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# The WIRELESS WORLD

## THE WEAGANT X-STOPPER

## TIME AND WIRELESS

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# Wireless in the Canary Islands

By A. Anselmi.

EARLY in 1917 it befell my lot to visit another beautiful country and so add to many and varied experiences on the Iberian Peninsula. I was to proceed to Teneriffe, one of the seven Canary Islands, to fit a Spanish gunboat with a 3-kw. Marconi installation. At the time of receiving my marching orders travel in this part of the world was very uncertain owing to the ruthless warfare waged by the pirate Huns against all neutral shipping. So, after many enquiries, resulting in as many vague replies, as to the actual sailings of vessels for the Canary Islands, I started on my journey from Madrid about the middle of April. The first part of it took me through some of the most picturesque and interesting parts of southern Spain. We traversed the extensive plains of Andalucia, where large herds of bulls can be seen grazing. The old towns of Cordoba and Seville, jewels of the ancient Mauresque Spain, we passed on our way to Cadiz. It had been my hope to reach this port in time to take passage on a large transatlantic boat which was due to sail for South America, calling on her way at Teneriffe. Although I arrived in Cadiz some six hours before the actual sailing of the ship, the shipping agents informed me that no more passages could be booked, owing to the consular formalities made necessary by the submarine menace. This shattered my prospects of a comfortable trip and forced me to voyage on a small 1,000-ton mail boat two days later. This was by no means a happy experience for me, as rough seas were running at the time, and, to crown it all, it took nearly four days to effect the crossing, thus adding much to the general discomfort.

Never did anyone have a more uneventful trip! During the whole voyage we did not sight a single ship, although everyone on board expected at any moment the appearance of a periscope. Some nervousness was displayed by the lady passengers. No cheering wireless spark broke the monotony on board, owing to restrictions on wireless transmission. I will now draw the curtain over those dreary four days of sea voy-

Photo: Exclusive News Agency.

*A view of Teneriffe and its famous Peak.*

aging and relate the wonderful scenes which greeted my eye on the morning of the 17th April as the boat made its entry into Teneriffe harbour.

The island of Teneriffe boasts as being one of the world's most charming spots and well deserves the name of Fortuna Insula, given her by the ancients. Her capital, Santa Cruz (de Teneriffe) possesses a very secure harbour and lies at the north-east side of the island. It has a population of approximately 40,000 inhabitants, mostly Spanish. The oriental aspect of the town, with its low flat-roofed and white-washed houses, is very pleasing to the eye. This wonderful picture cheers the heart of a traveller coming from the foggy north. In spite of the largest hotels being closed on account of the war, many smaller ones afford very fair accommodation for a not too fastidious traveller. The abundance of food surprised me. My friends on the mainland had informed me prior to my departure of the desperate food conditions in the Canary Islands, and consequently it was an agreeable surprise to find this fear baseless. This abundance was evidently not enjoyed by the poorer classes, for the prosperities of the island in general were greatly reduced by the absence of pre-war shipping on which the labouring classes depended for a living. In the far-off days of peace as many as twelve liners a day could visit Teneriffe, each boat helping to swell the coffers of the petty tradesmen.

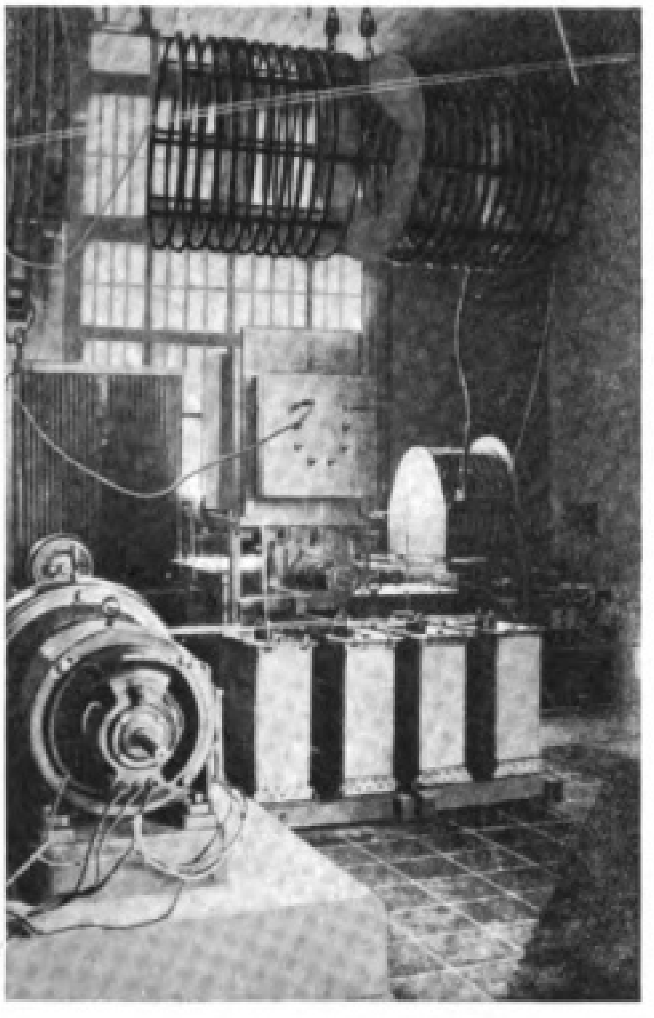
An important factor in the town's busy commercial life is its large wireless station, of which I will speak later.

During my stay in the island I had many opportunities for visiting this station, and later I was called on to run it for some time during the unfortunate illness of its chief.

There in the harbour I found the

gunboat "Toya," the last of her class not fitted with a wireless installation. This boat, of some 800 tons displacement, had been built in Cartagena's extensive Naval Yards, and had since been entrusted with the difficult task of patrolling the seas round a certain group of the Canary Islands. The low draught which the boat possesses makes voyages on her very uncomfortable, a fact with which I soon became acquainted. The wireless gear had preceded me, and, after some pains in finding suitable labour for the work I proceeded with the erection of the wireless cabin. The extreme slowness with which work proceeds there is at times very exasperating. This by no means surprised me. Anyone who works in southern climes knows of the easy-going nature of the workmen. Their frequent rolling of cigarettes makes one wonder how any work is ever accomplished.

Religious and secular feasts provide workmen with many holidays and interferes still more with work. These holidays seem especially abundant in this district, and taxed our patience to the utmost limit. On one of these days I witnessed a sight unique in its magnificence. It was "Corpus Christi" day, and my friends urged me to take the opportunity to witness the wonderful carpets of flowers lining the principal streets of the town of La Laguna, a few miles from Teneriffe. It was a very hot day, and, while the tramcar wended its way wearily up the hill in the direction of La Laguna, I wondered if all my trouble was worth the while.



*Transmitting Gear, Teneriffe Station.*

On arriving at the top of the hill the sight well rewarded me for my exertions. There in front of me, streets after streets were covered with carpets of wonderfully clever designs, and all of them made with millions of petals from many different natural flowers. Shows of this nature sort well with the easy-going, artistic temperament of the people. Work now proceeded normally on board the gunboat, and the wireless installation was nearing completion. The aerial, composed of six wire "sausages" of the T pattern, was erected, and things looked very hopeful when one fine day the island was visited by a most unwelcome guest! Influenza made its appearance and very soon the hospital at Santa Cruz overflowed with patients. On board the gunboat the first attacked were the stokers and machinists, and very soon of a crew of 90 only 10 officers and men remained on board.

Fortunately the wonderful climate prevailing there helped greatly to reduce

*Inside view of lattice mast.*

the effects of the epidemic, so that soon the abandoned ship had once more its entire crew on board.

The work was at length finished, and, after some preliminary tests, I awaited the date of the official trials. These were to take place at a minimum distance of 40 kms. from a land station. Far from enjoying the prospects of the voyage to the point "P" (as we called the spot from which trials were to be carried out) I rather dreaded it, and would like to impress on my readers the fact that wireless trials on any kind of warship are not exactly pleasure trips, there being much worry, to say nothing of probable sea sickness. The station on board the gunboat, "Toya," of the usual Marconi 3-kw. type, looked very neat indeed in the roomy white-painted cabin. The transmitting part consisted of a 3-kw. converter, having a shaft extension and Marconi disc discharger, giving a nice musical note of 600-spark frequency. This machine, together with the transformer, primary reactance and choke coil, was located under the large transmitting table inside the silence cabin. On top were the condensers of the hot-plate type, the wave change switch, the oscillation transformer, while on the left-hand corner the emergency coil with its spark gap stood ready to carry on should the ship's dynamo fail for any reason to supply the main set with current. The receiving table, at right angles to the transmitting table, was fitted with two crystal receivers, one for short and the other for long wave reception. Switchboards, starting resistance, aerial tuning box, aerial ammeter, etc., occupied the

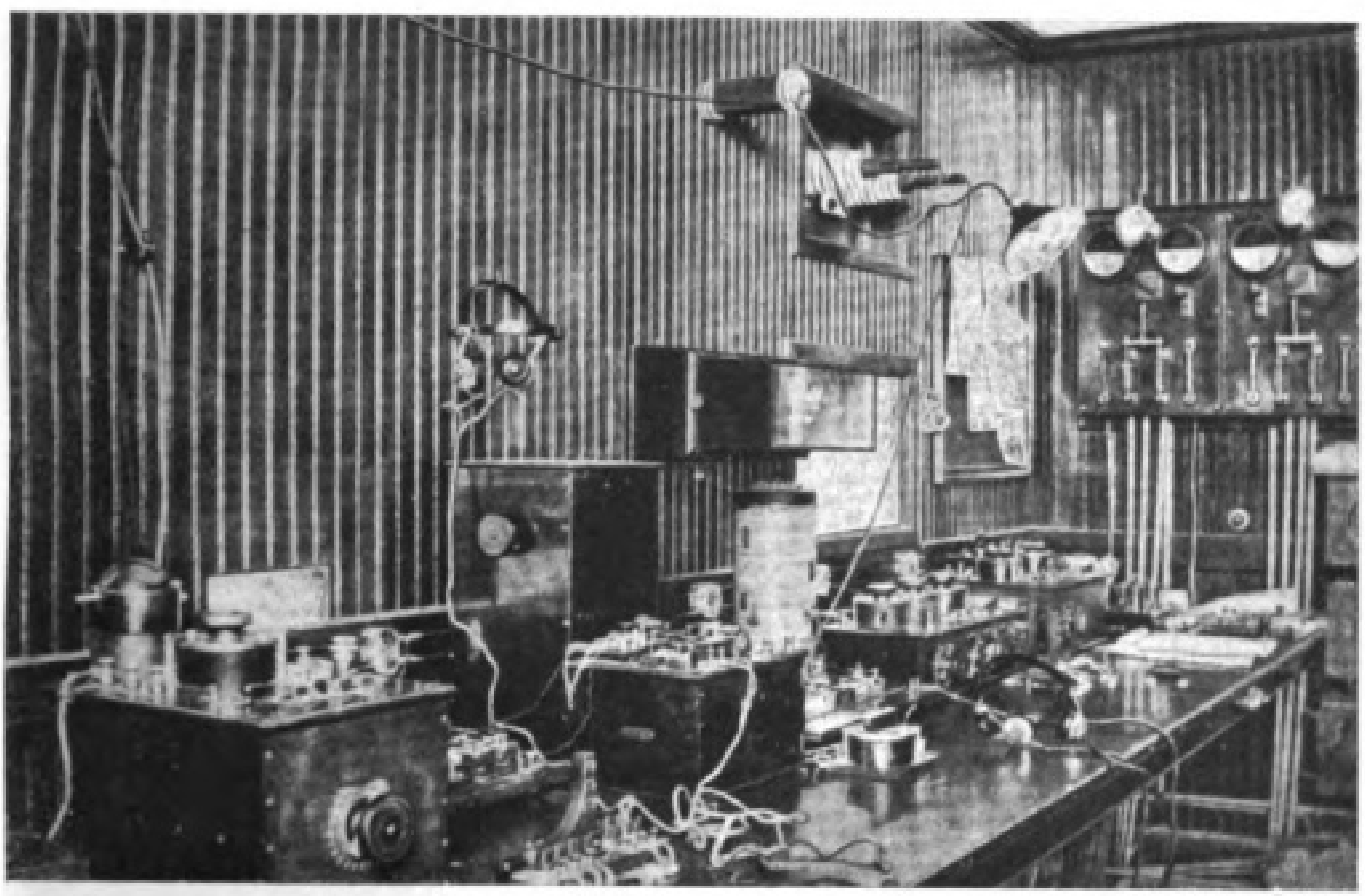
*The author beneath the aerial leads.*

four walls of the cabin. Many cares assail the wireless engineer on the eve of the official trials and not until these are satisfactorily ended, thus proving once more the efficiency of this system of communication, is the mind really at rest.

The Teneriffe wireless station, conspicuous by its four lattice towers, stands some little distance from the centre of the town. The towers placed some 300 feet distant from each other support an inverted L aerial by means of a triatic. The aerial is about 450 feet in length and is composed of 12 wires in parallel. Two other smaller antennæ run parallel to it, and are used for reception and transmission with the 3-kw. ship set. The main aerial of 12 wires is brought to a lead-in insulator fixed in the middle of a glass pane on the south side of the transmitting room. On the opposite side of the receiving table are the switchboards controlling the motor generator and disc of blower motors in the transmitting room. The power for driving the machinery is supplied from a 110 accumulator battery of some 700 ampere hours' capacity. This battery is charged by means of a dynamo directly coupled to a Gardner oil engine of 60-h.p.

The building possesses a very large transmitting room containing the Marconi 20-kw. and 3-kw. sets. The former set has remainders of a disused French wireless station, namely, a bank of 160 Moscicki tubes, placed in a pit some five feet deep. The duplicate synchronous disc discharger with its respective blower transformer, low frequency inductance, transmitting jigger, motor generator, and aerial tuning inductance suspended on the roof, completes this set.

On the left-hand side of this room stands a 3-kw. Marconi set used for communicating with ships and the surrounding islands.



*The receiving room at the Teneriffe Station.*

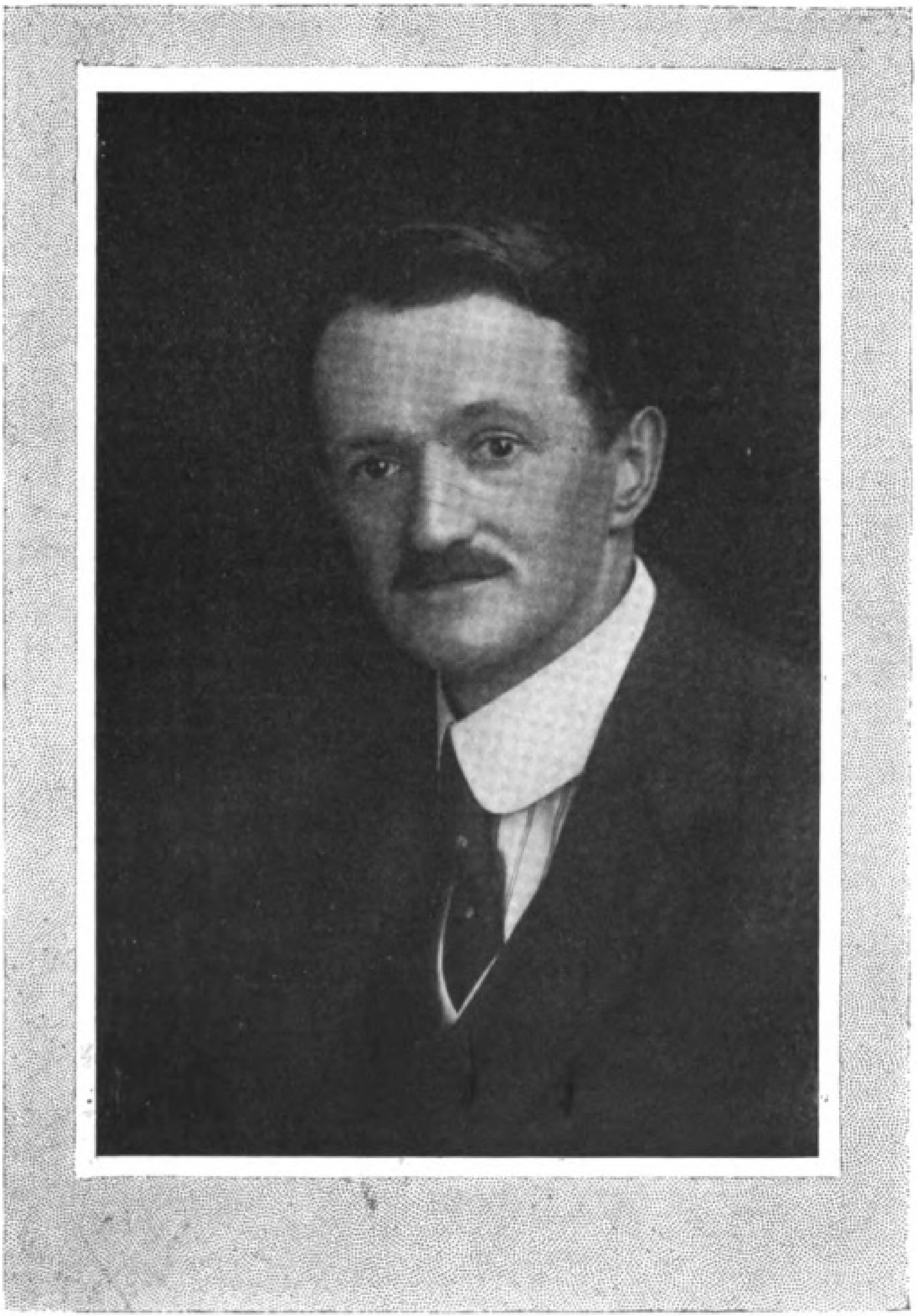


Photo: Elliott & Fry.

MR. HENRY W. ALLEN

# Personalities in the Wireless World

MR. HENRY W. ALLEN, F.C.I.S., was born in London on July 31st, 1870. Educated at Wilton and at Pitman's School, London, he spent four years at Tunbridge Wells, and then, in 1891, commenced commercial life in the Metropolis. In 1892 he entered the service of Mr. H. Jameson Davis, a cousin of Senatore (then Mr.) Marconi, and four years later made the acquaintance of the illustrious inventor himself, who came to England in 1896.

The following year saw Mr. Allen assisting in the formation of the Wireless Telegraph and Signal Co., Ltd. (the forerunner of what is now the world-wide Marconi organisation), and on its incorporation in 1897 he became its Secretary. The April of 1900 marks his appointment as Secretary of the newly-formed Marconi International Marine Communication Co., Ltd., and as Assistant Manager of Marconi's Wireless Telegraph Co., Ltd., of which latter firm he became Deputy Manager in 1910. In 1911, and again in 1913, Mr. Allen visited the United States and Canada in connection with the affairs of these two Marconi Companies, and after a lapse of four years was in 1917 elected to a seat on the Board of each. He was appointed Joint General Manager with Mr. W. W. Bradfield, C.B.E., of the same Companies in April, 1919, a position which he holds now.

Throughout his long connection with the Companies to which we have just referred Mr. Allen has consistently held in mind the welfare of the staffs which he was called upon to control, and as one example of this we may mention that he was personally responsible for the introduction and organisation of the beneficent Pension Scheme which is enjoyed by the employees of the Marconi Companies.

In addition to the positions which Mr. Allen occupies in respect to the management of the great wireless telegraph enterprises of this country, he is a director of the Relay Automatic Telephone Co., Ltd., and of the Sterling Telephone and Electric Co., Ltd., and other firms. He was elected a Fellow of the Chartered Institute of Secretaries in 1902, and a Member of the Council of that body in 1916.

# The Weagant "X-Stopper."

ONE of the greatest troubles in the operation of wireless receivers of all types is the disturbance arising from the reception of atmospheric strays or X's. It may be said that, in general, the disturbing effects of X's have come more prominently into notice with the development of more sensitive receivers. To take two extremes of the problem the interference due to these atmospheric impulses even in the old coherer days—bad though it then was—was almost as nothing compared with the terrific disturbances often experienced in modern long-distance receiving stations.

It is a fairly well-established fact that in most localities the intensity and number of strays received increases with the wavelength to which the receiving instruments are tuned. This applies to the majority of strays experienced in normal working, but under certain circumstances—particularly when local thunderstorms are prevalent, as in tropical regions—the reverse conditions are sometimes experienced.

The modern tendency to use longer wavelengths with the growth of the power of the stations, and of their effective range, has therefore brought in its train increased troubles from this cause—troubles which the introduction of amplifiers has not lessened, but rather aggravated.

A great many ideas and inventions have already been put forward for eliminating or, at least, reducing the effects of this troublesome hindrance to communication. A certain measure of success has been obtained in many cases, but the results are, nevertheless, very far from perfect. The essential idea of most of them is that of some form of balancing arrangement that will not seriously interfere with the strength of the received signal, but will yet enable the atmospheric to be more or less cut out.

In general it was found that, at the best, these schemes only served to reduce the atmospheric strength and not actually to cut it out—that is to say, they served somewhat to increase the ratio of strength of signal to strength of atmospheric.

The reasons for this may be seen in the following: Consider the circuit shown in Fig. 1 which represents the diagrammatic arrangement of one of the best methods, known as the Balanced Aerial method.

