The WIRELESS WORLD

VOL. VIII No. 6, NEW SERIES] 12th JUNE, 1920 [FORTNIGHTLY

CONTENTS

PRICE 6D. NET

THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. VIII. No. 6. JUNE 12TH, 1920 FORTNIGHTLY

CAN WE UTILISE SOLAR HEAT-ENERGY?

THERMO-ELECTRICITY AND SOME OF ITS APPLICATIONS

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

THE sun is a vast storehouse of energy—energy that is continually being dissipated into space and whose influence can be felt to the uttermost recesses of the Solar System. The sun's energy is in the form commonly known as heat energy, and its distribution throughout the solar system takes place by radiation. Heat—or, rather that manifestation of energy which we usually call heat—is commonly transferred from one body to another by one of three ways, styled respectively—Conduction, Convection, and Radiation.

Conduction of heat from one body to another can only take place when the bodies are in actual contact, either directly or through some intermediate material substance, so that the molecular vibrations of the body at the higher temperature can be communicated to the one at the lower.

Convection is essentially a process involving the action of a fluid as the intermediate material acting as the transmitting medium. It first involves the transmission of the heat energy to the particles of the fluid by conduction from the hot body, and then a change in the density of the fluid with increase of the temperature of its parts. A difference in density between its parts causes the establishment of circulating currents in the fluid, a redistribution of the heated parts being thereby effected

In the third method the transference of the heat energy does not involve the intermediary action of any material body, but the setting up of electromagnetic waves in the aether. These waves are of precisely similar nature to ordinary light waves (with which they are frequently, but not necessarily, accompanied) and to the longer electromagnetic waves used in wireless signalling. Their place in the aether spectrum partly fills up the space between the longest infra-red light waves and the shortest electromagnetic waves produced by direct electrical means in the laboratory.*

The mechanism of the transmission of the heat energy is therefore precisely similar to the radiation of electromagnetic energy from an ordinary wireless transmitting station.

The energy radiated from the sun per square mile of its surface has been estimated to be of the order of a quarter of a million H.P., giving a total radiation of 560 thousand-million-billion horse power Of this prodigious amount the earth, by reason of its comparatively small size and large distance from the sun, receives but a minute portion—but

*See *Wireless World*, April 17th, 1920, Fig. 1, page 39.

even this "small" quantity amounts to the receipt of a total of about 200 billion H.P. on the earth's surface.

Can we by any known means utilise any appreciable part of this energy? The total power requirements of the whole British Isles do not amount to anything like the above figure, and so could all be obtained from the energy received on a few square miles of the earth's surface near the equator, even supposing that the efficiency of the conversion of the heat energy to, say, electrical energy amounted to but 10 per cent.

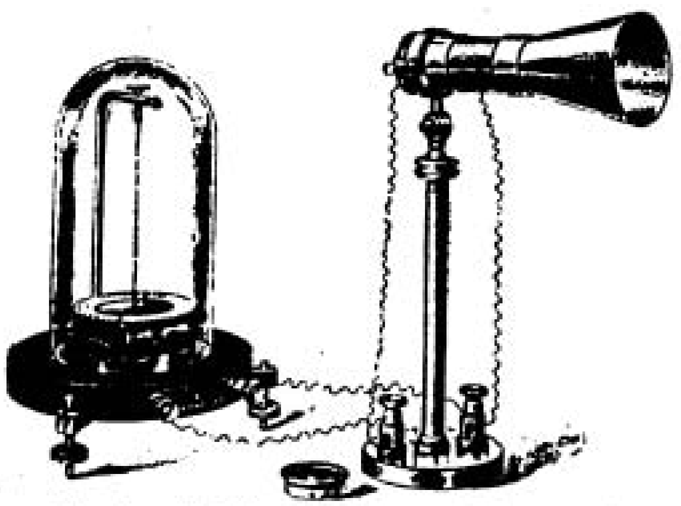


Fig. 1. A Laboratory form of Thermopile.
(*Courtesy of F. E. Becker & Co.*)

Various means have been proposed from time to time for utilising this energy source, and these have perhaps received more attention than usual at the times of the periodical recurrence of the scare about vanishing coal supplies. Perhaps the commonest suggestion of all is that of erecting large concave mirrors to concentrate the sun's heat rays upon a boiler, so as to heat water and generate steam which may then be employed, either for water pumping and irrigation, which constitutes the most prevalent demand for power in hot climates, or else for the generation of electrical energy, using a steam engine to drive a dynamo. This is evidently a very roundabout method, and one of consequently very low efficiency, certainly not over 10 per cent. At the present time no really satisfactory solution of the problem has been obtained, largely on account of the above difficulties and low efficiency. Any such method is evidently most suited for use in hot climates, deserts, etc., where there is very little cloud to absorb the energy before it reaches the earth's surface.

Another possible method—but, again, one that has not yet received practical application—is based on the phenomena of thermo-electricity. If two pieces of different metals are placed in contact with one another and the junction heated, while the remainder of the material is kept cool, it was found by Seebeck, in 1822, that an e.m.f. was set up between them, and if a closed path is provided between the cool ends of the material a current will be set up round that circuit. The e.m.f. established at the hot junction between the materials in this manner depends upon the nature of the two substances forming the junction, and the rise in temperature of the junction as compared with the cool ends of the materials. This e.m.f. is, however, in all cases only a small fraction of a volt.

The various known conducting materials may be arranged in order of their thermo-electric power, and for this purpose it is customary to take lead as an arbitrary standard of reference with which to compare the other materials. A table summarising this property of various materials is given below.

Material.	Thermo - Electromotive force in volts for hot junction temperature = 100°C. and cold junction = 0°C
Bismuth	+0.00682
Cobalt	+0.00320
Nickel	+0.00246
German Silver	+0.00148
Soft Platinum	+0.00012
Aluminium	+0.00006
Tin	+0.00001
Lead	—
Copper	−0.00017
Hard Platinum	−0.00022
Silver	−0.00029
Gold	−0.00033
Zinc	−0.00035
Iron	−0.00149
Antimony	−0.00463
Tellurium	approximately −0.05
Selenium	,, −0.08

The values of the thermo e.m.f. as given in this table vary considerably with the purity of the materials.

To obtain the thermo-electromotive force of any given combination by means of this table, the e.m.f. due to one material (referred to lead) should be subtracted algebraically from the e.m.f. of the other (relative to lead). The figures given in the table refer to a hot junction temperature of 100°C, and a cold junction one of 0°C.

Owing to the small value of this e.m.f. it is evidently desirable to connect as many junctions in series as practicable so that an e.m.f. of more reasonable order of magnitude may be obtained. A typical form of thermopile, as such a collection of junctions is frequently termed, is illustrated in Fig. 1. The instrument there depicted is a usual laboratory form suitable for experiments designed mainly to indicate the properties of thermo-electricity.

To employ this principle for the practical utilisation of solar heat-energy would evidently require the use of an immense number of cells in series in order to secure terminal voltages at all approaching ordinary working values. The junctions would also require to be constructed on a substantial basis to fit them for carrying comparatively large currents. The cost of such an installation would therefore be rather large, although it should be noted as a set-off against this that the construction, involving merely the contact between two different metals should not involve such technical difficulties, nor such insulation troubles, as are sometimes encountered in the design and construction of ordinary electrical machinery. It is doubtful, however, if the efficiency of the method would be very high.*

The smaller type of thermopile has, however, many interesting applications to which only a passing reference can be made in this article.

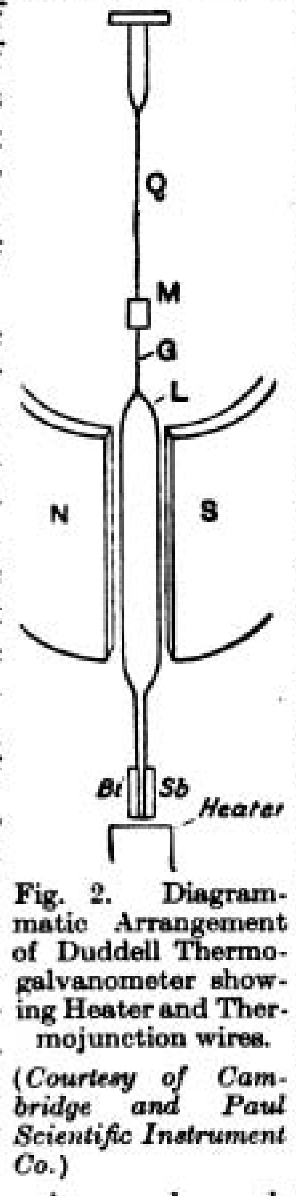


Fig. 2. Diagrammatic Arrangement of Duddell Thermo-galvanometer showing Heater and Thermojunction wires. (*Courtesy of Cambridge and Paul Scientific Instrument Co.*)

It is used, for instance, for the determination of high temperatures (of furnaces, etc.), by measuring the thermal radiation from the inside of the space of which the temperature is to be determined. Such instruments are termed pyrometers.

Thermometers are also constructed particularly for use at moderately high temperatures —1,000°C, or less—in which the indication is obtained on a galvanometer connected to a thermo-junction enclosed in a heat-resisting tube, which can be immersed in the high temperature material.

In investigations of the extreme infra-red, or "heat" end of the spectrum, very small thermopiles are often employed, made up in the form of a single narrow line of junctions, to measure the intensity of the radiation at wavelengths beyond the visible limit; and as another interesting application may be mentioned Duddell's thermo-galvanometer, one of the most sensitive of instruments for the measurement of very small alternating or high-frequency currents. In this apparatus a minute thermo-junction, marked *Bi Sb* in Fig. 2, is suspended from the lower end of the moving coil L of a galvanometer, and connected in series with that coil, as shown. Immediately under that thermo-junction a small heater wire is mounted, through which the alternating currents are passed. The small amount of heat radiated from this wire slightly warms the thermo-junction, and so gives rise to a thermo-e.m.f., and hence to a deflection of the moving coil, as indicated by a spot of light reflected from the mirror M.

Thermopiles may, like selenium cells, be used for telephony with light rays† as the heat radiation accompanying such rays affects the thermopile. The visible light may also, if desired, be cut off entirely and the communication effected by an invisible beam of heat rays between the two stations.

* Another interesting suggestion for the utilisation of Solar Energy was recently put forward by Mr. A. A. C. Swinton in a letter to *Nature* on Dec. 18th, 1919.

† See previous article on Selenium Cells, *Wireless World*, Vol. 8, pp. 145-149, 1920.

FRAME AERIALS FOR RECEPTION

THEIR THEORY, DESIGN, CONSTRUCTION AND USE

(*Concluded from page* 155).

The Design of Loop Aerials.

The efficiency of a loop aerial used for reception may obviously be measured by the voltage to which the tuning condenser can be charged by the effective e.m.f. set up in it. The voltage in the case of any loop has been estimated to be proportional to $\frac{NAL}{\lambda^2 R}$ where N = number of turns on loop, A = area of a turn, L = self-inductance of loop, λ = wavelength, and R = Total effective resistance of loop.

The value of this "reception factor," as it is termed, evidently should be our chief care in designing a frame aerial, and should, of course, be as high as possible. The problem, however, is not so simple as it might appear, for keeping the quantity NAL constant does not result, as might be supposed, in a constantly increasing efficiency as the wavelength (λ) is decreased. Nor does the steady increase in the area and number of turns of the loop result in a proportionate gain in efficiency, for such increase naturally raises the fundamental wavelength of the loop, and when this approaches half the wavelength of the incoming waves, the efficiency begins to fall off. Indeed it is very evident that for any given wavelength one particular combination of N and A is by far the best.

Type and Size of Loop.

Of the two types of loop aerials most easily made—the solenoid and the flat spiral (or pancake)—the former is preferable if only for its simplicity. The frame itself should be rectangular, but not necessarily square. As there is one particular size of loop most suitable for reception on a given wavelength, this part of the design depends largely upon the special needs of the designer. Most people will no doubt require an aerial for general use, and therefore should remember the general principle that within certain limits the best combination is a large loop with few turns for short waves, and for long waves more turns on a somewhat smaller frame. It is a good plan to have two loops of different size made up. The writer uses one, 3 feet square, and a small experimental type only 1 foot square. Surprisingly good results can be obtained with this small loop, which scores because it is easily manipulated with one hand and can stand comfortably on a chair. For amateurs, especially those who desire to use the aerial indoors, a 3 feet loop is recommended ; anything larger than this will be found cumbersome.

Number of Turns.

For general search purposes it is best to employ a considerable number of turns because loops so designed are efficient over a greater range of wavelength than those with only a few turns. Hence it is desirable to use a wire which has as low a resistance as possible. Bearing in mind that the spacing of the turns is a most important point, it is at once obvious that on a former or frame of moderate width, say 4 or 5 inches, the approximate number of turns required *will become apparent as soon as the spacing is decided upon.* It would be possible to give a table showing the correct number of turns on frames of various sizes *for certain wavelengths*, but it is believed that few amateurs desire to confine themselves to so narrow a field and so with the foregoing hints the matter is left to their own judgment and taste.

Best Spacing between Turns.

In order to keep the resistance of the coil as low as possible the turns must be well spaced. As, however, this reduces the induc-

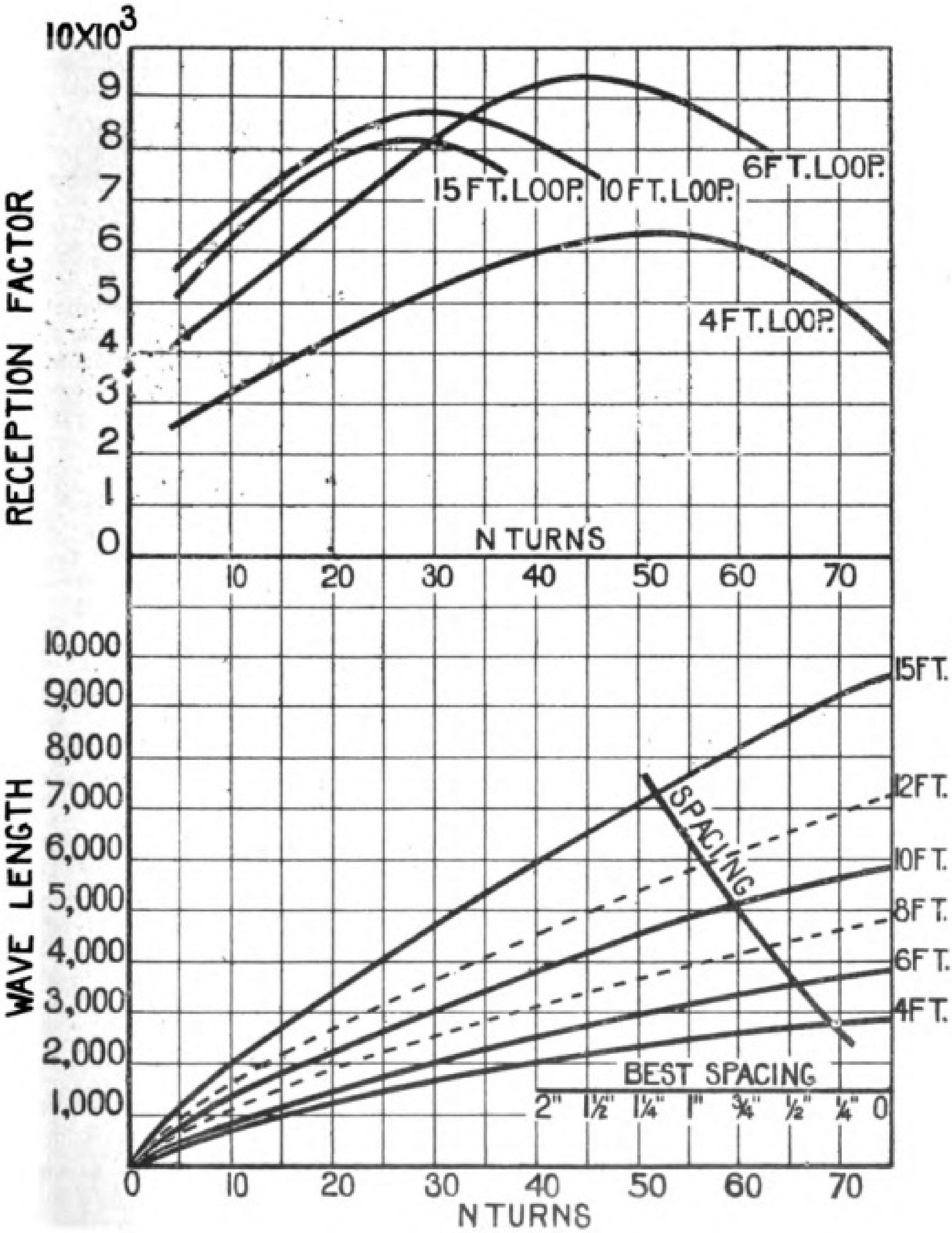

10X10^3
RECEPTION FACTOR
9
8
7
6
5
4
3
2
1
0
15 FT. LOOP.
10 FT. LOOP.
6 FT. LOOP.
4 FT. LOOP.
N TURNS
10
20
30
40
50
60
70
WAVE LENGTH
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
15 FT.
12 FT.
10 FT.
8 FT.
6 FT.
4 FT.
SPACING
BEST SPACING
2" 1½" 1¼" 1" ¾" ½" ¼" 0
0
10
20
30
40
50
60
70
N TURNS

Fig. 13.

tance it should only be resorted to where moderate wavelengths are to be received. For a frame 2 feet square the best spacing is 3/16ths inch, and for a 4 foot frame ¼ inch, whilst for a 5 foot frame the spacing required would be about 5/16ths inch. This is where one advantage of the "pancake" type appears, because with this type large spacing does not necessitate a wide frame. A few experiments in winding will soon reveal the most suitable combination.

Type and Size of Wire.

The reader is advised to use insulated copper wire of whatever size is most convenient to him or his purse, so long as it is not too fine. Experiment shows that one size is best for one wavelength and another size for a different wavelength. Certain advantages attach to the use of stranded wire in some cases and disappear when different wavelengths are being received, so that as the amateur is not as a rule particularly concerned with quantitative experiments he cannot go far wrong if he winds his loop with fairly stout bell-wire or lamp "flex."

Design Chart.

Fig. 13* is very useful in cases where it is desired to design loops for the reception of certain wavelengths. Let us suppose that we wish to know the best combination of size of loop, number of turns, and spacing for the reception of Eiffel Tower time signals. The wavelength is 2,500 metres. Reference to the bottom portion of the chart shows the following :—

Size of Loop	No. of Turns	Spacing
4 feet	50	¼ inch
6 feet	40	7/16ths inch
10 feet	23	¾ inch

Next, referring to the top portion of the chart we find that the all-important "reception factor" for each of the above sizes of loop is as follows :—

Size of Loop	Reception Factor
4 feet	6,400
6 feet	9,300
10 feet	8,600

which shows that to receive a 2,500 metre wave, a 6 feet loop with 40 turns $\frac{7}{16}$ths of an inch apart is the most efficient of the examples given.

This requires a large wide frame, but it should be noted that these dimensions are not *essential.* They are, however, the *best* for 2,500 metres.

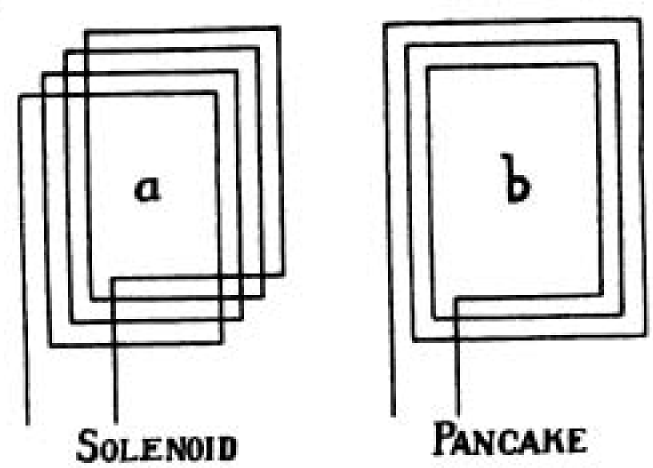


Fig. 14.

The tuning condenser used with any loop designed for a given wavelength should not have a greater capacity than 0·001 mfd.

CONSTRUCTION.

Fig. 14 shows the two forms of loop aerial, the solenoid and the "pancake," but the following remarks are intended to apply to the first named type although in some points they refer to both.

The first consideration is the frame itself. Each side of this should be some 4 or 5 inches wide unless designed for a certain wavelength, in which case the width is governed by the required spacing. It is worth while to dovetail the joints in order to preserve a true rectangle. For convenience and accuracy in

* Theory and Practical Attainments in the Design and Use of Radio Direction-Finding Apparatus using Closed-Coil Antennæ. A. S. Blatterman, *Journal of the Franklin Institute*, September, 1919.

winding the four edges over which the wires pass should be notched, after the spacing has been decided upon. Each side need not necessarily be of solid wood but may be made as a framework only.

Besides being made capable of rotation about a central axis the frame should be pivoted laterally so that it may be swung to a position in which its plane is parallel to the earth. In such a position the aerial is non-directional and may be used as a general stand-by. Once the desired station is tuned in, the frame may be dropped to the vertical and used as a direction-finder. In order that the frame may be used horizontally, the pivots should be made somewhat tight so that the frame will remain horizontal. An accurately-drawn compass-card must be fixed as shown, and a suitable pointer arranged.

The winding should permit both ends of the wire to leave the frame from the bottom centre, a little slack being left to enable the frame to be rotated through 180 degrees and to the horizontal.

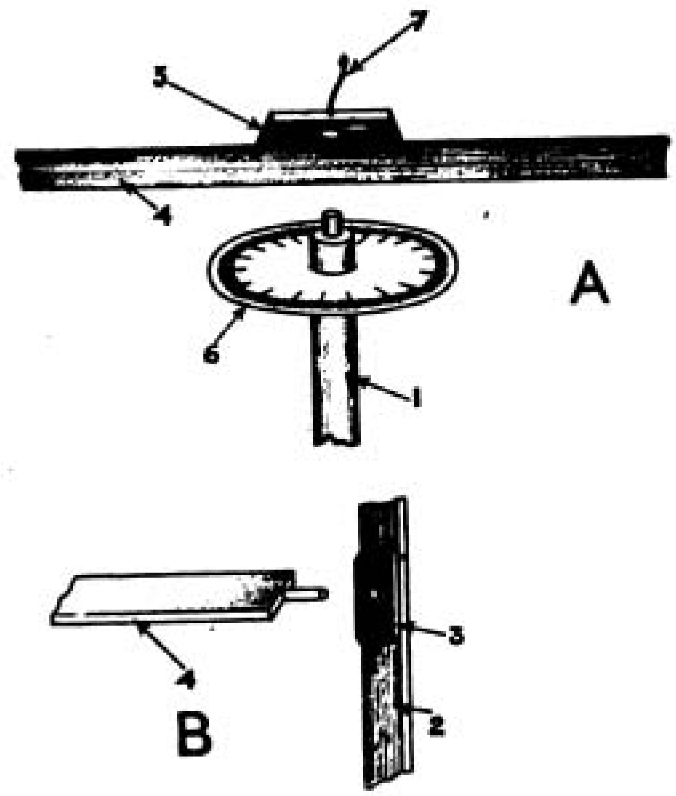


Fig. 16.

The base of the whole instrument should be made from stout, well-seasoned wood, sufficiently heavy to keep stationary during the manipulation of the frame.

Fig. 15 shows a simple form of frame, but the amateur, having grasped the essentials, may modify that particular type to suit his requirements, his purse or his ability as a carpenter. He should not, however, construct a frame for regular use smaller than 3 feet square, because if he does he will find that he will have to load it up with a large amount of A.T.I. Using a 3-foot frame wound with ten turns of ordinary bell wire, with a spacing of about $\frac{3}{8}$ inch, the writer found that only about 20 turns of a coil of $6\frac{3}{8}$ inch diameter (No. 22 wire) were needed as A.T.I. for 600 metre waves, when a condenser of 0·0008 mfd. was placed across the loop. These figures may serve as a guide to design.

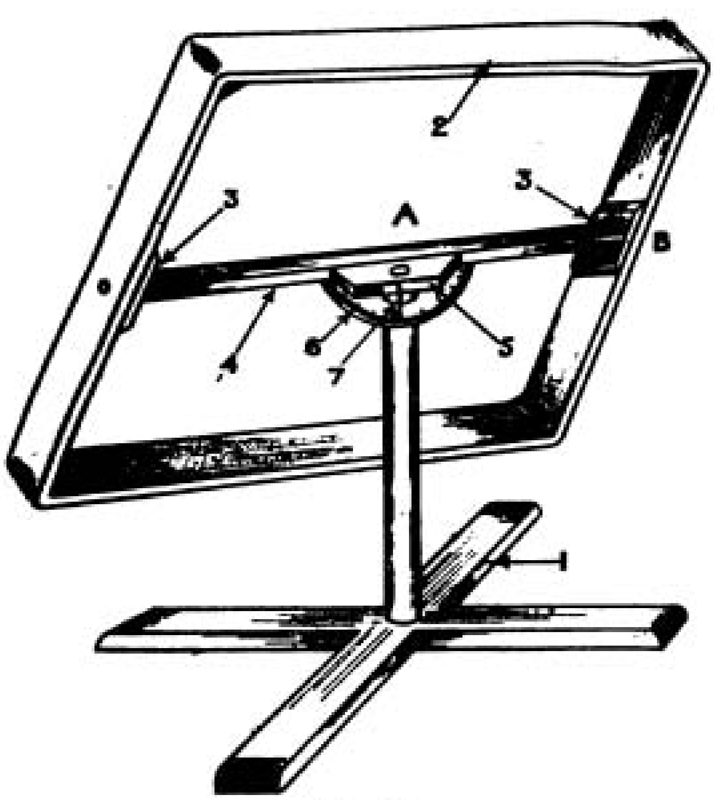


Fig. 15.

1. ***Stand*** *: cross pieces and support (wood).*
2. ***Frame*** *(wood).*
3. ***Swing blocks*** *(wood).*
4. ***Swing bar*** *(wood).*
5. ***Swivel block*** *(wood).*
6. ***Compass Card*** *(three-ply wood or cardboard with paper dial stuck on).*
7. ***Pointer*** *(tinplate or aluminium).*

Fig.* 16 *shows constructional details of the frame.

The Use of the Loop Aerial.

First of all, by means of a reliable compass, set the frame so that the compass card points due N. and S. If convenient, it is a good plan to mark on the floor the position of the base when the N. point of the card points due N.; this saves one from repeating the process every time the frame is used, because, luckily for us, the positions of the magnetic poles do not change from day to day.

Then set the frame horizontally and tune in some station the direction of which is known. Suppose we choose Havre (F F H), a station which can be easily heard with a valve amplifier anywhere in the British Isles. Havre is approximately south of London, and therefore (if the frame is in London) when it is tuned in and the frame is lowered for D.F. work the latter will point roughly N. and S. after retuning. Listen to the signals for a little while in order to judge their strength and then swing the frame round 180°. Again judge the strength of the signals and then mark whichever end of the frame pointed S. when the signals were strongest. You may then know when receiving any other station, that the marked end points in the direction of that station when you have found the position of the strongest signals. This direction may then be read off on the compass-card and may be checked, if you wish, by means of your compass and a good map. This process gives the direction of the transmitter but not its position, for, unfortunately, we have not yet devised a method of ascertaining by means of a single receiver the *distance* of the transmitter.

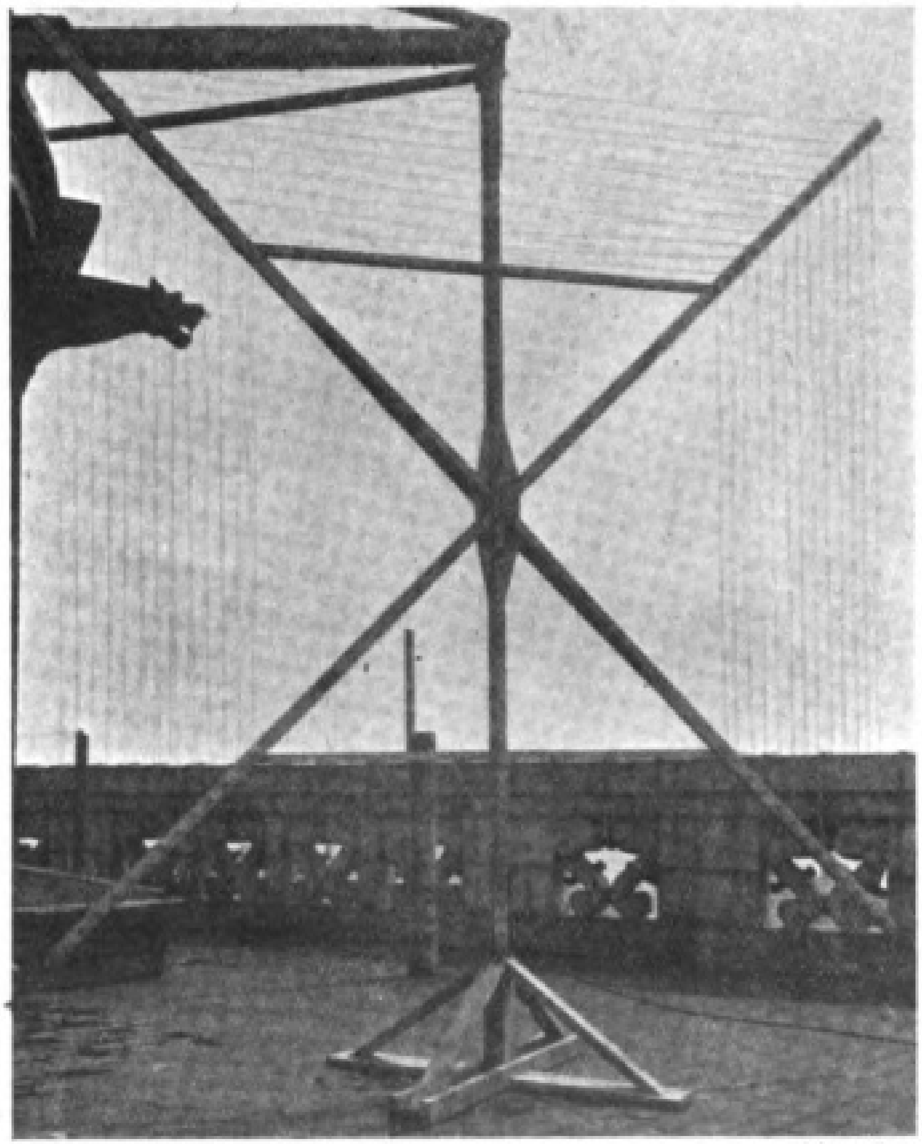


Photo Press.

Frame Aerial erected on the top of the Times Tower at New York.

Hints.

Do not forget that if the connections of the frame to the receiver are reversed, the direction shown by the frame will be reversed. Provide against this contingency.

Use a small A.T.I. in preference to a few turns of a large coil. Dead turns are not advisable and upset the accuracy of your work.

Keep the frame, the detector and the filament and H.T. batteries as high as possible above the earth.

If possible, find out the natural wavelength of the frame and the capacity of your condenser. Do not work in the dark, but know with what dimensions you are dealing.

NOTES AND NEWS

Wireless Telephony coming into its Own.—Not only by those who are more or less familiar with its values and uses, but also by those who are in a measure ignorant of its possibilities, the utility of the wireless telephone is being generally admitted to be superior in every way to the ordinary line instrument. Recently the London Fire Brigade made tests with a view to keeping headquarters in communication with the scene of a fire, and the result of these tests was such that one is led to believe that before very long every fire-engine will carry as part of its equipment a wireless telephone! Another instance is to be found in South Africa, where, the chief industry being farming, wireless telephony is being seriously considered as a means whereby farmers can link up their various areas, thus maintaining communication with their foremen, neighbours and distant towns.

The Forest Service of the Western United States has already adopted wireless telephone apparatus as part of its standard equipment, and in practical tests it was proven that such apparatus was more serviceable for reporting fires than is the line telephone; more practicable, inasmuch as that it is less liable to damage by the omnivorous flames of forest conflagrations.

In one instance more than ninety miles of telephone line were destroyed by fire, interrupting the service for more than a week. As against this, a wireless telephone installation was in one case saved, by floating it upon a log raft on a neighbouring lake, while the forest fire swept by; thereafter communication was re-established and maintained in less than one hour.

The accompanying illustration shows a typical commercial wireless telephony set, the undoubted efficiency of which is gaining more favour every day.

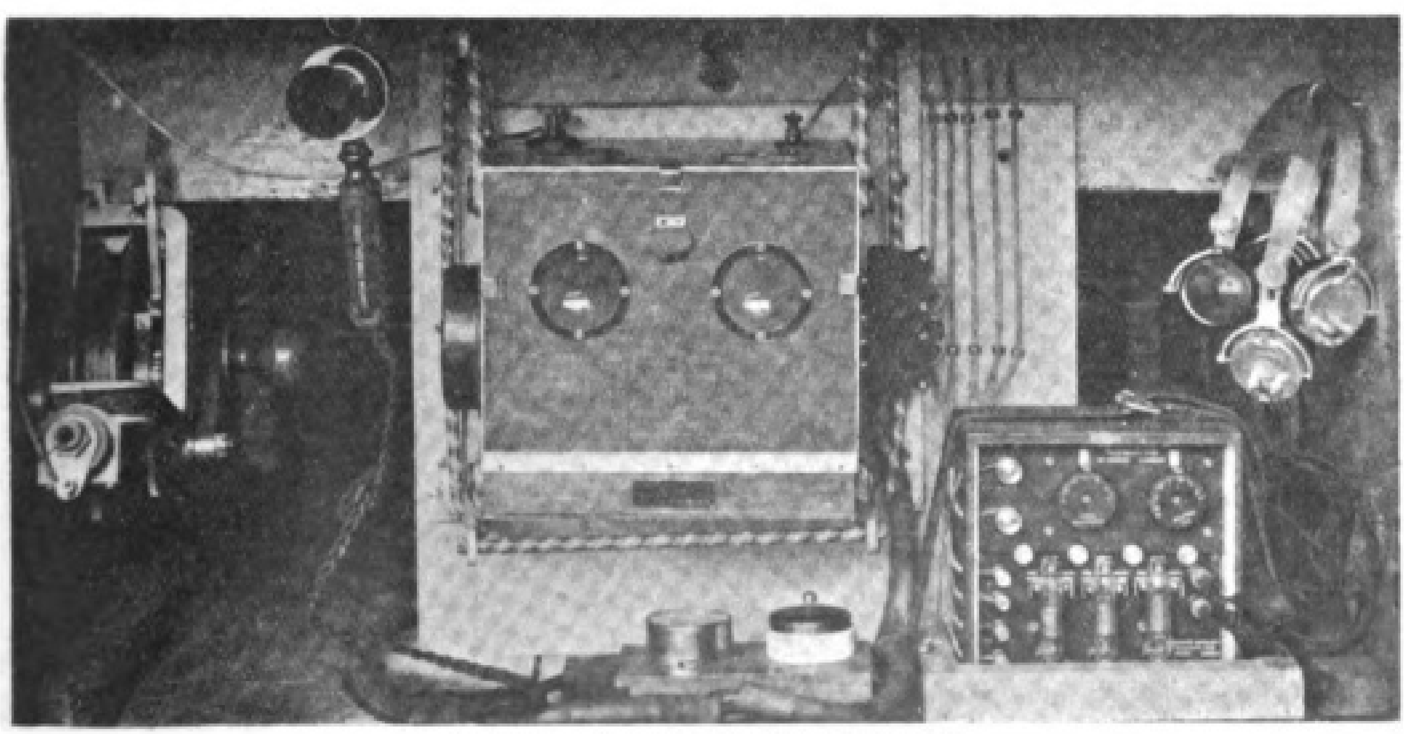
I.R.E. Gold Medal for 1920.—The Institute of Radio Engineers' Gold Medal for the year 1920 has been awarded by the Board of Direction of the Institute, to Senatore Marconi.

French D.F. Stations.—Griz-Nez (FNZ), not yet opened; Le Havre (FFU); Bernieres (UHN); Cherbourg (FFC); Treguier (FQC); Ouessant-Pen ar Roch (FHY), (replies through FFF); Brest Guipavas (FHA); Brest Capucins (HUD), (replies through FFK); Pointe du Raz (FPU); Lorient (FFL); Chemoulin (FUH); Rochefort Soubise (HOB); Barre de l'Adour (FLO); Casablanca-Chetaba (FCH), (replies through CNP.) These stations maintain a watch on 600 metres and reply on 450 metres and/or 600 metres.

German D.F. Stations.—Amrumbank Feuerschiff (KAF), 300 m., 600 m.; Borkum Riff Feuerschiff (KBR), 300 m., 600 m.; Bulk (KBK), 300 m.; Cuxhaven (KCX), 300 m., 600 m.; Eider Feuerschiff (KAJ), 800 m., 600 m.; Eiderlotsengaliote Feuerschiff (KCL), 800 m., 600 m.; Elbe Feuerschiff Eins (KBF), 300 m.; Norddeich (KAV), 300 m., 600 m., 1,800 m.; Sassnitz (KCV), 375 m.; Swinemünde (KAW), 300 m., 600 m., 1,800 m.; Weser Feuerschiff (KCW), 300 m. The wavelengths underlined are those normally used.

Czecho-Slovakia.—As from January 10th of this year the Republic of Czecho-Slovakia became an adherent to the Telegraphic and Radio-Telegraphic Conventions.

"Daily Mail" Wireless.—Like many American and Continental newspaper offices, the "Daily Mail" has taken unto itself a wireless receiving set. The set is a Marconi valve type, employing a 6-foot wooden frame antenna, and came into experimental operation on May 11th. More of this anon.



A commercial Wireless Telephony Set.

Lecture by Dr. J. A. Fleming.—At a lecture delivered at the Royal Institution of Great Britain on Friday, May 21st, Professor J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I., gave an interesting and most instructive paper on the Thermionic Valve in Wireless Telegraphy and Telephony. Starting from the point where Mr. Edison was experimenting with his carbon filament lamp, in 1883, Professor Fleming led his audience through the whole process of evolution and invention, until he reached the modern valve. The lecturer, as is usual with Professor Fleming, illustrated his paper with copious experiments, drawings and diagrams. His capabilities as an admirable lecturer were yet again indicated in the large audience, and the attention with which everyone followed his words.

Multiplex Wireless Telephony.—At a recent meeting of the Institute of Radio Engineers it was reported by Mr. Ryan that two wireless telephone conversations had been conducted through a single aerial over a distance of five miles. Mr. Ryan, who is engaged in extensive wireless research work, further stated that many more telephone conversations could have been carried on, had there been sufficient apparatus at hand.

The Steady March of Wireless.—At a recent Conference of the Associated Chambers of Commerce of Australia, a motion was unanimously passed advocating that the Commonwealth Government be asked to do its utmost in duplicating the present Pacific cable and to arrange for wireless communication with the United States, Canada, and other parts of the world.

In the Japanese National Budget for the coming year provision is made for wireless expansion. The renewing of the transmitting and receiving apparatus at the Funabashi Station is likewise provided for.

A wireless service between San Paulo (Rome) and Königswusterhausen (L P), Germany, has been established, but at present is only available for an hour at a time.

M. Dunoyer, a French wireless engineer, has invented what he terms an "electric safety lock." The arrangement is to direct the course of a torpedo and secure its explosion against an enemy warship, not only by wireless waves of the right length, but also by a proper sequence of Morse signals. Any error in the right sequence of dots and dashes would run the mechanism down to zero and so render the torpedo harmless. Each torpedo launched would have its own set sequence of Morse signals, eliminating the possibility of enemy tampering or interference.

