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THE WIRELESS WORLD

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MARCH 1917

Australasian Time Signals

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The Nauen Station

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Notes on Aerials

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FOR several years wireless has been used for the determination of longitudes where previously line telegraphy was in vogue. This application is of such vital and far-reaching importance that first of all it would be well to review some of the uses of accurate time signals, especially in the Southern Hemisphere and particularly in Australia.

In the first place, let us imagine ourselves at sea in a dangerous locality. Dangerous places are usually marked with lighthouses, but such a method of warning is inadequate in cases of fog. Before the captain can find out where he is situated he has to make two observations, one to determine his latitude and the other to find his longitude. Once having settled these he can point to the exact position of his ship on the earth. Whilst the finding of latitude is a very simple observation, the contrary is the case with longitude. Briefly stated, the longitude is the difference between the local time at the place and the time at Greenwich. The captain can easily determine his local time but has to depend on his chronometer for Greenwich time. It is easy to see, then, that if his chronometer fails or its rate varies he has no possible way of finding his longitude, and consequently does not know where he is. In fact, if his chronometer gains or loses four seconds he is one mile out in his reckoning, a situation more than serious in dangerous waters.

In the Northern Hemisphere there are several wireless stations which send out time signals twice a day, with the result that the ships' chronometers can be constantly checked. Until quite recently there were no stations transmitting time signals in Australasia, but Adelaide and Melbourne have now taken up the work at midnight and midday. All the other coast stations will shortly follow suit. These signals are always transmitted through a relay controlled by the Observatory clock, with the result that they are accurate to well within a quarter of a second. The reader will now be able to realise the importance to the mariner of exact time signals and how similar reasoning may be applied to land survey work. The surveyor has merely to erect a small portable set and pick up the nearest land station when he will have immediately the means of determining his longitude. The accurate reception of these signals is not nearly so easy as it sounds, and some of the difficulties and the means of overcoming them will be dealt with later.

In the compilation of the "Nautical Almanac" and other astronomical and geological works it is necessary to know the shape of the earth. The only satisfactory method as yet known is to survey the whole globe by means of chain and

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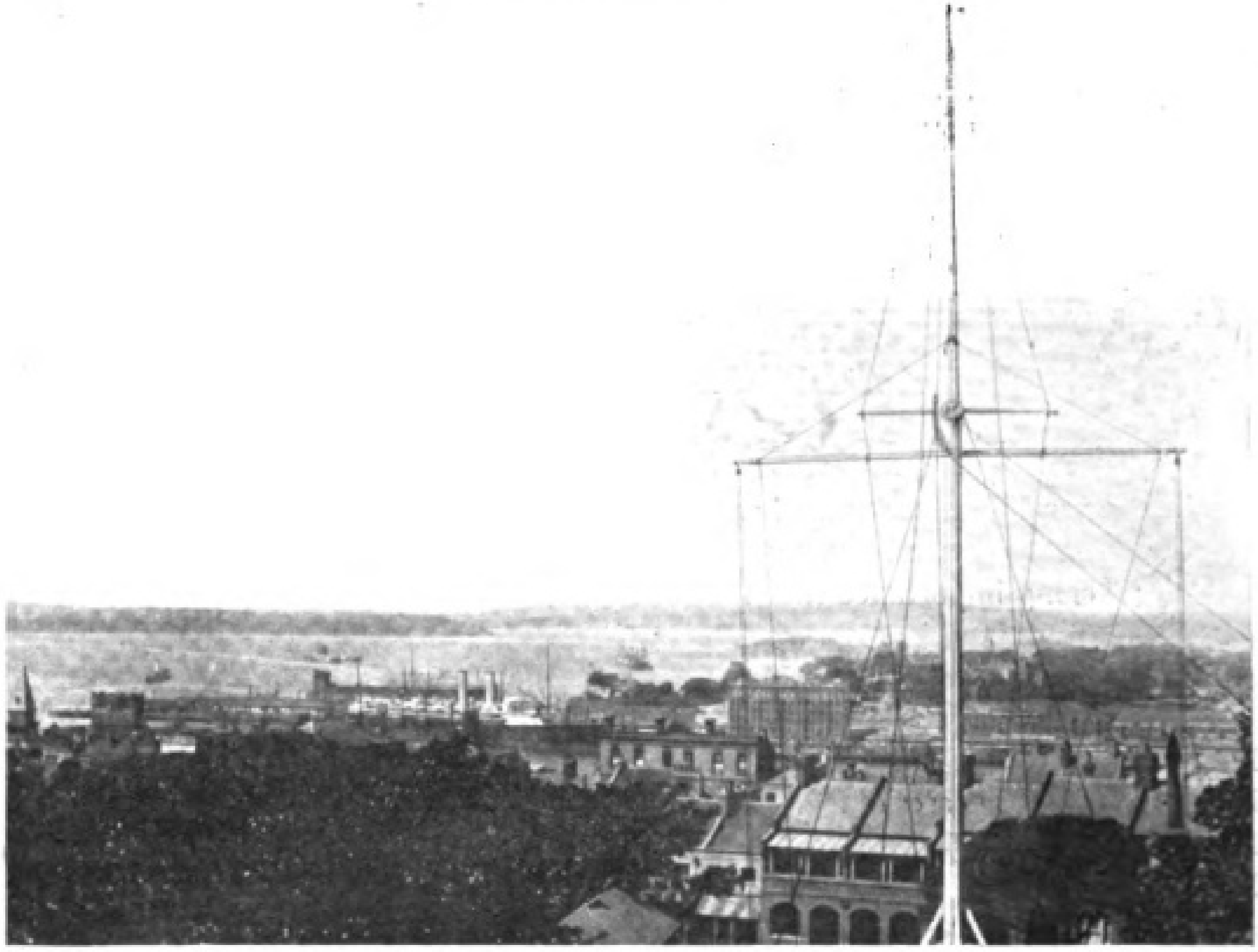

A VIEW OF SYDNEY HARBOUR FROM THE TOWER SHOWN ON PAGE 889. ON THE RIGHT IS THE FLAGSTAFF OF THE CENTRAL SIGNAL STATION. ON THE LEFT CAN BE SEEN THE SMALL ISLAND (FORT DENISON), FROM WHICH TIME IS DISTRIBUTED AT NOON BY GUNFIRE.

level. The importance of this survey has been so great that just prior to the war it was resolved to carry out a gigantic trigonometrical survey. In the Northern Hemisphere much work has been done, and all the principal observatories are linked up very accurately. In the Southern Hemisphere, however, there is very little land, thus making it much harder to survey. Australia has also the disadvantage of being far from the rest of the scientific world. It is expected that before long the Commonwealth Survey Department will carry out a trigonometrical survey of Australia, and if so it will probably be as accurate as any in the world.

We shall now see, briefly, how longitude determinations in the past have been attended with unavoidable errors, and how wireless has given us a means of eliminating some of the old errors by making it possible to carry out work in places where the sole means of communication is an occasional boat. We shall then see the importance of the scheme proposed by the New South Wales Government for charting the Islands in the Pacific.

In the past all the most accurate longitudes have been determined by means of either land line telegraphs or submarine cables. Before we can appreciate the advantage of wireless over the cable method it would be well briefly to consider how the cable is used and what errors are liable to occur. We shall entirely neglect

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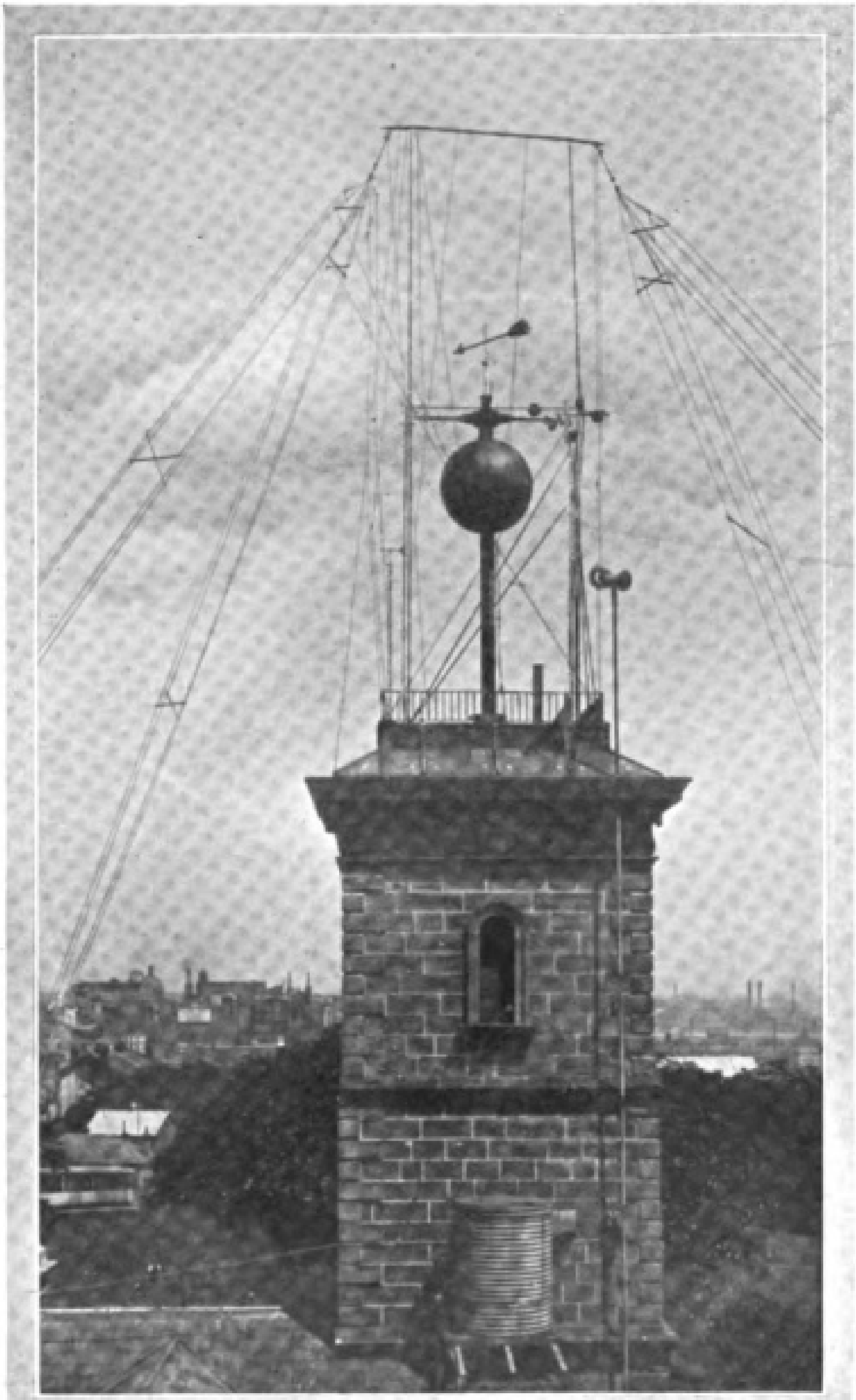
the astronomical side and concern ourselves only with the electrical part of th programme.

Let us take two stations, A and B. Suppose A be accurately fixed and B the station whose longitude we wish to find. At A the sidereal clock is connected to the cable and every second the contact is closed. The current then flows along the line to B. At B it closes a relay, which is connected to a chronograph and marks the seconds on this instrument. At B the local clock acts similarly. The difference in time between A and B can then be read off. At first sight this seems a very simple procedure and not likely to contain any errors. However, errors creep in as follows. First there is the time taken for the current to pass the clock contacts at A. Then we have the time occupied to saturate the coils of the relay. Next the current has to pass along the cable to B and saturate the coils of the B relay. This time is a very uncertain quantity and is almost impossible to ascertain. At B the current has to pass into and saturate the coils of the Pen relay on the chronograph. Further, the time lost in transmission is different for different lengths of cable.



THE SYDNEY OBSERVATORY TOWER, WITH TIME-BALL AND AERIAL. THE TOWER IS 50 FEET FROM THE GROUND, AND THE MASTS 30 FEET, MAKING A TOTAL OF 80 FEET FOR THE AERIAL. ON THIS ANTENNA SIGNALS FROM TUCKERTON, 10,000 MILES AWAY, WERE HEARD.

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When B is very far from A further trouble arises, since there is a maximum distance over which the clock beats can pass without being relayed. Also the use of different relays and different adjustments of the same relays cause unknown variations in the amount of lag. Even with these many difficulties wonderfully accurate work has been done. As an instance we might cite the case of Sydney. Sydney was linked up with Greenwich by a series of steps from Greenwich both west and east. The final results were: Eastward, 10 hours, ·04 minutes, 49·355 seconds, and westward, 10 hours, ·04 minutes, 49·287 seconds, the difference

THE MELBOURNE WIRELESS STATION IN ITS BEAUTIFUL GROUNDS.

THE MELBOURNE OBSERVATORY, CONNECTED BY WIRE WITH THE WIRELESS STATION NEAR BY.

being 0·068 seconds, equivalent to a distance of only 84 ft. It has always been felt that this was a wonderful coincidence, but it is advisable to check these results by a

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[*Photo: Underwood.*

A VIEW IN TAHITI, WHERE THERE IS A POWERFUL WIRELESS STATION WHICH WILL TAKE ITS PLACE IN THE TIME SIGNAL SCHEME.

third and totally different method. Before leaving the cable method we must bear in mind the old saying that no chain is stronger than its weakest link. In other words, when we have to use several steps in going from A to B, every error in each successive link is added to the next and so on. We see then that when three or four links are necessary, the final error is quite likely to be noticeable, even though the errors in the separate links be quite small. Let us now see how wireless offers us a solution to our difficulties.

There are two methods open to practical use. The first is that which has been used between Arlington and Paris. Briefly it is very much the same as the cable method except that there are no cable troubles and links. Otherwise at the transmitting end the methods are similar. At the receiving end, instead of recording the signals on a chronograph they are heard together with the beats from the local clock in a telephone receiver. By means of the method of coincidences (described in any good book of physics) it is possible when the ticks are sufficiently sharp to determine the time of the received signals within one-hundredth of a second. There are still openings for error in this method, especially at the transmitting end. Further, the dots issued every second are usually so faint that it is probably the end rather than the beginning of the dot that is heard. This latter difficulty has been overcome by means of the photographic recorder, although in using this instrument one is liable to have trouble arising from interference, due to " static " and jamming.

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[Photo: Un.'erwood.

NATIVES OF SAMOA, ONE OF THE ISLANDS IN THE AUSTRALASIAN TIME SIGNAL SCHEME.

The second method is the one suggested for the South Sea survey. In this method a third station is used, preferably about half-way between the two stations concerned. Let us call this station C. C sends out signals (usually a series of dots evenly spaced with intervals of nearly, but not quite, a second), A and B both determine the local time of these signals by means of the method of coincidences and compare notes afterwards. It will be evident that all transmission errors will be greatly reduced. The main risk of error in this case is in getting very sharp dots. Experiments are being made at the present time with the assistance of the radio station at Adelaide, and already the results are promising. One of the advantages of the wireless method is that a number of observatories can receive the same set of signals simultaneously and thus determine their relative positions with greater accuracy than by former methods. In fact, this will also act conversely and the joint result of the mean distance between Australia and Greenwich will be correspondingly strengthened.

Before outlining the proposed scheme it would be well to see what equipment we have in Australia for the project. For several years it has been felt that it would be advisable for the radio stations to issue time signals at midnight and midday for the convenience of shipping. Already Melbourne and Adelaide are doing this with very satisfactory results. Perth, Sydney and Brisbane will shortly be following suit. The several observatories have, or shortly will have, their own wireless receiving stations and will check the out-going signals.

At the beginning of this article reference was made to the trigonometrical survey of Australia. At present this survey is only important to the Australians

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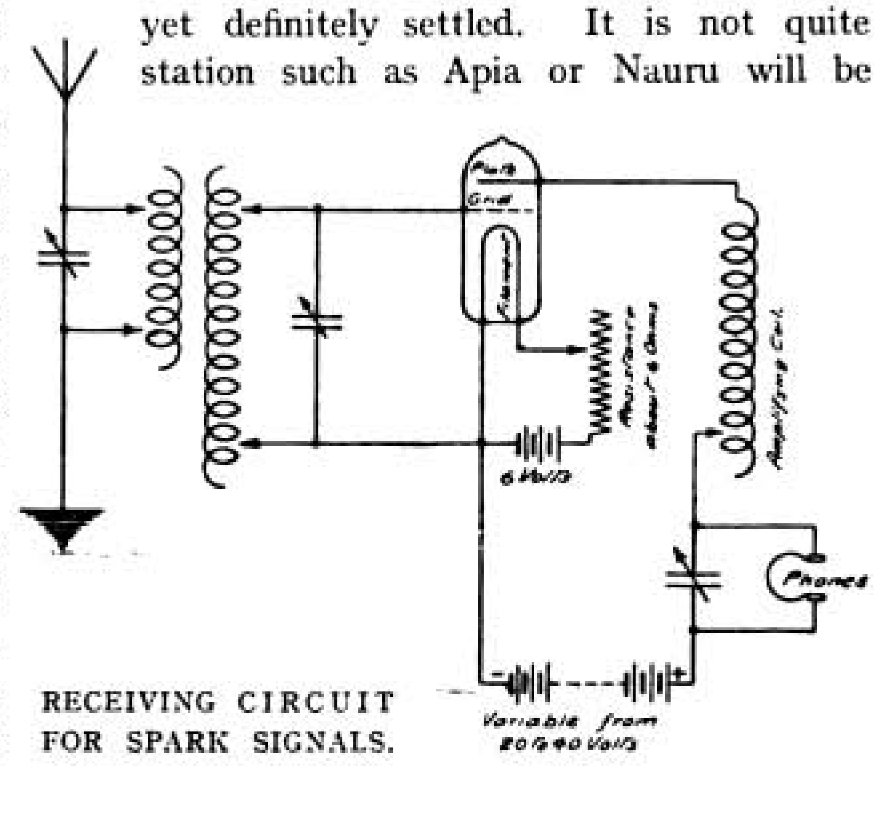
and will remain so until the position of some fixed station is definitely and accurately linked up with Greenwich. As soon as this is done, all our trigonometrical work will be of international importance, as it will make it possible definitely to place Australia on the map and so help to complete the general survey of the whole world.

Some few months ago the Surveyor-General for New South Wales proposed a scheme to the Government to extend this trigonometrical work to the South Sea Islands and thence to the other islands in the Pacific linking up with America, India and Japan. By means of wireless this survey could be carried on almost as accurately as the land survey. This would enable stations to be erected in the Pacific for issuing accurate time signals. At present this is impossible as the position of some of the islands is only vaguely known. Boats going to and coming from America have to rely absolutely on their chronometers, with the consequence that there have been a number of wrecks which might have been avoided had the scheme been carried out before this. The first work will be to link up Sydney with Honolulu, using the station at Nauru, a small island north of Sydney and nearly on the equator, as a central transmitting station. The installation at the Sydney Observatory can hear this station, as can also Honolulu. This will give a complete run through direct from Sydney to Honolulu, which latter place has already been linked up accurately with Greenwich. In this project the other Observatories at Melbourne, Adelaide and New Zealand will simultaneously fix their own positions. The second part of the programme will be to start from the east coast of Australia and work eastwards to the various islands, finally ending up at the American coast. All the different places where there are already wireless stations will be visited first. We might call this the major triangulation. Some of the suggested stations are Hobart, Adelaide, Melbourne, Sydney, Brisbane, Townsville, Awanui and Wellington in New Zealand, Suva (Fiji), Apia (Samoa), Chatham Islands, Tahiti, Nauru to Honolulu. After the major triangulation has been completed some of the other islands will be linked. This latter, or minor, triangulation will be carried out by means of a portable set. The officer in charge of the portable set will go from island to island linking up with one or other of the major points.

The final details are not yet definitely settled. It is not quite decided whether a central Pacific station such as Apia or Nauru will be chosen or whether the signals will be transmitted from Sydney. This point will be determined when we find out whether Sydney can be heard from all the different points. Experiments seem to show that this will be possible by means of an audion receiver.



RECEIVING CIRCUIT FOR SPARK SIGNALS.

One of the chief causes of error is that short dots will not carry so well as longer ones. This means that one is likely to observe the middle instead of

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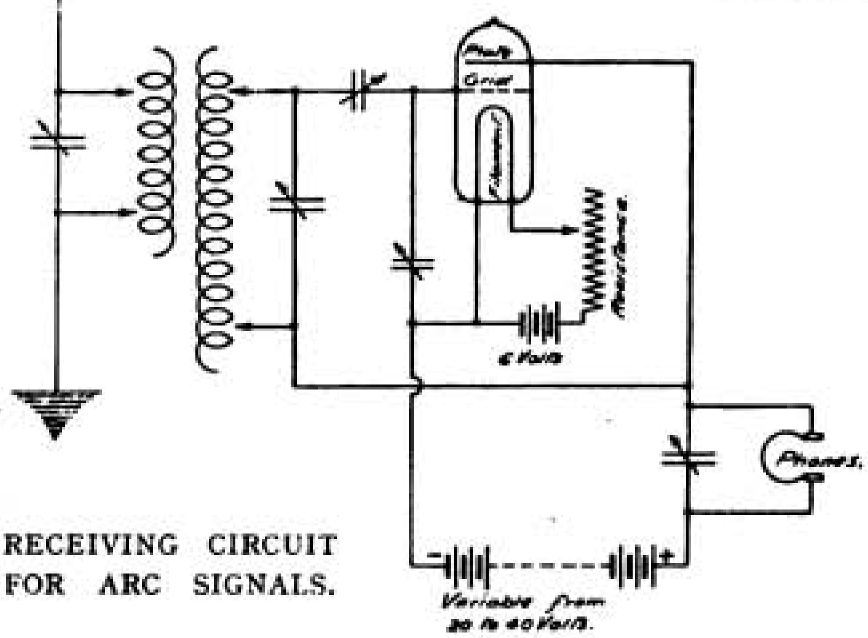
the beginning of the dot. The reason for a long dot carrying better than a short one is that it takes a definite time to charge the aerial fully. There are two suggestions open to eliminate this difficulty. The first is to send out a continuous sound broken at the correct intervals. In taking coincidences one must observe the silences instead of the beats. Obviously in this way the breaks can be as short as desired. The other method is to use continuous wave telegraphy. In this method a continuous wave is emitted and the dots are made by altering the wave-length. The latter method commends itself, as one can use the single dot or silence method at will by simply tuning to either of the two wave-lengths. Further, much longer wave-lengths can be used in arc work than in spark telegraphy for a given aerial. In spark work if one loads the aerial beyond a very small limit there is a great loss in the strength of the signals owing to reactance. In arc work, however, experiments seem to show there is practically no limit to the wave-length that can be used. It is a decided advantage to use long wave-lengths, as there is less chance of being jammed. Experiments are about to be made between Adelaide and Sydney on the silence method, also between Honolulu and Sydney on the arc method.



RECEIVING CIRCUIT FOR ARC SIGNALS.

Brief reference was made above to the audion receiver. It might be interesting to show what has been accomplished by the aid of the audion at our own station at the Sydney Observatory. The aerial consists of four squirrel cages 60 ft. long, each cage made up of four No. 14 S.W.G. hard-drawn copper wires. They are supported from a mast 80 ft. high and come down on the four sides at an angle of 45 degrees. The top ends are joined to four wires, which act as feeders and come down to the cabin at an angle of 30 degrees. On this aerial, using crystal, the greatest distance signals had been heard was from Nauru, a distance of about 2,500 miles. With the introduction of the audion signals can be comfortably read from Tuckerton, in New Jersey, a distance of about 10,000 miles. Several other American arc stations have been heard together with Honolulu, Japan, and even China. The wave-length used by Tuckerton was 9,000 meters. This necessitated a tremendous amount of loading. With Honolulu, 4,500 miles, we hear the big spark station readably and the arc station very strongly—both stations using the same power and a wave-length of 4,500 metres. This is an illustration of the loss in the case of the spark owing to loading.

Before concluding this article I wish to take this opportunity of thanking the many companies, private gentlemen, and different Government departments for the help they have tendered. In particular may I express my thanks to the American Marconi Company for the offer of the use of their station at Honolulu, the Federal

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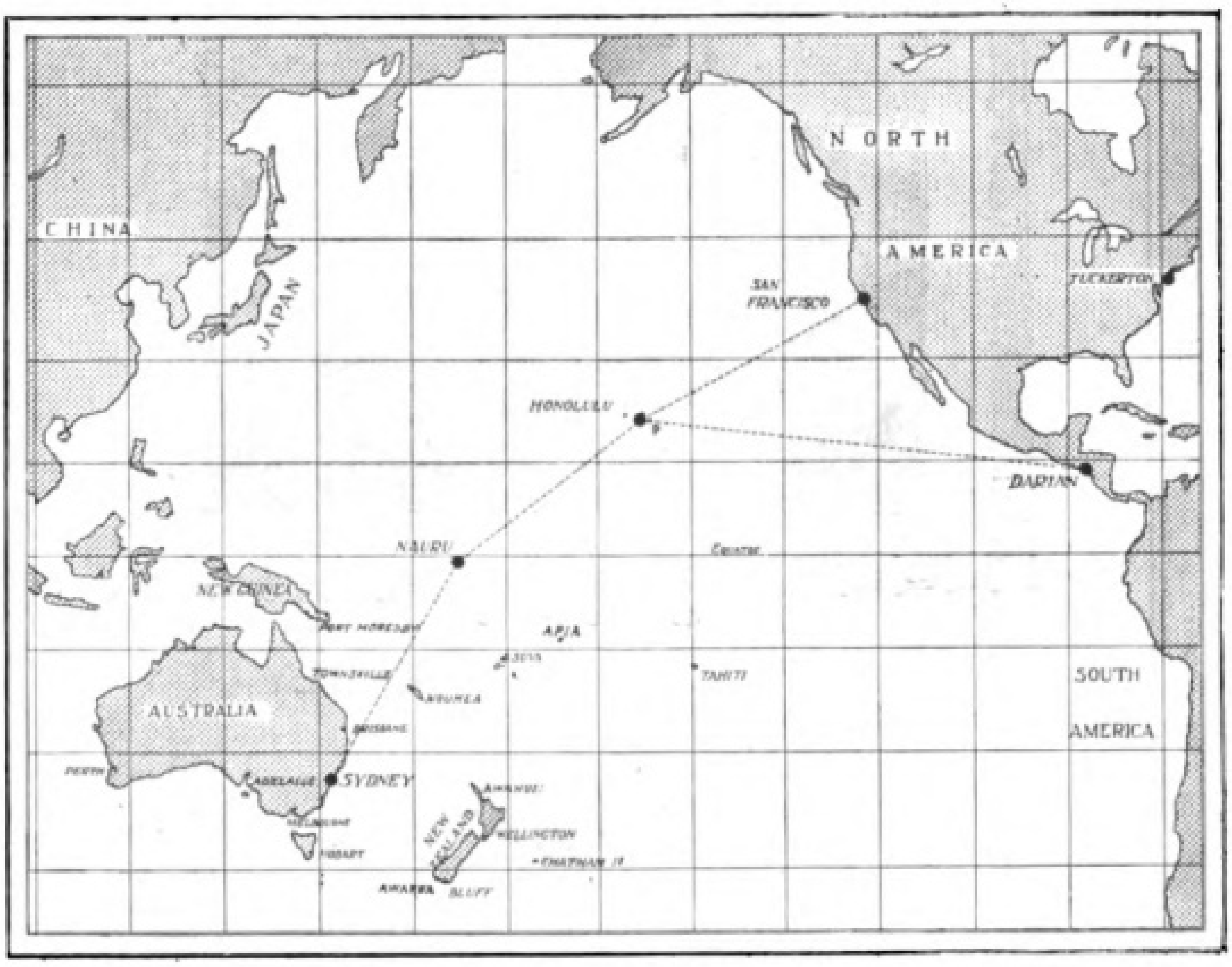
Telegraph Company for their arc stations at Honolulu and elsewhere, Lieutenant Creswell, the naval radio-telegraphic engineer of the Australian Commonwealth, for his kind interest (material and otherwise) in this work, the Amalgamated Wireless (Aust.), Ltd., for their assistance and advice, and many other private people who have placed their stations at our disposal.

The writer also wishes to thank anyone who will be kind enough to suggest anything in connection with this proposed undertaking.

In conclusion one might be forgiven for looking ahead into the dim mists of the future, where, without exercising undue imagination, we can see a great chain of wireless stations suitably positioned all over the globe, linking up the nations of the world as one whole, all striving for one end, irrespective of national differences. This furtherance of science will, we hope, help to bring about the great day when all peoples on this planet will work harmoniously together.

EDITORIAL NOTE

With reference to the above article, it has been recently announced by the Japanese Department of Communications that in future time signals will be sent out at 9 o'clock every evening (except Sundays) to all ships sailing within transmission radius of the Funabashi and Cosi wireless stations.



MAP SHOWING THE PROPOSED SCHEME OF TIME SIGNALS.

