Experimental Wireless

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Experimental Topics.

B.B.C. Activities.

No one could justly insinuate that the British Broadcasting Company is showing lack of enterprise. In fact their present activities are such as to arouse more than a passing interest amongst the more serious wireless experimenters. It is now common knowledge that the B.B.C. are seriously considering the erection of a high power central broadcasting station, and the announcement has given rise to considerable criticism. Capt. P. P. Eckersley, their chief engineer, too well known to our readers to need introduction, has written to us at some ength, and his communication is both an endeavour to justify the adoption of the suggested scheme and to reply to the chief cirticisms which have been levelled against it. The B.B.C. admit that simultaneous broadcasting is not all that can be desired, and that in the future provincial stations could relay a central station by a " wireless link " which would be immune from line troubles. Then there is the case of the man with a crystal set situated midway between two stations. At present his position is practically hopeless, and the only suitable solution lies in the use of greater power. Another point in favour of the " High Power'd Station " is that local jamming would be proportionately negligible. " But what is to become of the listener with a receiver embodying only short-wave tuned circuits ? " say the critics. " Buy or build loading coils " is the reply. This is certainly wise counsel, but we ourselves imagine that it will be a rather difficult problem for those whose sets employ one or more stages of H.F. amplification not provided with interchangeable coils. But then, of course, there is no need to listen to the new station, for the service is to be additional to that already existing, and so far as the broadcast listener (or " B.C.L. " as he is known in the States) is concerned, the proposition seems highly attractive. When we examine the technicalities of the scheme we find it is proposed to employ about 25 kilowatts of well modulated C.W. on 1,600 metres—something resembling a fairly well-tuned spark station. We do not wish to make any suggestions concerning the possible jamming that may arise, as we have before us no definite data, but we wonder what methods of telegraphic reception will be necessary round about 1,500 metres for stations situated in the immediate vicinity. Turning, now, to recent events, many readers have mentioned the relayed 100-metre American stations and have asked us if we know why the tests have been made, as they have received chiefly distorted speech and atmospherics. Frankly we cannot offer any suggestion, and regard the transmissions more as a scientific experiment than an entertainment. It is absolutely impossible to predict transatlantic reception conditions, and so far the B.B.C. seem to have been unlucky in the choice of dates. We venture to submit that transatlantic 100-metre transmission and reception still needs considerable investigation. So far as relaying is concerned night distortion seems to be the chief drawback, and it would no doubt be a wise policy to conduct further research in reception before continuing the relaying of American programmes. However, the B.B.C. are to be congratulated on their enterprising experiments, and we trust that future tests may be more successful.

Amateur Transmission and Broadcasting.

Under the heading of "Points from Letters" will be found some correspondence on the subject of broadcast jamming by amateur transmission. As will be seen, the alleged amateur jamming was really non-existent; the interference being due to a high-power station. However, the letters in question serve to indicate the attitude of the broadcast listener towards the experimenter, and there is no doubt that many "B.C.L.'s" seem to feel that their 10s. or 15s. licence entitles them to all the æther. The experimenter and "B.C.L." have an equal "right to the æther," and no genuine experimenter wishes to cause interference. There is no reason why he should not transmit occasionally during broadcast hours, and if jamming takes place it is due to the inefficiency of the broadcast receivers. In the latter case there should be some pleasant mutual arrangement between the parties concerned. Perhaps "B.C.L.'s" would find greater favour in the sight of the experimenter if some of them were a little less demonstrative and a little more reasonable. It is a great satisfaction to know that the Post Office have at heart the freedom of the experimenter and will do all they can to help him.

First Principles.

Some little while ago we were present at a meeting of one of the well-known wireless societies which holds regular meetings in London and has the support of several well-known radio engineers. A most interesting paper was read, and the ensuing discussion clearly demonstrated that the speaker's remarks had been closely followed by his listeners. Both the paper and the discussion were unquestionably illuminating, but, unfortunately, several statements and suggestions which were offered showed a considerable ignorance of some of the elementary fundamental principles of electricity. Perhaps, however, this may not have been due to entire ignorance, but rather to the speaker's inability to apply fundamental principles to any particular problem. We cannot impress too fully upon our readers the extreme value of some knowledge of elementary physics and electricity. Without such all experimental work is mere blundering in the dark, and results are achieved rather by accident than design. The ignorant experimenter is surely more an automaton than a scientific investigator. Admittedly it may seem more pleasing to experiment with some wonderful multiple circuit or freak reflex arrangement, for example, but the joys are merely transient. If the time were to be devoted to a little straightforward experiment conducted in a true scientific manner the radio enthusiast would soon find that he was in a position to master his apparatus instead of being subject to its sway. Similar reasoning holds good in the case of literature, and the experimenter who devotes a little time to simple text books rapidly rises above those whose interest lies only in light reading. The greater the knowledge and skill of the amateur the stronger will be his position. British experimenters must see that they lead the way in amateur radio work.

Amateur Construction.

A large proportion of amateur-assembled apparatus sent in for calibration has revealed many mechanical defects. Apparently, the radio enthusiast seems satisfied so long as his apparatus functions in the desired manner. There is no use denying the fact that almost any collection of gear, if correctly connected, will function, but the amateur should remember that in many cases electrical and mechanical efficiency are correlated, and it frequently happens that the former cannot be a maximum without paying due regard to the latter. We refer particularly to such instruments as variable condensers and other moving parts, such as switch arms. Rigidity of mounting of all components of a high frequency circuit is also of the utmost importance. In order to assist our readers in this direction we shall give from time to time some short notes on these and similar subjects, and we feel that information from the pen of a mechanical engineer should be of great assistance.

The Electromagnetic Screening of Radio Apparatus.

By R. L. SMITH-ROSE, Ph.D., M.Sc., D.I.C., A.M.I.E.E.

It might appear at first sight that the problem of screening any particular arrangement of apparatus is comparatively simple. This, however, is not the case, and below will be found the results of a considerable amount of experimental work on screening at high radio frequencies.

I.—General.

ALL those who have carried out experiments in connection with radio apparatus will have appreciated the fact that the shielding or protection of a body or space from a high-frequency electromagnetic field is very much more difficult than is the case when using steady electric or magnetic fields. Electrostatic screening may be effectively carried out by completely surrounding the body with a metal covering, (a Faraday cage), the thickness of which is immaterial. Where it is desirable to be able to inspect the interior the screen need not be continuous but may be constructed of metal gauze or perforated sheet, without sacrificing appreciably any of the screening properties for steady electric fields. Magnetic shielding of a body may be carried out by surrounding it with a heavy iron case which, however, only partially screens by deflecting the magnetic field through the space of greater permeability.

When the magnetic field is fluctuating or alternating the shielding effect of the iron is much more complete, and in this case also the shielding may be produced by other metals than iron due to opposing effects of the eddy currents set up in the metal by the primary fields. Simple experiments with oscillation generators give the impression that when the frequency of the alternating magnetic field is very high the difficulty of screening is greatly increased. This is, however, a false conception and arises from the fact that the induced e.m.f. in any circuit placed in an alternating magnetic field is directly proportional to the frequency, and thus weak fields give a comparatively large induced e.m.f. at the frequencies employed in radio work. It is this fact, together with the very high magnifications produced by multi-stage valve amplifiers, that leads to some rather surprising results when attempts are made to shield instruments from radio-frequency alternating magnetic fields. In actual fact the difficulty of reducing a field to a given fraction of its value decreases as the frequency is increased.

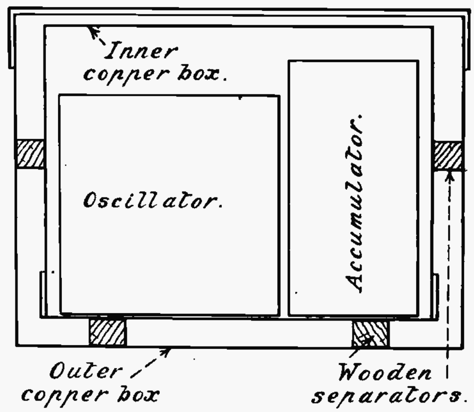


Fig. 1.—Triode oscillator screened with two complete copper boxes.

II.—Some Experiments on the Screening of an Oscillator.

(*a*) Preliminary Experiments.

Although most experimenters will need to carry out screening at the receiving end of their apparatus it is convenient to experiment on a source of oscillations. The fields so obtained will, in general, be much larger than those experienced in reception and the effects of the various screens will thus become much easier to detect. In the experiments about to be described no convenient means of measuring the induced e.m.f. from the local oscillator was available, and this made the carrying out of the experiments somewhat difficult.

To ascertain the general nature of the problem of screening preliminary experiments were carried out with a simple form of valve oscillator of the usual type. The 6-volt accumulator for the filament also served as the H.T. supply, so that the oscillations generated may be described as relatively weak. When receiving strong C.W. signals on a frame coil about 4 feet square and using a 7-valve amplifier, however, this oscillator was sufficient to give a beat note which was audible several yards away from the telephones even when the oscillator was placed at a distance of 100 feet from the coil receiver. This indicates how very small is the local oscillating current required to heterodyne incoming signals. In the majority of the experiments the continuous wave signals received by the frame were produced by a second oscillator which was coupled to the receiving coil.

Attempts were now made to screen the first oscillator to obtain a reduction of the stray field from it which links the frame coil receiver. The oscillator with its battery and connecting leads were therefore first

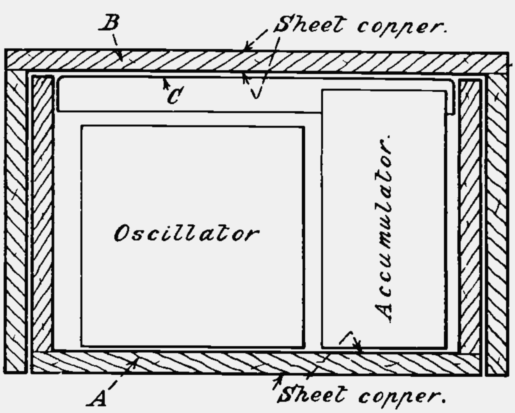


Fig. 2.—Simple screened oscillator.
A=Double copper-lined wooden box.
B=Double copper-lined wooden lid.
C=Inner copper lid.

placed inside a thin copper box provided with a loosely fitting lid. This considerably reduced the intensity of the corresponding oscillations induced in the receiving coil, and they were only effective in producing a beat note when the oscillator was brought within 20 feet of the coil. With a box of galvanised iron in place of copper a similar reduction of the induced oscillations was obtained of about the same order. In both these cases it was observed that the placing of the lid on the box had a considerable effect on the reduction; but the position of the otherwise open end of the box relative to the receiving frame appeared to be immaterial. A lid of fine brass wire gauze was not so effective as a solid sheet of metal, whether copper or iron.

With the oscillator and battery inside the copper box this in turn was supported on paraffin blocks inside the iron box with the respective lids in position. This arrangement only resulted in an audible beat note when placed within 12 feet of the coil. By using a small coil in the amplifier circuit as a search coil it was found that a considerable increase in the strength of the note was obtained with this coil placed near the aperture between box and lid, indicating that some at least of the energy escaped in this direction. Making metallic connection between the copper and iron box had no effect on the strength of the received signal. Further experiments showed that the copper box provided with a well-fitting lid giving about 3 ins. overlap was much more effective in screening than with the lid formerly employed only ½ in. deep.

(*b*) Boxes with Multiple Copper Linings.

As the combined copper and iron boxes seemed to give hopeful results further experiments were carried out with boxes with two and three linings. One such arrangement consisted of two copper boxes complete with close-fitting lids and separated from each other by 1 in. wooden strips. This arrangement was found to screen most efficiently when the inner box was inverted, as shown in Fig. 1. Again no difference was experienced on making contact between the two boxes.

For the next experiment a rough screening box was constructed of the form shown in the diagram in Fig. 2. Both the lower and upper halves A and B of the box were lined inside and out with thin copper sheet on a wooden frame, and the upper lid B was arranged to completely envelop the lower-half A. With this box it was found that putting on the lid made a considerable reduction in the escaping energy from the oscillator as indicated by the diminution in intensity of the note heard in the telephones. The box appeared in fact to be about as good as the combined copper

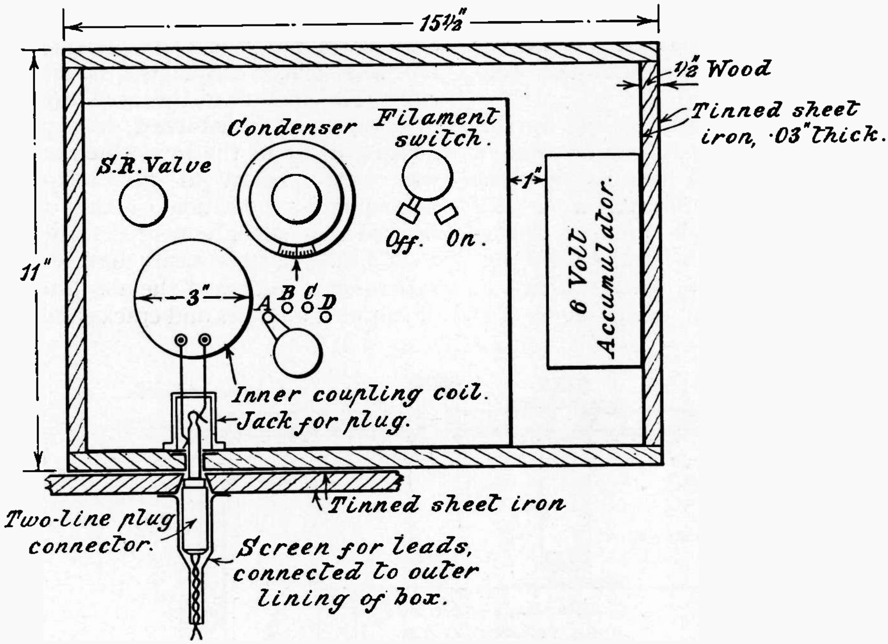


Fig. 3.—Plan of interior of screened oscillator.

and iron boxes previously tried, but was much more convenient from the point of view that the double-lined lid could be removed at one operation. The diminution effect was continuous as the lid was placed over the box, the telephone intensity being a minimum when the box was completely enveloped. It was subsequently found that the fitting of an auxiliary inner lid, as shown at C in Fig. 2, effected a still greater reduction in the emitted energy.

(c) Effect of Leads Projecting from the Box.

With a type of double-screened box as used above (Fig. 1) the external field could be rendered inappreciable when it was at a distance greater than 12 ft. from the frame coil receiver. In this condition a small coupling coil of a few turns was introduced into the inner box and a flexible conductor brought outside the whole enclosure. As long as this conductor remained entirely within the outer iron box the beat note was undetectable at 15 feet distance, but immediately a few inches of it were exposed outside the iron box good beat note signals were obtained, giving evidence of energy thrown off from these leads. Replacing the flexible wires by a lead-sheathed twin conductor overcame this trouble, which, however, recurred on connecting a small coil to the end of the screened leads with a view to coupling to the amplifier. In later experiments the construction of the coil in two halves of D shape wound in opposite directions was found to be a suitable manner of overcoming the difficulty.

III.—Experiments with Metallically Sealed Boxes.

(a) Sealed Copper Box.

Using one of the original boxes of sheet copper about 30 mils. thick, all joints at sides and bottom were sweated together with about ¼ in. overlap. With a well-fitting lid made of the same copper sheet and giving about ½ in. overlap, the external field from the oscillator within the box was easily detectable when the box was within 20 feet of the receiving set. Without altering any of the adjustments the box and lid were solidly soldered up using a good thickness of solder to cover all holes and cracks. In this condition the effect of the oscillator could still be detected when within 10 feet of the frame coil. When the box was placed inside the frame the beat note in the telephones could be heard 100 feet away. Also by tilting the box inside the frame a position giving practically dead silence could be obtained in the same way as with the oscillator unscreened.

The effect of hermetically sealing up this copper box was therefore to reduce some of the emitted energy which presumably came from the cracks round the lid, while still leaving a very appreciable amount apparently passing through the metal; the external field retaining the characteristics of that from the unscreened oscillator.

up as before, after which no beat note was audible in the telephones, even when the box was placed inside the frame receiving coil. The fact that the oscillator was still in operation undisturbed was proved by making a slit in the box, when a beat note was easily heard in the telephones. A subsequent repetition of this experiment showed that enough energy escaped through a slit ½ in. long to be easily detected. Further experiments indicated the absolute necessity of stopping all holes and cracks and of getting

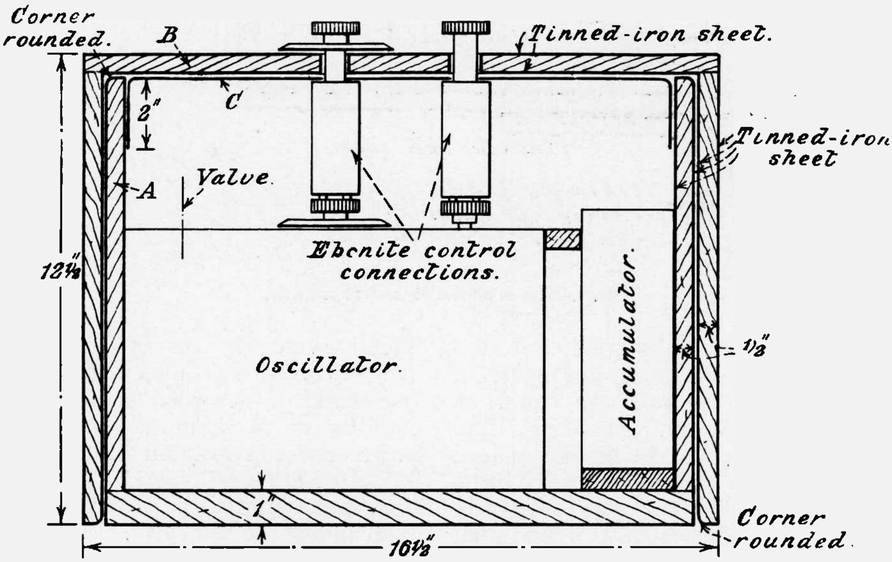


Fig. 4.—Sectional elevation, showing tinned-iron sheet linings, and control handles.

(b) Sealed Iron Box.

A similar experiment was next carried out with a box of the same dimensions constructed of sheet iron 28 mils. in thickness. When the oscillator was placed inside the box, with a well-fitting lid giving ⅜ in. overlap, the resulting beat note signals were about the same as for the copper box. Placing another iron covering over the lid caused an appreciable diminution in the signals, but no further reduction was obtained by covering the remainder of the sides of the box. This seemed to indicate that the major portion of the energy from the inner box was coming from under the lid.

Employing the same oscillation frequency (which corresponded to a wave-length of 2,400 metres), the box and lid were soldered good metallic contact across all the joints, as a " dry soldered " joint may easily be the cause of an external magnetic field.

These experiments indicate, therefore, that it is only possible to screen a valve oscillator completely, as far as the sensitivity of the above apparatus goes, by placing it inside a sealed box of tinned sheet iron of sufficient thickness to prevent the direct penetration of the high-frequency magnetic field through it. In the latter respect iron would appear to be far superior to copper, which is a result in complete accordance with the theory of the penetration of alternating currents into conductors. This theory indicates that iron should be equivalent to about four to six times its thickness in copper. It is probable, therefore, that if experiment (a) above were repeated, using a box of $\frac{1}{8}$ in. copper sheet, complete screening would also have been obtained. From theory also it may be shown that the thickness of metal required to reduce a field to any definite fraction of its original value varies inversely as the square root of the frequency. Thus, to give the same effect at a frequency of 100 as is obtained at 1,000,000 cycles per second by $\frac{1}{8}$ in. of copper requires a thickness of about 12 inches of the same metal or about 2 inches thickness of iron !

depth of $\frac{1}{2}$ in. to close all cracks was found to entirely stop all detectable field, even when the box was placed inside the frame. On raising the box at one side the smallest crack was immediately detected by the note in the telephones. Using the copper box in the above manner, however, a beat note was still obtained when the mouth of the box was below nearly 1 in. of mercury.

This comparison experiment is very striking. With the copper box placed over, the the beat note steadily diminishes in strength,

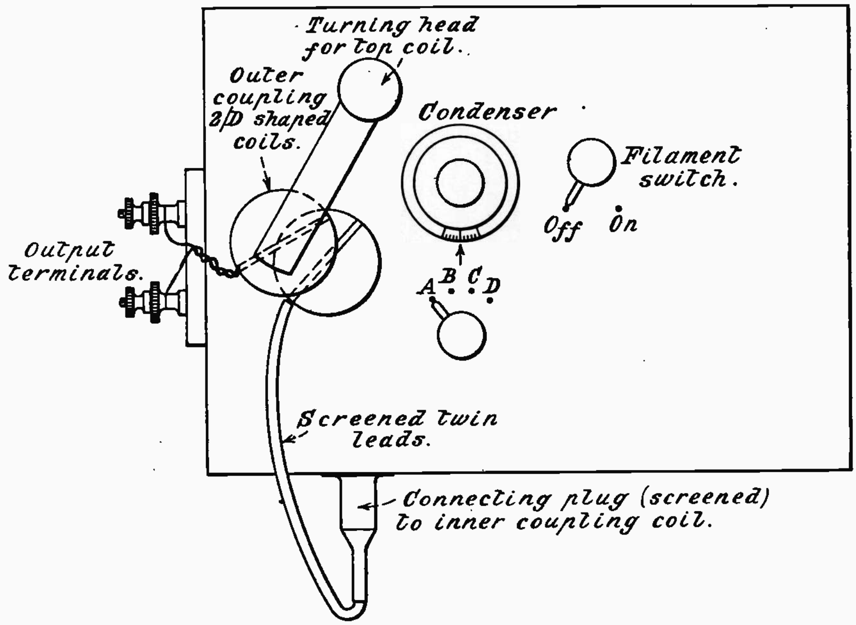


Fig. 5.—Plan of exterior of screened oscillator.

(c) Mercury Sealed-Boxes.

The process of soldering and reopening metal boxes containing a valve oscillator is very laborious and considerably limits experiments on these lines. It was thought that a mercury seal, if of sufficient thickness, would be as effective as solder in stopping up holes and cracks.

A suitable tray about $2\frac{1}{2}$ ins. deep was therefore made on which either the copper or the iron box could be placed giving an all-round clearance of about $\frac{1}{2}$ in. Placing the oscillator and battery in this tray with the iron box over it, the external field was easily detected when within 20 feet of the frame. Filling the tray with mercury to a

and a just detectable drop in intensity is noticed when contact is made with the mercury and the last crack closed up. With the iron box, however, the drop in intensity to entire inaudibility when contact is made with the mercury is very sudden and is a most marked effect. These experiments were repeated for oscillations corresponding to various wave-lengths over the range of 2,000 to 9,000 metres, and the residual effect with the copper box was found to be slightly increased at the higher wave-lengths, *i.e.*, at the lower frequencies.

These results thus fully confirm those previously obtained and indicate that the most complete method of screening valve oscillator is to enclose it in an iron box with welded joints, the removable lid being provided with a mercury seal. All external controls must be reduced to a minimum or even eliminated, owing to the apertures through which it is necessary to bring them. Such an extreme case would be very difficult to work with in practice, and some slight departure is necessary for the design and construction of a practical apparatus.

IV.—Design of a Screened Oscillator.

In the present section a detailed description is given of an *almost completely* screened oscillator designed by the author, which has been found very convenient and satisfactory for use with wireless direction finders and

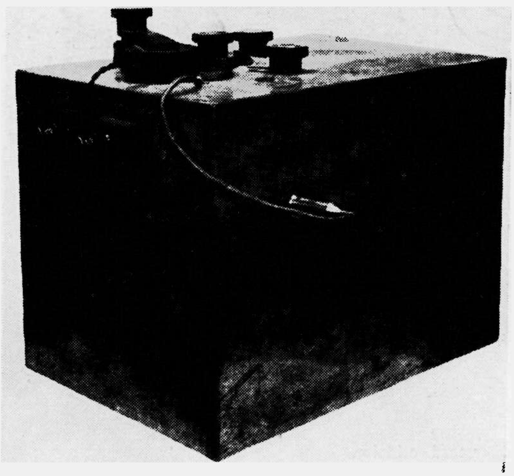


Fig. 6.—General view of oscillator showing controls.

with signal intensity measuring instruments The experiments had already shown that the next best arrangement to a sealed box was the provision of a tightly fitting lid with deep overlap, making good contact with the box over a large surface. In the present design the lid and box are of equal depth so that the former envelops the latter. The details of the design can be seen from the drawings in Figs. 3, 4 and 5. Both the box A and lid B are constructed of ½-in. five-ply wood, lined inside and outside with stout tin-plate. A lid C of depth 2 ins. is provided to complete the inner sheet metal lining, and the outer lid B is a tight driving fit over the box A to ensure good metallic contact between the respective surfaces.

Ebonite connecting pieces are used between the control handles on the top of the lid and the variable condenser, and the switches for filament current and inductance tappings within the box. Where they pass through the small apertures in the lid the controls are provided with metal bushes which make spring contact with the outer lining of the box. A separate coil is used within the box to couple to the oscillator inductances, and leads from this coil are brought out through the side of the box by a telephone jack and plug connection. The jack is mounted inside the box and the plug is pushed through holes in lid and box which are only in alignment when the lid is in its final position over the box. The plug is screened by a metal shield in contact with the outer lining of the box and the connections are taken through a metal sheathed twin flexible conductor to a double D-shaped coil forming half the outer coupling. Leads from the other pair of D-shaped coils are taken to the output terminals mounted on ebonite at the side of the box. A general view of the oscillator, showing the controls, is given in the photograph, Fig. 6, while Fig. 7 shows a plan of the interior of the box with the two lids.

The following points may be emphasised in regard to this screened oscillator.

(*a*). The entire control of the oscillator is obtained from the outside, and it need never be opened except for inspection, replacement of valve, or recharging of accumulator. A dull-emitter valve is used, and the filament supply is taken from a 6-volt accumulator, which forms the complete anode battery and which will run the set for about 120 hours continuously or intermittently.

(*b*). The opening up of the oscillator, when necessary, is a moderately simple operation. It entails the removal of the connection plug, control handles and the two screening lids.

(*c*). Close metallic contact is obtained at all points in the paths by which the high-frequency energy may escape from the box, other than by direct penetration through the sides.

(*d*). No part of the primary oscillator circuit is outside the inner metal lining.

Leads from the secondary circuit, which is untuned, are brought out by a screened conductor to an astatic coupling coil arrangement. The other half of this astatic coupling forms the tertiary output circuit to the measuring instrument. This coupling forms a convenient means of varying the strength of the output oscillation from a maximum down to nearly zero.

With this oscillator in operation a beat note was just detectable when it was placed about 5 feet from the frame coil receiver connected to its 7-valve amplifier, and the note was not very intense when the oscillator was placed inside the frame. Measurements are, of course, impracticable, but it is probable that the field has been reduced to about one millionth of its original strength.

V.—The Screening of Receivers.

For the screening of parts of radio receiving apparatus from stray electro-magnetic fields or for undesired incoming waves similar precautions must be taken on the general principles evolved from the above experiments. The chief point is to provide complete current paths in the screen of low resistance and in directions perpendicular to the undesired magnetic fields. Where the fields pass through the metal itself advantage can be taken of the permeability of iron to reduce the extent of the penetration. For general purposes, such as the screening of amplifiers, coil couplings, etc., a box of tinplate provided with a well-fitting lid and good overlap is very serviceable. To make the box non-directional in its action good conductivity must be ensured in all directions and the apertures necessary for control handles must be reduced to the minimum area. When the screening is not required to be as complete as in the above example wire netting or gauze of small mesh may be used, provided all slits are well-connected up. Such screens have been shown to reduce the field of an incoming wave to about 5 per cent. of its value outside the screen, and the use of solid metal sheet is only necessary in the not infrequent cases in which the reduction is required to be much less than one per cent.