The arrangement consists essentially of two separate aerial systems $A_1$ $A_2$, joined up to a common earth E, though the usual tuning coils $L_1$ $L_3$ and $L_2$ $L_4$ of two complete receiving sets. A common detector circuit $L_5$ $L_6$ $C_1$ is coupled to both aerial circuits as indicated. It is provided with a single detector D and telephones T in the usual manner.

To employ this circuit to reduce interference from X's, one of the aerial circuits, say $A_1$ $L_1$ $L_3$ E, is tuned accurately to the desired signal, which can then be heard in the phones T. The other aerial $A_2$ is then tuned up in a similar manner, when if coils $L_5 L_6$ in the detector circuit are connected up in

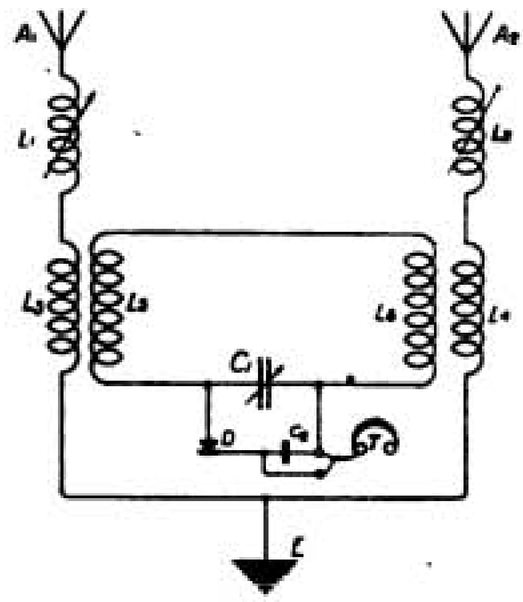


*Fig. 1.*

opposition, no signal should be received. By detuning one of the aerial circuits from its normal adjustment, the signal currents received in the two aerials are no longer equal and therefore no longer neutralise one another. Since, however, the X impulses have no particular wavelength, they still affect both aerials approximately equally, with the result that the effects of the atmospheric impulses should still cancel out in the detector circuit. A certain measure of success is obtainable but perfect results cannot be secured. The majority of X's consist merely of an electrical impulse which has the effect of an electrical blow upon the receiving aerial and so sets up oscillations therein. The process is analogous to the shock excitation of a transmitting aerial by means of a quenched spark gap. The oscillations set up in the aerial circuit by an X impulse are therefore *free* oscillations possessing the frequency of the *aerial circuit itself* and not of the outside source. The damping of the oscillations, too, is dependent solely upon the natural decrement of the aerial and its attached circuits. Hence the oscillations induced in each of the aerial circuits (Fig. 1) by the X impulse will be of different frequency and decrement since the two circuits are purposely detuned. It is, therefore, obviously not possible perfectly to balance out two opposing E.M.F.'s of different frequency.

It is important to note that two opposing E.M.F.'s. can neutralise each other *only when they have the same frequency, the same wave form, and opposite phase.*

In the case of damped oscillations, in addition to the above requirements, the damping of the two E.M.F.'s must also be identical. Similar remarks apply to the method in which two tuned circuits are branched off the same receiving aerial instead of employing two separate aerial systems.

Somewhat better results are possible by means of an audio-frequency balance (Fig. 2), in place of the foregoing arrangements using radio-frequency balance, but perfectly reliable results are not obtainable for reasons described above.

The Marconi Balanced Crystal and Balanced Valve Receivers perform a species of audio-frequency balancing. By their use the intensity of the disturbances arising from atmospherics may be reduced but not entirely eliminated.

From time to time attempts have been made to get rid of atmospheric inter-

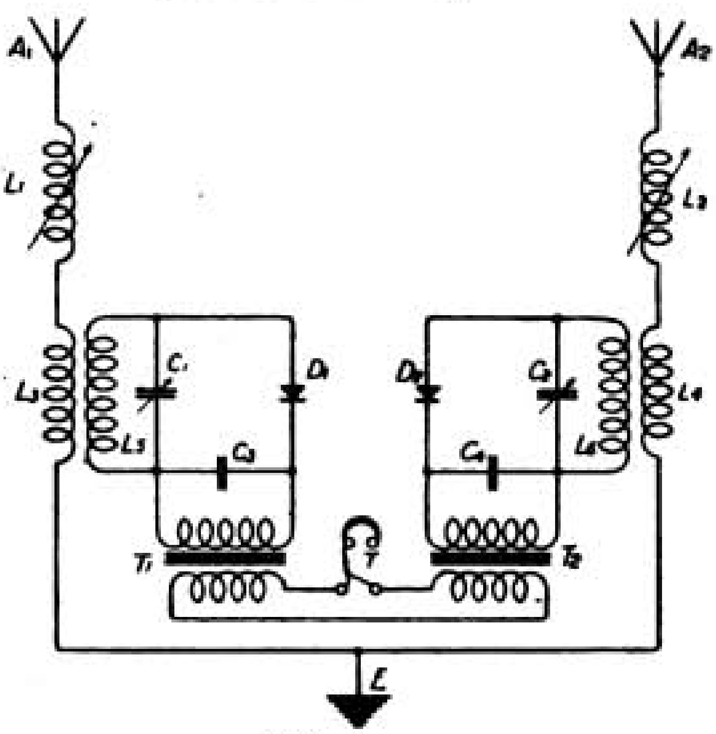


*Fig. 2.*

ference by means of various forms of directive receiving apparatus, such as the Marconi-Bellini-Tosi Radiogoniometer used in conjunction with double triangular loop aerials. Tuned interference from near-by transmitting stations can be considerably reduced by this means.

It has been found that the different types of X's differ considerably in their electrical characteristics. Dr. Eccles has classified X's into three main types:—"Grinders," "Clicks" and "Hiss" or Sizzle."

The most prevalent type varies with the locality of the receiving station. In tropical regions a great deal of the disturbance is due to local lightning discharges. In temperate regions, apart from infrequent local storms, the most common forms are Grinders and Clicks.

Hissing noises are due to actual static discharges from the aerial to earth caused by electrostatic induction from charged clouds or winds. In transatlantic communication it is found that "grinders" are the most troublesome type of disturbance.

Disturbance arising from definitely positioned local thunderstorms can evidently be located and cut out by means of direction-finding receiving apparatus.

Extensive experiments were carried out by Mr. Weagant, the Chief Engineer of the Marconi Wireless Telegraph Company of America, at the stations and works of the American Marconi Company with the Bellini-Tosi and other forms of directive receiving apparatus in order to determine the location (if any) of the most prevalent forms of atmospheric ("grinders"), and it was found that there was *no appreciable difference* between the strengths of atmospherics received from different directions; in other words, the X's appeared to converge upon the receiving aerials from all directions in space simultaneously.

The same general results were confirmed by the use of closed loop unearthed aerials or "frame" aerials as they are now often called. A diagrammatic outline of the "frame-aerial" circuit is indicated in Fig. 3.

The "aerial" itself comprises the loop of wire L. This may consist of one or more turns as convenient for the wavelength being used. The lower ends

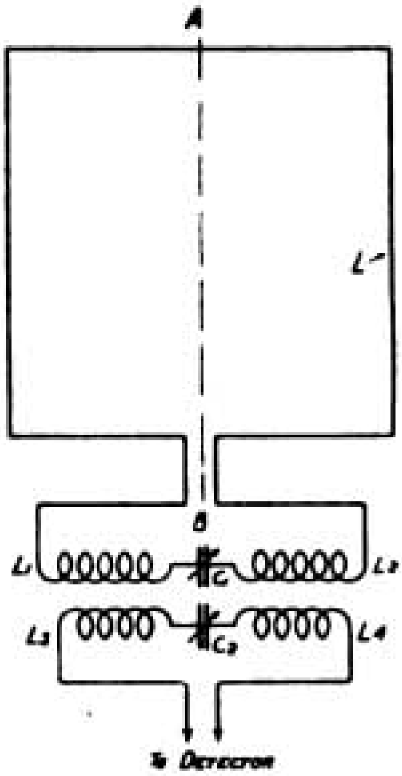



Fig. 3.

of the loop are joined to inductances $L_1$ $L_2$, and tuning condenser $C_1$, to tune the whole circuit to the frequency of the incoming signal waves. The detector circuit comprises the inductances $L_3$ $L_4$ coupled to $L_1$ $L_2$ and the tuning condenser $C_2$.

Such a loop aerial receives the maximum intensity of signal from waves arriving in the plane of the loop itself and minimum or zero signal from waves arriving from a direction perpendicular to this plane. Hence, by rotating the loop about an axis AB, the direction of maximum reception can be moved round to various points of the compass and the direction of an incoming wave thus determined. With this arrangement, too, Mr. Weagant found that the X's

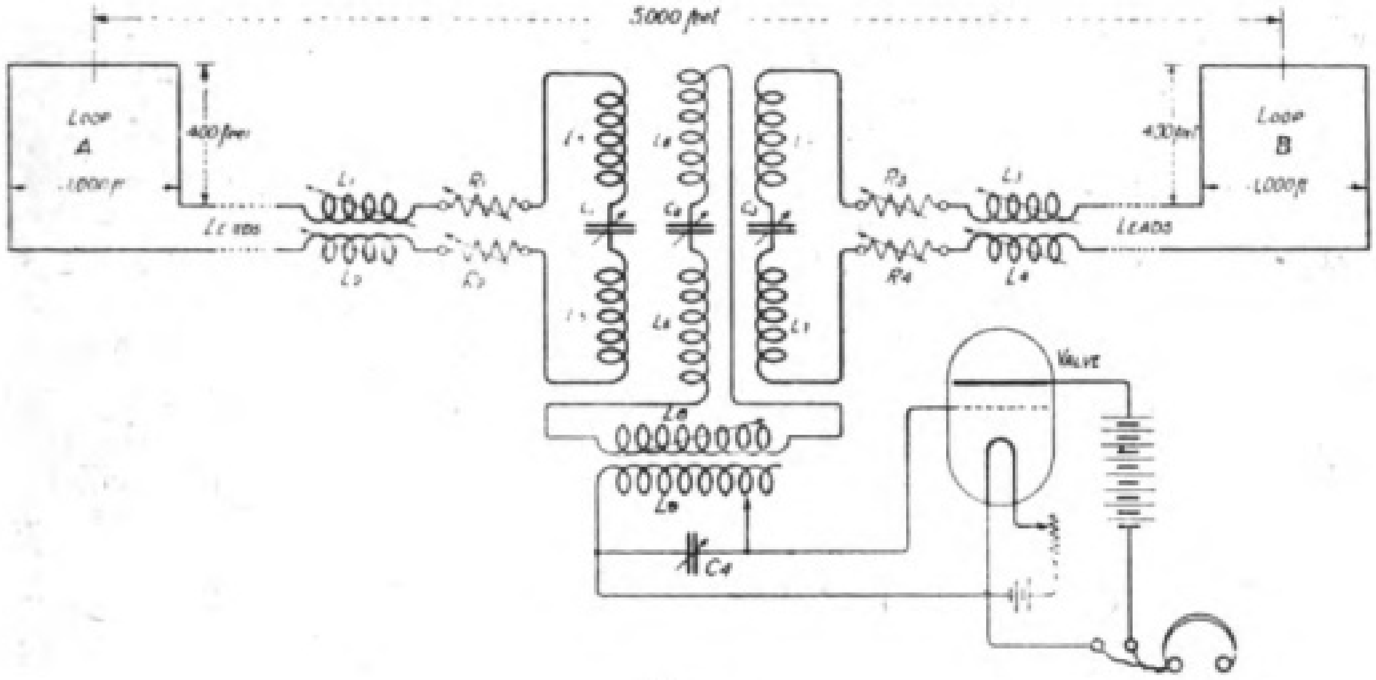



*Fig.* 4.

were received with equal strength independently of the direction of orientation of the plane of the loop.

As a result of these and similar experiments it occurred to Mr. Weagant that these static disturbances might be propagated *vertically*, instead of horizontally as is the case with ordinary wireless signal waves. Hence, if this is so, the direction of propagation of the X waves would be at right angles to the direction of the advancing wireless wave.

If this hypothesis could be definitely proved, then advantage might be taken of this difference in direction to separate the atmospheric from the signal currents flowing in the aerial circuit. This is the fundamental working hypothesis upon which the Weagant system is based.

Various experiments were subsequently devised in order to test the accuracy of this assumption, with uniformly confirmatory results.

Hence, if we accept this hypothesis of two mutually perpendicular directions of wave propagation, it merely remains to devise a scheme of aerial arrangement that will enable advantage to be taken of such a difference, so that the atmospheric waves may be cancelled or balanced out, without seriously impairing the reception of the desired signal waves.

One of the schemes devised by Mr. Weagant for this purpose takes advantage of the above-mentioned directive properties of loop aerials to enable the direction of maximum intensity of signal reception to be made to coincide with the line joining the receiving station with the transmitting station from which it is desired to receive.

The principle of the method is indicated in Fig. 4.

Two loop aerials A and B are employed, connected by long parallel leads to the apparatus in the receiving station which is placed approximately midway between the two loops. The variable inductances $L_1$ $L_2$ and $L_3$ $L_4$ serve to tune each loop circuit to the frequency of the incoming waves in conjunction with the variable condensers $C_1$ $C_3$. Coils $L_5$ and $L_7$ form the fixed coils of a radiogoniometer similar to the usual type used in the Marconi Direction-Finding Sets.

The movable coil $L_6$ of the radiogoniometer is tuned by the condenser

$C_2$ and the external inductance $L_2$, which is coupled to the usual type of valve receiving circuit as shown.

It should be noted that on account of the directional effect of loop aerials the plane of the two loops should be, as nearly as possible, in line with the direction of the transmitting station.

It then follows that as far as the horizontally propagated incoming signal wave is concerned, there is a phase difference between the currents induced in the two loop circuits, whereas both loops are symmetrically placed as regards a vertically propagated X wave. It is therefore possible to cancel out the two currents induced by the X disturbance and yet leave the signal wave current strength unimpaired.

The two loops must be spaced a considerable distance apart, in order to take full advantage of this type of aerial arrangement. The optimum effect is obtained when the distance between the centres of the loops is as nearly as possible one-half of the wavelength of the incoming signal. It is not, however, essential that the loop spacing should be exactly of this amount, as the oscillatory currents in the two loop circuits are combined vectorially by the radiogoniometer. Hence a somewhat smaller spacing will give rise merely to a slight reduction in the received signal strength.

*(To be continued.)*

## MAGNETIC STORMS.

IN the course of an interesting lecture on the above-mentioned subject, delivered before the Institution of Electrical Engineers on May 1st, Dr. C. Chree, F.R.S., while not specifically discussing wireless matters, brought to light a number of important facts that should be of great interest to wireless circles. The bulk of the lecture was devoted to a consideration of a number of very instructive records taken from magnetographs in various parts of the world, including some obtained during Antarctic expeditions. A notable feature of a great many of the records of magnetic storms is the very sudden changes in the value of the magnetic force that occur in particular at the commencement of a disturbance, and sometimes at intervals throughout its duration. It is conceivable that such sudden changes of the magnetic field may also give rise to disturbances in the telephones of wireless receivers. It has been proved by the examination of many records that a certain class of disturbance—particularly those with a sudden commencement—occur simultaneously over almost the entire globe. By averaging the records it has been shown that the bulk of magnetic storms occur in the evening and early hours of the night. Maximum increase of amplitude of the disturbance with increasing latitude is in a north-westerly direction in the British Isles, identical with the direction of maximum gradient of the frequency of auroral displays, proving at least some interdependence and hence possibly some connection between magnetic disturbances and wireless X's.

Some observations made at Bordeaux, of a magnetic storm on August 21st to 23rd, 1918, are of interest as showing that simultaneously with the variations of magnetic force exactly similar and synchronous variations of the electrical charge of the lower air also occur.

# Stray Waves.

## COMMUNICATION WITH CELESTIAL BODIES.

As a result of a few observations let fall by Senatore Marconi during an interview which he granted to Mr. Harold Begbie last January, widespread interest has been aroused in the subject of extra-terrestrial communication. We have seen the columns of our contemporaries extend their hospitality to a considerable number of attempts to develop ideas in this direction and have had the pleasure of hearing for the *n*th time about those delightful perennials, the Martians and their "canals." It appears to us that the question of whether we can or cannot communicate with other parts of the universe depends chiefly upon four things: (1.) Whether there is life there. (2.) Whether it is intelligent life. (3.) Whether the intelligence (if any) is sufficiently advanced. (4.) Whether the intelligent organisms (if any) *can communicate back to us.*

Firstly, nobody knows whether there are life-forms on Mars or any other planet. Speculation on the subject is rife, yet this "butters no parsnips." Prof. P. Lowell thought Mars is inhabited, but Prof. Russell Wallace wrote a book in order to prove that it is not only uninhabited but *uninhabitable.* As to the "canals" they may be the work of Nature, they may be the work of intelligent beings or they may be optical illusions. Here is a wide range of choice over which our readers can exercise their minds. Secondly, assuming the existence of highly intelligent organisms, one has to consider in what direction their bodies and intelligence have developed. Our distant fellow-creatures may be very clever *fish* possessing a perfect command of telepathic communication, but no implements, or they may live entirely underground and think in terms of four dimensions, and so on. Thirdly, unless they can reply in such a manner and by such means as will render it possible for us to receive the message and to be quite sure of the "office of origin" the whole attempt will be hopeless.

It has been suggested that communication might be effected by the means of light, a proposition which sounds reasonable until one remembers that at its nearest point to the earth Mars is some 30 million miles away, and that to make a reasonable display we should have to illuminate an area or a number of areas as large as, say, Australia.

"Ah," says the wild-goose chaser, "that depends upon the power of the Martians' telescopes," and to this we feel inclined to answer, "Quite so, but what about Reconstruction in the British Empire, and do you know that we still lack the perfect X-stopper"?

If the whole question be resolved into one of whether we can by wireless telegraphy transfer to Mars enough energy to admit of its detection there, then the answer is that this might be possible provided that we could attain the necessary radiation on a wave-length corresponding to a frequency somewhere between a million and a billion. This high frequency would seem to be necessary, in the light of our present knowledge, in order to make it possible for the waves to penetrate the Heaviside layer. Waves of an exceedingly small order of wavelength probably stand the best chance of traversing the layer, and we are not aware that any method has yet been devised by which they could be radiated with the requisite power and efficiency. From a rough calculation based on an adaptation of Austin's formula, and on the assumption that the amplitude of the waves would in interstellar space decrease according to the inverse square law, we think that to make a transmitter of the necessary power would not be outside present possibility.

## SENATORE MARCONI'S VISIT TO LLOYD'S.

Senatore Marconi, who was elected an Honorary Member of Lloyd's on April 9th, recently paid a visit to that institution on the invitation of its Chairman. After being received by the last-mentioned gentleman (Mr. C. I. de Rougemont) and the Committee, he was conducted to the Underwriting Room and introduced as a newly-elected member. The Chairman, in the course of his speech, made reference to the beneficial results accruing from the introduction of wireless telegraphy.

Senatore Marconi, who wore the uniform of a Commander of the Royal Italian Navy, in his acknowledgment of the hearty reception he had received, said:—

> "I thank the Chairman of Lloyd's for his kind introduction and for the way in which I have been received. I need hardly say how greatly I appreciate the high and unusual honour of having been elected an Honorary Member of this old and illustrious Corporation."

Senatore Marconi was afterwards entertained at luncheon by the Chairman, at the City of London Club.

## THE PROPHETIC TOUCH.

In an article entitled "Wireless Possibilities," published in the "*Year Book of Wireless Telegraphy and Telephony*" for 1918, Mr. A. R. Burrows wrote:—"There would be no technical difficulty in the way of an enterprising advertisement agency arranging for the interval in the musical programme to be filled with audible advertisements, pathetic or forcible appeals—in appropriate tones—on behalf of somebody's soap or tomato ketchup. Even to-day the departments of food economy and War Savings might provide periodic stentorian exhortations by wirelessly operated megaphones established at the traffic centres."

In view of this it is interesting to note a recent Reuter telegram from New York, which reads as follows:—"A striking feature of the Victory Loan celebration in Washington was the reading of President Wilson's Loan message from an aeroplane. By means of a wireless telephone and the newly-invented sound amplifier a crowd numbering about 15,000, assembled on the Treasury steps, heard distinctly President Wilson's words spoken through the air by an army aviator flying at a height of 2,600 feet."

## GERMAN INGENUITY.

Many and amusing are the examples of "substitutes" which were evolved by the artful Teuton under the stress of the Allied blockade. The following description of the materials used in the construction of a wireless receiver is of considerable interest, not only because it furnishes yet another proof of how the "shoe pinched" in the Fatherland, but because it provides us with a record of experiments in emergency electrical material. According to the *Electrical Review*, ebonite, rubber and brass are conspicuous by their absence. The switches are mounted on slabs of three-ply wood, blacked over, and the coupling coils on tubes of papier-maché, the windings being insulated by silk only. The buzzer is mounted on stone-ware, and its leads are insulated with paper; all nuts and terminals are of gun-metal, and the dry cell is closed with four layers of cardboard instead of with pitch. The only ebonite used is on the switchboard, notably for the knobs of the handles. A few more years of war and the world might have been enriched with *ersatz* electricity!