PERSONALITIES IN THE WIRELESS WORLD

PROFESSOR A. E. KENNELLY

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THE subject of our biography this month, Professor A. E. Kennelly, has had a varied and interesting career. Born in Calaba, Bombay, in 1861, he received his education in England, Scotland, France, Belgium and Italy. In 1875 he left school to become a telegraph operator in the Eastern Telegraph Company, and six years later became chief electrician on a cable ship. In 1886 he was appointed senior electrician of the ship's staff of the Eastern Telegraph Company, shortly afterwards becoming principal electrical assistant to the famous inventor, Thomas A. Edison, in his laboratories at Orange, N.J. After serving six years in this capacity, Professor Kennelly took up the profession of consulting engineer in Philadelphia, and from 1893 to 1900 worked in partnership with Mr. E. J. Houston, of the Thomson-Houston Company. Since that time he has undertaken some important work in connection with the laying of a cable from Vera Cruz to Campeche, and has held the position of Professor of Electrical Engineering at Harvard University and also at Massachusetts Institute of Technology. He is now Director of the Research Division of the Electrical Engineering Department of the latter institution.

In the world of wireless he is known as the President of the Institute of Radio Engineers for 1916, as the author of an important text-book on radiotelegraphy and of many scientific papers dealing with the subject.

Professor Kennelly has held many important positions on committees of various kinds and acted as Vice-President of the International Electrical Congress at Paris and Turin. He is a Corresponding Fellow of the British Association for the Advancement of Science, a member of the Institution of Electrical Engineers of London and Fellow of the American Academy of Arts and Sciences. In past years he has been Chairman and Secretary of the Standards Committee of the American Institute of Electrical Engineers and Secretary of the American Committee of the International Electrotechnical Commission. He has written 23 books as author and collaborator and is the author of more than 123 scientific papers. Professor Kennelly has specialised in alternating currents.

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An Outline of the Design of a Wireless Station

By BERTRAM HOYLE, M.Sc.Tech., A.M.I.E.E., Lieutenant R.N.V.R., H.M.S. "Excellent." 1917.

INTRODUCTION.

IN the following article the author sets out the steps by which the dimensions of the various pieces of apparatus involved are calculated.

As a datum for starting, it is assumed that a minimum aerial current of 45 micro-ampères is required at the receiving end in order to give satisfactory signals. Much depends on the type and efficiency of the detector used, as to whether this figure is excessive or not; and as the whole design of the station, and number of K.W. installed at the transmitting end depend upon this figure, it must be carefully considered.

The above aerial current is ample to work a magnetic detector, with efficient tuning circuits; and is on the high side for circuits using crystal detectors and aural receiving. It is also sufficient to work an Einthoven string galvanometer for automatic receiving in conjunction with suitable crystal detectors.

In order to start the design, the distance between the two proposed stations must be known, and as the distance apart of two widely separated places cannot be measured from maps, two simple methods by which it may be accurately calculated are given.

For the present design it will be assumed that the two stations are situated, one at Carnarvon (North Wales), 53° 10′ N. lat. and 4° 15′ W. long., and the other at Cape Breton (Nova Scotia), 46° 0′ N. lat. and 60° 0′ W. long., the latitude and longitude being taken from Volume XXXV. of the *Encyclopædia Britannica.**

TABLE OF SYMBOLS USED.

A = Correction function for insulation in inductance formula.
a = Radius of a coil, in cms.
B = Correction function for number of turns in inductance formula.
b = Breadth of coil, in cms.
D = Diameter, actual, or effective overall, in cms.
d = Diameter of conductor, in cms.
h = Height (unless otherwise stated).
I = Current intensity in ampères.
K = Capacity, in microfarads.
L = Inductance, in cms.
l = Length, in metres.
N = Spark train frequency (per second).
n = Oscillatory frequency (per second).
$p = 2\pi n$.
Q = Function used in Lorenz's inductance formula.

* EDITORIAL NOTE: These are hypothetical stations and do not refer to any existing installations.

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R = Resistance.
R^1 = High-frequency resistance.
t = Thickness, in cms.
V = Voltage.
W = Watts.
X = Function used in Rayleigh's inductance formula.

α = Longitudes.
δ = Logarithmic decrement (per semi-period).
ΔL = Correction to inductance calculations.
η = Efficiency.
ε = Base of Naperian logarithms.
θ = Latitudes.
Cos φ = Power factor.
λ = Wave length, in metres unless otherwise stated.
ρ = Specific resistance = 1,640 for copper.

PART I.

1. *Distance Apart of Two Points on a Sphere.*—The shortest distance between two places on the surface of the earth is the distance measured along the arc of the great circle passing through those two points.

Knowing the latitude and longitude of the two places, a and b say, the problem resolves itself into finding the angle subtended at the centre of the earth by the arc of the great circle joining them.

Let θ be the latitude of station a;
θ_1 be the latitude of station b;
α be the longitude of station a;
α_1 be the longitude of station b;
and φ the angle subtended by the arc a, b at the centre of the great circle.

Then two formulæ are available:

$$\cos\varphi = \sin\theta\sin\theta_1 + \cos\theta\cos\alpha\cos\theta_1\cos\alpha_1 + \cos\theta\sin\alpha\cos\theta_1\sin\alpha_1$$

or:

$$\text{hav}\,\varphi = \text{hav}\,(\theta-\theta_1) + \text{hav}\,(\alpha-\alpha_1)\sin(90^\circ-\theta)\sin(90^\circ-\theta_1)$$

$$i.e.,\ \text{hav}\begin{pmatrix}\text{Difference in}\\ \text{latitude}\end{pmatrix} + \text{hav}\begin{pmatrix}\text{Difference in}\\ \text{longitude}\end{pmatrix}\sin(90^\circ-\theta)\sin(90^\circ-\theta_1).$$

Since all ordinary trigonometrical tables give natural sines and cosines, the first formula will be most generally convenient, though the second is obviously the shorter one of the two to work out.

2. *Distance between Carnarvon and Cape Breton.*—Using the first equation to find the angle subtended at the centre of the great circle joining the two stations

$$\text{Cos}\,\varphi = (0{\cdot}71934\times0{\cdot}80038) + (0{\cdot}69466\times0{\cdot}5\times0{\cdot}6\times0{\cdot}99738)$$
$$+(0{\cdot}69466\times0{\cdot}866\times0{\cdot}6\times0{\cdot}074) = 0{\cdot}8100.$$

Whence $\varphi = 35^\circ\ 54'$.

By the second equation, using haversines:

$$\text{Hav}\,\varphi = \text{hav}\,7^\circ\ 10' + \text{hav}\,55^\circ\ 45'\sin 36^\circ\ 50'\sin 44^\circ$$
$$= 0{\cdot}00391 + 0{\cdot}21860\times0{\cdot}59949\times0{\cdot}69466$$
$$= 0{\cdot}09491.$$

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Whence $\varphi = 35° \, 53' \, 35''$.

Taking the radius of the earth as 3,440 miles, then the distance apart of the two stations will be :

$$2 \pi \, 3440. \times \frac{35 \cdot 9}{360}. = 2{,}154 \text{ miles,}$$

or 3,467 kilometres.

[NOTE.—Occasionally where θ and θ_1 or α and α_1 are approximately equal, then a simple approximation may be made as follows, to the two equations given above :

$$\text{Distance} = \left(\frac{\text{Difference of long. of } a \text{ and } b}{360}\right) 2 \,.\, \pi \,.\, 3{,}440 \cos \text{(mean lat.)}$$

$$\text{or} = \left(\frac{\text{Difference of lat. of } a \text{ and } b}{360}\right) 2 \, \pi \, 3{,}440 \cos \text{(mean long.)}$$

but it should be noted that the mean latitude or mean longitude formula must only be used when those latitudes or longitudes are not very different. Since in the present example the latitudes are not very different, the approximate method might be made to serve.

Taking mean latitude to be $49° \, 35'$ and difference in longitude to be $55° \, 45'$, then distance is approximately :

$$d = \frac{55 \cdot 75}{360} \times 2 \, \pi \, 3{,}440 \cos 49° \, 35' = 2{,}170 \text{ miles}$$

which is quite a close approximation to the true value. For latitudes differing by greater amounts the divergence from the correct value becomes greater.]

3. *Determination of Aerial Current, Height, and Wave Length.*—Knowing now the distance apart of the two proposed stations, it is advisable to determine next the transmitting aerial current, height, and settle the wave length, and for simplicity it will be assumed that the two stations employ similar aerials for both transmitting and receiving.

Austin, in the *Bulletin of Bureau of Standards, Washington*, Volume VII., No. 3, gives the following formula connecting the transmitting and receiving aerial currents :

$$I_s = I_R \div \left[4 \cdot 25 \frac{h_1 \,.\, h_2}{\lambda \,.\, d.} \, \epsilon^{\frac{-0 \cdot 0015 \, d}{\sqrt{\lambda}}} \right] \text{ ampères.}$$

where I_s = current in transmitting aerial in ampères ;
I_R = current in receiving aerial in ampères ;
$h_1 \, h_2$ = aerial heights in kilometres ;
λ = wave length in kilometres ;
d = distance between stations in kilometres.

The exponential term is the factor taking absorption into account ; and the numeral 0·0015 is empirical. Some experiments on absorption lead one to suggest 0·0015, whilst others seem to indicate that 0·0019 would more accurately represent the facts.

It should be remembered that at night time, this term may in certain regions approach unity, when I_s can be reduced very considerably.

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At present only I_R and d are known in this formula, and h_1 will be taken equal to h_2. The wave length λ, heights of aerial h and transmitting aerial current I_s have, therefore, to be settled simultaneously, and an infinite number of pairs of values of h and λ can be made to fit in with reasonable values of I_s.

Usually in practice a certain maximum value can be stated for h, whence the value of λ to give a reasonable sort of transmitting aerial current is found.

In this design the following values will be taken:

$h_1 = h_2 = 150$ metres or $\cdot 15$ kms, and $\lambda = 3{,}000$ metres or 3 kms.

Whence
$$I_s = \frac{45 \times 10^{-6} \times 3 \times 3{,}467}{4 \cdot 25 \times 0 \cdot 15 \times 0 \cdot 15} \, \varepsilon^{\frac{0 \cdot 0019 \times 3{,}467}{\sqrt{3}}}$$
$$= 48 \cdot 96 \times 1 \cdot 462 = 71 \cdot 65 \text{ amperes.}$$

If the smaller absorption term 0·0015 had been used the value of the exponential would have been 1·3499 and corresponding I_s 66·10 amperes. The value of I_s taken in the design of the station will be the higher figure 71·65 amperes.

4.—*Choice of Spark Train Frequency and Power of Station.*—The next stage is to settle the power to be employed in the transmitting aerial, and this depends on the capacity of the aerial, as the following will show.

It is necessary to assume some spark train frequency N and some working value for the logarithmic decrement δ.

For general working, a spark train frequency of 600 gives a good clear musical note which is easy to receive aurally; and this value will be assumed in the design. The alternator frequency will, therefore, be 300 per second.

The value of the logarithmic decrement δ must be assumed here; and in general it is taken from previous experience with similar stations where it has been measured.

For simplicity take $\delta = 0 \cdot 05$.

Three parallel examples will now make clear the method of deciding on a given aerial capacity; and the corresponding aerial power will be deduced.

It will be noticed that the greater the capacity of the aerial the less is the maximum voltage; and the less the power required in transmitting.

Take wave-length $\lambda = 3{,}000$ metres.

$\therefore$ Frequency $\quad n = \dfrac{3 \times 10^8}{3{,}000} = 100{,}000. \sim.$

and $p = 2\pi n = 628{,}320$.

$K_2 = 0 \cdot 0075$ mfd.	$K_2 = 0 \cdot 005$ mfd.	$K_2 = 0 \cdot 003$ mfd.
$V_{2\,R.M.S} = \dfrac{I_{R.M.S}}{K_2 \cdot p}$		
$= \dfrac{70}{0 \cdot 0075 \times 10^{-6} \times 628{,}320}$	$\dfrac{70}{0 \cdot 005 \times 10^{-6} \times 628{,}320}$	$\dfrac{70}{0 \cdot 003 \times 10^{-6} \times 628{,}320}$
$= 14{,}855$ volts.	$= 22{,}280$ volts.	$= 37{,}140$ volts.
$V_{2\,max.} = V_{2\,R.M.S.} \sqrt{\dfrac{8 n \delta}{N}}$		
$= V_{2\,R.M.S.} \times 8 \cdot 161$		
$= 121{,}250$ volts.	$= 181{,}800$ volts.	$= 303{,}200$ volts.

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Energy per spark : $=\frac{1}{2}K_2V_2{}^2{}_{max.}$ =52·25 Joules.	=82·71 Joules.	=138·0 Joules.
Kilowatts for 600 sparks per second : =31·35 K.W.	49·63 K.W.	82·80 K.W.

It is now obvious that certain capacities are quite inadmissible from the point of view of permissible maximum voltage.

On the other hand, as the maximum voltage and power required diminish as the capacity goes up, a balance must be struck between an expensive aerial (large capacity) and small power plant, or a smaller and cheaper aerial and larger power plant. Local circumstances govern the choice in any actual scheme ; but in no case does cheap power lead to very small aerials with correspondingly high power, because of the troubles with the insulation of the extra high voltages involved.

In this example the aerial will be designed to have a capacity of about 0·005 mfd., with a maximum voltage of 181,800 volts and aerial power of 49 to 50 K.W

5. *Design of Aerial to Give the Required Capacity*.—The quickest way to determine size and form of aerial is to use the curves or tables given by Professsor G. W. D Howe, D.Sc., in an article on "The Capacity of Radio-Telegraphic Antennæ," appearing in THE WIRELESS WORLD for December, 1914, and following numbers.

Referring to this article it will be noticed that :

r =radius of aerial conductor, in cms. ;
d =distance apart of adjacent spans, in cms.
D =overall width of complete aerial span in metres ;
l =length of aerial span, in metres.

Taking spread of twelve wires No. 10 S.W.G., where r is 0·1625 cms., then for the convenience of using tabulated figures without interpolation take $\frac{r}{d}=900$, whence $d=146{\cdot}2$ cms. and $D=11\times1{\cdot}462=16{\cdot}1$ metres.

Take now $\frac{l}{d}=300$, whence $l=439$ metres.

Table II. in the above-mentioned article now gives, in double-entry form, the capacity per foot run of the span (for $\frac{l}{d}=300$ and $\frac{r}{d}=900$) as 3·51 micro-microfarads.

Converting the span into feet and evaluating the capacity on the above basis

$$K_2=3{\cdot}51\times439\times3\times\frac{39{\cdot}4}{36}=4{,}540 \text{ m.mfd.}$$
$$=0{\cdot}00454 \text{ mfds.}$$

This is the theoretical capacity of the above aerial in space and takes no account of the proximity of the earth nor of the capacity of the leading-in fan.

(*To be continued.*)

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Digest of Wireless Literature

High versus Low Antennæ.

The present practice is to count the extended capacity of an antenna or at least a large part of it, at a great elevation above the earth. The author subjects this practice to a critical examination. The electric and magnetic forces set up at a great distance from an extended horizontal network of wires are discussed. It is shown that if the radius of an antenna consisting of a horizontal network of wires is two or three times as great as the height of the network above the ground, the electric and magnetic forces at a great distance from such a radiator are practically independent of the height of the network above the ground, provided the frequency of oscillation and the operating voltage from the network to ground are kept the same for the different mounting heights. That is to say, an extended network of wires charged to a given voltage and allowed to discharge to earth through an inductance tuned to give a frequency of say 100,000 cycles per second sets up the same electric and magnetic forces at distant points whether mounted 10 ft. or 200 ft. above the ground. In these two cases the rate of radiation (in kilowatts) from the two antennæ is the same, but the initial store of energy in the case of the 10 ft. mounting height is about 15 times as great as in the case of the 200 ft. mounting height. Therefore, the oscillation in the former case is much more persistent than in the latter; in fact, the oscillation becomes so persistent for low mounting heights that the power condensers and coupled circuits at present required in spark systems of wireless telegraphy may be dispensed with and a simple series circuit comprising capacity area, tuning inductance and spark gap may be used. Such a circuit has the merit of oscillating at a single frequency, whereas the coupled circuits have two frequencies of oscillation. Passing then to a comparison of the receiving properties of two stations with networks at different elevations, the author shows that if the radius of the network is large as compared with any feasible mounting height, then both stations are ultimately able to abstract energy at the same rate from passing electromagnetic waves, provided these waves are persistent and not rapidly damped.

The advantages of low over high antennæ for high-power stations are as follows:— Lower first cost (except where the cost of land per acre is very high); no necessity of power condensers; single frequency of oscillation; apparent possibility to obtain a smaller decrement than where power condensers are necessary; less likelihood of damage by lightning; probably less interference from "atmospheric." On the other hand, high antennæ have the following advantages over low antennæ; small antenna current (which may be of considerable advantage where arc generators or high-frequency alternators are used); a smaller number of insulators; less likelihood of interruption due to insulator failures. Edward Bennett, Bulletin Univ. of Wisconsin, No. 810 (Engin Series, Vol. 8, No. 4).

* * * * * *

Continuous Waves with a Spark Transmitter.

The drawing shows a transmitter described in U.S. Patent 1,166,892, issued in 1916 to R. A. Fessenden. The high-voltage direct current dynamo A charges the outer plates of the condenser B, through the resistance or impedance C. The condenser discharges through the oscillatory circuit formed by the adjustable

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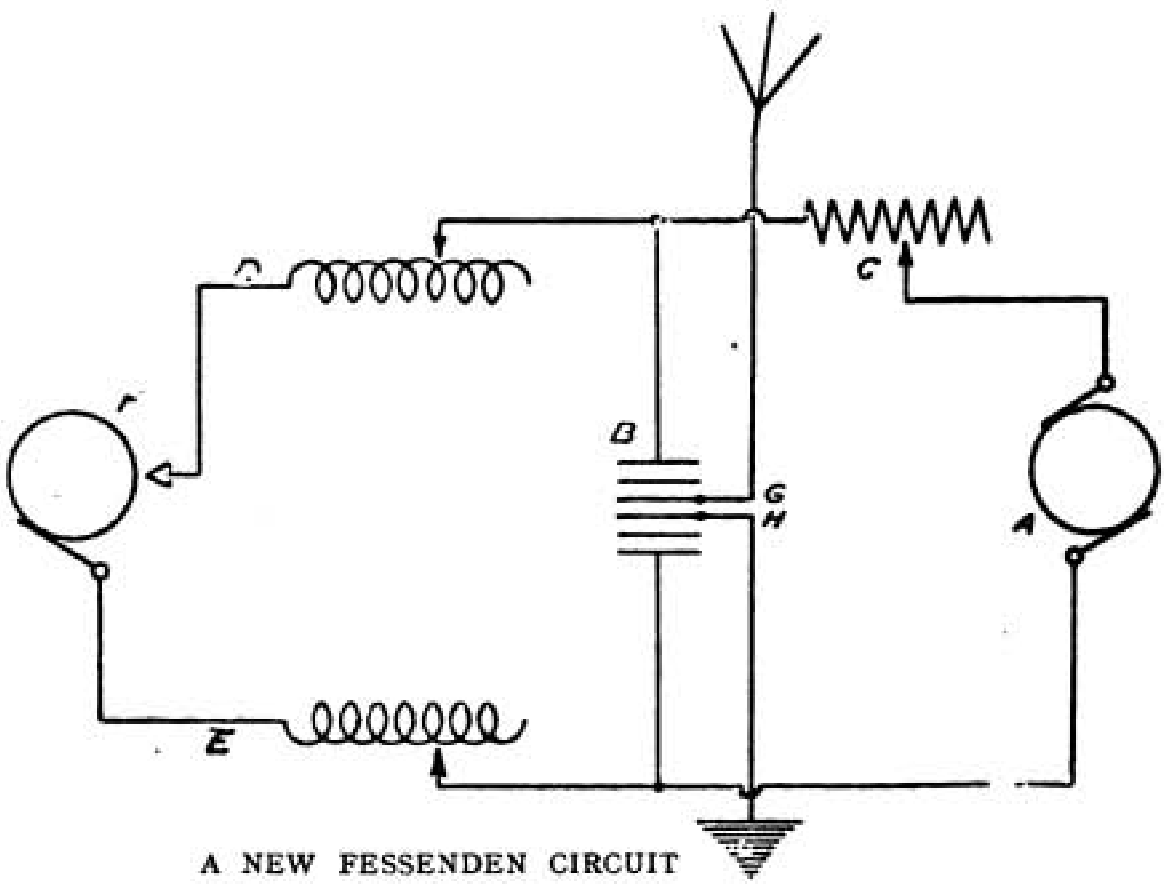
inductances in wires D and E, and the rotating spark-gap F. This gap consists of a stationary electrode placed near to a disc which revolves at high speeds; the inventor suggests that the relative movement of the two sparking points may be as high as 12 miles a minute. The construction may involve two rotating discs, or some other mechanical form which will operate at very great speeds and so prevent the formation of any arc in the gap. In such an arrangement, the specification states, continuous and regular discharges are produced and sustained, or practically sustained waves are generated at high efficiency.

The mode of coupling to the aerial circuit through the internal plates G H of the sending condenser possesses some interest. This is equivalent in many ways to the static-coupled transmitters which have recently been tried in connection



A NEW FESSENDEN CIRCUIT

with various types of arc and spark generators. In order to secure good transfer of oscillating current energy from closed to open circuit it is necessary that the radiating circuit be in tune with the local circuit formed by the plates of B, and the inductance in the lead wires D E. This is accomplished by the usual insertion of variable inductance or capacity in the antenna circuit.—*Popular Science Monthly.*

* * * * * *

ALKALI ACCUMULATORS.

A writer in a recent issue of our Contemporary "The Model Engineer and Electrician," gives some interesting particulars of the design of the Edison Accumulators. Against the high cost of these cells, says the writer, several advantages may be set, the most important being that they will stand very rough usage. If, for instance, alkali accumulators are allowed to stand in a discharged condition no injury results. Moreover, the cells may be charged and discharged at very high rates, and may even be short-circuited without any damage being done to the plates. Even if the current is passed into the cells in the wrong condition the plates will not suffer permanent injury. The plates will also stand any amount of vibration and

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jolting, this being one of the reasons why these cells have been used so extensively for working electrical vehicles. Lead accumulators, however, offer three main advantages over alkali accumulators. First, the initial cost is much lower, secondly, the voltage per cell is higher, and thirdly the efficiency is higher. The efficiency of a lead accumulator is about 75 per cent., whereas that of an alkali accumulator does not exceed 60 per cent. The electromotive force of an alkali cell is only 1.2 volts against about 2 volts for a lead cell.

The positive plates are composed of perforated steel tubes, heavily nickel plated and filled with alternate layers of nickel hydroxide and pure metallic nickel in excessively thin flakes. After being filled with the active material each tube is reinforced with eight steel bands, which prevent the tube expanding away from and breaking contact with the contents. The tubes are mounted in a steel frame or grid, which is also nickel plated. The negative plates are also composed of nickel-plated steel frames or grids, but in this case the pockets are rectangular and they are filled with powdered iron oxide. After the pockets have been mounted in the grids they are subjected to great pressure between dies, which corrugate the surfaces of the pockets and force them into practically integral contact with the grid. The plates are separated from one another by narrow strips of hard rubber. At the edges of the plates grooved rubber insulators are provided, which perform the dual function of separating the plates and insulating them from the sides of the container. Hard rubber is also placed between the surfaces of the outside negative plates and the container, whilst at the bottom of each cell a hard rubber rack is placed which insulates the lower edges of the plates from the bottom of the container. This bridge, however, is very shallow, since in an Edison cell no active material can leave the plates and accumulators at the bottom of the cell. The container is nickel plated inside and out, the object of this being to protect the case from rust. The terminal posts for the positive and negative plates pass through stuffing boxes fixed to the top cover, and between these stuffing boxes is an opening for filling the cell with electrolyte and for adding distilled water to make up for that which has evaporated during the charge. This opening is fitted with a water and air-tight cover and it is held in place by a strong latch.

The electrolyte consists of a twenty-one per cent. solution of potash, with a small quantity of lithia. In making the solution distilled water must be used and not tap water. Since the density of the electrolyte does not change hydrometer readings are unnecessary. The maintenance of these cells, in fact, is almost entirely a mechanical proposition, for all the attendant has to do is to keep the plates covered with solution by adding pure distilled water when needed, and to keep the steel containers dry and clean. The amount of water used depends entirely upon the service and the care that is taken when charging. If the cells are continually overcharged, there will of course be excessive evaporation of the electrolyte, and fresh water will have to be frequently added. Moreover, excessive overcharging involves waste of current and, in turn, waste of money. Alkali cells do not require long overcharges, for the plates cannot sulphate. After about two hundred and fifty discharges, the solution must be renewed, since it then shows a loss in strength, which, in turn, gives rise to a loss in the capacity of the battery of about five per cent. The renewal of the electrolyte not only restores the lost five per cent., but usually raises the capacity several per cent. above the original value.

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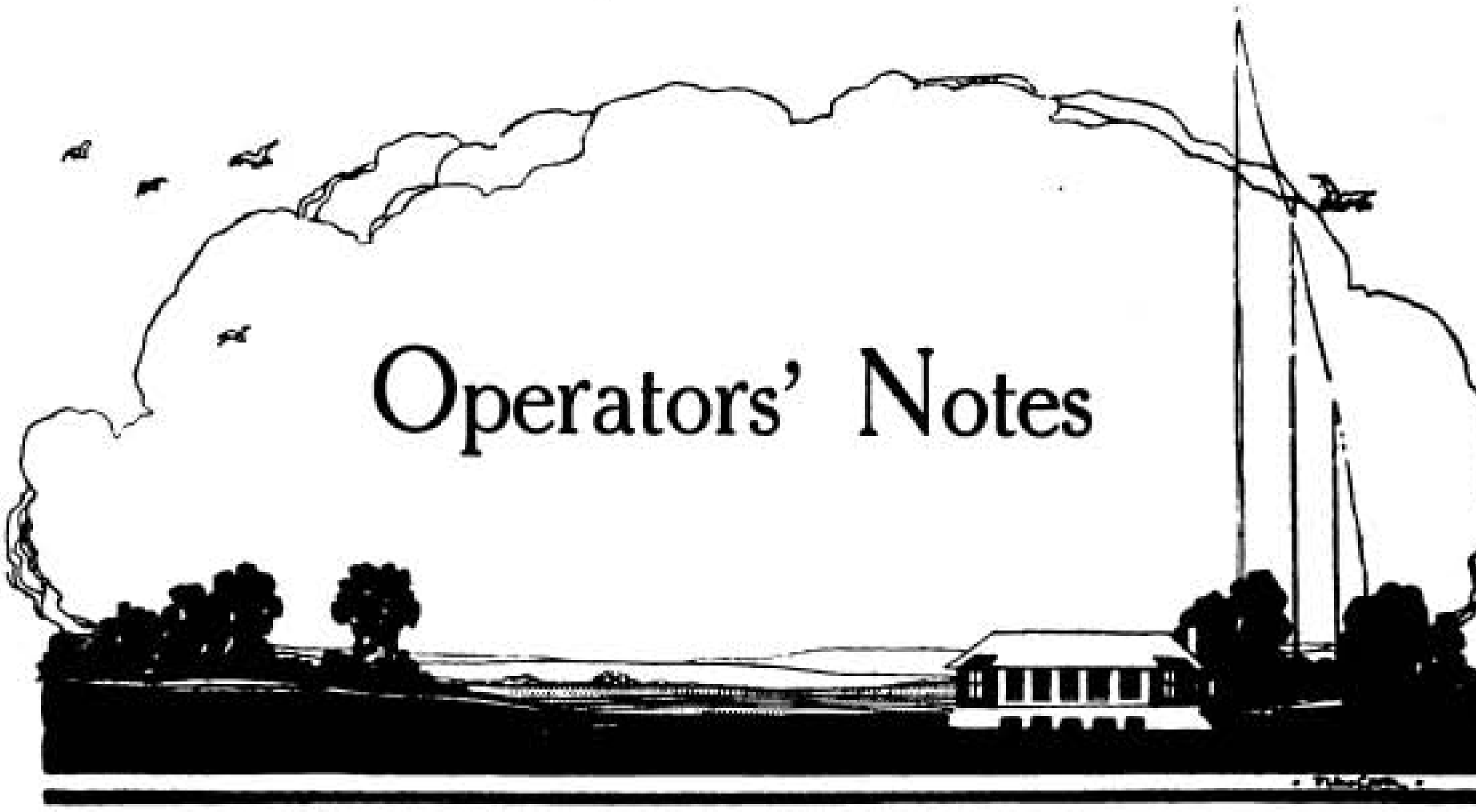

Some Notes on the Maintenance of Accumulators (III.)

By WILLIAM PLATT.

New Batteries.

It is a present-day practice when supplying new accumulator batteries to ship wireless stations to send the cells forward in a fully-charged condition, each cell containing its full quantity of electrolyte. Batteries received in this manner should be examined immediately on delivery, as despite many precautions, such as specially constructed travelling crates and lavish labelling, it frequently happens that a quantity of acid is lost during transit between the manufacturers and destination. With each battery there is supplied a porcelain bottle containing a gallon of dilute acid. Should it be found that acid has been lost from the cells during transit the necessary amount should be added to each cell, so as to bring the electrolyte from ½ in. to ¾ in. above the tops of the plates. The voltage and the specific gravity of each cell should be taken and the cells put on charge at the normal rate for a period of half an hour to an hour, as may be necessary, until all the cells are gassing freely.

