# THE WIRELESS WORLD



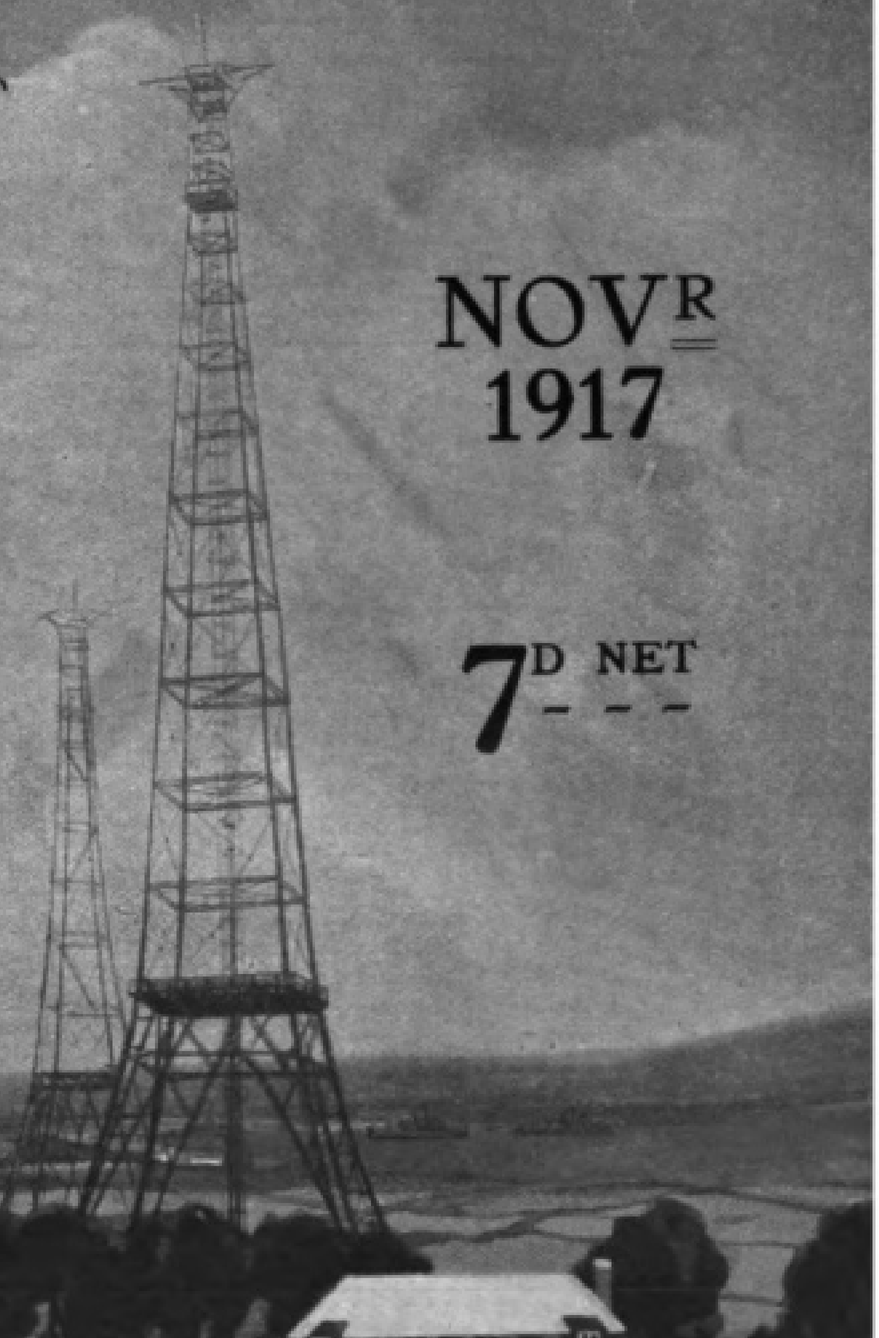
Free Wireless Training

Marconi's Appeal to American Wireless Men

Wavelengths of Antennae

NOV^R 1917

7^D NET



The
# WIRELESS
# · WORLD ·

Volume V. No. 56. NOVEMBER, 1917.

# Reminiscences of an Operator

By W. D. OWEN

## *II. In British Columbia*

CROSSING the Pacific by the "Great Circle" route is a dreary business. As one climbs into the higher latitudes white suits are put away and flannel underwear brought out to air. Two or three days after leaving Yokohama overcoats and mufflers are the fashion. Icicles appear like magic, and Jack Frost paints his masterpieces on our ports. Then one sees the Aleutian Islands like great gaunt icebergs sticking up out of the water. After that comes the fog, cold and damp, condensing on everything and causing our syren to blow at all-too-frequent intervals. A few monotonous days pass, and the thermometer gradually creeps up to 75, and after coming through a particularly dense patch of fog, we come out into glorious sunshine. The change is so sudden it is difficult to realise.

The glorious smell of the pine trees causes the ship's company to scan the horizon for the land that must be near, but several hours elapse before it can be seen.

After a brief halt at Port Townsend for medical inspection, we turn our bows towards Victoria, B.C., where we drop a few passengers and some mail, then on towards Vancouver. This journey is one of great beauty on account of the many little islands through which we thread our way. Scene follows scene in stately grandeur. What a welcome contrast to the weary journey across the Pacific!

CAPILANO CANYON, B.C.

Vancouver City, as can be seen from the map, is opposite Vancouver Island, but on the mainland. It is cut into by many creeks and inlets. North Vancouver is backed by great mountain peaks with snow upon the summits and forests of pines covering the slopes.

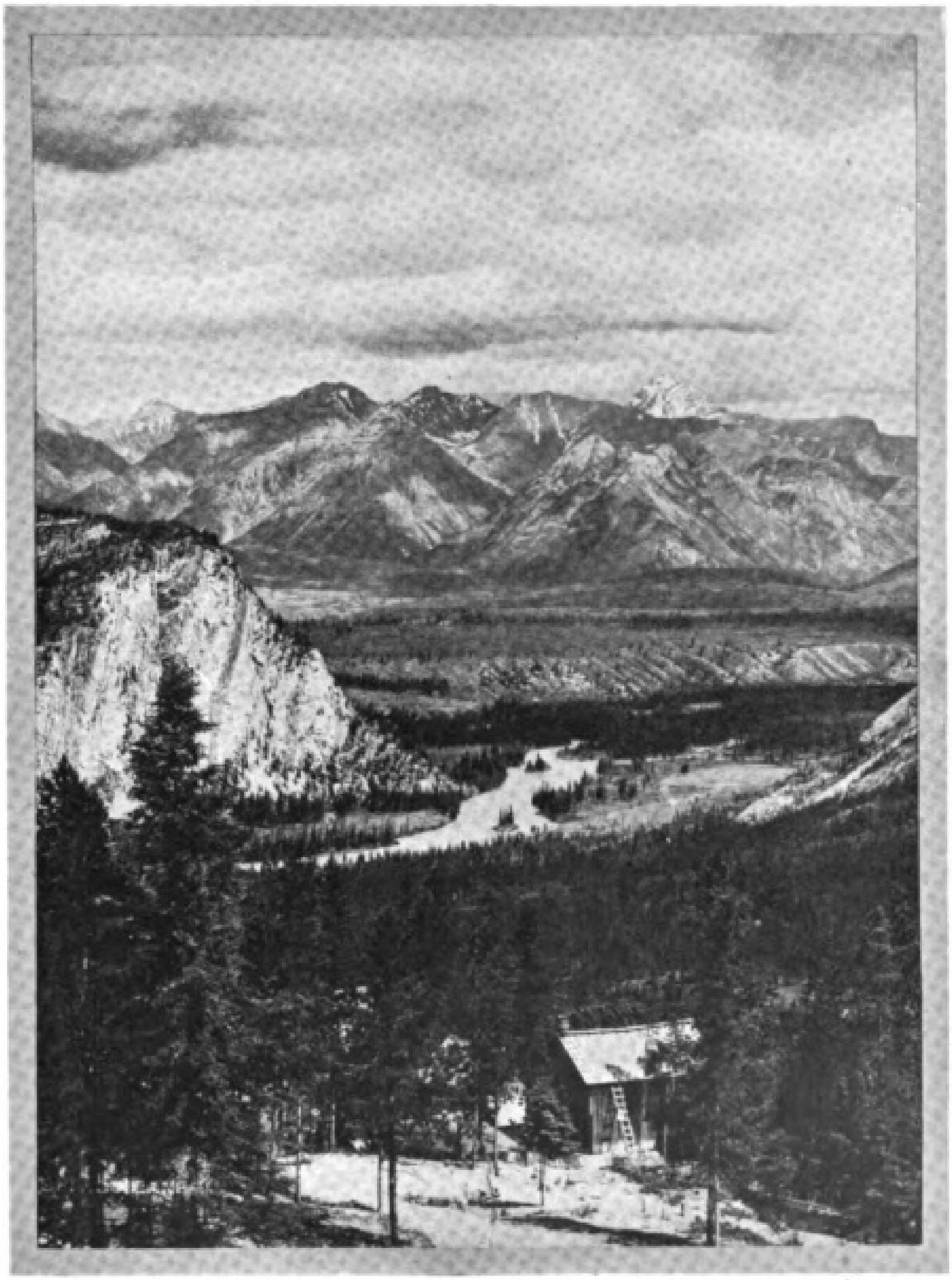
Having heard of the beauties of Capilano Canyon, the Doctor and I set out on an exploring expedition, and we were positively startled by the grandeur of the scenery.

We bestirred ourselves early in the morning in order to have the whole of the day at our disposal, took a ferry to Moodysville (N. Vancouver), and thence we made our way by car to the Capilano Road.

We were surprised to find a car-line so far from the town, but we learnt afterwards of the co-operation between the tramway authorities and the "real estate" speculators. Fortunes are being made by judicious dealings in "real estate." Tracts of land are to be bought very cheap. If held for a year or two, levelled, cleared of trees and undergrowth, the value rises many-fold. In order to help up the value of the land the Government, in conjunction with enterprising combines owning large tracts, run car-lines right along the land. What they lose on the cars they make up on the appreciation of land values. Thus car-lines may be found running through miles of forest and bush land, generally terminating near some spot of extra beauty that is boomed as a natural park. Such was the car-line that took us to the Capilano Road through several miles of bush.

Alighting at the terminus, we started climbing the hillside until we came to a yawning chasm. In the distance we could see a suspension bridge, high up above the torrential waters, looking as frail as a spider's thread. So we set out to reach the bridge. Arriving there hot and dusty, we refreshed ourselves at a log-house retreat that Providence had placed there for our special benefit, and filled our pockets with suitable "stores." From the log-house a fine view of the suspension bridge was duly recorded by the Doctor's Cameo.

A rough toll-house hid the bridge from sight, but on passing through and



[Photo: H. J. Shepstone.

A TYPICAL SCENE IN BRITISH COLUMBIA.

paying our dues we came upon one of the most wonderful sights it has ever been our good fortune to witness. Two wire ropes were slung across the Canyon hundreds of feet above the water, and from them dangled a wooden footway three or four feet wide. The whole structure swayed in the breeze. Every footstep, no matter how light, sent a tremor rippling across it like surface waves on a lake.

The view from the bridge was magnificent. Huge mountains rose high into the clouds on either side; and far below a raging torrent of water from the hills.

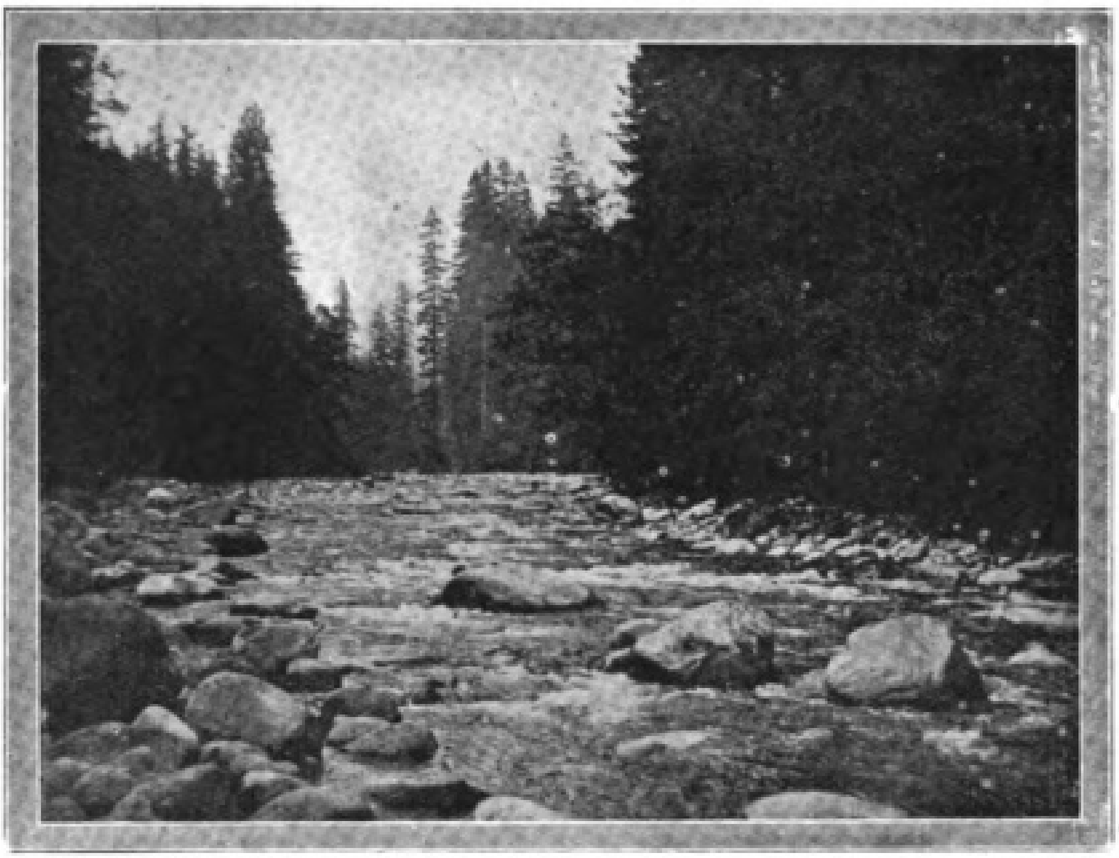
I must confess that I stood awestruck for awhile. It seemed almost like sacrilege to attempt to photograph the scene, but we made a few studies and passed over to the other side. Here, we were told, we would find the "flume," or aqueduct, which had been erected to carry the timber down to the sea. Timber is the source of great wealth to the country. It costs practically nothing beyond the cost of the labour. Cartage is a big trouble, however, and this "flume" surmounts it to a certain extent. The trees are cut and roughly trimmed on the spot, then they are placed in the "flume" and are carried down to the sea by the flow of water.

Although rough, the "flume" is a fine piece of engineering. Many miles of mountain-side are crossed by this wooden trough, which diverts part of the water from the mountain streams and carries the logs down to the awaiting lumbermen at the mouth of the Capilano Creek. It is supported on trestles, and is of wood throughout. All along one side of it is a narrow plank footpath scarcely a foot wide. This footpath forms the quickest way to what is known as the Second Canyon, and although the distance is barely two miles, it seemed very much longer; but this was obviously due to the mode of transit. When one has to do the Blondin act across precipices and ravines upon a springy nine-inch plank, it is not surprising that the two-mile journey seemed like ten. Apparently this journey is thought little of, for we passed a couple of ladies going in the opposite direction, and a terrible business it was, too, letting them pass. The Doctor thought they were rather ill-bred, because they did not acknowledge our efforts

SUSPENSION BRIDGE ON THE WAY TO CAPILANO CANYON, B.C.

on their behalf; but I put it down to their reluctance to speak with their mouths full, for if their hearts were not in their mouths they must have been hard cases. A false step would have meant a broken neck.

Soon the trees began to thin out a bit and the roar of the waters grew louder, and suddenly on taking a sharp turn, the path led up to a scene that brought an involuntary cry of surprise to our lips. If the first Canyon was magnificent, what combination of adjectives would fitly describe the appalling grandeur of this one? Here the water was lashed into pure white foam by the rocks, and large fishes were flung wriggling into the air with the spray. Towering rocks all round and giant trees everywhere.



CAPILANO CREEK, 200 FEET BELOW THE SUSPENSION BRIDGE.

We stood for awhile fascinated by the scene before we unslung our cameras and made an attempt to photograph it, fully realising, of course, that no picture could compare with that fairy landscape. Long and earnestly did we drink in the beauty of our surroundings, then we climbed down the hillside and played like children among the water-washed rocks in the little bays, where it was safe. We cooled our tired feet in the water, and then, as the sun began to get low on the horizon, we started reluctantly back, stopping at the log-house, where we had the nicest tea since leaving home.

British Columbia is well provided for as regards radio stations, having no less than nine Government-controlled stations open for general public correspondence. These stations maintain a very fine meteorological service, all messages relating to the weather or to navigation being handled free. Indeed, it is obvious that in such a country, a large part of which is occupied by a sparse population, and which is made up of many varieties of land formation and climate, the facilities offered by wireless telegraphy are more than usually useful. Of the total area, which is estimated at about two hundred and fifty million acres, only about five hundred thousand acres are as yet occupied.

# PERSONALITIES IN THE WIRELESS WORLD


CAPTAIN RUPERT STANLEY.

THE branch of the Stanley family, to which the subject of this biographical notice belongs, settled in Ireland under James I.; and he himself, born in 1876, received his early education at Irish schools and universities. After three years of pupilage in Electrical Engineering he joined the technical staff of the Isle of Thanet Electrical Light and Power Company, whose service he quitted two years later to fill the post of lecturer in Physics and Electrical Engineering at the Brighton School of Science and Technology. The Emerald Isle recalled her distinguished son to herself in 1903, the year in which he received the appointment of Professor of Physics and Electricity at Belfast Municipal Institute. It was at the age of twenty-seven that Professor Stanley supervised the organisation, the design and the equipment of his newly established department in this Northern Irish training centre. His training and practice as Electrical Engineer corrected any tendency towards high-and-dry professorialism, and the wireless section of the Telegraphic Department was established *ab initio* on those practical progressive lines which have been maintained ever since. Later on, when Belfast instituted her new university, Professor Stanley received the appointment of Extra-mural Professor of Electrical Engineering; his private consultative connection keeping him all the time in close touch with the fresh developments so constantly occurring in the Electrical Industry. He became a Member of the Institution of Electrical Engineers, and in 1914 undertook the preparation of a "Textbook of Wireless Telegraphy" which—published after the oubreak of war—has become a standard textbook on the subject, both at home and in America.

Professor Stanley started his war service as second in command of a Field Company in the Ulster Division, but was soon transferred to Radiotelegraphic work; and in March, 1915, assumed command of the depot at the Wireless Training Centre. In October, 1915, he crossed the Channel for service with the Wireless units of the British Expeditionary Force, and is still serving his country in France. The French President has made him a Chevalier of the Legion of Honour in recognition of his services.

In 1903 Captain Stanley married the second daughter of Sir Chas. A. Cameron, C.B., the renowned analyst and hygienic expert.

# On the Matter and Elimination of Strays

## *An Investigation under the Auspices of the Dutch East Indian Department of Telegraphs*

By CORNELIS J. DE GROOT, Sc.D., E.E., M.E.

**(Engineer of the Department of Telegraphs, Dutch East Indies)**

*Continued from page 455 of our October issue.*

As a matter of fact, these very strong atmospheric disturbances will result in a loss of some words. It is clear, however, that a signal which pierces all strays and is 500 times audibility, gives a deflection on the tape of only 0·02 mm. (0·008 inch) and therefore is not detectable. On the other hand, the continuous crackling atmospherics of small amplitude in Fig. 2, which would not cause the loss of any signals, still represented strays 20 times and more as strong as signals of 500 times audibility. This again brings out clearly the superiority of musical signals.

The tape, on the other hand, records the average atmospheric disturbance during the afternoon in the tropics and shows clearly how difficult radio communication is under these circumstances. We may take as the basis of comparison that a signal of 500 times audibility gives an unreadable deflection of 0·02 mm. (0·008 inch), while the actual strays give deflections of the order of millimetres.

B.—Classification of Strays as to Electrical Nature and Source.

The *strength* and *frequency of recurrence* of strays were the most important factors from the point of view of the designer, since they determined the necessary signal strength at the receiver, and therefore the output of the transmitting station. Of course, the variation of received signal strength and the speed of transmission must be considered.

The source of strays and the mode of their propagation is of the most scientific value, although such knowledge also assists the designer in devising improvements for rendering strays harmless and therefore permitting the maintenance of service with smaller station outputs. In order to procure this necessary knowledge, the operators were ordered to note the typical features of disturbances which were received, in order that a possible classification thereof, relative to origin, might be considered. In this way we succeeded in getting three distinct types of atmospheres.

Type 1.—*Loud* and *sudden clicks* occurring in more or less widely separated groups. When these are not mixed with other disturbances, they do not interfere seriously with communication. They cause the heavy dominating groups of Fig. 2.* Generally, they will result in a loss of a single word in a message for each of the widely separated groups, and they were shown to originate ***in nearby or distant lightning discharges.***

* See page 454 of our October issue.

Type 2.—A *constant hissing noise* in the telephone receivers giving the impression of a softly-falling rain or of the noise of water running through tubes. This type occurs only occasionally when there are dark, low-lying electrically charged clouds near the receiving antenna.

This type was studied in great detail by one of my collaborators, Lieutenant H. G. Holtzappel of the Royal Dutch Navy and now engineer of the Dutch Indian Telegraph Service. These strays proved to be intermittent, uni-directional currents in the antenna. A direct current galvanometer switched into the antenna without any rectifier showed a deflection corresponding to these strays.

The hissing noise in the telephones as well as the fact that the condenser in series with the galvanometer altered but did not stop the deflection, proved, however, that we had to deal here not with ordinary direct current but with uni-directional impulses. The ordinary course of events with this type of strays was the following: The galvanometer gave an increasing deflection for about one-quarter hour, and a maximum of some 0·3 milliampere effective current was reached. Thereafter the deflection decreased for another quarter hour and strays became normal again.

At the same time incoming signals had the opposite tendency to become weaker and weaker, and after one-quarter hour they began to increase until the normal signal strength was again obtained at the close of the disturbance.

Lieutenant Holtzappel attributed the fading away of the signals to the alteration of the antenna constants by the passing clouds. We should rather suggest (or possibly add thereto) the alteration of signal strength caused by overload of the detector and consequent diminution of sensitiveness of the detector. The antenna current produced by these strays is rather strong, as has been stated, and the hissing sound produced in the telephones shows that a large amount of energy is being transferred to the detector.

As disturbances of the type are rather rare and last for only a short period, they did not interfere seriously with communication, and are rather of *scientific* than of engineering interest.

I would suggest that these disturbances are due to physical contact of the antenna with charged particles or to an invisible brush discharge of the antenna toward the low-lying highly charged clouds. The fact that the current induced in the antenna grows and diminishes synchronously with the arrival and departure of the clouds hints at the correctness of the latter solution.

Type 3.—This type produces a *continuous rattling noise* in the telephone something like the tumbling down of a brick wall. Such strays *are always present.* Their strength is a function of the period of the year, and they are most troublesome in afternoon and night They are not well known during the daytime in temperate climates, as in Europe, but are always present in the tropics.

Since these disturbances are of a continuous character, they are the most troublesome to handle; and in fact frequently suppress communication entirely. Often during the period of the west trade wind or monsoon they are accompanied by heavy thunder-storms, these latter causing disturbances of type 1, though this is not the general rule for all seasons of the year. As a matter of fact, the maxima of types 1 and 3 do not coincide at the same portions of the year.

Both types 1 and 3 do not affect to any noticeable extent the loudness of the

B

signal, as do strays of type 2. The signals are merely actually overwhelmed by the superior loudness of the strays.

So far as these disturbances were known in Europe, they were largely attributed to distant tropical thunder-storms* Dr. Eccles' well known theory is based on this assumption. It will be proven further on that Dr Eccles' theory does not cover strays of type 3, since these have been shown to be aperiodic. In contrast, strays of type 1 have been shown to have only a very limited range, especially during the daytime.

On the other hand, M. Dieckmann† has already pointed out that other disturbances may possibly be produced by sudden alterations of the potential distribution in air levels near the earth. It was, therefore, thought of interest to investigate to what extent the three types of strays were different in nature and source, in order that they might be separated electrically.

## C.—Tests for the Separation of Different Types of Strays.

The means of investigation is this direction were given by Dieckmann himself in that he recommended the use of an aperiodic shielding cage around the antenna. If this cage is suitably designed it will permit signals and such periodic disturbances as those of type I to pass through and reach the antenna ; and they will be received almost unweakened. On the other hand, aperiodic variations in the static field around the earth and other aperiodic disturbances would not reach the detector, the antenna being screened from the earth field by the Dieckmann cage.

As such a cage is not easily built around extensive antennas, a special antenna was built for this purpose, consisting of phosphor bronze wire of 1·5 mm. (0·06 inch) diameter, surrounded by a vertical cage. The length of both the wire and this cage was 30 meters (100 feet).

The cage consisted of four vertical hemp ropes placed parallel to the antenna wire and at equal distances from it. The four ropes were linked together every 50 centimetres (20 inches) by horizontal square loops of galvanized iron wire, making a large cage the section of which measured 50 centimetres by 50 centimetres (20 by 20 inches).

As these squares of wire were all placed perpendicular to the antenna wire, they could not interfere seriously with the reception, but could only increase the effective antenna capacity.

All sixty of these squares were connected aperiodically to each other and to the earth by a thin high-resistance manganin wire. Afterward it proved possible to connect them by a copper wire and to connect the entire system to the earth from this wire through the high resistance without spoiling the results. The best solution remains, however, to have resistance coils inserted in the down leads, so that practically no part of the cage can swing electrically.

