The WIRELESS WORLD

FORTNIGHTLY] JULY 9th, 1921. PRICE 6D. NET

THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. IX. No. 34. JULY 9TH, 1921 FORTNIGHTLY

LOUD SPEAKING TELEPHONES—II.

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IN an earlier article some of the advantages of the "electrodynamic" form of loud-speaking telephone over the more usual patterns were pointed out.* Chief amongst these, it may be recalled, are the ability to obtain larger forces on the diaphragm, and the linear relation between this force and the applied electrical stimulus. The first of these, in particular, is a feature that may also be claimed by an *electrostatic* form of loud-speaking telephone that was demonstrated at a meeting of the Institution of Electrical Engineers, on May 26th, during a lecture by two Danish engineers—Alfred Johnsen and Kund Rahbek. This lecture dealt with a peculiar electro-static phenomenon, and with some of its many applications, and in view of the striking nature of the phenomena shown it may be of interest to set out some of its chief features.

If we take two metal plates and set them up parallel to each other on suitable insulating supports, so as to form a condenser, and then connect them to any convenient source of electrical potential, an attractive force will immediately be set up between them. If the plates are not large and they are spaced some distance apart in air, this attractive force will not usually be evident unless the voltage applied to the plates is extremely high. The magnitude of this force, and the laws governing its relation with other physical quantities, were first investigated by Coulomb, who, in 1785, described an instrument—now called a "Torsion Balance"—with which such investigations could be made. This instrument consisted of a glass vessel in the centre of which a small horizontal rod, carrying metal spheres or discs at its ends, was suspended by a wire so as to be capable of rotation. Near one of these spheres or discs a second fixed sphere was mounted on an insulated support. When the two spheres were charged up so that there was a difference of potential between them, the repulsive force that was established caused the suspended sphere to move away from the fixed one. By means of a twist applied to the suspending wire it was then possible to restore the sphere and rod to its initial position, and thus to calculate the force acting between them.

By this means it was shown that the force between two charged bodies was proportional to $Q_1 Q_2/d^2$ where Q_1 and Q_2 are the magnitudes of the charges on the two bodies, and d is their distance apart.

When the two bodies are charged with the same sign (*i.e.*, both positive or both negative) the force is a repulsive one, but when they are charged with opposite sign the force is one of attraction. The latter corresponds to the case of a condenser of the ordinary type in which the two plates are charged with opposite polarities at any given

The Wireless World, 8, pp. 791—794, February 19th, 1921.

instant. The charges on each plate are then equal in quantity but opposite in sign. Hence, the above expression to which the attractive force is proportional may be written Q^2/d^2, where Q is the charge on either plate of the condenser. But it is well known in electrical circuits including condensers, that there is a simple connection between the charge Q on the condenser plates, the capacity of the condenser C, and the voltage V between the plates. This relation is $Q = CV$. Hence, we may say that the attractive force between the condenser plates will be proportional to C^2V^2/d^2 by making the above substitution for Q. But the capacity of a parallel plate condenser may be written as follows (neglecting small corrections due to uneven field distribution near the edges of the plates) $C = KA/4\pi d$, where K = the specific inductive capacity of the dielectric = 1 for air; A = area of each plate; and d = distance between the plates as above.

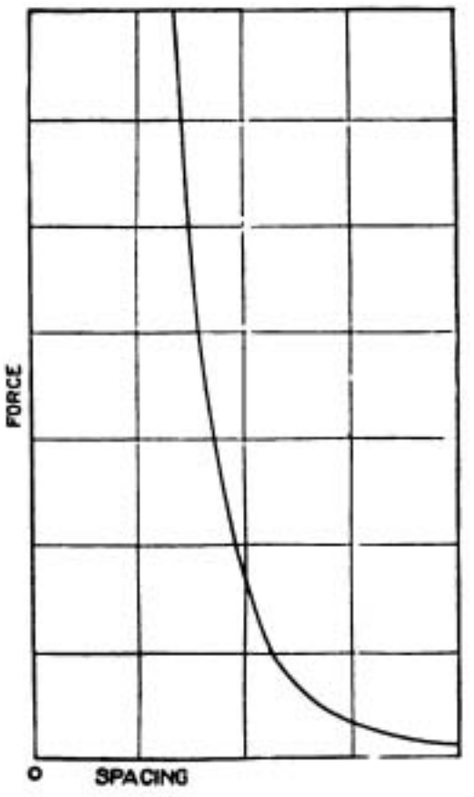


Fig. 1

Hence, if we substitute this value for C in the above expression for the attractive force, we derive the following:

$$F \propto K^2A^2V^2/16\pi^2d^4$$

or for air,

$$F \propto A^2V^2/16\pi^2d^4 \propto A^2V^2/d^4,$$

showing that if a given voltage V is maintained between two plates of given area A, the attractive force exerted between them will increase inversely as the fourth power of their distance apart. The rapidity with which a quantity that varies inversely as the fourth power of the variable mounts up with decreasing values of the variable quantity in question is indicated in Fig. 1, which shows how the force increases with decrease of the plate spacing d. The curve in this diagram is not drawn for any particular dimensions of the plates, etc., but is plotted out to arbitrary units.

It becomes obvious, therefore, that F may become extremely large if d is made small enough.

Emphasis may be placed upon this case in which the voltage V between the plates is maintained *constant* (as by connecting the plates to a battery or other source), as compared with the case in which the plates or electrodes are charged up, and the charges remain constant. In the latter case V will vary with their distance apart, as in the classical experiments of Coulomb. This gives the inverse square law, whereas the former gives the relation involving the inverse *fourth power* of the distance of separation as has been pointed out above.

The chief interest in the apparatus described by Messrs. Johnsen and Rahbek lies in the means adopted to secure a small effective value of the quantity d. If the two metal plates are brought very close together in air a discharge will pass across the space between them, even if V is only three or four hundred volts, before d becomes small enough for large forces to be set up.

If, however, the space between the plates is occupied by some material other than air, and a material that at the same time is a sufficiently good conductor to allow *some*

small charging current to flow through it, but is also a good enough insulator to prevent the charges on the plates from being dissipated by a spark discharge, then much smaller values of d become possible and much larger forces are called into play.

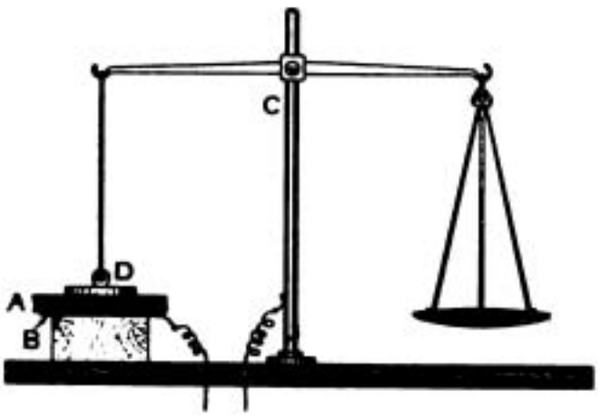


Fig. 2.

The general arrangement of the apparatus used to demonstrate these effects is shown in Fig. 2. In this diagram A represents a slab of the partially-conducting material in question—or "semi-conductor," as it may be termed, and B is one of the metal plates or electrodes of the condenser. In this instance this electrode is in the form of a metal foil—such as tinfoil—pressed well into contact with the surface of the semi-conductor. The opposite plate is the brass disc D, of some 2 ins. diameter, which is suspended from one arm of the balance C.

The weight of the disc is arranged to be just counterbalanced by the weight of the pan on the other arm, so that quite a small weight in the pan suffices to raise the disc away from the slab of material A. When a voltage of about 440 volts was applied to the apparatus between the disc and the metal foil B, it was found that the attractive force acting on the disc was so great that a kilogram weight in the pan could not pull the disc away. The current flowing through the apparatus was extremely small—so much so, indeed, that the lecturer was able to include himself in the supply circuit, by holding a wire in each hand, without any appreciable diminution in the pull on the disc. Immediately, however, he released one of the leads from his fingers the disc was pulled sharply away by the weight.

One may ask how it is possible for such large forces to be brought into play when the distance between the two electrodes, B and D, is so large—over an inch in the apparatus shown in operation—especially in view of the statements made above as to the increase of the force with decrease of the distance. In the apparatus in question the actual thickness of the slab of material (within, of course, obvious limits) makes little difference to the results obtained. The explanation of these apparent discrepancies is that with these peculiar materials the real effective spacing between the disc D and the electrical charge of opposite polarity by which it is attracted is not the thickness of the slab A but *the thickness of the minute air film* between the under surface of the disc and the top surface of the slab A. This thickness, of course, is very small—and becomes smaller as the two materials are more highly polished.

This, then, is the function of the "semi-conducting" material A — to conduct sufficiently to allow the accumulation of a layer of electrically charged ions, or of electrons, on the surface of the material adjacent to the metal electrodes, but at the same time to insulate sufficiently to prevent that charge being wholly dissipated by contact between the electrode and one or two points of the surface of the material. With ordinary good conducting materials, contact at one point, however small, is sufficient to completely dissipate the electric charges on their opposing surfaces, and to set up a "short-circuit" between them. The high surface resistance of these semi-conducting materials is sufficient to prevent this occurrence in their case, while their conductivity *through* the material is sufficient to enable the charges to accumulate.

The state of affairs may, perhaps, be made clearer by Fig. 3, which represents the slab

of material A in section, and the two metal electrodes B and D. These electrodes are shown separated from A by narrow air spaces, but the thickness of these gaps is, of course, much exaggerated in the diagram in order to make it clearer.

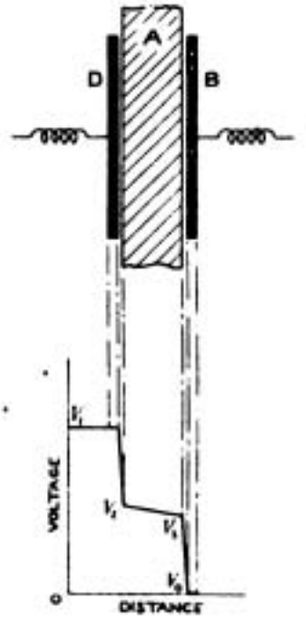


Fig. 3.

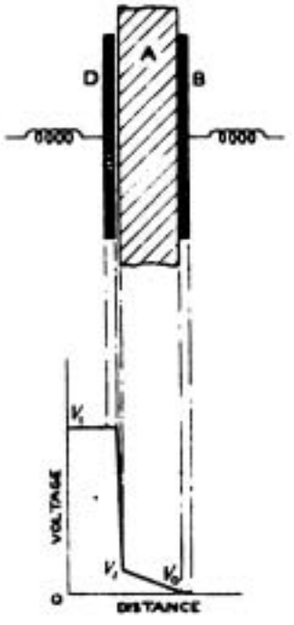


Fig 4.

The lower part of the figure is intended to represent, approximately, the electrical conditions as regards voltage drops in the various parts, the voltage represented by V_1 being that applied to the whole apparatus. This voltage, V_1 (assuming that B is at zero potential) is maintained throughout the thickness of the disc D, as indicated, but in crossing the air gap between D and A, nearly half of the applied potential difference is expended. Hence, at the left surface of A the potential may be represented by the value V_2. Through the thickness of the material A there is only a relatively small voltage drop, since although the resistance of A is high, the resistance of the air gap is relatively much higher. On the right hand surface of A, then, the potential will be V_3; and in crossing the second air gap between A and B, the remaining voltage is expended, so that at B the potential is zero, as shown at V_0.

The fact that the largest parts of the applied potential are found across the two thin air gaps accounts for the attractive force that is set up between the electrodes and the surfaces of the semi-conducting material. It may be noted from Fig. 3 that each plate is attracted to the material with approximately equal force, since the two voltage drops across the air gaps are approximately equal. If now, one of the electrodes, say B, is placed in such close proximity to the semi-conductor that the air gap is to all intents and purposes eliminated, then practically the whole of the applied voltage will be expended in crossing the air gap between A and D, so that a proportionately greater pull will be set up between these two. From the equation for the force F derived on page 5, it is seen that F is proportional to the square of the voltage applied between the two surfaces, so that if this change is made the attractive force exerted on the disc will be increased nearly four times. This arrangement is indicated in Fig. 4, and is the one generally adopted in the practical applications of the apparatus. From this diagram we see that the voltage drop is across the air gap between the disc D and the semi-conductor A $V_1 - V_2$, and that this voltage is nearly equal to V_1, since $V_2 - V_0$ the voltage drop across A is comparatively small.

In connection with these diagrams it may be as well to emphasise the fact that the air gaps shown are only those existing when the disc D is actually mechanically resting on the surface of A. The disc is not intended to be spaced away from A by any artificial means.

(A further instalment of this article will appear in our next issue.)

A PHOTOGRAPHIC RECORDER FOR WIRELESS SIGNALS

SINCE the development of the valve amplifier has given wireless amateurs a means of obtaining signals strong enough to operate a make-and-break relay, there have been many attempts at recording wireless signals on Morse inkers and similar apparatus. New Morse inkers are expensive pieces of apparatus, and second-hand ones are not always easy to obtain ; further, they require a well-constructed relay to operate them satisfactorily, and such relays are in themselves sufficiently expensive.

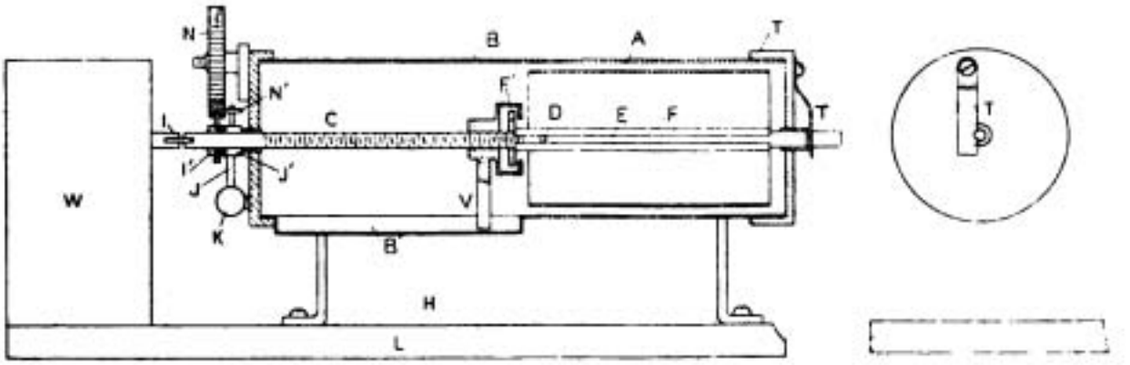
An interesting alternative to the usual ink-and-tape method of recording is furnished by a reader, Mr. D. McNamara, who sends us a description and drawings of a photographic recorder, the making of which should not overtax the ingenuity of those readers who have elementary workshop facilities. Its manufacture should be a relatively inexpensive matter, and in addition it possesses the advantage that it is self-contained, *i.e.*, no separate relay is required to operate it.

In principle the device consists of a cylinder resembling that of the old-fashioned phonograph, mounted on a shaft driven by a converted gramophone motor. The shaft is threaded, and not only rotates the cylinder, but by means of a sliding sleeve draws it along in the direction of its axis. At the completion of its travel an automatic device disconnects the motor and the cylinder ceases to rotate or move forward.

Round the cylinder is wrapped a strip of ordinary photographic film as used in cameras of the Kodak type. The cylinder moves within a light-tight case, in the side of which is cut a small aperture, the width of the line it is desired to record, and of equal length—a small square hole, in fact. On the same base as the cylinder case and motor is mounted a re-wound telephone receiver of the watch-case type, bearing on an extension arm a strip of metal terminating in a small shutter which just covers the aperture above referred to. At the point where the metal strip passes over the magnets of the telephone receiver it carries an armature. It will thus be seen that when the receiver magnets are energised by the received current, the armature is drawn down and the shutter uncovers the aperture in the cylinder case.

To provide the necessary light for recording purposes, an electric bulb such as is used for flashlamps is fitted in a casing bearing a concentrating lens. The light is focussed on the hole and impinges upon the sensitive film within the casing.

From the above description the operation of the apparatus will now be clear. The film is first fitted round the drum in a manner shortly to be described, and the clock-work set in operation. As the drum rotates and moves along the shaft the light is intermittently let into the casing, the admission and shutting off being controlled by the re-



(a) *Fig. 1.* (b

ceived signals, and a spiral record is obtained on the film. As suggested by our correspondent, this should be developed and printed, but we would point out that the work is immensely facilitated (and, incidentally, considerably cheapened) by using ordinary bromide paper in place of the film. When the bromide paper is developed the signals appear as black lines on a white base, which is more pleasing than white lines on a black base, as would occur with prints made from a film. It is true that with a film a number of duplicates are readily obtainable, but this is not a practical advantage, and such duplicates are not often required.

Now as to actual constructional details.

Figures 1*a* and 1*b* show the general construction of the cylinder, shaft and casing, with the motor and automatic stopping gear. The cylinder A is mounted on the shaft C. B is a light-tight case, mounted on standards secured to the base LL and fitted with bearings at both ends, in which the shaft C revolves. A detachable cover T is fitted at one end, so that the film or paper may be inserted and removed. A split tube F leaving an opening E, which allows a stud D secured to the shaft C to slide freely along, is put through the centre of the cylinder, and soldered at both ends, one end being prolonged a little outside the cylinder, so as to allow the collar F′ to be soldered on. A quick-threaded screw with a pitch corresponding to the width between the record signals, is cut for over halfway on the shaft. The nut on this screw is provided with an attachment to embrace the collar F′, and a projection V (Figs. 1*a* and 2) which fits loosely into a groove B′, formed in about half the length of the lower portion of the light-tight case. When the shaft rotates the nut is prevented by the projection V from rotating, and therefore carries the cylinder along the shaft as previously described.

Fig. 2.

The whole is set in motion by the spring motor W, which, in this case, is an old gramophone motor slightly altered to suit the purpose. One of the wheel axles, I′, is made to project outside the frame (not the turntable axle, as this is too fast, but the slower one next to it), the end of which is provided with a tongue I, which fits into a slot in the cylinder axle. This is so arranged that it can be thrown out of gear by the spring T which fits into a groove on the opposite end of the cylinder shaft and constantly tends to pull the shaft in that direction. Normally, this spring is prevented from pulling the shaft out of gear by a collar kept in place by a catch to be later described.

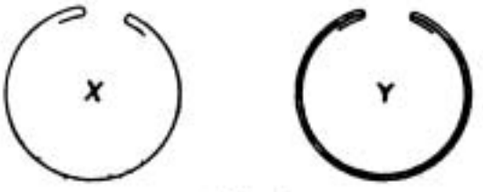


Fig. 3

The sensitive film or paper is wound on a split sheet-metal sleeve Y (Fig. 3), bent so as to fit the cylinder and project a little outside so as to enable the finger and thumb to grasp it when removing the record. Both cylinder and sleeve are slightly tapered for the same reason. In Fig. 3, X shows how the film is curved, and Y the film in place on the sleeve. It is necessary to keep the sleeve sprung out while the film is being fitted, but when it is inserted on the cylinder, the springiness of the sleeve keeps it tightly in place.

It will be seen that the film is not continuous around the cylinder, owing to the manner in which it is wound, but the break is not any disadvantage, and if a dot or dash should run over it, there is only a very slight break in the opened-out record (see example), not enough to mutilate the signals.

A safety device for automatically disconnecting the spring motor when the record is complete is shown in Fig. 4. N is a starwheel. For every revolution of the cylinder this wheel is advanced one tooth by means of the pin M (shown clearly in Fig. 4) until

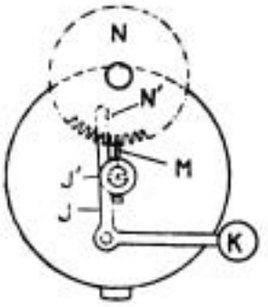


Fig. 4.

the pin N' (standing out from the side of the starwheel) comes into contact with the lever J. This lever disengages the curved cap J', which fits in between the collar I' and bearing of cylinder shaft, thereby allowing the spring T to pull the shaft away from the tongue I of the spring motor axle, thus bringing the machine to rest. The weight K holds cap in position. The spring T can be turned aside and out of the groove on shaft when removing the cap T'.

A small square aperture O' (Fig. 5) is cut in one side of the outer case at about midway in its length. On the opposite side is bored a round hole, somewhat larger, with a sliding cover not shown in sketch. This is

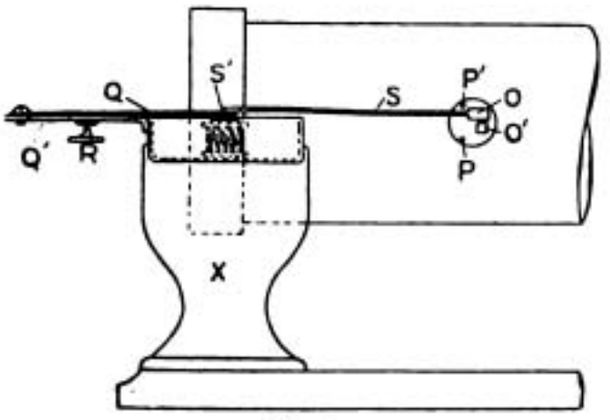


Fig. 5.

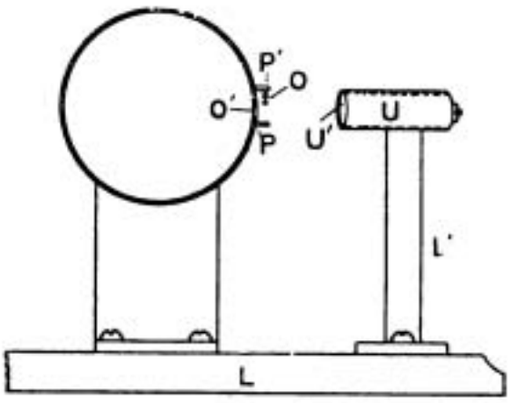


Fig. 6.

for the purpose of observing the light when adjusting, as both holes are in the same line (they are a little above centre, so as to avoid the cylinder shaft blocking the view). When such observations have to be made the cylinder must be moved aside so as to leave a clear space to look through. A detachable handle on the cylinder shaft is used for this purpose. It is also needed for bringing the cylinder to the end of outer case so as to remove or insert film. The square aperture O' (Fig. 5) is equal in dimensions

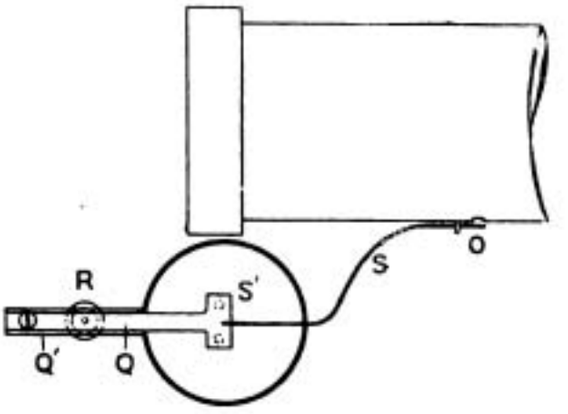
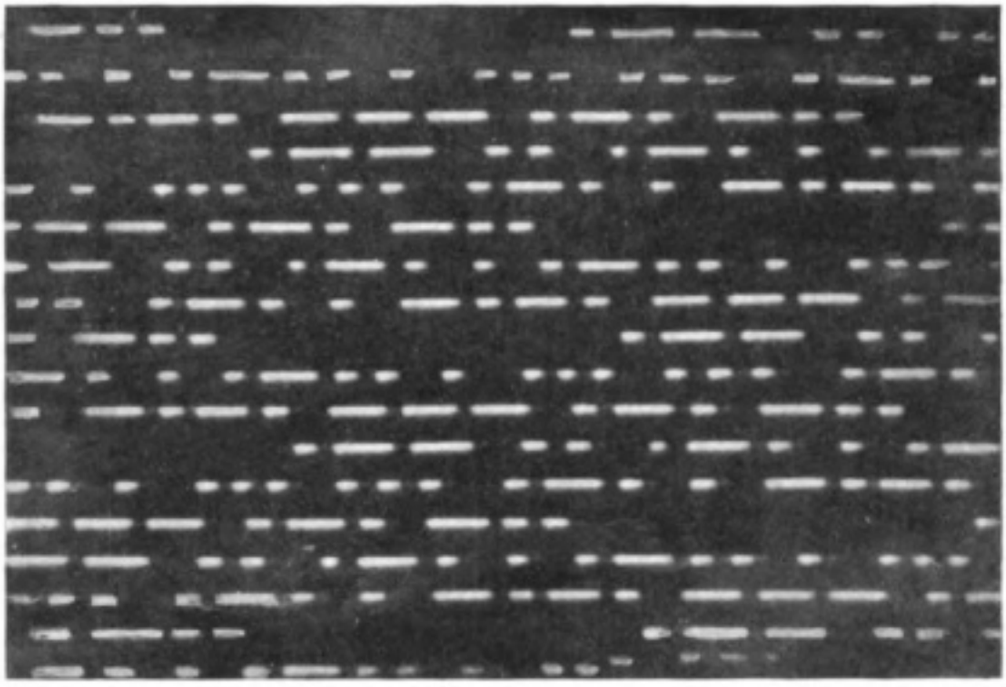


Fig. 7

to the width of the lines forming the record. When the relay is at rest, this aperture is covered by the shutter O resting lightly on a pin or stop P. In the sketch the aperture is fully open, the shutter lever being in contact with the upper pin P'.

A small electric bulb, such as is used in pocket flash lamps, is inserted in the tube U (Fig. 6), which is screwed to pillar L' and

fastened to wooden base L L. A three-cell dry battery, not shown in sketch, lights this bulb. A beam of light is projected by the lens U′ through the square aperture as comes to a focus on the sensitized film on the revolving cylinder. The relay is made from an old telephone watch receiver secured horizontally to wooden pedestal X (Fig. 5). The bobbins were rewound with very fine S.C. wire, giving a resistance of about 3,000 ohms, the diaphragm and vulcanite portion being removed. A bracket Q′ (Figs. 5 and 7) is soldered on to telephone flange. A strip of ferrotype plate is cut to the shape Q shown in plan (Fig. 7), the enamel being scraped off and one end fastened to the outer end of the bracket Q′ by a small screw. A disc of sheet brass takes the place of the diaphragm, the armature (that portion of ferrotype strip forming the T) resting lightly thereon. This can be adjusted by the screw R in such a manner that it is practically balanced when nearly touching the brass disc, the elasticity of the strip having a tendency to move it away from the disc and the pull of the magnet on telephone to draw it in, both being counteracted by the adjusting screw R. In this state the relay is exceedingly sensitive. An extension arm, S, of the same material is soldered on to armature edgewise at S′, the other end forming the shutter O, the armature and extension arm combined are exceedingly light. In practice it is better to allow the shutter arm to rest lightly on the bottom pin, so as to have it slightly overbalanced. This will allow the shutter to respond to very rapid signals. In order to avoid complications, the battery connections are not shown ; but, of course, they are quite simple to understand.



A Print made from a specimen film. It will be seen that signals broken on the right-hand side are completed on the left-hand side on the next line.

Fig. 8.

The sample record shown in Fig. 8 is a print made from a film negative of experimental signals not received by wireless, as when it was made wireless reception by amateurs was still forbidden.

THE DESIGN OF HIGH FREQUENCY RESISTANCE AMPLIFIERS*

By Lieut. N. H. Edes, R.E.

ON October 30th and November 13th last there appeared in *The Wireless World* a report on the proceedings of the Wireless Society of London, the principal matter under discussion being a paper by Mr. M. Child on his experiences with high frequency resistance amplifiers.

During the ensuing discussion two very important points were raised :—

(*a*) Should the grids of the valves have a positive or a negative potential applied to them ?

(*b*) What should be the value of the condenser connecting the plate of one valve to the grid of the next ? And what should be the value of the grid leak ?

These points will be treated in turn.

1. The Effects of Grid Potential.

With regard to this, Mr. J. Scott-Taggart pointed out that optimum efficiency is, in general, obtained when we so arrange matters that all valves except the last are employed for amplification, the last valve being used for rectification (and, incidentally, for further amplification).

As explained by Mr. Scott-Taggart, the result of imposing a positive—or even zero—potential on the grids of the first five valves (in the case of a six-valve amplifier) is considerable damping of the signals, owing to the flow of grid-filament current. This, obviously, is undesirable.

It is interesting, however, to go a step further and investigate exactly what form this damping takes. At the risk of covering ground which is already well-known, the writer will endeavour to outline briefly the method in which the incoming signals are amplified, and passed on from valve to valve.

