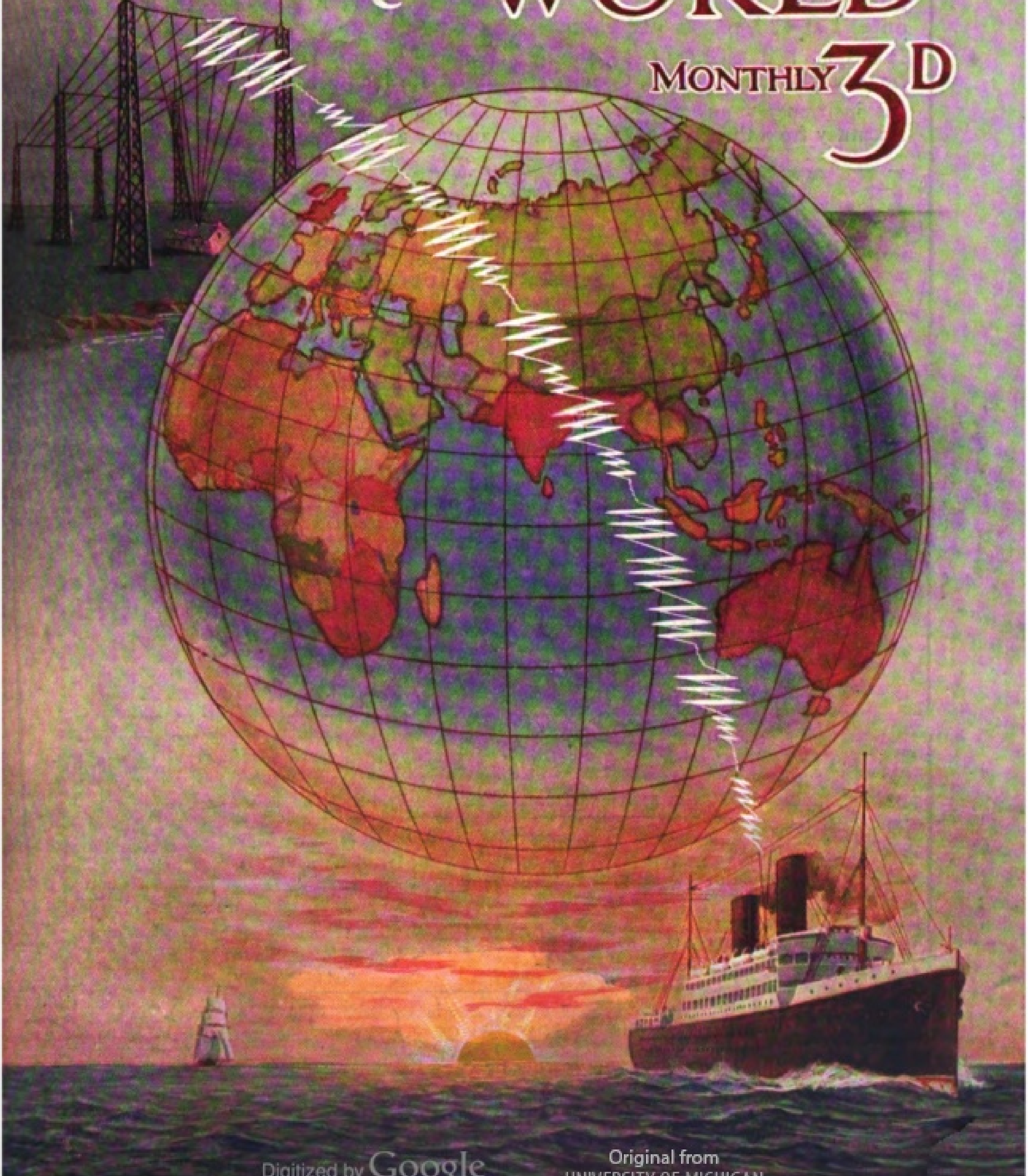
WIRELESS WORLD

MONTHLY 3D



THE WIRELESS WORLD

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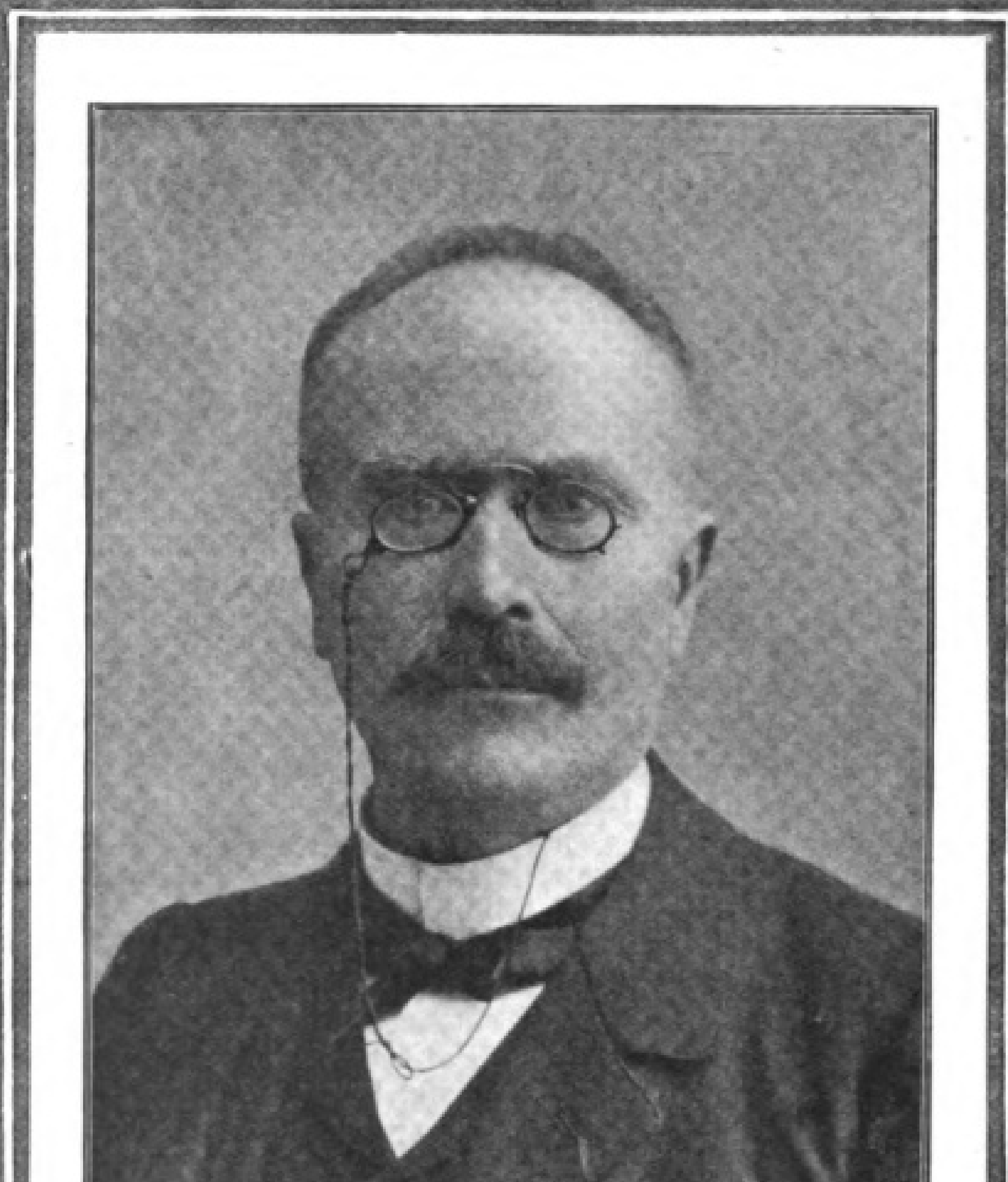
Progress

Remarks on the Practical Development of Wireless Telegraphy.

On October 22nd, 1913, our esteemed contemporary *Punch*, himself of world-wide fame, published a striking cartoon in which, as representative of the human race, he addressed Commendatore G. Marconi in the following terms: "Many hearts bless you to-day, Sir. The world's debt to you grows fast." A long series of examples had impressed the world with the value of the distinguished Italian's invention from the point of view of life-saving at sea, and it is no secret from those honoured by personal contact with him that this constitutes a feature which appeals most keenly to his kindly and sympathetic nature. The operators sent out by the various Marconi companies to take up duties at sea have shown themselves imbued with the same spirit of devotion to the cause of humanity. On every occasion when heroism has been demanded these young men have never failed. Were this the only result attained, it would in itself form as proud a record as that of any other invention; but this is only one field of activity amongst many.