When the cells are sent forward in a dry state the " setting up " of the battery needs more careful attention. The plates should be lifted out of each container, the packing removed, and separators fitted between each pair of plates. Care should be taken that the plates are placed on nothing likely to short the groups. It is better to lay the plates on one side so that the outer negative plate only comes in contact with anything else. The containers should be examined to see that they are perfectly clean ; the side insulating pieces and wooden bridge should be fitted into the containers and the two groups of plates carefully replaced in position, special notice being taken that the side insulating pieces are not crushed down underneath the plates. Acid of the correct specific gravity should then be added to each cell and the battery immediately placed on charge. This initial charge should be given at a rate slightly below the normal rate and continued from eight to ten hours after the voltage and specific gravity have ceased to rise.

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It is then desirable to discharge the battery to a half of its capacity, after which it should be re-charged until the voltage is 2.5 to 2.7 per cell on charge and all cells gas freely. This operation should be repeated from three to four times. During this period there will be considerable evaporation, to compensate for which water should be added to the cells after they are fully charged.

Indications that the cells are fully charged are as follows: (1) Specific gravity at maximum density; (2) voltage at maximum; (3) cells gassing freely; (4) electrolyte assumes a milky appearance; (5) positive plate becomes a chocolate brown colour; and (6) the negative plate becomes a light grey.

* * * * * *

BUCKLING.

During charging there is an increase of bulk in the positive plates produced by the reducing of lead sulphate ($PbSO_4$) to lead peroxide (PbO_2). If from any cause this expansion is not even over the whole surface of the plates the unequal expansion distorts the grids or frames and buckling eventually ensues. One prolific cause of unequal expansion is too rapidly discharging and the discharge being allowed to continue after the voltage has fallen below 1.8 per cell. Sulphating is a healthy action of a good cell. This action is going on during the whole time of discharge, but when the discharge is allowed to go past the limit referred to above the formation of insoluble sulphate (Pb_2SO_3) takes place and shows in white uneven patches over the surface of the plates. During charging the parts of the plate covered with insoluble sulphate do not expand equally with the other parts, and distortion of the grids takes place and buckling inevitably results. Another cause of insoluble sulphate is the acid being above strength, due to topping the cells with acid instead of water.

In such cases sulphating is carried on to excess. Acid does not evaporate, and the losses are very small indeed, therefore acid should not be added to the cells unless some of the electrolyte has actually been spilt.

* * * * * *

CARE OF CELLS.

Emergency batteries on shipboard will require to receive the greatest attention during the time a vessel is in port. It is important that when a vessel leaves port the cells should be in a fully-charged condition, and the battery should not be discharged during the time the vessel is at sea. On the voyage readings of the voltage should be taken and recorded daily, and if it should be necessary to give the cells a small charge this should be done on the low rate. On arrival in port the cells should be taken out of the accumulator cupboard and all leads removed from the containers. Connectors and wing nuts should be cleaned, readings of the voltage and specific gravity should be taken and the cells connected up outside the cupboard and put on discharge at the normal rate.

When the voltage of the twelve cells has fallen to 21.6 on load, a discharge should be discontinued and the battery immediately put on charge again at the normal rate, this charge to be continued until each cell is gassing freely. During the periods of charge and discharge the battery should never be left and frequent examination of the specific gravity and voltage should be made, all readings being

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correctly recorded. These records should be preserved, as they are one of the most helpful means of determining the condition of the cells. If during charging it should be noticed that one cell is charging slowly it should be taken out of the battery and carefully examined for short circuiting, later being replaced in the battery. When the battery is again discharged this cell should be left out of the circuit and only connected up with the battery when it is put on charge later. One of the causes of short-circuiting is pieces of paste from the plates breaking away and falling between the two plates. However, with the ship type cell the separators are packed between the plates very closely and such faults seldom happen. Overcharging after the cells are gassing freely is not recommended, and the only time when it should be necessary is after the cells have been left out of use for an extended period and allowed to sulphate in excess. When overcharging is necessary the rate should be decreased to a quarter of the normal rate. Slight sulphate may be removed by persistently overcharging at a low rate, say, two or three amps., and discharging at a special low rate, say, one amp. When the cells are fully charged the tops of the lead-lined containers should be wiped with a clean cotton cloth to remove any splashes of acid which have occurred during gassing. This prevents the formation on the lead lining of hard sulphate, which if allowed to collect eventually eats its way through the container.

Care should be taken to see that the water used for replenishing the cells is clean and pure. Distilled water is, of course, the best for this purpose, but is not always possible to obtain. On shipboard evaporated water is readily procurable, and this should be used when necessary. It is spoken of as " condensed water," but care should be taken not to confuse this with the water which has passed through the condenser tubes to the ship's boilers. This latter would be very damaging to the accumulators, as it contains all sorts of impurities. All terminals and connections should be kept scrupulously clean and treated with a thin coating of vaseline. The rubber sleeves on pole pieces should be always kept in position. These rubbers are really intended as insulators to prevent the cells discharging across the lids, a not unlikely occurrence in moist atmospheres or where dirt has been allowed to collect on the leads. It is an excellent practice to wipe over the whole of the outside of the wood containers frequently for the purpose of removing all conducting dust or dirt, as through such a medium it is possible for the cells to " ground."

It is important that all batteries shall be securely battened when placed in position, otherwise during the heavy weather the battery is likely to be thrown out of the cupboard. The inside of the cupboard should also be painted with anti-sulphuric paint, and in all cases the bottom of the cupboard should be provided with a wooden grid to raise the cells from the deck. In later practice it is usual to fit a lead-lined tray underneath this grid; this tray protects the deck from any acid that may be spilt.

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The Principles of Electric Wave Telegraphy and Telephony*

By J. A. FLEMING. Reviewed by Professor E. W. MARCHANT, D.Sc., of Liverpool University.

IT is now just over ten years since Professor Fleming first produced this book. When it was issued it assumed at once a commanding position as an authoritative exposition of the scientific principles involved in wireless telegraphy. Since that time many books have been produced dealing with the subject, some from the point of view of the practical engineer engaged on the erection of stations, others from the point of view of the operator who has to handle the apparatus in an ordinary ship or shore station, but there is none that approaches Professor Fleming's in the completeness of its treatment of the subject from its scientific aspect, and which, at the same time, contains so much information which is of value to those who have to deal with the practical business of transmitting and receiving wireless radiograms.

The opening chapter deals with the production of high-frequency currents; it is interesting to compare this chapter with the corresponding one in the ten years old first edition and to realise what progress has been made. Since those days the Alexandersen machine and the Goldschmidt alternator have been developed, and it is now possible to build alternators capable of developing 100 kilowatts or more of high-frequency power for radio-telegraphic purposes.

The Poulsen arc, too, has become a practical and effective machine for producing continuous electrical oscillations. All these are described in detail, and the mechanism of their operation fully explained.

A very elaborate account is given, also, of the production of damped electrical oscillations, and a number of photographs of electrical discharges is included. This chapter contains a small treatise on the induction coil and its use for the production of electrical oscillations, the various forms of break used in wireless work are described and the theory of their action discussed. The Pliotron oscillator which seems likely to prove a very important method of generating continuous oscillation is described later in the chapter on Radio-telephony.

The next chapter, on High-Frequency Measurements, is of the greatest interest to all radio engineers. It covers a very wide field, from the calculation and experimental measurement of capacity and inductance to the determination of dielectric hysteresis loss and the dielectric strength of air. The figures given for the variation in the specific inductive capacity of glass are of great interest; they emphasise the irregular nature of the changes in dielectric capacity with frequency found by different observers. It is satisfactory to find that Professor Fleming's observations agree with those of most other experimenters in showing that the dielectric constant of glass with high frequencies is less than that measured ballistically. There is also a very complete account of the observations that have been made on the dielectric strength of air between spheres, which will be of value to many who are not radio engineers. The chapter on Damping and Resonance also covers a wide field. This

* *The Principles of Electric Wave Telegraphy and Telephony.* By J. A. Fleming. London: Longmans, Green & Co. Third Edition, 1916. 911 pages. Price, 30s. net.

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subject has been developed very extensively during the last few years ; a fact which is emphasised by the increase in size of the chapter compared with that in the earlier edition, but still more by the nature of its contents. The measurement of the decrement of an oscillating circuit is now almost as important as a determination of its natural wave-length and frequency. Professor Fleming lays emphasis on the effect of spark resistance on decrement in circuits producing electrical oscillations by the spark method. It is, however, unfortunate that no attempt has been made to compare the values of spark resistance measured by different observers on the basis of the instantaneous value of the current passing. An attempt was made by the author of this review in this direction in some experiments made many years ago and the results were fairly consistent. If a curve could be calculated showing the effective resistance of a spark between one-inch spheres when carrying different currents, the results would be of great value in the calculation of decrements. The figures given, while useful for capacities of the values used in the experiments, are generally of little service, since the capacities used are very rarely the same as those with which the experiments have been made. As the author observes, a full examination of all the factors affecting spark resistance has not yet been made, and the subject is one which might well engage the attention of scientific workers engaged on high-frequency measurements. There is a good theoretical treatment of the effect of coupling on resonance and on methods of measuring logarithmic decrements ; but the bulk of the latter subject is deferred to a later stage.

Part 2 of the book deals with Electric Waves. Chapter 4 is very much the same as in previous editions and deals with the production of stationary waves on wires. The next chapter now headed "Electric Radiation" is similar to the one on "Electromagnetic Waves" in the earlier edition. Some useful figures, due to Austin, are given of the effect of varying the emitted wave length on the apparent resistance of an antenna due to the induction of eddy currents in the surrounding earth. It would have been useful if the conductivity of the soil had been stated, so that a comparison could have been made with antennæ working under different conditions. A great deal of research work is published which is of little practical use, except for elucidating the phenomena described in the original research. It is a laborious task to sift out useful facts and figures from a multitude of papers and so provide reliable information based on the observations of a number of different workers ; though the task is laborious, it is worth doing, as there is usually little value in a series of detached scientific experiments. It would have made this book of even greater value if the data given could have been still further sifted and analysed. Chapter 6 deals with the appliances used for the detection and measurement of electric waves ; starting historically, it describes the development of the coherer and the magnetic detector.

A very complete bibliography is given of the work done on the effect of high-frequency currents on the hysteresis loss in iron. The electrolytic detector, the barretter, or hot wire detector, and the well-known rectifying detectors (such as the crystal and the Fleming valve) are dealt with fully. A great deal of valuable information is given about the latter device which, in its modified form as the audion and the Lieben Reisz telephone relay, seems destined to produce great results in the development of "small current" electrical engineering. Various forms of cymo-

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meters or wave meters are described, and the chapter ends with a description of the decremeter now largely used in all wireless measurements.

Part 3 deals with Electric Wave or Radio-telegraphy; that is, primarily, with the application of the principles laid down in the preceding chapters, but also with the practical problems that arise in the transmission of wireless signals. Although at the opening of chapter 7 the suggestion is made that those interested in the history of the development of Radio-telegraphy should consult other sources, a short summary is given of the chief steps in its development; the space occupied by this, however, is much less than in the earlier editions. There is an excellent description of the directive antennæ used in wireless work, though the experiments of Kiebitz on this subject are left to a later chapter. An account follows of the various methods of exciting an antenna, of the effect of tight and loose coupling and of the forms of spark gap or discharger now in practical use.

The chapter concludes with a description of the receiving apparatus used in connection with the various so-called "systems of wireless telegraphy," but also includes the Einthoven galvanometer and the Brown magnifying relay. The chapter on Radio-telegraph Stations will be of great interest to all radio engineers, as it contains a very complete description of the high-power long distance stations at Clifden and Carnarvon now regularly used for Transatlantic transmission, as well as that at the Eiffel Tower and at Tuckerton, New Jersey, where a Goldschmidt alternator has been installed. An account is given of military sets, and of some of the newer forms of aircraft transmitters and receivers. Subjects like the prevention of interference and the efficiency of radio-telegraph stations are included here. The small station described on page 785 with an overall efficiency of just over 4 per cent. is a very good example of "how not to do it," though Professor Fleming seems to think 25 per cent. as high an efficiency as it is possible to attain for a station of this size. The few pages on the design of a radio-telegraph station will be of value to many radio engineers. The chapter on radio-telegraph transmission will be of interest to all; the function of the earth is fully discussed, and an interesting collection of data, obtained mainly by Austin and Hogan at the U.S. Experimental Stations have been included; an account is given of the well-known sunset effect and of the variations that have been observed from day to day in the strength of wireless signals received from a station emitting daily messages. This is a subject which requires much further study, but the increase in our knowledge of it during the past few years has not been inconsiderable. The book ends with a chapter on Radio-telephony, a subject which has not perhaps developed as rapidly as some people anticipated. Progress has been made, however, and it seems as if the "Pliotron" already referred to may possibly solve the most difficult part of the problem, *i.e.*, the production of an absolutely steady train of electrical oscillations. A microphone capable of dealing with large currents also has not proved an easy thing to make; progress, though slow, has been steady, and the day may not be far distant when wireless telephones become of general practical utility. As this review indicates, Professor Fleming's book is exhaustive and complete; the new edition (especially the almost entirely re-written Part 3) gives a large amount of valuable information, and all those engaged in wireless work who make any pretensions to a scientific understanding of their subject should possess it.

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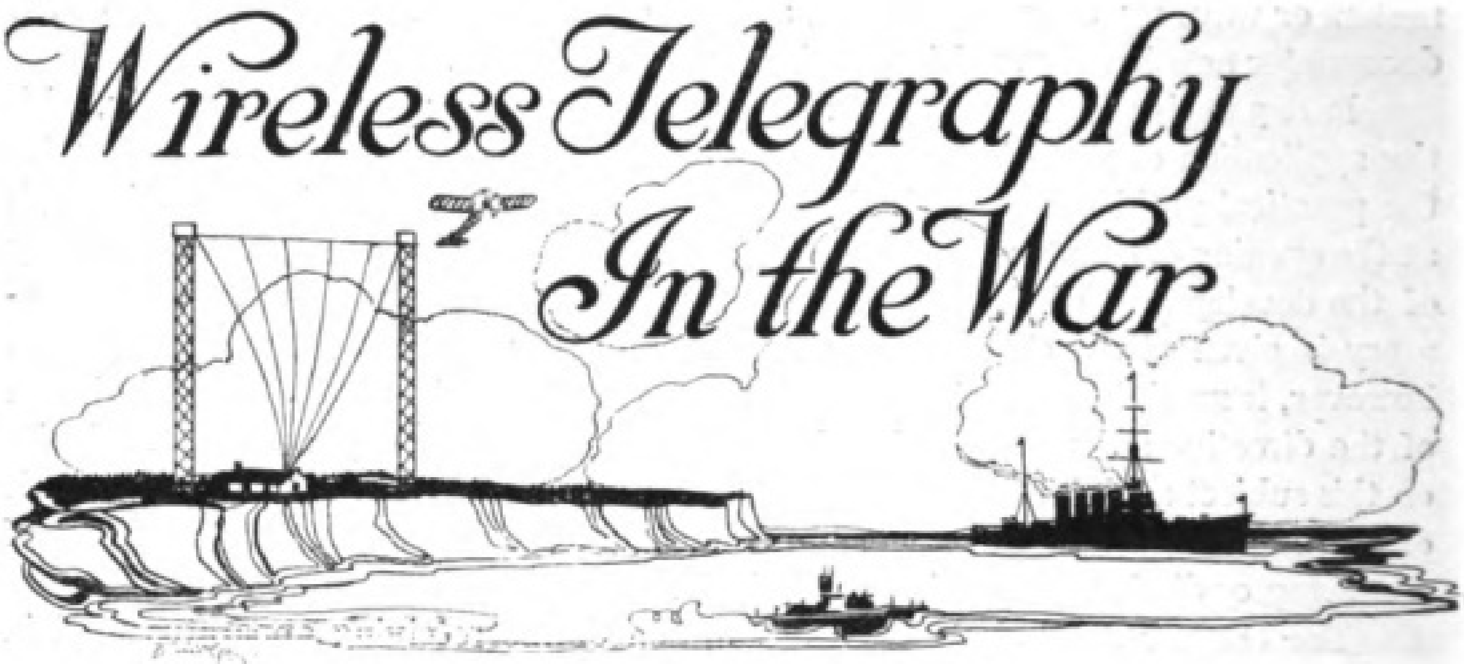

SELF-CENTRED OBSESSION.

A LARGE number of people have been commenting upon the recent action of Germany in notifying neutral nations that they must submit to untrammelled U-boat piracy, as though their actions were actuated simply by sheer impertinent disregard for the rights of other people to exist. As a matter of fact, however, it would appear to be doubtful whether the course so taken by them was *consciously* impertinent at all. The modern German is so obsessed by a sense of his own importance, that nothing appears to him to matter in comparison with the welfare of Germany and the Germans. Provided that anyone with whom he is dealing is prepared to accept to the full all the consequences which follow from the doctrine that *Deutschland* is really and indisputably *Ueber Alles*, he is quite willing to consent to " accommodate " them in his own condescending way. This attitude is aptly exemplified by the announcement issued to the world at large through the German long distance wireless station, that the " All Highest " was " prepared to oblige " neutral governments and shipowners by placing the Nauen station at their disposal for radiating wireless messages to any ships at sea, which might otherwise, through ignorance, violate the boundaries of the sacred " War Zones " which the Kaiser's Ministers have been recently ruling across the seas surrounding Great Britain and her Allies ! What such an announcement as this meant is nothing less than a confession that the German administrators are so besotted with their own sense of self-importance, as not to perceive that, in sending out such an announcement, they are but piling insolence on insolence. Just as they, apparently, failed to realise that it was outrageously insulting to attempt to dictate to independent nations exactly where and how they might despatch their vessels, under penalty of instant death to all their subjects on board in the event of " disobedience," so do they fail to realise that to offer facilities for blind acquiescence in such instructions is not a mitigation of their offence but an addition to it.

As far as Nauen station is concerned, it has already attained an unenviable notoriety. From this centre have been radiated the larger number of " wireless lies " and other malversations of the truth with which neutral nations have been flooded

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ad nauseam since the British cut all German cables in the first few hours of warfare. Readers will find a fairly full description of this Hun radio station on pages 919 to 923 of the present issue.

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WIRELESS VERSUS SUBMARINES.

Up to the present, one of the chief obstacles to the arming of British merchantmen with artillery capable of dealing with submarine piracy has been the refusal of neutrals to receive within their ports and treat on the footing of traders vessels so armed. As a result of such non-armament, practically the only weapon of defence possessed by British and neutral merchant vessels against German submarines of the later type has been their power of summoning the aid of men-of-war through the medium of their aerials. The account which Mr. Alfred Noyes was recently allowed to publish in detail of the escape of the *Anglo-Californian* through this medium admirably illustrates the consequent situation. In the earlier days of the war the speed possessed by enemy submarines was so limited that vessels were frequently able to escape by reliance upon their own superiority in this respect. Now that superiority has ceased to exist. Apart altogether from the strained relation resulting from the recent development of German audacity in the interest of " the freedom of the seas," there would appear to be good reason to hope that neutrals will in future desist from putting obstacles in the way of the arming of British merchantmen for defensive purposes, irrespective of the position in which the guns may be located. But even in such an event, the importance to merchantmen, when attacked, of being able to radiate from their aerials appeals for assistance, will be little less than it is at present. The size and gun power attained by the more recently constructed German under-water craft is such as to raise them almost to the status of cruisers, so that it would require more powerful warlike apparatus than would normally be at the disposal of the ordinary tramp steamer for the combat to be developed on equal terms if a single merchantman were acting " on her own."

Photo: Topical.

BRITISH WIRELESS STATION AT KUT.

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[*Official Photograph per Central Press.*

WIRELESS DIRECTION OF ARTILLERY ON THE BALKAN FRONT.

THE ROYAL FLYING CORPS.

The co-relation between aeronautics and wireless is very close. The utility of the former depends largely upon the latter. In our last issue we illustrated this fact by quoting the words of an aeroplanist whose machine lacked radio equipment. They tend to show that it is of little use to observe the enemy's dispositions if the result of such observations cannot be promptly conveyed to the officers directing operations. On this page we show a group of gunners whose aim is being guided against a foe on the other side of a mountain ridge, a foe totally invisible to them, for whose benefit they are training their gun in accordance with instructions wirelessed to them from the air. The direction of artillery by aircraft through the medium of wireless constitutes one of the most striking developments in warfare which we have seen in the course of the present struggle. This gun-fire direction forms one of the most important branches of the work of the "Royal Flying Corps."

In former issues we have referred over and over again to the training of airmen in radiotelegraphy at many centres and notably at Marconi House, London. We have recently received an account of the activities of one of the branches of this

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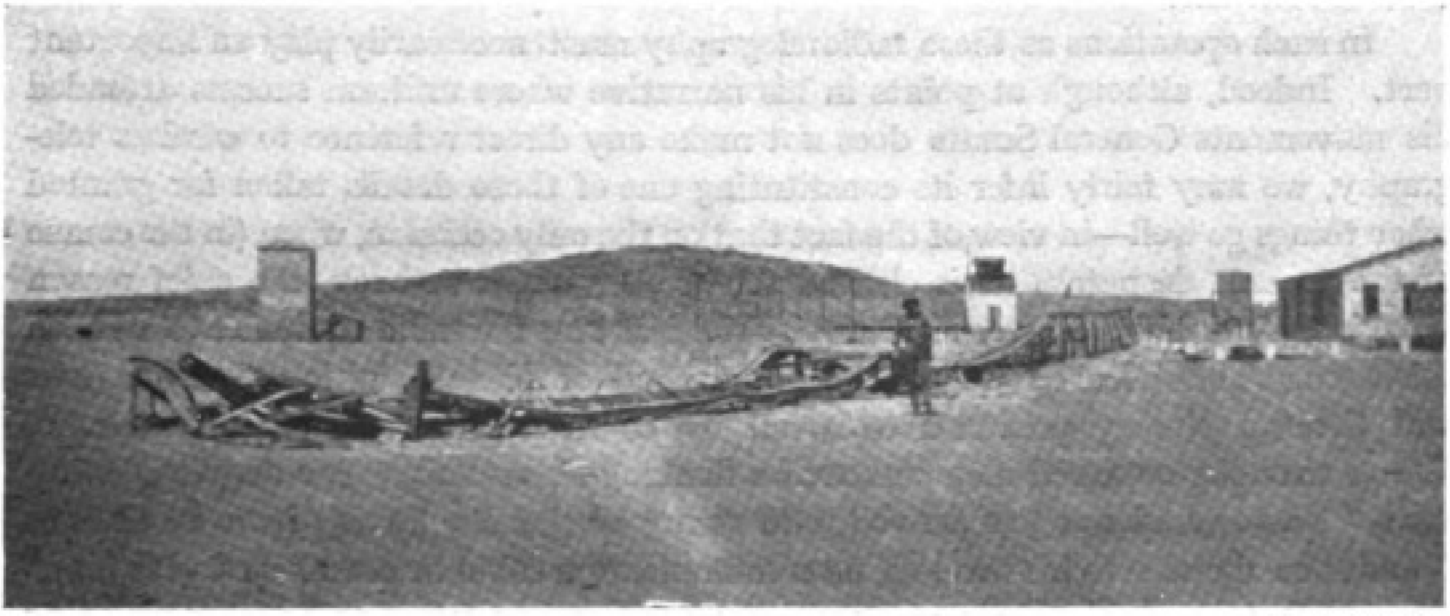
young but already world-famous corps. It comes from the East African Force, and was communicated by an aviator of Africander birth. The main point upon which he insists to start with is, that his own particular branch is constituted upon Royal Imperial lines: it is not the Royal African Flying Corps, but the South African Squadron of the Royal Flying Corps. " It reports direct to the Imperial Authorities, " and it also reports to South Africa. Apart from the actual flying, it is a self- " contained unit. . . . It guards its own camps, builds its own block houses to " protect its own aerodrome, and—when it wants to communicate with Head- " quarters—it speaks through the medium of its own wireless installation."

In our December issue we printed an account from one of the R.E. wireless men, and pointed out how absolutely essential it was that forces campaigning in such wild undeveloped areas should make the fullest possible use of wireless telegraphy. The communication with which we are now dealing confirms this opinion. Our correspondent enlarges upon the endless forests which lend themselves so admirably to the concealment of troops on foot, and where herds of game raising clouds of dust as they move along were frequently mistaken for troops on the march. On one occasion, it appears, a swarm of locusts was believed to be a dust cloud raised by the enemy. A Department, whose military organisation owed much to radio communications, " put on record the fact that the morale and actual effect of our " bomb raids were invaluable in destroying the morale of the enemy. . . . Men " who had previously spent the day in their dug-outs sheltering from the enemy's " artillery swarmed to the hill-sides to watch the smashing blows of the great " 100 lb. bombs and hear the dull reverberation of the explosion whilst the enemy " camp became slowly enveloped in great clouds of dust and smoke."

The excellent arrangement under which General Smuts will attend the Imperial War Conference summoned by our present Prime Minister, which involves his relinquishment of the task which he has carried out so well, forms a plain indication of the fact that only the " cleaning up " process remains to be accomplished. But accounts such as those to which we have above referred, and that from which we



[*Photopress.*

WITH OUR FORCES IN EGYPT. A WIRELESS STATION WRECKED BY THE ENEMY BEFORE RETREATING.

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have just quoted, conspire together to indicate, as history alone will be able to recount in detail (when it comes to be written), the formidable nature of the task the East African Force undertook, and the difficulties with which commanders and commanded had to wrestle. Only detailed narration can do anything like justice to the importance of the part played in this work by radiotelegraphy, and by the gallant pilots and observers of the Royal Flying Corps.

* * * * * *

HUMAN INTEREST IN AN OFFICIAL DESPATCH.

Some particulars, of the kind referred to above, figure in the official despatch issued as a supplement to the *London Gazette* under date of the 17th January last, wherein Lieutenant-General Smuts reports his operations up to the end of October last. This report includes a summary of operations extending over a considerable time and covering a wide field, so that it is impossible here to attempt any epitome; but we can assure readers that a perusal of the document itself, side by side with "the Large-scale Map," which the late Lord Salisbury so constantly recommended to newspaper readers, would amply repay them for any expenditure of time and attention.

The first impression given by perusal is that the key to General Smuts's practically invariable success lies in his decision to adopt the line of advance least expected by the enemy. This comes out over and over again in the course of his narrative. When dealing, for instance, with the occupation of the Pare, Usambara and Handeni areas, the General writes: "Our advance was expected to follow the railway, which "had been fortified at all convenient points for 100 miles. . . . I therefore decided "on the following dispositions for my advance." The "dispositions" of which he speaks consisted largely of utilising mountain tracks and passes, and even in places of cutting a path for his forces across virgin territory so as to materialise his search after the unexpected. The results attained justified General Smuts's judgment. The rapidity, with which the Anglo-Africander Forces advanced, "exceeded my "best expectations; we had reached the Usambara in 10 days, covering a distance "of about 130 miles over trackless country along the Pangani River and through "the mountains."

In such operations as these radiotelegraphy must necessarily play an important part. Indeed, although at points in his narrative where uniform success attended his movements General Smuts does not make any direct reference to wireless telegraphy, we may fairly infer its constituting one of those details taken for granted when things go well—in view of the fact that on the only occasion, when (in the course of the present despatch) he is obliged to record a slight setback, the chief reason for this mishap is put down specifically to the fact that the radio equipment had been damaged. This occurred in the neighbourhood of Kissaki, which General Brits and General Nussey prepared to assail by co-ordinated attack, whilst General Enslin with the mounted men executed a flanking movement. The despatch states that "Nussey had not yet arrived, and owing to the roughness of the mountains "and some damage to his wireless, no communication could be established with him," General Brits made the attempt alone; the position was found to be strongly held; and the enemy were able to keep Enslin at bay; eventually succeeding in outflanking him, with the consequence that the whole force was obliged to retire. Nussey,

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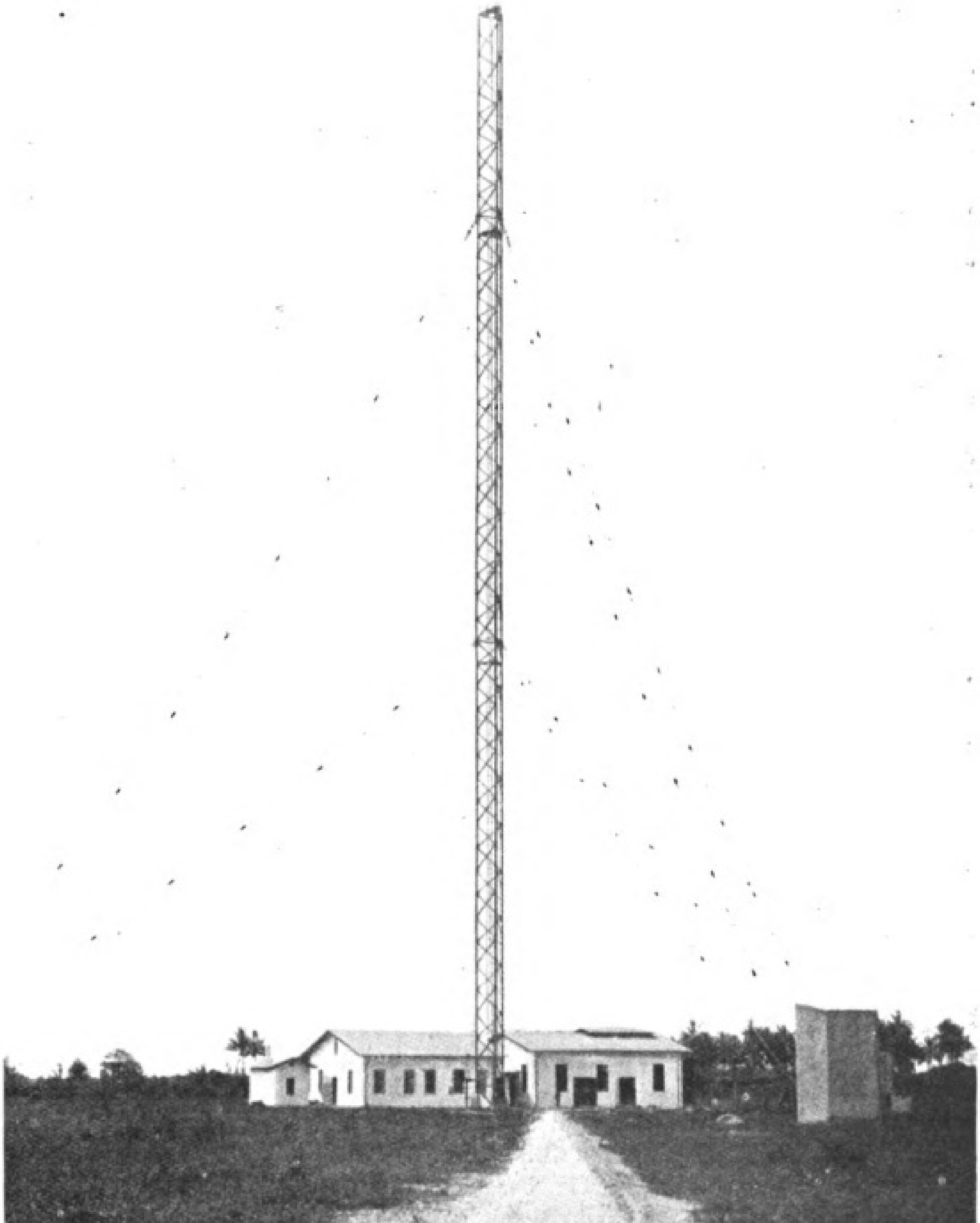

A PRIMARY OBJECTIVE IN GERMAN EAST AFRICA: the powerful Telefunken long-distance station at Dar-es-Salaam. It was bombarded by the Navy, and surrendered on September 3rd, 1916, the enemy forces having retired a few days before.