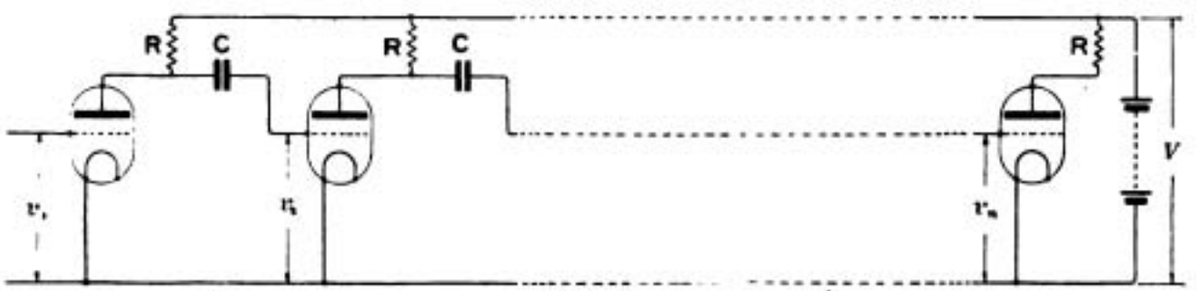


Fig. 1.

Fig. 1 represents the 1st, 2nd and *n*-th valves of a resistance-coupled amplifier.† Condensers C are inserted merely to isolate the grids from the H.T. supply.

For the present it will be assumed that these condensers pass on in full any changes of potential occurring on the plates to which they are connected. Their action will be examined in detail later.

Let v_1, v_2.....v_n be the instantaneous values of the oscillating components of the potentials on the grids of the 1st, 2nd, ... and *n*-th valves.

Let i_1, i_2.....i_n be the instantaneous values of the oscillating components of the plate currents of the 1st, 2nd, ... and *n*-th valves.

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* Paper read before the Wireless Society of London on Monday, June 27th, 1921—for introductory remarks and Proceedings of the meeting see next issue of *The Wireless World*.

† Omitting for the sake of simplicity the grid leaks which are customarily employed in such an amplifier.

Let V be the voltage of the H.T. battery.

Let the resistances in the plate circuits of the valves be each equal to R, and assume that there is no grid-filament current, *i.e.*, that each of the grids is connected to the filament through a potentiometer (imposing negative potential) and a resistance of so high a value that its conductance will not affect the oscillating potentials handed on to each valve from the previous one. For the sake of simplicity neither potentiometer nor high resistance is shown in Fig. 1.

Take the case of the first valve—

i_1, v_1, and V are connected by the following well-known relation :—

$$i_1 = av_1 + b\,(V - i_1\,R) + k \qquad \ldots \quad \ldots \quad \ldots \quad (1)$$

where a, b and k are the constants of the valve, and $V - i_1R$ is the plate voltage (i_1R being the voltage drop in the resistance R due to current i_1).

Suppose v_1 varies by a small amount δv_1.

Then
$$i_1 + \delta i_1 = a\,(v_1 + \delta v_1) + b\,[V - (i_1 + \delta i_1)\,R] + k \qquad \ldots \quad (2)$$

By subtraction

$$\delta i_1 = a\delta v_1 - bR\delta i_1$$

$$\therefore\ \delta i_1 = \frac{a\delta v_1}{i + bR} \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Therefore, voltage change of plate due to this small pulse of potential on the grid is

$$-R\delta i_1 = -\frac{aR}{1 + bR}\,.\delta v_1$$

But the voltage change of the plate of the 1st valve = voltage change of grid of the 2nd valve $= \delta v_2$.

$$\therefore\ \delta v_2 = -\frac{aR}{1 + bR}\,.\delta v_1 \ldots \qquad \ldots \quad \ldots \quad \ldots \quad (4)$$

Similarly,
$$\delta v_3 = -\frac{aR}{1 + bR}\,.\delta v_2$$

$$= (-1)^2\left(\frac{aR}{1 + bR}\right)^2.\delta v_1$$

or,
$$\delta v_n = (-1)^{n-1}\left(\frac{aR}{1 + bR}\right)^{n-1}\delta v_1$$

and
$$\delta i_n = (-1)^{n-1}\frac{a^nR^{n-1}}{(1 + bR)^n}\,.\delta v_1 \qquad \ldots \quad \ldots \quad (5)$$

From these results it is clear that the greater R is compared with $1/a$ and $1/b$ the greater will be the total amplification of the apparatus. In the limiting case when $R = \infty$ the voltage change of the grid of the n-th valve is $\left(-\frac{a}{b}\right)^{n-1}\delta v_1$. The practical objection to making R very large is that, in order to keep the voltage on the plates at a value suitable for the operation of the valves in use, the H.T. battery will have to be of extremely high voltage, and its dimensions will be inconveniently large. Usually R is given a value approximately equal to that of the plate to filament resistance of each valve, *i.e.*, equal to $1/b$. In this case the amplification per valve is $-(a/2b.)$

Hence
$$\delta v_n = \left(-\frac{a}{2b}\right)^{n-1}.\delta v_1$$

and
$$\delta i_n = (-1)^{n-1}\,b\left(\frac{a}{2b}\right)^{n-1}\delta v_1 \qquad \ldots \quad \ldots \quad (6)$$

It will be seen from the above investigation that a positive pulse of potential on the grid of the first valve will produce a negative pulse on the grid of the second valve, which will produce a positive pulse on the grid of the third valve, and so on.

Now, let us remove the potentiometers previously mentioned so that all the grids are normally at zero potential, *i.e.*, at the potential of the negative legs of the filaments.

Were it not for the effect of the plate potential, the grid-filament current would commence to flow as soon as the grid potential rose above zero. The effect of the attraction of the positive charge of the plate on the electrons emitted from the filament is usually to cause this current to commence when the grid potential rises algebraically above a value slightly below zero. At any rate, with all the grids kept normally at zero potential we can safely say that a small positive pulse of potential on the grid would considerably increase the grid current flow, while a small negative pulse would decrease this flow or cut it off entirely.

Now a flow of grid current will naturally tend to disperse the charge on the grid, and any part of a circuit connected to it—*i.e.*, it will tend to damp out the particular signal-pulse in which the grid-current flows.

Hence, in the case of a single valve the positive halves of an oscillation of applied grid potential will be damped out more than the negative halves—in other words the valve will rectify. But in the case of the resistance amplifier it has been shown that a positive pulse on the first grid becomes a negative pulse on the second grid.

Therefore, if grid current is present in both first and second valves only, the negative half-cycles of the original oscillation will appear on the grid of the second valve, owing to the positive halves being more or less damped out in the first valve. These negative half-cycles of the original oscillation will appear as positive pulses on the second grid, and will be damped out owing to the grid current of the second valve.

Expressed in another way, both valves are rectifying, *but in opposite senses.*

Similarly with the succeeding valves.

What this amounts to is that we are carefully arranging that each valve is fully qualified to amplify those half-cycles which have been *more or less obliterated in the previous valve*, while it damps out those which *have* been passed on to it.

The majority of designs for H.F. amplifiers that one sees possess this feature—each valve being worked under conditions giving rectification by means of grid-current damping, and one may almost be tempted to wonder at any amplification being obtained at all.

The writer believes that the fallacy of the average experimenter is that he is not clear as to which of his valves is rectifying and he probably contents himself with the supposition that they *all* rectify to a certain degree, oblivious of the fact that this, in itself, is detrimental to the working of the instrument.

Mr. Scott-Taggart's arrangement—in which a negative potential is applied to all grids except the last—is, therefore, exceedingly welcome, for here the first five valves are used for pure amplification, the last valve providing rectification of the signals thus amplified.

The writer hopes, however, that the above investigation may emphasise the importance of differentiating between the processes of amplification and rectification.

2. Design Conditions for Resistance-Coupled Amplifiers.

We have now established the fact that with the arrangement under discussion an alternating E.M.F. on the grid of any valve produces an alternating E.M.F. on its plate.

The remaining problem is to decide the most efficient method of communicating this E.M.F. to the grid of the next valve. Up to the present we have assumed that it is passed on without any reduction in value.

The circuit we have to consider is shown in Fig. 2.

We will agree that condenser C_1 is necessary to isolate the grid from the steady voltage of the H.T. battery.

We will also agree that grid leak r is necessary in order to prevent the grid from becoming so negative that the operating point is carried off the straight portion of the characteristic curve.

Let C_2 be the capacity between grid and filament of the second valve; e, e_1, and e_2 be the R.M.S. values of the oscillating P.D.'s between the points shown by the arrows, so that e is the oscillating voltage output of the first valve, and e_2 is the oscillating voltage input of the second valve.

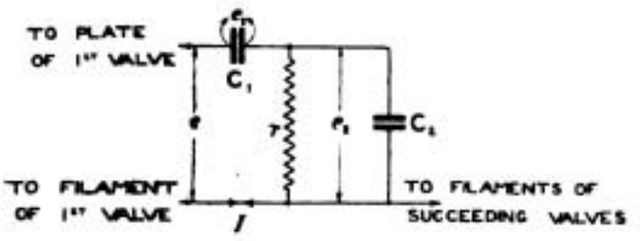


Fig. 2.

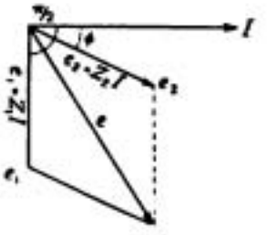


Fig. 3.

For maximum amplification e_2/e must be a maximum.

Let I be the R.M.S. value of the oscillating current in the portion of the circuit shown by the arrow.

Then the impedance of r and C_2 in parallel is

$\frac{r}{\sqrt{(1 + r^2C_2^2\omega^2)}} = Z_2$ say, and I leads e_2 by the phase angle $\tan^{-1} rC_2\omega$, where ω is $2\pi \times$ the frequency of the current.‡

The impedance of C_1 is $1/C_1\omega = Z_1$, say, and I leads e_1 by $\pi/2$. Also $e_2/Z_2 = I = e_1/Z_1$.

Fig. 3 is a vector diagram showing the relations between A, e, e_1, and e_2. In this diagram the angle ϕ is given by $\phi = \tan^{-1} r_2C_2\omega$

Also, from the diagram we have :

$$e = A\sqrt{Z_1^2 + Z_2^2 + 2Z_1Z_2 \sin\phi} \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$= A\sqrt{\frac{1}{C_1^2\omega^2} + \frac{r^2}{1 + r^2C_2^2\omega^2} + \frac{2r^2C_2}{C_1(1 + r^2C_2^2\omega^2)}} \quad \ldots \quad \ldots \quad (8)$$

$$\therefore \frac{e_2}{e} = \frac{\frac{r}{\sqrt{1 + r^2C_2^2\omega^2}}}{\sqrt{\frac{1}{C_1^2\omega^2} + \frac{r^2}{1 + r^2C_2^2\omega^2}\left(1 + 2\frac{C_2}{C_1}\right)}}$$

$$= \frac{r}{\sqrt{\frac{1 + r^2C_2^2\omega^2}{C_1^2\omega^2} + r^2\left(1 + 2\frac{C_2}{C_1}\right)}}$$

‡ N.B. This statement can be derived from a simple vector diagram.

$$= \frac{r}{\sqrt{\frac{1}{C_1^2\omega^2} + r^2\left(1 + \frac{C_2}{C_1}\right)^2}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

This attains a maximum value when r and C_1 are both infinite the maximum value being 1 which is, of course, obvious, as the circuit then consists of the E.M.F. e directly across the capacity C_2.

We therefore conclude that the coupling condenser C_1 should be large compared with the grid-filament capacity of the valve, and that the grid leak r should be large compared with $1/C_1\omega$. The grid leak, however, must not have so high a resistance that it allows the grid to accumulate a negative charge large enough to carry the operating point off the straight portion of the characteristic.

It will thus be seen that the frequency of the signals to be received does not affect the value which we should give to the coupling condenser ; but the higher the frequency the smaller can be the resistance of the grid leak.

Any parasitic capacity across the grid leak at high frequencies will produce the same effect as an increase of grid-filament capacity, and all that is necessary to minimise this effect is to make the coupling condenser large compared with the grid-filament capacity of the valve *plus* the roughly estimated capacity across the grid leak.

As both the latter capacities are, in practice, small, any reasonably large capacity (say 0·002 microfarad), will work efficiently as a coupling condenser.

THE LAW GOVERNING WIRELESS TRANSMISSION

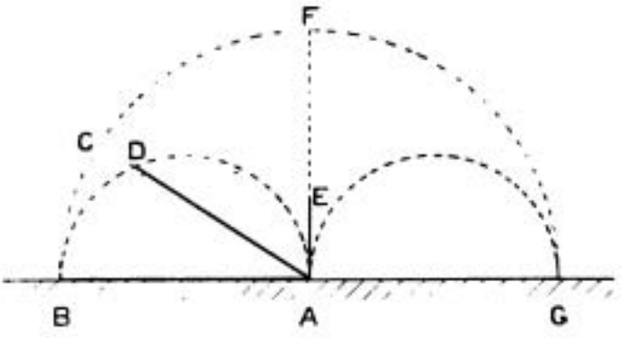
IN the March 19th issue of *The Wireless World* a reply was given in the Questions and Answers columns to *J.W. (Leith)*, who asked certain questions regarding a formula due to Professor Howe.

The following letter was received from J.W. (Leith) in criticism of the replies published :—

" Many thanks for your answers to my queries published in the March 19th issue (p. 883), which I have only just received.

" Might I point out, however, that, with regard to question (1) my objection to Prof. Howe's formula, which gives field strength of a vertical aerial as inversely proportional to the distance from it (*Radio Review*, 1, p. 598, September, 1920), has not been cleared up? If you remember, my contention was that the inverse square rule should apply.

" You say that I had neglected the vertical wire's directional properties, but this is not so, as I have always understood that the radiation from such an aerial is proportional to the cosine of the angle between the direction of radiation and the horizontal.



" Thus, in the diagram, if AB represent the magnitude of the field-strength vector at any horizontal distance AB from the aerial AE, then at C, any point on the hemisphere of radius AB, the vector will

be AD, *i.e.*, AB × cos CÂB.

"In the vertical direction AF, the field strength is, of course, as you say, nil; but, nevertheless (if the reasoning is so far correct, and in confirmation I might quote Prof. Vallauri, *Radio Review*, February, 1921, pp. 79/80, and formula (4)), the radiation is distributed over the whole hemisphere BCFG, and not confined to the horizontal circle of radius AB as it would have to be to justify the 1/distance rule. That this distribution is not uniform does not affect the matter, as will be seen upon a little consideration."

At our request Prof. Howe himself has been kind enough to deal with the matter as follows:—

"The explanation given in *The Wireless World* of the error into which J.W. (Leith) has fallen is not correct. The law of the variation of the field strength with distance has nothing to do with the directional properties of the transmitter. The light emitted from an ordinary lamp obeys the inverse square law, although its candle power is very different in different directions. The energy radiated from a wireless transmitter also obeys the inverse square law, that is to say, the energy passing through a given area normal to the direction of transmission in a given time, is inversely proportional to the square of the distance. The energy per cubic centimetre is, however, proportional to the square of the electric field strength E, and this latter magnitude is therefore inversely proportional to the distance and not to the square of the distance. The electromotive force induced in a receiving aerial of height h will be Eh, and if it is tuned and has a total resistance R, the power received by it will be E^2h^2/R. This is inversely proportional to the square of the distance. If J.W.'s idea were correct, the received power would fall off as the fourth power of the distance, and long distance radio telegraphy would be impossible."

THE EDUCATIONAL VALUE OF WIRELESS IN ELEMENTARY SCHOOLS

By R. J. Hibberd.

GRAYSWOOD village school nestled in a picturesque valley beneath Hindhead, one of the beauty spots of Surrey, is perhaps unique amongst elementary schools inasmuch as it possesses a wireless station of its own.

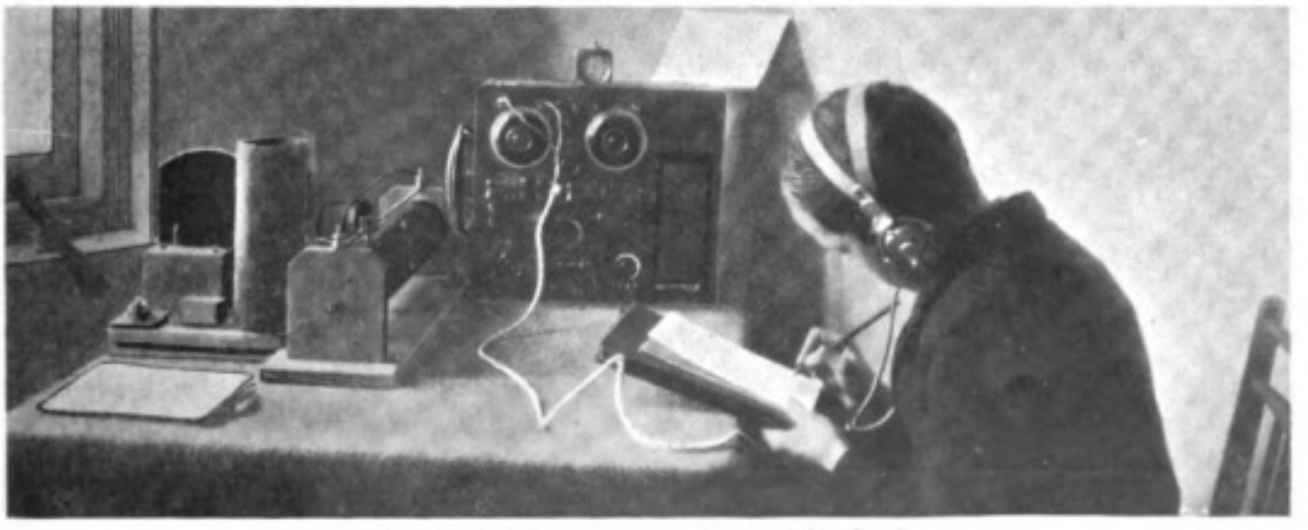
The fact that I possessed a wireless set created curiosity and interest amongst my pupils, boys and girls, and I decided, therefore, to introduce the subject into the school curriculum. Of course, this appeared a rather difficult matter, owing to the lack of scientific knowledge amongst the children and the necessity of imparting knowledge in a very non-technical manner. However, these difficulties were overcome, and readers of *The Wireless World* will be perhaps interested to learn of what real value wireless can be in a school. The course commenced by teaching the fundamental principles of electricity and magnetism, and as often as possible, its relation to wireless was introduced and emphasised with regard to its functions in this respect. In the meantime the upper class, which consists chiefly of boy scouts and girl guides, was busy learning the Morse Code. By the end of the first term surprising results were obtained, and we were thus enabled to commence on real wireless work during the second term. A single wire aerial, 100 feet in length, was fixed from a tall oak tree to one of the school chimneys, and having an L type "lead in." Our set was then got together, and a short description of it here will, perhaps, be of interest. As illustrated, it consists of a

The Lecture Table.

Mark III short wave tuner, into which is introduced a coil, as recently suggested in *The Wireless World*, and which was constructed by some of the boys. The aerial tuning condenser of the S.W.T. was also "tapped off," and is connected to one of F. O. Read's W160 two-valve sets, as shown. A "Burndept" coil, which can be seen in a small case in the illustration, is attached to the valve set, and also a "loud speaker." When working, one pupil listens to spark signals by means of a pair of Brown's telephones connected to S.W.T., whilst the rest of the class can hear by means of the "loud speaker," which is connected to valve set. The same condenser is used for both sets, adjustments being made by means of slider on large coil, and variable capacity reaction condenser on valve set. By having both sets working at the same time, the pupils can compare respective strengths of signals (in the case of spark) and realise thereby the real value and function of valves.

Despite the sheltered position of the school, splendid results are obtained. The Eiffel Tower time signals, which are taken each day, and the school clock adjusted accordingly, can be heard by the whole class of fifty-six children. Nauen, Coltano, Taranto, Malta, have been picked up in great strength, and, of course, we get Horsea "hot and strong," being only about 25 miles distant.

Not only as a science lesson has wireless proved of great value, but also in the teaching of physical geography. Weather reports are taken, and these are decoded by me, and the information gained used in explaining climatic conditions and weather phenomena existing in Europe and the necessity of gaining speedy weather reports. When the pupils improve in knowledge the calculation of wavelengths, etc., will be introduced in the mathematics



One of the enthusiastic pupils receiving Paris.

lessons. Only by experience can one fully realise what a real value wireless can be in a school. It commands the pupils' keenest interest and the educational value cannot be over-estimated. Of course, in a Secondary School it can be developed still further by the reception of foreign news, which can be translated in the language lessons, thus dispensing with the dry-as-dust French or German primer and at the same time imparting to the scholars an up-to-date knowledge of the form of expression of the language received.

I expect there are a great many other teachers who are interested in wireless and who are in a position to make far greater strides than I have, as I am handicapped in many ways ; and I trust, therefore, this short article will inspire them to make further efforts for the cause of wireless. It is a fascinating science to the younger generation and appeals to them far more than Coulomb's Torsion Balance or the picking up of a piece of paper by means of an ebonite rod. We may yet live to see every school equipped with a wireless station.

A HOME-MADE 4-VALVE AMPLIFIER

THE Hon. Secretary of the Aberdeen and District Wireless Society, Mr. W. W. Inder, M.I.RadioE., recently gave a demonstration before the Society on his home-made set comprising a 4-valve H.F. amplifier and 2-valve note magnifier. The results were very successful, signals being made audible through an improvised loud speaker of telephone ear-piece and phonograph horn. Most high-power Continental stations were clearly audible to everyone, and particularly good signals were received from ships.

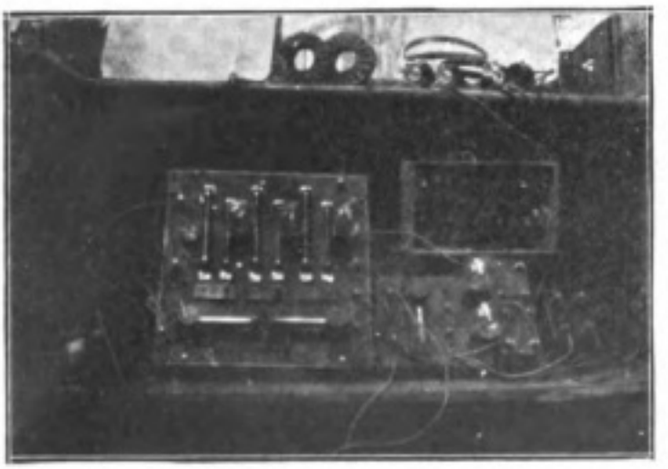


Fig. 1.

A description of the amplifier may be of use to amateurs in general, and is as follows :—

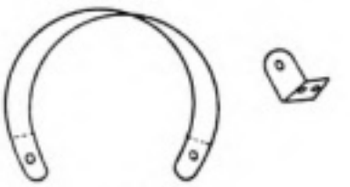


Fig. 2.

It is of the usual resistance type made for demonstration purposes, hence all the working parts are clearly visible, the wiring only being obscured. Fig. 1. On the panel, which is 12 in. × 12 in. × ¼ in., are seen the grid and anode resistances (Mullard's) of 80,000 and 3 million ohms respectively, placed between the valve holders and supported between clips made from the ends of old headbands, Fig. 2. Below these are the three grid condensers the capacities of which were guessed rather than calculated, but giving immediate good results they were not disturbed. They consist of three sheets of copper foil interleaved with two others ½ in. square overlap separated by 0·01 in. mica sheets.

Below these are the potentiometer and filament resistance. On the right of the panel

A HOME-MADE 4-VALVE AMPLIFIER

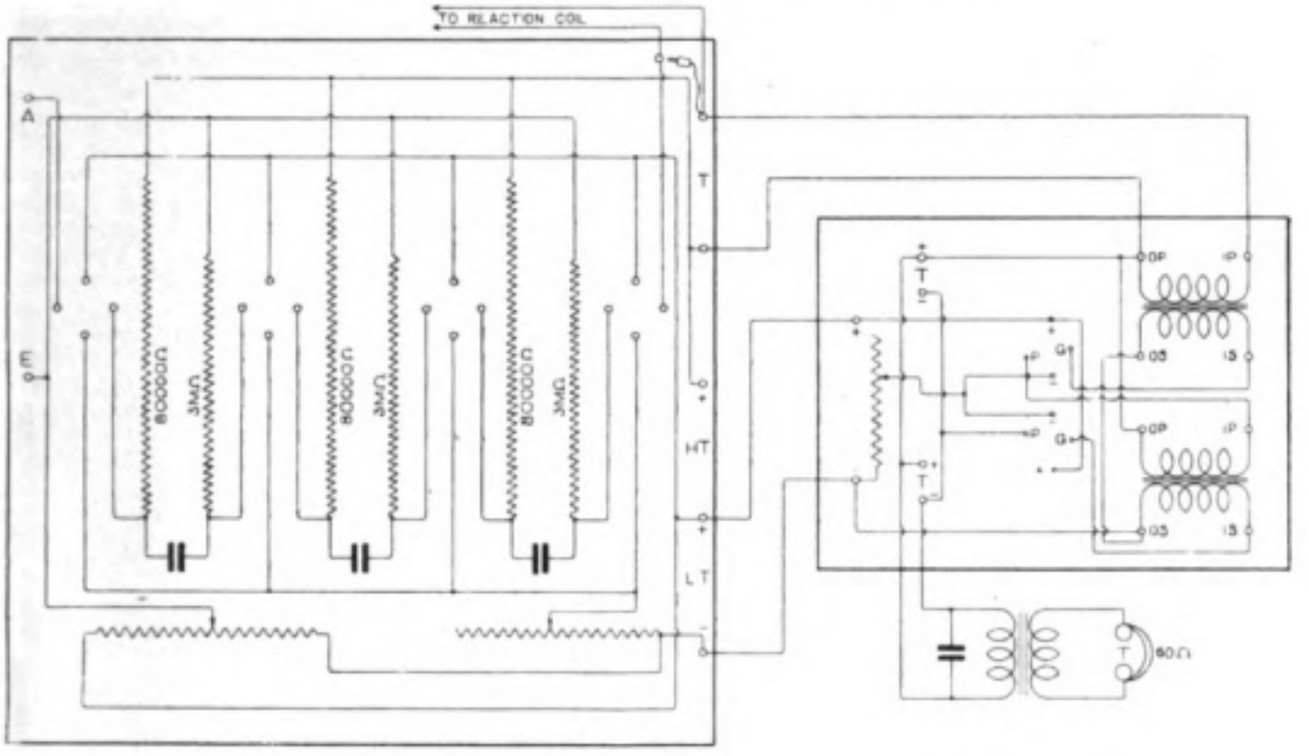


Fig. 3.

are, upwards, the L.T., H.T., telephones, and reaction-coil terminals respectively. On the left are the aerial and earth terminals connected to which are seen the home-made honeycomb loading coil and variable air condenser. The reaction coil is seen to the right of this coil.

The reaction coil may be dispensed with and capacity reaction used by shortening the coil terminals and connecting a billi-condenser between the last plate and aerial terminals. Equally good results are obtained by this method.

Connected to the amplifier is the two-stage note magnifier shown on the right. The L.F. intervalve transformers are from Messrs. Butler & Co., and are very efficient.

Above this is the H.T. battery of 20 flashlamp cells with tappings for 60, 75 and 80 volts. To the extreme right is the telephone transformer.

Diagram of connections is shown in Fig. 3.

The set is remarkably free from howling, though trouble in this respect was at first met with, but a rearrangement of the wiring proved effective in preventing it.

Speech from the Hague and Kōnigswusterhausen is clearly audible on the set if very careful adjustment of the reaction coil is made.

Although there is nothing unusual in the construction of the set the arrangement of parts may appeal to amateurs as being simple.

INTERNATIONAL WIRELESS CONFERENCE

M. Paul Laffont, Under-Secretary of State for Posts, Telegraphs and Telephones, presided over the inaugural sitting of the International Technical Committee on Wireless Telegraphy held on Tuesday, June 21st. The Committee comprises representatives of the Governments of Great Britain, France, Italy, Japan and the United States of America, who have been called together by the French Government in order to carry out the decisions arrived at by the Communications Conference, which met at Washington at the end of last year.

WIRELESS CLUB REPORTS

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter in the exact form in which they are to appear and as concise as possible, the Editor reserving the right to edit and curtail the reports if necessary.

The Editor will be pleased to consider for publication papers of unusual or special interest read before Societies.

The Wireless Society of London.