No longer when steamers lose touch with land do they cease their intercourse with the rest of the world. Their wireless apparatus enables them to transmit and receive private messages of every description over a large area of the ocean, and keeps them in touch with the world's news. Anyone who, like the present writer, has had the experience of long sea voyages before the invention came in vogue and after, cannot fail to realise the immense difference which it makes to ocean travellers. Many vessels belonging to the mail steamship lines are able to publish newspapers containing the latest telegrams. As we write we have before us an instance where a vessel crossing the equator received news, published in one of these papers, of the result of last year's Derby ten hours after it was made known at Epsom; whilst another issue informed travellers from South America of the declaration of war by Great Britain four days before they could have received it by any other means.

Our current number and its recent predecessors emphasise more up-to-date development still in their series of articles entitled "Wireless Telegraphy in the War." It is not desirable, for obvious reasons, to go into these matters in detail; but it is impossible to take up a single daily paper, morning or evening, without having instances of its utility in this respect brought forcibly home. The winning of supremacy in the wireless message field places in the hands of one side or another an immense advantage over their rivals. It is hardly too much to say that the naval success of the Germans off the South American coast was largely due to the fact that they locally possessed in this respect superiority over the British admiral. When Admiral von Spee passed out of this sphere of local wireless advantage, he was taken by surprise and his fleet destroyed. The complete history of the exploits of wireless telegraphy in the war is still in the making. Its final record will be written when the course of events has lifted the veil now enveloping it.



PROFESSOR EDOUARD BRANLY

Personalities in the Wireless World

DR. EDOUARD BRANLY.

THE famous old city of Amiens, once the capital of Picardy, was the birthplace of Edouard Branly, who first saw the light under the shade of its cathedral of Notre Dame on October 23rd, 1844. The subject of our portrait page, who will be remembered by posterity as one of the small group of physicists who paved the way for wireless telegraphy, started his education in Amiens at the College of St. Quentin. Professor Branly afterwards placed himself under the wing of Paris University, the *alma mater* of French students, pursuing his studies at the Henri IV. College. Here he turned his attention in the direction of medicine and physical science and attained such distinction as to be elected a Fellow of the University. He graduated in 1873 with the degree of Doctor of Physics, and, continuing his study of medicine, became M.D. in 1882.

Before the latter distinction was secured, however, Dr. Branly had added to his fame in other directions. After graduating from Paris he received an appointment as Professor at the College of Bourges, and later as Director of Physical Instruction at the Sorbonne. He left the State University in 1876 to give lectures in Natural Philosophy at a free school for advanced students, and commenced a practice in medicine.

Dr. Branly's world-wide fame was assured by his electrical researches, particularly those associated with the intermittent electrical conductivity of radio-conductors. Although Mr. D. E. Hughes made remarkable observations on "distance-phenomena" connected with electric sparks as far back as 1879, Branly was the first to investigate and describe the fact that an electric spark at a distance had the power of changing loose aggregations of metallic powders from indifferent to good electric conductors. These investigations were first made public in 1900, and the apparatus which he employed as a detector of electrical waves was later known as a Branly coherer, the word "coherer" being coined by Sir Oliver Lodge.

In 1900 the International Jury of Superior Precept Instruction awarded Dr. Branly a *grand prix* for his exhibition of this class of scientific apparatus, and the French Minister of Public Instruction conferred upon him the coveted distinction of the ribbon of Chevalier of the Legion of Honour. This decoration was accorded to Professor Branly in recognition of the part he has played in connection with the discoveries and extension of wireless telegraphy.

In 1899, just prior to the publication of his researches in the new field of electrical phenomena, Dr. Branly was invested by Pope Leo XIII. with the Order of Commander of St. Gregory the Great.

The researches of Dr. Branly, which he treats in an interesting style, a factor too often neglected by scientific writers, appeared in volumes cxi. and cxii. of *Comptes Rendus*, published between 1902 and 1906.

In 1903 Dr. Branly was awarded the Osiris Prize in conjunction with Mme. Curie (of radium fame), and in 1910 he became the recipient of double honours, being awarded the Argenteuil Prize and an Associateship of the Royal Belgian Academy.

In later years he has devoted special attention to the investigation and construction of various independent distributing apparatus for producing tele-mechanical effects without wires. He also constructed, in 1906, a safety apparatus, independent of syntonisation, for preventing the action of accidental sparks in tele-mechanical effects without wires, whilst permitting exclusive correspondence between a transmitting and a receiving post.

These researches, combined with his previous achievements, resulted during January, 1911, in his election as a member of the Academy of Science in Paris.

On the Capacity of Radio-Telegraphic Antennæ*—III.

By Prof. G. W. O. HOWE, D.Sc.

IN *The Electrician* of February 14th and 21st, 1913, Mr. Louis Cohen develops a method of calculating the capacity of antennæ from the self and mutual inductances of the wires, and finally applies his formulæ to two actual antenna :—

1. A 10-wire antenna of the dimensions taken in the above example, but at a height of 64 ft.

His calculated capacity is 0·0007, to which he adds 0·00013 for the leading-in wire, making a total of 0·00083 mfd., *whereas the measured capacity was* 0·00105, *a difference of about* 20 *per cent.*

He then says : " While these formulæ cannot be depended upon to give results with any degree of accuracy, yet it is hoped that they will be of service to wireless engineers." Fortunately, however, there is no need for radio-telegraph engineers to be content with formulæ which give results differing from the real values by 20 per cent.

Let us now calculate the capacity of the above antenna by the formulæ developed in the present Paper

$$\frac{l}{h}=\frac{155}{64}\cdot\frac{nl}{4h}=\frac{10\times155}{4\times64}=6{\cdot}06,$$

or $$\frac{l}{2h}=1{\cdot}212,\ \mathrm{E}=1{\cdot}1 \text{ and } n\mathrm{E}/2=5{\cdot}5;$$

therefore $$\mathrm{C}=\frac{170}{34{\cdot}75-6{\cdot}06}=5{\cdot}93,\ 10^{-6} \text{ mfd. per}$$

foot, or, by the more accurate formula,

$5{\cdot}81,\ 10^{-6}$ mfd. per foot.

The total capacity will therefore be

$5{\cdot}81\times155\times10^{-6}$ mfd. $=0{\cdot}0009$,

to which 0·00013 has to be added for the leading-in wire, *making a total of* 0·00103 *mfd., which agrees almost exactly with the measured value.*

2. Mr. Cohen does not give the size of the wire in his second example, but assuming that the wire is the same as that in the other case, the capacity calculated by the above method agrees with his calculation, which differs from the measured capacity by 28 per cent. There is evidently something wrong, however, with the measurements, as the second antenna has the same number of wires (10) closer together (2 ft. instead of 2·5 ft.), only 110 ft. long instead of 155 ft , 80 ft. high instead of 64 ft., and yet its measured capacity is only 10 per cent. less. Not only so, but Mr. Cohen's calculated values only differ by 10 per cent., whereas it is obvious, from the data given, that the second antenna must have a much smaller capacity than the first. By the formulæ developed in this Paper it should be 32 per cent. smaller, if the leading-in wires are neglected.

If the second antenna had an effective distance from earth of 25 ft. instead of 80 ft., the calculated capacity would agree with that measured, and it would therefore be interesting to know whether the space between the antenna and earth was occupied by buildings.

IRREGULAR ANTENNÆ AND THE EFFECT OF LEADING-DOWN WIRES.

The calculation of the capacity of an antenna is usually complicated by the presence of the leading-down wire or wires, which make the application of the simple formulæ and curves which we have developed impossible, except as a first approximation. The method which we have applied to antennæ of regular shape can be applied, however, to any arrangement of overhead wires, and, although simple formulæ of general application cannot be used, the calculation of the capacity in any given case can be carried out very rapidly to a high degree of accuracy by the aid of formulæ which we shall now consider.

* Paper read before the British Association at Sydney, N.S.W.

If the antenna under consideration be of the ordinary T type, with a vertical leading-down wire at the centre, and a uniform distribution of charge be assumed over the whole antenna, including the vertical wire, then the average potential of the horizontal part will be the sum of four potentials due, viz., to itself, to the vertical wire, to its own image and to the image of the vertical wire. The average potential of the vertical wire will similarly be made up of four components. If these component potentials can be readily computed, the average potential over the whole antenna, and therefore its capacity, can be found.

We shall consider the various problems here involved, and shall then apply the method to a few actual examples to show the relative importance of the various items.

POTENTIAL OF A VERTICAL WIRE DUE TO THE INDUCED CHARGE ON THE EARTH.