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in total ignorance of these events, as well as of the position of General Brits, arrived before Kissaki on the morning of the following day. Instead of attacking he found himself attacked; and was in his turn obliged to withdraw. General Smuts comments: "If communication between Brits and Nussey could have been maintained "there is no doubt a general attack would have led to the capture of Kissaki, whereas "the two isolated efforts led to a double retirement and a regrettable recovery of "enemy morale."

A further illustration of what may happen when, for some reason or other, wireless apparatus cannot be used will be found in the account of the earlier manœuvres of General Enslin's column before it debouched from the 'Nguru Hill-Ranges; for we read that "one of Enslin's mounted regiments had lost its way in the mountains and had finally emerged at Matamondo," a point situated at a considerable distance from its intended objective.

The wireless installation of our German foe had originally been very complete, and formed an essential part of his military defences. The daily Press have reported the destruction of the great long-distance stations, like that of Dar-es-Salam which forms the subject of our illustration; but we learn for the first time from this despatch how, one after another, the radio stations at Kondoa Irangi and Mwanza (where the installation is criticised as "powerful"), as well as several smaller installations, were dynamited by the Germans, to prevent their falling into our hands.

The language employed by General Smuts throughout this official report is characterised by extreme restraint. It is therefore all the more interesting to note the unqualified praise with which he closes his despatch. He will not dwell upon the gallantry of his men because, "in view of the foregoing statement of the main "facts, eulogy of the troops appears unnecessary and misplaced. The plain tale of "their achievements appears the most convincing testimony to the spirit, deter-"mination, and prodigious efforts of all ranks. . . . Great credit is due to the "Signal Service (to which the wireless sections are attached) for the really excellent "way in which communication has been maintained. The resources of the Service "have been strained to its furthermost limits, and it has only been by unremitting "efforts that success has been achieved."

Insurance by Wireless

ACCORDING to the *Spectator*, U.S.A., the Prudential Insurance Company of America is probably the first company to employ the wireless telegraph to transmit insurance funds to a foreign country.

In August, 1896, in Amsterdam, N.Y., Gertrude E. Orth took out a twenty-year Prudential endowment policy for $1,000. Soon afterwards she moved to Germany. The policy matured this year and the Prudential was anxious to pay it. To send it by mail meant a war risk, however, so the policy proceeds were deposited with the National Bank of Commerce in New York city, with instructions to notify its correspondent at Frankfort-on-the-Main, Germany, by wireless that it had the money for Mrs. Orth. The notification was successful.

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THE TRANSMITTING APPARATUS AT NAUEN.

Germany's Central Wireless Station

The Installation at Nauen.

AMONG the wireless stations which have come into prominence in the great war is that of Nauen, the giant Telefunken station in the vicinity of Berlin. Of extremely high power and with a central mast ranking as one of the tallest in Europe, Nauen, in conjunction with Eilvese (described in our October issue) had handled at the German end the bulk of the enormous transatlantic wireless traffic upon which the Central Empires have had to rely since the cutting of their cables on the eventful 4th of August, 1914.

Had Germany gained her world aspirations and retained her Colonies, Nauen would now be the centre of a giant long distance wireless scheme inter-linking the distant Colonies with the Fatherland. In the early part of 1914 and before even a small cloud of war had appeared on the horizon, a series of elaborate and careful tests had established the fact that Nauen could communicate with Togoland, the little German Colony on the west coast of Africa which was later to fall to the allied troops. Not only was direct communication from Germany to Togoland found possible, but it was also reported, and we have no reason to doubt the fact, that signals from the great station could be faintly heard when conditions were extremely favourable, as far south as Windhoek, the one-time capital of German South-West

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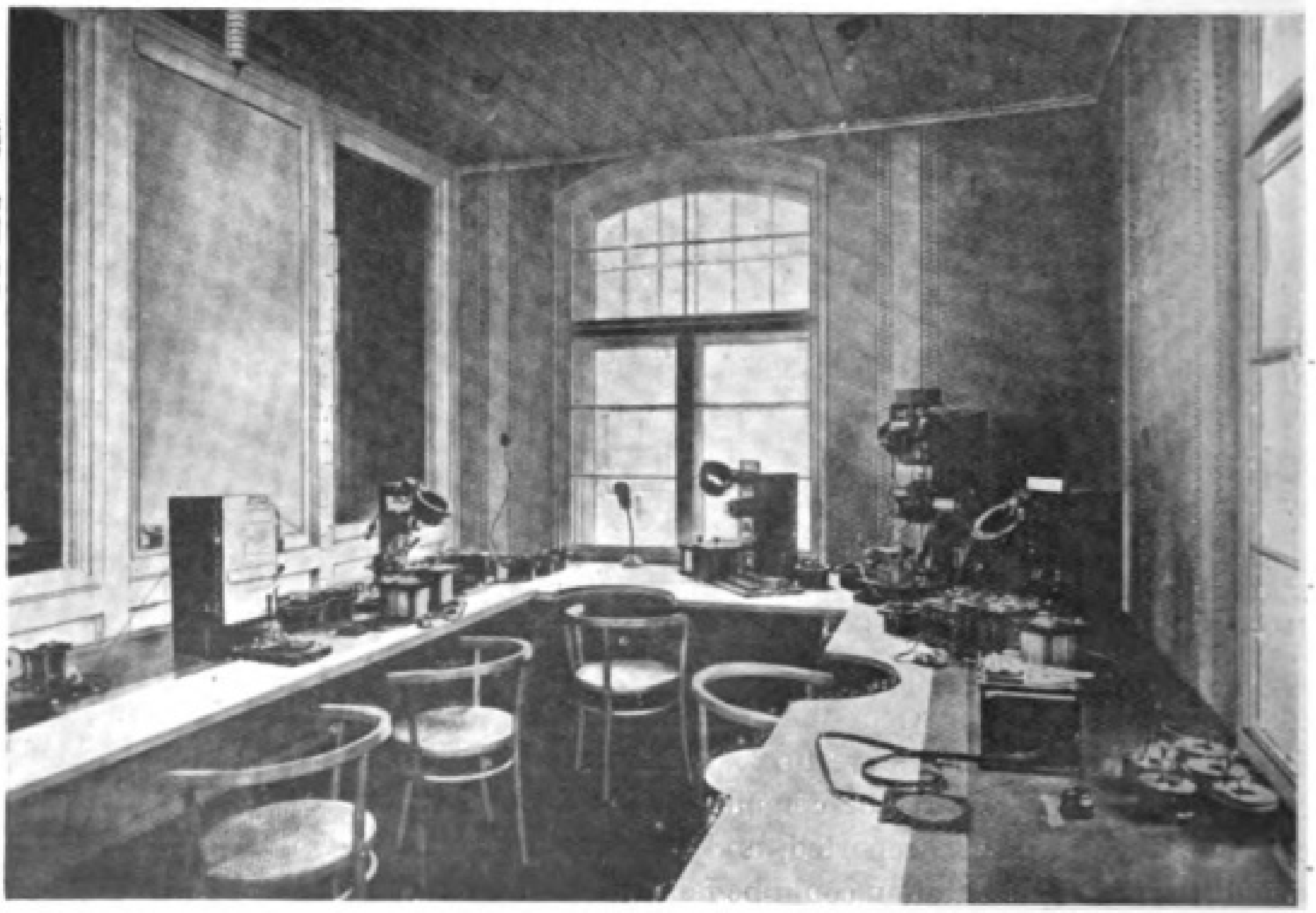
Africa. The enormous distance separating Berlin and Windhoek will be realised on the first glance at a map.

By relaying from Togoland, the Germans were able to reach their East African Colony and this in turn could communicate directly with Windhoek. The Togoland station situate at Kamina and the installation at Windhoek, were both of exceptionally high power and could spread their messages far and wide.

On the occupation of German territory in Africa by the Allies, the Kamina station was found demolished. Windhoek, however, was not seriously damaged, although a number of vital parts had been removed by the retreating enemy.

Returning to the Nauen station, we find that it first came into use as a finished station in the year 1906. The installation is situated about 12 miles north-west of Berlin, in flat country where there is no difficulty in obtaining a good earth connection. As first erected the station consisted of a small building to contain the plant and an aerial supported by a steel lattice tower of triangular sections. At the base of the mast the girders which formed it came together and were embedded in a cast steel sphere which rested on a socket. The foundation of the tower was made of concrete and a slab of marble served both as an insulator and to take the pressure. The original tower was 300 ft. high with 12 ft. sides. Our photograph on page 921 clearly illustrates the method of supporting the base of the tower which, not being self-supporting, needed to be carefully stayed. The stays, which were secured by heavy anchors about 600 ft. from the foot of the tower, were divided into sections by insulators, as it was found that without such sub-division strong surgings were set up, which detracted from the power radiated.



NAUEN. THE RECEIVING ROOM.

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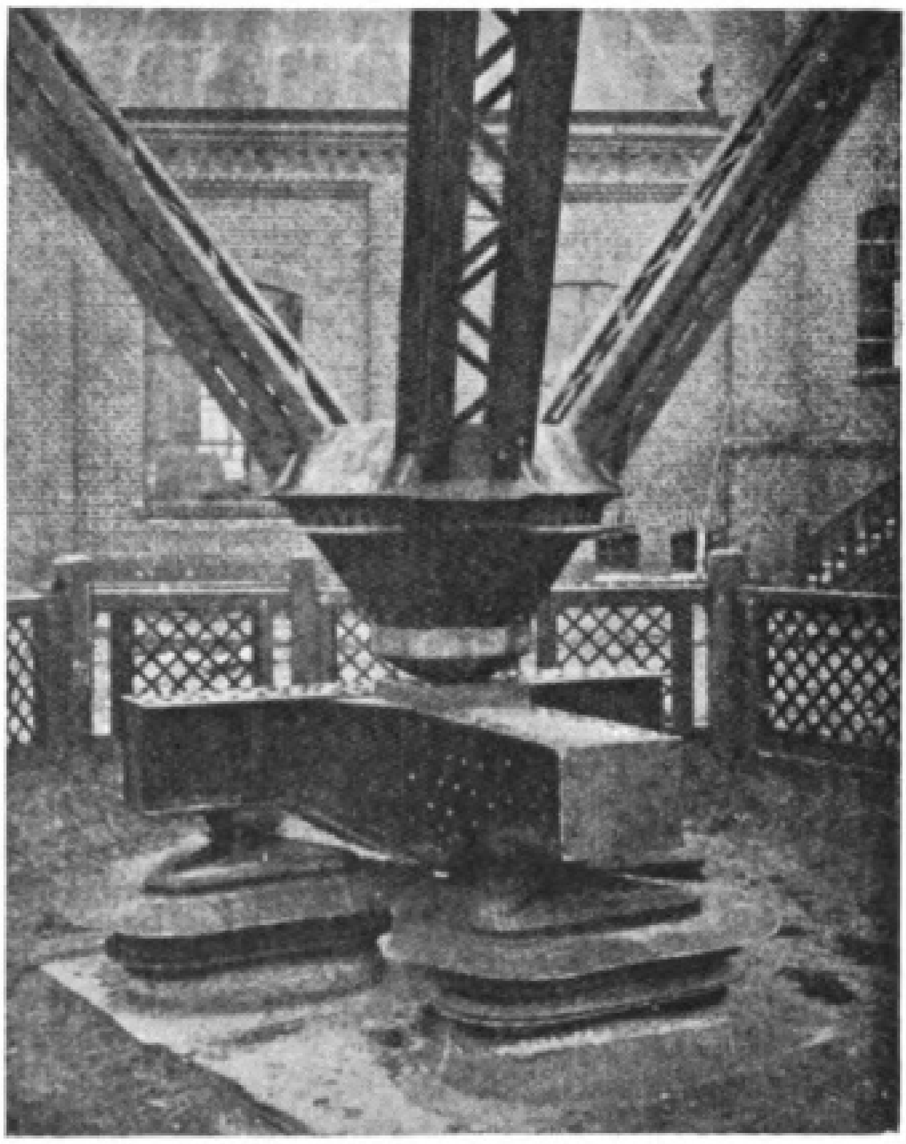
The aerial first erected was of the umbrella form, in six segments, arranged so that the opposite sides balanced one another. The whole aerial, which could be raised or lowered by means of pulleys, covered about 650,000 square ft. The "ribs" of this umbrella aerial were held outward by means of hemp cords connected to porcelain insulators. It should be noted that the aerial wires were not insulated from the mast, which thus formed a part of the oscillatory circuit. This practice is adopted in a number of Telefunken stations.

The earth wires, which were made of iron, radiated fanwise, 108 wires splitting into three at their extremities making 324 in all. The space occupied by the ground connection was over 30 acres.



BASE OF THE MAIN TOWER, NAUEN.

The first station building was a two-storey structure with the operating rooms, receiving apparatus and sleeping accommodation on the ground floor, and the condensers, spark gaps, and jiggers on the first floor. At first the power was about 10 kw., but three years later a 36 h.p. steam engine was installed and drove a 25 kw. 50 cycle alternator, which charged a large bank of glass tube condensers through four transformers. The condenser consisted of three sets of 120 jars, with a total capacity of 400 microfarads. The jigger, which was of direct-coupled type, consisted of a helix of silver-plated tubing. The spark gap was of multiple form (not the quenched gap, for this was not invented at the time) and was air cooled.

The operating and receiving room contained nothing of special note, the receivers being of the usual Telefunken type, and the change from transmitting to receiving being effected by a large antenna switch.

In 1911 the power was raised to 35 kw., and since that time has been increased on several occasions. There is good reason to believe that since the outbreak of war great changes have been made at Nauen. Transmitting apparatus for continuous waves as well as of spark type have been installed for some time. The continuous wave apparatus at the outbreak of war consisted of an inductor alternator generating 250 kw. at a frequency of 8,000 cycles per second, this frequency

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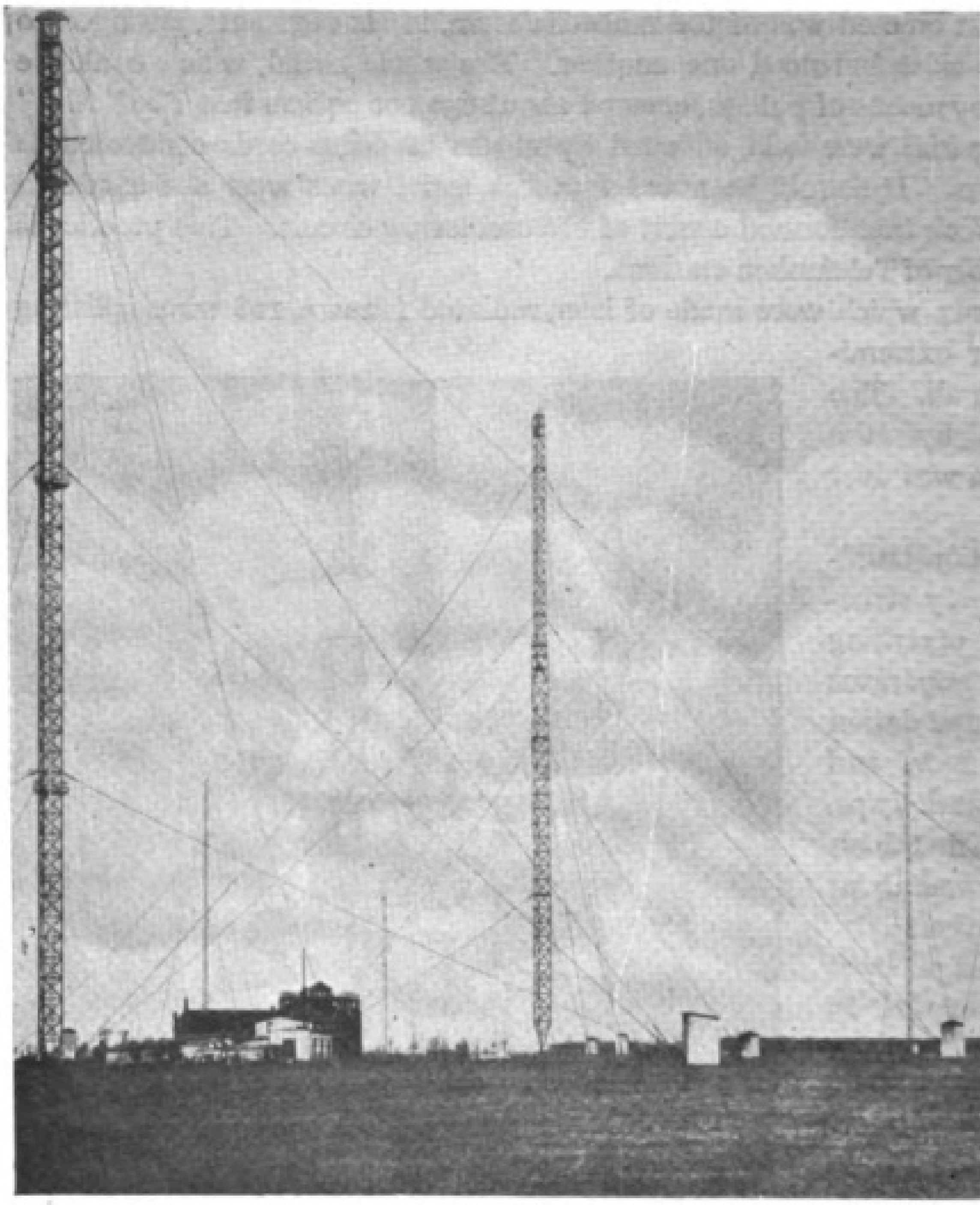

NAUEN. THE STATION BUILDINGS AND THE MASTS.
THE 900 FOOT MAIN MAST IS SEEN IN THE CENTRE.
IT IS SURROUNDED BY FIVE LESSER MASTS.

being increased a number of times by special frequency multiplying apparatus of the Joly type. No less than 100 kw. was said to be delivered to the aerial, the antenna current being 120 amperes.

The illustration at the head of our article clearly shows the quenched spark transmitter at Nauen. The two heavily insulated leads from the transformer beneath the floor will be seen just to the left of the centre of the photograph, and the condenser (now consisting of copper and glass plates immersed in oil and no longer of the tubular type) will be seen behind them in the corner of the room. The four glass cases on insulating feet contain the numerous banks of quenched gaps, which are cooled by a strong blast of air. The large case against the further wall contains the jiggers, the single pole switches being used for changing the internal connections. A large aerial ammeter will be seen on the extreme left of the photograph, just below the decorative dado of painted inductances and condensers. Readers should also note the festooned wave forms supported by insulators painted on the wall. The receiving room is shown on page 920 and contains accommodation for a number of operators. The tall piece of apparatus on the right hand side of the window (not in the window itself) is a microphonic amplifier, which at one time was used with success to increase the strength of the received signals. It has now been replaced by a form of three electrode-valve, which acts both as a detector and amplifier.

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Outside the buildings great changes have been made. First of all the 300 ft. mast was increased in height to 600 ft., but it had scarcely been completed when the whole structure crashed to the ground in a gale. Undeterred by this the engineers recommenced the work, and after many months of labour the new tower, nearly 1,000 ft. in height, was safely hauled into position A number of other towers were later erected, smaller than the central tower, but still very tall as masts go, and a new aerial of the double inverted-L type was erected. The new aerial, of course, required a much more extensive earth system than formerly, and many miles of wire are now embedded in the ground for conveying the high-frequency current to earth. The new central mast is of a similar construction to that first erected, and rests on a similar ball and socket. Our full page illustration gives some idea of the appearances of the masts and stays. The aerial wires, however, are too fine to be seen in such a photograph. In the distance can be seen the large station buildings and a good idea is obtained of the surrounding flat country.

Nevertheless, with this giant aerial and the high-power plant employed, Nauen has not been uniformly successful in its transatlantic work. On many occasions in bad conditions long-drawn out calls from POZ (Nauen) to WSL (Sayville) have vibrated through the ether without any answering call from the other side of the Atlantic. When conditions are favourable, however, and with the delicate amplifying receivers now in use, Nauen has been heard at very great distances, even on the west coast of America.

Among the Societies

The Wireless Institute of Victoria, Australia.

THE Wireless Institute of Victoria was inaugurated in the year 1913, and in the twelve months prior to the outbreak of war did much for the progress and enlightenment of its members, who totalled 110.

Thanks to the assistance of Mr. Balsillie, at that time Engineer of the Commonwealth Radiotelegraphic Service, a number of tuned installations were erected by the members. Mr. Balsillie also kept the Institute well posted with full particulars regarding call letters, etc., of land stations and ships in the Commonwealth. Many lectures were given by leading Victorian Scientists, including a brilliant and instructive demonstration of "Electrical Discharges in Air and Vacuum," by Professor Kernott, at the Melbourne University, and a lecture by Dr. Endacott dealing with Electric Wave Transmission as applied to X Ray Work. These were greatly appreciated.

On the outbreak of the war, amateur wireless working was of course immediately suspended and the majority of members, eager for further wireless experience, instantly offered their services in H.M. Forces for wireless work ashore and afloat. A number are also employed by Amalgamated Wireless (Australasia), Ld.

Credit is due to the Institute for the prompt way in which ninety per cent. of its members answered their country's call. At the present moment, these young men are in the fighting line and on the sea, carrying out those duties which have taken such a prominent place in the world-conflict.

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Maritime Wireless Telegraphy

BRITISH TRADITIONS UPHELD.

H.B.M. AUXILIARY Cruiser *Laurentic* was sunk off the Irish Coast by a German mine or submarine late on January 25th last, and at the Coroner's inquest on seventy-four of the victims, Captain R. A. Norton, R.N., the Commanding Officer, bore proud testimony to the upholding of traditional pluck and coolness in the face of danger. She met with her fate at 5.55 p.m., an hour after leaving port. The Captain was on the bridge, when a violent explosion took place "abreast of the fore-mast on the "port side the ship; followed, twenty seconds later, by a similar explosion abreast "of the engine-room on the port side." The *Laurentic* was at the time steaming full speed ahead and showing no lights. Captain Norton immediately ordered "full speed astern," fired a rocket, gave the order to turn out the boats, and issued instructions that a wireless call for help should be radiated. It was found, however, that no radio message could be sent, because (in the Captain's own words), "the "second explosion which occurred in the engine-room stopped the dynamos and "left the ship in darkness." Of course, in itself, this would not have prevented the wireless being worked, seeing that emergency sets are always carried on British steamers for the express purpose of taking the place of the regular source of power in cases where the latter gets cut off. We are, therefore, probably justified in inferring that the second explosion not only stopped the dynamo but also caused such damage in the wireless cabin as to prevent the auxiliary apparatus from being used.

The Captain himself set a noble example. Not only was he, to use his own expression, "naturally the last to leave," but whilst the ship was settling in the water he descended into the hold and the men's quarters between decks to search with his electric torch for any who might have been disabled and prevented from saving themselves. There was no trace of panic; the boats were as coolly manned and handled as though those engaged in the operation were performing peace-time "boat drill," and the Secretary of the Admiralty was able to issue the following Official Statement:

"There was ample time to save everybody, the ship was carefully searched "above and below, and all hands were put into the boats. Those who were

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"lost perished owing to the cold and severity of the weather preventing them "from reaching the shore."

It is sad to record in the face of such heroism that out of her complement of 470 the survivors number only 121; so that 349 officers and men have perished.

The *Laurentic* was before the war the property of the White Star Line, and employed on the Canadian route. A triple-screw steamer of 14,892 gross tons, she was built by Harland and Wolff, of Belfast, in 1908.

* * * * * *

RECRUITS FOR THE NAVY.

THE naval recruiting authorities are anxious to make known the advantage they can offer to lads about to be called up for military service. Marconi operators are wanted and the age limits are 18 to 23. Those who have not yet received individual calling-up notices may, when they report for attestation, notify the recruiting officer of their desire to offer for this service, and if found suitable they will be given four months' training at the Crystal Palace, after which they will be posted to ships where there are vacancies. Service is for the duration of war, and those who join will be able to look forward to the after-war prospect of returning to civil life qualified to take up a profession that promises to be lucrative. There are other vacancies in the Navy that will enable youths of 18 to combine national service with the task of fitting themselves for paying professions after the war. Unfortunately, very little is known of these openings, but the naval recruiting officers attached to the various depots are now taking steps to supply information.

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SALVAGE INDEED.

In our January issue we recorded, as one of the adventures which seemed to crowd "thick and fast" around the Dutch steamer *Rijndam*, the fact that she answered a wireless SOS signal from the *Vigilant*, a little tug owned in New York, and bound from Newfoundland to Cardiff. The Dutch steamer proceeded to her assistance,

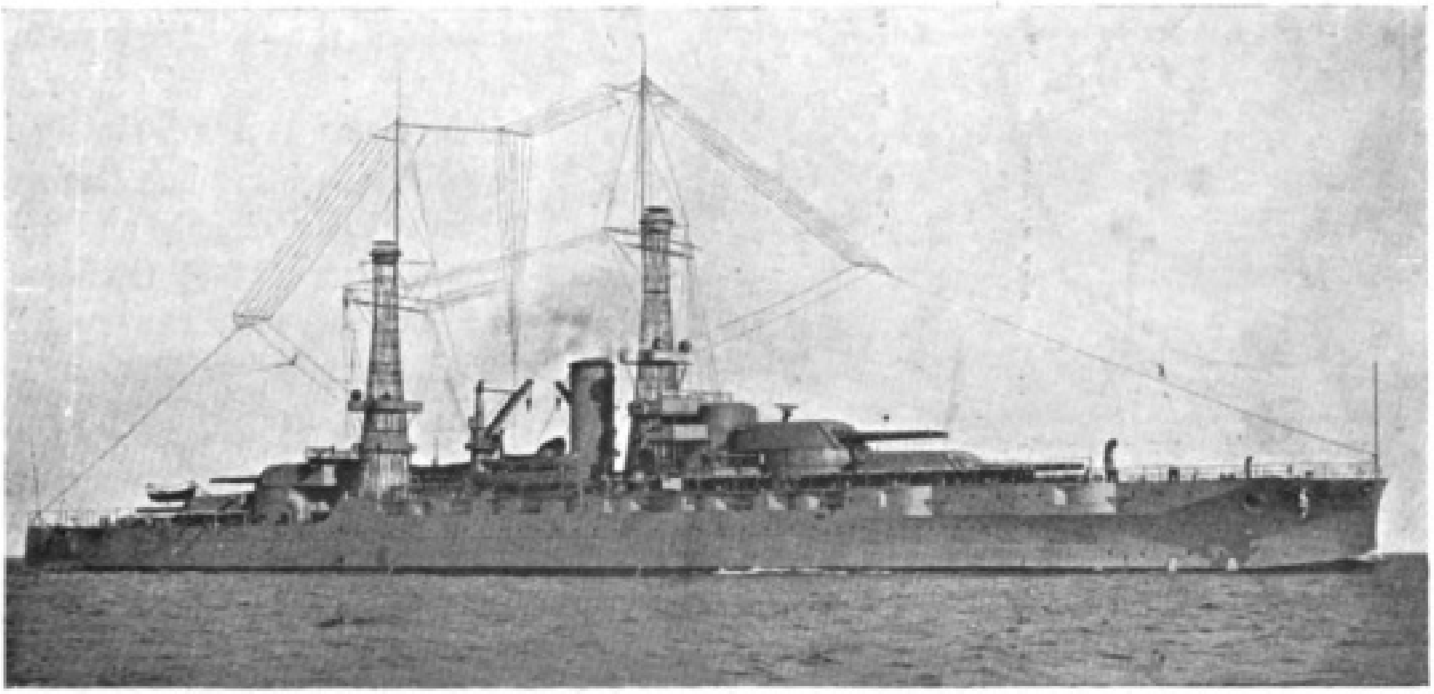

Photo by] [*Courtesy of "The Engineer."*

U.S. BATTLESHIP "ARIZONA." SEVERAL DISTINCT AERIALS ARE COMPRISED IN THIS ARRANGEMENT.