What would seem to be the first step towards linking the West Indies with the American and European continents, is to be found in the fact that the Department of the Canadian Naval Service, at Ottawa, has recently announced the inauguration of a commercial wireless service between Canada and the Island of Bermuda. The service will be maintained by the wireless station at Barrington Passage, Nova Scotia, and the Station at Bermuda.

Naval Observatory Time Signals.—Illustrating the accuracy of time signals sent out by the United States Naval Observatory, more especially those transmitted by wireless, Mr. C. C. Wylie, of the Observatory staff, gives the following records of a specimen month (February, 1919). Each signal being recorded on the chronograph by the standard clock, the amount of error is accurately determined. The errors in setting the transmitting clock were almost negligible, there being 2 of 0.02 sec., 21 of 0.01 sec. To the signals from the three wireless stations operated by the transmitting clock of the observatory, the following corrections for lag have been determined: Arlington, +0.02 sec.; Great Lakes, +0.10 sec.; Key West, +0.28 sec. It is recommended that whenever great accuracy is required, wireless time signals should be used in preference to those transmitted over the ordinary telegraph lines.

Watches *versus* Wireless.—The use of wireless time-signals as a method of measuring longitude values has called forth efforts on the part of chronometer manufacturers to raise their standard of accuracy. A number of trials will shortly be arranged in which to save time and reduce possible errors; watches will be carried backwards and forwards by aeroplane between Greenwich and Paris; observation being made at each place. The results will be compared with the standard determinations of longitude already made by means of wireless signals.

The invention of the chronometer gave the mariner Greenwich time wherever he went. In practice, however, the readings given by the chronometer were only close approximations to the truth, whereas the wireless time-signal, which is received practically at the same moment as it is dispatched, provides a more accurate means of transmitting time.

An interesting comparison was made recently between longitude values determined by wireless telegraphy and those ascertained by means of special chronometers. The chronometers were conveyed from Neuchatel to Washington, U.S.A., *via* Bordeaux. At Bordeaux the two readings were exactly the same and at Washington the difference was only 1·6 of a second or an error of about 300 yards.

Music by Wireless.—At the recent Conversazione of the Royal Society, at Burlington House, a wireless telephone demonstration was given by the Marconi Company. Tunes from a gramophone and musical instruments played at the Company's works at Chelmsford were received on a small frame aerial which stood on the lecture table. The signals were rendered more audible by further amplification.

Questions and Answers.—Our readers will confer on us a favour if they will bear in mind the fact that we cannot undertake to reply to queries by post. The inclusion of a stamped and addressed envelope in no way affects this rule. Much as we desire to give our readers promptly the information necessary for them to be able to go on with their work, we cannot, at present, do so other than through the Questions and Answers pages.

THE PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

SOME OF THE PROBLEMS OF ATMOSPHERIC ELIMINATION IN WIRELESS RECEPTION

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

AN Ordinary General Meeting was held on Friday, May 21st, 1920, at 6 p.m., in the Lecture Hall of the Institution of Civil Engineers, Admiral of the Fleet, Sir Henry B. Jackson, F.R.S., occupying the Chair.

The Minutes of the previous meeting were read and confirmed.

The Chairman: I regret to inform you that Mr. Campbell Swinton, our President, is ill in bed with a very severe attack of gastritis, and is quite unable to attend the meeting this evening. Therefore I have been asked to take the chair in his place. I propose that the Secretary should write a sympathetic letter to our President, expressing the hope that he will speedily recover. It is very sad indeed, because I think it is the first meeting our President has not been able to attend. The ballot papers for the election of new members have been distributed, and it is requested that you will read the names through and hand the papers to the Secretary. Should you object to any of the names, please put a cross against them. There are two other names to be added since the ballot papers were prepared, viz., Brigadier-General Sir Henry Capel Holden, K.C.B., F.R.S., who is well known to you, and also Mr. Sydney H. Naylor, whose name has been approved by the Committee. I am sorry we could not get the names on the list, but they were not received in time. If anybody objects to either of these names will they please write them on the paper and put a cross against them. If the names are not written down we will consider that the votes are in their favour. I hope that is clear. Mr. W. Walpole, an Associate Member, has been elected by the Committee to-day as a full member. The Edinburgh Wireless Society has requested to be affiliated with our Society, and the request has been granted. I will now call on Mr. Philip Coursey to give us a lecture on "Some of the Problems of Atmospheric Elimination in Wireless Reception."

INTRODUCTION

The object of this paper is not so much to consider the probable true nature and origin of the atmospherics or X's which are heard in wireless receivers, and which are frequently such a disturbing element by hindering satisfactory radio communication, but rather to deal with the problems with which we are confronted in trying to eliminate the effects of these disturbances, and to indicate some of the solutions that have been put forward on various occasions. No particular claim can, therefore, be made to originality in the subject matter described, but it is hoped that a systematic collection of the different methods by which this elimination has been accomplished to a greater or less extent may be of some interest to the members of this Society.

Nomenclature.

The use of the term "X" to designate these disturbances dates back to the days of the early coherer receiver, when all messages were recorded on the tape of a Morse inker operated from the coherer and its attendant relay. On these tapes irregular and unintelligible marks were frequently found and from their unknown source and origin these were termed "X's." The development of the more modern sensitive receivers soon enabled us to recognise that these X's were not all of the same nature. Some evidently originated in local thunderstorms and lightning discharges, but others had no such obvious origin, and from their widely distributed nature (many X's are frequently recorded simultaneously by different wireless stations over a large area of the earth's surface) they were assumed to be caused by some widespread electrical disturbance of the earth's atmosphere as a whole. Hence the now more generally accepted term "atmospherics." A name frequently applied to them in scientific literature and discussions is "strays"—and this term appears to have received the support of the British Association Committee for Radiotelegraphic Investigation. Our American friends, however, more usually refer to them simply as "static." For the purposes of this paper the exact term is really immaterial and I may use any one of them that is most convenient.

The word "atmospheric," however, is favoured as being a good all-round expression and is equally applicable for the description of any or all of the recognised types of such disturbances.

Classification of Atmospherics.

Atmospherics, in general, have been classified into three main types: Grinders, Clicks, and Hisses Of these, the first type is probably the most prevalent, and includes all the various miscellaneous sounds commonly associated with atmospherics, other than those specifically described by the second and third designations. As a general rule, the "click" variety of atmospheric arises through isolated lightning and similar discharges in the atmosphere, while the "hisses" are due to static discharges from, or to, the aerial itself, such as may be caused by induction from highly charged clouds, or by charged rain falling on the wires.

The effect of the last type of X may generally be eliminated by surrounding the aerial wires with an electrostatic shield, consisting of a number of wires connected to earth through appropriate resistances. The aerial itself is thus protected from electrostatic induction effects, while the resistances included in the circuit of the shielding wires prevent the latter from absorbing a prohibitive proportion of the incoming signal. These shields are frequently called "Dieckmann cages," from their description by that writer, but it appears that the same arrangement was patented by G. W. Pickard in 1907, some years before Dieckmann's account.*

Electrical Characteristics of Atmospherics.

I want in this paper to try to set out the essential principles underlying the problem of eliminating the effect of atmospherics in wireless receivers, to demonstrate experimentally, if possible, the fundamental basis of these principles, and then to describe some of the arrangements that have been tried out in practice and have yielded a certain measure of success.

With this purpose in view, it will perhaps be best if I first indicate to you the fundamental differences between atmospherics and ordinary signals. An ordinary signal current may be either an undamped (continuous) oscillation, or a damped one, as is well known. An atmospheric is for all practical purposes an aperiodic impulse, that is to say, it partakes of the nature of a non-oscillatory discharge, which may perhaps best be likened to an electrical blow delivered to the circuit which is affected by it.

The difference between these cases is solely a matter of decrement. Fig. 1 shows

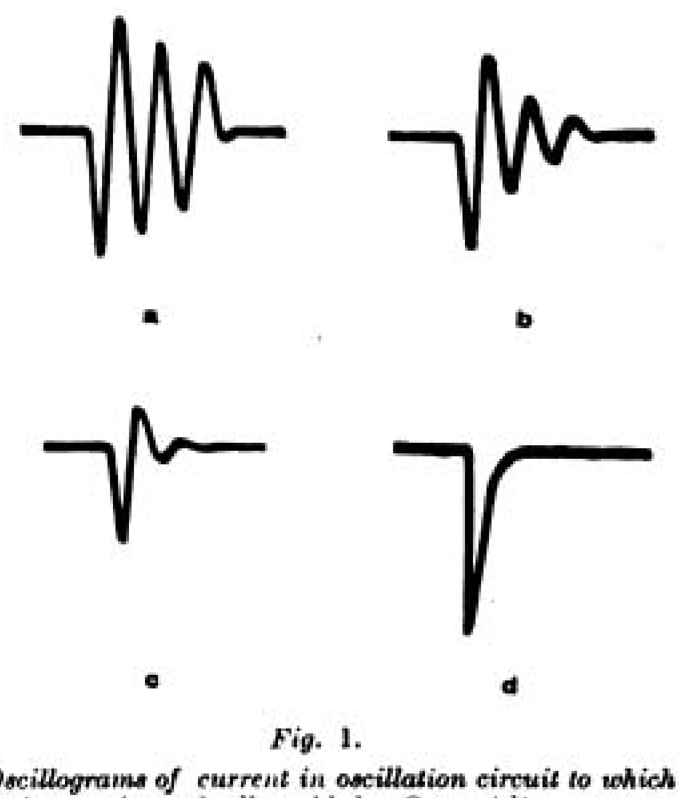


Fig. 1.

Oscillograms of current in oscillation circuit to which resistance is gradually added. Curve (d) *represents an atmospheric.*

a series of oscillograms of the current in an oscillation circuit to which resistance is gradually added. Curve (a) indicates the case with minimum resistance and represents a slightly damped oscillation. In (b) and (c) more resistance has been added, and finally curve (d) represents the case when the discharge is no longer oscillatory and is what is usually

* G. W. Pickard, U.S. Patent No. 842910.

referred to as an aperiodic discharge. Such an aperiodic discharge may be taken as representing in a general way the nature of an average atmospheric—more particularly those of the "click" variety, since the wave form of the "grinder" must evidently be more complicated in shape, although the same general characteristic of the non-oscillatory discharge is in all probability retained.*

The possibility of separating out the atmospheric impulses from the desired signals must therefore be made to depend upon this difference in their nature, and on the difference in the effects to which they give rise in the given receiving circuit. It should further be evident from an inspection of these curves that the separation of atmospherics from C.W. signals should be easier than their separation from a spark signal. This separation of the different types of impulse is not, however, quite so easy as might at first sight be thought from the different appearance of these curves. This may perhaps best be seen by considering the wave form of the currents induced in a tuned secondary circuit coupled to the aerial in which the various impulses are induced.

In Fig. 2 is shown a series of four oscillograms indicating the current in a secondary oscillatory circuit coupled to the primary in which the oscillatory discharge occurs. The upper and lower curves marked (a) represent respectively the current in the primary and secondary for a slightly damped primary oscillation when the secondary circuit is tuned to the primary, and the pair of curves marked (b) are similar curves with the secondary detuned from the primary. It should be noted that in this latter case the amplitude of the current in the secondary circuit is very much less than in the first case. Curves (c) and (d) are corresponding curves for the case when the secondary is tuned and

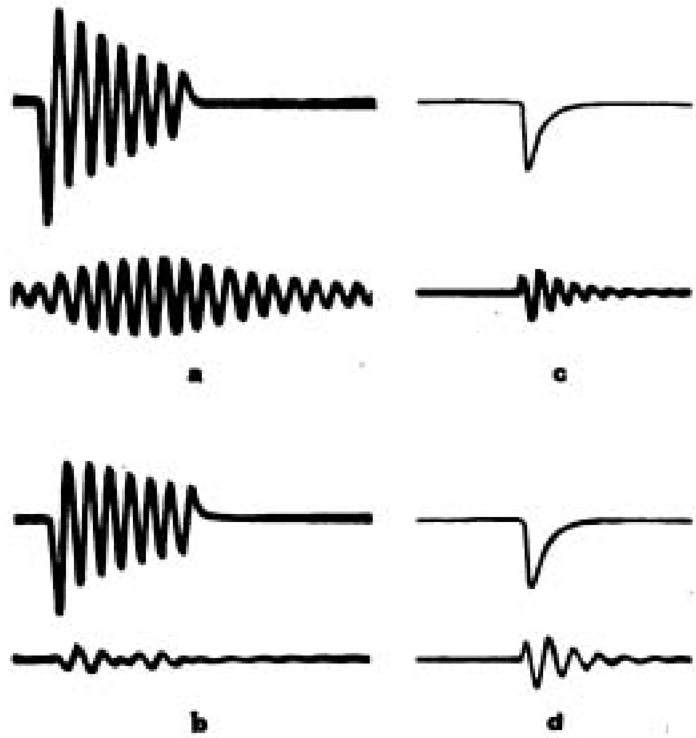


Fig. 2.

Oscillograms of currents in primary and secondary circuits when tuned and untuned, for damped wave signal and also for atmospheric. Curves (a) *and* (c) *are tuned,* (b) *and* (d) *not tuned. The primary curve is the upper one in each case.*

not tuned respectively to the primary circuit in which an aperiodic discharge occurs, and it may be seen from these that the current amplitude in the secondary circuit remains practically constant and independent of the tuning of that circuit while the oscillation set up in the secondary has the natural oscillation frequency of that circuit.

This difference in the tuning in the two cases can be shown by means of a "tonic-train" signal from an oscillating valve and an artificially manufactured X obtained by discharging a large condenser through a coil coupled to the receiver. Using this apparatus it is easily shown that the receiver must be carefully tuned to the "tonic-train" signal in order for any sounds to be heard in the telephones, whereas the X-impulse can be heard at all positions of the tuning condenser.

These amplitude differences therefore indicate to us the fundamental method of distinguishing between the effects due to the signal which we are desiring to receive and the atmospheric which we wish to eliminate, and also show up the advantages of the use of a highly

* It should be noted that the scale of these curves is not uniform, but has been adjusted in each case to be more suitable for reproduction, while the whole of the oscillation in curve (a) is not shown, as the end of it was cut off by the contact-maker connecting the oscillograph to the oscillatory circuit.

selective receiver sharply tuned to the incoming signal.

The effect of Coupling

It may also be noted from similar experiments to the above that when the coupling between the primary and secondary circuits is weakened the secondary current induced by the highly damped primary impulse falls off somewhat more rapidly than does that arising from the continuous oscillation, and hence there is an obvious advantage in using as weak a coupling as possible when receiving.

This simple method of reducing the effect of the atmospherics on our receiving apparatus cannot be carried very far as if the coupling is weakened too much we lose the signal entirely, and it is here that the great value of the modern valve amplifier may at once be seen because by its use we can, if desired, weaken the coupling of our receiver to a very much greater extent than would be possible when using, say, a crystal detector

It should be noted on the other hand that however much the coupling is weakened we cannot entirely eliminate the effect of the atmospheric. If the atmospheric impulse is a powerful one some effect of it will still be felt in the secondary circuit however much the coupling is weakened.

Apart from actually wiping out the effect of the signal itself if it occurs at the same time, a powerful atmospheric also rather tends to deaden the sensitiveness of the ear to succeeding signals, and therefore it is very desirable that the very loud atmospherics should be suppressed as far as possible, or at the very least that they should be reduced in intensity until they are of the same order of magnitude and preferably somewhat weaker than the signal itself.

Improved results may frequently be obtained by the use of a so-called aperiodic aerial with very loose coupling to the receiver. By the use of an aperiodic aerial is meant simply the insertion of a coupling coil in the earth lead, this coil being of insufficient inductance to tune the aerial to the wavelength of the incoming signals. The aerial circuit is not therefore strictly aperiodic but merely detuned. The receiver itself should, of course, be tuned to the desired signal wavelength and should be very loosely coupled to the aerial coupling coil. As we have seen above the effect of the atmospheric impulse is to set up oscillations in the receiving aerial of the frequency to which that aerial is tuned. If therefore the aerial is tuned to a frequency different to that of the incoming signal, the atmospherics will set up oscillations in the aerial of that different frequency and not of the same frequency as the signal. The signal itself, however, will produce very feeble forced oscillations in the aerial of its own frequency, and by the use of a carefully tuned secondary circuit loosely coupled to the aerial, these feeble forced oscillations may be picked up and subsequently amplified by a multi-stage amplifier, thus giving greatly increased freedom from atmospheric disturbances. The use of the valve amplifier is essential to the success of this arrangement This type of aperiodic or untuned aerial may be regarded as a simple form of the filtering circuits which will be described later on in the paper.

CLASSIFICATION OF METHODS.

The various proposed methods of eliminating or reducing the effects of atmospherics may be broadly classified as follows :—

1. Intensity Limiters.
2. Directional Reception Methods.
3. Filtering circuits.
4. Methods dependent upon the aerial form.

Each of these will be briefly considered in turn, and the chief features of each class indicated.

1.—INTENSITY LIMITERS.

One of the early attempts to effect this limiting action was made by L. W. Austin, who proposed the use of a special crystal contact connected either across the aerial and earth terminals or in shunt to the secondary circuit of the receiving apparatus, with the object of limiting the response of the detector to a certain definite maximum, whatever the strength of the incoming impulse.*

The particular crystal combination advocated, viz., a contact between silicon and arsenic, acts somewhat in the manner of a self-decohering coherer. The great disadvantage of these limiters is that while their resistance is lowered and they are passing the atmospheric away to earth, any signal current that arrives in the aerial at the same instant is also shunted away and its effect on the receiver lost, so that if atmospherics are frequent very little signal may be received. Their chief action is to protect the ear from the deafening effect of the loud atmospherics. Various other and similar arrangements have been proposed from time to time but this one of Austin's is one of the most satisfactory of its kind.

Other arrangements which operate in a somewhat similar manner are the balanced crystal and balanced valve receivers used by the Marconi Company. In these instruments either two crystals or two valves are arranged in opposition so that if a strong signal or atmospheric is received the effect will be largely cancelled out by the opposition of the

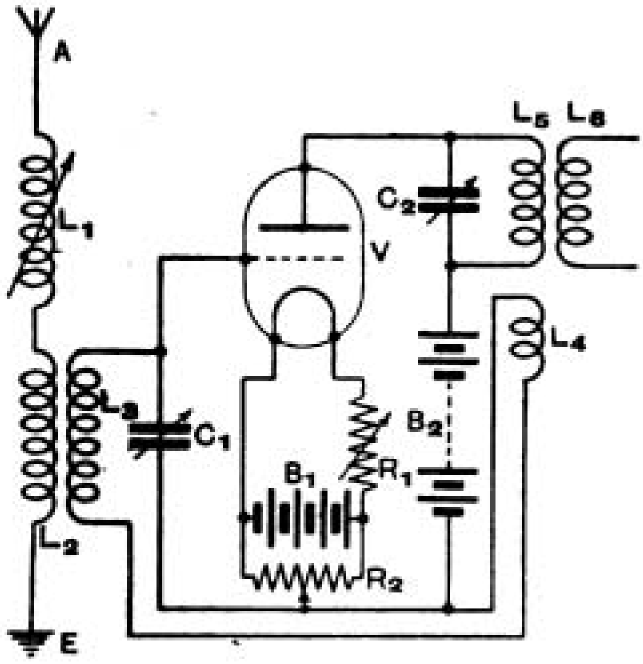


Fig. 3.

Diagrammatic arrangement of G. M. Wright's Dimmed Valve Limiter.

two detectors, but a weak signal will be received on one of them only. Their chief disadvantage is that in order to secure the best results the strength of the desired signal is also considerably weakened.

Various arrangements of valve limiters using valves with dimmed filaments may also be classed in this category. One due to G. M. Wright is indicated in Fig. 3.† The triode valve V is connected in the usual manner of a high frequency amplifying valve between the aerial circuit A L_1 L_2 E and the receiver proper which is joined to the coil L_6. By dimming the filament of the valve V until the signal is only just heard any stronger impulse that is received will not give any louder effect in the receiving telephones because the dimmed valve cannot pass any larger current. The coil L_4 coupled to L_5 is added to balance out the effect of the capacity between the grid and plate of the valve since this capacity acts as a direct coupling between L_3 and L_5. The coupling between L_4 and L_5 should be adjusted until no signals, however loud, can be heard when the valve filament is switched off.

An experiment was shown at the meeting to demonstrate the limiting effect of a dimmed valve. A "tonic-train" signal was used from an oscillating valve, and a limiting valve connected between the signal source and the receiver proper. When the valve filament was bright the signal could be heard at full strength but when the filament was gradually dimmed the intensity did not diminish much at first, but then suddenly fell off to zero as the filament was dimmed beyond a certain point.

An improved arrangement of valve limiter has recently been described by L. B. Turner.‡ The arrangement uses two valves and is a modification of the "Kallirotron" amplifier described by him in the same paper. The circuit is indicated in Fig. 4. The two valves shown are joined up with their filaments in parallel. The anode of one valve is connected to the grid of the other through the batteries indicated, the resistances

* *Journal of the Washington Academy of Sciences*, 3, p. 386 (1913). *Electrician*, 7?, p. 176 (1913).

† British Patent, 8926/1915.

‡ *Radio Review*, 1, pp. 317-329, April, 1920.

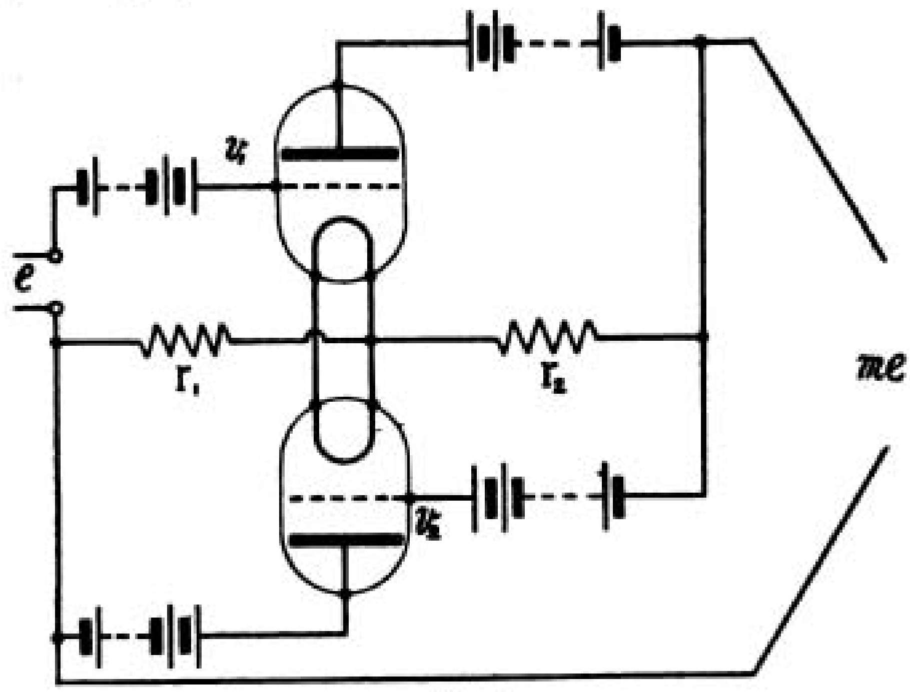


Fig. 4.

Arrangement of L. B. Turner's "Kallirotron" Limiter.

r_1 r_2 being joined to the common filament connection. These resistances r_1 r_2 may be of the order of 10,000 ohms with anode voltages of about 85 and grid voltages of -8. The input is applied to the two terminals marked *e* on the left and the output is taken from the point marked *me* on the right hand side. The operation of this amplifier may be seen from an inspection of the curve in Fig. 5, from which it will be noted that as the input voltage is increased the output rises to a maximum and then falls off again. This arrangement therefore possesses considerable advantages over the simple valve limiter in that it not only limits the strength of the loud disturbance to that of the desired signal but actually weakens it beyond that point.

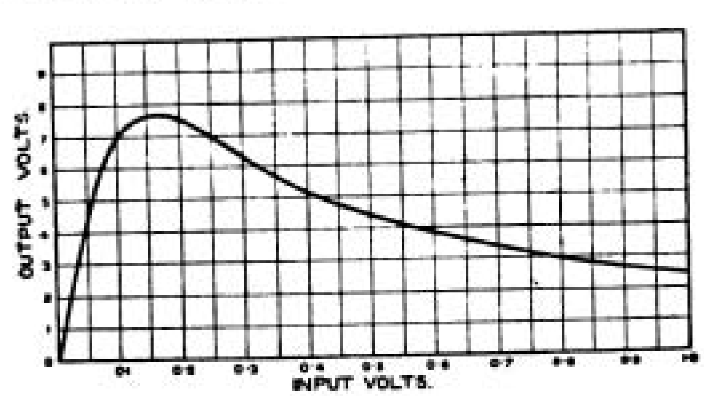


Fig. 5.

Typical Output curve for the "Kallirotron" Limiter. (This particular curve corresponds to a "weak-signal" magnification of $\mu = 100$.)

When using small aerials the troubles of atmospheric elimination are not nearly so great as when larger ones are employed at the big wireless stations. In the former case these valve limiters are often fairly effective, but in the latter their use although helping to some extent does not produce all the desired effect With a very large aerial it is extremely difficult to efficiently protect the receiver from atmospheric disturbances, since these often set up currents in the masts, staywires, or any other metal work that may be adjacent to the receiving apparatus, and these currents will cause disturbances in a very similar manner to those coming down the aerial itself.

2. — Directional Reception Methods

The failure or partial failure of all the above described arrangements when very bad atmospherics are prevalent leads us to ask whether any other selection arrangement is possible in addition to those described.

The use of a directional receiver is of some advantage in this connection as it limits the area from which atmospherics are heard. The simplest directional receiver uses simply an ordinary loop or frame aerial. The polar diagram of the reception intensities in different directions of such a loop is shown in Fig. 6. This indicates that although the received intensity is a maximum in two directions only, yet very considerable signal strength will be received from most other directions except those directly at right angles to the plane of loop.

The problem of the reception of a distant station and the elimination of other disturbances may be likened to the detection of a source of monochromatic light when the whole scene is flooded with brilliant daylight. The effects at the receiver can obviously be improved in that case by the use of colour filters to cut out the unwanted rays while improved selectivity will evidently also be obtained if we use in addition a telescope pointed at the source of monochromatic light

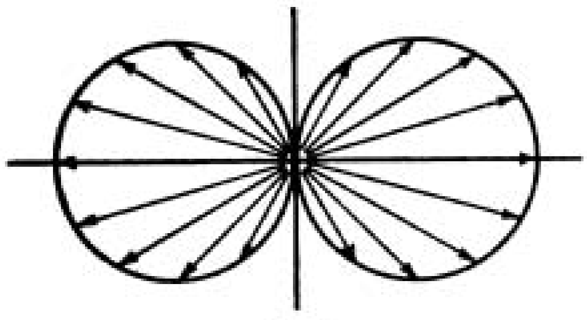


Fig. 6.
Polar Reception Curve for Loop Aerial.

The telescope may be taken as indicative of the directional wireless receiver, and the colour filters of the electrical filters and limiters which will be described later

Spaced Aerials.

Consider for a moment the use at the receiver of two separate aerials spaced apart a distance approximately equal to half the wavelength that is being received, as indicated in Fig. 7. It has been shown on many occasions that a large number of the powerful atmospheric impulses are heard simultaneously at receiving stations separated considerable distances from one another, and it is therefore fairly reasonable to suppose that these two

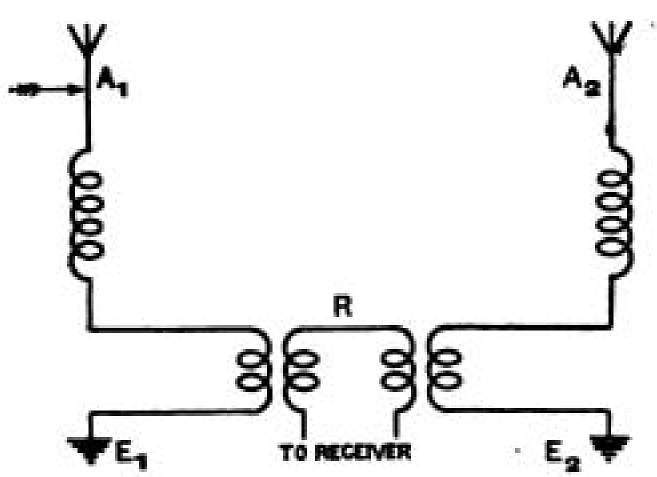


Fig. 7.
Diagram of two Aerials spaced one half-wavelength apart with opposing couplings to the Receiver.

aerials A_1 and A_2 would be affected simultaneously, or practically simultaneously, by the atmospheric impulse. This will be particularly the case if this impulse originates in the upper atmosphere, or nearly over the receiving station as appears often to be the case. Next consider the effect on these two aerials of a continuous wave signal approaching from the left hand side, in the direction of the arrow. The wave front of this signal will evidently reach the aerial A_1 before it reaches A_2, and since we have assumed that these two aerials are spaced approximately half a wavelength apart, it is evident that by the time the wave front has reached the aerial A_2 its sign will have reversed. If now we connect these two aerials to a common receiver placed between, say at R, and arrange the couplings so that the two aerials act in opposition on that receiver, then evidently since the effects of the signal are in opposite directions on the two aerials the effects of the signal on the receiver will add to one another, and a strong signal will be obtained Since, however, an atmospheric affects both aerials practically simultaneously and in the same phase the currents induced in these aerials by the X will be in the same directions, and on account of the opposing coupling will evidently cancel out in the receiver. Such an aerial arrangement may in fact be regarded as part of an open loop receiving circuit of large dimensions. It is therefore directional and will receive the maximum intensity of signals from directions in the plane passing through the two aerials. The selective action of this aerial arrangement will evidently be greater for continuous wave signals than for highly damped spark signals, since the effects of the latter approximate more to that of the atmospheric impulses.

One of the various applications of these spaced aerial arrangements is indicated in Fig. 8, and is known as the balanced aerial method. The two aerials are represented at A_1 and A_2 and are connected to earth, E, through the tuning coils L_1 L_3 and L_2 L_4.

The two aerials are coupled together through the tuned circuit L_5 L_6 C_1 so that they produce opposing effects in this circuit. The detector D and telephones T are shunted across the tuning condenser C_1. This is practically the simple arrangement described above, but it is not absolutely essential that the two aerials should be placed half a wavelength apart, although it is preferable that they have this spacing. The chief idea of this balanced aerial arrangement is that one of the aerials, say A_1, should be tuned exactly

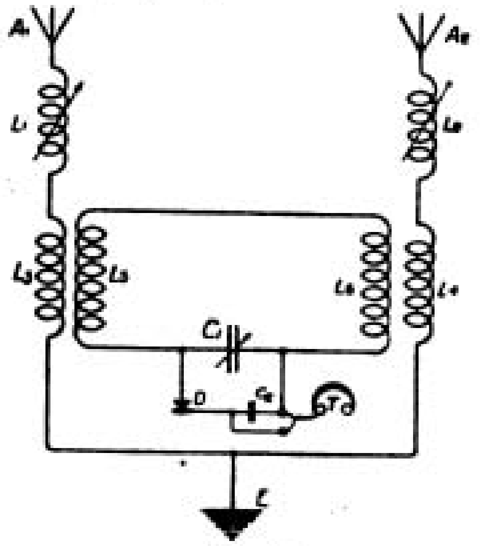


Fig. 8.
Balanced Aerial Receiver with Radio-frequency Balance.

to the wavelength of the incoming signals, while the other A_2 is slightly detuned. The signal strengths received from the distant station are therefore no longer equal on the two aerials and hence there will be a resultant signal in the telephone T. Since, however, the atmospherics affect both aerials equally and independently of their tuning, the signal strength of the atmospheric would be approximately equal on both aerials and the currents should therefore cancel out in the telephones. This arrangement gives a certain measure of success, but perfect results cannot be secured for the reason that two opposing e.m.f.'s can neutralise each other *only when they have the same frequency, the same waveform, and are of opposite phase.*

The truth of this statement may be demonstrated by a simple experiment in which we superimpose in one circuit two signals of different frequencies. For convenience I have chosen audible frequency for the signals, but that does not affect the validity of the argument. The circuit to which they are both coupled is connected to the valve amplifier and loud speaking telephones so that the resultant current in that circuit can be made audible, Fig. 9. In this diagram V_1 and V_2 in conjunction with the transformers T_1 T_2, and the variable condensers C_1 C_2, are two oscillating valve circuits generating alternating currents of audible frequencies. The frequency of the currents in either circuit may be varied by the condensers C_1 C_2. The plate circuits of the two valves include the potentiometer-resistances R_1 and R_2, as indicated, so that between the sliders of these potentiometers an adjustable e.m.f. of the frequency of either of the oscillating circuits may be drawn off and applied to the four valve amplifier as indicated, so that the resultant currents can be made audible in the telephones. When the valves are oscillating at slightly different frequencies the well known phenomenon of beats is heard, and by varying the position of the sliders on R_1 and R_2 so as to vary the proportion of either of the currents in the telephone circuit, it can be shown that for no adjustment is there silence in the telephones, that is to say two currents of different frequencies can never cancel out each other whatever their relative amplitudes. When, however, the two valves are set to oscillate at the same frequency, by a proper adjustment of the potentiometers the two e.m.f's oppose one another and cancel out almost completely, giving practically silence in the telephone, thus showing that when the two currents are of equal frequency they can neutralise each other if they are of equal strength.

The same apparatus may also be used to show that if the waveform of the two oscillating currents are not the same the cancellation of the two currents is not nearly so perfect. A slight change in the waveform of one of the circuits may be effected by altering the voltage of the H.T. battery supplying its oscillating valve, or by altering the ratio of capacity to inductance in the oscillation circuit.

Somewhat better results are possible by means of an audio frequency balance between the two aerials of a double aerial receiver as indicated in Fig. 10. In this arrangement the two aerials A_1 and A_2 are each provided with a separate receiving circuit L_5 C_1 D_1 and L_6 C_2 D_2. The telephone circuits of

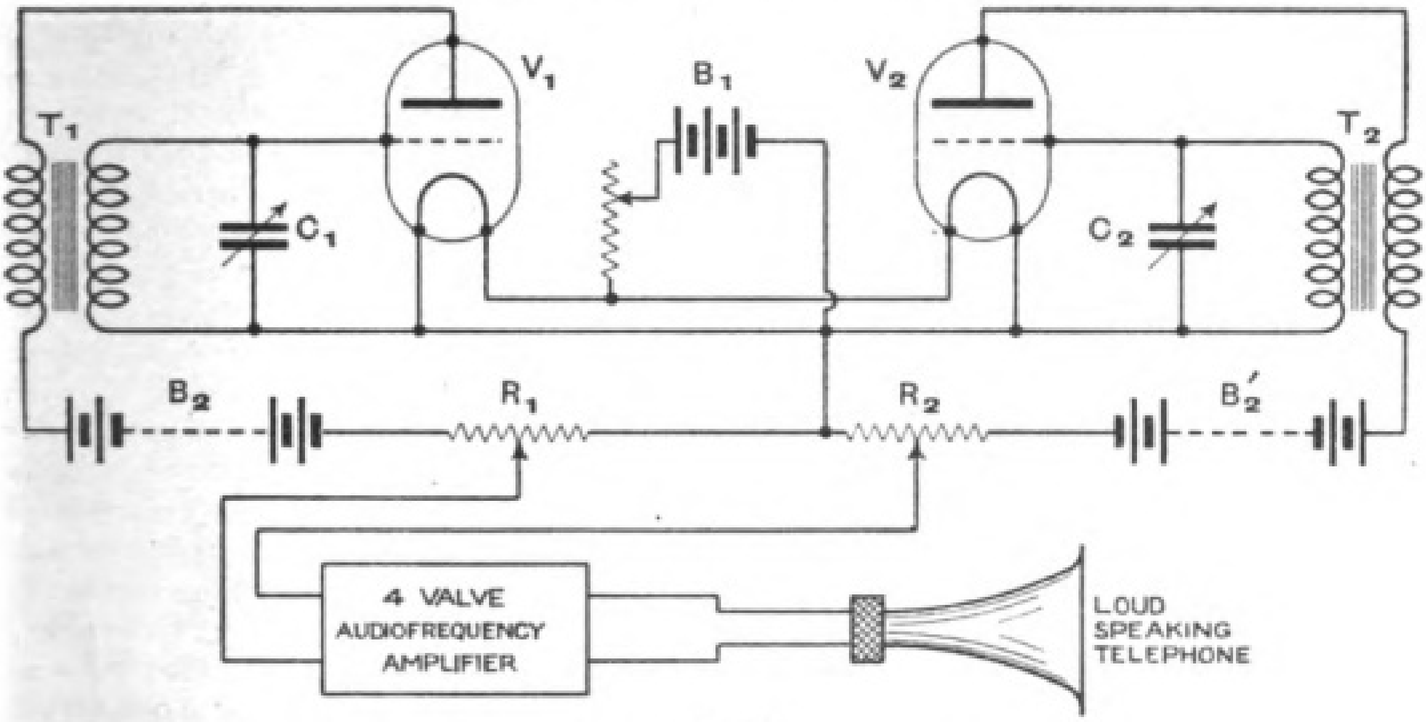


Fig. 9.
Arrangement of apparatus used at the meeting for demonstrating the non-cancellation of two currents of unequal frequencies and the cancellation of two currents of the same frequency, if of opposite phase and equal amplitude.

these two receivers are connected in opposition so that the effects cancel out in the telephones. Similar arguments are applicable in this case as in that of the preceding one, since if the aerial currents are of differing frequency and waveform, the rectified currents yielded by the two detectors cannot be of the same type,

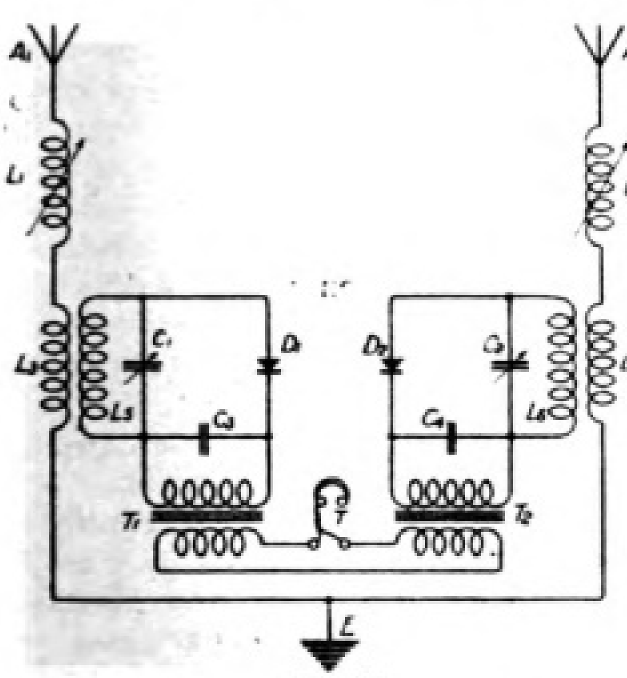


Fig. 10.
Balanced Aerial Receiver with Audio-frequency Balance.

and will therefore not give a perfect cancellation in the telephones. The arrangement is also dependent upon a critical adjustment of the two detectors D_1 and D_2.