If a wire, ABC, is uniformly charged, the potential V_a at the point A, due to the whole charge, may be considered as the sum of the potentials at the same point due to the two parts AB and BC. Hence, V_a due to BC $= V_a$ due to AC $- V_a$ due to AB. Applying this principle to Fig. 21, which represents a vertical wire with its lower end near the earth, we see that the potential V_p at any point, P, due to the uniform distribution of unit charge per centimetre on the image, is given by the formula

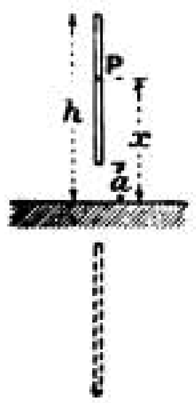


Fig. 21

$$V_p = \log_e \frac{2(x+h)}{r} - \log_e \frac{2(x+a)}{r},$$

and for the average potential over the wire due to the image we have

$$V = \frac{1}{h-a}\int_a^h \left(\log \frac{2(x+h)}{r} - \log \frac{2(x+a)}{r}\right) dx,$$

which, integrated out, gives

$$V = \frac{1}{h-a} \log_e \frac{2^{2(a+h)} h^{2h} a^{2a}}{(a+h)^{2(a+h)}}.$$

$$= \frac{1}{h-a} \log_e \frac{2^{2(a+h)} \left(\frac{a}{h}\right)^{2a}}{\left(1+\frac{a}{h}\right)^{2h} \left(1+\frac{a}{h}\right)^{2a}}.$$

If a is small compared with h, *i.e.*, if the lower end of the wire is close to the earth, we have approximately

$$V = \frac{1}{h} \log 2^{2(a+h)} \left(\frac{a}{h}\right)^{2a}$$

or

$$V = \frac{1}{h}\left[2(a+h)\log_e 2 + 2a \log_e \left(\frac{a}{h}\right)\right],$$

or, neglecting the second term because a is very small,

$$V = 2 \log_e 2 = 1{\cdot}38.$$

Hence the average potential of a wire, the bottom end of which is close to the earth, due to its image—that is, due to the charges induced on the earth—is 1·38 times the charge per unit length. This is very easily proved for the case in which the wire is actually touching the ground, *i.e.*, when $a=0$, as follows. The average potential of a wire of length $2l$ due to its own charge is $2\left(\log_e \frac{2l}{r} - 0{\cdot}31\right)$, and this must also be the average potential of one-half of the wire; but the average potential of this half due to its own charge is $2\left(\log_e \frac{l}{r} - 0{\cdot}31\right)$, and the difference, viz., $2\left(\log_e \frac{2l}{r} - \log_e \frac{l}{r}\right)$ or $2 \log_e 2$, must be due to the charge on the other half. This figure falls off rapidly as the distance of the lower end from the earth is increased, and by working out a number of examples by means of the accurate formula

$$V = \frac{1}{h-a} \log_e \frac{2^{2(a+h)} h^{2h} a^{2a}}{(a+h)^{2(a+h)}}$$

it is found that, for the cases most likely to arise in practice, where the lower end is 3 ft. or 4 ft. from the ground, the potential due to the earth is approximately equal to the charge per unit length, and not to 1·38 times this value. Seeing that this potential due to the earth is in any case small compared with the potential due to the charge on the wire itself, from which it has to be subtracted, there is no need for very great accuracy in its determination.

TWO WIRES MEETING AT RIGHT ANGLES.

To find the average potential of AC due to a uniformly distributed charge of 1 unit

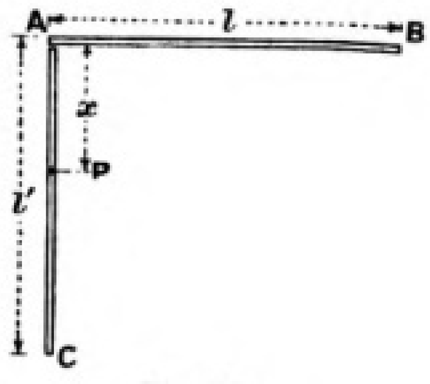


Fig. 22.

per centimetre of length on AB. Consider a point P, on AC (Fig. 22).

$$V_P = \sinh^{-1}\frac{l}{x}.$$

Average potential from A to C

$$\frac{1}{l'}\int_r^{l'} \sinh^{-1}\frac{l}{x}\,dx$$
$$=\frac{1}{l'}\left[x\sinh^{-1}\frac{l}{x} + l\sinh^{-1}\frac{x}{l}\right]_r^{l'}$$

NOTE—

$$\int \sinh^{-1}\frac{l}{x}\,dx = x\sinh^{-1}\frac{l}{x} - \int x\,d\left(\sinh^{-1}\frac{l}{x}\right)$$
$$= x\sinh^{-1}\frac{l}{x} + \int x\cdot\frac{1}{\sqrt{1+\frac{l^2}{x^2}}}\,\frac{l}{x^2}\,dx$$
$$= x\sinh^{-1}\frac{l}{x} + l\int\frac{dx}{\sqrt{l^2+x^2}}$$
$$= x\sinh^{-1}\frac{l}{x} + l\sinh^{-1}\frac{x}{l}.$$

$\therefore$ Av. pot.

$$=\frac{1}{l'}\left[l'\sinh^{-1}\frac{l}{l'} - r\sinh^{-1}\frac{l}{r} + l\sinh^{-1}\frac{l'}{l} - l\sinh^{-1}\frac{r}{l}\right].$$

If we put

$$\frac{l'}{l} = \frac{\text{length of uncharged wire}}{\text{length of charged wire}} = m,$$

$$V_{av} = \sinh^{-1}\frac{1}{m} + \frac{1}{m}\sinh^{-1}m - \frac{r}{l'}\sinh^{-1}\frac{l}{r} - \frac{1}{m}\sinh^{-1}\frac{r}{l}$$

of which the last two terms are negligibly small, so that

$$V_{av} = \sinh^{-1}\frac{1}{m} + \frac{\sinh^{-1}m}{m}.$$

The values of V_{av} for different values of m are given in Table XIV., and are plotted in Fig. 23.

The variation of the potential along the uncharged wire is shown in Fig. 24, where the abscissæ represent distance from the junction.

To calculate the potential accurately, we should require to know the average potential

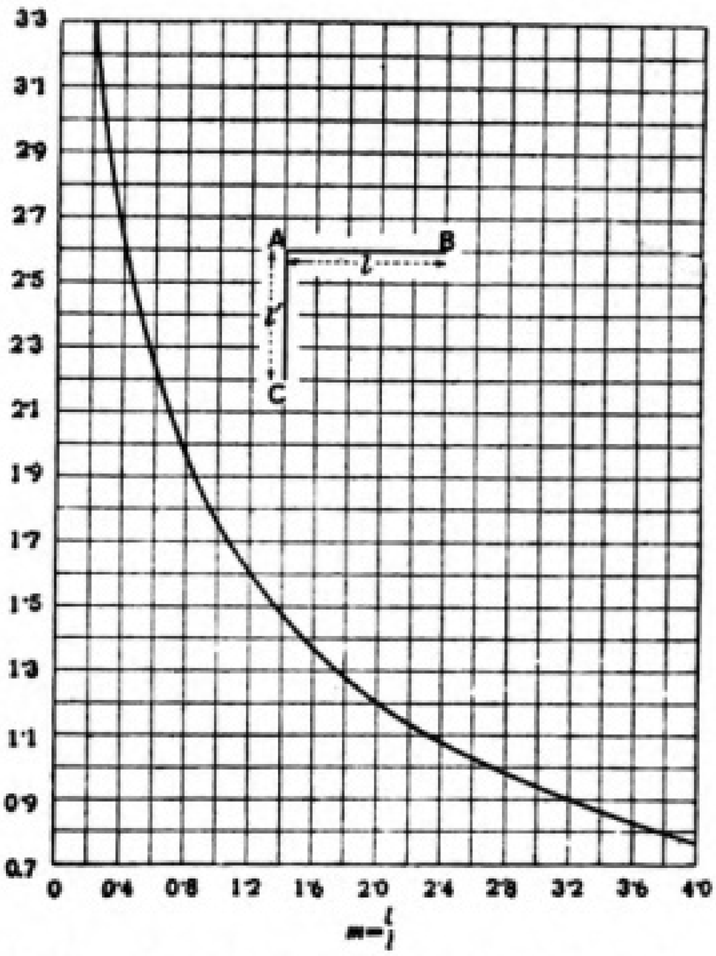


Fig. 23.—Average Potential of Wire, AC, due to Unit Charge per Centimetre on Wire AB.