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and took off the Captain and twelve of the crew. Robert Ferguson, the second mate, however, offered, if a couple of others would volunteer to assist him, to finish the voyage and bring the vessel to her destination. Two firemen, named Thomas Welch and John Smith, volunteered, and despite the terrible weather encountered *en route*, which smashed several parts of their little craft and kept them for fifty hours on end without food, water, or sleep, they succeeded in reaching Berehaven.

Interest in the case was recently revived by the men being awarded salvage amounting to £5,000; one half of which went to Ferguson, whilst the other half was divided between the two firemen.

* * * * * * *

No News.

In normal days of peace, which now seem so far away that we scarcely realise what they are like, relatives of ocean travellers when they go to the docks of a great port in order to meet friends arriving from perhaps the other side of the world, have their attention arrested by a number of notice boards, similar to those displayed upon the platform of many great railways. They can see chalked upon these boards the movements of the vessels expected to arrive, together with a note stating alongside which pier or jetty they will moor. This information is, for the most part, due to wireless telegraphy, which thus keeps the shore officials, the shipping agents and the passengers' expectant friends even more closely in touch with incoming steamers than railway signals and telegraphs keep the station staffs *au courant* with the position of incoming trains. The economy in time, patience and money which results therefrom is so large that it can scarcely be estimated.

NO NEWS FOR THE PORT OFFICIALS TO RECORD.

Our illustration, on this page, depicts one of these steamer notice boards and its attendant "Familiar" on the quays of Hoboken—the railway entry to New York Harbour. The man is there, his chalk is ready, yonder hangs the board, but the entries are blank; no wireless intelligence is hastily scribbled as heretofore upon the spaces destined for it. This is one of the results of war, a plain indication that "all who run may read"—or rather, perhaps, in this case "fail to read"!

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Notes of the Month

A Hardy Annual.

Our enterprising contemporary, *The Daily Express*, quoting recently from the *New York World*, speaks of a " wireless dog " as the " latest American invention." Many readers of The Wireless World will doubtless remember that in July, 1915, on page 214, we gave particulars of this ingenious mechanical animal, whose idea was suggested by Mr. John Hays Hammond, jun., whilst the mechanism was worked out by Mr. Meissner. The reference made in the *Express* paragraph to selenium cells located behind the eye-lenses and controlling a relay which actuates the motor and one of the two steering magnets at the rear of the device, plainly indicates that the animal in question is our old friend. To speak of it as " wireless," however, is a slight misnomer ; in view of the fact that the controlling power is actuated by a beam of light and not by radio-telegraphic waves. There are certain " hardy annuals " which, like the great sea serpent, appear to turn up afresh at various intervals, and this " gay dog " would appear to be one of them.

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Prominent Recruits for the R.E. Wireless Section.

The Wireless Section of the Royal Engineers appears to possess special attractions for men of distinction who, under present war conditions, transfer their activities into military channels. Amongst the recruits who have recently attached themselves to this branch of H.M. fighting forces are Captain Priestley and Mr. Bickerton. The former accompanied both the Scott and Shackleton Expeditions as geologist and published a book dealing with his adventures. The latter was at one time connected with the Gaiety Theatre and enjoyed a close friendship with Mr. Charles Frohman. Mr. Bickerton used to keep up a luxurious flat in Paris and last year dispersed his valuable collection of Eastern curios in aid of the French Red Cross.

* * * * * *

Language in the Making.

Anyone who has the curiosity to compare the language used by newspaper writers of to-day and that employed by writers in the same newspapers 100, or even 50, years ago will notice considerable changes in the vocabulary employed. These developments of the English language are constantly going on ; every new discovery adds its own quota, and the flexibility of our native tongue is indicated by the ease with which these are absorbed. In the *Daily News* of 1868 the word " cablegram " is referred to as " a new word . . . used by a New York contemporary to criticize a telegraphic despatch." Wireless telegraphy is responsible for quite a number of additions to the modern British vocabulary, amongst them being such words as

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"Marconigram," "radio-telegraphy," "Marconi system," etc. We have even seen the word "wireless" used as a verb, and as a matter of fact it would seem to fill a decided gap differentiating the act of radio transmission from the more general terms of "to wire," "to telegraph," or "to cable."

Wireless for Women

Mexican Girl receives Operating Licence.

ON several occasions we have made reference in our pages to wireless telegraphy as a profession for women, and in a recent issue we published a photograph of a number of young ladies who are now performing special duties at one of the great wireless stations in Wales. In this country no attempt has been made to place women as wireless operators on board ship, and it is unlikely that any change will be made in the present restriction of ship operating to men. In a few cases the Postmaster-General's Certificate has been obtained by lady students; the first case to our knowledge being that of the wife of a naval officer who obtained her "ticket" a year or so before the outbreak of war.

From the United States now comes the news that a Miss Maria Dolores Estrada has passed an examination for the highest class licence awarded by the Department of Commerce of the U.S.A., and is said to be the first lady to receive a First Grade Commercial Wireless Operator's Licence.

Miss Estrada has had an interesting career. She was born at Zacatecas, Mexico, on the 21st of July, 1890, and studied at the Normal School from which she graduated as a telegraphist when she was fifteen years old. For one year Miss Estrada worked at the Central Telegraph Office at Zacatecas, and was then transferred to Villa Garcia as Chief Telegraphist. Here she remained for another twelve months, after which she proceeded to Villanueva, where she remained for three years, occupying the same position as at Villa Garcia.

It was while Miss Estrada was at Villanueva that the first Mexican insurrection broke out. In this affair the leader, Madero, came into conflict with Diaz. As the young telegraphist had sympathies with the former she joined his staff, and, on Madero rising triumphant, she was appointed chief of the Mazapil Telegraph Office, one of the most important offices in the State of Zacatecas.

Miss Estrada continued working for Madero throughout the insurrection of Pascual Oroaco, when she had to work day and night without rest. Trouble in this revolutionary country still continued however, and when Madero was killed by Huerta, in 1913, a new insurrection broke out. The enterprising young lady sided with Carranza, and worked under the orders of General Gutierres until the troops of Huerta arrived at Mazapil. Huerta's troops, under Fomal Velaquezin, captured Miss Estrada and her mother, stole the telegraph and telephone apparatus and took the ladies to Concepcion del Oro (15 miles from Mazapil), where they were kept prisoners for twenty-two days. Then General Gutierres returned to the town with 2,000 men and, after taking the town and killing nearly 600 Federal soldiers, released

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the young lady and her mother. Later on, after further adventures, Miss Estrada set out to the capital of Nuevo Leon, but on reaching Saltillo, she met an old acquaintance of her Mazapil days, General Francisco Coss, who gave her a letter of introduction to Carranza. On presenting this letter to Carranza, Miss Estrada was ordered to join his staff as telegraphist in July, 1914. Here she worked until January, 1916, when she went to the United States and began the study of English at Fairmont Seminary. In May last she entered the National Radio School, and prosecuted her studies so successfully that she obtained the First Grade Commercial Wireless Operator's Licence in five months.

MISS MARIA DOLORES ESTRADA.

Of Miss Estrada's future plans we have no knowledge. Perhaps she will return to Mexico and take up important work in connection with the radiotelegraphic service of that country. In any case, for one who has seen so much and shown such great enterprise there should be a brilliant future.

The Marconi Companies and the War Loan

WE are pleased to be able to announce that the Directors of Marconi's Wireless Telegraph Co., Ltd., have offered to assist the staffs of the Companies having their headquarters at Marconi House in subscribing to the new War Loan.

The entire sum required to meet applications for Stock will be advanced free of interest subject to such applications being approved by the Secretary, and to the subscribers undertaking to repay the amount so advanced by the Company within six or twelve months by weekly or monthly instalments deducted from his or her salary.

At a meeting of the staffs of the Marconi Companies, held at Marconi House on February 12th, Mr. Godfrey Isaacs, the managing director, announced as a further inducement that Marconi's Wireless Telegraph Co. would allow repayment to be made over two years in all cases where members of the staff took up a sum equal to at least 10 per cent. of their salaries. This proposal was received with enthusiasm, and a very large sum has been subscribed in this way.

Marconi's Wireless Telegraph Company have applied for £200,000 in the new loan, and the Marconi International Marine Communication Co., Ltd., for £50,000 (all new money).

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The Message, or "Pack Wireless"

Another thrilling War Story by "Perikon"

THE final inspection at the wireless depot is in full swing. Across the stretch of flat ground a small limbered wagon is careering, drawn by a four-horse team. Ahead and behind the swaying limber ride a posse of horsemen.

The glittering hubs and shining wheels are as clean as emery, "elbow grease" and "oil-preserving wood" can possibly make them. The horses have all the glossy satin coat which comes of decent treatment, feeding and grooming. The harness and saddlery glitter. Buckles, irons and bits gleam silver in the sun. The men themselves are spick and span, and sit their saddles well.

A number of whistle blasts, and the canter changes to a gallop. The cavalcade takes the prepared ditches and banks without slackening speed—the team horses straining into their breast collars and their traces taut. A second blast, and the troop halts abruptly. The team is swiftly unhooked, the "single mounts" are passed to the drivers and the horses move off in a bunch and "stand easy" some hundred yards off—snorting and blowing and generally having a breather.

The wagon is left with the station crew, who fall in smartly in the rear, and next second are busy "erecting station." Three minutes later the first mast is raised, stayed and secured. The second follows, and in a brief space there is a sudden roar and a hiss as the motor starts, and Number One depresses the transmitting key.

"Station ready and working—six and a half minutes—not so bad," remarks a dapper officer of Engineers standing some hundred yards off—"Dismantle." The order is conveyed by whistle blast, and eight minutes later the pack trots past *en route* for stables and dinner—the dreaded ordeal over and with the conviction that they've done well and will surely soon be across the Channel.

* * * * * *

Two weeks later sees the limber, then the trail, being swung aloft by a giant crane and swiftly lowered into the spacious hold of a "trooper." The horses are "'tween decks" with their saddlery on, but with loosened girths. The station crew are squatting on deck and doing their best to avoid the various white-hot steam pipes with which the decks of a tramp seem to abound, and in drawing their life-belts from the roomy chests on deck and elsewhere.

* * * * * *

Ten months later the advance guard of the 160th Corps rattles through the deserted little village. First a troop of lancers, then four wicked-looking Q.-F.'s with ammunition limbers apiece, and a couple of baggage and forage wagons behind. Then a small limbered wagon with a small posse of horsemen ahead, and behind—the wireless wagon. If you looked closely you'd recognise it as the same one you'd noticed at the home depot undergoing its final inspection. But there's a drastic

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change in everything. The wagon is encrusted in dry mud and dust, and small pieces of turf are adhering to wheel and limber. The horses have lost much of their satin, and the metal fittings of the harness no longer shine silver, instead they are thick in rust. No glittering buckles, irons or bits now. The men look thinner perhaps, and their stubbly beards and unwashed appearance almost convince you that they can't really be the same men. You note a difference—a vague something in their way of looking at one, and you decide they're *not* the same men.

Behind them another troop of grimy cavalry clatter—horses in a lather, and horsemen blue-chinned and hollow-eyed. For three days they've pushed on, pressing and worrying the rearguard of the crack East Prussian Corps directly opposed to them. The great retirement has begun and the Germans so far have conducted it in a swift and businesslike manner. Another twenty kilometres perhaps, and they'll swing round and make a stand, for the black-eagled frontier posts begin just beyond that—*then* there's a possibility of firework displays on a large scale. Meanwhile the grey Uhlans of the rearguard can sometimes be picked out with the naked eye crossing fallow, or silhouetted for a fleeting instant on the sky line.

The leading troop of our advance guard and the four wicked-looking Q.F.'s suddenly swing through a gap in the roadside hedge and canter in the direction of a small plantation. The rest of the cavalcade follows and halts in the shade of a row of tall elms. A "fleeting opportunity" target has offered itself in the shape of a dense blue-grey smudge toiling like a big lizard into the heat haze some two miles ahead. An instant later the Q.F.'s are showering them with douches of whining metal. Smoke obscures the lizard, but when it clears nothing can be seen distinctly by the naked eye—perhaps it's better.

We turn round and see the pack crew hurrying to and fro at the double, "erecting station," much as they did on the depot ground more than ten months ago. Important "stuff" must be got through to Corps' Headquarters, and that within the next fifteen minutes, for the seeming impossible has happened. The enemy has been strongly reinforced—Heaven knows how or from which quarter—and is turning and slowly crawling back in his tracks. Squadron after squadron of apparently fresh cavalry can be picked out deploying in extended order from spinney and hedgerow, looking much like hurrying ants at the distance. It means our advance guard falling back perhaps ten kilometres, unless at least a cavalry division and the Corps' "heavies" can be rushed up in time to meet the oncoming wave and send it staggering back. Two troops of the finest cavalry and four Q.F.'s of small calibre can do some considerable damage, but it's suicide to attempt to stem an entire enemy division equipped with well over thirty light pieces maybe.

The enciphered message goes hissing out into space, and a yawning operator at Corps Headquarters (a tumbledown farm some four miles in the rear) takes down the message group by group, hands it to his superintendent, and signals the pack to go on with his "stuff."

Meanwhile the Q.F.'s have abruptly ceased firing, and their teams are trotting over to move them. The cavalry outposts have galloped in. A ranging shell bursts over the trees a decent hundred yards to the right, and occasionally spent bullets go whining overhead. An orderly canters over to the wireless station, and

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next minute the masts are down and being packed, the aerial is running home on its drums, and the gear is being loaded.

Just as the orderly is gathering his reins to canter off, a giant billowy ball of saffron-hued smoke springs out of nothingness about ten feet off the ground, a deafening crash is heard—smoke and explosion occur at precisely the same instant. The orderly and horse appear to lift some three feet in the air and thud inert to earth. Three of the pack crew go down, ripped up in hideous strips. Two others attempt to get up and roll over with curious gurgles. They have crossed into calmer water. A horse shrieks and lies lashing at the lifeless carcase of his team-mate. The wagon is splintered and the fore limber is wrecked. Only three of the pack crew are unscathed. Smart gunners these enemy horse artillerymen—not exactly blacks. Suddenly the Q.F.'s limber up and gallop towards the gap in the hedge.

"Come on, you people, get a horse and move yourselves, their patrols are three fields off," yells a Major of Artillery.

"No time to repair"—the rest is lost in the rumble of limbers and the sog-sog of the hoofs. The pack crew hastily unstrap their axe and pickaxe and do a seemingly curious thing. They smash into the apparatus, and next second the shining fabric of ebony and nickel, of which they were so proud, lies in a tortured heap. A tin of petrol is ripped up and the pile drenched, a light applied, and a crimson tongue of flame shoots up, stationary messages, etc., are thrown on top. Two minutes later three horsemen are tearing down the poplar-lined pavé in the wake of the fastly moving Q.F.'s and cavalry. Mauser bullets hum and whine about their ears and occasionally crack into the poplars with loud whiplike snaps.

One grimy rider turns to his comrade: "Anyway we got *the* message through, and the swine can't use our gear--get up, Billy boy"—as his weary horse stumbles and picks up his stride again.

Three kilometres farther on a loud close-at-hand rumbling assails their ears—our heavies about a kilometre off by the sound. Suddenly the Q.F.'s halt, unlimber, and send salvoes of shell shrieking into the strung-out advance guard of the enemy. Our cavalry reinforcements have arrived, too. To right and left they can be seen streaming and deploying. Eighteen-pounders, too, battery on battery are coming up at the trot through stiff plough, and unlimbering and beginning to spit and cough. Machine guns rattle, rifles and carbines crack, riderless horses tear insanely and aimlessly in all directions. The enemy's patrols wheel round, and in a few minutes they can again be picked out, their squadrons lighter, hurrying into the shimmeriig haze, much like scurrying ants.

The Q.F.'s gallop back on their tracks in a fog of choking dust, a squadron of lancers, more horse artillery, another dragoon and hussar squadron, and cantering hot in their wake with limber and trail swaying, and an eddy of dust astern, another pack wagon clatters. Everybody looks fresher and cleaner than the advance guard. They've all come up in response to *the* message.

PERIKON.

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Correspondence

To the Editor of THE WIRELESS WORLD.

SIR,—I was very interested in the article given by Mr. Coursey, B.Sc., in your January number, on the calculation of inductances.

I think, however, that for comparison (on the plea of simplicity) between Nagaoka's formula :

$$L = \pi^2 D^2 n^2 lK,$$

quoted by Mr. Coursey, and Lorenz's :

$$L_s = an^2 Q \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

or Raleigh's :

$$L_s = 4\pi an^2 X \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

quoted by me in the December issue, it would be more reasonable to give the comparisons using the three formulæ, either all corrected or all uncorrected.

Actually, there is then little difference between Mr. Coursey's results and mine, and that difference is more in the inaccuracy of working than that of the method. Thus Mr. Coursey (January issue, 1917, p. 789), quoting my first example (December issue, 1916, p. 672), gives : by Nagaoka's formula the result, 150,000 cms., which if worked out to more figures gives 150,550 cms., whereas taking my *uncorrected* figures

$$L_s = 47985{\cdot}77 \times \pi = 150{,}760 \text{ cms.}$$

Again, where he quotes my second example, if Nagaoka's formula be worked out to full accuracy using $K = 0{\cdot}471865$ (a, given in the tables of the *Bulletin of Bureau of Standards*, vol. viii., 1912) the value of the uncorrected of L is 2,911,300 cms., whereas the value of L_s also uncorrected given in my example is 2,911,700 cms., which is naturally closer than taking my corrected value for comparison—namely, 2,901,620 cms. Taking K to three figures 0·472 would, therefore, be nearer than 0·471.

The same correction formula quoted by me—namely,

$$-\Delta L = 4\pi an\ (A + B)$$

applies to all these formulæ.

Of course, if the formulæ do not break down for the example taken, then the corrected or uncorrected values should agree, as I have shown they do.

The one advantage of Nagaoka's formula ($L = \pi^2 D^2 n^2 lK$) when Mr. Coursey's curves are available (*Electrician*, vol. lxxv., page 841) is that the function K carries the formula over a larger range than my Q or X alone.

I think even now that the two formulæ $L_s = an^2 Q$ and $L_s = 4\pi an^2 X$ are somewhat simpler, especially when the corrections are not applied. I might also mention that Rosa and Grover in the *Bulletin of Bureau of Standards* do not advise the use of Nagaoka's formula where the breadth is less than one-fifth the diameter, or where $\frac{2a}{b} < 0{\cdot}2$.

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It is for limitations of this sort that I have given two formulæ and two tables of functions to cover all ratios of diameter to breadth of coil likely to be encountered.

Yours, etc.,
BERTRAM HOYLE,
(Lieutenant R.N.V.R.).

H.M.S. *Excellent*,
January 19th, 1917.

Radiation Simply Calculated

To the Editor of THE WIRELESS WORLD.

SIR,—In your issue for January last an abstract is given on page 755 of an article on the above subject. It is rather interesting to note that from the formula given :

$$P = 640 \frac{h^2}{\lambda^2} \cdot I^2.$$

for a vertical-wire aerial, the radiation resistance of such an aerial, ***when oscillating at its natural frequency***, is independent of its height. For in such a case we have :

$$\lambda = 4\,h, \text{ nearly},$$

Hence radiation resistance

$$R = \frac{P}{I^2} = 640 \frac{h^2}{16\,h^2}$$
$$= 40 \text{ ohms}.$$

This means that any vertical-wire aerial radiating its natural wave-length has a radiation resistance of 40 ohms. It is clear that this result is owing to the fact that a diminution of radiating power due to a reduction of height is exactly counterbalanced by an increase due to the higher frequency at which the aerial oscillates.

Another point of interest regarding the two different formulæ given for (1) a flat-topped aerial and (2) a vertical wire aerial is that these two formulæ become identical if we take h as being the height of centre of capacity (*see* Austin in *The Electrician*, November 19th, 1916, page 246), instead of height of aerial. For case (1) these two heights are practically identical, but for case (2) the centre of capacity is equal to $2/\pi\ X$ height of wire. Hence if we substitute $\frac{\pi}{2} \cdot h$ for h in the second formula we get :

$$P = 1575 \frac{h^2}{\lambda^2} \cdot I^2$$

or substantially the same as in the first formula.

Yours, etc.,
R. C. CLINKER.

January 18th, 1917.

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Some Notes on Aerials

By W. D. LACEY

In the construction of aerials several considerations are involved, and it is the object of the writer to present these in their clearest form, together with the compromise effected between this advantage and that disadvantage of the various materials available for use.

The operator at sea has no choice of material, but the considerations which led to the selection of his various wires and insulators will be instructive.

During the course of the writer's experience several different aerial wires have been tried, varying from copper, phosphor bronze, steel copper clad and enamelled, and lastly, silicon bronze.

From the point of view of electrical efficiency there appeared to be no practical difference between one or the other, but doubtless with suitable testing apparatus (which is not available to the operator at sea) different efficiencies could be tabulated for each of the above mentioned materials.

One of the first considerations, then, is the mechanical strength of the wire, but we immediately find that another essential condition is a high conductivity, so that we may tabulate our available materials as follows :—

Material	Tensile Strength Tons cub. cm.	Conductivity Per cent.
Hard drawn Copper	14	100
Hard drawn Silicon Bronze	40	42
Hard drawn Phosphor Bronze	50	28

Evidently then copper would appear to be the best conductor, but it is too soft to use in positions where it would be subjected to strains. It is found with copper aerial wires that they gradually stretch, and eventually break at a point where the wires have become thin.

Phosphor bronze would be the most preferable from the point of view of strength, but its conductivity as compared with copper is low, therefore the best compromise is to select silicon bronze, which has nearly the same tensile strength as phosphor bronze, and nearly twice its conductivity.

The breaking strain of the 7/19 silicon bronze wire used for aerials is about 900 lbs., but to allow for windage and general deterioration it is not good practice to set up the aerial to a greater tension than 100 lbs. per wire.

In order to ensure perfect conductivity for feeble received oscillations it is necessary to solder all joints in the wire, otherwise a high resistance film of oxide will form at the joint, which might even insulate a portion of the aerial for weak oscillations.

We find, however, that when a hard drawn metal is soldered, owing to the effect of the heat, its tensile strength is very much reduced, so that it is inadvisable to put any severe strain on the joint.

To obviate this difficulty a special method of jointing has been devised, which is shown in the accompanying sketch (Fig. 1).

Therefore so far as possible no part of the aerial under strain is subjected to the

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heat of soldering, but it is found necessary to solder the seizings at the ends of the wires in preference to splicing, where thimbles are made fast.

It is found that the wire simply bent round the thimbles, seized and soldered in three places with four or five turns of No. 20 solt annealed copper wire, is as strong as the wire itself.

Reference to the diagram on page 937 will make this clear.

In making soldered joints great care must be taken not to leave any points exposed at the ends of the aerial wire itself, or its seizing wire. as this would cause loss of energy by brush discharges.

INSULATION OF AERIALS.

In the matter of the selection of insulators very much the same considerations are involved between mechanical strength and good insulating qualities.

Good insulation is of the utmost importance, as poor insulators mean leakage and loss of power. The effect of bad insulation is to increase the damping, so that in addition to loss of power the tuning is flatter.

The loss of energy due to leakage is less in the case of loosely coupled circuits than in the case of close coupling, so that in a directly excited aerial (plain aerial), the loss due to leakage may quite easily represent nearly all the energy supplied to the aerial.

From this we see the first essential to consider is the dielectric strength of the material.

The following table shows the dielectric strength of the different substances which are suitable for use :—

Material.	Voltage required to puncture 1 cm. thickness.
Ebonite	500,000
India Rubber	450,000
Glass	250,000
Porcelain	100,000

The next point to consider is the surface insulation.

At high voltages electricity will creep over the surface of a perfectly dry insulator far more readily than it will spark through the substance. In restricted positions it is usual to corrugate the insulator in order to increase the surface distance between its extremities, but in the case of aerials the space is not usually limited, and therefore a straight insulator can be used, long enough to ensure freedom from serious leakage.

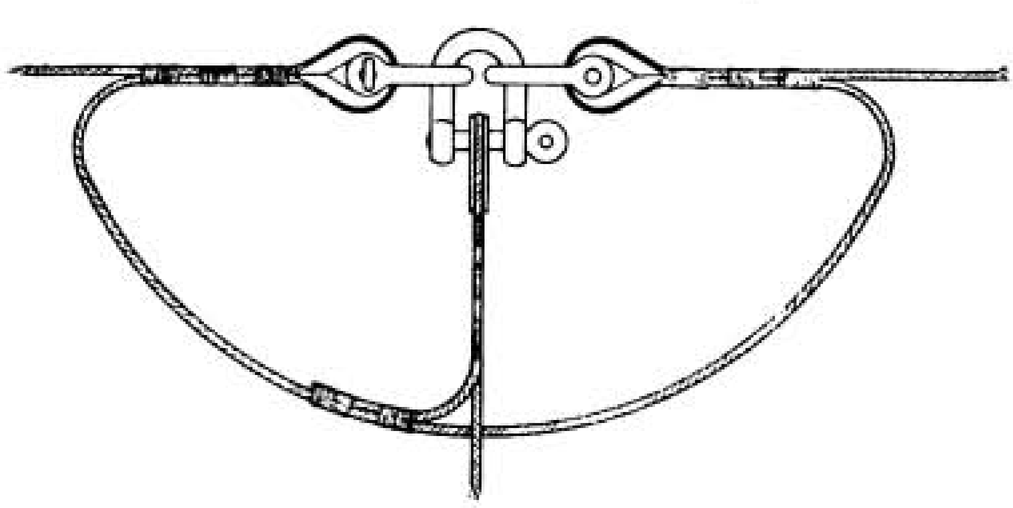

FIG. 1.

For dry insulators about 4 cm. of surface length is allowed for every 30,000 volts, but in the case of aerial insulators where dirt

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and moisture accumulate long insulators are necessary in order to maintain sufficient insulation.

In this connection it is well to remember that dirt accumulates slowly, and trouble from this source can be avoided by periodical inspection and cleaning.

It is good practice to have two sets of insulators in use, so that when the aerial is lowered the spare set can be attached in the minimum of time, and the other set cleaned at leisure.

(This does not mean putting the insulators away and forgetting them until they are required for use again.)

In marine installations there are three different types of insulators in use, viz., 3 feet waterproof flexible rubber strop, 3 feet ebonite sheathed strop, and 40 inch ebonite rods.

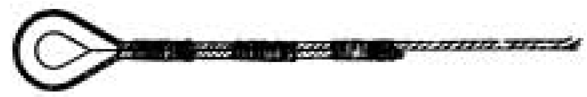

FIG. 2.

The 3 feet waterproof is built up of an endless strand of Palmer cord laid up into a strop, seized along the shank, covered with a continuous skin of rubber, vulcanised, and fitted with a thimble at each end.

The working load of this insulator is 15 cwt.

The 3 feet ebonite insulator is similar, but encased in an ebonite tube fitted with anti-sparking discs, and screwed on end caps carrying a lug attachment for fitting a shackle.

The 40 inch pair of ebonite rods consists of two 20 inch by ¾ inch ebonite rods fitted with screw eyes at the ends, and linked together. The ends of the rods are seized with wire to prevent bursting, and one of the rods is fitted with a light cone to protect it from moisture.

This insulator will stand loads up to 10 cwt., but owing to the brittle nature of ebonite, the load should not exceed ¾ cwt.

The principal use of this insulator is to secure the down leads and steadying lines of the aerial, and in these positions heavy strains do not often occur.

Another type of insulator in use on coast stations is a highly vitrified porcelain rod, two feet between eyelets and one inch in diameter.

So long as the glaze remains perfect these insulators maintain a very high insulation, but they accumulate moisture from the air owing to the hygroscopic property of porcelain.

Measurements taken by the writer on an aerial fitted with these insulators showed variation of resistance between 80 megohms and 100,000 ohms in a few hours, although no rain had fallen in the interval between the tests.

The hygroscopic property of glass is very much greater than that of porcelain, and for this reason glass is never used as an aerial insulator; in fact even in dry positions indoors when glass is used it is usual to stand it in oil cups.

As far as possible insulators in an aerial should not be placed in parallel, as each additional insulator so used is an additional path over which leakage can take place.

It should be remembered that the resistance of an insulator to an alternating potential is less than its resistance to direct current voltage.

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SPREADERS.

The most suitable wood for spreaders is ash, on account of its flexibility and great strength combined with lightness.

The standard size spreader for ship installations is 12 feet 6 inches in length, 3 inches diameter at middle tapering to 2 inches at ends.