An improved arrangement has recently been described, designed with a view to overcoming this difficulty of non-equality of the frequency and waveform of the currents in the two aerial circuits. The principle of this arrangement is that the two aerial circuits should not be coupled directly but through a form of frequency changer. It is suggested that this might be of the Goldschmidt alternator type and be arranged to convert the frequency of one aerial circuit to equality with that of the other.

Alternatively an oscillating valve may be employed as the frequency changer between the two aerial circuits provided that its oscillation frequency is adjusted so that one of the beat frequencies between the aerial circuit and the oscillating valve is in each case the arithmetic mean of the frequencies to which the two aerial circuits are tuned. When this is done the atmospheric impulse which affects both aerial circuits cancels out in the telephones since in this case the currents from the two branches are of the same frequency and can be of equal amplitude and opposite phase. A signal, however, will only affect one of the aerials and therefore will be heard in the receiving telephones. Thus, for example, let us suppose that one of the branches of the aerial circuit is tuned to the frequency $N_1 = 50000\sim$, and the other to a frequency of, say, $N_2 = 40000\sim$. The frequency of the coupling valve circuit should then be adjusted so that this valve generates oscillations of a frequency of $n = 5000\sim$. We then have resultant "beat" frequencies set up of $N_1 + n = 55000\sim$, and $N_1 - n = 45000\sim$ by reason of the reaction with one aerial circuit, and frequencies of $N_2 + n = 45000$ and $N_2 - n = 35000\sim$ by the reaction with the second aerial circuit. The circuit coupled to the detector is tuned to $45000\sim$ so that the higher and lower beat frequencies of $55000\sim$ and $45000\sim$ will not affect it. When therefore an atmospheric sets both aerial branches oscillating the two resultant currents of $45000\sim$ will be able to neutralise each other; but when a C.W. signal is received it will affect one aerial only, and therefore in this case the current of $45000\sim$ frequency will pass through and affect the detector.

I am unable to say, however, what sort of results this arrangement will give in practice, as no test figures are available, but at least theoretically it looks very promising.

Spaced Loop Aerials.

Besides using two elevated antennæ of the ordinary type spaced a fraction of a wavelength apart as in some of the arrangements described above it is possible to employ, sometimes with advantage, two closed aerials spaced apart like the elevated antennæ. Various arrangements of this type were recently described by R. A. Weagant in a paper read before the Institute of Radio Engineers (New York), and these are often now referred to as the Weagant arrangements, although some are covered by prior patents of J. S. Stone, G. W. Pickard and others.

When two loop aerials are spaced apart by a half-wavelength, currents will be induced in them by the passing waves which are approximately 180° out of phase. By combining these two loop aerial circuits together by coupling with a third common circuit joined to the receiver and detector their effects may be combined so that a signal arriving from a point lying in the plane of the two loops will cause a response in the receiving detector, whereas a signal or atmospheric coming from any other direction will not produce so much response. The arrangement is particularly designed to eliminate atmospherics coming down on to the receiving station from a point nearly overhead, since the waves due to such impulses would arrive at both loops practically in phase with one another, and hence they would produce no effect on the receiver since the two loop circuits are coupled in opposition, just as in the case of the two open aerials spaced a half-wavelength apart, as mentioned above. If, however, the two loops are not spaced exactly half a wavelength apart, it is desirable to insert in their circuit a suitable phase-adjusting arrangement (generally consisting of adjustable inductance, capacity and resistance in series) so that the phase of the currents induced in the two loops may be adjusted to reinforce one another.

Evidently an arrangement of this type, as mentioned above, is most suitable for eliminating atmospherics arriving from points nearly vertically over the receiving station, but they were found to be not so effective for X's coming from any other direction, while in particular atmospherics from points near the transmitting station were not eliminated. As a further extension of the idea, with a view to eliminating as far as possible atmospherics coming from all directions, another arrangement was described in Weagant's paper, using three receiving loops, two of which served to collect atmospherics only, while the third picked up the signal.

The arrangement is indicated in Fig. 11. In this diagram A and B are the two loops whose function is mainly to collect the atmospherics and not the signal proper. For this purpose they act in a similar way to the two loops described above for cutting out

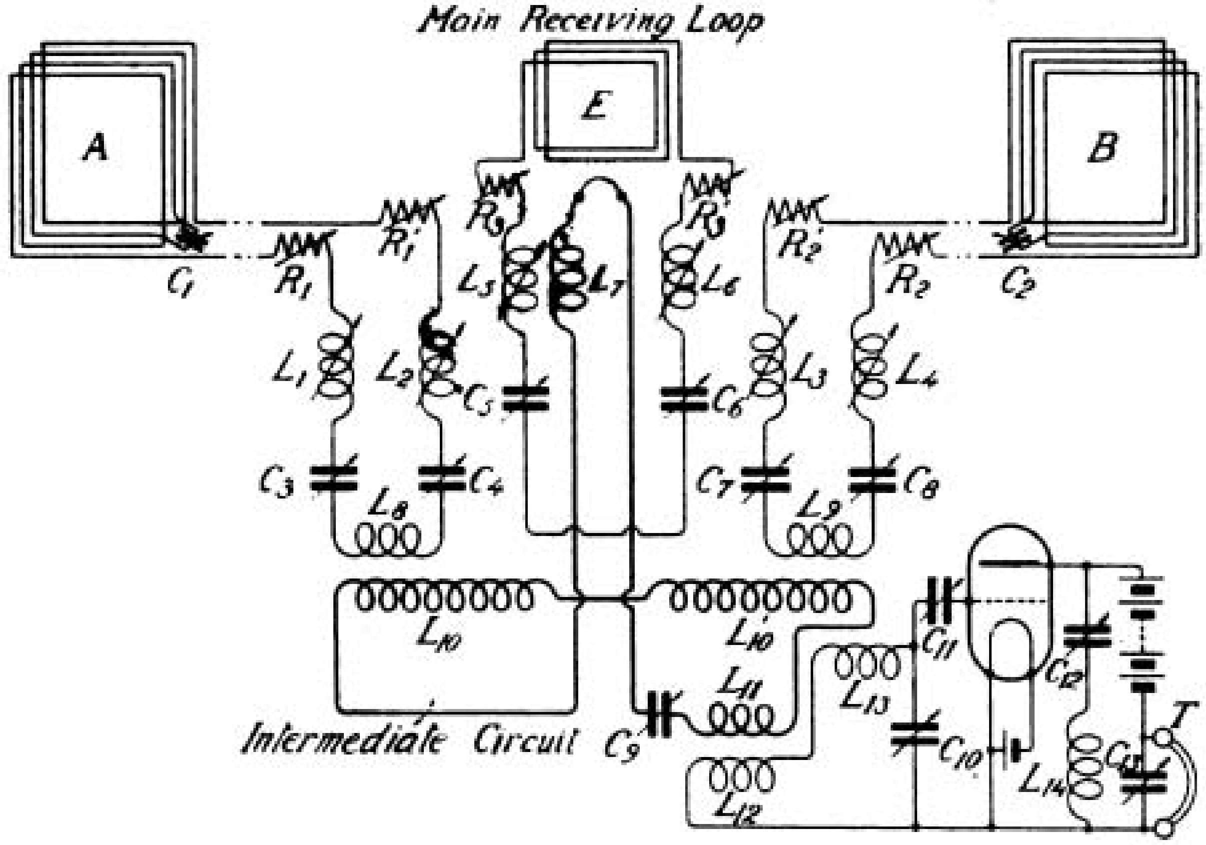


Fig. 11.

Diagram of Weagant's Triple-loop Receiver for eliminating atmospherics.

atmospherics and collecting the signal, but instead of their circuits being connected in opposition they are joined so as to assist one another. The signal current being out of phase in the two loops will therefore cancel out, given proper phase adjustment by means of the resistances and inductances in the loop circuits, so that the resultant current will only be that due to the atmospherics.

If now we take a third receiving loop indicated at E in the diagram and couple this to the receiver in the usual way it will pick up both the signal and the atmospherics. To this loop we may couple the circuits of the two outer loops A and B so that the atmospherics picked up by these loops will cancel out the atmospherics picked up by the main loop E. This coupling is effected by means of the coils L_8 L_9 L_{10} of the intermediate circuit which includes the condenser C_9, the coupling L_5—L_7 to the main loop, and the coupling L_{11}—L_{12} to the receiving valve.

This arrangement possesses the great advantage over the balanced aerial arrangement in that there need be no detuning between the circuits picking up the signal and the circuits picking up the atmospheric, as since the resultant current of the loops A and B contains no component due to the signal the circuits of these loops may evidently be tuned to the signal frequency. This means that the atmospheric impulses derived from loops A and B may have the same frequency and be given the same decrement as the atmospherics picked up by the loop E. These currents therefore can be made to exactly oppose and neutralise one another, leaving only the true signal in the circuits of the detecting valve.

Various other modifications of this idea have also been worked out, for example, the use of horizontal receiving aerials in place of the main receiving loop, etc., but the above described example will suffice to illustrate the principle of all of them.

(To be concluded in the next issue).

WIRELESS CLUB REPORTS

The Wireless Society of London.

At the meeting on May 21st it was announced that the next meeting would take place on June 29th in the Lecture Room of the Royal Society of Arts, at 8 p.m. Mr. G. G. Blake is to give a lecture on the Construction and Design of a Small-power Wireless Telephony Set, showing the instrument transmitting speech. Admiral of the Fleet, Sir Henry B. Jackson, has promised to give some account of his recent work with loop aerials and to describe in detail one that has given complete success. It is also expected that Captain S. R. Mullard, M.B.E., will show and describe valves and other interesting pieces of apparatus.

It was announced that members of the Society had been invited to visit the Marconi Works, at Chelmsford, and June 30th was mentioned as being the most suitable day. The visit will probably take place in the afternoon. Members will be advised in good time of definite arrangements.

The Committee are pleased to announce that Brigadier-General Sir C. Holden, K.C.B., F.R.S., has recently joined the Society.

The Edinburgh Wireless Club has been elected for affiliation.

There will be no meetings of the Society during July and August.

Hon. Secretary, Mr. H. Leslie McMichael, 32, Quex Road, West Hampstead, N.W.6.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

This Society, during the month of April, conducted lectures and papers at its usual fortnightly meetings. On April 16th Mr. Bacchini gave a paper on "W/T Communications in France," explaining the different sets used, their shortcomings and final improvements.

Another paper, by Mr. Middleton, on "Wireless Installation in the Navy and Wireless Control at the Battle of Jutland," had an excellent reception from all members, it being both interesting and instructive. On April 30th a debate on "Wireless Technology" proved both animated and far-reaching, giving general satisfaction.

May 7th.—With Mr. R. C. Laws in the chair, the members were given demonstrations by Mr. J. K. A. Nicholson, A.M.I.E.E., on the 1.5 kilowatt installation. Every demonstration was interesting and instructive, and the following are quoted from them:—(1) How to make and use an emergency receiver; (2) A small aerial transmitter was erected, which excited the emergency receiver across the room; (3) The field regulator of the 1.5 kilowatt installation was utilised in place of the handle starter to start up the rotary converter; (4) Demonstrations of the methods of testing for a broken primary or secondary in the induction coil, and a punctured condenser; in the latter case one complete bank of a condenser of .02 microfarads capacity with glass dielectric was placed across the spark electrodes of a 10-inch induction coil, and another bank, with a punctured plate in, was treated similarly, comparisons being drawn between the arc and spark discharge; (5) Showing the method of testing circuits with a cell and galvanometer; (6) The inspection of an accumulator for voltage, specific gravity and general condition. An exceptionally interesting, practical and instructive lecture.

May 14th.—The chair was taken by the President, Mr. W. S. Templeton, M.A., B.Sc., A.M.I.E.E., when the Society was given papers by the following gentlemen:—(1) Mr. Hampton, (2) Mr. Palfrey, (3) Mr. Furneaux, (4) Mr. Canniford.

(1) "The Usage of Transformers on Marconi Standard 1.5 Kilowatt Installation": an excellent paper, fully detailing the following:—(*a*) Closed core transformer, its construction and the purpose for which it is used; (*b*) air core, or oscillation transformer, and the principle on which it works; (*c*) telephone transformer, and how an induction coil can be used as one; (*d*) frequency transformer, or magnetic detector, giving a description of how the oscillation frequency is stepped down to allow the diaphragm of the 'phones to correspond.

(2) "The Usage of Condensers on the Marconi Standard 1.5 Kilowatt Installation": a well thought-out paper, giving the construction, function and static induction principle on which they work; the purposes of having two banks, a container and high flash oil. A description of charge and discharge.

(3) "Description of Wave Motion in Air and Aether": a precise paper, giving a good insight into pressure waves, aether waves and the media through which they are transmitted.

(4) "Comparison between the 0.5 Kilowatt and the 5 Kilowatt Marconi Installations": a minute and exhaustive comparison of the sets from mains to aerials.

Hon. Secretary, Mr. W. G. Terry, Municipal Technical School, Plymouth.

Burton-on-Trent Wireless Club.

(Affiliated with the Wireless Society of London.)

The Burton Wireless Club exhibited wireless apparatus at a fete and gala, held in the town on Whit Monday, the proceeds of which were in aid of the local infirmary. The exhibition included a valve set, pocket wireless set, complete receiving and transmitting set, complete receiving set (belonging to Mr. F. V. A. Smith), a horophone, etc. A portable umbrella aerial (kindly lent by Mr. A. J. Selby) was erected on the ground, and signals were exchanged with the Club headquarters, temporary transmitting licences having been obtained from the Postmaster-General. A charge of sixpence was made to view the Wireless Exhibition, which opened at 3 p.m. till 5 p.m. and from 5.30 p.m. to 7 p.m., and a total amount of £14 8*s*. was handed to the Secretary of the Fete Committee at the end of the day.

The thanks of the Club are due to the following members, who rendered valuable assistance towards making the exhibition a success: Messrs. Andrews, Blant, Butt, Fielding, Kempster, Plant, R. Rose (Hon. Secretary), Selby, Smith, Waller and A. J. Wright.

Captain Bemrose (Hon. Secretary of the Derby Wireless Club) has very kindly invited a party from Burton to visit one or two of the Derby stations, and a visit is being arranged for Saturday, June 19th.—Hon. Secretary, Mr. R. Rose, 214, Belvedere Road, Burton-on-Trent.

North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

A meeting of this Club was held at Shaftesbury Hall, Bowes Park, on May 19th, at 8.30 p.m. The chair was taken by the President, Mr. A. G. Arthur. It had been arranged for Mr. Holton to continue his lecture on the "Uses of the Valve for Reception and Transmission," and, as usual, his lecture proved most interesting. Among other circuits, he illustrated that of the Marconi direction finder, and described its method of use. The next meeting will be on June 2nd. Full particulars of the Club may be obtained from the Hon. Secretary, E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N.21.

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)

On May 1st a whist drive and social, held at the Clarion Café, was well attended by members and their lady friends. After a light supper, a few words were delivered by the Secretary, advocating the work of the Club and in appreciation of the rapid strides made by members in their endeavours to advance the science of wireless telegraphy.

Some members of the Manchester Wireless Society on a visit to the Bury Electric train system.

On May 5th the Club's usual meeting was held at the headquarters of the Society, during which it was announced that another room had been acquired. This room will be at the disposal of members engaged upon the construction and testing of instruments.

On May 8th, in accordance with arrangements made with the Manchester and Bury Electric Train System, several members were afforded the opportunity of visiting the sub-station, situated under the main track at Victoria Station, Manchester; Mr. McKennan conducting the party. Leaving the sub-station, the party was then conveyed to Clifton Junction, where is to be found the main generating station. Here the party divided, the station engineer conducting one half and Mr. McKennan leading the other. The tour was greatly enjoyed by all; many interesting facts of power transmission being seen for the first time. At the conclusion of the tour the party embarked on the 8 p.m. train for Manchester. The accompanying photograph shows a few of the tourists outside one of the cars, Mr. McKennan being on the extreme left.

Another visit of this kind is to take place in June, when Mr. Davies, of the Stuart Street Generating Station, Manchester, will make the necessary arrangements. This station is said to be the largest of its type in the country, and members of other societies wishing to take part in the tour should communicate with the Hon. Secretary, Mr. Y. Evans, 7, Clitheroe Road, Loudsight, Manchester.

Halifax Wireless Club.

(Affiliated with the Wireless Society of London.)

In response to a suggestion from the Halifax Wireless Club, which has its headquarters in the Y.M.C.A., Clare Hall, Halifax, the Chelmsford high-power wireless telephone installation was used to send greetings to Princess Helena Victoria. The occasion was the opening of a Y.M.C.A. Boys' Department, on May 17th, and at three arranged periods the following message was transmitted to the Halifax Wireless Club:—

"To the Halifax Wireless Club.—We, the Marconi's Wireless Telegraph Co., Ltd., send heartiest greetings to Her Highness Princess Helena Victoria, on the occasion of her visit to Halifax to open the Halifax and District Young Men's Christian Association's Boys' Department, and rejoice in the continued interest Her Highness is showing in the young life of the country. We also congratulate the Halifax Y.M.C.A. upon the splendid success which has attended their efforts since its inception, some twelve to fifteen months ago, and wish them every success for the future. Especially do we congratulate the Association in providing a home for the Halifax Wireless Club at its inauguration, this being the only Wireless Club on Y.M.C.A. premises in the North of England. Further, we shall be delighted at all times to help the Halifax Wireless Club in any endeavour it may make towards the advancement of Wireless."

Her Highness has agreed to accept a copy of this message, printed on silk, and the Club is therefore taking the matter in hand at once. The last meeting of the Club was on May 17th, when a paper was read by one of the members on "The Close Alliance that Exists between Magnetism and Electricity."—Hon. Secretary, Mr. L. Pemberton, The Y.M.C.A., Clare Hall, Halifax.

Wireless and Experimental Association.

(Affiliated with the Wireless Society of London.)

At the regular weekly meeting of this Club proceedings were opened on May 19th with a much-welcomed buzzer practice. This practice was followed by a short lecture on "Harmonics," by the Chairman (Mr. A. W. Knight), special emphasis being laid on the matter of "beats," enlightening the members on what is meant by "heterodyning" and how it is necessary to obtain beats in order to receive C.W. An animated discussion arose on the question of series and shunt connections as applied to inductances and condensers, and our experts have agreed to study the matter, giving the Society the benefit of their conclusions. A meeting on May 26th, at 16, Peckham Road, was opened with a consideration of what constitutes parallel and series connections. This being an exhibition evening, Mr. Saunders presented a neat and compact pancake pocket-book inductance with reactance coils with which he had been very successful.

Mr. Tanner produced an ammeter, reading 1 m.a. to 15 amperes. Mr. Horwood, a naval type crystal tuner. Mr. Kirkby, a large auto-jigger, taking up to 6,000 metres.

Messrs. Knight and Heather brought a selection of ex-military apparatus, loaned by Messrs. Mitchell, of Rye Lane, and according to all accounts there are some genuine bargains to be obtained by licensed amateurs who give the firm a visit.

The display was photographed by Mr. Kloots.

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

Liverpool Wireless Association.

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

A meeting of the Liverpool Wireless Association was held at 56, Whitechapel, on May 12th, the evening being set apart for the hearing of members' wireless troubles. It was very interesting to hear of the varied experiences; the ensuing discussion being very instructive and helpful. New members still keep rolling in.

It was agreed to apply to the Postmaster-General for a licence for a portable apparatus for the Club's use during the summer months.

The usual bi-monthly meeting was held at 56, Whitechapel, Liverpool, on May 26th, when the subject under review was the "Winding of Inductances" and "Loose Couplers." Numerous methods of construction were discussed, and varying experiences under numerous conditions related. A member also exhibited a piece of apparatus for winding honeycomb coils.

Applications from intending members cordially invited. All communications to Mr. S. Frith, Hon. Secretary, 6, Cambridge Road, Crosby, Liverpool.

The Bradford Wireless Society.

The first meeting of this new Society was held on Monday, May 10th, in the Y.M.C.A. at Bradford, when the Hon. Secretary (Mr. Bever) proposing that the chair be taken by Mr. W. Ramshaw, was seconded by Mr. J. W. Cooper. It was proposed, seconded and duly carried that—Mr. C. Wood (who was not present) should be asked to be President; Mr. W. Ramshaw, to be Vice-President; Mr. J. W. Cooper, to be Treasurer; Mr. J. Bever, to be Secretary; that the Society should affiliate with the London Wireless Society; that, for the present, the officers should act as a committee; that a copy of rules issued by the London Wireless Society for the guidance of Provincial clubs, be obtained. Mr. Licerdet kindly placed at the disposal of the Society a room in Randallwell Street, beonging to Messrs. Thwaites Brothers. It was decided to apply for a licence for a receiving station. It was decided that the subscription should be 5s., and that the financial year end on December 31st, 1920.—Hon. Secretary, Mr. John Bever, Bradford Wireless Society, 85, Emm Lane, Bradford.

Birmingham Wireless Association.

On Tuesday, May 18th, a committee meeting of the Birmingham Wireless Association was held at the Midland Institute, Room 21, Mr. J. H. Tucker in the chair. It was decided to instal a standard wireless valve receiver set at the Club, and the Secretary was instructed to write to various companies for full particulars. The Chairman (Mr. J. H. Tucker) offered to provide wire and insulators for the erection of a new aerial, and two members of the Committee offered to erect it during the week. Buzzer practice then took place, twenty-five members being present.

On Wednesday, May 19th, Mr. Briggs, of the Midland Wireless School, invited the Club to be present at a lecture and demonstration in the schoolroom, given by Mr. Halliwell, of the Manchester School of Wireless. There were thirty-five members present, and they heard a very instructive lecture on the difficulties of producing a low cost instrument which would be capable of receiving over a wide range.

On Thursday, May 20th, Mr. Westwood gave a lecture on the Construction of a Portable Receiving Set. There were forty-two members present. The lecturer demonstrated very clearly his method of constructing pancake inductance coils, and his ingenious method of adjusting the loose coupling was much appreciated.—Hon. Secretary, A. H. Handford, Birmingham and Midland Institute, Paradise Street, Birmingham.

Newcastle and District Amateur Wireless Association.

A meeting of the above Society took place on Monday, May 27th. It was announced that arrangements had been made with the manager and proprietor of the North Eastern Schools of Wireless Telegraphy, Eldon Square, Newcastle, for the use of one of their rooms as a Club room, until the Association can obtain suitable premises of their own. Meetings are arranged for Monday and Thursday evenings at 7.30 p.m. until further notice.

The rate of subscription has been fixed at 10s. 6d. per annum, falling due on June 1st for the ensuing year. An entrance fee of 5s. will be charged to new members after the first three months (*i.e.*, after June, July and August). An application for a receiving licence and for the return of apparatus has been made to the G.P.O. authorities. Several gentlemen have promised gifts of apparatus.—Hon. Secretary, Mr. Colin Bain, 51, Grainger Street, Newcastle-on-Tyne.

Gloucester Wireless and Scientific Society.

The first general meeting of the Gloucester Wireless and Scientific Society was held in the Physics Laboratory of Sir Thomas Rich's School, Gloucester. Permission to use this up-to-date scientific laboratory as the permanent headquarters of the Society has been very kindly granted by the governors of the Gloucester United Schools, and an endeavour is to be made to make it one of the best-equipped wireless stations in the country. The members of the Society include men of high scientific training, who are most enthusiastic in their efforts to make this Society a huge success. It was proposed to hold monthly lectures of a practical and demonstrative kind, not only for the benefit of members, but also for the advanced students of Sir Thomas Rich's School. The Society are fortunate in possessing first-class scientific instruments, including a complete X-ray set, testing and high-frequency apparatus, and they look forward to many pleasant and instructive evenings.

The meeting opened by tendering a vote of thanks to the Governors of the Gloucester United Schools for their unprecedented kindness in according such suitable headquarters, and to the President for his successful efforts in bringing this about, and to the editor of the *Wireless World* for his kind assistance.

It was unanimously decided to devote the first hour of each meeting to buzzer practice, and it was stated that arrangements were already in hand, and a working committee formed, to fix up the aerial, etc. The Hon. Secretary is in communication with the Wireless Society of London for their sanction to become affiliated to that body. Some of the members have had much useful and practical experience during the late war, and their help will be greatly appreciated.

The officials of the Society are—President, Mr. F. J. Freeman; Vice-President, Mr. C. J. Scott; Treasurer, Mr. J. W. Jones; Hon. Secretary, Mr. J. Mayall, Burfield Lodge, St. Paul's Road, Gloucester.

Cardiff and South Wales Wireless Society.

A most interesting evening was spent by the members of this Society on Thursday, May 20th, 1920, at the Wireless Department of the Technical College, Cardiff, when there was also over thirty-five visitors present. By the courtesy of the gentlemen of the Marconi Special Demonstration Staff (resident in Cardiff for demonstrations to shipowners) we were treated to a most interesting exhibition of the new distress-calling device, as perfected by the Marconi Company, under actual working conditions; a ship in Newport Docks having been temporarily fitted with the apparatus for the special purpose of the Cardiff demonstration. The device worked splendidly, and was a continual source of wonderment and praise. There was also a complete set of the Marconi patent direction-finding instruments, with necessary D.F. aerial and six-valve amplifier, which was a great source of interest.

Two complete telephonic transmitting and receiving sets had temporarily been brought down from Chelmsford and installed in the department, and also one at Porthcawl, for intercommunication and demonstration purposes. C.W. and buzzer-valve transmission on the same sets were also tested, and results were splendid. Tonic-train transmission was made, and also a demonstration of the new Marconi quenched-spark system.

Mr. Clifford G. Rattray, of the Marconi Engineering Staff, Chelmsford, was afterwards good enough to give the members a lantern lecture on "Wireless," which was much appreciated by all present.

Mr. W. A. Andrews (President) proposed, and Mr. A. E. Hay (Secretary) seconded, a very hearty vote of thanks to Mr. Rattray for his very interesting lecture, after which the members adjourned for the ordinary business. A code of rules was discussed and partially formed. The membership list of the Society is increasing steadily, and we already have members in three counties; as membership of the Society is open to all wireless workers in Glamorganshire, Carmarthenshire, Pembrokeshire, Brecknockshire, Radnorshire, Cardiganshire and Monmouthshire, it is anticipated that the membership of the Society will soon number several hundreds.

Mr. Charles Coles, B.Sc., Principal of the Cardiff Technical College, has been elected a Vice-President of the Society, and Le General Ferrie, of F.L. station fame, Commandant of the French Army Wireless Service, has written, accepting office as Vice-President.

The next meeting is fixed for the Committee on June 3rd, and the next ordinary meeting takes place, at Room 305, of the Cardiff Technical College, at 7 p.m. on June 5th, 1920.

Interested persons and anyone desiring membership kindly apply to the Hon. Secretary, Mr. A. E. Hay, 6, Oxford Street, Mountain Ash, Glam., South Wales.

Ipswich and District Wireless Association.

Still another amateur wireless Club has been formed, and we take this opportunity of wishing it every success. Under the name of the Ipswich and District Wireless Association, this new Club is anxious to increase its membership, and those interested should communicate with the Hon. Secretary, Mr. F. Boddey, 3, Tokio Road, Ipswich.

Oxford Amateur Wireless Society.

The first meeting of the above Society was held on Monday, May 24th, at 7.30 p.m., in St. Ebbe's Rectory, when the following officers were elected:—President, Mr. F. Pickett; Secretary, Mr. S. Barter; Assistant Secretary, Mr. P. R. Bunce; Treasurer, Dr. Stansfeld. A committee of four were also elected.

It was decided that a receiving station should be erected in the grounds belonging to Dr. Stansfeld, at Shotover Hill, near Oxford. Assistant Secretary, Mr. P. R. Bunce, 7, Bartlemas Road, Oxford.

Walsall Amateur Radio Club.

Under the title of the Walsall Amateur Radio Club, a new society has been formed at Walsall. The first meeting called by Mr. H. Fillery was attended by sixteen persons. It was decided to form a Club, and a small committee was formed to undertake its inner working.

The committee has under consideration the purchase of a good receiving apparatus, and the necessary permission from the Postmaster-General to erect an aerial is to be applied for. The Club meetings will be at 8 p.m. each Wednesday, and several local gentlemen have been approached with a view to arranging a series of lectures on electrical work, especially that covered by wireless telegraphy. The present membership of the new Club is forty, and it is certainly to be congratulated upon its rapid growth.—Hon. Secretary, Mr. E. W. Bridgewater, 46, Caldmore Road, Walsall.

PAGES FOR BEGINNERS

Under this heading we publish COMPLETE *instructional articles, forming a series specially designed and written for beginners in wireless work. Hardly any mathematics will be introduced, and we hope to present the fundamental facts of wireless in such a manner as will prove attractive to a much wider range of students than that for which this series is primarily intended.*

OSCILLATORY DISCHARGES AND TUNING.

THE discharge of a condenser, and the phenomena accompanying it, constitute perhaps the most important foundation of the science of Wireless Telegraphy. It was some time, however, after the discovery of the Leyden Jar, that the nature of the discharge was closely investigated. In 1842, Henry, an American physicist, announced that the spark obtained on discharging a condenser did not consist of a sudden unidirectional rush of current, but consisted in reality of a number of surges or impulses of energy flowing first one way and then the other, until they gradually died away In other words, the spark was of an *oscillatory* nature.

Photographic records have been obtained of the spark accompanying the discharge, which clearly show that what appears to be a uniform spark, or flash of light, is really a succession of sparks following one another in quick succession.

The cause of these oscillations will be quite clearly understood by referring once more to a mechanical analogy. Imagine a weight clamped at the end of a flat steel spring. We apply a force to the weight, and move it out of the position of rest to one on either side of the perpendicular. Immediately the force is released, the elasticity of the spring tends to restore the weight to its original position, but, owing to the inertia of the weight it overshoots the centre, and continues to travel forward until the restraining force of the spring brings it to rest. It then commences to move back, the inertia again carrying it past the central position, until it finally comes to rest.

Each time that the weight oscillates to and fro a certain amount of the energy stored in the spring is wasted in overcoming air friction, and through various other causes. The distance travelled each side of the central position will therefore gradually decrease until the movement of the weight ceases.

In the case of a condenser, the voltage applied corresponds to the force which displaces the weight. On discharging, the potential energy stored in the condenser takes the form of a rush of current, which is shown in the spark that takes place at the terminals. The inductance of the wires forming the discharge circuit correspond to the inertia of the weight. This inductance, as was pointed out before, tends to keep the current flowing. The condenser is therefore again charged, but to a less degree than before (some of the energy was dissipated in heat), and with the opposite polarity. The elasticity, so to speak, of the dielectric then overcomes the inductance of the circuit, and the condenser discharges again, with a corresponding rush of current in the opposite direction. The cycle of operations is then repeated until all the stored up energy is dissipated, and the condenser is discharged. Fig. 1 shows the relation between the mechanical and electrical cases.

Fig. 2 shows the oscillatory current, which gradually diminishes with each successive charge and discharge.

There must clearly be some method by which the frequency of oscillation of the current can be altered. In the case of the

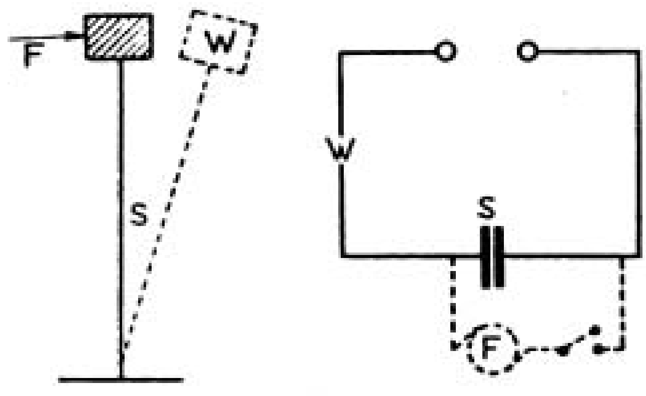


Fig. 1.

weight and spring the frequency of vibration can be altered in the following ways :—

By increasing or decreasing the weight attached to the end. The heavier the weight, the more slowly will it vibrate.

We may also make the spring longer or shorter. The frequency of vibration will increase with a decrease in the length of spring.

Further, if the resistance of the medium in which the spring is vibrating be increased, the vibrations will quickly die away. The vibrations of a weight in air, for example, might last for a considerable time, but it the same weight and spring were immersed in oil, the weight would come to rest after a very short interval.

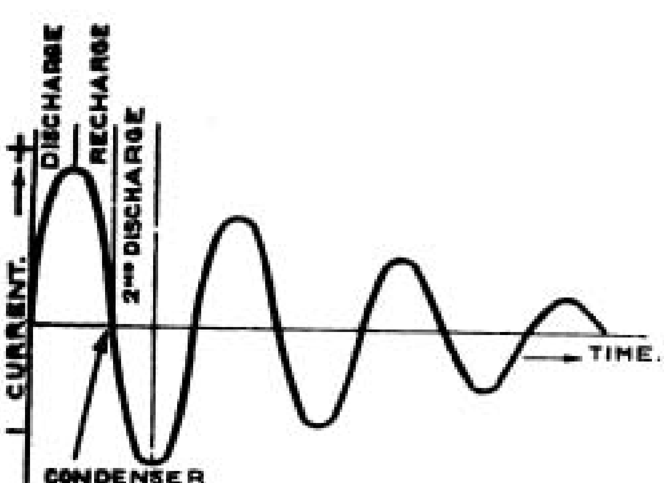


Fig. 2.

Applying these factors to the electrical case, we can alter the frequency of oscillation by altering either the capacity of the condenser or the inductance in the circuit. If resistance is inserted in the discharge circuit, the oscillations will die away in a very short time. The train of oscillations in that case is said to be "damped."

On the other hand, suppose that a certain amount of additional energy was supplied to the circuit during each oscillation, which counterbalanced the energy lost in heat. The condenser would then be charged to the same degree every time, and the amplitude of the oscillations would be constant. The curves in Fig. 3 illustrate the effects referred to. The train of oscillations in the second case is said to be "continuous," or "undamped."

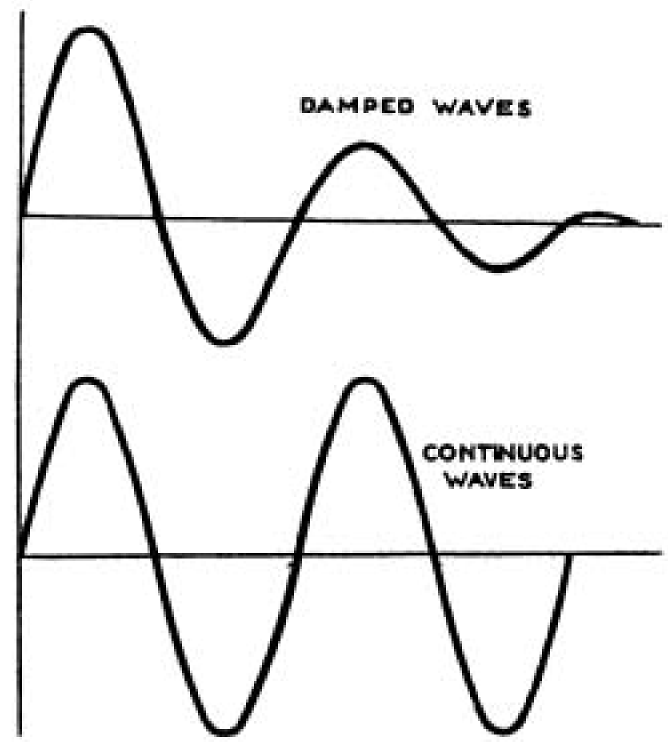


Fig. 3.

The formula giving the *frequency* of the oscillations is given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

where L and C are the values of the inductance and capacity of the circuit, reckoned in henrys and farads respectively.

It was seen before that in a circuit where the current is continually growing and diminishing, energy is radiated, due to the growth and collapse of the electric and magnetic lines of force.

During the time, therefore, that the condenser is discharging, there is a radiation of

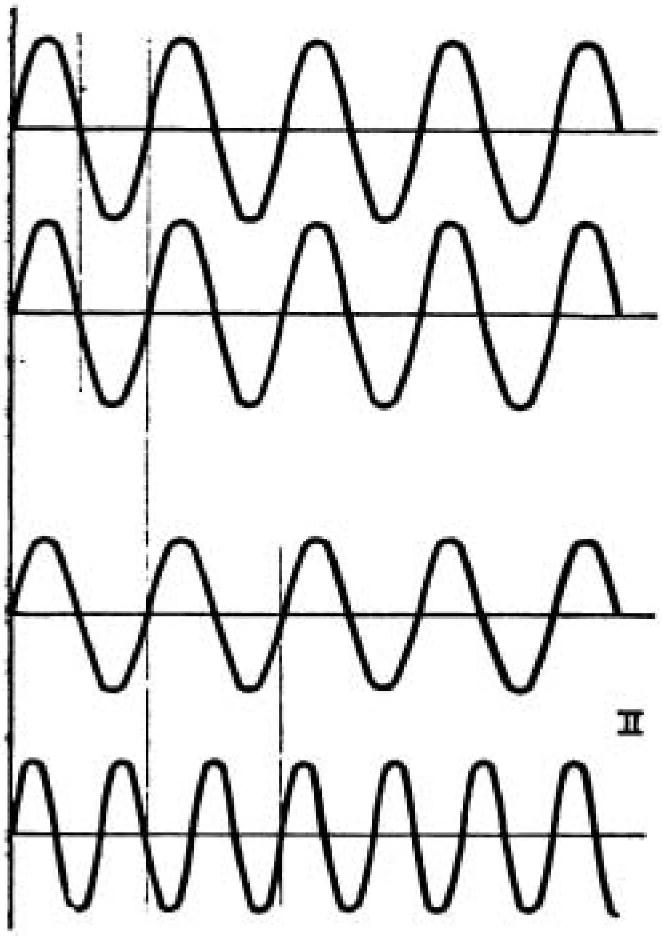


Fig. 4.

energy waves having a frequency the same as that of the oscillatory circuit.

Now imagine a similar arrangement of condenser and inductance placed near the oscillatory circuit.

As the radiated waves strike the second circuit, a small current will be induced in it, which will tend to oscillate with the same frequency as the circuit which induces it.

The action is similar in effect to two tuning forks which give the same note: *i.e.*, have the same frequency of vibration. If two forks are placed side by side, each having a frequency of, say, 256 a second, and one is struck a light blow, the sound waves impinging on the other, will cause it to vibrate, and emit the same note.

The first wave transmitted will strike the side of the fork, and cause it to move slightly. It will return to the position of rest, overshoot it, owing to inertia, and commence to move back again. On its return movement, the second wave from the vibrating fork will strike it and augment its movement. The impulses from the first fork will occur always at the right moment to help the vibration of the second. The final result will be that the second fork will give a note in unison with that of the first.

In the case of the two tuning forks which have not the same frequency of vibration, the second will not give its note when the first is struck. The reason for this is that one will be vibrating slightly faster or slower than the other, and the vibrations from one will not occur at the right time to exert an additive effect. The curves in Fig. 4 illustrate the vibrations (i) of two tuning forks which are in tune and (ii) which are out of tune. In the second case it will be seen that the vibrations are only in tune at intervals of one-and-a-half wavelengths. At other periods the first impulses will tend to annul those of the other.