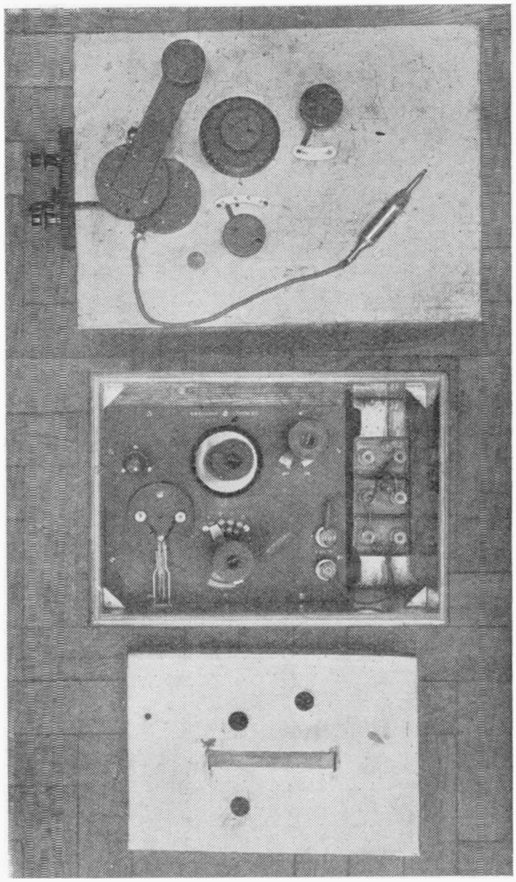


Fig. 7.—Plan view of interior of the box with the two lids.

Selectivity.

By L. J. VOSS.

Below will be found a brief review of the problems of selectivity and various methods of interference prevention are discussed.

IN 1899, when there were less than half a dozen radio stations on the earth, Dr. J. Erskine Murray said : " The difficulty in wireless is not to *receive* a signal, but to keep one *out*." How much more true is that to-day ; yet how many design and build sets with this in mind ? Few, deplorably few. An almost analogous case occurs in the practice of photography ; the correct procedure is to expose for the shadows, leaving the latitude of the plate or film to deal with the high lights. Beginners—and some others who will never get far—fire away with a fine disregard for the principle. So in wireless, our *main* efforts should be directed to keeping interference out. With some success in this direction, it is a poor set that will not bring in what is wanted.

No complete solution of the problem of interference exists, but Dr. Erskine Murray has indicated three partial solutions : a combination of two or all of these is usually possible, and brings a fair measure of success within our reach. Directional transmission and reception, organisation, and selectivity are the three partial solutions referred to. Of these, it is proposed to deal with the last, as being more within the scope of amateur work than the others.

Transmission must be dismissed—or, perhaps, postponed—in a few words. All responsible for the operation of transmitters *should* keep within the allotted wave-band, avoid harmonics, etc., and should use no more power than necessary at any time. Dead sharp tuning is impossible, for to signal one must modulate in some way, and this means that a band of wave-lengths of greater or less width is occupied ; decrement also plays a part. Telephony is the worst form of modulation from the point of view of interference production, both by spreading out over a wide band, and by heavy and variable decrement ; next comes chopped C.W., then spark and tonic train (sine modulation), about on a level, followed by high speed C.W. Hand-keyed C.W. does not give much trouble in this way. Incidentally, it may be noted that the method of signalling by de-tuning adopted at most arc stations may be less troublesome than " on and off " methods. It is unfortunate that many transmitters at present in use are incapable of being adjusted to give pure narrow band transmission ; but such apparatus tends to give place to better systems as time passes.

The ether hog, however, will probably survive for some years yet, and will trouble other people by carelessness in adjustment and by butting in out of turn, and with ten times the necessary power. As this type will *not* QRT (even when Land's End is insistent in the matter), we must provide every possible resource in the receiver for cutting out any anticipated form of interference. Let us explore the possibilities.

First, we have tuning—the only adjustment for selectivity provided in most receivers. Obviously, tuning can deal only with interference, differing appreciably in wave-length from the desired signals ; if carried too far distortion results—of small moment in telegraphy, but fatal in the case of telephony. A little distortion of speech may not prevent the acquisition of information from that speech, but spoils the effect of readings, recitations, dramatic recitals, etc., and ruins music absolutely. Our resources in tuning include single, double, or multiple circuit adjustment for both wave-length and coupling, and such devices as rejectors (drains, wave-traps, etc.) and filters, which all depend on differences of wave-length. Suppose, however, that the interference is so near to the required signals in wave-length, or the damping is so great, or the distance from the receiver so little that it is utterly impossible to tune it out ; need we abandon hope ? Not a bit of it ! If the jamming can be reduced (by tuning) to a smaller strength than the desired signals, we may still suffer annoyance from it, especially in telephony, so we weaken the coupling of the tuner, when the interference disappears first, leaving us free to amplify the received signals, if required, far more effectively, than when mixed with other noises. This remedy is denied us in the case of a set worked near oscillation point, as loosening the coupling in such a case produces instability. On the other hand, if the interference is stronger than the desired message we have to seek other means of elimination. One simple but effective device is the balanced crystal detector. The carborundum-steel combination is not sensitive to weak signals unless a certain potential is applied, but strong signals come in well with considerably less applied potential, or even none at all. Advantage is taken of this to use two such detectors in parallel, but connected in opposite directions. One is rendered as sensitive as possible, the other less so ; then signals stronger than a certain critical value pass equally through both branches, thus producing no resultant current in the phones, whilst weaker signals are rectified by the sensitive crystal, not affecting the insensitive one at all. Thus, the originally weak impulses affect the telephones, whilst the strong signals wipe themselves out. The weaker the signals required the more can the second crystal approach the sensitive point, when any jamming or atmospherics giving rise to higher pressures are either completely silenced or weakened to a point far below those sought. There are always plenty of "experts" ready (and eager) to tell one that balanced crystals are "no good," absolute wash-out, etc., etc., but on careful enquiry one finds that these experts have never tried them, and do not understand the action, nor even what classes of interference they are designed to cut out. It remains that this device, coupled with intelligent handling, will cut out jamming that tuning will not touch. Balanced two and three-electrode valves have been tried, but are less satisfactory than the crystals, being less sensitive, and involving greater complication. The Marconi Co. not only fitted balanced crystals to ships' sets, but up to fairly recently employed the system (with H.F. and L.F. valves) in commercial transatlantic reception. If balanced valves are not a practical proposition, there is another property of a valve which can be turned to account—and is utilised in the great majority of commercial stations of to-day. This property is known as "limiting," but goes further than its name would suggest. The original idea was so to adjust a valve that the required signals carried it to saturation ; then any stronger impulses on the control electrode could not produce a greater change in anode current than these signals ; hence the possible resultant strength of any incoming impulses can be *limited* to that of the signals desired ; in other words, strong signals do not appear in the recording or reproducing instrument at greater strength than any selected weak signals. Fate, in this instance is kind ; on trying out such arrangement of valves, in nearly all cases a similar effect to the balanced crystals is found, and the selected messages give stronger response than either originally stronger or weaker signals. The limiting valve may precede any H.F. valves, may also act as H.F. amplifier, or may also act as detector. In practice, it is found that the last is quite convenient and simplifies the adjustment considerably. It should be noted that valves with pure metal filaments only —*i.e.*, not dull emitters—are flexible enough for use in this service ; it is necessary to have the saturation point under minute control, and the emission characteristics of the various dull emitters are not sufficiently controllable.

In the case of continuous waves, sharper tuning is possible, but greater care is needed in the application of limiting or balancing, or these may not be effective. However, further control is possible in this case than in damped waves. Looser coupling to the aerial is possible, and if a separate heterodyne is used (as it should be), the adjustment of its strength at the point of application to equal exactly the strength of the required signals ensures that all other signals, whether stronger or weaker originally, are weaker in the phones.

It is not suggested that the methods outlined above will deal with all forms and degrees of interference ("wipe out" will defy the most frantic efforts, for example), but a full use of these effects will go far fowards minimising the nuisance.

In Search of a Real Receiver.

By H. ANDREWES, B.Sc., A.C.G.I.

The writer being dissatisfied with the conventional system of receiving, and at the same time being strongly opposed to the use of freak circuits, gives below his experiences of a circuit which embodies interesting refinement.

I THINK it would be as well if I made my object in writing this clear at the start. I have *not* discovered a new circuit which is to revolutionise the whole science. Again, I am *not* going to describe how I can receive all the B.B.C. stations on a 2-ft. loop. I merely wish to clear up in my own mind, and I hope in the minds of some of my readers, what we are really out for when we try and design our receiver. I am going to look at the problem solely from one point of view, namely, that of the active transmitter.

Theoretical Considerations.

Now I think most transmitting licence holders will agree with me that when "all's said and done," if you want to work "DX" regularly and get some useful reports, the average "freak" circuit is not much good.* That may, of course, be a sweeping statement to make, but still I believe it to be true.

In the case of the man who only has a reception licence of course it may be different, he has more time to prevent his circuit from "spilling over"; but when you never know when the H.T. supply won't fail or your smoothing condensers start flying about the room, well—then I do like to know that, at any rate, my receiver will function.

Let us, therefore, take the standard circuit, which we were all brought up on, and see what its deficiencies are and whether we can remedy them.

The circuit I refer to is, of course, the single-valve regenerative. Now, first of all, about regeneration. They can say what they like at 2LO, but there will always be, in my humble opinion, much too much difference between a regenerative and a non-regenerative receiver to make it worth while considering the abolition from our receiver of regeneration. Of course we then come up against the "oscillator" difficulty (not broadcast, of course, but listening to yanks !). Let us draw a veil.

Turning now to the design of our receiver. We will assume that we set up a single-valve regenerative which works. I do not propose to go into considerations of dead-end in coils, the size of reaction coils, etc., as I am convinced that there are no rules in that game at all and one can only go on till one is lucky ! Now with this circuit we shall get good results, but there are several disadvantages.

Firstly, our signals are not very loud. This may be easily remedied by adding a stage of L.F. amplification. This does not in anyway complicate the working of the set, and brings previously faint signals up to a reasonable strength.

Secondly, reaction is not very easy to control, and considerable practice is needed in the manipulation of the circuit.

Next let us consider H.F. amplification. According to the text-books we are told that, by using H.F. amplification, we can bring in stations which would otherwise never be heard. With this statement we all agree *provided* our H.F. amplifier amplifies. This, then, is our first serious problem. Can we get satisfactory H.F. amplification ?

As regards waves within and above the broadcast band, the answer is unhesitatingly yes, but below 300 metres I think the argument starts.

With a view to satisfying himself on the subject the author carried out a number of experiments. In all the tests "tuned anode" H.F. was used, as in practice it gave better results than transformers. It was then found that down to about 150 metres good H.F. amplification could be obtained, but that in the region of 100 or 120 metres very slight increase in signal strength was obtained by adding one H.F. valve. This is presumably due to the methods at present

* The author of course does not include the Supersonic amplifier in this category, as it is *the* way out if you can afford it.

used, and there is no doubt that the great need at the present time is the invention of an H.F. amplifier which really does amplify at 100 metres and below.

From the results obtained above it was decided to incorporate one stage of H.F. amplification, as there is no doubt that, even though we may get no appreciable amplification on 100 metres, we do gain considerably in selectivity.

As regards the actual method, variometer tuned anode is to be preferred, as by reducing the capacity across the tuned anode coil we increase the E.M.F. (up to a certain point, of course), which is transferred to the grid of the detector valve. It will also be noticed that tuning is not quite so sharp, and also, owing to the shape of the variometer, anode tuning is easier near the zero of the scale, as the anode tails off much more gradually than does a variable condenser.

Let us now consider the circuit as far as we have got. It will be, presumably, something like Fig. 1.

In this case we placed the reaction coil in the anode circuit of the detector so that when the coupling is sufficient the detector is "feeding back" into the grid circuit of the H.F. valve, and the constants of both valve circuits will affect regeneration. This circuit is used very largely at the present time, and there is no doubt from the point of view of sensitiveness and selectivity it is very good. But I think most people, even after several years, will agree that it is not easy to work when one is searching for a station of a considerable band of wavelengths. Now for this circuit to work successfully it must be kept only just oscillating, as then it is most sensitive, and also the two circuits, namely, the grid and anode circuits of the H.F. valve, must be exactly in tune. We find, therefore, that our whole trouble is really the control of regeneration. As a rule a reaction coil is used to control regeneration, but this is never satisfactory, as when the coupling is altered to reduce (or increase) reaction the wave-length to which the grid circuit is tuned is inevitably charged, so that a signal, such as faint telephony, takes quite an appreciable time to tune in.

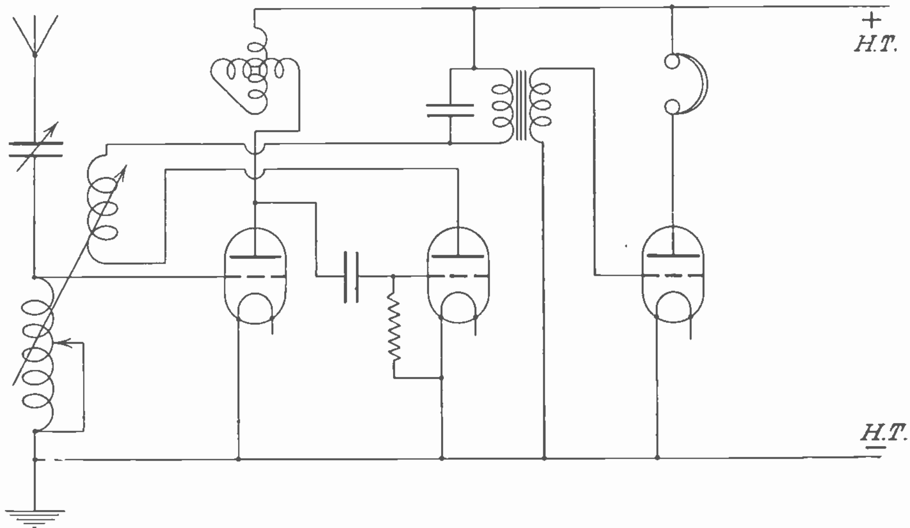


Fig. 1.—The conventional tuned anode and note magnifier circuit which forms the basis of the new arrangement.

Now in any oscillatory valve circuit there are in general three main ways of controlling regeneration :—(*a*) magnetically ; (*b*) electrostatically ; (*c*) by increasing the losses. I think (*a*) is the most commonly used at the present time, but it has the disadvantages alluded to above ; (*b*) has been used to quite a considerable extent, but the author does not like this method as one must inevitably by-pass a little energy from the grid of the first valve, and, secondly, it has all the disadvantages of de-tuning which are so disastrous in the case of magnetic control.

There is another method of control which, perhaps, should be mentioned here, namely, control by filament temperature. It is not, I think, a method which is very widely used. But in order to give everything a chance this method was experimented with, but with very poor results. It was found that one of three things happened with this method. Either (*a*) one turned down, so to speak, the signal with the filament of the valve ; (*b*) the valve started and stopped oscillating with a violent " plop " ; or (*c*) one obtained the desired state, either just oscillating or just not oscillating, depending, of course, on whether one was receiving 'phone or C.W., but that things were very unstable. This is a state of things which one might reasonably expect, because there is no doubt that, unless one can afford 120-amp.-hour accumulators or take very considerable precautions with filament rheostat (carbon ones being, of course, particularly prone to variation of resistance with temperature), an absolutely constant supply of filament juice is difficult to obtain. A very good demonstration of slight variations of filament voltage, inevitable even with large accumulators, may be obtained by setting up such a circuit on the " Multivibrateur," a circuit for producing audio-frequency oscillation with two triodes. In this circuit the frequency will be found to slowly alter all the time owing to slight changes in the filament temperature, due to variations in the supply even when large accumulators are used.

We now come to the last method of control, namely, by introducing losses. It is well known that in the mathematical analysis of an oscillatory circuit consisting of inductance capacity and resistance, if the value of the resistance is above a certain limiting value, with a given E.M.F., no oscillations will be produced. Here, then, we have an excellent method of controlling the oscillatory tendencies of circuit. By introducing resistance into the grid circuit of the H.F. valve we can bring the valve to any desired state, either just oscillating or just off the point where oscillations commence. The practice of this method is not, perhaps, quite so simple as the theory, as we at once come up against a snag in designing our resistance. In order that the method may be effective the resistance must, of course, be (*a*) continuously variable ; (*b*) absolutely non-inductive up to frequency of, say, 3×10^6 cycles ; (*c*) noiseless in action ; (*d*) capable of fine control. A large number of experiments were made to find a suitable resistance. First of all, a non-inductively wound wire resistance was tried, having, of course, a sliding cutout, but this, although sufficiently non-inductive, was found to be too noisy in action and also the adjustment was not fine enough. Next a filament resistance of the compressed carbon type was tried. This was very much more successful. It was found to be quite fairly silent, to have good control, but unfortunately the maximum value was found to be not quite high enough (about 40 ohms). Apart from this defect this resistance worked very well. Various " home-brewed " resistances were then tried. These were made by dissecting a variable grid-leak of the compression type and filling it with various carbon mixtures. At first powdered carbon microphone granules, powdered graphite, etc., were tried, but these all proved very unstable and noisy. Stove polish was then tried, this consisting of graphite presumably mixed with some oily substance to give it a semi-solid consistency. Unexpectedly, this proved very effective, as quite a big variation of resistance was obtained (from 15–20 ohms to about 70 or 80 ohms), and it was quite silent in action. Unfortunately this resistance did not prove very consistent, but this was due, I think, largely to the design of the compression " gear " being unsuitable.

Turning now to the circuit itself, as we have successfully eliminated the reaction coil it is now possible to use a variometer in the grid-circuit of H.F. valve as well as in the anode circuit. By doing this it is again possible to increase materially signal strength, as dead end is eliminated on very short wave-lengths, and over the whole range of one's set, say 90–600 metres, it is possible to use a small series aerial condenser and a large inductance. In the author's case this resulted in quite a considerable increase in signal strength on distant broadcast stations. We now have a circuit as in Fig. 2. By using a well-designed variometer, as A.T.I., it was found possible with a 500-μμF. A.T.C. to cover the whole range required (90–600) with a series

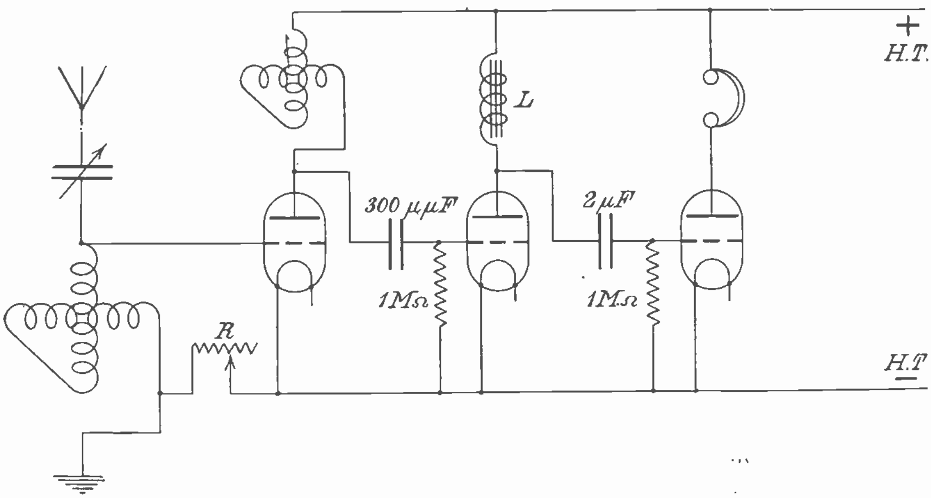


Fig. 2.—The final circuit embodying "resistance control" and a choke-coupled amplifier.

condenser. It should be pointed out here, I think, to the experimenter that this circuit does not, as a rule, work straight off as with this method of reaction control a considerable amount of juggling with H.T. and L.T. may have to be done to bring the control within the range of the resistance; but, then, how dull our lives would be if everything we tried worked first time! One other gadget might be mentioned in connection with receivers. It has probably been the experience of many of us to burn out L.F. transformers—an expensive pastime. It occurred to the author to try choke-capacity L.F. for a change, and this was found to be very effective. As a choke the secondary of a "Ford" coil was used, with a 2-μF. "Mansbridge" as an intervalve condenser. This gave quite as much amplification as a 25s. transformer, and, if anything, improved the quality of speech. This seems a much cheaper method of amplification, as the supply of "Ford" coils is never likely to run out and almost "any old condenser" will do.

In conclusion, the author hopes, if he hasn't assisted anyone, at least he may raise a discussion, as resistance control is really worth trying.

The New French Official Regulations for Wireless Stations.

We give below a summary of the new French regulations which should be of great interest when compared with those obtaining in this country.

THE following are the main provisions of the official regulations governing the operation of wireless receiving and transmitting stations in France.

Stations are divided into two main categories: (I) Receiving, and (II) Transmitting, which are again subdivided into various classes.

I.—Receiving Stations.

There are three classes of these:

(1) Receivers for the reception and distribution of broadcast information at no charge to the general public. These are not subject to any tax.

(2) Receivers installed for public auditions (*i.e.*, places where the public are admitted on payment), including apparatus installed at restaurants, public halls, cinemas, etc. These will be subject to an annual tax, varying with the population of the district in which they are situated, the tax being 50 fr. for a commune of less than 25,000 inhabitants, 100 fr. for a commune of less than 100,000 inhabitants, and 200 fr. for a commune containing more than 100,000 inhabitants.

(3) Receivers not installed for public or paying auditions (this class being equivalent to that granted a broadcast licence in Great Britain). The only charge is a registration fee of 1 fr. (for French citizens), which may be paid at any Post Office.

In all cases receiving apparatus must not send out any waves capable of interfering with neighbouring stations.

II.—Transmitting Stations.

These are divided into five classes.

(1) Fixed stations for private use. The power input of these is limited to 400 watts, and they may use a band of wave-lengths from 150 to 200 metres. Groups of such stations (as, for example, a number established for the purpose of intercommunication between the head offices of a works and the residences of its officials, outlying parts of the works, and intercommunication stations in towns, are restricted to 100 watts input and a band of wave-lengths from 125 to 150, and the height of the aerial must not exceed 30 metres.

(2) Portable stations and their corresponding fixed stations are limited to 400 watts and wave-lengths of from 150 to 180 metres. This regulation does not apply to existing stations established under International Convention, or under special Government regulations, under which their technical characteristics are specially defined.

(3) Radio-telephone stations transmitting items of news and general interest. Technical conditions of such stations may be specially determined by the Ministry of Posts and Telegraphs.

(4) Stations equipped for testing and scientific experiments. The technical characteristics of these are governed by the special nature of the proposed tests or experiments.

(5) Amateur stations. These are limited to 100 watts input, on 180 to 200 metres wave-length.

Stations of the third, fourth and fifth classes must not be used for personal or business communications.

Licences for transmitting stations can only be obtained by persons who hold an official certificate either as radio-telephonist or radio-telegraphist, or persons who employ a certificated operator. Examination for these certificates is held at the home of the candidate, for which he has to pay a fee of 15 fr. The test for an amateur is for capacity to send and receive sound signals in Morse code at a speed of eight words a minute, and other classes of applicant must be able to send and receive at the rate of fifteen words a minute. Candidates must also show a knowledge of customary telegraphic abbreviations, and must be able to regulate apparatus on three different wave-lengths. Candidates for certificates as radio-telephonists must show their capacity for sending and receiving speech, knowledge of radio-telephone procedure, and regulation of apparatus on three different wave-lengths. The law came into force on January 1 of this year, and all existing operators are given three months from that date in which to secure certificates.

Continuous wave transmission only is allowed, controlled or modulated by speech or musical sounds, and French only must be spoken or used, except by special permission of the authorities. Any special or unusual mode of transmission is strictly forbidden.

All transmitting stations in Classes (1) and (2) are subject to a licence fee of 100 fr. per kilowatt, and an annual tax of 40 fr. per watt. All other stations will pay a tax of 100 fr. per year per kilowatt, temporary stations paying in proportion to the time for which they are in operation.

A Valve Generator for Audible Frequencies.

By E. SIMEON.

Electrical oscillations at audible frequencies, or actual sound waves at high frequencies, are of considerable value in many experiments. Below will be found complete data for constructing a suitable oscillator.

THE instrument described below was made to give a wide range of musical notes, as pure and loud as possible, and which would not vary appreciably in pitch and amplitude at any given setting. Such an apparatus is very useful in making and testing low-frequency apparatus, such as transformers, loud speakers or oscillographs, or recording apparatus.

With the circuit of Fig. 2 one can obtain at least one musical note. It consists of an oscillating valve circuit in which the coils have sufficient inductance to give a frequency well within the audible range. The ends of the primary winding (used as the reaction coil) must, of course, be joined the right way round to produce oscillations. A small fixed condenser across the secondary will lower the note produced.

To increase the volume the H.T. may be raised to 200 volts with an "R" type valve, and one or two grid cells may be necessary. Using this voltage and a loud speaker the note should be easily audible 50 yards away.

Using a small power valve such as the O-10-B does not seem to increase the volume appreciably.

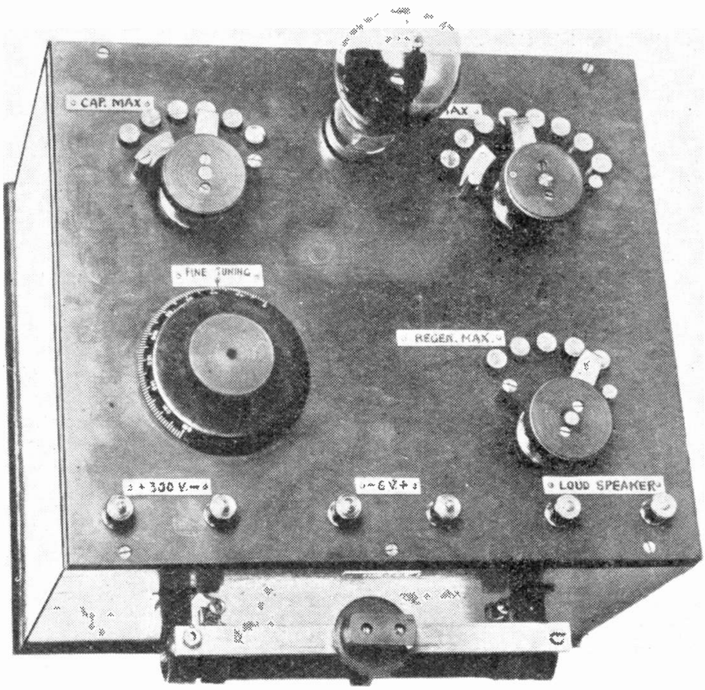


Fig. 1.—A general view of the oscillator showing various controls.

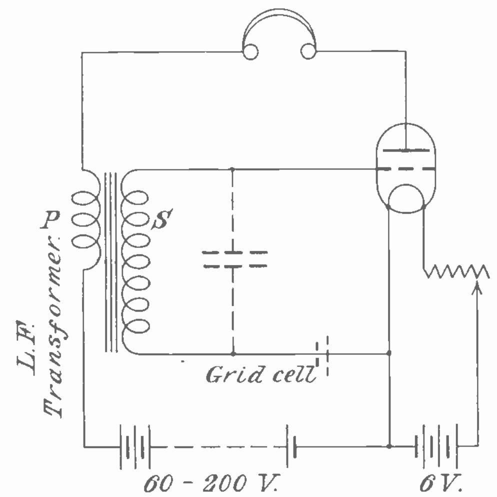


Fig. 2—An oscillator employing an inter-valve transformer.

Small alterations in frequency are caused by altering the filament temperature, etc. The frequency falls if through any cause the anode current increases.

The instrument shown in the photographs is an elaboration of the foregoing, to give frequencies from about 170 to 10,000 per second, which corresponds to a wave-length of 30,000 metres and might be tuned in on a long-wave radio receiver.

Constructional Details.

The tuning condenser has a value of from 0 to ·006 μF. This consists of a ·001 μF. variable air condenser and three fixed condensers, which are introduced by the switch shown in Fig. 3. This arrangement is easier to make and capable of finer adjustment

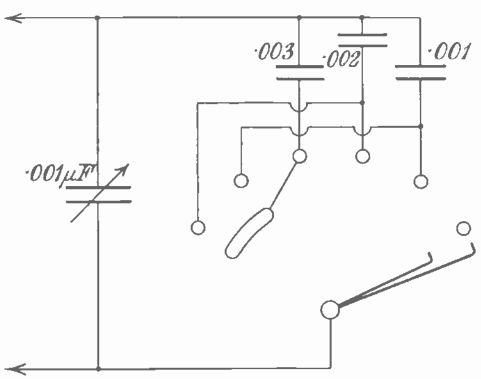


Fig. 3—Arrangement of variable condensers.

than a single large variable condenser. A larger parallel capacity should not be used, or the volume will be reduced considerably.

If desired, a sliding iron core might be used in the inductance, in which case the condenser could be dispensed with and variation in frequency between the tappings obtained by pulling the core in and out.