They are fitted with double lug steel bands 3 inches from each end, to which are attached the aerial insulators, thus spacing the aerial wires 12 feet apart.

The bridle is generally made of 2½ inch hemp rope, and is fitted with a thimble and shackle at each end for attachment to the lugs of the spreader bands.

The bight of the bridle is provided with a thimble for attachment to the halyard.

The distance from the bight of the bridle to the middle point of the spreader should not be more than 6 feet, nor less than 3 feet.

It will be seen, therefore, that the materials employed in the construction of present day aerials are the result of long and careful experiment under actual working conditions.

There is still room for improvement in the matter of insulators, as the conditions under which aerial insulators are used demand the utmost efficiency under the most trying circumstances.

They have to withstand all extremes of temperature, varying degrees of humidity, the corrosive action of sulphur fumes from the ship's funnel, rain and salt spray.

They must withal have excellent insulating qualities, and be mechanically strong.

Under certain circumstances the material of which the aerial wire is made is varied, as in the case of large fast ships, where there are excessive strains in heavy weather, and greater deterioration from the heat and fumes from the funnels. In such cases heavy steel copper clad enamelled wires are used, the enamel giving very great protection from the corrosive fumes.

New U.S. Army Wireless Stations

Guarding the Mexican Border

AUTHORISATION has been given for the erection of powerful radio stations at Laredo, El Paso and Fort Huachuca, Ariz. These will be a type similar to the wireless station at Fort Sam Houston, but of greater receiving radius, and will give the army a complete system of radio-communication along the Mexican border from Brownsville to the Pacific Coast.—(*The Electrical Experimenter*.)

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Among the Operators

THE GERMAN PIRACY CAMPAIGN.

AT the time of writing the new German piracy campaign has been in full swing for some little time. Far from frightening our gallant sailors, it has, if possible, steeled them still more strongly in their resolve to fight with all the means at their disposal against the now desperate enemy. The wireless operators, as usual, are carrying out their work nobly, and with their instruments are proving the means of saving hundreds of lives each week.

OPERATOR H. SPROAT.

On board the *California*, the large Anchor liner recently torpedoed without warning, the two operators were H. Sproat and W. Craven. Mr. Hew Sproat is of Scotch birth, and is now in his thirtieth year. Born at Ayr, he was educated at Ayr Academy and the Glasgow and West of Scotland Technical College. On completing his studies he became an engineer, and later left this profession to study wireless telegraphy at the Liverpool Wireless Telegraph Training College, where he obtained his Postmaster-General's certificate. Entering the Marconi Company in July, 1913, he was appointed to the staff, and sailed first on the s.s. *Lancastrian* and was later transferred to the s.s. *Caledonia*. He then served on a number of other ships, and held the position of senior operator on the ill-fated *California* for a good many voyages before she was sunk. We are very pleased to say that he was saved from the wreck, and to the best of our knowledge sustained no injury of any kind.

The junior operator, Mr. Walter Craven, is 18 years of age, and comes from Newcastle-on-Tyne. After leaving school he studied wireless at the North Eastern School of Wireless Telegraphy at Newcastle, where he obtained his certificate. He joined the Marconi Company quite recently, and the *California* was his first ship. Mr. Craven was also among the saved, and we trust he will be more fortunate on the next vessel to which he is appointed.

OPERATOR W. CRAVEN.

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OPERATOR S. TAIT.

S.S. "ARTIST."

We regret to announce that Mr. Sidney Tait, operator of the s.s. *Artist*, which was torpedoed and sunk in January, is reported missing, and is feared to have lost his life. Mr. Tait, whose home was in Edinburgh, was 20 years of age, and studied wireless at the North British Wireless School, Edinburgh. He entered the Marconi Company's London School in January, 1915, and was shortly afterwards appointed to the s.s. *Star of India*. From this ship he transferred to the s.s. *Atlantia*, and then served successively on the *Cymric* and the *Inca*, transferring to the *Artist* in January of this year. Deep sympathy is felt with the late operator's parents in their sad bereavement.

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PRISONERS OF WAR.

In a few cases the wireless operators and other officials of ships sunk by the German raider have been made prisoners of war. This is the case with Messrs. James Young and Edward Alan Godsell, of the s.s. *Georgic*, sunk recently. Mr. Young was born near Newcastle-on-Tyne, and is now in his thirtieth year. After leaving school he entered business, and later took a course of training in wireless at the British School of Telegraphy. In April, 1913, he entered the services of the Marconi Company, and after a short period in their training school was appointed to the s.s. *Caronia*. He afterwards served on several vessels, including the s.s. *Irishman*, on which he made a number of trips, and was appointed to the s.s. *Georgic* at the end of last year. We sincerely trust that he will receive good treatment, and that he will soon be back in his home country again.

OPERATOR J. YOUNG.

OPERATOR E. A. GODSELL.

Junior operator Mr. E. A. Godsell, who was also taken prisoner, is a comparatively new recruit to the wireless service, having joined the Marconi Company only a few months before the *Georgic* was sunk. Born in County Cork in 1890, he received his education in that district, and after leaving school entered upon a

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THE LATE OPERATOR W. S. LUCA.

business career. Later he studied wireless as an evening student at the Irish School of Telegraphy, Cork, and obtained his Postmaster-General's certificate at that place. On entering the Marconi Company he was appointed to the s.s. *Georgic*, which was sunk on his first voyage. Mr. Godsell we hope will also be well treated and soon return safely.

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S.S. "FLORIDIAN."

In the case of the sinking of the s.s. *Floridian* the senior operator, Mr. A. R. Beynon, was taken prisoner, but the junior operator, Mr. W. Seaton Luca, lost his life. The late operator was but 17 years of age, and was born at Liberton, near Edinburgh. After leaving school he took a course of training at the North British Wireless Schools, Edinburgh, where he obtained his Postmaster-General's certificate. He joined the Marconi Company in July last, and was appointed almost immediately to the s.s. *Floridian*, on which vessel he remained until she was sunk. Sincere sympathy is felt for the late Mr. Luca's parents in their sad bereavement, the sorrow for which will be tempered by a pride in knowing that, although so young, he died nobly in the services of his country.

OPERATOR A. BEYNON.

Mr. Austin Reginald Beynon, the senior, who was fortunately saved, hails from Cardiff, where he was born in 1893. On leaving school he held a clerical position for some time, and then turned his attention to wireless telegraphy and studied at the British School of Telegraphy. In 1912 he entered the services of the Marconi Company, his first ship being the s.s. *Franconia*, from which he transferred to the s.s. *Corsican*, and afterwards to the s.s. *Canadian*. Later he served on the s.s. *Ansonia*, s.s. *Kanawha*, s.s. *Lake Michigan*, receiving his appointment to the s.s. *Floridian* in July last. We trust he will be well treated.

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A Simple Geometrical Construction

By S. LOWEY

THE joint resistance of a number of resistances in parallel is equal to the reciprocal of the sum of the reciprocals of the individual resistances.

Two resistances of a ohms and b ohms connected in parallel have thus a joint resistance of

$$\frac{1}{\frac{1}{a}+\frac{1}{b}}=\frac{ab}{a+b} \text{ ohms.}$$

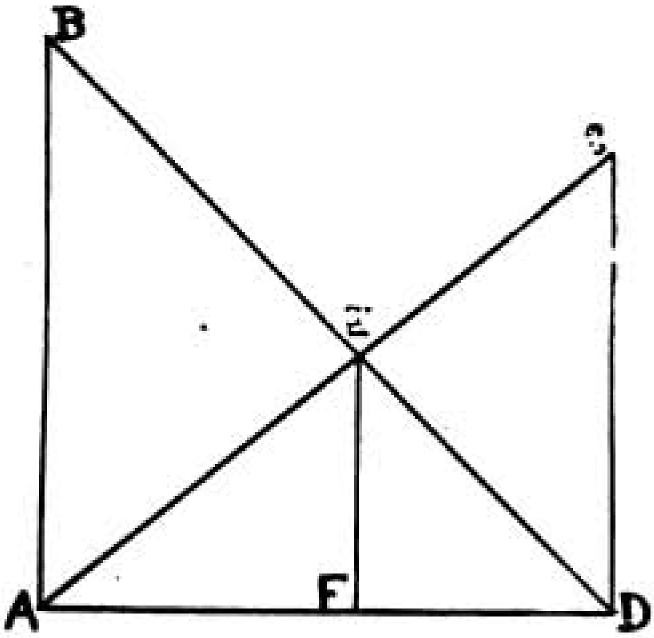

Fig. 1

This may be solved by a simple geometrical construction which, while not new,* is worthy of being made more widely known.

In Fig. 1 AB and CD are drawn perpendicular to AD and represent to a scale the resistances of the two conductors. (This may be done very easily on squared paper.)

Join AC and BD, and from the point of intersection E, draw EF perpendicular to AD. The length of EF to the same scale gives the joint resistance in parallel of the two resistances.

The problem may be proved very easily, as follows, the lines being marked as in Fig. 2:

$$\tan\theta=\frac{x}{m}=\frac{b}{s}\ \therefore\ b=\frac{xs}{m}$$

$$\tan\phi=\frac{x}{n}=\frac{a}{s}\ \therefore\ a=\frac{xs}{n}$$

The joint resistance

$$\left(\frac{ab}{a+b}\right)=\frac{\frac{xs\times xs}{mn}}{\frac{xs}{n}+\frac{xs}{m}}=\frac{x^2s^2}{mn}\times\frac{mn}{xs\,(m+n)}=$$

$$\frac{x^2s^2}{mn}\times\frac{mn}{xs\,(m+n)}=\frac{x^2s^2}{mn}\times\frac{mn}{x.s.s}$$

$$=x.\quad Q.E.D.$$

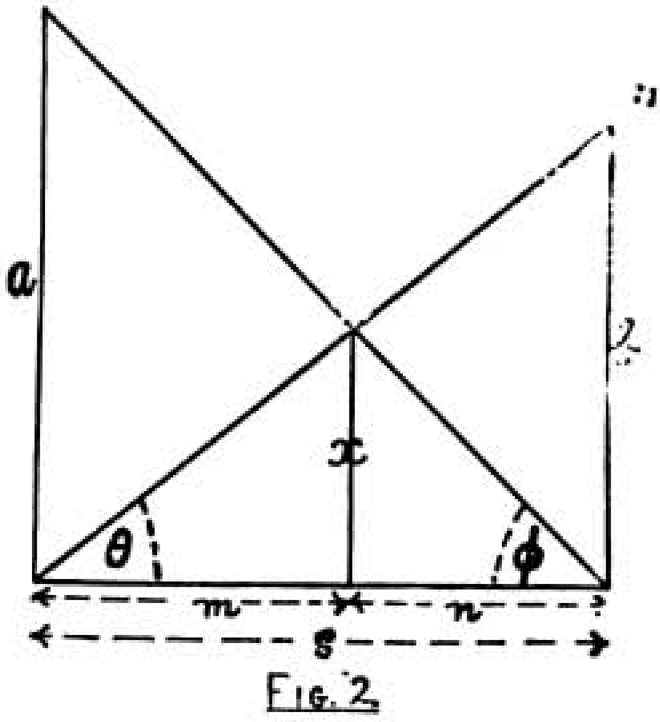

Fig. 2

* The writer was first introduced to this method at Liverpool Central Technical School (about 1902) by J. E. Lloyd Barnes, Whit.Sch., who was then lecturer in electrical engineering.

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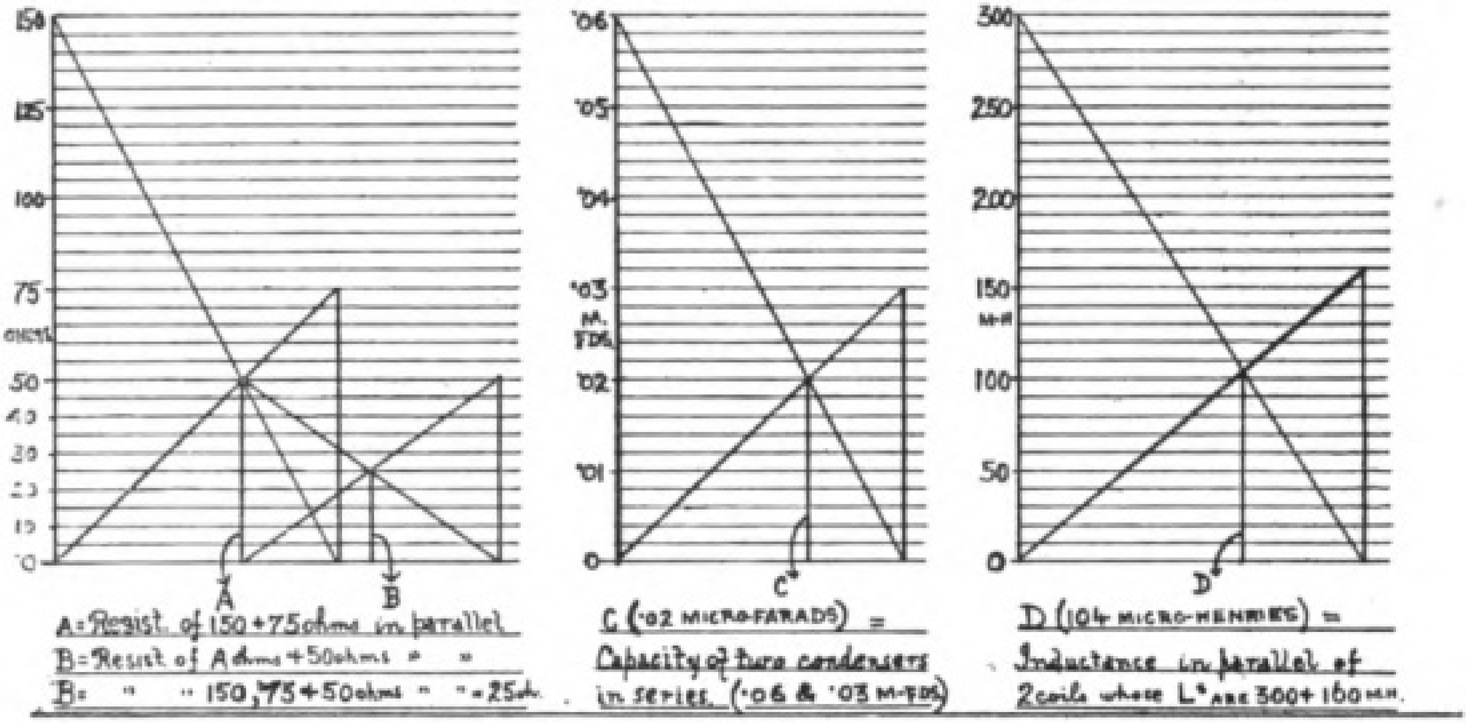

FIG. 3

The formula for joint resistance may be applied to find the capacity of condensers in series, and also to inductances in parallel, providing that the mutual inductances of the coils is negligible.

If two or more operations are being performed by the graphical method, the joint resistance of two conductors is taken as one resistance in dealing with the third conductor, and so on for any number of conductors.

Several examples are given in Fig. 3, which scarcely need further description.

Wireless to Help United States Forest Service

ACCORDING to the *Electrical Experimenter*, the U.S. forest service will probably use wireless telegraph in extending its communication system in New Mexico and Arizona as a result of an experiment held on the Apache national forest of Arizona.

The forest service would not supplant its telephone and telegraph lines by wireless. That, of course, would mean unnecessary expense. Wireless would be used in connection with the present system, which provides communication between the district headquarters and all forest supervisors. Rangers, however, cannot always be reached by this means, and therefore wireless would be very useful.

Wireless may also be used instead of telegraph lines which the forest service plans to build. Cheapness of construction and maintenance in comparison with wire systems is a great recommendation.

District Forester Paul G. Redington, speaking of the experiment, explained how a message was sent from the Baseline ranger station by wireless to a station at Clifden, Ariz, forty miles away. This is believed to have been the first wireless message sent from a ranger station in the United States.

The Baseline plant was installed by Ranger William R. Warner and Ray M. Potter, at a cost of $75. The project was conceived by Ranger Warner. Mr. Redington was in the station when the message was sent. It was relayed by wire to the district headquarters.

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The Resistance of the Wheatstone Network

By A. F. BURGESS, B.Sc.

THE system of conductors generally known as the Wheatstone bridge network has such important uses that many of its peculiarities are very well known. For ordinary purposes the network is of the greatest interest when "balanced"; this condition is satisfied when the ratio of the resistance arms $p:q$ is equal to the ratio $r:s$ (see Fig. 1). Thus, for example, when q and r are interchanged, the product qr is still equal to ps, so that the balance is unaffected by joining the battery to the G corners and g to the B corners. Again, when the arm r is a galvanometer and g a simple resistance or equivalent, an alteration in the value of g from zero to infinity produces no change in the current distribution, and the galvanometer deflection is unchanged—Kelvin or Thomson test. Further, r may be a battery, g a galvanometer, and a resistance across the B corners may be altered from zero to infinity without changing the galvanometer reading—Mance test.

But the "unbalanced" network has also some interesting properties; one of these, the effective resistance of the system between the B corners, will be considered here.

To calculate this resistance assume that one ampere flows in at B_1, see Fig. 1, of which x amperes go along p to G_1, where the current again divides and y amperes flow along g. Then applying the Kirchoff laws, we may write expressions for the P.D. between B_1 and B_2, which will be equal to the equivalent resistance of the network:

$$R = px + q(x-y) = r(1-x) + s(1-x+y)$$
$$= px + gy + s(1-x+y).$$

When rearranged these equations become:

$$(p+q)\,.\,x - q\,.\,y = R$$
$$-(r+s)\,.\,x + s\,.\,y = R-(r+s)$$
$$(p-s)x + (g+s)\,.\,y = R-s$$

and these by the ordinary methods yield the solutions:

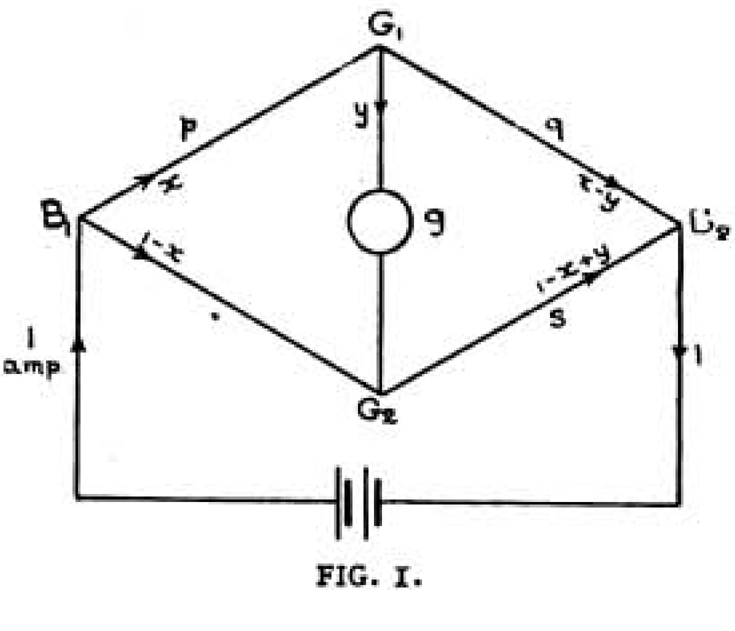

FIG. I.

$$x = \frac{(r+s)\,g + r(q+s)}{(p+q+r+s)\,g + (p+r)\,(q+s)}$$

and

$$y = \frac{(p+q+r+s)\,r - (p+r)\,(r+s)}{(p+q+r+s)\,g + (p+r)\,(q+s)} \quad \text{or} \quad \frac{qr-ps}{(p+q+r+s)\,g + (p+r)(q+s)}.$$

Then

$$R = (p+q)\,.\,x - q\,.\,y.$$
$$= \frac{(p+q)\,(r+s)\,g + (p+r)\,(qs) + (pr)\,(q+s)}{(p+q+r+s)\,g + (p+r)\,(q+s)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1.$$

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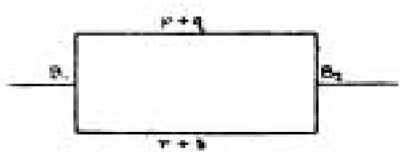

FIG. 2.

which may also be written in the form

$$R=\frac{m_1g+m_2}{n_1g+n_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $m_1=(p+q)\ (r+s) \quad m_2=(p+r)\ qs+pr\ (q+s)$

$n_1=(p+q+r+s) \quad n_2=(p+r)\ (q+s)$

This form (2) is of interest because it can be so easily obtained from the following considerations.

If g is very large, the value of R becomes $R_1=\frac{m_1}{n_1}$, and the diagram simplifies to that of Fig. 2, from which the value of R_1 may be easily found.

Again, if g is very small, the value of R becomes $R_2=\frac{m_2}{n_2}$, and the diagram becomes that in Fig. 3.

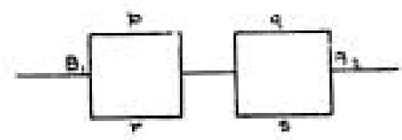

FIG. 3.

Thus, by first performing the simple calculations necessary for these two extreme cases, the equivalent resistance for any value of g may be at once written down. One important point must, however, be noticed, so a numerical example will be given.

Let $p=10$, $q=2$, $r=2$, $s=10$ ohms and $g=5$ ohms. Referring to Fig. 2, R_1 will be $\frac{(10+2)\ (2+10)}{(10+2)+(2+10)}=\frac{144}{24}$. *Note* that this result must not yet be simplified. Also, referring to Fig. 3

$$R_2=\frac{10\times 2}{10+2}+\frac{2\times 10}{2+10}=\frac{20}{12}+\frac{20}{12}=\frac{240+240}{144}=\frac{480}{144}.$$

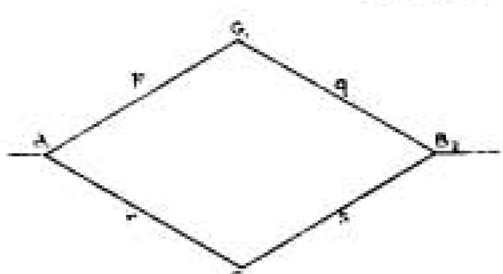

FIG. 4.

Again *note* that the "long" method of adding fractions *must* be used here as in the general case. Then the equivalent resistance when $g=5$ ohms is

$$R=\frac{5\times 144+480}{5\times 24+144}=4.55 \text{ ohms.}$$

EFFECT OF INTERCHANGING CONNECTIONS TO *B* AND *G* CORNERS.

Consider next the resistance of the network between the G corners. Fig. 4 is transformed to Fig. 5—*i.e.*, the arms q and r are interchanged. The value of R_1 in Fig. 2 was

$$\frac{m_1}{n_1}=\frac{(p+q)\ (r+s)}{p+q+r+s};$$

this now becomes

$$R_1{}^1=\frac{(p+r)\ (q+s)}{p+q+r+s}=\frac{n_2}{n_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Also the value of R_2 as determined from Fig. 3 is changed from

$$\frac{m_2}{n_2}=\frac{(p+r)\ qs+pr\ (q+s)}{(p+r)\ (q+s)}$$

to $R_2{}^1=\frac{(p+q)\ rs+pq\ (r+s)}{(p+q)\ (r+s)}$

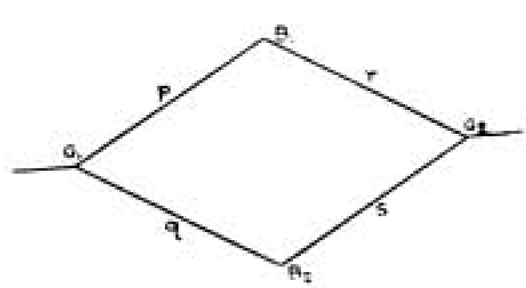

FIG. 5.

which is equal to

$$\frac{(p+r)\,qs+pr\,(q+s)}{(p+q)\,(r+s)} \text{ or } \frac{m_2}{m_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Therefore the equivalent resistance between the G corners when the B corners are connected by a resistance g, obtained from formulæ (3) and (4), is

$$R^1=\frac{gn_2+m_2}{gn_1+m_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This result may be obtained from formula (2) by interchanging m_1 and n_2.

Further, the ratio $\frac{R_1{}^1}{R_1}=\frac{(p+r)\,(q+s)}{(p+q)\,(r+s)}$; also the ratio $\frac{R_2{}^1}{R_2}=\frac{(p+r)\,(q+s)}{(p+q)\,(r+s)}$, so that $\frac{R_1{}^1}{R_2{}^1}=\frac{R_1}{R_2}$. That is to say, the percentage change in resistance between the G corners when the arm between the B corners is altered from 0 to ∞, is the same as for the B corners when the arm between the G corners is similarly treated.

THE EFFECT OF ALTERING THE VALUE OF g FROM ZERO TO INFINITY.

In the original figure

$$R_1=\frac{m_1}{n_1}=\frac{(p+q)\,(r+s)}{p+q+r+s} \text{ and } R_2=\frac{m_2}{n_2}=\frac{(p+r)\,qs+pr\,(q+s)}{(p+r)\,(q+s)}$$

therefore,

$$R_1-R_2=\frac{(p+q)\,(r+s)\,(p+r)\,(q+s)-[(p+q)+(r+s)]\,[(p+r)\,qs+pr\,(q+s)]}{(p+q+r+s)\,(p+r)\,(q+s)}$$

which is found to simplify down to

$$\frac{(ps-qr)^2}{(p+q+r+s)\,(p+r)\,(q+s)}.$$

Therefore, the change of resistance, due to change in g from 0 to ∞, expressed as a fraction of R_1—*i.e.*,

$$\frac{R_1-R_2}{R_1}=\frac{(ps-qr)^2}{(p+q)\,(q+s)\,(s+r)\,(r+p)}.$$

Obviously if the network is "balanced" $ps=qr$, and the effect of short-circuiting the G corners is nil. For the "unbalanced" network the effect depends to a large extent on the out-of-balance term $(ps-qr)$. For example, if p and q are each equal to a, and $r=a(1+x)$, $s=a(1-x)$, then $(ps-qr)^2=4a^4x^2$; also $(p+q)\,(q+s)\,(s+r)\,(r+p)=2a\,.\,a\,(2-x)\,.\,2a\,.\,a(2+x)=4a^4\,(4-x^2)$. Under these conditions $\frac{R_1-R_2}{R_1}=\frac{x^2}{4-x^2}$, and if the network is nearly in balance x is small and the fractional change of resistance is proportional to x^2—*i.e.*, to the square of the "out-of-balance."

When the value of g lies somewhere between 0 and ∞ the value of R is obviously between R_1 and R_2. From (2),

$$R=\frac{m_1g+m_2}{n_1g+n_2} \text{ and } R_1=\frac{m_1}{n_1},$$

so that

$$\frac{R_1-R}{R_1}=\frac{m_1n_2-m_2n_1}{m_1n_1g+m_1n_2},$$

where $(m_1n_2-m_2n_1)$ is $(ps-qr)^2$ as previously found. The following table shows some particular cases, the fraction being expressed as a percentage for various

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values of g. It will be noticed that when three of the arms are of similar resistance, the percentage change is fairly low, but is very high when the network is badly out of balance.

			$g=$	∞	1,000		100		10		0	
p	q	r	s	R_1	R	%	R	%	R	%	R_2	%
1,000	1,000	1,000	10	671	606	9·7	531	20·8	512	23·7	510	24
10	10	10	1,000	19·6	19·52	0·4	18·83	3·9	16·5	15·8	14·9	24
1,000	10	10	1,000	505	342	32·3	100	80·2	29·2	94·3	19·8	96·2

Our New Volume

Important Announcements

WITH this issue the fourth volume of THE WIRELESS WORLD comes to a close, and we confess it is with a feeling of pride that we look back upon our achievements. In spite of the greatly increased difficulties of production, the closing down of all amateur stations and the cessation of all private wireless research, we can claim a steadily rising circulation and the retention of a circle of readers with whom we are proud to be in touch.

Next month, on receiving their copies of THE WIRELESS WORLD, our readers will find it presented in a bright new cover, highly artistic in design, which has been prepared for us by the well-known artist, Mr. J. W. Nicolson. With regard to the contents, whilst no great changes can be made in the present stress of war, the quality will be fully maintained and a number of minor improvements introduced. Of these we shall have more to say in our next month's pages.

A valuable new series of instructional articles dealing with Alternating Current will begin with the April issue, and will be written by a wireless expert who will lay particular emphasis upon those portions of the study which have most practical use to the wireless man. In arranging these series we have been largely influenced by correspondence we have received from a number of our readers who are anxious to study alternating current work. We would take this opportunity of pointing out that THE WIRELESS WORLD Instructional Articles are kept right up-to-date as the months go by. In this way our readers receive a type of instruction unobtainable elsewhere.

The last but not the least important announcement we have to make is that in future THE WIRELESS WORLD will be published on the 25th of each month, the April number thus being on sale on the 25th of March. Readers will do us a great service in reminding those of their friends who are not yet readers that the April number affords an excellent opportunity to commence their subscriptions.