The same effect will be observed in the case of electrical oscillatory circuits. Suppose a circuit to be made up of a condenser of 100 microfarads capacity, and an inductance of 25 micro-henrys. The frequency of oscillation of the circuit would then be

$$\frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{\frac{25}{10^6}\times\frac{100}{10^6}}}$$

$$= \frac{1}{2\pi\sqrt{\frac{25}{10^{10}}}} = \frac{10^5}{30} = 3000 \text{ approximately}$$

A similar circuit containing half the capacity and double the inductance would oscillate at the same frequency. Therefore if the two circuits are placed side by side (Fig. 5) and

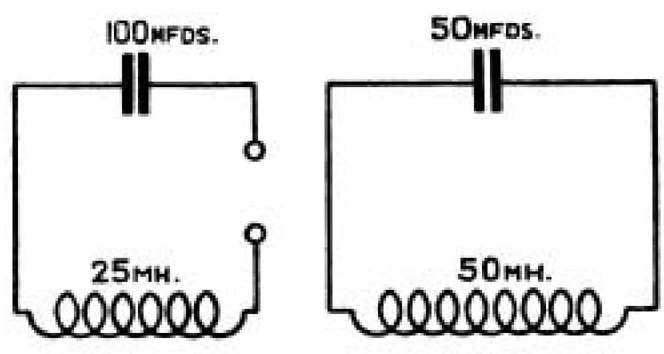


Fig. 5.

one is caused to oscillate the wave impulses will reach the other circuit at correct intervals to increase the induced current.

The phenomena of induced oscillations was first demonstrated by Hertz in 1887, who succeeded in causing an oscillatory discharge to produce a spark in another circuit having the same natural frequency This experiment was the first practical step towards Wireless Telegraphy.

Let us go a step further, and replace the fixed condenser of the second circuit by one of which the capacity can be varied if necessary. If the first circuit is caused to oscillate, and the variable condenser is set at a particular value, a slight current will be induced in the secondary circuit. As the capacity is altered, the frequency will increase until it very nearly approaches that of the oscillatory circuit. The current will continue to grow until the frequencies of both circuits are the same, when it will attain a maximum. Any alteration of the capacity above or below this value will result in a diminution of the induced current.

When the induced effect is greatest, the frequency of both circuits is the same, and they are said to be *in tune*. The operation of varying the values of capacity (or inductance) of the secondary circuit is known as *tuning*.

So far, no mention has been made of resistance in either circuit We noted that the effect of resistance would be to damp down the oscillations. It is easily seen, therefore, that the resistance could be increased to such an extent that no oscillations would take place It has been shown mathematically that a circuit containing capacity, inductance and resistance will not oscillate if the value of the resistance is greater than the square root of four times the inductance divided by the capacity ; or in symbols

$$R > \sqrt{\frac{4L}{C}}$$

The CONSTRUCTION *of* AMATEUR WIRELESS APPARATUS

A Separate Oscillator for C.W. Reception (Part II).

The Inductance Windings.

To make the valve "oscillate" with very small anode voltages it is necessary that the coupling between the two circuits should be as "tight" as possible. This coupling may well be obtained by the use of flat pancake coils.

There are two or three types of pancake coil, viz., Basket, Flat, and Honeycomb winding. For amateurs the Basket type, although tedious to make, will be the best to undertake.

The "Basket" coil is so called because the method of winding is similar to the construction of a basket—the wire being woven in and out round pegs mounted on the periphery of a central core. The former used is known as a "spider" and an example of one is shown in the photograph (Fig. 1). The pegs are so fitted into the core that they may be removed when a winding is completed. The spider shown in the photograph was used to wind coils for the purpose of this article. Its core was $\frac{3}{4}$" diameter, and the 15 equally spaced pegs were made of steel rod slightly under $\frac{1}{8}$" diameter

For the amateur a good spider may be made with a piece of round wood $\frac{3}{4}$" diameter and 5" long, with pegs of $\frac{1}{8}$" brass rod, 3" to 4" long, mounted at one end, leaving about 4" of the wood to serve as a handle. The holes drilled in the wood for the pegs should be slightly smaller than their diameter so that the ends of the pegs may be tapered and driven into the wood so that they are sufficiently rigid and yet do not fit too tightly to be pulled out when the winding is com-

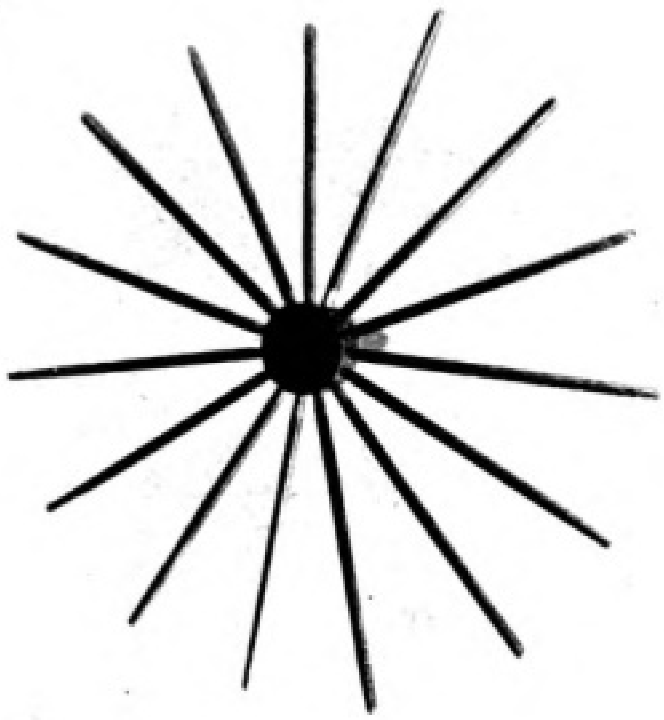


Fig. 1.

pleted. Some little care must be exercised to make a satisfactory former, but it is worth doing and will be useful when in a future article we shall describe the construction of a "Tuner" in which coils of this type will be used.

In order to obtain the results given below the number of pegs should be the same as used in the experimental coils, *i.e.*, 15, as the inductance value of the windings will depend upon the spacing of the turns, which will depend upon the number of pegs used. The greater the number of pegs the higher the inductance for a given diameter and size of wire.

It will be noticed that an odd number of pegs is specified. The reason for this will be seen immediately. To wind the inductance make the wire fast to one of the pegs and commence winding from the inside, taking the wire in and out round the pegs. When commencing the second turn it will be seen that the wire will go round the pegs opposite to the way in which the first turn went. Similarly the third turn will be on the opposite of the pegs to the second turn, and on the same side as the first turn. This is the desired effect and gives a rigid flat coil of one turn per layer. An even number of pegs would not give this effect as all the turns would follow one wave.

Continue winding to the required diameter, taking care that the turns are wound tightly and are evenly spaced, and also that the wire does not slip down out of its place.

When fully wound immerse the whole coil in a bath of liquid paraffin wax. After draining, allow it to stand for the wax to cool. When the wax is set the pegs may be taken out and the core removed.

The coil should then be as shown in the photograph (Fig. 2).

Flat Pancake coils are obtained by winding

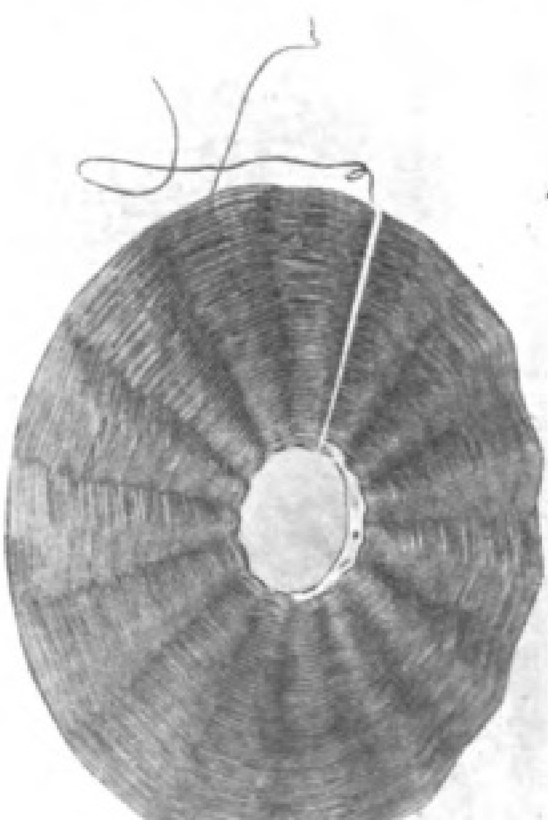


Fig. 2.

wire layer by layer on to a core provided with flat end cheeks which are $\frac{1}{8}''$ or $\frac{3}{16}''$ apart. This is not true "Pile" winding but is a method by which a lot of wire can be got into a small space yet keeping the self capacity of the coil very small. The number of turns per layer is very small and therefore the potential between the layers is small. Using a given wire and winding to the same diameter and thickness a coil of this type will have several times the inductance of a basket coil.

A disadvantage of this type of coil for short wave oscillators is that when only a small amount of inductance is required it is put into such a small diameter that sufficient coupling cannot be obtained between the grid and anode circuits. With a basket coil a bigger diameter coil would be necessary to give the same inductance and owing to the dimensions of the coils there would be more coupling between the circuits. To wind this kind of coil it is necessary to use a lathe or other mechanical turning device.

Honeycomb coil is the name given to coils wound on a special type of winding machine. The wire is wound on in layers as with the flat pancake, but in this case the wire travels backwards and forwards across the layer a number of times each turn, according to the adjustments of the machine and the gauge of wire used. Such coils are out of the question for the amateur worker. With each of these three kinds of pancake coil it is not possible to calculate the inductance; it is a case of determining it by experiment.

Experimental coils gave results as under :—

Coil A. No. 30 D.W.S. 140 turns 805 mhy.
Coil B. No. 36 „ 220 „ 4150 mhy.

Coils made of wire below 30 D.W.S., Basket type, do not give sufficient inductance to be useful for our purpose. Wire thicker than No. 30 D.W.S. can be used satisfactorily for flat pancakes.

The wavelengths given will of course depend upon the condenser used. Values are given below for condensers which are probably the extreme limits of condensers used by amateurs :—

	Condenser of Max. Cap.	Metres.
Coil A ...	0·0005 mfd.	580 to 1,580
„ A ...	0·003 „	1,100 „ 3,100
„ B ...	0·0005 „	1,500 „ 3,200
„ B ...	0·003 „	2,000 „ 7,000

It will thus be seen that if a 0.0005 condenser is used with the two sets of coils a range of 580 to 3,200 metres may be obtained and with a 0·003 mfd. condenser a range of 1,100 to 7,000 metres can be obtained.

The ranges for condensers of intermediate value may easily be calculated.

It is of course not essential to keep the coils 4" diameter, they may be increased to 6" if desired.

It should be noticed that the wavelength range from minimum to maximum capacity of the condenser is approximately 2·5 times the minimum wavelength obtained, and that to cover a wide range of wavelengths several sets of coils must be used. One set of coils comprises two—one for the grid circuit and one for the anode.

When the coils are being assembled with the rest of the apparatus the connections to the coils should be made as follows to ensure that the set "oscillates." With the two coils placed on top of one another, with the windings running in the same direction, connect the outside end of one coil to the anode terminal of the valve and the outside end of the other coil to the negative terminal of the filament; the inside end of the first coil to the positive 6-volt terminal and the inside end of the second coil to the grid of the valve.

When the apparatus is complete place it close to the crystal receiver or place a "pick-up" coil—wound with a few turns and connected in the aerial circuit of the receiver—over the inductances of the oscillator. Adjust the receiver until "spark" signals from a station such as Eiffel Tower are received. Then light up the valve—which should burn fairly brightly—and adjust the "oscillator" condenser. If it is "oscillating" the note of the spark signals will be broken up into a kind of scratchy hiss as the oscillator is tuned to near the spark wavelength. This will show that the set is oscillating properly. Then the search for C.W. stations may be carried out by tuning the receiver to various wavelengths and adjusting the wavelength of the oscillator to get interference. Wavelengths of 1,000 to 1,400 are quite useful for searching over for C.W. signals.

If the set does not oscillate, see that all connections are good and that the directions of the windings are correct. If still unsuccessful add two or three dry cells to the anode voltage by connecting the negative terminal of the added cells to the positive 6-volt terminal and the positive terminal of the added cells to the end of the winding which is connected to the anode of the valve.

Note.—The anode terminal of the V24 valve is coloured green.

A USEFUL CRYSTAL DETECTOR

SOME of the costly, complicated, and massive crystal detectors sold for the use of amateurs seem to fail to give results. in any sense commensurate with their cost. They fail most frequently, perhaps, in the matter of maintaining their adjustment and of being troublesome to readjust.

The detector described below is almost perfectly steady, small, sensitive, simple and inexpensive to construct.

The elements are Zincite and Bornite or Copper pyrites. The crystals are mounted in cups ¼" diameter for the top (bornite) and ⅜" diameter for the bottom (zincite). Woods metal is used and revolver cartridge cases or thick brass screws drilled to form cups. The cups are soldered into stiff springy brass strips (see Fig. 1). The top one (A) is ½" wide × 2½" long. The bottom one (B) is ⅝" wide × 1½" long.

Pressure is obtained by screw (S) Fig 2, and the adjustment of contact by the top plate pivoting around (S) and the bottom plate around (T).

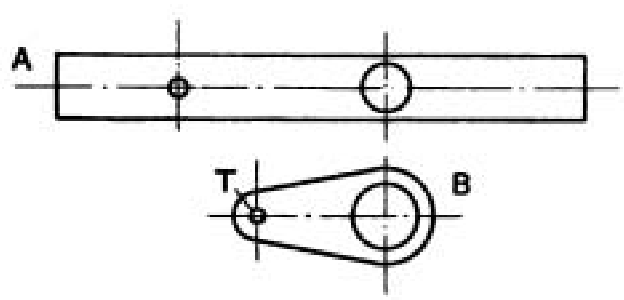


Fig. 1.

The blocks (C) (C) (Fig 2) may be of any material (cork answers quite well), their thickness depending upon the height of mounting of crystals.

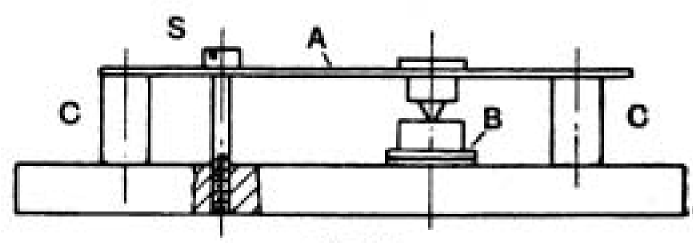


Fig. 2.

Remarkable steadiness is obtained by the very adequate support of the elements combined with the fact that the movable parts are light and if the base receives a jar the inertia of the parts is not sufficient to cause trouble. The top plate is supported and steadied at C C S, and point of contact of crystals. The lower plate, after adjustment, is securely screwed to the base by screw T.

The writer recommends the construction and mounting of two of these, firstly, because he has never known two such to be off together; secondly, because somewhat greater sensitiveness is frequently got by using two in parallel; and thirdly, because being so small, two may be mounted in the space usually occupied by one.

BOOK REVIEWS

SELENIUM CELLS: THE CONSTRUCTION, CARE AND USE OF SELENIUM CELLS, WITH SPECIAL REFERENCE TO THE FRITTS CELL.

By F. W. Benson.

New York: Spon & Chamberlain. London: E. &. F. N. Spon, Ltd. Pp. iv + 63. Price, 7s. 6d. net.

THIS little booklet is apparently written to meet the needs of two classes of readers, those who are merely interested in scientific matters generally and might desire some information relative to the uses of selenium cells, and also for the experimenter and handy-man who can construct his own apparatus and is anxious to carry out experimental work.

The first chapter deals briefly with the discovery, with the natural sources, and with the various forms of selenium, while Chapter II. introduces the real subject matter of the book.

The flat-type cell, which is the pattern most usually met with in experimental work, is first described. Its chief disadvantage—that the light does not penetrate into the whole of the mass of the selenium through which the current passes—is also emphasised. The cylindrical pattern of the cell used by Ruhmer, the Bell and Tainter cell, the Mercadier cell, the Gripenberg cell, and, lastly, the Fritts cell, are also described.

As stated in the title and preface of this book, the author deals particularly with the Fritts cell, and sets out its practical advantages over the other patterns referred to.

Chapters III. and IV., which comprise the major portion of the book, contain a wealth of detailed information relative to the construction, maturing and testing of these Fritts cells. The book closes with two short chapters devoted to a brief summary of the applications of selenium cells to various practical purposes, also including a few remarks as to the care of selenium cells.

The detailed instructions that are given throughout the book for construction and testing should render this little volume eminently suited to anyone desirous of repeating such work and constructing these cells for himself; in fact, it might seem that the detail is carried rather too far. For instance, it seems scarcely necessary to tell anyone that a Bunsen burner should be adjusted to give a steady blue flame, or to describe in detail both the Wheatstone bridge and the substitution method of measuring the cell resistances. There are very few misprints throughout the volume, but some of the abbreviations adopted, although fairly obvious, are rather unusual. It would, perhaps, seem to be worth while if publishers who contemplate their books being circulated in this country and in America would adopt well-recognised forms of abbreviations or would give alternative methods of measurement (such as for wire gauges, etc.). This practice has already been adopted to a certain extent by some technical societies and is worthy of more universal consideration.

On page 392 there is what is apparently a misprint, although it savours very much of the loose style of expression that is occasionally adopted with semi-popular works.

With reference to the arrangement detailed on pages 24 and 25 for measuring the cell temperature, it appears scarcely probable that very accurate results would be obtainable, unless some thermally good conducting liquid, such as mercury, is placed in the thermometer well. No mention of such a liquid is made, neither is there any discussion of the harmful effects of some impurities upon the light-sensitiveness of the selenium, nor of the precautions that should be taken to avoid such effects.

Despite the few blemishes such as these, the book should be a very valuable one to experimental workers, and the most serious criticism which can be levelled against it is its prohibitive price of 7s. 6d. for a meagre 64 pages.

P. R. C.

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 Fditor 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.**

F.G.P. (Doncaster) *asks* (1) *What is the most suitable valve receiving circuit for telephony.* (2) *If there is any advantage in using a crystal as rectifier instead of a valve, other valves being used for initial H.F. magnification.* (3) *Referring to Bangay's Oscillation Valve, (Fig. 97), what is the reason for the condenser in series with the A.T.I., if the inductance is continuously variable.* (4) *Which is the most efficient way of tuning up to long waves on a short aerial—a loading coil in series with the A.T.I., or a condenser in shunt with it.*

(1) Any good receiver circuit is quite satisfactory. For the best working it should be adjusted to be nearly, but not quite, on the point of generating oscillations.

(2) Only the saving in expense of installing and working another valve. The results obtained are nearly the same.

(3) The condenser shown, even on a small aerial, enables you to use a coil of higher inductance, which gives you bigger changes of P.D. on the grid.

(4) There is not much difference. It is generally more convenient to use a loading coil.

W.H.T. (Westminster) *has a receiver which will not give signals. He mentions the parts of apparatus used, but does not give a sketch of connections. The only information that he gives is that if he connects the aerial to earth through the telephone he gets a very slight click, and this click is more distinct if he includes a dry cell in the circuit. He asks why the set will not work.*

The apparatus you are using should be all right for a simple receiver, but without a diagram we cannot say whether you have connected it up properly. The click which you get without a cell is quite natural, and tends to show that the insulation of your aerial is all right. It is due to a discharge of atmospheric electricity which has accumulated on the aerial. The click with a cell in series *might* be due to defective insulation, if the previous result did not seem to show that this is not the case. It is probably due to a rush of current into the aerial charging it up. We can only recommend you to examine the insulation of the aerial carefully, and to make quite certain, by referring to a text book, that you are using a proper type of circuit.

"VALVES" (Marple) *asks* (1) *Whether it is possible to receive C.W. by means of a crystal receiver.* (2) *Whether it is possible to receive spark signals on a valve receiver.*

(1) It is possible, but none of the methods are simple or convenient. It is, however, possible to receive C.W. fairly simply by substituting a "tikker" or similar device for the crystal in a crystal receiver.

(2) Certainly.

A.R.P. (Marlborough College) *sends a diagram of a receiver (a Marconi 2-valve Trench Set) built to work from 400-2,000 ms. He has tried to increase maximum wavelength considerably, but finds that the valve refuses to oscillate above about 4,500 ms. He asks* (1) *How to make the set work to about say 17,000 ms.* (2) *Why the valve would not oscillate.* (3) *Why adding inductance between the aerial and earth terminals decreases the maximum wavelength.*

(1) It is naturally not always easy to adapt a receiver intended for one wave range to work well on such a greatly extended range. To increase the range, add a loading coil in series with the aerial, and considerably increase the size of the reaction coil. You will have to find the best size for this by trial.

(2) The reaction coil is probably much too small for long wavelengths.

(3) Because by so doing you are adding one inductance in parallel with another, and therefore reducing the resultant inductance.

W.E.C. (Rotterdam) (1) *Sends two sketches of aerials (Fig. 1), and asks which we recommend.* (2) *He queries the diagram on page 144 of Bangay's Oscillation Valve, and asks if the arrangement of the second and third valves is a misprint.* (3) *He also asks for information on the subject of valve receivers in which the telephones are placed in the grid circuit and the signals impressed on the plate circuit.*

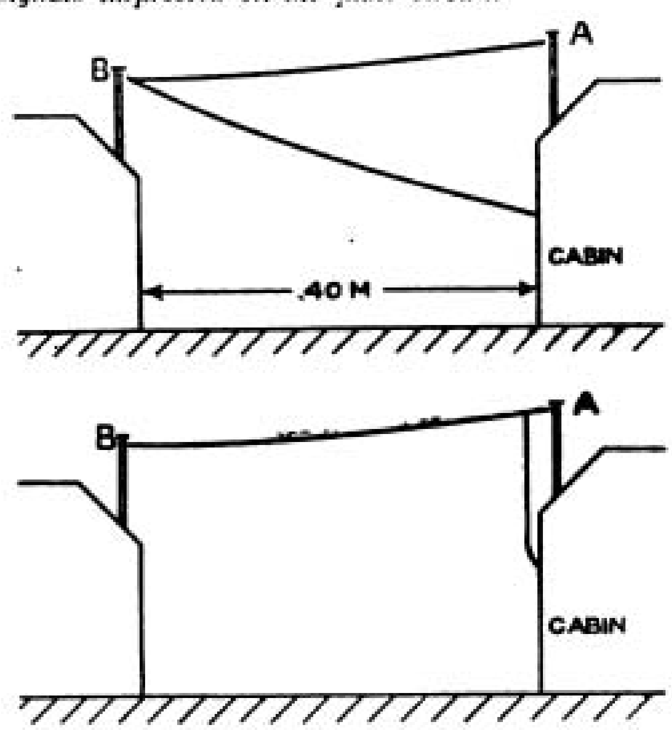


Fig. 1.

(1) The second, in which the down-lead comes from the end marked A is much preferable. (*Cf. the reply to* **DAMPED** *in the Second Number of this Volume*)

(2) The diagram in question is wrong, at any rate in the earlier copies. The grid and plate connections of these valves should be interchanged.

(3) Receivers can be made to work on these lines. As a rule they are inferior to the usual type, though they may have certain special applications. We do not know of any publication in which they are dealt with.

W.V.G.N. (Dulwich) *has a magnetic detector, and asks* (1) *Where No. 40 c.c. iron wire can be obtained, and if plain wire varnished and vaselined would do as a substitute.* (2) *How the ends of the band are joined.* (3) *What is the minimum speed for the band for efficient working.* (4) *The resistance of his phones being 240 ohms, whether he is right in winding his secondary to this resistance too.*

(1) You could probably best get the small amount you would require from dealers in amateur wireless sundries, or failing that, from the Marconi Company. The substitute would probably be quite effective, but the insulation would very likely need renewal fairly frequently.

(2) With No. 36 iron wire.

(3) About one metre per minute.

(4) Yes.

C.E.S. (Dublin) *asks* (1) *Whether a hoop aerial consists of a loop of thick wire forming part of a closed oscillatory circuit.* (2) *How it is that the currents induced in one down limb are not exactly neutralised by the similar currents in the other down limb.* (3) *In which direction does the aerial radiate or receive best.*

(1) Yes.

(2) Because there is a slight difference of phase between the currents in the two limbs. It is because this difference is generally small, and the currents therefore do nearly neutralise each other, that this type of aerial is insensitive unless made very large.

(3) In either direction in the plane of the loop.

A.B.H.F. (Peterborough) *has a crystal plus low frequency amplifier receiver which will give signals audible 25 yards away from the phones. He asks if he is likely to be able to work a P.O. relay with the currents he is getting, and if we can suggest any likely improvements in the receiver for this purpose.*

It is possible that you might do this, by setting the relay very fine. For this purpose you would probably get better results if you used either the last valve, or an additional valve, as a grid condenser rectifier with a very high leak resistance. This will give you very great current changes, if suitably adjusted, but will probably give you some trouble when X-s are bad.

W.H.T. (Norbiton) *asks* (1) *How the wavelength of a small receiving station can be determined.* (2) *If there is any formula for the capacity of a variable condenser.* (3) *Whether when using a crystal, a battery is necessary in the telephone circuit.* (4) *If the apparatus shown in a sketch should work all right.*

As you have not yet used a set, and have only a vague idea of the principles of the subject, we should advise you to study carefully Bangay's "First Principles" or a similar text book.

(1) We are not very clear as to your meaning. A receiving set nearly always has a comparatively large range of possible wavelengths. This range can be measured by a wavemeter. For the method consult any text book. (2) There are formulæ for various simple kinds. On the other hand some types of condenser have capacities which cannot be calculated by any simple formula. We cannot quote a formula without knowing the type of condenser for which you want it.

(3) The purpose of a battery in such a circuit is to apply a potential to the crystal. It is desirable with most forms of crystal, but not with all.

(4) The circuit shown is quite impossible. You will find suitable methods of connection in Bangay or any other elementary text book.

"SILICON" (Dundee) *has a receiver which will not give signals, except from Stonehaven. He sends a diagram of his connections (Fig. 2), and asks* (1) *What is wrong, and* (2) *If tram wires parallel to his aerial and about 50 feet from it should prevent him from getting signals.*

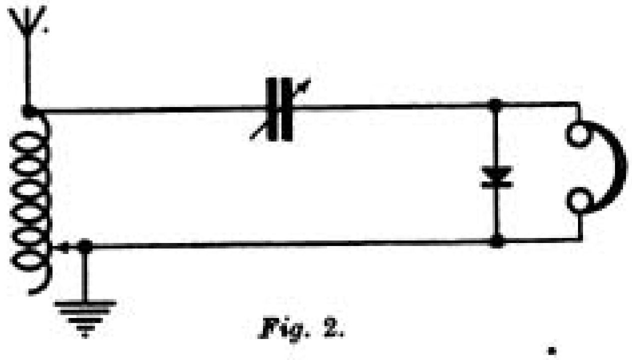


Fig. 2.

(1) The connections of the circuit are wrong. The crystal should be in parallel with the condenser, and not in series with it. Only the nearness of GSW enables you to receive even him. Consult any crystal receiver diagram.

(2) The wires will probably weaken signals somewhat. They are more likely to give you trouble through induction from the currents flowing in them.

PETE (Leeds) *asks* (1) *If a wireless club exists in Leeds.* (2) *What is the power of Eiffel Tower.* (3) *On how high a wavelength it would be possible to receive efficiently with an aerial of natural wavelength 130 ms., using one H.F. magnification and crystal rectification.*

(1) None as far as we know.

(2) Musical spark, 150 K.W.; non-musical spark, 70 K.W.; and C.W., 150 K.W.

(3) It is impossible to give any definite figure, so much depending on the design of the set, and what you consider efficient reception. We might suggest 5,000 ms., but you could no doubt get signals from high power stations at short range even up to the figure of 16,000 ms. you suggest.

H.E.P. (Upminster) *asks* (1) *How to connect up the following instruments: a 2-slider tuning inductance, loose coupled tuner, detector (nature not* *stated, presumably crystal) and head phones (2000 ohms.). He does not wish to use anything else. (2) Whether time signals are sent summer time, or Greenwich mean time.*

(1) The list of apparatus is by no means a suitable one for a station. However, you might make a receiver of sorts as in the following diagram, the loose coupler being merely used as an additional inductance or variometer (Fig. 3).

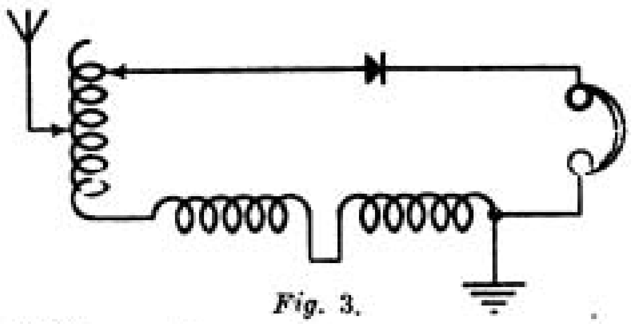


Fig. 3.

(2) Greenwich mean time.

F.W.D. (Constantinople) *asks whether the intervalve transformers of a low frequency amplifier could not be wound with resistance wire, as the only thing necessary appears to be the correct ratio of turns.*

Correctness of ratio is not the only thing necessary. Compare the case of a power transformer, in which other factors have to be considered when the load it is to handle is remembered. Roughly speaking, the conditions are similar in the two cases, and unproductive resistance (*i.e.*, resistance not necessary to produce magnetic effects) is bad in both. The transformers should certainly not be wound with resistance wire.

A.L. (Madrid) *asks for an explanation of hissing in valves used with closed oscillatory circuits.*

The hissing is, in nearly every case, due to irregular discharge of the batteries, either low tension or high tension. The chief causes of the trouble are approaching exhaustion of dry cells, or too much discharge of accumulators. It may also be due to poor quality of the cells, even if up to their right voltage, or bad connection, either in the interior of the batteries or in almost any other part of the circuit. The *reason* such causes give rise to the noises is that, by altering the resistance of the circuit, they vary the voltage applied to the valve.

S.R. (Newcastle-on-Tyne) *sends particulars, with sketch, of a receiver, which, he says, will only give signals from GCC, about 14 miles away. He asks if we can help him to find any fault.*

You give much useful information, and your sketches are quite clear. Unfortunately, you do not give the sizes of the formers on which your inductances are wound, so that we cannot say if they are of suitable value. The secondary of the loose coupler may very likely be too small. You might try increasing this. In all other respects your circuits, the alternative arrangement as well as the original set-up, appear to be quite all right. We can only recommend you to try all the usual methods of fault tracing, such as testing all connections, and the insulation of your aerial.

L.H. (Liverpool) *sends a diagram of a two-valve receiver, and asks (1) If it is right to use a battery to light two filaments, as shown. (2) Which is the better aerial to use, an L or a T, the top being 50 ft. long and the down lead 20 ft. (3) What range he should get with the set shown. (4) Whether he could get results with an indoor frame aerial 10 ft. square, and if he would be allowed to use this.*

(1) Yes, certainly. You can also use one battery for the two plate circuits if you wish. (2) The *L* type, except for very short wavelengths indeed. (3) It is impossible to estimate, so much depending on the actual construction and handling of the set. You describe your aerial tuning coil as a 10,000 m. coil, and your loose coupler as a 35,000 m. loose coupler; we do not understand quite what you mean by this. As you do not give any other dimensions, we cannot say if you have proportioned your circuits right. (4) The frame aerial should give satisfactory results, but you must have the Postmaster-General's licence to use it.

J.W.S. (Sedburgh) *sends a diagram of a receiver and aerial arrangement. He hears no-one but GCC faintly, and asks if we can suggest a cause, stating that all his connections are satisfactory.*

The type of circuit used should be quite satisfactory. The only likely fault seems that your A.T.I., which you say gave good results on a 4-wire aerial 200 ft. long, may be too small for the smaller aerial you are now compelled to use. This is borne out by your statement that the length of wire on it is only 146 ft. To get anything like a good range of wavelengths you will probably want at least six times this length. You can use finer gauge than the No. 20 you are now using, if you prefer it. We take it that you have connected the positive of the H.T. battery to the plate.

A.S. (Burnley) *has made a receiver of the type shown on Fig. 12, page 530, December, "Wireless World." He is using it with an indoor aerial. He thinks he hears faint signals at times, but if they are there, they are masked by a noise which can be tuned to any pitch between a slow tick and a high note. He asks for advice, this being the first set he has put together. He also asks (2) Whether more than one valve is desirable with a small aerial such as he uses, and, if so, how the several valves should function.*

(1) The circuit shown is rather of "freak" nature, and therefore hardly suitable for a beginner. It should also have a grid leak, not shown in the diagram. We should strongly advise you to use one of the simpler types, shown in Bangay's book, at present. The noise you hear is due to oscillations set up by the valve. You are getting the well-known heterodyne beats, probably between oscillations in the aerial and others in the closed circuit.

(2) The sketch of your aerial has not come to hand: you probably omitted to include it. More than one valve will be almost essential, unless the frame is very big. The simplest combination will be a rectifying valve, followed by one or more low frequency amplifiers. You will find circuits in Bangay's book.

The WIRELESS WORLD

VOL. VIII. No. 7, NEW SERIES] 26th JUNE, 1920 [FORTNIGHTLY

CONTENTS

PRICE 6D. NET

McGRUER SPARS

The ACME of STRENGTH and LIGHTNESS.

This Hollow Wooden Structure is ideal for **WIRELESS MASTS** (telescopic or in one length), **AERIAL SPREADERS, INDUCTANCE FORMERS,** etc.

MASTS of any length can be constructed by this unique method, where high insulation is required the advantages gained are infinite.

McGRUER HOLLOW SPARS do not hold the damp like solid poles.

HOLLOW AERIAL SPREADERS are an enormous advantage. We specialise in these and have a range of sizes from 2 ft. 6 in., weighing 8 ozs., to 12 ft., weighing 7 lbs. The smaller sizes have a double grooved block at each end for bridle and aerial wires; and the larger a two-eye cranse is fitted. These Spars are double tapered and are very strong and light.

WRITE FOR BOOKLET.

**COMMERCIAL ROAD,
LAMBETH, LONDON, S.E.1**

Telephone: Hop 718.
Teleg.: "Ollosparsh, Watloo, London."

THE BRITISH SCHOOL of TELEGRAPHY Ltd.

179, CLAPHAM Rd. LONDON. S.W.

EXPERT TRAINING FOR YOUNG GENTLEMEN (15-25) IN INLAND, CABLE & WIRELESS TELEGRAPHY. Good appointments are open to our students as soon as qualified, the demand for Skilled Operators in all Services being greater than the supply. Special Short Course suitable for men wishing to obtain Government Certificate and enter the service of the Marconi Co. At several recent Government Exams. all candidates obtained 1st Class Government Certificate. No Branches or Postal Tuition. Fees moderate. Recognised by the War Office, Admiralty, Wireless Telegraph and Cable Companies.

WRITE FOR PROSPECTUS. A. W. WARD (Manager). 'Phone: BRIXTON 215

THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. VIII. No. 7. JUNE 26TH, 1920 FORTNIGHTLY

STATIONARY WAVES ON WIRES

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

IN the course of his experiments on electromagnetic aether waves, Hertz carried out some investigations on the propagation of waves along wires. At that time he was chiefly concerned with a comparison of the velocity of propagation of the waves along the wires and through the air. By coupling a long wire stretched out horizontally a few feet above the earth to a simple Hertz oscillator it is possible to set up in it a series of stationary waves by reason of the superimposition of the direct waves coming from the transmitter and the reflected waves from the end of the wire.* If the wire is given an appropriate length the reflected waves will reinforce the direct waves, and stationary waves will result. The presence of these stationary waves on the wire may be shown by the occurrence of maximum sparking in a Hertz resonator, held near the wire, at certain points along the wire, and minimum or zero sparking at intermediate points. The distribution of current and potential along the wire may be represented by the curves in Fig 1. The curve marked *I* indicates the distribution of current, and that marked *V* the distribution of potential. These it will be seen are both harmonic curves, and when one is a maximum the other is zero, and *vice versa*. The maximum sparking will occur in the resonator when it is placed adjacent to a current maximum (or antinode) and least when opposite a current node. The distribution of current along the wire can thus be mapped out by recording the length of the sparks in the resonator for different points along the wire, and the *I* curve obtained. If, however, we approach an insulated piece of metal to the wire, it will be found that sparks will pass between it and the wire at some places but not at others, thus indicating the points where the voltage *V* is greatest.

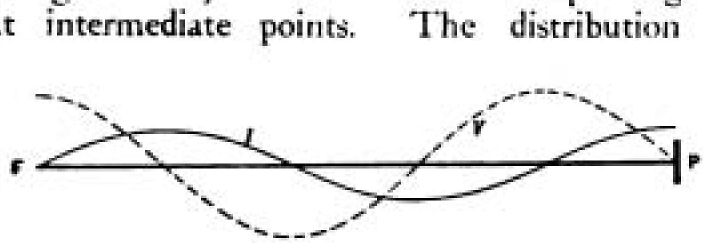


Fig. 1.

Diagram illustrating distribution of Current and Potential along a horizontal wire on which a stationary wave has been set up.
Curve I represents the current and V the potential. The plate P is placed close to the Hertz Oscillator used to excite the waves, and the end F is insulated.

Another and more sensitive detector that may be used for indicating the presence of these nodes and loops of potential is furnished by a simple vacuum tube which may be held in the hand near the wire. When such a tube is filled with rarefied neon gas* a very sensitive indicator is obtained since neon possesses a low ionising potential—that is it requires a smaller potential to produce a visible glow in neon than for air or other gases.

The chief disadvantage of the above arrangement is that on account of the small capacity

* See earlier article, *Wireless World*, Vol. 8, pp. 73 to 75, May 1st, 1920.

* Neon is one of the inert atmospheric gases, symbol Ne.

and inductance of the single wire it requires a very high oscillation frequency to set up the stationary waves, and it is not easy to produce these very high frequency oscillations of much power using a Hertz oscillator.

We can utilise more energy and obtain more powerful oscillations by employing a closed oscillation circuit shunted across the spark gap, and connecting the long horizontal wire to a high potential point on this circuit. It is not easy, however, even with this arrangement to produce powerful oscillations of as high a frequency as given by the Hertz oscillator, while if lower frequencies are employed, it means that the wavelength is longer, and that therefore the wire must be much longer if stationary waves are to be set up along it.

This difficulty can be overcome by coiling up the wire into a long spiral, as this increases its inductance per unit length, and also somewhat increases its capacity.* Using a solenoidal coil of fine wire in this way, the phenomena of stationary waves may easily be demonstrated with a coil 6 to 8 feet long, although the effects are more striking with a still longer coil—say 10 to 12 feet in length. This coil should by preference be wound on an ebonite tube, but the writer has obtained quite good results using a cardboard tube, well impregnated with paraffin wax, as the support for the winding. Any convenient diameter, say 1½ in. to 3 inches may be used, provided that the constants of the oscillation circuit are proportioned to the size employed.

The following dimensions are convenient for demonstration purposes :—

Helix. 6 feet long × 3½ ins. diameter, closely wound with No. 26 S.W.G., d.c.c. copper wire, giving about 36 turns per inch length, or about 2,600 turns in all. This may be wound on a cardboard tube, and the whole well impregnated with paraffin wax.

Oscillation Circuit Condenser—capacity =0·0025 mfd. in two sections that can be connected in series or parallel, or used separately.

* *i.e.* per unit length of the *coil* in both cases.