An ordinary general meeting of the Society was held at the Royal Society of Arts, John Street, W.C.2., on Monday, June 27th, 1921, at 8 p.m. The agenda included (1) a paper by Lieut. N. H. Edes, R.E., on "The Design of Resistance-coupled Amplifiers" (*see* p. 233 in this issue), which, in the absence of the author, was read by Mr. Philip R. Coursey, and (2) a demonstration of the "Piezo-electric Properties of Rochelle Salt Crystals," by Mr. Philip R. Coursey, B.Sc., F.Inst.P., A.M.I.E.E. The detailed Proceedings of this meeting will be published in a later issue.

It is requested that all members of the Wireless Society of London will notify the Secretary (Mr. H. Leslie McMichael, 32, Quex Road, N.W.6) immediately of any changes in their permanent postal address, in order that the distribution of the publications of the Society may not be delayed.

North Middlesex Wireless Club.

(*Affiliated with the Wireless Society of London.*)

A meeting of the North Middlesex Wireless Club was held at Shaftesbury Hall, Bowes Park, on June 1st. It had been arranged that Mr. Dockree should give an address on Direction Finding Stations in America, but at the last moment he was called away on business, and could not appear. Mr. Evans then suggested that a discussion should be held on the experiences of members on getting the Dutch Concert, so that those who had not been successful should benefit by the experiences of others. He opened the debate himself by describing a very simple set on which the Dutch Concert could be clearly and loudly received, and on a very primitive aerial. Other members then gave their experiences, and a lot of useful information was gathered.

A meeting of the above Club was held on June 15th, at Shaftesbury Hall, Bowes Park, and was well attended. In order to allow members to hear what the Club's set was capable of when properly adjusted it was arranged to devote the evening to reception of signals. The results were highly satisfactory, loud clear signals being obtained. Mr. Saville had kindly lent some additional instruments which enabled some very long wave stations to be heard which would otherwise have been beyond the normal receiving length of the Club's set.

Particulars of the Club may be had form the Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, N.21.

Leicestershire Radio Society.

(*Affiliated with the Wireless Society of London.*)

On June 6th a well attended meeting of the above Society was held at their Headquarters, the Vaughan College, Mr. C. Atkinson in the chair.

A new list of rules had been drawn up by the Committee. These were submitted to the meeting, and passed unanimously. Printed copies were then distributed to all members present.

After business details had all been dealt with, the Secretary announced that the lecturer had not turned up, and had not been heard of for a fortnight, so that it was up to somebody to do something.

Mr. S. Skeet stepped into the breach with the second half of his lecture on Radio Theory and Amateur Applications.

Mr. Skeet gave a very clear description of the principles of tuning and gave some curious circuits which made all present conclude that there is more in tuning than turning a knob.

He had *measured* currents down to one-ten-thousanth part of one milli-amp.

Mr. Skeet possesses the valuable art of inciting members to question, criticise and discuss to a high degree. The meeting closed with a hearty vote of thanks to Mr. Skeet.

All particulars of membership may be obtained from the Hon. Secretary, Mr. J. W. Pallett, 59, Dulverton Road, Leicester.

Wireless and Experimental Association.

(*Affiliated with the Wireless Society of London.*)

At the meeting on June 8th, after the usual buzzer practice, Mr. Childs produced a magnetic needle pivotted over a spinning copper disc, and some of the members were puzzled to understand how it was that the needle was deflected. This gave the Secretary an opportunity for a short lecturette on lines of force and eddy currents. A discussion arose as to the simplest apparatus for detecting wireless signals, and some of our members seemed almost to be able to do it on their fingers.

Our Society is by no means tired of Einstein, and hailed with delight Mr. Kloot's exposition of his theories on the evening of June 15th.

The junior or elementary members were also catered for by the Secretary's description of the office of the aerial.

Mr. Knight gave some very practical hints on the choice and care of accumulators and dry cells.

Mr. Kennedy resigned the post of installation engineer, and Mr. Hunter was unanimously elected to fill the vacancy.

The Gloucester Wireless and Scientific Society.

(*Affiliated with the Wireless Society of London.*)

Hon. Secretary, J. J. Pittman, 1, Jersey Road, Gloucester, from whom any particulars of this Club may be obtained, or any information on amateur wireless willingly given.

A meeting of the Club was held on June 9th, at which a very complete and interesting lecture was given by Mr. E. W. Witchard on "Colour

Photography." This was illustrated by a number of slides the lecturer had made, and these were exhibited in a lantern. The subject matter chosen for this lecture ably illustrated the Club's policy of being not only a Wireless Society, but willing to welcome any scientific branch of an interesting nature.

Birmingham Experimental Wireless Club.

(Affiliated with the Wireless Society of London.)

A meeting of the above was held on May 29th, at the Club Headquarters, Digbeth Institute, Birmingham, when an instructive lecture was delivered by Mr. L. J. Dore, on "Electrical Measurements for Amateurs."

The meter bridge method of measuring resistance, capacity, etc., was explained in detail, and illustrated by many practical experiments which clearly showed the simplicity and accuracy of the methods of measurement advocated by the lecturer. Mr. Dore was heartily thanked at the conclusion of his paper.

At the same meeting an advisory Sub-Committee of six was appointed to discuss the erection of the Club's instruments at the new Headquarters.

The Hon. Secretary, Mr. F. S. Adams, 110, Ivor Road, Sparkhill, will be pleased to hear from ladies and gentlemen interested in wireless work.

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)

At the fortnightly meetings at the Headquarters, Albion Hotel, Piccadilly, Manchester, on May 11 and 25th, discussions took place on "Wireless Freaks." Mr. J. McKernan (the chairman) in his opening remarks, urged all amateurs to make a record of any experiences which they might have in that direction, because although as isolated incidents, they might not mean much to the amateurs concerned themselves, yet by bringing them to the notice of all members they might lead to new avenues of investigation. Many members joined in the discussion, and the Society was honoured by the presence of Mr. A. T. Stacey, Provincial Hon. Secretary of the Radio Society of South Africa.

At the next meeting, on June 8th, Mr. Stacey delivered a lecture on "Amateur Wireless in South Africa." Mr. Stacey outlined the constitution and aims of the South African amateurs, and fully explained the difficulties to be met with out there, the least difficulty of all being the Post Office authorities, who appear to be hand-in-glove with the Society. Several circuits were explained and the results obtained under very unfavourable circumstances. The outstanding feature of the evening being the close co-operation, which was very marked, between all the amateurs, who evidently make full use of the 50 watts allowed for transmission. Unfortunately, Mr. Stacey explained, that as there are only four land stations in the whole of South Africa, no other adjustments are required beyond 2,000 metres (Admiralty stations C.W.) and 600 metres (Post Office spark), so that reception is extremely limited except to the smaller W.L.S. (160 metres and 200 metres) employed by the members.

Any attempt at amplification in order to receive far-distant stations had disastrous results, owing to the continual presence of heavy atmospherics, though evidence was given of some very good results overland by amateur stations. A good average was for C.W. 75 miles, tonic train 60 miles, and telephony, 35 miles.

A novel H.T. battery was explained by Mr. Stacey, consisting of ordinary test tubes 8" long by ¾" diameter, connected by an inverted "U" of ordinary roofing lead and immersed in an electrolyte of dilute sulphuric acid of 1150 specific gravity. After a first charge of thirty hours these cells held their charge for one hour, and after two or three charges of about half the above duration the charge was held from three to four hours, and this capacity increased with every charge, until after about two months' constant use the maximum capacity of about 6 to 7 hours was attained. The special feature of this battery appears to be the total absence of sulphating and the lack of deposit due to wasting of the plates, which is extraordinary, in view of the poor quality of lead which is used. These cells are used by almost all South African amateurs, and units up to 500 volts are frequently met with.

A hearty vote of thanks to the lecturer was proposed by the Vice-Chairman (Mr. J. C. A. Reid) who announced that an honorary membership had been bestowed upon Mr. Stacey during his three-months' stay in this country.

An outing, with portable sending and receiving sets, took place on May 28th in the neighbourhood of Knutsford. This was one of an extensive series of telegraphy and telephony demonstrations which the Committee have arranged for the summer months.

Hon. Secretary, Mr. E. Samuels, 1, Parkwood, Victoria Park, Manchester.

Bradford Wireless Society.

(Affiliated with the Wireless Society of London.)

A public meeting was held at Randallwell Street, Bradford, on June 17th at 7.30 p.m., in the large room lent to us through the courtesy of Mr. Liardet. After addressing a few words of welcome to the audience, the chairman (Mr. Ramshaw) called upon Mr. Whiteley to give his lecture on "The Commercial Development of Radiotelegraphy."

The lecturer, in as simple language as possible, outlined the vast development of the commercial radio services from their commencement to the present day. The lecture was admirably illustrated by lantern slides, kindly lent by Messrs. Marconi's Wireless Telegraph Co., Ltd. Demonstrations were given on the apparatus, and the people present were able to hear signals from various stations by means of a loud speaker. Mr. Denison, of the Halifax Society, kindly sent us some telephony, which was much appreciated.

The proceedings concluded with a vote of thanks to the lecturer, proposed by Mr. A. Bever and seconded by Mr. Barber. Mr. Whiteley suitably replied, and thanked the various gentlemen who had arranged the demonstrations, etc. We had an attendance of about 150 people.

Acting Secretary, Mr. N. Whiteley, 8, Warrels Terrace, Bramley, Leeds.

Dartford and District Wireless Society.

(*Affiliated with the Wireless Society of London.*)

The usual fortnightly meeting of the above Society was held on Friday, June 17th, 1921, at Dartford Grammar School. Mr. J. R. Smith, A.M.I.E.E., Vice-President, occupied the chair, there being a good attendance of members.

The minutes of the previous meeting were read and confirmed, the members spending a short time in discussing experiments and reports of work brought forward.

The main item of the evening was a lecture by one of the members, Mr. R. H. Lyne, on "Valves." This member, having had considerable experience and training in wireless during his time of service in the R.A.F., was fully conversant with the theory and the practical application of valves in wireless work, and very clearly explained the subject, demonstrating his remarks by means of excellent blackboard drawings. Several good circuits, both for reception and amplification, were drawn for the benefit of those present, the whole subject being demonstrated in a very excellent and precise manner.

The membership of the Society is still increasing, ladies now being eligible, and all persons interested are invited to communicate with the Hon. Secretary, Mr. E. C. Deavin, 84, Hawley Road, Wilmington, Dartford.

Sussex Wireless Research Society.

(*Affiliated with the Wireless Society of London.*)

At the Society's meeting on June 8th, with the President, Capt. Hoghton, in the chair, Mr. W. E. Dingle described the construction and demonstrated the working of a single-valve two-circuit set, all the parts of which had been made by himself. The set was designed for spark, C.W. and telephonic reception, and operates on wavelengths of 200 to about 4,500 metres. Signals from a number of different stations were received very clearly, one feature of the set being specially noticeable, namely its quietness when oscillating, this being attributed by Mr. Dingle mainly to the firm leads employed and their secure attachment.

The next session will open in October, and the Hon. Secretary, Mr. Hughes, The Technical College, Brighton, will be pleased to hear from anyone in Sussex desirous of becoming a member of the Society.

The Wireless Society of Hull and District.

This Society continues to make good progress. On May 19th Mr. Jephcott read a most instructive Paper on "Electricity and Magnetism," in which a number of members joined in the discussion which followed. Then, on June 16th, Mr. Featherstone, who is well known in the city as a pre-war wireless amateur and ex-postal servant, gave a most interesting account of his experiences since he commenced as an amateur under the title of "Pre-war and Present-day Wireless." In the course of his remarks he related many amusing incidents, chief among them being the occasion, a few years ago, when he was so keenly interested in the inspection of a wireless installation on board a steamer lying at Hull, that he did not observe that she had, in the interval, left the quay, until it was too late for him to be put ashore, therefore he had no option but to take a forced voyage to a port in Norway, where the vessel was bound. Beyond feeling very uneasy about his people at home, he stated that he enjoyed his little trip.

The annual meeting for the election of officers for the ensuing year, and the transaction of other business, will be held on Thursday, July 21st, at 7.30 p.m.

All readers who are interested in the study of wireless and allied subjects, and resident in Hull and district, are reminded that a really active Society exists in the city, and the Hon. Secretary, H. Nightscales, 16, Portobello Street, Hull, will be pleased to give full particulars on application. The meetings are held at the Metropole (Marlboro' Room), West Street, monthly during the summer season and fortnightly during the other months. Resolutions for the annual meeting should be sent in to the Hon. Secretary at once.

Barrow and District Amateur Wireless Association.

During the past fortnight well attended meetings have been held each Monday night in the Club-rooms, Market Tower, Barrow-in-Furness.

The membership of the Association has increased considerably, and if the present enthusiasm, both with regard to study of theory and the learning of the Morse code, continues, splendid progress should be made.

By way of a change from the preceding theoretical "talks," and with a view of assisting new members desirous of learning the details and construction of inductances, a very interesting and instructive practical demonstration was given by Mr. W. Woods.

In the course of the demonstration, Mr. Woods showed exactly how the wire winding of an inductance should be commenced and finished in order to ensure a strong and workmanlike job.

He also demonstrated the construction of "pile-wound" coils, "honeycomb" coils, slab coils, etc., and, through the kindness of Messrs. Burnham, was able to show a complete set of their patent "Burndept" coils, which, when tried later upon the Club's aerial, gave excellent results.

Upon the following Monday evening, Mr. J. P. Atkinson gave a lecture relating to the theoretical considerations underlying the design of inductance coils. Coils intended for use in a receiving set only were dealt with, and the lecture was intended to follow on the previous week's demonstration as far as possible.

Mr. Atkinson discussed in a clear and more or less elementary manner, such matters as the elimination of self-capacity from receiving inductances and the formula for calculating the inductive values of various forms of coils.

Several members are making a start upon their stations, in addition, of course, to the several members already fitted up and duly licensed, and altogether it is thought that the Association is progressing in a satisfactory manner.

WIRELESS CLUB REPORTS

Wimbledon and District Wireless Society.

The monthly meeting of the above Society was held on June 8th, Mr. H. Nutton, A.M.I.E.E., in the chair, the occasion being a lecture by Mr. A. V. Ballhatchet on "Valves."

Mr. Ballhatchet, commencing with a brief outline as to what was meant by "Electrons" and "Ether Strain," and their relation to electro-technics, proceeded to deal with the historical development of the three-electrode valve, starting with Edison's original discovery and tracing step by step the improvements made as time went on. The construction of valves was next dealt with, and the lecturer, in order to illustrate his remarks, exhibited a very fine array of various types of valves, both transmitting and receiving. Mr. Ballhatchet treated his subject very skilfully, and everyone present agreed that his lecture was typical of those required by the amateur.

Mr. Ostler, in proposing a vote of thanks, remarked that there was in existence a vast army of experimenters, a large number of whom were totally ignorant as to the theory of the apparatus they were using. It was to be hoped that someone of that army would be fortunate enough to bring out some improvement: but this could only be attained by some definite theoretical reasoning. The lecture was one which would supply a number of amateurs with just the requisite knowledge to carry on. He remarked that he could not help wondering if, in time, the soft valve would come into its own again, as he thought that for good all-round reception a soft valve is greatly preferable to a hard one, providing that the instability of the vacuo could be overcome.

Mr. R. H. Drew seconded the vote of thanks, which was duly accorded.

The next meeting is on Wednesday, July 6th, at the Technical Institute, Wimbledon, S.W.19.

Hon. Secretary, Mr. W. G. Marshall, care of Technical Institute, Wimbledon, S.W.19, or 48, Warren Road, Merton, S.W.19.

Plymouth Wireless Society.

A meeting of the Plymouth Wireless Society was held on June 10th, Mr. H. W. Langmaid occupying the chair.

A third lecture on "Thermionic Valves," was given by our Vice-President, Mr. J. K. A. Nicholson, A.M.I.E.E., who dealt with the subject in its application to the high-frequency tuned amplifier. This lecture was greatly appreciated by all members, and a hearty vote of thanks was passed to Mr. Nicholson.

A meeting of the Plymouth Wireless Society was held on June 17th, Mr. W. J. Lewarn in the chair.

A fourth lecture on thermionic valves was given by our Vice-President, Mr. J. K. A. Nicholson, A.M.I.E.E., who dealt with the reaction or heterodyne principle, with particular reference to independent heterodyne and self-heterodyne methods of detecting C.W. signals.

Cambridge and District Wireless Society.

A meeting of the Society was held on June 8th, at 8 p.m., at the reading room of the Photographic Society, Ram Yard, with the Chairman, Mr. W. S. Farren in the chair. The chairman, after a little formal business was concluded, called upon the Secretary to deliver his discourse on "Valves." This he did, dealing firstly with the Fleming, and secondly with the Triode valve. At the completion of the discourse, a vote of thanks was passed to the Secretary. The subject was then declared open, and many questions relevant upon the subject were asked.

Blackpool and Fylde Wireless Society.

The members of the Blackpool and Fylde Wireless Society held another meeting at the Waldorf Cafe, Church Street, Blackpool, recently. There was, as usual, a good attendance. Mr. R. D. Ball, of South Shore, gave a most interesting lecture on "Low Frequency Amplifiers." He gave particulars of how to make transformers, and his helpful hints and advice were greatly appreciated by the members.

Hounslow and District Wireless Society.

The above Society held its first meeting on Thursday, June 2nd, at the temporary Club-room, The Mission Hall, Pears Road, Hounslow. There were fourteen members to start. We elected the usual officers—President, Mr. A. R. Pike; Vice-President, Mr. Saxby; Treasurer, Mr. Parker; Hon. Secretary, Mr. A. Rolfe; Assistant Secretary, Mr. H. F. Rolfe. The following gentlemen were elected on the Committee: Messrs. Ward, A. Downie, F. W. Osborne, H. Rolfe, and Marchant. The most of the first evening was given to discussion on all matters, relative to the formation of a wireless club, the matter of rules was left over until the next meeting.

The next meeting was held on Thursday, June 9th, and owing to the publicity given in the local paper, we enrolled six new members, making us just over twenty strong. The temporary permit having arrived, the Secretary, with the assistance of members of the Committee, erected a temporary aerial, and a two-valve set, kindly lent by Messrs. Burnham & Co., Ltd., of Deptford, and as Mr. F. O. Read was transmitting on that evening he arranged to speak to us but I am sorry to say we did not hear him. The Dutch concert was heard nicely, although we had a dozen pairs of telephones on. We take this opportunity of sincerely thanking Messrs. Burnham & Co. for the loan of the apparatus and to Mr. F. O. Read for his interest in the Club.—Hon. Secretary, Mr. A. J. Rolfe, 20, Standard Road, Hounslow.

West London Wireless and Experimental Association.

A meeting of the above Society was held at Belmont Road Schools (near Chiswick Park Station), on Thursday, June 9th, during which Mr. Studt continued the course of "Wireless." The lecturer explained the electron theory of matter very lucidly as a groundwork to succeeding lectures which would deal with inductance and capacity. The lectures are greatly appreciated by all, and although primarily intended for new members the thoroughness with which the subject is taken makes them instructive and interesting to the more advanced.

On June 16th Mr. Hirst will lecture on "Gadgets," a previous lecture on this subject having been found very interesting.

We are greatly indebted to Mr. F. O. Read, M.I.R.E., of Messrs. Burnham & Co., who is a member of the Society, for his special transmission of speech and music to the Society. The telephones were in great demand by the members, and it was decided that to allow all to "listen in" and not merely the fortunate few, a Brown loud-speaker would be purchased shortly.

The Society is progressing very favourably, and new members are admitted every week. All interested are invited to call any Thursday night at 7 o'clock at the above Club-rooms. Particulars will be gladly furnished by the Hon. Secretary, Mr. S. J. Tyrrell, 2, Providence Road, Yiewsley, Middlesex.

The Rugby and District Wireless Club.

Owing to the lack of suitable accommodation, the Committee of the above Club have decided to suspend activities during the summer months, with a view to commencing again in the autumn.

Would any gentleman in the locality who has a room to spare kindly communicate with the Secretary ?

Smethwick Experimental Wireless Club.

A most successful meeting of the Club was held on June 14th at the Smethwick Technical School, Mr. R. W. Hutchinson, M.Sc., A.M.I.E.E., F.R.G.S., F.G.I. (President), has agreed to support the Club in every possible way.

After the usual buzzer practice by our Instructor Mr. McKale, Mr. Saunders gave a lecture on static electricity.

The Chairman, Mr. Grew, brought his 3-valve amplifier and other apparatus, and a very interesting evening was spent in examining these various exhibits.

Anyone wishing to join the Club is cordially invited to communicate with the Hon. Secretary, who will gladly furnish further particulars.

Hon. Secretary, Mr. R. H. Parker, Radio House, 31, Wilson Road, Smethwick, Birmingham.

Anerley Wireless Society.

An interesting and highly successful meeting was held at the Club's headquarters on Wednesday last, when a demonstration was given to the members by "R. M. Radio," a firm whose name is well known to every amateur. The lecturer dealt very thoroughly and comprehensively with the theoretical working of thermionic valves, and demonstrated a new production, a soft valve of peculiar mushroom design which gives many times the magnification of the ordinary "R" type, and which will, if properly used, enable an ordinary polarised relay and any good tape machine to be used for the reception of wireless messages. This was followed by some very useful notes regarding the successful erection and operation of amateur stations, and finally the demonstration of a very fine set of instruments and a new 4-valve amplifier, which enabled the audience to hear, on the Club's aerial, signals, the strength of which would have done credit to a foghorn.

The Secretary will be pleased to hear from anyone desiring particulars of membership.

Secretary, Mr. F. Bailey, 14a, Weighton Road, Anerley.

The Wandsworth Common Wireless Club.

A most interesting and instructive lecture was given to the above Society by Mr. Turner (of the Edison Swan firm) on the subject of Thermionic Valves. The lecture was well attended, and with the aid of several different types of valve the lecturer cleared up many of the more obscure points connected with the study of valves. Any persons who are interested in radio work will be heartily welcomed should they care to give a call on any Friday, after 8 o'clock. Applications for membership should be forwarded to Mr. H. F. Buckmaster, 59, Hendham Road, Wandsworth Common.

Ilford and District Radio Society.

A successful meeting of the above Society was held at 8 p.m. on June 8th. A set of rules was put forward by the Committee and accepted by all members present. After the business of the evening eight new members were elected to the Society, and a very interesting lecture was given by the Vice-President, Mr. Welch, entitled, "The Condenser." A short discussion followed, and a hearty vote of thanks was accorded to Mr. Welch.

A meeting was held on June 22nd at the Society's permanent headquarters at Fuller's United Electric Works, Ltd., Chadwell Heath, which room has been kindly lent to the Society by Mr. Fuller. As soon as permission is obtained the aerial is going up and apparatus will be installed. An interesting half-hour was spent at buzzer practice, and it was decided that the entrance fee should be fixed at half-a-guinea and the yearly subscription at half-a-guinea.—Hon. Secretary, Mr. L. L. Vizard, 12, Seymour Gardens, Ilford.

Southwark.

It is proposed to form a Wireless Society (Amateur) for Southwark. Will those interested please write to Mr. J. R. Seabrook, 220, East Street, Walworth, S.E.17.

Brondesbury.

Mr. J. F. Stevens, of 119, Fordwych Road, Brondesbury, desires to get into touch with other amateurs in his district.

A CORRECTION.

On page 207 of the June 25th issue the photograph reproduced was incorrectly described as "The City of London School Wireless Society's Apparatus." The photograph should be described as a visit of the City of London School Wireless Society to the Handley-Page Aerodrome, at Cricklewood, where (by kind permission of Messrs. Marconi) the members inspected the wireless apparatus installed there.

QUESTIONS AND ANSWERS

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Questions should be numbered and written on one side of the paper only, and should not exceed four in number. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. **(4) The Editor cannot undertake to reply to queries by post.** *(5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.**

G.B. (Persian Gulf).—(1) The field round a basket coil will be as shown in the diagram given in Fig. 1.

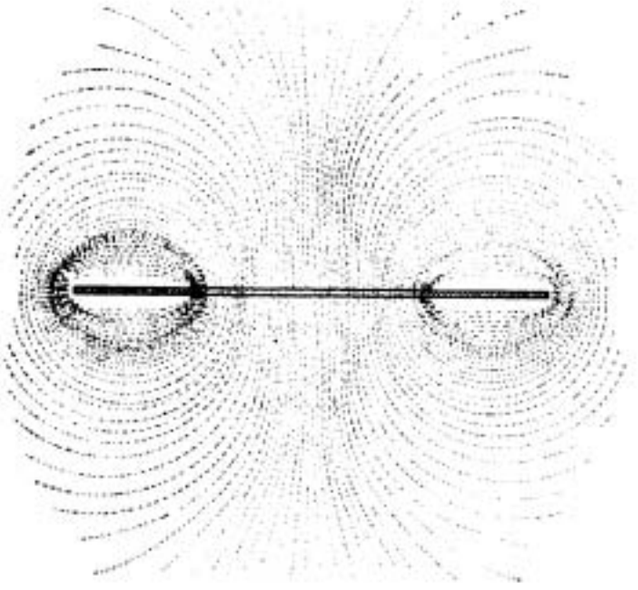


Fig. 1.

(2) Marconi valves have the connections to the various parts well separated; therefore the holders will have no capacity effect. Valves of the French type have the four connections made to a four-point plug. This plug holder will have an extremely small capacity of its own, which is negligible and which will not affect the internal capacity of the valve. The capacity of a valve is not the same incandescent as when cold.

(3) Possibly the Marconi Company could supply a soft valve of "N" type, which requires 50 volts on the anode.

(4) A small quantity of oil on the electrodes probably has a quenching effect similar to the action of the quenched gap, which quenches out the primary oscillation after one or two swings, and therefore reduces the secondary circuit damping. Too much oil increases the spark resistance, thus causing a considerable energy loss.

CONCERTS (Newcastle-on-Tyne) *asks with regard to the split H.T. battery shown in connection with a two-valve amplifier circuit on page 68, of the issue of The Wireless World for April 30th, 1921.*

The portion B_2 of the H.T. battery is arranged merely to compensate for the voltage drop in the anode resistance R_1, when the normal valve current is flowing. If this normal current is, say, $\frac{3}{4}$ milliamp the volt drop $= \frac{3}{4} \times 50{,}000 \div 1{,}000 = 37{\cdot}5$ volts. The part B_2' is the normal H.T. battery for the detecting valve in use. Value of B_2 for any other conditions of your set can easily be worked out by the above method. If the resistance of the primary of T is small, B_2 will be approximately the same voltage as B_2'.

TILAS (Falmouth).—(1) Aerial circuit 3,000 ms. Secondary (condenser 0·0006 mfds.), 8,000 ms.

(2) Aerial circuit, 4,000 ms. Secondary unchanged.

(3) Yes.

(4) Connect the grid and filament of the first valve to the secondary condenser in place of the crystal.

W.W. (Sutton).—(1) In order that a cylindrical coil may have the same inductance as a similar coil wound on a former of rectangular section it is necessary, to a first approximation, that the diameter of the cylinder should $= 1{\cdot}11\sqrt{ab}$ when a and b are the sides of the rectangle.

(2) Omitting the aerial switching arrangements, and similar details, Fig. 2 gives the type of circuit required.

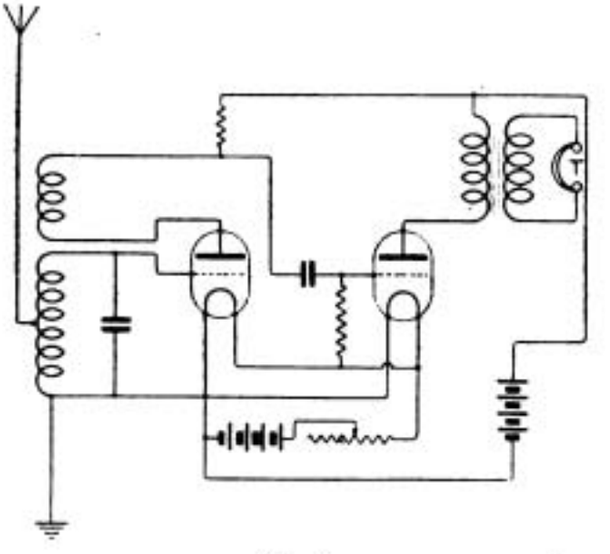


Fig. 2.

S.E.W. (Wandsworth Common).—(1) The iron pipe will have no effect—provided the aerial wire is well insulated from it. There is no need

to earth the mast. It will be better to drop the mast into the timber to the ground level. There will be more support then.

(2) Approximately 0·0015 mfds. for two sheets of foil separated by 1 mica and clamped very tight. For any condenser, multiply by the total number of spaces between the foils.

(3) No. (At least two valves will be required for good readable speech.)

(4) Wind a 4" former with 4" of No. 22.