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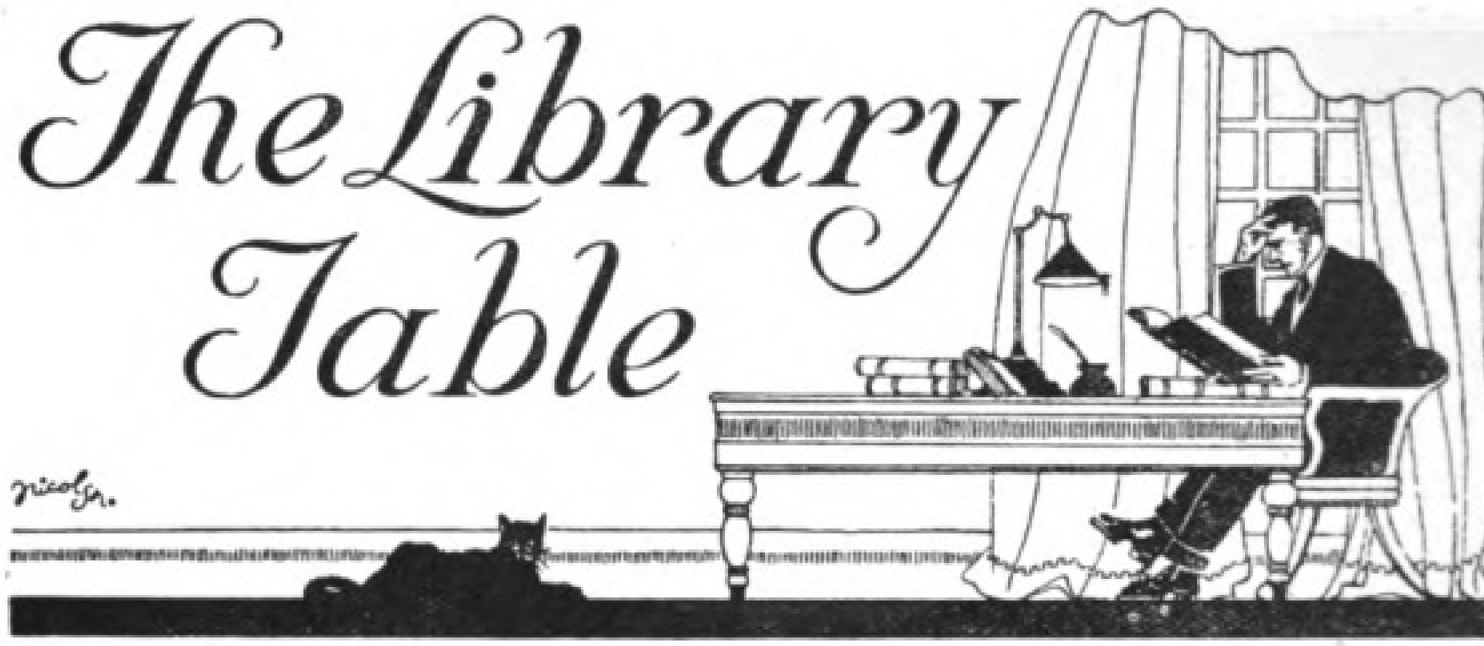

"THE 'PRACTICAL ENGINEER' MECHANICAL POCKET BOOK AND DIARY, 1917."
London : The Technical Publishing Co., Ltd. 1s. 6d. net.

"THE 'PRACTICAL ENGINEER' ELECTRICAL POCKET BOOK AND DIARY, 1917."
London : The Technical Publishing Co., Ltd. 1s. net.

The operator who wishes to make good progress in his profession must go through life continually acquiring information. Generally speaking, the more he learns about electrical and engineering subjects the greater interest he will take in his work and of greater value will he become to the firm employing him.

The two little books before us—really pocket books and not bulky volumes masquerading under that name—contain a vast store of thoroughly sensible and practical information on a great number of subjects of interest to the wireless operator, and their careful perusal in spare hours cannot fail to be of great benefit to the average man. We take pains to point this out for the reason that we are constantly receiving in our "Questions and Answers" section letters from sea-going operators making inquiries regarding many points clearly explained within these little volumes.

The Mechanical Pocket Book, containing more than 600 pages of literary matter, besides the diary, treats of steam, steam generators, various types of engines, turbines, etc., gas and oil engines (a valuable section for the wireless man), mechanical engineering materials, pipes, girders, etc., and much else of an engineering nature. We must not omit to mention the notes on the choice and use of lubricants, and for the business man there is a useful "Buyer's Guide" in French, Spanish and Russian.

The Electrical Pocket Book, which is, of course, the more valuable of the two from the point of view of the wireless man, deals with conductivity and resistance circuits and systems of wiring, measuring instruments, alternators, transformers, converters, accumulators, electric lighting, electric furnaces, and many other branches of electrical engineering. There is a useful little section devoted to wireless telegraphy in which the subject is treated in a lucid fashion without the over-loading with out-of-date material which so often figures in such sections. The various wire tables included in the book will be found very useful by all who have any work connected with electrical wiring, and the section devoted to general information contains in a handy form many tables which are needed almost daily. Altogether the editors and publishers of these two handy books are to be congratulated on the excellence of their production.

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"SEA POWER." By Archibald Hurd. Constable & Co. 1916.

Mr. Hurd's special qualifications with regard to naval matters render his little book of more than usual interest. It only runs to a matter of 94 pages; but we venture to say that the outline which he has been able to sketch within so short a space forms an excellent basis for the general reader upon which he can with advantage build up a more important perception of the value and working of sea power.

After a passing reference to the way in which Admiral Mahan was first attracted towards this subject, which afterwards became so peculiarly his own, Mr. Hurd proceeds to sketch the history of British sea power from the times of the coracles of the Ancient Britons to the present day. His comparison between the situation of England in the great Continental struggle with Napoleon with that which she now occupies in the international struggle against Prussian domination is particularly *apropos* at the present moment. The main points telling for or against the two distinct policies followed by England in the Napoleonic wars and in the present struggle, constitute an admirable illustration of how a study of history is essential for the proper consideration of current events. And the earlier part of his book must be gone through very carefully before the full bearing of his remarks can be realised.

There are many omissions, of course; it is not possible to compress the contents of a whole library into 94 pages; but, on the whole, the essentials are here. One interesting and not insignificant detail which appears to have escaped Mr. Hurd's observation occurs in Chapter IV., when he is dealing with the defeat of the Spanish Armada. The warning that Spain's mighty argosies, so long held up, were rapidly approaching our shores is correctly ascribed to Captain Fleming; but Mr. Hurd has omitted to mention that this gallant Scotsman was at the time in command of what our Elizabethan ancestors knew as "Moorish Corsairs." He was one of a band of patriotic English sailors, who, in order to "singe the King of Spain's beard," had placed their skill at the disposal of the Moors. These latter had been especially incensed against the Spaniards and Portuguese by the recent expulsion of the Moriscos from Spain and were burning for revenge. The Moors themselves had never been anything more than boatmen, and owed such seamanship as they acquired to the leadership and training of British sailormen.

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"THE FLYING MACHINE FROM AN ENGINEERING STANDPOINT." By F. W. Lanchester, M.I.C.E., M.I.M.E., M.Inst.A.E. London: Constable & Co., Ltd. 4s. 6d. net.

Whilst a great deal has been written on the subject of flying and flying machines, it is safe to say that few books of an authoritative nature have so far appeared. In this class, however, must be placed the book before us.

Mr. F. W. Lanchester, who has closely followed the progress of aviation and contributed to our knowledge of the subject from its earliest days, is well known as a member of the Advisory Committee for Aeronautics. This volume is a reprint of his "James Forrest" Lecture delivered before the Institution of Civil Engineers three months prior to the outbreak of war. In addition, there is included a discussion concerning the "Theory of Sustentation and the Expenditure of Power in Flight," being a paper presented at the meeting of the International Engineering Congress in San Francisco in 1915. It is true, as the author points out in the preface, that since

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the outbreak of war, from considerations of national secrecy, very little of a technical character has been added to the stock of public information, and for this reason the position existing immediately prior to the war has become a matter of more permanent interest than the author anticipated at the time his lecture was prepared. He has, therefore, revised the lecture and brought it out in book form.

A perusal of this book immediately brings home to the reader the enormous progress which has been made in aeronautical research during the last few years. In writing a book with the object of dealing with those problems in mechanical flight which come more directly within the purview of the aeronautical constructor, Mr. Lanchester has not attempted to deal with matters such as the theory of stability; the result of existing investigations have been assumed as established facts. In the first few pages we find a general consideration of the flying machine as an instrument of locomotion, its limitations being carefully considered. Now that the project for a transatlantic flight by aeroplane has been revived it is interesting to turn to the author's consideration of this problem. In 1914, at all events, such a flight would, according to Mr. Lanchester, be practically impossible, unless constant air current in the right direction could be relied upon to assist.

Among the subjects dealt with are "Catastrophic Instability," "The Laws of Resistance," "Propulsion," "Dynamic Load-Factor and Factor of Safety," "Landing Gear," and "Stability and Control." Under the heading of "Propulsion" some highly interesting facts are given regarding the propeller. Whether we appeal to experience or to theory, says Mr. Lanchester, it would appear that there is only one method of propulsion available—namely, the screw propeller. In a footnote it is pointed out that nature's method of propulsion—wing flapping—besides being very objectionable from a mechanical point of view, shows certainly no higher degree of mechanical efficiency than the screw propeller.

It is interesting to note that, roughly speaking, the conditions of usage of propellers in water and air may be compared by merely taking cognisance of the relative densities of the two media—approximately 800 to 1. It has been frequently said that the theory of the screw propeller is entirely empirical and quite unsatisfactory. Mr. Lanchester does not hold this opinion, and states that the theory of the screw propeller based on the theory of the aerofoil as laid down in *Aero-Dynamics*, appears fully to meet the requirements of the aeronautical designer.

Altogether this is a highly interesting and very valuable contribution to the literature of flying, and it will be welcomed by all who are desirous of making a serious study of flight from the engineering standpoint.

Share Market Report

London, February 13th, 1917.

Dealings in the shares of the various Marconi issues were somewhat restricted at the beginning of the month owing to the issue of the War Loan. There has been considerable buying during the past week, and the prices are well maintained. Prices as we go to press are: Marconi Ordinary, £2 17s. 6d.; Marconi Preference, £2 7s. 6d.; Marconi International Marine, £1 17s. 6d.; American Marconi, 16s. 9d.; Canadian Marconi, 9s.; Spanish and General Wireless Trust, 10s.

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Personal Notes

On behalf of our readers and ourselves we beg to express the deepest sympathy with Dr. Fleming in the sad bereavement he has suffered in the loss of his wife, who passed away on February 6th last. The personality of Dr. Fleming is so familiar that, with a large number of us, it is no mere matter of condolence, but a sharing of his grief.

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We deeply regret to announce the death of Charles William Pain, who passed away on January 22nd from a tubercular affection of the lungs. Mr. Pain entered the services of the Marconi International Marine Communication Co., Ltd., in 1912, and later transferred to Marconi's Wireless Telegraph Co., Ltd. On May 1st, 1913, he was appointed for duty at the Clifden Transatlantic Wireless Station and remained at that place until January, 1916, when he proceeded to London for the purpose of taking the position of instructor in the school for lady wireless operators organised by Marconi's Wireless Telegraph Co., Ltd. For some time prior to his death Mr. Pain had been receiving treatment and was at Niton, Isle of Wight, when the end came. Deep sympathy is felt for the late Mr. Pain's relatives in their sad bereavement.

* * * * * *

Several changes in the personnel of the Marconi's Wireless Telegraph Co. of America have been recently announced. Mr. Charles J. Ross, who for some time has held the position of auditor to the Company, now receives the title of comptroller; Mr. David Sarnoff, whose interesting contributions to our pages under the title of "American Letter" are well known to our readers, has been appointed manager of the Commercial Department; Mr. G. Harold Porter takes the position of assistant manager in the Commercial Department; and Mr. Lee Lemon has been appointed purchasing agent.

THE LATE MR. C. W. PAIN.

* * * * *

George Payne, described as a wireless operator, and giving an address at Chatham, was recently charged on remand with obtaining 2s. 6d. by false pretences from

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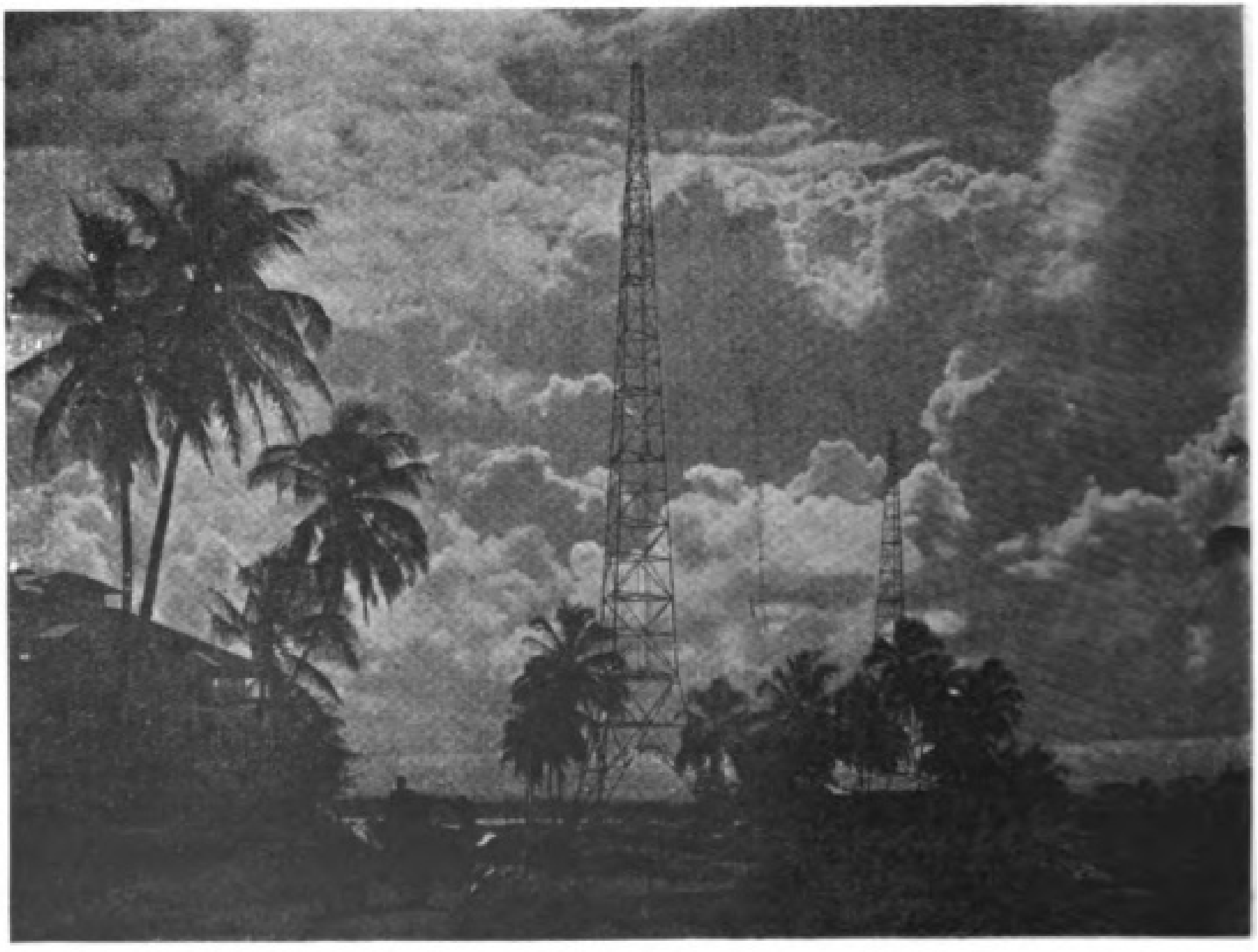
his landlady. A detective described the prisoner as a mean thief, and said he had been convicted 26 times. Payne was committed to prison for nine months. It should be pointed out that this man was never at any time in the employment of the Marconi Company.

* * * * * *

In the list of officers who lost their lives when H.M.S. *Laurentic* was sunk we find the name of Warrant Telegraphist Richard J. Thompson, R.N.R. Warrant Telegraphist Arthur Bower, of the same vessel, was fortunately saved. All wireless men will join with us in offering deep sympathy to the late Mr. Thompson's family in their terrible loss.

* * * * * *

Many of our readers will be interested to read that Mrs. Murray, wife of Mr. T. W. Murray, senior operator on an important liner of the R.M.S.P. Company, has been decorated with the Bar of Distinction by the Italian Government for service on the Italian front. She was serving there with the British Red Cross during 1915.



A MOONLIGHT VIEW OF THE WIRELESS STATION AT COLON, PANAMA. THIS STATION IS OWNED BY THE UNITED STATES GOVERNMENT.

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Pastimes for Operators

Model Making

In a previous pastime article emphasis has been laid upon the importance of cultivating the faculty of observation if success is to be attained. In nothing is this more essential than in model-making—a pastime pursued by a number of sea-going operators.

Under the general heading of model making we may place miniature shipbuilding, the construction of working models of steam engines, and a great deal of small electrical work including the making of wireless apparatus. Of the three, perhaps miniature shipbuilding is the easiest. The materials required are few, and, provided the aims of the constructor are not too ambitious, the expense is practically nil. Recently we had the opportunity of seeing a set of small reproductions of battleships, cruisers and torpedo boats, all constructed from pieces of wood by a member of the Marconi staff with such a faithfulness to detail that the models could profitably be studied by anyone interested in the trend of modern shipbuilding. Even supposing the models had no value in themselves—and this was far from being the case—the careful study of the disposition of funnels, guns, turrets and other details must have afforded a great fund of instruction and amusement to the ardent model maker, and given him a training in design of considerable value. There are many forms of aerial for instance most difficult to show in a diagram or drawing which are easily copied by small scale models between miniature masts. Land stations are even easier than ships to set up in diminutive form.

On a much more ambitious scale was a model recently constructed by an operator who had made a number of long voyages on a comparatively quiet route. In this case the model had practically every detail faithfully reproduced, deck fittings such as winches, ventilators, sky-lights and steam pipes being all in correct position and proper proportions. A steam engine and boiler concealed in the hull provided the motive power, and when finished the boat was so heavy that it taxed the strength of the proud builder to carry it off the ship !

A few words regarding the construction of the more detailed models such as that referred to will not be without interest at this juncture. It is a mistake to think that every tiny part has to be cut out and finished by hand. Deck fittings of every shape, size and form for model ships can be purchased from firms specialising in such things and are not expensive considering the care which is bestowed on their manufacture. Of course, it is much more interesting to make the details than to buy them, but a few judicious purchases will greatly lighten the labours of the constructor and leave him more time to devote to the hull and general structure.

Except in the smaller models, the hull is rarely cut out of a solid block, but is generally constructed of thin strips of wood shaped and fastened to a framework. A first essential is a set of good working drawings, to full scale, showing the plan and elevation of the boat and cross sections at various positions. If the operator is endeavouring to construct a model of his own vessel, he should have a chat with the

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chief engineer, who will be able to show him accurate blue prints of the vessel which will serve as a splendid guide in preparing the designs. In a general article we cannot more than indicate the main lines of working, and would recommend those who contemplate taking up this kind of work to purchase a small book on model shipbuilding. Several will usually be found advertised in our excellent contemporary, *The Model Engineer and Electrician*, a little weekly paper full of helpful articles for the model maker, and obtainable through any newsagent and bookseller.

A small spokeshave, a sharp knife and sandpaper will be used to shape and finish off the outside of the hull, the inside of which may be left rough unless an engine and boiler are to be fitted, in which case provision will need to be made for them. No attempt should be made to paint or varnish the hull until the work is practically finished, as a model has a great deal of handling during construction, and paintwork would be sure to be scratched if done too early.

Once the hull is finished a stand should be made, upon which the model can be placed while work is undertaken upon the deck and fittings. The masts will require great care if they are to make a good appearance, as any slight inequality is readily noticeable. Rigging is carried out with good strong thread, such as that used by bootmakers.

A brass or other metal tube can be made to serve as the funnel provided a piece can be selected of the right proportional diameter. In cases where the full-size funnel has bands which stand out slightly, these can be copied by gluing bands of thick paper round the tube before it is painted.

Except in very large models it is useless to attempt to inlay glass for portholes and skylights. Clear celluloid is a far more satisfactory material to handle, as it is thin and readily cut to correct shape. Handrails, if the model is sufficiently large to require them, had best be made from stiff brass wire ; softer wires are useless, as they get bent with the slightest handling. Capstans, winches, ventilators and the like, if not purchased ready made, should be cut and filed from scrap brass or copper, as iron or steel will rust in the sea air.

The final painting of the model must be most carefully done, or the whole effect will be spoiled. A number of very thin coats must be applied to obtain a perfectly smooth surface, each coat being allowed to dry thoroughly before the next is applied. The small tins of enamel sold at any oil shop are quite suitable for this work, if thinned down, and allow of small quantities being purchased.

One of the most difficult parts of the finishing of a model ship consists in the more delicate painting and lining. This requires a very steady hand and straight eye, and unless well done will ruin the whole appearance of the boat.

So far we have omitted any reference to the fitting of engines, because most operators will find quite enough to do in building a scale model without them. Some men, however, have made excellent boilers and engines, calling in the aid of the engineers on board for the more difficult metal work. A model fitted up in this way can be made to propel itself in ponds or other smooth waters, but will inevitably lack the beauty of the first type described, as the more delicate finish of rigging and deck work has to give way to the requirements of the mechanism. Further, a steam model is always " messy " owing to inevitable leakage of oil, water and spirit, and the paintwork is bound to suffer from the heat of the burners.

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Enough has been said to show that model shipbuilding is worthy of attention when considering what hobby shall be taken up. Some matter-of-fact people may ask what good purpose is served in spending so much time and trouble on what is at best a toy. The answer is that the pleasure derived from the construction of the model, the training in observation, the mechanical skill acquired, and the possession of a scale model of a modern boat are sufficient reward for the labour expended. The expert model maker, further, is in a much better position than his less skilled confrère to appreciate the beauties of modern shipbuilding.

A recent issue of the *Scientific American* contained an illustrated description of a most elaborate model ship, copied accurately from a well-known United States cruiser; it measured some six feet in length and was propelled by steam. The owner had spent some years in building the vessel, and lavished so much care upon it that when completed it was a perfect miniature of the giant vessel from which it had been copied. The guns were made to fire electrically, the model searchlights threw tiny beams in any direction at will, and even the launches were steam driven. The method of propulsion adopted for these latter craft is worthy of a brief description, as a similar means could readily be used in many other small vessels.

In each launch the boiler, which was made strong enough to stand a considerable pressure, had a small tube attached to it and led to the stern of the vessel. The tube terminated in a very small orifice, and when the boiler was heated a thin jet of high-pressure steam impinged upon the water, meeting therewith resistance, and forcing the boat along. There were thus no screws, wheels or reciprocating parts, and the boats could be made very light and tiny.

It is worth remarking that the whole vessel was built of metal, with the exception of one or two insignificant details. The tall lattice masts of the approved American pattern represented a great amount of labour, for there were hundreds of joints, all of which had to be soldered. Finally, the vessel could be steered from shore by wireless telegraphy. A description of the apparatus used will be published in a future number of the WIRELESS WORLD.

Still another branch of model making, and one which will particularly appeal to the wireless man, consists in the construction of small electric working models. These may range from the simplest and most crude motor to the elaborate multiple dynamo capable of running a battery of small lamps or even a miniature wireless set.

Take, for instance, the simple motor illustrated in the accompanying sketches. It can be constructed by practically anyone from old scraps of wood, metal and wire and will run merrily from a few dry cells. No sizes are marked on the sketches, as the details can be varied to suit the tastes of the constructor.

To make a start we must obtain a block of wood (A) to form the base and on this must be fastened an upright (B). A wood screw through the base will be found more satisfactory than glue. Next we have to procure a horseshoe shaped piece of *soft* iron (C) (bent iron rod will do), on which will be wound the two coils of fine wire (D1 and D2) which serve to magnetise the iron. To wind these coils neatly, take a lead pencil of the size of the iron rod, or any cylindrical piece of wood of the right thickness, and attach to it two discs of cardboard separated by a distance equal to the length of the coil it is desired to make (see illustration). If the pencil or rod is now rotated, the wire can easily be wound in place. When the spool is complete

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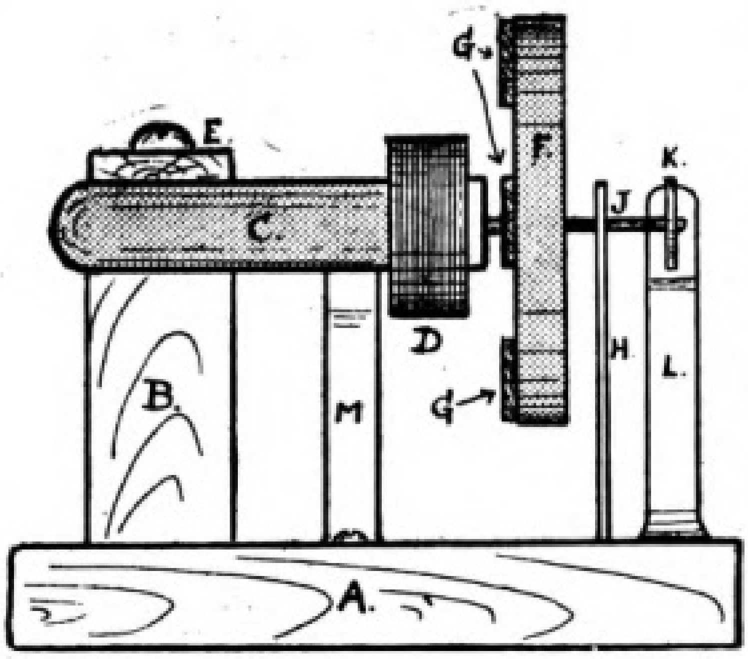


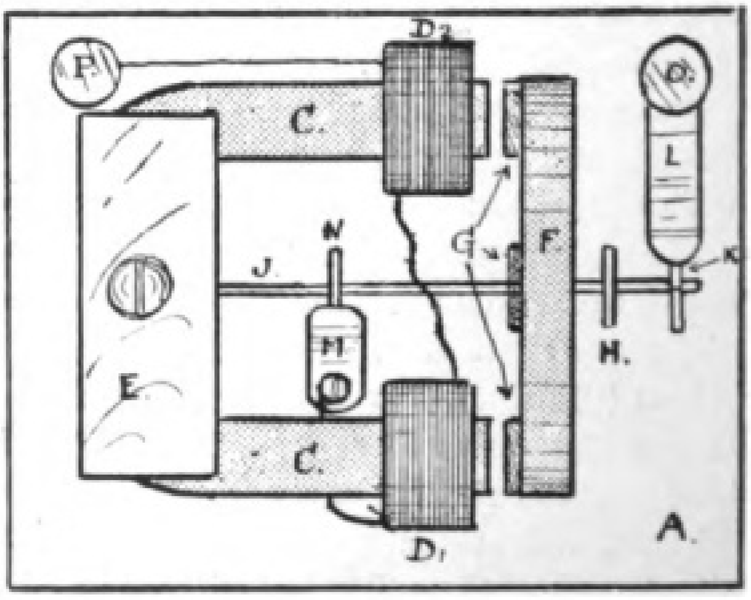
SIDE VIEW

the whole should be immersed in melted paraffin wax, the surplus wax run off, and the spool left to set. When cold the complete coil, in a solid mass, can be removed from the rod and slipped on to the iron pole-piece of the magnet. Two such coils will be required, one for each pole, and the two windings must be joined in series, care being taken that the magnetic effect is correct.

Having completed the magnet, the flywheel next engages our attention. This can be made from the lid of a tin, filled with lead if it is too light by itself. On this wheel are soldered, at equal distances apart, four pieces of soft iron so arranged that when the wheel is held in front of the magnet a piece of iron is opposite each pole. The wheel needs to have a spindle, which can be made from a stout metal knitting needle, and this must run easily in the support (H), and in (E), which holds the magnet down. A small square piece of brass (K) is soldered to one end of the spindle and a small brass disc (N) near the other. Two thin brass springs (L and M respectively) press lightly on these pieces of brass and serve to carry the current. Finally, two terminals (O and P) are required, O being connected to L, and P to one of the coils. The other coil connection is led to the spring M.

Let us now see how the model works. Current entering P will pass through the coil D1 and D2, magnetising the iron, pass through M to N, along the spindle to K, down L and back by O to the battery. Provided the position of K is properly set, and the pieces of iron G are not immediately opposite the pole-pieces, they will be attracted towards the poles. As soon as they arrive opposite the poles the circuit will be broken at K and the coils demagnetised. The momentum of the wheel will carry it forward until contact is restored at one of the points of K, and the action will then be repeated. These little motors attain very high speeds when carefully made and adjusted, but they provide very small power for driving other models.

A coat of paint will greatly improve the appearance of the finished motor, and indeed, if the woodwork be varnished, the iron magnet painted black and the coils and wheel red, the model will look very smart. Such motors are useful for studying the blending of colours by means of painted segments of cardboard discs.