Oscillation Circuit Inductance, variable in value up to about 120,000 cms. This range may conveniently be obtained from a coil of bare copper wire — say of No. 10 or No. 12 S.W.G. wound on to a supporting cylinder 6 inches diameter and about 14 inches long, the successive turns being ¼ inch apart, giving about 55 turns in all. Provision must be made with a clip or sliding contact to obtain a connection to any point along the coil, so that the inductance in the circuit can be continuously varied from practically zero up to the maximum. A spark gap must be provided—of any convenient form—to give a spark length of 1 or 2 mms. If facilities are available, it is also advantageous to provide an air blast between the spark gap electrodes, as this not only cools them, but at the same time renders the discharge much more stable. The spark gap must be supplied with a source of high voltage, which may conveniently be an induction coil, or a step-up transformer working off an A.C. supply. The voltage required will be of the order of 10,000 volts, and the condenser used must of course be designed to withstand the voltage safely—and in fact a still higher one—(say, 15,000 volts) since the voltage across the condenser in an oscillation circuit is always higher than the spark gap voltage

The helix should for convenience be supported horizontally about 18 inches above the table, on insulating supports (ebonite) and the waves are somewhat better defined if a sheet of thin metal is spread out over the surface of the table under the helix. A convenient size is 6 feet long by about 1 foot wide, although the use of this metal is not at all essential for a demonstration. The apparatus should be connected up in the manner shown in Fig. 2

To set the apparatus in operation the inductance L must be varied until resonance with the helix is secured as shown by the production of a strong brush discharge at the free end. By moving the neon tube along the helix a short distance away from it, it is easily seen that the potential of the helix is very small at the end joined to the induc-

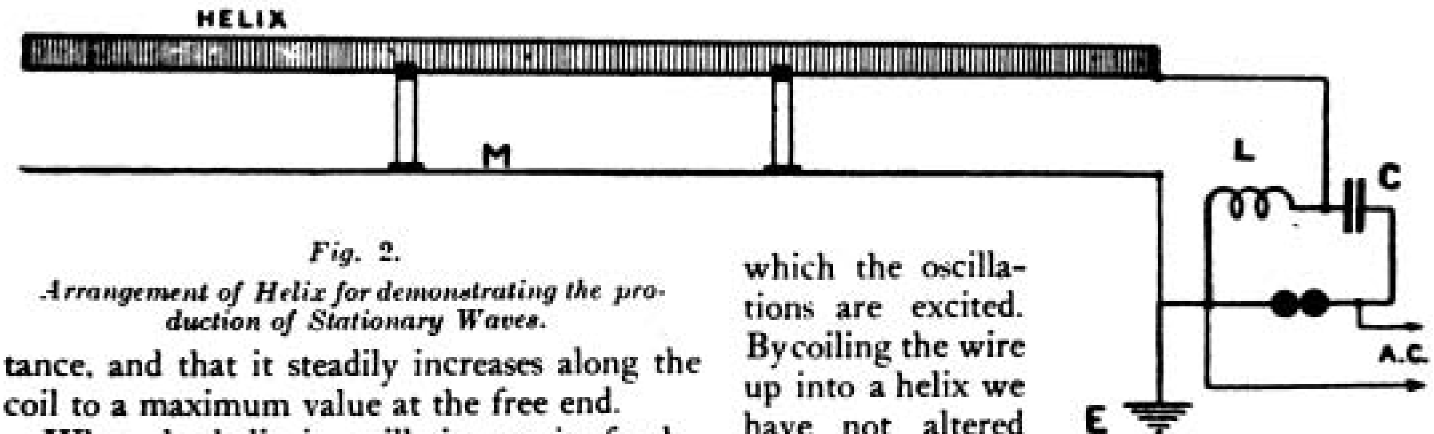


Fig. 2.
Arrangement of Helix for demonstrating the production of Stationary Waves.

tance, and that it steadily increases along the coil to a maximum value at the free end.

When the helix is oscillating at its fundamental frequency, as in the above case, there is evidently only one quarter of a wavelength along the helix (Fig. 3A). To obtain the next harmonic, having a wavelength ⅓ of the fundamental, the frequency of the oscillation circuit must be increased three times, *i.e.*, the product of the capacity *C* of the condenser C, and the inductance *L* of the coil L must be decreased to $\frac{1}{9}$ of its original value. This may be done by putting the two sections of C in series, thus reducing the capacity to ¼, and then readjusting on L. When resonance is again obtained the distribution of potential along the helix will be somewhat as indicated in Fig. 3B.

By similar and successive adjustments of the inductance several other harmonics can be set up in this manner, but their intensity becomes weaker as the frequency increases.

When oscillating at its fundamental frequency the helix represents the conditions existing on an ordinary uniform transmitting aerial in tune with the primary circuit in which the oscillations are excited. By coiling the wire up into a helix we have not altered its properties but merely reduced it to a more easily workable size for experimental purposes, and put it into a form much more suitable for investigation of the phenomena involved. The two important electrical properties possessed in common by both the helix and the aerial are distributed capacity and distributed inductance, and it is these that are responsible for the establishment of the conditions described above. Evidently therefore it is possible for an ordinary aerial to have set up in it waves of higher frequency than its fundamental, but although possible they are not very commonly met with. When using arc or valve continuous wave transmitters these harmonics are much more easily found, as they may be reinforced by harmonics in the oscillations of the transmitter itself.* In such cases trouble has occasionally been experienced at short wave stations near high power long wave ones, due to interference from a harmonic of the longer wave.

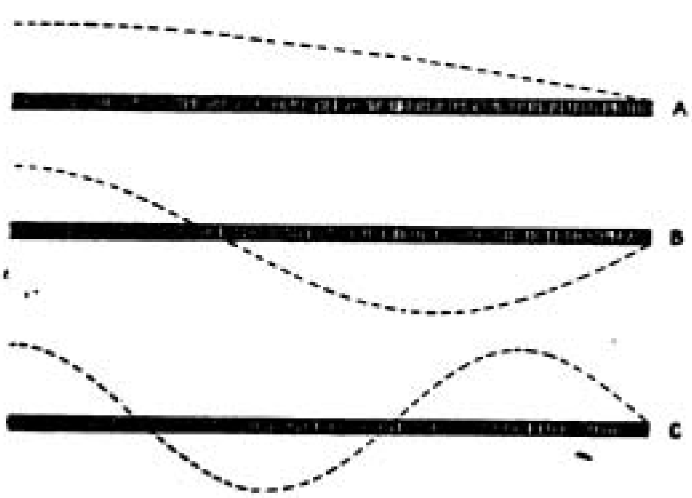


Fig. 3.
Curves showing potential distribution along helix.

Stationary waves have, however, other uses than the demonstration of the conditions existing along a transmitting aerial wire. For example, on another page of this magazine** will be found a description of a Filtering Circuit devised by L. Lévy in which a series of circuits containing capacities and inductances is so arranged that the signal that it is desired to receive can set up a stationary wave along the circuit, whereas any irregular impulse that is not sustained cannot set up such a wave, and therefore its effect may by this means be eliminated in the receiving apparatus

* See for example paper by L. Broadwood, *Wireless World*, Vol. 8, pp. 82 to 91, May 1st, 1920.
** See page 223.

NOTES AND NEWS

The Amateur Position.—It has come to our notice that certain amateurs, wishing to obtain the Postmaster-General's permission to instal receiving sets, have met with considerable diffidence on the part of those who have been asked to stand as referees. This disinclination is stated to arise as a result of the persons asked not knowing to what fields their references might lead, and though actually nothing more is required than is asked for by the average Civil Service Examination Application Form, the subject of amateur wireless seems to be commanding extraordinary caution.

For the guidance of amateurs and those of their friends whom they may ask for references we quote the following paragraph from the official statement issued by the Postmaster-General regarding the amateur position :—

> "The applicant should produce evidence of British nationality, and two written references. Certificate of birth should be furnished. The references should be given by persons of standing who are British subjects and not related to the applicant."

British D.F. and W.T. Stations. — The following D.F. Stations are established in the United Kingdom :—Amlwich (BXV), Berwick (BVG), Carnsore (BVZ), Flamborough (BVN), Larne (BXJ), Lizard (BVY), Peterhead (BVL), Rhyl (BZW), Seaview (Malin Head) (BXK).

Rhyl is not fitted with transmitting apparatus, and is controlled by Amlwich. Seaview is not fitted with transmitting apparatus, and is controlled by Malin Head, which keeps watch on 600 metres.

Wireless telephony stations are open for work at Croydon and Lympne for the London–Paris and London–Brussels air routes. The French authorities have also installed similar stations at St. Inglevert, Valenciennes and Paris (Le Bourget). The wireless control of British stations, including stations licensed on private aerodromes, will be carried out by Croydon. The wavelength of these stations is 900 metres, and the hours of watch for British stations are 6.30 a.m. to 7.30 p.m., Greenwich mean time.

Capt. Malgat, Chef du Service Radiotelegraphique, Ministere des Colonies, Paris.

Captain Emile Malgat, whose photograph appears on this page, is the new Chief of the French Radiotelegraphic service. He was born in 1883, at Illzach (Alsace), and studied at the Ecole Polytechnique of Paris, becoming a sub-lieutenant of Colonial Artillery in 1904. Before the war he was Chief of the French Radiotelegraphic Service of Equatorial Africa ; during the war he served on the Central Radiotelegraphic Military establishment under General Ferrié, and, since May, 1919, has been technical adviser in wireless telegraphy to the French Colonial Office, in succession to Captain Paul Brenot.

The Institution of Electrical Engineers.—A wireless section of this institution has been formed, and is open to members who are "actively engaged in the study, design, manufacture, or operation of wireless or high frequency apparatus." The Committee for 1920 is composed as follows :—Dr. W. H. Eccles, Chairman ; The President, I.E.E., *ex-officio* : the Chairman of the I.E.E. Papers Committee, *ex-officio* ; E. A. Barker, M.C. ; Sir Charles Bright, F.R.S.E. ; J. Erskine-Murray, D.Sc. ; A. Gray ; Professor G. W. O. Howe, D.Sc. ; Captain J. K. Im. Thurn, R.N., C.B.E. (nominated by the Admiralty) ; Admiral of the Fleet Sir H. B. Jackson, R.N., G.C.B., K.C.V.O., F.R.S. ; W. Judd ; Sir Oliver Lodge, D.Sc., F.R.S. ; Professor E. W. Marchant, D.Sc. ; Senatore G. Marconi, G.C.V.O., LL.D., D.Sc. ; Captain H. R. Sankey, C.B., R.E. ; J. Sayers ; E. H. Shaughnessy, O.B.E. (nominated by the Post Office) ; Major T. Vincent Smith, M.C., R.A.F. ; A. A. Campbell Swinton, F.R.S. ; J. E. Taylor ; Wing-Commander A. D. Warrington-Morris, C.M.G., O.B.E. (nominated by the Air Ministry) ; Lieut.-Col. R. H. Willan, D.S.O., M.C. (nominated by the War Office).

Radio Research Board.—Mr. O. F. Brown, M.A., B.Sc. (Oxon.), B.Sc. (Lond.), an Assistant Inspector of Wireless Telegraphy in the Post Office, has been appointed Technical Officer to the Radio Research Board, which has recently been formed under the chairmanship of Admiral Sir Henry Jackson, in connection with the Department of Scientific and Industrial Research.

Obituary Notices. — We deeply regret to announce the death of Mrs. Marconi, who passed away, on June 3rd, 1920, at the age of eighty-one. It is largely due to the encouragement given to the illustrious pioneer of wireless by his mother, the deceased lady, that he was able to prevail, in the days of his early discoveries, against the incredulity of the scientific world. Senatore Marconi, who was cruising on his yacht *Elettra*, was unable to attend the funeral, which took place at Highgate Cemetery on June 7th, owing to his inability to reach England in time. His brother, Mr. Alfonso Marconi, however, was present, together with the Hon. Donough O'Brien, the Hon. Miss L. O'Brien, and Mrs. Marconi's sister. Senatore Marconi has received by wireless telegrams of condolence from the King and Queen of Italy and from Count Medici.

The death is announced to have taken place, at Hampstead, of Major S. C. A. Wace, C.B.E., Royal Marine Artillery, head of the Wireless Telegraphy Board. During the War he was in charge of the wireless station at Malat. He was the author of a handbook on Wireless Telegraphy.

Astronomical Announcements by Wireless.—Professor Kobold, Editor of the Astr. Nachrichten and director of the Centralstelle, announces that arrangements have been made for the distribution of astronomical information by wireless telegraphy from the Nauen Station (POZ). Such messages will bear as signature "OBS" and it is suggested that institutions wishing to receive these messages will make arrangements with the nearest wireless station in their vicinities.

It is hoped that such institutions will contribute towards the upkeep of the service. The use of wireless in this manner is somewhat similar to that adopted in the case of weather, and in cases of such unexpected phenomena as outbursts of novæ, where early observations are of special value, the advent of wireless is of undoubted service.

Weather Reports by Wireless.—On and after June 1st, 1920, the Air Ministry Wireless Station (GFA) will transmit synoptic messages in the same code as hitherto at 3.15 a.m., 8.45 a.m., 8.15 p.m. and general inferences in plain language, based upon observations at 7 a.m. and 6 p.m. The wave-length used by GFA is 1,400 metres (C.W.) and the times referred to are Greenwich mean time. The synoptic telegrams issued at 2.30 a.m. and 2.30 p.m. GMT from Aberdeen Wireless Station (BYD) on a wavelength of 3,300 metres C.W. will continue unaltered.

Brussels Fair.—In common with the Société Anonyme International de T.S.F. the Marconi Wireless Telegraph Company has on exhibition a large variety of apparatus at the Brussels Fair. The most modern instruments for D.F. work, valves and wireless telephony sets form the greater part of the exhibit, but there is also to be seen an automatic call device. The stand contains also a large number of instruments used for purposes of measurement, etc., together with a large collection of publications of the Wireless Press, Ltd., and Marconi International Code Co.

Long-distance Wireless at Sea.—As a result of the success obtained with the new sets on board the Cunarders *Imperator*, *Mauretania* and *Carmania*, the White Star liners *Olympic*, *Celtic*, *Cedric*, *Adriatic*, *Baltic* and *Megantic* are to be fitted before their next sailing from England. These vessels will maintain direct communication with land over a distance of 1,400 miles.

Economic Electric, Ltd. — We have just received this Company's new catalogue, and much is contained therein which is of interest to amateurs. Many types of receiving apparatus, valves, etc., are illustrated.

An Interesting Catalogue of Wireless Apparatus has been issued by Messrs. F. O. Read & Co., Ltd., which should be of great interest to most amateurs, especially as it contains a very good list of long wave stations, with wavelengths, a number of useful circuit diagrams, a table of data for the winding of frame aerials, and a chart of the Eiffel Tower Time Signals as published recently in the *Wireless World*.

Technical School of Dublin.—The Wireless section of this School has started a Magazine, intended to serve as a record of the doings of the many students of the School, past and present. We take this opportunity of wishing both the School and its Magazine every success.

That Dutch Wireless Telephony Station.—We are now in a position to give the following fuller information about the station PCGG, which is delighting amateurs weekly with its concerts by wireless telephony. The station belongs to the Nederlansche Radio-Industrie, and is situated at The Hague. It works every Thursday from about 6.40 to 10.40 p.m. and on Sunday afternoons from about 1.40 to 3.40 (G.M.T.), on a wavelength of between 800 and 1,000 metres. The aerial used consists of three wires each 40 metres long, raised 15 metres high. At full load the aerial current is about 1·3 amperes on 1,000 metres wavelength, and 1·6 amperes on 800 metres. The Nederlansche Radio-Industrie, Beukstraat 8–10, The Hague, Holland, would be glad if amateurs would send them notes if they should pick up this telephony.

Japan's Lofty Masts of Concrete.—Believed to be the highest concrete poles in the world, the masts of the new Japanese stations are 660 feet high. Being made at Tomicka-cho, they are intended for the wireless stations which will shortly open up further communication between Japan and the United States. The capacity of these stations is said to be 8,000 words each way per diem.

Huge Wireless Plant.—The Radio Corporation of America has bought 6,000 acres of land at Rocky Point, Long Island, for the largest wireless plant in the world. The estimated cost of this plant is 10,000,000 dollars, and it will have a three-mile diameter, with a system of antennæ on 400-foot steel masts at a mile and a half radius from the main power house.

The station will communicate with France, Italy, Poland, Scandinavia, Germany, and the Argentine.

The wireless station at Nauen, near Berlin, is the biggest now operating, but the one at present building at Bordeaux, with its eight towers of 800 feet high, will surpass it.

Rocky Point will far surpass Bordeaux, and if the American towers are comparatively low the reason is that the Alexanderson alternators and multiple antennæ will permit of a bigger range on less power.

United States Wireless Stations.—The House of Representatives of the United States has passed a resolution authorising the Navy Department to continue for a further period of two years the operation of all wireless stations open for General Public Correspondence. The resolution will be considered by conference of the Senate and the House.

WIRELESS AND THE PRESS

THE *DAILY MAIL'S* WIRELESS STATION

ON May 11th, 1920, *The Daily Mail* achieved the record of being the first London newspaper to instal a permanent Wireless receiving station on its premises, and after a short period devoted to experiments accomplished on May 28th a further record, that of being the first British newspaper to receive by wireless telephony news messages for publication. These messages were transmitted by the Chelmsford high power wireless telephony plant belonging to Marconi's Wireless Telegraph Co., Ltd., and received on *The Daily Mail* station in London, the work being done by the paper's own reporters.

In addition to providing amateur wireless men with an especial treat, the demonstration furnished ample proof that on account of delay in legislation the advantages obtainable from a branch of science, the growth of which was forced in the heat of the Great War, are being allowed to remain to a great extent unplucked for service in the arts of peace. Eighteen months have elapsed since the signing of the Armistice, and a great London " daily " is forbidden, save on the special occasion described above, to publish news gathered by wireless ! To those who know the varied nature of the aether-traffic in these days, and the precise amount of secrecy it is at present possible to preserve, the need for stringent legislation is patent and the attendant difficulties are obvious. The latter are not, however, insuperable, and those who realise that the age of aether is with us look eagerly forward to the forthcoming moves on the part of the authorities. Wireless telegraphy and telephony are clearly destined to play the leading part in communication, not only with respect to the dissemination of news to the world's press but in every industry. That it should be otherwise is unthinkable. Therefore, the sooner prophecy is converted into fact the better. Wireless must not be allowed to lag behind aviation, for these two things are the most striking and potent human achievements which this century has yet brought forth.

Intimately bound up with the whole question of the civil use and practice of wireless is the desire of a rapidly-increasing number of enthusiasts, many of whom are experts, for freedom to experiment not only in wireless reception but in transmission also. The lure of wireless telephony beckons them with a magic it is difficult to resist. Are they for ever to be debarred from a hobby which is one of the few a Government might well encourage ? War apart, there may yet arise some great national emergency when the services of hundreds of wireless fitters and operators may be urgently needed on the instant. By securing a reasonable measure of freedom to the amateur experimenter the Government would ensure betimes a generous response to such a need.

As our readers know, *The Wireless World*, the oldest wireless periodical in the British Empire, has always paid special regard to the needs and aims of amateurs and since the War has spared no efforts on their behalf. An Annual Conference of Wireless Clubs is now definitely decided upon and the first conference has already taken place. Almost every large club in the kingdom is now affiliated with the Wireless Society of London and looks to that influential body for guidance, assistance and support in the matter of obtaining a maximum of concessions. We feel that British amateurs have proved their right to be taken seriously and that fifty per cent. of their claims should not be dismissed by the process of whittling down at the hands of the permanent officials of half-a-dozen Government departments. Amateurs may congratulate themselves upon the fact that *The Daily Mail* has begun to think " wirelessly."

The Daily Mail installation consists chiefly of a six-foot frame aerial of the

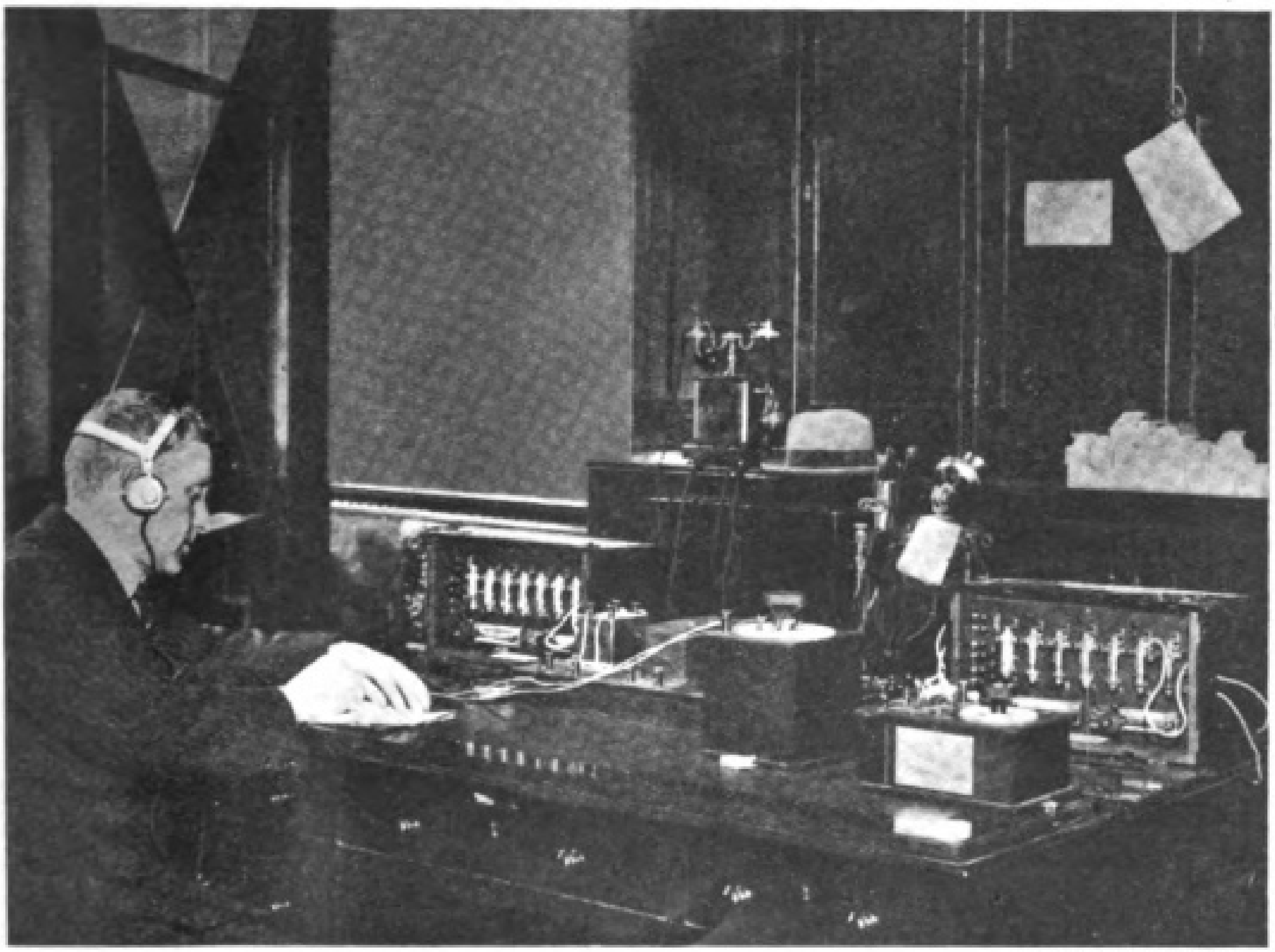


Photo by *Daily Mail.*

The Daily Mail *Wireless Station.*

solenoid type, wound with 48 turns of wire, used in conjunction with Marconi 7-valve high frequency amplifiers and detectors, Types 55A and 55D, which have been previously described in our pages and are familiar to most of our readers. Type 55 is one of the most sensitive receivers in existence and is particularly suitable for use with a loop aerial. The tuning arrangements permit of reception on wavelengths of from 600 metres to 18,000 metres. Damped and undamped waves and wireless speech can be equally well received on this apparatus, which is no amateur set but an instrument which has been thoroughly proven both in war and commerce, and is capable of detecting signals from any high-power station within a radius of 3,000 miles. In a vision of the future one sees the inside of a newspaper office, where reporters are busy receiving "copy" from their colleagues in provincial towns, whilst automatic receivers click out tape records of news messages sent at 100 words a minute from the world's high-power news-distributing stations. From this to direct type-setting by wireless is, maybe, not so far a cry as from Marconi's early experiments to his first great achievement, transatlantic wireless telegraphy !

If, in addition, this future newspaper draws its electrical power from some huge Wireless Power Station, why then—then we shall have really begun in earnest to use that incomparable, universal medium, the aether.

A visit to Carmelite House and a conversation with *Daily Mail* officials revealed that the latter intend to lose no time in assisting wireless and journalism to join hands. They look forward to the time when a reporter shall start for the scene of his "story" in an aeroplane—"and arrive," one of them humorously interpolated—and deliver his "copy" to headquarters by a system of linked wired and wireless telephony, the message being received at the paper's own wireless station. They intend to make as much use of wireless as possible and entertain no doubt but that present day apparatus can fulfil all the demands likely to be laid upon it by Fleet Street in general. The idea of an "exclusive" message being flung out on an indiscriminating, generous aether, and intercepted by rival papers, created a disturbing ripple in the flow of conversation. Knowing that a similar objection has been levelled at wireless telegraphy for twenty years we do not view this question in quite such a serious light. There is this point, too, which must be taken into account—directive wireless is probably not far distant.

We found *The Daily Mail* exceedingly sympathetic about the position in which wireless amateurs find themselves to-day—a position we know by heart and which we described as fully as possible.

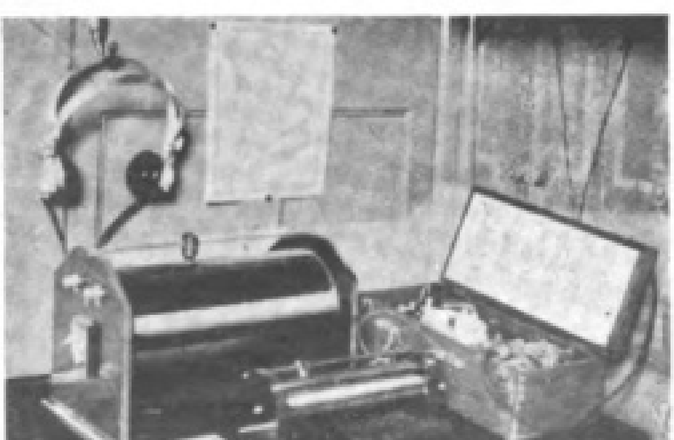
Up to recently much that has appeared in the daily press about wireless, though published with the best of intention, has often been merely a series of bright, humorous, interludes in the life of technical wireless men, but now that our contemporary has acquired a "man's size" installation and has the intention of furthering with its accustomed energy the cause of commercial wireless, we feel that the steps it has taken are of extreme significance to the world of wireless and to that portion of the working world which at present lacks wireless.

AN EFFICIENT PLAIN AERIAL RECEIVER

By A. Cooper.

THE accompanying photograph shows a simply - constructed amateur receiving station. A photographic negative box is fitted with a false bottom about an inch from the top. On this are fitted a carborundum crystal with point contact and a potentiometer, reconstructed from a low voltage motor-field regulator, with porcelain base and iron wire resistance.

A battery switch, telephone terminals and tuning buzzer are also fitted, having buzzer battery and telephone condenser fixed at the bottom of the box. The double slide inductance is connected in series with the aerial and in parallel with the receiver, thus acting as a transformer. Wavelengths of 300 and 600 metres are easily obtained by moving sliders to positions on the calibrated brass rods.



The large tuning inductance consists of a section of a washing-machine roller of $6\frac{1}{2}''$ diameter by $11''$ long, being wound with $\frac{3}{4}$ lb. of No. 26 enamelled copper wire. A single slide makes contact on the bared wire at each turn, and a short-circuiting switch is fitted at the terminal end. This inductance used in conjunction with the smaller double slide inductance gives a maximum wavelength of about 3,500 metres when using a double wire aerial of about 50 feet in length.

A pair of "Browns" 4,000 ohm resistance headgear telephones completes the set. Signals on 600 metres are quite readable at night from over 500 miles distance. The whole cost of installing was less than £4.

THE PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

SOME OF THE PROBLEMS OF ATMOSPHERIC ELIMINATION IN WIRELESS RECEPTION

By Philip R. Coursey, B.Sc., A.M.I.E.E.

Continued from p. 201, June 12th.

3.—Filtering Circuits.

The circuits that have been described above have made use very largely of the directive effect of the receiver in cutting out the atmospherics. We have now to consider still another class of arrangement in which the selection of the signal from the atmospherics is accomplished mainly by filtering out the desired currents and rejecting the remainder. The influence of direct tuning on such a selection was considered at the beginning of the paper, but some of the more complicated arrangements remain to be dealt with.

The selectivity of the receiving circuits, particularly for C.W. currents of a definite frequency, can be considerably augmented by the use of a proper "negative resistance," particularly if this is used in conjunction with a large ohmic resistance to damp out all currents of other than the desired frequency. The effective resistance of a circuit for currents of a definite frequency can be considerably reduced by including in that circuit a three-electrode valve provided with reaction coupling, Fig. 12. Since such a valve tends to maintain

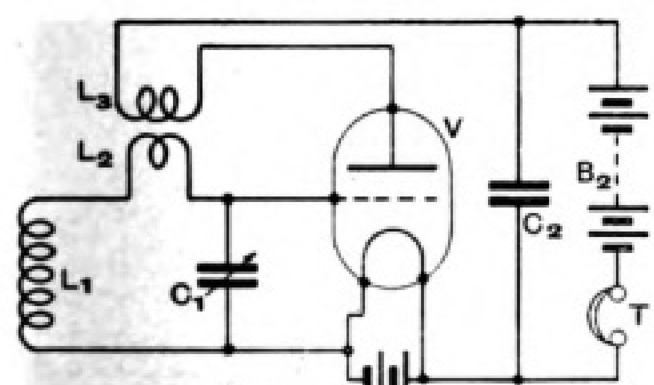


Fig. 12

Three-electrode valve with reaction coupling, acting as a "negative resistance."

currents of the frequency to which it is tuned, the result is equivalent to a reduction of the ohmic resistance of the circuit. This may be looked upon in another way by saying that the valve has added "negative resistance" to the circuit. The "Dynatron" of A. W Hull is one of the most effective of these negative resistance valve arrangements.* In the "Pliodynatron" valve invented by the same investigator four electrodes are fitted—the filament, a grid of the ordinary type, a

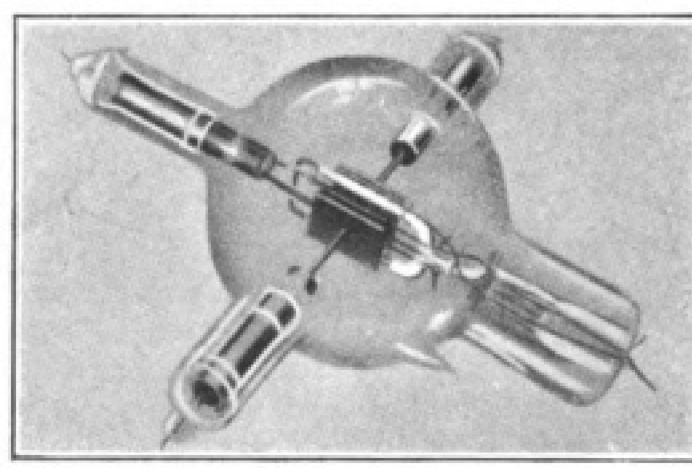


Fig. 13.

A. W. Hull's "Pliodynatron" 4-electrode Valve.

perforated anode and a main anode. The negative resistance effect is obtained by reason of the emission of secondary electrons from the main anode back to the perforated anode. An illustration of the valve is given in Fig. 13.

As an illustration of the utility of these negative resistances we may perhaps take a rough numerical example. Suppose that by proper arrangement of the valve we can obtain a negative resistance of say 5,000 ohms.

* *Proceedings of the Institute of Radio Engineers,* 6, p. 5 (1918.)

Then if we connect, say, 5,050 ohms in series with the valve the effective resistance of the whole circuit to a C.W. signal, of the frequency to which it is tuned, will be $5050 - 5000 = 50$ ohms, whereas to an aperiodic impulse, or to a signal of different frequency, the effective resistance of the circuit will be practically the whole of the 5,050 ohms. This high resistance will therefore considerably cut down the amplitude of the interfering impulse.

The early patterns of Marconi "X-stopper" may be regarded as some of the earliest examples of true filter circuits. Fig. 14 indicates a typical circuit of one of these stoppers and is almost self-explanatory.

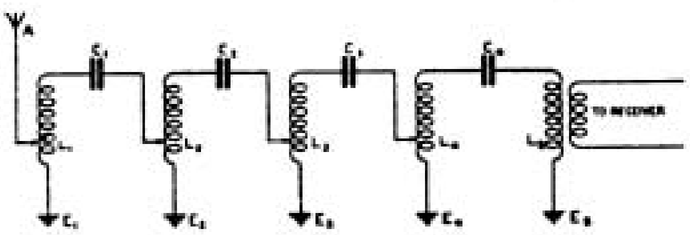


Fig. 14.
Circuit diagram of one form of Marconi "X-Stopper."

Much more recently several patterns of tuned and untuned filtering circuits have been patented by the Western Electric Company and others. Fig. 15 may be taken as an example of one of these. It consists essentially of the combination of a number of circuits containing resistances and capacities, and is so arranged that currents of frequencies between two limits only are allowed to pass through.

A rather complicated filter due to L. Lévy has been used to some extent in France. Both this and the preceding one are much more suited to C.W. reception than to spark signals, for the reason that the tuning of a C.W. signal can be made much more selective. The circuit diagram of Lévy's filter is indicated in Fig. 16. In this diagram the aerial circuit A L E is coupled to the input end of the three valve amplifier V_2 V_3 V_4. The separate heterodyning valve V_1 is also coupled to the aerial circuit, and the oscillation frequency of this valve is chosen so that the incoming signal is heterodyned to a supersonic beat frequency, that is to say, to a frequency above the audible limit. A convenient value is somewhat about 10,000 ~. The filter circuits proper comprise inductances and capacities C_2 L_2, C_3 L_3, ... C_{14} L_{14}. The coupling to the receiver proper is made to one of the inductances of the filter and in the diagram is shown as coupled to L_5. This coupling is both a potential and a current one, the coil L_{15} being coupled to L_5 which is joined across the filter, and the coils L_{17} L_{18} being coupled to L_{19} L_{20} which are joined between two of the filter condensers. By connecting these two couplings—the potential and the current couplings—in opposition to one another it is claimed that the effect of the atmospheric can be largely eliminated, since the atmospheric will only set up one or two oscillations which will travel through the filter as a progressive wave, whereas the maintained C.W. signal will set up a stationary wave along the whole filter.

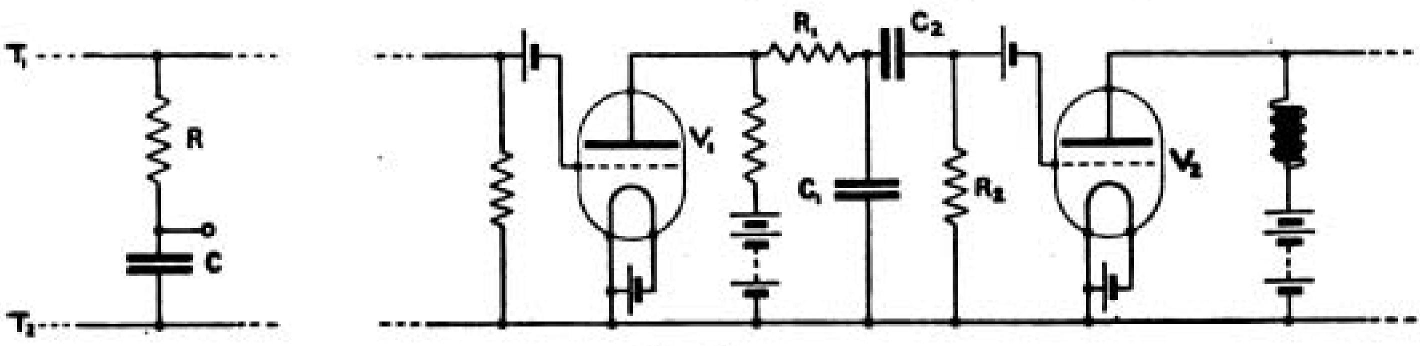


Fig. 15.

Schematic arrangement of Western Electric Co.'s filtering circuits. The elements of a single filter unit are indicated on the left-hand side. The complete filter comprises a long series of such units arranged with amplifying valves between them.

The purified supersonic current is further amplified by the valves V_5 V_6 .... V_{10}. The

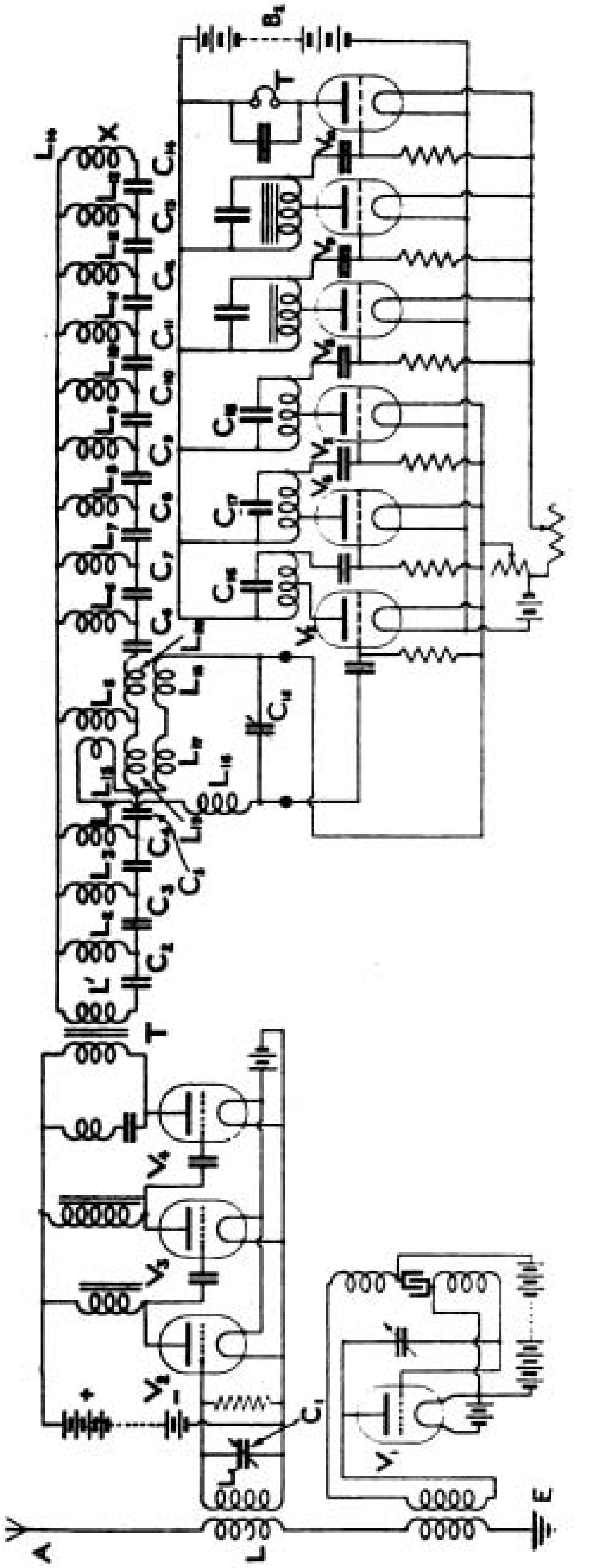


Fig. 16.

Connection scheme of L. Lévy's filtering circuit.

circuits of the first three of these valves are tuned to a frequency near the supersonic beat frequency so that an audible beat frequency is thus obtained which is finally detected in the telephones T.