ELECTRON (South Shields).—(1) Yes. Connect the blocking condenser across the H.T. battery as well as telephone transformer primary.

(2) Assuming 6" of winding, the maximum wavelength will be 9,000 ms.

(3) 3 ozs. of No. 32 on a former 6" long.

(4) 5 plates, 2" × 1", with 0·002" mica.

A.C.D. (Rushden).—(1) As far as we can judge without a wiring diagram of the panel illustrated, the set is of quite good type, and not susceptible of any considerable improvement without redesign for use with a greater number of valves.

(2) The best value for the A.T.C. will depend on whether it is connected in series or in parallel with the A.T.I. As your illustration does not show, you will have to trace this for yourself, or inquire of the makers. If in series, the capacity should be about 0·005 mfds. If in parallel, not more than 0·001 mfds.

(3) Using a condenser of 0·001 mfds., which will be desirable for such a long wavelength as 20,000 ms. the A.T.I. should be 16" × 8", wound with No. 30, if single layer; or 7" × 3" wound with No. 24, if a 5-pile winding is used. The latter is more difficult to wind, but would give better results.

AETHER (Burton Joyce) *asks.*—(1) *for connections for adding a T b R.N.A.S. amplifier to a set (of type not specified).* (2) *The purpose of the* 0·4 *jar condenser across the grid of the first valve.*

(1) See Figure 3. As you do not state the type of set, we will presuppose a crystal set. If you are already using valves a little alteration of the amplifier will probably allow the same batteries to be used for both, though this is not altogether desirable, as it tends to increased liability to "howling."

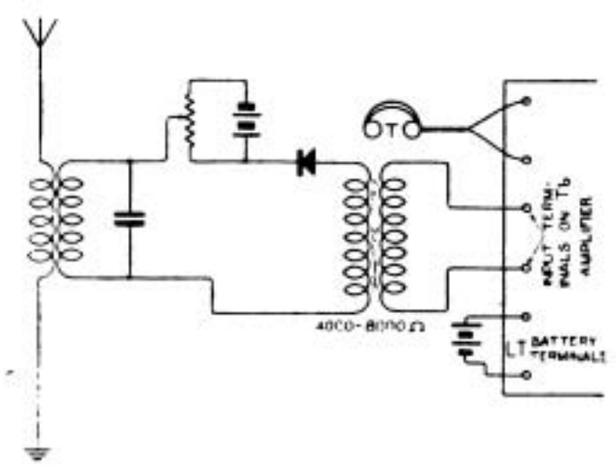


Fig. 3.

(2) The purpose of the condenser appears to be for approximate L.F. tuning of the grid circuit. The value given is probably one arbitrarily chosen to give the best results with the transformer secondary of some already existing set.

WIMBEACHO (London).—(1) The suggested air-cored L.F. transformer will probably give fair results. The winding ratios are about right, but a bigger former with larger grooves containing more wire would be much preferable. With the sizes you suggest results would be considerably improved by introducing some iron to the core.

(2) The efficiency of an L.F. transformer is entirely independent of the wavelength of the signals. It will, however, vary somewhat with the note frequency. We cannot, however, predict from the data supplied what will be the optimum note for reception.

I.G.P. (Glasgow).—(1) The suggested switching arrangements are O.K., except that the telephone arrangements are not very good, as the currents from the two valves may not be in phase to assist each other. We should prefer to arrange a switch to throw the telephones into either of the valve anode circuits at will. This would, of course, involve putting the telephones on the positive side of the battery, which would make the use of a telephone transformer desirable.

(2) Subject to this, and the fact that you show no filament resistance for one of the valves, the circuit should be satisfactory, if you put a blocking condenser across the telephones.

L.J.V.K. (Towyn).—(1) The tappings cannot be correctly made.

(2) A L.F. amplifier will be the simpler, and probably more suitable for your purpose. A constructional article on L.F. magnifiers has just appeared in the magazine. With slight modification for H.R. telephones it will meet your requirements.

(3) We cannot say.

(4) The wavelength will depend on the condenser and loading inductance, which you do not mention. A 2' frame is not of much use without several valves.

NOVICE (Taunton).—(1) It is impossible to say. Have you followed instructions as to the winding of the formers? Perhaps you have the sections opposing each other, either on one former or on the other. The set works well.

(2) A valve set is oscillating when musical note spark signals are changed into a hiss, and it should be adjusted for this condition in order to receive C.W. Read R. D. Bangay's book: "The oscillation Valve."

F.E.W. (Wednesbury).—(1) Two coils in series on a P.M.G. aerial, 2,400 ms.

(2) 2,500 ms.

(3) Yes. Have you tried a potentiometer to the crystal, also a blocking condenser across the telephones.

(4) Probably due to a break in the crystal circuit.

E.F.H. (Epsom).—The long wave set recently described is quite suitable for spark signals. You may find it an improvement to use a grid condenser and leak.

QUESTIONS AND ANSWERS

CONSTANT READER (The Hague).—(1) We know of no special reason for this. The limit is 100′ single wire or 140′ of twin wire.

(2) This is simply LOCK, meaning that the buzzer key is held down continuously in that position.

HOWLER (Harlesden) *asks* (1) *How are the windings for H.F. intervalve transformers determined, and is there a formula for calculating windings to give maximum sensitivity on any certain wavelength.* (2) *In order to obtain maximum sensitivity on a wavelength of* 1,000 *ms. in radio-frequency amplification, it is proposed to wind on an ebonite rod* $1\frac{3}{4}$″ *diameter in eight slots* $\frac{1}{16}$″ *wide, and cut* $\frac{1}{2}$″ *deep and (to give fairly good coupling) to connect alternate slots in series. What would be then the most efficient windings for both primary and secondary.* (3) *What is the cause of a high-pitched howl when using more than three L.F. amplifications.* (4) *How can this howl be eliminated.*

(1) No; at present H.F. transformers are adjusted experimentally.

(2) Try winding all sections full of No. 44 S.W.G. See amateur constructional articles appearing shortly on this subject.

(3) Inter action—magnetic or electro static—between the L.F. transformer causes audible frequency oscillations to be generated.

(4) It can nearly always be stopped by reversing the transformer connections. These should be methodically carried out.

R.A.C. (Fulham) *asks for a formula for calculating wavelengths to which an aerial circuit can be tuned, having the A.T.C.* (1) *in series.* (2) *In parallel.*

(1) For small aerials only, such as allowed by the P.M.G., use the following :—

(1) With no series condenser

$\lambda = 1885 \sqrt{LC}$ wherein L = added inductance, and C = capacity of the aerial—usually about 0·0002 mfd.

With series condenser. This reduces the capacity of the whole circuit. $\lambda = 1885 \sqrt{LC}$ wherein C = resultant capacity of the aerial and tuning condenser in series.

(2) $\lambda = 1885 \sqrt{LC}$ wherein L = added inductance and C = capacity of the two condensers in parallel, *i.e.*, the aerial (0·0002 mfd.) and the tuning condenser.

N.B.—These formulæ are approximate only, and must not be expected to give less error than 5 to 10 per cent.

G.W.B. (Northampton).—(1) The Postmaster-General, G.P.O., London.

(2) Description, height, length and arrangement of aerial; diagram of connections and wavelength of receiver. An ordinary permit does not cover the use of valves, for which you must make special application. You will have to furnish references and sign a declaration and pay 10s.

G.R.H. (Elland).—(1) The circuit is O.K., but is the grid condenser and leak a good one?

(2) The set should work well; have you followed the directions as to winding the pile inductance, and are the sections of the winding opposing each other?

(3) Huddersfield (Y.M.C.A.) Wireless Society, Hon. Secretary, Mr. F. Simpson, 3, Daisy Street, St. Andrew's Road, Huddersfield.

(4) 1,000 ohms telephones are neither high nor low. Why not use 120 ohm with a good transformer.

"CRYSTAL" (London).—(1) The Dutch concerts have now been carried on for some considerable time, and, as far as we know, are to be continued indefinitely.

(2) When you give the range of your receiver as 1,000 miles you probably mean on signals from high power stations. If your ship is stationed anywhere near London you are not likely to get these concerts on crystal alone, as the transmitted power is quite small.

R.B. (New Malden).—(1) The circuit is a very poor one. We strongly advise you to use one of the normal type, for which see Fig. 6, page 64, April 16th issue.

(2) and (3) We cannot state the wavelength of the set or the constants of the components, as you do not give us either the diameters of the inductance formers, or the thickness of the dielectric of the condenser.

(3) No particular resistance is desirable for telephony. The proper resistance to use depends on the nature of the set, and not on the purpose for which it is to be used. With a crystal a higher resistance than 300 ohms is desirable unless you use a telephone transformer.

A.J.F. (Chippenham).—We should have been able to give you more accurate values for your coils if you had sent a sketch or description of the way you propose to connect up the various instruments you mention. If you are using two circuits and reaction, make the A.T.I. winding 5″ deep of No. 24; closed circuit $3\frac{1}{2}$″ deep, of No. 26; and the reaction coil $3\frac{1}{2}$″ deep, of No. 32. You should not be troubled with insufficient coupling if you are using basket coils.

G.W.D. (Sydenham).—(1) and (2) The reason for the noises in both the cases you describe is probably intermittent oscillation of the set. In the neighbourhood of the critical reaction, very slight variations in such items as the voltage of the batteries are sufficient to start and stop oscillation. Your H.T. battery is probably not above suspicion.

(3) A discussion of the relative merits of different methods of H.F. and L.F. amplification would take more space than we can spare in these columns. A L.F. amplifier, with an iron cored intervalve transformer, is generally the easiest type to add to an existing set and to handle, and it gives very useful results.

(4) Most receiving valves are quite satisfactory amplifiers. The "R" type is quite suitable for this purpose.

C.C.M. (Bearsden).—(1) Various valves of the "French" type are made, requiring different plate voltages. The common R type should not be run much above 100 volts. The B type can be run on higher voltages, as it is pumped harder.

(2) It is very difficult to suggest a range, as so much depends on the efficiency of the sets and local conditions. Possibly 15 miles for telephony and 30 for C.W. telegraphy.

C.F. (Cricklewood).—(1) Yes, fairly, but it is quite unnecessary to use heavy insulation on an aerial wire.

(2) This can be done, if desired, but is not really necessary. An arrester gap between the aerial and earth leads will serve the purpose.

(3) We regret that we have no exact information as to these windings, but think it is very unlikely that they are unsuitable.

(4) An article on this subject is appearing shortly.

GAUSE MAT (Newcastle).—(1) Both are useful circuits. It is doubtful if you have sufficient reaction coupling in your tuning arrangements on long waves, as the coupling inductance (2) only forms a small part of the total inductance of the aerial circuit.

(2) Approximately, 0·0003 mfds.

(3) 13,000 ms. without parallel condenser.

(4) It would probably give better results connected, by means of the intervalve transformer described in place of the telephone transformer, in the anode circuit of the second valve.

J.G. (Coventry).—(1) Tuning coil 4" in diameter wound for 8", with 8 ozs. of No 24.

(2) Reaction coil 3" in diameter, wound for 3", with 1½ ozs. of No. 28.

(3) Aerial series condenser 0·0005 mfds. variable.

(4) The reaction coil need have no condenser across it.

E.A. (Rhyl).—(1) and (2) We have no experience with this type of transformer, but think it should be satisfactory. As you wish to use thicker wire, it will probably be necessary to use 8 ozs. for the first winding, and 2 to 3 ozs. for the second winding.

X.Y.Z. (Seaham) *wishes to make three condensers, two ordinary* (0·001 *mfds. and* 0·005 *mfds.*) *and one adjustable, and asks* (1) *How many pieces of tin foil,* 1½" *round, go to make these.* (2) *How many* 2" × 4" *would make the same.* (3) *How many zinc plates,* 4" *round, cut in half,* 2 *mms. thick and* ⅛", *between moveable and fixed plates, go to make a* 0·0005 *variable condenser.*

(1) Assuming the thickness of the dielectric as 0·005", use 4 rolls for 0·001 mfd. condenser, and 16 for 0·005.

(2) For 0·001 use 2 foils, and 6 for 0·005.

(3) Approximately 16 fixed vanes and 15 moving.

T.T. (South Shields).—(1) No particulars of the variable condenser it is proposed to use are given, therefore we cannot calculate the necessary inductance. For such a long range the frame should have not more than 20 turns.

(2) Yes.

(3) Useful for loud signals, but weak signals would not be so easily detected as with head telephones.

TINFOIL (West Hampstead).—(1) Any value round about 0·001 to 0·002 mfds.

(2) Approximately 0·00025 mfds.

(3) Assuming the area of overlap of the plates as 15 sq. cms. and the thickness of the waxed paper 0·005", the total number of foils should be 5.

(4) Approximately 4,000 mhys. Wavelength on standard aerial barely 2,000 ms.

L.H.P.W. (Covent Garden).—(1) See the article on page 168 of the issue for June 11th.

(2) Run the earth lead bare wire—down outside the house.

(3) You will probably get most satisfactory results with a simple single valve reaction circuit. See recent articles.

(4) With a crystal set on the P.M.G. aerial you will get ships and coast stations on 600 ms., and four or five stations on about 3,000 ms. With a single valve reaction set you will get other stations besides these on intermediate wavelengths.

B.R. (Oxford).—(1) No. Strong signals are required for loud speakers.

(2) We have no particulars of these loud speakers.

(3) We can only recommend you to try these things. We should be glad to hear the results.

(4) Yes, if the aerial is large enough.

Q.J.G. (Grigglestone).—(1) We are sorry we have no full details such as you require to hand. The gauge of wire is probably about 24.

(2) Nos. 14, 15 and 16, Vol. VIII.

(3) No.

(4) Results have been published in *The Wireless World.*

H.O.N. (Callestick) *asks in reference to diagram on p.* 840, *Vol.* 8, *No.* 25, *The Wireless World* (1) *If a single* 150 *H.T. can be used instead of two as shown.* (2) *Could a second pair of valves be connected up in cascade.* (3) *Do the values of H.T. and resistances for V24 valves require to be different.* (4) *Using for C.W. must a separate oscillation generator be used.*

(1) No.

(2) Yes. With two separate H.T. batteries for each amplifier unit.

(3) Yes. Less H.T., say 40 to 60 volts, for V24 valves.

(4) Usual but not essential.

J.D. (Chesterfield).—(1) and (3) The set shown is of somewhat clumsy and obsolete type. It will have a probable range of from about 3,000 ms. to 10,000 ms. We should strongly advise you not to build it, as at least equal results could be obtained with a three-valve resistance amplifier of normal type, using only one L.T. and one H.T. battery for all the valves.

(2) The set was designed for soft Audion valves, but would probably work fairly well with hard valves if you introduced grid leaks.

G.C.B. (Wolverhampton).—(1) and (2) All these windings will be all right, but you could increase the diameters of the coils in the aerial circuit somewhat and get longer wavelengths efficiently if you wished to.

(3) Minimum a few hundred metres. Maximum about 3,000 ms.

(4) Large bichromate cells could be used for the filament of a valve, but we should strongly prefer an accumulator, on the score of cheapness in running, cleanliness, and convenience.

C.B. (Stoke Newington).—See replies to G.C.B. above, who has submitted the same circuit with the same windings. Two mfds. is too big for a telephone condenser. The value should be about 0·002 mfds.

G.B.S. (Winscombe).—(1) The circuit will be quite correct.

(2) No. 24 wire will be quite suitable for all the coils, including the A.T.I.

(3) A small condenser in the place shown dotted is very useful to increase the wavelength of the aerial circuit.

(4) It is quite immaterial which you use.

K.F.H. (Walthamstow).—(1) The circuit should work quite well for spark and telephony, but will not receive C.W., as you are not using any reaction.

(2) There is no ground for the belief that crystals have any particular advantage over other types of detectors for telephony. Any good spark receiver should be equally good for telephony.

(3) Certainly; common H.T. and L.T. batteries may be used. For the principle of connections used, see various recent sketches in these columns.

(4) These depend on the dimensions of the rest of the apparatus. The term "ratio of transformation" for a loose coupler is undesirable, as in such a circuit the volts induced are not proportional to the ratio of the number of turns:

A_1 may be 6" × 5" of No. 22.
B_1 may be 5" × 3" of No. 24.
C_1 may be 5" × 3" of No. 24.

Coupling coil may be 40 turns of No. 22, on a former 2½" in diameter.

L.B.B. (Cape Town).—(1) We know of no formula of much use for the wavelength of a tuned H.F. transformer. The value depends too much on more or less indeterminate factors such as the capacities of the windings.

(2) The circuit is quite good. There is no need for a loading coil in the plate circuit of the first valve. A telephone transformer would improve results.

(3) If C and L be the capacity and inductance of the aerial, and L_a is the loading inductance required for a wavelength of λ_a, then

$$\lambda_a = 1885 \sqrt{C (L + L_a)}$$

(4) For aerials of P.M.G. size an inverted L is better than a T; for larger sizes neither has any particular advantage over the other. 3/20 wire will be somewhat better than No. 16.

M.D.M. (Cricklewood).—(1) Either is quite good, but in general, inductive reaction is somewhat the easier to arrange and handle.

(2) For long waves resistance amplifiers are very good, but they give poor results on short waves. The transformer type is good for any wavelength if suitably designed for that wavelength, but the transformers require to be differently wound for different ranges of wavelengths.

(3) No grid leak is shown in the diagram referred to because no grid condenser is used in the set. As there is no grid condenser there is evidently no necessity for a grid condenser leak.

(4) Yes, if the baskets are slightly separated from each other. If they actually touch, capacity effects will be undesirably large.

"ARC" (Dundee).—(1) There is no formula applicable to the case of several basket coils connected in series, as the total inductance depends in an involved way on such factors as the thickness of the pegs on which the baskets are wound, and how closely the baskets are fitted together.

(2) Over a long range of wavelengths such as you give we should prefer the resistance type.

(3) No single transformer would be suitable for such a large range, and the design of a complete set for the purpose is outside the scope of these columns—(compare reply 2).

R.B.P. (Sedbergh).—(1) Yes, quite.

(2) Coupler is too small for the range you specify. Increase primary to 10" by 6", wound with No. 24; and the secondary to 8" by 5", wound with No. 28.

(3) Fairly satisfactory, but a higher resistance would be more efficient.

(4) No; for the range of wavelength you specify, even with the windings we have given you, you will require at least 0·001 mfds.

F.D.C. (Bristol).—(1) The scheme you suggest is unnecessarily complicated. Use any one coil with a variable condenser as mentioned across it in the aerial circuit. This will tune the aerial circuit to values slightly above those which you quote.

(2) For the reaction coil use any one of the coils not in use in the aerial circuit, finding out by trial which gives the best results at different wavelengths. You will probably find that at short waves the reaction coil should be a little bigger than the A.T.I., while at long waves it may be possible to use it considerably smaller than the A.T.I.

(3) Yes; but preferably only use small values of it, particularly at short wavelengths.

(4) Circuit should be quite all right; but the series condenser is not at all necessary.

ANTENNA (Liverpool).—(1) Aerial is rather too small to give good results with a crystal only, but you should get stations fairly near all right. Distance apart for the wires should be as large as possible, up to about 8'.

(2) Circuit is wrong in nearly every particular; see Fig. 4, page 756, January 22nd issue, and many other similar diagrams.

(3) With this circuit your components would tune to about 2,500 ms., but would be inefficient above about 1,000 ms., owing to your condenser being too large.

(4) Quite suitable.

"JACK EMMA" (Winchester).—The information you require is rather scattered, and much recent work is still unpublished. You will find a good deal of information in the abstracts in the *Radio Review*, and Dowsett's recent book deals with the Einthoven galvanometer method, of which you appear to be thinking. The photographic method appears to be becoming obsolete, owing to its inconvenience. Very high speeds have been attained by chemical methods not based on photography, but the most promising work is being done with P.O. relays and high-speed inkers, in conjunction with specialised circuits of various types.

R.O.G. (Scarborough).—(1) It is quite possible for an amateur handy with tools to make a satisfactory receiving set. For reception without use of an outdoor aerial the type of set necessary is somewhat more complicated than a set to give similar results with an outdoor aerial. A small transmitter can also be made by an amateur, *i.e.*, one suitable for a range of about a dozen miles. On the other hand transmission for 150 miles

would require much more power than an amateur is allowed to use, and the construction of a suitable set would become too much of a workshop job for an average amateur to undertake.

(2) There is no very suitable book available. You will find full working instructions for many types of receivers in the constructional articles in this magazine.

(3) This will probably prevent you from getting a transmitting licence, but not a receiving. You will, however, be prevented from using certain types of circuit which would be liable to give interference.

L.E.B. (Bradford-on-Avon).—(1) Quite satisfactory, except that we should prefer the use of a telephone transformer, as the telephones are on the positive side of the H.T. battery.

(2) About 4,000 ms.

(3) It should be.

(4) We doubt if you will get very much on 600 ms. situated where you are, as we cannot call to mind any such stations in your neighbourhood.

T.P. (Peterborough).—(1) The set mentioned appears to be of quite good design, and should certainly be well made at the price quoted.

(2) Yes.

(3) We think the figures you give represent the approximate maxima for the set, and not the maximum and minimum. From the cut published, there appears no reason why the set should not tune down to 600 ms. as it stands. If it will not, the design is very poor.

(4) Yes.

F.H. (Sunderland).—(1) We are not clear whether you mean range in miles or range in wavelength. If the latter, up to about 3,000 ms. If the former, it depends entirely on the power of the sending station, but you would not be likely to get anyone at more than about 500 miles.

(2) To receive any station however large at 4,000 miles on as small an aerial as yours, you would require at least three valves, unless you possess considerable skill and experience. Also one H.T. battery, one L.T. battery, loose coupler, three or four condensers, valve holders, resistances, intervalve transformers, telephones, etc.

(3) Yes, judiciously used, quite a good earth can be got from wire netting laid on the ground.

(4) The normal receiving licence fee is 10s.

G.B. (Southfield).—(1) For critical work better results can be obtained with separate heterodyne if the number of valves in the receiver are not changed: but you would probably get better results with a 2-valve receiver on self heterodyne, than on a 1-valve receiver with a separate heterodyne.

(2) Circuit suggested would probably oscillate, but it would be difficult to predict the wavelength range. We should prefer the more normal type with the grid and plate circuits separate.

(3) It would be sufficient if you made these coils with a few tappings on each.

(4) You would get a beautiful howl!

C.M.L. (Brighton).—(1) Fairly well, but the design might be a good deal better.

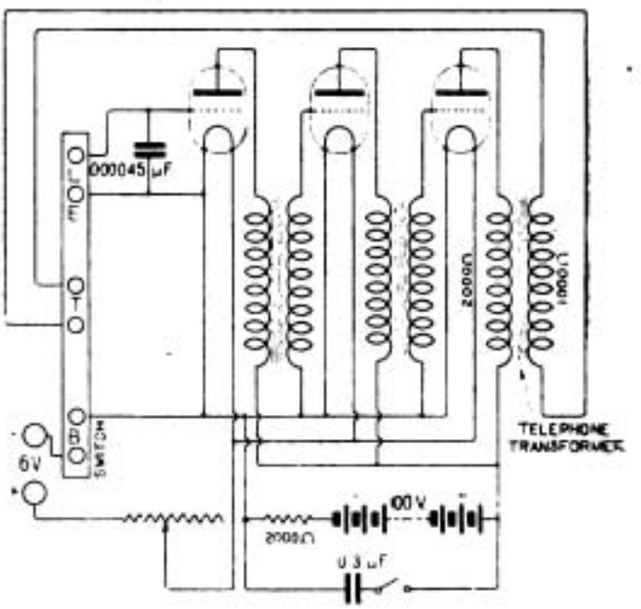
(2) Transformer may be 1 oz. and 2 oz. of No. 44, wound on an iron core ½" in diameter.

(3) Both the condensers may be blocks. The values given will probably be fairly suitable.

(4) The core should be of soft iron wire, of fairly small gauge.

H.W.D.—(1) Many ways are possible, but the simplest would be to use the additional valve as a L.F. amplifier, connected in by means of an intervalve iron cored transformer, introduced immediately on the positive side of the H.T. battery. The telephones will, of course, be removed, and introduced in the plate circuit of the additional valve, preferably with a telephone transformer. For the method of using the same batteries for both valves see many circuits shown in this magazine.

Below is a diagram of the R.N.A.S. Tb amplifier for which several readers have enquired.



SHARE MARKET REPORT.

There has been very little business done in the Wireless Group during the last fortnight.

Prices as we go to press, July 1st, are:—

Marconi Ordinary	£2	5	9
,, Preference	£2	5	0
,, Inter. Marino	£1	6	3
,, Canadian		7	6
Radio Corporation of America:—			
Ordinary		9	0
Preference		10	6

The WIRELESS WORLD

FORTNIGHTLY] JULY 23rd, 1921. PRICE 6D NET

THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. IX. No. 35. JULY 23RD, 1921 FORTNIGHTLY

A SIMPLE MACHINE FOR WINDING COILS OF HONEYCOMB TYPE

By W. FORBES BOYD.

TO those amateurs who believe in making their own apparatus, the tediousness and time taken in winding inductance coils has always presented a serious problem.

The following article describes a method of winding such coils quickly, symmetrically and without sides.

Figs. 1 and 2 show the finished coils, one of them being mounted on an ebonite centre piece.

In order to wind a honeycomb coil it is necessary to give the wire a regular lateral movement as the coil is rotated, this lateral movement giving the wire a wave formation so arranged that the second turn slightly leads or lags behind the first turn, and so on.

At the end of a certain number of turns, say 25 turns, the wave formation of the wire exactly coincides with the first turn so that there are several thicknesses of wire between one turn and the subsequent coincident turn, thus reducing the equivalent self capacity of the coil to a very small value.

If the lead or lag given to the wire is only, say, 1/100th part of the circumference of the coil, although the distance between coincident turns is increased, the distance between consecutive turns becomes less and the effect is more like a plain layer-wound coil, which has a high and undesirable equivalent self-capacity.

It has been found that a lead or lag of 1/25th part of the circumference of the coil having an inside diameter of 1½ ins. when wound in the manner to be described with

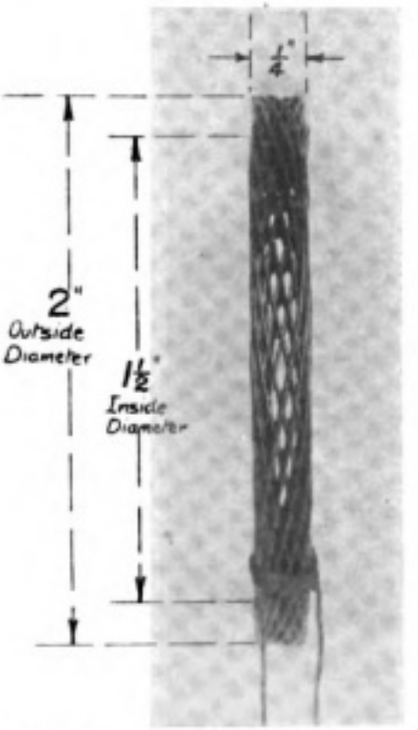


Fig. 1. Machine Wound Honeycomb Coils showing the formation of the wire.

No. 36 S.W.G. wire gives good results, having approximately 1/16th of an inch between consecutive turns.

Fig. 3 shows a diagrammatic arrangement of the mechanism.

A screwed spindle A is held between the centres of a lathe and on this spindle a wood boss B is clamped upon which the coil is to be wound.

The spindle A drives another spindle C at right-angles to it through Meccano bevel wheels D, having a gear ratio of 1 : 1.

This spindle C is mounted on a wood base block which is fixed to the bed of the lathe and is provided with a Meccano pinion E, having 25 teeth.