TABLE XIV.

m.	V_{av}.	m.	V_{av}.
0·2	3·31	1·5	1·422
0·4	2·625	2·0	1·20
0·6	2·23	3·0	0·94
0·67	2·134	4·0	0·77
0·8	1·957	6·0	0·58
1·0	1·754		

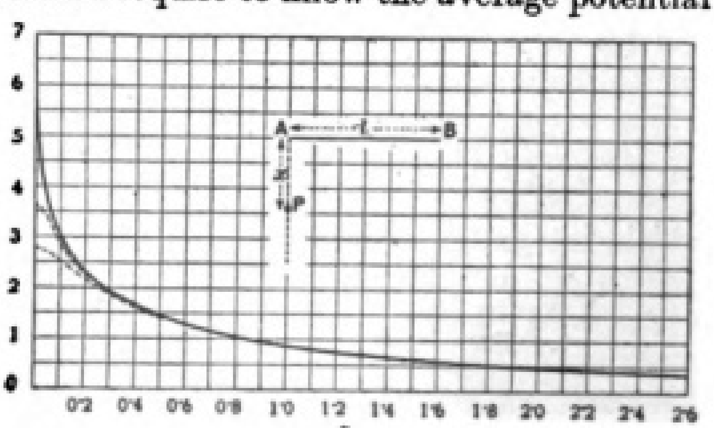


Fig 24.—$\sinh^{-1}\frac{l}{x}$=Potential at P due to Unit Charge per Centimetre on AB.

of each vertical wire due to the charge on each horizontal wire. For instance, in Fig. 25 we should have to work out the

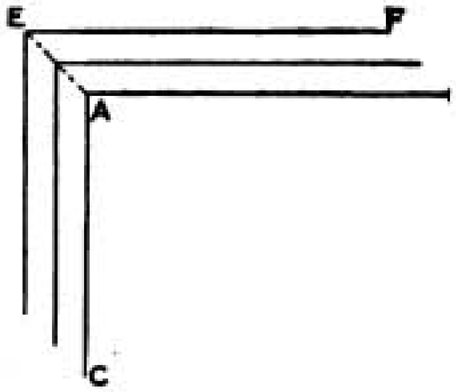


Fig. 25.

average potential of AC due to the charge on EF, and similarly for every other combination of a horizontal and a vertical wire. This would obviously be a laborious procedure, and is really unnecessary, as a close approximation to the necessary correction can be obtained in a simple manner as follows :—

The distance to which the wires approach at their nearest points varies for an outer wire from 0 to $(n-1)d$, and for a middle wire from 0 to $\frac{n-1}{2}d$, where d is the distance between adjacent wires. The average distance between a vertical and a horizontal wire at the junction is not a fixed fraction of the over-all width, but depends on the number of wires, as follows :—

TABLE XV.

n.	Mean distance in terms of over-all width.
2	0·5
3	0·445
4	0·416
5	0·386
10	0·366

If, now, we assume that all the, n, horizontal wires and the, n, vertical wires are bunched together into one horizontal and one vertical wire, not meeting at a point but separated by this mean distance, then the average potential of either due to the charge on the other wire will be a close approximation to the actual case.

The fact that the wires do not meet will not appreciably affect the potential except in the neighbourhood of the "junction." The dotted curves in Fig. 24 give the potential along the vertical wire on the assumption that it is displaced perpendicular to the plane of the paper, so that its upper end is at a distance from A equal to $0{\cdot}05l$ for the upper curve and $0{\cdot}12l$ for the lower curve. The average potential can be found for various lengths of vertical wire by finding the areas enclosed between these dotted curves and the base line. This has been done for a number of cases, and the results are plotted in Fig. 26, in which the ordinates are the percentages by which the values obtained from Fig. 23 must be reduced. The three curves refer to three different ratios of the mean distance between wires to the length of the charged portion, this latter length being measured, however, on one side only of the junction, as is clearly

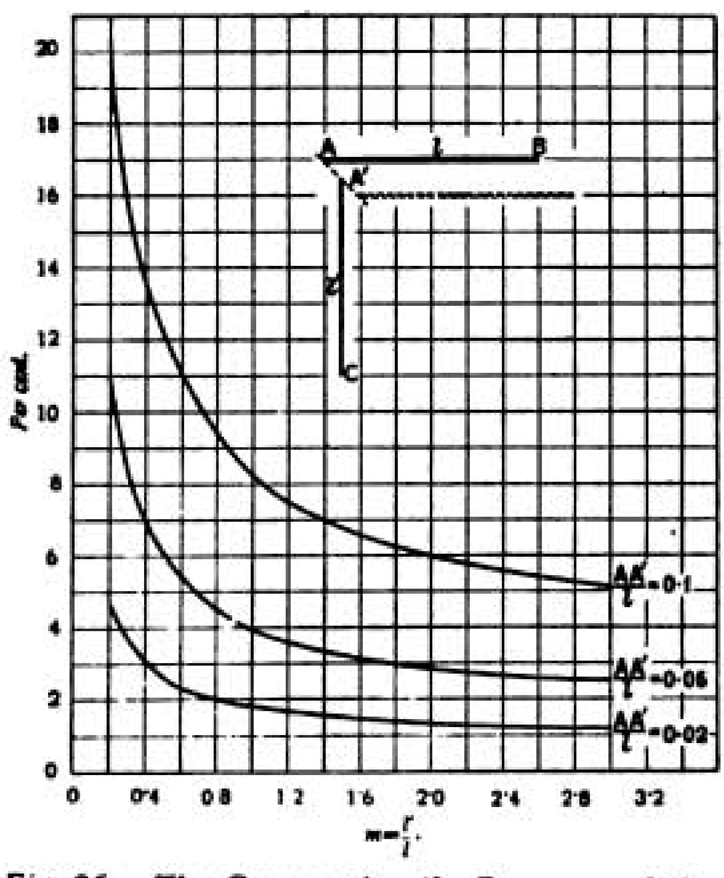


Fig. 26.—The Curves give the Decrease of the Average Potential of A'C Due to the Charge on AB when A and A' do not Coincide.

shown in the figures. The mean distance between the wires is found from the over-all width by means of Table XV.

AVERAGE POTENTIAL OVER THE WIRE AB DUE TO A UNIFORM CHARGE ON THE WIRE BC (Fig. 27).

This problem is important in fan-shaped antennæ and where the leading-down wires

B

are arranged in this way. We shall calculate the average potential of the wire AB due

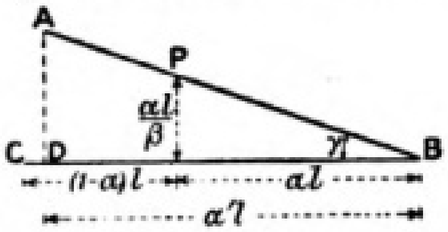


Fig. 27.

to a uniformly distributed charge of 1 unit per centimetre on the wire BC.

Let $\beta = \text{cotan}\ \gamma$,

then $\frac{\beta}{\sqrt{\beta^2+1}} = \cos\gamma$

and $\frac{1}{\sqrt{\beta^2+1}} = \sin\gamma$.

For the potential at the point P on the wire AB we have

$$V_P = \sinh^{-1}\beta + \sinh^{-1}\left(\frac{1-\alpha}{\alpha}\beta\right)$$

and

$$V_{av} = \sinh^{-1}\beta + \frac{1}{\alpha'}\int_0^{\alpha'} \sinh^{-1}\left(\frac{1-\alpha}{\alpha}\beta\right)d\alpha\ ;$$

$$V_{av.} = \sinh^{-1}\beta + \frac{1}{\alpha'}\left\{\left[\alpha\sinh^{-1}\frac{1-\alpha}{\alpha}\beta\right]_0^{\alpha'} - \int_0^{\alpha'} \alpha\frac{-\dfrac{\beta}{\alpha^2}}{\sqrt{1+\dfrac{(1-\alpha)^2}{\alpha^2}\beta^2}}d\alpha\right\}$$

$$\left[\text{NOTE. } \frac{d\left(\sinh^{-1}\dfrac{1-\alpha}{\alpha}\beta\right)}{d\alpha} = \frac{1}{\sqrt{1+\dfrac{(1-\alpha)^2\beta^2}{\alpha^2}}}\times\frac{-\beta}{\alpha^2} = \frac{-\beta}{\alpha\sqrt{\alpha^2+(1-\alpha)^2\beta^2}}\right]$$

Therefore

$$V_{av.} = \sinh^{-1}\beta + \frac{1}{\alpha'}\left[\alpha\sinh^{-1}\frac{1-\alpha}{\alpha}\beta\right]_0^{\alpha'} + \frac{1}{\sqrt{1+\beta^2}}\left[\sinh^{-1}\frac{\alpha(1+\beta^2)-\beta^2}{\beta}\right]_0^{\alpha'}$$

$$= \sinh^{-1}\beta + \sinh^{-1}\left(\frac{1-\alpha'}{\alpha'}\beta\right)$$

$$+ \frac{\cos\gamma}{\alpha'}\left\{\sinh^{-1}\left(\frac{\alpha'(1+\beta^2)}{\beta}-\beta\right) + \sinh^{-1}\beta\right\}$$