The two windings are wound in separate slots on an ebonite bobbin $2\frac{1}{2}$ ins. diameter. The slot for the tuning coil is $1\frac{1}{4}$ ins. wide, wound with about $\frac{1}{2}$ lb. of No. 44 D.S.C. wire, with six tappings. The reaction coil is contained in a slot $\frac{5}{8}$ in. wide, and consists of 2,500 turns of No. 36 wire, tapped at 400,

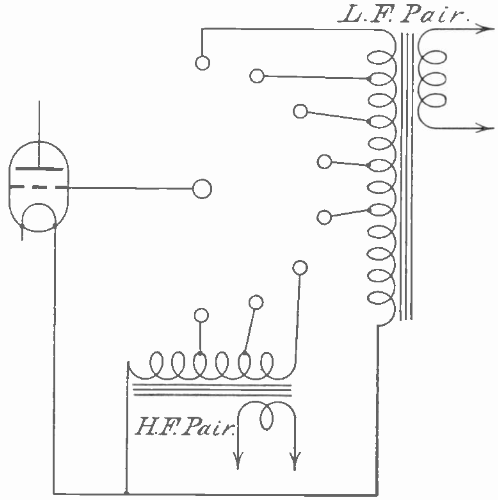


Fig. 4—Connections of tuning coils to switch.

1,100 and 2,500 turns. An open core of iron wires $\frac{3}{4}$ in. diameter is inserted through both windings.

The ends of the bobbin should be about $\frac{3}{8}$ in. wide, so that small studs, to which the tappings are soldered, may be screwed into them as the coil is wound.

The following method of taking tappings from the tuning coil was used :—The reaction winding having been put on and the condenser completed, sufficient turns were wound to give, by trial, the highest note in the range. This gives the first tapping. On shunting this by the maximum capacity a much lower note was given. Turns were then added till the latter note was again obtained, but with the condenser at zero. This gives the second tapping. Then on adjusting the condenser to its maximum capacity a lower note again was obtained, more wire wound on, and so on until the lowest note required was given. For very low notes the number of turns increases rapidly, and the coil becomes bulky, besides introducing another effect. It was found that when a large number of turns were wound on the first few sections would not work. For the highest frequencies a separate and smaller pair of coils were therefore made, spaced from and at right angles to the larger pair. Both tuning coils are, however, introduced by the same switch (see Fig. 4). The two reaction coils are put in circuit by another similar switch.

The insulation should be good, particularly between the ends of layers. If a small part of the winding becomes shorted the oscillations will probably cease entirely, due to damping caused by induced currents flowing in the closed circuit formed. It is not, however, necessary or desirable to use shellac or wax, which would cause trouble if the coils had to be rewound for any cause.

The few tappings on the reaction coil cannot very well be omitted. It was found that if a medium-sized reaction coil were used on all frequencies it was insufficient to give full strength on low notes, while on high ones it had a choke effect preventing the frequency rising beyond its natural frequency.

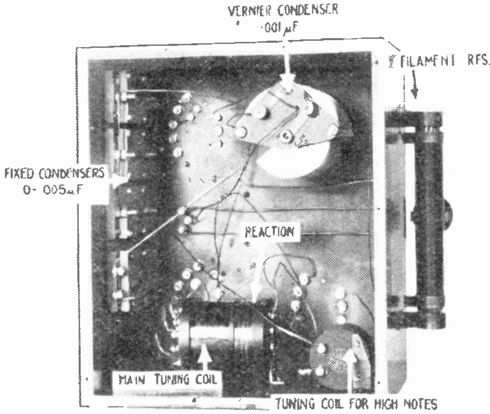


Fig. 5—Showing the arrangement of the oscillator coils and condensers.

Spade Tuning.

Although the system of tuning by eddy current variation is well known to every experimenter, little practical information seems to be available, and we give below data for the construction of suitable plates.

VERY few experimenters seem to make use of this very simple and inexpensive method of tuning. Essentially it consists of a copper spade which is moved over the face of a slab coil, causing a variation of wave-length.

The action is due to the eddy currents set up in the spade by the high-frequency currents in the coil. The currents in the spade are in the opposite sense to those in the coil, and hence the self-inductance of the whole system is reduced, owing to the mutual induction between the spade and coil currents. The same phenomenon is met with when the secondary of a transformer is short-circuited. The inductance of the primary is destroyed.

A secondary effect is that the self-capacity of the coil is increased. This, of course, affects the wave-length oppositely, but reduces the effect of the inductance change very slightly. It is too small to be of any importance.

To obtain the maximum effect, the induced currents must be as large as possible. Hence the spade has to be of low resistance. The best material is soft copper sheet, about 20 S.W.G.

The tuning is remarkably sharp, especially when a little reaction is used, and perfect stability is assured by connecting the spades to earth. The efficiency is at least as good as the parallel condenser, and will be much greater with good design.

The coils used should be of the slab type, of which there are several good makes. By means of a small fixed condenser in parallel with the coil the initial maximum wave-length is obtained. The spade is then made to move over the coil face, as close up to it as possible. As the coil is covered, the wave-length will decrease. On broadcast wave-lengths the variation will be 100 to 200 metres, according to the type of coil and closeness of spade to its face. On higher wave-lengths the variation will increase, but not quite proportionately.

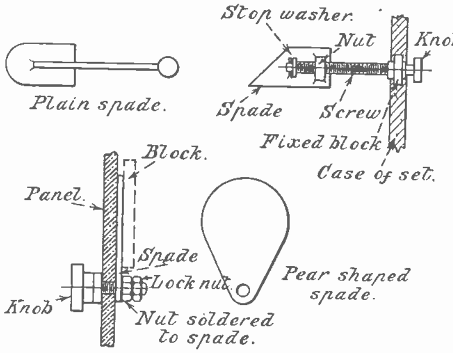


Fig. 1—Details of three forms of "spades."

The plates may be moved in a variety of ways. A well-known two-valve receiver uses a direct pull on rods attached to the plates. A three-valve of the same make has a quick thread screw rotated by a knob. The plate is fixed to a nut moving on the screw. Another method is to use a pear-shaped plate, the apex being drilled and secured with two nuts to a spindle on which is the operating knob. The latter is, perhaps, the most convenient method. These three are shown in Fig. 1.

Straight-line tuning can be obtained by suitably shaping the spade. The actual outline is best determined by experiment, but a rough idea of it is given in Fig. 2.

The coils may be fixed in position, or may be made interchangeable for any wave-length. They are best mounted in ebonite blocks, but this is beyond the capabilities of the average tool-kit. A very satisfactory substitute is available, however. Some hard wood, 3-16th in. thick, is soaked in paraffin wax and scraped clean. It is then cut up into suitable squares, say of 3-in. side. If the diameter of the largest coil exceeds 2 ins., then a larger block will be better. A

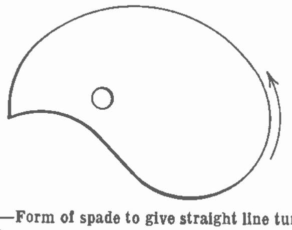


Fig. 2—Form of spade to give straight line tuning.

hole is cut through the wood, centrally, of such a diameter as to admit the coil, and two small recesses are cut out from it, as shown in full lines in Fig. 3. On one face of the block is screwed a $\frac{1}{8}$-in. ebonite plate, with two contact studs placed so that their nuts fit the recesses and clear the coil and the wood. Round-headed 4 B.A. screws, about $\frac{1}{4}$ in. long, are suitable. The coil is then inserted and the ends soldered to the studs. Good cotton wool packing is used to hold the coil in position. Wax is not recommended, as it increases the self-capacity of the coil, causing losses and broadening the tuning. It is also advisable to melt off any superfluous wax already on the coil, as too much is often used to keep the turns in place.

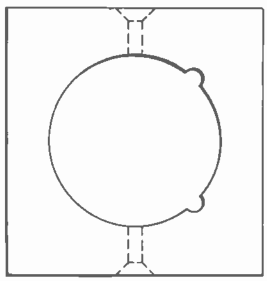


Fig. 3—A coil former for use with the system.

The coil should then be covered on the back with some thin stiff card, glued and pinned on. A thin sheet of ebonite is better, and can be screwed on with fine, short, countersunk screws.

When using card care should be taken that the spade does not rub on it too hard and cut it. Ebonite will stand this rubbing without harm. As the coil should be packed to come right up against the thin back, this is a point to be watched (Fig. 4).

The mounting of the blocks has, of course, to be adapted to circumstances. If an interchangeable system is to be used a pair of guides should be made of stiff brass, about ¼ in. wide, and fixed to the back of the panel at such a distance apart that the block will be a fairly tight fit. Contact with the studs is made by a couple of springs fixed to an ebonite strip, which may support the lower ends of the guides and also act as a block rest. The supporting panel may be of wood, as it is insulated from the coil, and the spade has no electrical connection with the circuit. The idea is illustrated in Fig. 5.

If thin plates are used on both sides of the block, and a couple of narrow strips of ebonite are screwed on two opposite edges, then the guides themselves may be used to make the contacts with a couple of flat studs. In this case the two recesses in the circle cut out of the block are dispensed with for two holes drilled as shown by the dotted lines in Fig. 3. A groove for the nut holding the stud should also be cut as indicated, so that it shall not touch the wood. This method can be adopted if the guides are properly insulated from the wood panel. On the whole, the first method given is preferable.

Other methods to suit given conditions may be devised, and the idea can be extended to a plate moving between two coils which are set close together concentrically, or even with plates moving over the outer faces as well. With a series parallel switch a very large wave-length variation may be obtained. In this case it is advisable to fit a vernier adjustment to the spade control.

When two or three tuned circuits are to be used the coils may all be mounted in one block, spaced, say, 2 ins. apart. Then the operation of changing from one wave-length range to another is very much simplified.

Sufficient has been said to show that there is a wide field for experiments with this tuning system, and any time spent on it will not be wasted.

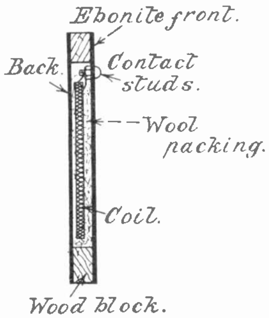


Fig. 4—Showing how the coil should be packed.

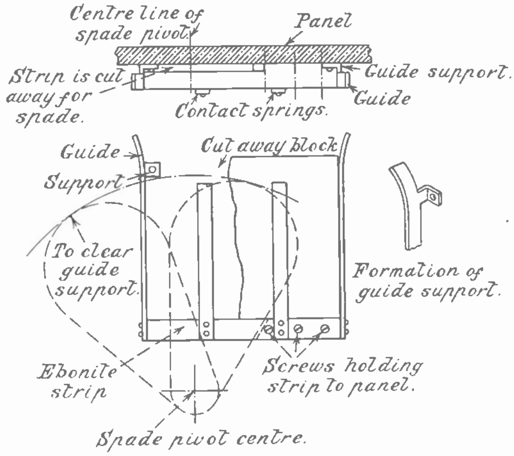


Fig. 5—Arrangement for mounting the "blocks."

A Correction.

In the March issue of EXPERIMENTAL WIRELESS the term $-\frac{2L}{C}$ was omitted from the equation at the bottom of the second column on page 319. It is thought, however, that the omission was so obvious as to cause no confusion to our readers.

Filter Circuits in Radio-Telegraphy.

By Dr. N. W. McLachlan, M.I.E.E., F.Inst.P.

The subject of selectivity is one of the greatest problems in radio engineering, but is nevertheless one to which the amateur experimenter may well give his attention. Before doing so a sound knowledge of the principles involved are necessary, and the following article should be of great value.

Introduction.

It is well known that various components of a radio broadcasting system possess the property of selectivity. So far as the tuned or oscillatory circuits are concerned selectivity is imperative to minimise jamming, but when telephones, loud speakers, iron-cored transformers and the like are concerned, selectivity is decidedly deleterious. Going a step further, and touching on the question of a high degree of reaction, it can be shown that the effect of the selectivity

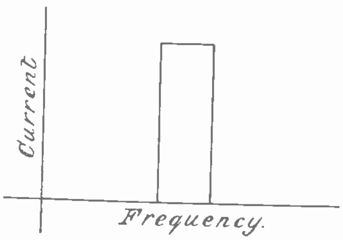


Fig. 1.—Showing relation of current to frequency.

concomitant with this phenomenon curtails the higher tones in telephony and spoils the quality of speech and music. In the present article the intention is to deal with selective circuits in a somewhat different way, but more particularly with their application to the reception of continuous wave telegraphy. When one invades the band of wave-lengths associated with the radio communication services between Europe and America, duly armed with *ordinary* receiving apparatus, the first impression is one of chaos. Indeed, the satisfactory reception of some of the long-wave American stations, say Marion (WSO), seems well-nigh impossible through the jamming from Stavanger (LCM), Nauen (POZ), etc. This is where selectivity reigns supreme and an indifferent type of circuit is quite useless. In fact, the design of satisfactory circuits for continuous operation requires considerable skill and experience. In order to present as concise an idea as possible on the above matter we shall deal with the salient features of filter circuits which are used for commercial work.

Circuits in Cascade.

Imagine a variable-frequency continuous-wave generator, *e.g.*, a valve generator loosely coupled to an oscillatory circuit whose condenser is set to a certain reading, but can be altered if desired. If the frequency of the generator is varied through the resonance frequency of the oscillatory circuit, and the steady E.M.F. induced in this circuit by the fundamental oscillation of the generator is constant, the relationship between the frequency and the steady r.m.s. current in the oscillatory circuit is in the well-known form of a resonance curve (see Fig. 1). Let the resonance frequency be 30,000 cycles per second, and the root mean square current in the circuit be 1 unit for simplicity. Then at a frequency of 29,700 or 30,300 cycles, the current will be less than that at 30,000 cycles. The ratio of the two values of current depends on the high-frequency resistance of the circuit at 30,000 cycles. The greater the resistance, the greater the ratio of the current at 29,700 to that at 30,000 cycles, *i.e.*, the flatter the resonance or selectivity curve. Moreover, the object to be attained to secure good selectivity is to construct a circuit in which the ratio of L/R (inductance/resistance) is as large as possible. Put in another way, if the size of the inductance is fixed, the resistance at high frequencies must be as small as possible. The resistance is chiefly due to the inductance coil when air condensers are used. In high-frequency work air condensers are generally used, although on long wave-lengths good mica condensers are serviceable. Particular care must be exercised to avoid dust between the plates of air condensers, badly soldered joints and faulty contact to the moving vanes. In long-wave radio circuits, to obtain as small a resistance as possible, the usual practice is to employ stranded cable, the individual strands generally being insulated by silk. The best wire is made up in multiples of 3, *i.e.*, a cable of 81×36 S.W.G. D.S.C. would have $[(3 \times 3) \times 3] \times 3$ strands. Assuming that the value of L/R is sufficiently large, the selectivity curve of the circuit will have a fairly sharp peak. One circuit in itself is generally insufficient to give the required degree of selectivity, so that it is essential to loosely couple another circuit to it. Granting for the moment that the *only coupling between the circuits is electro-magnetic*, the selectivity of the combination is greatly enhanced over that possessed by one alone (see Fig. 2). Some figures will make this clearer. We have already premised that the current at a resonance of 30,000 cycles is unity, and we may assume that at 29,700 and 30,300 it is $\frac{1}{3}$. This is the current in the first tuned circuit. In the second tuned circuit the current will obviously be less by an amount depending on the degree of coupling, the resistances of the circuits and the selectivity. At a frequency of 30,000 cycles assume again for simplicity that the current is 1; then its value at 29,700 and 30,300 cycles will be $\frac{1}{3}$ of unity—neglecting the reduction due to loose coupling, whilst illustrating the principles involved—provided the current in the first circuit was the same at all frequencies. But the current at 29,700 and 30,300 cycles in the first circuit is only $\frac{1}{3}$, hence its magnitude in the second circuit is $\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$. Similarly at another frequency, if the current in the first circuit were 1-10th, that in the second circuit would be 1-100th. It will be evident now that the method of arriving at the current in the second circuit is to square that in the first circuit. In the case of three circuits the current at a given frequency in the first would be cubed to get that in the third, *e.g.*, at 29,700 cycles the current in the third would be 1-27th. In the foregoing discussion we have disregarded the reduction of the currents in the various circuits due to the effect of loose coupling. Moreover, if the ratio of the maximum currents in the first and second and the second and third circuits is $\frac{1}{4}$, due to loose coupling, the current in the third circuit at 29,700 cycles would be $\frac{1}{3} \times (\frac{1}{3} \times \frac{1}{4}) \times (\frac{1}{3} \times \frac{1}{4}) = $ 1-432nd the maximum current in the first circuit.

A curve plotted in this manner for several circuits *loosely coupled* in cascade is a guide to the overall selectivity of the system for a series of *steady* currents of different frequencies (see Fig. 3).* The arrangement is known as a filter, since the undesirable steady frequencies on either side of the frequency it is desired to receive are filtered out. It is essential to take precautions to prevent the current in the first circuit inducing into those which follow; similarly for the second circuit and so on, *i.e.*, the couplings must be solely from 1 to 2, 2 to 3, 3 to 4, etc. The customary procedure is to house the various units in earthed screening boxes, the coils within the boxes being arranged astatically if desired. Coupling between adjacent units is obtained by means of small coils. The contiguous portions of consecutive circuits are such that condenser action (sometimes termed electrostatic coupling) is the least possible. In present radio practice there is a limit to the number of circuits which can be cascaded. The limit is fixed by (1) the amount of variation of wave-length at the transmitter;

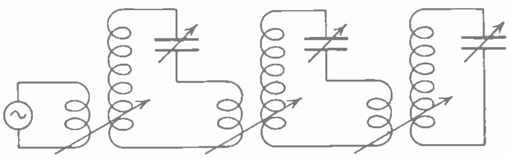


Fig. 2.—Tuned circuits in cascade.

(2) the speed of sending. The first limiting cause is fairly obvious, because a variation in wave-length from 30,000 to 29,700 cycles on a four-circuit filter system of the above nature would result in a reduction of signal strength from normal value to $\frac{1}{3} \times \frac{1}{3} \times \frac{1}{3} \times \frac{1}{3} = $ 1-81st of that value. As this figure refers to voltage or current reduction, and the energy in the telephone receiver is proportional to the square of the voltage, the energy would have been reduced to 1-81st × 1-81st = 1-6,561st of its normal value. This would obviously be an impossible

* When the currents are increasing or decreasing (transients) the case is different.

state of affairs. Either a modified circuit or a much more constant wave-length, or both, would have to be obtained. In modern valve transmitting plant the usual practice is to employ a master oscillator, this being coupled *via* one or more banks of amplifying valves to the aerial. By this means the variation in frequency can be confined to extremely narrow limits. In practice the receiving circuits should be arranged so that the top of the selectivity curve is approximately flat. This means that the received strengths of all waves covered by the flat top will be approximately equal.

Telegraphic Modulation.

The second source of limitation is far from obvious, but an example may make the matter clear. Consider a series of dots to be sent by a radio station. When the current in

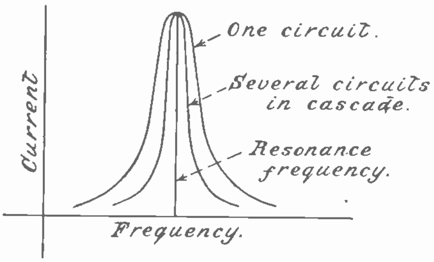


Fig. 3.—Resonance curves for various circuits.

the aerial is plotted against time the result is a series of high-frequency oscillations lasting for the duration of a dot, these being separated by blank periods of equal length, in which there are no oscillations. This can be viewed as a class of modulation of the carrier or main wave, the wave form of the modulation being rectangular. In postulating this wave-form, the building-up period at the beginning of a dot and the decay period at the end have been disregarded for simplicity, *i.e.*, the transients at the transmitter have been assumed to be of sufficiently short duration to be neglected. Imagine the usual form of valve oscillator with a switch in the anode circuit so that the supply from the battery can be made and broken. When the switch is closed for the duration of a dot the D.C. voltage on the circuit is equal to that of the supply from the battery and is constant. When the switch is opened the D.C. voltage on the circuit is zero. If these opening and closing periods correspond with the dots and dashes of the Morse code the D.C. voltage wave form is a series of rectangles. Now a rectangular wave can be resolved mathematically, by aid of Fourier's theorem, into a sine wave of fundamental frequency equal to the frequency of the dots, and a series of harmonics, whose frequencies are integral multiples of the fundamental. For example, if there were 100 dots per second the frequencies of the various sine waves would be 100, 300, 500, 700, etc. Moreover, the transmitter can be considered to be modulated by a series of audio-frequencies having these values. The problem is different when the dots are interpolated by dashes and irregular spaces. Under these conditions the modulation is complex. This modulation, on regular dots, yields side frequencies with which we are so familiar in radio-telephony. In telephony on, say, 430 metres, *i.e.*, 700,000 cycles, a side frequency corresponding to an audio-frequency of 700 cycles is only 1-10th per cent. variation from the fundamental, whereas on a 10,000-metre wave, *i.e.*, 30,000 cycles, it is 2·5 per cent., or twenty-five times as much. With a circuit of average selectivity, the side frequencies of 700,000+700 and 700,000−700 cycles would be received almost as strongly as the fundamental, whereas in the long-wave circuit there would be a considerable reduction in the strength of these frequencies. In practice it is usually satisfactory to include the fundamental and the triple-frequency harmonic corresponding to a chain of dots.

The frequencies of the side tones depend on the speed of transmission. The higher the speed the greater the frequencies of those side tones which are of importance compared with the fundamental. If, however, the fundamental tone were reduced considerably owing to a high degree of selectivity at the receiver, the dots as heard or as recorded would be too short, since an adequate amount of energy would not be supplied at the receiver. Thus, at a given wavelength, to obtain dots of reasonable duration, the speed of transmission must not exceed a certain value. The ideal selectivity curve for steady oscillations—in accordance with our present mode of viewing the subject—is one with a flat top and vertical sides (see Fig. 3). In this way a range of frequencies on each side of the central frequency can be received equally well. This provides for the proper reception of the side frequencies, which fall within the range covered by the flat top. Since for a given speed of sending the percentage variation of the side frequencies from the main frequency decreases with decrease in wave-length, the maximum speed of transmission with a filter circuit of given or constant percentage selectivity—*i.e.*, the width of the top of the filter expressed as a percentage of the main frequency—increases with decrease in wave-length. If the percentage is fixed the width of the top in cycles per second increases with the frequency, *i.e.*, with decrease in wave-length. The percentage in practice for any given speed of transmission decreases with decrease in wave-length. The width of the top is limited owing to the necessity for protection from atmospherics and jamming due to other stations. A filter having ideal characteristics would suppress all steady currents whose frequencies lay on either side of the range covered by the flat top. Taking a frequency of 30,000 cycles, if the width of the top were 200 cycles, all frequencies except those within the range 29,900 to 30,100 would be suppressed. In practice, however, the desired ideal cannot be attained. The top is not quite flat and the sides curve downwards in the well-known manner. The steepness of the curve depends, as we have already shown by the aid of simple calculations, upon the number of circuits arranged in cascade. The complete operation of filtering is not usually accomplished in the high-frequency circuits, and the customary practice is to pass the signals on to one or two high-frequency amplifying valves, and then, after being heterodyned, the signals are delivered to a rectifier.

In order to allow for strong atmospheric disturbances the length of the valve characteristic covered due to the signal should be short. Thus in the event of a strong atmospheric impulsing the system, none of the valves will reach their rectification or saturation points, and the signals, therefore, suffer the minimum of mutilation. In fact, distortionless *amplification** is just as essential here as it is in broadcasting. After rectification the signals are passed to a series of filter circuits tuned to the note or beat frequency. To take our example of 30,000 cycles again, assume that it is desirable to reduce to a negligible amount all frequencies except those within a band 50 cycles on either side of the central frequency of 30,000. This, as we have seen, is not done in the high-frequency filter, since it includes a band, say, 100 cycles on either side. Now 50 cycles is only $\frac{1}{6}$ per cent. of 30,000, whereas if the beat tone were 2,500 the percentage variation is 2. It is easier to construct a note filter for a 2 per cent. variation than a H.F. filter to cope with a variation of $\frac{1}{6}$ per cent. We have merely mentioned that filters are required to reduce all undesirable frequencies, but nothing was said regarding the origin of these aliens. They may be due to signals from a comparatively nearby station, *e.g.*, Nauen, Lyons, etc., or, worse still, they may be due to atmospherics. As explained in a recent article in EXPERIMENTAL WIRELESS†, an atmospheric can be resolved into a band or spectrum of continuous waves. Consider, for the sake of argument, the band of frequencies lying between 30,500 and 29,500 cycles, due to an atmospheric. If the width of the H.F. filter included this 1,000 cycle band, the ration of the strength of the atmospheric to the strength of the steady signal would be larger than that where the width of the filter was only 200 cycles, since in the latter case all the frequencies due to the atmospheric from 30,100 to 30,500 and 29,900 to 29,500 would be attenuated appreciably. Where the filtering process is extended after rectifying and heterodyning, the immunity from atmospheric interference is still further augmented. In the example just cited the width of the band at the note filter is assumed to be 100, *i.e.*, 50 cycles on each side of the central frequency. Thus the beats due to the atmospheric band frequencies which penetrate the H.F. filter —whose width we assume to be 200 cycles— will be suppressed by the audio-frequency

* In broadcasting, it is imperative to secure distortionless reception as well as distortionless amplification, *i.e.*, the high frequency circuits must have the minimum of effect on the "shape" of the signals. In telegraphy the use of filter circuits of low decrement distorts the signal badly. For example, a chain of dots of fairly square formation become a series of curves, thus : 

† N. W. McLachlan, "Electrical Impulses," February, 1924.

filter from 2,550 to 2,600 cycles, and from 2,450 to 2,400 cycles.

Summary.

We may sum up the preceding argument by the following cardinal points :—(1) Selectivity reduces the effect of jamming and of atmospherics by narrowing down the band of frequencies it is possible to receive to any appreciable degree. (2) Selectivity necessitates a constant wave-length at the transmitter. (3) The width of the receiving filter as measured in cycles per second must be sufficient to allow for (*a*) a slight variation in the frequency of the transmitter ; (*b*) the reception of the necessary side frequencies arising from the modulation at the transmitter when sending Morse characters.*

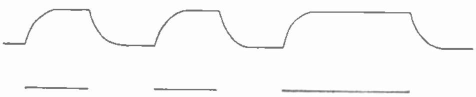


Fig. 4.—Showing wave form of modulation.

(4) Given a filter arrangement with a certain degree of selectivity to operate on a definite wave-length, there is a limit to the speed of transmission, *i.e.*, above a certain speed the signals received are illegible. The longer the wave-length the lower the limit of speed. (5) In practice the width of the filter band should be variable. When conditions are favourable, *i.e.*, jamming and X's are slight, the band of receivable frequencies can be widened and the speed of transmission increased. Under unfavourable conditions it is necessary to make the band narrower, and hence it is imperative to reduce the speed of transmission. (6) For a filter with a given range of reception, or width of the filter expressed as a percentage of the main wave, the shorter the wave-length the higher the speed of reception which is permissible. A similar argument applies at the transmitter, where it is obviously essential that the characters should be clear cut.

* In general the modulation is due to the dots and dashes of the Morse code—not merely a sequence of regular dots. Owing to the initial and final transients accompanying the Morse characters at the transmitter the modulation is not absolutely square cut, but of the form shown in Fig. 4. This represents the letter u, and it is clear that the initial and final stages are a greater proportion of a dot than of a dash. Moreover, when a very narrow band filter is used at the receiver, the effective duration of a dot is curtailed appreciably, and the only characters of consequence are the dashes. The initial and final periods can, of course, be resolved into their spectra of frequencies.

Atmospherics.