Since the antenna under test was supported by a mast from which other antennas were also suspended, these antennas and all other parts of the masts and stays that could be set into electrical vibration had to be grounded through high resistances.

* Dr. Eccles' paper, September 4th and 11th, 1912, before the "British Association," and *Jahrbuch der drahtlosen Telegraphie*, etc., volume 7, part 2, page 203.

† M. Dieckmann, *Luftfahrt und Wissenschaft*, part 1, 1912.

This precaution is very necessary to make the cage function effectively; since otherwise aperiodic strays would cause the above systems to vibrate by shock excitation in their fundamental frequencies and the electro-magnetic waves produced by them would pass through the cage and reach the test antenna. In this way strays would be propagated through the cage and received.

Other investigations have not found the Dieckmann cage of any use, and I can attribute their failure only to lack of the preceding precautions.

After the precautions mentioned were carried into practice, however, we found Dieckmann's statements as to the usefulness of the electrostatic shielding cage to be strickly confirmed, inasmuch as a certain aperiodic type of strays was quite suppressed thereby. The result of comparative tests was that on afternoons when distant lightning showed in the sky, loud clicks produced by atmospherics of type 1 were received regardless of whether the cage and surrounding oscillators were aperiodically earthed or not.

While observing these distant lightning flashes almost every click or group of clicks in the receiver coincided with a distant flash, thus proving that the lightning type of atmospherics (Eccles' type) cannot be cut off by the Dieckmann cage, and for this reason must be of periodic character as heretofore supposed.

It should be noted that the strength of signals received when using the Dieckmann cage was not appreciably reduced.

On the other hand, at night-time, after thunder-storms and rain in the afternoon (the neighbourhood being then quite free from lightning disturbances), rattling strays that could still be heard as long as the cage and neighbouring oscillators were insulated would be completely cut off as soon as all these conductors were aperodically grounded.

This proved that this particular type of strays (of type 3) was not of periodic character, but must have been of aperiodic type found by Dieckmann.

The type 2 disturbances did not happen to occur during these comparative tests, but since their natural source is known as before stated, it is easily seen that the Dieckmann cage must eliminate them.

The only type not cut off by the cage seems to be type 1. or the lightning type of strays.

We shall next prove that these strays of type 1 are by no means the general type they were supposed to be by Dr. Eccles. Thereafter it will be clear that strays of type 3 are the most *important and main type* of strays.

### Proof that the Lightning Type of Strays is not the most general Type (as supposed by Dr. Eccles) and that the Difference between Day and Night Strays is not due to Differences of Absorption between the Lightning Centre and the Receiving Station.

(*a*) The continuously present strays of rattling character, without much space between the different groups, faint in the morning, stronger in the afternoon, and at least equally strong or even stronger at night, do not originate in distant lightning at all. This is clearly shown by the above-mentioned tests with the Dieckmann cage. These strays were easily screened off, whereas strays originating in lightning passed through.

(*b*) The Eccles theory presupposes a long range for strays originating in lightning, and especially during the night-time because of the lack of absorption in the intervening medium. This supposition must be doubted. At our three stations we frequently had to ground one of the receiving antennas because of dangerous and violent thunder-storms in its immediate neighbourhood. On the other hand, at the same time both of our other stations were continuing their communication without noticing any trace of extraordinary strays.

As the stations are only between 890 and 1,610 kilometres (550 and 940 miles) apart, and thunder-storms at one station did not produce noticeable disturbances at our other stations, there is no way of understanding how strays originating in thunder-storms could reach temperate zone countries (*e.g.*, in Europe) at least ten times as far away and produce serious disturbance there. As a second proof of the short range of disturbances produced by thunder-storms, it will be remembered that on nights following afternoons during which a thunder-storm occurred with heavy rainfall, no strays originating in thunder-storms were received. This was known by the fact that during such nights the strays could be cut off by the Dieckmann cage.

Since the strays produced by the above-mentioned thunder-storms were clearly local in character, it was obvious that distant thunder-storms do not produce appreciable disturbances.

(*c*) Dr. Eccles takes the tropics as the origin of thunder-storms. This being supposed to be their origin, there could be no large difference between strays during the day and during the night, the source being at all times comparatively near at hand.

Though this point of view is partially supported by the fact that there are some times of the year when strays are almost as loud in the afternoon as during the night, still there is always enough difference, even in the worst months (and especially in those months during which strays in the daytime are not strong) to make it certain that the tropics are not the centre of strays originating in thunder-storms.

The tropical regions cannot be a centre of lightning storms and resulting strays for the reasons mentioned, and in addition they cannot be at a great distance from a long-range centre, since, in the latter case, strays at our different stations, though of different loudness, should always occur at the same moment. This is positively shown not to be the case by experiments, though the same average daily and annual laws of intensity variation are found. The same definite noise or burst of strays is not heard at the same moment by the different stations.

As our stations are not in the supposed centre of stray origin, and since they are also obviously not outside of this centre, the stray centre of Eccles cannot exist. There are, of course, centres of wave propagation in the neighbourhood of thunder-storms, but the range of these strays is certainly less than 900 km. (550 miles).

Consequently the stray phenomena observed in Europe cannot simply be explained on the basis of the assumption of a tropical thunder-storm centre and subsequent variations in the strength of strays caused by changes in propagation through the intervening ether. It is clear, then, that the most generally present type of strays, namely, those of type 3, must be generated in some other way than that suggested by Eccles, that is, by tropical thunder-storms, and the simultaneous existence of the different types of strays may account for the failure of the many arrangements attempted to eliminate strays.

Marconi's original "X-stopper," which operated on the assumption of a definite frequency of the incoming strays, could only reduce strays of type 1, but was not effective in practice because it failed to eliminate strays of types 2 and 3.

The Dieckmann cage could only eliminate strays of types 2 and 3, but could not prevent strays of the first type from reaching the detector.

Since the investigators were not aware of the different existing types of strays, both of the devices were rejected as being non-operative.

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# A Call to Wireless Training

On pages 567–8 we print details of a scheme for training wireless men in Provincial centres, and in the particulars which will be found there it will be noticed that Newcastle-on-Tyne forms one of the localities where special attention is being given

to this matter. Our illustration (above) depicts Neville Street and St. Mary's (R.C.) Cathedral, the central point of this important city.

# Digest of Wireless Literature

## Absolute Sensitiveness of the Oscillating Valve.

In a paper recently presented to the Institute of Radio Engineers by Dr. Louis W. Austin, of the United States Naval Radiotelegraphic Laboratory, some interesting details are given regarding a test to determine the sensitiveness of the oscillating valve or "audion," as it is usually termed in the United States. The relative audibility of the oscillating audion and the old type audion for buzzer signals has been determined many times, says Dr. Austin, the average ratio being about 600. Similar comparisons have been made between the old audion and the free-wire electrolytic, with the result that the mean sensitiveness of the old audion is found to be 1·7 times that of the electrolytic. The extreme deviations with different bulbs are 1·5 and 1·8. At the time of the Brant Rock tests * a rather careful determination was made of the number of watts in the receiving system required to give an audible signal for normal ears in the telephone then used with the electrolytic. This was determined to be $25 \times 10^{-10}$ watts. With the improvement in telephones this has been reduced to about $12{\cdot}25 \times 10^{-10}$ watts. From all these data it was estimated that the least power capable of producing a signal on the oscillating audion is $1{\cdot}2 \times 10^{-15}$ watts, using 2,000 ohm telephones having a current sensitiveness of $5 \times 10^{-10}$ amperes at 1,000 cycles. From this value a table † was calculated on the assumption that the oscillating audion produces a current variation in the telephone proportional to the square root of the received watts.‡

In order to obtain a more certain knowledge of audion sensitiveness, a direct determination of the power in the receiving system corresponding to unit audibility in the oscillating audion has recently been made. The method used is practically that used in the Brant Rock experiments. The arrangement of apparatus is shown in *Fig.* 1. The sending wave meter, *A*, was excited by an oscillating audion capable of giving out several watts, thus making it possible to use loose coupling between the circuits *A* and *B*. The detector in circuit *B* was removed, and a sensitive vacuum thermoelement of 28 ohms resistance was placed directly in the circuit. This thermoelement with the galvanometer used gave a deflection of 1 millimetre (0·04 inch) for $40{\cdot}4 \times 10^{-6}$ amperes in the *B* circuit. A double pole, double-throw switch was introduced in the *C* circuit so that the receiving circuit proper could be connected to the audion or to a silicon detector and galvanometer. Using the silicon detector in the *C* circuit with the coupling, *B C*, adjusted so as to give the largest deflection on the silicon galvanometer, a comparison was made between the thermoelement deflections in circuit *B* and the detector deflections in *C*. By exterpolation it then became possible to use the detector galvanometer in *C* to measure

* *Bulletin Bureau of Standards*, 7, page 315; Reprint 159, 1911.
† *Proc. I.R.E.*, 4, page 255, 1916.
‡ *Journ. Washington Acad.*, 6, page 81, 1916.

the radio frequency currents in *B*, even when small enough to bring the response of the oscillating audion within the range of the audibility box when the audion was connected to the secondary receiving circuit *C*.

The sensibility of the audion depends very much on the adjustments of its circuits. It is therefore necessary to choose some definite method of making these

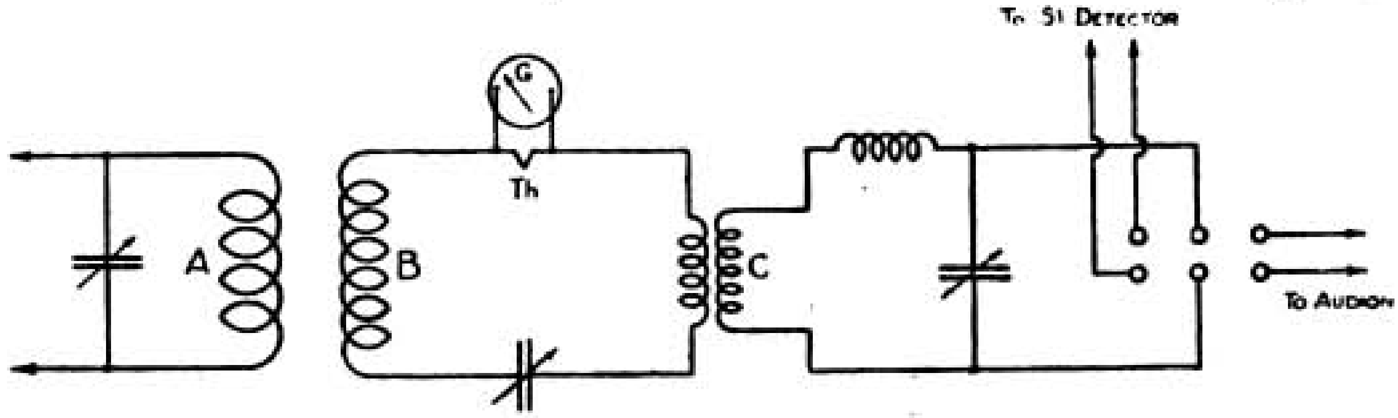



FIG. 1.

adjustments. The following method, while not giving the greatest sensibility, seems to give the most easily reproducible readings. The antenna and closed circuit are first tuned for best signal at very loose coupling adjusting the bridging condenser, grid condenser and reinforcing coupling, if one is used. Then the main coupling is gradually closed to the best point, and the secondary returned slightly for the note desired, leaving the antenna unchanged.*

The audibility observations were made by the test-letter method, mentioned in another portion of the paper. Three wave-lengths were used in the measurements, three thousand metres, six thousand metres and ten thousand metres. The inductance in the secondary, *C*, for three thousand metres was approximately 12 mh. At six thousand metres observations were made with inductances of twelve mh., and thirty-six mh. At ten thousand metres thirty-six mh. were used.

* * * * * *

In Table I. the complete data for a set of observations at three thousand metres are given. Here *D* is the detector galvanometer deflection, *I* is the current in circuit *B*, *W* is the watts in circuit *B*, *A* is the corresponding audibility on the audion

TABLE I.

$\lambda = 3{,}000$ m., $R = 65$ ohms, $L_c = 12$ m.h.
1 mm. deflection of Si detector galvanometer $= 6{\cdot}2\,(10)^{-6}$ amp. in circuit *B*.

| *D* mm. | $\sqrt{D}$ | *I* $10^{-6}$ amp. | *W* $10^{-10}$ watts | *A* | *Wo* $10^{-15}$ watts. |
|---|---|---|---|---|---|
| 2·3 | 1·52 | 9·4 | 57·2 | 2,500 | 0·92 |
| 4·0 | 2·00 | 12·4 | 100·1 | 3,000 | 1·11 |
| 2·0 | 1·41 | 8·7 | 50·1 | 2,000 | 1·25 |
| 2·2 | 1·48 | 9·2 | 55·2 | 2,300 | 1·02 |
| 4·0 | 2·00 | 12·4 | 100·1 | 3,000 | 1·11 |
| — | — | — | — | — | 1·09 average |

* In order to prevent false readings, if the signals are stronger than 100 audibility it is necessary to ground one side of the observing telephones through a suitable choke (pair of 2,000 ohm telephones) to prevent the effects due to the capacity of the observer's body. To prevent the breaking down of the oscillations a high resistance (a hundred thousand ohm or more) may be placed across the grid condenser, or the grid may be grounded through a condenser of a few ten-thousandths microfarad.

and $W_o$ is $\frac{W}{A^2}$ or watts for unit audibility. The total resistance, $R$, of the table is the resistance of the $B$ circuit plus the resistance due to coupling the $C$ circuit with the silicon detector attached. This sum amounts to 1·7 of the resistance of the $B$ circuit alone.

TABLE II.

| λ metres. | $Lc$ m.h. | $Wo$ $10^{-15}$ watts. |
|---|---|---|
| 3,000 | 12 | 1·09 |
| 6,000 | 12 | 1·72 |
| 6,000 | 36 | 1·55 |
| 10,000 | 36 | 1·51 |
| — | — | 1·45 average |

In Table II. the mean values of the power required for unit audibility for the given wave-lengths are given.

Since the watts are proportional to audibility squared, and audibility is by far the least accurate of the observed quantities, the accuracy of the value of watts for unit audibility is not very high. If we assume the error in the mean value of the audibilities to be 20 per cent., which is certainly great enough under the actual experimental conditions, the error in watts for unit audibility would be 40 per cent. We can then consider the probable minimum value of this quantity for our telephones and observers roughly as $1 \times 10^{-15}$ watts, and the maximum value $2 \times 10^{-15}$ watts. The value found by the comparison of the oscillating and non-oscillating audions, $1{\cdot}2 \times 10^{-15}$ watts, lies within these limits. The E.M.F. produced on the antenna by the incoming waves and the received antenna current, which are from the theoretical standpoint the most important quantities derived from the observations in long distance work, have the same error as the audibility readings.

* * * * * *

## ELIMINATION OF ATMOSPHERICS.

We read in *The Wireless Age* that in collaboration H. D. Arnold and H. W. Nichols have evolved a method whereby a transient atmospheric discharge may be eliminated when the receiving apparatus is adjusted to an undamped or sustained oscillation transmitter.

The proposed method of obtaining selectivity by the use of a number of resonant circuits in series between the antenna and oscillation detector, while thoroughly efficient gives rise, on account of the number of coupling coils in use, to considerable energy losses. Beyond this a static discharge striking the antenna system produces a loud response in the receiver even though the circuits are sharply resonant.

The fundamental principle of the apparatus is as follows : Under the impressed electromotive force of an impulsive disturbance the initial rush of current in a receiving circuit is inversely proportional to its inductance ; but the final current during the flow of sustained oscillations is dependent solely upon the resistance of the circuit. Following out this principle, if two parallel circuits have impressed upon them an electric impulse, the initial rush of current in each will be inversely proportional to the inductance, and if the inductances are made equal they may be connected in a circuit to annul each other's effects. This will be the case even though the resistance and capacity in the two parallel circuits are widely different.

If, however, the impressed electromotive force on the two parallel circuits has a sustained oscillatory character, the current which will finally be built up will depend upon all the constants of the circuit, and in the case of a tuned circuit it will depend upon the resistance being inversely proportional thereto. If the one circuit is tuned to the frequency of the received electromotive force and has a low resistance, while the other circuit has equal inductance but a higher resistance, the current flow in the first will be much larger than in the second. In order to obtain discrimination between impulsive electromotive forces and sustained oscillations, it is therefore necessary to give one circuit a large damping constant. This is most easily accomplished by increasing the resistance or decreasing the inductance. By using a third circuit inductively connected to both of the primary circuits, the effect of an impulsive current may be neutralised, but the effect of the sustained oscillations will be transferred to the detector circuit.

Like all devices of this kind where discrimination between the two incoming signals is obtained, there will be loss of energy which can be compensated for by amplifying the desired signal through a number of three-electrode vacuum valves or thermionic amplifiers connected in cascade.

One method of applying this principle is shown in Fig. 2, where it will be noted

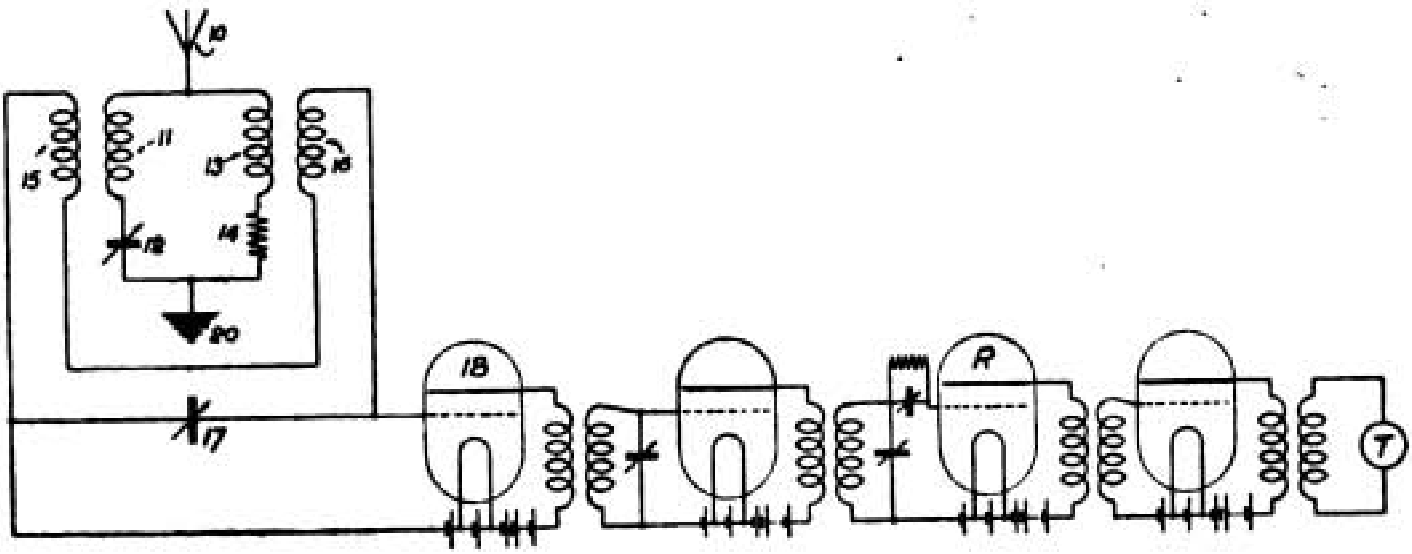



FIG. 2.

that two branch circuits, 11 and 12, 13 and 14, are connected in parallel between the antenna and the earth. In the right-hand branch the resistance, 14, is large in order that the damping constant, $R/L$, of that branch shall be large compared to that of the left-hand branch. Coils 11 and 13 are inductively coupled to coils 15 and 16, which are connected in series, and the final terminals to the grid and filament of a vacuum valve. As is usual in circuits of this kind a source of electromotive force, 22, is connected in series with the grid to maintain a strongly negative potential with respect to the heated filament. It will further be noted that a number of valves are connected in cascade, transformers being employed in the local circuit of the one circuit to the next one, and so on throughout the series. These circuits may be tuned or untuned at the discretion of the experimenter.

The action of the apparatus in Fig. 1 is as follows: If sustained waves of desired frequency are impressed upon the antenna of the receiving station, the current in the tuned branch 11 and 12 is large, while that in the branch 13 and 14 is very small. Energy is therefore transferred to the circuit 15, 17 and 16 and from there on to the oscillation detector, but if static or impulsive disturbances are impressed upon the antenna the current in the two branches will neutralise each other's effects in circuits 15, 17 and 16.

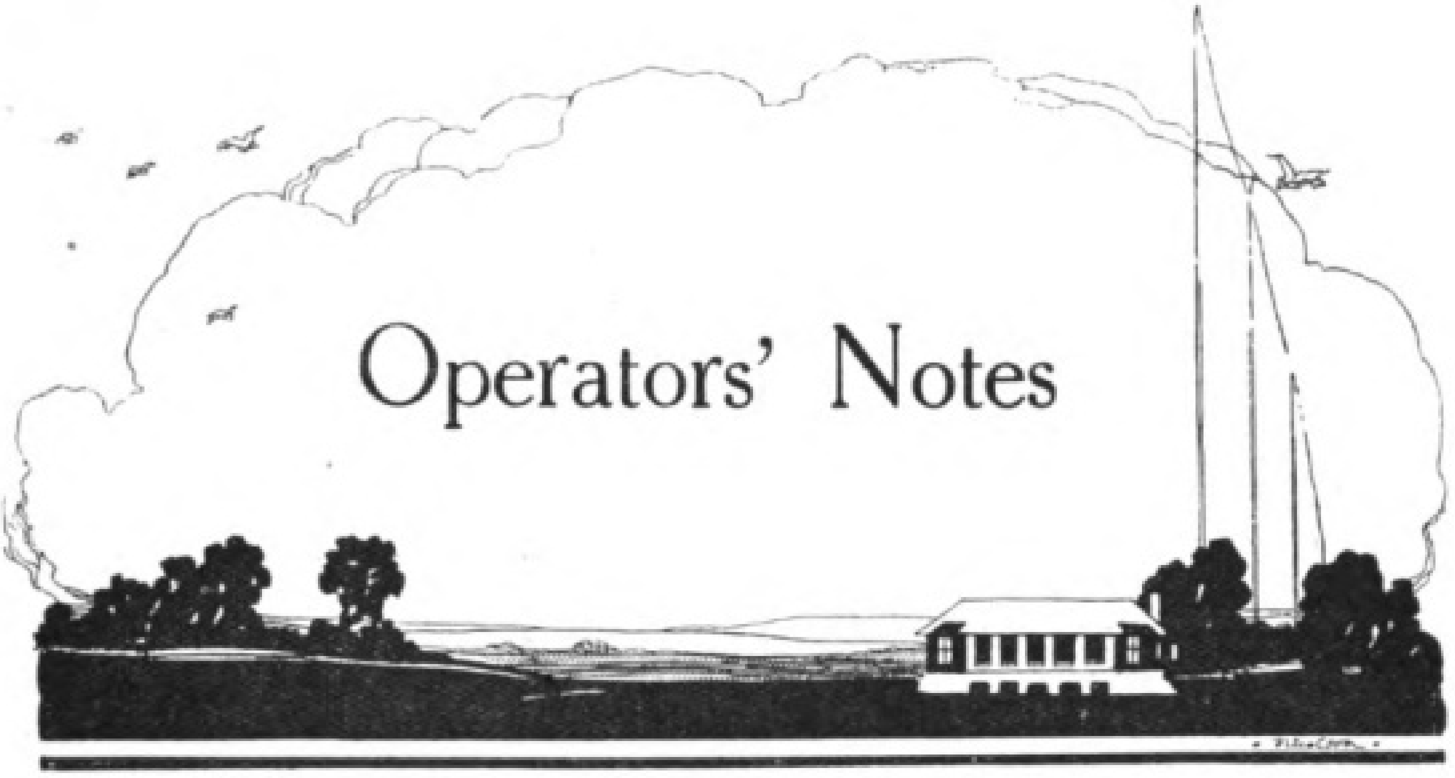
In practice, inductances 11 and 13 are made approximately equal in order that the currents will be equal, but this is by no means necessary, for any difference in the inductance of 11 and 13 can be compensated for by changing the coupling or inductive relation between 11 and 15, or 13 and 16.

# A New Wireless Training Centre

[Photo: Valentine.

THE CENTRAL TECHNICAL SCHOOL, BIRMINGHAM, WHERE THE MARCONI COMPANY ARE OFFERING FREE TRAINING.

THERE are few facts at the moment more eloquent of the progress in wireless than the insistence of the appeal to young men to come and be trained, and the increased facilities now offered to them to do so. The article on page 541 contains an account of the "Call to the Wireless Men of America," and that on pages 567–8 details a Marconi scheme, whereby students in provincial centres may be trained without quitting their own homes or domiciles for the purpose. Full details of the arrangements will be found set forth on pages 567–8. We feel sure that readers will appreciate the urgency of the appeal there made.



# Operators' Notes

## *Hints on the Manipulation of Magnetic Detector*

THE magnetic detector, although less sensitive than some other forms of detector, possesses nevertheless a number of advantages which are of great practical value. Prominent among these is the fact that once properly adjusted it will remain in that state indefinitely. The following are the correct adjustments :—

*Magnets.*—After loosening the securing clamp, remove both magnets, and taking the left, replace it so that its right-hand pole just fits into the middle of the secondary bobbin, the whole magnet being at an angle of 60° from the perpendicular to the left. Then taking the other magnet place it almost at right angles to the first magnet, but with its left pole some little way above the right pole of the first magnet. When this has been done and the clamp tightened, the instrument should be tested with the buzzer, a slight alteration being made when necessary to gain the maximum sensitiveness.