4.—Methods Dependent upon the Aerial Form.

The type of aerial used at the receiving station exerts some influence upon its selectivity to the signal and upon the elimination of atmospherics. The ordinary type of open elevated antenna picks up the atmospherics from almost all directions in space, while as we have seen above the directive receiving aerials exert a certain selection by cutting out some of the atmospherics from some directions and leaving only those from others.

M. Abraham has discussed this question mathematically and has shown that the selective action of different aerials is largely a question of their effective resistance as regards the signal being received.*

A further limitation of the direction from which atmospherics may affect the receiving aerials may be obtained by combining ordinary open aerials with directive aerials. If this combination is properly effected an assymetrical reception curve is obtained and the signals are received with maximum strength in one direction only. The effects of atmospheric impulses are therefore largely limited to those coming from this direction.

A useful circuit by means of which these two effects may be combined to produce the best results is due to G. W. Pickard.† It was also described by W. H. Priess in a discussion on a paper by E. F. W. Alexanderson read before the Institute of Radio Engineers last year ‡ The arrangement is indicated in Fig. 17 It depends essentially upon the fact

**Jahrbuch der Drahtlosen Telegraphie*, 14, pp. 259–269. August, 1919. *Radio Review*, 1, pp. 147–148, Abstract No. 72, December, 1919.

† See paper by G. W. Pickard, read before the Institute of Radio Engineers on "Static Elimination by Directional Reception."

‡ See *Radio Review*, 1, pp. 150–152, Abstract No. 75, December, 1919.

that the ratio of the strength of signal to strength of atmospheric is different in the case of a simple loop circuit to what it is when the loop structure as a whole is used as an open

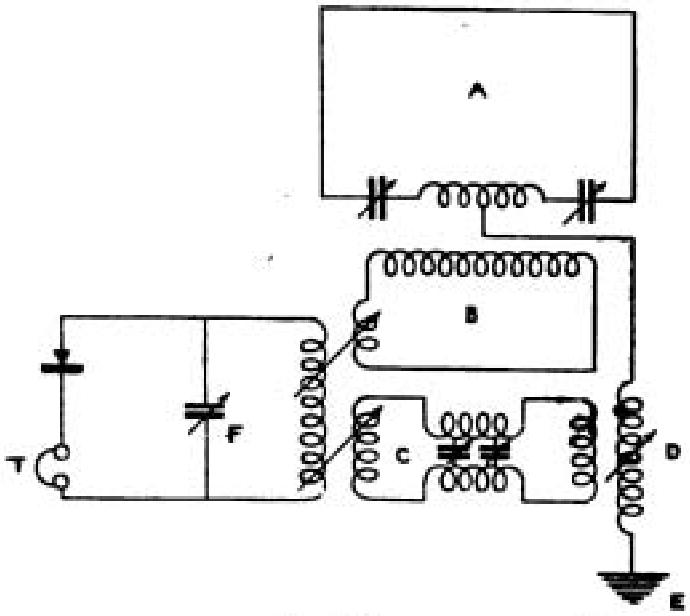


Fig. 17.

Receiver using a loop aerial both as a closed loop and as an open antenna, to lessen the effect of atmospherics.

aerial to earth. In the diagram the loop A is coupled to the intermediate circuit B and thence to the detecting circuit F by a variable coupling. The centre of the loop coupling-coil is joined to earth through the coil D which is coupled to the phase-adjusting circuit C which again is coupled to the same detecting circuit F. The function of the circuit C is to adjust the phase of the currents flowing through the coil D to an appropriate value as compared with the phase of the currents flowing in the circuit B.*

Various improvements of this circuit have been worked out by G. W. Pickard and others, but they are all dependent upon the difference in the ratio of signal strength to atmospheric strength with different forms of the aerial so that when two aerials such as, for example, a horizontal aerial and a loop aerial or a loop aerial and a vertical aerial, etc., are combined together the atmospheric effect can be largely wiped out and the signal retained

* This circuit was patented by G. W. Pickard in 1907, U.S. Patent No. 876996.

The use of low horizontal aerials stretched either a short distance above the earth's surface or actually buried beneath it, is of considerable use in improving the reception of signals through atmospheric interference. The great disadvantage of the horizontal aerials is the extensive ground area required for their use This applies to a certain extent also to the spaced loop aerials of Weagant's and Pickard's arrangements, but the size of these latter arrangements may be considerably reduced without impairing their efficiency to any very great extent. It has been claimed that the whole of Weagant's receiver can be reduced in size until it can be enclosed inside an ordinary room and yet retain its effectiveness.

A large number of experiments on "earth" and similar aerials have been described by A. H Taylor in papers read before the Institute of Radio Engineers (New York). These aerials not only give a fairly sharp directional effect but also have a much larger ratio of signal strength to atmospheric strength than ordinary open aerials.†

In particular we may mention one of the circuits used by A. H. Taylor in which a

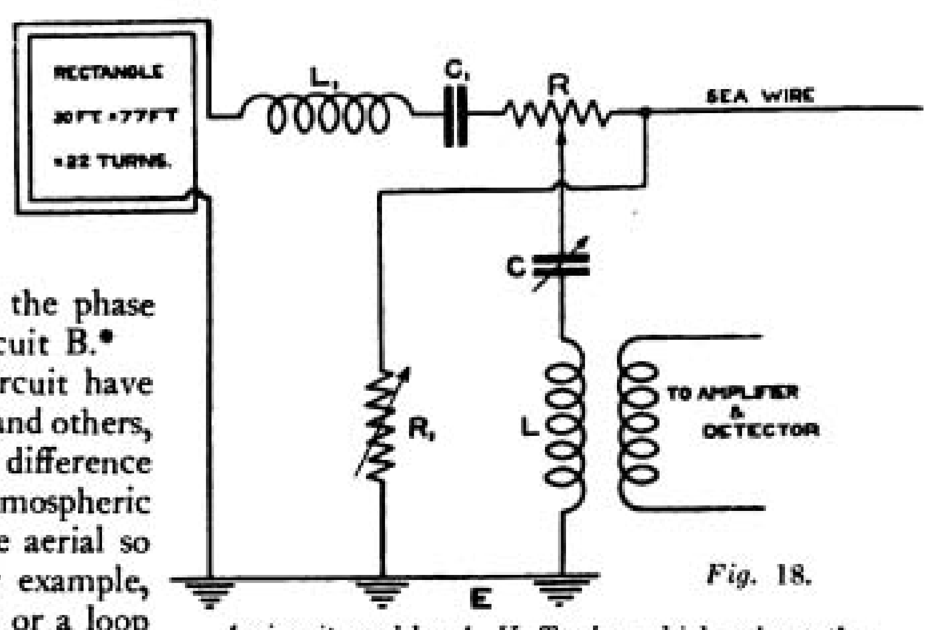


Fig. 18.

A circuit used by A. H. Taylor which reduces the effects due to atmospherics.

† *Proceedings of the Institute of Radio Engineers*, 7, pp. 337–362, August, 1919; and pp. 559–583, December, 1919. *Radio Review*, 1, pp. 204 and 360, Abstracts Nos. 149 and 313, January and April, 1920.

horizontal wire was combined with a loop aerial as indicated in Fig. 18. The loop aerial circuit includes the coil L_1 the condenser C_1 and the resistance R. The horizontal wire is earthed through the tuned circuit C L, the coil L being coupled to the amplifier and detector. The point of junction of the resistance R with the horizontal aerial wire is also earthed through a variable resistance R_1. It was stated in Taylor's paper that the function of this resistance was not very clear although it has considerable effect upon the results obtained, but it seems probable that its action is very similar to the case of Pickard's circuits, mentioned above, where it serves the purpose of equalising the currents in the two aerial circuits so that they can be made to effectively neutralise one another. In this particular arrangement the circuit L_1 C_1 R serves as the phase-adjusting coupling to adjust the equality of phase.

This arrangement is claimed to give a very considerable improvement in the ratio of signal strength to atmospheric strength.

Conclusion.

In conclusion too much emphasis cannot be laid upon the need for further work in this direction. A very great number of experiments have already been made, as we have seen, in several different directions in attempting to obtain the desired freedom from atmospheric disturbances, many more in fact than it has been possible to refer to in this brief *resumé* in which it has only been possible to skim over the leading features of typical methods. Although conditions as regards such disturbances are not nearly so bad in these temperate latitudes as they are in the tropics, yet the question is still an important one, not only for long distance reception in large commercial stations but also in cases in which the members of this Society are probably more interested, namely, that of receiving over long distances using quite small receiving aerials. Using these small aerials, long distance reception can only be accomplished by the use of amplifying valves, and it is under these conditions that the desirability of an effective means of cutting out atmospheric troubles is brought home to the operator. The subject is closely allied with the prevention of interference from other stations, a subject of considerable importance in this country where at no point can we be far from the disturbance of powerful ship and land stations. In this connection I would urge particularly the co-operation of all members of this Society in thoroughly testing out such means of atmospheric elimination and interference prevention as are available, and which they can fit up in their own stations, so that, if possible, we may arrive in time at an arrangement which will be truly effective, at least for small stations in these latitudes, if not in all. In the development of these different kinds of atmospheric eliminators, and in experimenting with them, the importance of studying the fundamental basis upon which they all depend cannot be too highly emphasised, and I hope that the outline given in this paper may help in this direction. Finally I wish to express my best thanks to Messrs. Marconi's Wireless Telegraph Company, Limited, for the loan of some of the apparatus used for the demonstrations this evening, and to other friends who have assisted in their preparation.

DISCUSSION.

The Chairman: I think the Society is very much indebted to Mr. Coursey for his lecture. He said he had only skimmed the subject, but I think he has skimmed the cream and given us some very valuable information. All this enormous number of different problems are scattered, but Mr. Coursey has concentrated them and put them into a very useful form. I think we are also very much indebted to him for the beautiful experiments he has shown us, especially the one showing the impossibility of currents of different phase cancelling each other. The subject is older than wireless telegraphy. It has been with us ever since the beginning: it was one of the first troubles we ever experienced, and it is a trouble which must remain while nature's laws are what they are. Therefore, it is no good trying to say that we shall eliminate atmospherics. We must eliminate their effects on our receiving apparatus. We have had a very large number of drawings put before us, showing the different ways which have been proposed. They began with simple apparatus and they gradually developed until they have got into what we can only call extremely complicated—and I think they will get more complicated—apparatus, and anyone who can invent a simple means of doing it will be benefitting the whole wireless world. That is one of the aims in wireless, one of the most important and most difficult, and Mr. Coursey's suggestion—that the members of this Society should study it carefully —is a very good one. I personally, as Chairman of the Radio Committee, shall be very glad to hear of their results, and I hope they will do what has been suggested. It wants rather an organisation for doing it so that large numbers of different stations can be listening at the same moment. Then we may be able to progress. I hope you will join with me, after the discussion, in thanking the author for his very interesting lecture, and I will now ask anybody who has any remarks to make to discuss the lecture. If anybody has used any of these latest arrangements that have been described and can give us the result of their experience, it would be very useful.

Mr. M. Child : I have been very much interested in Mr. Coursey's extremely interesting lecture to-night. I think I may say that for the past fifteen or eighteen years, right from the very earliest days, when we used coherer receivers, I have been up against the problem of atmospherics in connection with reception. I was interested when Mr. Coursey mentioned Marconi's early X-stopper, but I am afraid I did not think very much of that X-stopper when it was first brought out, for the simple reason that, whenever I connected it, it eliminated the atmospherics all right, but I never got any signals at all: it eliminated both atmospherics and signals. Probably at the time it might have been used so that it would have a certain effect in eliminating atmospherics and also signals, and the reason why it gave the results it did was perhaps that we knew very little about the proper tuning of circuits, and no instructions were issued. We had a box given us, and we were told it was an X-stopper. The result was, that when you thought you had X's, you put it on, and when you did not think you had them you took it off, and that may have accounted for the thing not working very well.

I should like to ask a question about getting atmospherics on buried aerials. It is a curious thing that when you have aerials laid a few feet deep in the ground and insulated, you do get atmospheric disturbances on these aerials. I have never had the opportunity of experimenting actually with grounded aerials, and I should like to ask Mr. Coursey whether he can tell us what the nature of the disturbances is which come on to these grounded aerials: whether they are actually "grinders" or "hisses" or "clicks," or whether everything of that type comes in on these particular aerials. Mr. Coursey mentioned the question of Weagant's devices for eliminating atmospherics. I think it was mentioned in one of the technical journals,*—"The Electrician," I believe—some time ago, when they published details of this X-stopper, that Weagant had discovered definitely that the X's come in a vertical plane, and not a horizontal plane. I should like to ask Mr. Coursey whether he has any information on that point. I think one great difficulty we are all up against in this question of discovering how to eliminate these X's or atmospherics, is the fact that year after year we seem to be getting far more sensitive receiving apparatus, which, of course, is really going the wrong way about the thing, it seems to me. The X's are all pretty well of known strength, and it seems to me that the simple and quite obvious thing to do is to increase the power of your transmitters and decrease the sensitiveness of your receivers. If you go about it that way you can have receivers extremely insensitive, and use transmitters much more powerful, relatively speaking, to what they are to-day, and you eliminate your X's right away or make them practically very small.

There is one other point, and that is the question of wavelength. It has often been said, in connection with atmospherics, that they are stronger on long waves than on short waves. I cannot say I have found that to be the case. I have found generally that the atmospheric disturbances always seem to be strongest on or about the natural wavelength of the aerial that your are actually using, *i.e.*, the natural wave of the aerial unloaded with a large amount of inductance. If you have a small aerial whose natural period is 300 metres, and you load that up to 600, then you will get atmospheric disturbances fairly strong. If you load it to 2,000 or 3,000 metres, the atmospheric disturbances seem to go right away. It may be that the loading up introduces resistance into the circuit, and that that reduces the strength.

Mr. K. Hele : With reference to the last speaker's remarks, I have noticed on my apparatus that the atmospherics come in varying strengths on different wavelengths. I have conformed to the Post Office Regulations, and have a fairly sensitive apparatus, and sometimes I find that at about 5,000 or 6,000 metres, the atmospherics will be louder than they are from 6,000 to 12,000 or 13,000 metres, and then from 15,000 to 17,000 metres they will be almost nothing. Of course, that is with a small apparatus; with a small aerial, 16,000 metres needs a large amount of inductance and capacity. I do not know if there is any information as to whether I am correct in making this statement, but it seems to be so with my apparatus.

Mr. F. Hope-Jones, M.I.E.E. : This very interesting lecture seems to have said very little on the subject of what atmospherics actually are and how they originate. That was all the topic years ago, and I remember well, when our Society was young, in the year 1913—it seems a long time, seven years ago—I think it was in the schools here at Westminster, we had a meeting, and Dr. Eccles was then Secretary of the Radio Committee of the British Association, and he pointed that out as one of the subjects which justified the existence of the Wireless Society, that it might perhaps help in investigating what strays really were. I remember sitting on a small committee and helping, with Dr. Fleming, Dr. Eccles and others, to prepare forms which were to be circulated among wireless experimenters and observers generally throughout the country, who were to use them to take a systematic note of all the "strays" which they heard, putting them into the three classes Mr. Coursey

* See *Wireless World*, Vol. VII, pp. 127, 209, and 271, for description of Weagant's X-stopper.

has mentioned, and noting their time precisely and degrees of loudness. It is rather interesting to see to-night the attitude that has come over us since then. The super-sensitiveness of receivers owing to valves in cascade has led us to concentrate upon the effect of the strays. All we are concerned with is eliminating them, and we have rather left out of consideration what they primarily are and how they are caused. Without doubt they are static charges, electrical storms, and I rather gather from a remark of our Chairman just now that perhaps his Committee may also avail themselves of our help, and I take it that his thoughts must have been running on the same lines—that a system of observation of strays will be of assistance to some other body than the British Association later on, in which case our Society with its organisation can undertake systematic observations if called upon to do so. Mr. Child's remark—that we are working the wrong way, and that we ought to increase the power of our transmitting stations and decrease the sensitiveness of our receiving instruments, seems rather suggestive that he wants us to rival Jove, and I do not agree with him in that. I do not think we can increase the power of our transmitting stations in order to beat thunderstorms or other sources of "strays." I think we know too little about strays and what their real origin is. However, I think we have had a most interesting lecture, and that Mr. Coursey is to be congratulated on having had the assistance of Mrs. Coursey as his demonstrator. I had something to say at the last meeting, or the meeting before, on the admission of ladies to our Society, and I said I thought we were justified in admitting ladies; but, after to-night, I do not think we require any further justification.

Mr. E. Blake, A.M.I.E.E. (*communicated*): I think the literature of wireless is considerably enriched by Mr. Coursey's paper, for the collection and classification of the various methods suggested or actually employed for the elimination of atmospherics badly needed doing. It is not until one is suddenly faced with some query with respect to X-stopping that one realises that all the available information is scattered amongst a hundred-and-one books and periodicals, and that a long and painful search is in store. The lecturer seems to have a peculiar genius for the kind of work he has put into his paper, and I am aware, also, that he has been at enormous pains in preparing the experiments and lantern slides.

In reviewing the whole subject, it would appear that, owing to the unfortunate fact that several kinds of atmospherics exist, no device has yet coped with the pests entirely. We eliminate the "grinders," but the "clicks" remain, ably reinforced by the "hisses." I have tried several arrangements which certainly removed the stings from the tails of the "grinders" and "hisses," but had no effect on the "clicks," which seem destined to remain, like the poor, with us always. There is a specially malignant type of atmospheric, generally encountered in the tropics in thundery weather, which does not tally with any of the commonly-described types. It arrives with a startling crash and lasts for about one-and-a-half seconds; then there is dead silence till the next one comes, and they are as regular as the ticking of a clock. This type has always ridden roughshod over every X-stopper I have tried on them. I mention this, because I have always felt, as a practical observer, that the nomenclature adopted by the British Association Committee by no means covers all the types of X sounds heard, and that there exist wide differences of opinion as to whether certain sounds should be called "grinders" or something else.

There is no doubt that, hand-in-hand with direct experiment, there should be carried on further researches into the nature and origin of atmospherics. The question is closely connected with atmospheric and terrestrial electricity, which, up to the present, has not been exhaustively studied. The problem involves a consideration of all possible contributory factors, such as barometric pressure, air movement, humidity, temperature, time of year, time of day, wavelength, direction from which the X's arrive, geographical position of station, and so on. From this it follows that it is highly desirable to standardise the whole process of observation, not only in respect to the apparatus, but also as regards the setting-down of the results.

Apparatus.

The aerials employed should all possess as nearly as possible the same fundamental wavelength, so as to ensure a uniform loading for the various wavelengths. It would be preferable for the standard aerial to conform closely to the most common ship type and size, so that full advantage may be taken of observations made on board ships.

As far as possible, too, the receiver for this work should be standardised. Even if this is not found to be practicable, it might at least be arranged that all observations shall be made with receivers of the same general type, because it seems to me that the results will be misleading if some observers use a crystal, others a common type of one-valve C.W. receiver, others a seven-valve amplifier designed for the reception of damped waves, and so forth. The need for standardising the receiver is most patent when one considers that many of the receivers now in use *already possess devices for eliminating atmospherics*. This alone would tend to give unreliable data.

Description.

The chief difficulty seems to lie in the description of the various kinds of sounds heard. The human element enters so largely into the matter that only a set of specially trained and agreed observers might be reasonably sure of uniformity of observation within the limits of their individual physical differences. World-wide observation by persons with no training other than the printed instructions of the British Association Committee, are bound to produce in the bulk doubtful results, for a "crackle" to one observer might honestly be described by another as a "grinder." Again, the strength of atmospherics as recorded admits of great divergence of judgment if measured by ear alone.

I do not know whether any attention has been paid to the factor of light strength, but it seems to me that this might well be done. Observations made with a "Bee Meter," or some other standard photographic instrument, might prove of use, especially in the case of sunrise and sunset effects.

I was much interested in Weagant's announcement that atmospherics are propagated vertically, although I believe that the truth of the statement has been denied by Tesla: probably the real fact is that some are and some are not.

Mr. Child's suggestion to reduce the sensitivity of the receiver and increase the power of the transmitter is logical but not practical. We need the sensitive receivers in order to cover the distances over which we wish to transmit, and we need also to reduce the power used. This might become a possibility if we could hit on an efficient eliminator of atmospherics.

I should not like it to be thought that I do not admire the enthusiasm of the British Association Committee and the skill and energy with which they set about collecting all the data they could in order to tackle the problem dealt with in this paper. I believe that they have put this data to very good uses already and learnt much from it. Yet, as one who has tried to take observations on the lines laid down by them, I feel that the method of description employed might be either improved or else expanded to cover the many other kinds of sounds heard in the telephones.

The Chairman: If no other member wishes to make any remarks, I will call on Mr. Coursey to reply to the discussion.

Mr. P. R. Coursey: I must thank all the speakers for their kind remarks relative to the paper. As I said, I could only just touch on the chief outlines, and for that reason I did not consider at all the question of the nature of atmospherics. Each one of the items considered, including that of the nature of atmospherics, could form the subject for a paper in itself, and in the short time available at one meeting it is impossible to deal with all and give full justice to them.

I am glad to hear that Sir Henry Jackson encourages the idea of co-operation, because I am sure that, with suitable co-operation, some practical work might be done by members of the Society.

With regard to Mr. Child's remarks relative to the Marconi X-stopper, I think that arrangement was before its time. When the Marconi X-stopper was brought out, plain spark gaps were used—in fact, plain aerials were not entirely abolished—and they were giving us wave trains in the aether which were almost of the same type as atmospherics. Therefore if your signal is the same electrically as the atmospheric you have no hope of trying to cut it out. Such an arrangement of successive tuning is undoubtedly an advantage with a C.W. signal as compared with a damped spark signal, and it is therefore practically entirely with C.W. signals that these arrangements are of value. It is a question of the relative decrement of the signal and of the atmospheric. As to atmospherics on buried aerials, it certainly is peculiar that we should get atmospherics at all on an aerial that is screened by being buried in the earth. Undoubtedly such burial does screen them from purely inductive and electrostatic effects. Any charged rain falling on a buried aerial could not give us atmospherics such as on an elevated wire, nor could the passage of a charged thunder cloud. The disturbance which occurs in the aether, due to a powerful lightning discharge, or whatever other disturbance it may be that is giving us the atmospherics that are heard, seem to be of such a powerful nature that they really upset the electrical condition of the whole earth, and probably also of the Heaviside layer. This agrees with Weagant's observation, that the atmospherics appear to be propagated vertically, for if we get a powerful lightning discharge in a cloud, there will be momentarily a violent electrical surge and an oscillatory current set up, both in the earth's surface and, in all probability (if not by direct conduction from the cloud, at least by induction), in the Heaviside layer as well, and that will give us the vertical propagation which he observed. The vertical propagation may not always be from the earth, it may be from the oscillatory currents in the Heaviside layer: in all probability it is from both, but in any case we have the vertical propagation, and it is largely on that point which the system depends. There is also the question whether they are really always propagated vertically, and I do not think that is the case. A paper was read recently before the Institute of Radio Engineers, in which G. W. Pickard disproved, by his observations, the question of vertical propagation. But I think it is all a question of the time and the place of observation. Things vary from day to day, and moment to moment: sometimes you get vertical propagation and sometimes horizontal.

On the whole, I think, in agreement with Mr. Hope-Jones, that I do not favour the idea of making our transmitters much more powerful. We have so much noise in the aether now, that if we increased our transmitter power, say, ten times, it would be perfectly awful. In fact, I cannot imagine anyone trying to work through it. It is true that weakening the sensitivity of the receiver would help matters, but it does not seem at all a very good thing to do. There is also this further consideration, that to radiate a largely increased power from the transmitter would necessitate the provision of much larger and higher aerial structures even than are used at present, while, if any considerable ranges were required, the receiving aerials would likewise have to be increased in size. This, however, would automatically increase the effect of the atmospherics, so that we should be no better off than at present, and have merely expended a great deal more money unnecessarily. It is perhaps something to be thankful for that the natural atmospherics have their existing strength. If they had been many thousand times as strong as any signal that we could produce by artificial means, it is very doubtful if wireless would ever have progressed to its present stage.

As to the question of wavelength and whether atmospherics are stronger on some wavelengths, I think the origin of that statement is largely a matter of the size of the aerial that is used in any given case. With small aerials, atmospherics are undoubtedly generally heard most strongly, using ordinary receivers, on fairly short wavelengths.

With high-power stations and a wavelength of thousands of metres for the aerial, it will get its atmospherics on the long wavelengths and not on the short ones. I think it is generally recognised that atmospherics are worse on long wavelengths and big aerials, than on small aerials and short wavelengths. It is undoubtedly a question of the size of the aerial. Mr. Hele also mentioned a similar point as to the wavelengths of atmospherics, and I agree with him that atmospherics are sometimes worse on particular wavelengths. I have at times heard atmospherics very strongly on about 150 metres, whereas, when the wavelength was increased to 600 metres, it was practically quiet. At longer wavelengths the atmospherics were again heard. This particular case was apparently due to a thunderstorm a few miles away which was not giving us atmospherics on some wavelengths at all, but they were exceedingly bad on the very short wavelengths. At other times, with different conditions in the atmosphere the wavelengths on which the atmospherics were found were different. It is probably a question partly of the cloud area that is involved relative to the earth. A lightning discharge would probably have an oscillatory period which would differ with the size of the cloud from which the discharge took place, just as the capacity of a condenser varies with the size of the opposed plates and with their distance apart (in this case the height of the cloud).

I think I have already referred to Mr. Hope-Jones' remarks with regard to the nature of atmospherics. There is a great deal more to be investigated, but I was only treating one side of the subject to-night, *i.e.*, the question of trying to eliminate some of their effects in receivers. This statement may also refer to some of Mr. Blake's remarks, in which I was much interested. The question of the vertical or horizontal propagation of X's which he also mentions has already been touched upon above. In particular localities, I believe, it has been found that X's come in generally most strongly from one particular direction only. The use of directional receivers may help in elucidating some of these problems, and there are indications that they have already made a start in this direction. A particular instance of this effect was mentioned recently by Captain H. J. Round* in connection with observations on the East Coast of England. The question of refraction over a coastline may also influence the results†, as has been noticed in some of the American receiving stations near the coast.

The correct classification of strays is undoubtedly a difficult one, and one on which it would seem desirable to adopt certain more definite conventions than are at present in use. Personally, I generally take the term "grinder" to include *all* the miscellaneous irregular forms of X that are not either pure clicks or hisses, and I should therefore place the variety mentioned by Mr. Blake in this class, although perhaps they also partake to some extent of the "click" nature. It might be worth while defining some sub-groups to the "grinder" class of X, so as to obtain a more definite classification.

The suggestion relative to the standardisation of receiving aerials for such experiments is undoubtedly a good one, but the gear itself can hardly be standardised, since most of the methods of X elimination involve different arrangements of receiving apparatus. As far as pure observations of X strength go, however, the receiver ought certainly to be specified in every case; but, after all, the true criterion in *every instance* should be the **ratio of the atmospheric strength to the strength of some standard signal,** as, say, from a given fixed transmitting station, as it would seem that only by some such method as this can truly comparative results be secured.

The Chairman: I may mention, with regard to the point raised by the lecturer and Mr. Hope-Jones in respect to co-operation and working together with experiments in the elimination of atmospherics, that it may be possible to give you a lead somewhat later on; but I welcome any joint action by this Society to get to the bottom of these difficulties. We shall never get rid of atmospherics, but we may be able to make them less troublesome. I call upon you to join with me in the usual manner to give a hearty vote of thanks to Mr. Coursey for his very interesting lecture.

The proposal was cordially responded to.

The Chairman: All the members whose names are before us for election have been elected, to the number of fifteen. It is proposed to hold the next meeting on Tuesday, June 29th, at the Royal Society of Arts, at 6 p.m., when Mr. G. G. Blake will give a lecture on Wireless Telephony, which he will demonstrate with apparatus of his own. I believe the lecture will be rather a short one, and I will therefore try to mention some experiments I have been carrying out with frame aerials in order to improve the sensitiveness. I will try to fill up the time in that way and to bring forward some matter to provoke discussion.

Marconi's Wireless Telegraph Company have given us a very kind invitation to visit their works at Chelmsford, and the date which is proposed at present is the day following our next meeting, *viz.*, Wednesday, June 30th. We propose to go by a train leaving Liverpool Street at 2.15 p.m. It is very kind of the Company to ask us, and we hope that about fifty members will take advantage of the offer.

Mr. H. G. Eades: Will you allow me to say a few words. I do not know what the future programme of our Society is, and I do not know whether I shall receive a certain amount of support from the members here to-night; but I do hope that in that programme you will think of those who are not so well up in wireless telegraphy as some others. I myself have been a member since the beginning, but I am not an electrical engineer, and a great many of the subjects that are dealt with are, I am bound to admit, a little bit beyond me. I am not finding fault with the lecturers, but you will realise they have gone a long way ahead of some of us during the war. I should like, if it is at all possible, that some of

*Paper on "Direction and Position Finding," *Journal of the Institution of Electrical Engineers*, 58, pp. 224-225 (1920).

† See "Refraction of Electric Waves," by T. L. Eckersley, *Radio Review*, 1, pp. 421-428, June, 1920.

the less abstruse problems might be put before us and especially, if it is possible, for some of our members who know more about the subject, to help us in the manufacture of our own apparatus. I have been playing with wireless telegraphy ever since the days of the coherer, and I try to help in my own little way by writing in such a paper as the *English Mechanic*. I shall always remember how much I was indebted to Mr. Shaw, in 1912, for the very excellent articles he published. They may appear puerile now, but at the time they were a boon to myself and no doubt to many others, and although I never saw any other person's apparatus, I was able from these articles to make my own and I do not think I did so badly. I am not trying to show you my powers of doing things, but I know there are many of us—because I have been in communication with a few of the members—who would appreciate sometimes a lecture on the making of instruments, and I hope that, in the programme which the Society is preparing for the future, they will manage to squeeze in one or two such lectures.

The Chairman : I quite agree and sympathise with you, because I have been very much in the same state myself, not being an engineer, and I rather like to make some of my own apparatus. There were some articles in *The Wireless World* a little while back showing how to make apparatus.

Mr. H. G. Eades : I was only witnessing this week a very excellent form, so it seemed to me, of resistance, which was made by passing cotton through water. It seemed to work very well indeed, and I do not think I should be doing wrong in saying that it was due to a member of your Committee. It seemed to work excellently, and I am sure some of the members would appreciate seeing how that was done. There is also the question of telephone transformers and inter-valve transformers. Personally, I am not over endowed with this world's wealth, and I like to make my own apparatus if I can.

The Chairman : I think we will do our best to meet your wishes. I imagine that will be the general opinion of the members present.

Mr. Hope-Jones : In that connection I would like to mention that we all feel the lack of our club-rooms, and it is one of the charms of regular and informal meetings at club rooms, that one is certain on every occasion to meet some of one's friends there and speak on the little details of manufacture. That was the great merit of the club rooms when we had them in the pre-war days, and I hope it will not be long before we have a happy announcement to make on that subject. In the meantime, I may say that our President, Mr. Campbell Swinton, has always felt that our lectures should be illustrated by apparatus. I am glad to think that our very next lecture, by Mr. Blake, on the subject of Telephony, will be to some extent constructional. The Committee welcome very much any such expression of opinion as we have had spontaneously to-night, and we will give very serious attention to it and try to work along the lines suggested.

The meeting then adjourned at 7.30 p.m.

WIRELESS CLUB REPORTS

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)

The usual weekly meetings were resumed from June 2nd, and many members attended, looking very fit and keen after their holidays. A portable 3-valve receiving set, constructed by a member, was very kindly lent for the evening, and the intricate and delicate interior formed a very suitable subject for discussion. A few members gave details of experiments carried out during the last fortnight, which, for the most part, consisted of reception "stunts," such as receiving European stations on various kinds of frame aerials, including the old familiar bedstead aerial. The most interesting result, however, was the reception of all the well-known stations without aerial or earth wire, using one valve with only 18 volts grid potential. This latter experiment is being very closely followed up, and the effect of an amplifier will be tried, among other circuits: it is expected that some useful work will be done in this respect. Two members mentioned having heard the "Daily Mail" telephony test with great clearness.

On Wednesday, June 9th, this Society met as usual, and engaged in general discussion and Morse practice. A portable receiving set was on view, having been lent by one of the members. It is anticipated that several other members will shortly be equipped with similar apparatus, and subject to the approval of the Postmaster-General it is intended that various experiments be carried out with a definite object in view. Plans were also made for the furnishing of the experimental room, which is being fitted entirely by the members, and will comprise a combined workshop, laboratory and lecture room. A committee meeting was held, at which the business of the Club was discussed. Two new candidates for membership were also recommended for election. It has been decided to increase the membership fees to an entrance fee of 5s. and annual subscription of 10s. 6d., and for Associate Membership an entrance fee of 5s. and an annual subscription of 5s., after the 51st member has been accepted. Present membership, 47.

An application has been made on behalf of the club for a receiving and transmitting licence, and, when this is obtained, extensive experiments will be carried out by the members of the Society, in a specially selected room and without the aid of aerials, the chief aim of the Society being to make wireless without wires (or "*wire less*") except for the actual instruments.

Among apparatus recently presented for use of members are a 10-inch induction coil, with Leyden jars, an arc lamp and a complete Marconi transmitting jigger; also a complete set of tools is being lent, along with other "tricks o' the trade."

The room selected for experiments is open to all members, day and night: by this method inspiration can be put to practical test almost immediately. Particularly are amateurs encouraged in this direction, as experience shows that a keen amateur, given facilities, can compete with some of the more experienced operators.

New members continue to enrol, and it is expected very shortly to establish branches of the Society in outlying districts, and also to form a junior section, in order to encourage the rising generation to take up this wonderful science. An extensive programme is being prepared and will shortly be promulgated. Intending members should communicate with the Hon. Secretary, Mr. J. H. Evans, 7, Clitheroe Road, Longsight, Manchester. Correspondence is also invited from other Societies and Clubs, at home and abroad.

Southport Wireless Experimental Society.

(Affiliated with the Wireless Society of London.)

The membership of this Society is steadily on the increase. A meeting took place at the Drill Hall, Manchester Road, on Tuesday, June 1st, at 8 o'clock, and after matters of general business had been attended to, the members adjourned to the building situated in Kensington Road, which has been adopted as the Society's headquarters. After considerable expenditure of energy on the part of the President and a few members, the room is assuming a very comfortable appearance, and although it is by no means everything to be desired it will serve the Society's requirements during the shortage of accommodation.

Arrangements are being made for the installation of roof wires for the purpose of obtaining buzzer practice, and the Society is happily situated in having as members three or four gentlemen who have served in His Majesty's Forces as wireless instructors. The Committee have now taken over the management of the Society's affairs, and we hope shortly to be in a position to issue our general rules. It has been decided to charge an entrance fee of 10s. 6d. in addition to the annual subscription of 5s.

Mr. T. Moor has been appointed to a position on the Committee to fill the vacancy caused by Mr. Wainwright's having taken up residence at Maghall. Arrangements are also in progress regarding the management of the Society's library, which will now be centralised at the room, and various contributions from members were duly received by Mr. Lomas, Hon. Librarian.—Hon. Secretary, Mr. P. H. Christian, 9, Russell Road, Southport.

North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

A meeting of this Club was held at Shaftesbury Hall, Bowes Park, N., on Wednesday, June 2nd, the President being in the chair. It had been arranged that the meeting should be of an informal character, to enable the members to make use of the Club's receiving set. Signals were successfully received on instruments belonging to the club and some of the members. Later Mr. Elam explained the working and construction of a very ingenious tuning coil with an arrangement of switches to obviate dead ends. Full particulars may be obtained from the Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.

Wireless and Experimental Association.

(Affiliated with the Wireless Society of London.)

At the weekly meeting on June 9th Mr. Saunders exhibited a very novel form of variometer receiving tuning inductance. Removing the meat from a cocoanut he had embedded two coils in paraffin wax, one in each half of the shell and had wound the moving coil on a croquet ball which could be rotated from the outside. The result was very striking, and it is quite efficient on both spark and C.W.

What Mr. Saunders, who is a real genius at extemporisation, would evolve if he had a transmitting licence, we hesitate to conjecture, and evidently the P.M.G. is loth to give him a chance of shining in that aspect of affairs.

The brothers Kloots again proved their worth. The senior evolved and proved an equation for honeycomb coils and the junior fetched in good signals with two pancake coils connected between the gas and the water pipes.—Hon. Sec., Mr. G. Sutton, 16, Melford Place, East Dulwich.

Liverpool Wireless Association.

(Affiliated with the Wireless Society of London.)

A meeting of the above Association was held at McGhies Café, 58, Whitechapel, Liverpool, on June 9th. As many members are now joining who have had no previous experience in wireless telegraphy, some considerable time was devoted to coaching and assisting the "raw recruits," and it is intended at each meeting to set apart a certain portion of time to dealing with the very elementary stages of wireless for the benefit of new members, in order to make the subject attractive and popular to both old and new members. New members are cordially invited, and should apply to Mr. S. Frith, Hon. Secretary, 6, Cambridge Road, Crosby, Liverpool.

Bristol and District Wireless Association.

(Affiliated with the Wireless Society of London.)

A meeting of the above Society was held at 6, West Mall, Clifton, on Friday, June 11th, at 8 p.m. A large number of new members were elected.

At the conclusion of the business portion of the meeting Mr. Wade demonstrated a portable 3-valve amplifier set, by which many stations were rendered audible to all in the room. Mr. Wade also showed many other pieces of wireless apparatus. At the close of the meeting a hearty vote of thanks was accorded Mr. Wade for the trouble he had taken.

The next meeting of the Association will be held on Friday, July 2nd, in the Physics Lecture Theatre, University of Bristol. Dr. Hodgeson, O.B.E., will lecture on "The Principles of Wireless Telephony."—Hon. Secretary, Mr. A. W. Fawcett, 11, Leigh Road, Bristol.

Stockport Wireless Society.

June 4th.—An inaugural meeting was held in the Foresters' Hall, Stockport, at which some twelve enthusiasts attended. The rules of the Society were drawn up and officers elected as follows:—Hon. Secretary, Mr. Z. E. Faure; Hon. Chairman, Mr. H. C. Woodhall; Hon. Treasurer, Mr. H. Hallworth. The future work of the Society was discussed at length. It was resolved to seek affiliation with the Wireless Society of London, and to apply for permit to use a valve set, this to be constructed as far as possible by members.

June 12th.—Our Hon. Secretary, Mr. Faure, having been called away for a further six weeks' service at sea, an Acting Secretary was appointed pending Mr. Faure's return. Circuits were discussed for the proposed receiving set, and the allocation of parts to various members for construction was effected. It was decided to inaugurate a library, and a librarian was duly appointed, in the person of Mr. H. M. Driver.

Mr. H. Woodyer introduced the subject of Honeycomb Coils, and produced several very interesting specimens of excellent workmanship. We look forward to a paper to be read at our next meeting on the construction of these coils, and their use as A.T.I., loose coupler and reactance units.

An interesting meeting concluded with half-an-hour's buzzer practice. A number of new members enrolled, and several more local wireless experimenters have promised to join.

Intending members are invited to write to the Acting Secretary, Mr. W. Hervey Banks, 110, Bramhall Lane, Stockport, or to visit the Society's rooms, Foresters' Hall, Stockport, any Friday evening at 7.45.

The Wireless Society of Glasgow.