We may now take an alternative view of the problem of atmospherics and their effect on a receiving circuit. In reducing the effect of an atmospheric we are not concerned with the absolute magnitude of the disturbance, but with its value relative to that of the signal. For simplicity assume that we have a receiving circuit consisting of a loading inductance and an aerial tuned to the wave-length of the incoming signals, whose decrement can be varied at will. This might be accomplished by using some suitable and sensibly *stable* form of reactive circuit. Assume also that the wave form of the atmospheric is of the heavily damped sinusoidal variety whose frequency is much less than that of the signal*. Then there are two sources of E.M.F. in the aerial : (1) The undamped or continuous wave due to the signal ; (2) the highly damped wave of comparatively short duration, but large initial maximum value, due to the atmospheric. So far as reception is concerned, it is the E.M.F. across the inductance which counts. We can assume this to be applied to a rectifier or detector valve. The signal E.M.F. across the inductance increases as the decrement of the circuit is reduced (by reducing the resistance), since the current through the inductance is augmented. In fact, the *steady* signal E.M.F. across the inductance is inversely proportional to the decrement. Thus, if the E.M.F. with a decrement of 0·1 $\left[= \frac{R}{2fL}\right]$ were 0·001 volts, that with a decrement of 0·01, obtained, say, by reducing the resistance of the loading coil would be 0·01 volts, provided, of course, that the current had reached a steady value. During the initial and final epochs of a Morse character, when the current in the receiver is growing and decaying, the E.M.F. across the inductance is not inversely proportional to the decrement. It is during such periods, when the signal current falls short of its maximum value, that the atmo-

* This is represented by the equation $e = Ee^{-at} \sin qt$.

spheric, if of suitable phase and magnitude, can be peculiarly offensive.

Taking the *assumed* atmospheric of damped sine wave form, this causes E.M.F.'s of two different frequencies across the loading coil. One E.M.F. has the same frequency and damping as the atmospheric, and is known as the "forced" E.M.F., the other E.M.F. has the same frequency and damping as the aerial, and is known as the "free" E.M.F. When the atmospheric frequency is very different from that of the signal, it is only the free E.M.F.—due to the circuit oscillating at its own natural frequency—which need be considered. The first or initial maximum of this E.M.F. is almost independent of the damping of the aerial for the wave-lengths and decrements employed in practice. After attaining its initial maximum, the free oscillation due to the atmospheric dies away in accordance with the decrement of the aerial circuit. Moreover the atmospheric will have substantially the same initial amplitude in the aerial loading coil for a decrement of 0·1 as for one of 0·005. In the former case it will die away much more rapidly than in the latter, where it will be appreciably persistent. Superficially it would appear, therefore, that owing to the persistence of the atmospheric a circuit of low decrement would accentuate rather than mitigate the disturbance. In making this statement we have overlooked the effect of the low decrement aerial on the signal E.M.F. across the loading coil. With a decrement of 0·005, the *steady* signal E.M.F., which would follow the usual building-up period (this also is prolonged by reduction in decrement, and therefore a diminution in the speed of transmission is entailed), would be twenty times that with a decrement of 0·1, whereas the atmospheric E.M.F. would be equal in both cases. Thus the vector sum or difference in E.M.F. between the signal and the atmospheric increases in favour of the signal with decrease in decrement. It is this difference with which we are chiefly concerned in practice, both in reading and recording signals, since this is the voltage—in our particular case—applied to the grid of the rectifying valve or detector. As we pointed out above, this analysis is only valid for the steady state, and the ratio $\frac{\text{signal}}{\text{atmospheric}}$ is less when the current is growing.

When employing a circuit with low damping the result—as found from practical experience—is to weed out—relatively—all the minor atmospherics, since their E.M.F.'s are small in comparison with that of the signal, and the fact that they persist is, therefore, of little moment.

So far as the weaker atmospherics are concerned, suppose we have our aerial decrement as 0·1, and let us assume that the decrement as 0·1, with the result that the initial maximum voltage of the atmospheric is equal to that of the signal. Then the result will depend on the phases of the two E.M.F.'s. The worst case will occur when they oppose each other, for the effect will be almost to suppress the voltage applied to the rectifier for a short time. Now imagine the decrement to be 0·005. The signal will be twenty times the value of the atmospheric, and therefore the voltage applied to the rectifier will not be appreciably affected, even though the E.M.F. due to the atmospheric persists.

With a strong atmospheric the resultant voltage will depend on the ratio signal to atmospheric and upon their phase relations. During a dot, a dash or a space, the effect on the ear is reduced by employing circuits of low decrement. In recording, it is immaterial if the atmospheric and signal give augmented voltage during a dot or a dash when an instrument is used which functions between fixed stops. On the other hand, if

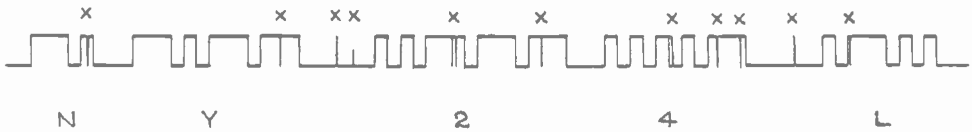


Fig. 5.—Sample of tape obtained from New Brunswick, U.S.A., (WII) with magnetic drum recorder. The rapidity of action of the instrument and the adjustment of the receiving circuit is such that the tape is not rendered illegible by atmospherics, automatic transmission taking place at 25 words per minute.

the superposition of the two yields an appreciable reduction in voltage the dot or dash is split or partially obliterated according to conditions. When a strong atmospheric comes during a space it yields a voltage which actuates the recording mechanism.

Using suitable high and low frequency filters arranged so that the decrements of the various component circuits are such that duration of the oscillation due to an atmospheric is short compared with that of a dot, it is possible to secure a legible record, provided the recorder responds very rapidly, and strong atmospherics are not too abundant. The appearance of the tape is of the form exhibited in Fig. 5. This is a reproduction of a portion of a message obtained from (WII) U.S.A., with the author's magnetic drum recorder.*

The question of atmospherics has been treated from two standpoints, *viz.*, (*a*) taking the spectrum of the atmospheric without reference to any particular wave form; (*b*) assuming the atmospheric to be a highly damped wave whose frequency is much lower than that of the signal. Both methods are instructive, and each has its merits on certain points. In practice the wave form of the atmospheric varies considerably and in many cases does not even resemble the simple shape we assumed. Furthermore, the effect in the receiver at any instant may be due not merely to a solitary atmospheric, but to a rapid succession of them, *i.e.*, the high-frequency oscillations in the receiver due to the various atmospherics are superposed on one another and on the signal. Under favourable conditions the atmospherics may appreciably annul each other. It is, however, the unfavourable conditions with which the radio engineer must cope.

The further reduction of atmospherics over and above that obtained with selector circuits of low decrement, which is possible with the aid of directional apparatus, has not been considered, as it is beyond the scope of the present article. In passing, we may state that to atmospherics of the damped sinoidal variety—and probably to other types—the only advantage of a single frame aerial lies in its directional properties.

Circuits of Low Decrement.

There is another aspect of the problem which can be treated, and one which is concomitant with high selectivity. When a train of electro-magnetic waves arrives at the receiver the currents in the various circuits do not attain their maxima values instantaneously. In this respect a comparison can be made with a motor car starting from rest. It cannot attain a speed of 30 miles per hour at once, since there is an acceleration period during which the speed gradually grows. The period of growth is due to the inertia of the car and the fact that a definite amount of energy must be supplied so that it can acquire a certain speed. The same reasoning applies to an electrical circuit. Electrical energy has to be added, and a certain time must elapse before the necessary condition is satisfied. The electrical circuit has a property which is equivalent to inertia, and this is associated with the inductance of the loading coil. The greater the ratio of the inductance to the resistance, the longer is the time taken for the oscillatory current to build up to its sensibly steady or maximum value. Moreover, if an incoming Morse dot is short enough, *i.e.*, the speed of transmission is sufficiently high, the current in a highly selective circuit would never attain a steady value. Consequently the apparent duration of the dot at the receiver would be very small, and in some cases almost imperceptible. But this is not the only side of the situation. When the incoming electric waves cease at the end of a dot, the currents in the receiving circuits do not stop suddenly, just in the same way as a motor car does not come to a standstill as soon as the engine is declutched and the brake applied. It moves on for a definite distance in virtue of the energy supplied during the initial acceleration period, or, more generally, in virtue of the kinetic energy due to its motion. Consider a circuit in which the ratio (inductance/resistance) is large, *i.e.*, the damping is small. On a long wave of, say, 20,000 metres, at a speed of 150 words per minute, the first of a chain of dots would scarcely be heard, because the current in the circuit would never reach its maximum value. At the end of the dot the current in the circuit would begin to decay, but would not be zero when the next dot started. The current would build up again, and by the end of this dot it might not attain its full value. There would be the

* See *Journal I.E.E.*, Aug., 1923.

usual decay period during the accompanying space, when the current would fall slightly in value. Thus the building up process would go on until the current approached its maximum value at the end of, say, the fifth dot. It would never be reduced to zero during the accompanying space, and its value during a space would be a fraction of its value at the termination of the preceding dot. The magnitude of the fraction would depend on the ratio (inductance/resistance). This phenomenon is readily obtained experimentally with the proper circuits, and is variously termed " hanging on," " ringing," " sustained " or " loud pedal effect." The latter terminology is almost self-explanatory, since it obviously refers to the effect obtained on a piano when the sustaining pedal is depressed continuously so that succeeding sounds merge together.

The phenomenon to which we have alluded is easier to obtain with several audio-frequency circuits in cascade than with high-frequency circuits. In making this statement it has been tacitly taken for granted that reaction is not employed either intentionally or accidentally. The well-known effect of reaction in dynamically reducing the resistance of an oscillatory circuit, and thereby enhancing its selectivity, can be employed to exhibit the phenomenon. The degree of reaction must, however, be under control, and it is essential that a slight variation in adjustment should not be accompanied by oscillation.

Finally, for satisfactory and continuous reception on a long-distance commercial service selectivity is indispensable, but the degree employed depends—amongst other things—on the conditions at the receiver, provided always that the circuits at the transmitter are sufficiently damped to give clear-cut transmission, *i.e.*, absence of appreciable sustained effect. With the low-resistance transmitting circuits employed in present day commercial radio, the initial and final stages of a character may be of importance at the higher speeds of transmission.

Suitable Valves for Grid-Absorption Modulation.

A popular method of modulating the output of a valve transmitter for telephony consists in shunting a control valve across the grid-coupling coil of the main oscillator valve, the plate of the modulator valve being connected to the upper end of the grid coil and the filament to the lower end. Microphone potentials from the usual type of microphone transformer are applied between grid and filament of the modulator valve. This circuit, which is sometimes referred to in the London district as " the 2OM circuit," depends for its successful operation largely on the use of suitable modulating valves. The ordinary R-valve gives quite good results as an absorption modulator up to powers of about 30 watts. We find, however, that low-impedance power-amplifier valves are particularly suitable for the purpose. Tests were made with the L.S.5 valve, which was found to be particularly excellent and to give much fuller control than R-valves. No doubt other low-impedance valves, such as the Western Electric, would give similar results.

When an L.S.5 is used its grid should be given a negative bias of at least 6 volts, and a positive bias on the anode of 15-20 volts seems to improve the modulation to a certain extent under some circumstances, though good results may be obtained without any D.C. potential on the anode of the modulator valve at all.

When using grid absorption control it is a good plan to tune the grid circuit either with a variable condenser or by using a variometer. The use of grid tuning gives a flexible control of the modulation, and usually renders any close coupling between the grid and anode circuits unnecessary, in order to maintain the set in oscillation.

The Use of Neon Tubes for Electrical Measurements.

By GERALD R. GARRATT (5CS).

The neon tube is receiving considerable attention at the present time and probably many more applications will be devised. As a voltage measurer it has much to commend it from the amateur's point of view and the following details should be of considerable use.

FOR some time past neon tubes have been used for the comparative measurement of high resistances, such as grid leaks, and also for the measurement of large capacities, but, as far as the author knows, they have not yet been used for the measurement of voltage.

Some time ago it was found necessary to measure the supply voltage of the author's transmitter, but it was not convenient to purchase a direct-reading instrument, partly because they are often inaccurate and partly on account of the price of a reliable meter.

Therefore, some other method had to be found, and the method finally adopted made use of one of the properties of neon tubes.

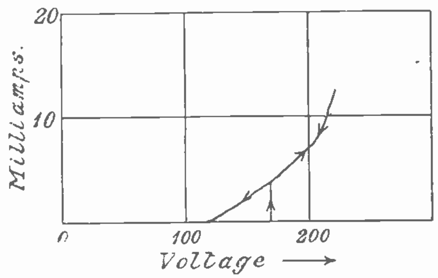


Fig. 1.—Typical characteristic of an "Osglim."

It might be mentioned that the neon tubes for this purpose should not contain the safety resistance embodied in the cap of the commercial type of lamp. This should either be removed, or a special tube purchased which contains no series safety resistance.

Since a recent article by Mr. E. H. Robinson has dealt extensively with the properties of neon tubes, only a brief explanation will be given here.

Fig. 1 shows the general form of the characteristic curve of a neon lamp. This curve shows that if the applied voltage is gradually increased from zero no current flows until a certain voltage is reached (the striking voltage), when the current suddenly jumps from zero to a few milliamps. The current increases slowly, with further increase of applied voltage, but when the voltage is gradually reduced the lamp continues to glow even when the striking value is passed, and the current does not fall to zero until the applied voltage is 15 or 20 volts below the striking voltage.

By use of this property it is possible to arrange the tube as a generator of oscillations. The most usual arrangement is shown in Fig. 2.

The current flows slowly through the high resistance, and slowly charges up the condenser. When the E.M.F. of the condenser reaches the striking point the lamp commences to glow, and continues to do so until the potential of the condenser falls to the extinguishing value. The condenser then recommences to charge, and the cycle is repeated.

The frequency of the flashes is controlled by the values of resistance, capacity, and voltage in use, and by the constants of the particular neon tube. It might be mentioned that different lamps, even of the same type, vary enormously as regards striking and extinguishing voltages, due probably to slight differences in the pressure of the gas within the tube.

It will be apparent that by reducing the values of resistance or capacity the frequency of the flashes can be caused to increase, and exactly the same effect will occur by increasing the value of the applied voltage.

In practice the frequency is variable from one flash in several minutes to the upper limits of audibility.

The range, however, with which we are concerned is what might be termed the "visible range"; that is, the range of frequencies which may be counted with absolute accuracy by the unaided eye. Up to 150 flashes a minute can be counted by the average man, but with a little practice this may be increased to 250 or more.

For the purposes of measurement of resistance, capacity, or voltage, it is essential that some apparatus of known values should be available. For instance, for the measurement of voltage it is essential that a supply of known voltage should be at hand with which to make a comparative measurement.

It is almost impossible to give even a rough list of values required for different purposes, as they vary so much with the tube in use. In the author's case, for the measurement of voltages from 300-2,000 volts, a G.E.C. "beehive" tube is used in conjunction with a 2-mfds. Mansbridge condenser and a few grid leaks—about 2 megohms for 300-900 volts, and about 4 megohms above this.

The apparatus is first standardised on the 240-volt D.C. mains (which should first be measured with an accurate meter, as in some districts the voltage varies considerably at different times of the day), and the number of flashes in a minute counted. Then the apparatus is applied to the unknown voltage and the number of flashes in a minute again counted.

Since the rate at which the condenser charges is directly proportional to the applied voltage, the number of flashes in a given period of tune is also proportional to the applied voltage, and thus the value of the unknown voltage may be easily obtained by working out a simple proportion.

It is rather surprising to notice how the number of flashes with given apparatus on a constant voltage will vary from day to day. This is due to the change in resistance of the "grid leak" with the humidity of the atmosphere. One particular cheap but widely advertised "constant grid leak" varied from ·7-3·8 megohms under ordinary working conditions from day to day! This variation also applies to some of the cheap anode resistances. A resistance stated to be 100,000 ohms will often vary from 80,000 to 160,000 ohms. Needless to say, this variation is not met with in the better types, which are specially protected against humidity changes.

Owing to the variation of the value of the resistance it is advisable to standardise the apparatus on a known voltage every time it is used, and to ensure absolute accuracy it is advisable to re-standardise the apparatus after the measurements in order to make certain that the resistance has not changed during the operations.

Normally, however, with reasonably good apparatus, no difference at all can be detected

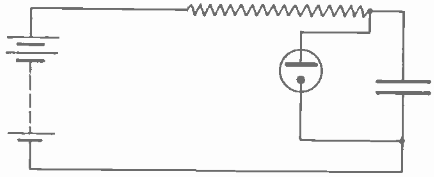


Fig. 2.—Circuit used for the generation of impulses.

and using high-class instruments no variation can be detected from day to day, even if the flashes are counted for several minutes. It is possibly unnecessary to point out that the accuracy attainable must depend to some extent on the time during which the flashes are counted.

At first I expected that the value of the resistance would vary with the current flowing through it, owing to a slight rise in temperature, but I have never been able to detect any error due to this cause. The reason is, of course, that the energy consumed is so small, usually about 1-100 watt.

The minuteness of the power consumed is one great advantage which this method of measurement possesses. Most high voltage meters require at least 5 milliamps for full scale deflection.

Exactly the same principle may be applied to the measurement of high values of capacity or resistance, provided that standards are available with which to compare the unknown values.

Electrostatic Transmitter Amplifier Circuits.

The two weak links in any broadcasting "chain" are undoubtedly the microphone and the telephone receiver. Considerable experimental work is now being conducted with an electrostatic microphone, with a view to improving the quality of speech and music, and we give some details of the special amplifiers which are necessary.

THE electrostatic transmitter, which was developed to a considerable extent by E. C. Wente some years ago, has been described on several occasions and considerable details may be found in the *Physical Review*. It would be somewhat redundant to deal with the actual transmitter at any considerable length, and our readers are, therefore, referred to the publications mentioned.

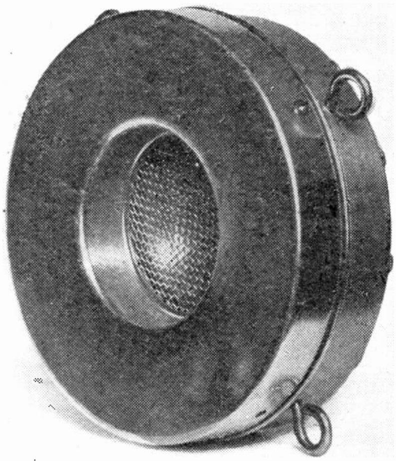


Fig. 1—Front view of the microphone showing wire gauze guard.

However, for the benefit of those who do not wish to investigate it very fully, we reproduce in Figs. 1 and 2 an illustration of the microphone which is a little more than half natural size. It consists essentially of a corrugated back plate which is at a distance of about 2 mils. from a tightly stretched steel diaphragm, which forms the second electrode of the condenser. The diaphragm is electrically connected with a metallic case, and also a wire gauze disc, which protects the diaphragm from damage. The leads from the microphone constitute a concentric cable in which the outer wire is connected to the diaphragm and the metallic case of the microphone, which are earthed.

The microphone is capable of giving very faithful reproduction, and a response curve is given in Fig. 3 for frequencies up to 5,000. It will be seen that this is substantially flat, and when it is remembered that the ear cannot appreciate an increase of some 300 per cent., the usefulness of the characteristic will be realised.

Owing to the comparative insensitiveness of the transmitter, a considerable number of stages of amplification has to be employed, and as the construction of a microphone of this description is not beyond the scope of many experimenters, it is thought that some details of a suitable amplifier will, therefore, be of value. The electrostatic transmitter has been perfected by the Western Electric Co., and we are indebted to them for the details of the amplifier circuits about to be described, and these, it is thought, will serve as a basis for experimental work. The operation of the instrument is probably well known, and consists essentially of connecting the condenser microphone in series with a high resistance and high voltage supply. Sound waves impinging upon the diaphragm cause the distance between the diaphragm and the back plate to vary, thereby altering the capacity fo the condenser, and causing potential variations to be set up across the high resistance. The actual amplifier employed can best be divided into two parts, the first part, comprising two stages, being shown in Fig. 4. The electrostatic transmitter is in series with a high resistance, and the applied potential is 220 volts. The potential variations set up across the resistance R1 are communicated to the grid of the first valve by means of a condenser C1, which serves to insulate the grid from the high voltage, a grid leak R2 being used, of course, to prevent the grid acquiring a high negative potential. The first valve V1 is Western Electric 102D, and has an amplification factor of 30, and an anode impedance of about 50,000 ohms. This is resistance coupled to the second valve by a resistance R3 of about 100,000 ohms, the coupling condenser C2 being about 2 microfarads. The second valve is a Western Electric 101D, and is of much lower impedance. It will be noticed that the grid of this is biased by the battery B2 through the grid leak R4. Attention is here directed to the resistances R5 and R6 in the filament circuit of the valve V1. The filament of this valve normally works at 3 volts, but it will be noticed that it is supplied by a 6-volt battery. The function of the two resistances R5 and R6 is to cause a volt drop of some three volts, but the resistance is divided in each leg so as to provide the bias of about 1½ volts for the grid, which, of course, is communicated by means of the resistance R2. The second valve V2 is connected by means of an output transformer of the shell type to the input of the second amplifier. It will be noticed that two chokes L1 and L2 are included in the secondary of the output transformer, and are for the purpose of adjusting the impedance to that of the input transformer of the second amplifier, so as to obtain substantially constant working at all speech frequencies.

The second amplifier is of the three-valve impedance coupled variety with a differential input and output transformer, and is standard Western Electric gear. This amplifier, it may be mentioned, has been described in EXPERIMENTAL WIRELESS in connection with the article on simultaneous broadcasting, and details of this will be found in the December issue on page 126. Although it will not be possible for the average experimenter to reproduce the amplifier shown in Fig. 5, a somewhat similar arrangement can easily be devised by substituting

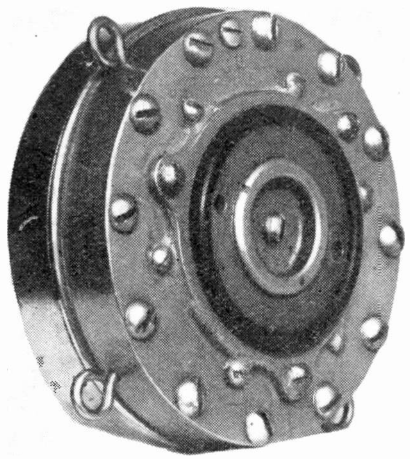


Fig. 2—Rear view of transmitter. Note the insulating ring between the two electrodes.

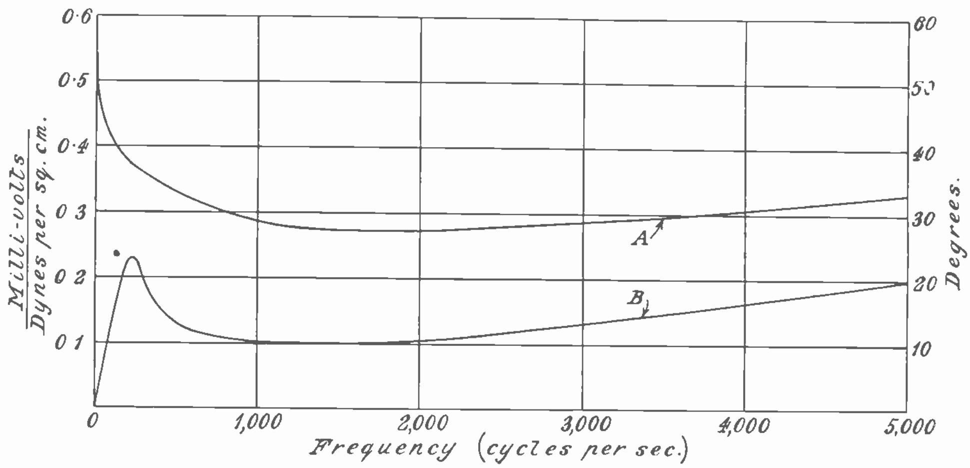


Fig. 3—Sensitivity characteristics of the microphone. A = Volts per unit of pressure. B = Phase lag of e.m.f. behind pressure.

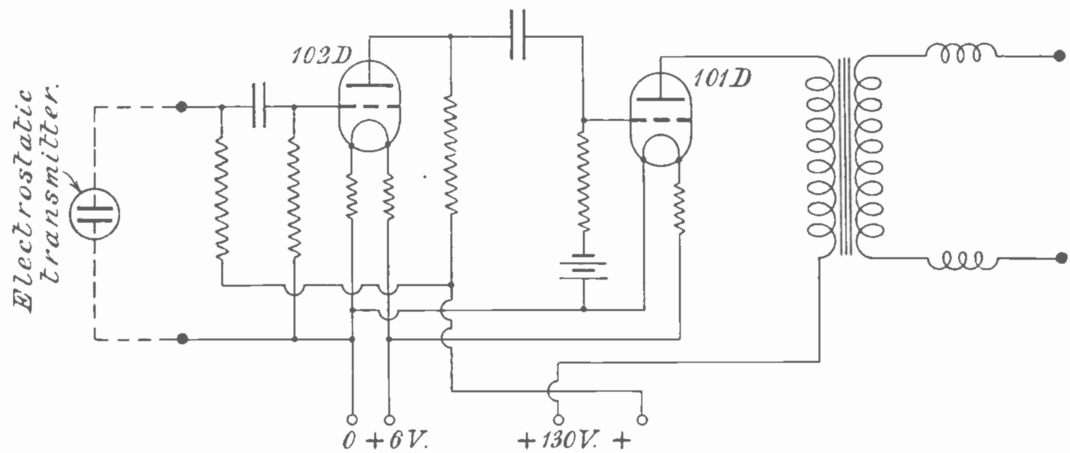


Fig. 4—The two-stage resistance coupled amplifier, showing the connection of the capacity microphone.

ordinary input and output transformers, adjusting the values of the various chokes and resistances to suit the valves available. pany's stations, and there is no doubt as to the excellency of the quality of speech and music which is obtainable,

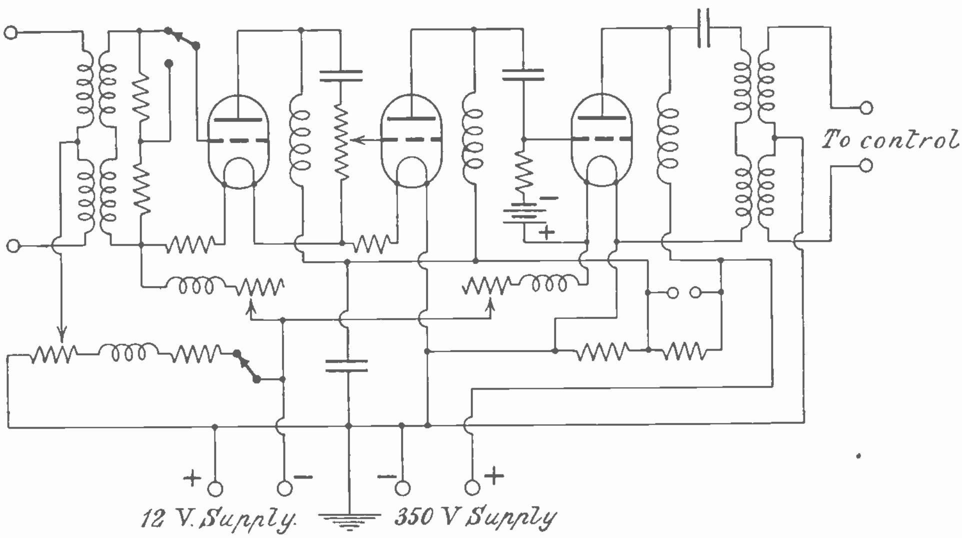


Fig. 5.—The arrangement of the three-stage impedance coupled amplifier, employing differential input and output transformers.

In passing, it may be mentioned that the electrostatic transmitter is now being used in some of the British Broadcasting Company's stations, and there is no doubt as to the excellency of the quality of speech and music which is obtainable, and it is certainly not beyond the scope of the amateur experimenter to work on similar lines.

A Two-stage Radio Frequency Amplifier.

As there has been a demand for details of a multistage radio frequency amplifier, we give below constructional data, together with the factors determining the design.