The question as to whether like or unlike poles should be together must be decided by the operator himself. With like poles a slight breathing sound is heard in the telephones, while when unlike poles are together this breathing can be removed, although the sensitiveness is slightly less. Some men prefer a slight breathing with greater sensitiveness, others prefer to annul all breathing at the sacrifice of some sensitiveness, believing that very weak signals may be lost in this breathing sound. On this point there is some difference of opinion.

*Tension of Iron Band.*—The tension of the iron band must be so adjusted that it will move freely round the pulleys without, on the one hand, slipping, or on the other, impeding the movement of the pulleys.

*Faults and Replacements.*—If it is suspected that the primary or secondary windings are faulty they should be disconnected from the tuner and telephones, and tested with a cell and galvanometer. To replace a broken primary it will be necessary to disconnect the two ends of the iron band. These ends which are looped are bound together with a strand of soft iron wire which will have to be cut. *The band must not be cut at any other point,* or it will be found impossible to make a satisfactory joint on reconnecting.

With the band removed, the faulty primary can be pulled from its place in the centre of the secondary. When fitting the new primary it will probably be found necessary to unfasten the cotton which secures the wire to the tube at one end in order to make it small enough to pass through the secondary. The new tube must be inserted in the secondary very carefully to avoid injury to the very fine wire of which the primary is made. The bell mouth end of the primary must be at the end at which the band enters.

The primary winding as sent out from the works will usually be found slightly longer than necessary. When in place it should be shortened by removing a few turns until its length is exactly the same as that of the primary previously fitted. In order to prevent further unwinding the loose end should be secured in place with a touch of paraffin wax or by tying with cotton.

Once the primary winding is in place it will be necessary to secure the two ends to the outer terminals of the detector by a soldered connection. This can be effected by removing the insulation from the ends of the wires and pressing them into the solder by means of a heated soldering bolt. This operation requires some little dexterity and should be carefully carried out. The secondary winding can easily be removed, by unscrewing, after the band has been removed, and its two ends can be secured to the two centre terminals of the detector in the same way as described for the primary. Take great care in removing a good primary from a faulty secondary or the former will be injured and rendered useless.

When replacing an iron band or fitting a new one, the ends must be fastened together with a strand of soft iron wire, a close and careful joint being made, otherwise it will be too big to pass through the tube of the primary. A new band should be well rubbed with vaseline before being fitted so as to make it thoroughly pliable.

*Cleaning the Clockwork.*—When it is necessary to clean the clockwork proceed as follows: After removing the lid of the detector unscrew the winding handle by turning it to the left, and pull out the starting and stopping knob, having set it to the "stop" position. Next loosen the iron band by means of the screw at the left end and after loosening the small screw which will be found underneath it, lift off the right-hand disc. Next remove the screws which secure the bottom of the box and slide the box slightly to the right. The top can then be lifted off, leaving the clockwork exposed on the base. Use only watchmakers' oil for lubricating.

*Replacing a Broken Spring.*—Should it be necessary to replace a broken spring, the brass top plate of the clockwork must be removed, and the spring with its fitting lifted out bodily. New springs are supplied complete with fittings and only need to be dropped into place. In some cases the toothed wheel, which fits on the tiny spindle *above* the top plate, is supplied with the new spring, and where this is the case this wheel must, of course, be removed before the new spring is fitted into the frame. In replacing the top plate care should be taken to see that each of the pivots fits into its correct bearings. As soon as the new spring is in place, and the top plate screwed down, the piece of wire surrounding the barrel should be cut, thus releasing the spring for working.

Some trouble is occasionally found with the bearing in which the fan spindle works. This is held in a fitting which screws to the base plate. Should this fitting be loose the clockwork will not run satisfactorily.

If the spring breaks and no spare is available, a fairly satisfactory service can be carried on by turning the wheel by hand until arrival in port.

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# The Logbook

*Operator D. M. Harris was killed at his post on board H.M. Trawler " Floandi," during a fight in the Gulf of Otranto. His " wireless " logbook has been recovered, and a line running down one of its pages shows how his pencil slipped at the moment death overtook him. A valued contributor sends us this poem, inspired by the subiect.*

Straitly ye kept watch and ward,
Knowing ye had ears to hear
Signals from the Outer Guard,
Or the drifter sinking near.
Tremorlessly sent ye news
Of what deadly work in hand,
Of what scathe to other crews,
Or what devilry by land.
*All that ye did is written fair, written there,*
*In the log.*

Heeding not the moment's stress,
Or private griefs that pressed thee sore,
Ye did the duty, and no less
For that the deck the shrapnel tore.
Pawn in moves so often lost,
Yet ye knew the stake in play,
Knew the hazard and the cost—
And took up th' appointed way.
*And that ye did is written fair, written there,*
*In the log.*

Oh, stricken in that last dread flame,
Do ye dream what scroll ye hold,
Know ye that it is of gold,
And that Honour is its name ?

* * *

For this service nobly done,
Beyond wage, beyond all wage,
By the death ye died alone,
*By the last mark on the page,*
*This that ye did is written fair,-written there,*
*In the log.*

# Lifting the Veil

## *The Ever-growing Field for Wireless, in War and Peace*

Most persons in this troubled world of ours are now fully alive to the meaning and effect of censorship in relation to news; but it is permissible to wonder how many have grasped the fact that, save for some isolated instances only remotely associated with the great drama now being unfolded before us, scientific and technical knowledge, generally speaking, is three years behind the times. Assuredly a few, if not many, of the discoveries made under the reigning condition of intensive research have resulted in developments transcending in practical value many of the most striking inventions of pre-war times. Some of these, of course, have so far merely military or destructive applications; others may prove equally useful handmaids of peaceful progress. This is most certainly the case with regard to the sister-science of aviation. More progress has been made during three years of war than fifty years of peace would have been likely to produce. And the effects of this war progress will be definitely advantageous under peace conditions. Press censorship most wisely absolutely estops all revelation of detail with regard to aircraft and wireless progress alike. But there can, we hope, be no objection to the general statement that many fruits have ripened in the hothouse of war which will be found really "rare and refreshing" to industry and commerce when they can be brought out into the open-air country of peace.

These thoughts, and, incidentally, others bearing testimony to the effectiveness of the censorship on technical progress in the belligerent countries, cannot fail to arise in the minds of those who read on another page of this issue Senatore Marconi's advice to amateur wireless experimenters in the United States. Senatore Marconi is known in this country to have a keen aversion to publicity, and it may be taken for granted that nothing but his knowledge of the extent to which wireless is being used in the field, and the machinery which the United States possesses—through her thousands of skilled amateurs—for meeting the ever-increasing demands for wireless operators, has prompted him to lift the veil, ever so lightly, upon what "wireless" is doing in the cause of the forces of liberty and freedom.

In a matter so technical in character, it is perhaps a good thing that the war-story of wireless has so far not been widely dealt with by our popular writers, though, if we are not mistaken, there is sufficient romantic material, quite apart from scientific data, to cause surprise and wonderment. We venture to suggest in all modesty that so far "Perikon," the able writer of trench stories in this magazine, has succeeded in giving us the broadest hints upon the part of "wireless" in the field, but even he has not made such surprising and definite statements as Mr. Marconi when he announces that: "with the exception of the first two or three months of the war, wireless has furnished the sole means of communication in the first line of trenches," and elsewhere that "the entire heavy artillery control is conducted by wireless."

These facts now being revealed, we are perhaps provided with a clue regarding the enemy aviators' marked anxiety to bring down our observation machines, and the importance publicly indicated by the German High Command to any success in this direction. On the other hand, this same news may explain to a degree the extraordinary proficiency which we have attained in the hitherto neglected field of mobile heavy ordnance.

Mr. Marconi's statements, we repeat, were made with a view to impressing upon the numerous wireless enthusiasts in the United States the very real value which they now possess for their country and its Allies. This message applies with equal force here, though, perhaps, with a reasonable appreciation of the sea-faring instincts of the British race, we would apply it for the moment to an appeal for men for service at sea. There is a big demand by the British wireless service at this moment for young men with a keen sense of duty and an interest in things electrical, and although the official attitude here in the past towards amateur wireless operators neglected the possibility of an emergency like the present, we feel confident that the response will prove adequate for the needs of the moment. Incidentally, the present experience may stimulate the authorities to consider the wisdom of giving amateur wireless greater encouragement in the future. The demand, which, as time goes on, becomes ever more and more insistent, has found forcible exemplification in the Marconi scheme set out in detail on pages 567–8. We have made a number of references to this scheme in other parts of the present issue. The illustration at the foot of this page is one of five views of important British Provincial centres in which fresh facilities for Wireless Training are being offered under the new Marconi scheme above referred to.

THE COUNCIL HOUSE AND COLMORE ROAD, BIRMINGHAM.

# Wireless Telegraphy In the War

ARGENTINA WITHDRAWS PERMIT FOR GERMAN WIRELESS "EXPERIMENTS."

MAKING all possible allowances for the German willingness to submit to military dictatorship, and a readiness to accept all that is told them regarding their virtuous characteristics and the righteousness of their cause, it is difficult to believe that a national mentality can be so hopelessly paralysed as to be incapable of appreciating the fact that something must be amiss when one country after another, some of them openly friendly to the Central Empires before the war, takes up arms against them. The history of the present year has been freely punctuated by declarations of war against, or severance of diplomatic relations with, Germany and her unhappy satellites. The several South American Republics, which certainly might have been regarded as politically uninterested in the terrible world upheaval, have one after another refused to tolerate the affronts so barefacedly offered them by an absolutely unscrupulous diplomacy.

The Argentine, which has never hindered German commerce in the past, and even recently gave the Germans permission to make "experiments" in connection with the reception of wireless communications from Nauen, has now withdrawn the permit, having undoubtedly discovered through first-hand experience of German official slimness that these "experiments" might prove something more than the ingenuous occupation of guileless physicists. We all know that the rapid development of long-distance wireless communication has created problems which can only be solved in a world-wide laboratory, but it is difficult to believe the efficiency of Nauen could not have been equally well determined by investigations at other South American stations already in existence. A report from the Argentine received but a fortnight before the news of the withdrawal of the permit stated that the station in the vicinity of Plomar, which was being erected through the intermediary of the Siemens-Schuckert Company, was making rapid progress. Intended for the reception of messages only, it was being erected under the strict supervision of an Argentine Government official. The aerials were to be supported on sixteen masts each 100 feet high, placed at intervals of about 790 feet. That the Argentine was wise in its determination to eliminate all possibility of a further exhibition of the standard Teutonic roguery becomes more apparent each day. The Buenos Aires authorities, we venture to suggest, will have no reason for regretting their decision.

In Berlin, of course, the attitude of the Argentine Government will not be understood.

* * * * * *

### Naval Operations on the Tigris.

As a happy contrast to the Mesopotamian Commissioners' depressing report, upon which we commented as recently as August last, there has since appeared the official despatch covering the naval operations which materially assisted General Sir Francis Maude in his recapture of Bagdad in the early spring. This report, although silent upon the work conducted as it were "behind the scenes" during the twelve months which elapsed between the ghastly episodes of February and March 1916 and the triumphal progress during the same months of the present year, unquestionably affords another instance of British ingenuity, adaptability, and persistence of effort when faced with adverse circumstances.

There must be many officers and men on the great battleships in the North Sea who would gladly have exchanged the tedious business of waiting for the German High Seas Fleet for the rollicking but highly dangerous enterprise which good fortune entrusted to Captain Wilfrid Nunn, C.M.G., an officer who, although, from a strictly naval viewpoint, of "less standing" than is usual for the command in so important a task, showed himself, as his Admiral has since reported, "not only to "have been worthy of his responsible position, but to have carried out his duties with "a zeal and dash worthy of the best traditions, and to have displayed remarkable "capacity for command." Captain Nunn deals yet another blow to the theory of chronic pessimists that the present generation lacks the "Nelson Touch."

[*Photo: H. J. Shepstone*

ARAB ENCAMPMENT ON THE TIGRIS.

Wherever the British Navy strips for action, even though it may be on the dust-swept and mine-sown stream in a hostile eastern country, wireless has its part. The new school of officer would as soon think of lifting anchor without his wireless telegraph gear as he would with empty magazines. Exactly how far the success of this spring's Tigris operations was due to the absolute co-ordination of effort secured by wireless intercommunication between the military commander and the shallow-draught fleet, which played such havoc amongst the retreating Turks, can only be conjectured, but we are assisted to a degree in our estimate by that Appendix to the Report which opens : "The King has been graciously pleased . . ." and continues . . . "To receive the Distinguished Service Medal." Here follow three names of warrant officers who, it may be taken for granted, are highly familiar with "wireless" as employed in His Majesty's Navy—Leading Telegraphist Sydney Boulter, O.N., J.15349 (Chatham) ; Leading Telegraphist Martin L. Elliott, O.N., J.29215 (Devonport), and Telegraphist Herbert W. Prior, O.N., J.32080 (Chatham).

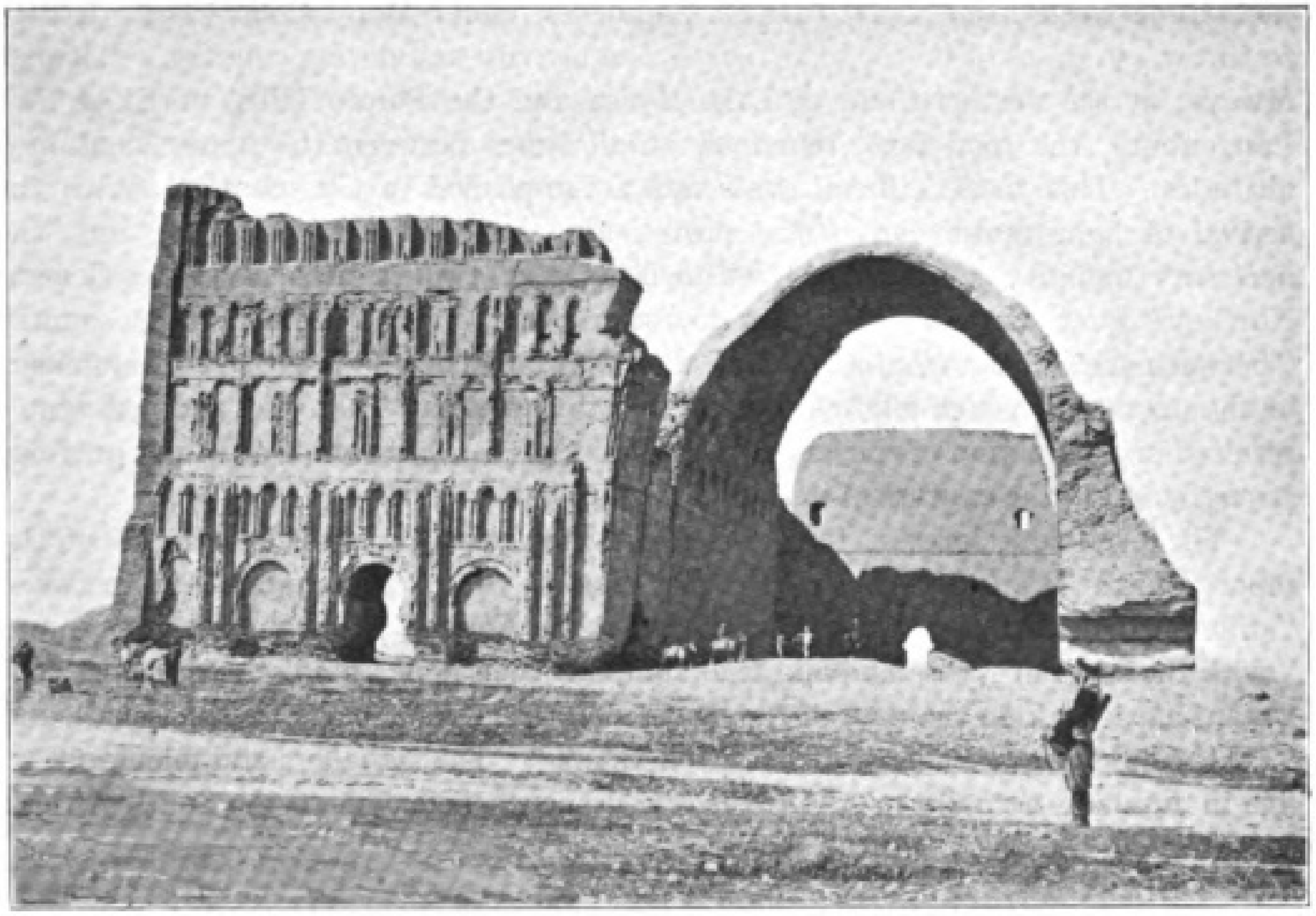
The serious business for these heroes appears to have commenced when, on February 26th, to use Captain Nunn's own words, "I received a message by "wireless telegraph from General Sir F. S. Maude during the forenoon to push on "and inflict as much damage as possible." With this signal, H.M. Ships *Tarantula*, *Mantis*, *Moth*, *Gadfly* and *Butterfly*, vessels whose life history it is suggested form a romantic story, made full speed ahead, only to encounter as their first target for damage, another of their family, H.M.S. *Firefly*, the gunboat abandoned by the British in December, 1915. The *Firefly* had a four-inch gun which it is naïvely reported made some "good shooting" and even when finally silenced this ship caused some anxiety by developing a fire which threatened the magazine.

Supporting the *Firefly* was a large body of the enemy which found employment in directing a fire on the river fleet from three directions, but this game apparently lost all interest for the landsmen when the gunboats developed the idea of firing six-inch shells amongst them at a range of 400-500 yards.

There is not much cover for a gunboat worming its way through the desert plains traversed by the Tigris, and so it came about that at times Captain Nunn's fleet were under severe cross fire. The *Moth* lost about 50 per cent. of her complement, but her boiler tubes bore a charmed existence. Upon the *Moth* returning to Basra for "redecoration" the *Waterfly* joined in the chase.

Strong deserted positions were passed at Ctesiphon, where some of the most striking ruins in the world mark the site of the ancient Parthian capital, but the boats again came under heavy fire at the junction of the Diala with the Tigris, eight miles below Bagdad. Here some excitement was caused by the grounding of one of two motor lighters full of troops which had been sent under cover of darkness to land them on the left bank above the Diala. H.M. *Tarantula*, however, freed the lighter before daybreak.

Here no further details of fightng are given. The Bagdad railway was seized early on March 11th and the gunboat flotilla, with mine sweepers ahead and the battered *Firefly*, once more jauntily flying the White Ensign, steamed majestically to the citadel of Bagdad in the afternoon of Sunday, March 11th. In company with this hardy little fleet of warriors was Paddle Steamer *No.* 53, having on board Sir F. S. Maude and his staff.



[Photo: H. J. Shepstone.

THE ARCH OF CTESIPHON, MESOPOTAMIA.

Once during the operations, which we have just briefly outlined, the guns of this river fleet were unable to give aid owing to the inability to distinguish objects through a dense sandstorm. It requires no great demand upon the imagination to anticipate that on an occasion such as this when all visual methods of signalling are temporarily out of action some very useful work may have been accomplished by wireless telegraphy.

### Motor Roads through Central Africa.

A second report, published within a week of that just reviewed, has an entirely different setting. This time the scene is laid—not on a sand-skirted waterway, but in the heart of Africa in dense tropical country 600 miles from the nearest railway and at altitudes varying from 1,500 to 8,000 feet. We learn, in fact, something of a year's work undertaken by the Nyasaland-Rhodesia Force, under Brigadier-General Northey, in the difficult task of keeping the harassed Germans in German East Africa from breaking south into the British territory between the Great Lakes. There are no deails of heavy fighting or slaughter such as Captain Nunn suggested by the use of 6-inch guns at almost point-blank range, although over 600 known casualties were inflicted on the enemy in two autumn months of 1916, but there appear instead some very striking references to engineering and transport achievements, conducted under all the difficulties which face frail man in remote tropical regions.

To meet, amongst other things, the disquieting fact that each of the thousands of native carriers was eating about the equivalent in weight of his own load during each three weeks, the South African Engineers, under Major Colin Clark, decided to throw 450 miles of motor roads across the heavily undulating country. Between Mwaya, at the northern end of Lake Nyasa and the Poroto Hills, north of New Langenburg, the road level remained at all times between the above-mentioned altitudes. This most difficult task was accomplished in six months. With the arrival of light motor lorries the provisioning problem was simplified and the necessary mobility secured, and within the next two months Brigadier-General Northey's force was able to occupy 20,000 miles of "very rich and fertile country "between the New Langenburg and Bismarckburg districts." A further development of the operations which followed during the late autumn of last year and last winter resulted in a reduction of the enemy's detachments to about one-third their previous strength and in the capture of various light and heavy guns.

The particular interest for "wireless" men appears towards the end of the report, when Brigadier-General Northey states that "Communication between "different columns operating far apart, with the Central Railway, via Iringa, and "with the bases in Nyasaland and Rhodesia, has been kept up only by the most con- "stant hard work on the part of the Signal units (telegraph, *wireless* and visual), and "by the indefatigable energy of despatch riders." The signallers and telegraphists, five in number, actually mentioned in the despatch belonged to the South African Infantry and the South African Rifles.

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The Town Hall, Leeds. Special facilities are being offered to wireless students in this city; for particulars of the scheme see pages 567–8.

# A Call to the Wireless Men of America

By GUGLIELMO MARCONI

*EDITORIAL NOTE.—Senatore Marconi's reluctance to write anything for publication is fairly notorious. The article which follows is based on an exclusive interview which was given to the editor of our contemporary, "The Wireless Age," in connection with his work as Acting President of the National Amateur Wireless Association, and is published as Senatore Marconi's official statement to the loyal wireless experimenters of the United States.*

THE most striking features of my observations since I have been on this official visit to the United States is the surprising ignorance of your wireless men concerning the conditions in the fighting zone abroad. It has required a readjustment of viewpoint for me to appreciate the fact that so much of the scientific development of the wireless art has been kept secret for military reasons; naturally the United States cannot know of things which to us have seemingly become elementary.

For example, it appears that American wireless men still look upon a portable set as a novelty, whereas on the Western front, and particularly in the trenches, portable sets of all types have become indispensable. They vary in appearance from carefully designed equipments in neat containers to a key, coil and crudely manufactured accessories, strapped to a board. There has been no attempt at standardisation—we have not had time.

A second impression, very general among Americans, is that wireless has not been a great factor in the war. In various quarters I have heard it said that you understood wireless was tried in the early months of the fighting and, being found impractical, was virtually abandoned so far as the army is concerned. Nothing could be further from the truth. To illustrate its great importance in modern warfare, I have only to say that with the exception of the first two or three months of the war, wireless has furnished the sole means of communication in the first line of trenches.

No longer are wired telephones and telegraphs used in the trenches bordering No Man's Land. We found it impossible to maintain these lines with the constant shelling by high explosives. When you go into a first-line trench to-day, you will find very little else occupying it but the wireless men. These trenches are not filled up with infantry at all times, as the popular conception has it. Unless an engagement is in progress, there will be found only a handful of fighting men with machine guns, distributed in small detachments about every 400 yards, and supported by the ever-present wireless man with his portable set. Through the continued and heavy shelling it is not possible to maintain many troops in these trenches, so until an advance of enemy infantry is observed, the wireless man and a few infantrymen to protect him are in sole possession. With the first observation of an infantry attack, the wireless man gets in action and sends back his call for troops from the supporting trenches. They pour in then through a traverse and the hand-to-hand engagement begins.

A RECENT PORTRAIT OF SENATORE MARCONI.

It can be readily seen from this that the Allies faced some serious problems in supplying the right sort of men for this duty, and, in fact, in supplying the armies with sufficient wireless men for their needs. We were far better equipped, however, than the Americans, because of the fact that the European nations had large standing armies with men well trained for their soldierly duties. It was simpler for us to take soldiers and train them as operators, and this we did. We had very little choice in the matter, however, because we had no great body of amateurs to call upon as you have in this country. Your war problem, so far as wireless is concerned, is obviously directly opposite to ours—by our, I mean all the Allied European nations. It appears to me the most logical and the only practical thing to do here, since you have no great standing army, is to train your wireless operators as soldiers, which is a relatively short process when compared with the necessity which we faced of training soldiers technically. I do not know but that you are better off than we were for this reason. It is certain anyhow that the United States can be a material factor in the war by sending us at the earliest possible date all its available wireless men.

What I have said may convey the impression that there is no such person as a wire operator at the front. On the contrary, there are a great many, as many I should say as there are wireless operators, but certainly not more. Their duties are a little different. They maintain the very important telephone and telegraph communications between the supporting trenches and the field bases and keep in operation a network of connecting lines directly back of the fighting zone. There is a constant need for signalmen, and the American development of amateur experimenting having been so extensive, I look to the wireless men to make a great record in this war

The trained signalmen of the United States Army are a fine, efficient lot, and they will do very effective service for us in France, but their numbers are so few they will have to be considerably augmented to occupy the space we provide in our tactical organisations. Furthermore, as with us before the war the United States

Army has done its field work on a manœuvre basis. They will have much to learn and something to unlearn, just as we did. But used as a leaven for the host of civilian signalmen which can be quickly gathered together, they will be very valuable,

So pressing has been the need for operators, we have taught some of our men transmitting only, and assigned them to duties where a knowledge of receiving is not essential. It is, of course, obvious, however, that a man who can both send and receive is far better equipped for duties where the lives of thousands of human being are involved.

Now, in the consideration of wireless as applied to air service, I have a subject which caused me greater surprise than anything I have learned here as to American misconception of what has been done. The general supposition seems to have been that spotting of artillery fire has been accomplished through the use of various forms of visual signalling, such as flags and smoke bombs dropped from a 'plane. The truth of the matter is that our entire heavy artillery fire control is conducted by wireless from aircraft. At the very outset of the war, we had neither equipment, experience nor personnel to accomplish this, so it was our custom to send up an observer with the airplane pilot who carefully drew a picture of the enemy battery emplacements, flew back to his own lines and dropped these drawings. This is no longer done. The observer now notes the results of his artillery fire and sends back by wireless such messages as "too short," "three to right," "two to left," and so on.