If the wires are equal in length—*i.e.*, AB=BC,

$$\alpha' = \text{cosine}\ \gamma, \qquad \beta = \text{cotan}\ \gamma = \frac{\alpha'}{\sqrt{1-\alpha'^2}},$$

$$\therefore \frac{\alpha'^2}{1-\alpha'^2} = \beta^2,\ \therefore \alpha'^2 = \frac{\beta^2}{1+\beta^2},\ \therefore \alpha' = \frac{\beta}{\sqrt{1+\beta^2}},$$

$$\therefore \frac{1-\alpha'}{\alpha'} = \frac{\sqrt{1+\beta^2}-\beta}{\beta}$$

and

$$V_{av} = \sinh^{-1}\beta + \sinh^{-1}(\sqrt{1+\beta^2}-\beta) + \sinh^{-1}(\sqrt{1+\beta^2}-\beta) + \sinh^{-1}\beta_1$$

$$= 2\{\sinh^{-1}\beta + \sinh^{-1}(\sqrt{1+\beta^2}-\beta)\}$$

$$= 2\log_e(1+\sqrt{1+(\text{cosec}\ \gamma + \text{cotan}\ \gamma)^2}).$$

This is the average potential of one wire due to a uniformly distributed charge of 1 unit per centimetre on the other, both wires being of the same length. In the following table the value of $V_{av.}$ is given for various values of β and γ; intermediate values can be read off the curve in Fig. 28.

TABLE XVI. (*See* Fig. 28.)

γ.	β	$\sinh^{-1}\beta$.	$V_{av.}$	d/AD.
0·95°	60·3	4·78	9·58	0·366
1·9°	30·0	4·10	8·24	0·366
5·7°	10·0	3·00	6·10	0·366
11·3°	5·0	2·31	4·82	0·367
18·45°	3·0	1·82	3·96	0·359
26·55°	2·0	1·445	3·37	0·355
45·0°	1·0	0·881	2·57	0·363

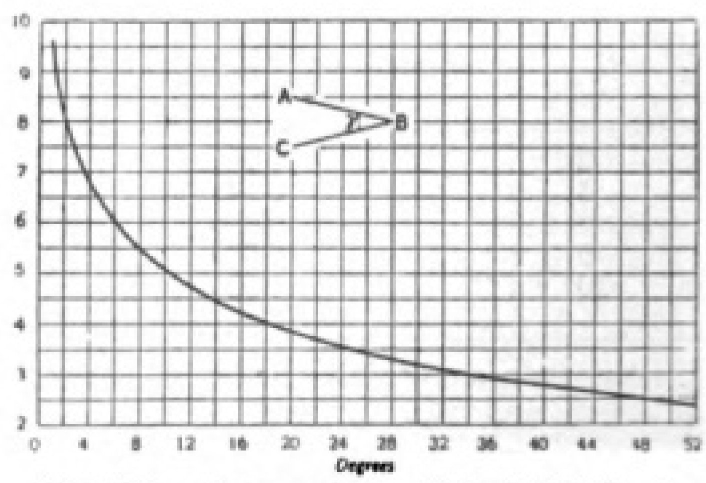


Fig. 28.—Average Potential of AB due to Unit Charge per Centimetre on BC.

The distance, d, has been calculated at which the wires would have to be placed parallel to each other, so that the potential of each due to the charge on the other would be the same as it actually is with the wires at an angle. From the last column it is seen that this distance is always 0·36 to 0·37 of their greatest distance apart. Fan-shaped antennæ and leading-down wires can, therefore, be treated as parallel wires with the value of d determined in this way.

When γ is very small $\sinh^{-1}(\sqrt{1+\beta^2}-\beta)$ is negligible and $V_{av.}=2\sinh^{-1}\beta$. Now, the potential at the point on the uncharged wire immediately opposite the mid point of the charged wire has always this value, and from the table we see that for angles up to 6° the average potential is within 2 per cent. of the potential at this point.

Example I.—Calculation of the capacity of a single horizontal wire and vertical leading-down wire at centre

$$l=200 \text{ ft.}$$
$$r=0{\cdot}048 \text{ in.}$$
$$l/r=50{,}000$$
$$h=100 \text{ ft.}$$

Assume unit charge per centimetre, then $2\pi r\sigma=1$.

Potential of horizontal wire—

Due to its own charge

$$=2\left(\log_e\frac{l}{r}-0{\cdot}31\right) \quad = \quad 20{\cdot}98 \text{ (see Fig. 3)}$$

Due to vertical wire

$$\left(\text{note, } m=\frac{100}{100}\right) \quad = \quad 1{\cdot}76 \text{ (see Fig. 23)}$$

Due to its own image

$$\left(\frac{l}{d}=\frac{l}{2h}=\frac{200}{200}\right) \quad = \; -\; 0{\cdot}94 \text{ (see Fig. 20)}$$

Due to image of vertical wire (approx.)

$$= -\;0{\cdot}63$$

$$\text{Total} = \quad 21{\cdot}17$$

Potential of vertical wire—

Due to its own charge $= 19{\cdot}58$

Due to horizontal wire $\left(m=\frac{100}{100}\right) = 3{\cdot}52$

Due to its own image $= -1{\cdot}00$

Due to horizontal image $= -1{\cdot}27$

$$\text{Total} = 20{\cdot}83$$

Average potential of whole antenna

$$=\frac{200\times 21{\cdot}17+100\times 20{\cdot}83}{300}=21{\cdot}06.$$

Charge on whole antenna

$$=300\times 30{\cdot}5=9{,}150 \text{ units.}$$

$$\text{Capacity}=\frac{Q}{V}=\frac{9{,}150}{21{\cdot}06}=435 \text{ electrostatic}$$

units.

= 483 micro-mfds.

For the sake of comparison it is interesting to note that if we neglect the proximity of the earth—

The capacity of—

$$\left.\begin{array}{l}100 \text{ ft. alone}=173\\ 200 \text{ ft. alone}=323\end{array}\right\}=496 \text{ micro-mfds.}$$

300 ft. alone = 467 micro-mfds.

Example II.—Ten parallel wires, 4 ft. apart. $l=600$ ft., $h=200$ ft., $r=0{\cdot}048$ in. Assume 10 leading-down wires at the centre of the antenna, converging to a point near the earth.

$$\frac{l}{d}=150. \quad \frac{d}{r}=1{,}000. \quad \text{Assume } 2\pi r\sigma=1.$$

Average potential of horizontal part—

Due to its own charge $=$

$$\frac{33{\cdot}9\times 10}{3{\cdot}845} \quad = \quad 88{\cdot}2 \text{ (see Fig. 13)}$$

Due to vertical part

$$\left(m=\frac{300}{200}\right)(n=10) \quad = \quad 13{\cdot}7 \text{ (see Fig. 23)}$$

Due to its own image

$$\left(\frac{l}{d}=\frac{l}{2h}=\frac{600}{400}\right) \quad = -13{\cdot}2 \text{ (see Fig. 20)}$$

Due to vertical image

$$\left(\frac{10\times 200}{336}\right) \quad = -\;6{\cdot}0 \text{ (approx.)}$$

$$\text{Total} = \quad 82{\cdot}7$$

Average potential of vertical pa·t—

Due to its own charge $= 84{\cdot}8$

Due to horizontal part

$$\left(m=\frac{200}{300}\right) \quad = \quad 40{\cdot}4$$

Due to its own image $= -10{\cdot}0$

Due to horizontal image

$$\left(\frac{10\times 600}{336}\right) \quad = -17{\cdot}9$$

$$\text{Total} = \quad 97{\cdot}3$$

Hence we have 10×600 ft. of wire at an average potential of 82·7, and 10×200 ft. of wire at an average potential of 97·3, or, together, 10×800 ft. of wire at an average potential of 86·35.

The total charge is 8,000×30·5 units, and the capacity is, therefore,

$$\frac{8{,}000\times 30{\cdot}5}{86{\cdot}35}=2{,}825 \text{ electrostatic units.}$$

= 3·14 milli-mfds.

NEW FORM OF TELEPHONE.

THE thermophone, a new form of telephone apparatus, which is said to be capable of giving a more faithful representation of sound than the ordinary type of hearing instrument, was explained to the members of the Royal Society at Burlington House by the inventor, M. de Lange, of Utrecht.

He pointed out that thirty-four years ago the late Sir William Preece connected a thin platinum wire with a diaphragm, and thereby succeeded in reproducing sound waves of the human voice on the diaphragm. Sir William Preece, however, never realised the great practical value of his invention. The great difference between it and the thermophone was that the latter was not associated with the mechanical operation of a wire, but depended simply and solely on a change of temperature in the wire, which made speech possible without any diaphragm.