## ABSORPTION OF ELECTRO-MAGNETIC WAVES ON PARALLEL WIRES.

An account is given in the ***Analen der Physik*** by W. Arkadiew of the absorption of electromagnetic waves on two parallel wires. For the purposes of the experiment damped waves of wavelengths ranging from 72.7 cm. to 1.27 cm. were produced, and it was shown that the wave energy decreases exponentially as a result of absorption. A means of measuring the absorption co-efficient is given, and the writer also deduces a theoretical formula for calculating the velocity of propagation and the absorption co-efficients. The latter, for magnetic wires show a rapid fall of permeability towards the shorter waves. The permeability of various magnetic metals was calculated from the co-efficient of absorption and by extrapolation it was found that for iron the permeability should be unity at a wave-length of a few millimetres.

## WIRELESS AND "WIND-JAMMERS."

By a royal decree of Feb. 20th, 1917, the installation of wireless on all Spanish vessels of over 500 tons was made compulsory. Enter Don José Maria Caballero Aldanore, owner of two sailing vessels of more than 500 tons, with a petition. He did not wish to fit wireless apparatus on his ships; they were sailing ships; he submitted that the decree should be left in abeyance. One gathers that Señor Aldanore is a wire-puller of discrimination and power, for another royal decree of February, 1919, enacts that the former decree shall be modified in the sense that sailing vessels above 500 tons, which habitually carry at least 50 persons, crews and passengers together, and which are engaged in lengthy voyages, shall be obliged to be equipped with only a "call station" (transmitter?) which can be manipulated by any member of the crew. So the worthy caballero has saved many pesetas. If he spent them on a wireless receiver and operator he might have the privilege of being the instrument, under Marconi, of saving lives.

It is a matter for wonder that so few sailing ships are provided with wireless telegraph apparatus, for all the arguments in favour of its use on steamers apply equally to such vessels. The small technical difficulties in equipping sailing ships have been met and overcome long ago.

## THE PEACE TREATY AND GERMAN WIRELESS STATIONS.

Amongst the clauses of the Peace terms, which were handed to the German delegates on May 7th, is one relative to the future of German wireless working. For three months the stations at Hanover, Nauen and Berlin may not be used for naval, military or political messages without the assent of the Allied and Associated governments, but for commercial purposes only, under supervision. During the same period Germany is not to build any more high-power wireless stations.

# Digest of Wireless Literature

## "UBER ROHRENSENDER."

*By A. Meiszner. Elektrotechnische Zeitschrift.* 20.2.19. *p* 78.

BY the method explained previously (*see* WIRELESS WORLD, *May*, 1919, *p*. 75) the curve shown on Fig. 11 was obtained for the anode current. When analysed into a Fourier series this curve will give:

$$i_A = 65.2 \, Sin \, wt - 26.5 \, Cos. \, 2wt + 8 \, Sin \, 3wt + \ldots \; ^*,$$

the harmonics higher than the third being neglected.

The relative values of the amplitudes of the harmonics can be determined in a very simple way experimentally. The loop *S* (*see* Fig. 3**) is coupled for this purpose to a wave-meter, and the readings of the hot-wire (or any

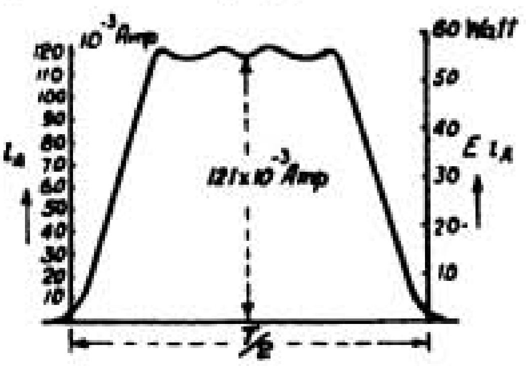



*Fig.* 11.

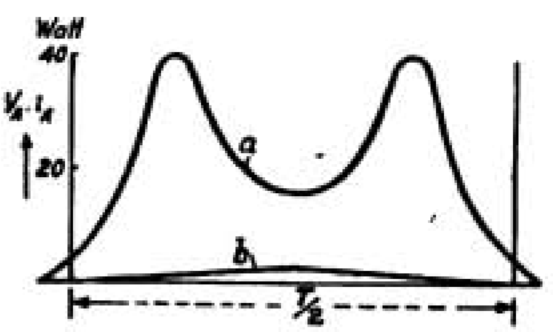



*Fig.* 12.

other integrating) indicator are observed, first for the fundamental and then for the higher frequencies. The relative position of the wave-meter with regard to loop *S* must remain constant during all the observations. Bearing in mind that the energy

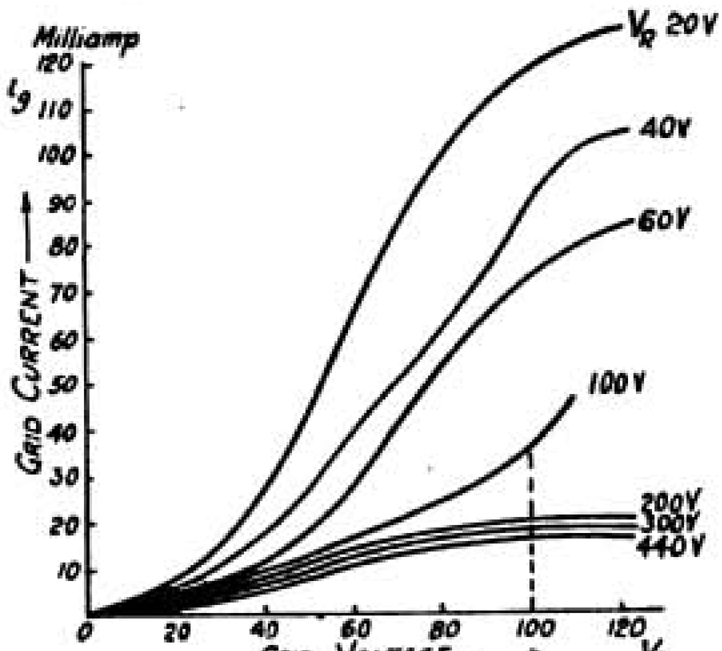



*Fig.* 13.

* The original paper has for the second term, probably an oversight, + 26·5 *Sin* 2*wt*.
** For figures 1–10, the reader is referred to WIRELESS WORLD, *May*, 1919, *p*. 75 *f*.

transferred to the wave-meter is approximately inversely proportional to the squares of the various frequencies, we are at once enabled to evaluate the ratio between the amplitudes of the component oscillations. Thus, for instance, for the case considered the readings were:

1. For the fundamental frequency – 29
2. For the second harmonic – 17
3. For the third harmonic – 9

We obtain, therefore, for the ration between the amplitudes:

$$\sqrt{29} : \sqrt{\frac{17}{4}} : \sqrt{\frac{9}{9}} = 5{\cdot}39 : 2{\cdot}06 : 1 =$$
$$= 65 : 25 : 12$$

The losses in the valve will obviously be given by $i_A \times V_R$ (for values of $V_R$ see Fig. 8) and are represented by curve "a" in Fig. 12. As to the losses in

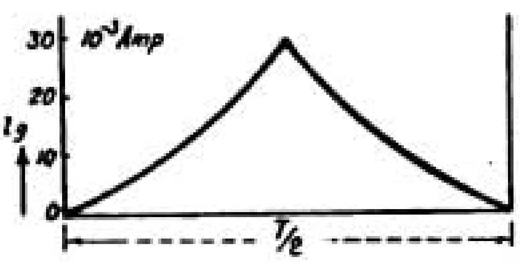



Fig. 14.

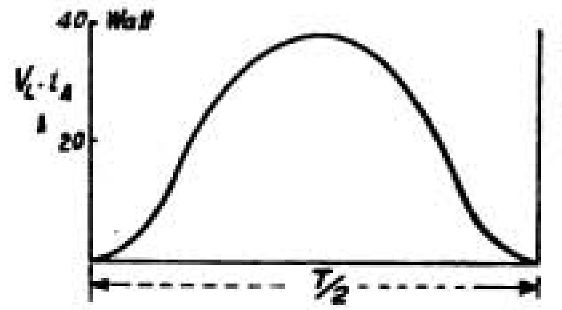



Fig. 15.

the grid circuit they are represented on Fig. 12 by the curve "b," which can be obtained from the grid-voltage and grid-current curves in the same way as curve "a." Fig. 13 gives the family of static grid characteristics, from which the grid-current curve shown on Fig. 14 has been obtained.

The energy consumed by the valve during the interval $T$, when current flows through it, will be given by the product of the applied constant voltage $E$ and the

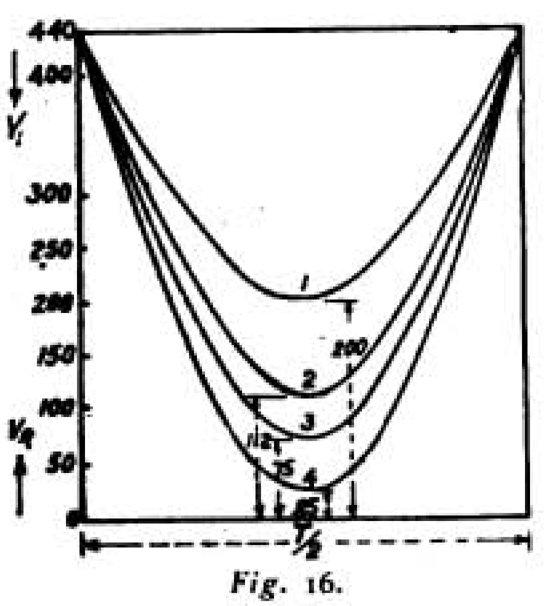



Fig. 16.

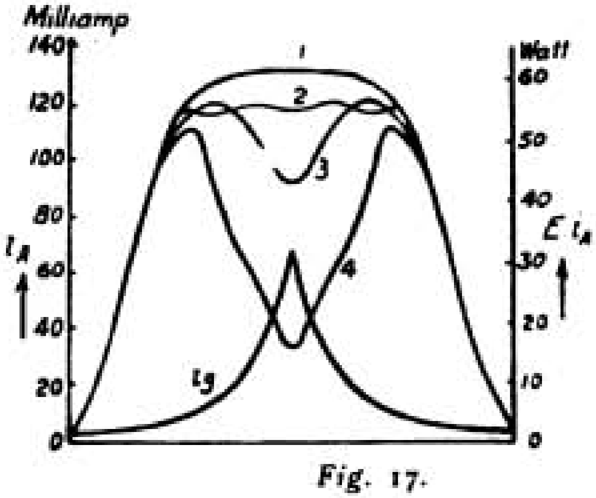



Fig. 17.

anode current $i_A$. The curve thus obtained will be identical with that shown on Fig. 11. From the area enclosed by this curve and the horizontal axis, we obtain:

$$E\, i_A = \frac{41}{2} = 20{\cdot}5 \text{ watts.}$$

The readings of the instruments were:

$E = 440$ volts $i$ (average) $= 48.10^{-3}$ amp.

which gives $Ei = 21.1$ watts.

The useful energy transferred to the oscillatory circuit can be obtained from the area inclosed by the curve and horizontal axis of Fig. 15, the ordinates of the

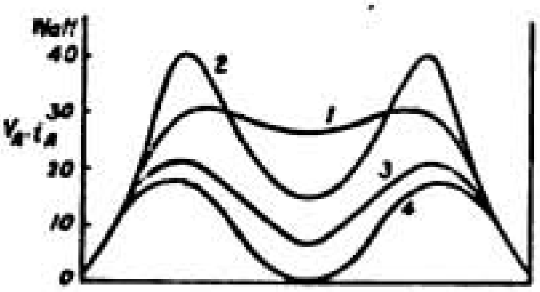



*Fig.* 18.

curve being determined for any moment by the product of the values of $V_L$ (*see* Fig. 8) and $i_A$ (Fig. 11) at that moment.

For the valve under consideration, the useful output has been found by this method to be 11.5 watts.

This result was checked by direct measurement of current and resistance. This gave:

$$I^2_{eff} \times R = .86^2 \times 17.5 = 11.5 \text{ watts}$$

We can now find the efficiency of the arrangement. It will be seen that it amounts to:

$$\eta = \frac{11{\cdot}5}{20{\cdot}5} = 56\%$$

or, if 21.1 watts, the figure obtained by direct measurement of the input, is taken:

$$\eta = \frac{11{\cdot}5}{21{\cdot}1} = 54{\cdot}5\%$$

The author investigates next the question of how a variation in the value of $L$ (Fig. 3) will affect the arrangement. Fig. 16 gives a series of curves for

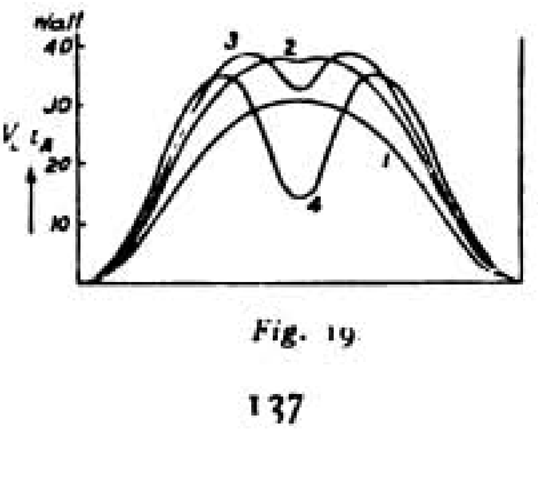



*Fig.* 19.

$V_L$ max. = 415, 365, 328, and 240 volts, corresponding to different values of $L$. The values of $V_R$ can be read off in the same manner as in Fig. 8. Assuming the same grid voltage ($V_g$ max. = 102 volts) we can obtain from Figs. 16, 9 and 10 the family of curves for the anode current as shown on Fig. 17 in the same way as Fig. 11 was obtained. The curves for the losses in the tube and for the useful energy transferred to the oscillatory circuit II (Fig. 3) are given on Figs. 18 and 19 respectively.

An inspection of these figures shows that for small values of $V_L$ (*e.g.*, curve 1) the anode current rises, the losses in the tube are comparatively large, while the energy delivered to the oscillatory circuit is comparatively small. The efficiency of the tube will therefore be low.

For large values of $V_L$ (curve 4) the anode current and therefore the input energy fall, the losses in the tube decrease and are concentrated in the first and last thirds of the half-cycle, the output falls also, but not considerably. The

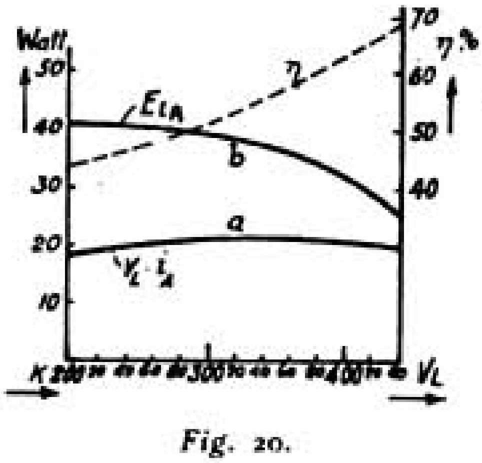



*Fig.* 20.

efficiency of the tube is good, but the output is not the largest which can be obtained from the tube.

The results obtained are shown on Fig. 20, where the variations of input (curve *b*), output (curve *a*) and efficiency (curve $\eta$) are given as functions of $V_L$.

It will be seen that from the point of view of the best utilization of the valve, $L$ must be so chosen as to give a value of $V_L$ max. about 30 per cent. smaller than the applied constant voltage " E." This adjustment does not coincide with the point of highest efficiency.

In conclusion the author states that an investigation similar to the foregoing, but with constant $V_L$ and variable $V_g$ has shown that the best results were obtained for $V_g$ max. = 102 volts. The tests show that generally the efficiency of the tube is higher for small values of $V_g$ than for larger. At the same time, however, the output begins to decrease if the coupling between plate and grid circuits is made too small. Therefore, in this case also the best adjustment will not occur at the point of highest efficiency.

# Time from a Wireless Point of View.

*By E. J. Wagstaff.*

WHAT is Time? Little more than the duration of existence arranged on an arbitrary basis for the ordering of men's lives and actions. It has been from time immemorial the rule to utilize the (apparent) movements of the sun for its measurement, and it has been always and everywhere accepted that noon, the period when the sun stands at its highest place in the heavens, shall be the starting point for calculation.

Now this meridian varies in different parts of the world, indeed its variation starts the moment one passes east or west of the point selected for the solar observation. So long as the eastward or westward distances are not great, it is found convenient to ignore these comparatively small divergencies and establish what is called a Standard Time. Thus English Standard Time regulated on the meridian of Greenwich is applied, not only to the British Isles, but to France and other countries situated round about the longitudinal line which passes through Greenwich. The Central European countries, lying considerably eastward observe a Standard Time based upon a meridian 15° east of Greenwich. Similar variants exist west of Greenwich, and so on through the other quarters of the globe.

Until steam traction on Sea and Land brought the world closer together, these arrangements answered fairly well. Now that steamship and railway

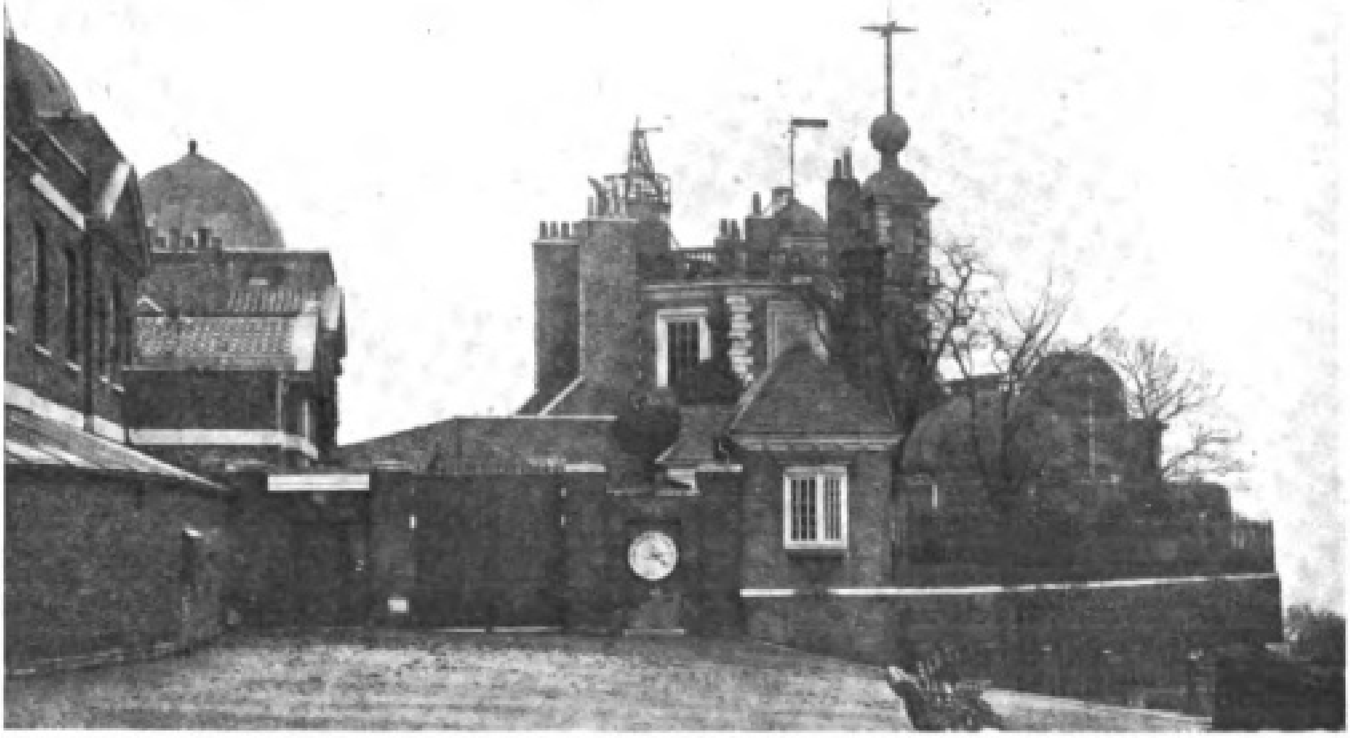


Photo: Courtesy, Astronomer Royal.

*A view of the Royal Observatory at Greenwich, with the clock from which G.M.T. is taken.*

development has been intensified by practice, and supplemented by the advent of aviation, and now that radiotelegraphy has provided a messenger equal in speed to the light of the sun, some change in the method of registering time has become a matter of urgency.

The systematization of time-measures was first undertaken from a land point of view, and in 1883 European experts agreed to select Greenwich as a universal basis; whilst in the following year a conference at Washington ratified their choice and drew up a system of universal time. But up to a recent date, despite the fact that three-quarters of the globe is covered by water, time at sea has been left in its traditional confused condition; so that when we receive a radiotelegram from a ship at sea, and observe its date and the time at which it was handed in, we are faced with the problem:—Does the entry there recorded mean: (a) Greenwich time, (b) Local time, (c) Ship's time, (d) Standard time, or (e) Summer time?