The reconnaissance machines are protected by fighting 'planes which fly in squadrons over enemy lines, attacking every enemy machine they encounter, and thus

SENATORE MARCONI RECEIVING MEMBERS OF THE WOMEN'S DIVISION OF THE NATIONAL AMATEUR WIRELESS ASSOCIATION AT THE RITZ-CARLTON HOTEL, NEW YORK.

allowing the observers to complete their work undisturbed. It is such an ordinary sight to see these airplanes at all hours of the day that their presence means nothing special to us. They are merely part of the great fighting machine, which we have builded up. Their observations continue all day long and are of incalculable value. Many of the airplanes now in use show amazing development in power, speed and carrying capacity. We have quite a number of 'planes which carry as many as six or eight men armed with machine guns.

AN AMERICAN WIRELESS OPERATOR OUTSIDE HIS CABIN.

The wireless operator who makes the observations for fire control is provided with a map of the terrain blocked off into small squares. As he spots the fall of the shells, he sends back by wireless the number of the square and records a hit or gives directions for greater accuracy. While he is spotting he is continually subjected to tremendous shelling, white puffs of smoke break around the reconnaissance 'planes all day long, but it is surprisingly seldom that they are hit.

I do not know that I can say anything further than the generalities with which I have just dealt, because our technical development is a very carefully guarded secret. Quite amazing things have been done in the navy, as well as in the army, but I am not at liberty to disclose any of the details. I do wish to say this, however, American wireless men are exceptionally well qualified to take an active part in important signalling work. Much valuable material will be found in the amateur ranks, as these young men are accustomed to transmission on short wave-lengths. A great deal of our communication is carried on with low power and wave-lengths in the neighbourhood of 200 metres—the exact type of communication to which they are most accustomed.

We have not had a reserve of amateurs like the United States. So the training of our soldiers for communication had to be rapid and continuous.

The demand for wireless operators is best illustrated by saying that at least half of the signalmen are wireless operators. The communication service is about equally divided between wire and wireless.

America is fortunate in having perfected its organisation of the amateur field.

The National Amateur Wireless Association, which has had my hearty support since its inception, has done valuable work in co-ordination and standardisation of instructional methods. The younger men in the experimental field have a very definite place in the war scheme. The military laws of the Allied nations did not permit using boys under eighteen, but I can see no reason why a boy of sixteen, who has the necessary qualifications, cannot be used; in fact, I think this will be done, if it is not already being done. Ability to communicate at a speed of twenty words per minute is adequate, for it is seldom that we have to use a greater speed than this, but while operation of this kind can be taught in a comparatively short time to any intelligent person, the amateur has a tremendous advantage in possessing the fundamental knowledge of wireless, which requires extended study. Extremely valuable also is his knowledge of all kinds, sizes and types of low-power equipment.

My word to the amateurs of America is: Begin at once some form of military training. Begin with essentials, and later take up the study of map-reading and observation. It will help wonderfully in increasing war-time efficiency and will be invaluable to those subject to draft.

I am not given to inspirational utterances as a rule, but I have been impressed and pleased with what I have learned of the work the amateurs are doing in the Junior American Guard. I had hoped to see them in an exhibition, but my engagements prevented this.

Perhaps it will not be long, however, before I will see many of them—over there.

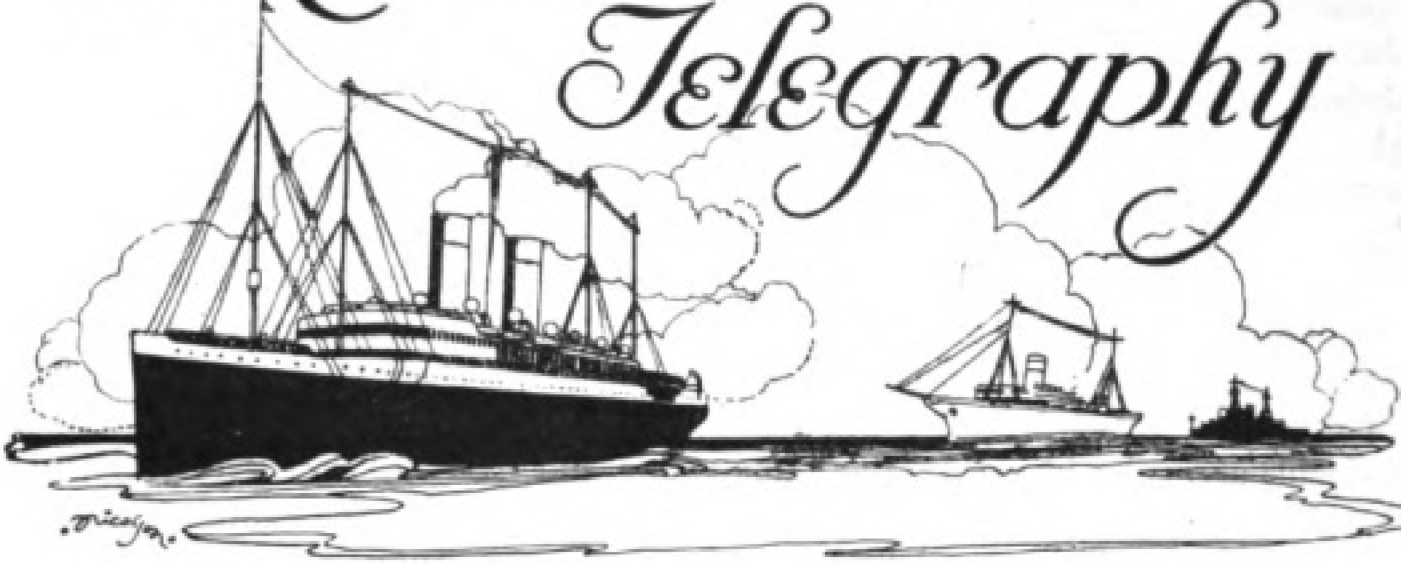
EDITOR'S NOTE.—*This message to wireless men was given just before Mr. Marconi left America. His safe arrival in Paris on August 6th has since been announced.*

# Women and War-time Wireless

THAT women are likely to play a still wider part in wireless as applied to warfare is once more indicated by the fact that the Women's Division of the National Amateur Wireless Association of New York, which, under the directorship of Mrs. Herbert Sumner Owen, already comprises five Divisions of twenty-five members each, has instituted a preparatory course specially designed to prepare efficient operators for service at stations conducting Government or Commercial radio traffic. Colonel C. McK. Saltzman, chief signal officer of the United States Army, in a letter of congratulation to Mrs. Owen, states "The womanhood of America must be relied on to assist in bringing this war to a successful termination."

That England can provide these patriotic American women with encouragement is provided by the record of Mrs. Gateshill, of Newcastle-on-Tyne, who, as mentioned in our May issue, has gained a first-class Postmaster-General's Certificate for knowledge of three different systems. Mrs. Gateshill, of course, is but one of many English women with a practical knowledge of wireless. We would remind readers, moreover, of an incident at sea, recorded in our October issue, page 475. On an occasion when one of two operators carried by a Swedish steamer was too ill to attend to his duty, a lady wireless operator happened to be on board and stepped into the breach.

# Maritime Wireless Telegraphy



## Oil on Troubled Waters.

### True Stories of U-Boat Engagements.

In the middle of September the British Admiralty placed at the disposal of the Press the first of a series of records of apparently successful engagements by aircraft, naval and merchant ships, and even British submarines, with German U-boats. In most instances the naval authorities left it to the imagination of the reader as to what was the actual outcome of each respective incident.

Wireless played "a walking-on part," in the very first narrative, for there, instead of figuring in its usual rôle on the side of the hero, it merely served, through the intermediary of an aerial, to retain for the attacking ship a portion of its starboard lifeboat which was blown into the air by the explosion of the torpedo. Whether the operator was able to conduct business as usual with this addition to his "capacity" is not told, for the narrative at this point turns to the gunnery side of the encounter.

There are two episodes toward the end of the story, which make no unfair claims upon the imagination: "The U-boat wallowed along for a space, stern almost submerged with oil squirting from its side, and the crew came on deck and waved their hands." "A loud explosion took place forward, and, falling over on its side, the enemy sank, the last thing seen being the sharp bow, end up, slowly disappearing beneath the water. Two survivors were picked up. Our ship made harbour."

Another tabloid incident naïvely concludes with the following statements: "The oil, which was still rising after an interval of twelve hours, was of a heavy brown nature, with a smell of petrol." A splendid example of German camouflage, you may say? Perhaps so, perhaps not.

* * * * * *

## America's First Aerial Hunt for Submarines.

Details of America's first aerial hunt for enemy submarines have now been published in the United States.

It will be remembered that last March, shortly after Washington's decision to defend right against might, two submarines were reported by a Long Island lighthouse to be lying in toward the Sound. A fleet of civilian aviators immediately arose from a Long Island aerodrome and defying a 40-mile gale, rain and fog commenced a detailed reconnaissance of the coastal waters. Two aviators, Acosta and Briggs, were away from the aerodrome for three days searching inlets and piloting vessels. Two others, Captain Briggs and Lieutenant Wehrle, included in a most creditable piece of work a flight of 124 miles in a driving rainstorm. No enemy ships were found, and it turned out that the objects which had caused the alarm were not enemy craft but two new coastal patrols returning from a trial trip.

This performance incidentally gives the lie to Germany's repeated assertion that America had always been hostile to German interests and had only awaited a favourable opportunity for revealing her true sentiments. None of the machines engaged in this initial enterprise were equipped with "wireless" gear, neither was there a receiving station in operation. Anyone who is acquainted with American thoroughness in even small things will require no further evidence of that country's honest desire to maintain neutrality.

We imagine that conditions have been altered since the experience here recorded.

* * * * * *

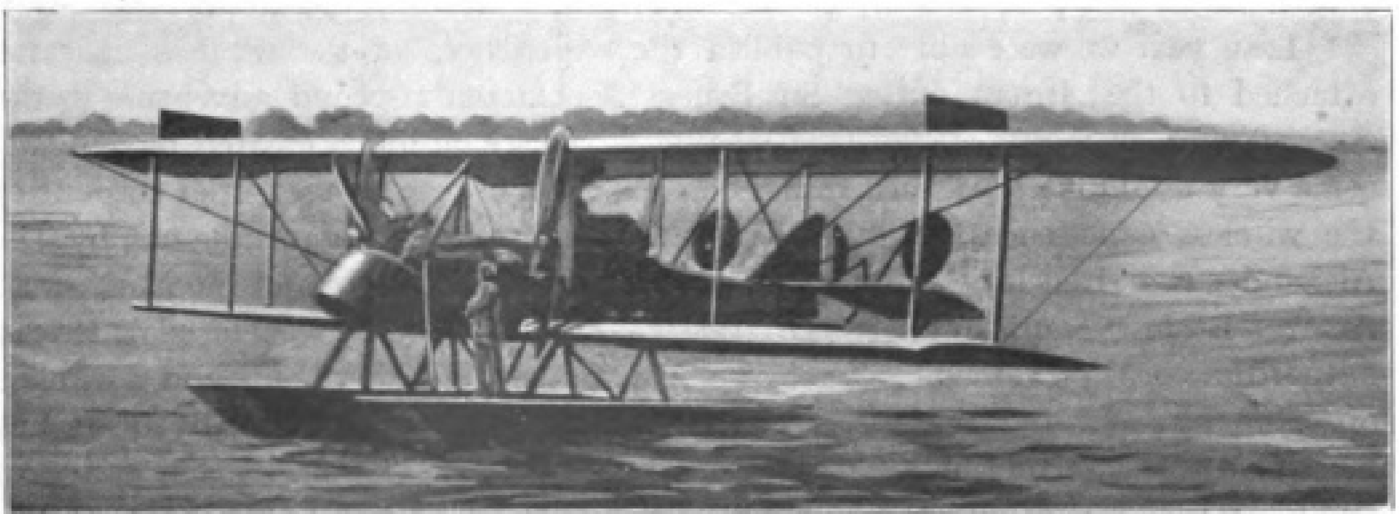
### How the First Armed American Ship Succumbed to a U-Boat.

How the first armed American ship to leave an American port was sunk by a submarine when nearing Europe is told by the wireless operator, Watson Sidney, in the September issue of the *Wireless Age.*

The *Aztec,* of the Oriental Navigation Company, bound for a French port, left New York on March 18th. The eventful portion of the voyage commenced at 6 a.m. on April 1st, when the gunners sighted a submarine following the ship. The submarine commander, possibly mindful of the day and the fact that it was not yet noon, maintained a traditional attitude and disappeared.

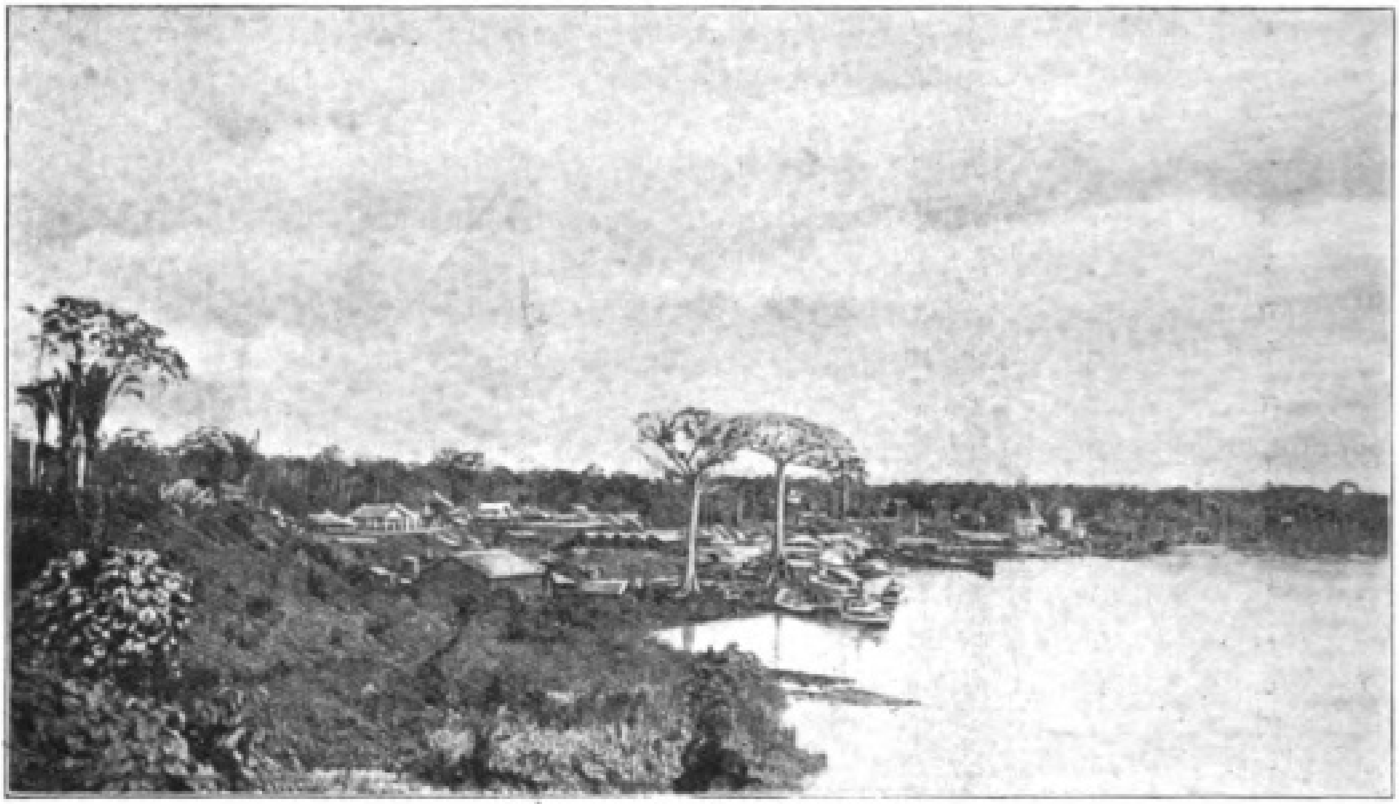
All went well until 9.30 p.m., when the wireless operator left his cabin to investigate a complaint that a light was visible through the porthole. Hailing the gunner, who was leaning over the rail intently searching for periscopes, he received as a reply a mysterious blow which hurled him 25 feet along the deck, tore away the leg of his trousers and inflicted a gash in the left leg 14 inches in length.

Recovering and running back to the wireless cabin, Sidney found the gear completely wrecked and water up to his knees. The gunner had completely disap-



*By kind permission of "Flight."*

AN AMERICAN SEA PLANE OF A RECENT TYPE.



ON THE RIVER AMAZON

peared, and another man, who had been standing by, had been killed instantaneously. The first boat capsized through a block fouling and the ropes being slashed.

On reporting himself to the Captain, Sidney was ordered into the third boat. The *Aztec* sank when this boat had got but 100 yards away, only seven minutes having elapsed since the torpedo struck the vessel. Five hours elapsed before the survivors—six out of thirty-six—were rescued by the French patrol boat *Joan d'Arc.* The French officers with traditional courtesy provided the party with dry clothing and warm quarters.

* * * * * *

## Portable Wireless in Uncharted South America.

For some peculiar reason, possibly the joint result of ignorance and innate conservatism, several years passed between the development of reliable portable sets and the adoption of wireless by explorers as a means for keeping in touch with outlying parties and with civilisation generally. Now it would appear that this practice is already passing from the realm of novelty into that of regular procedure.

Last year we were able to publish the experiences of the wireless operator attached to the *Aurora* during Sir Ernest Shackleton's second adventure in the Antarctic, when it was shown that despite adverse conditions created by the war some very useful work was accomplished. Now there reaches us a brief account of the wireless experiences of an American scientific expedition conducted by Dr. Alexander Hamilton Rice and his wife in the wilds of Rio Negro and the North-west Amazon Basin in South America. Dr. Rice was accompanied by recognised American authorities on tropical medicine, geographical and geodetic surveying, and a wireless operator, Mr. W. H. Boyle. The latter gentleman's activities were by no means limited to the interception of news from high-powered stations within range of audibility; he was also engaged on the important work of testing the practicability of portable wireless in tropical regions.

The signals from the well-known American naval station at Arlington, we are told, were received sharp and clear when the yacht carrying the expedition was off Iquitos, roughly 2,100 miles up the Amazon and about 2,500 miles distant from the transmitting station. How far atmospherics made themselves prominent we are not told, but for some reason or another the reception of signals on the portable set was more successful on the south bank of the river Paduiri than on the north bank.

The fact remains that Dr. Rice has returned full of enthusiasm regarding the employment of wireless on expeditions of this character. As he is confident that the experiments made will be of great value to similar explorers in the future, and as there are 50,000 miles of navigable waterway in the Amazon system, much of it but little known, we look forward to the publication of the data provided by this very interesting trip.

A glance at the wireless map of the world will show that the advantages and possibilities of wireless as a commercial means of intercourse over the wooded wilds and jungles of the great South American Continent is being fully grasped by those who are interested in the development of these wide expanses of latent wealth. With respect to the useful employment of portable sets in South American exploration and prospecting we are confident that Dr. Rice's enthusiasm is not misplaced, and we would even suggest that no expedition in these days is adequately equipped which does not include apparatus for wireless intercommunication. The question of weight need no longer figure as a serious obstacle, for improvements in design, largely stimulated by the needs of warfare and simplified by the extraordinary developments in relation to the sensitiveness of the receiving instruments, make possible many things which were little dreamed of three years ago.

BRAZIL INTERIOR SCENERY.

# On the Wave-lengths of Antennae with Flywheel Coupling, and a Second Approximation for the Time Period of a Wavemeter

By BALTH. VAN DER POL, Jun., Docts.Sc. (Utrecht)

AMONGST those who have had some experience in sending or receiving with an antenna with the so-called flywheel coupling, it is generally known that under certain circumstances an antenna so coupled sends out, or receives, waves of more than one wave-length. The mathematical explanation of this phenomenon is usually given by considering the whole arrangement (antenna and flywheel coupling) as a pair of coupled quasi-stationary circuits, that is of circuits whose dimensions are small in comparison with the natural wave-lengths of the system. With this assumption the system can be treated as two coupled circuits in each of which the capacity, as well as the inductance, are wholly separated.

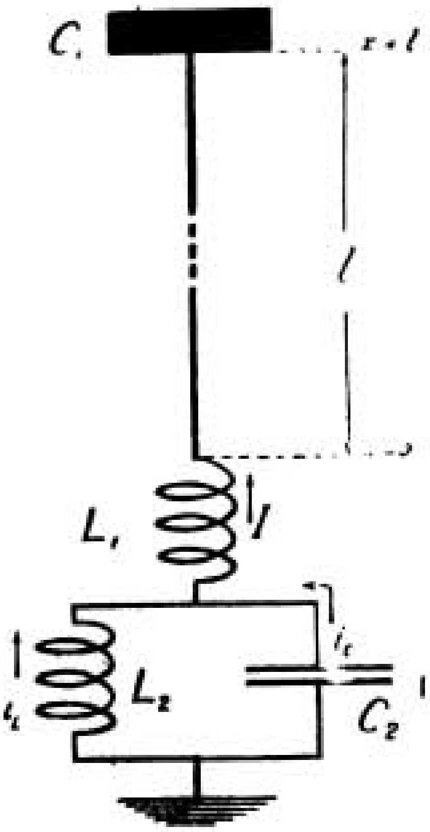



FIG. I.

In this way the possible wave-lengths have been calculated by Mr. G. Baillie, L.Sc., in his article in THE WIRELESS WORLD of September 1917, page 402. The principal result arrived at is embodied in his formula (8), and is equivalent to the well-known formula for the wave-lengths of a pair of coupled circuits, as, for instance, given in Professor Eccles's *Handbook of Wireless Telegraphy and Telephony*, page 301, where the matter is treated in the same way.

Now, with the assumption that the self-inductance and capacity of the vertical part of the aerial are equally distributed over the length of it, the problem of finding the natural wave-lengths can be solved with the aid of elementary mathematics, and as the result of this solution yields some interesting peculiarities of the fundamental and higher harmonics of an antenna with flywheel coupling, peculiarities that are usually not considered in the leading text-books on wireless telegraphy. It may perhaps not be superfluous to give the solution here in full.

Referring to Fig. 1, let $C_1$ be the capacity attached to the top of the antenna in the form of more or less horizontally extending wires [inverted T, L, or umbrella aerial]. The vertical part of the aerial over which the equally distributed self-inductance and capacity per unit length is $C$ and $L$, is represented from $x=o$ to $x=l$, where $x$ is the ordinate measured along the vertical part. Inserted at the bottom of the antenna, we have the inductances $L_1$ and $L_2$ in series, with a condenser of capacity $C_2$ shunted across the terminals of $L_2$. The whole system is earthed at the bottom.

If the current and voltage in the vertical part are called $i$ and $v$ in the directions as indicated in the figure, and the current through $L_2$ and $C_2$, $i_L$ and $i_C$ respectively, and we assume the current through $L_1$ and $L_2$ quasi-stationary, we have the following equations:

$$\left.\begin{aligned} \bar{L}\frac{di}{dt} &= -\frac{dv}{dx} \\ \bar{C}\frac{dv}{dt} &= -\frac{di}{dx} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

with the conditions

$$\left.\begin{aligned} &\text{for } x=o: && v = -\frac{1}{C_2}\int^t i_C dt - L_1\frac{di}{dt} = -L_2\frac{di_L}{dt} - L_1\frac{di}{dt} \\ &\text{and for } x=l && v = \frac{1}{C_1}\int^t i dt \\ & && i_{x=o} = i_C + i_L \end{aligned}\right\} \quad . \quad . \quad . \quad (2)$$

in which equations the resistances have been omitted as being only of secondary influence on the current and voltage distributions.

Now as particular solutions of (1) and (2) may be taken:

$$\left.\begin{aligned} i &= I\cos\left(\frac{\omega x}{a}-\beta\right).\cos\omega t \\ v &= I\sqrt{\frac{\bar{L}}{\bar{C}}}\sin\left(\frac{\omega x}{a}-\beta\right).\sin\omega t \\ i_C &= I_C\cos\omega t \\ i_L &= I_L\cos\omega t \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (3)$$

where $a^2 = \frac{1}{\bar{L}\bar{C}}$ = the square of the velocity of propagation,

$\omega = \frac{2\pi}{\lambda}$ ($\lambda$ = wave-length to be found)

and $\beta$ = a phase constant to be determined.

Applying the second of the conditions (2) to (3) we find:

$$\tan\left(\frac{\omega l}{a}-\beta\right) = \frac{1}{C_1\omega}\sqrt{\frac{\bar{C}}{\bar{L}}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Calling:

$$\frac{\omega l}{a}\left(=\frac{2\pi l}{\lambda}\right) = \theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

(where $l$ is practically identical with the antenna height) and

$$\theta - \beta = \alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5a)$$

calling further the total vertical inductance $L = l\bar{L}$ and the total vertical capacity $C = l\bar{C}$.