We have much pleasure in announcing still another amateur Club, at Glasgow. Recently formed, the Society assembled its members at a general meeting to decide upon the title under which it should pursue its labours, and it was agreed upon to name it "The Wireless Society of Glasgow." Mr. W. Mitchell, of 237, North Street, Charing Cross, Glasgow, has been elected Hon. Secretary, and would be glad to hear from interested persons with a view to membership, or for further particulars.

Barrow and District Amateur Wireless Association.

We are pleased to note that this Club is now resuming its activities. Prior to the war considerable progress was made by this Society, but with the outbreak of the war this Club, like so many others, was called upon to dismantle its installation, only recently resuming its work as an association. Its headquarters are in Market Street, Barrow.

Wireless Club for Hull.

It is suggested to form an amateur wireless Club at Hull. Mr. C. W. Greene, a Hull amateur, has been the recipient of many letters from persons interested in wireless telegraphy, and though willing to give his assistance and advice in the matter, he is not in a position to promote such an institution. As the *Wireless World* has been very successful in assisting amateurs to form Clubs in many parts of the country we would be pleased to hear from interested readers.

The Chiswick, Acton and District Amateur Wireless Association.

We are pleased to acquaint our readers with still another amateur Club, which has recently been formed at Chiswick. Though the members are not many at present, there are sufficient, however, to justify a meeting each Wednesday evening, to which meetings all prospective members are invited.—Hon. Secretary, Mr. C. W. Hirst, 58, Agnes Road, Acton.

Wireless Society of East Anglia.

The first meeting of this Society took place on April 23rd, when the question of rules was discussed. It was decided to hold fortnightly meetings, and the following officers were voted, the Presidency being decided later:—Vice-President, the Very Rev. the Dean of Norwich; Chairman, Henry A. Flick, Esq.: Hon. Secretary, H. Willink, Esq. Owing to the last-named gentleman leaving England, Mr. Chas. Thayne has been subsequently elected Hon. Secretary in his stead. At the Club's second, third and fourth meetings discussions on wireless apparatus took place, and certain resolutions regarding publicity were passed.

At the last meeting, on June 4th, three new members were nominated, one of whom is a lady. At the meeting Captain Hampson gave an interesting address on certain types of Condensers and Valves.—Hon. Secretary, Mr. Charles Thayne, 29, St. Andrews Street, Norwich.

Nottingham and District Wireless Society.

Will all old members of the late Nottingham and District Wireless Society, also intending new members, please forward their present address to the Hon. Secretary, Mr. J. H. Gill, 18, Fourth Avenue, Sherwood Rise, Nottingham, in order that a meeting may be arranged.

Amateur Clubs.—It may interest our readers to know that there are in the United Kingdom thirty-one Clubs, formed for the purpose of studying and practising Wireless Telegraphy and Telephony. Of these Clubs, nineteen are affiliated with the Wireless Society of London. As far as we are able to gather from our records, the total number of Amateur Club members in the United Kingdom is, approximately, 1,000; but since the honorary secretaries of many Clubs have not apprised us of further membership, our figures must necessarily be short of the actual total. There are still wanted to form Wireless Clubs at Bournemouth, Spalding, Doncaster, Exeter, Grimsby, Aberdeen, Rugby, and Glasgow. Those interested should communicate with Mr. T. H. Dyke, Hill Garage, Bournemouth; Mr. W. G. A. Daniels, Pinchbeck Road, G.N.R. Crossing, Spalding; Mr. A. H. Wasley, Glenholme, Ravensworth Road, Doncaster; Mr. H. E. Alcock, 1, Prospect Villas, Heavitree, Exeter; Mr. C. Hewins, 42, St. Augustine Avenue, Grimsby; Mr. W. W. Inder, Crown Mansions, 41, Unions Street, Aberdeen; Mr. A. T. Cave, 3, Charlotte Street, Rugby; Mr. W. Mitchell, 237, North Street, Charing Cross, Glasgow.

WIRELESS SERVICES *on* AIRCRAFT ROUTES

When considering the provision of "Wireless" for Aircraft, it does not require much imagination to realise the immense importance of efficiency both in regard to the apparatus and to the organisation of its use.

Without efficient apparatus it is hopeless to attempt to organise a useful service, and efficient apparatus is useless where large numbers of machines are engaged on a crowded route unless well organised procedure is laid down and followed.

The organisation of procedure, etc., is constantly receiving the most careful attention from the Air Ministry, and the regulations are revised from time to time as necessity arises, so we need not discuss this side of the question.

It has already been fully demonstrated that efficient apparatus has been designed to give satisfactory Wireless Telephony communication to and from Aircraft in the air up to ranges exceeding 100 miles and we can now discuss how this apparatus can best be employed, how it can prove of most value to a pilot engaged in flying on a recognised air route.

As an example of what may be accomplished the following analysis of traffic handled by ground stations and aircraft is worthy of note :—

(a) The interchange of weather reports throughout the day ;
(b) Enquiries from machines *en route* as to weather conditions ahead ;
(c) The reporting to distant stations of the arrival and departure of machines ;
(d) The passing of weather reports by machines flying over the route ;
(e) SOS calls from machines to ground stations. (Forced landings, etc., and location of same) ;
(f) Messages between passing machines as to weather just experienced.

The above very clearly demonstrate a very essential point, viz :—The interdependency of air and ground stations. It is clear that no matter how many machines are equipped with Wireless, unless suitable ground stations are provided for their use, none of this traffic or practically none, can be handled, and the value of Wireless in Aircraft is considerably lessened.

A well equipped air route will then embody the necessary number of ground stations, the number being dependent on the length of the route and ranges obtainable to and from Aircraft.

The Aircraft routes of the future will either be :—(a) Long distance oversea, or (b) Short distance overland. On the former will be employed the big type of passenger-carrying machine or airship, while smaller two or three-seater machines, as well as the larger types, will be employed on the latter.

The two necessary wireless services required by all types of aircraft, either on short or long runs, are, firstly, efficient air-ground communication, and secondly directional wireless.

The latter enables a course to be steered in fog, above clouds and overseas, while the former allows information to be given to the machines in flight as to weather ahead, and having been guided to its destination by the direction finder, say, above a bank of low clouds or fog, landing instructions can be given. The pilot is thereby enabled to descend through the clouds with the certainty that a clear patch exists over the aerodrome, or alternatively, if unfit for landing, he can be directed to the nearest aerodrome where good landing conditions exist.

It will thus be seen that the two types of wireless communication naturally depend on one another, the one indicating the best weather course for flying, and the other steering the machine along the course indicated.

The main difference between overseas and overland routes is that in the case of the latter, where small two-seater machines are used, limitations of space make it impossible to carry the trained wireless operator, while weight, bulk and shape of the instruments have to be specially considered for individual types of machines.

Aircraft Stations.

There are, therefore, two distinct types of air station :—(1) For small machines which carry no operator. (2) For big machines on which an operator is carried.

It will at once be appreciated that where the wireless operator is carried, whose sole duty is to attend to messages and to keep his set working efficiently, more complicated and therefore more efficient apparatus can be supplied than in the case where the pilot has to work the wireless in addition to his numerous other duties of flying the machine, plotting his course, etc., etc., and whose apparatus has to be practically without adjustments.

In the latter case, some slight efficiency as to range and sensitivity has to be sacrificed to ease of working.

The Pilot's Set.

This consists of a simple two-way working wireless telephone on which are only two adjustments, a selecting and intensity adjustment and a change-over switch to enable him to send or receive. After the selecting adjustment has been once set it ceases to be any longer an adjustment, inasmuch as after once communication with another station is established no further movement is necessary. All the pilot then requires to do is move his switch to and fro as he desires to speak or listen, and to decrease or strengthen the incoming speech as the ground station is approached or left behind.

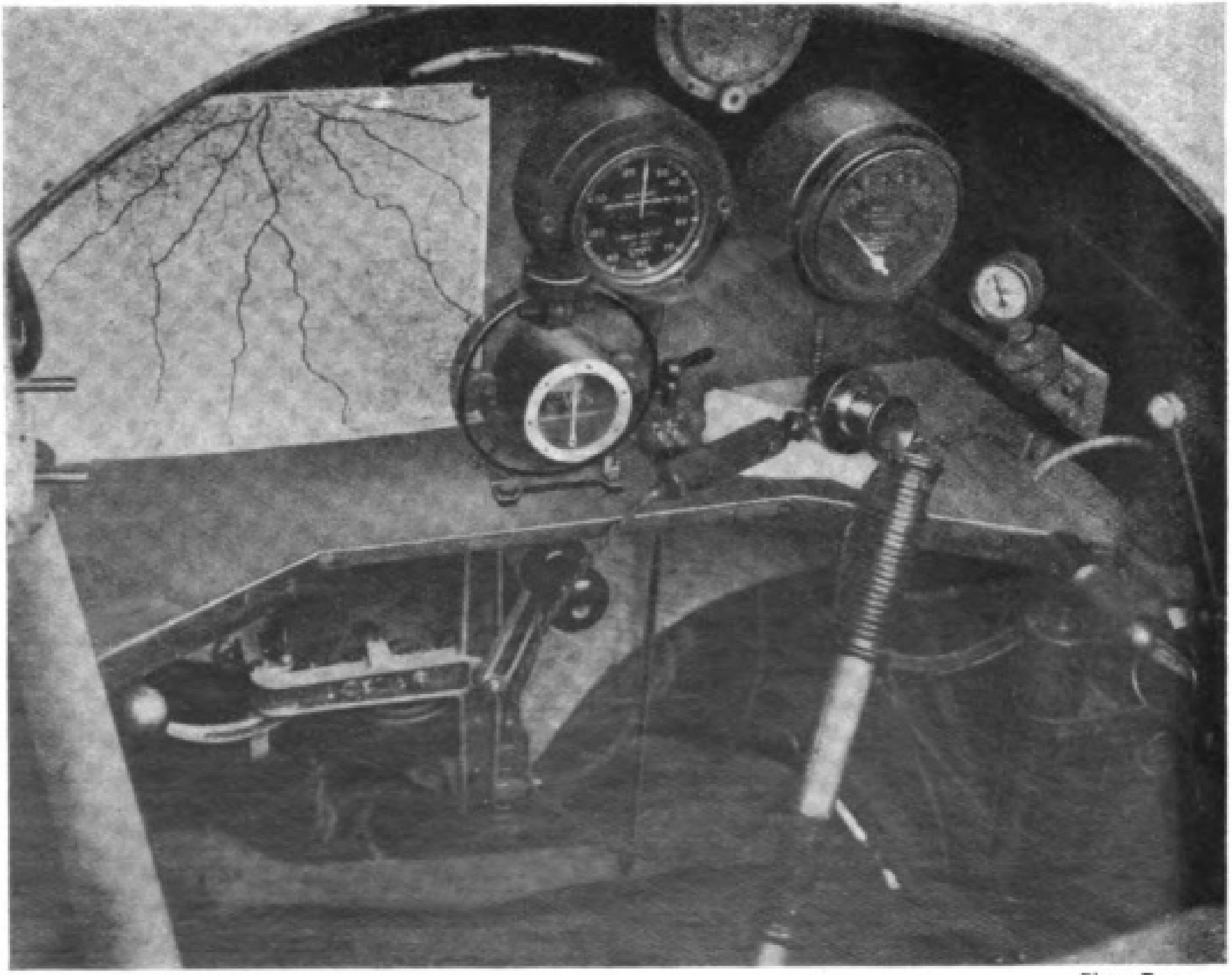


Photo Press

The cockpit of a D.H.6 aeroplane, showing wireless telephone transmitter and aerial winch.

These adjustments are placed in a small switch box, away from the main set, and called the "Remote Control," and can be installed in any convenient position, such as the instrument dash board, or wherever the pilot can best get at it, while the main set can be fixed in any part of the machine where there is room. The two parts are joined by a length of cable.

As it is manifestly impossible for direction finding to be carried out by means of wireless on a small machine owing to the pilot being already fully occupied, and to limitations of space for carrying apparatus, an alternative system is arranged; ground stations on routes on which this class of machine is employed being equipped with position finding apparatus in order to give smaller machines an opportunity of enjoying the manifold advantages of this valuable branch of wireless development. This system is used with the ordinary telephone set, all that is necessary being for the machine to transmit that he requires bearings to any of the ground stations, which in turn plot his position by means of the suitable apparatus and immediately give him his position and course to his destination.

A smaller machine can, therefore, to a slightly modified extent, enjoy all the advantages in regard to wireless that apply to the larger type.

The Operator's Set.

Consists of almost identically the same apparatus with the addition of means for sending Morse Signals by tonic train or continuous waves, the use of C.W. Morse transmission approximately doubling the range to the ground, and the tonic train enabling communication with ships to be carried on.

The full range of wavelengths for transmission and reception is provided in accordance with the Air Convention.

In addition to this, direction finding apparatus is installed, by means of which an operator, specially trained in this work, can independently obtain bearings on any known stations and give the pilot his exact position and course.

In this case the big Marconi Trans-Ocean Stations are always at his service, and are sufficiently powerful to reach him in any part of the globe.

Intercommunication.

An intercommunication telephone set is provided as an addition to the wireless telephone by means of which the pilot or navigator or any passenger on the machine can ring through to the operator and get into touch with the nearest ground station, and send or receive personally any message required. At present, however, the regulations do not permit of private messages being transmitted by passengers to the ground stations, but facilities are provided which may prove of great value in the developments of the future.

The Ground Station.

Since considerations of weight and bulk do not apply to the ground station, all wireless apparatus designed for this purpose combines maximum power allowable for transmission and highly sensitive receivers in order to obtain not only the greatest range possible to machines in the air, but also between ground stations.

Distance between ground stations is dependable on the range obtainable to and from the air if the machine is to maintain constant communication, and at first sight it appears a waste of power to have ground stations capable of transmitting over longer distances than the aeroplane, but cognisance must be taken of the fact that on the ground perfect conditions for reception are the rule, whereas, in the air, the operator has to receive very powerful speech or signals before he can hear them at all above the roar of the powerful unsilenced aeroplane engines.

In addition to this, a factor of safety is introduced by providing high-powered ground stations. If, for instance, a machine encounters a stiff gale, as is possible in countries where sudden unexpected changes of weather occur, it may be blown 50 or 100 miles off its course, within a very short space of time and become totally lost. It is at this moment that the higher powered station comes in.

Even if not fitted with the directional wireless apparatus, the pilot, provided the machine is still within the range of a single ground station transmitter, can turn his machine until he receives loudest signals, this indicating from the natural characteristics of the aircraft apparatus that he is heading in the direction from which the signals are emanating. A skilful and experienced operator can now roughly indicate a course depending on the ever-increasing strength of the signals as a ground station is approached.

Ground stations will also be used for the transmission of messages to one another and form a complete method of communication from one end of the aerial route to the other, thereby saving the laying down of telephone or telegraph.

If high-powered stations are used, messages can be passed along the chain with greater rapidity owing to the fact that intermediate links can be jumped, thus saving the time that would necessarily be required were each station in the chain to receive and retransmit the message.

Sites for Ground Stations.

Stations are erected as near as possible to aerodromes *en route*, such proximity adding to the efficiency and usefulness of the wireless system.

The site of the station must be carefully chosen in regard to the topographical conditions existing in the immediate vicinity so that the position finding station may work as accurately as possible, power and jamming be reduced to a minimum, and machines approaching or leaving the aerodrome exposed to no danger through high masts being erected on the line of flight.

Special cases may occur where direct meteorological reports are necessary owing to the continually changing weather conditions. Where this occurs it may not be possible to erect the station near an aerodrome, but individual consideration must be given to each case.

Standard Ground Stations

These are equipped with a continuous wave transmitter capable of transmitting either telephony, tonic train or pure C.W.

High tension for these sets is supplied either by a motor generator where electrical power is installed at the aerodrome, or by a petrol driven generator where electrical facilities do not exist.

A sensitive receiver is supplied with specially selective circuits which reduce interference caused by jamming to a minimum, and employing high-frequency magnification for the reception of very weak signals.

In addition, the up-to-date ground station will be equipped with facilities for connecting the land line telephone through to the wireless by means of which it will be possible for a machine to call up a number on any exchange and carry on an ordinary conversation *via* the nearest wireless ground station.

Position Finding.

Position finding is arranged for on the Marconi system, this directional aerial serving the dual purpose of position finding and the ordinary reception of signals.

The transmitting and receiving aerials are kept some short distance apart for obvious reasons, but the whole of the operations of transmitting, receiving and position finding are carried out in one building, called the Control Station, means being employed for actuating the transmitter remotely from this central position.

Accumulator charging is arranged for in a second building containing the power and transmission apparatus.

Masts.

The masts used are, as a rule, 70 feet high, but since range increases with the height of the masts, in special cases higher masts may be erected to meet individual requirements.

The foregoing remarks cover the installation of wireless apparatus on machines and at ground stations, and given reliable sets it is only necessary to supply an efficient maintenance and operating staff to ensure a wireless service which will be found invaluable in maintaining a reliable "all-weather" aerial service, which will do much to solving a large part of the difficulty besetting the aerial pilot.

PAGES FOR BEGINNERS

Under this heading we publish COMPLETE *instructional articles, forming a series specially designed and written for beginners in wireless work. Hardly any mathematics will be introduced, and we hope to present the fundamental facts of wireless in such a manner as will prove attractive to a much wider range of students than that for which this series is primarily intended.*

THE TRANSMISSION OF WIRELESS WAVES

IN the last article it was seen how a discharge through an oscillatory circuit would induce a current in a similar circuit placed a small distance away. The waves radiated by such a circuit have a very small amplitude, and consequently will not travel a great distance. If we wish to transmit wireless energy over the surface of the earth, it will be necessary to alter the conditions of the oscillatory circuit so that powerful waves of high amplitude are transmitted.

The essential apparatus for producing these waves may be summed up as follows :—

(1) A circuit in which an oscillatory current is produced.

(2) A method by which the frequency of the oscillations can be altered, and hence, the wavelength transmitted.

(3) The conductor, or aerial wire by which the energy is radiated.

In order to produce a continually oscillating current it is obviously necessary to have a means by which the condenser can be charged at suitable intervals, and allowed to discharge again.

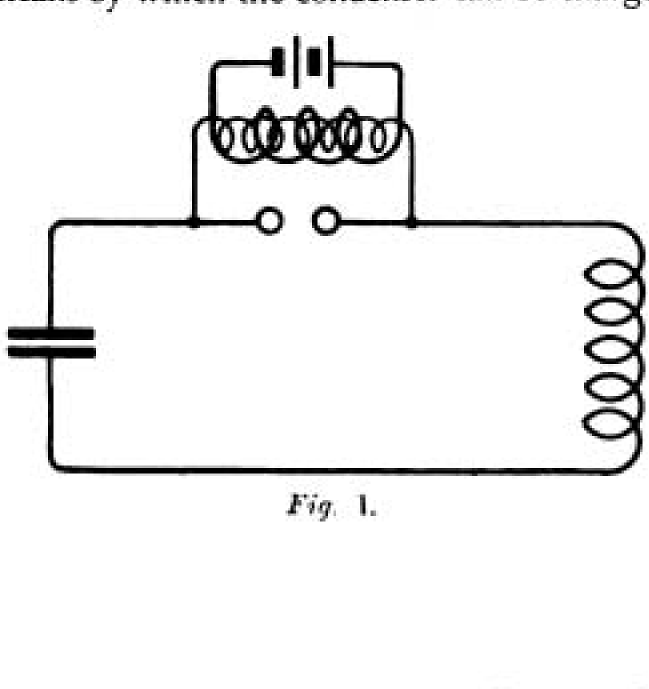


Fig. 1.

Examine the circuit indicated in Fig. 1. A condenser and inductance are connected in series with a spark gap. Across the gap is connected an induction coil, excited by a storage battery. If, now, the coil is set working, and the spark gap is sufficiently wide to prevent the secondary winding from sparking directly across, the condenser will be charged. A time will come when the strain on the dielectric is too much and the voltage across the terminals of condenser is sufficient to break down the insulation of the air gap. The condenser will then discharge through the inductance, and an oscillatory current will flow until the potential of the condenser is too low to cause a spark to pass. Another impulse is applied by the induction coil, the spark is re-established and the circuit oscillates again. The effect is to produce a continuously oscillating current.

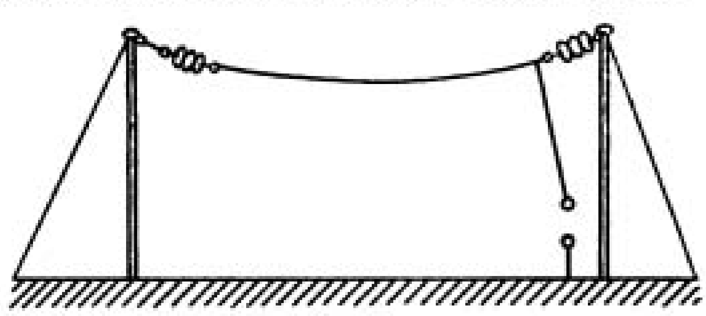


Fig. 2.

Suppose the condenser were replaced by a single wire, suspended by insulators above the surface of the earth as in Fig. 2.

It will easily be seen that it will act in exactly the same manner as a condenser, since we have the two plates represented by the wire and earth respectively, and the dielectric is formed by the air between them.

Further since a straight wire possesses a certain amount of inductance, this insulated wire will have all the properties necessary for an oscillatory circuit, and if excited, will oscillate at a frequency proportional to its inductance and capacity. Such a wire is called an *aerial* or *antenna*.

If an induction coil were connected so as to excite the aerial in a similar manner to the circuit in Fig. 1, an oscillatory current would flow in the aerial, and energy would be radiated from it to a distant station.

Now, the power of the oscillatory circuit depends primarily on the capacity of the condenser, and the potential to which it is charged. These factors must clearly have a limit. With very high voltages, the difficulties of insulation become very great, as the potential itself may be so high as to break down the air gap and cause a spark to flash over. Also, an aerial formed by a single wire has a very small capacity. If we endeavour to increase the capacity by increasing the number of wires composing the aerial, it would become unwieldy. Therefore it is not very practicable to generate the oscillatory current in the aerial direct, when high power is required to cover long distances.

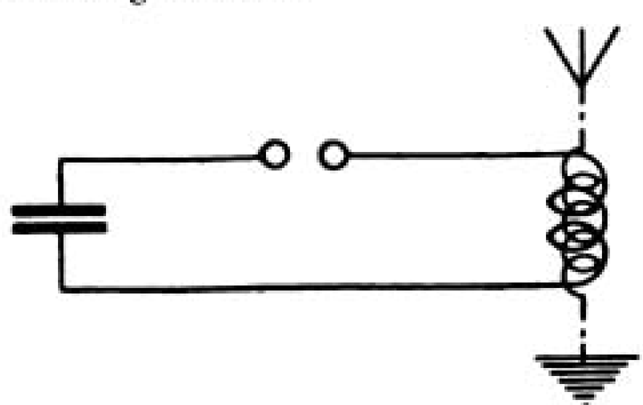


Fig. 3.

In the case of a closed oscillatory circuit, however, comparatively large capacities can be used, and the wavelength can be readily adjusted.

By a combination of the two circuits, therefore, the best results can be obtained. Such a circuit is shown in Fig. 3.

An oscillatory current generated in the closed circuit will cause a similar current to flow in the aerial circuit.

The reason for this is clearly seen, if the action of the induction coil is remembered. The current in the coil of the closed circuit, which we will call the primary, will induce a current in the secondary coil by the action of the magnetic lines of force.

There is one important condition which must be fulfilled, however, if we are to get the maximum power out of the oscillatory circuit. The capacity and inductance of both circuits must be such that they are *in tune*.

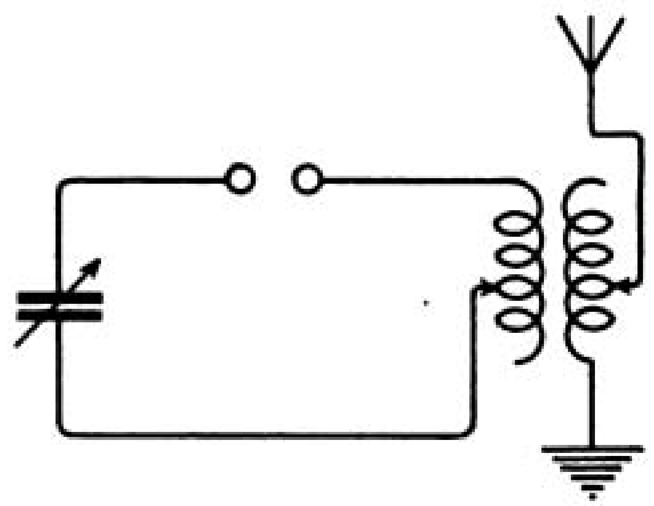


Fig. 4.

If the frequency of oscillation of the two circuits is not the same, the oscillations induced in the aerial circuit will interfere with each other, and only a small amount of energy will be radiated.

From the formula connecting frequency, capacity and inductance, it is seen that there are several methods of adjusting the circuits so that they are in tune. The capacity and inductance of the oscillatory circuit may be altered, or extra inductance or capacity may be inserted in the aerial circuit.

A conveniently variable circuit is shown in Fig. 4.

It would be as well to note here the formula expressing the wavelength radiated by an aerial.

The wavelength in *metres* is given by

$$\lambda = 1885 \sqrt{LC}$$

where *L* and *C* are in microfarads and microhenries respectively; the sub-division of the units will be found more convenient for practical work.

A form of variable inductance which is widely used is known as the "variometer." Imagine an inductance wound on two bobbins which are free to move with regard to one another.

Fig. 5.

With the two coils side by side as Fig. 5, there is no difference between them and a singly wound inductance. But if we were to reverse the position of one coil, at any instant the back e.m.f's in the turns would be in opposition, and hence neutralise each other. (Fig. 6.) The growth and stopping of the current would therefore not be impeded; in other words the inductance would be reduced to a minimum.

So, for any position of the coils between the positions in Figs. 5 and 6, there is a corresponding value of the total inductance.

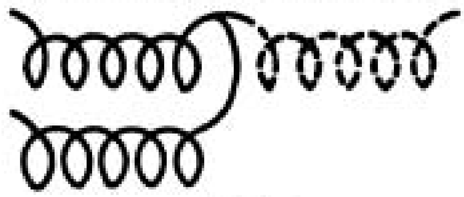


Fig. 6.

One of the coils may be so arranged as to slide in and out of the other, or it may be pivoted inside and rotated by means of a handle (Fig. 7.) The advantage of the variometer method of varying the inductance is easily seen. It is capable of very fine adjustment, and the circuit is never broken, as might possibly occur in the case of stud contacts.

A very wide range of variation may be obtained by combining a variometer and an

Fig. 7.

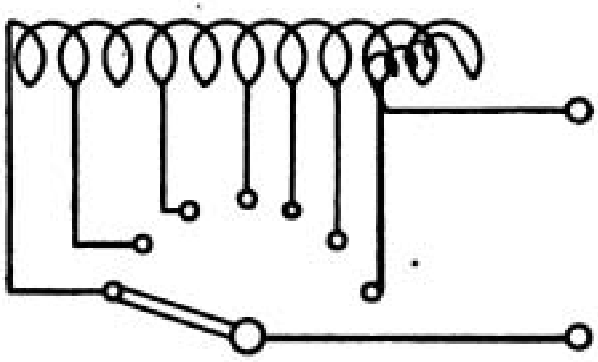


Fig. 8.

adjustable tapping inductance as in Fig. 8. The coarse adjustment may be made by moving the switch arm, and the variometer is then used to "tune" correctly.

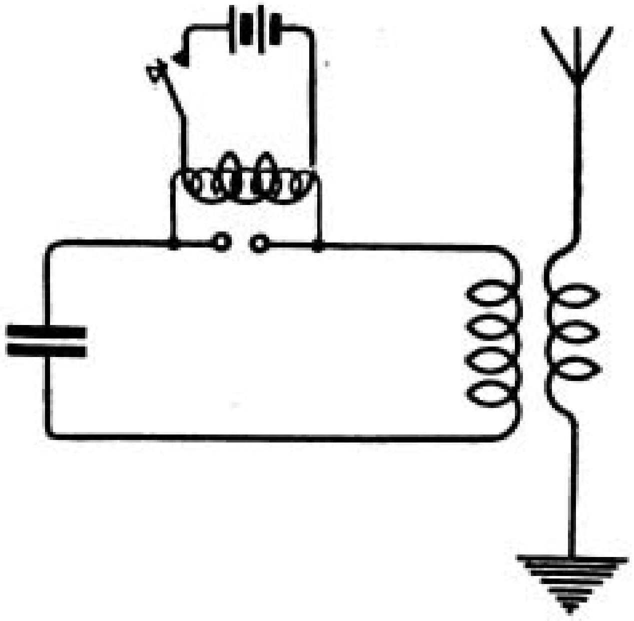


Fig. 9.

It now remains to see how signals may be transmitted by the arrangement of circuits considered.

In the primary circuit of the induction coil is connected a switch, or a tapping key (Fig. 9.)

If the key is depressed, the coil will charge the condenser, causing, on its discharge, an oscillatory current to flow in the closed circuit, and inducing a similar current in the aerial circuit; a succession of waves will then be radiated into space.

When we consider the frequency of these oscillations, say 10,000 per second, it is seen that a mere tap on the key will cause a number of trains of waves to be radiated, the number depending on the length of time the current is allowed to flow.

The CONSTRUCTION *of* AMATEUR WIRELESS APPARATUS

How to make a Direction Finder (Part I).

IN recent years direction finding by wireless telegraphy has been developed to such an extent that it is possible, with apparatus suitably designed, to determine with a very high degree of accuracy the position of a transmitting station. It is only natural that the interest of amateurs should be centred on this subject, and therefore, with some practical hints and data we shall describe a complete direction-finding station.

Direction-finding apparatus and its manipulation requires more careful study than ordinary receiver instruments. Owing to the necessary use of loops or small frame aerials signals are not so strong and therefore, in addition to an ordinary crystal receiver, some form of magnification will be required.

Aerial System.

Our aerial system will consist of two triangular loops. These aerials bisect each other at right angles.

It must be clearly understood at the outset that good results will not be obtained if the aerial system is placed in such a position that it is partially or totally screened by surrounding houses. Also, the receiving apparatus must be close to the foot of the mast, for reasons that will be understood later.

To proceed, the height of the apex of each loop aerial must be as high as possible from the ground and for general purposes we must assume that a light mast 35 feet high is procurable. This must be suitably guyed in four places, a pulley with a running halyard must be fixed to the top and an insulator made fast to the rope. This insulator will be the top point of the aerials and great care must be taken that the aerials do not touch each other at this point, neither must the wire be cut; the aerials go straight up and down again.

The base of the triangle for a 30-foot perpendicular should be between 20 and 25 feet; this will leave a height of about 5 feet from the ground to the horizontal base of the aerial. The aerials must also be insulated at the corners.

The aerials must be suspended and hang at exactly 90° to each other; the wires may then be cut in the centre of the base of the aerials and the four wires made fast to an insulator fixed to the mast. These four wires will eventually be connected directly to the direction finder.

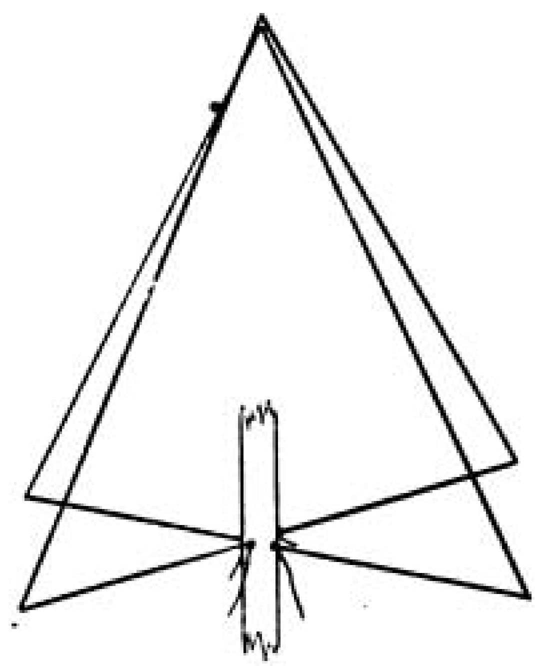


Fig. 1.

The arrangement of the aerial is shown in the sketch Fig. 1.

The Direction Finder.

This is a type of oscillation transformer with two primary windings and one secondary winding. The primary windings known as the "field" coils are wound at right angles to one another and the secondary, which is free to rotate, is mounted inside the primary windings. This winding is known as the "search coil." The two aerial loops are connected to the field coils, one loop to each coil. The oscillating currents in the aerials and field coils magnetically affect the search coil and by so adjusting the position of the search coil with respect to the two field coils it is possible to get either the maximum or minimum magnetic effect, from which it is possible to obtain the direction of the wave which produces the oscillating currents. The search coil has a pointer mounted on its spindle which indicates the position of the coil on an engraved scale. This scale is "set" with respect to the cardinal points of the compass.

The action of this unit should be fully understood by those taking up the subject of this article and the following will help to make it clear.

In Fig. 2 AB and CD are two loop aerials the field coils of which are similarly marked. If a wave advances from the direction X oscillating currents will be set up in the aerial AB but none will be set up in CD. To obtain the maximum induction in the search coil the plane of the coil must lie in the plane of the field coil. Thus if the pointer were fitted to the search coil in the plane of the coil, with maximum induction it would point to the direction from which the wave came. If the waves were travelling from the point Y oscillating currents would be set up in both aerials and the position of the

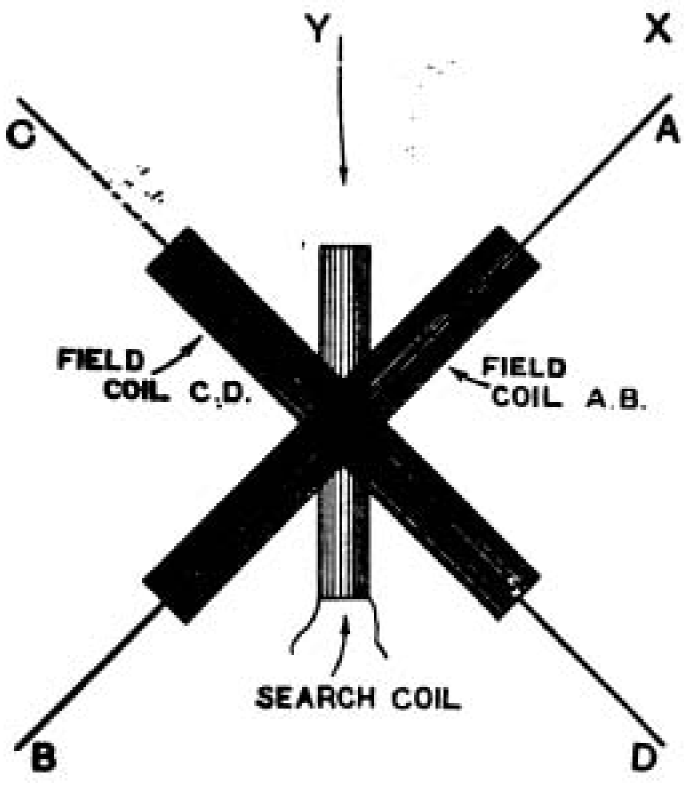


Fig. 2

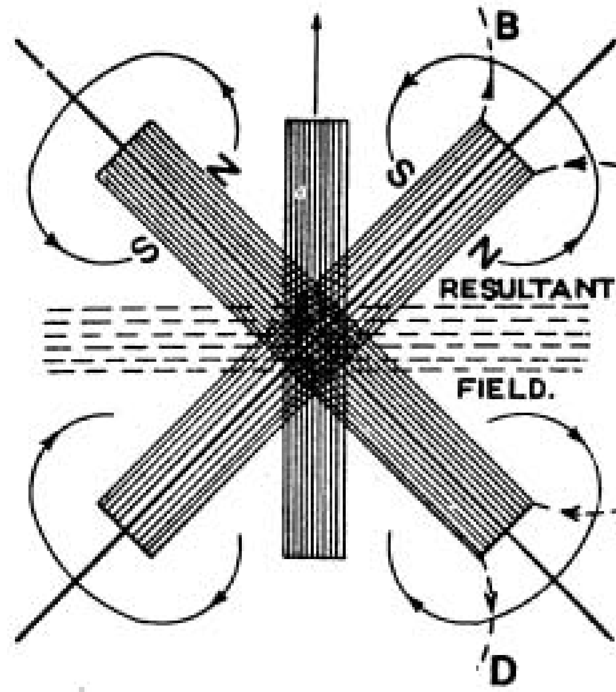


Fig. 3.

Position of search coil indicating maximum induction from Y.

search coil for maximum induction would be determined by the position of the resultant field caused by two magnetic fields acting at right angles. In Fig. 3 the position of Y is taken mid-way between the loops and the point of maximum induction in the search coil found to be mid-way between the two aerials on a line bisecting the angles AC and BD. If the diagram be redrawn with the direction of the current in one of the field coils reversed it will be found that the position of maximum induction in the search coil is 90° out—lying along the line bisecting the angles CB and AD. This would give bearings 90° out. It is a practical point which should be watched. In practice it is found difficult to determine which is the maximum point with strong signals, so that it is the usual practice to set the pointer on the search coil at right angles to the plane of the coil. By this means the pointer indicates the direction from which signals are coming when the *minimum* signal is obtained in the telephones. Modern D.F. sets employing valve amplifiers give strong signals and therefore the minimum signal method is necessary, but amateurs with much weaker signals will probably obtain as good results with the maximum signal methods. It is easy to change from one method to the other by providing that the pointer is only friction tight and not screwed to the spindle. If aerial AB is mounted with its plane North East by South West and aerial CD mounted North West by South East and the "nought" degrees of the scale pointing due North, the scale being engraved from 0 to 360 degrees in a clockwise direction, direct readings will be obtained giving the position of a station as being on a line a certain number of degrees say 20, East of North.

It will be apparent that the actual position of a station cannot be determined by a single D.F. station, but only its direction. In the next issue full details will be given of the windings of the D.F. and a crystal circuit and "note magnifier" for use with it.

(To be continued.)

ADVENTURES OF A THERMIONIC VALVE

By R. A. Travers.

A RADIO valve travelled for many miles through the Pacific Ocean and tossing over a coral reef, came to rest upon the glistening sands of Washington Island, a dot in the ocean having only eleven miles of coast. Washington Island is 1,000 miles south-west of Honolulu, and the nearest steamship lanes, those to Australia, are 500 miles to the westward. The only steamer in the adjacent waters is the little steamer "Kestrel," copra carrier for Fanning Island, Ltd., the owners of Washington Island. This vessel is not equipped with wireless.

Where the valve has come from is difficult to guess. A study of the currents about the island reveals little ; the Equatorial is not far but the Counter Equatorial current runs between and makes the matter rather confusing. From wreckage picked up on the island now and then, the drift seems to be from the eastward. A life-boat passed the island ; it was brought ashore and later was found to have been washed overboard off the coast of Mexico ; a direct line of 3,300 miles. Presuming the valve to have been guided by similar winds and current, it is possible it too has come from the Pacific Coast.

The valve was found on the beach by a native and suspended in his house as an ornament. Mr. R. A. Travers, operator in charge of Washington Island radio, saw the valve there and took possession.

The valve is a double grid and double plate

Where the valve was found.

type and also has two filaments. It measures 2" in diameter and 2½" from top to bottom. The tip is in the plate end. Plate and grid terminals are from one end and the filament from the other. Both filaments are broken but appear to have been burnt out in use and not broken by the sea. The copper terminals are badly corroded, indicating a long sojourn in the water. The illustration of the reef will give some idea of the hazardous end of the voyage.