RADIO frequency amplification in a receiving system provides both increased signal strength and greater selectivity. More important, however, is the increase in signal strength since recent experiments show that equal selectivity in the final signals can be obtained at audio frequencies ; this, of course, refers to telegraphy only, selectivity of speech at audible frequencies being an obvious impossibility. If a square law is assumed for rectification, the importance of obtaining as large an initial potential as possible is clearly seen. This points to efficient radio frequency amplification, and should one stage be insufficient, it is vital to add additional stages until the desired potential can be given to the rectifier. Multistage amplification at audible frequencies is, comparatively, a simple matter, as intervalve transformers are substantially aperiodic at all audible frequencies ; in other words, no tuning is necessary, and no complications arise in the operation of the receiver. Amplification at high radio frequencies calls for tuned intervalve couplings, and each stage represents increased difficulty in operation. The use of resistances would render the amplifier aperiodic, but its

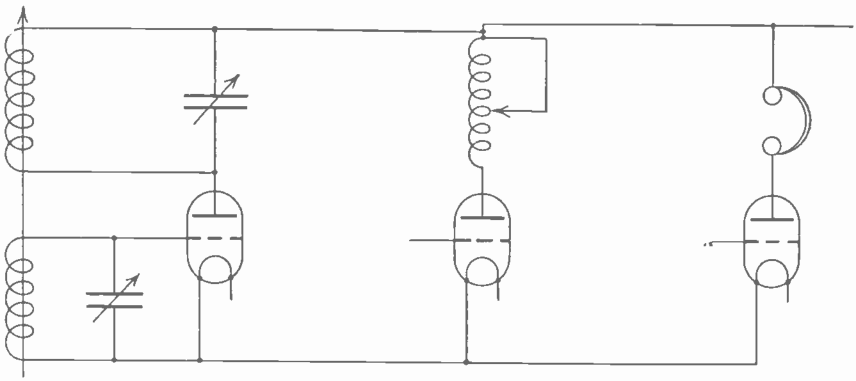


Fig. 1—Regeneration is here produced between the anode and grid circuits of the first valve.

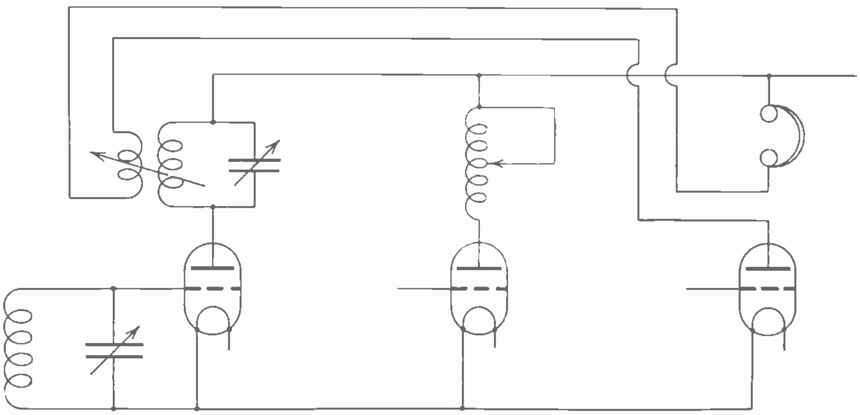


Fig. 2—Here regeneration is produced between the anode circuit of the first amplifier and the detector.

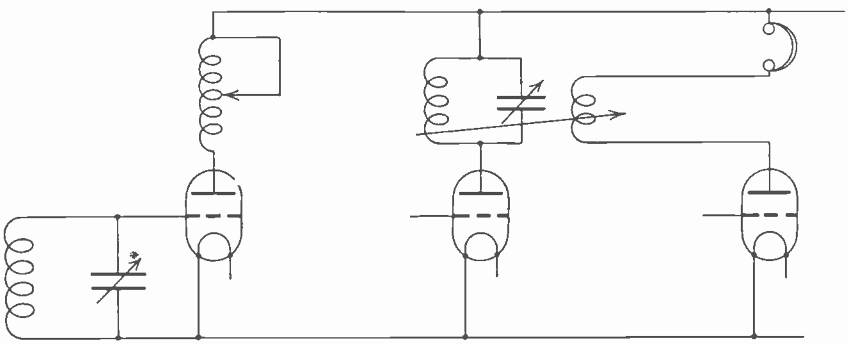


Fig. 3—In the arrangement adopted regeneration is produced between the anode circuit of the last two valves.

efficiency is limited by the inter-electrode capacities of the valves, which act as a shunt admittance. For this reason resistance coupling is normally only possible down to about 2,000 metres, or with special precautions and low capacity valves, down to about 1,000 metres.

The amateur usually requires to work on much shorter waves, and in addition, his receiver must be capable of rapid search. The object of the following notes is to enable him to build an instrument which will meet these requirements, and at the same time include only two critical adjustments, being, therefore, no more complicated than the familiar tuned anode receiver.

One obvious solution to the problem is the use of one critically tuned stage in conjunction with one or more semi-aperiodic

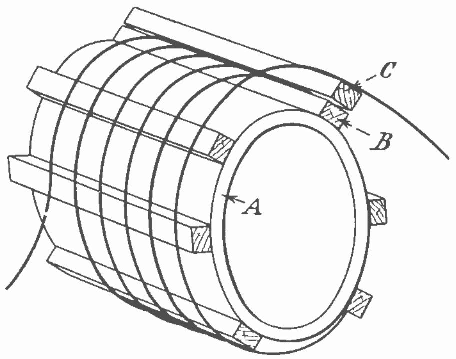


Fig. 4—A suitable method of coil construction for short waves.

stages. The input circuit of the first ampl.fier must, of course, be sharply tuned, but whether this is made the aerial circuit or coupled to it either loosely or tightly is left to the reader. The writer, however, would strongly advise a coupled aerial circuit. Whether the first amplifier is to be sharply tuned or semi-aperiodic must next be decided.

Assuming that both amplifying valves have similar charactertisics, the total amplification will be substantially the same with either arrangement of the coupling devices employed. Actual amplification, however, is not the only factor to be considered, selectivity and stability being almost of equal importance, while every effort should be made to minimise radiation when the receiver is in an oscillating condition. Reaction must obviously be employed in order to increase both selectivity and amplification, and also for the purpose of producing self-oscillation, unless, of course, a local heterodyne is used. For short waves this is really unnecessary, except for very critical work, and in any case would introduce another adjustment, thereby defeating the object of the design.

Obviously, then, there are three practical arrangements, these being shown diagrammatically in Figs. 1, 2, and 3 respectively. In Figs. 1 and 2, the input and anode circuits of the first valve are critically tuned and a regenerative effect is obtained between them or between the first and the anode circuit of the detector valve. Here there are three critical adjustments, the tuning of the two circuits and the coupling. The semi-aperiodic anode reactance, of course, only requires rough adjustment for different bands of frequencies. The arrangement of Fig. 3 is rather different, the input circuit of the first valve and the anode circuit of the second valve being critically tuned. The regenerative effect is obtained between the anode circuit of the second amplifier and the anode circuit of the rectifier.

The circuit of Fig. 1 gives greater selectivity to the aerial circuit, but also results in greater radiation, since the first valve generates oscillations. If the circuit of Fig. 3 is employed, the input circuit is less selective, but the radiation from the aerial circuit is considerably reduced, so much, in fact, as to be quite unimportant. There are two other useful features of the circuit of Fig. 3. The first lies in the extreme stability of the whole system. The degree of regeneration is easily controlled, and there is no tendency for self oscillation to occur, resulting in an entire absence of overlap, provided, of course, that the various constants of the circuit are suitably chosen and that the apparatus is properly arranged. The other advantage of making the first anode circuit semi-aperiodic is appreciated when atmospherics and "mush" are strong. These both cause impact excitation of the aerial circuit, and if the anode circuit of the first valve is sharply resonant and near the point of oscillation, a strong atmospheric may cause the circuit to be "triggered." The use of a semi-aperiodic circuit obviously minimises this effect. The chief advantages of the circuit of Fig. 3 are, therefore, stability, ease of operation, and minimum of radiation, and it would seem that they fully justify the adoption of the system.

The Tuned Circuits.

Almost as important as the arrangement of the amplifier is the use of suitable tuned

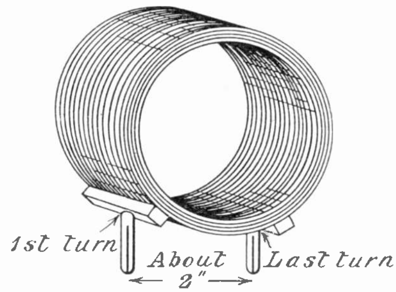


Fig. 5—Position of plugs on short wave coil.

circuits. The amplifier is intended essentially for wave-lengths from about 200-1,000 metres, but the range is capable of extension more or less efficiently. There are only two resonant circuits, the grid filament of the first amplifier and the anode circuit of the second amplifier. The selectivity of the amplifier will be absolutely dependent upon the sharpness of resonance in these circuits, and accordingly they should be carefully considered and losses reduced to a minimum.

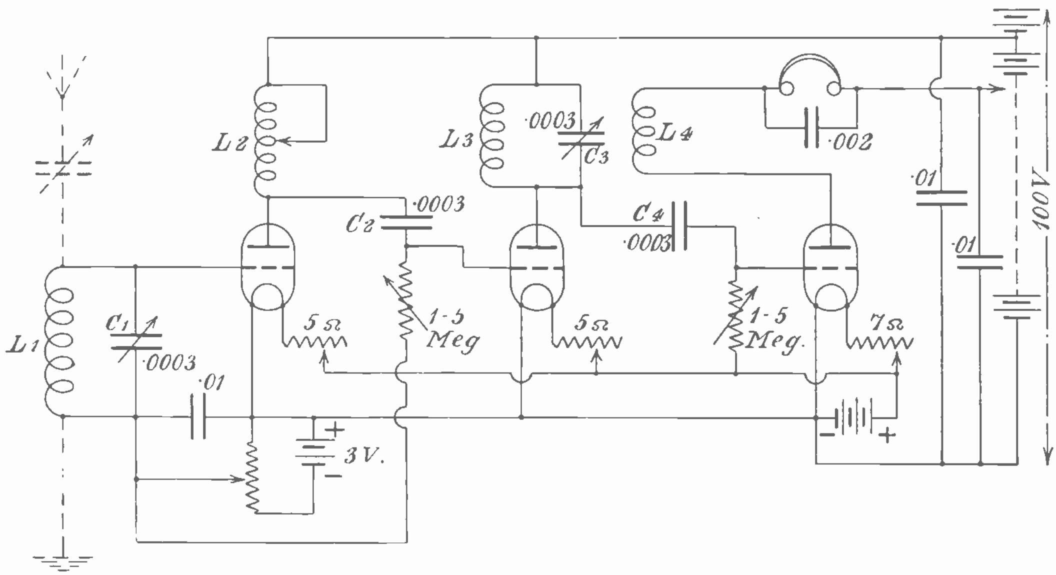


Fig 6.–The circuit employed showing suitable valves for the components.

A large amount of literature has appeared recently on the subject of inductances, but it will be advisable to consider what type of inductance is best suited for this particular amplifier. The position can be summarised quite briefly when it is remembered that the requirements are sharpest resonance and maximum potentials across the tuned circuits. This obviously points to a circuit having a low high frequency resistance. Considering the inductance only, the high frequency resistance can be reduced by so constructing the coil that the self capacity and dielectric losses are made as small as possible. The actual gauge of wire used is not very important so far as ohmic resistance is concerned, but too large a size should not be used, as the capacity is increased and also it is not unlikely that eddy current losses may arise. Dielectric losses may be reduced by keeping any dielectric as far out of the field of the coil as possible.

Short Wave Coils.

A very suitable form of coil construction is shown in Fig. 4, and this, or some modification of it, is preferred by the writer for frequencies of the order of 2,000 kilocycles. The former A should be either a rod or tube (preferably the latter) of some material having low losses, good hard wood usually being found superior to many grades of ebonite. The distance pieces B should be made as thin as possible to minimise the amount of dielectric in the field. These are fixed to the former, and the first layer of spaced wire is wound over them. Another series of distance pieces is then put in position, and the next layer is wound above them. This process is continued until a coil of the desired inductance is obtained. Coils of this description should be used for the input circuit, and the tuned anode circuit. The reaction coil in the anode circuit of the detector valve is not so important, and may take the form of the basket or honeycomb variety. When mounting the coils just described, the leads should on no account be brought to a two-pin plug ; neither should the first and last turns be brought near each other. A form of mounting on the lines of Fig. 5 is advisable.

The choice of the condenser used to tune the circuits is worthy of some consideration.

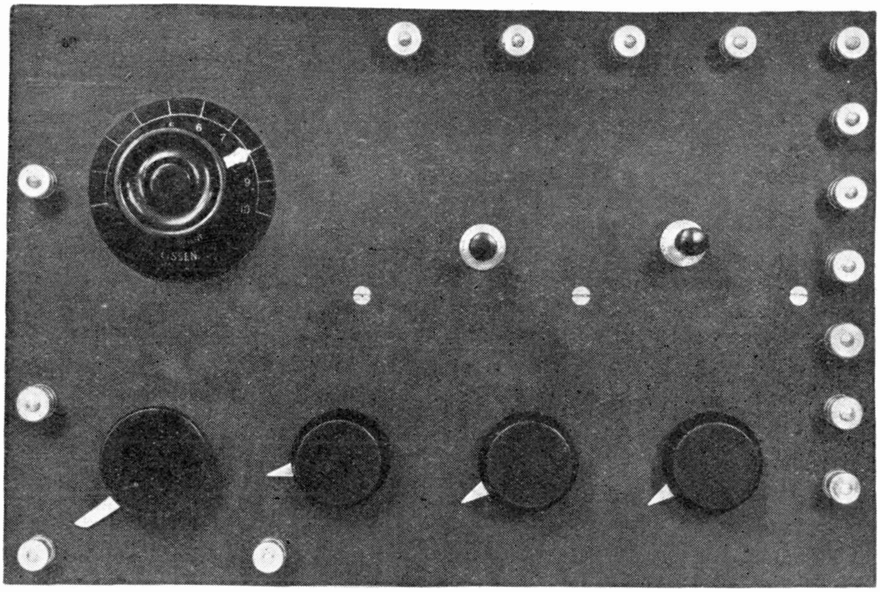


Fig. 7—Layout of front panel showing position of controls.

The chief requirements here are low ohmic resistance and low dielectric losses in the end plates. It is essential that all the plates of each section of a variable condenser are in efficient electrical connection. This is not always the case with cheap amateur assembled models, and may be responsible for considerable loss resulting in flat tuning. Another source of loss may occur through dust settling between the plates. The obvious remedy is to enclose the condensers in some suitable form of case.

The Layout of the Amplifier.

Enough has now been said to give the reader a good idea of the form of tuned circuits to employ, and it should be realised that the success of the amplifier is largely dependent upon efficiency in this direction. Of equal importance, however, is the arrangement of the apparatus, and too much care cannot be exercised in carrying out the internal wiring. Stray capacities are the cause of more than half the inefficiencies which may arise. First of all, any appreciable capacity across the input circuit should be avoided. This means, of course, that the wire from the first grid to one input terminal should not be brought near to anything connected with the filament circuit. There is no objection to the wires from the input terminals being two or three inches long, or even running parallel, provided that they are not close together or near other parts of the circuit at widely different potentials. Here it is well to remember that capacity is inversely proportioned to distance. Thus, for example, an alteration of even half an inch in the position of a lead may make a very great difference. Anode and grid circuits must also be kept well apart, and, of course, any leads or apparatus forming part of them.

The foregoing points will be better understood, perhaps, by briefly examining the suggested layout which should be quite clear from the accompanying diagrams and illustrations. The complete circuit is shown in Fig. 6, and should need no further explanation. The values of the fixed condensers and resistances are given in the illustrations. The input to the amplifier is connected across the grid of the first valve, and the slider of a potentiometer, which may have a value of between 200 and 400 ohms. A fixed condenser of about ·01 μF. is placed across the part of the potentiometer included in the input circuit in order to by-pass the H.F. currents. The variable reactance (L2) in the anode circuit of the first valve should be one of the familiar tapped variety now on the market. That shown in the photograph was supplied by Lissen, Ltd., and has been found to func-

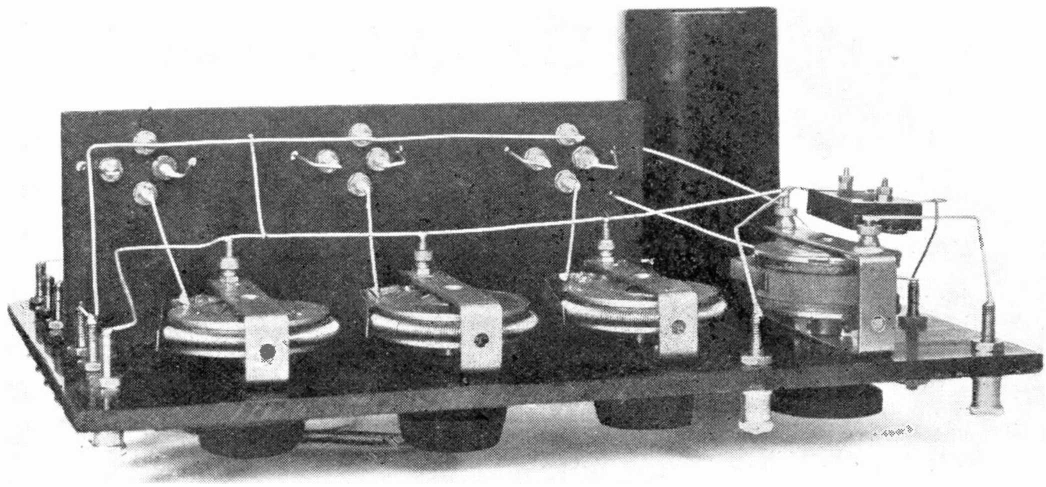


Fig. 8—Arrangement of wiring of the filament circuits beneath the valve panel.

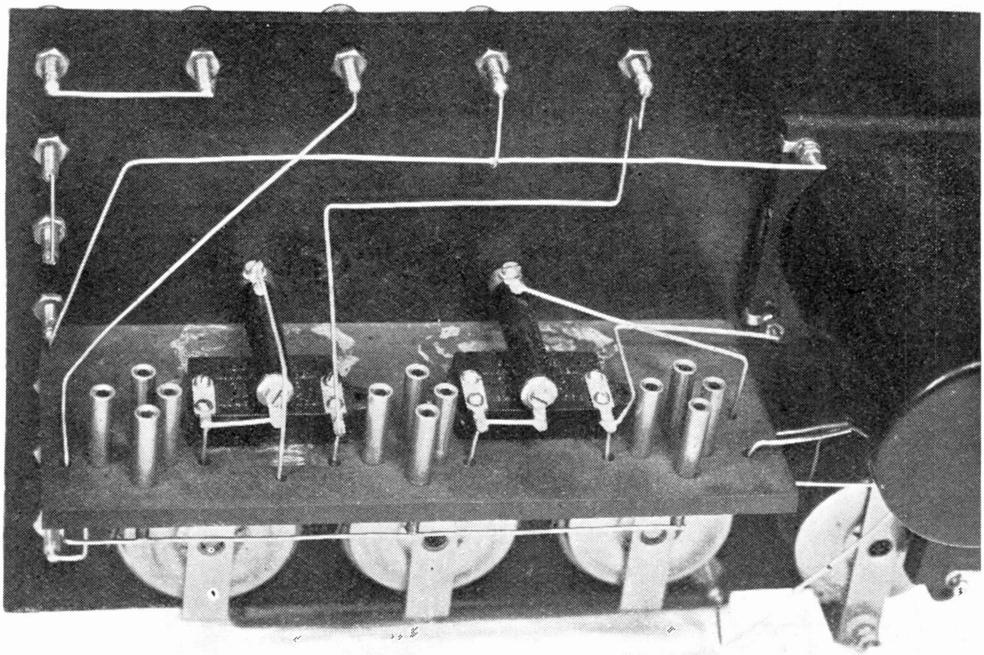


Fig. 9—Illustrating the short grid wires and arrangement of the anode leads to minimise capacity effects.

tion quite well. The coupling condenser C2 should be about ·0003 μF., and the grid leak of the order of 2 megohms. This is preferably of the variable type. The second grid condenser, C4, is for the purpose of providing cumulative rectification, and should be about ·0003 μF. The second grid leak should also be variable, and should be connected to the positive filament. The negative high tension should be taken to the *negative* filament, as this partially safeguards the valve filaments in the event of a short circuit between input and tuned anode circuits.

In carrying out the wiring, the leads should be made as short as possible without bringing them too close together, so as to minimise capacity effects. The actual wiring employed is best understood by referring to the two close-up views, and it is suggested that it should be adhered to fairly rigidly, since it results in very stable operation.

The panel shown in the photographs fits a 12×6 cabinet supplied by the Grafton Electric Co., Ltd., and is of a size most suited for the amplifier. Readers who construct the amplifier should adopt a similar arrangement of the apparatus, and should neither spread it out nor condense it to any considerable extent.

Adjustment of the Amplifier.

Little else need be said of the amplifier itself, but perhaps some notes on its adjustment will be of value. The best wave-length on which to test the amplifier is undoubtedly in the neighbourhood of 600 metres, on which ship stations of various strengths can be heard at almost any period of the day or night. First of all, select suitable coils for the input and tuned anode circuits, and tune the aerial approximately to 600 metres. Place the switch on the tapped reactance L2 in what is assumed to be the correct position, and then light the valve filaments and place the potentiometer in the minimum position so that the input circuit is connected directly to the negative side of the filament. Next brighten the first valve fairly fully, and make the second valve a little duller than the first. Then tune in a station accurately on the tuned anode circuit, meanwhile varying the position of the switch on the first anode reactance until maximum strength is obtained. The aerial tuning should then be accurately adjusted. After the signal is properly tuned in, the valve filaments, potentiometer, grid leaks, and high tension should all be varied. No definite instruction can be given, but probably the maximum signals will be obtained with about 1-1·5 volt negative on the first grid, with a bright filament, and about 80-100 volts on the anode. The second valve may be a little less brilliant. These remarks refer, of course, to R type valves. The detector valve is preferably a soft one of the Dutch type, and will require a quite low anode voltage. Reaction should now be applied, and if the signals gradually increase and if self oscillation starts and stops without a loud click, the adjustments are correct. Should overlap be present, the filaments and anode voltage of the amplifier valves, and particularly the grid potentiometer and leaks should be varied until the points marking the starting and stopping of self-oscillation are coincident, or in other words, until overlap vanishes. If the amplifier is correctly built and adjusted, it should receive all British and Continental broadcasting stations without interference from each other. Tested on these wavelengths in the London district, all British stations were audible without applied reaction.

In conclusion, the reader is reminded that the efficient lower limit for any amplifier of the type just described is certainly not below about 200 metres, although, of course, it can be made to function at higher frequencies. For short waves, however, entirely different methods are adopted.

The Month's "DX."

Recorded by HUGH N. RYAN (5BV).

The increasing efficiency of amateur transmitters and receivers is resulting in the creation of many new long-distance records which are undoubtedly worthy of mention. It is proposed to record month by month work in this direction, and the Editor will be pleased to receive details for inclusion in these pages.

At the time of writing it would appear that the season for transatlantic work is coming to an end, though it may yet last some time, and there is just a possibility that some intermittent work may continue right through the summer. Stations on this side are still working, of course, with the States and Canada, but the average strength of transatlantic signals has decreased very considerably, and it is not so easy to get into touch with the other side as it was a month ago.

On the other hand, it is, of course, possible that we are merely passing through a "bad period" as we have often done before, in which case we may expect things to become better before long. However, this does not seem likely, as a "bad period" usually begins fairly suddenly, and "when it *is* bad it's horrid," whereas at present signals are not really very bad, but appear just to be fading slowly away.

If we do lose touch with the other side during the summer, as most of us expect, it will be very interesting to see which of our men finishes the season with the greatest number of transatlantic "stations worked." Unless the season continues for a considerable time there is little doubt that the honour will lie between 2OD and 2KF, who are far ahead of any other stations.

At the time of writing 2OD has worked 32 and 2KF 29 Americans and Canadians, so we may expect a close finish. I believe 2NM and 2SH have each worked about 15, and 5KO 11. I have only been able to come "on the air" one morning a week, so have only managed to work 7.

During the month several more of our stations have been successful, 5LF, 6RY, and 5FS each having worked two Americans or Canadians, while 2WJ has worked 1XJ, 1XAH and 1BQ, and has been reported by 1BCF.

Of course, the original excitement of transatlantic work is now over, and now it is simply a matter of those who have not yet "got over" trying to do so, and those who have already been successful trying to get as good a "log" as possible before the end of the season. If touch is lost during the summer there will be the same keenness to be the first to resume communication next autumn.

The work which we have done so far on the very short waves has taught us a great deal about these waves, and caused us to modify our original views considerably. The only fact which cannot be contradicted is that we can cover much greater ranges on the same power on these short waves. At first I think most of us thought that there was some special virtue in the band from about 95 to 120, and that anywhere outside this band was nearly as bad as 200 metres. It has become evident that we were wrong, and that there is no such restricted band.

The present American theory is that, to obtain a good useful radiation the aerial must be operated below its fundamental wave-length, and therefore the only hard and fast dividing line is that wave-length.

It is unfortunate that we have not sufficient data to confirm or refute this theory, since nearly all our successful stations have "got over" either on the short wave only or on 200 metres only. As far as I know, only four stations (2OD, 2KF, 2NM and 5BV) have been received in the States on both waves, and the limited data available in these cases does not seem to confirm the theory of a definite dividing line at the fundamental wave of the aerial. In all three cases the same aerial was used for both waves, and in two cases approximately the same power. 2KF used slightly less power on 200 metres.

I will quote the actual figures in my own case only, as I am most familiar with them. My aerial has a fundamental wave of about 170 metres, and the upper wave transmissions were made on 200 metres. The aerial current was about 3½ amperes, and signals were apparently of quite good strength, though the wave was well above the fundamental.

With the same power on a wave well below the fundamental only 1 ampere was obtained at first, being later increased to 1·6. This "got over" quite well, but was still not reported as being strong until the wave-length was further reduced. I believe more or less similar figures apply to 2NM and 2KF.

These data, though very rough, seem to show that the "carrying" power of our signals depends upon shortness of wave alone, regardless of the size of our aerials. If the "sudden change at the fundamental wave" theory were true, it would not seem likely that any of our stations would have "got over" at all on the small power used, with wave-lengths above the aerial fundamental.

The above has little to do with "DX" reporting, but it concerns a subject of great importance to "DX," so perhaps my digression will be forgiven.

To get back to the reporting. In Europe most of the work has centred around the French stations, of whom there are now a considerable number working.

The work has not been of any great interest, apart from showing that very low power signals can still travel a long way on the despised 200 metres. 8SSU, of Bonn, another station run by members of the French Rhine Army, has been much in evidence, and has worked many British stations, including those as far North as 5SZ.

Of the Danish stations, 7ZM and 7EC have been working occasionally with our men on 200 metres, but they are very weak. 7QF has gone down to 125 metres, and, of all the stations, European or American, who have moved to the short waves, he has certainly improved the most.

On 200 he was hardly ever heard, and when heard was very difficult to read. On 125 his signals are very strong indeed, sometimes uncomfortably so. It is curious that some stations do not seem to gain so much as others from the short waves. In contrast to 7QF, 2JF has reduced his wave-length, but the change does not seem to have done him any good. His signals are, of course, stronger, as are all signals on short waves, but the increase in strength is not very great in London.

A few Dutchmen are still working on 200

metres, but nearly all have adopted the short wave, there being about a dozen now working there. The only fresh success is, I believe, that of PCTT (Noordwijk) who " got across " the Atlantic some time ago. Their star station, of course, remains PCII (Leiden), who has worked a very large number of Americans.

Of the two Italians, 1MT does not seem to have been working much this month, and ACD was only working at the beginning of the month. The latter has now closed down for several weeks, while the whole station is rebuilt. The new transmitter at ACD will have accumulator high-tension supply, so that we shall at last have a Continental amateur using pure CW. May many more Continental (and British) stations follow his example.

XY (Geneva) is still working, and has worked several British stations, including 5DN and 2ZT. The latter, by the way, was not working for a long time until nearly the end of 1923, but in the short time since then, he has put up an imposing log of European work, including Danish 7EC, Swiss XY, and Italian 1MT.

Belgium now has an amateur transmitter, situated in Brussels, and using the call sign P2. His signals are quite strong, on about 118 metres. I have worked him several times, and believe he has also worked other British stations. Another station, P5, is working, but I do not know whether he is also Belgian.

A short time ago some of us were surprised to hear FL (Eiffel Tower) testing on about 110 metres. His signals were not extremely strong, and he sounded just like an amateur station, with a slightly unsteady wave. He worked with two British Stations (5KO, 5BV) at the beginning of his tests, but does not now listen for replies by radio.

Poldhu has also been testing on about 95 metres recently, his signals being of teriffic strength.

During January and February many of you probably heard a British station signing 2AP. This station had a really remarkable career, doing about as much " DX " in less than a month as most of our stations do in a season. The station started work on January 19, and closed down on February 11, during which time he worked nearly all the well-known British stations, and stations in France, Belgium, Holland, Germany, and Denmark.