This item in the message might easily become of supreme importance. The man in charge of a business house might have wirelessed to his Principal at sea, giving certain information and asking for instructions. Under present circumstances it is possible for him to receive a radiotelegram which—judging from the times therein recorded—was an answer to his enquiry; but which might in reality have crossed his own message and been despatched in total ignorance of the information contained therein. Again, take the case of births and deaths at sea; it may be of extreme moment, from the point of view of inheritance and other considerations, to know the exact hour at which a child was born, or that at which some one on board ship breathed his last. Moreover, weather and meteorological problems depend largely for their solution upon the time at which the phenomena connected with them are observed and telegraphed. Travel on land, sea, and air grows ever more and more, and it is becoming increasingly evident that time at sea is of as great importance as time ashore.

A system of zones appears to offer the most hopeful solution of the problem.

Radiotelegraphy has brought ships at sea into continuous touch with land and with other ships, and has in consequence simultaneously added insistence to the problems and afforded opportunities for its solution. The French Ministerial Circular, dated 22nd March, 1917, laid special emphasis upon this fact. That memorandum was issued with the object of "Setting forth the Notation of Time at Sea after the Fashion of Zone Times," and was closely followed by a Conference held at Whitehall between the 21st June and the 3rd July, 1917.

As a result, the British Admiralty put forward a proposal for zone time at sea, advocating the establishment of 24 zones, with Greenwich as the zero, and the other zones numbered westward + 1 + 2, etc., eastward − 1 − 2, etc. In this proposal it is left optional to the Commander of each vessel to alter his ship's time-piece in accordance with his convenience in working the vessel, and the suggestion is made that for the despatch or reception of radiotelegrams, etc., either zone time should be used or that of Greenwich. The latter suggestion does not meet the exigencies of the case, and—whatever may be the practice adopted by the Commander of the vessel so far as his working time on board is concerned—it would appear essential that the clock in the wireless room should be changed the moment the zone limit is crossed, so that all radio working should be kept strictly to zone time. Under present circumstances no provision is made in radiotelegraph regulations for fixing the time standard utilized in wireless telegraph working, and only such a course as that just recommended can obviate the confusion and uncertainties which are almost inevitable under present conditions.

The rule hitherto observed is for the ship's wireless operator to use G.M.T. when working with other ship stations, and the coast station time when working with coast stations; an arrangement obviously impracticable now that the wireless telegraph service is being developed in all parts of the world. We may exemplify this impracticability by considering the case of a vessel working the Australian Coastal Service. Here a local standard time would be in use, and if the operator on a British Trans-Oceanic steamer were, in his communication with the Australian ship, to utilize G.M.T. for entering time particulars, as required on the message form ("Time handed in"), the addressee might not improbably be surprised by finding that—on the face of the telegram—he received his message before it had been handed in at the point of origin. Of course such an anomaly might be defended by the explanation that the entry of the time comprises an unpaid telegraph service instruction, and that therefore a discrepancy of this nature would be immaterial. In view, however, of the fact that the entry appears on the telegram as handed to the addressee, such an explanation could hardly be considered satisfactory, or indeed other than detrimental to the Public Telegraph Service. How is any member of the public to differentiate between what is intended for him and what is not?

The suggestions which the present writer would put forward are:

1. That (as indicated above) zone time should be strictly adhered to in all radiotelegraphic offices afloat and ashore, ship's time being corrected the moment the vessel crosses from one zone to another.
2. That all radiotelegrams should bear the zone time of the station of origin; in the case of messages emanating from ship stations the time should be supplemented by the zone number with the indication E. (East) or W. (West).
3. When the radiotelegram arrives at the final wireless handling office, such time should be amended and expressed in the standard zone time of the receiving station (a matter which under this system would be perfectly simple). This suggestion applies particularly to messages exchanged between ship and ship, and from ship to shore, it being in such cases that ambiguity usually arises with regard to time.
4. The time entries inserted in the Operator's log of communications should be made on the zone standard, a clear indication being shown of the moment when the wireless office clock is advanced or put back one hour, as the ship passes from one zone to another. By this means it will be possible to identify *exactly* the time of any event noted in the ship's records.
5. General use should be made of the Continental method of indicating time on the 24-hour principle, which obviates the insertion of a.m. or p.m.

In exemplification of (3) let us take a message handed in at noon on board a ship at sea within zone 1W, and transmitted to the Wireless Station at Valentia (zone G.M.T..). This message would be amended by the Coast


*Map of the World showing suggested division into Time Zones.*

Station Operator, as far as time is concerned, before being passed to the Land Lines for delivery; so that the "Time handed in" should read "1300." (G.M.T.). Where the final wireless handling office is a shore station in a country utilizing summer time, allowance would be made in the adjustment for this arrangement.

In order to illustrate the working of this time zone proposal, a map has been prepared showing the world on Mercator's projection divided off into 24 longitudinal zones of 15° each, the time difference between one zone and another being therefore one hour. Greenwich has been taken as the central point, and—following on the lines of the Admiralty proposal—the Central Zone (wherein is adopted Greenwich mean time) stretches from 7°.30′ west to 7°.30′ east. The other zones are numbered 1W, 2W, etc., 1E, 2E, etc., according to whether they lie west or east of the Central Zone. It will be noted that the zone lines are not continued across land areas because our proposal is essentially one for wireless time at sea, and there are certain complications ashore into which it is needless for us to enter here. We refer to such matters as the possible desire on the part of countries like India and New Zealand for establishing an Intermediate-Zone Standard Time to suit their own requirements.

The emission of time signals by radiotelegraphy in all parts of the world offers a ready means for standardizing time. Most of these signals are based on G.M.T., and by the adoption of a systematic sixty-minute time zone all calculations in relation thereto are simplified and time can be regulated with precision.

At present stations nearby or widely separated use time adjusted on different standards and on standards which are frequently unknown to each other. The general introduction of radiotelegraphy has emphasised these shortcomings and enhanced the need for standardization.

Only by a system such as outlined above can stations ashore and afloat eliminate misunderstandings with regard to time and maintain their entry records on a universally accepted standard.

In order to obtain the fullest advantage from the procedure above set forth, it would be necessary to secure its adoption throughout the whole world. The disadvantage which attends any deviation from International Convention Regulations on the part of any important country, may be exemplified from the fact that, although the United States and Canada ratified the International Radiotelegraph Convention of London, they have hitherto found themselves unable to give effect to one or two of its provisions. Amongst those affected by this reservation, is the one which relates to the entry on the radiotelegram of the time at which it is handed in at the point of origin. The custom in those two countries has hitherto been for the Land Line telegraphist to insert the time at which the message was received by the Land Line from the Coastal Receiving Station, a practice which has led to considerable confusion and inconvenience.

Such a uniformity of regulation and working can only be effected through the medium of the International Convention. Rapid progress in wireless working, and the increased facility with which Radiotelegrams are now handled, renders the meeting of such a conference a matter of extreme importance, and it is to be earnestly hoped that amongst the matters towards which the delegates' attention is directed, may be a most serious consideration of the question of time-keeping from a wireless point of view.

# Notes of the Month

## MARITIME COMMERCIAL WIRELESS TELEGRAPHY.

As from May 1st, 1919, all restrictions on the use of Wireless Telegraphy at sea are cancelled except in regard to ships when in the North Sea, English Channel (east of a line joining Dungeness and Boulogne), the Baltic and Northern Russian waters, the Mediterranean Sea, Black Sea and Sea of Marmora.

## WIRELESS OPERATORS AND B. OF T. EXAMINATION.

An amendment to the Board of Trade Regulations concerning the examination of masters and mates reads as follows:—"If a candidate has been engaged on articles of agreement as seaman, or in any seaman rating, and has served both as a seaman and as a wireless operator, the service may be counted as qualifying service in full." Also, "If a candidate has been engaged on articles of agreement as a wireless operator, and has served as such, one quarter of the service up to a maximum of twelve months may be counted as qualifying service." On the grounds that this arrangement will tend to overcrowd a profession, the ranks of which are already well-filled, the Council of the Mercantile Marine Service Association have registered a protest against the amendment.

## FRENCH OVERSEAS WIRELESS STATIONS.

According to the *Revue Générale de l'Electricité*, there are 35 French wireless stations at work, exclusive of those in France; 25 are being constructed, and 20 more are projected. Included in this scheme are stations for Algeria, the Congo, Timbuctoo, Madagascar and Indo-China.

## MR. JOSEPHUS DANIELS IN ROME.

Christopher Columbus discovered America. Mr. Josephus Daniels, Secretary of the United States Navy, recently returned the compliment, and whilst in Rome said in the course of a speech: ". . . . . . . . We shall never forget that it was your Marconi, a distinguished member of the Italian Mission in 1917, who first caused the electric spark to radiate freely into space, in obedience to the will of man, in such a way as to transmit the messages of mankind across space and over all obstacles without the help of an electric cable. It is because of the daring of his inventive genius that our ships are now able to speak to each other across hundreds and even thousands of miles of ocean, and that time and space have been abolished in so far as concerns the communications of man with man."

## WIRELESS INVESTIGATIONS OF THE SOLAR ECLIPSE OF MAY 29th, 1919.

Shortly after the issue of the present number of the *Wireless World* certain experiments on the effect of the forthcoming eclipse on signals transmitted across the zones, will be carried out under arrangements made by the British

Association Committee for Radiotelegraphic Investigation.

During the eclipse various wireless telegraph stations will emit signals consisting of letters of the alphabet changed according to a definite plan at the end of each minute; the programme of letters is so arranged that no two come together in the same order more than once. They will be accurately timed at selected receiving stations. On the day before the eclipse the stations will send practice signals for a short time near noon (Greenwich Mean Time). The stations at Ascension and the Azores will transmit during the transit of the umbra across the Atlantic, receiving stations north of the Equator being detailed to listen to Ascension, whilst those south of the Equator will observe the signals from the Azores. The receiving operators will denote the signal strength on a scale from 0 to 9. Certain pairs of stations such as Darien and Falkland Islands, and an Egyptian station and a South African station, will, it is hoped, conduct special experiments. One of the aims of the scheme is to clear up the problem of the effect of the changes of the ionisation of the air on long and short waves. For further information application should be made to Dr. W. Eccles, Hon. Sec. of the Committee, City and Guilds Technical College, Leonard Street, E.C.2.

## WIRELESS CLUB NOTES.

On April 2nd the Three Towns Wireless Club of Plymouth met, the chair being taken by Mr. Boniface, who represented Major Malden, a Vice-President of the Club. Mr. Lowe performed a series of experiments illustrative of electro-magnetism and the application of electricity to daily life. On April 9th the Chairman was Mr. J. Jerritt. The meeting was devoted to instructional purposes, election of new members, etc. It was announced that Sir A. Shirley-Benn had consented to become a Vice-President. The subject of the lecture on April 16th was Wireless Telegraphy, the lecturer being Mr. Voss, an ex-instructor in the Air Force, who carried out his task in an able and interesting manner.

Applications for membership of the Club should be addressed to the Hon. Sec., Mr. W. Rose, 7 Brandreth Road, Compton, Plymouth. Corresponding members are invited to join.

The Wireless Institute of New South Wales decided recently to link up all the experimental associations in Australia, with the view of forming a national association of amateur wireless experimenters and users.

We are requested by Mr. A. W. Knight, of 26, Stanbury Road, Peckham, S.E.15, to state that he will be glad to hear from anyone who is willing to act as Organiser or Secretary to a projected Wireless Club for S.E. London (Dulwich, Peckham and Camberwell). Stationery, membership cards, books and apparatus are available.

## DUBLIN MUNICIPAL WIRELESS COLLEGE SOCIAL.

On April 14th, in the Art Room, Kevin Street, there took place a social and dance of the students of the Dublin Municipal Wireless College. The guests included Mr. L. E. O'Carroll (Secretary, Technical Schools), Mr. W. J. Lyons (Principal, Wireless College), Messrs. Smyth, Hodgens, McAteer, O'Kelly and Feely (Wireless Instructors), and Mr. D. Soraghan (Editor of "Billi Condenser," the College Journal). A highly successful feature of the evening was Mr. Harvey's exhibition of characteristic curves to the accompaniment of Mr. Johnston.

# Heterodyne Envelopes.

*By* J. St. Vincent Pletts

WHEN a received oscillation is heterodyned, that is to say when it has superimposed upon it a locally generated alternating current of a different frequency, a pulsating oscillation is produced, and it is the magnitude, frequency, and shape of this pulsation which determines the interference or beat note heard in the telephone when the pulsating oscillation is rectified. The note heard, therefore, depends entirely upon the envelope of the pulsating oscillation, or upon what may be called the heterodyne envelope, which is here investigated.

If the received oscillation be due to a continuous wave it may be represented by :

$$a = A \sin pt$$

while the heterodyne current, if assumed to have the same phase when $t=o$, may be represented by :—

$$b=B \sin(p \pm q)t$$

Putting these in the form of vectors it will be seen from Fig. 1 that, if $DE=A$ and $EF=B$, the maximum amplitude at $t=o$ is given by $DF=A+B$, and that

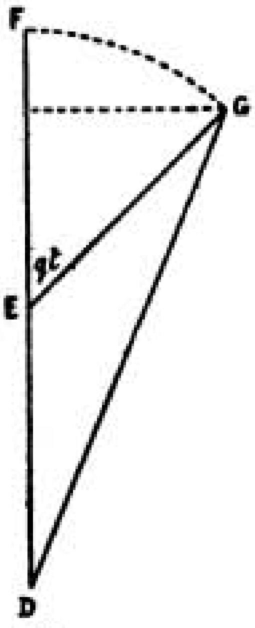



Fig. 1.

at some later time $t$ the vector $B$ will have turned to $EG$ through an angle $qt$ relatively to the vector $A$, giving the maximum amplitude $DG=C$. Now :—

$$(DG)^2=(A+B \cos qt)^2+(B \sin qt)^2$$

so that the equation for $C$, which is of course the equation for the heterodyne envelope, becomes :—

$$C=\sqrt{A^2+2AB \cos qt+B^2}$$

In Fig. 2 I have drawn these envelopes for values of $B$ one, one and a half, two, three, and five times $A$, and it will be seen that they vary from a succession of half sines at equality to a nearly pure sine of twice the frequency when $B$ is five

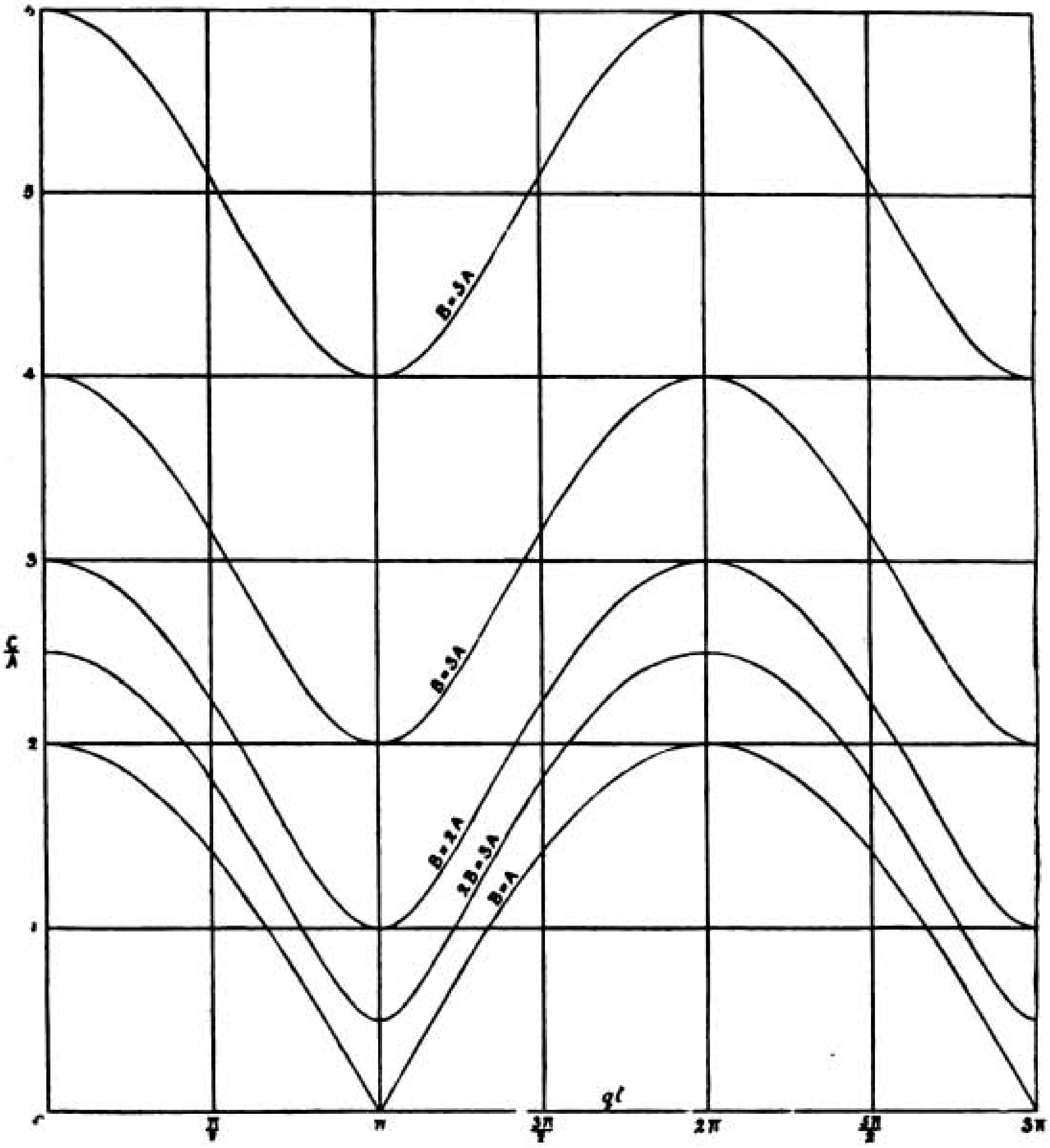


Fig. 2.

times $A$. That the envelope is a succession of half sines at equality is seen at once from the expression for $C$, since if $A=B$:—

$$C=A\sqrt{2(1+\cos qt)}$$
$$=\pm 2A\cos\tfrac{1}{2}qt$$

But it is evident that the upper half can, like all the other envelopes, be expressed in the form:—

$$C=BC_0+AC_1\cos qt+AC_2\cos 2qt+AC_3\cos 3qt+\cdots$$

The curves in Fig. 3 give the values of $C_0$, $C_1$, $C_2$, $C_3$ and $C_4$, for values of $B$ from one to five times $A$, and it will be seen that the harmonics, which are at first fairly large, rapidly diminish, until at $B=5A$ the envelope is very approximately represented by :—

$$C=A\ (5 \cdot 1+Cos\ qt- \cdot 1\ cos\ 2\ qt)$$

so that the note is the fundamental with its octave of a tenth the strength. The more $B$ is increased relatively to $A$ the nearer does the envelope approximate to :—

$$C=B+A\ cos\ qt$$

and the purer does the fundamental note become. It will also be seen that the

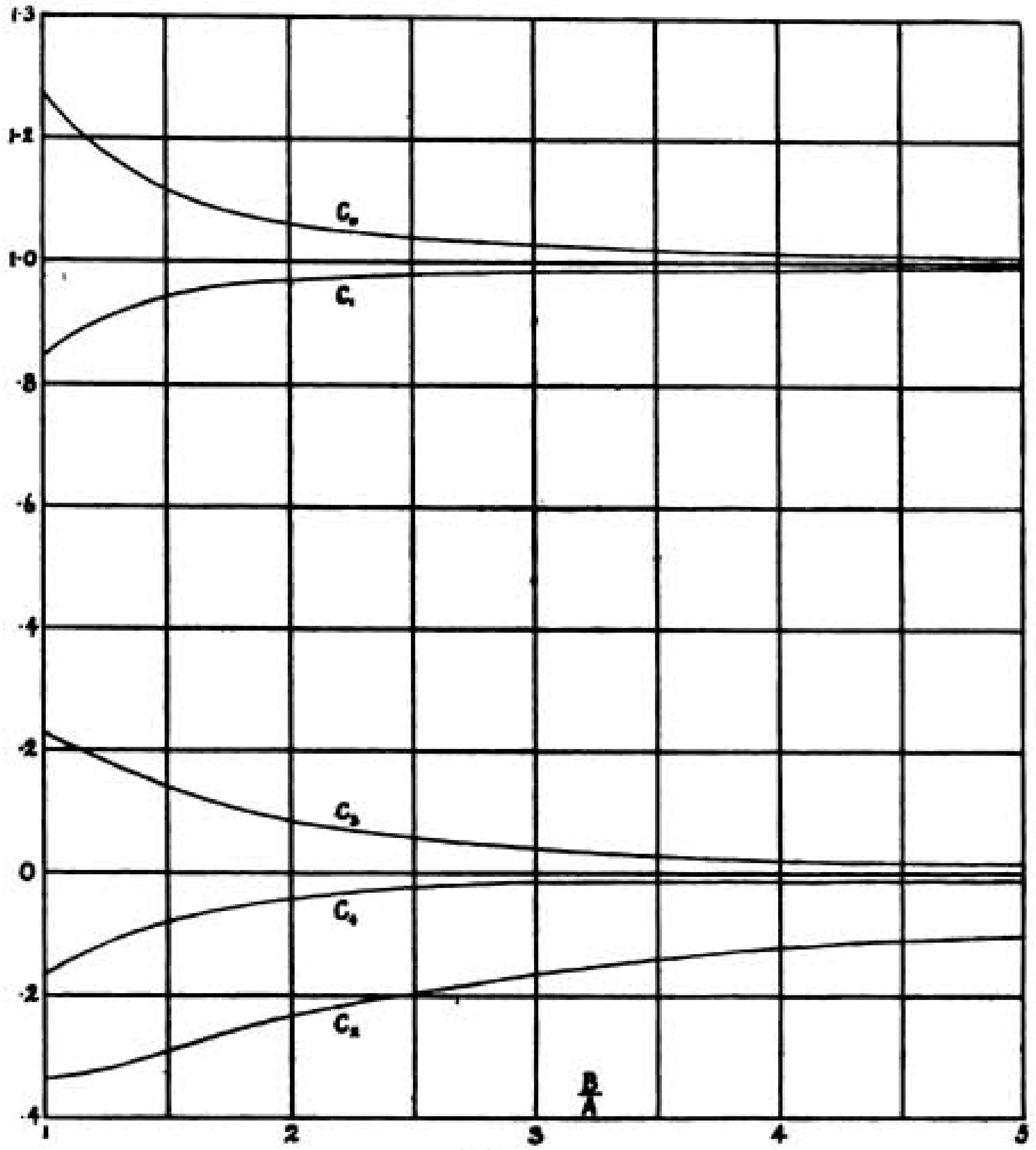



Fig. 3.

amplitude of the fundamental note is only 84% of the maximum at equality, and that it asymptotically approaches $A$ as the ratio of $B$ to $A$ is increased, so that the fundamental note can be strengthened nearly 20% by increasing the heterodyne current.