BOOK REVIEWS

DESIGN AND CONSTRUCTION OF AUDION AMPLIFYING TRANSFORMERS: RADIO AND AUDIO FREQUENCY TYPE.

By EDWARD T. JONES, Assoc. M.I.R.E.

New York: The Experimenter Publishing Co., Inc., pp. 16, 25 c

IN this small booklet of sixteen pages (7½″ × 5″) written in a lucid, concise manner, constructional details are given of an audion amplifying transformer, both radio and audio frequency types, simple in design and easy to make. The radio type transformer consists of two primary and six secondary coils, each primary inserted between two secondary sections, clamped on to a circular wooden core 6½″ long by 2″ diameter. The total length of wire employed is 42,000 feet: 3,000 feet on each primary coil, and 6,000 feet on each secondary. The audio type of transformer is made up of a core of soft iron wires, measuring 3″ long by ½″ diameter, over which is wound the primary winding of 4,000 turns, and on top of this the secondary winding of 15,000 turns, the insulation being effected by layers of cloth between the primary and core and between the primary and secondary.

There are twelve diagrams in the booklet, including circuits of the connections of the transformer with one-step and two-step amplifiers.

THE DESIGN AND CONSTRUCTION OF AERO ENGINES.

By C. SYLVESTER, A.M.I.E.E.

London: Aeroplane and General Publishing Co., Ltd., 6s. net.

In his preface the author states that the method of presentation adopted in the text is largely based upon his experience as Technical Instructor to the Siddeley Deasey Motor Car Company.

He opens with a short survey of the various standard types of internal-combustion engines, and passes on at once to give an outline of such factors of the general theory of heat as are necessary to an elementary understanding of the energy changes that accompany the cycle of operations of any heat engine.

The rest of the book is devoted mainly to detail parts, and working processes, such as drop forging, hardening and plating, employed in the course of their manufacture.

The action of the magneto, the order of firing cylinders and timing of spark, and the theory of carburetting, together with some account of the qualities of various liquid fuels are amongst the features dealt with in some detail and in an elementary manner.

The last two chapters are devoted to methods employed in testing the strength of materials, and to running tests of the completed engine, the latter including some account of the Service methods used by the Aeronautical Inspection Department of the R.A.F.

The illustrations are of mediocre interest and quality.

The scope of the book as a whole can hardly be said to justify its somewhat ambitious title, though it contains much information that may be useful to those who wish to form an acquaintance with the internal-combustion engine as a preliminary to a more specialized study of the various modern types that have been evolved to meet the needs of aviation.

PRACTICAL AND EXPERIMENTAL WIRELESS TELEGRAPHY.

By W. J. SHAW (Member of the Wireless Society of London.)

London: E. & F. N. Spon, Ltd., New York: Spon & Chamberlain, pp. 102, 41 illustrations.

This book, though giving many details of aerials, condensers, etc., is somewhat out of date inasmuch as there is little contained therein relative to modern detectors. There is much in it, however, which is likely to interest those amateurs desirous of constructing their own apparatus.

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.**

CLAN CHATTAN (Bournemouth) *sends an abstract of an account in the "Scientific American" last year of experiments by Leroy on igniting inflammable substances by what is essentially a Hertzian resonator. He has made further experiments himself, and asks* (1) *If the danger zone is purely local.* (2) *If* C.W. *would have a greater or lesser effect than spark.* (3) *If bales, surrounded by metal hoops, should be stacked on the break joint principle, and all broken hoops removed.* (4) *He also asks if it is feasible in using loop aerials to tap them off at suitable points to a switchboard to get lengths suitable for receiving different wavelengths. And* (5) *which is the more directive—a loop in a vertical plane, or one in a horizontal plane.*

(1) In the vast majority of cases, purely local. The falling off of intensity with distance is extremely rapid. (2) Probably a stronger effect. (3) We hardly think this is necessary. All commercial stations use wavelengths of at least some hundreds of metres. The wavelength to which a broken hoop resonator would respond would be of the order of 1 to 10 metres, and being so far out of tune, there would be very little likelihood of large enough oscillations being built up to jump a gap. Any harmonics in the sending wave of about this length would be too weak to give effects at any distance. (4) The scheme suggested would be possible, but better results would be obtained more simply by using a single frame for all the desired wavelengths and tuning it by additional capacity or inductance as required. (5) A loop in a vertical plane.

H.I.H. (Birkenhead) *sends a diagram of a proposed receiver for criticism.*

The diagram sent is well drawn, and shows a type of crystal receiver which is somewhat complicated, but which contains little unusual except a throw-over switch, enabling the aerial tuning condenser to be put (*a*) in its usual position in series with the A.T.I., or (*b*) in parallel with the primary of the loose coupler. While this arrangement is interesting, we doubt if it is worth the complication involved, as in the (*b*) position it will have little effect in increasing the wavelength, the primary of the loose coupler being small, and it may cause weakening of the signals. For use with high resistance crystals, two pairs of 'phones should, if used, be connected in series and not in parallel, as shown. In other respects the design is satisfactory, and should give good results

A.F.H. (Bishop's Waltham) *sends a sketch of his detector circuit, and asks why touching certain terminals improves the signals, while touching certain others has no effect.*

This is a very common effect with crystal circuits, and may be due to a variety of causes. It may, in your case, be due to somewhat faulty insulation on the DEF side. We cannot say definitely without examining the set.

F.H.K. (Balham) *asks* (1) *for directions for making a grid condenser and leak, and* (2) *If in diagram on page 530 in the last volume, the grid condenser should have a leak.*

(1) The best size will depend on the type of valve, etc. Try about ten sheets of foil, 1 in. by 2-in., separated by two sheets of thin mica between each pair. The leak is easiest made by putting two terminals, about 3-in. apart, in a block of ebonite and rubbing lead from a pencil between the terminals until a satisfactory resistance is obtained.

(2) Yes, condenser C3 should have a leak.

G.C. (Newcastle-on-Tyne) *asks if it is possible to get good results with a pair of 1,000 ohm 'phones, using a zincite-bornite detector.*

Yes. The resistance of the 'phones should preferably be higher than this, but you will probably get quite satisfactory results.

H.H.B. (Fulham) *asks* (1) *If it should be possible to communicate a quarter of a mile with certain specified apparatus.* (2) *For a diagram of connections for a receiver consisting of double slide tuning coil, crystal, potentiometer, blocking condenser and 'phones.*

(1) Beyond the dimensions of the aerials, which are of average amateur type, very little useful information is given, except that transmission is by ¾-in. coil and reception by crystal. With any reasonably efficient arrangement of apparatus a greater distance should be possible with such a coil and a crystal. N.B.—No transmission by amateurs is allowed.

(2) *See* Fig. 1.

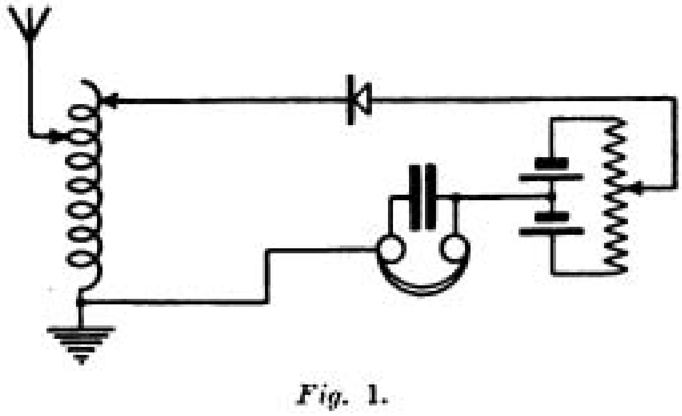


Fig. 1.

J.R.J. (West Kensington).—(1) Glace Bay (Canada), *GB*, 9,000 metres, Marconi musical spark; New Brunswick (N.J.), *NFF*, 13,600 metres, C.W.; (2) Both of these send ordinary commercial traffic. (3) Both, if you use a good valve circuit.

ENGINEER (Devon).—(1) and (2) You can be examined in any well-known system. (3) Such training would be difficult to obtain. You might enquire of some of the Wireless Schools advertised in our columns. (4) We strongly recommend the latest edition as the apparatus has undergone modifications since 1913.

J.N.R. (Co. Dublin).—(1) We think you will find that you will have to combine Marine Engineering with Electrical Engineering for the purpose of obtaining employment in the latter branch, or else qualify as a ship's electrician pure and simple. For details it would be quickest and most satisfactory for you to write to the shipping companies. (2) In many cases outside aerials as generally used are already dispensed with *for reception*, a loop or coil of wire being employed instead. The reason for this is not the one you suggest, but it is because the thermionic valve is so sensitive that the small quantity of energy intercepted by a loop aerial is sufficient to operate it efficiently.

F.J.S.W. (Bury).—(1) No. (2) No, the demand for certificated operators is steady. (3) No, certainly not.

C.J. (Liverpool).—Not at sea. As to land stations you would do well to approach the firms exploiting them; in respect to aircraft the same remark applies, but at present there are very few openings.

A.F.H. (Bishop's Waltham).—You do not give enough details about the station you hear at 4 p.m. for us to identify it. Surely it has call-letters. As for the station which works at 5 p.m., "too faint to read," and of which you ask "Could it be Cleethorpes?" we can only reply "It could." Why not go in for valves and abolish weak signals?

SPARKS (Kingston) *asks for the best way of connecting up a valve for receiving C.W.*

There are many possible ways, as you suggest. Consult the diagram on page 675, February issue, for a satisfactory one. With the valve you are using you should introduce a H.T. battery of about 75 volts in the plate circuit, between the T.T. primary and the reaction coil. The condenser shown across the transformer primary should then be connected across both this coil and the H.T. battery.

The reason for the four terminals at the base of the valve is that this type valve has three filaments, so that it is not necessary to scrap it when one is burnt out. You can use any one of the three filaments at will by picking out the appropriate pair of terminals to connect the battery to.

L.A.B. (North Finchley) *wishes to make a set for a large range of wavelengths, and asks* (1) *if about* 5,000 *ms. is about a suitable limit to work to on a small aerial.* (2) *Whether a loose coupler, of which he sends a dimensioned sketch, would be suitable.* (3) *For suggestions to improve this piece of apparatus.* (4) *If an amplifier, sketched, could be adapted for reception of* C.W.

(1) Yes, this is about the limit for effective reception.

(2) Yes, this and the whole circuit suggested are quite satisfactory.

(3) Only that you should put sliders or tappings along the coils, to facilitate tuning shorter wavelengths.

(4) The amplifier shown, being a L.F. note magnifier, could not be adapted for this purpose without complete re-design. We should recommend you to use this apparatus as it stands, and if you wish to receive C.W. to substitute a suitable valve circuit for the receiver and crystal detector shown, using the note magnifier after this valve to amplify the heterodyne beats.

J.B. (Dundee) *asks* (1) *Why* Hawkhead *shows the static leak of a multiple tuner as a resistance and not as an inductance, and* (2) *Why the North Pole does not attract the aether waves which are daily being sent through space.*

(1) A static leak could be either an inductance or a resistance. In the tuner, the leak, though not wound non-inductively, has a good deal of resistance and would probably work fairly effectively by virtue of its resistance alone.

(2) Why should it? Aether waves are not attracted by magnetic poles.

TALKING BOTTLE (Port Dinorwic) *asks for a diagram for adding a two-stage note magnifier to an existing single valve receiver, using only one* H.T. *and one* L.T. *battery.* (2) *If it is possible in such a circuit to couple back from the last plate circuit into the aerial circuit with advantage.* (3) *What is the inductance of a coil of No.* 28 D.C.C. *on a former* 12 *inches long by* 5½ *inches in diameter, and to what wavelength it would tune an aerial* 50 *feet long.* (4) *If there is any advantage in introducing a tuning condenser in the plate circuit of a one-valve grid tuned* C.W. *receiver.*

(1) *See* Fig. 2.

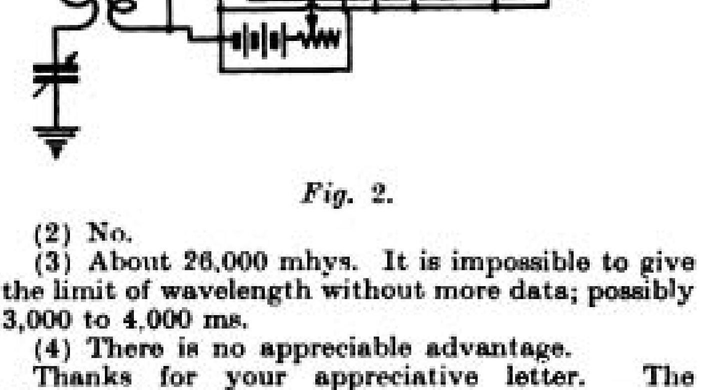


Fig. 2.

(2) No.

(3) About 26,000 mhys. It is impossible to give the limit of wavelength without more data; possibly 3,000 to 4,000 ms.

(4) There is no appreciable advantage.

Thanks for your appreciative letter. The *Wireless World* is now the experimenter's magazine.

LAMBDA (Bolton) *sends a diagram of a proposed receiver, and asks* (1) *What values to make the various inductances to get a maximum wavelength of 6,000 ms.* (2) *What capacity to give the plate condenser.* (3) *What wire to use.* (4) *If the plate coils and reaction coil should be variable.*

(1) A.T.I. – – – roughly 20,000 mhys.
Plate coil Y – – – 5,000 mhys.
Reactance coil X – about 500 mhys.
Adjust this until you get the best results.

(2) It might conveniently be about 0·003 mfds.

(3) Aerial tuning inductance might be wound with about No. 30. Remaining coils might be about No. 26. The exact sizes do not matter much.

(4) If you want to get down to low wavelengths it will be desirable to divide the plate coil into two or three sections. You may find it necessary to do this with the reaction coil also, to get local oscillations throughout the whole range.

Very little advantage is got by tuning the plate circuit as well as that of the grid in receivers of this type. Your high tension battery is shown shorted; we take it this is merely a slip of the pen.

F.W.E. (Heaton Moor) *wishes to make a variometer, winding his coils many layers deep on short bobbins. He asks* (1) *If this would be efficient, and to what wavelengths windings of a stated size would work.* (2) *He also sends a valve circuit of grid condenser type, and asks whether a 24-volt valve will give good results, or whether he should get one of 80-volt type. And* (3) *What should be the value of his condensers, and if one marked C2 is necessary.*

(1) Multiple layer coils of this type are exceedingly inefficient, and should never be used.

(2) A 24-volt valve will give quite satisfactory results.

(3) C1 should be about 0·0005 mfds, C2 about 0·0002 mfds. C2 is necessary, but not C3. C2 should be shunted by a high resistance leak.

A.F.S. (Southport) *sends a sketch of the aerial tuning coil switch of a receiver now on the market, and asks* (1) *for the reason for the rather complicated system of construction used.* (2) *How moving the handle from stud 3 to stud 4 can increase the wavelength.* (4) *Why the small studs could not be done without, and a tapping made from 4 to the coil.*

(1) and (3) The idea of this construction is evidently to diminish the action between the active coils with the handle on the earlier studs and the coils not in use in these positions. For instance, on stud 2, the second section of the inductance is shorted, and on stud 3 the third section is. The complete series of small studs may be fitted for effect, or possibly as a path for the smaller contact. The arrangement appears needlessly complicated and expensive. It may have been found imperative to get over certain troubles from stray ends of coils. Otherwise, it is difficult to see why the process was not carried further and more of the small studs used.

(2) Stud 4 appears to serve no useful purpose, unless there is a mistake in the connections. It gives the same connection as stud 3, except that the third section of the coil is no longer shorted. Many thanks for your kind remarks in respect to this magazine. A little appreciation goes a long way.

J.H. (Poole) *asks for the inductance of a wavemeter coil, wound on a square former of 17·5 cm. side, with 12 turns per cm. and 27 turns in all.*

293 ± 10 mhys.; *i.e.*, the result of the calculation is 293 mhys, but there is a possibility of error up to about 10 mhys either way, due to inaccuracy of the formulæ available, etc.

H.E.J.S. (Ealing) *asks why GNI and GNF come in so loud on his receiver that he is often unable to tune them out.* (2) *If it is correct for C.W. telegraphy and telephony on the same wavelength to interfere and cause beats, and* (3) *For a very simple circuit using a valve, 50 volt battery, billi condenser, and single slide tuning coil.*

(1) We know of no special reason for these stations giving trouble, except that their decrement may be rather high. Your receiver is probably not very selective; but if so, you should get similar trouble with other stations. (2) Certainly. (3) The circuit shown in Fig. 3 should be fairly satisfactory

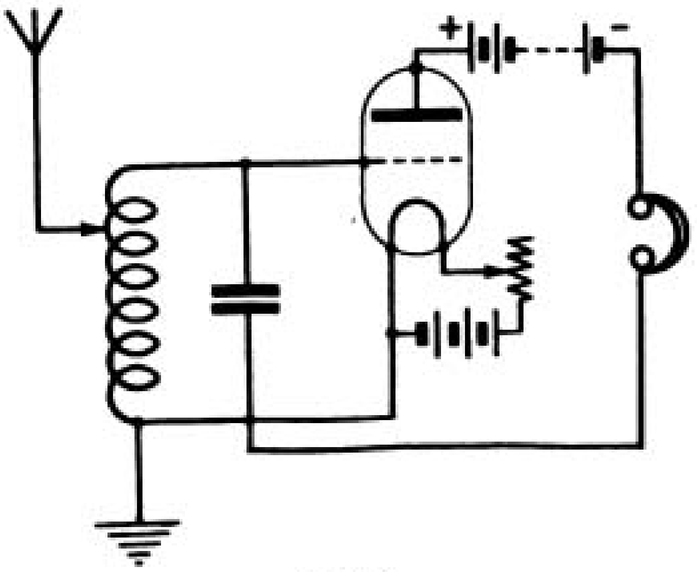


Fig. 3.

if the dimensions of your component parts are suitable. It will not receive C.W. without the addition of a reaction coil. For making the necessary alterations, if desired, consult the constructional articles in the last volume of the *Wireless World.*

N.H. (Newcastle-on-Tyne) *asks* (1) *How to calculate the capacity of any condenser.* (2) *How to calculate the inductance of any coil.* (3) *What wavelength he should get with certain circuits.* (4) *What is a good elementary book on valves.*

(1) and (2) There is no rule applicable to every case of either inductances or condensers. The type of formula used depends on the type of coil or condenser, and many of either of these cannot be calculated at all. You will find formulæ for certain cases given in this column recently. If you wish to go into the question more fully, get Nottage's book on "The Measurement of Inductance and Capacity," from the Wireless Press.

(3) As you only give the outside dimensions of your coils and condensers, and the wavelength depends on the size of wire used, number of turns, thickness of dielectric, etc., we cannot make even a rough estimate.

(4) Bangay's "The Oscillation Valve," from the Wireless Press.

QUESTIONS AND ANSWERS.

T.B. (Ashington) *wishes to make a loose coupler, with dimensions as follows :—*

Primary, former 6¾ in. long by 6¾ in. diam., wound with No. 20 ;

Secondary, former 6¾ in. long by 6 in. diam., wound with No. 28.

He asks (1) If this will be suitable, and (2) What wavelength it will tune to ?

You do not give any information about the other parts of your set, which makes it difficult to give you any exact information. If your aerial and closed circuit condenser are about normal in value you will find that you have far too little wire on the primary coil. The secondary will be all right, and might tune up to nearly 10,000 ms.

H.M. (Manchester) *sends a diagram of a multi-valve amplifier, which gives very poor signals, weaker than crystal. He asks (1) What is wrong. (2) How to eliminate induction from a neighbouring power station. (3) Why stations of less than 1,000 ms. do not come in. (4) For particulars of the inductance in the Polaris Mediwaver.*

(1) The amplifier is of a type which is quite sound, if well constructed and skilfully worked. Its bad action is probably due to the reaction capacity coupling being in the wrong sense. This may also explain your difficulty.

(2) We are afraid there is no certain cure for this trouble. You may get some improvement by altering the disposition of the apparatus, by shielding the receiver in a metal case, or even by using a balancing aerial, adjusted, if you can do it, to balance out the induction without balancing out signals entirely.

(3) We should have expected you to have some difficulty in tuning stations on *more* than 1,000 ms, from the dimensions you give of your closed circuit. Try connecting the condenser C3 to either the second or fourth valve instead of the third.

(4) You may perhaps be able to get the particulars from the makers.

F.A.S. (Gravesend) *asks (1) Whether a coil wound as in his sketch will be suitable for an inductance. (2) If so, what would be the inductance of such a coil of stated dimensions. (3) Whether an aerial, consisting of 17 turns of wire wound on a square former of 1 foot side, hung at the top of a 40-ft. mast, with a single lead in about 30 ft. long, would give good results. (This is described as a frame aerial.) (4) If the coil described in (1) is unsatisfactory, what is the best form for a portable coil.*

(1) This type of coil is quite unsuitable for a receiving inductance.

(2) The case being of no practical use, we do not know of a formula having been worked for the inductance of such a coil.

(3) We do not think this arrangement will give any better results than the simple lead-in alone. A frame aerial is a closed loop used instead of the ordinary wire, not an open loop attached by one end to an aerial of ordinary type.

(4) Portable coils can be wound in spirals on a flat plate, if the ordinary cylindrical type of former is not desired ; but the latter is easier and does not take very much more room unless the inductance required is very high.

ENTHUSIAST (Harlesden) *asks (1) Whether the openings for a wireless designer are as good as those for, say, a dynamo designer. (2) What is a good book on wireless design. (3) In a two-circuit valve receiver, what is the most efficient combination of capacity and inductance in both circuits. (4) In a telephone transformer, does the winding ratio depend on the number of valves. (5) How are the numbers of turns arrived at. (6) In heterodyne reception, how is the size of the reaction coil determined.*

(1) Probably about the same. There is not a great opening for either, as the number of men required for each is quite small.

(2) We do not know of any, as the practice has hardly been standardised enough yet for such books to be useful. Eccles' Handbook contains a good deal of useful information.

(3) The constants of the aerial circuit are deduced from the aerial constants and the wavelength range required. For the closed circuit with any potential operated detector, the capacity should be kept small, and the inductance chosen to tune with this to the maximum wavelength required.

(4) No.

(5) Generally empirically ; any great accuracy of calculation is not necessary.

(6) The size can be calculated, but in practice it can usually be arrived at very quickly from previous experience *plus* a little experiment. In view of the fact that you appear to have a rather limited knowledge of wireless design, we think you would do well to take up some other field, if possible, in which you have less leeway to make up.

A.E.B. (Surbiton) *asks (1) Where he can obtain No. 28 D.C.C. or resistance wire. (2) Whether a loose coupler arranged as follows would be efficient—primary, 50 turns of No. 18, on a former 9 inches in diameter ; secondary, 50 turns of No. 22. (3) What diameter should the secondary former be.*

(1) You will find various firms advertising such goods in the pages of the *Wireless World*.

(2) With suitable circuits and sufficient loading inductance, such a coupler might give good results. You do not say what range of wavelengths you wish to use. It is usual to wind considerably more wire on the coupler, and couple less tightly than you would have to. It is not necessary to use such heavy gauge wire.

(3) The former might be 8 inches in diameter, arranged to slide right inside the primary.

D.E.O.N. (Peckham) *asks if it is possible to calculate the wavelength of a circuit knowing the value of the fixed inductance, and of the variable capacity at its maximum point. Also if there is any formula taking into account the angles of the condenser pointer at other settings.*

The first part can be given fairly accurately, only neglecting stray effects, such as that due to the inductance of the leads.

The wavelength (in metres) $= 1885 \sqrt{L_{\text{mhys.}} C_{\text{mfds.}}}$ The variation with condenser setting depends, of course, on the construction of the condenser. For semicircular vanes, to a first approximation, the *capacity of the condenser* will be proportional to the angle of the pointer.

COMPANY REPORTS

THE
Marconi International Marine Communication Company, Limited.

REPORT of the DIRECTORS and STATEMENT OF ACCOUNTS for the Year ended 31st December, 1919.

The Directors submit herewith the Balance Sheet and Profit and Loss Account for the year ended 31st December, 1919.

The Company's business continues to show substantial expansion.

The gross revenue for the year amounted to £772,018 16s. 1d., which is an increase over the preceding year of £208,813 8s. 10d. This increase is in part due to an advance in ship subsidies in consequence of a large advance in salaries of telegraphists during the period, and is counterbalanced to a considerable extent by the increase in expenditure.

In consequence of unfavourable rates of exchange which obtained at the end of the year, considerable sums of money have been allowed to remain abroad on deposit or invested in Foreign Government securities. A sum approximating £50,000 has been debited to Profit and Loss Account, calculating the rate of exchange on the 31st December, as though the money had been brought home at that date, and the loss incurred. The loss, however, has not been actually incurred, and when in the course of time exchanges improve, as no doubt they will do, the sums written off will figure in a future balance sheet as a profit.

Notwithstanding this temporary depreciation and the writing off of some £20,000 representing depreciation in investments in Government securities the profit for the year shows an increase over the preceding year.

The Directors have pleasure in recommending the payment of a final dividend of 10 per cent. for the year 1919, which with the interim dividend of 5 per cent. paid in January last will make 15 per cent. for the year.

During the year under review 748 Debentures of a par value of £14,960 were redeemed.

The total number of Public Telegraph Stations owned and worked by the Company on the high seas increased from 2,549 at the end of December, 1918, to 2,842 at the end of December, 1919. The organisation of the Company, together with that of its Associated Companies, has continued to render inestimable service in the saving of life and property.

The Amalgamated Wireless (Australasia) Limited, in which this Company is interested, has paid a Dividend of 5 per cent. in respect of the year ending 30th June, 1919.

The Directors are pleased to record that of the 600,000 new shares offered to shareholders, at par, on the 10th May, 1919, 592,726 shares were subscribed.

Since the last Ordinary General Meeting, THE RIGHT HON. LORD HERSCHELL, G.C.V.O., has been appointed a Director of the Company. In accordance with Article 67, that gentleman retires and, being eligible, offers himself for re-election.

The Directors retiring by rotation are SENATORE GUGLIELMO MARCONI, MR. ALFONSO MARCONI and CAPTAIN H. RIALL SANKEY, who, being eligible, offer themselves for re-election.

The Auditors, MESSRS. COOPER BROTHERS & CO., also retire and offer themselves for re-appointment.

By order of the Board,
H. W. CORBY,
Secretary.

MARCONI HOUSE,
STRAND, LONDON, W.C.2.
2nd June, 1920.

The Marconi International Marine Communication Company, LIMITED.

BALANCE SHEET, 31st December, 1919.

Dr.

	£ s. d.	£ s. d.
To Capital—		
Authorised. 1,500,000 Shares of £1 each	1,500,000 0 0	
Issued. 1,192,726 Shares, fully paid ..		1,192,726 0 0
To 4,819 5½ per cent. First Mortgage Debentures of £20 each		96,380 0 0
To General Reserve Account ..		258,013 13 0
To Reserve for Obsolescence of Plant		50,000 0 0
To Creditor Balances		287,974 13 6
To Profit and Loss Account—		
Balance brought forward from 1918 Account	142,657 14 1	
Balance of Account for the year ending 31st December, 1919	198,141 5 2	340,798 19 3
		£2,225,893 5 9

Cr.

	£ s. d.
By Plant, Apparatus, Furniture and Stores..	672,236 0 2
Note.—It has not been possible to obtain certified Inventories for Apparatus and Stores amounting to £47,551 2s. 0d. The balance, £624,684 18s. 2d. has been certified by representatives of the Company.	
By Licence and Rights and Shares in Associated Companies	228,879 11 7
By Debtor Balances	556,529 12 9
By Cash at Bankers and in Hand	41,573 15 6
By Investments and Loans against Securities	726,674 5 9
	£2,225,893 5 9

GODFREY C. ISAACS, } *Directors.*
W. W. BRADFIELD, }

Dr. PROFIT AND LOSS ACCOUNT for the year ending 31st December, 1919. Cr.

	£ s. d.		£ s. d.
To Salaries and Directors' Remuneration ..	54,383 6 10	By Ships' Telegrams, Contracts, Rentals and Sundry Receipts	772,018 16 1
To General Charges Difference in Exchange and Depreciation of Investments	60,382 10 5	By Transfer and Other Fees	443 13 0
To Expenses of Ship Telegraph Stations, including loss of Plant and Apparatus and cost of training Operators	397,548 19 6		
To Depreciation of Plant and Apparatus ..	57,281 14 0		
To Debenture Interest	4,724 13 2		
To Balance carried to Balance Sheet ..	198,141 5 2		
	£772,462 9 1		£772,462 9 1

APPROPRIATION ACCOUNT.

	£ s. d.		£ s. d.
To Interim Dividend of 5 per cent. for the year ending 31st December, 1919, paid 15th January, 1920	59,636 6 0	By Profit and Loss Account, as per Balance Sheet..	340,798 19 3
To Proposed Final Dividend of 10 per cent. for the year ending 31st December, 1919	119,272 12 0		
To Balance carried to next Account, subject to Excess Profits Duty for 1916, 1917, 1918 and 1919	161,890 1 3		
	£340,798 19 3		£340,798 19 3

REPORT OF THE AUDITORS TO THE SHAREHOLDERS.

We have audited the above Balance Sheet with the books in London and accounts from Rome. We have obtained all the information and explanations we have required, and in our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us and as shewn by the Books of the Company.

COOPER BROTHERS & CO., *Chartered Accountants.* } *Auditors.*

London, 2nd *June*, 1920.

THE
Marconi International Marine Communication Company, Limited.

The REPORT of the TWENTIETH ORDINARY GENERAL MEETING.

The Twentieth Ordinary General Meeting of the Marco niInternational Marine Communication Company, Limited, was held at the Connaught Rooms, Great Queen Street, Kingsway, W.C.2, on Friday, the 18th day of June, 1920, *at* 12 *o'clock noon,* MR. GODFREY C. ISAACS *(Managing Director) presiding.*

The CHAIRMAN said: Ladies and Gentlemen, in view of the sad circumstances of which you are no doubt aware, under which Senatore Marconi has only just returned to this country, he naturally prefers that there being no official Chairman of this Company I should preside at this meeting to-day. I am sure that you will have the same satisfaction that my colleagues and I have in his being with us and in good health.

The Report and Balance Sheet for the past year are in your hands, and I propose, if you do not object, to adopt the usual course of taking them as read.

If you will be good enough to turn to the Balance Sheet I will deal with the figures in so far as they appear to me to require comment or explanation. On the debit side you will see that the authorised capital now stands at £1,500,000, and that of this amount 1,192,726 shares have been issued and paid up. The first mortgage debentures have been reduced by purchase during the year by some £14,000.

The general reserve account and reserve for obsolescence of plant are unchanged. I would remind you that it is our habit to write off every year a sufficient sum in the form of depreciation of plant, apparatus, furniture and stores, and the General Reserve of £258.000 being in excess of the license and rights and shares in Associated Companies, which figures on the other side of the account at £228,000, it is not deemed necessary to further add at present at all events to the reserve account.

The creditor balances happen to be higher by some £87,000, but this arises in the ordinary course of business.

On the credit side of the account the only figure perhaps that requires any explanation is that of debtor balances, amounting to £556,000, which is a very substantial increase over the figure of the preceding year. This is accounted for by the large sums which were due to us at the end of the year from the Ministry of Shipping, and have since been paid.

Turning to the profit and loss account, the salaries and directors' remunerations show an increase over the preceding year of some £14,000; this, in consequence, as regards salaries, of the higher rates of pay which obtain generally, and in some small part to the increase in directors' remuneration, which was voted at the last General Meeting.

The general charges, difference in exchange, and depreciation of investments, show an increase of some £49,000, which is accounted for mainly by difference in exchange and depreciation of investments at the end of the year.

As stated in the Report, we have not brought our money home from abroad, nor have we sold our investments. In due course, therefore, we may hope that these monies may return to us, if not in their entirety, at least in some part.

The expenses of ship telegraph stations shows an increase of some £130,000 over the preceding year. This is due almost entirely to the increase in pay and conditions of employment of the wireless operators. This figure, however, does not materially affect our accounts for approximately the sum representing the increase is counterbalanced by the higher subsidies received from the Shipping Companies, whose payments to us vary according to the rate of pay to the operators. I will have more to say to you upon this subject a little later.

Depreciation of plant and apparatus is increased in consequence of the additional wireless stations installed during the year.

Debenture interest is reduced in consequence of the redemption of debentures.

The balance carried forward is £198,000, which shows an increase of £12,000 over the preceding year, notwithstanding the substantial sums written off (let us hope only temporarily) in respect of both difference in exchange and depreciation of investments.

In the appropriation account £59,636 6s. is absorbed by the interim dividend, which was paid on the 15th January last. Subject to your approval, we propose to pay a final dividend of 10 per cent., which will require a further sum of £119,272 12s., and we shall carry forward, subject to excess profits duty, for the years 1916-17-18-19, the sum of £161,890 1s. 3d.

As you will have learned from the Report, our business has continued to increase during the past year, the number of ships installed at the end of December being 2,842, as compared to 2,549 at the end of 1918.

The past year has been a somewhat difficult one, in consequence of the dismantling of a great many ships, following the cessation of war and a large number of vessels changing hands and being dismantled for other reasons; but, on the whole, we have reason to be well satisfied with the balance, showing what we may regard as a very reasonable increase in the total number in view of all the circumstances.

We have during 1919 benefitted by the receipts obtained from ships' telegrams, but in consequence of the disturbed conditions which prevailed after the war and the limitation of travelling facilities, the revenue from this source had not reached normal conditions. Whilst dealing with this subject, I would like to refer to what I think is general misunderstanding on the part of the public in respect of the tariffs obtaining for telegrams addressed to ships at sea.

We are frequently told that our charges are far too high. The cost per word for sending a message from this country to a ship at sea is 10½d.; this, of course, includes the Post Office telegraph rate, the Post Office coast station and the ship station. Of this amount 6½d. per word belongs to the Post Office and 4d. per word to the ship station. Of this 4d., 2d. goes to the shipowners and 2d. to our Company. I think if it is appreciated that we receive 2d. per word of the 10½d. it will not be considered in any way an excessive remuneration for the work we do.

Last year I told you that we thought it was probable an additional source of revenue to the Company would arise from the use on board ships of what is known as the Direction Finder. This apparatus has been further improved, and is now becoming a really valuable device in assisting navigation, and will, we are confident, become a serious factor in the protection of life at sea. I am glad to say it has now been installed upon a number of ships, and we look forward to its being largely employed.

You will, of course, be anxious to hear something from me about the strike of Wireless Telegraphists.

It would, however, I think, be well for me to make quite clear to you in the first instance what is the Company's position as regards the wireless operator. We contract with the shipowner to put on board a wireless apparatus, to maintain it and to operate it. The shipowner pays us a given sum per annum, which represents the loan of our apparatus, its maintenance and operation, and a sum which is supposed to represent the average cost per annum of one or more operators, as the case may be. The operator, therefore, is in our employ and is paid by us, but we are in turn reimbursed by the shipowner. The shipowner is not responsible to us for any increased wage paid to the operator, unless we first agree with the shipowner in respect of such increase.

During the war we met the Association of Wireless Telegraphists, which was then an association of our own employees, and we sympathetically considered their request for changed conditions of pay. Eventually increases were accorded them which, including war bonuses, amounted to 142 per cent. upon pre-war rates for every man in his first year of service; in addition to these, other improved conditions were conceded. We were obliged, of course, to confer with shipowners before these terms could be accorded, and they were given finally with their consent and approval.

In September of last year the Association intimated to us that they proposed to put forward further demands. No intimation, however, of what they were was given to us until December, but this we could not officially recognise at the time, as we informed them, in consequence of the Association having entirely changed its attitude and scope, necessitating our withdrawing our recognition pending their reply to certain questions of the greatest importance which we had put to them in a letter. Several months passed before an answer to that letter was received. On the 21st April we received a deputation from the Seafarers' Joint Council, to which the Association of Wireless Telegraphists had just become affiliated. The deputation was comprised of men of experience and good sense, and we had no difficulty in at once agreeing with them to give recognition to the Association of Wireless Telegraphists under its new conditions, so long as the abuses to which we had previously called attention in our letter were not repeated. On the 17th May a deputation waited upon us, consisting of the Executive Committee of the Association of Wireless Telegraphists, and submitted to us the new terms which they desired us to consider. We pointed out to them that, having regard to the changed conditions of the Association, they having become a Trades Union, comprising all wireless telegraphists, and not only those in our employ, we did not think we were any longer qualified to deal with the matter ourselves and would probably find it necessary to hand the matter over to the Engineering and National Employers' Federation. We promised to consider the matter and give a definite decision as quickly as we could. The deputation present informed us that they thought it quite a proper course and one to which they could see no objection whatsoever.

On the 22nd May a further communication was received from the Association of Wireless Telegraphists, in which substantial additions were made to their demands.

I immediately took steps to confer with other interested parties to know whether they approved the course I proposed to adopt, and, as soon as I had their agreement, the matter was handed over to the Federation, and the Association of Wireless Telegraphists was informed accordingly.

We requested the Federation to convene a Conference of all concerned at the earliest possible date. It is public knowledge that ours is not the only wage question which is being raised at the present moment, and the Federation have their hands pretty full with other conferences which have precedence. They, however, agreed to allocate the first free day they had, namely, the 22nd June, and this we accepted, and notification was given to the Association of Wireless Telegraphists, with a request that they should advise whether that date would be convenient to them.

Immediately after receiving the notification of the date of the Conference a meeting was convened, and a strike decided upon.

It is an extraordinary fact that until we were officially advised that the strike had commenced we had no notification whatsoever from the Association of Wireless Telegraphists that they were about to call a strike. It is true that their letter of the 22nd May informed us that a genuine effort must be made on both sides to arrive at an agreement or they would not wait longer than the 15th June for the putting into operation of the scale of wages and allowances which they claimed. I think a genuine effort at least was made on our side by the convening of the conference for the earliest date which was available.

The demands which are now made would, if acceded to by the Company, represent an annual payment of approximately £500,000 sterling. One has but to look at the Company's published accounts to realise that, however well disposed one might be, it would be impossible for us to concede the demands made, without the approval and authority of the shipowners.

A matter of this vast importance can, of course, only be dealt with at a conference, in which everybody concerned takes part. I think we may reasonably assume that, if this conference takes place, what is fair and equitable will be conceded by all; but so long as the men are on strike, committing breaches of agreements with us and threatening to hold up the whole of the mercantile shipping of the country, no conference is possible. In fact, there would be no operators members of the Association in our employ, for each of them would have committed a breach of his agreement and that agreement would be at an end; there would, therefore, be nobody with whom to confer. If this state of things arose, our whole system would be changed, and, instead of giving permanent employment and remuneration with regular increments, seniority acquired by length of service, sick pay, leave pay, superannuation benefits, and prospects of advancement, to other branches of the Company's service, we should have recourse to casual employment beginning and ending with each voyage at a fixed rate of pay and without any of the advantages accruing under the present system of continuous service. It is to be hoped, however, that wiser counsels will prevail.

I am pleased to be able to inform you that the Right Hon. Lord Herschell, G.C.V.O., accepted an invitation to join the Board of the Company in October last. It now only remains for me to move the Resolution :—

> "That the Report of the Directors submitted, together with the annexed statement of the Company's Accounts at 31st December, 1919, duly audited, be received, approved and adopted."

Captain H. RIALL SANKEY, C.B., R.E.: Ladies and Gentlemen—I have much pleasure in seconding the Resolution.

The Resolution was then put and carried unanimously.