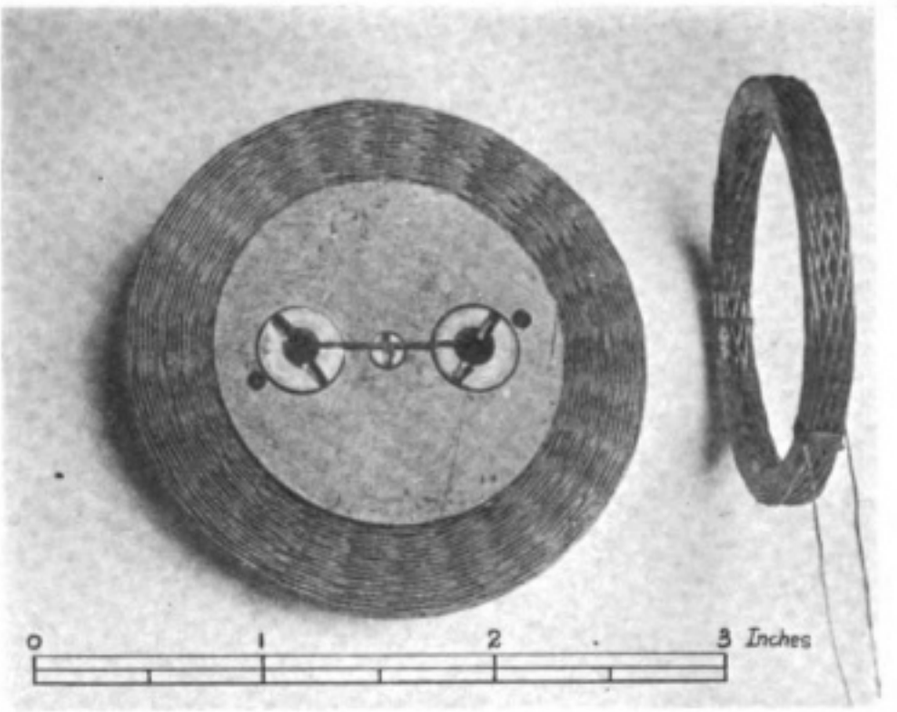


Fig. 2. Two coils, one of them with centre ebonite disc and brass hollow screws for quick connection.

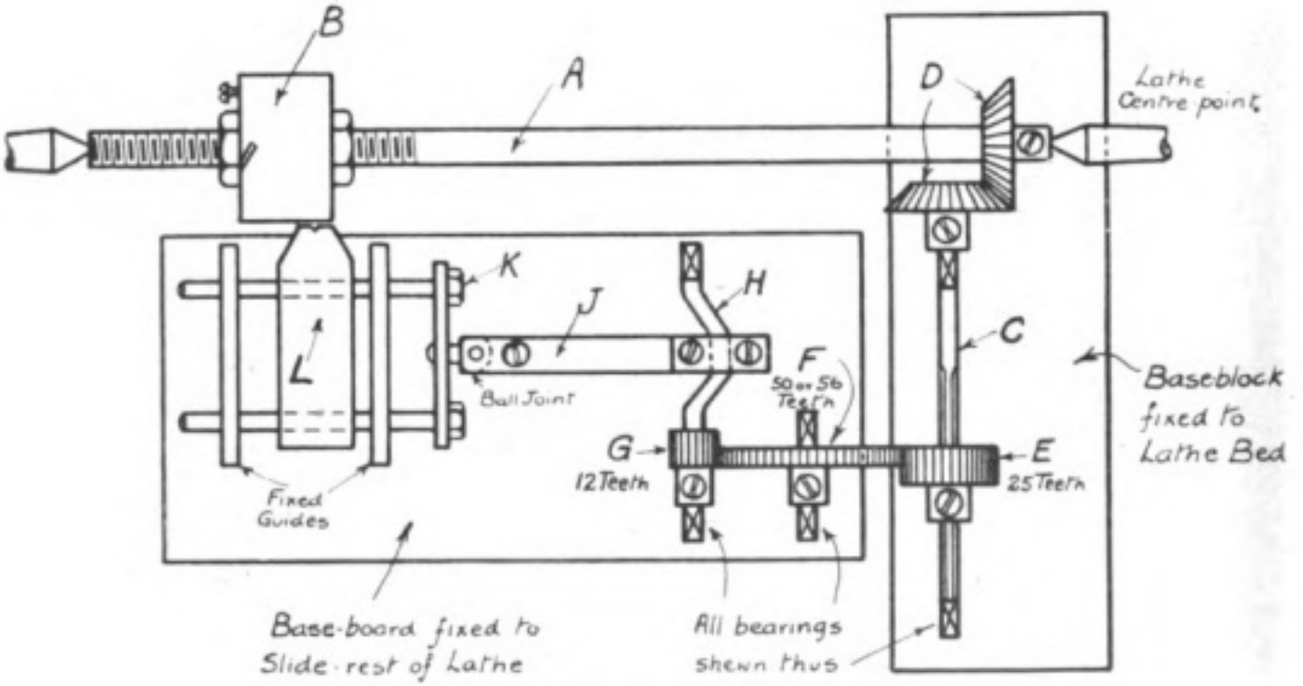


Fig. 3. Line drawing of general arrangement.

The pinion E drives another Meccano pinion G, having 12 teeth, through a gear wheel F having any number of teeth ; convenient stock sizes being 50 or 56 teeth.

The pinion G is rigidly attached to a cranked shaft H, and by means of a connecting rod J and slider gear K the rotating motion of the crank is converted to a straight line motion.

To the sliding gear K a pad L is fixed, which comes opposite to the wood boss B.

All the material from the gear-wheel F to the pad L is fixed on a base-board which is attached to the slide rest of the lathe.

The wire which is to be wound is brought over a small groove on the pad L, being fed as near as possible at a tangent to the outside diameter of the boss B, and revolving the spindle A *towards the wire*, the pad L is kept as near the work as possible without touching.

After the coil has become ¼ of an inch thick, the pinion E is unscrewed and moved along the spindle C, a flat on the spindle ensuring symmetry of winding.

It is important that there should be no play or back-lask in the moving parts H, J and K, also that the wire be fed with a constant tension through a felt-lined clamp or similar device.

It is also advisable to wind about 6 layers of paper on the boss B before starting to wind the coil thereon, in order to facilitate the drawing off of the coil when completed.

When winding, the writer keeps the shellac brush touching the coil with one hand and with the other hand moves the slide-rest

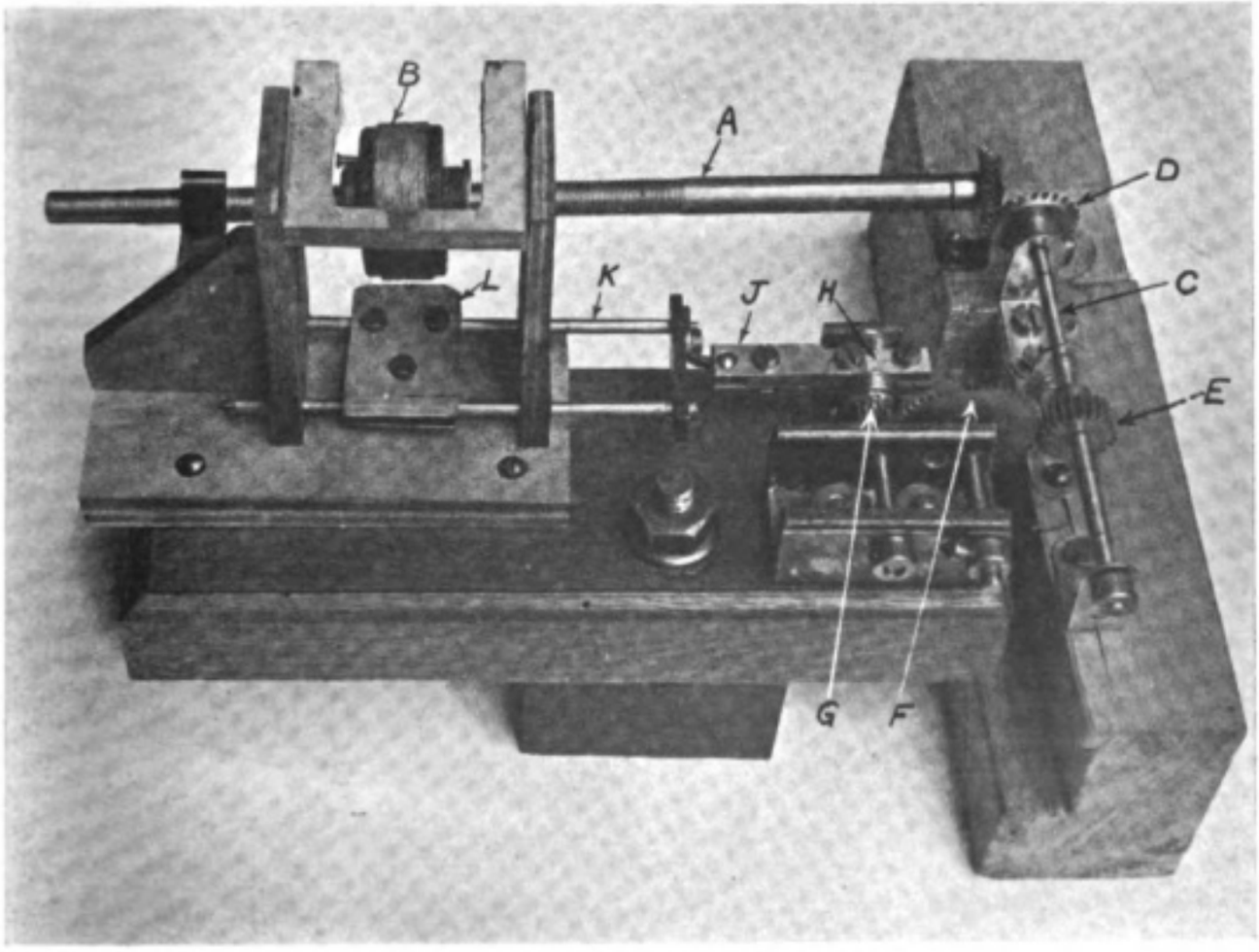


Fig. 4. Photograph of general arrangement.

screw which is constantly screwed away from the boss B as the coil increases in size.

Fig. 4 shows the general arrangement, the photograph being taken without the lathe.

The crank in the illustration has a throw of ¼ of an inch which makes the coil the same thickness, but it is an easy matter to have a set of cranks to make coils of different thicknesses although the writer favours the standardisation of coil thickness and making coils of varying diameters for different inductance values.

If coils of larger inductance are required, several coils of 3-inch outside diameter are mounted together and connected in series.

LOUD SPEAKING TELEPHONES—II.

By PHILIP R. COURSEY, B.Sc., F.Inst.P., A.M.I.E.E.

(*Continued from page* 228.)

AS has been indicated in the first instalment of this article, any material having the necessary slight conductivity and high contact resistance will serve the purpose of the "semi-conductor" there referred to, but different materials will obviously differ in their effectiveness in this direction. Some show these large adhesive forces much better than others, and in particular lithographic stone, slate, agate, gelatine film, some kinds of paper, hard wood and similar materials will usually show the effects well, but a great deal depends upon the state of the surface of the material, and success or failure often depends upon this detail. A good polished surface is necessary in order that the metal electrode may be in the closest possible position relative to the surfaces of the material.

The above list is not intended by any means to be an exhaustive one of these materials, and almost any substance that is not either a metal or a very good insulator will show these effects to a greater or less degree. Interesting experiments can easily be carried out to investigate different materials in this connection, and to determine their relative value for these purposes.

These electrostatic forces may be made use of in a number of different ways, but an application of considerable interest to wireless engineers is to the construction of another type of loud-speaking telephone. One way in which this result may be achieved consists in making up the semi-conducting material in the form of a cylinder having a metal core—which serves to form the fixed electrode designated by B in the preceding diagrams—which can be rotated by some suitable motor such as clockwork or a small electric motor. Such a cylinder is indicated diagrammatically at A in Fig. 5. Round the surface of the cylinder a thin metal band BB is laid, one end being attached to the centre of a diaphragm and the other fastened to a spring S so as to retain it in tension. The cylinder is driven round in the direction indicated by the arrow. When an attractive force is set up between the metal band and the surface of the cylinder there is an increase in the friction between them so that the moving cylinder drags on the band and hence deflects the diaphragm. A variable voltage applied between the metal

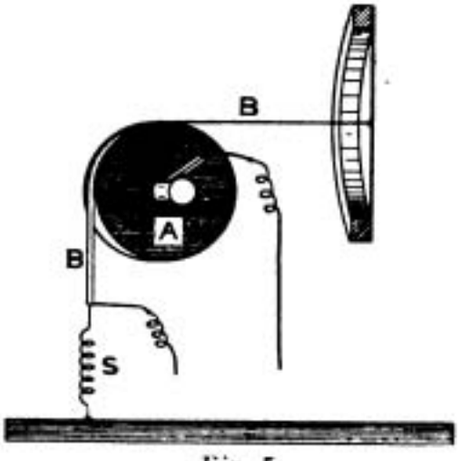


Fig. 5.

band and the metal core of the cylinder will, therefore, produce corresponding movements of the diaphragm, so that a sound wave will be set up having a form corresponding to the waveform of the voltage applied to the apparatus.

Since the attractive force is very small for small voltages, it is desirable to apply a steady polarising voltage to the apparatus, and to superimpose the variable voltage upon it. The attractive force increases with applied voltage somewhat as indicated by the curve of Fig. 6, so that the steady or "polarising" voltage should bring the apparatus approximately to the condition represented by the point V, so that the variations of voltage superimposed upon the voltage V will not

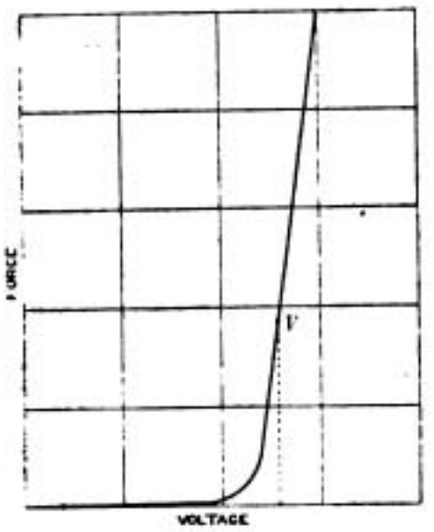


Fig. 6.

only cause much larger changes of force than were they applied alone, but the changes of force will be much more nearly linearly related to the voltage changes, an obviously desirable condition if speech distortion is to be avoided.

The polarising voltage may be derived from a suitable battery joined in series with the transformer or other source of the variable voltages applied to the apparatus, but when the instrument is used with a valve amplifier, as is frequently the case, the H.T. battery which supplies the valve may, at the same time, furnish the necessary polarising voltage by a suitable arrangement of the circuits. One possibility is shown in Fig. 7, and others can evidently be made up on similar lines. In this diagram T is the input transformer

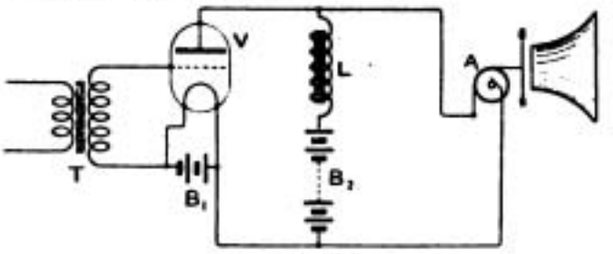


Fig. 7.

connected to the grid of the valve V. This transformer may be connected on its primary (or input) side to the microphone, telephone line, or other source of voltage variations that it is desired to reproduce acoustically by the loud speaker, or it may be fed from the anode circuit of another valve in the usual manner of a transformer-coupled multi-stage note magnifier. The anode circuit of the valve includes the usual H.T. battery B_2, which in this instance is joined in series with the choke coil L, so that the variable anode current of the valve will produce voltage variations across the ends of this choke. The above-described arrangement of loud-speaking telephone is represented at A, and is shown as connected across the combined choke and H.T. battery. The battery B_2 thus normally provides the steady polarising voltage for A, and when the valve is magnifying up variations applied to its grid, these will be superimposed upon the steady voltage of B_2 by the action of the choke coil.

To turn the whole instrument into a loud-speaking telephone the diaphragm to which the metal band is attached should be provided with a suitable horn or trumpet so that the movements of the diaphragm will set a greater volume of air into motion and produce a louder sound.

In the apparatus as demonstrated at the lecture above referred to, the body of an ordinary violin was used as the vibrating diaphragm, and the metal band was directly attached to it. The strings and other attachments were removed from the violin and the rotating cylinder (in this case of

agate) was mounted across the instrument. The resulting sounds emitted by the violin very faithfully reproduced not only music from a violin played in another room of the building, but also speech, the latter with remarkable clearness, and with entire absence of the muffled sounds frequently given by the usual forms of loud-speaking telephone.

By arranging the semi-conductor in the form of a disc with a metal back, a loud speaking telephone can be made up resembling very much the conventional arm of phonograph, the disc of semi-conductor taking the place of the record, and the metal brush resting on its surface attached to the diaphragm replacing the usual needle and reproducer. Similar apparatus may also be adapted to telegraphic recording, by utilising the varying friction between the metal and the moving cylinder or disc to actuate a pen working on the usual syphon recorder principle.

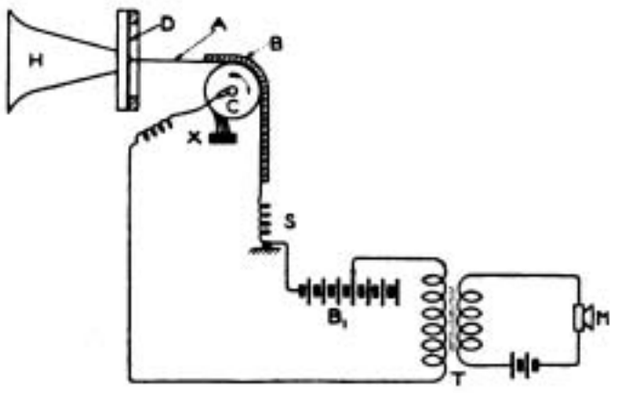


Fig. 8.

It is not essential that the semi-conductor should be in the form of a rotating cylinder or disc, as implied in the above descriptions, but, if preferred, the semi-conductor may be stationary, and merely its metal core may revolve. A number of applications of the apparatus as arranged in this form are described by Messrs. Johnsen and Rahbek in their patent specifications.*

The modification of the above described arrangement of loud-speaking telephone, when the metal alone is rotated is indicated in Fig. 8. In this diagram C is a metal cylinder around part of which is wrapped the band of semi-conductor A, which is coated with a metal electrode B on its outside surface. In this case the semi-conducting band must be flexible, and may conveniently be of gelatine film in this instance. The metallic connection B on the outside of the band may be of tinfoil, gold leaf or other similar flexible metallic body. Certain kinds of paper will also show these effects, and may be used to replace the gelatine film band of the arrangement of Fig. 8. In this diagram the end of the band B is joined to the diaphragm D, which is provided with the horn H to magnify the sounds. The spring S maintains the band B in tension, and the battery B_1 provides the polarising voltage for the apparatus to get it to the sensitive point in its working curve. The apparatus is for the sake of example shown as connected up to the transmitting microphone M, through the step-up transformer T, so that the sounds spoken to M will be reproduced in a magnified manner from the horn H. The step-up transformer T should have a large step-up ratio of turns, since the apparatus is almost entirely a voltage-operated device and requires only an extremely small current. The "load" on the secondary of T is therefore an extremely small one, and a large ratio of the turns in the primary and secondary windings of the transformer can therefore usefully be employed without undue loss of effective step-up ratio.

Other ways of use of the instrument as a loud speaker will be obvious to the reader, the one here shown being merely illustrative of how it may be employed.

Further as regards the properties of the semi-conductor A, whether used as a cylinder, disc or band, it may be noted that, as pointed out in the patent specifications, the essential requirements are that the material should have a high contact resistance with metallic bodies placed in contact with its surfaces, but that its internal conductivity should be relatively good. Such materials are essentially

* *British Patents* 144761, March 6th, 1919 (Patent accepted June 7th, 1920); 146747, September 6th, 1919 (Patent accepted July 15th, 1920).

not "insulators," in the true sense of the word, as has already been indicated in the earlier parts of this article. This interior conductivity is probably derived in part, at least, from moisture absorbed from the atmosphere, or naturally present in the materials, but the materials should be quite "dry" in the ordinary sense of the word, and in particular their surfaces should be dry or the contact resistance will be lowered, and the effects spoilt.

To further emphasise this difference between the internal and the surface conductivity of the material the following simple experiment may be noted. Take a piece of ordinary slate sheet—say about ¼ in. thick, and apply tinfoil sheets to both sides, smoothing the foil well into contact with the surface of the slate. The current passing through the slate under a voltage of 200 or so can then be measured by means of a sensitive mirror galvanometer. The resistance of the slate can thus be found knowing the value of the voltage applied to it. Next moisten the contact surfaces of the slate with water, and again press the tinfoil into contact with the material, taking care that sufficient water is used only to moisten the actual contact surfaces. The remainder of the slate should be quite dry. A second measurement of the current passing through the slate from the same supply voltage will indicate a much lower resistance. This is practically the internal resistance of the slate slab in question, since the contact resistances have been largely eliminated by moistening the surfaces.

The need for maintaining the surfaces of the cylinder or band used in the loud-speaking telephone in a quite dry condition will thus be evident, since the small amount of moisture deposited by breathing on the cylinder is often sufficient to destroy its proper action. The surfaces must also be kept free from dust, and for this purpose a cleaning brush, such as X in Fig. 8, may, with advantage, be fitted so that the surface of the cylinder is kept cleaned as it rotates. A similar arrangement could, with advantage, be fitted to Fig. 5. Cleaning the surfaces of the semi-conductor, and of the metal electrodes with alcohol, is recommended if the friction falls off due to their becoming greasy.

To illustrate the above-mentioned large difference between the contact resistance of these materials, and their true internal resistance, the following measurements may be quoted. They were carried out with two pieces of slate—one being ordinary grey slate, and the other having a pronounced green hue—in the manner outlined above. An H.T. battery of dry cells was used to supply the voltage, and the currents flowing through the material were measured by means of a sensitive mirror galvanometer. The thickness of the grey slate was ¼ in., that of the green specimen was ½ in., and the area of the tinfoil electrodes was approximately 4 square inches in each case. The measurements made—(1) with the tinfoil electrodes dry and pressed into contact with the dry surfaces of the slate; and (2) moistened with water and similarly pressed into contact, are set out in the table below. Care was, of course, taken that the surfaces of the slate were not moistened at any parts other than under the foil, so as to obviate undesired leakage of current round the edges of the material.

GREY SLATE SPECIMEN.		
State of Contacts.	Resistance.	Ratio of Resistances.
Dry -	94 megohms	1,560
Wet -	60,000 ohms	

GREEN SLATE SPECIMEN.		
State of Contacts.	Resistance.	Ratio of Resistances.
Dry -	380 megohms	808
Wet -	470,000 ohms	

These figures mean that, with these

particular specimens when dry, the voltage drop in their interior when they are subjected to an applied voltage of say 400 volts, will be less than a volt, and that therefore almost the entire applied voltage is dropped on the contact resistance. Referring again to Figs. 3 and 4, in the first instalment of this article, this means that the parts V_2V_3 of Fig. 3, and V_2V_0 of Fig. 4 will be even less than there shown, being in fact only a small fraction of 1 per cent. of the whole applied voltage V_1.

The above figures also serve to further emphasise the importance of maintaining the working surfaces free from all moisture if good results are to be secured.

Another interesting arrangement of this apparatus as a loud-speaking telephone, is also shown in the patent specification. A sketch of the arrangement there described is given in Fig. 9. In this modification the rotary part is the metal disc C, which is mounted on the vertical spindle S and driven round by a suitable motor, like a gramophone record.

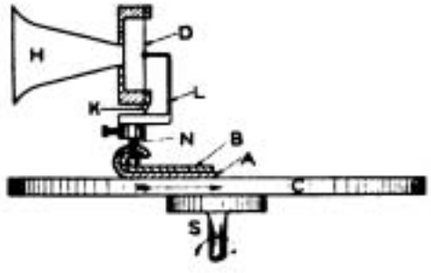


Fig. 9.

The semi-conductor A with its metallic backing B is in the form of a narrow strip mounted on the end of the needle N, which is held in a holder much resembling that used on an ordinary gramophone. The diaphragm D, in front of the horn H, is actuated by the lever L pivoted on knife edges K, against which it is held by small springs just as in the case of an ordinary gramophone sound-box attachment.

A further modification of the apparatus of particular interest in connection with the reception of Morse wireless signals, but of no value for telephonic reproduction, is disclosed in the second of the patent specifications referred to above. It is stated that by the use of this modification "wireless signals may be reproduced with such enormous intensity that they may be heard for miles." The essential details of the suggestion are indicated in Fig. 10.

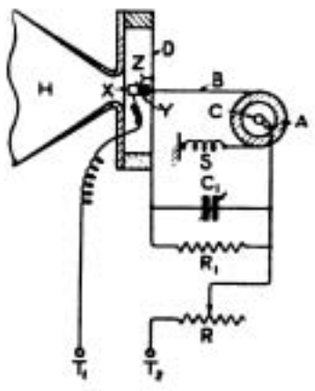


Fig. 10.

A large diaphragm D is used, and is provided with a horn H to intensify the resulting sounds. This horn is only shown in part in the diagram, and may, of course, be of any convenient size. The diaphragm is provided at its centre with a small contact arm Z, which can move over either a contact or an insulated section, according to the position of the diaphragm. This contact is indicated at X, and the adjacent insulated segment at Y. The diaphragm is coupled at its centre to the end of the flexible metallic band B, encircling the cylinder of semi-conducting material A, with its metal core C, to which one of the connections is made. The spring S serves to maintain the band B in tension round the cylinder A. The whole apparatus is supplied by the terminals T_1T_2, with a voltage derived from the signal, by some such arrangement of amplifying valve as has already been described in Fig. 7, and a high resistance R is inserted in the circuit to regulate the rate at which the cylinder A is charged up on the application of the voltage, and hence to control the rapidity with which the tension is applied to the band B and the diaphragm

is set in motion. When the diaphragm is deflected outwards to the right, the contact arm Z passes off the conducting contact X on to the insulated one Y, so that the instrument is thus disconnected from the source of voltage. The charges that have been accumulated on the cylinder A are then dissipated through the shunting high resistance R_1, so that after a definite time interval the apparatus is discharged, the friction between A and B falls to normal, and the diaphragm returns to its undeflected position, making contact between X and Z, and enabling the whole cycle to be repeated again. This will occur many times per second, so that the diaphragm and horn will emit a musical tone of definite pitch. This pitch is, of course, largely dependent upon the size of the diaphragm D, and the inertia of the parts attached to it, but it can also be adjusted within limits by regulating the variable condenser C_1 and resistance R_1 shunting the instrument, and the resistance R in series with it.

(To be concluded.)

Correction.—In the first instalment of this article, on p. 228, the page reference at about the centre of the right-hand column, should be 226 instead of 5.

MY EXPERIMENTAL SET

By E. E. Hart.

THE set consists of a three-valve audio frequency amplifier, with the usual connections.

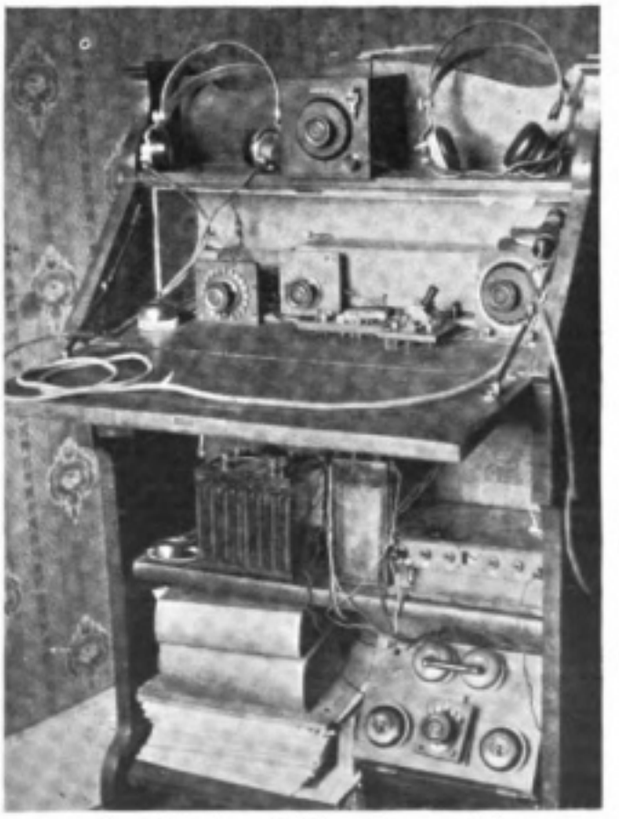
The amplifier is seen at the bottom right-hand corner of the photograph, the switches on the front enabling either one, two or three valves to be used.

Referring to the main portion of the cabinet, the arrangement, from right to left, is as follows. The first instrument is a variable condenser of 0·001 mfd., connected either in series or parallel with the A.T.I. by the first double-pole switch.

The second switch changes over from the long wave set to an inductively-coupled tuner for amateur wavelengths. The first tapping switch controls the reaction coil, and the second the A.T.I.

The box-like instrument seen behind the switches is the tuning inductance, with the reaction coil sliding therein on the left. Extra inductance is added to both tuner and reactance when necessary, and these extra coils are fixed to the back of the cabinet. The wavelengths obtainable vary from 600 to 20,000 metres.