The operator has now gone to North Africa, and hopes to put up a station there to work with England. If he succeeds he will be a very useful relay point between us and South African amateurs.

Last month I spoke about the possibilities of working Australia, and mentioned the wonderful low-power work which had been done by Mr. McClurkan (Aus. 2CM).

I have been deluged with letters asking whether the figures I gave were correct or misprinted, since 1,200 miles on ·004 watt seemed impossible. The figure for the power was correct, but the distance should have been given as 1,500 miles instead of 1,200! The plate voltage was 15, and the plate current ·25 milliamp (much less than most of us put into our wave-meters!) Even with this absurd power, signals at the other end (New Zealand 4AA) were still reported as QSA! After that, I think it is really up to us to " put it over " to Australia next year.

We hear very little of home DX, but nevertheless a large amount of excellent work is being done on very low power, Mr. Jacksonley, of Nottingham, for example, having got through to the London district on telephony with an extremely small input. The reception was carried out on a single valve by Mr. R. E. Broomfield, of Brixton Hill.

Next month the arrangement of " The Month's DX " will be somewhat altered, the local reports being written by several well-known local amateurs.

This should make these notes of interest to a wider circle of " hams " than is possible at present. General " DX " news will still be written as at present.

The Transatlantic "PA9."

By K. C. VAN RYN.

We give below some details of the Dutch Station PA9, which was specially licensed for the recent transatlantic tests.

BRITISH experimenters will have noticed the appearance of the Dutch short-wave station PA9 since the commencement of the transatlantic amateur tests.

As you are aware, transmission is not yet permitted in Holland. Nevertheless, steps have been taken by the writer since May, 1923, to obtain permission from the Government for a transmitter for the object of testing on very small wave-lengths. After much trouble, permission has been granted to use the licence of the Technical University of Delft (Holland) from October, 1923, to May, 1924. At the end of November last the writer, in co-operation with Mr. G. T. Eschauzier, planned to erect the station, both being students of the University.

The time for preparation was short, as the necessary components were not available until December 15. On December 17 we commenced assembling them, and on the 19th the first radiation took place. On December 22 at 1 G.M.T. (prompt) we started the automatic code relay, radiating 75 watts (2·5 amps.) on a wave-length of 195 metres.

At that time the set was comprised of nothing in particular. The "tickler coil" circuit was used fed at the filament side of the plate circuit. After a few days it rendered about 60 per cent. The plate current supply was 50 periods single rectified alternating current. The generator valve was a Phillips' 25, and the rectifiers (two in parallel) Phillips ZG5 tubes. On the fourth day of the tests a telegram was received stating that PA9 had been heard on the first three nights.

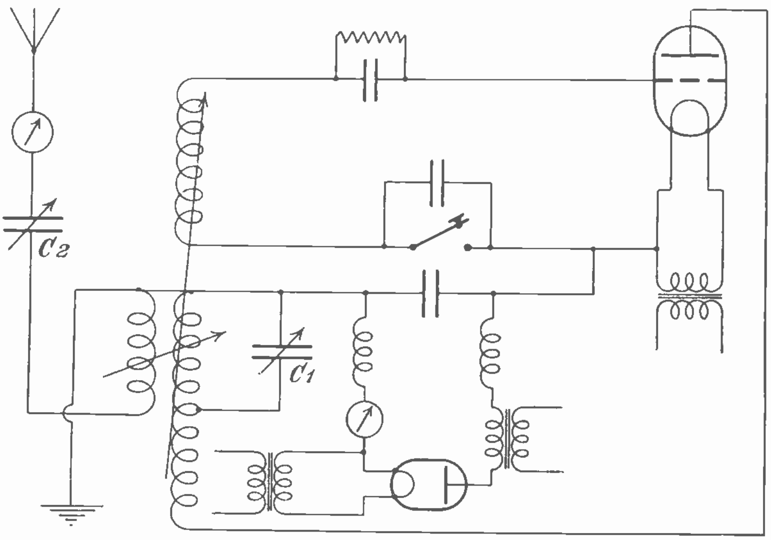


Fig. 1.—Showing the arrangement of the circuit employed, which, no doubt, is quite familiar.

Noticing the success in using very short wave-lengths, and the fact that many American amateurs were heard on them, we decided to turn to a shorter wave-length. Therefore, on December 31 we changed to 108 metres, using an entirely different circuit. Two days later we succeeded in communicat-

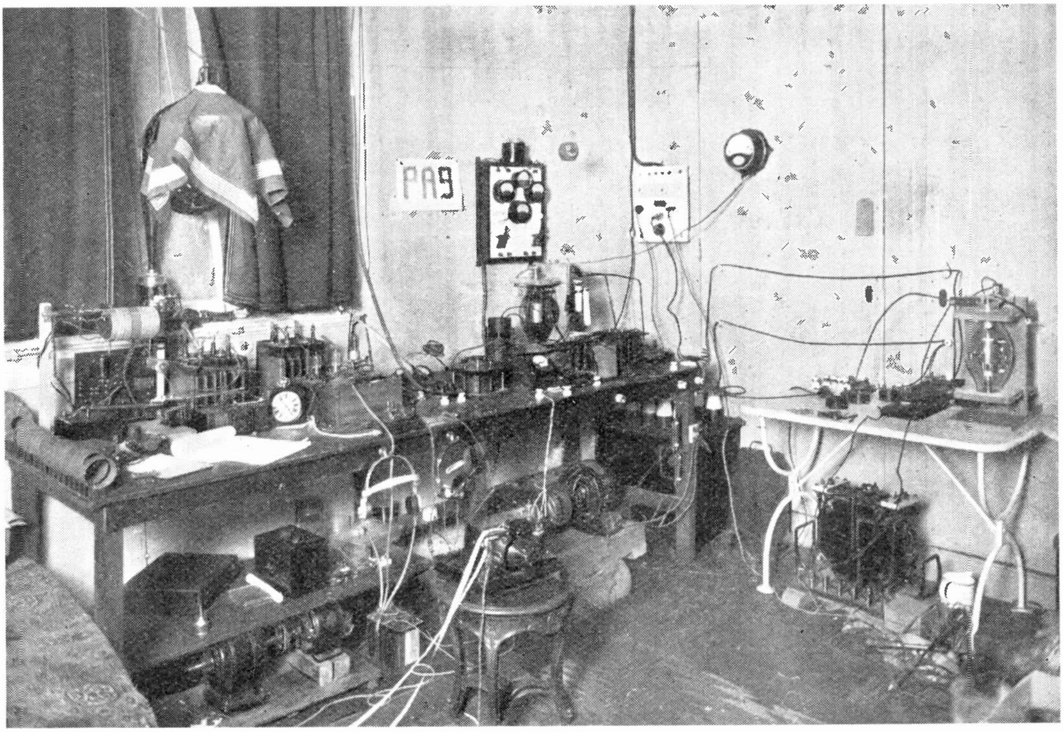


Fig. 2.—A general view of the apparatus which was rapidly arranged for the tests.

ing with U2AGC and U1XW, and since then we have maintained an almost daily communication, the total aerial energy being about 350 watts.

Primarily we started to tune the same circuit down to 100 watts, taking away each dead end which proved absolutely necessary, but the adjustments became too critical, and could not be relied upon. Changes were constantly taking place, the origin of which could not be overlooked. It should be remembered here that the Phillips valve works in the lower bend of its curve, so as to increase the efficiency, and this also made adjustment more difficult. We decided, therefore, to turn our attention to the circuit recommended in the October number of *Q.S.T.* by Messrs. Brown, Darne and Basim (3BNT), and found it much more flexible in operation. Here is the circuit changed in detail for the particular power supply. The condenser C is the only component that fixes the wave-length and the capacity should not be taken very small. In this particular case the capacity of C2 became rather small. The fundamental wave-length of the aerial being 207, it had a value of 60—70.

At the time of writing the first part of the transatlantic tests have been concluded, and we are looking forward to the communication tests. As already stated, we had the opportunity of working a number of stations of the first and second districts, and signals were always reported QSA (time mostly 0600-0820). Fading was scarcely noticed, and never as bad as on 200 metres. It will be interesting to note the results when a larger stretch of land is interposed.

It is intended to diminish the wave-length still more, and we expect to change to about 60 metres very soon.

Finally, I wish to state that we are quite prepared and willing to conduct serious tests in this direction, with any experimenters, especially those at long distances from Holland, and should be glad if they would communicate for this purpose with the writer at the address given.

Dutch PCII.

By a Dutch Correspondent.

PCII was one of the first Dutch stations to be received by British amateurs, and it is thought that some details of the latest improvements will be of interest.

In spite of our very, very bad situation owing to our position with the authorities we have tried to take our share in amateur transmitting, and soon we hope to make it still better.

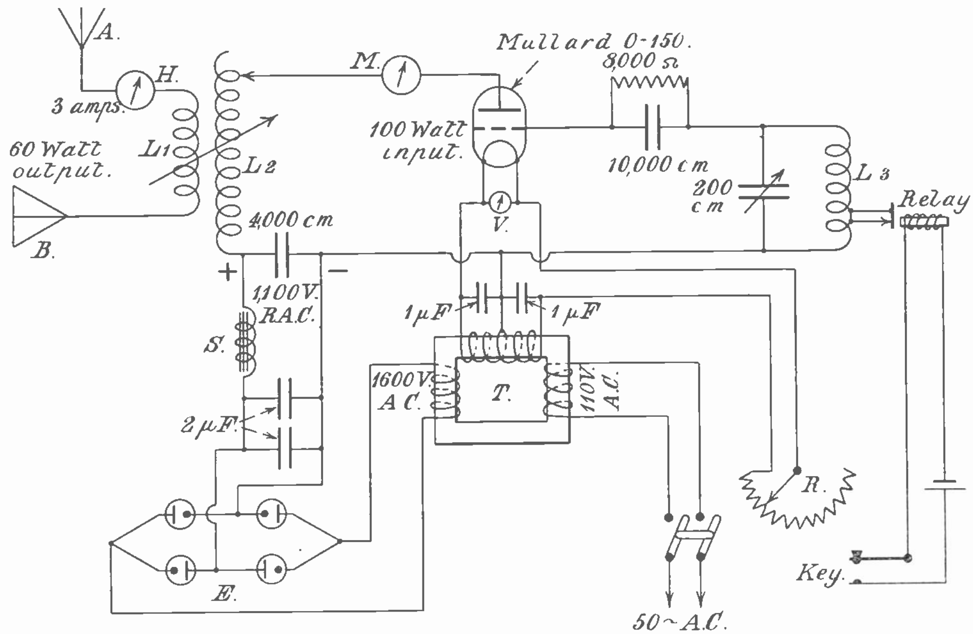


Fig. 1.—Showing the transmission circuit, which is described in detail in the text.

May I now introduce to you our famous PCII station?

It is located "somewhere in Holland," "ten miles from Amsterdam," "ten miles from the Hague," etc. He who has worked PCII knows better. Ask 2KF for details.

The other day I was looking for some news at his place and nearly stumbled down over a thin wire drawn one inch above the floor for about 24 feet, and then disappearing in the ceiling. It was part of the 390 square feet transmitting frame. PCII was just busy to put some 2 amps into it on a 220-meter wave. Later on the evening I heard him from my station (distance about ten miles) R9 on one valve (or A41 as we say now) with the frame at right angles to my direction.

Last week I went down to see why his signal strength had increased so awfully (!) Well, he showed me his hot-wire ammeter, rated 0-4 amps. It was burned out. That afternoon he had connected two additional wires to his counterpoise and the ammeter went up in smoke. And for some time he didn't know whether he had 5 amps. or 50 amps. in the aerial!

This is PCII—and now the apparatus.

The circuit in use is the Armstrong-Kühn transmitter with chemically rectified A.C. for plate supply. The most interesting point of this circuit is the position of the grid-coil, which is tuned by a variable condenser to the wave-length corresponding with the natural period of the antenna-counterpoise circuit. Whereas the plate-coil is not tuned critically the slightest alteration of the grid circuit (for instance, shortening of a few turns of the grid-coil for keying) will stop the radiation absolutely. The grid-coil is placed at right angles to the antenna and plate-coil and about two feet apart to prevent coupling or reaction. The oscillations are set up only by the electrostatic coupling due to the internal elements of the valve.

The circuit is given in detail by Fig. 1. It explains itself fully, but for the experimenter it will be interesting to have the constructional data as completely as possible.

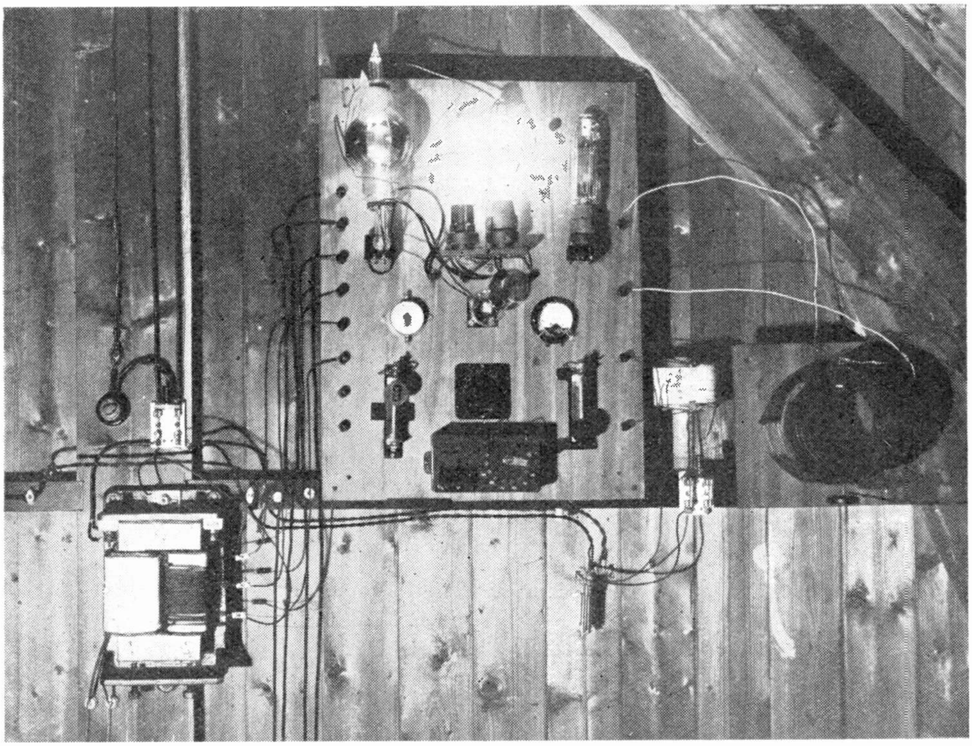


Fig. 2.—A near view of the valve panel and transformer.

The components of Fig. 1 are as follows :

L_1 Aerial inductance, 9 turns diameter 12 cm., revolving inside L_2.

L_2 Plate inductance, 19 turns, diameter 17 cm., tapped.

L_3 Grid inductance, 23 turns, diameter $9\frac{1}{2}$ cm.

R Filament resistance, shortened when filament is properly lighted ; used only for starting the valve slowly to prevent the building up of undesired high-tension currents.

E Chemical rectifier, consisting of four groups of eight jam-pots connected to get full-wave rectification. The electrodes are Al and Pb. The solution is 5 to 7 per cent. phosphate of ammonium with distilled water.

T Transformer with primary winding for the 50-cycle 110-volt line, a step-down coil with midtap, wound to the proper filament voltage, and a high tension section giving 1,600 volts. After passing the rectifier and the filter circuit, the R.A.C. voltage left is 1,100 volts. The cross section of the transformer-core is $4\times5\frac{1}{2}$ c.m.

S Filter-choke of 3,000 turns 0·5 mm. wire on core of $3\times3\frac{1}{2}\times15$ cm.

V Voltmeter controlling filament voltage.

M Ammeter giving the milliamps. in the plate current.

H Aerial hot-wire ammeter. Shows 3

amps. on 100 watts input and 60 watts output.

The transmitter apparatus are at 20 ft. distance from the receiving set. The keying is done by a relay-line, as shown in the drawing.

trapezium. The operating wave-length with L_1 as aerial coil is 203 m.

To make the operations for switching-over as simple as possible, as well as to eliminate all losses developed by complicated wiring, PCII has erected a separate receiving aerial

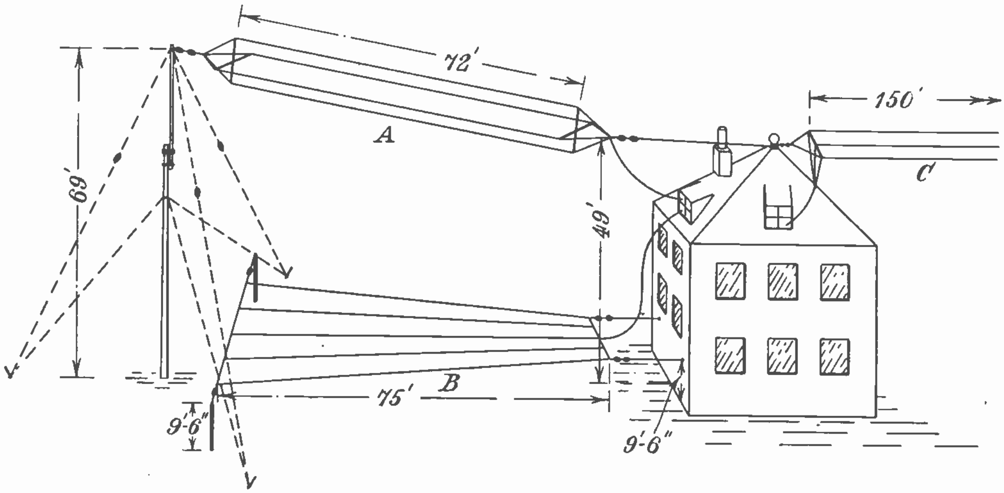


Fig. 3.—The radiating system showing the separate receiving aerial.

The part of a transmitting station outside of the apparatus is in no way less important. Probably PCII owes very much of his fine results to the well-constructed antenna system.

(C) of the inverted L type, 150 ft. in length, three wires. This aerial runs at right angles to the transmitting antenna system, and at proper distance to eliminate losses, etc.

Fig. 2 gives a photograph of the transmitter

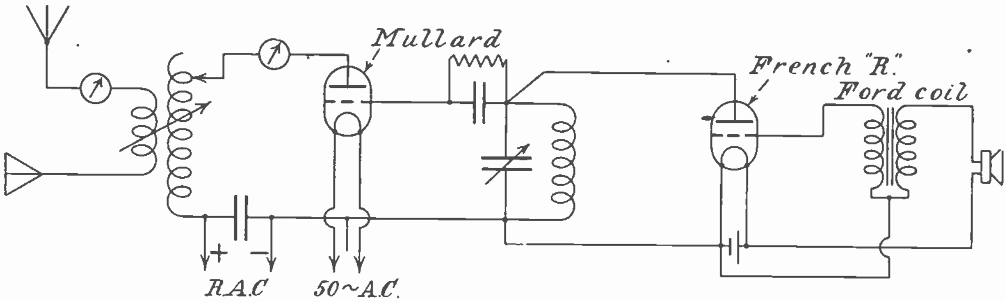


Fig. 4.—For telephony, absorption modulation and a tuned grid circuit are employed.

The four-wire cage aerial (A) is supported by the roof of the house, and a splendid 69 ft. pole, average height 60 ft. above the ground, and 50 ft. above the counterpoise. The counterpoise (B) is suspended symmetrically under the aerial, consisting of five wires of 75 ft. each. The form is of the fan type, or better still, it can be compared with a

valve panel, the inductance coils, and the transformer. Note the simple wiring. Besides the 0-150 Mullard at the left upper corner of the panel, there are mounted three Telefunken 5-20 transmitting valves, two of which are connected in parallel with the "big bottle" to increase the power. The third 5-20 valve (type RS.5) is used for rectifying

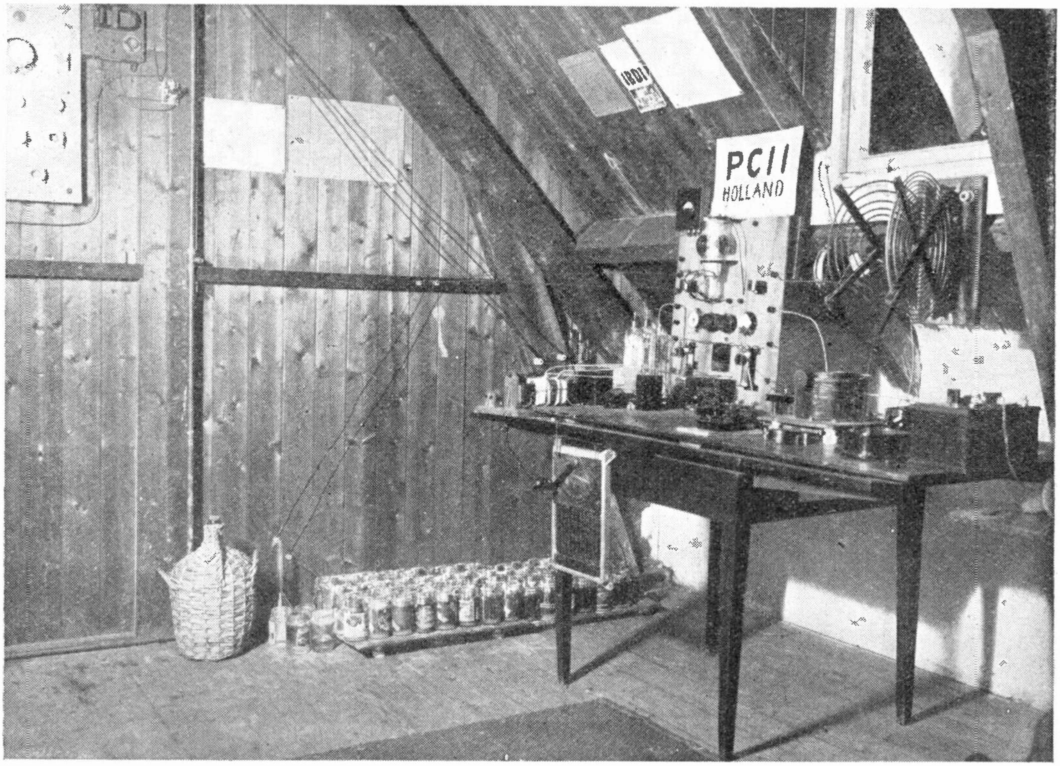


Fig. 5.—A General View of the Apparatus. Note the Chemical Rectifier in the Corner of the Room.

purposes. Right in the centre of the panel is a French R valve (receiving type) used as modulator for telephony.

Fig. 4 shows the general arrangement of the telephony circuit (got it from 2KF !). Good results were obtained at the first tests with 5KO (Bristol), reporting strong and clear speech.

The receiver in use for the short waves is a special Reinartz one-valve set of original design, using normal spider-web plug-in coils. Waves down to 40 m. can be received with this arrangement without difficulty. American amateur signs are coming in very well with one valve.

Overseas Transmission.

Amateurs holding transmitting licences are reminded that communication with foreign countries must not be conducted without permission from the Post Office. When working tests, the following international prefix should be used:

V A	Canada	K B	Germany
O U	Denmark	I	Italy
O N	Belguim	F	France
P A	Holland	E A	Spain

Experimental Station 7ZM.

By GUNNAR BRAMSLEV.

Most British experimenters are familiar with many of the Continental amateur stations, but it is thought that little is known of Danish methods. Below will be found details of 7ZM, which was one of the pioneer stations.

UNTIL quite recently nothing was heard from Danish amateurs, and although radio experimenters exist in Denmark, as in every country, they are very few, and not many of them possess transmitting apparatus. The Government restriction upon amateur transmitting (half a year ago, also receiving) has not yet been removed, and this is the probable cause of so few experimenters.

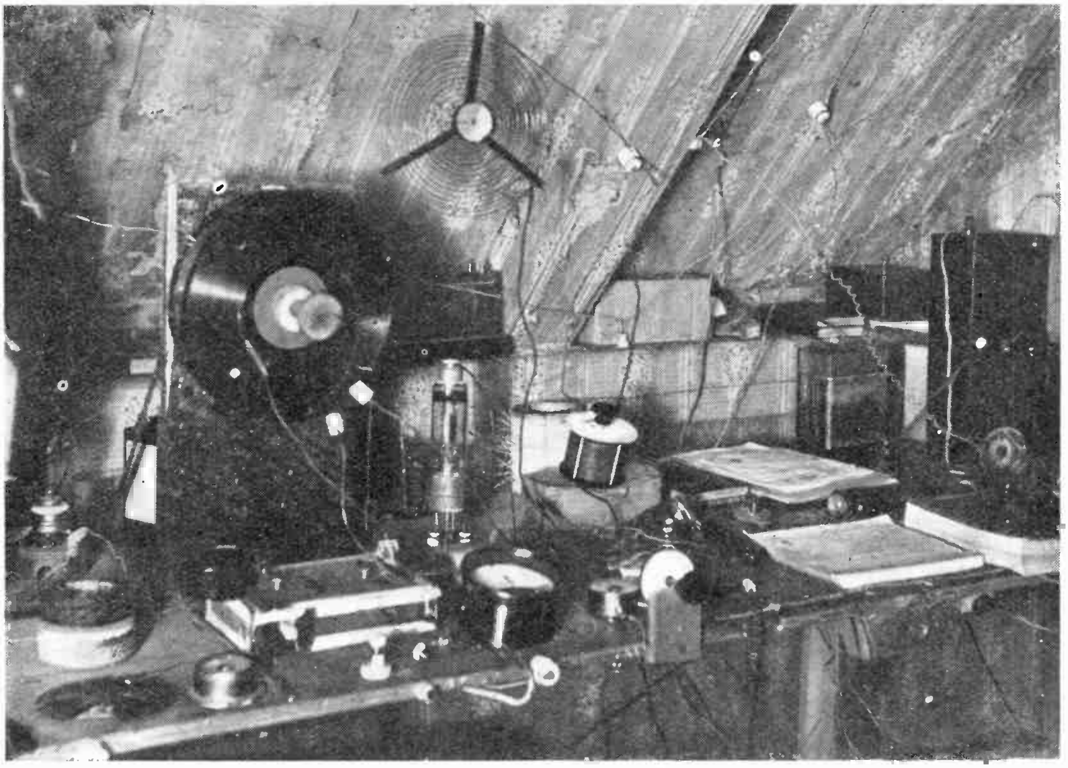


Fig. 1.—A near view of the transmitter.

A description of 7ZM will possibly be of interest, as this station was the first that was heard in England. The writer started wireless experimenting in 1920, when the station was equipped for crystal reception only. Since then the receiver has undergone many alterations, and the first valve transmitter was started in May, 1923.

The antenna system is of the inverted L type, and consists of three wires 135 ft. long supported on 3-ft. spreaders, 3-wire lead-in about 20 ft. long. The mast at the lead-in end being 33 ft. high. The distant end is supported to the chimneys of a house. Unfortunately a nine-wire counterpoise cannot be installed, but a one and two-wire which is used for transmission has given very satisfactory results, having reduced the aerial resistance considerably. The surroundings are far from ideal for transmission, as the house is situated at the foot of a hill and almost completely screened by trees and other houses. The aerial seems rather long for 200-metre transmissions, but difficulty only arises when trying to get under 180 metres.