RESULTS OF RUSSIAN EXPERIMENT.

Following the process of a Russian experimenter, who, by placing a Wollaston wire in an insulating medium and then treating the wire with acid, obtained a good thermophone (although it was impossible by this means to convey the required volume of sound), M. de Lange claimed to have succeeded in making the thermophone of practical everyday use by fixing a wire of a diameter of from two to twelve microns in a Gothic curve.

The thermophone, when listened to in the open air, sounded extremely weak, but as soon as the platinum wire was placed under a cover, which had a small opening or several small openings, the sound at once became clear and distinct. The volume of sound increased in accordance with the decrease in the size of the cover. The size which approximately agreed with the size of the human ear funnel seemed to be the most suitable. Metal covers were better than those of ebony, and by surrounding these with some cooling substance the acoustic effect became doubled. As to the theory of the thermophone, the most he could say was that the decrease and increase of heat in the platinum wire of the telephone took place isochronically with the vibrations in the microphone.

PROBLEMS OF RADIO-TELEGRAPHY.

WIRELESS TELEGRAPH CIRCUITS.

IN the Physics Section, Prof. Lyle read a paper on a "Mechanical Analogue and Model of Coupled Wireless Telegraph Circuits." The model has two gravity pendulums suspended from a carriage which moves very freely on wheels on a carefully levelled platform. When one pendulum is started its motion is affected by and communicated to the other at a rate and to an extent depending on the relative masses of the carriage and of the pendulums. Dr. Eccles complimented the author on realising a model which worked so perfectly and showed so accurately the behaviour of magnetically coupled circuits. Many models had been described previously, but most of these were wrong fundamentally, because they utilised elastic connections, such as rubber cords or steel springs, between the vibrators, whereas inertia only should be employed. Dr. Eccles described a simple model consisting of a string passing over two pulleys in fixed bearings and under an intermediate hanging loose pulley. At the ends of the string are tied two weights each equal to half the weight of the loose pulley, and these weights were pulled down by fixed vertical springs which gave two natural frequencies to the system. By varying the moment of inertia of the pulleys, various values of self and mutual inductance could be simulated. Of this model Prof. Lyle said it would only explain transmission, not reception.

SCIENTIFIC ASPECTS OF WIRELESS.

Prof. A. W. Porter, referring to Mr. Balsillie's observation of the occasional asymmetry in north and south signals, suggested that this might be due to the reflecting surface of the sky being corrugated parallel to circles of latitude, with the northerly faces of the corrugations all more nearly vertical than the southerly faces, or *vice versa*. In the case mentioned, waves propagated by the whispering gallery process would be propagated more abundantly from south to north than in the opposite direction, while east and west signalling would not be affected.

A Typical Norwegian Landscape.

From Continent to Continent

Linking Norway with the United States. High-speed Duplex Operation.

CARMEN SYLVA, Dowager Queen of Roumania, whose beautiful thoughts and lofty ideals provide a pleasant relief to much that is written to-day, reminds us that the sun never sees the world except bathed in warmth and light. This same suggestion applied from another view-point to a more material plane of life reminds us that behind the clouds of strife which now hover over Europe there is still a lining of peaceful pursuit—that neutral countries exist where the arts, science and engineering progress as usual.

In this perpetuation of progress Marconi engineers are playing a great part. They are continuing their peculiar task of bridging space with ethereal tremors, of uniting countries and peoples by a media which, undetected by the senses, still remains a mystery to the multitude.

Many fascinating chapters have been added to the romance of engineering in recent times, but it is doubtful whether any will excel in wonder that dealing with work at present in hand.

Were a stranger to buttonhole you to-morrow and insist that he was preparing to use snowflakes as high speed messengers between Europe and America, he would be quickly summed up as a possible danger to the public, and a certain candidate for a lunatic asylum.

Yet, safe from war's alarms, on the coastal plains of New England and the picturesque shores of Norway two groups of Marconi men are now hurrying forward the preparations for this very task. They are arranging that Scandinavia, through the silent snow-flakes " born in the bosom of the air " shall enjoy direct aerial intercommunication with America. Two thousand miles of ocean are to be bridged in a flash of time by the energy originally accumulated by myriads of snow-flakes settling on the rugged heights in the home of the Vikings.

Just over twelve months ago THE WIRE-

LESS WORLD published a report on the work accomplished at the Norwegian end of this new Transatlantic system. It was then pointed out that Stavanger and neighbourhood had been selected for the stations and that the workmen were already engaged in blasting rock for the foundations of the great steel masts. Interesting details were given of the manner in which the work was accomplished, and of the idiosyncrasies of the Norwegian workmen.

Now further details are to hand conveying not only fuller details of the Norwegian station, but of the giant counterparts on the other side of the Atlantic—at Marion, and Chatham in Massachusetts.

The interest taken by the Norwegians in the great works now in hand around Stavanger cannot be attributed entirely to the

Stavanger Fish Market.

novelty of wireless telegraphy, for Norway has six coastal stations open for "ship to shore communication." These stations are at Ingo, Bergen, Rost, Sorvaagen, Flekkero, and Tjomo, and as nine-tenths of the Norwegians live in villages on the coast or fiords, and rely upon steamships for their transport, there can be but few who by now have not seen something of the external equipment of a shore station.

It is the immensity of the structures that is inspiring these honest Scandinavians with awe and wonder. And they may well be excused, for even the experienced engineer will find something in them to arouse his admiration.

The receiving station at Stavanger is situated on an eminence behind the harbour, known as the Udlanhaug. From this hill a beautiful view is obtained of the neighbouring fiord scenery and of places intimately associated with stirring events in Norwegian history. The transmitting station at Naerbo, twenty-six miles southward on the coast, will derive its electrical energy from 30,000-volt dynamos driven by the power from waterfalls in the neighbourhood. The Norwegians are now missing no opportunity for adapting to industrial purposes their endless source of energy locally known as "white coals."

As the American stations are very similar to the Norwegian, and are more advanced in construction, the technical details of the former may be taken, unless otherwise stated, as applying equally to the Scandinavian stations.

The American receiving station is being constructed at Chatham in Massachusetts, Chatham being on Cape Cod, about seventy-five miles south-east of Boston. The transmitting station is at Marion, some forty miles distant, in the same State.

Thirteen years of experience in long distance transmission have shown that the ideal situations for operating stations are not necessarily elevated points on the coast-line. Directional work often finds other places more suitable, so that the preliminary survey of a site for such a station is now a very exacting duty. The difficulty of finding sites is enhanced by the fact that so much ground is now covered; for instance, the receiving station at Chatham requires a T-shaped tract of land, each limb being about 1½ miles long and 500 feet wide; whilst the transmitting station occupies a strip about 1½ miles long and 1,000 feet wide.

After a long period of negotiations the engineers on the American side settled on the places already indicated as the most suitable for directional work. They had in mind at the time the fact that these stations are to be arranged for duplex working—that is, they would be employed for sending and receiving messages at the same time.

At Chatham quite a village will spring up around the station, for in addition to the operating house, the power building and the usual stores, a hotel is to be constructed, and six cottages. There will be thirty-five operators working in three shifts, and in order that these men shall have the highest physical fitness, tennis courts and other recreation grounds are being built.

Two antennæ will be carried back about a mile and a half from the power-house on six tall steel masts, and in order to screen this aerial from interference by the transmitting station at Marion a balancing aerial supported on steel towers 100 feet high will be placed, pointing towards the Marion station.

The transmitting station at Marion will take power from public service mains supplying energy in three phases at 22,000 volts and 60 cycles. This will be transformed in the power-house by the most modern methods into the necessary high-frequency oscillating current. Forty tons of glass is stated to have been employed in the construction of the 390 tanks forming the electrical condenser banks.

The aerial wires radiating from the power-house will be supported on no less than fourteen masts, each 423 feet high. Upon the methods of constructing these masts details have already been given. They are being arranged in pairs, each pair being about 900 feet apart. These wires are suspended from cables stretched between the tops of these masts, and are thirty-two in number. After spreading fanwise from the power-house they run horizontally away from the power-house for about one mile and a quarter. The directivity of the emitted wave from this station is controlled by this arrangement.

Temporary Water Supply, Chatham Station.

Some Local Attractions—Human and Scenic.

By the equipment of these stations for duplex-working, messages can be sent from and received in America simultaneously. Apart from this, apparatus will be installed which will permit by its automatic operation of high speed transmission.

The traffic handling at the American end, which will be repeated at the station in Norway, will be roughly as follows: The messages for Europe, as fast as they are received over the land line at Chatham, will be distributed amongst operators, who, instead ot tapping them out on the actual transmitting key as in olden days, will translate them into Morse perforations on a paper tape. This work is performed on a machine similar in operation to a typewriter, and, as one pressure of the key provides all the Morse characters for that letter, considerable time is here saved. The tape is then automatically fed into a sender, which finds no difficulty in transmitting 100 words a minute.