The wavemeter between the telephones gives readings from 500 to 2,000 metres. As the aerial used is only 15 ft. high one end and 20 ft. the other, abnormal results cannot be expected. With two valves, all the high-powered European stations can be read with



ease, and with the third valve working many of these can be read anywhere in the room.

SOME USEFUL GRAPHS AND TABLES FOR WIRELESS AMATEURS

By Jas. F. Herd, A.M.Inst.R.E.

THE wireless amateur—and not infrequently the wireless professional—is often under the necessity of finding the approximate inductance of a cylindrical coil of wire of given dimensions—a very common type of wireless inductance.

For such calculations text books usually quote the formula

$$L = (\pi Dn)^2 l \quad . \quad . \quad . \quad . \quad (1)$$

Where l is the axial length of the coil, in centimetres, D is the diameter in centimetres (from centre to centre of wires), n the number of turns per centimetre length of coil, and L the inductance in C.G.S. units or centimetres, when dividing by 1,000 will give an answer in microhenries.

This is only true, however, for a coil where l is very large compared to D, and if this condition be not fu filled the formula becomes

$$L_{\text{centimetres}} = (\pi Dn)^2 \times l \times k \quad . \quad (2)$$

where k is known as Nagaoka's factor and has the value

$$1 - 0{\cdot}424\frac{D}{l} + 0{\cdot}125\left(\frac{D}{l}\right)^2 - 0{\cdot}015625\left(\frac{D}{l}\right)^4 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The working out of this formula is very tedious, and the appearance of it frequently frightens the none too mathematical reader.*

The formula can, however, be rendered much less formidable by a tabulation of values of k, and can be made still simpler by multiplying these values by π^2, and dividing by the 1,000 necessary to obtain an answer in microhenries.

The formula, thus modified, becomes

$$L_{\text{microhenries}} = (Dn)^2 \times l \times F \quad (4)$$

where the value of the factor F depends upon the ratio $\frac{D}{l}$, and can easily be found from Table I, (p. 263), or the curves of Fig. 1.

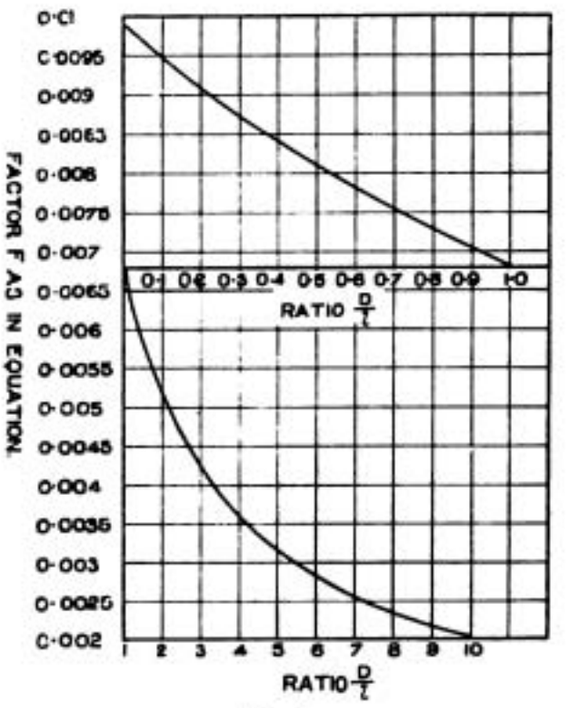


Fig. 1.

Inductance of a cylindrical coil, l centimetres long, D centimetres diameter, wound with n turns per centimetre of length,

$$L_{\text{microhenries}} = (Dn)^2 \times l \times F$$

where F is found from Table I or Fig. 1.

As an example, take a random case of a coil, 16 cms. long, 10 cms. diameter, wound with No. 25 S.W.G., S.S.C. wire approximately 18 turns per cm.

Here $\frac{D}{l} = \frac{10}{16} = 0{\cdot}625$, and from Fig. 1 $F = 0{\cdot}0077$. Substituting in equation (4),

* *Editorial Note*—The expression here given for the factor k is part of a formula for inductance calculations usually attributed to A. Russell not to Nagaoka [A Russell, *Philosophical Magazine*, 13. p. 445, (1907).] The formula is more accurate for long coils than short ones. Nagaoka's expressions for k for short coils are very much more complex than the one here given, but it is possible to put a simpler short coil formula due to Rayleigh and Nivens into a form suitable for combination with Nagaoka's formula (equation (2) above). For details of this transformation see P. R. Coursey, *Proceedings of the Physical Society of London*, 31, pp. 155—167, August, 1919.

and working out by ordinary arithmetic the answer is 3,991 microhenries, or working by slide rule, approximately 4,000 microhenries. Using the same data and working

TABLE I.

Ratio d/l	F as in Equation	Ratio d/l.	F as in Equation
0·0	0·0987	1·5	0·05872
0·1	0·09465	2	0·05187
0·2	0·09081	2·5	0·04657
0·3	0·08724	3	0·04236
0·4	0·08389	4	0·03607
0·5	0·08095	5	0·03156
0·6	0·07782	6	0·02816
0·7	0·07509	7	0·02551
0·8	0·07256	8	0·02335
0·9	0·07018	9	0·02159
1·0	0·06795	10	0·02006

out equation (3) by four figure logarithms, the answer is 3,991 microhenries, so that the accuracy of *F* as given by Table I or Fig. 1 is quite sufficient for practically every ordinary purpose.

TABLE II.

SWG NO	Turns per Centimetre		SWG NO	Turns per Centimetre	
	Single silk covered	Double silk covered		Single silk covered	Double silk covered
20	10	9·5	31	30	27·5
21	11·5	11	32	32	29·5
22	13	12·5	33	33	31·5
23	15	14	34	36·5	33·5
24	16·5	15·5	35	40	36
25	18	17	36	43	40
26	20	18·5	37	47·5	43·5
27	21·5	20	38	52	47·5
28	23·5	22	39	58·5	52·5
29	25·5	23·5	40	62	56
30	28	25·5			

Table II gives the approximate number of turns per centimetre of length that can be obtained with (*a*) single silk-covered and (*b*) double silk-covered wire of the range of gauges such as might be used for coils under various circumstances. The exact dimensions of these types of wire may vary slightly according to the particular thickness of insulation used by different makers, but the figures of Table II are of average exactitude, and of sufficient accuracy for most practical purposes. Enamelled wire is of approximately the same overall size as single silk-covered.

The relations between capacity and inductance, and the resulting wavelength represent another set of problems frequently before the wireless worker—amateur and professional. These relations are, of course,

$$\text{Wavelength} = \text{a Constant} \times \sqrt{\text{Inductance} \times \text{Capacity}}$$

$$\text{whence Capacity} = \frac{(\text{Wavelength})^2}{(\text{Constant})^2 \times \text{Inductance}}$$

$$\text{and Inductance} = \frac{(\text{Wavelength})^2}{(\text{Constant})^2 \times \text{Capacity}}$$

The value of the constant depends on the units in which capacity and inductance are expressed. These usually are, in practice, microhenries for inductance and either jars or microfarads for capacity, when the constant has the value $20\pi = 62{\cdot}83$ for capacity in jars and 1,885 for capacity in microfarads.

Although the working out of these equations is quite simple—particularly with a slide rule or logarithms—most wireless workers find it an advantage to have a quick method of solution, and this is provided by the abacs of Figs. 2 and 3.

The method of procedure should be clear from the "Instructions for Use" accompanying each, and can best be illustrated by a few random examples.

As an instance, find the wavelength given by a circuit of 250 microhenries inductance and 2 jars capacity.

Multiplying capacity and inductance we get the product 500, as the "L S" or "Mic.-Jars" value, doubtless familiar to readers who had any wartime connection with the Naval services. Opposite 500 on the left scale of Fig. 2, we read 1,400 metres, which is the approximate wavelength. Four figure log tables give an answer of 1,405 metres.

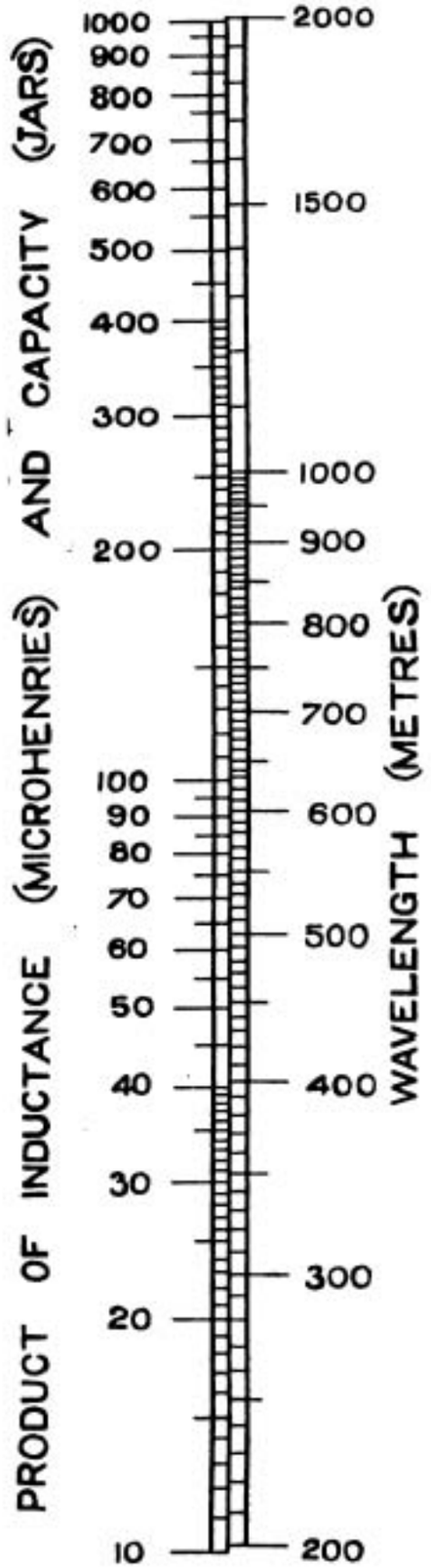


Fig. 2.

Abac relating Inductance (microhenries), Capacity (Jars), and Wavelength (Metres).

INSTRUCTIONS FOR USE.—(*a*) Knowing inductance and capacity to find wavelength:—Multiply inductance and capacity together, and opposite their product, read wavelength. (*b*) Knowing wavelength and either inductance or capacity, to find the other:—Opposite wavelength read the product of capacity and inductance and find the unknown by dividing the product by the known. (*c*) For values beyond the scale:—For values of product between 1,000 and 10,000 use scale 10 to 100 and multiply wavelength by 10; for values of product between 10,000 and 100,000 use scale 100 to 1,000 and multiply wavelength by 10.

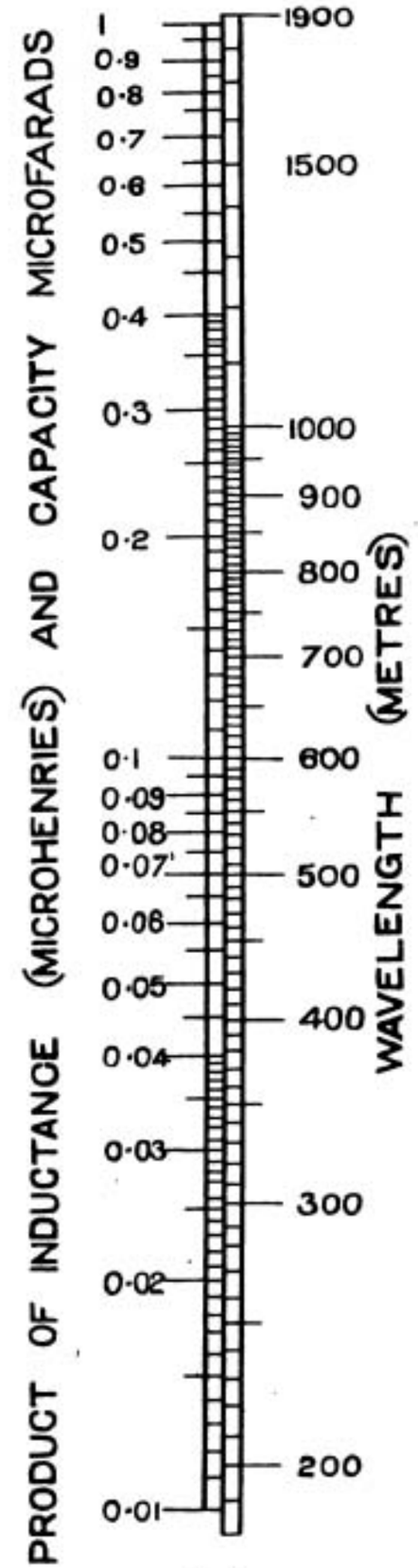


Fig. 3.

Abac relating Inductance (Microhenries), Capacity (Microfarads), and Wavelength (Metres).

INSTRUCTIONS FOR USE.—(*a*) Knowing inductance and capacity to find wavelength:—Multiply inductance and capacity together, and opposite their product read wavelength. (*b*) Knowing wavelength and either inductance or capacity, to find the other:—Opposite wavelength read the product of capacity and inductance and find the unknown by dividing the product of the known. (*c*) For values beyond the scale:—For values of product between 1 and 10 use scale 0·01 to 0·1 and multiply wavelength by 10; for values of product between 10 and 100 use scale 0·1 to 1 and multiply wavelength by 10.

Similarly, find the inductance of a coil required to be used with a condenser of 0·0015 microfarads to give 1,000 metres wavelength. Opposite 1,000 on the right scale of Fig. 3 we estimate the value 0·286. Dividing 0·286 by 0·0015 we get approximately 190 microhenries, while working with four figure log tables gives 188·5.

It is also advisable to consider cases where the values are beyond those shown on the scales, *e.g.*, find the wavelength given by a circuit of 1,000 microhenries and 0·0025 microfarads. The product is 2·5, which is 100 times 0·025 of the left-hand scale of Fig. 3. Opposite 0·025 we estimate 298, which multiplied by 10 gives approximately 2,980 metres.

Lastly, find the capacity, in jars, necessary to give 5,000 metres wavelength in conjunction with 2,500 microhenries inductance. Opposite 500 on right-hand scale of Fig. 2 read approximately 65 which is one hundredth part of the required "LS" value. Divide 6,500 by 2,500 we obtain 2·6 jars, which is approximately correct.

These principles can, of course, be extended indefinitely, the above examples no doubt sufficing to make their application clear.

UNITS AND SUB-UNITS OF CAPACITY AND INDUCTANCE.

Capacity :—

1,000	centimetres	= 1 jar
900	jars	= 1 microfarad
1,000,000	microfarads	= 1 farad

Inductance :—

1,000	centimetres	= 1 microhenry
1,000	microhenries	= 1 millihenry
1,000	millihenries	= 1 henry

PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

An ordinary general meeting of the Wireless Society of London was held at the Royal Society of Arts, John Street, Adelphi, W.C.2, on Monday, June 27th, 1921.

In the absence of the President the chair was taken by Mr. A. A. Campbell Swinton, at 8 p.m.

Mr. A. A. Campbell Swinton : I am sorry that the President (Dr. J. Erskine-Murray) is ill in bed and consequently is unable to be present, and I have been asked to take the chair in his absence. I will call upon the Hon. Secretary to read the minutes of the last meeting.

The Hon. Secretary then read the minutes of the previous meeting, which were duly confirmed.

Mr. A. A. Campbell Swinton : There will be no ballot for new members to-day. This is the last meeting of the session, and although the Committee has approved two names for election to the Society, it is thought best to postpone the ballot for them until the next meeting, because otherwise they will be asked to pay a subscription a long time in advance of the new session.

I have to announce that the following wireless societies have become affiliated to this Society: The Corinium Wireless Society, which I understand is established at Cirencester; The West London Wireless Society, and the Sutherland and District Amateur Radio Society.

I will now call upon Mr. Coursey to read the paper by Lieut. Edes on "The Design of Resistance Coupled Amplifiers," and afterwards Mr. Coursey is kindly going to give us an experimental demonstration of the "Piezo-Electric Properties of Rochelle Salt Crystals," showing interesting modern applications of an ancient electrical discovery.

Mr. Philip R. Coursey : I feel somewhat at a disadvantage this evening in reading a paper that has been written by someone who is not in this country, and with whom I have not had an opportunity of discussing the subject. The author of the paper is, I believe, stationed in Egypt, and he submitted it primarily as a contribution to the discussion on Mr. Maurice Child's paper, which was read before the Society some few months ago on the subject of Resistance Coupled Amplifiers.* As, however, the paper is rather long for a discussion only, it was felt that it might be read as a separate paper.

In his covering letter Lieut. Edes states that "he is enclosing some remarks on resistance coupled amplifiers, which may possibly be of interest. As pointed out in the course of these remarks there is, I believe, often some misconception as to the exact method of functioning of this type of amplifier, in particular it is only on

* See *The Wireless World* 8, pp. 543-552, October 30th 1920.

rare occasions that one sees laid down a clear differentiation between the properties of amplification and rectification."

The part of Mr. Child's paper to which Lieut. Edes is here referring is a section in which it is stated, "that with this instrument [*i.e.*, the one Mr. Child described] used as it is with ES4 valves, which have similar characteristics to the well-known French valve, the process of rectification is more or less distributed, or can be distributed, over the whole six valves."

Lieut. Edes continues in his letter:

"A proper appreciation of the exact electrical processes involved would enable designers to produce instruments which, without in any way being more complicated, would give a considerably increased efficiency. The whole problem is to choose suitable constants for the amplifier."

He further says that he was much interested in the reports of the Wireless Society, which were published on October 30th and November 13th, and still more so in the discussion that followed.

I am afraid that Lieut. Edes' paper is rather on the mathematical side in parts, which makes it a little bit difficult to treat adequately when reading it as a paper. It is more in the nature of a contribution that can be studied better when printed than it can by any oral exposition. However, I have had a few sheets copied out, giving the leading equations and diagrams of the paper, and these, I think, have been distributed, so that I will now just run briefly through a few of the points and try to indicate the essential features of the paper to you.

The paper was then read, and the derivation of some of the equations indicated on the blackboard. (See *The Wireless World*, June 25th issue, page 233-237 for the paper.)

The paper was discussed by Messrs. Maurice Child, R. E. H. Carpenter, C. F. Phillips and A. A. Campbell Swinton, and a brief reply was made by Mr. P. R. Coursey who stated that the remarks of the various speakers would be transmitted to Lieut. Edes so that he could reply to the questions that had been raised. His reply will be printed with the report of the discussion in *The Wireless World*, and in the *Journal* of the Society.—(See subsequent issue of *The Wireless World* for this report.)

Mr. A. A. Campbell Swinton: I will now call upon Mr. Coursey to give his demonstration of the "Piezo-Electric Properties of Rochelle Salt Crystals."

Mr. Philip R. Coursey: As the paper that we have just discussed was rather a short one, I have been in communication with Mr. MacMichael as to the possibility of filling up the remainder of the evening with something more interesting than mathematics. I was rather fortunate in connection with that in being asked by Mr. E. Kilburn Scott last Wednesday to help him with a demonstration at a meeting of the Faraday Society held that evening. Mr. Kilburn Scott has recently come over from New York and brought with him the apparatus I have here this evening which was loaned to him by the Western Electric Company of America. Mr. Kilburn Scott has passed on to me the apparatus to show this evening, which I hope to be able to do in conjunction with a valve amplifier. The amplifier was not used at the Faraday Society demonstration last Wednesday, but it makes the effects much more striking.

Piezo-electricity is the electrification of any material by pressure. It is, I believe, closely related to pyro electricity, which is the generation of electricity by heat. The terms are applied to effects shown by certain substances—and in particular by a large number of crystals. If these materials are warmed they become electrified at their ends, and if they are pressed they become electrified also.

The actual discovery of these effects I am afraid I have not been able to trace. I have been told that Theophrastus, about 300 B.C., referred to pyro-electricity, and I have a definite date of 1703, when some Dutch chemists described the piezo phenomena. This is coming down to comparatively modern times. Anyway, we are fairly safe in describing it as 200 or 300 years old, and probably a great deal more.

Like the electrostatic effects which were described at the Institution of Electrical Engineers by Johnsen and Rahbek, a short time ago, we have here another case of an old discovery, which, in the light of modern knowledge, has some useful application, and in that respect it has a certain amount of interest.

The Rochelle salt (that is a crystal of Rochelle salt) can be grown artificially to quite large sizes. Rochelle salt is a tartarate, and has the formula, $C_4H_4O_6NaK.4H_2O$. If a crystal of this material is twisted slightly its two ends become positively electrified, and its centre part negatively and, under favourable circumstances with a good crystal, quite a moderate force may generate as much as 200 to 300 volts. The resistance of the crystal is, however, very high, so that the amount of energy which it is possible to get out of it is very small. Similarly, the reverse process will take place if a voltage is applied to the proper points of the crystal, and minute movements of the crystal will be set up. It is hoped that these properties may be of use for certain cases of deafness where the actual nerve is not destroyed, by inserting one of these crystals inside the ear and connecting it to a receiver secreted somewhere in the person's clothing.

In order to show up these effects I have here a crystal of the flat kind, similar to the one that I exhibited just now, which is mounted between two aluminium pressure plates, with a third plate at one end, fitted so that it can have a gramophone needle fastened to it. If this combination is placed on a gramophone record, in place of the usual sound-box, it will generate currents in accordance with the speech sounds. The vibrations of the needle produced by the record set up twisting stresses in the crystal, which give rise to the voltages between the electrodes.

An interesting part about it is that it is not like a microphone of the ordinary sort, which merely modulates an external current, but the whole of what you hear is being generated by the crystal and amplified up for reproduction by the loud-speaking telephone.

[A demonstration was then given of the apparatus on exhibition, using the crystal as a gramophone reproducer, and a 3-valve amplifier and loud-speaking telephone, to render the results audible to the audience].

You may notice that there is a little distortion somewhere, but I think it is amplifier distortion rather than crystal distortion.

It will reproduce Morse just as well as music. I have one of the Wireless Press Morse Instructional gramophone records here, and I think you can see from that it does not matter what sort of sound you give it to reproduce.

I think, also, that I may be able to show you the reverse effect in which the application of a voltage reproduces the sound. Here I have one of the same crystals that has been mounted up in a similar way between two aluminium plates, but with a piece of parchment clamped between and plates twisted to give a slight torsion to the crystal. Around the centre of the crystal is a tinfoil band, and the two outside ends are connected together. If we apply a modulated voltage between the end plates and the tinfoil band, the slight movements of the crystal make this parchment vibrate and reproduce the sound. It is not very loud partly because I have not sufficient voltage to apply, as I have just tried the effect with a transformer that was available and as it worked I thought I would show it this evening. It has a step-up ratio of about 50 : 1, and I have put a step-up microphone transformer in series with the primary winding. I have got four dry cells in series with the primary of the microphone transformer, which is connected to an ordinary microphone. For convenience I have put the microphone at the end of a long flex so that it can be taken outside the room so as not to hear the person speaking. I am afraid the articulation is not perfect partly because the crystal container is rather a large box, and, therefore, has rather a low natural note of its own so that nothing above 500 or 600 cycles comes through very well. I have no doubt that the arrangement could be applied to a different form of apparatus to give better articulation, and, if the transformer were more suitably designed it would give better results. A power transformer is hardly the best thing to put in a microphone circuit, but I think you will hear that the articulation is at least understandable.

[A demonstration of the apparatus was then given and words spoken to a microphone outside the room were clearly reproduced by the crystal. The sounds were not very loud, but could be clearly heard some distance from the apparatus].

I do not think I have much more I can say about this apparatus this evening, except that it is obvious that a smaller crystal would have a higher period of vibration and would be easier able to transmit higher notes without distortion.

I hope in the near future to be able to write up a more complete description of the apparatus, and of the way in which it can be used, which I hope will be published in *The Wireless World* in due course.

Mr. A. A. Campbell Swinton : I am sure we are all delighted with this admirable demonstration of a very remarkable phenomena. My impression is that this effect was used in this country in the war for submarine signalling. I do not think it has been published and I don't know if I am giving any secrets away, but my impression is that Sir Joseph Thomson made a series of experiments using these crystals for imparting vibrations to water, and also for picking them up again for signalling between submarines.

Mr. P. R. Coursey : I think they have also been used for investigations on explosion pressures, because the crystals are very rapid in their response, and there is no distortion.

Mr. A. A. Campbell Swinton : They used a crystal immersed in water with some form of registering galvanometer, and when the explosion takes place the sound waves come through the water and produce a record. Distances can be determined with extraordinary precision. Several observing stations are used, and knowing the velocity of sound in water records are made of the receipt of the signals from the different places. The position where an explosion took place can then be determined to within a yard or two. I believe an apparatus of this kind was probably used.

We are all delighted to see the experiments so beautifully carried out. I would like to ask Mr. Coursey whether he used a resistance amplifier or a transformer amplifier.—(*Laughter.*)

I would ask for another vote of thanks to Mr. Coursey for what he has been able to show us.—(*Applause.*)

As you are probably aware this is the closing meeting of the Session, and I am asked to say something on the subject of club rooms, but I wish the President were here to say it. This is a matter that has been on the mind of the Committee very seriously for a long time. As you will know, we have been trying to arrange something with the Institution of Electrical Engineers, but the Institution of Electrical Engineers have had difficulties with the Government with regard to the return of their premises. They expected to get back there immediately after the Armistice was signed but have only just succeeded in getting possession again within the last few weeks, and the building is still in a state of chaos to a large extent. The Committee of the Society hope, however, that before we meet again that something will be arranged. I cannot say more than that. The President has been giving the matter serious attention, I know, and he might have been able to tell you more than I am able to. It is unfortunate he is confined to bed. Consequently, I do not know whether he has been able to arrange anything since the last Committee meeting (which was about a week ago), but you can be assured that everything that is possible is being done with regard to that matter. It is really rather absurd that all the small wireless societies should have their own place and this Society should not have a home.

I think that is all to be said. We will meet again in the beginning of October, and notices will be sent to you in due course.

The meeting terminated at 9.25 p.m.

WIRELESS TELEPHONE DEMONSTRATION

ON Thursday morning, July 7th, a lecture and demonstration on wireless telephony was given at the Polytechnic, Regent Street, W.1, to mark the occasion of the installation of a wireless station in connection with the Electrical Engineering Department.

The chairman, Mr. J. E. K. Studd, President of the Polytechnic, opened the demonstration with a brief mention of the purpose of the installation of a wireless set. He explained that during the years of the war the Polytechnic took a share in the training of wireless recruits for the Forces, and it was felt that this important branch of electrical engineering should not be neglected by the Polytechnic in its educational syllabus.

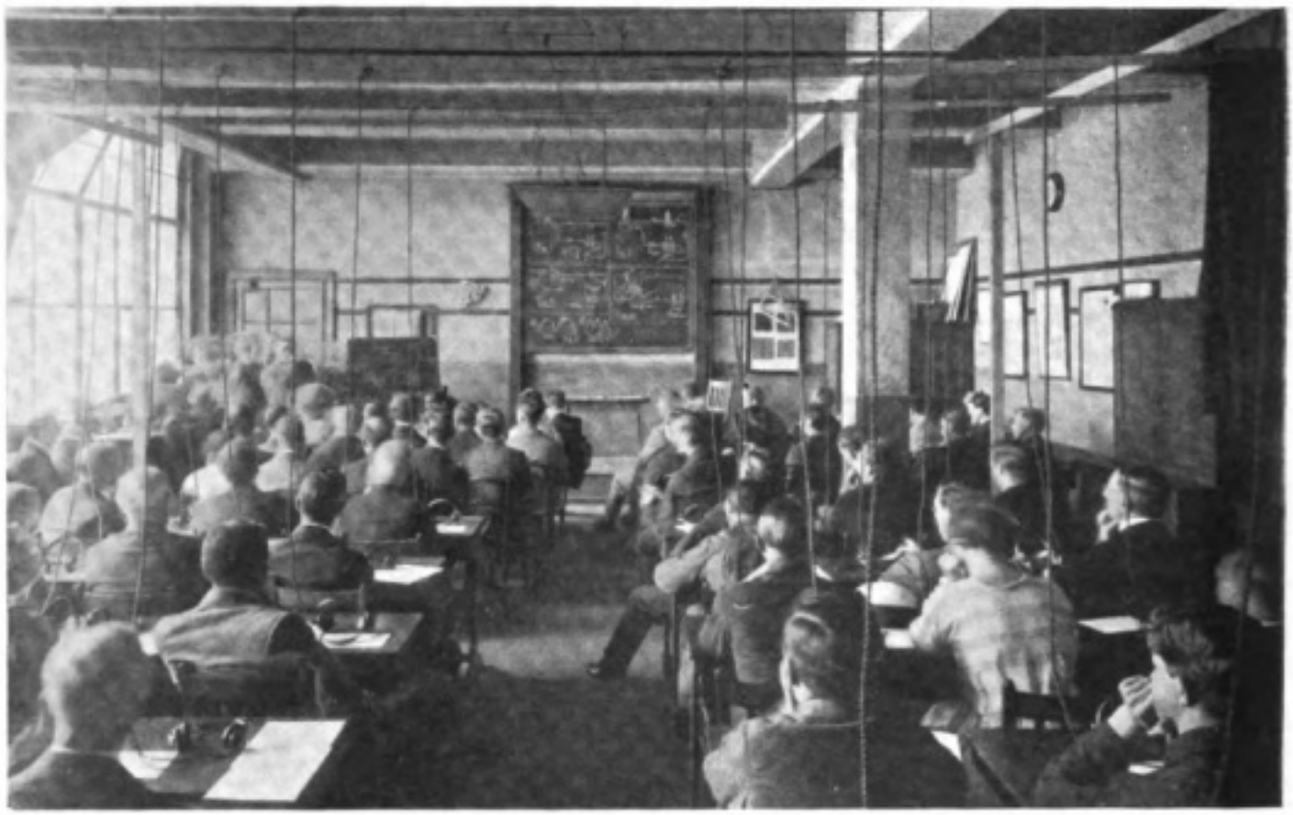
The chairman's introduction was followed by a lecture by Mr. J. W. Turner, on wired and wireless telephony.