(4) may be written using (5) and (5a)

$$\tan\alpha = \frac{C}{C_1\theta}.$$

On the other hand, applying the first of the conditions (2) to (3), we have:

$$\left. \begin{aligned} I\sqrt{\frac{L}{C}}\sin\beta = \frac{I_c}{C_2\omega} - L_1\omega I\cos\beta = \\ = -L_2\omega I_L - L_1\omega I\cos\beta \end{aligned} \right\} \quad . \quad . \quad . \quad . \quad (6)$$

and, further, according to the last of the conditions (2).

$$I\cos\beta = I_C + I_L$$

so that after eliminating $I_C$ and $I_L$ we get

$$\tan\beta = \frac{1}{\dfrac{C_2\theta}{C} - \dfrac{L}{L_2\theta}} - \frac{L_1\theta}{L}$$

$\tan\alpha$ and $\tan\beta$ now being known, $\tan\theta = \tan(\alpha+\beta)$ can be calculated:

$$\tan\theta = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta} = \frac{\left(\dfrac{C_2\theta}{C} - \dfrac{L}{L_2\theta}\right)\left(\dfrac{C}{C_1\theta} - \dfrac{L_1\theta}{L}\right) + 1}{\left(\dfrac{C_2\theta}{C} - \dfrac{L}{L_2\theta}\right)\left(\dfrac{L_1C}{LC_1} + 1\right) - \dfrac{C}{C_1\theta}} \quad . \quad . \quad . \quad (7)$$

This transcendental equation has an infinite number of solutions $\theta$, and therefore an infinite number of natural wave-lengths is theoretically possible for an antenna with flywheel coupling.

This equation (7) is best solved graphically by drawing in the same plane one curve for which $y = \tan\theta$, and another for which $y =$ the last member of (7). The ordinates of the points of intersection then give us the solutions $\theta$, and at the same time, for $\theta = \frac{2\pi l}{\lambda}$, also the natural wave-lengths of the system antenna plus coupling.

If a wave-length to be expected is long in comparison with the antenna height $l$, $\theta$ will be a small quantity, and $\tan\theta$ may be identified with $\theta$, so that with the assumption $L_1 = o$ (7) becomes:

$$LC_1L_2C_2\frac{\theta^4}{C^2L^2} - \left\{C_1(L+L_2) + L_2(C+C_2)\right\}\frac{\theta^2}{CL} + 1 = 0$$

and as

$$\frac{\theta}{\sqrt{CL}} = \omega$$

this may also be written

$$LC_1L_2C_2\omega^4 - \{C_1(L+L_2) + L_2(C+C_2)\}\omega^2 + 1 = 0$$

and this equation is just the one which determines the frequencies of a pair of coupled quasi-stationary circuits, if only the capacity $C$ of the vertical part of the aerial may be neglected in comparison with $C_2$, the capacity attached to the bottom, or $C_1$, the capacity attached to the top of the antenna.*

If, on the other hand, we do not assume the condition that a wave-length is long in comparison with the antenna height, the general formula (7), though applicable to an actual antenna, is somewhat too complicated for a simple discussion.

To simplify the problem, therefore, we assume that $C_1$ and $L_1$ both are zero, so that we have a plain rod-aerial with an inductance load $L_2$ at the bottom com-

* Compare, *e.g.*, Mr. Baillie's form (5), *loc. cit.*

pletely shunted by a condenser $C_2$. The peculiarities we shall find in the simplified case are *mutatis mutandis* the same as in the more complicated general case.

With these assumptions (7) becomes:

$$\tan\theta = \frac{L}{L_2\theta} - \frac{C_2\theta}{C} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

When $\theta = \frac{2\pi l}{\lambda} = \pi$

we have $\lambda = 2l$

and $\frac{\theta^2}{LC} = \frac{1}{C_2 L_2}$.

But $\frac{\theta^2}{LC} = \omega^2$

where $\omega$ is the angular velocity of the complete system, so that

$$\omega^2 = \frac{1}{C_2 L_2}$$

and we see that *the fundamental wave-length of an unearthed vertical wire is not altered when a self-inductance and shunted capacity are attached to the bottom so as to form a flywheel coupling, if only this attached system has the same natural time period as the unearthed antenna.** The current distribution is then as in Fig. 2.

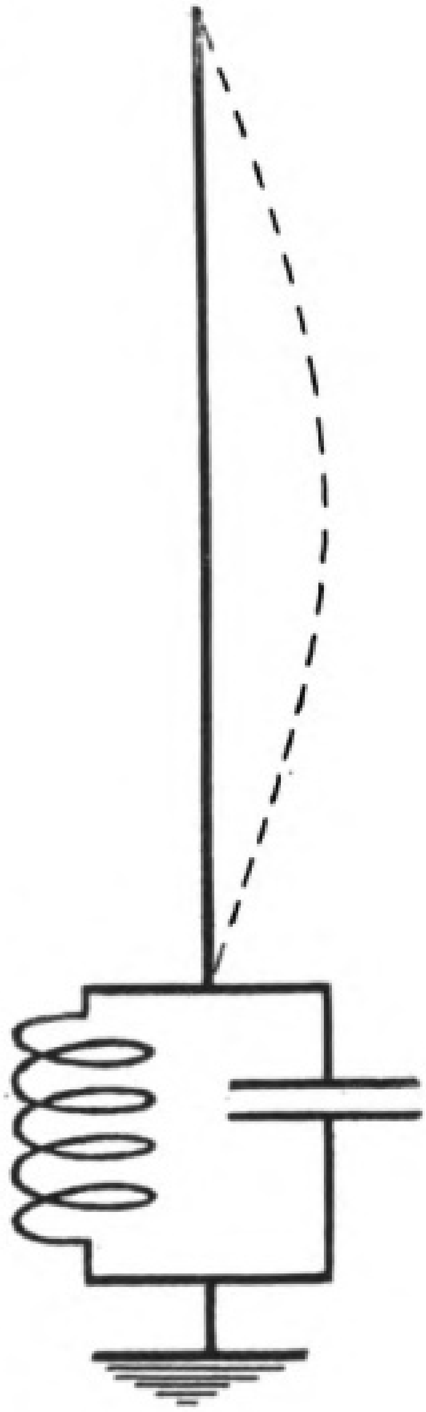


FIG. 2.

Putting in (7) $C_1 = o$ and $L_2 = \infty$, we get the case of a simple-rod aerial with a capacity and inductance now *in series* at the bottom. The natural wave-lengths are then given by

$$\tan\theta = \frac{1}{\frac{L_1\theta}{L} - \frac{C}{C_2\theta}}$$

where $L_1$ and $C_2$ are in series now.

When here $\theta = \frac{\pi}{2}$ we have $\lambda = 4l$.

Further, we have again just as in the first case

$$\frac{\theta^2}{LC} = \omega^2 = \frac{1}{C_2 L_1}$$

so that *the fundamental wave-length of an earthed vertical wire is not altered when a self-inductance and capacity are inserted in series*

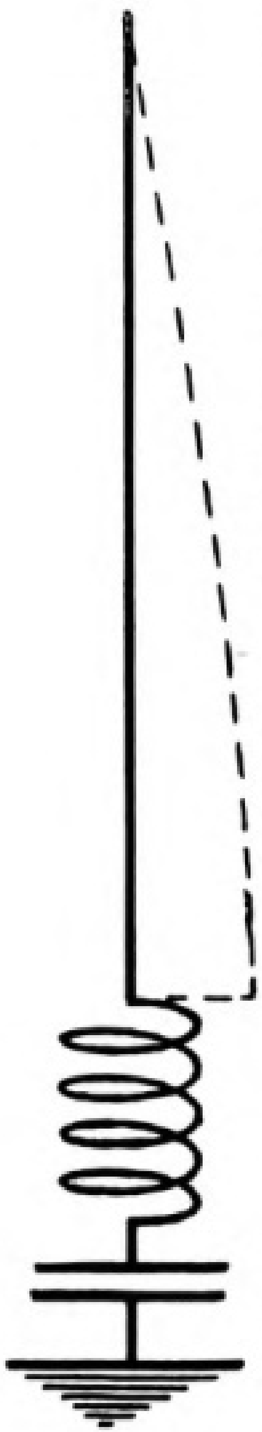


FIG. 3.

* Under these conditions there also exists one natural wave-length longer than the one that would be obtained with the antenna directly earthed without any load at the bottom.

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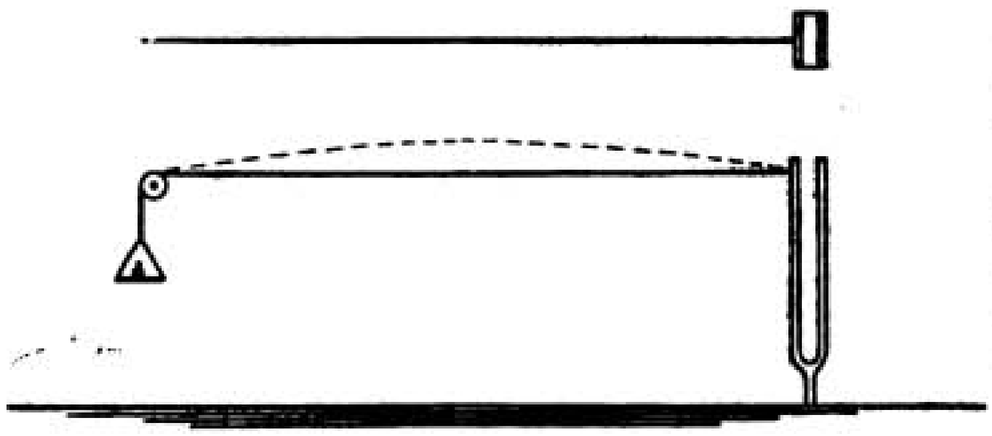

FIG. 4.

*at the bottom, if only this inserted system, when closed in itself, has the same natural time period as the earthed antenna.* The current distribution in this case is given by Fig. 3.

An interesting analogy of these electrical phenomena exists in acoustics. In the experiment of *Melde*, a string is attached to a tuning fork in such a way that the complete system under certain conditions is capable of vibrating. When the prongs of the fork move while vibrating in the direction of the string [see Fig. 4], the combination tuning-fork string can stably vibrate if the weight per unit length and the tension of the string are such that the natural time period of the latter when fastened at both ends is, if we only consider the fundamental, equal to the time period of the fork. This is the analogy of the flywheel coupling.

If, on the other hand, the string is attached in such a way that the prongs of the tuning-fork move perpendicularly to the direction of the string, a possible vibration is given in Fig. 5, which case is analogue to Fig. 3, where at the bottom of the aerial an inductance and capacity were inserted in series.

Returning now to the general solution of (8), the roots of this equation can be found, as already mentioned above, by drawing in the same plane two curves with $y$ and $\theta$ as ordinates and abscissæ: (*a*) $y=\tan\theta$

$$(b)\ y=\frac{L}{L_2\theta}-\frac{C_2\theta}{C}$$

the abscissæ of the points of intersection giving a value of $\theta$ which suits both (*a*) and (*b*), and is therefore a solution of (8). The curve (*b*) is a hyperbola from which only the branch in the first and fourth quadrant leads to a physical solution.

Two curves (*a*) and (*b*) are drawn in Fig. 6. From (*b*) it is clear that the hyperbola $H$ cuts the axis of $\theta$ at the point $\theta=\sqrt{\frac{LC}{L_2C_2}}$. Let it cut the curve $y=\tan\theta$ *a.o* at two points, whose projections on the axis of $\theta$ are $A$ and $B$. It is interesting to find out the conditions for which these points $A$ and $B$ are very near together —*i.e.*, for which two natural wave-lengths of the flywheel-coupled antenna are so near

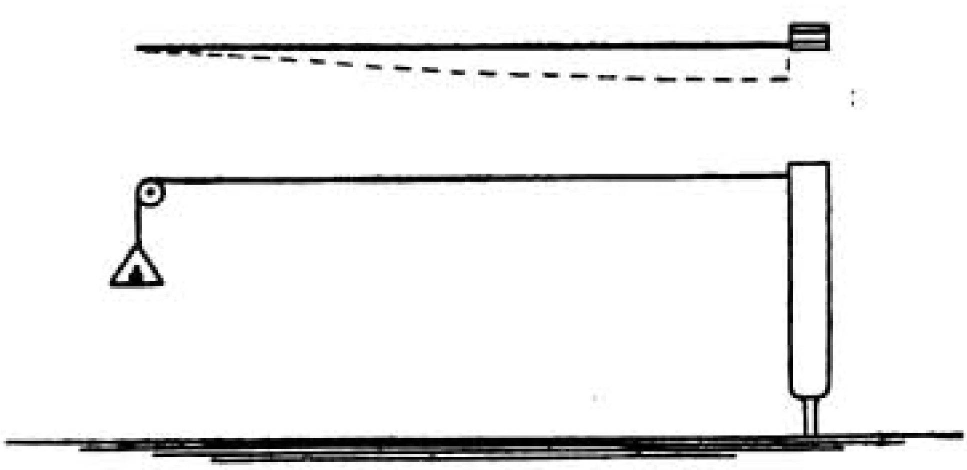

FIG. 5.

together that, say in receiving, interference of the two may be expected. In Fig. 6 the asymptotes of the hyperbola have been drawn, and their equations are

$$\theta = o^* \text{ and } y = -\frac{C_2}{C}\theta.$$

Now the hyperbola $H$ becomes steeper the nearer the angle $\varphi$ which the asymptote $y = -\frac{C_2}{C}\theta$ makes with the axis of $\theta$ is to $-\frac{\pi}{2}$, that is the greater is the ratio $C_2/C$.

Further, the points $A$ and $B$ will be nearer together the steeper the part of $H$ is

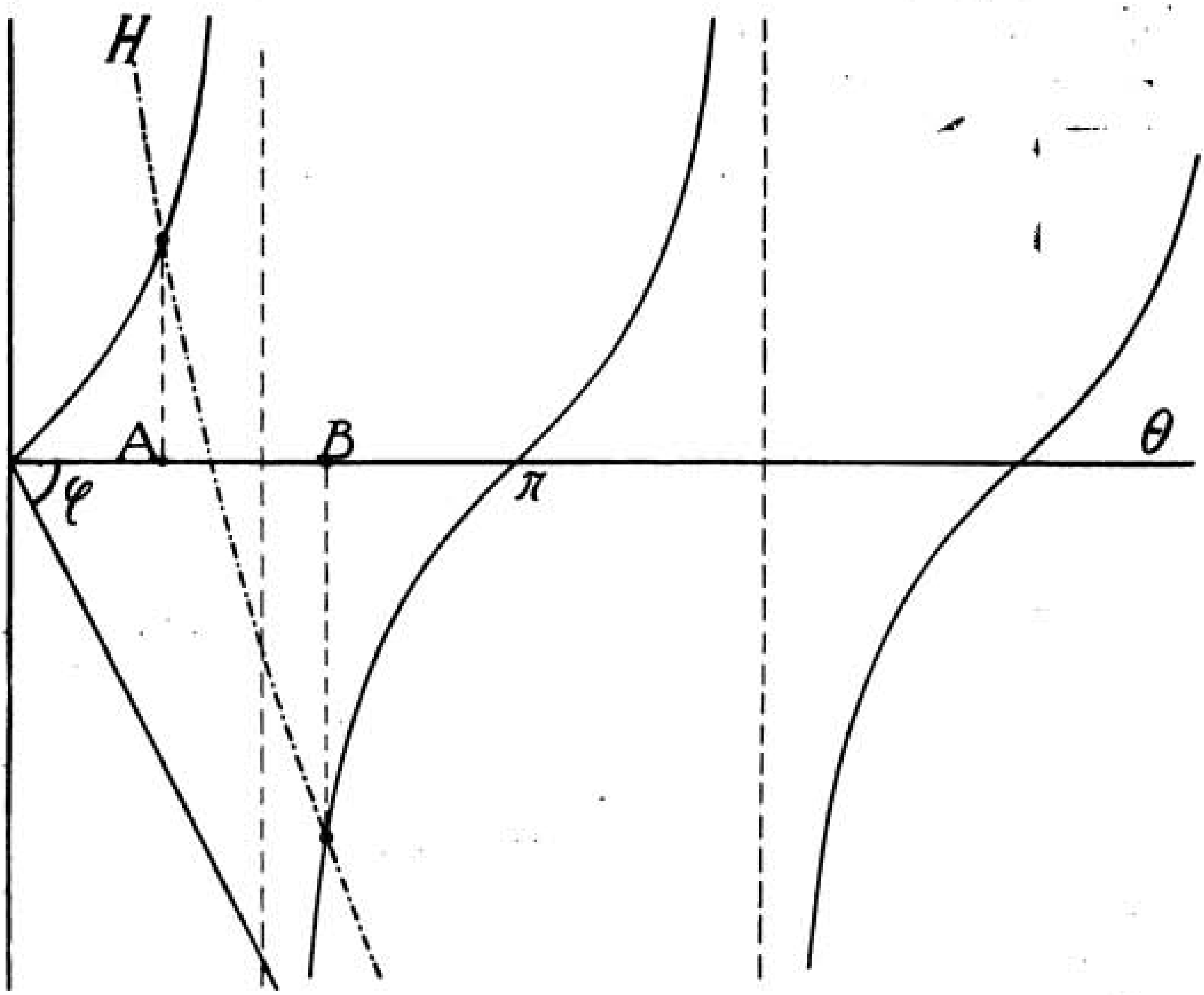


FIG. 6.

that lies between the two branches of the curve $y = \tan\theta$, and the nearer the hyperbola passes through the point $\theta = \frac{\pi}{2}$ on the axis of $\theta$. The conditions, therefore, that two natural wave-lengths of the antenna with flywheel coupling are near together are:

$$\sqrt{\frac{LC}{L_2C_2}} \text{ near to } \frac{\pi}{2}$$

and

$$C_2 \gg C$$

* As the hyperbola finally approaches the axis of $y$, and the first branch of the $y = \tan\theta$ curve finally approaches the line $\theta = \frac{\pi}{2}$, we see that always one wave-length must exist for which $\theta < \frac{\pi}{2}$, and it is therefore *longer* than the natural wave-length of the directly earthed antenna.

that is: (1) the frequency of the attached flywheel circuit must be near to the frequency of the simple antenna without the bottom load, and (2) the antenna capacity $C$ must be small in comparison with the condenser $C_2$ shunted across the inductance, or what is the same thing, the loading inductance $L_2$ must be small in comparison with the total antenna inductance. It is interesting to notice that this phenomenon of two natural wave-lengths being only slightly different can only occur once in the infinite region of possible natural wave-lengths, as a glance on a more extended diagram with more branches of the curve $y=\tan\theta$ shows at once. It also appears from the diagrams that the two slightly different wave-lengths that are often found while receiving with the flywheel coupling may be interpreted as being different harmonics, for they are provided mathematically by different branches of the curve $y=\tan\theta$.

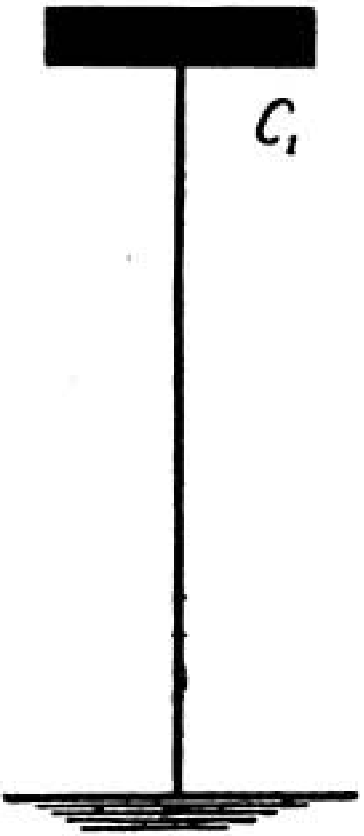


FIG. 7.

From these deductions it is therefore obvious that in order *to get an accurate tuning with a flywheel coupling, it is better to use a small condenser across the terminals of a large tuning inductance than a big condenser shunted across a small inductance, though the wave-lengths in both cases may be the same.*

The general formula (7) can be specialised still in another way. If $L_1=L_2=o$, and $C_2$ remains finite, (7) becomes:

$$\tan\theta=\frac{C}{C_1\theta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

which is the condition for the wave-lengths of a system as drawn in Fig. 7. The condition for the validity of (7) and (8) is that the inductance and capacity is equally distributed over the vertical part. If we now assume the same for a straight coil, the vertical wire may be replaced by a coil. Also $C_1$, which has a capacity to earth, may be replaced by a plate condenser and the antenna with capacity load at the top is changed into a wavemeter.

Now (8) provides us readily with a second approximation for the wave-length of a wavemeter if only the coil of the latter is not too short. If the condenser capacity $C_1$ is large in comparison with the small distributed capacity of the coil, $\theta\tan\theta$ is a small quantity, and for the fundamental $\tan\theta$ may be replaced by its development:

$$\tan\theta=\theta+\frac{\theta^3}{3}+\frac{2\,\theta^5}{15}+\ldots$$

Using only the first two terms of this development (8) becomes:

$$\theta^4+3\,\theta^2-3\,\frac{C}{C_1}=o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

If now $\lambda'_c$ is the natural wave-length of the coil measured along itself when free at both ends, and since according to the elementary theory $\lambda'_c$ may be replaced by $2l$, we have

$$\theta=\frac{\omega\,l}{a}=\frac{\omega\lambda'_c}{2a}=n\frac{\omega}{\omega_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

where $\omega_c$ has been written for the number of oscillations in $2\pi$ seconds if the coil alone vibrates freely.

Also $$\frac{C}{C_1}=\frac{LC}{LC_1}=n^2\frac{\omega_o^2}{\omega_c^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

where $\omega_o$ is the number of periods in $2\pi$ seconds of the wave-meter calculated in the ordinary way by the aid of the Thomson formula, as if the capacity were wholly located in the condenser.

Using (10) and (11), (9) may be written:

$$n^2\omega^4+3\,\omega^2\omega_c^2-3\,\omega_o^2\omega_c^2=o$$

or passing to the wave-lengths (where the indices have the same meaning as before), we get:

$$\lambda^4-\lambda_o^2\lambda^2-\frac{n^2}{3}\,\lambda_o^2\lambda_c^2=o$$

from which the real wave-length $\lambda$ of the wave-meter can be found in terms of the natural wave-lengths $\lambda_c$ of the free coil and of $\lambda_o$ the wave-length of the meter calculated in the ordinary way by the aid of the Thomson formula.

Writing $$o=\lambda^4-\lambda_o^2\lambda^2-\frac{n^2}{3}\,\lambda_o^2\lambda_c^2\equiv f(\lambda)$$

and bearing in mind that when the capacity of the condenser is large in comparison with the capacity of the coil, as is always the case for wave-meters used in the practice of wireless telegraphy, $\lambda$ will be only slightly different from $\lambda_o$. Putting, therefore,

$$\lambda=\lambda_o+p$$

where $p$ is a small quantity, we have the first approximation of $p$ given by:

$$p=\left[\frac{-f(\lambda)}{f'(\lambda)}\right]_{\lambda=\lambda_c}=\left[\frac{-\lambda^4+\lambda_o^2\lambda^2+\frac{n^2}{3}\,\lambda_o^2\lambda_c^2}{4\,\lambda^3-2\,\lambda_o^2\lambda}\right]_{\lambda=\lambda_o}=\frac{n^2\lambda_c^2}{6\,\lambda_o}.$$

so that the final formula becomes:

$$\lambda=\lambda_o+\frac{n^2}{6}\frac{\lambda_c^2}{\lambda_o}=\lambda_c+1{,}645\,\frac{\lambda_c^2}{\lambda_o} \quad . \quad . \quad . \quad (12)$$

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In application of this formula to a practical case, it appears that the correction term is usually small, but for accurate work it may possibly have some value. In conclusion, we point out again that $\lambda_c$ in (12) is *not* the wave-length of the free coil measured along the coil, but the wave-length in air that corresponds to the natural frequency of the coil alone. Its value is according to some measurements of P. Drude comprised between 1.4 and 5 times the total length of wire on the coil depending on the ratio of length to diameter of coil. It is very nearly equal to twice the length of wire for a coil without a core, whose length is 1·34 times its diameter.

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GRAY, DAWES & Co.—We are informed that on Monday, October 1st, Messrs Gray, Dawes & Company removed to their new offices, 122, Leadenhall Stieet, London, E.C.3, to which address all communications intended to reach them after that date should be directed.

# Those "Bits of Braid"

## *A Stirring Story of Wireless Work at the Front*

By "PERIKON"

How did I get it ? asked Cyclone, glancing at the narrow strip of gold Russia braid on his left cuff. Well, I don't usually shout the tale from the housetops, but if you promise to sit quiet and behave, I'll inflict it on you. I qualified for that the same night as McTavish. Samuel was there, too, but didn't further burden the taxpayer by requiring an issue of braid. It wasn't his fault, though. Oh no! He deserved one, too. It's just his luck that his cuff's still barren of braid.

To begin at the beginning, we were in the Y.M.C.A. tent near B—— one evening. You remember how it used to sit like a drab Aladdin's cave in the waste of festering field up behind Ypres. Well, we were yarning there one dark night, McTavish, Samuel and myself, when suddenly there was a shout for silence from the packing-case counter, and the Y.M.C.A. man asked if there were any of the ——th Corps Trench Wireless Section present. If so, they were to return immediately to billets.

We got up and left the tent. "We must be for up the line, the night," said McTavish.

"Probably, old scout, probably," agreed Samuel.

We got back to billets and found a pigeon car purring outside in the roadway. We knew then that we were off somewhere.

We were told to pack our kits and get aboard the car. We did so.

"Now, you chaps," said Samuel, when the auto was well under way, "we're h-hitting the old t-trail for the front line, and we——"

"A wish ye'd steyed at hame a' the same, Samyull," broke in McTavish, "it's bad enough gaun up, le alane hivin you wi' us. The tree at Z—— is aye grrreen in ma memrrry. A hope ye don't tak it in yer heid tae hae anither bit speel."

"Look here, McTavish, as you'd phrase it in your Harry Lauder *patois*, I'm fly for it this time. I don't think I'll do any Jolly Jack the Sailor stunts this time."

"Aye, but a'm willin' tae bet that ye pit yer fit in it some ither wey. A wish a wis as sure o' Kingdom Come, onywey," growled McTavish.

"Well," pursued Samuel, "we're g-going to stake our c-claim at the centre battalion headquarters of the ——th Infantry Brigade, and the b-boss hinted we might g-get some real traffic to handle, too. We go as far's the ramparts on t-this automobile, t-then we p-pad the rest."