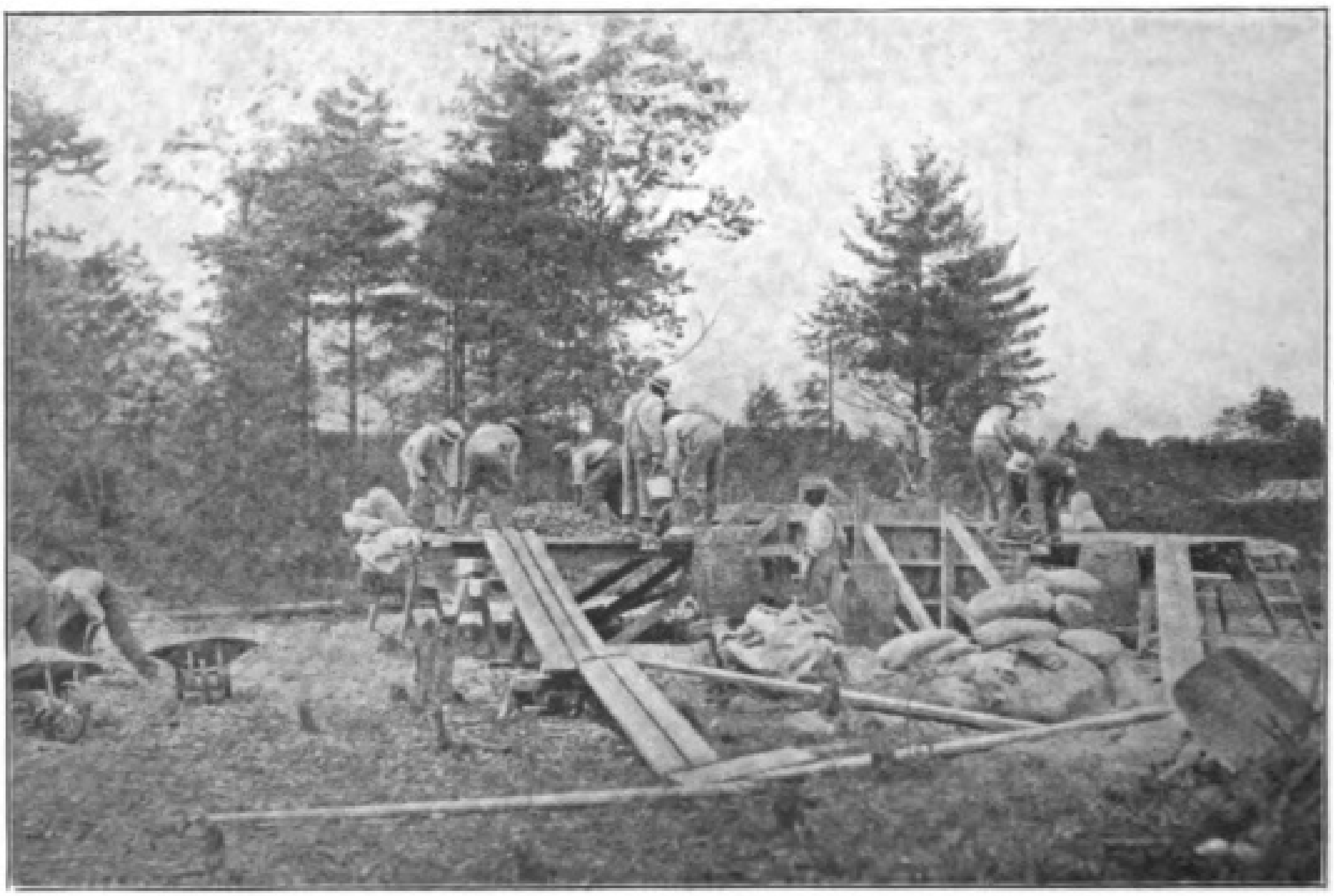
The flood of dots and dashes thus set under way by the Chatham station actuates relays at Marion which cause corresponding groups of high-frequency disturbances in the extensive aerial.

The receipt of messages transmitted at this speed is of course altogether outside the range of human ability, so the receiving stations in Norway and America will also be fitted for automatic reception. The machines employed for the purpose will resemble dictaphones in principle, the message being impressed upon a rotating cylinder by a stylus acting under the influence of the detector. As each cylinder is filled with impressions it will be handed to an operator, who, possessed of a dictating machine running at reduced speed, will translate it into what we in this country term " King's English."

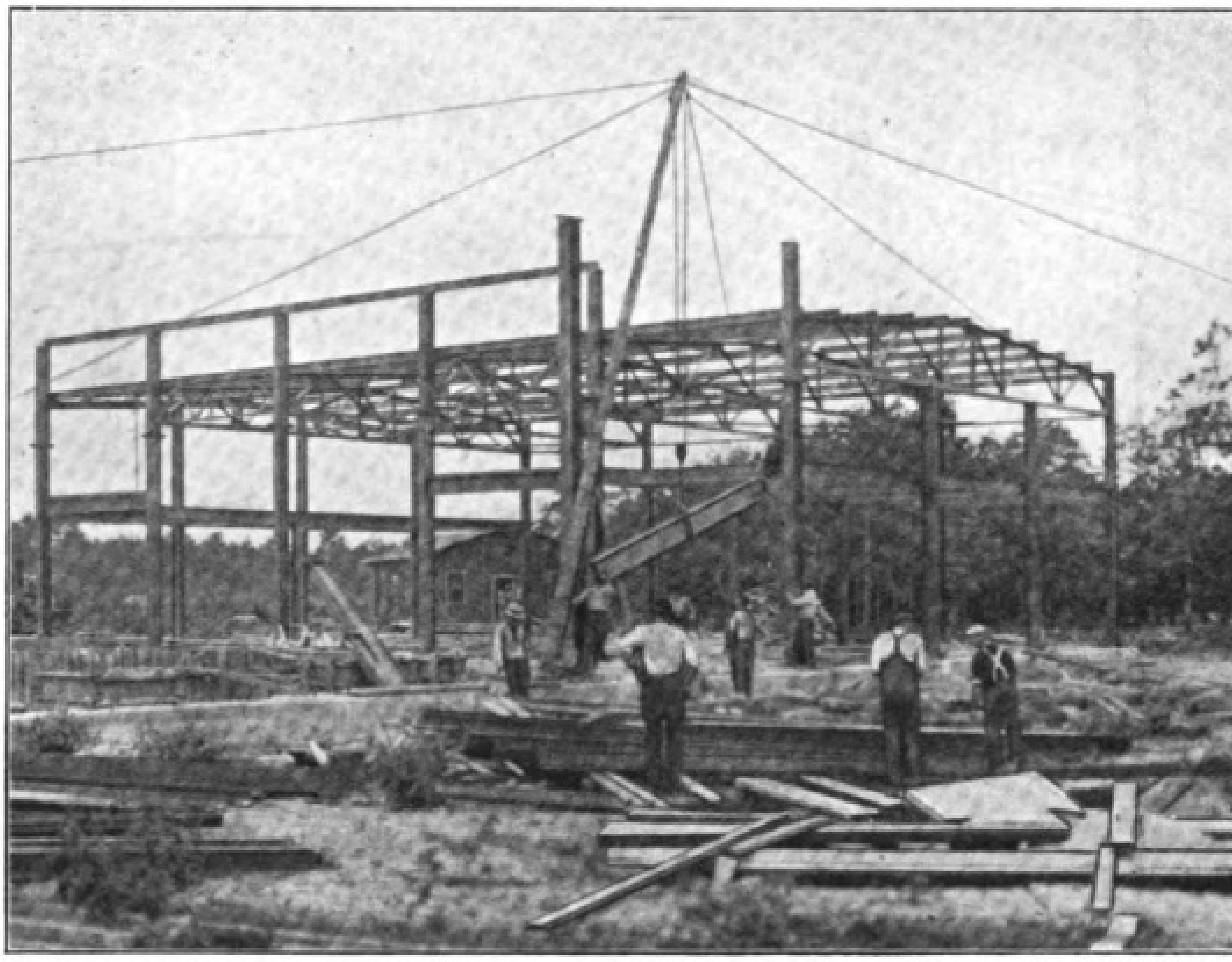
The buildings at the American end are nearing completion, and the masts, which in some instances have been growing at the rate of 50 feet per day, are more than half completed. The masts consist of thirty-one steel cylinders, some 15, some 10 feet long, each built up from quarter sections by bolts placed through vertical flanges. Massive concrete foundations support these giant tubes, and they are stayed at intervals with steel cables.