The same law holds when the amplitude of the heterodyne current is less than that of the received oscillation, but such an arrangement is inefficient as the amplitude of the note is then limited to that of the heterodyne current. This limitation might perhaps be made use of in the case of strong interfering signals, for a small heterodyne current would reduce the notes to equality of strength so that they could be separated out in circuits tuned to the beat frequencies.

Damped oscillations can also be heterodyned, and (still assuming coincidence of phase when $t=o$) the equation for the envelope then becomes:—

$$C = \sqrt{A^2\epsilon^{-2\delta t} + 2AB\epsilon^{-\delta t}\cos qt + B^2}$$

where $\delta$ is $p$ times the decrement per period of the received oscillation. In Fig. 4 I have drawn the envelope for the case where $A = 2B$ and $\delta = \frac{q}{3\pi}\log 2$, so that the amplitudes are equal at the moment when they come into opposition for the second time. It will be seen that the envelope starts as a wave of constant

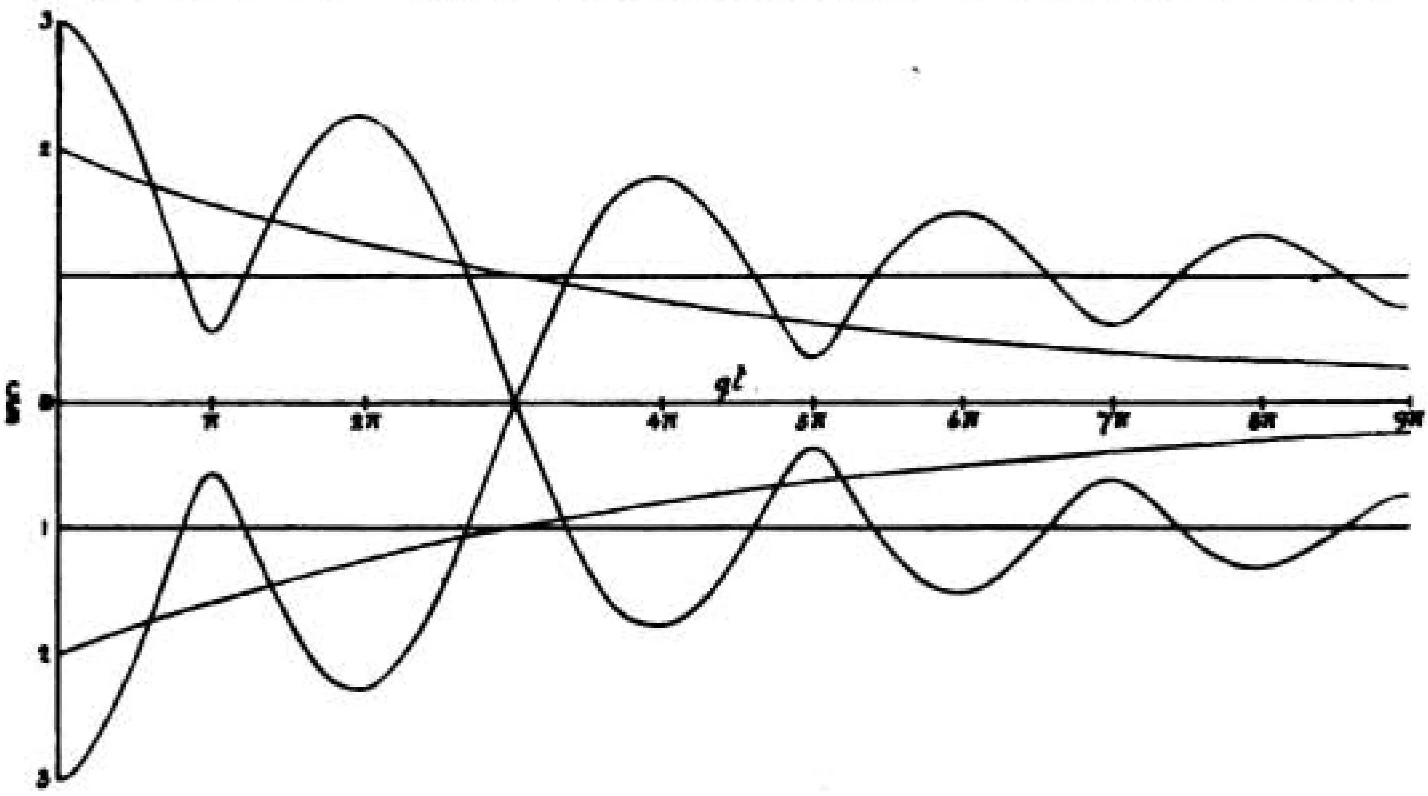



Fig. 4.

amplitude and increasing impurity on top of a decreasing current, but after passing through zero becomes a wave of decreasing amplitude and increasing purity on top of a constant current, and finally dies out as a pure sine ripple on the rectified heterodyne current.

As every rectified current can be expressed as a series of the form:—

$$C = A_0 + A_1\cos pt + A_2\cos 2pt + A_3\cos 3pt + \cdots$$

or:—

$$= \sum_0^n A_n \cos npt$$

it is obvious that the value of the current for the purpose of, say, charging an accumulator is $A_0$; but I do not think it is as generally recognized that the value for, say, heating the filament of a lamp is quite different, or in other words that the $C^2R$ losses are not equal to $A_0^2R$. Indeed it generally causes some surprise that with the arrangement shown in Figure 5, where independent sources of direct and alternating currents are connected to a common resistance $R$, the reading of the

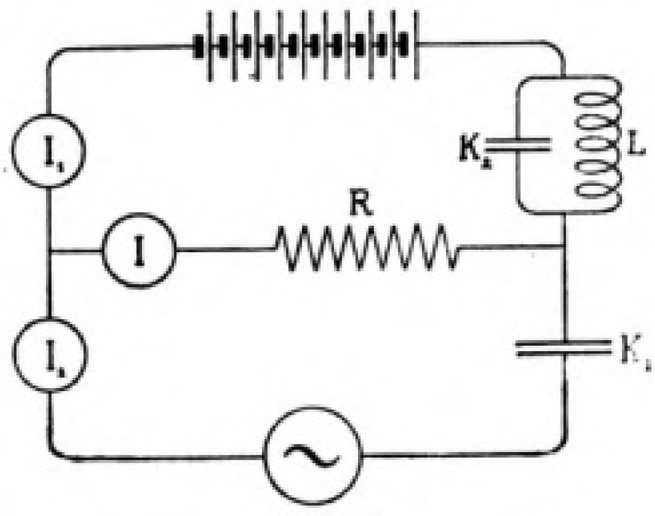



*Fig. 5.*

ammeter *I*, whether it be a direct or alternating current instrument, does not equal the sum of the readings of the ammeters $I_1$ and $I_2$. although the condenser $K_1$ and the blocking circuit $LK_2$ prevent the passage of any direct and alternating current through them respectively. The heating value of a rectified or other varying current is given by :—

$$C_{RMS} = \sqrt{\frac{p}{\pi}\int_0^{\frac{\pi}{p}} \left(\sum_0^n A_n \cos npt\right)^2 dt}$$
$$= \sqrt{A_0^2 + \tfrac{1}{2}\sum_1^n A_n^2}$$

so that the R.M.S. value of a varying current is the root of the sum of the squares of the R.M.S. values of all the constituent harmonics, including the direct current component.

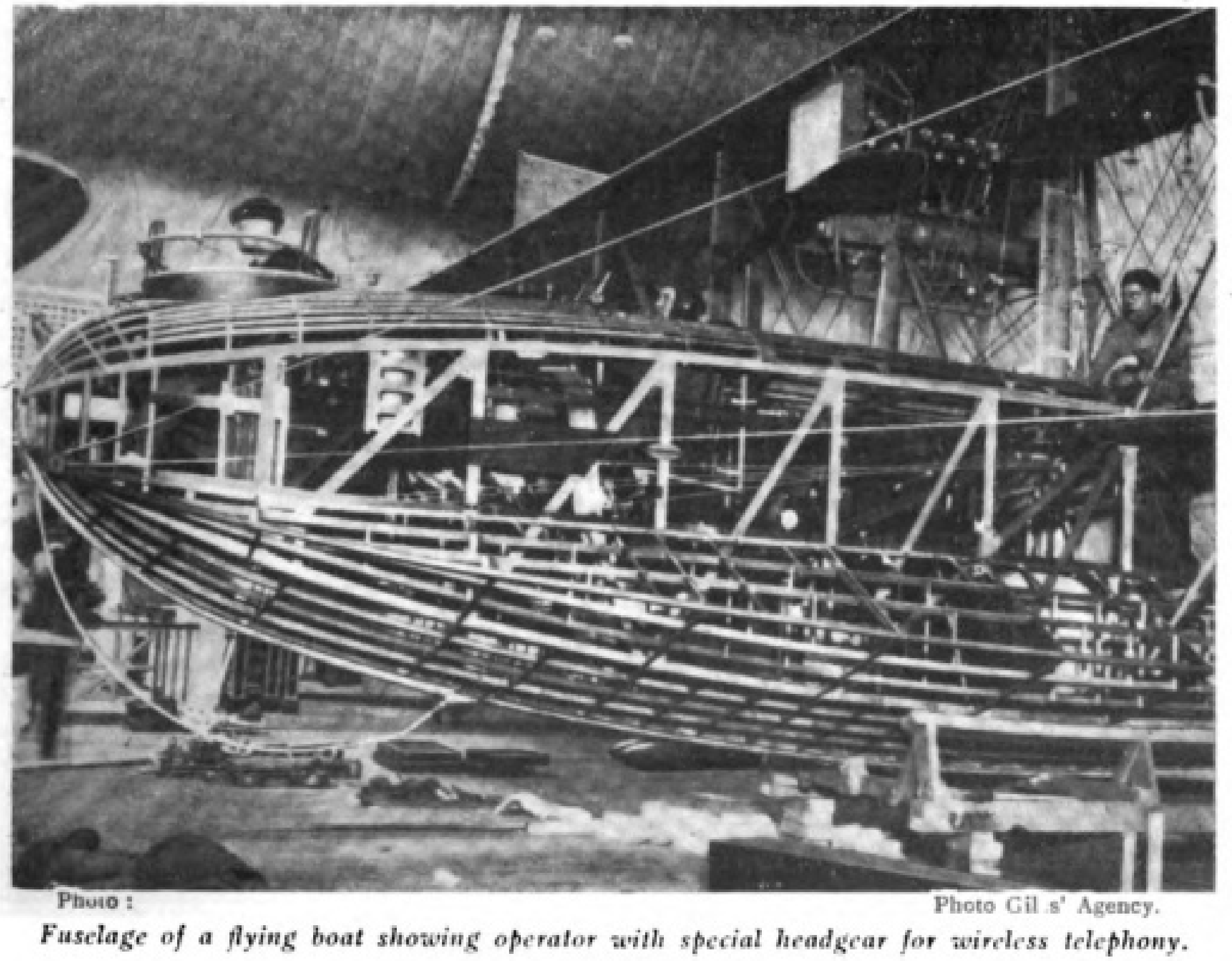


Photo : Photo Gil s' Agency.

*Fuselage of a flying boat showing operator with special headgear for wireless telephony.*

# Correspondence

## THE AMATEUR POSITION.

Up to the time of going to press no announcement relating to the lifting of the ban upon private wireless work has been made by the authorities. Nevertheless, we entertain strong hopes that by the time our next number appears amateurs will be busy with aerial-erection and the furbishing-up of their long-lost coils and condensers. We base our hopes upon the indication afforded by the gradual disintegration of D.O.R.A. The restrictions on the use of maritime W/T are now removed to a certain extent, and many prohibitions on trading have been rescinded; hence, with the Peace Treaty signed, there should ensue sweeping movements towards pre-war conditions.

We publish this month another letter in defence of amateur rights and should like to direct attention to a remark alleged to have been made by Captain H. R. Sankey, which is reported therein, to the effect that no case had been proved against any amateur station in respect to interference with Government stations. Although we think the writer is in error in attributing it to Capt. Sankey, yet we believe it to be a perfectly accurate statement, so far as stations in Great Britain are concerned, up to the outbreak of war, and we trust the authorities to bear it well in mind.

To the Editor of the WIRELESS WORLD.

DEAR SIR,

Re your wish in the March issue of your valued magazine (THE WIRELESS WORLD) for opinions from amateurs relative to the permission for the re-organisation of amateur Wireless Stations. I myself endorse the opinion of the writers of the articles published by you in this edition. I with many others bitterly lamented the closing down of our Radio Stations and consequent stagnation to our researches which were to some of us our very life. No order could have been more bitter to us than the order to dismantle our stations and shelve the work which was our heart's desire. Reverting back to the plea for amateur rights, I myself am fully convinced that many amateurs have earned the right to expect full permission to restart the work which was their best pleasure, after putting their capable services to their country's benefit, as operators, constructional radio engineers, etc., and I am persuaded that many now who are still in their King's service will be utterly disappointed on return to civil life should their life's hobby be refused them. I myself have not been able to do anything in direct service for my country, as my younger friends have done, but I pride myself on the fact that I have been instrumental in helping many men into the service of the Marconi Mercantile Marine Service, who on declaration of war subsequently served their country on mine sweepers, secret ships, and armed merchant cruisers, and in other capacities. One member of my firm in the textile fabric branch, is now 2nd-Lieut. in the R.A.F., Egypt, wireless engineer in charge through my personal aid, and many others of our ranks have been able in some way to indirectly help our country by their knowledge of wireless telegraphy. Some of our best young wireless enthusiasts have given their life for their country, of whom I may mention Mr. Halliday Findlay of Parsons Green, S.W., a personal amateur friend of mine, who's young life was sacrificed on the sinking of the Aboukir in the early stages of the war. Surely, the amateur wireless telegraphist has earned the indebtedness of his country at large, and a right to claim once more freedom to enjoy that for which he was willing to stake his life. With regard to amateur interference, I don't remember whether Dr. Eccles was at the inaugural meetings of the Wireless Society of London at Westminster Schools, but no less an authority than Capt. H. Riall Sankey told us that he congratulated the many wireless amateurs present that no case had ever been proved against any amateur stations interfering with any Government or other station. I trust that our combined testimonies may through your valued columns, which have done so much to encourage us in our work of love, prove to give us those liberties once more which to us are so dear.

Yours faithfully,

(Signed) W. J. FRY, Engineer, Maple & Co., Ltd.; late Committeeman, Wireless Society of London.

# Practical Notes on the Use of Small-Power Continuous Wave Sets

BY J. SCOTT-TAGGART, M.S.BELGE E., A.M.I. RADIO E.

*Continued from May Number, page 93.*

The fault may be due to any of the following reasons:—

(*a*) The coupling between *R* and *L* may not be adjusted correctly; it is possibly too loose.

(*b*) The high-tension voltage may not be high enough.

(*c*) The insulation of the aerial or the set may be faulty.

(*d*) The value of the filament current may be too low.

(*e*) The connections of the valve, or the valve itself, may be faulty.

In order to make the valve oscillate, it is, therefore, necessary to look to these points. Possibly the valve has stopped oscillating owing to the accumulator having run down somewhat, in which case all that is necessary is to increase the filament current until a click is heard, indicating that the valve has begun to oscillate again.

The value of the filament current and high-tension voltage should be as small as possible because, even when receiving, the set is emitting waves which, if made unnecessarily strong, will cause interference with other stations.

Once the valve is oscillating, it is necessary to tune the set in to the transmitting station. This is done by varying the inductance and condenser $C_1$ until the station is heard. On turning the condenser round a "chirp" is first heard, which, when analysed, as described above, consists of a high note dropping to nothing and then rising again as the receiving condenser is turned. The note can therefore be varied at will and either side of the silent interval may be used. If one side is being "jammed" by another C.W. station, the other side should be used. Only the loudest signals can be obtained by trying different combinations of filament current, reaction coupling, high-tension voltage, inductance and capacity.

An aerial of great capacity, for example, will need a higher value of high-tension voltage, or filament current, or reaction coupling in order to make it oscillate. It will generally be found that the best results are obtained when the valve *just* oscillates. This condition may be obtained by gradually loosening the coupling or reducing the filament current. In order to keep this critical point it is advisable to use an accumulator of considerable capacity, so that there is no likelihood of signals being suddenly cut off when the voltage of the accumulator drops. It must be remembered that, in reception as well as in transmission, when the reaction coupling is varied in order to obtain the loudest signals, the wave-length also is varied slightly at the same time, and it will be necessary to compensate for this by a slight returning of the condenser $C_1$. The selection of a good valve is also advisable if the best results are desired. A softer valve than the one used for transmission will generally be found most suitable. A valve having similar characteristic curves to those given by the writer in the Paper on "Valve Characteristic Curves"* will be found suitable for transmission or reception.

In order to adjust the receiving circuits so as to ensure hearing the transmitting station without unnecessary waste of time and uncertainty, a heterodyning wave-meter is necessary. The wave-meter described above may be used as a transmitting or receiving instrument. If the condenser of the wave-meter be set to the wave-lengths being transmitted it will radiate feeble waves of that length, by which the receiving set may be tuned. It may frequently be desirable to know the wave-length on which a certain station may be working. In order to do this the receiving apparatus is tuned until the distant station is heard. The note-frequency of the received signals may be varied at will, and for the present purpose the apparatus should be tuned so that nothing is audible in the receivers, and yet, if the tuning be varied either way, the distant station will be heard. When this condition is obtained, the frequency of the local oscillations generated by the valve is equal to the frequency of the incoming waves. If a wave-meter be now brought near to the receiving instrument the feeble waves emitted by the latter can be accurately measured in exactly the same manner as described above. The length of these waves is the same as that of the waves from the distant station.

When a central station has to work to two or more other stations at the same time, the wave-meter again proves its usefulness. Owing to the very fine tuning, it is somewhat difficult to arrange to receive the replies from a number of stations without making a re-adjustment for each station. It can, however, be done by deciding to make all the stations adjust the condensers of their transmitting sets so that the silent intervals of all their signals coincide on one point on the receiving condenser. If the silent interval of one of the stations is found, for example, to be five degrees further up the condenser than the other stations, the station at fault should be informed of the fact and told to reduce the value of his transmitting condenser five degrees. After one or two corrections, the silent point of his signals can be made to coincide with the silent intervals of the other stations, and therefore all the stations can be heard on the one adjustment, which, of course, is a little to one side of the silent interval. If desired, the incorrectly tuned station may be told that he is working on a wave-length so many metres "out." The wave-length of the controlling station may be checked by one of the other stations.

This system is preferable to checking wave-lengths by means of wave-meters. The following method, however, is useful. The controlling station sends out on the true wave-length. The remaining stations tune their sets so that the silent interval is obtained. The receiving circuit is now emitting feeble waves of exactly the same length as those of the control station. Each station then listens on his wave-meter and adjusts it until the silent interval produced by these feeble oscillations is obtained. The operator then presses the key of his sending apparatus, and, still listening on his adjusted wave-meter, moves the transmitting condenser round until the silent interval is found. The transmitting station will now be working on exactly the same wave-length as the control station.

It will be recognised that, since the tuning appears less fine, the longer the waves used the more easy is it for a

* *Vide* "Valve Characteristic Curves and their Application in Radiotelegraphy," THE WIRELESS WORLD, September and October, 1918.

number of stations to work between themselves, or for a central station to call up several stations at the same time. Since stations are liable to miss calls unless tuned absolutely correctly, it is often advisable for the transmitting station to depress his key for a moment and to vary his transmitting condenser once or twice a very little to either side of the correct adjustment. This saves the receiving operator the trouble of continually varying his adjustment while listening-in; he listens on the normal adjustments, and when his attention is drawn to the momentary "swish" of the transmitting station he tunes his set accurately.