A diagram of the transmitter is seen in Fig. 2, and a photo in Fig. 1. The valve

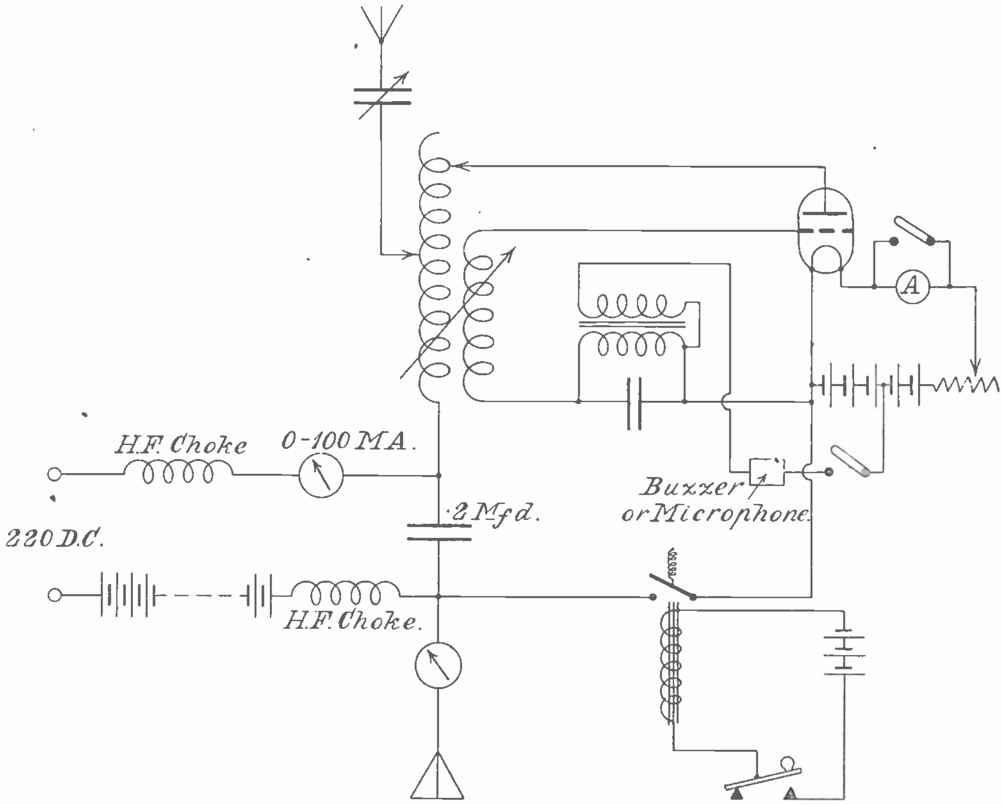


Fig. 2.—The transmission circuit showing method of keying.

is a Telefunken type RS.5.C.II.a with filament consumption 10-12 volts and 3 amperes. At present it is only supplied with 10 volts. The tuning inductance consists of 18 turns of 1.5 mm. bare copper wire tapped at each turn. Both this and the grid coil, which is aperiodic, can be seen in the photo wound on old gramophone records. The relay, which is controlled by the key on the receiving table, is placed in the plate circuit. It has been very difficult to obtain a good high tension supply, and I now use 220 volts D.C. from the mains in series with a home-made accumulator battery with about 80 small cells. This gives 380-400 volts, but a higher value was desirable. The set is not used much for telephony transmissions, but ordinary grid modulation is employed, giving very good speech at distances up to 20 miles with an aerial current of 0.2.

With this transmitter a radiation of 0.75 amps. is obtained when the input is 10 watts, but I hope to increase this in the near future with a better H.T. supply.

The receiver portion of 7ZM will be seen in Fig. 3. On waves above 300 metres home-made honeycomb coils are used for tuning, and on the short waves 120-300 metres special single-layer, large diameter cylindrical coils are used. Two valves are used, the amplifying valve either being H.F. or L.F. If large amplification is required all the four valves can be put together as one H.F. (tuned anode), detector, and two L.F. The various parts, including two home-made inter-valve transformers and four filament rheostats, can easily be identified in the photo.

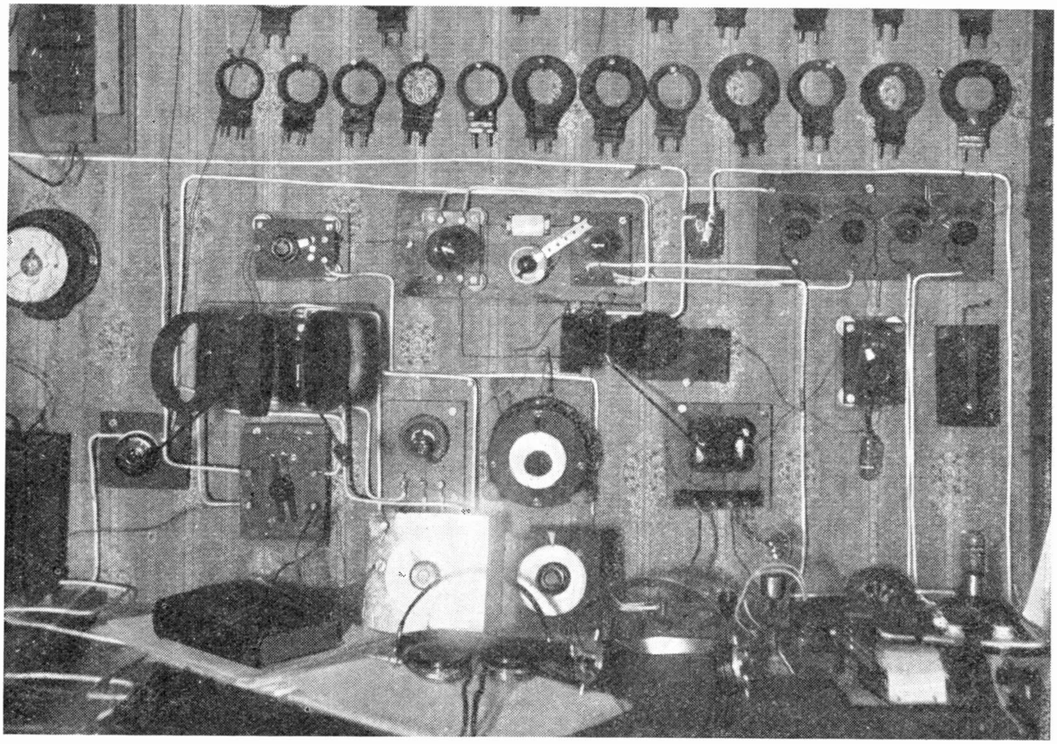


Fig. 3.—A general view of the receiver.

With this receiver all the British broadcasting stations can be heard at any time when it is dark, and it may possibly interest English amateurs to know that nearly all Danish broadcast listeners get their entertainment from the splendid programmes of the B.B.C. stations; their own broadcasting station, Lyngby, being far from perfect. English amateurs come in very well over here on two valves in spite of the distance being in the neighbourhood of 600 miles. Over 140 foreign experimental stations have been logged, including four American. Sometimes the distance between England and Denmark is covered with very low aerial currents and small power. For instance, in August last year I heard 5RZ, when he was using 3 watts input and 0.12 in the antenna, and a few days ago 2IJ, who stated that he was radiating 0.15.

The first long distance transmission from 7ZM was done on September 8, 1923, when my "test" call was answered by 2KW; owing to QRM, however, communication could not be established. The next Saturday greater success was obtained, and the first two-way communication established with 2JF who reported the signs QRK on one valve. Since then I have communicated with 2DF, 5KO, 2NA, and many others The longest transmitting range has been 1,400 kilometres to 8CT.

In conclusion, I may say that the station is situated in Roskilde, about 20 miles west of Copenhagen, and I shall always be pleased to arrange transmission or receiving tests with British amateurs.

The Trend of Invention.

We summarise below the more important wireless inventions which have been disclosed during the month, special reference being made to those of immediate interest to the experimenter.

Improved Super-Regenerative Circuit.

Various modifications of the Armstrong super-regenerative circuit, of which the Flewelling circuit is the best known, have been devised, in which the quenching frequency is supplied by grid-leak howl. The resistance of the leak in an autodyne regenerative receiver is made of such a value that the accumulation of negative potential on the grid of the valve periodically stops the valve oscillating, the frequency of this intermittent stopping and starting being controlled by the use of a variable grid-leak. British Patent Specification No. 192,090 (Westinghouse Co. and J. Slepian) points out a defect which ordinarily attends the working of such circuits, and describes an arrangement intended to overcome the defect. The trouble lies in the fact that the negative D.C. potential that accumulates on the grid of a valve using the usual condenser and leak can never exceed, or even reach, the peak value of the impressed signal voltage, and the quenching cannot take place until the oscillations have built up to a value determined by the limits of the valve's characteristic. The chief object of the invention is to cause the incoming signals to put a greater negative D.C. potential on the grid than the peak values of the alternating grid potentials themselves. Fig. 1 shows one way of attaining this end. The grid condenser and variable leak are placed at L and M, instead of the usual position immediately next to the grid. The plate circuit C, D is coupled not only to the grid coil F, but to an auxiliary coil E, which is in series with a two-electrode valve J, as shown. It is stated that the arrangement allows the quenching due to the negative blocking potential to take place before the oscillations have built up to a maximum. The necessary blocking potential is smaller for weak signals than for strong ones, so that a more or less proportional amplification is obtained. Instead of using a two-electrode valve, a two-grid valve may be used instead of H, the connection which otherwise would have gone to the plate of the two-electrode valve going to the extra grid.

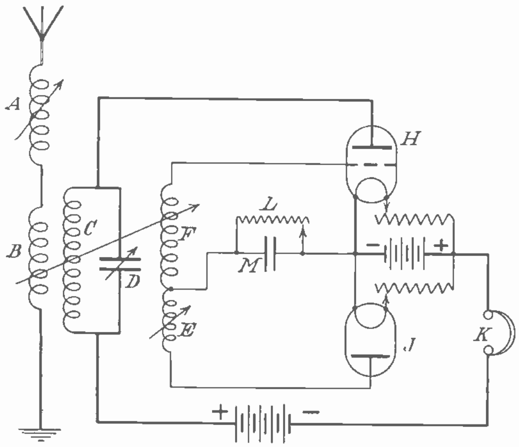


Fig. 1—A super-regenerative circuit.

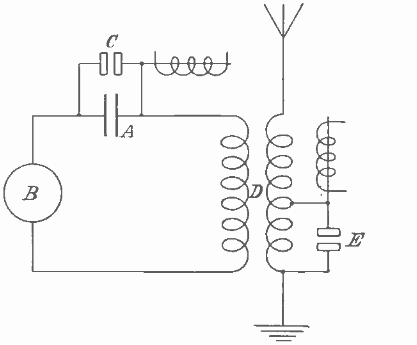


Fig. 2.—A keying system delivering greater power to the dots

Morse Keying.

One of the difficulties experienced in keying long-wave high-power transmitters using aerials with low-damping is that the full amplitude of oscillation in the aerial is not established immediately, but may take an appreciable fraction of a second to grow. Thus, with fairly high speed sending the dots may be lost or become indistinct. One solution of this difficulty that has been sug-

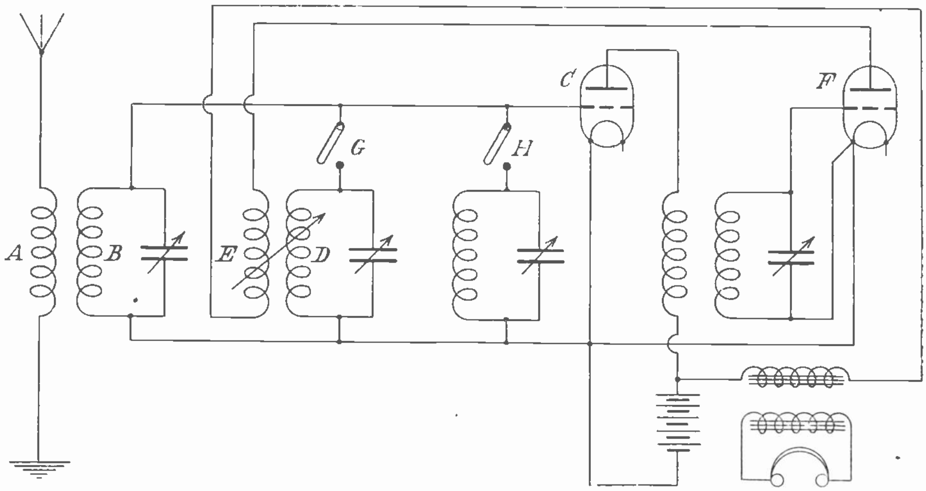


Fig. 3.—The fundamental principle of the Hinton rejector system.

gested is to use more power on the dots than on the dashes.

Fig. 2 illustrates a scheme for delivering greater average power into an aerial during the dots than the dashes (Société Française Radio-Electric).

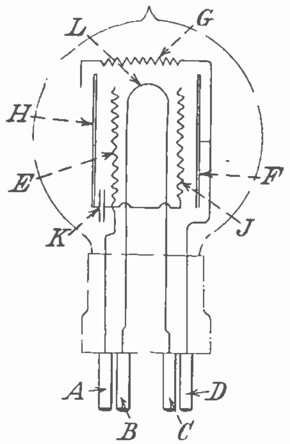


Fig. 4.—A "resistance capacity coupled" valve.

C and E are contacts capable of being simultaneously opened and closed. When the contacts are open a certain power will be delivered from the generator B to the aerial through the H.F. transformer D. When the contacts are closed the condenser A in the closed circuit is short-circuited, and a few turns of the aerial inductance are short-circuited, and by correctly adjusting the number of turns shorted the whole system may be maintained in resonance, but delivering greater power to the aerial. If, then, it is arranged that the contacts C and E are closed during dots and open during dashes, a greater average power is transmitted during the dots. The specification describes other means for producing the same effect by iron-cored windings supplied with independent saturation-control fields.

The Hinton Rejector.

The use of parallel-tuned rejector circuits to by-pass or cut out all but unwanted signals is as old as wireless itself. In order that such a circuit shall be very sharply selective, however, it is necessary to use a large capacity and small inductance, and the H.F. resistance of the circuit should be as nearly as possible zero. Unfortunately, such a circuit is not easy to construct, but the necessary effect can be obtained in some degree by using a rejector circuit whose damping at the resonant frequency is neutralised by the use of regenerative reaction coupling from a three-electrode valve. This is the principle underlying the Hinton rejector (British Patent 209,455, N. P. Hinton), an elementary form of which is illustrated in Fig. 3. A, B, C, and F are components of a normal type of two-valve receiver employing one stage of transformer-coupled H.F. amplification. D is an additional tuned circuit which can be connected in shunt with B by closing the switch G. By means of the coil E reaction coupling is established between D and the plate circuit of the last valve F, this coupling being arranged to bring the circuit D nearly to the point of oscillation. Under these conditions circuit D rejects sharply at the frequency to which it is tuned. It should be noted that there is no magnetic coupling between D and B. A second rejector circuit may be brought into play by closing the switch H.

The specification referred to describes various modifications in which the principle is applied to audio-frequency tuning as well as radio frequencies. It is not quite clear, however, where the fundamental difference lies between the Hinton rejector and the ordinary regenerative receiver where the resonance is sharpened up by the use of reaction on one or more tuned circuits. Surely would not the circuit in Fig. 3 work just as well if we removed circuit B, and tuned in straight away on D? In this case we should have a circuit commonly used ever since the invention of the hard valve.

A Novel Idea in Amplifying Valves.

The valve illustrated in Fig. 4 really consists of two resistance-capacity coupled valves, complete with coupling resistance and condenser in one bulb. Only four pins are necessary. It would be interesting to know how such a valve functions as an H.F. amplifier. (British Patent 209,775, E. K. Hunter).

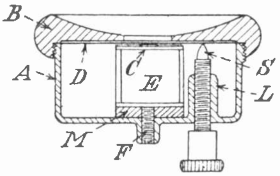


Fig. 5.—Showing how the telephone is adjusted.

Telephone Receivers.

Fig. 5 shows a method of adjusting the clearance between the diaphragm and pole-pieces of a telephone receiver. The diaphragm seating and pole-pieces are so ground that the diaphragm normally lies flush against the pole-pieces. The thumbscrew is tipped with ivory or some similar elastic material and it is turned until it just urges the diaphragm from the pole-pieces. It is claimed that this gives a nice adjustment of clearance and improves the quality of reproduced speech. In spite of its extreme simplicity the idea strikes us as a particularly useful one. (British Patent 201,212, A. C. Brown.)

Correspondence.

Letters of interest to experimenters are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—The article on "Transatlantic Telephony" in the current issue of EXPERIMENTAL WIRELESS is one which is very valuable to the experimenter, and personally I appreciate the large amount of practical detail supplied. There are, however, one or two points of theory on which I venture to disagree.

The author says that 1 ampere aerial current 80 per cent. modulated is better than 2 amperes 35 per cent. modulated. It can be shown that the useful effect in the receiver is proportional to the product of the aerial current and the modulated amplitude. The relative effects produced in these two cases, therefore, are 0·8 and 1·4 respectively, *i.e.*, the former is little more than half as good as the latter, and, further, in a less carefully designed transmitter than the one described would be considerably more liable to distortion.

With reference to item five on the list of transmitter requirements, the following sentence occurs: "Sharpness of tuning of the modulated output is a matter of efficient transmission, *i.e.*, utmost concentration of the available energy into a definite operating waveband of least possible width . . . and lies in the correct design of the antenna system . . . ." etc. As the band of frequencies, and consequently wavelengths, constituting a modulated carrier wave is equal to exactly double the modulation frequency, and hence is determined solely by the pitch of the highest note which occurs in speech or music, I have difficulty in seeing what effect the antenna system has.

It is stated that the aerial ammeter is inductively coupled because of the resistance introduced by connecting it direct. The same amount of power is absorbed by the meter in giving a reading however it is connected, but in the inductive method the loss is not less, but greater, due to the added loss in the coupling coils, and, further, the meter must be recalibrated, the readings being now uncertain and varying with the coupling.

A choke, L7, is shown in order to prevent H.F. currents taking a path along the L.T.— lead, but no choke is shown in the L.T. +H.T.— lead, so that any H.F. currents stopped along the former will have no difficulty in making their way to earth *via* the latter.

In Fig. 3 a variable resistance is shown in shunt with the H.T. output. If a resistance is required here at all it would surely be in series, as usually a voltmeter takes enough current from such a supply without wishing to increase it by a shunt.

In describing the speech choke, the inductance is given as 12 microhenries. This is obviously meant to be henries.

—Yours faithfully,

MARCUS G. SCROGGIE.

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—In this month's issue, in an article entitled "Transatlantic Radio Telephony," the writer states that on January 20 last, "two-way transatlantic telephony" was successfully established for the first time in history.

A keen "DX" experimenter myself, and particularly in the direction of transatlantic working, I should be glad if the author of the article in question will be good enough to make known through your journal the following points :—

1. The station in America with which the British Station worked "two-way telephony," giving address and call signs of both stations.

2. The type of receivers used at the respective stations.

3. The wave-lengths used, and the powers employed by the U.S.A. station.

The reason I am anxious to ascertain the above details is that I am in constant communication with the headquarters of the A.R.R.L., who are not at present aware of this achievement, and would welcome any particulars relating to such a performance, as would, no doubt, many of your readers.

—Yours faithfully,

J. A. PARTRIDGE (G.2KF).

The Efficiency of the Propagation of Short Waves.

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—It appears to be a matter of wonderment that some workers on short waves are able to cover with apparent ease distances, to cover which high-powered stations, with all their attendant complicated apparatus are employed using very long wave-lengths.

In trying to obtain a clear understanding of any complicated subject it is of great assistance to find, if possible, an analogy in some common object which will, by its familiarity, appeal with ease to the mental faculties, and in comparing the propagation of short and long waves the following analogy may materially help one to appreciate the action of a radio wave, and it might be imagined thereby that long-distance communication on short waves is not so dependent on power, but more on such factors as time and condition.

If we wish to drive a screw into a piece of wood there are certain factors to be taken into account which decide the necessary force to be employed to do the work. It is obvious that a screw having a very fine pitch—that is, where the threads are very close together—will require for a given diameter less power to drive it than one with a coarse thread —that is, where the threads are far apart. The "pitch" of a screw thread is the distance in a straight line parallel with the axis of the screw from the top of one thread to the top of the next thread. This corresponds to what is known as the wave-length of a radio wave, and it is measured in like manner. Given the same power applied in each case, the fine-pitched screw will be driven the required distance in less time than the coarse-pitched screw. We have, therefore, time factor being constant, a variation in power ; and, conversely, power factor being constant, a variation in time or rate of progression. But the power factor is partly proportionate to the pitch, so that time factor will also vary in like proportion and time becomes dependant on power.

Now apply this to radio waves. Let the pitch of the thread represent the wave-length and the depth of the thread the amplitude. The long wave has similar charactistics to the coarse-pitched screw—it takes more power to drive it than the short wave or fine-pitched screw, and its rate of progression is also less. If it were possible to measure with accuracy it might be found that the time occupied in transit through a given distance is greater for a long wave than a short one. But the speed of travel of radio waves is so great that variation in speeds need not be taken into consideration for purposes of communication. It would appear that impedance is an important factor, as in the case of a fine screw thread driven through a dense substance, where the resistance might be so great as to altogether deflect its direction or to so damage its delicate thread as to make it no longer a screw. It seems under good conditions —that is, where the intervening medium is a proper one—the transit of communications over great distances by short waves may actually be an advantage when one considers the very much greater distance in space covered by the passage of a long wave of great amplitude, the risk of atmospheric disturbances being thereby increased, but one must also assume that under bad conditions, where the impedance is considerable, and particularly where it is irregular, the delicate short waves may be so deflected or broken up as to become a negligible quantity.—I am, dear sir, yours faithfully,

"SHORT-WAVE."

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—In your March issue of EXPERIMENTAL WIRELESS the author of the article on "High-Frequency Resistance" has made one very serious mis-statement, which may lead other experimenters into difficulties. In the latter part of his article he mentions a method of measurement using a "Moullin" voltmeter (anode rectifier type), and he states that the voltmeter *can be calibrated on D.C.*

This is emphatically *not* the case, as the accompanying curves show, which were taken on my own instrument. As a matter of fact, this should be obvious on theoretical grounds, since the action of the voltmeter depends on the rectifying properties of a triode (*i.e.*, on the *rate of change* of slope of the characteristic curve of the triode), whereas if D.C. is applied between the grid and filament no rectification occurs and the anode current depends directly on the slope of the characteristic curve, which is different for different values of applied D.C.

I should be glad if you will draw the author's attention to this, as the errors involved are large (at 2 volts over 70 per cent. in the case of my own instrument).

The "Moullin" voltmeter is such a useful and convenient instrument that it would be a pity if experimenters were put off using it owing to incorrect instructions for its calibration.

Full instructions for calibrating are given in Mr. Moullin's paper before the I.E.E.—it is done on low-frequency A.C., *not* D.C.

I have used methods 2, 3 and 4 for measurement of H.F. resistance, with a "Moullin" voltmeter across the coil in place of a current-measuring device, such as a hot-wire ammeter or thermo-junction.—Yours faithfully,

DESMOND DE BURGH,
F/L., R.A.F.

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—I would like to suggest to the manufacturers of wireless apparatus that they might give a more scientific description of their apparatus than they do at present. I refer, in particular, to audio-frequency transformers. I see no reason why the impedance at a given frequency should not be published along with the ratio of transformation, instead of the present type of description, which is obviously the result of a more than fertile imagination.

In the case of the telephone receiver, it appears to be usual to give only the D.C. resistance, which is nothing more than a confession of ignorance of the conditions under which it operates.

There are no objections to the imaginative type of description, apart from the fact that it is valueless to experimenters, so why not give physical data at the same time and thus satisfy both the experimenter and broadcast listener.—Yours faithfully,

"5BG."

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—I should like to call your attention to a much-needed protection for wireless experimenters, owners of broadcast receivers, and all users of radio valves in the shape of some guarantee that the valves they buy have not been previously used on demonstration sets.

Under present conditions there is nothing whatever to prevent the unscrupulous use of a valve for any period, it being subsequently put back into stock and sold as new. The purchaser is shown that the filament is unbroken by the simple process of heating it to incandescence, and this is all the guarantee he gets. The fact that a considerable part of the life of the filament may be spent by reason of such unscrupulous use is entirely overlooked.

I would suggest that the desired protection be afforded by the manufacturers placing a seal, in the form of an adhesive strip, across the grid and anode legs of a valve. This would effectively prevent

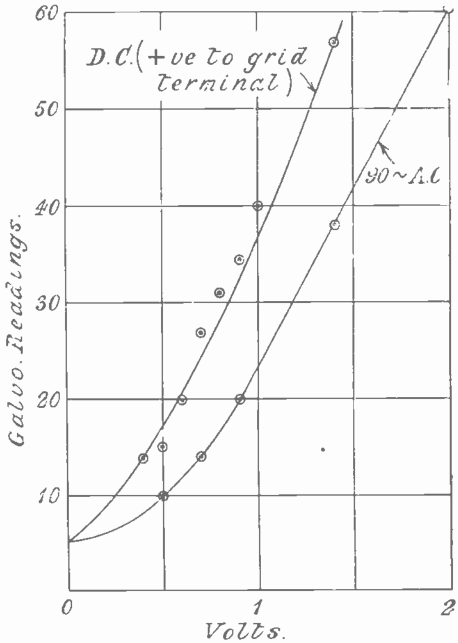


Fig. 1.—Calibration of Moulin voltmeter.

its use in a holder, and at the same time would not hamper the very necessary operation of testing the continuity of the filament.

Copies of this letter are being sent to the Radio Society of Great Britain, the principal technical magazines, and the various valve manufacturing companies.—Yours faithfully,

J. W. HADFIELD CRAVEN.

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—I thought that perhaps a short account of some receiving experiments carried out in a train might be of some interest.

A three-valve set (1-v-1) was used and a 14-foot aerial. 10 feet of wire being stretched in the corridor and the remaining 4 feet serving as a lead in. An earth was obtained on the steam heating pipes.

The experiments were carried out whilst travelling between Ipswich and London, between the hours of 12 and 3 p.m. Signals were first received in Ipswich station, the musical programme from Radiola being clearly audible. On entering the tunnel on the London side of Ipswich station all signals vanished although the receiver had a wavelength range of from 300 to 5,000 metres.

On leaving the tunnel Radiola was heard again and signals from Ongar were received with strength about R7; GFA was received with about the same strength.

Spark stations on 1,000 metres were received and telephony from Croydon aerodrome, also various C.W. stations.

Observations were then made of the variations in strength of the signals from Ongar.

It was noticed that when passing under a brick arch fading occurred. The fading started a few feet before the arch was reached and continued for a few feet on the other side of the arch, the signals being a minimum under the centre of the arch.

A signal-box on the N. side of the line caused considerable fading, but the most noticeable decrease in signal strength occurred when passing under a metal signal gantry, the C.W. practically vanishing when directly under a gantry and fading being noticed at least 10 feet on either side of the structure. A curious point noticed was that the large Bryant and May's building just north and close to the line caused no appreciable fading.

It was thought possible that some fading would be caused by the various structures slightly altering the aerial tuning and so cause variations in signal strength. This, however, was not found to be the case, the C.W. beat note remaining quite constant.

More fading, and perhaps variations in the beat note, would probably have been noticed had a station with a shorter wave-length been observed, but no continuous short wave signals were available.

Hoping that this account may prove of interest to some of your readers.—Yours faithfully,

R. E. GRAY.

Points from Letters.

Mr. A. L. Williams, of Kensington, writes to us as follows: "On the morning of February 20 I was testing a tuner I had just completed for short waves and observed the following interesting phenomena. I was receiving KDKA as a dist nt station of known wave-length with 'untuned' aerial. Leaving the set on, I disconnected the aerial to try the effect of another turn in aerial coil, and found that KDKA still came in at almost same strength. I then disconnected earth lead and managed to receive this station clearly on the loud speaker (having burned out my phones) on detector and 2 L.F. on a coil 4″ diam.!

"On looking further into this, I found that I was not truly working without an aerial, because when the end of the aerial (which hung down six feet away) was 'earthed,' nothing but a faint 'carrier' could be heard. This effect is only noticeable below 120 metres.

"Touching aerial terminal of tuner, aerial wire, or altering distance of aerial wire from tuner seemed to have no effect, though it is not possible to remove the wire more than six feet, due to size of room.

"Reception that morning was good, four other American broadcasting stations being clearly audible on loud speaker."

No doubt other readers have experienced similar effects. It would be impossible to say exactly how the receiver was energised without full details of the apparatus and aerial system. What actually happens, of course, is that the received energy is passed on from the aerial to the set, probably by a combined inductive and capacitative effect. It is well to remember that at frequencies of the order of 3,000 kilocycles, conditions are very different from those obtaining on wave-lengths normally used for commercial work, particularly where capacities are concerned.

Wireless Spoil Sports.

[We particularly draw the attention of our readers to the following letters relating to interference with broadcasting. They serve to indicate once more the feeling which is prevalent amongst many broadcast listeners.]

To the Editor of the "Southern Daily Echo."