"Jings, hoo awfully r-r-ripping," said McTavish, flippantly. "And ye'll likely tak the lightest bits o' gear yersel. Whit we want fur thae excur-r-rsions is a cuddy an' a barra'," he continued, looking at the assortment of stores on the floor of the pigeon car.

"W-whatever's a cuddy an' a barra ? " queried I.

"O ! " said McTavish, " that means a dunky and a kert."

"And what's that, Mac ? "

"Man, yer thick in the heid," said he, "D-o-n-k-e-y, dunky, and C-a-r-t-, kert."

"O! I see, yes! you're right, Mac," I agreed.

"You w-want," said Samuel, "t-to cease shooting out your shaggy neck, M-McTavish, and p-please do try to b-beat your remarks into understandable king's English. W-what we want is an in-interpreter, not a 'buddy and a carr'—I m-mean a 'cuddy and a barra.'"

"Best hae the lot an' mak a meal o' it," growled Mac. "See's a match yin o' ye"; and he lit up.

For a spell there was silence, save for the swish of the whirling tyres on the pavé. Then Samuel woke up again.

"Any of you chaps been n-near —— Copse before? That's w-where the headquarters are."

Nobody pleaded guilty.

"W-well, I've g-got a map. W-we'll p-probably l-locate the settlement without much difficulty."

"A hae ma doots Samyull. Can ye read a map?" queried Mac.

"You go a-and chew ate-kokes—I m-mean oat-cakes. Any chappie with a g-glimmer of horse-sense can read a map. C-child's play."

"Imphm," grunted Mac, "Jist that."

Well, we arrived at length at the —— Gate with the broken road ahead, and the ruins of Y—— behind. The car slowed up and we began to off-load our stores and kits.

"Anither thing," said Mac, "that's still green in ma memry is the terrible weight o' thae boxes, specially gaun up thae trenches. Haud on a wee an a'll pinch a barra. A saw yin at the door o' a ruin a wheen hunner yairds back."

And off McTavish went, back along the Rue de ——. At length we saw him returning, pushing a good-sized handcart before him.

"Wheesht," cautioned Mac, "A'll tell ye aboot it wanst we get on the road. If a'd done this in civvy life a'd a got ten years. An' me a'most an elder o' the kirk at hame. A wunner whit Mrs. McTavish wud say if she saw her man pinchin' the rashun barra o' the ——th Siege Battery, Garrison Artillery. That's the name on it onywey. The gunners wis inside the hoose somewhere. A could hear them bletherin'. Come on, see's up thae poles and that box. A've nae desire tae pass the night in the nik."

"What's the nik, Mac?" I asked.

"Nik, ma dear Cycle, is Scotch fur jile."

"Jile? And what's that?"

"Awa an' throw bricks at yersel, J-a-i-l, jile. Compree?"

"Quite right, old scout, we'll g-get off our m-mark now," said Samuel. "A-at the same time I wish I c-could induce you to w-write out a l-list of y-your Harry Lauderistic nouns and verbs and s-set down t-the equivalents in English."

"Ach, ye'll soon get tae ken them," said Mac. "Come on, a think a hear thae gunners lookin' fur thur barra."

And off we went. We took turns between the shafts as far's —— Corner and there we sat down for a spell. The night was pretty noisy. Fritz was heaving H.E over pretty freely, but on the corner it was quiet.

"N-now," said Samuel, "a-according to the map we take t-this road on the left and the track t-to headquarters is a lane, t-the second lane on the right. T-there's sure to be a sentry or ration party on the roads, and t-they'll be able to g-give us partics. See." pursued Samuel, flashing his torch on the map, "here are the cross-roads we're on, a-and he—."

Cr-r-ash ! ! !

"That crump wis meant fur them tae. Come on," howled McTavish, and off we raced barrow and all. Clods and splinters rained down all round. We kept going for a bit.

"The next time," puffed Mac, "ye flash that contrapshun we'll aw be deid mutton. Hivn't a telt ye afore aboot it ?"

"W-well," panted Samuel, "how did I know t-the rotten c-corner was under observaish ?"

"—— ——" howled Mac, between puffs, "hae ye nae savvy in that muckle heid at aw. Yer mair like a wean at a Sunday school swarry than a sodjer at the war. Cycle an I will hae tae buy ye some safer kin o' toy than yer fancy flashlamp."

"O ! g-go and eat haggis," said Samuel.

"Ma dear Samyull, a big feed o' haggis wid kill ye," countered Mac. "Mind that shell-hole or ye'll coup the barra."

"A-ah," said Samuel, steadying the cart with one hand and mopping his forelock with the other, "here's lane number one at any rate. The n-next one's ours. G-good job it's not very dark. H-here's a chappie coming down ; we'll ask our b-bearings from him."

The figure came abreast and Samuel asked the way to —— Copse.

The chap didn't know, but there was a lane a decent bit farther up on the right. He didn't just know where it led to, however.

"T-thanks, old scout," said Samuel, "that's our track sure enough, Good-night." And off we went again.

"Things is gettin' a bittie quieter," observed Mac. "There no very many leeries gaun up," as he glanced to the south where a solitary star shell was hanging motionless at its zenith.

"N-no, the pyrotechnics a-re somewhat d-disappointing to-night," agreed Samuel.

"Whaur did ye dig that yin up, Samyull ?" asked Mac.

"Dig w-what up ?"

"Polytechnics. Pits me in mind o' good auld Argyll Street."

"If you refer to that one-horse s-settlement Glasgow, I r-refuse to bite," said Samuel. "Once I w-was forced t-to spend a week-end there. It was l-like a mau-mausoleum—o-only more so."

"You lea Glesca alane, an' the next time ye want tae say fireworks *say* fireworks an' no pyro-pyrothingimayjigs. We're no a' blissed wi a fancy educashun," concluded McTavish. "But," he added as an afterthought, "we manage tae wauchle alang no sae hielan."

Well, we kept going for a good ten minutes, then the lane came to an end. It led into a field, apparently.

We halted for another rest, just at the end of the hedgeway.

"I think I see a b-bit of a p-plantation away over on the left there," said Samuel, peering over the hedge.

McTavish and I looked too.

"Aye," said Mac, "It's a wud right enough, bit ur ye sure it's the wan we're lookin' fur."

"It must be, t-there isn't another p-plantation f-for m-miles."

"Weel, I'm a bittie dubious masel, but there's nae use loafin' aboot here like a lot o'—like a lot o' Paddys at a fair. It's gettin' late."

"Yes, l-let's b-beat it f-for t-the p-plantation," said Samuel, and once more the handcart went creakingly forward.

After we had gone a hundred yards or so we came abreast of a line of wire which seemed to run parallel with the sides of the field. It looked comparatively new, too.

"Here, whaur the h—— ur we?' cried McTavish, suddenly.

"A-as far's I'm aware, old ch-chappie, were s-still at t-the war," replied Samuel.

"Just hae a closer look at that wire," said Mac, "and don't try tae be funny."

Well, we all turned our heads to look, and here we met our Waterloo. There was a terrific bump and the cart shot sideways and downwards, dragging us with it. We all rolled in a heap and when we sorted ourselves out we discovered we had fallen into a huge shellhole.

"You, as usual, wis tae blame, Samyull," groaned McTavish, shifting a heavy box from off his corns. "Ye should hae watched whaur ye wur gaun."

"O! s-shut up," snapped Samuel. "You and your d-dry remarks give me a p-pain. I n-nearly b-broke my n-neck then."

"A don't wish ye ony harm, Samyull, bit a wish tae Goad ye hud," moaned Mac, hugging his muddy boot.

"The next move," began Samuel, "will be to get this cart and the stores o-out of the h-hole. Then w-we'll b-beat it for that p-plantation."

We were just hauling the barrow to the top when things began to happen.

A starshell blazed up with alarming suddenness directly overhead.

We slid swiftly back to the bottom.

"Goad," cried McTavish, drawing his balmoral over his eyes to shield them from the white hot glare, "that's wan o' Fritz's. A ken them."

Then the truth broke on us. We must have strayed and got into No Man's Land. The lane had been a "blind patch," devoid of trench or wire. These patches occur almost every half mile, sometimes oftener. They are so well covered by light field pieces, rifle batteries and machine guns, that it's suicide to attempt a passage even at night. How we managed through unmolested is still a mystery.

"W-well, we're p-properly in the mud," gasped Samuel.

"Let's have a look. We m-must try to f-fix our own t-trenches and g-get b-back toward them."

We clambered cautiously to the lip of the hole once again and peered toward the line of wire.

Everything was deadly quiet. From away on the right and left we heard occasional machine guns stuttering in a muffled half-hearted manner.

Suddenly there was a faint swishing sound from behind. The sort of sound a flight of wild ducks make, only a trifle more subdued, and glancing swiftly to the rear we saw a fast-forming trail of sparks soaring upward. Next instant the flare blazed up, and again we crouched back into the hole.

"That's wan o' oors," said McTavish, softly. "Oors are mair yellow nor Fritz's."

"W-well, we m-must beat it towards where t-that flare came from," said Samuel, "it's at l-least three hundred yards. A-and we m-must g-get the stores out of it too."

"This," said McTavish, "is the —— leemit! A telt ye ye'd pit yer fit in it, didn't a?" to Samuel.

"W-we must have missed t-the real lane number one when t-that s-shell shifted us f-from the corner," admitted Samuel, sadly.

"Cheer up, Samyull, some day ye'll hae mair sense," said Mac. "But a hae ma doots," he terminated, shaking his head.

"W-well, we'll nip now," said Samuel, "t-take all you c-can carry."

"Half a tick," whispered McTavish, "a thocht a heard something. Jist a second," and he crawled upward and peered round to the left and right.

"Goad!" whispered Mac hoarsely, "the place is moving wi Fritzes. They're crawlin' frae the direction o' that wire. See's ma gun, quick!"

We swarmed quickly alongside McTavish and peered into the gloom. What Mac had said was true. There were at least fifteen vague, sack-like objects wriggling and crawling toward our shell-hole. It was either an enemy patrol or a small raiding party. Evidently they had heard, and were bent on either finishing or capturing us.

"Come on," gritted Mac, and he scrambled out of the hole. We followed. Then Donnybrook Fair, multiplied by four, broke loose. McTavish was on top of the leading figure first and battered its brains out. Samuel made for his man, tripped and accidentally knocked his opponent senseless with his rifle. Somebody rushed at me and I lashed out with my left boot. McTavish rushed at his second man and clubbed him before he got off his knees. Then somebody, evidently an expert boxer, got me right on the chin. I went down, but managed to get in a terrific kick on the boxer's ribs as I was going. McTavish shot the pugilist in the kidneys as he was preparing to wipe his boots on my face. Samuel then, in the confusion, made a terrific swipe at McTavish, which would certainly have put Mac on the Roll of Honour had it got home, but Mac dodged and put Samuel right by howling a string of unprintable nouns at him.

"Come on, run for it," panted McTavish, "here's mair o' them."

And we ran. But back to the shell hole. The "people across the way" blithely took up the chase, but losing the direction of our funk hole had to submit to five rapid apiece from the three of us. This left about five who continued to run here and there brandishing their nail-studded knobkerries and muttering.

"Come on," panted Mac, "finish 'em off in case they begin heavin' bombs."

So we loosed off again, but they disappeared.

"Now," gasped Samuel, ' catch hold of as much as y-you can carry, and run like h——. Don't leave anything."

We did so. But we ought to have been more cautious. Fritz kept putting up flares and sweeping with his machine guns. McTavish and I stopped four rounds between us in the legs and Samuel lost his cap. It flew right off his head as if it had been whisked aloft by invisible wires. Just an inch lower and Samuel would never have known it. Luckily, we were able to make our own trenches, but not before a light infantryman loosed off a round and got a reply to his challenge.

" Halt ! who goes " ? he yelled.

BANG ! ! !

" Awa and bile yer can," howled McTavish. " Let us in. We've nae time fur ceremonies."

" Who are you ? " repeated the sentry.

" Friends, o-old scout," gulped Samuel. " T-three of them."

" Advance one ! " and McTavish scrambled over the parapet.

Then we followed. So did the explanations, and B Company of the ——th —— Light Infantry grinned broadly.

We had six weeks at Boulogne, Mac and I, and that's how we got the bits of braid.

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# Wireless in Glasgow

The grand old city of Glasgow is the second most populous city in Great Britain, ranking next to the "Great Wen," as the Metropolis of the Empire is occasionally

called. We would refer Glaswegians and others to the details of a wireless training scheme affecting this city which will be found on pages 567-8. Our illustration (above) shows George Square and the Municipal Buildings.

# Among the Operators

"Missing."

No feeling heart can ever fail to go out in the deepest sympathy to those who have sons or relations reported "missing." This month it is our sad duty to report three cases falling under this category.

The first is that of Robert Sharp Gardner, who joined the Marconi Company in 1913, and had only reached the age of twenty-four at the time when his vessel went down. Born at Airdrie in the County of Lanark, and educated in the same locality, he first learnt the trade of a wire-drawer, and later on studied wireless telegraphy at the North British Wireless Schools, Glasgow. After leaving this institution he came to London to join the Marconi Company's School, and there completed his training. In the autumn of 1913 he received his first sea appointment, starting his operator's career on the s.s. *Saxonia.* Thence, after but one trip, he was transferred to the s.s. *Oropesa.* He next sailed on the s.s. *Hesperian,* again for a single voyage, and later on made the s.s. *Numidian* his wireless home for a considerable period. After serving on various other vessels he joined his last ship in January of this year. The vessel met with disaster in August last. As no news has been received of the gallant operator since the wreck, it is presumed that he is no longer "on this side." Mr. Gardner leaves a widow and two children, to whom we offer our sincere condolence.

ROBERT SHARP GARDNER.

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The second instance we have in mind occurred on a large vessel recently sunk by the enemy. She carried two operators, Messrs. Charles Edward Blight and Arthur Charles Truman. We deeply regret to say that both operators were reported missing after the wreck and are presumed to be drowned. Mr. Blight, the senior, is a London man, who had recently attained his majority. On leaving school he went in for a systematic study of business methods and took up office work for two years. He then turned his attention to wireless telegraphy, joining the Marconi Company in March, 1916. He served on the s.s. *Mattawa,* and was thence transferred to the s.s. *City of Bristol.* He joined his last vessel in August of this year.

CHARLES EDWARD BLIGHT.

Mr. Truman, the junior operator, was born at Clapton and educated at the Owens School, Islington. For a number of years he served in the Accountant's Department of the Marconi Company, and was very popular with his fellow workers. In December last he transferred to the Marine Operating Staff, and the vessel on which he lost his life was the first on which he served at sea.

WALTER SWEENY.

We are informed that immediately after the ship was struck, the senior operator, Mr. Blight, reported to the bridge for orders, and these having been duly received, he retired to the wireless cabin to carry out his instructions. After these orders had been given them neither of the telegraphists was seen again, and it is presumed that they went down with the ship. The loss of both young men is deeply deplored, and we extend our sincere sympathy to their relatives in their sad bereavement.

* * * * * *

The third case in point is that of Mr. Walter Sweeny, who was serving on board a vessel which recently fell a victim to the torpedo of the infamous Huns. Mr. Sweeny was a native of Castlerea in County Roscommon, and was born in 1895. Educated in Dublin and Kildare, he took an early interest in wireless telegraphy, and pursued his studies in this subject at the Atlantic Wireless College, Cahirceveen. Mr. Sweeny joined the Marconi Company's London School six or seven months prior to the outbreak of war, and there completed his training just before the start of hostilities. His first ship was the s.s. *Caledonia*, and he later served on the s.s. *Mongolian*, s.s. *Saxonia*, s.s. *California*, and a number of other vessels. He joined his last ship in July of this year. Deep sympathy is felt for his relatives in their time of trouble.

WILLIAM GARNETT.

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LOST AT SEA.

Messrs. W. Garnett and William Shearer served as senior and junior operators respectively on board a merchant vessel, which fell victim to an enemy torpedo within the last few months. Unfortunately in this case both men were drowned.

Mr. Garnett, the senior operator, was 23 years of age, and hailed from Kirkoswald in the County of Cumberland. On leaving school, he entered his father's business; and

WILLIAM SHEARER.

later on studied radiotelegraphy at the Liverpool Wireless Training College, where he obtained his Postmaster-General's Certificate. On joining the Marconi Company he was soon appointed to his first ship, s.s. *Kastalia*, and after two trips on this vessel was transferred to the s.s. *City of Glasgow*. In June of this year he was appointed to his last ship.

The junior operator, Mr. Shearer, of Craigard, Gourock, Renfrewshire, was 20 years old. After receiving his education at Gourock, Greenock Academy and Crieff, he studied at a business college in Glasgow and entered a firm of shipowners as a clerk. Later he became a motor mechanic in Glasgow, and it was this occupation that he left in order to join the army. He failed, however, to reach the official standard of physique and, desiring to serve his country in some useful capacity, he entered the Marconi Company's School in London this year. In July, having received a P.M.G. Certificate, he was appointed to his first ship and had not served long with that vessel before she was sunk by a German submarine.

It is sad to realise that so promising a career should thus be broken, and we can only offer his surviving parent our sincerest tribute of sympathy, and trust that some consolation may be derived from the knowledge that he gave his life for the country he burned to serve, as truly as any of those other heroes who die in active combat at the front.

# In the Air

## *A Significant Feature of the New German Machines*

When this present war first started the ordinary civilian sat, as it were, at the feet of the professional expert, and listened with 'bated breath to the words of wisdom that fell from his lips. Experience has begot scepticism, and now that we are told the war is to be won in the air we can only express a pious hope that this prophecy will be more fortunate than its predecessors. It is certain anyhow that both sides are making strenuous aerial preparations, and we shall assuredly see a clash of arms in " the unstable element."

There is one factor which, through all the varying changes, has gone on steadily increasing in importance. That factor is Wireless. We have called attention so frequently to the close connection between radiotelegraphy and aircraft that it is a work of supererogation to repeat our lesson. We cannot refrain, however, from calling attention to one feature in the details recently published by a morning contemporary concerning the new four-engined Gothas which our enemies are said to be building. The supreme direction is left in the hands of the wireless man. The fact that the radiotelegraphist captains the aircraft, in itself constitutes a really eloquent recognition of the supreme importance of wireless to aerial navigation.

# A Splendid Opportunity for Young Men

## *The Marconi Company Offers Free Training*

From time to time we receive letters written by correspondents who enquire where they can receive training as wireless operators. We are now in a position to bring to their notice an extensive scheme, under which suitable applicants between the ages of sixteen and eighteen are trained free of cost, not only London, but also in the Provinces.

Young men who are desirous of entering the wireless profession should avail themselves of this offer without delay, for, of course, there is a time-limit, and the offer will not be open indefinitely.

Applicants who wish to join the Marconi Company's London school should write to the :—

Traffic Manager,
The Marconi International Marine Communication Co., Ltd.,
Marconi House,
Strand, London, W.C.2.

Those who are located in Birmingham should apply to :—

Mr. A. J. Chesterton,
Municipal Technical School,
Suffolk Street,
Birmingham.

Applicants who desire to train in Leeds to :—

The Marconi Representative,
Central Technical School,
Cookridge Street,
Leeds.

Whilst those who are domiciled in Glasgow should apply to :—

The Marconi Representative,
The Royal Technical College,
Glasgow.

In Newcastle the company are offering free scholarships at the Rutherford Technical College Wireless School, and particulars can be obtained on application to the :—

School Representative,
Marconi International Marine Communication, Co., Ltd.,
Milburn House,
Newcastle-on-Tyne.

Similar schemes are about to be started in other provincial centres, and if any of our readers are in doubt as to whether they can avail themselves of these offers, they should communicate immediately with :—

The Traffic Manager,
Marconi International Marine Communication Co., Ltd.,
Marconi House,
Strand, London, W.C.2.

asking for particulars of the nearest school to their home.

The course of training is so arranged that any intelligent young man can pass the Postmaster-General's Examination for a First-Class Certificate in from twenty to twenty-five weeks, and immediately on successfully passing this test they will be appointed to positions on board ship at a commencing salary of 25s. a week, and all found.

As some applicants may wish to have a clear understanding of their position under the Military Service Acts, we subjoin the official Government statement on the question :—

"Owing to the present urgent demand for wireless operators in the Mercantile "Marine, students entering the school prior to their eighteenth birthday and making "such progress that they are able to obtain the necessary certificates on or before "reaching the age of eighteen and a quarter, will be temporarily exempted from "military service until a sufficient number of operators has been obtained. This "exemption continues so long as students of military age who have passed into "the Mercantile Marine are employed as operators at sea."

Full particulars of the conditions of service, pay, etc., will be forwarded immediately on application to any of the above centres, and parents and guardians who wish to obtain further particulars will be given a personal interview on application to the Marconi representative.

# Sailors and the War

THE British and Foreign Sailors' Society is celebrating its centenary shortly, and in view of this event hopes to raise £250,000 for the further extension of its work. Founded in the days of Lord Nelson and with Admiral Gambier as its first president, the Society has made the welfare of British seamen its first charge throughout the past hundred years. During the progress of the war the Society's institutions in all parts of Great Britain and elsewhere have given shelter, food, and clothing to thousands of men, including crews of torpedoed ships. The Society's King Edward VII. Nautical School has trained lads for the merchant service, and over 4,000 have received their Board of Trade certificates at the School. The centenary fund will enable this school to be extended. Centenary subscriptions may be sent to Sir Frederick Green, J.P., Sailors' Palace, Commercial Road, E.14.

# The Wireless Transmission of Photographs

Article II—*continued*

By MARCUS J. MARTIN

EDITORIAL NOTE: *The previous article of this series appeared in our issue for June last.*

THE formation of an image of some distant object in its principal focus is one of the most useful properties of a convex lens, and it is this property that forms the basis of several well-known optical instruments, including the telescope, microscope, camera, etc.

If we take an oblong wooden box, *AA*, and substitute a sheet of ground glass, *C*, for one end, and drill a small pinhole, *H*, in the centre of the other end opposite the glass plate, we shall find that a tolerably good image of any object placed in front of the box will be formed upon the glass plate. The light rays from all points of the object, *BD*, Fig. 7a, will pass straight through the hole, *H*, and illuminate the ground glass screen at points immediately opposite them, forming a faint inverted image of the object, *BD*. The purpose of the hole, *H*, is to prevent the rays from any one point of the object from falling upon any other point on the glass screen than the point immediately opposite to it, therefore the smaller we make *H* the more distinct will be the image obtained. Reducing the size of *H* in order to produce a more distinct image has the effect of causing the image to become very faint, as the smaller the hole, *H*, the smaller the number of rays that can pass through from any point of the object. By enlarging the hole, *H*, gradually the image will become more and more indistinct until such a size is reached that it disappears altogether.

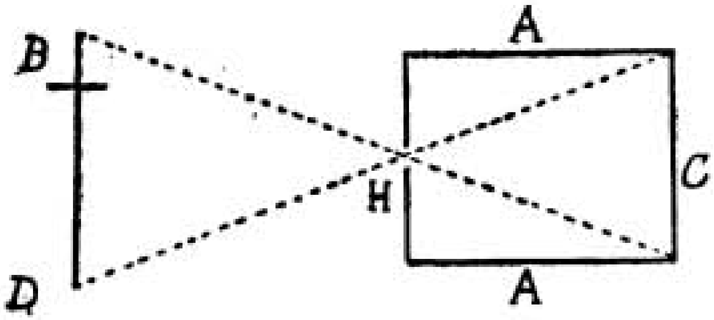


Fig. 7a.

If in this enlarged hole we place a double convex lens, *LL*, Fig. 8, whose focal length suits the length of the box, the image produced will be brighter and more distinct than that formed by the aperture, *H*, since the rays which proceed from any point of the object will be brought by the lens to a focus on the glass screen, forming a bright, distinct image of the point from which they come. The image

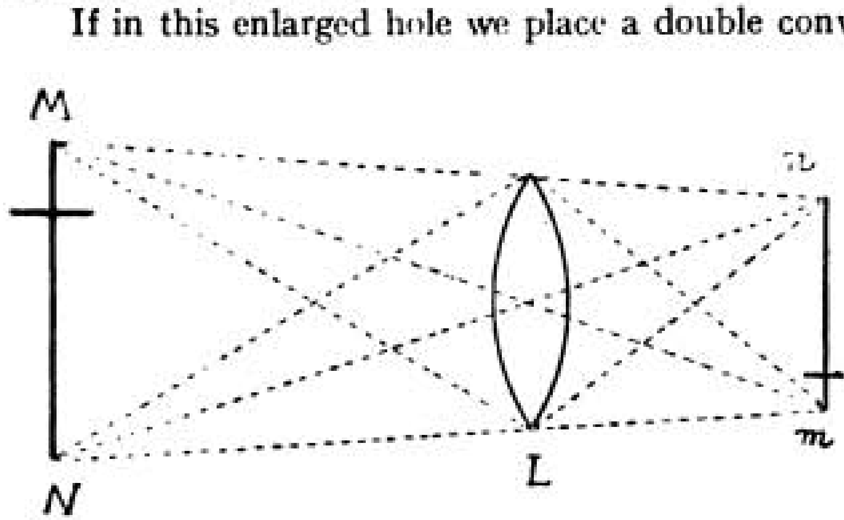


Fig. 8.

owes its increased distinctness to the fact that the rays from any one point of the object cannot interfere with the rays from any other point, and its increased brightness to the great number of rays that are collected by the lens from each point of the object and focussed in the corresponding point of the image. It will be evident from a study of Fig. 8 that the image formed by a convex lens must necessarily be inverted, since it is impossible for the rays from the end, *M*, of the object to be carried by refraction to the upper end of the image at *n*. The relative positions of the object and image when placed at different distances from the lens are exactly the same as the conjugate foci of light rays as shown in Fig. 7. The length of the image formed by a convex lens is to the length of the object as the distance of the image is to the distance of the object from the lens. For example, if a lens having a focal length of twelve inches is placed at a distance of 1,000 feet from some object, then the size of the image will be to that of the object as 12 inches to 1,000 feet, or 1,000 times smaller than the object; and if the length of the object is 500 inches then the length of the image will be the 1/1,000th part of 500 inches, or ½ inch.