Since heterodyne reception proves efficient for damped as well as continuous waves, considerable interference by spark stations is liable to occur when using the circuit of Fig. 5, even when the interfering stations are on a different wave-length. This trouble may be very largely obviated by having an independent aerial circuit very loosely coupled to a receiving system oscillating at a frequency slightly different from that of the incoming signals. Sets using circuits similar to those of Fig. 5 may be adapted by having the aerial and earth connected to a simple outside circuit, instead of to the Fig. 5 circuit. Fig. 8 shows the arrangement, the aerial circuit being several feet away from the set. The aerial and earth terminals of Fig. 5 may be left open, shorted, or shunted by a fixed or variable condenser, each arrangement giving a different range of wave-lengths as desired. The aerial circuit is

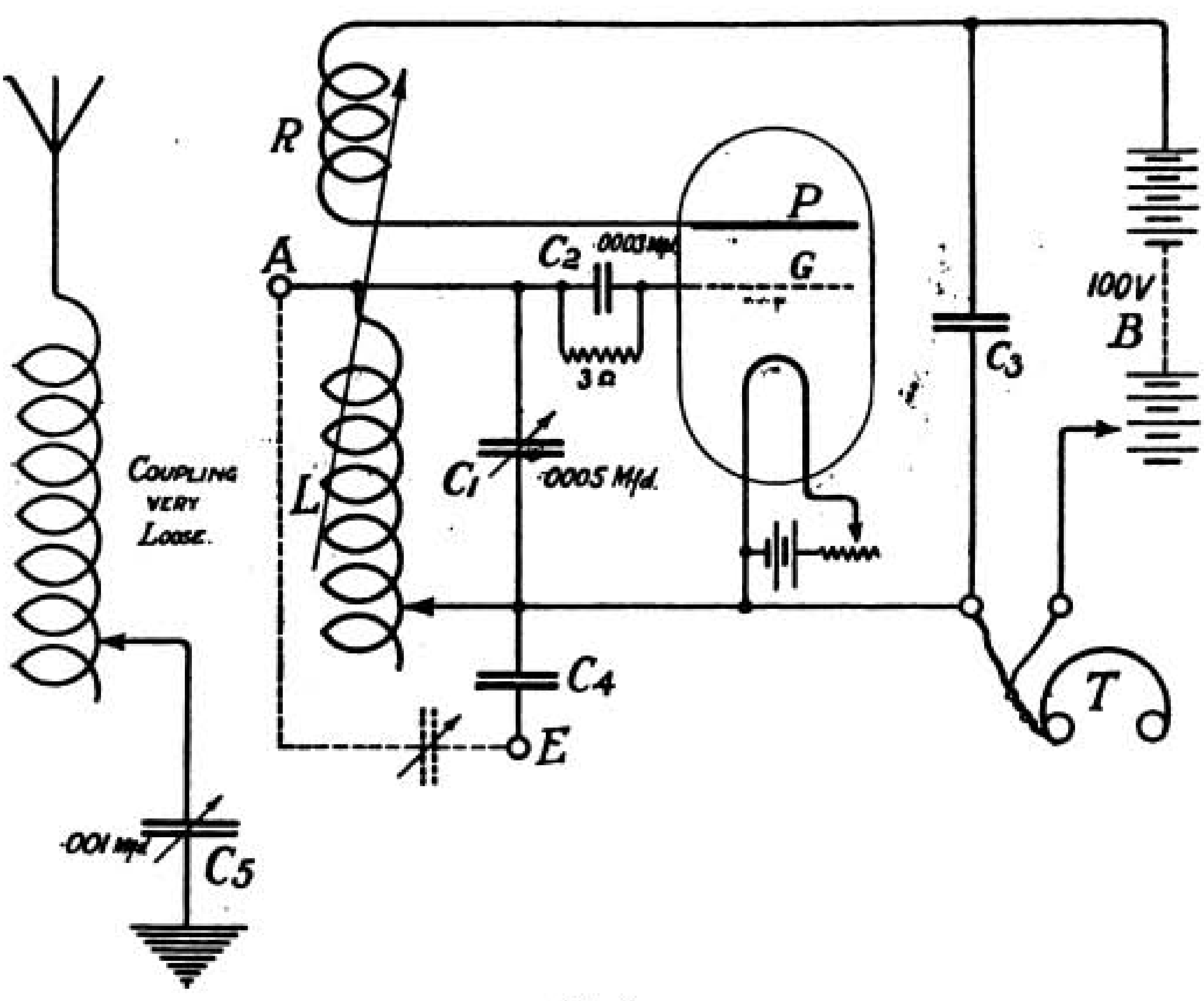



Fig. 8

tuned approximately to the incoming signals, and the operator adjusts his Fig. 8 circuit until the C.W. transmitting station is heard. The signals in the aerial circuit consist of forced oscillations, and therefore varying the tuning of that circuit does not alter the *pitch* of the note heard in the 'phones, but only the strength, which, of course, is greatest when the aerial circuit is in tune with the incoming waves. If desired, a simple aerial circuit may be arranged, and the operator may listen-in on his wave-meter; or the inductance and condenser of the Fig. 5 set may be used for the aerial circuit, the valve current being decreased, the operator listening-in on his wave-meter. In all cases the principle is the same. The continuous oscillations of the aerial circuit are capable of inducing across a greater distance than spark signals which practically die out on account of the very loose coupling. Spark interference may thus be cut down to a minimum or eliminated altogether. The strength of the continuous wave signals is also somewhat decreased, but not in the same proportion, and their strength can always be subsequently increased by low-frequency amplification.

Interesting experiments may be carried out by using a Fig. 5 circuit which is just *not* oscillating, the incoming signals being heterodyned from outside by means of an oscillating wave-meter placed near the set. Altogether, the subject affords ample opportunities for experimental and research work, and will undoubtedly play a very great part in wireless communication in the future.

Photo: Giles' Photo Agency.

*The Crew of the Handley-Page Aeroplane which at Easter made the first successful flight round Great Britain. Wireless Operator Dymant is the figure on the extreme right (bottom row).*

# Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

*These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.*

## AIRCRAFT WIRELESS SETS.

### The Sterling Transmitter—(Continued.)

### TUNING THE OPEN CIRCUIT.

IN the case of the open circuit the question of tuning is somewhat more involved. It is obvious that the aerial-earth capacity of the ordinary land aerial is here re-

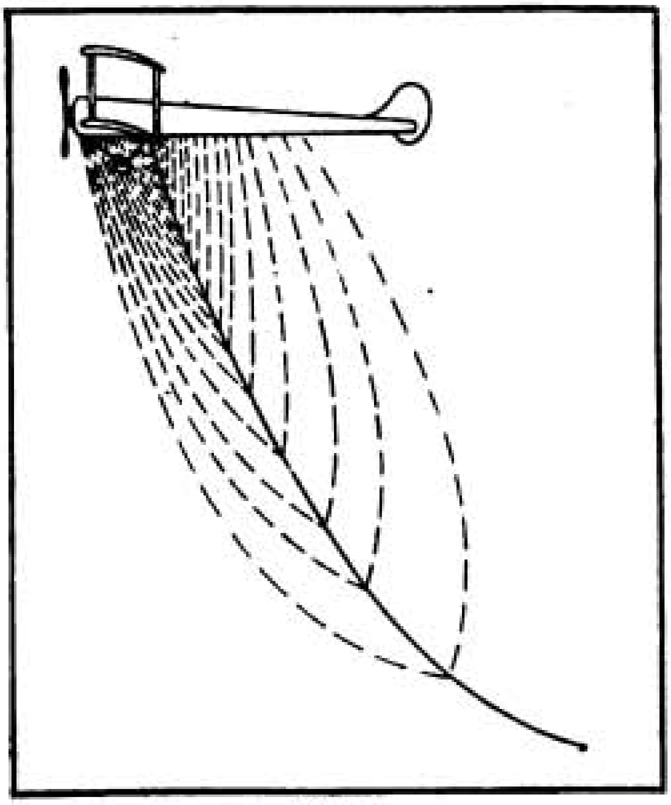


*Fig. 5.*

placed by the capacity effect between the plane and the hanging aerial.

The distribution of the lines of static strain are shown approximately in Fig. 5. The concentration is greater close to the plane than it is further out towards the plummet of the aerial.

In consequence, equal increments in aerial length give diminishing increases of capacity value. Moreover, the total capacity of the circuit for any given length of aerial will vary with each type of plane. The earth lead of the set is connected to the engine and to any other metalwork available, such as petrol tank, wire stays, etc., and the capacity value of these is dependent upon their total weight, area, disposition, etc., factors that alter with different types of machines.

It is obvious therefore that the only satisfactory way of tuning the open circuit is by experiment whilst in the air with the particular machine in question.

In practice the set is placed in the bus after the *closed circuit* has first been adjusted to the required frequency by means of the tuning-clip. *The coupling should be loose*, say one turn of the helix.

The machine is then taken up and the aerial is let out—fairly rapidly at first—until a length approximating the correct value is approached. During this time the transmitting-key is operated at fairly frequent intervals and a watch is kept upon the readings given by the hot-wire ammeter.

A maximum reading will obviously be shown by the ammeter when the open circuit is accurately in tune with the closed circuit, for then, and then only, do the inductance and capacity of the open circuit counterbalance each other for the particular frequency to which the closed circuit has been set, thereby enabling the current in the former circuit to acquire its maximum value—limited only by natural or ohmic resistance. The ammeter readings should therefore increase with length of aerial until the correct length is in play to put the circuit in tune.

Beyond that point further increase in aerial length only results in a decreased ammeter reading. As the critical point is being approached the aerial should be let out more gradually and the ammeter readings carefully watched.

(It will be remembered that the coupling was, in the first place, set at "loose." The necessary adjustment that should now be made in order to increase this degree of coupling up to the most efficient radiation value is more fully described in the next paragraph. It does not affect the correct aerial length, as just determined, to any perceptible amount, but it is the next adjustment to be made in completing the calibration of the set.)

Once the exact length has been ascertained the aerial should be marked in any suitable way or adjusted permanently to that length for future use.

If the aerial is intended for use with more than one wavelength, a similar calibration must be carried out for each wavelength, after first adjusting the closed circuit to the new frequency by means of the tuning-clip. The aerial is then marked at the points so determined and can therefore in future use be rapidly dropped to the correct depth for the wavelength required.

The manner in which the aerial length varies with different wavelengths in the case of an R.E.8 machine is shown in the following graph:

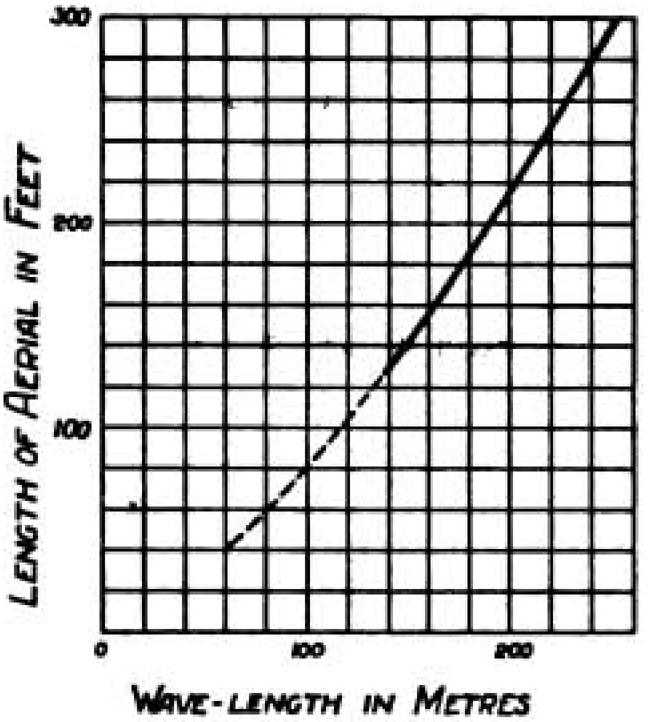



*Fig. 6.*

It may be of interest here to note that the value of the *inductance* of 180 feet of Service type of aerial (R4 seven-stranded spiral) is almost exactly 90 microhenries. Every additional foot measure beyond this length adds 0.8 microhenry to the total.

The inductance value of the calibrated helix is relatively small—approximately 11 mics.

As previously stated, the added capacity effect grows less and less for equal increments in the aerial length. Hence as the aerial is lengthened, the inductance of the open circuit increases at a greater rate than the capacity effect, a fact which adversely affects the " form factor " and the radiation decrement for the longer wavelengths.

## COUPLING.

The final adjustment so far as the circuits are concerned is to determine the degree of coupling that gives maximum radiation of energy at the particular wavelength desired. As has already been pointed out the circuits are auto-coupled through the common part of the helix. The length of this common part and therefore the degree of coupling is fixed by the position of the coupling-clip.

This part that is common to the two circuits, is, of course, the channel through which energy is transferred from the closed to the outer circuit. Considered merely as a path of transfer, the greater the extent of coupling the more energy—of a kind—is passed.

But the circuits have both been tuned to a definite wavelength, say 200 metres, and the problem is to transfer the greatest possible amount of energy at this particular frequency.

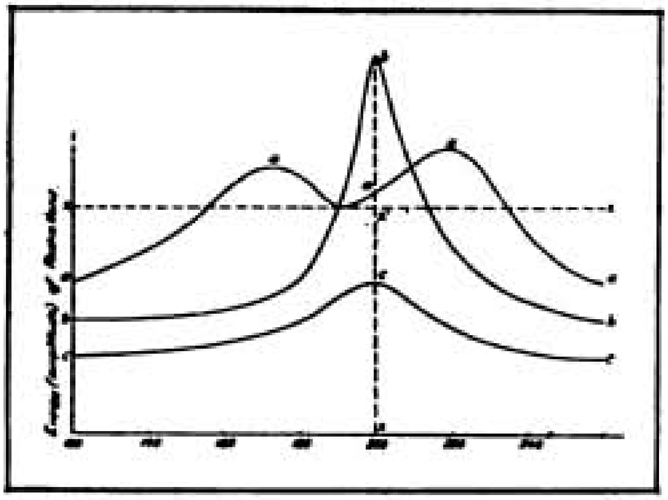


*Fig. 7.*

If too loose a coupling is used, but little energy gets through to the aerial and thence to the other. The curve *c*, Fig. 7, shows the effect that energy so radiated would have upon an infinitely-sensitive receiver tuned in succession to different frequencies. The maximum effect would be registered by the receiver when tuned to 200 metres, but the impulsive effect represented by the ordinate $cX$ would be relatively small. The total energy (at all wavelengths) so radiated would be measured by the area of the curve.

On the other hand, the curve *a* represents the effect of too tight a coupling—or too wide a path of energy transfer.

It must be borne in mind that not only is the coupling a path for energy to flow from the closed to the open circuit, but it is also equally a channel whereby the open circuit reacts inductively upon the closed circuit. The greater the amount of energy transferred in one direction, the more violent is the inductive reaction that causes energy to be poured back from the open to the closed circuit through the coupling channel, and therefore to be wasted so far as radiation is concerned.

The result of such over-coupling as registered by the above receiving-device is shown by the curve *a* where $aX$ is the value of the energy radiated at 200 metres wavelength.

The intermediate curve *b*, however, represents the ideal condition as obtained by correct coupling. The actual amount of energy radiated may not be so great as in the previous case, but the bulk of it is concentrated at or about a frequency corresponding to a 200-metre wavelength, and it will therefore react powerfully upon a receiver tuned to that wavelength.

In the case of a receiver not infinitely sensitive, but, as in actual practice, only responsive to ether vibrations having an amplitude above that represented by the dotted line *xx*, it is now obvious that when such an instrument is tuned accurately to 200 metres, energy, corresponding to the curve *c* will not be registered at all; that corresponding to curve *a* will only be faintly responded to, proportionately to the height $aX^1$; whereas energy radiated according to the curve *b* will have a pronounced effect corresponding to the height $X^1b$.

The last then corresponds to correct transmission giving a high degree of selectivity.

In practice—as opposed to theory—the adjustment of the coupling point is a simple matter and is ascertained immediately after the open circuit has first been tuned in the air. Whilst the correct aerial length for tuning is actually being determined, the coupling should be kept loose—not more than one turn.

As soon as maximum ammeter reading has indicated that the open circuit is in tune, then the coupling should be gradually tightened by moving the coupling-clip inwards along the helix. This will give a slight further increase in ammeter reading up to the critical point of correct coupling. Any increase in coupling beyond this point will cause a fall in ammeter reading.

The additional inductance thrown into the open circuit by tightening the coupling is so small in comparison to the total inductance of that circuit as not to cause any significant de-tuning effect, so that no readjustment of the aerial length is necessary.

The correct degree of coupling varies with different wavelengths owing to the fact that the aerial length and therefore the inductance of the open circuit is altered with the wavelength to be transmitted, and consequently also the value of the reaction effects between the two circuits, of which the coupling factor is a function.

The results so determined in the air should be recorded, and a complete calibration test should show (a) what length of aerial to use; (b) the turns of coupling required, for (c) each particular wavelength to be transmitted. This information should be tabulated by the person responsible for fitting and testing the wireless installation of each plane, and a corresponding calibration card fixed up in some convenient site in that plane to serve for the guidance of wireless operators subsequently using the set.

As an example, the following table shows the relation between wavelengths, aerial lengths, and degree of coupling in the case of an R.E.8.

Photo: Topical Press Agency.

*Wireless Apparatus for the Short Transatlantic Aeroplane.*

| Wavelength (metres) | Aerial length (feet) | Coupling (turns) |
|---|---|---|
| 140 | 131 | 1.25 |
| 160 | 160 | 1.50 |
| 180 | 185 | 1.50 |
| 200 | 212 | 1.50 |
| 220 | 245 | 1.75 |
| 240 | 285 | 1.75 |
| 250 | 300 | 2.00 |

## POWER FACTORS.

It is difficult to give accurate figures representing the input and output of power in such a set as the Sterling. Some useful comparative information may, however, be obtained by a consideration of the approximate energy distribution throughout the circuits.

As measured by a direct-current ammeter, the normal current flowing in the primary circuit whilst the set is in operation is about 3 amps. This is, of course, not a reliable way of measuring the value of a periodically interrupted current, but it is a useful approximation. As the normal voltage is 6, these figures represent roughly an energy input of 18 watts.

In the secondary circuit we may for the present purpose assume a spark frequency of 250 per second, and a spark voltage of 5,000. Then as the condenser has a fixed capacity of .0025 mfds., the energy flow may be roughly reckoned as that due to a condenser discharge of 5,000 volts at the given frequency—

i.e., energy in watts $= \frac{1}{2} KV^2 \times 250$

$$= \frac{1}{2} \times \frac{\cdot 0025 \times 5000 \times 5000 \times 250}{10^6}$$

$$= 7 \cdot 81 \text{ watts.}$$

The proportion of this energy that is transferred through the auto-coupling to the open circuit is much more difficult to estimate.

If the whole of the energy were represented by undamped oscillations, then after an initial period of time practically all the energy from one circuit would be transferred to the other. But, actually, the high-frequency oscillations are damped, and heavily damped, so that a big proportion of the total energy of a wave train is carried by the first wave. The proportion of the energy of this first wave transferred from the closed to the open circuit will primarily depend upon the degree of coupling, so that within limits it may be taken that this factor mainly determines the energy transfer.

In actual practice, a loose coupling means a small proportion of energy transfer, and therefore a short range, whilst tight coupling secures a greater energy transfer, and consequently a longer range, considering only untuned radiations in both cases.

When, as is more usual, selectivity is a consideration, and it is desired to radiate at a definite wavelength, the effect of mutual interaction between the open and closed circuits, becomes important, and the coupling is adjusted, as previously described, so as to ensure a maximum radiation at the required wavelength, rather than a maximum energy radiation at all wavelengths.

(*To be continued.*)

## WIRELESS TELEPHONIC CONTROL OF AIRCRAFT.

New Yorkers had the unique privilege of listening to wireless telephone conversations with a squadron of aeroplanes which soared over the city in battle formation each afternoon during the period of the Aeronautical Exposition, held from March 1st to March 15th. The squadron flights were controlled entirely by wireless telephones.

The novel feature was the privilege given to the general public to wear flying headgear and helmets during the period when formation flying was under way. Visitors were permitted to converse with the squadron commander and also listen to the orders given from the ground, and from the squadron commander to the rest of his pilots.—("*The Wireless Age.*")

# Aviation Notes.

## THE TRANSATLANTIC FLIGHT.

As we go to press, expectation of an imminent start is still maintained from day to day. Messrs. Hawker and Raynham have for some time past only been waiting for a weather report that could reasonably be interpreted with the word "go."

Unfortunately the public generally have been kept at such a fever heat of anticipation by the newspapers that the prolonged delay has, by reaction, introduced an element of farce into the situation. This has not been lessened by the unfortunate experience of Major Wood, who was forced by engine trouble into the sea near Anglesey whilst on his way from Eastchurch to Limerick, whence he proposed to make the ocean flight westwards.

That incident, however, only serves to emphasize the wisdom of waiting for such weather conditions as at least offer a fair prospect of success, for even with this much in hand, the handicap, as Major Wood has demonstrated, is severe enough. Foolhardiness is sometimes favoured with luck, but success more surely attends him who tempers ardour with due precaution.