The audience showed great appreciation of Mr. Turner's clear exposition of the general principle of action of the wireless telephone.

At the conclusion of the lecture the audience was invited to adjourn to the roof to inspect the aerial during the interval which remained before the reception of the pre-arranged wireless telephony from the Marconi Station at Chelmsford. Two transmissions were made to enable all the members of the audience to listen in with the large number of telephones provided for the purpose, as shown in the photograph. Two Marconi engineers were present to conduct the reception.

After the transmission of telephony, the time signals from Paris were listened for at 11.40, and watches were checked by the signals.

In proposing a vote of thanks to those responsible for the demonstration the chairman specially thanked the Marconi Company for their interest shown. This appreciation was suitably responded to by the representative of the Company present.



The room where the Demonstration took place showing how the telephones were arranged for the audience to listen in.

WIRELESS CLUB REPORTS

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter in the exact form in which they are to appear and as concise as possible, the Editor reserving the right to edit and curtail the reports if necessary.

The Editor will be pleased to consider for publication papers of unusual or special interest read before Societies.

The Wireless Society of London.

On the afternoon of Monday, June 27th, 1921, a visit to the Experimental Station of the Radio Communication Company, at Slough, was arranged for members of the Society. The party, which included a number of ladies, left Kingsway, W.C.2, by motor charabanc at 2.15 p.m., and were conveyed direct to Slough.

Interesting demonstrations were arranged by Messrs. N. Lea (Chief Engineer of the Company), and J. Ree of the Company's 1½ k.w. synchronous rotary spark ship installation, and of the receiving and emergency gear used in conjunction therewith. The complete transmitter is of the panel type, the apparatus at the back being enclosed by expanded metal doors, which allow of ready access to all parts. The rotary converter and its synchronous spark gap is mounted in the lowest part of the panel, with the spark gap opening forward for ease of adjustment. The automatic starter (of the Igranic type) is mounted on the panel, and is controlled by push buttons on the operating bench. A wavechange switch is provided, giving 3 or 4 waves as required, and the coils and connections to this switch are so arranged that both primary and secondary circuits are simultaneously tuned by one movement of the handle, and the coupling is also adjusted beforehand to the correct value for the wavelength in use.

For emergency purposes, a motor driven commutator of the Wilson type is employed, which excites the main oscillation circuit of the set, so that auxiliary tuning is required on changing over from the power to the emergency set. This change-over is effected by a small rotary switch on the operating bench. A lever on the panel serves to cut out the rotary spark and replace it by a small fixed spark gap for the emergency working.

The receiver, of the single valve type, covers a tuning range up to 10,000 metres, while the addition of a small second unit enables the range to be extended to at least 20,000 metres. Additional amplifying valves can be added as required.

A novel feature of the receiving set is the provision of a window showing through it a scale indicating the wavelength of the secondary circuit. A pointer moves over this scale under the control of the variable condenser, and the scale itself is changed automatically by the switch controlling the inductance tappings, so that the wavelength to which the secondary circuit is tuned can always be read off at a glance. A buzzer is provided for tuning the aerial circuit into resonance with the secondary for any particular wavelength to which it is desired to set the apparatus.

A demonstration was also given of a 25 k.w. arc transmitter, of the Elwell-Poulsen type, and the various water circulating motors, anode rotation motor, and other auxiliaries controlled automatically by the starting panel were shown in operation in detail, before the arc was actually struck. The arc was then put into operation, and when burning steadily put about 44 amperes into the aerial. The relay keys, controlled by the small key on the operating bench, served to short circuit part of the aerial loading inductance, thus changing the wavelength slightly for the signals.

A few of the effects of the high frequency fields surrounding the aerial tuning inductance were also demonstrated.

An experimental valve radiotelephone transmitter was shown in operation, and the quality of the articulation obtained could be judged by listening in at a small receiving set in a hut separated some little distance from the main building. Both music and speech modulation were demonstrated and excellent articulation obtained in all cases.

At the conclusion of the demonstration the party proceeded to Windsor where tea was served at the Castle Hotel. Mr. F. Hope-Jones as chairman proposed a vote of thanks to the Radio Communication Company, and in particular to Messrs. Lea and Ree for the able way in which they had carried out the demonstrations. A suitable reply was made by Mr. Lea.

A vote of thanks to Mr. Hope-Jones was proposed by Mr. L. McMichael, to mark the appreciation of the members for the trouble he had taken in arranging the details of the outing.

At the conclusion of the repast the party returned to London, arriving there about 7.15 p.m., in time for the evening meeting, which was held at the Royal Society of Arts—(see page 265 in this issue for Proceedings).

Newcastle and District Amateur Wireless Association.

(Affiliated with the Wireless Society of London.)

Secretary, Mr. Colin Bain, 51, Grainger Street, Newcastle-on-Tyne.

The Society held its annual general meeting on June 27th, at which officers were elected.

A balance sheet for the past twelve months was made out by Mr. Burdis. This was submitted and accepted by the members as correct. A voluntary subscription list was started under the name of "Instrument Fund." It is open to members to give a small sum weekly in order to help to acquire some necessary instruments for permanent installation in the Club-rooms. Arrangements are being made for a monthly series of demonstration lectures during the winter months. Members are urged to read papers before the Society. Members have recently re-erected the Club aerial substituting phosphor bronze $\frac{7}{20}$ for the No. 14 aluminium previously used. Spreaders three feet wider than the old ones were

also fitted. The length was increased 12 feet (double). The result is very satisfactory to everyone. Members should note that subscriptions are now due (July 1st) to 1921-1922.

Birmingham Experimental Wireless Club.

(Affiliated with the Wireless Society of London.)

Hon. Secretary, Mr. Frank S. Adams, 110, Ivor Road, Sparkhill, Birmingham.

A meeting was held on Friday, June 10th, at the Digbeth Institute, Birmingham, 26 members being present.

The chair was taken at 8 p.m. by the President, Mr. A. L. Lancaster. The minutes of the previous meeting having been read and confirmed, the Hon. Secretary announced the affiliation of the Club with the Wireless Society of London.

The President then called upon Capt. J. Ryan, M.C., to deliver his lecture on "Wireless in the Field." Capt. Ryan described the systems of radiotelegraphic communication used by the British Army during the military operations in France, and gave many interesting details of the types of instruments and the purposes for which they were used. On concluding, the lecturer was accorded a hearty vote of thanks. Major J. Danielson, Officer Commanding Royal Corps of Signals (T.F.) Birmingham, then addressed the meeting, thanking the members for the reception given to Capt. Ryan and himself.

Woolwich Radio Society.

(Affiliated with the Wireless Society of London.)

Hon. Secretary, Mr. H. J. South, 42, Greenvale Road, Eltham, S.E.9.

The monthly general meeting of the above Society took place on June 24th at the Woolwich Polytechnic at 8 p.m. There was a good attendance.

Mr. W. L. McPherson, B.Sc., Vice-President of the Club, gave a very interesting paper on "Simple Valve Circuits," which he illustrated by means of many very clear diagrams on the black board.

After the discussion a hearty vote of thanks was proposed by the Chairman, Mr. W. T. Jones, which was heartily responded to.

Three new members were elected at the end of the meeting, making 15 in the last two months.

The next general meeting will be held on August 26th, it having been decided to abandon the one for the last week in July. The Society, however, will continue to meet every Thursday evening during July at the Old Mill, Plumstead Common, for experimental work, and new members will be heartily welcome there.

Wireless and Experimental Association.

(Affiliated with the Wireless Society of London.)

Hon. Secretary, Mr. Geo. Sutton, A.M.I.E.E., 18, Melford Road, S.E.22.

At the meeting on June 22nd, Mr. G. Horwood reported receiving Constantinople, Bermuda, Annapolis and Glace Bay on a single valve.

Magnetic storms were discussed, and the Secretary gave some experiences of his.

Mr. H. Kloots gave the meeting another instalment of Einstein, which was received with rapt attention by even the most junior members.

At a meeting of the Association on June 29th, the Secretary read a postcard from Mr. Hunter, a member, who claimed to have read G.N.F. without any wireless apparatus. The fact that he was standing just outside the station may have had something to do with it. Mr. Sutton and Mr. Kloots discussed squirrel-cage motors, and Mr. Knight gave some handy hints on the care of valves. Mr. Voigt dealt with electrostatic attraction between metals and semi insulators.

Bradford Wireless Society.

(Affiliated with the Wireless Society of London.)

Acting Secretary, Mr. N. Whiteley, 8, Warrels Terrace, Bramley, Leeds.

A meeting of the Society was held in the Club-room at 7.45 p.m. on July 1st, with the President, Mr. C. Wood, in the chair.

The minutes of the last two meetings were duly read and confirmed, after which four members were elected. The Chairman then called upon Mr. Eskdale to give his lecture upon "The Care and Maintenance of Accumulators." In a very clear manner the lecturer dealt with the theory, working and charging of accumulators, and also defects and their remedies. At the close of the lecture there was a general discussion, following which, a vote of thanks was proposed by Mr. Liardet, seconded by Mr. Daniels, and carried unanimously. The meeting then adjourned to the instrument room where the Society's Receiving Apparatus was in operation.

Notice to Members.—It has been arranged to hold special Morse classes at 7.30 p.m. on the evenings of the Society's meetings. We hope there will be good attendances.

Folkestone and District Wireless Society.

(Affiliated with the Wireless Society of London.)

Hon. Secretary, Mr. H. Alec S. Gothard, A.M.I.R.E., 8, Longford Terrace, Folkestone.

On Thursday, June 16th, at their Headquarters in Christ Church Road, Folkestone, the above Society gave a Public Demonstration in long-distance telegraphy and telephony. The lecture room was packed to its fullest extent, and, unfortunately, over 30 people were turned away.

Owing to the unavoidable late arrival of the Chairman, the Hon. Secretary (Mr. H. A. S. Gothard), took the chair. The Chairman opened the demonstration with a short address.

The wonders of wireless telegraphy and telephony were fully demonstrated on home-made apparatus. Messages from ships passing in the Channel were audible all over the room, also land stations in America, Norway, France, Germany, Holland and England were received.

At 8.15 the demonstrator (Mr. A. G. Mills) tuned in the Dutch Concert, the audience listened with great interest to the enchanting strains of "Tales of Hoffman." Later a lady sang, and then Part I of "Lohengrin" was received. The most remarkable feature was that messages were received on a home-made set, constructed by Mr. A. G. Mills (Vice-Chairman). With the exception of the Loud Speaker, very kindly loaned by Messrs. S. G. Brown, Ltd., everything was the work of the enthusiastic amateur. The set is the last word in finish and ingenuity.

The Hon. Secretary, in his opening remarks,

said the object of the demonstration was to get the people of Folkestone interested in the science of wireless telegraphy and telephony. The Society had need of new members, and after that evening's demonstration he hoped a number of the audience would join the Society. (Applause.) Continuing, he hoped that, in order to convince the audience in the wonders of wireless telephony, the demonstrator would be able to tune in the Dutch Concert. This feat was extremely difficult even with most expensive and well-constructed apparatus, owing to the low power with which it was transmitted.

Mr. A. H. Ullyett, the Chairman of the Society, spoke regretting his absence during the earlier part of the evening.

After Mr. Mills had picked up the Dutch Concert and made it audible to those present, Mr. Ullyett, on behalf of all, thanked him very much for the entertainment. He thought the experiment had been a great success. (Applause.) Mr. Mills briefly returned the thanks, and said he hoped there would be a rush to join the Society.

The Society's thanks were due to Messrs. S. G. Brown, Ltd., who very kindly loaned one of their Loud Speakers for the occasion.

Full particulars of the Society may be obtained from the Hon. Secretary,

North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

Particulars of the Club may be had from the Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N.21.

A meeting of the North Middlesex Wireless Club was held on June 29th, at Shaftesbury Hall. The greater part of the evening was devoted to Morse code practice, two "classes" being held, one using a low note buzzer for slow workers, and the Club's loud speaker was connected to the aerial for the fast readers. This proved highly successful, and although it had been intended to "shut down" the buzzer work at 9 o'clock, it was continued at the request of those concerned.

Leicestershire Radio Society.

(Affiliated with the Wireless Society of London.)

A general meeting of the above Society was held at the Vaughan College, on July 4th, Mr. C. T. Atkinson, President, in the chair. This being a half-yearly meeting, the President delivered a short address followed by a discussion on the business to hand. It was decided to co-operate with the Loughborough College Wireless Society at their invitation in research work. This will open a new era for members to take an interest in, and provide closer investigation.

Unfortunately the lecturer for this evening was unable to attend, and the President asked Mr. J. W. Pallett to finish the portion of his previous lecture on "Marconi Spark Transmitters," which was omitted on May 9th owing to meeting being closed before he had time to finish.

The President thanked Mr. Pallett for this, which had provided a very interesting subject, and a sincere vote of thanks was passed.

The meeting closed at 9.45 p.m. Applications for membership and all other matters relating to the Society's business should be addressed to the Hon. Secretary, Mr. Jos. W. Pallett, 59, Dulverton Road, Leicester.

Dartford and District Wireless Society.

(Affiliated with the Wireless Society of London.)

Full particulars of the Society are obtainable from the Hon. Secretary, Mr. L. Burcham, "Gouzeacourt," Chestnut Avenue, Oulton Broad.

The usual fortnightly meeting of the above Society was held on Friday, July 1st, 1921, at Dartford Grammar School. The minutes of the previous meeting were read and confirmed, and various items in connection with wireless transmission and reception discussed. A crystal set was brought up for test on the Society's aerial.

The chief item for the evening was a paper given by the Hon. Secretary on "The Elwell-Poulsen System of C.W. Transmission," illustrated by lantern slides.

The paper was divided into 4 sections, viz. :—

(i) Historical introduction.
(ii) Practical long distance wireless telegraphy.
(iii) Aerial structures.
(iv) Important long range stations.

Additional reference was also made to Army Wireless on the spark system.

The historical section dealt with the early research of Prof. Maxwell, Dr. Hertz, Sir Oliver Lodge, and Signor Marconi in connection with the theory of wireless.

The second section was devoted to the use of the electric arc for continuous wave transmission, photographs being shown of the apparatus used and the methods of connection. The aerial structures of various stations were shown with the details explained as to the manner in which they were erected.

Photographic slides of the exterior and interior of Horsea, Lyons, Rome and Honolulu stations were exhibited, the whole series of slides, 47 in number, proving to be of great interest to those present.

All persons interested in wireless and desirous of becoming members are invited to communicate with the Hon. Secretary and Treasurer, Mr. E. C. Deavin, 84, Hawley Road, Wilmington, Dartford.

Lowestoft and District Wireless Society.

On June 21st a lecture was given on "The Construction of Receiving Apparatus No. 1" by the Secretary, the full constructional details of a crystal receiver were given, with detailed sketches on the blackboard, and various pieces of apparatus.

At a meeting of the Committee on June 21st four new members were admitted to the Society, and a proposal was put forward to hold a field day on Saturday, July 9th, and the Secretary was instructed to prepare a scheme before the next meeting.

On June 28th a lecture was given on Valves by Mr. Trent, the lecturer illustrating the subject by numerous diagrams, which was thoroughly appreciated by all present.

Stockport Wireless Society.

The above Society still continues its activities, and considerable progress has been made in the past half year. The winter session at the Technical

School having expired, the Society now holds its meetings at its old Headquarters, Crossley's Café, Market Place, Stockport, on Wednesday evenings, commencing at 7.30.

On Wednesday, June 29th, an extraordinary general meeting was held. The Secretary reported that headway had been made despite the trying times, and he commented upon the loyalty of the members, and said that there was no reason why the Stockport Society should not be one of the foremost in the country.

The balance sheet was then presented and approved, and a hearty vote of thanks for the useful and esteemed services rendered to the Society by the Secretary and Treasurer was accorded to both gentlemen. The appointment of officers then took place. Vice-Presidents, Mr. A. Roberts, Mr. H. Fildes, M.P., and Mr. W. A. Shaw; Chairman, Mr. A. Roberts. The Secretary and Treasurer, Messrs. J. J. McLachlan and W. Pickford, were both re-appointed. The Committee consists of Messrs. R. Ryder and R. H. Jackson, who were re-appointed, and Messrs. C. Froggatt, Barlow and Corner. Auditors re-elected, Messrs. Barlow and Joule. Librarian, Mr. Ryder (Jnr.). An Advisory Committee was appointed to draw up details for the purchase of the new receiver, and a syllabus of lectures was presented and accepted. A new time table was also agreed upon, and various other questions affecting the future welfare and prosperity of the Society were discussed. The meeting closed with a vote of thanks to the Chairman.

Mr. J. J. McLachlan, the Hon. Secretary, 13, Slade Lane, Levenshulme, would be glad to give particulars of the Society to anyone interested, and desiring to join the Society. The present is a unique opportunity for anyone wishing to acquire a good knowledge of the theory of wireless, and new members are particularly desired in order to extend still further the scope of the Society.

Blackpool and Fylde Wireless Society.

Mr. J. C. Doog is the Hon. Secretary, Seventh Avenue, off Broadway, S. Blackpool.

Mr. Sharples, the Chairman of the Blackpool and Fylde Wireless Society, extends a hearty welcome any Thursday evening to members of other Clubs when visiting Blackpool, to present themselves at the Society's Headquarters, The Waldorf Café, Church Street, a few doors lower than the Winter Gardens.

This Society is desirous of keeping the weekly meetings on during the summer season, and considering the numerous counter attractions there is always a fair attendance of enthusiasts.

Mr. Victor Sharples was the recipient of the news of the great fight approximately some 13 minutes after the result. It was received in French and immediately translated. Mr. Sharples mentioned this to prove to the outside public that amateur wireless enthusiasts were doing more than playing at the work, and Blackpool public are now beginning to give the local Society a little more support and consideration. Mr. Sharples would like to know if it would have been at all possible for to have got special permits to have made the news of such big events public.

This question is asked on account of the big crowd that began to congregate round the station on Saturday night. It was a natural thing to do, as the public know nothing of the restrictions and secrecy placed upon all stations.

Mr. Sharples was kept busy informing the people that no news could be made public.

During the past month lectures and demonstrations have been given by Messrs. Ball, Blackburn, Taylor, Frost, and C. V. Sharples, all of which have proved most interesting, in spite of the hot weather and Blackpool's attractions.

Kensington Wireless Society.

Headquarters, 2, Penywern Road, S.W.5. Hon. Secretary, Mr. W. H. McMillan, 288, Earl's Court Road, S.W.5.

A meeting of the above Society was held on June 22nd, when the President, Captain de A. Donisthorpe, gave a very interesting lecture on "Some Undiscussed Points on Thermionic Valves." He demonstrated a new type of valve of his own design, with an umbrella-shaped plate with which he claims to obtain greater efficiency than with the usual tubular shaped plate, in which the electrons passing from the filament to the plate are to some extent repelled out of the ends of the tube. He also demonstrated the "Thermagnion" combination of a magnetic field with a triode, and showed the electrons in a soft valve following the path of the field of a magnet held near it, the blue glow arranging itself on the magnetic lines of force.

After the lecture a demonstration was given of the working of a Morse Recorder.

Meetings have been arranged for the first Thursday and the third Tuesday in the month at 8.30 p.m., except during August. The Secretary would be glad to hear from wireless enthusiasts in the neighbourhood who would like to join the Society.

Southend District Wireless Club.

This Club was formed in May last, and meets at the Technical Institute, London Road.

At the weekly meeting held on Thursday, June 23rd, Mr. Plaistow gave a very interesting description of his receiving set, and described a novel method of coupling which he uses. Various questions were then asked by members, after which Mr. Dudley read a short paper on "Oscillating Circuits and How to Tune Them." A helpful discussion followed, and the meeting closed with a hearty vote of thanks to both speakers.

Those interested can obtain particulars of membership personally at 300, London Road, or by letter from the Hon. Secretary (*pro tem.*), Mr. D. W. Plaistow, 21, Oakleigh Park Drive, Leigh-on-Sea.

City of London School Wireless Society.

NOTICE.

On Monday July 25th, the Society is holding an exhibition of wireless apparatus, including exhibits from Messrs. Marconi, Burnham, F. O. Read, S. G. Brown, Mitchell's, Gamage's. Would any firms who would care to include exhibits write to Mr. J. A. Chapman, City of London School Wireless Society, City of London School, Victoria Embankment, E.C.4.

METEOROLOGICAL REPORTS

TRANSMITTED BY THE EIFFEL TOWER

PROGRAMME OF THE FRENCH, AND EUROPEAN SYNOPTIC REPORTS

Synoptic meteorological reports are issued from the Paris Weather Bureau and transmitted daily from the Eiffel Tower station at 0245, 0815, 1415 and 1930 hours G.M.T. These reports are compiled from observations taken at the following 24 stations in France which are identified in the reports by the figures shown:—

01	Rochefort.	19	Strasbourg.
02	Biarritz.	21	Toulouse.
03	Bordeaux	22	Tours.
04	Brussels.	24	St. Julien.
07	Dijon.	27	Alençon.
08	Calais.	28	Amiens.
09	Limoges.	29	Cosne.
11	St. Mathieu.	30	Le Havre.
13	Mayence.	31	Istres.
14	Montpellier.	32	Metz.
15	Paris.	33	Privas.
18	Rennes.	34	Sommesous.

The European Synoptic Report which is given on pages 275-276 of this issue is sent out daily at 1130 hours G.M.T. from Eiffel Tower, and is a report based on observations from 43 different locations in Europe taken at 0700. This report is for international use, and the codes used are those accepted internationally for the transmission of meteorological information.

The European Reports issued in England by the Air Ministry station, and also the reports transmitted by the German stations at Nauen and Koenigswustuhausen are in a form which agrees in the main with the Paris European Synoptic Report.

Details of the Air Ministry reports were published in *The Wireless World* for April 2nd, 1921, pp. 25-29: the German reports will appear in a subsequent issue.

FRENCH SYNOPTIC REPORTS.

At 0815 the signals sent out are in the following code:—BBBDD FCTTN βbbPP MMmmμ.

At 0245, 1415 and 1930, the code is:—BBBDD FCTT βbb.

Where—
BBB = Barometer in millimetres and tenths (initial 7 omitted).
DD = Code as below.

Code for reports of wind direction to indicate the "tens" figure in the Barometric Tendency.

Direction.	Barometer Tendencies of 9 or less.	Barometer Tendencies of 10 -13.	Barometer Tendencies of 20 -29.
	Code Numbers for Wind Direction.		
Calm - -	00	33	66
N. by E. -	01	34	67
N.N.E. - -	02	35	68
N.E. by N. -	03	36	69
N.E. - -	04	37	70
N.E. by E. -	05	38	71
E.N.E. - -	06	39	72
E. by N. -	07	40	73
E. - - -	08	41	74
E. by S. -	09	42	75
E.S.E. - -	10	43	76
S.E. by E. -	11	44	77
S.E. - -	12	45	78
S.E. by S. -	13	46	79
S.S.E. - -	14	47	80
S. by E. -	15	48	81
S. - - -	16	49	82
S. by W. -	17	50	83
S.S.W. - -	18	51	84
S.W. by S. -	19	52	85
S.W. - -	20	53	86
S.W. by W. -	21	54	87
W.S.W. - -	22	55	88
W. by S. -	23	56	89
W. - - -	24	57	90
W. by N. -	25	58	91
W.N.W. - -	26	59	92
N.W. by W. -	27	60	93
N.W. - -	28	61	94
N.W. by N. -	29	62	95
N.N.W. - -	30	63	96
N. by W. -	31	64	97
N. - - -	32	65	98

F = Force of the Wind as given by the Beaufort Scale below.

	Designation.	Velocity in Metres per Second.
0	Calm	From 0 to 1
1	Almost calm	" 1 " 2
2	Very weak, slight breeze	" 2 " 4
3	Weak = little breeze	" 4 " 6
4	Moderate = nice breeze	" 6 " 8
5	Fairly strong = good breeze	" 8 " 10
6	Strong = fairly fresh	" 10 " 12
7	Very strong = very fresh	" 12 " 15
8	Violent = windy	" 15 " 18
9	Storm	Above 18

W = Weather by following code :—

0	Fine, cloudless.	5	Rain.
1	Less than half sky covered with cloud.	6	Snow.
2	About half sky covered with cloud.	7	Mist (not wet fog but fog less thick than for 8).
3	About ¾ sky covered with cloud.	8	Fog.
4	Overcast.	9	Thunderstorm.

TT = Temperature of the air in whole degrees Fahrenheit.

N = Letter indicating direction of upper clouds (type cirrus), similar to code below :—

0 = Clouds observed having no appreciable movement.

1	= Clouds coming from		N.E.
2	= "	"	E.
3	= "	"	S.E.
4	= "	"	S.
5	= "	"	S.W.
6	= "	"	W.
7	= "	"	N.W.
8	= "	"	N.

9 = No observations.

β = Indicates barometric tendency for the period of 3 hours preceding time of observation.

Old Scale.

0	Barometer steady.
1	" unsteady.
2	" rising continuously.
3	" falling continuously.
4	" falling, then rising.
5	" steady, then rising.
6	" steady, then falling.
7	" falling, then steady.
8	" rising, then steady or falling.
9	" *sudden* rise with marked change of wind and weather.

bb = The amount of change or tendency b is expressed in ½ millibars for preceding 3 hours, in millimetres and tenths where millimetres are used for barometer. (For negative values of the tendency 50 used to be added to the actual numerical value of bb : where millimetres were used negative values used to be indicated by adding 50 to the wind direction DD.)

PP = Two figures indicating rainfall in millimetres since 7 a.m. of the previous day.

MM = Two figures indicating the maximum temperature in whole degrees between 7 a.m. of the previous day and 7 a.m. of the day of observation.

mm = Two figures indicating minimum temperature (for same period as MM above).

μ = Indicates the nature of the surface of the sea according to the following code :—

0 = Calm—glassy.
1 = Very smooth—slightly rippled.
2 = Smooth—rippled.
3 = Slight—rocks buoy.
4 = Moderate—furrowed—choppy.
5 = Rather rough—much furrowed.
6 = Rough—deeply furrowed.
7 = High—rollers with steep fronts.
8 = Very high—rollers with steep fronts.
9 = Phenomenal—precipitous.