The image formed by the convex lens in Fig. 8 is known as a ***real image***, but in addition convex lenses possess the property of forming what are termed ***virtual images***. The distinction can be expressed by saying, ***real images are those formed by the refracted rays themselves, and virtual images those formed by their prolongations***. While a real image formed by a convex lens is always inverted and smaller than the object, the virtual image is always erect and larger than the object. The power possessed by convex lenses of forming virtual images is made use of in that useful but common piece of apparatus known as a reading or magnifying glass, by which objects placed within its focus are made larger or magnified when viewed through it; but in order to properly understand how objects seem to be brought nearer and apparently increased in size, we must first of all understand what is meant by the expression ***the apparent magnitude of objects***.

The apparent magnitude of an object depends upon the angle which it subtends to the eye of the observer. The image at *A*, Fig. 8a, presents a smaller angle to the eye than the angle presented by the object when moved to *B*, and the image therefore appears smaller. When the object is moved to either *B* or *C*, it is viewed under a much greater angle, causing the image to appear much larger. If we take a watch or other small circular object and place it at *A*, which we will suppose is a distance of 50 yards, we shall find that it will be only visible as a circular object, and its apparent magnitude or the angle under which it is viewed is then stated to be very small. If the object is now moved to the point *B*, which is only 5 feet from the eye, its apparent magnitude will be found to have increased to such an extent that we can distinguish not only its shape, but also some of the marking.

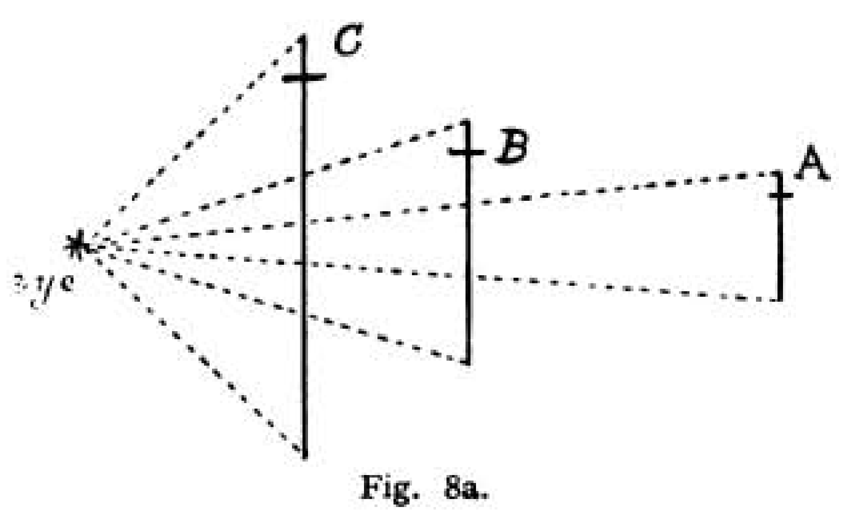


Fig. 8a.

When moved to within a few inches of the eye as at *C*, we see it under an angle so great that all the details can be distinctly seen. By having brought the object nearer the eye, thus rendering all its parts clearly visible, we have actually magnified it, or made it appear larger, although its actual size remains exactly the same. When the distance between the object and the observer is known, the apparent magnitude of the object varies inversely as the distance from the observer.

Let us suppose that we wish to produce an image of a tree situated at a distance of 5,000 feet. At this distance the light rays from the tree will be nearly parallel, so that if a lens having a focal length of 5 feet is fastened in any convenient manner in the wall of a darkened room the image will be formed 5 feet behind the lens at its principal focus. If a screen of white cardboard be placed at this point we shall find that a small but inverted image of the tree will be focussed upon it. As the distance of the object is 5,000 feet, and as the size of the received image is in proportion to this distance divided by the focal length of the lens, the image will be as 5,000 ÷ 5 or 1,000 times smaller than the object.

If now the eye is placed six inches behind the screen and the screen removed, so that we can view this small image distinctly in the air, we shall see it with an apparent magnitude as much greater than if the same small image were equally far off with the tree, as 6 inches is to 5,000 feet, that is 10,000 times. Thus we see that although the image produced on the screen is 1,000 times less than the tree from one cause, yet on account of its being brought near to the eye it is 10,000 times greater in apparent magnitude; therefore its apparent magnitude is increased as 10,000 ÷ 1,000, or 10 times. This means that by means of the lens it has actually been magnified ten times. This magnifying power of a lens is always equal to the focal length divided by the distance at which we see small objects most distinctly—viz., 6 inches, and in the present instance is 60 ÷ 6, or ten times.

When the image is received upon a screen the apparatus is called a *camera obscura*, but when the eye is used and sees the inverted image in the air, then the apparatus is called a *telescope*.

The image formed by a convex lens can be regarded as a new object, and if a second lens is placed behind it a second image will be formed in the same manner as if the first image were a real object. A succession of images can thus be formed by convex lenses, the last image being always treated as a fresh object, and being always an inverted image of the one before. From this it will be evident that additional magnifying power can be given to our telescope with one lens by bringing the image nearer the eye, and this is accomplished by placing a short-focus lens between the image and the eye. By using a lens having a focal length of 1 inch, and such a lens will magnify six times, the total magnifying power of the two lenses will be $10 \times 6 = 60$ times, or ten times by the first lens and six times by the second. Such an instrument is known as a *compound or astronomical telescope*, and the first lens is called the object glass and the second lens the magnifying glass, or eye-piece.

We are now in a position to understand how virtual images are formed, and the formation of a virtual image by means of a convex lens will be readily followed

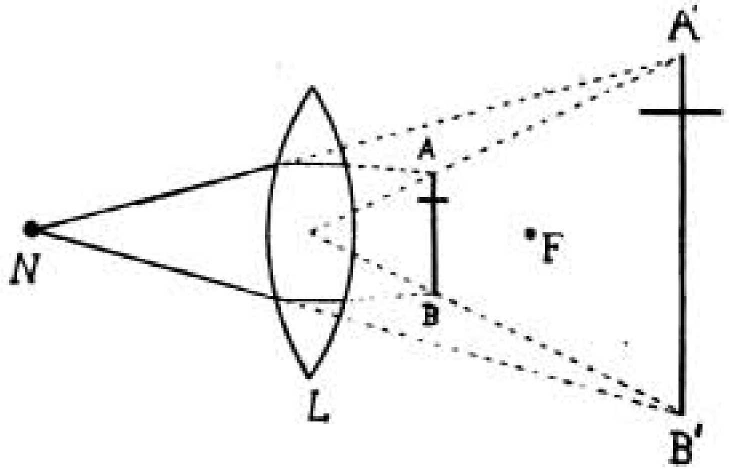


Fig. 9.

from a study of Fig. 9. Let $L$ represent a double convex lens, with an object, $AB$, placed between it and the point $F$, which is the principal focus of the lens. The rays from the object, $AB$, are refracted on passing through the lens, and again refracted on leaving the lens, so that an image of the object is formed at the eye, $N$. As it is impossible for the eye to follow the bent rays from the object, a virtual image is formed and is seen at $A^1B^1$, and is really a continuation of the emergent rays. The magnifying power of such a lens may always be found by dividing six inches by the focal length of the lens, six inches being the distance at which we see small objects most distinctly. A lens having a focal length of ¼ inch would magnify 24 times, and one with a focal length of 1/100th of an inch 600 times, and so on. The magnifying power is greater as the lens is more convex and the object near to the principal focus. When a single lens is applied in this manner it is termed a *single microscope*, but when more than one lens is employed in order to increase the magnifying power, as in the telescope, then the apparatus is termed a *compound microscope.*

Unlike a convex lens, which can form both real and virtual images, a concave lens can only produce a virtual image; and while the convex lens forms an image larger than the object, the concave lens forms an image smaller than the object. Let $L$, Fig. 10, represent a double concave lens, and $AB$ the object. The rays from $AB$, on passing through the lens are refracted, and they diverge in the direction $RRRR$, as if they proceeded from the point $F$, which is the principal focus of the lens, and the prolongations of these divergent rays produce a virtual image, erect and smaller than the object, at $A^1B^1$. The principal focal distance of concave lenses is found by exactly the same rule as that given for convex lenses.

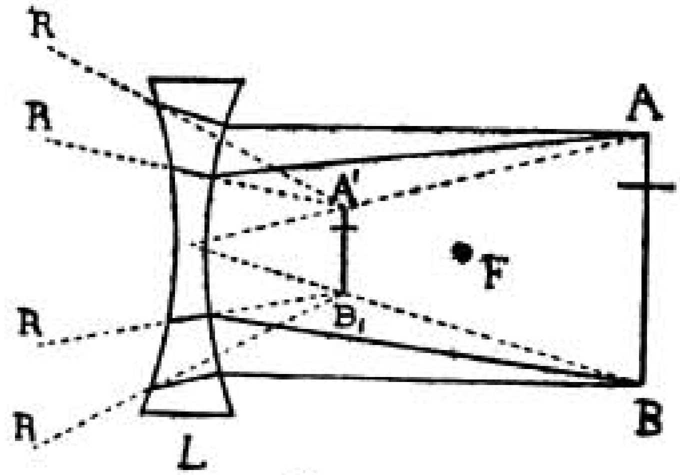


Fig. 10.

Up to the present we have assumed that all the rays of light passed through a convex lens were brought to a focus at a point common to all the rays, but this is really only the case with a lens whose aperture does not exceed 12°. By aperture is meant the angle obtained by joining the edges of a lens with the principal focus. With lenses having a larger aperture the amount of refraction is greater at the edges than at the centre, and consequently the rays that pass through the edges of the lens are brought to a focus nearer the lens than the rays that pass through the centre. Since this defect arises from the spherical form of the lens it is termed *spherical aberration*, and in lenses that are used for photographic purposes the aberration has to be very carefully corrected.

The distortion of an image formed by a convex lens is shown by the diagram Fig. 11. If we receive the image upon a sheet of white cardboard placed at *A*, we shall find that while the outside edges will be clear and distinct, the inside will be blurred, the reverse being the case when the cardboard is moved to the point *B*.

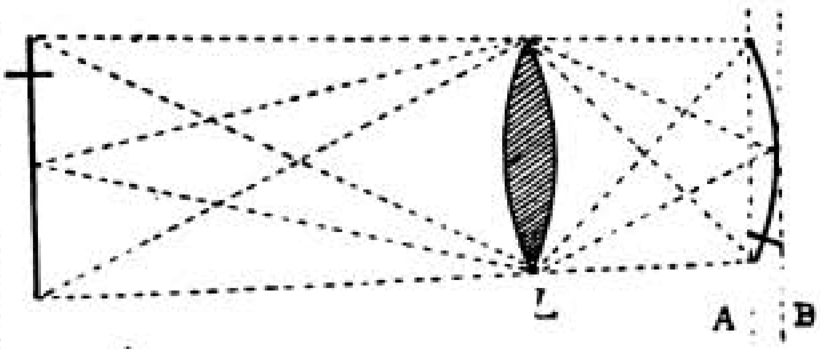


Fig. 11.

Aberration is to a great extent minimised by giving to the lens a meniscus instead of a biconvex form, but as it is desirable to reduce the aberration to below once the thickness of the lens, and as this cannot be done by a single lens, we must have recourse to two lenses put together. The thickness of a lens is the difference between its thickness at the middle and at the circumference. In a double convex lens with equal convexities the aberration is $1\frac{67}{100}$ths of its thickness. In a plano-convex lens with the plane side turned towards parallel rays the aberration is only $4\frac{1}{2}$ times its thickness, but with the convex side turned towards parallel rays the aberration is only $1\frac{17}{100}$ths of its thickness.

By making use of two plano-convex lenses placed together as at Fig. 12, the aberration will be only one-fourth of that of a single lens, but the focal length of the lens, $L^1$, must be half as much again as that of $L$. If their focal lengths are equal the aberration will only be a little more than half reduced. Spherical aberration, however, may be entirely destroyed by combining a meniscus and double convex lens as shown at Fig. 13, the convex side being turned to the eye when used as a lens, and to parallel rays when used as a burning glass or condenser.

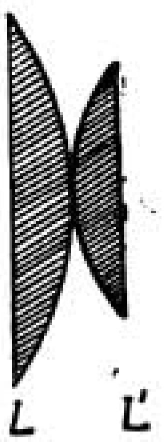


Fig. 12.

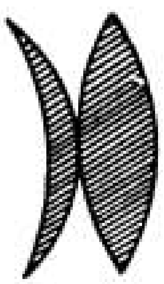

Fig. 13.

Before, however, leaving the subject of lenses, there are several points in connection with the preparation of the metal prints used for transmitting that will not be out of place to mention here. In regard to the copying stand described on page 108 of the *Wireless Transmission of Photographs*, an extra improvement would be to rule the surface of the copying board, *A*, Fig. 60, in a manner similar to that shown in the diagram, Fig. 14, accompanying this article. The rulings should be marked off from the centre of the board, and should enclose parallelograms of the various plate sizes ranging from $3\frac{1}{4} \times 4\frac{1}{4}$ inches up to the full size of the board. By fastening the picture or photograph to be copied in the space on the board corresponding in size, we can ensure that it is in the correct position for the whole to be included on the photographic plate, providing, of course, that the centre of lens and board coincide.

With the copying arrangement under discussion it is only possible to employ it for reducing, it being necessary to employ a bellows camera with a back focussing attachment for purposes of enlarging, and this constitutes the chief drawback to the use of a fixed focus camera. By replacing the box camera with a focussing camera of the same size, we shall have a piece of apparatus capable of reducing or enlarging, only in this case the camera should be a fixture and the board, *A*, arranged to slide backwards and forwards instead.

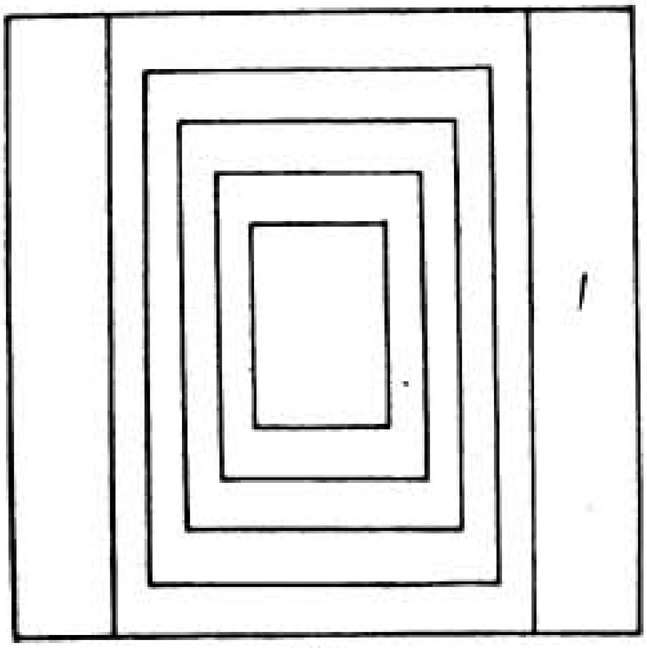

Fig. 14.

With regard to the lens required, the practice adhered to by most photographers is to use a lens having a focal length equal to the length of the diagonal of the plate used. Thus for a ¼-plate camera a 5-inch lens should be used, and for a ½-plate an 8-inch lens, and so on. For a 5×4-inch camera a 6-inch lens will be required. The following is a simple rule for finding the conjugate foci of a lens, and is useful in obtaining the distance from the lens to the photographic plate and the picture to be copied. Let us suppose that we wish to make an enlarged line negative, measuring $5 \times 4$ inches from a $3\frac{1}{4} \times 4\frac{1}{4}$-inch print. Add 1 to the number of times it is required to enlarge and multiply the result by the focal length of the lens in inches. To enlarge from a ¼-plate to $5 \times 4$ in. is a $1\frac{1}{2}$ times enlargement, so in the present case this will be $1\frac{1}{2}+1=2\frac{1}{2}$; and if a 6-inch lens is used will be $2\frac{1}{2} \times 6=15$ inches, which will be the distance of the lens from the plate. Divide this number by the number of times it is desired to enlarge and the distance of the lens from the picture to be copied is obtained; in this instance $15 \div 1\frac{1}{2}=10$ inches. The same rule can be followed when it is required to reduce any given number of times, only in this case the greater number will represent the distance between the lens and the picture to be copied, and the lesser number the distance between the lens and the plate.

In reducing, a ¼-plate lens will be found to fully cover a 5×4-inch plate, providing the reduction is not greater than three to one.

# The Share Market.

THE market in the various issues has been very active during the past month. Chief interest has centred round the new issue of the Marconi International Marine shares, which now stand at 15s. premium. The shares of the parent Company have come into steady demand, and the price has risen considerably. The shares of the American Company have been steadily bought on good account, and shown a marked improvement at 24s. The shares of the other issues all show an appreciable advance. The prices as we go to press are :—

Marconi Ordinary, £3 10s. ; Marconi Preference, £2 17s. 6d. ; Marconi, American, £1 4s. ; Marconi, Canadian, 12s. 3d. ; Spanish and General Trust, 11s. 6d. ; Marconi International Marine, £2 11s. 3d. ; Marconi International Marine New, 15s. premium.

# Instructional Article

## NEW SERIES (No. 8).

*EDITORIAL NOTE.—In the opening number of the new volume we commenced a new series of valuable instructional articles dealing with Alternating Current Working. These articles, of which the present is the eighth, are being specially prepared by a wireless expert for wireless students, and will be found to be of great value to all who are interested in wireless telegraphy, either from the theoretical or practical point of view. They will also show the practical application of the instruction in mathematics given in the previous volume.*

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### HIGH-FREQUENCY RESISTANCE.

**43. The Skin Effect.**—If a unidirectional current flows through a conductor the distribution of the current is uniform over the area of cross-section of the conductor. It is also practically uniform when a low-frequency alternating current is flowing in a conductor, unless it is of very large cross-section. If, however, a current having a periodicity, such as is met with in the oscillating circuits of wireless telegraph sets, flows in a conductor, the current will **not** be **uniformly** distributed over the cross-section of the conductor. The current **density** will be **greater** through a thin or **outside** layer of the conductor, so that the current is practically confined to a thin layer of the conductor, and this is known as the **skin effect.**

The frequency of an oscillating current in a wireless telegraph set may be anything between about 3,000,000 periods per second to 30,000 periods per second (wave-length of 100 metres to 10,000 metres respectively); under these circumstances special precautions have to be taken that the **active** cross-section of the conductor is sufficient to carry the current without any undue heating.

The **depth** to which a high-frequency alternating current will penetrate, for all practical purposes, in any conductor can be calculated from the formula: *

$$x = \frac{0{\cdot}636}{\sqrt{n\mu\sigma}}$$

where $x$ is the required depth, $n$ the frequency, $\mu$ the permeability, and $\sigma$ the conductivity, or

$$x = \frac{{\cdot}636\sqrt{\rho}}{\sqrt{n\mu}}$$

Where $\rho$ is the specific resistance.

The current at the depth $x$ would be about 2 per cent. of that at the surface of the conductor.

**Example.**—Calculate the depth of penetration into a copper conductor of an alternating current of frequency (*a*) 2,250,000 ~ and (*b*) 32,400 ~.

For copper $\rho = 1600$ c.g.s. units, $\mu = 1$.

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* See Fleming's *Principles of Electric-wave Telegraphy.*

Then (*a*) when $n = 225 \times 10^4$.

$$x = \frac{\cdot 636 \sqrt{1600}}{\sqrt{225 \times 10^4}}$$

$$= \frac{\cdot 636 \times 40}{15 \times 10^2} = 0{\cdot}016 \text{ cm.}$$

when $n = 32400$

$$x = \frac{\cdot 636 \times \sqrt{1600}}{\sqrt{324 \times 10^2}}$$

$$= \frac{\cdot 636 \times 40}{18 \times 10} = 0{\cdot}14 \text{ cm.}$$

**44. Measurement of High-Frequency Resistance.**—The calculation of the high-frequency resistance of any conductor is a somewhat difficult proceeding, there being only a few cases where this can be done with any degreee of accuracy. Methods have been devised, therefore, whereby the high-frequency resistance of a conductor can be measured experimentally.

If a conductor is traversed by a unidirectional current the rate at which energy is dissipated in the torm of heat is **proportional** to the **square** of the **current** passing. This is also true when a conductor is traversed by a high-frequency current.

Dr. Fleming * has utilised this agreement for determining the ratio of the direct-current resistance to the high-frequency resistance of a wire. Unfortunately the method is only applicable to short straight lengtns of wire.

Let the steady resistance of a wire carrying a direct current be $R$ ohms and the current be $C$ amperes. Then the heat generated in that wire will be proportioned to $C^2R$.

If now an alternating current of $C_1$ amperes is passed through another wire exactly similar which has a high-frequency resistance of $R_1$ ohms then the heat generated will be proportional for $C_1^2R_1$. Now if the direct current is adjusted so that the heat generated in the two wires is equal, then :

$$C^2R = C_1^2R_1$$

$$\frac{C^2}{C_1^2} = \frac{R_1}{R}$$

The two wires are placed in the two glass tubes of a differential air thermometer, then the direct current is adjusted until the air pressure in the two glass tubes is equal. When this is the case, the heat dissipated by tne two wires is equal, thereby the ratio of the steady resistance to tne high-frequency resistance can be obtained from the above formula.

This method illustrates only one way by which the ratio of the steady resistance to the high-frequency resistance can be determined experimentally. There are many formulas for calculating the high-frequency resistance of a wire, but the majority of them only apply to the cases of straight wires or those bent into a simple

* See Fleming's *Principles of Electric-wave Telegraphy*.

geometrical form. In the case of an oscillating circuit of a wireless telegraph set there are several factors, such as stray magnetic fields and irregular forms of windings, that render the calculation of the high-frequency resistance of little use and accuracy.

**45. Guarding against High-Frequency Losses.**—When a high-frequency current traverses a helix made of a solid wire the resistance of the wire is greater than if the wire were laid out straight, since, in addition to the crowding of the current into the outer skin, it also tends to crowd into the part of the wire forming the inside of the helix.

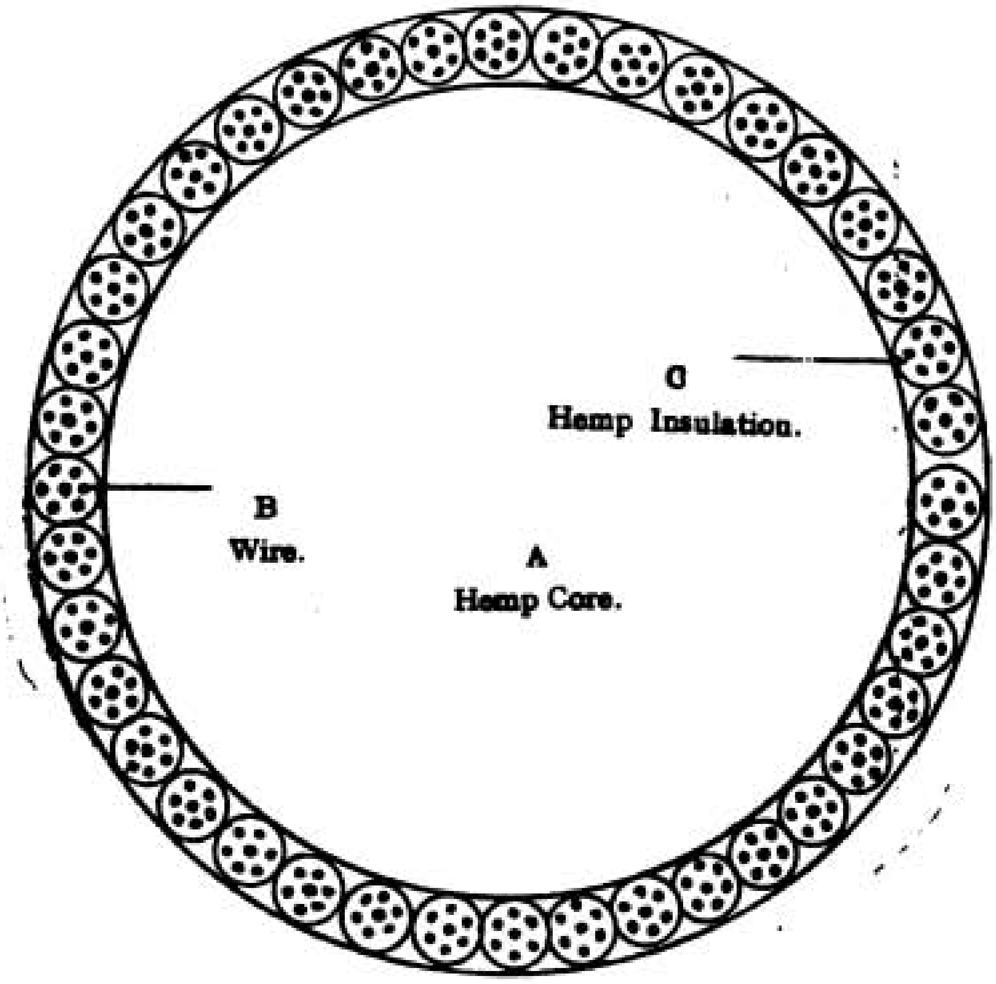


Fig. 35.

If a cable is made of separately insulated wires of No. 40 or less diameter, the high-frequency resistance is less than the high-frequency resistance of a solid cable the same diameter. If the high-frequency current is small this method is useful, but when the high-frequency current is of the order used in a transmitting set the difficulty of using cable constructed of many separately insulated strands of No. 40 wire, become such as to render this method inapplicable.