It is a pity, in one sense, that public interest has been so long and continuously stimulated by day-to-day reports of an immediate start, whilst in fact, owing to the very unfavourable period of the year, the probability was very much against any prospect of a reasonable attempt until the weather became more stable with the advance of summer. However, that time is now approaching, and there is every probability that in our next issue we may be able to congratulate the victor, and perhaps one or more acolytes.

## THE BOULTON-PAUL MACHINE.

Messrs. Boulton and Paul, of Norwich, have entered the list of competitors for the £10,000 prize. The machine is a special adaptation of their long-distance bomber. She has a cruising range of 3,800 miles, and is fitted with two 450 h.p. Napier Aero engines.

The firm are making a special feature of "safety first." The machine will fly fully loaded on one engine only; though under full power her maximum speed is no less than 148 miles per hour, with a normal cruising speed of 116.

She will carry three pilots, two being navigating and wireless experts. Two wireless installations are fitted—one a "spark" set for transmitting and receiving, the other a directional outfit for navigating purposes.

The flight will not be made before June or July. It is, however, intended to make the flight whether or not the cash prize has previously been won, the point of view being that the prize is only an auxiliary consideration to the more important point of demonstrating the future commercial possibilities of the right type of machine.

## OFFICIAL WIRELESS CALLS FOR THE OCEAN FLIGHT.

For the information of all concerned, the Air Ministry has issued the following announcement:—

"Some confusion appears to exist

with regard to the wireless call signs allotted to aircraft for the Transatlantic flight.

Each machine is given a group of three letters lying within the limits DKA to DMZ, which serve as a call sign, and as a rapid method of establishing the machine's identity.

Thus DKA is the wireless call sign of the competing Sopwith machine.

A further official announcement states that it has been provisionally agreed upon by the Aerial Sub Committee of the Peace Conference that the International signal, S.O.S., either by means of wireless or visual telegraphy, shall be the recognised urgent appeal signal for Aircraft in distress.

## WAR WIRELESS.

Whatever may have been the case in the early days of the war, there is no doubt that latterly our whole wireless organization was much in advance of the Germans. The work of one Section of our Intelligence Department was to decipher each new code as it was evolved by the enemy. It was a fascinating business, and despite the utmost ingenuity of the Hun it seldom took more than a few days for our experts to pick his brains and unravel his weirdest cryptograms.

In the course of time, also, our operators became so familiar with certain of the enemy senders' characteristics that in many cases they could distinguish a particular transmitter even when he had been transferred from one station or plane to another.

An instance of wireless strategy occurred in connection with a big British counter-offensive in the Amiens sector. A big demonstration was arranged elsewhere, to which certain of our advanced wireless stations were despatched, with instructions to flood the air with bogus messages. This created such a vertical breeze that enemy reinforcements were immediately rushed to that quarter and away from the spot where they were afterwards badly wanted.

## THE ANDOVER DISASTER.

Easter was marred by the news of the tragic accident to a Handley-Page Service machine at Weyhill Aerodrome, near Andover, in which, out of a crew of seven, five were killed and two injured. The machine was specially detailed for wireless work, and was about to start on a circular tour of Great Britain, a particular object of the trip being the testing of the efficiency of the wireless direction-finding installation.

According to the evidence of Lieutenant A. E. Greenwood, R.A.F. (Wireless), the machine started to "take off" at 2.20 a.m. About three-quarters of the way along the flare line her tail lifted, and shortly afterwards she left the ground. Almost immediately she appeared to bear slightly to the right, and following that two slight crashes were heard, succeeded by a louder crash. At the scene of the last crash the machine was found piled up against the wall of a hut and blazing furiously. Lying on the ground about twenty yards away, his clothes in a blaze, the rescue party discovered Lieutenant Westall, R.A.F., the Navigating Officer, one of the two survivors.

The remaining survivor, Flight-Sergeant H. W. Smith, told how, when the crash came, he found himself so entangled in the telephone leads that, but for the presence of mind of Lieutenant Westall in releasing him from the wireless receiver head-gear, he would have been unable to escape from the blazing wreck.

The machine carried 400 gallons of petrol. In the crash the tank burst, causing so fierce a blaze that it was im-

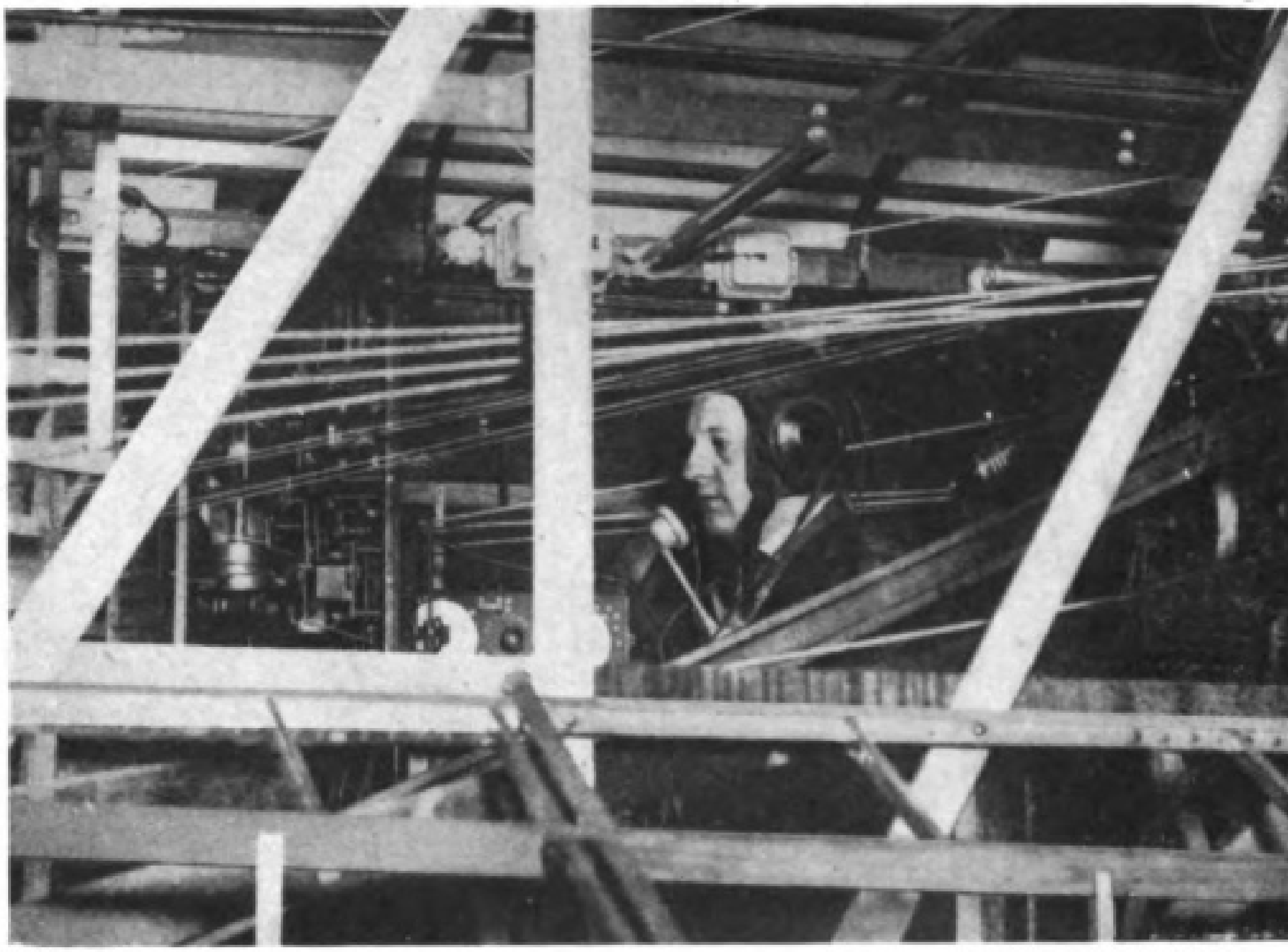


Photo Photo Giles' Agency.
*Wireless Telephony apparatus on flying boat. Note the headgear worn by pilot.*

possible to approach the wreck for some time. It was, however, the positive opinion of Captain Bannerman, the medical officer, after an examination of the bodies, that death must have taken place in each instance, before the machine burst into flames.

The pilot, Major Batchelor, R.A.F., was one of the victims. Captain Gilroy in his evidence, stated that Major Batchelor was an extraordinarily careful pilot, and had considerable experience in flying Handley-Page machines. He was noted for his care in not climbing a machine too steeply, and possibly this very precaution, combined with the darkness, resulted in an error of judgment which led to the fatal result.

## WIRELESS TELEPHONY BOGIES.

One can, it seems, have too much of a good time, and the development of the wireless telephone is beginning to cause a little anxiety as to where precisely its possibilities stop.

One writer deplores it as adding another horror to life. His dream of a peaceful week-end by plane to the South Sea Islands, to "some solitude where none intrude," is shattered by the threatened prospect of being rung up by his wife, with some long tale of woe, detailing how and why the new cook has given notice.

Another contemplates with satisfaction the joyful prospect of the crop of slander actions that will arise from indiscriminate tuning-in on other folks' conversation. Candour will be an expensive luxury!

However, we haven't reached that stage yet. There is still time for the coming generation to adapt themselves to the new complexities of life. We have just had a war, and it is only right that they should have their share of trouble too!

# The Library Table

## "YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1919."

London: The Wireless Press, Limited, 7s. 6d. net. (7th Edition).

THE appearance of the seventh edition of the "Year Book of Wireless Telegraphy and Telephony" serves to emphasize the great extension of wireless working that has taken place under the strenuous conditions of a world-wide war. The whole of the information on recent wireless development is not yet available for publication, and in view of the large masses of data that have to be handled such publication must necessarily be slow.

The summary of the 1918 progress in the development of new apparatus and in high power and long distance wireless working is given in this volume. in a handy and useful form, while the extensive recent alterations to the Laws and Regulations relating to wireless working in various countries has brought this section of the Year Book up to no less than 475 pages.

Amongst other alterations a useful new feature has been added to the calendars in the form of a list giving particulars of the official holidays in the various countries of the world. The valuable section on land and ship stations and particulars of call signals has been overhauled and brought up-to-date as far as the current information allows. This section should also be of particular use to the wireless amateur and experimenter as soon as the present restrictions are relaxed, especially in view of the large increase in receiving ranges consequent upon the modern development of the valve amplifiers. Dr. J. A. Fleming has once again contributed with a valuable discussion upon "Maxwell's Electromagnetic Theory of Light and Its Important Relation to Wireless Signalling." The intimate connection between radiotelegraphy and aircraft is emphasised by an interesting article by Dr. W. H. Eccles dealing with the special maps for which the rapid progress of wireless and aeronautics is creating a demand. The uses of wireless telephony on aircraft are also dealt with amongst other matters in "A Review of the Methods and Progress of Radiotelephony" which is contributed by Mr. Philip R. Coursey. An instructive communication dealing with the "Experimental and Acoustic Characteristics of Telephone Receivers," by Dr. Louis V. King, has also a bearing upon the same thing.

Mr. I. Schoenberg's series of analytical notes and "Valve Patents in 1918" is likely to prove of great utility to experimenters in this field and forms an instructive addition to the similar series published last year, as does also the list of patent applications dealing with wireless, made during 1918.

A mention of the section on International Times and Weather Signals must not be omitted, especially on account of its great importance in connection with long distance aircraft flights. The map of the wireless stations of the world has again been brought up-to-date and now includes some 900 stations.

The Bibliographical notes have been revised and augmented, as have also the Definitions and the Five Language Dictionary of Technical Terms used in Wireless.

# Personal Notes

## WIRELESS OPERATOR RECEIVES MILITARY MEDAL.

Mr. Montague V. Pocock (formerly 9176, 1st Air Mechanic) of Cardiff, has been decorated with the Military Medal for "conspicuous gallantry and devotion to duty." It seems that on June 25th, 1917, whilst working in conjunction with an aeroplane which was observing for a siege battery, Mr. Pocock's aerial was broken up by shell-fire. He mended the aerial under heavy fire and "carried on" after only a short interruption to the "shoot."

## NEW APPOINTMENTS.

We learn that Captain W. A. Andrews, B.Sc., has been appointed lecturer in wireless to the Marine Technical School which is to be established at Cardiff Technical College.

Mr. H. E. Penrose, formerly the Chief Instructor in the School of Wireless Telegraphy at Marconi House, has been appointed by the Marconi International Marine Communication Co., Ltd., as their Resident Inspector at Capetown. Before his departure from this country Mr. Penrose received an illuminated address and a gift of silver from his colleagues in the School, with whom, as with all who know him, he was exceedingly popular.

Mr. H. E. Watterson has been appointed Wireless Telegraph Engineer to the Egyptian Government. This gentleman entered the service of the Marconi Company as an operator in 1903, and was eventually transferred to the engineering staff, doing duty connected with the erection and running of wireless telegraph stations in many parts of the world. During the war he held a commission in the R.N.V.R.

## OXFORD HONOURS GENERAL FERRIÉ.

On May 6th, the University of Oxford conferred on General Gustave Auguste Ferrié, Technical Director of Military Wireless Telegraphy in the War Office at Paris, the degree of Doctor of Science *honoris causâ*.

## OBITUARY NOTICE.

It is with deep regret that we have to record the death, on Friday, 9th May, of Mr. Henry Spearman Saunders, who was a director of the Associated Marconi Companies. Born in 1841, the deceased gentleman was the son of the Hon. Frederick Saunders, Treasurer of Ceylon. At an early age Mr. Saunders joined his parents in that colony, where he devoted himself to public and commercial life. On returning to England some eighteen years ago, Mr. Saunders accepted a seat on the Board of Marconi's Wireless Telegraph Company; later, he became a director of the Marconi International Marine Communication Company.

By his death, the Marconi Companies have sustained a severe loss.

## HEROIC OPERATOR ON MIDLAND RAILWAY STEAMER.

Amongst other names that of Mr. A. Cowler, wireless operator on the s.s. *Donegal*, has been mentioned for valuable services performed when that vessel was sunk by enemy action on April 17th, 1917. Mr. Cowler, who lost his life on that occasion, was partly instrumental in saving the lives of some 700 wounded soldiers who were on board.

# The Construction of Amateur Wireless Apparatus

*This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of Condensers. The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.*

*Article Three.*—CONDENSERS.

IN the last article we pointed out the value of paraffined cardboard as an insulating material for the construction of apparatus. It must not be forgotten that it is only suitable for use in cool places and consequently it is not advisable to wind on cardboard formers coils in which an appreciable amount of heat may be developed. It is particularly valuable for the construction of inexpensive receiving apparatus.

*Dielectric of Condensers.*

(a) *Fixed Condensers.* The nature of the dielectric of a fixed condenser is governed by

(1) Potential to which condenser will be charged.

(2) Grade of insulation resistance required.

(3) Capacity of complete condenser.

Thus before any particular type of condenser is constructed thought should be given to the suitability of the contemplated design to the purpose in view. For the primary condenser of a spark transmitter a high insulation resistance is required, combined with great dielectric strength, but the total capacity required is in general small. These conditions are fulfilled by the employment of glass as dielectric. The plates of the condenser being formed by sheets of thick zinc or copper interleaved with the glass plates. Such a condenser is best totally immersed in dry vaseline oil. The oil keeps moisture from the plates and increases both the dielectric strength and capacity of the condenser. A sketch of such a transmitting condenser is shewn in Fig. 1.

For general use and for portable stations the best form is that shewn in Fig. 2. It consists of a glass tube, closed at one end, something like a large test tube. The tube is copper-plated both inside and outside to within a few inches of the open end. This copper-plating on glass is done by a special process, which gives a strong and durable coating in the closest possible contact with the surface of the glass. These condenser tubes are made of standard capacities, so that by connecting a number of them in parallel or series transmitting condensers of any desired capacity can be made up. Individual capacities of from 0.0006 to 0.001 mfd. are obtainable. Each tube will take a power of about 100 watts. It must be borne in mind that the power for which a primary condenser may be used is dependent upon the total volume of dielectric employed. This will be

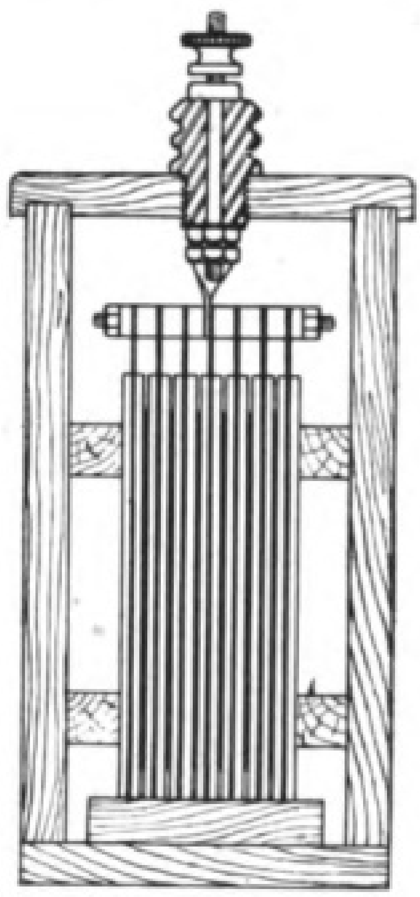


*Fig. 1.*

clear from a consideration of a numerical example. Suppose that we have one cubic inch of dielectric; this may be made up, for example, either as a condenser with plates 1″ square separated 1″, as shewn at (a) Fig. 3; or, on the other hand, it may be employed as at (b) Fig. 3, in which case the plates are 2″ square and the dielectric is $\frac{1}{4}$″ thick. Now, in case (a) let the maximum permissible voltage we may apply to the plates be V, and let the capacity of the condenser be C. Then the energy $E_1$ stored is given by

$$E_1 = \tfrac{1}{2}CV^2 \quad \ldots\ldots (1.)$$

In case (b) the dielectric is only $\frac{1}{4}$″ in thickness and therefore we may apply one quarter of the voltage allowable in case (a). But since the plates of the condenser are only separated by one quarter of the distance of the plates in (a), the capacity *per square inch of plate* is four times as great as before. And as the plates are now four square inches each in area, instead of one square inch, the capacity of (b) condenser is sixteen times as great as (a). The energy $E_2$ which can be stored in this new condenser is therefore given by

$$E_2 = \tfrac{1}{2} \times 16C \times \left(\frac{V}{4}\right)^2$$
$$= \tfrac{1}{2}CV^2 \quad \ldots\ldots (2)$$
$$\therefore E_2 = E_1.$$

And since the volume of dielectric in the two cases is the same, we obtain the important result that the energy which can be stored in any condenser is simply proportional to the volume of the dielectric, and is independent of the size of the plates and the thickness of the glass or other insulator. It might appear from this that the power which may be put into any given condenser will be directly proportional to the spark fre-

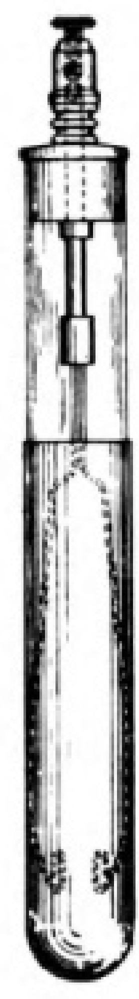
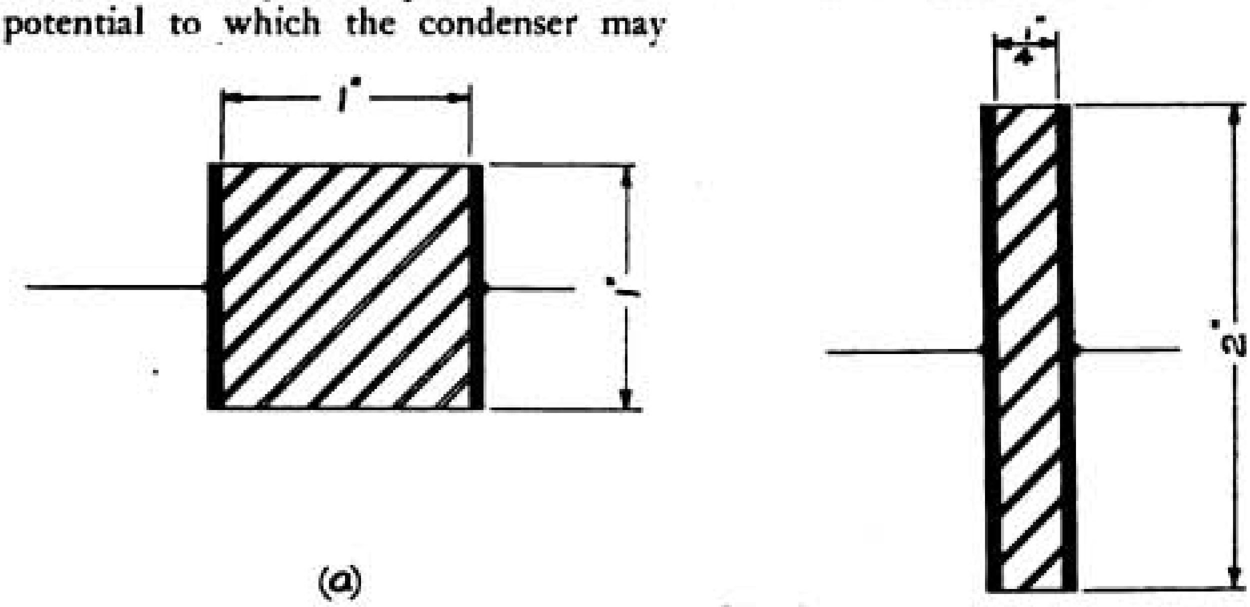


*Fig. 2.*

quency. It is found, however, that in practice an increase of spark frequency must be accompanied by a decrease of potential to which the condenser may be charged before the spark occurs. This is due to the fact that the ultimate strength of the condenser is dependent upon the temperature of the dielectric. Now when an oscillatory current is flowing through the condenser there are losses in the glass or other dielectric employed. These losses appear in the form of a rise of temperature of the dielectric. The temperature rise which is allowable for any given insulation strength will limit the power which can be dealt with by the condenser. For this reason it is usual to specify small condensers by the maximum power they may be used for. As before mentioned, the copper-plated tubes are suitable for about 100 watts each.