The above is followed by D_1, V_1, D_2, V_2 up to D_6, V_6, the lettering D indicating direction of the wind at different altitudes, and V indicating force of the wind at different altitudes, as per the following code :—

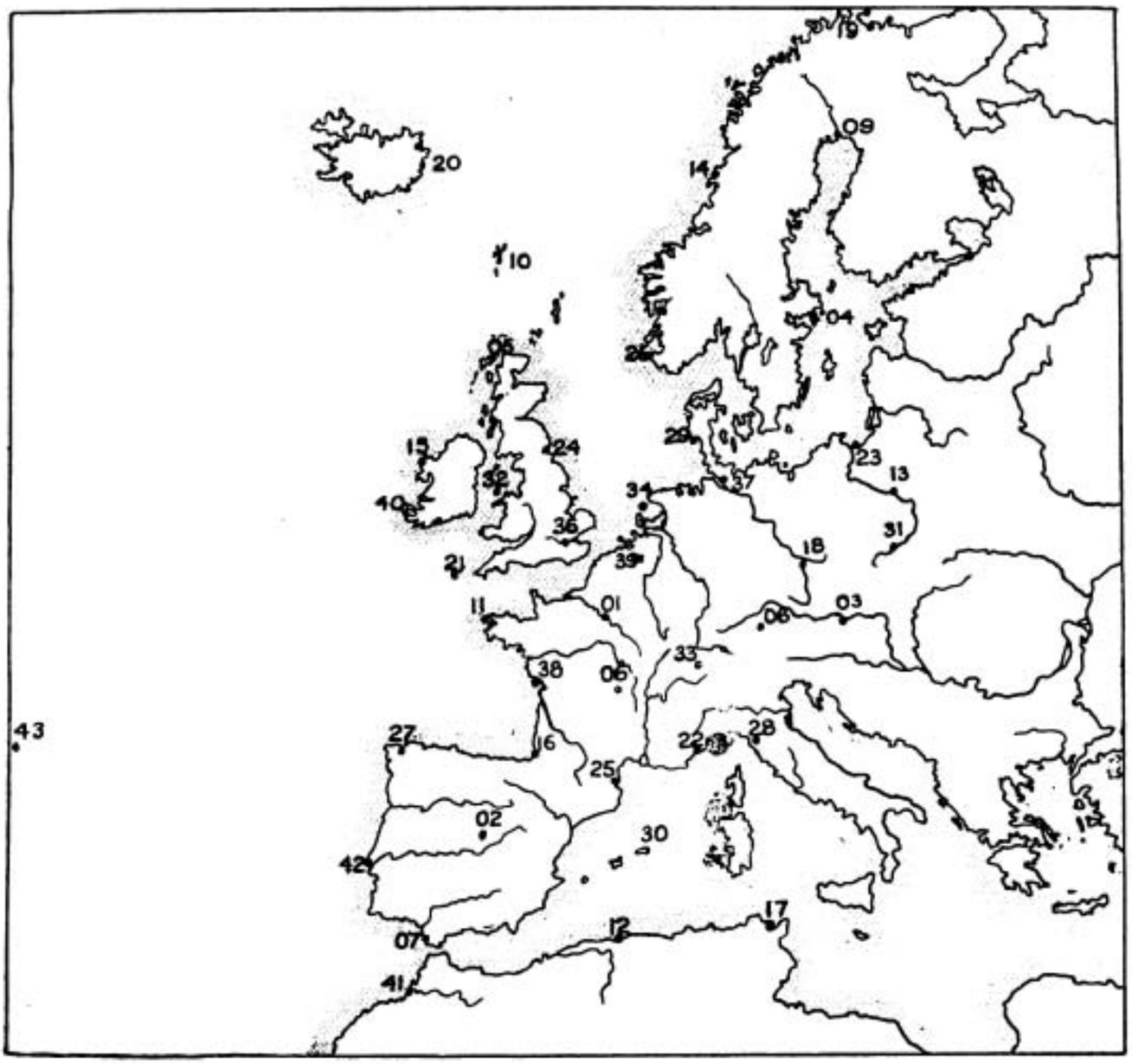
D_1	and	V_1	at	500 metres.
D_2	"	V_2	"	1,000 "
D_3	"	V_3	"	1,500 "
D_4	"	V_4	"	2,000 "
D_5	"	V_5	"	3,000 "
D_6	"	V_6	"	4,000 "

Code for D is as follows :—

N.N.E.	a	S.S.W.	i
N.E.	b	S.W.	j
E.N.E.	c	W.S.W.	k
E.	d	W.	l
E.S.E.	e	W.N.W.	m
S.E.	f	N.W.	n
S.S.E.	g	N.N.W.	o
S.	h	N.	p

Code for V is as follows :—

Metres per Second.		Metres per Second.	
0	a	26	n
2	b	28	o
4	c	30	p
6	d	32	q
8	e	34	r
10	f	36	s
12	g	38	t
14	h	40	u
16	i	42	v
18	j	44	w
20	k	46	y
22	l	48	z
24	m	The letter x denotes missing observations.	



EUROPEAN SYNOPTIC REPORT.

European Synoptic Reports are sent out daily from Eiffel Tower, Paris (FL), at 1130 from observations taken at 0700 at the following stations whose positions are shown in the map above :—

Meteorological Observation Stations.

01	Paris.	23	Dantzig.
02	Madrid.	24	Tynemouth.
03	Vienna.	25	Porpignan.
04	Stockholm.	26	Skudonas.
05	Stornaway.	27	La Corogno.
06	Clermont-Ferrand.	28	Florence.
07	San Fernando.	29	Fano.
08	Munich.	30	Mahon.
09	Haparanda.	31	Cracovie.
10	Thorshavn.	32	Holyhead.
11	Saint-Mathieu.	33	Berne.
12	Alger.	34	Le Helder.
13	Varsovia.	35	Parata.
14	Bronno.	36	London.
15	Blacksod Point.	37	Hamburg.
16	Biarritz.	38	Ile d'Aix.
17	Tunis.	39	Bruxelles.
18	Prague.	40	Valentia.
19	Vardo.	41	(Rabat).
20	Soydisfiord.	42	(Lisbonne).
21	Scilly.	43	(Horta).
22	Nice.		

The message commences with the letters ONM (Office Nationale Meteorologique), followed by the words "Meteo Europe," after which follow 40 series composed of 3 groups containing 2, 5 and

3 figures respectively. The first pair of figures representing the observation station as given in the code above.

The code for the remainder of the series is as follows :—

BBB = (See page 273.)

DD = (See page 273.)

F = Force of wind from Beaufort Scale (See page 274.)

N = Cloudiness and indication of tendency (See page 274.)

	Positive Tendency.	Negative Tendency.
Clear sky	0	5
¼ Covered	1	6
½ Covered	2	7
¾ Covered	3	8
Overcast	4	9

b = Barometric tendency in half millimetres (tens indicated by the DD code, p. 273).

CORRESPONDENCE

To the Editor of *The Wireless World*.

Dear Sir,—With reference to your very interesting article in *The Wireless World* of June 25th, by Mr. Campbell Swinton.

I have been using for the last eight months radio frequency transformers built on the same lines as those of Mr. Campbell Swinton with excellent results.

These transformers are made by Messrs. E. M. Ashley, of Renshaw Street, Liverpool, and are really efficient. The primary and secondary are wound in separate grooves about 1/8th inch apart, and Messrs. Ashley have supplied me with a set suitable to my requirements. At present I am using a 7-valve set constructed by myself, the first two valves being used for radio frequency amplification. Two sets of radio frequency transformers are used, they being wound for 400, 600, 1,000, 2,000, 5,000, and 10,000 metres, which give all the range I desire. They have been arranged so as to be plugged in.

I have no connection with Messrs. Ashley except as an enthusiastic user of their goods.

I hope shortly to write up a description of my station, which may possibly be of interest to readers of *The Wireless World*. I trust you will see your way to publish this letter for the benefit of amateurs who may wish to get in touch with a firm who manufacture these transformers.

Yours truly,
(Signed) J. C. WALKER.

To the Editor of *The Wireless World*.

Sir,—Your reply to C.S.F. (Doncaster) in *The Wireless World* of June 25th is apt to be misleading. My experience of attic aerials is quite the reverse of what is conveyed in your statement.

The aerial I am at present using is inside the roof, close to slates, and consists of two wires. Using crystal I get the usual spark stations including ships, FL, POZ, MPD, BYB, GSW, etc. With a *single* valve the range is anything between 400 and 23,450 (LY) metres, including the four American stations—WII, WSO, WGG, and NSS. As a matter of fact I get better results with this aerial than a single wire outdoor aerial of standard dimensions.

Yours,
EXPERIMENTER (Glasgow).

To the Editor of *The Wireless World*.

Dear Sir,—In reference to the notice in the last number of Mr. Campbell Swinton's paper on HF amplifiers, with special reference to the one I have made, it is hardly clearly indicated that short-wave telephony (300 metres or less) is quite as easy to obtain as telephony on longer wavelengths. We get a given station, who sends on less than 300 and also on 1,000 metres using the same power, quite as strongly on the short wave as on the long one. This without any low frequency amplification at all. This may interest some of your readers.

Yours truly,
(Signed) H. H. BURBURY.

To the Editor of *The Wireless World*.

Dear Sir,—May I, as a frequent "Listener in" make a suggestion to transmitters.

My experience can be put shortly, thus: first thing picked up, music; then a voice, possibly, "Hallo Jones—Hallo Blackheath, hope you are getting me well"; then more music; finally, "I am closing down, good night Jones—goodnight everybody"; finis.

I suggest ending thus:

"99YZ to Jones—good-night. 99YZ to Blackheath g.n. 99YZ to everyone, good-night."

For one, I would be glad to send a p.c. whenever I hear a good transmission. For example, someone to-day, about 4.30 B.S.T., on 480 metres, spoke to K.S., who replied on 1,020. The former's enunciation of p. 65, *The Wireless World*, of April 30th, 1921, was by far the best I have yet caught. Judging from the results of known near stations, I must have heard some far away. It would be mutually pleasing if—(1) I could identify the sender: (2) he could know he had been heard at such long distance.

Yours faithfully,
(Signed) J. H. REEVES.

QUESTIONS AND ANSWERS

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Questions should be numbered and written on one side of the paper only, and should not exceed four in number. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. **(4) The Editor cannot undertake to reply to queries by post.** *(5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.**

RADIO (Devon).—(1) Try the circuit given in Fig. 1.

(2) GLD is Lands End. GNI Niton, Isle of Wight.

(3) Probably Koenigswusterhausen, LP, who works daily about this time on 4,000 metres.

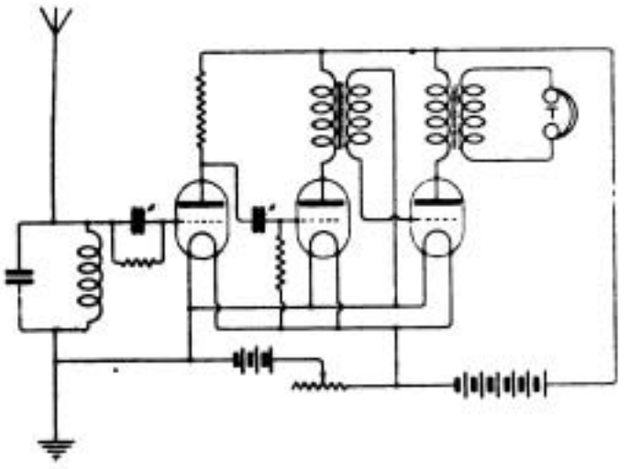


Fig. 1.

C.G.H. (Streatham).—(1) Results will be considerably improved by the introduction of a variable tuning condenser of about 0·0005 mfds. across the coupler secondary.

(2) See diagram, Fig. 2.

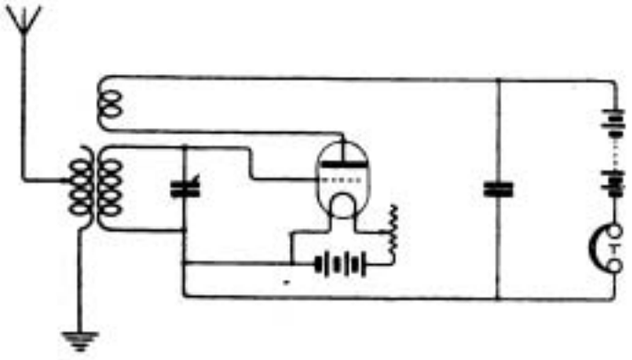


Fig. 2.

(3) A reaction coil is necessary for C.W. reception, but not for spark or telephony, though even for these it is useful. For a winding try 4" by 3" of No. 30.

(4) Not very efficiently.

B.W. (Coventry).—(1) No; the connections of a simple crystal set should be as in the diagram, Fig. 3. The difference is small, but absolutely necessary.

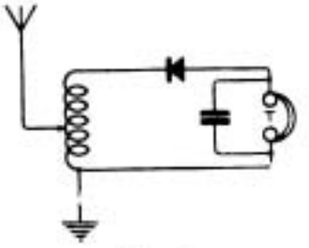


Fig. 3.

(2) You should increase the size of the coil to 10" by 6", wound with No. 24 wire, and should then be able to get as far as Paris.

(3) Yes, a licence is necessary, whether the apparatus is home made or not.

N.L.Y.F. (Reading).—(1) The suggested circuit should be quite all right as it stands.

(2) Yes.

(3) A somewhat larger A.T.C. may be necessary. Except for this the set will tune to 6,000 ms. as desired.

(4) You will probably get the air stations in the neighbourhood of London. There are no regular concerts being given just now, except the Dutch, which you are unlikely to get.

F.A.D. (Hornsey). See diagram, Fig. 4.

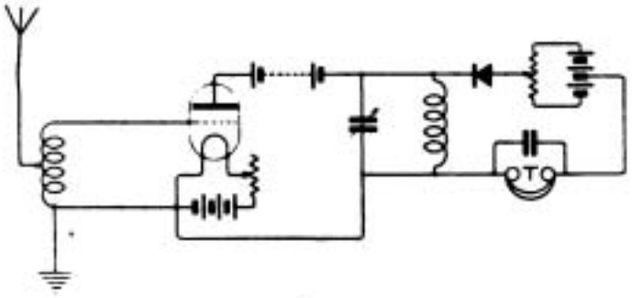


Fig. 4.

ELECTRON (South Shields).—(1) Yes; connect the blocking condenser across the H.T. battery as well as the telephone transformer primary.

(2) Assuming 16" of winding, the maximum wavelength will be 9,000 ms.

(3) 3 ozs. of No. 32 on a 4" former, 6" long.

(4) Five plates, 2" · 1" with 0·002" mica dielectric.

E.M.T. (Wimbledon).—(1) Unfortunately, no.

(2) Better results should be obtained with No. 2 aerial, but what appears wrong with the other one is that the lead in wire is at too sharp an angle. Make it into a T aerial by joining the lead-in directly above the house.

(3) Stiff smooth-surfaced drawing card. Use cartridge paper or stiff drawing paper. The size is entirely a matter of experiment.

(4) Join grid and filament to terminals "valve" and place the detector switch in the 45 degree position.

J.G.T. (Wimbledon).—(1) Quite a useful arrangement, except that switch S2 merely short-circuits the A.T.C. The correct connection is shown in Fig. 5. The gauge of wire is not given, therefore the wavelength cannot be calculated; but the proportion of capacity to inductance in both circuits is too great.

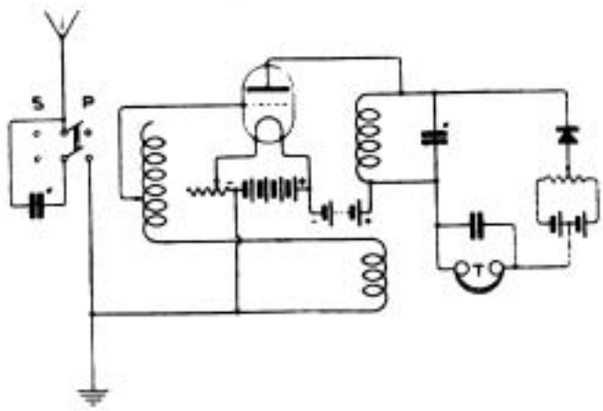


Fig. 5.

(2) Try the circuit given in the figure.

(3) Your circuit, no. Circuit in figure, yes.

G.H.D. (Leigh-on-Sea).—(1) Break the lead from the anode of No. 3 valve to the one side of the telephone, and insert a reaction coil connection.

(2) Anode resistance, approximately 50,000 ohms. Grid leak resistance, approximately 2 to 5 megohms. Condenser between anode and grid, 0·0005 mfds. Condenser across telephones and H.T., 0·002 mfds.

(3) No. You already show a condenser across the H.T. telephones.

(4) Quite a useful circuit.

C.F.H. (Nottingham).—(1) For Dutch concerts see the April 30th issue. Make the A.T.I. former 4" diameter and 6" long, wound full of No. 22 D.W.S. Connect variable condenser across the A.T.I. Reaction coil 3" diameter, wound with 4" of No. 30 D.C.C.

(2) Signals will be very weak with one valve, and unless you stand-bi tuned to 1,100 ms. you will probably not hear it.

(3) No. 18 bare copper wire. Use two wires spaced 4' apart.

SEMCAR (Cumberland).—(1) Fixed condensers, as shown, will increase the wavelength; but the tuning with variable slide inductances will not be very satisfactory. You cannot make a good sliding contact inductance with No. 28 and 36 wire.

(2) It is too fine for aerial circuits. Re-design your circuit and then write again.

(3) The turns should be insulated from each other. The greater the resistance, the less the current taken from the battery. 200 ohms is a good value, in which case 10 ohm steps will be all right.

J.B.B.M. (Bothwell).—(1) The secondary circuit should be tuned by a variable condenser of about 0·0005 mfds. The formers are small; for long wavelengths they should be at least 6" in diameter.

(2) Aerial circuit 1,500 ms. The secondary is untuned.

(3) and (4) To make the set suitable for 5,000 ms. —the limit with a crystal detector—primary should be 6" diameter 10" long and the loading inductance 6" diameter by 14" long, both wound with No. 24 D.C.C. or enamelled wire. The secondary should be 5" diameter and 9" long, wound with No. 28 and used with a 0·0005 variable condenser.

ENQUIRY (Todmorton) *asks various questions with regard to the windings of the Magnavox loud speaker, sketched on page 793 of the issue for February 19th.*

We regret that we have no information as to the details of the windings used by the makers; but think you should get fairly good results with dimensions as under:—

Field core, diaphragm and moving coil may be 50% to 100% larger, lineally, than shown in the sketch. Field coil wound with No. 36, moving coil with about No. 40. Air gap not larger than necessary to give free movement of moving coil. Transformer should be iron-cored and of construction similar to a telephone transformer. H.R. winding as for telephone transformer, L.R. winding of about 38 to the resistance of the moving coil.

W.B.P. (Monkseaton).—(1) Difficult to say, as it depends largely on the value of the parallel A.T.C., which is rather uncertain; maximum not less than 3,000 ms., and probably not more than 4,500 ms. The minimum is still more uncertain, but probably 200 or 300 ms.

(2) Probably all the stations mentioned except Clifden, and Chelmsford, which is now working C.W. telegraphy

(3) Probably due to a bad connection, most likely in the telephone leads.

(4) Not very much, but a valve used as an amplifier would be quite useful.

E.A.G. (Ipswich).—The dimensions of the reaction coil will depend on the dimensions of the A.T.I., which you do not state. Try a coil 5"×3" of No. 28, with about 4 tappings. If this is not convenient for your A.T.I. you can alter the shape within reasonable limits, keeping the length of wire the same, without greatly altering the results.

(2) Yes, if carefully wound.

(3) Yes.

C.W.P. (Dorchester).—(1) BLN in a message is usually an abbreviation for Berlin, either as part of an address or an office of origin.

(2) We should say that it was an exceptionally good result.

(3) The circuit can be altered on the lines shown in Fig. 6.

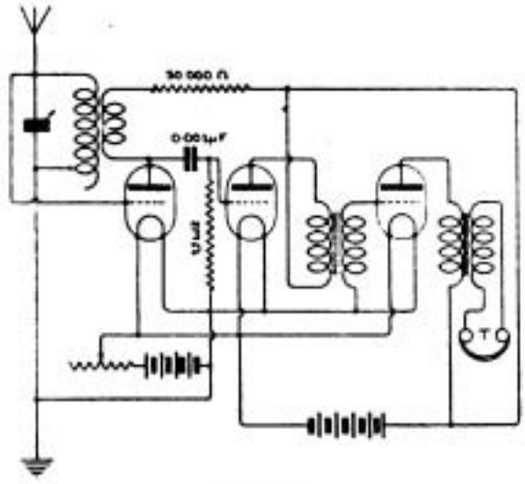


Fig. 6.

LUCRU CAUSA (Chelmsford).—(1) The maximum wavelength will be 4,000 ms. For 7,000 ms. rewind the secondary with No. 30, and increase the capacity of the condenser to double the present value.

(2) C = 0·00033 mfds.

C = 0·000075 mfds.: too small to be of much use as a blocking condenser.

(3) For 7,000 ms. a parallel A.T.C. will be desirable; maximum capacity should be about 0·001 mfds.

(4) Very unlikely.

W.H.W. (Worsley).—(1) Get the license altered for an outside aerial, as a frame is no good with one valve only.

(2) Try the circuit given on page 853 of the issue for March 5th.

(3) The connections for the Brown relay are as in Fig. 7.

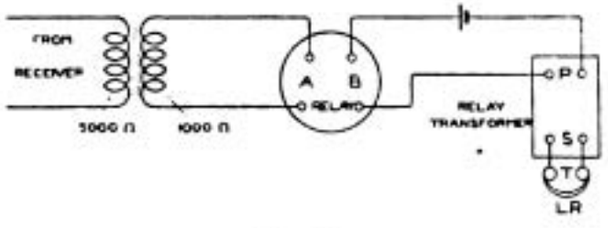


Fig. 7.

The transformer marked "relay transformer" is part of the equipment supplied by the makers.

Two of these relays may be connected in series, if desired, through a step-up transformer of about 100/1,000 ohms.

H.V.R. (Elstree).—(1) and (2) The aerial condenser should be approximately 0·0005 mfds. The wavelength range will be increased to 10,000 ms. if the A.T.C. is connected in parallel with the A.T.I. The diagram on page 157 of the May 28th issue shows how this should be done.

(3) For an R valve the voltage required is approximately 50. This may be obtained by joining 12 or 14 pocket batteries (of three cells each) in series.

(4) The reaction coil may be made to slide in and out of the A.T.I.

BEGINNER (Castle Bromwich).—(1) Arrange the apparatus as shown in Fig. 3, page 185, of the June 11th issue. The variable condenser across the inductance should be 0·0003 to 0·0005 mfds. We cannot give the range, as you do not give the windings.

(2) Not with a small aerial. During a storm join the aerial and earth leads together.

(3) Yes, but we expect they will be rather weak.

(4) Birmingham Experimental Wireless Club. Hon. Secretary, Mr. F. S. Adams, 110, Ivor Road, Sparkhill, Birmingham.

L.K.C. (Ilford).—(1) The potential difference between two points (with direct current) is given by Ohm's Law, which is, $E = IR$, where E = voltage drop, I = the current, and R the resistance between the two points.

(2) The resistance of conductors in parallel is given by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ where R is the joint resistance, and R_1 and R_2 the resistances of each conductor alone.

D.G.B. (South Shields).—It is almost impossible to make an efficient reaction coil for 500 to 26,000 ms. on a 4" × 3½" former. Give full particulars of the set, and we will advise you.

J.A.Y. (Pangbourne).—(1) If you have a condenser available you can easily try it. It should improve the strength of signals.

(2) You might get signals out from very strong stations only.

T.E.N. (Copenhagen) *asks how to calculate the inductance of honeycomb, duolateral and lattice-wound coils. If not possible to give accurate formulæ, can we give approximations.*

See the articles appearing in *The Wireless World*, October 2, 16 and 30 and December 11, 1920.

ELECTRON (Dulwich).—(1) If the condenser is 0·0005 mfds., make the A.T.I. former 8" × 14", wound full of No. 26. Reaction 7" × 10", wound with No. 28. If condenser is 0·001 mfds., use former 6" × 10", and reaction 5" × 8", wound with wires as before.

(2) Condenser B is unnecessary, as the series parallel condenser is for tuning up the circuit.

(3) There should be no trouble in making a movable coupling arrangement instead of the arrangement that you suggest. Constructional article in the April 17th, 1920, issue shows such an arrangement. The coil D you suggest would be useless, as it does not couple into the A.T.I.

(4) The windings given above are suitable for 1,000 to 10,000 ms. For wavelengths below this you should have quite a separate coupling unit, in which case you need not worry about dead-end effects.

J.E.F. (Woodford Green).—(1) Connections are quite right.

(2) The aerial is hopeless. Try a single wire outside aerial.

(3) No.

(4) A 3′ frame would be all right with four valves. It is of no use with only a crystal.

F.I.C. (Tamworth).—(1) and (2) With H.F. transformers it is not possible to give windings for definite wavelengths except as the result of experiment under the conditions for which they are to be used. Use any gauge of copper or eureka between 40 and 47, the finer the better. About 1 oz. will be sufficient.

(3) and (4) Copper transformers give better results at the natural wavelength of the transformers but resistance transformers give good signals over a much wider range. *See* a forthcoming constructional article on H.F. transformers

W.H.P. (Bristol).—(1) Yes, possibly you can improve the aerial by making it a twin one of the same length.

(2) Either carborundum-steel, or zincite-bornite combinations will give you good results, the latter without a battery and potentiometer.

(3) Wavelength approximately 3,000 ms.

(4) This should be of small capacity, say 0·0003 to 0·0005 mfds.

X.B.S. (Redcar).—(1) Assuming the overlap of the plates is 4″ × 3″, for 0·0015 mfds. you will require nine plates, and for 0·003, sixteen plates.

(2) It would be best to make two separate inductance units, either of which can be connected to the valve and condenser. If you use the condensers given in the article: No. 1, 4″ × 6″, of No 26, with reaction coil 3″ × 4″, of No. 30. No. 2, 6″ × 14″, of No. 26 with reaction coil 5″ × 8″, of No. 30.

(3) Sample wire, No. 22, is too small for the aerial. Use at least No. 18.

(4) It may improve results. Try 0·0005 mfds., with 2 megohms resistance.

AVANTI (Sheffield).—Assuming an aerial series-parallel condenser of 0·0005 mfds is used, twelve basket coils in series should give approximately the range required. The coils should be made 4 cms. inside diameter, 16 cms. outside diameter, wound with No. 26.

C.C.R. (Norwood).—Bad induction troubles on a crystal set are rather unusual. Place your apparatus as far from the electric light leads as possible, and also run your aerial and earth leads as far from them as you can. If you still get trouble, try screening your apparatus in metal boxes.

R.H.P. (Rugby).—(1) Bury a long length of wire netting or a galvanised iron or zinc plate, 2′ or 3′ wide and 6′ long, in good damp soil. Unless you are fond of digging, you can bury it horizontally.

(2) During storms, or when the aerial is not in use, join the aerial and earth leads together. No special junction is necessary.

AMATEUR (Ealing).—Crystal receivers are not required at the present time to go above 5,000 ms., as there are, no spark stations on wavelengths longer than this. For a 5,000 ms. set, try this: Loose coupler, primary 6″ × 9″, wound with No. 24; secondary, 5″ × 9″, wound with No. 28. Connect a 0·0005 mfds. variable condenser across the secondary. Loading coil for the aerial, 8″ × 12″, wound with No. 24.

J.G.N. (Tonbridge).—(1) Circuit No. 1 is wrong.

(2) Circuit No. 2 is better; maximum wavelength about 4,000 ms., with a P.M.G. aerial. Arrange the circuit as in Fig. 5, page 218, June 25th.

(3) 0·0005 mfds.

H.C.E (Clapham Common).—(1) There would probably be very little difference.

(2) Between 0·001 and 0·002 mfds.

(3) We do not know of any list obtainable other than that in the "Year Book."

(4) Code 1 on page 27 of the April 2nd, 1921, issue of *The Wireless World*, is now in use.

H.C.H. (Victoria, W.).—(1) Aerial should give poor results, but increase the length if possible. Use two wires spaced about 5′ apart.

(2) Yes, valves will, of course, increase the strength of signals.

(3) A 0·002 mfds. condenser across the telephones will improve the signals.

(4) High resistance telephones, 2,000-4,000 ohms per head, or low resistance 60 ohms per head, with a telephone transformer, as described in March, 1920, issue.

WIRELESS PATENT ACTION.

As the result of an action brought against Messrs. A. W. Gamage Limited by Marconi's Wireless Telegraph Company Limited, for the infringement of two Marconi patents (C. S. Franklin No. 13636 of 1913, and H. J. Round No. 28413 of 1913), judgment by consent of the defendants has been given by Mr. Justice Eve in the High Courts of Justice. By this judgment Messrs. Gamage are to pay £150 agreed damages and the Marconi Company's taxed costs, and are ordered to destroy all wireless receiving apparatus made or used by them (including "Polaris" receiving apparatus) infringing the above-mentioned Marconi patents.

SHARE MARKET REPORT.

Business is very quiet in all the Marconi issues. The buying public are waiting for the report that will be out at the end of the month.

Prices as we go to press, July 14th, are:—

Marconi Ordinary	£2	5	0
,, Preference	£2	3	9
,, Inter. Marine	£1	6	3
,, Canadian		7	6
Radio Corporation of America :—			
Ordinary		9	0
Preference		10	6