PLAN

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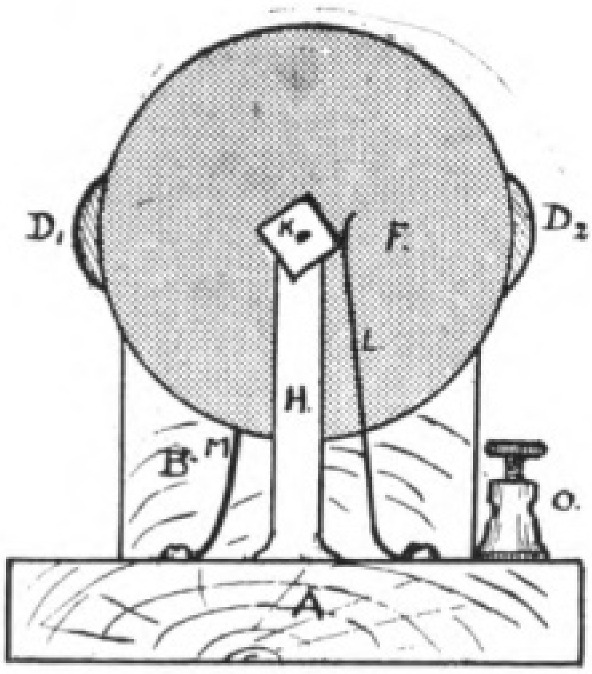

END VIEW

For particulars of more elaborate electric motors we would refer our readers to the many handbooks on motor building now obtainable. By the aid of castings, which can be purchased from several firms, some very fine motors and dynamos can be constructed quite inexpensively, but of course their construction takes time and care, and is not lightly to be undertaken.

At the same time, building small dynamos and motors constitutes valuable training and will help the operator to understand and appreciate the machine he is called upon to use in his daily work. A man who is skilled in the construction of model dynamos and motors will never be at a loss as to what to do in the event of a breakdown in the full-sized machine.

A few months ago (February 1916 issue) we published an article on building a model alternator by L. F. Isaac. Readers to whom the present article appeals should turn back to this and restudy it in the light of what we have said. We should also be glad to hear from subscribers who have constructed similar models.

WINDING THE COILS

Administrative Notes.

Spain.

A DECREE has been issued placing all wireless telegraph stations in Spain under official supervision, and henceforth they will be worked under State control.

* * * * * *

French West Africa.

Owing to present circumstances, it has been decided to close to public correspondence with ship stations, until further notice, all coast stations of French West Africa.

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Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor,* THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered : and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

A. F. H. (Bishops Waltham).—There are considerable differences of opinion on the subject of what is the best capacity of the condenser in the base of an induction coil. For example, the 10 inch coil made by some makers has a condenser of 1·25 mfd capacity, whilst others run down to 0·5. Provided the capacity of the condenser is not too small it may be varied within wide limits without objection, but if the platinum hammer break is employed it is better to err in the direction of using too much rather than too little capacity. Roughly speaking, the capacity of a condenser made with sheets of tin foil, separated by double or treble sheets of paraffin paper may be taken to be equal to 0·01 mfd. per square foot of effective tin foil surface (see Fleming's *Principles of Electric Wave Telegraphy and Telephony*, 3rd edition, page 53).

H. H. (Nelson).—(1) We cannot offer an opinion as to which service, the Marconi Company or the Navy, offers better prospects for an operator with a good education. So much depends on what arrangements are made in the Navy after the war. (2) Selected operators are taken when vacancies occur to fill positions as travelling inspectors, inspectors on shore, operators on foreign land stations, instructors, etc. The number of these vacancies is, of course, limited, and it is not possible to say exactly what pay attaches to the various positions. Everything depends upon the particular appointment and the ability and experience of the man in question. (3) It is quite exceptional for a wireless telegraphist in the Navy to rise to commissioned rank.

X. Y. Z. (Cardiff).—The Marconi Company employs only men who are physically fit and no applications are considered from men above 25 years of age. If you were rejected from the Army on the grounds you mention you would probably be rejected by the Marconi Company's doctor, even if you were under 25. (2) The wireless operators on practically all mercantile vessels are controlled by the Marconi Company. (3) We think it very probable that a French wireless company would reject you on the same grounds as those given above. We wonder that you did not ascertain before taking up a course that it would be very difficult to obtain any position if your age were above 25.

G. W. (Newcastle-on-Tyne) asks what we consider the length of time it would take an ordinary youth to gain the Postmaster-General's Certificate by (1) day classes, (2) evening classes, (3) correspondence courses.

Answer.—(1) Six months in day classes, if the youth works hard. (2) Probably ten to twelve months is the minimum. (3) As we have pointed out several times before, it is not possible to obtain the Postmaster-General's Certificate by correspondence tuition alone. In answer to your other question, there is no set standard of height and chest measurement for Marconi operators. They are simply required to be in sound health and physically fit. Naturally a man with a very small chest measurement could not be termed physically fit, and an extremely short man would not be able to carry out the work properly and would therefore not be accepted.

W. G. C. (Cheshire).—An excellent article dealing with the "Calculation of Logarithmic Decrement" appeared in our issue for December, 1915. In this we think you will find all the information you require. Should there be any other points on which you require enlightenment please write to us again.

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H. L. H. (London).—(1) We cannot say whether there will be many vacancies for operators in the Marconi Company in three months' time. The demand at present is very strong and we think it probable that it will continue for some months to come. (2) Yes, men with Second Class Certificates are taken at the present time. For conditions of service apply to the Traffic Manager, the Marconi International Marine Communication Co., Ltd. Marconi House, Strand, W.C. (3) Apply to Regent Street Polytechnic.

H. W. (H.M.S. ——).—A wireless telegraphist in the Navy can obtain the Postmaster-General's Certificate either by making application to the Secretary of the Post Office to be examined and passing the necessary examination at the place appointed, or he can be examined for this certificate by the naval authorities themselves. Why not apply to your superior officer, informing him of your desire? He will be able to give you more information than we can.

A. F. B. (Cheshire).—The fact that your right eye is practically useless even with glasses would debar you from acceptance in the marine operating staff of the Marconi Company.

J. L. (Stepney).—For some years it has been a rigid rule that no person other than a British subject is allowed to operate the wireless apparatus on board a British ship. At the present time, and ever since the outbreak of war, it has been necessary not only that the operator shall be of British birth, but also of British parentage on each side. In no circumstances is this rule relaxed. There is no reason, however, why, provided you become properly qualified, you should not obtain employment in a foreign wireless telegraph company. We would suggest that you apply to the Société Anonyme Internationale Telegraphie Sans Fil, Marconi House, Strand, W.C. Perhaps they might have something to offer you.

"Inter Nos" (Crosby).—As mentioned in reply to another correspondent, the operators on practically all British ships are in the employ of the Marconi Company, to whom we would suggest that you apply.

C. T. A. (South Wigston).—The answer to your first question is that the lines of force from the primary of a closed core transformer pass through a secondary winding in the same way as they do with an open core. You should remember that lines of force are generated round every turn of the primary. Question 2. We cannot tell you the use of the piece of apparatus you mention without seeing it. The particulars you give are not sufficient to identify it.

J. W.—To calculate the inductance of the coil of which you send a sketch there is no simple formula. The self-inductance of each layer can be obtained from a formula, and then by obtaining the sum of all the mutual inductances between the various layers, the inductance of the whole coil can be obtained. An approximate method which is simpler is as follows: Assume the coil to be replaced by a single layer winding, the diameter of which is equal to the *mean* diameter of the actual coil, and having the distance between turns equal to the distance between the sections of the actual coil. Calculate the inductance of the single layer coil by one of the methods given in previous issues of The Wireless World, and multiply by the square of the number of turns in each layer. The advantage of this coil is that it is more compact than an equivalent single layer coil, but on the other hand its self-capacity and therefore its dielectric losses are much larger.

C. E. S. C. (Manchester).—(1) The Iolanda switchboard is simply another name for the A. C. switchboard used on the 1½ k.w. Marconi installation. (2) We cannot say what line schools usually follow in their instruction. It all depends upon the particular school. (3) Yes. (4) No. (5) It is not usual to sell such portions of wireless installations to the general public.

G. I. (France.)—The subject which you are studying and on which you ask for information, the distribution of potential around an earth connection, is of too extensive and elaborate a nature for us to devote much space to it in these columns. You do not state whether it is the earth-system of a wireless aerial which you are considering, but if this is the case we do not see that the theory of the Morse, Lindsay, and Willoughby Smith system would be of much use to you, as this is a system of conduction telegraphy. The best account of the function of the earth in wireless telegraphy will be found in Dr. Fleming's "Principles of Electric Wave Telegraphy." You will also find some oscillograms of vowel-sounds in that work, but we do not know where a complete collection of these is to be found.

E. F. W. V. enquires what wave-form would be shown on an oscillograph connected to a circuit whose natural period is, say, 600 per second, when the circuit is connected to an alternator of 50 cycles per second, the oscillograph being in parallel with the condenser. He also asks the bearing of the above on the circuit of an asynchronous discharger wireless transmitting circuit.

Answer.—If the alternator has a pure sine-wave form of 50 periods then the oscillograph will record a sine-wave of 50 periods. The amplitude of the curve will depend on the voltage given by the alternator and the value of capacity and inductance in the circuit, *i.e.*, it will be different for a circuit of small capacity and large inductance from what it would be for one of large capacity and small inductance. This can be seen by calculating

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the impedance of these quantities for the frequency of the current. If the alternator has a wave form containing harmonics then the wave shown by the oscillograph will contain the same harmonics but their relative magnitude will be altered since the impedances of the circuit will be different for each frequency. Provided the wave form of the alternator is not changed in itself on connecting the load then the shape of the oscillograph curve may be calculated if the magnitude of each harmonic is known. When the frequency of one harmonic corresponds to the frequency of the circuit this will be greatly increased in the oscillograph wave. The circuit cannot of itself introduce a new frequency into the wave form, but can only change the relative magnitude of the frequency components. For the asynchronous discharger circuit the low frequency system is approximately tuned to the frequency of the discharge since this will give the largest current-flow in the circuit. But the wave form is very irregular due to the sparking (see illustration in Hawkhead & Dowsett, so that only approximate tuning is possible. The tuning is in this case only to assist the current flow, not to manufacture a special frequency.

M. F. (Dartmouth).—Your calculation of the capacity of the variable condenser is correct. The capacity and inductance of the aerial will be given exactly by the method of the article in the March, 1916, WIRELESS WORLD. The method given in the "Year-Book of Wireless Telegraphy, 1916," is exactly the same but is given graphically instead of in the form of a table. To calculate the capacity of the aerial from its dimensions the method given in Professor Howe's articles is quite suitable. The term $-0{\cdot}63$ in his first example is obtained as follows: Since the distance between the horizontal wire and the image of the vertical wire is considerable, and moreover the correction due to the effect between them is small, it is sufficiently accurate to calculate the potential between these by assuming the charge on the vertical image to be collected at its middle point and to take the distance from this point to the middle point of either half of the horizontal wire. This distance = 158 feet, or $158 \times 30{\cdot}5$ centimetres. As the assumed charge is 1 unit per cm. the potential

$$= \frac{\text{charge}}{\text{distance}} = \frac{-100 \times 30{\cdot}5}{158 \times 30{\cdot}5} = 0{\cdot}63$$

The quantity $-1{\cdot}27$ is twice the above, $0{\cdot}63$, since we have charges at the mid-points of the two halves of the horizontal wire. In the second example the quantities

$$\frac{100 \times 200}{336} \text{ and } \frac{100 \times 600}{336}$$

are obtained in the same way, 336 feet being the mean distance as before. To calculate the inductance of a coil in the detector circuit the usual formula

$$\lambda_m = 1885\sqrt{L\,\text{mh},\ C\,\text{mfd.}}$$

is used. We are unable to go into details as to all your calculations of inductance of coils, as you can easily check them for yourself; from your letter it is evident you know the formulas and only need confidence in your results when worked out. For the inductance of a coil consisting of a number of windings separated by spaces on one former, the method given in the Instructional Article for May 1915, should be used. You will find the correct connections for a carborundum detector in "The Principles of Wireless Telegraphy," by R. D. Bangay, page 113.

SPECIAL NOTICE.

Readers will considerably facilitate the work of our Expert if they write their questions on one side of the paper only, and make their queries as clear and full as possible. Questions should be numbered for reference and should not exceed four.

APARTMENTS, special terms to Marconi Students only, 15 minutes by tube to "The Strand," good table, excellent references, 16/6 per week inclusive.—MRS. BARRY YORKE, 22 Hogarth Road, Earl's Court, London, S.W.

LADY seeks position as Wireless Instructor; fully qualified; excellent references.—Box No. 252, THE WIRELESS WORLD, Marconi House, Strand, London, W.C.

APARTMENTS.—One or two Gentlemen (operators, students or staff) could be comfortably accommodated as guests by member of Marconi staff. Nice house in pretty suburb within easy and speedy reach of Waterloo. 6d. return.—Write G. J. T., Box 41, THE WIRELESS WORLD, Marconi House, Strand, London, W.C.

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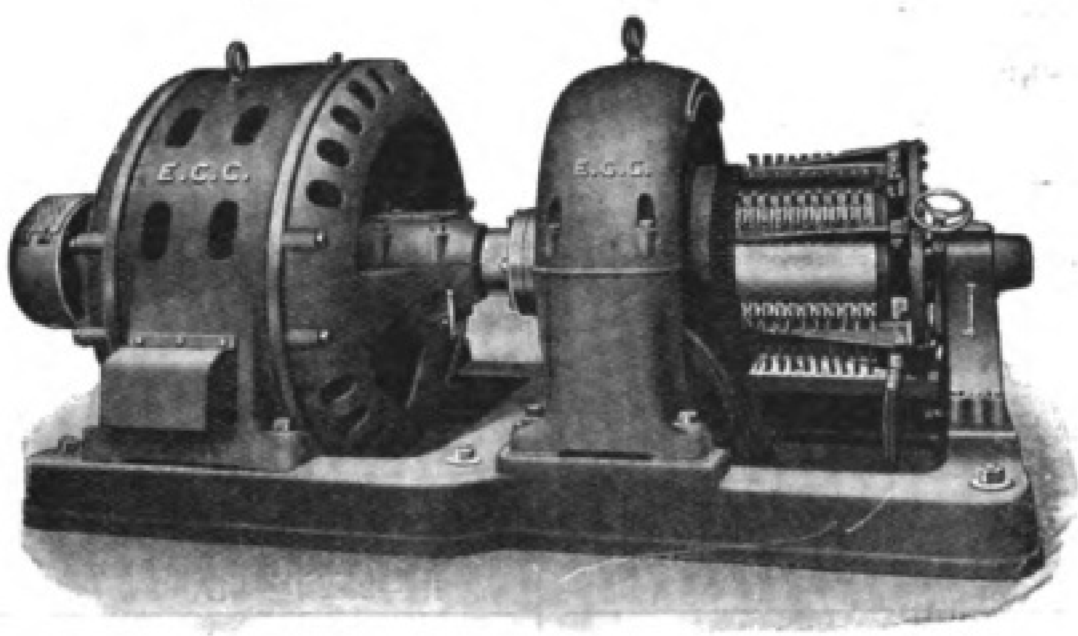

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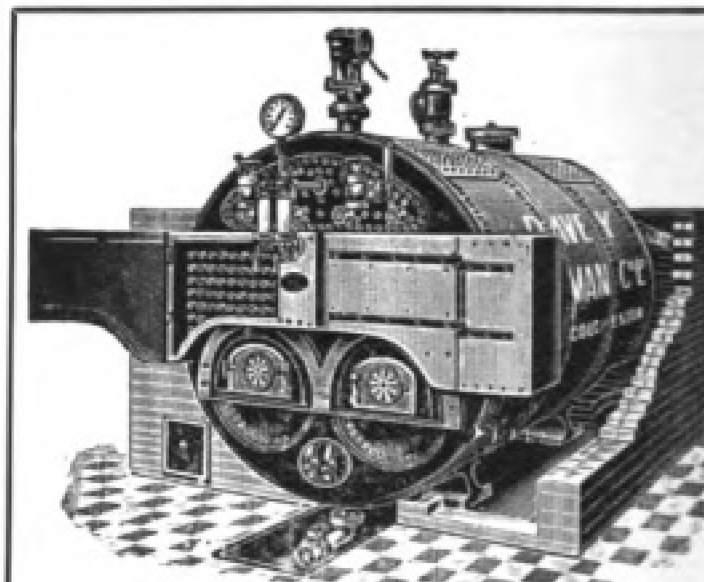

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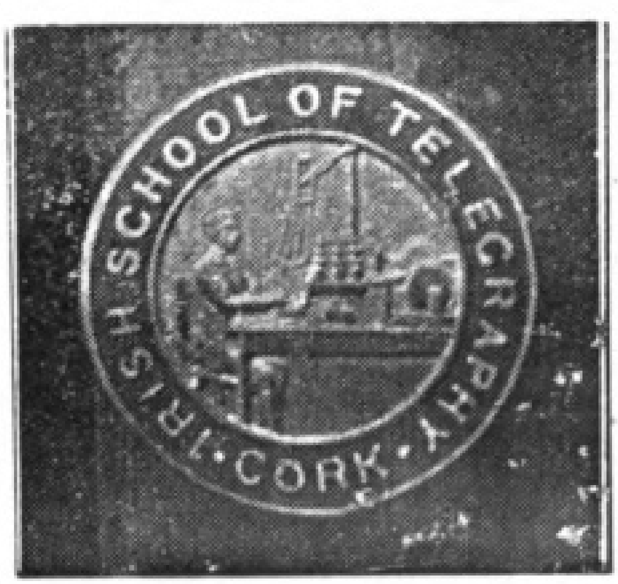

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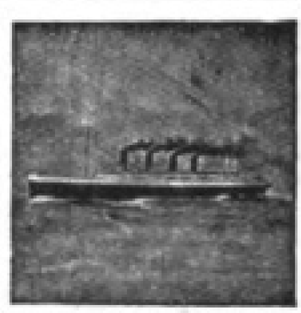

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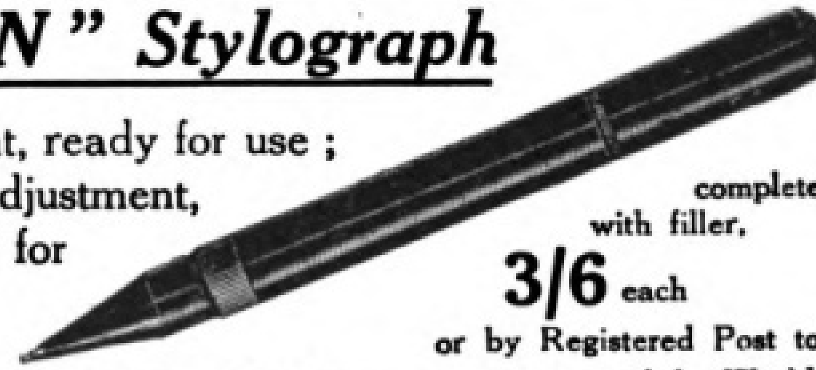

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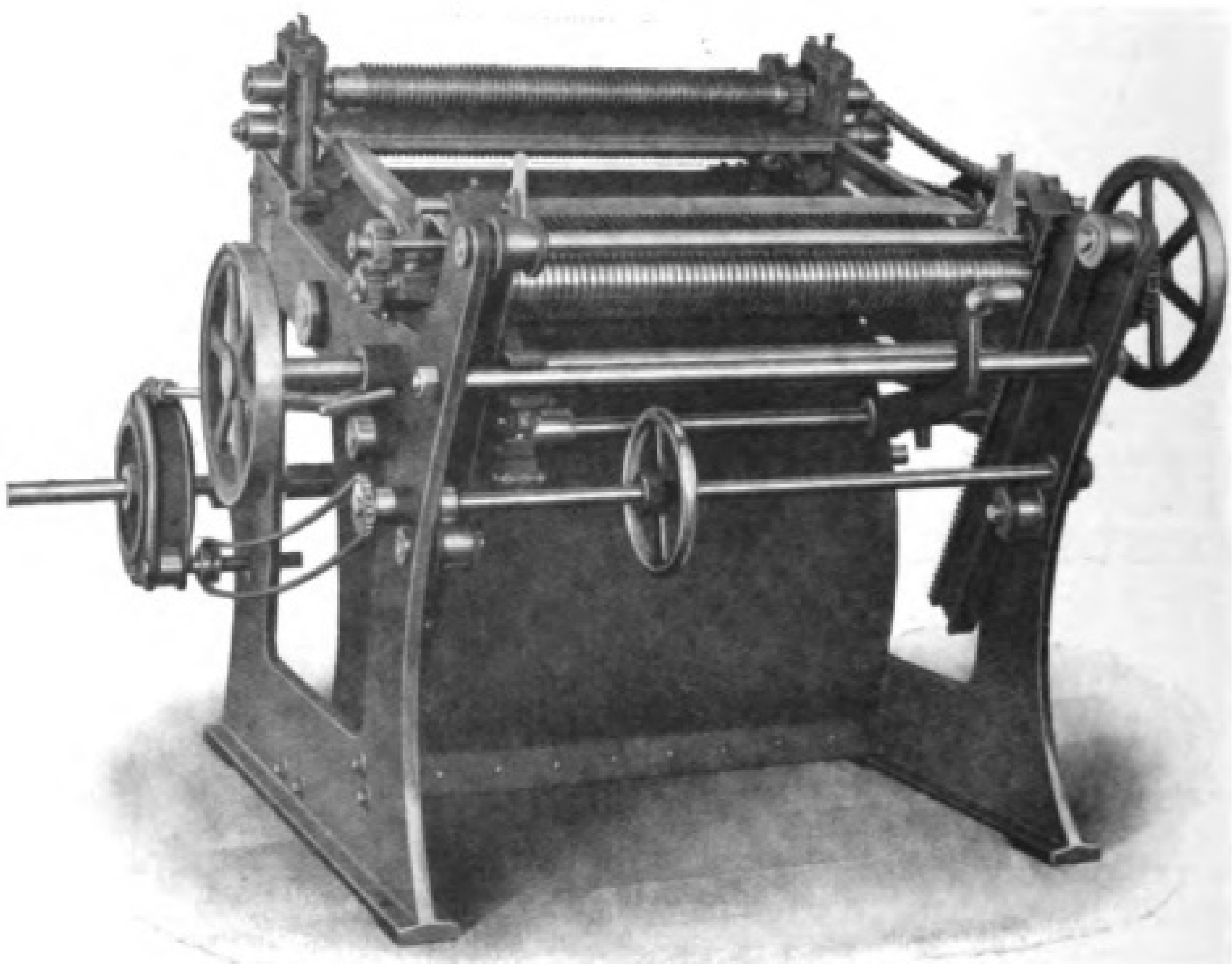

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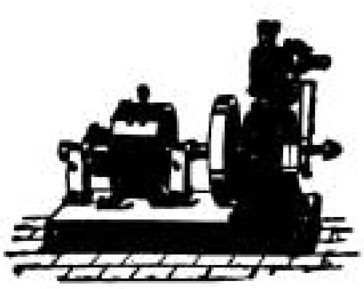

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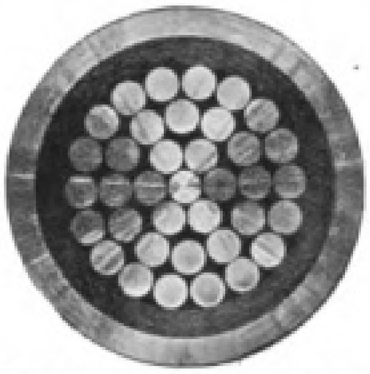

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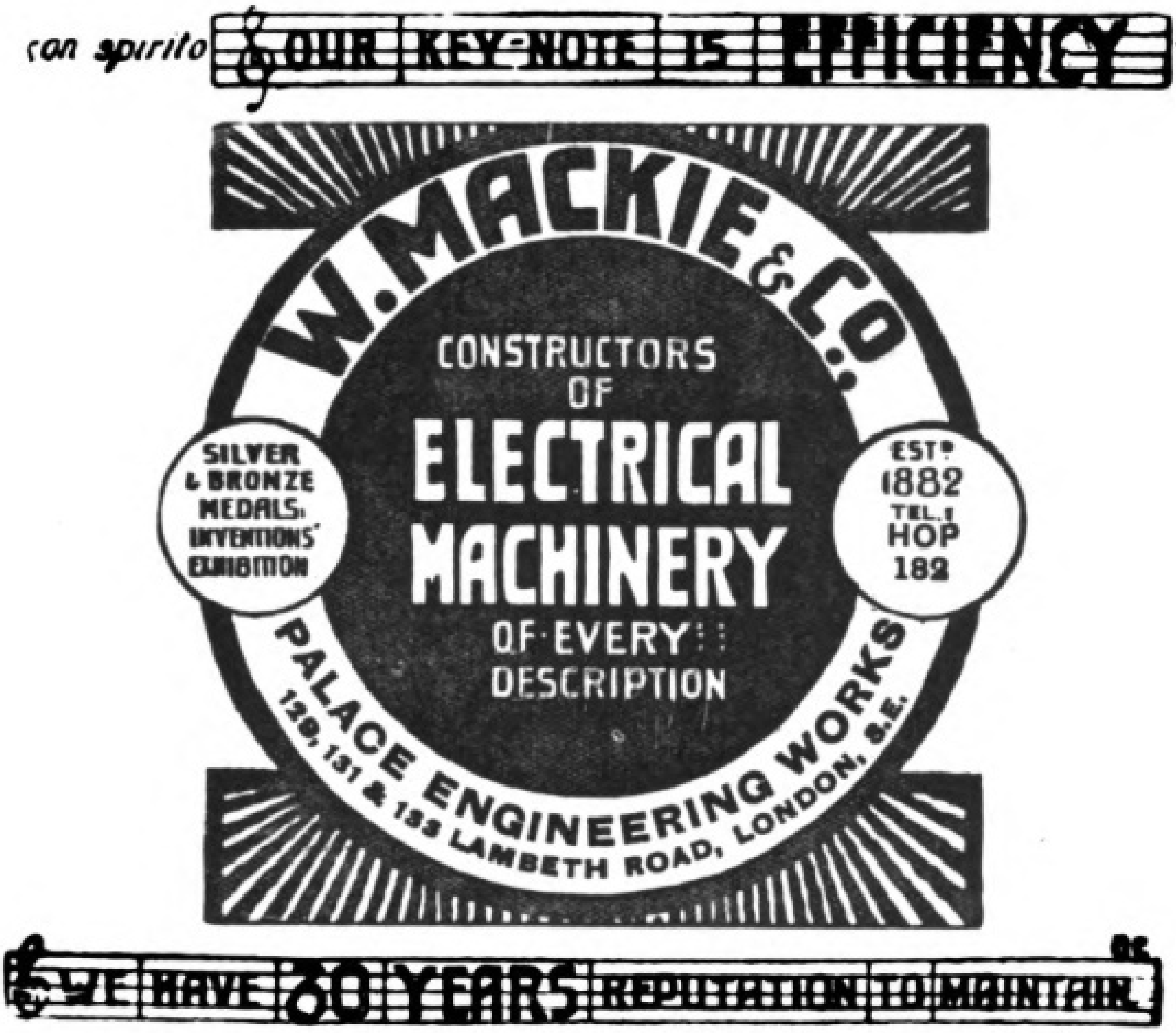

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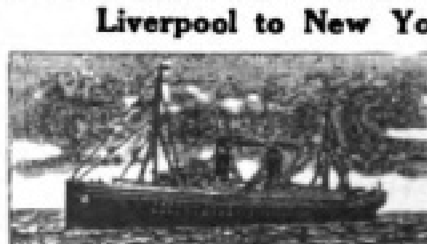

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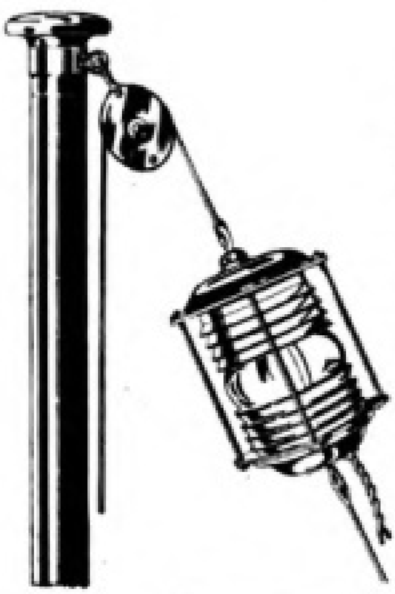

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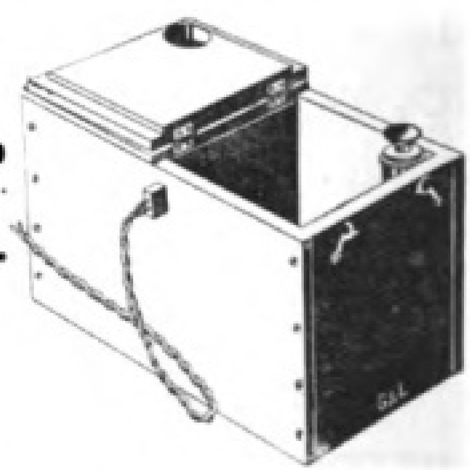

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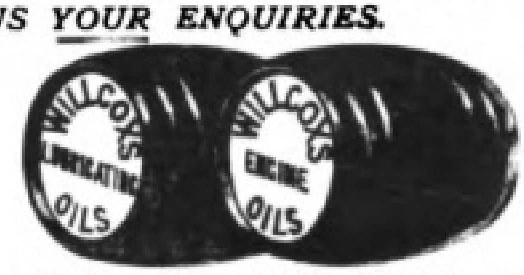

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