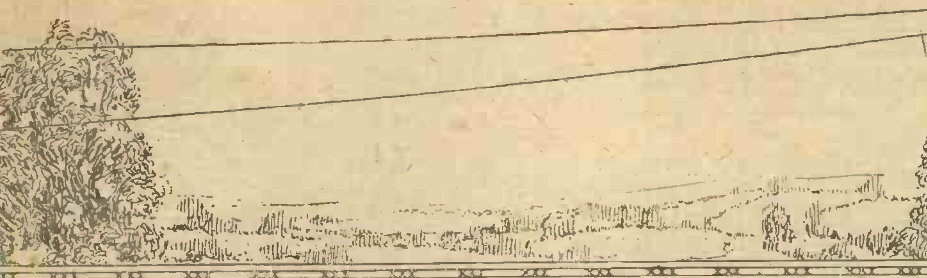

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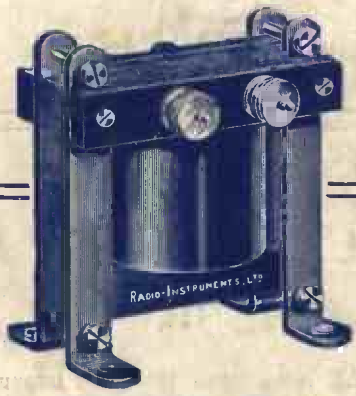

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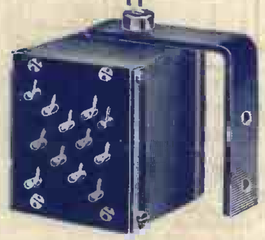

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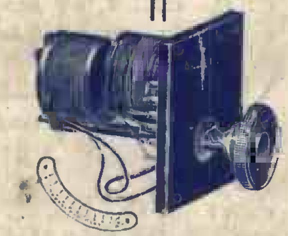

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