(b) *Variable Condensers.* Undoubtedly the best type of adjustable capacity for receiving work (and low power C.W. valve transmitters) is the "air condenser." This pattern is made in various forms, but always consists of a number of fixed plates or vanes between which a similar series of plates are arranged to move. The insulation between the plates is provided simply by the air gap between them. This type of condenser is the most efficient in existence. The insulation resistance is practically infinity and there is no dielectric loss. When designing an air condenser care should be taken to maintain insulation of a very high order between the leads connecting the plates to the terminals of the condenser. Any resistance in the connections will nullify the advantage obtained by the use of air dielectric.



(a) (b)

*Fig. 3*

The chief disadvantage of the air condenser lies in the fact that it is bulky and costly for a given capacity. By the use of ebonite sheets in between the plates as dielectric, the size and cost of the complete condenser can be very much reduced. The ebonite generally used is very thin. It is specially selected and is ground down to a definite thickness. This material is a commercial article. Its use is recommended, as condensers with ebonite insulation are more easily constructed by the amateur; the plates can be got much closer together without the danger of shorting, which exists in the case of the air condenser. Detailed designs for variable condensers will be given at a later date.

One of the most difficult points in the construction of a variable condenser is the connection from one terminal of the instrument to the moving vanes or plates. Quite a good method is that of a rubbing contact, secured by a brush pressing on a slip ring or collar on the spindle of the moving plates. When this type of contact is used, it is necessary that the ring should be in an accessible position in order that the contact surface may easily be cleaned when required. The construction is employed on many condensers manufactured by the Marconi Company, and will be familiar to amateurs acquainted with the "Multiple Tuner." Another method of securing contact is to use flexible leads. This has the advantage of the most certain contact, *as long as the lead is intact.* But condensers which are in continual use are liable to faults owing to breaks in the connecting leads. Great care should be taken in soldering any flexible leads which are subject to repeated bending. In any case only resin should be used as a flux, as corrosion is certain to set in close to the soldered point if any chemical soldering compound is used. Another form of contact to the moving member consists of a gold wire making an arc of contact on a grooved pulley. The wire is kept in light tension by means of a small spring. Fig. 4 illustrates this method. Owing to the movements of the pulley the groove rapidly becomes plated with gold and good contact is thereby ensured. It is most important that the contact should not be microphonic in character. It is just as important that contacts in the oscillatory circuits of a receiver should be as perfect as in the batteries or telephone circuits. Bad contacts on the moving parts of a condenser will cause scraping noises in the telephones whenever an adjustment is made. It is not safe to rely simply on the contact between the spindle supporting the moving plates and the bush in which it moves. Grit and dirt will always collect in the part, and eventually result in inferior conductivity. If it is necessary to use this method some form

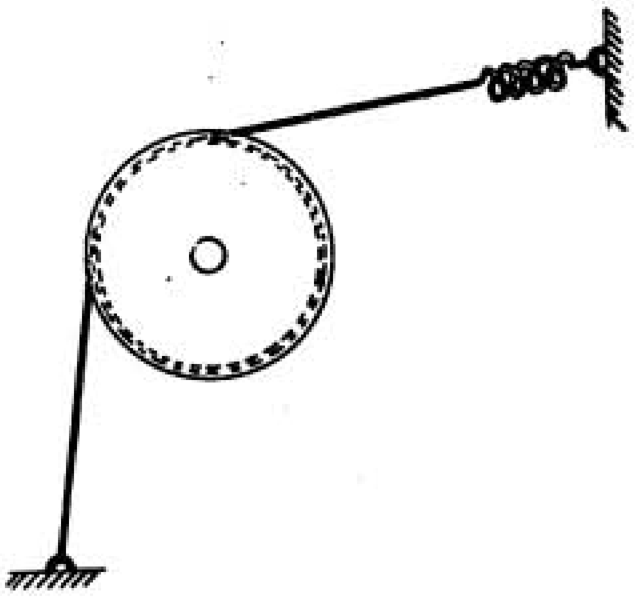


*Fig. 4.*

of spring washer should be inserted between a collar on the shaft and the bearing bush. In the case of copper on brass, or brass on brass contacts, the conductivity is improved by the presence of a little vaseline on the rubbing surfaces. The action of the vaseline is uncertain. One would imagine that the presence of a film of insulating oil between the metal surfaces would raise the contact resistance. As a matter of fact, the measured resistance of a lubricated contact is considerably less than the same contact when worked dry. Of course the vaseline is not to be used on the gold wire contact just described.

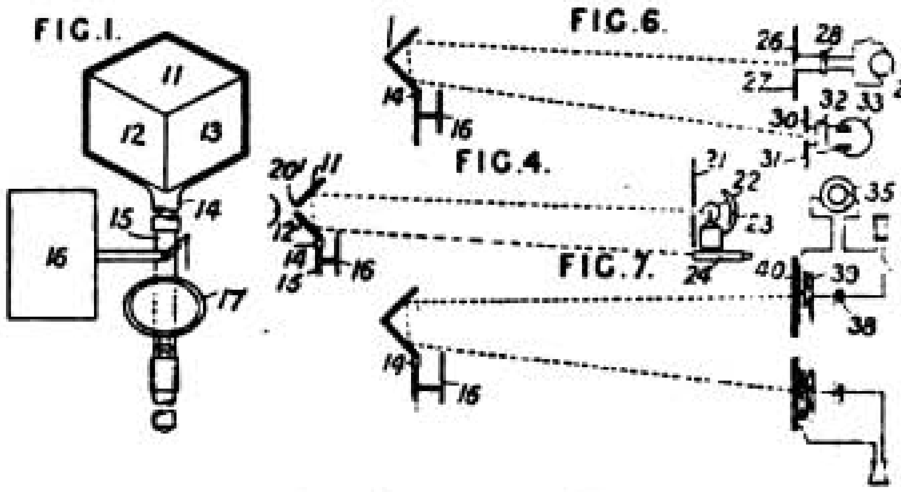
In general, the amateur may safely use the flexible lead connection in cases where the condenser will only be adjusted occasionally. Where constant movement takes place the rubbing type of contact should be chosen. It should also be noted that the system shown in Fig. 4 allows the moving plates to be rotated continuously in either direction.

# Patent Section

*Under this heading will be printed each month abridgments from the Illustrated Official Journal (Patents) of wireless patents recently published.*

122,418. Signalling, etc., reflectors. Fessenden, R.A., 1677, Beacon Street, Brookline, Massachusetts, U.S.A. January 14th, 1910. No. 1012. Convention date, January 14th, 1918. Not yet accepted. Abridged as open to inspection under Section 91 of the Act (Classes 13, 40 (v), 97 (i), and 118 (ii)).

Signalling is carried out by employing a reflector formed of three surfaces each at right angles to the other two which is used to reflect waves of light, sound, electricity, etc., back to the place of origin independently of the position of the mirror, provided that the waves to be reflected enter the solid angle between the three surfaces. The invention is described in connection with signalling from advanced positions to bases during an attack from aeroplanes or for locating the position of buoys, and in connection with wireless telegraphy, and means for producing and detecting sound waves of a frequency above the limit of audibility. As shown in Figs. 1 and 4, applied to an optical signalling system between an advanced position and a base, etc., the forward operator is provided with a reflector 14 formed of three surfaces 11, 12, 13 which are plane mirrors which may be formed with a hole 20[1], at the point of intersection. The reflector 14 is mounted on a rod 15 to which is fitted a shutter 16 which may be employed to send messages back to the rear position at which the transmitting lamp 22, reflector 23, and shutter 21 are situated. A telescope 24 is employed, and when this is directed towards the reflector 14, the reflected light is seen. The shutters 21, 16 can then be used to transmit messages. The forward operator carries the reflecting device only, and is thus not impeded. A mirror 17 may be mounted on the rod 15 and the device is then usable as a periscope in conjunction with the mirror 11. The shutter 16 can be worked from a trench without exposing the operator. The mirror may be formed of a glass tetrahedron with three silvered reflecting surfaces, the base being formed of plane glass, and if desired a small part of the glass at the intersecting corner is ground away to serve the same function as the opening 20[1], Fig. 4. Ultra-violet rays may be used for night signalling, and detectors such as fluorescent screens of quinine sulphate may be used at the position 20[1], or at the object glass of the telescope. A number of reflectors as 14 may be attached to a buoy, and by means of a searchlight it may be picked up by an observer on a ship without mistaking a shore light for a buoy light, and without indicating to an enemy the position of the buoy. As applied to wireless telegraphy the waves produced by conductors 26, 27, Fig. 6, are audion or pliotron 28, and a source of electric power 29, are reflected by a mirror 14 and a metal shutter 16 can interrupt the reflected waves before they reach a receiving device comprising conductors 30, 31, receiver 32, and a double telephonic head receiver 33. For utilizing sound waves of high frequency, these may be produced by a diaphragm 40 operated by transmitting high frequency alternations through a condenser system 39, and in some cases through a telephonic transmitter. The receiving apparatus is similar to the transmitter, and a shutter 16 is used to send the signals from the trench position. The high frequency alternations are produced by a pliotron generator or a high frequency dynamo of the kind described in U.S. Patent 706,737. The sound waves may be produced as described in U.S. Patent 1,167,366.



# 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 telegraphy. 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) Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony. (7) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.*

"CURIOUS" (London) E14.—Has experienced one of those static phenomena which are very difficult to explain. We will give a precis of his letter for the benefit of our readers:—

> "About June 15th, 1918, I was serving in a ship in the neighbourhood of Portland Bill. About 2 p.m. a humming was heard in the telephones which increased in strength. The receiving set was switched off and it was noticed that the transmitter connections were humming. Also a continuous stream of sparks occurred at the earth arrester. The sound emitted from the silence chamber when the door was opened was almost unbearable, and when the cabin was darkened brushing was observed at the Bradfield connection and the sockets of the A.T.I. The demonstration lasted about 25 minutes. The weather was quite clear and there were practically no X's."

It is possible that the effect was caused by a powerful station in the vicinity of the ship. The fact that the effect was continuous and with no semblance to the Morse code could be caused by the "holding down" of the transmitting key. Possibly the ship's set was in tune with the wavelength of the transmitting station, which would induce comparatively large currents to flow in the ship set. We have come across instances of aerials, close to a powerful transmitting station, being in tune with the wavelength of that station. In one case the primary of a magnetic detector was "burnt out," and in the other a spark gap was inserted in the lower end of the aerial when sparks occurred across a gap of about $1\frac{1}{2}$ inches and fused the two nails forming the gap. We have not, however, come across a case where the effect produced was as powerful as seems to have appeared in the instance reported. If any of our readers were in the neighbourhood at this time and came across any like effect we should be pleased to have their experience.

"THANK YOU" (Bolton).—Wishes to know (1) Why when the magnets of a magnetic detector are placed with their like poles together "hissing" is heard in the telephones, but not when unlike poles of the magnets are placed together?

The hissing heard in the telephones, or "breathing" as it is technically known, is due to a peculiar hysteresis of the iron forming the band, which does not occur when unlike poles are placed together. Some operators prefer to arrange the magnets so that the breathing is eliminated, but the result is a certain amount of decreased sensitiveness.

(2) How is it that in the D.C. Side of a $1\frac{1}{2}$K.W. rotary converter the instruments indicate a current of 15 amps. at 100 volts, when on the A.C. side the instruments indicate 25 amps. at 75 volts a seeming increase of power?

Our correspondent evidently does not realise the fact that the instruments in the A.C. side of the converter do not indicate the power in that circuit. This circuit contains a certain amount of self inductance, and when an alternating current circuit contains self inductance the product obtained by multiplying the volts and amperes is greater than the actual power in the circuit. The product $C \times V$ is known as the "apparent" watts and this product must be multiplied by a fraction known as the "power factor" in order to obtain the power or "true" watts in the circuit.

The power factor of a circuit is the cosine of the angle of lag, which angle is determined by the amount of inductance in the circuit. Hence we get that the power in an alternating current circuit

$$= C_V \times E_V \ Cos.\ \theta$$

where $C_V \times E_V$ is the virtual value of the current and voltage and $\cos\theta$ the cosine of angle of lag.

(3) If the speed of a $1\frac{1}{2}$K.W. rotary converter is increased would the power also be increased?

Speeding up the converter increases the spark frequency, but this may result in either an increase or decrease of the radiated power. There is with every set a speed which is the most efficient and it all depends on whether the alteration in speed becomes nearer to or further from the critical speed as to whether more or less power is radiated.

"Thank You," in the fourth question, states that inductance depends on the ampere-turns and the rate of change (*i.e.*, frequency) and that if the frequency is increased the inductance is increased, whereas in a high frequency circuit the wavelength is increased by increasing the inductance but the frequency is decreased.

The whole of our friend's trouble arises from the fact that he is confusing "rate of change" of current, with the frequency or rate of alternation of the current. The frequency of the current in any alternating current circuit is a constant value for that circuit, and depends on the frequency of the supply, but the "rate of change" of current is a varying quantity and is a maximum when the current is at zero and decreases to a minimum when the current is a maximum. The inductance of an air core inductance coil depends on its geometrical form, but for an iron-cored coil it depends on the physical properties of the core as well as the dimensions of the coil. The magnetic state of the iron varies somewhat with the frequency of the current, but for all practical purposes it can be taken that the inductance of a coil is independent of the frequency.

G.B. (Plymouth).—Desires to know what should be the dimensions of a coil, and the size of wire with which it should be wound, to tune an aerial 50 feet long to a wavelength of 2,500 metres?

*Answer.*—For the benefit of those readers who may take up the study of wireless in the near future, we will deal with this question fully in the hope that new investigators may themselves make these necessary calculations. In the question under consideration we will assume that the aerial is a vertical straight wire 50 feet long.

Now the natural wavelength of an ordinary vertical aerial is roughly equal to four times its length, so that the natural wavelength of a single wire aerial 50 feet long is 200 feet, or 60 metres. The wavelength it is desired to receive is 2,500 metres, the ratio therefore being,

$$\frac{2{,}500}{60} = 41$$

The capacity of an aerial depends on the diameter of the wire, and also on its situation with respect to the earth. As we have assumed our aerial to be a straight vertical wire the earth effect may be neglected when making rough calculations.

Let the diameter of the wire be 1 mm., then for a wire 15 metres long the ratio

$$\frac{L}{\frac{d}{2}} = \frac{15{,}000}{\frac{1}{2}} = 30{,}000$$

By referring to Prof. Howe's article reprinted in W. H. Nottage's Calculation of Inductance and Capacity, page 126, we can find, on reference to Table 5, that taking the ratio

$$\frac{L}{\frac{d}{2}} = 30{,}000$$

gives an average potential for our aerial of 20v. The capacity is equal to

$$\frac{\text{Total charge on aerial}}{\text{average potential}} = \frac{1{,}500}{20} = 75 \text{ e s u}$$
$$= 83 \text{ micro-microfarads.}$$

We can assume that the aerial may be treated as a concentrated capacity without inductance—since the latter is negligible compared to that of the tuning coil required—so that the formula $\lambda\,m = 1885 \sqrt{L.C.}$ can be used.

Hence

$$2{,}500 = 1{,}885 \sqrt{0.000083 \times L.}$$
$$L = 20{,}000 \text{ mhy.}$$

This will be somewhat too large, since a coil of this inductance will have of itself an appreciable capacity comparable to that of the aerial, which has been neglected.

A coil which would have an inductance of 20,000 mhy. can be made by winding 520 turns of No. 26 s.w.g., s.s.c. wire on a former 16 cms. in diameter, and 28 cms. long. We will leave "G.B." to work out the length of wire required. If the former is made of cardboard tube the tube should be coated with shellac varnish before winding and the winding should then be shellaced. It will be necessary in order to make contact with the turns to bare a strip along the coil about ¼-in. wide and to use a sliding contact. Our correspondent should have no difficulty in picking up the more distant stations whose wavelength is within that of his own set, provided he uses his detector, etc., to the best advantage.

BRONDESBURY (Brondesbury).—(1) The school to which you refer no longer exists. This reply disposes of your second question.

E.E.H. (Stratford, E.).—For reception by ear, 25 words a minute is about the average speed. Naturally, the speed of working depends upon the amount of "jamming" present and the strength of signals, apart from the operator's skill. As regards the speed of transmission, this is obviously regulated by the speed at which the receiving operator can receive. We do not know the highest speed an expert *can* attain, but we have known men to receive and write down legibly at 48 words per minute, and transmit by hand at about the same speed. If the message is not to be written down, receiving speed may be as high as 60 words per minute.

D.J.M.C. (Edinburgh).—Quite impossible to answer your question, because the matter in question is regulated by a fixed scale based on length of service, and grade. Why not apply direct to the company you mention?

J.C.R. (Bournemouth).—Certainly, provided you do not without permission (at the present time) obtain apparatus for W/T or divulge information which is at present the secret of any Government authority. Applications for permission to purchase and use W/T apparatus must be addressed to the Secretary, G.P.O., London.

S.B.M. (Glasgow).—It is possible for you to obtain an appointment as a Marconi operator and join a ship without coming to London, but you would have to communicate with the London office of the Marconi Company.

H.W.C. (Leith).—(1) Your navy experience may not have included what is very necessary, viz., a knowledge of commercial wireless sets (Marconi system), and a knowledge of the extensive rules regulating commercial wireless traffic. A short course should, however, be sufficient. (2) In C.W. there is no break between each cycle. This question discloses your need of further study.

W.L.B. (Ealing).—In a discussion on Ohm's Law and carborundum crystals, W.L.B. maintained that Ohm's Law is not interfered with in the case of a crystal; he deduces that the variation of effective resistance due to Joulean heating and Peltier effect will explain the shape of the current-voltage curve, without interfering with Ohm's Law.

From this he arrives at the conclusion that no known substance obeys Ohm's Law, since all substances vary their resistance with heat—"with the possible exception of manganin at normal temperature."

*Answer.*—In the first place W.L.B. is not quite clear about the definition of Ohm's Law, which states that "In any conductor at *uniform temperature* the current is directly proportional to the P.D. between its ends."

This means that as long as the conductor remains at a constant temperature, the curve connecting the current and the voltage will be a straight line. If the temperature of the conductor is raised, and maintained at that temperature, the current-voltage curve will still be a straight line, and will always be a straight line no matter what the temperature of the conductor, providing it is kept constant during the time the readings of current and voltage are taken. The temperature co-efficient curve which W.L.B. is confusing with the Ohm's Law curve is obtained by noting the current due to a known voltage when the conductor is at different temperatures.

We have placed a part of W.L.B.'s statement in inverted commas, as this somewhat defeats his argument since he includes the words at "normal temperature." The temperature co-efficient curve of manganin is a straight line because its resistance does not increase with temperature.

Now the exact action of a carborundum crystal is not yet understood, but it is well known that even when great care is taken to keep the temperature of the crystal constant, the voltage current curve has a rising characteristic shape, and since the current flowing is not proportional to the applied voltage, it is quite true to say that a crystal does not follow Ohm's Law.

The metals mostly have a positive temperature co-efficient, that is, an increase of resistance with increase of temperature, but carbon and most non-metals have a negative co-efficient, that is, the resistance decreases with an increase of temperature.

R.E.T. (Scotland).—We regret to hear that you have been forced to leave the Service owing to ill health, and hope that when the restrictions on amateur working are raised you will be an enthusiastic worker.

With regard to the fact that a small spark can be obtained by allowing newly ground oatmeal to fall on to an iron plate, this is due to the particles of oatmeal becoming electrified by friction during grinding. When standing on a presumably insulated iron plate the charge is stored until discharged by connecting to earth. The spark would resemble an oscillatory spark owing to the capacity of the oatmeal and body.

(2) It is quite impossible to give any idea of the price of fitting up a receiving set as everything depends on the range of the set, and the ability and facilities for making one's own apparatus.

## SHARE MARKET REPORT.

The shares of the Marconi group have shown considerable activity during the past month, owing to recent developments in Wireless and to the fact that the whole system is working.

The announcement of the new issue of Shares in the Marconi International Marine Communication Company was very favourably received, and the Shares show a marked advance in price.

Prices as we go to press (13th May) are:—Marconi Ordinary, £5. 7. 6; Marconi Preference, £4. 10. 0; American Marconi, £1. 8. 0; Canadian Marconi, 16s. 9d.; Spanish and General, 12s. 6d.; Marconi International Marine, ex the new issue, £3. 6. 3; Marconi International Marine, New, £2. 6. 3.