SIR,—Hundreds of listeners-in of wireless programmes in Southampton and district must have been annoyed beyond endurance last night by a would-be transmitter of Morse code, who kept up a terrible din by repeating the same two letters with a "buzzer" for at least an hour. The noise was so intense in this district that on a three-valve set working a loud speaker it could be heard distinctly several rooms away, and came in at about the same volume as the Savoy bands on the Bournemouth wave-length. This must be either the work of an amateur at close quarters, or, if broadcast all over the town, must be from a very powerful set. If the owner is so ignorant of the rudiments of wireless that he is unaware of spoiling other people's reception for miles around, then he is obviously unfit to hold a transmitting licence, if he has one. Cat-calls owing to oscillation have been very common of late, and have been generally regarded as the result of carelessness, but this last effort seems to prove the existence of the kind of "fiend" who delights in spoiling other people's pleasures out of pure mischief. If those who were affected last night will kindly drop me a P.C. stating the intensity with which they received the signals as compared with the Bournemouth Station's output, it will be possible at least to localise the offender, and, having done this, will allow the

B.B.C. to deal with him as they think fit.—Yours faithfully,

(Signed) D. S. Baker.

"West Brook," Millbrook Road.

February 6, 1924.

Dear Sir,—I note your correspondent, Mr. Baker, has been disturbed by some powerful station sending the same two letters with a "buzzer" for at least an hour, and that he wishes to locate the offender with a view to his being reported to the B.B.C. Well, Sir, the "buzzer" is a high-power transmitter of probably 125 kw. (some "buzzer"), and the offender an Admiralty Station. In some cases other such stations create the same so-called terrible din. They did so before broadcasting became a hobby. Probably this will save many P.C.'s.—Yours faithfully,

(Signed) Albert Parsons.

65, Cromwell Road, Winchester.

February 7, 1924.

Sir,—*Re* the letter in last night's *Echo*, may I be allowed to enlighten the author on a few points?

1. The "buzzer" was C.W. from a powerful station.
2. The two letters were P.1.
3. The Morse did not emanate from a local amateur transmitter, as they are forbidden to send during broadcasting hours.
4. The signals were received with great volume all over the town.
5. The same station was working yesterday evening (Wednesday), sending P.1, changing to P.2, and then a jumble of letters and figures, finishing with A.R. (end of message). No call sign given.
6. The signals were heard on every wave-length of the B.B.C.
7. When B.B.C. closed down signals ceased, and could only be received by making receiving set oscillate.

Trusting this will clear the air somewhat for Mr. Baker's inquiries.—Yours faithfully,

"6JW."

Sir,—Will you permit me to thank the numerous users of wireless who sent me their experiences yesterday. Dozens of letters arrived from all parts of the town and suburbs—Totton, Hamble, Westend, etc.—all giving practically the same account, that they had to close down on Tuesday night after 10 o'clock, and on Wednesday in the "Children's Hour" and after 10 o'clock again. It seems pretty evident, therefore, that the trouble came from outside the town on the high-power set.

Your correspondent, Mr. Parsons, of Winchester, judging by the tone of his letter, is either a transmitter or has some technical knowledge of these matters, and seems to be uncannily certain of his own deductions. He seems to have overlooked enlightening us as to the main factor in the situation, however, *viz.*, why, if the signals came from an Admiralty Station, no call sign was used, and under what conceivable circumstances an Admiralty Station would send out a repetition of P.1's for hours at a stretch.

However, having focussed attention on this matter, the full weight of the evidence has been transmitted to Bournemouth for the B.B.C.'s perusal, together with the suggestion that some unauthorised person may have gained access to a high-powered set between hours. They will, no doubt, take such action as they think fit to prevent a repetition of the nuisance, if they have not already done so, as I note there was no interference yesterday.

Thanking you for your valuable help in this matter.—Yours faithfully,

(Signed) D. S. Baker.

"West Brook," Millbrook Road.

Sir,—May I again beg space to enlighten numerous amateurs with regard to the interference they have had to contend with within the last few days.

It is the custom of high-power stations to measure "field strength," etc., at certain periods with a view to gaining further knowledge of the behaviour of waves radiated, absorption factors, harmonic phenomena and the like. This, of course, needs more than one station, the chief of which is the transmitter. It may be also that a new type of transmitter required testing. This necessitates the station sending for a given period. For different wave-lengths and powers different symbols are used, the one we have heard being P.1 (P one).

This symbol was sent out by a station which did give a call sign, namely, "BYC," hence "BYC" has been experimenting again, and we, through being in close proximity to such a high-powered station, have been the victims of harmonic interference. As an experimenter I find great pleasure in trying to devise some means whereby these harmonic effects may be eliminated during such tests as we have just experienced.

Who knows but what these experiments were being carried out for the benefit of amateurs in the future?—Yours, etc.,

(Signed) Albert Parsons.

65, Cromwell Road, Winchester.

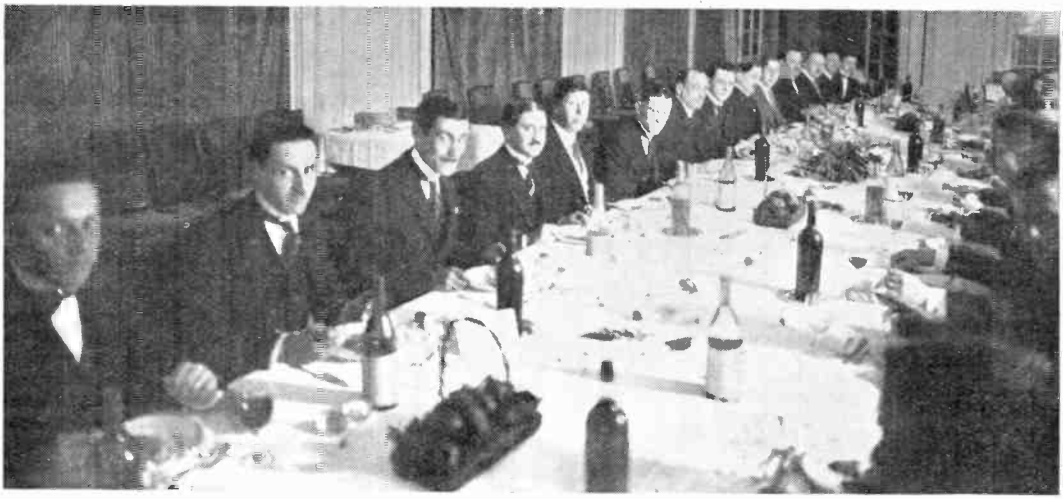
February 9, 1924.

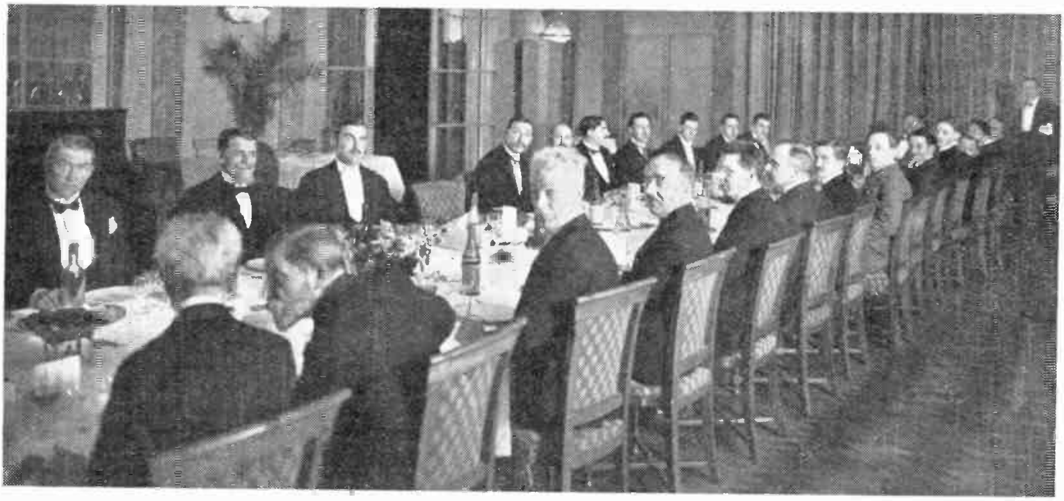
Sir,—The thanks of all wireless enthusiasts are due to Mr. Baker for focussing and consolidating attention in the proper quarter to the recent disturbances. It is only by prompt and energetic action that this sort of thing can ever be eradicated and wireless made enjoyably possible. If an Admiralty station was at the bottom of the trouble, as per Mr. Carter's suggestion, the B.B.C. will no doubt arrange with them in future to try new apparatus at some other time than during the few hours that thousands, probably millions, of people are enjoying a harmless amusement.—Yours, etc.,

R. M.

Bassett.

February 11, 1924.





The visit to France of Mr. Percy Hiram Maxim, President of the American Radio Relay League, resulted in the formation of an International Amateur Radio Association. Several important meetings and dinners were held, at which many well-known British and Continental amateurs and several radio engineers were present. In the upper photo British 2NM, 2KW, and 2SH will be recognised by many readers, while in the lower photo Mr. Maxim is sitting third from the left in the foreground and General Ferrié will be noticed second from the left facing camera.

Business Brevities.

A Combined Frame Aerial and Mast.

We have just received from the Abbey Engineering Works of Watton, Norfolk, some details of their new frame aerial, which is so constructed as to enable it to be fixed to a mast. It is, of course, capable of being rotated so as to point in any direction, and can, therefore, be used for directional work. The mast can be supplied alone for indoor use, for fixing to existing masts, or complete with a mast of any desired length. The idea appeals to us as being of particular value to those who are unable to employ a long aerial. The frame can be used, of course, as a closed loop, or when used on the top of a mast chiefly as a capacity. When used on a short chimney mast it should be particularly free from screening effects, although the

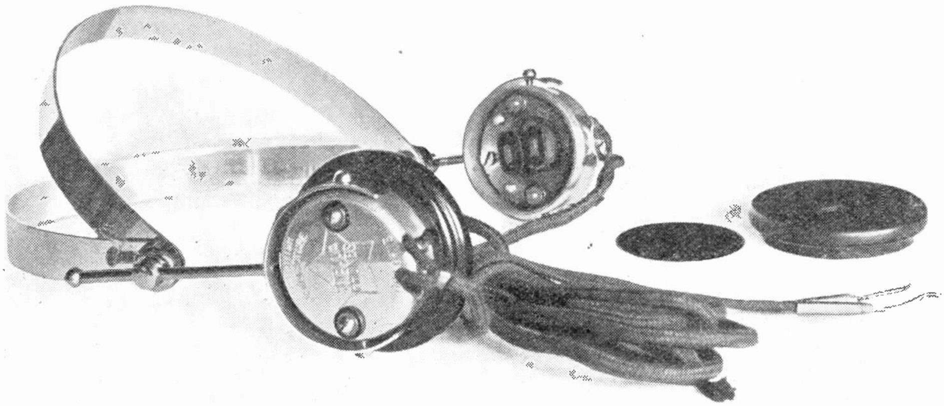


Fig. 1.—Illustrating the construction of the Stella Phones.

mast and leads would introduce a local error in bearings if employed for accurate D.F. work. The frame is supplied at 40s. ready for fixing to an existing mast, or for indoor use. We hope to be able to report on some actual tests very shortly.

* * *

STELLA PHONES.

Telephone receivers are already counted by their dozens, and the "Stella Phones" are the latest arrival amongst the ever-swelling ranks. Their most attractive feature is the extremely moderate retail price of 17s. 6d., and this at first made us rather sceptical of their quality and performance. However. as far as we can remember, we have not tested a better instrument at the price. It would be unfair, of course, to compare them with the high-priced phones which the experimenter is accustomed to use, but on test they were found electrically to come very near to our standard, both quality and volume of speech being good. The appearance can be gathered from the accompanying photograph, in which the head-band and method of mounting may be seen, which results in comfort, even if worn for long periods. The magnetic system is similar to that employed in the well-known low resistance "watch" receivers.

* * *

THE H.C.W. TRANSFORMER.

We have always been rather prone to doubt the efficiency of a low priced intervalve transformer, but the H.C.W. has caused us to modify our views somewhat, as it is certainly an exception to the rule. The H.C.W. transformer which has been placed on the market by S. T. Hosken, of 153, Fleet Street, London, E.C., is of the shell type having a core of soft annealed iron wire. This is enclosed in a steel tube which is closed at one end with a brass plate and at the other by an ebonite terminal board. The general appearance can be gathered from the accompanying illustration. The ratio of the windings is 1 to 5, there being 5,000 turns on the primary. The performance is remarkably good. It was first tested as a first stage amplifier on broadcasting and far greater amplification was obtained than expected, without any appreciable distortion. The transformer was then placed in a power stage and showed no sign of saturation, the quality and degree of amplification being as good as before. As a general purpose transformer we can thoroughly recommend it to our readers who should find it

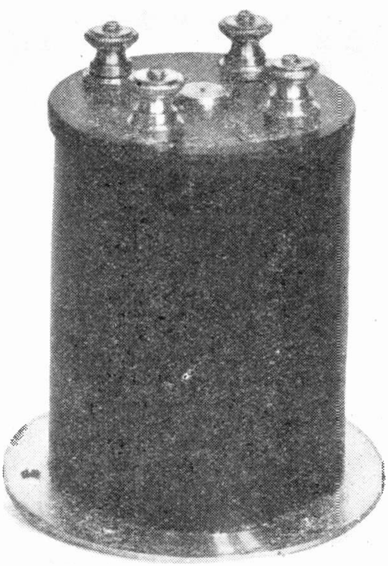


Fig. 2.—The H.C.W. Transformer.

extremely good value, especially in view of the moderate price of 15s. 6d.

* * *

St. Ivel Crystal.

It is quite a relief to find a crystal of the galena variety which is not another "ite." The British General Radio Co., Ltd., of 74, Hindford, Yeovil, have sent us a specimen of their St. Ivel crystal which, it is claimed, possesses the unique feature of being washable. When first tested we found it quite sensitive, not in one place only, but practically all over. We were also interested to note that it was not particularly susceptible to pressure. We next examined the effect of washing. A definite amount of energy was introduced into a tuned circuit, and the crystal was connected across the circuit and the rectified current measured. The crystal was then removed, made thoroughly dusty and dirty, washed, dried, and replaced. The amount of rectified current was found to be unaltered, and when subsequently tested on broadcast signals, was found to be quite satisfactory. A specimen of the crystal is sent post free for 1s. 9d.

A Condenser Brush.—Messrs. Goswell Engineering Co., Ltd., have produced a combined panel and condenser brush which consists essentially of a small brush and a pipe cleaner in the form of a loop fixed to the handle. The device should be of great use to those who allow their condensers to become dusty, and should also prove of general utility. The address of the manufacturers is 12a, Pentonville Road, London, N.1.

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The Eagle Engineering Co., Ltd.

We have received a new catalogue from the Eagle Engineering Co., Ltd., and in addition to several broadcast receivers we note a large variety of useful components which should make the list of value to our readers.

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The Library Press.

We have been asked to announce that the Library Press have just moved into larger premises, the new address being 83, Southwark Street, London, S.E.1.

Experimental Notes and News.

The Radio Society of Great Britain and the Radio Transmitters' Society.

On Tuesday, February 26, at the Headquarters of the R.S.G.B., at 53, Victoria Street, London, S.W., a joint meeting between members of the Committees of the Radio Transmitters' Society and of the Transmitting and Relay Section of the R.S.G.B. was held. This meeting arose out of the resolution recently passed by the members of the Radio Transmitters' Society in general meeting, when the principle of amalgamation with the Transmitting and Relay Section was approved. The business done at the meeting was of a preliminary nature, the main object being to settle the officers and devise the machinery for the carrying on jointly of the work which hitherto had been done by the two bodies.

On the proposition of Dr. W. H. Eccles Captain Ian Fraser was appointed chairman of the Amalgamated Committee, and Mr. Gerald Marcuse was appointed honorary secretary. Mr. W. Corsham and Mr. D. K. Alford accepted the office of joint traffic managers, and were asked to prepare a scheme for consideration at the next Committee meeting to be held on Tuesday, March 11, for the carrying on and development of transmission tests, calibration signals, etc. It was agreed that the Committee should continue the series of successful lectures which under the auspices of the Radio Transmitters' Society had been regularly held, and the Secretary was asked to book a room at the Institute of Electrical Engineers for March 14 and 28, and April 25. It is not possible to announce in time for publication the names of the lecturers on these occasions, but notices will be served upon the members in due course.

As regards finance, it was reported that the Radio Transmitters' Society had a substantial balance to hand over for the use of the new Committee, and a sub-committee, consisting of Messrs. Maurice Child, E. J. Simmonds and H. S. Walker (honorary treasurer of the R.T.S.) was appointed to advise the Committee as to the best method of adjusting all outstanding matters relating to subscriptions, etc.

General satisfaction was expressed at the prospect of future harmonious working under the auspices of the R.S.G.B., and the Committee were confident that, after a brief delay to allow all matters under negotiation to be properly settled, the new and enlarged Transmitting and Relay Section of the R.S.G.B. would be able to offer its members more adequate facilities and stronger representation than had hitherto been available.

Manchester and District Radio Transmitters' Society.

The inaugural meeting of the above Society was recently held at the Grand Hotel, Aytoun Street, Manchester. There was an attendance of twenty-five.

After Mr. W. C. Barraclough (5AJ) had been elected to the chair, a few remarks were made by Mr. W. R. Burne (2KW), and correspondence read relating to the formation of the Society. Finally, it was decided unanimously that the Society be formed. Between fifteen and twenty gentlemen were unable to attend the meeting, but expressed their willingness to join the Society.

This gives a membership of nearly fifty, and it is hoped that all who hold transmitting permits will avail themselves of this unique opportunity afforded them for forming one strong Society for transmitting amateurs in the Manchester district.

The following officers were appointed :—Hon. secretary, Mr. W. R. Burne (2KW) ; assistant hon.

secretary, Mr. A. Rainford (6IK); while the duties of the hon. treasurer and chairman were entrusted to the able care of Mr. W. C. Barraclough (5AJ).

The following gentlemen were asked to serve on a temporary committee :—Messrs. Stevenson (5IK), Cross (2RN), Davies (2PC), Sparrow (2TR), Cash (2GW), Chadwick (2WT), Bailey (2UF), Cropper (6XY) and Bolt (6BB).

The Hon. Secretary will be pleased to hear from all who, possessing transmitting permits, would care to join the Society, if they would write to "Springfield," Thorold Grove, Sale. The Committee would especially welcome, at the next extraordinary general meeting, which commences at 7.30 p.m. prompt, on Tuesday, March 11, 1924, at the Grand Hotel, Aytoun Street, Piccadilly, Manchester, any newcomers.

It is intended to hold the meetings about once a month, when speakers of special interest to holders of transmitting permits will be asked to deliver lectures on subjects dear to the hearts of the transmitting amateur.

Board of Radio and Scientific Research.

A new body has been formed, to be known as the "Board of Radio and Scientific Research."

The objects of this body are to carry out deep and serious investigations into problems of a radio and scientific nature, and to provide such societies as desire to avail themselves with the results of these investigations in the form of papers, lectures, etc., free of charge.

Notice will be given in the Radio Press in due course when such offer is ready, and those interested should write to the Hon. Secretary, "Kitray," 132, Handcroft Road, W. Croydon, Surrey.

Experiments have recently been carried out on the Great Western Railway to demonstrate the feasibility of the reception of broadcasting on a train travelling at 80 miles per hour. A double wire indoor aerial laid along the roof of a corridor coach was used. It is understood that the success of the experiment will probably lead to the regular adoption of reception equipment on long-distance trains, passengers being able to use the 'phones on payment of a small charge.

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The German Government has under consideration a proposal to assume the monopoly of the wireless industry, both as regards the manufacture of receiving apparatus and the operation of broadcasting stations.

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Senatore Marconi is reported to have made considerable progress in his experiment on directional wireless transmission. He stated in a recent interview that he had already succeeded in sending messages on a "beam" over a distance of 2,000 miles.

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The White Star liner *Olympic* has been fitted with an apparatus which has enabled messages to be sent automatically at 90 words a minute from the ship 700 miles from land to Devizes, and thence to the G.P.O., London, where they were printed in ordinary roman letters. This is the first time that such transmission has been employed for sending messages from ship to shore.

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Mr. Dan Godfrey, lecturing recently, at Sheffield, on the broadcasting of music, stated that the great difficulty in transmitting drum music had been overcome by standing the drums on raw rubber. To get effective results with a choral society of about seventy performers, it was necessary for them to stand with their backs towards the microphone, and the voices then rebounded off the walls into the microphone, so minimising the vibrations.

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The following call signs have been adopted for the new relay stations :—Edinburgh, 2EH; Hull, 2HU; Leeds, 2LS; Liverpool, 6LV; Plymouth, 5PY.

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The first broadcasting station in Australia has been erected in Sydney by Messrs. Farmer & Co., and a service comprising music, vocal items, news, lectures and theatrical performances is already in operation. The Government issue licences to broadcasting companies, who must deposit £1,000 as a surety that they will continue to operate for five years; the company is then allotted a definite wave-length. Intending listeners-in must take out a Government licence at the cost of 10s., and also subscribe to any company whose programme they desire to receive. The receiving sets will be sealed, so that no wave-length can be tuned in except that of the company to which the subscription has been paid. Genuine experimenters, how ever, are permitted to use unsealed sets. Messrs. Farmer have obtained the first licence, and operated on a wave-length of 1,100 metres. The station is situated eight miles from Sydney, at Willoughby, and is known as 2FC.

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Mr. Nikola Tesla, well known in connection with high-frequency electrical research, is reported as claiming a new discovery of a system of electrical power transmission through the earth. He states that loss in transmission to the greatest terrestrial distance, say 12,000 miles, will not amount to more than a quarter of one per cent., as against 20 per cent. loss in normal transmission through cables.

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The opening of Plymouth Broadcasting Station, 5PY, was fixed for March 28, so it is doubtless in full operation by the time these notes appear.

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Trouble has been caused in South Wales by radio aerials falling across overhead electricity distributing lines. In one instance an aerial in course of erection was allowed to fall across a 400-volt overhead power line, but fortunately the safety device in the local sub-station operated and the line was made "dead," otherwise the erectors would have received a severe shock.

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The Pope is one of the latest converts to the benefits of wireless. A receiving installation has just been installed at the Vatican.

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Seven high-powered wireless stations are to be erected in the West Indies on the islands of St. Kitts, Antigua, Dominica, St. Lucia, St. Vincent, Grenada and Barbados, the crescent-shaped archipelago which flanks the Caribbean.

Recent Wireless Publications.

Figures after the title of each publication indicate Volume and Number of Publication containing the article. Where only one number is given, this indicates the serial number of the publication.

ABBREVIATIONS OF TITLES OF JOURNALS USED IN THE BIBLIOGRAPHY.

Amer. Acad.—American Academy of Arts and Sciences.
Am.I.E.E. J.—Journal of American Institute of Electrical Engineers.
Ann. d. Physik—Annalen der Physik.
Boll. Radiotel.—Bolletino Radiotelegraphico.
Elec. J.—Electric Journal.
El. Rev.—Electrical Review.
El. Times.—Electrical Times.
El. World.—Electrical World.
Electn.—Electrician.
Frank. Inst. J.—Journal of the Franklin Institute.
Gen. El. Rev.—General Electric Review.
Inst. El. Eng. J.—Journal of the Institute of Electrical Engineers.
Inst. Rad. Eng. Proc.—Proceedings of the Institute of Radio Engineers.
Jahrb. d. drahtl. Tel.—Jahrbuch der drahtlosen Teleg, etc.
Mod. W.—Modern Wireless.
Nature—Nature.
Onde El.—L'Onde Electrique.
Phil. Mag.—Philosophical Magazine.
Phil. Trans.—Philosophical Transactions.
Phys. Rev.—Physical Review.
Phys. Soc. J.—Journal of Physical Society of London.
Q.S.T.—Q.S.T.
R. Elec.—Radio Electricité.
Roy. Soc. Proc.—Proceedings of the Royal Society.
Sci. Abs.—Science Abstracts.
T.S.F.—Telegraphic sans fils, Revue Mensuelle.
Teleg. without Wires, Russia—Telegraphy without Wire, Nijni Novgorod.
W. Age—Wireless Age.
W. Trader—Wireless Trader.
W. World—Wireless World and Radio Review.

I.—TRANSMISSION.

ANTENNA SERIES CONDENSERS, GOOD AND BAD.—S. Kruse (*Q.S.T.*, 7, 8).

SOME GOOD LEAD-IN INSULATORS.—S. Kruse (*Q.S.T.*, 7, 8).

LA MODULATION EN TÉLÉPHONIE SANS FIL AVEC DES MODULATEURS MAGNETIQUES.—Marius Latour (*R. Elec.* 5, 54).

TRANSATLANTIC RADIO - TELEPHONY.—Capt. St. Clair-Finlay, B.Sc. (*Exp. W.*, 1, 6).

II.—RECEPTION.

RADIO FREQUENCY AMPLIFICATION.—Stuart Ballantine (*Q.S.T.*, 7, 8).

HOMODYNE.—F. M. Colebrook, B.Sc. (*W. World*, 236).

ALIMENTATION DES RÉCEPTEURS RADIOPHONIQUES PAR LE COURANT ALTERNATIF DU SECTEUR.—I. Podliasky (*R. Elec.* 5, 54).

LE MEILLEUR RÉCEPTEUR POUR TOUTES LONGEURS D'ONDE (80 À 25,000 MÈTRES).—J. Reyt (*R. Elec.* 5, 54).

HOWLING IN RESISTANCE AMPLIFIERS.—F. M. Colebrook, B.Sc. (*Exp. W.*, 1, 6).

THE TELEPHONE RECEIVER AND ITS APPLICATION TO WIRELESS RECEIVING CIRCUITS.—Alexander J. Gayes (*Exp. W.*, 1, 6).

THE MANUFACTURE OF HIGH RESISTANCES FOR WIRELESS RECEIVING CIRCUITS (*Exp. W.*, 1, 6).

THE REFLEX.—(*Exp. W.*, 1, 6.)

III.—MEASUREMENT AND CALIBRATION.

A METHOD FOR ACCURATE FREQUENCY CALIBRATION.—N. V. Kipping (*W. World*, 236).

THE MEASUREMENT OF LOW-FREQUENCY AMPLIFICATION.—R. L. Smith-Rose, Ph.D. (*W. World*, 238 and 239).

HIGH - FREQUENCY RESISTANCE.—H. Andrewes, B.Sc. (*Exp. W.*, 1, 6).

IV.—THEORY AND CALCULATIONS.

FORMULES APPLICABLES AU CALCUL DE L'INFLUENCE DE LA NATURE DU SOL ET DE L'ANGLE D'INCIDENCE DES ONDES ELECTROMAGNÉTIQUES SUR LE FONCTIONNEMENT DES ANTENNES ET DES CADRES DE RÉCEPTION.—Léon Bouthillon (*R. Elec.* 5, 54).

V.—GENERAL.

ON COMPARING VALVES.—P. K. Turner (*W. Trader*, 2, 13).

HOW ANTENNÆ WORK.—John L. Reinartz (*Q.S.T.*, 7, 8).

THE OPERATION OF CLOSE COUPLED TRANSFORMERS.—W. P. Powers (*R. News*, 5, 9).

A.C. MAINS FOR FILAMENT HEATING AND PLATE CURRENT.—E. H. Turle (*W. World*, 236).

THE SELECTION OF TAPPING POINTS IN INDUCTANCE COILS.—A. H. Burnand (*W. World*, 236).

AN IMPROVEMENT IN FRAME AERIAL CONNECTIONS.—W. B. Medlam and A. O. Schwald, B.Sc. (*W. World*, 237).

ANOTHER USE OF THE NEON LAMP.—J. F. Payne (*W. World*, 237).

A PRACTICAL DEMONSTRATION OF SOME APPLICATIONS OF THE CATHODE RAY OSCILLOGRAPH.—N. V. Kipping (*W. World*, 238).

THE TESTING OF L.F. TRANSFORMER WINDINGS.—F. L. Devereux, B.Sc. (*W. World*, 239).

FILAMENT CURRENT FROM THE MAINS.—(*W. World*, 239.)

TELEVISION.—Nicholas Langer (*W. World*, 240).

UNE APPLICATION INDUSTRIELLE DE LA HAUTE FREQUENCE : LES FOURS ELECTRIQUES.—P. Dastouet (*R. Elec.*, 5, 54).

WIRELESS FOR POLICE WORK.—(*Electn.*, 2391.)

DIRECTION-FINDING.—Cmdr. J. A. Slee (*Electn.*, 2391).

DIRECTIVE RADIO-TELEGRAPHY AND TELEPHONY.—R. L. Smith-Rose, Ph.D. (*Exp. W.*, 1, 6).

THE SELF-CAPACITY OF COILS.—J. H. Reyner, B.Sc. (*Exp. W.*, 1, 6).