In a medium power wireless telegraph set, the jigger primary and secondary are made of stranded wire built round an insulating core. Fig. 35 shows the section of such a cable. Each strand of wire *B* is separately insulated with cotton; a group of wires is again insulated with hemp, *C*, and placed round a hemp core, *A*, in the form of a spiral. The whole is then covered with braid. Hence all the conductors lie on the surface of a tube of large diameter, and the current distribution is more uniform than if they were made into a solid cable.

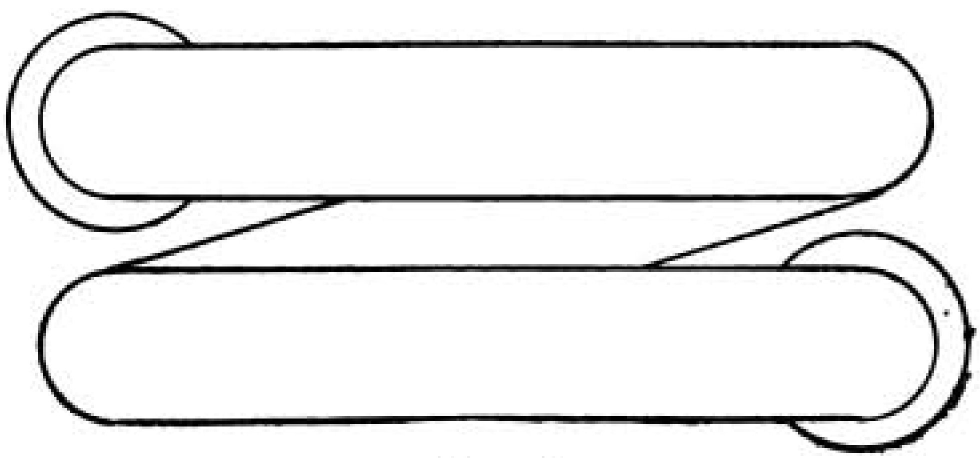


Fig. 36.

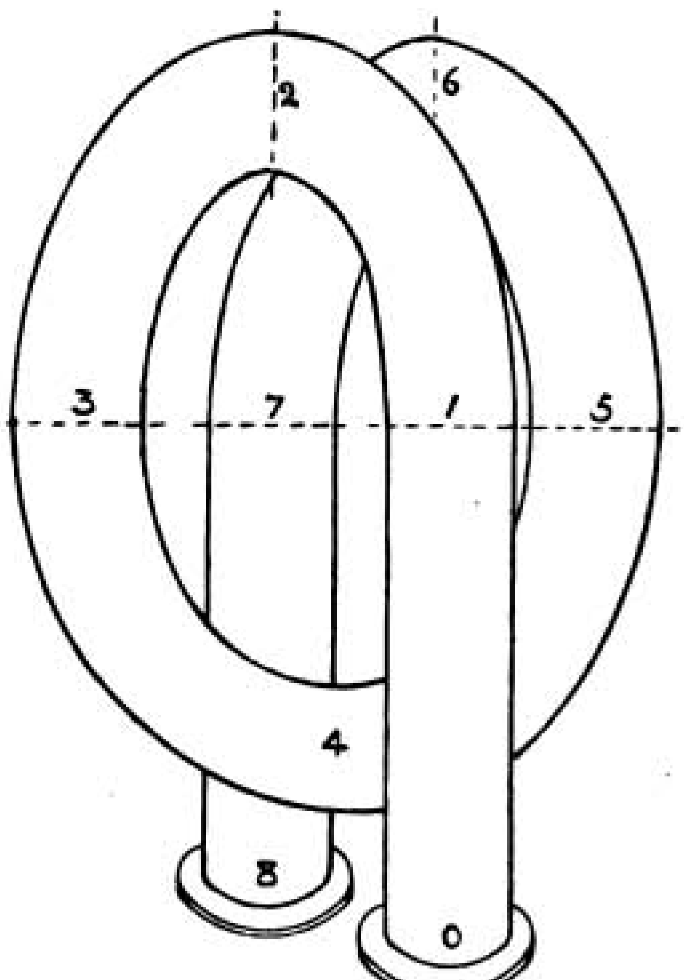



Fig. 37.

When it is desired to wind a helix for the jigger primary of a high-power set, such as a Transatlantic Station, a different method is adopted. In Figs. 36 and 37 are two views of a double-turn primary jigger. The former is made of wood. Equal lengths of stranded wire are laid one deep along the former, in such a way that each wire is presented to the inside and the outside of the coil alternatively. This will be more easily followed from Fig. 38. Each circle represents the section of the helix at the points marked on Fig. 37. Let one wire start at the cross on circle 0. Then, as the wire is laid along the former, it is given a slight turn until the circle 1 is reached, when the wire will have moved round the circumference of the former, a quarter of a circle. The dot represents the position of the wire and the cross the point of origin on circle 0. The turn is continued until at 2 it is a half of a turn round the circumference. When the wire reaches the position 3 it will be three-quarters of a turn round the former. At 4 the wire will have completed the full circle as well as a complete turn of the helix. This is continued in the same way round the second turn of the helix, until the wire arrives at 8 when it has completed two turns round the former and the two turns of the helix.

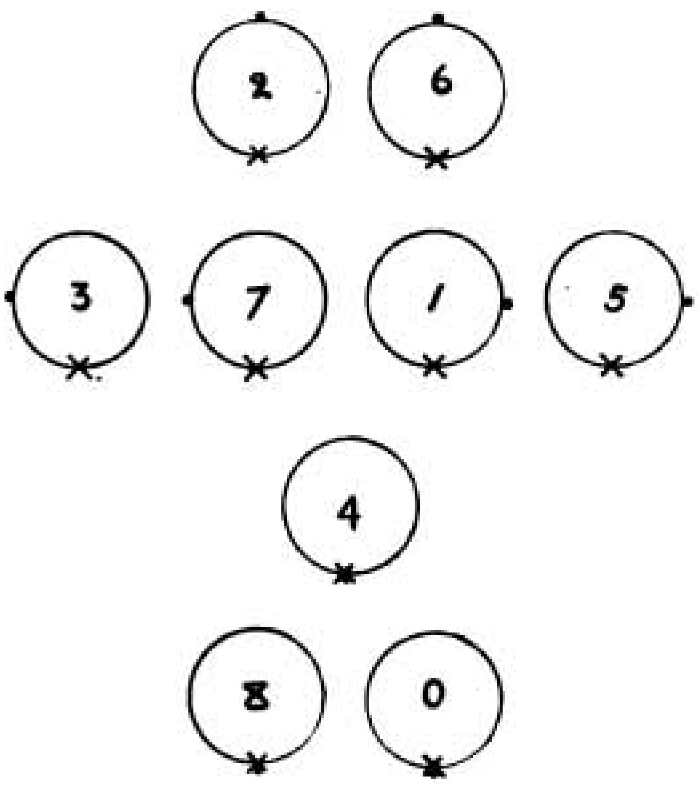



Fig. 38.

It will thus be seen that each wire will be the same length and that each wire appears the same numbers of turns on the inside and outside of the former, thus preventing the current crowding into any one wire more than the other on the inside of the helix.

# Company Notes

## *Amalgamated Wireless (Australasia), Ltd.*

The shareholders of the above company have every reason to view with satisfaction the steady progress made by the company from year to year. The eighth half-yearly ordinary general meeting was held at the registered office of the company, Wireless House, 97, Clarence Street, Sydney, on Thursday, August 30th, 1917, at 12.30 p.m. The directors presented a report, including the balance-sheet and profit and loss account for the six months ended June 30th last. They appended various remarks founded on the figures given, which we summarise as follows :

Revenue.—The revenue from general trading has been maintained at about the same level as previously, although it is necessary to remark that operations continue to be restricted in some directions owing to the generally adverse conditions arising from the war.

Ships' Message Traffic.—The acceptance of messages from the public is practically prohibited, a fact which accounts for the shrinkage of revenue from this source. The directors point out that little change is likely to ensue in this respect before the close of hostilities.

Subsidy Ships.—In view of the confidential nature of this work the directors were advised not to publish the actual number of vessels now equipped. They were able, however, to make the gratifying announcement to shareholders that the number has been materially increased.

The Manufacturing Department.—Work in this department has been plentiful and has exercised all the company's resources. In point of fact, an extension has been made to permit of greater output and further extensions are anticipated in the near future. The well-known standard of excellence and quality characteristic of the company's productions has been fully maintained, and further recognition of their high standing and repute has been recorded at home and abroad with beneficial results.

Other Business.—In the last report submitted by the directors, they referred to an *interim* occupation for some of the spare funds of the company. This investment has so far justified its introduction by paying interest at the rate of 6 per cent. ; but in view of the possibility of further extension in several departments of the existing business, and in other directions more closely allied thereto—they have considered the advisability of releasing the capital thus invested, and are pleased to report that, since the close of the half-year, satisfactory arrangements have been made in this connection.

Profit for the Period.—The profit for the period is £2,913 6s. 6d., which, with £5,563 17s. 10d. brought forward, amounts to £8,477 4s. 4d. Out of this the directors proposed payment of a dividend for the year at the rate of 5 per cent., absorbing the amount of £7,000. They are adding £1,000 to the Marine Insurance Fund, and thus leave the balance of £477 4s. 4d. to be carried forward to next account.

## *The Marconi Wireless Telegraph Company of Canada, Ltd.*

In submitting their annual report of the company's business and statement of accounts for the year ending December 31st, 1916, the directors point out that in accordance with the change adopted at the last annual meeting whereby the company's fiscal year terminates with the 31st December, instead of January 31st as heretofore; the period covered represents only an eleven-month period, and not the full twelve-month period which was covered by the preceding reports.

VOLUME OF TRAFFIC.—The directors continue by pointing out that this was the third successive season during which the company was obliged to contend with the abnormal conditions created by the war. Many difficulties had been imposed by various restrictions, but in spite thereof an increased volume of transatlantic traffic had been handled between the company's Glace Bay Station and Great Britain. This expansion had been anticipated in the report of last year, and the directors state that it continues to be well maintained.

ORGANISATION AND INSTRUCTION.—The value of the company's organisation, both to private shipowners and to the Naval authorities, has once again been demonstrated during the past year. In no case did it fail to meet the numerous demands made upon it. The School of Instruction conducted by the company has proved a most valuable factor in contributing to maintain the company's staff and in replacing operators assigned for duty in all parts of the globe. Schools working in affiliation with the company are also conducted on the Pacific Coast at Vancouver and Victoria (British Columbia).

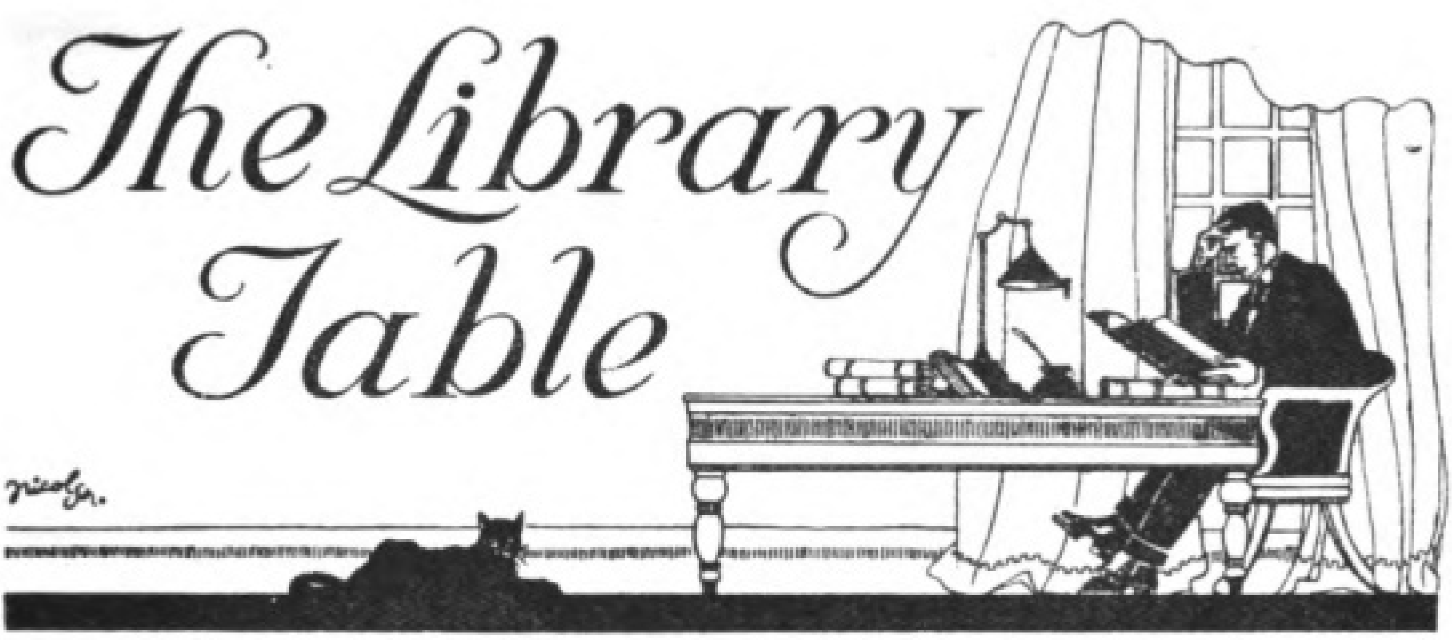
IMPROVEMENTS IN APPARATUS.—Owing to the fact that a smaller number of installations was required for Naval purposes the directors report that the output of the company's plant in Montreal was somewhat less than the record reached during the previous year, and advantage was taken of this opportunity to develop an improved type of ship apparatus, combining the best practice and design with reliability of operation in unskilled hands. The directors contend that, compact and self-contained, the new Cabinet Set, either of medium or large size, can be installed on board ship at short notice, and is thus well fitted to meet the frequent demand under present conditions for emergency installations. The new design has received favourable reception both in naval and mercantile quarters, and its success has been followed up by the development of a smaller set on similar lines, which is expected to open up a large field for service on cargo and smaller vessels, where the cost of wireless equipment has hitherto been regarded as over costly.

EXPANSION OF OPERATIONS.—The directors further report an allotment to the company of a number of further important orders for the purchase of a considerable quantity of wireless sets of various types. As a further step in the company's policy for increasing the facility of its service to shipowners, a Divisional Office for the Maritime Provinces has been established at Halifax, thus completing the plan of maintaining stores and offices at the important divisional centres of Vancouver, Toronto, Montreal, Halifax and St. Johns (Newfoundland).

MORE SHIPS FITTED.—Despite the fact that several installations had been lost or transferred to other routes, the number of wireless telegraph stations operated by the company on shipboard has shown an increase during the year under review. The same difficult conditions as were referred to in the last report had prevailed with regard to message traffic to and from ships, due not only to general dislocation of sailing schedules, but also to strict censorship and other limitations imposed on commercial messages. The directors do not anticipate any improvement in these adverse conditions during the continuance of hostilities.

GENERAL REMARKS.—The directors expressed regret at not having yet been able to obtain from the Government a basis of settlement in respect of remuneration for the use of certain coast stations taken over by the Naval Department since the commencement of the war, or by way of compensation for other services rendered to the Admiralty and elsewhere.

The operating profit for the year ending December 31st, 1916, is $104,929; and, after deducting interest, depreciation, etc., the surplus account is increased from $80,815 to $141,106.




*ESSENTIALS OF ELECTRICAL ENGINEERING. By John Fay Wilson, B.S., E.E.* 10s. 6d. *net. London:* 1917. *Constable & Company, Ltd.*, 10, *Orange Street, Leicester Square, W.C.*

SO MANY important contributions have been made to electrical science by our cousins and Allies in the United States that a respectful approach is naturally due to all treatises which are written in that country, provided they bear evidence of having been written by a serious exponent of electrical matters and not by a sensationalist engaged upon a new and hair-raising " stunt." There is always in a world of progress such as that embraced by the numerous branches of electrical study a field for fresh expositions, whether dealing with the development of new theories, or in the orderly presentation of established principles. Until the ultimate nature of electricity has been discovered no individual, however profound in his knowledge of the science and its applications, dare refuse without a hearing any serious contribution to the study of this fascinating medium.

The author of the *Essentials of Electrical Engineering* makes no pretence at revolutionising established ideas in relation to electrical phenomena. His object has been to produce a text-book for colleges and schools which will display fundamental laws in a manner both orderly and concise. He has an advantage in this direction of applying his experience as instructor in electrical engineering at the University of Michigan, an experience which certainly reveals itself in many places.

One happy idea which undoubtedly will find favour, is the marginal numeration for reference purposes of every equation, and of each stage in the mathematical development of formulæ or equations.

Putting the methods of presentation aside Mr. Wilson still has a novelty in hand. This is a calculated system of dispelling the prevalent belief that continuous and alternating currents are not subject to the same general laws. He shows very clearly that the principles and laws, which relate to the flow of continuous currents, also govern the flow of alternating currents.

The *Essentials of Electrical Engineering* does not, as one might imagine, deal specifically or even broach the electrical problems peculiar to wireless, but it does provide for such students of this fascinating branch of electrical development as are familiar with trigonometry and have an elementary knowledge of calculus, a clear exposition of basic principles and of the factors underlying the construction of prime movers, and various other important appliances which "wireless" calls into its service.

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*MEXICO OF THE MEXICANS. By Lewis Spence. Published by Sir Isaac Pitman & Sons, 1, Amen Corner, London, E.C. 6s. net.*

Although temporarily overshadowed by the urgency of the great world-struggle, at the apogee of its crisis now that the U.S.A. has entered the lists, Mexico and her troubles are still awaiting settlement, and must, at some future date, occupy considerable public attention on the eastern, as well as on the western side of the Atlantic. The fact that the declaration of war by President Wilson was immediately followed by the transfer to Mexico of the wireless activities of the German secret agents, is sufficient indication of the closeness of the links between the "land of the Aztecs" and her great northern neighbour.

The appearance of this volume, *Mexico of the Mexicans*, written by Mr. Lewis Spence, is, therefore, peculiarly opportune, and Sir Isaac Pitman & Sons are to be congratulated on having selected so capable an author for the composition of this item in their "Countries and Peoples" series. The title gives the keynote to the general plan of this, as of all the other volumes in the scheme. It is, therefore, the actuality of to-day towards which the author directs the attention of his readers. His adherence to this general design is rigidly carried out, almost a little too rigidly for the personal taste of the reviewer, who would have liked to see rather more space devoted to those historical and antiquarian matters which add so vastly to the interest of the subject. There is a good deal to be said, however—particularly from the point of view of bulk—for adhering strictly to the general scheme.

The earlier chapters, notably those dealing with the racial origin, with the character and family life, and with the organisation of society, are particularly illuminating. We note with much pleasure Mr. Spence's insistence upon the regard for etiquette which prevails not only amongst the upper, but amongst the artisan and peon classes. It is a point far too frequently ignored by readers on this subject. Says Mr. Spence :—

> The *Peon*, a scion of the grave and punctilious Aztec folk, is not to be outdone even by the descendant of the proud and courtly Castilian. Indeed, the uniform respect with which the peasant class treat those above them in the social scale has not now its parallel in any European country.

We have not space to do more than refer to the remaining sections of the volume before us. They include an account of the provinces and their central towns, of Mexican ranching life, of the mines and commercial enterprises, and finally a delightful chapter on aboriginal tribes. A cursory review of the course of the present Revolution, with a few words of prophecy regarding the future, rounds off the work.

We regret that Mr. Spence should have altogether neglected the applied science which constitutes our own special subject and *raison d'être*. Wireless telegraphy already plays no mean part in Mexico, and is certain to increase the importance of its *rôle* in the near future. The omission of all reference thereto constitutes the only serious quarrel which we have with the author of this excellent monograph.

# Questions & 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. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would 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) Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly. (3) Queries should be as clear and concise as possible. (4) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers. (5) The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.*

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F. R. G.—(1) An operator on entering the service of the Marconi Company is required to provide his own uniform and kit, the total cost of which should not exceed £10. This expense has to be borne by him personally. (2) The Marconi Company is prepared to accept suitable applicants at any stage of training, but in the event of a man already in a wireless school and receiving instruction, it is considered desirable that he shall remain in the particular school until he obtains his Postmaster-General's certificate. (3) A wireless operator in the service of the Marconi Company commences with a salary of 25s. per week and all found on board ship. As soon as he is promoted to the position of operator in charge of a wireless installation, which frequently happens within a few months, he receives an increase of 5s. per week. Of course, the value of the free board and lodging provided on the ship is considerable at the present time.

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Amateur (Polmont).—To tune in on a multiple tuner proceed as follows: With the change-over switch on stdbi, the tuner-switch on the first stop and the aerial tuning inductance on the first stop, vary the aerial tuning condenser from zero to "short" steadily, listening carefully on the telephones meanwhile. If no signals are heard by the time "short" is reached, slowly increase the aerial tuning inductance stud by stud until signals are heard the loudest. Adjustment of the aerial tuning condenser should then be made to get the best signals. Having got good signals on the stdbi side, put the change-over switch on "tune" and set the tuning switch on one of the four studs depending on the position of the aerial tuning condenser as follows: If no aerial tuning inductance is in circuit and the reading on the aerial tuning inductance is very low, it may be necessary to place the tuning switch on the first stop, but in most cases (such as a 600-meter wave) the second stop will be the correct one. Then placing the intensifier handle at 90°, place both the intermediate tuning condenser and the detector tuning condenser on zero, and then take hold of both at the same time, vary them together slowly until signals are heard loudest. The coupling should then be reduced, and all three condensers readjusted to give the best results. The looser coupling—*i.e.*, the smaller reading on the intensifier handle, the sharper will be the tuning, but the weaker the signals. With coupling in the neighbourhood of 10°, tuning is very sharp, and very careful adjustment of the condensers must be made. When any considerable amount of aerial tuning inductance is inserted, the third or fourth stops of the tuning switch will need to be used.

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"Want-to-Know" (St. Helens).—(1) A Second-Class Postmaster-General's Certificate differs from the First-Class only with regard to the speed of the holder. Whilst a First-Class Certificate indicates that the holder can send and receive at not less than twenty words a minute, the Second-Class indicates that he can send and receive at not less than twelve words per minute. A temporary First-Class Postmaster-General's Certificate indicates that the holder is competent to take charge of a wireless station during the war, and is capable of sending and receiving at not less than eighteen words per minute. The latter certificate is, of course, more useful at the present time. (2) All operators in the service of the Marconi Company appointed to duty on board ship commences at 25s. per week, with all found on board ship. (3) As soon as conditions permit all holders of temporary certificates will be required to complete their training for the First-Class Certificate. (4) There is a great demand for wireless operators at the present time, and if you wish to enter the service you should make immediate application to the Traffic Manager, Marconi International Marine Communication Co., Ltd., Marconi House, Strand, W.C.2, whether you have any knowledge of the subject or not, as free training is now being given to suitable men. (5) This question is answered under (3).

We take this opportunity of pointing out to our correspondents who expect early replies that this magazine is now published on the 25th of the month, and, of course, goes to press much earlier. This particular letter was received in the Editorial Office on September 24th with a request that it should be answered in the October issue. This is expecting a little too much in war-time!

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A. H. D. (Ilford) asks: What is the voltage which will break down the condenser in the base of a coil? The condenser referred to is that in the base of a 10-inch induction coil supplied with the Marconi Emergency Gear, and consists of sheets of tin foil interleaved with varnished paper as a dielectric. *Answer:* We cannot furnish the figure for this breakdown voltage, and can only say that it takes a far higher voltage than that generated in the primary of the coil to puncture the dielectric. In this case, as in all others, the Marconi Company allows an ample margin of safety, but does not publish the test-room figures. The answer, we think, given above should be sufficient for any examiner.

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C. L. L. T. gives no address, so that we cannot answer his query.

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W. G. H. (West Hartlepool).—If you are only slightly short-sighted, this should not debar you from service on the marine staff of the Marconi Company, provided your eyesight is suitably corrected by glasses.

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H. G. (Hulme, Manchester).—You will find full particulars of Marconi kit in the *Wireless Diary and Note Book*, published by the Wireless Press, Ltd., and advertised on another page. Any of the tailors advertising in this magazine will be able to supply you with full outfit.

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A. B. (Enfield) asks us to inform him as to what it is necessary to know in the way of education before he is able to train as a wireless operator in the Marconi Company's School. The only answer we can give to this is that the Marconi Company requires each applicant to have a fair general education, such as is given in the average school. We notice our correspondent spells necessary "nessesary," which indicates that his spelling at least is weak.

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H. S. (Durban).—Your question is by no means a silly one, as you seem to think. It is one which has occurred to almost every intelligent student. An "earth" connection is not absolutely necessary on a wireless station, although it greatly increases its efficiency in nearly all cases. Aeroplanes and airships have, instead of earth connection, which is obviously impossible, what is known as a "balancing capacity." On an aeroplane, for instance, the aerial is a trailing wire and the balancing capacity some metal part of the machine such as the engine. The field then extends between the aerial and the balancing capacity instead of between the aerial and the earth as happens on a land or ship station. We are always glad to answer questions from our readers in distant parts of the Empire.

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F. J. H. (Croydon).—In another part of this issue you will find particulars of the free training scheme provided by the Marconi Company for young men who wish to become wireless operators, and if you desire your application to be considered you should forward it at the earliest possible moment to The Traffic Manager, the Marconi International Marine Communication Co., Ltd., Marconi House, Strand, W.C.2.

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A. M. (Liverpool).—(1) For the information asked for in your first question you should apply to Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, London, W.C.2. (2) The Secretary, General Post Office.

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**THIS MAGAZINE CAN BE SENT FREE TO OUR TROOPS ABROAD BY LEAVING IT AT A POST OFFICE.**