Above these great composite columns will be the main wooden masts, which in actual construction are raised as the work progresses. An excellent account of the manner in which this is accomplished is given in the *Wireless Age*, the American counterpart of THE WIRELESS WORLD. The main stee column, it is there pointed out, carries the top mast in square openings in the plates between the cylinders. The hoisting arms are attached to the upper end.

Fitted with blocks and hoisting cables, chain hoists depending from these arms support a wooden cage for the workmen, which can be raised and lowered at will while the sections are being bolted together. At a signal from the foreman a huge steel



Laying the Foundations of an Aerial.



The Power Station in its embryo stage.

section is raised by a steam winch, placed in position, and secured temporarily. Three other sections are successively raised and placed in position, thus completing the cylinder. These are then bolted rigidly together, and the diaphragm plates which separate each cylinder from its neighbours are temporarily fixed. The mast rope lead sheave is placed in position, and the flexible steel cable used for hoisting the top mast is reeved. Pulling this cable lifts the topmast. As soon as each cylinder is bolted together and the mast rope is fitted to its lead sheave and anchored, the ground end of this rope is led through a snatch block to the drum of the steam winch. When the workmen in the cage are ready the foreman signals the winch man to haul on the mast rope. The topmast is thus lifted. As soon as it is raised above the top of the completed cylinder a sufficient height to allow of the construction of another cylinder a fid pin hole through the topmast shows clear of the completed steel work. A steel pin is passed through this hole and the mast rope lowered until the weight of the topmast and its fittings is taken by the pin, which is then supported by the diaphragm plates fitted to the top of the completed cylinder. The pin supports the topmast during the erection of each additional cylinder, is removed during each hoisting of the topmast, and is replaced so as to rest upon the top of the latest completed cylinder. As the erection proceeds the stays are attached at the required points.

To stay these masts, which appear ridiculously small in comparison to their height, each is held by some 12,000 feet of cable. This cable is constructed with a view to obtaining a minimum of elastic extension, a problem which has been rendered particularly difficult by the exacting requirements of high insulation. The stays are composed of short lengths connected by porcelain insulators. Specially

The Engineer's-Cottage.

designed couplings are used to ensure a straight pull. The stay anchorages, four to each mast, are heavy concrete blocks, placed equidistant at a radius of 250 feet from the base.

The men engaged in the erection of these masts are raised and lowered to their work by a steam winch, but the riggers, those responsible for the fitting of the antennæ, rely upon a team of horses. In this case the lofty climb is accomplished in a small chair attached to a steel cable running over a pulley attached to the topmast and down to the horses. The trip to the top and back takes about ten minutes, and although the men swing freely in heavy winds no casualties have been recorded to date.

The completion of this important link between the Old and New World has been somewhat delayed by the war owing to the difficulty of obtaining an unrestricted supply of material. The day, however, is not far distant when business will be freely conducted between Stavanger and Chatham. Apart from the fact that this new link will afford to Central Europe an alternative to the more congested traffic routes passing through the United Kingdom, it may have a value that even the promoters themselves did not foresee at the time when they first drafted the scheme. There are stories abroad amongst those who claim to know something of the secret history of to-day, that one of the outcomes of the present war will be a new artery for commerce linking up the great Russian Empire with Great Britain and the Western Atlantic. Freight, instead of passing through Germany, or running the risk of being held up in the winter months by a frozen Baltic, will be landed instead at Bergen and carried by rail over Norway and Sweden to its destination. Whether this proposal is a serious one or the result of an active imagination we cannot say, but it is not difficult to conceive that in the event of some such scheme materialising, the Stavanger-Chatham stations may play a great part in the regulation of European traffic.

Measurement of Incoming Waves

By H. S. POCOCK.

IN the experimental work of the amateur the first essential to be considered, after the apparatus has been set up and tested, is the subject of taking measurements. The instrument employed for the measurement of waves is beyond the purse of the average amateur, but the manufacture of a wave-meter should impose no considerable tax upon his ingenuity. The best known and simplest type of wave-meter consists of a fixed inductance and a variable condenser, with a crystal detector and telephones placed across the variable condenser, as in Fig. 1.

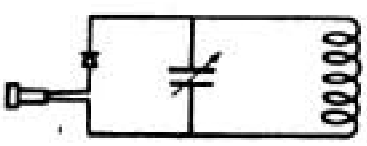


Fig. 1.

Having made the variable condenser (which should be of large maximum capacity) and the fixed inductance, it only remains to calibrate the wave-meter, and if this is to be done satisfactorily it will be necessary to borrow a calibrated instrument for the purpose.

The method of calibrating the wave-meter is then as follows: Instead of placing 'phones and a detector across the variable condenser of the instrument, the wave-meter must be used as a transmitting set and the borrowed wave-meter as a receiving set. The two circuits are then inductively coupled as in Fig. 2. W1 represents the

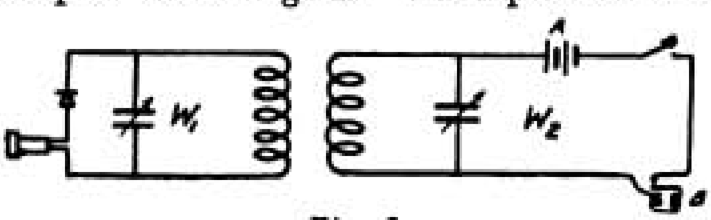


Fig. 2.

calibrated wave-meter and W2 the other instrument, excited by means of a buzzer, B.

Whilst listening in the 'phones, the calibrated wave-meter is set to various definite wave-lengths and the condenser of the home-made instrument is varied until the maximum strength of signals is heard in the 'phones when the buzzer circuit is completed. The instrument is then in tune with the calibrated wave-meter and the scale on the variable condenser may now be marked to indicate the wave-length to which the calibrated instrument was set. In calibrating a wave-meter as above the two meters should be so loosely coupled that the slightest variation of capacity in either will reduce the strength of signals.

For most purposes the wave-meter is used as a receiving set—*i.e.*, the telephone and detector circuit taking the place of the buzzer excitation circuit—and nearly all text-books will explain clearly how the wave-meter should be used in taking measurements under these conditions.

The measurement of incoming waves from distant stations is, however, a task which frequently baffles even experienced amateurs, and for this reason the following description of a simple and efficient method may be of interest.

The receiving circuit should be tuned as sharply as possible to the incoming wave, so that the maximum strength of signals is obtained in the 'phones. The wave-meter should then be coupled to the antenna lead, as in Fig. 3 (a single loop of the antenna lead will suffice).

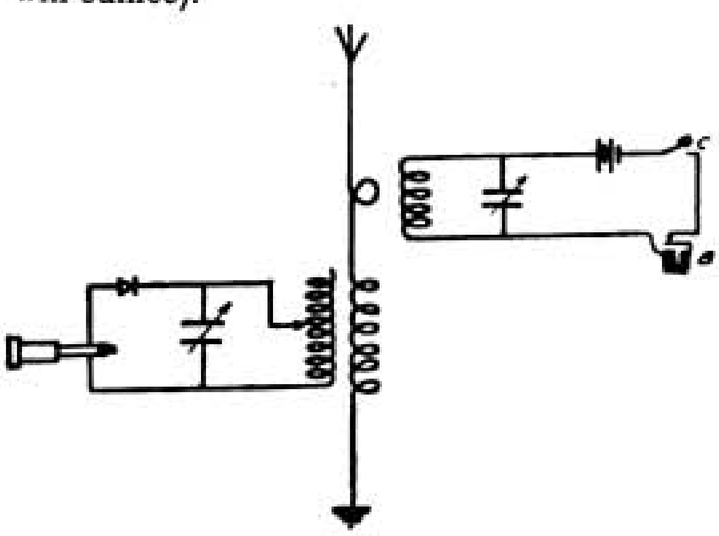


Fig. 3.

On the cessation of the incoming signals the buzzer circuit is completed at C, so that a continuous signal is given and the wave-meter is then adjusted until the maximum sound is heard in the telephones of the receiving circuit, the tuning of which has remained constant with the incoming wave. The coupling of the wave-meter to the antenna circuit should be so loose that the slightest variation of capacity of the meter reduces the maximum sound in the telephones. The reading of the wave-meter will then indicate the wave-length of the incoming wave.

If two wave-lengths are recorded by the wave-meter this is due to too tight coupling of the primary and secondary of the receiving circuits when tuning to the distant station. Record both readings of the wave-meter and then again tune to the distant station, varying the primary and secondary and tuning with the loosest possible coupling. On again testing with the wave-meter it will be found that the incorrect wave-length will have a different value or will not be distinguishable at all, whilst the correct wave-length will have remained constant.

The above use of the wave-meter can also be applied for calibrating the receiving set, thereby greatly facilitating the picking up of any particular station.

A Criticism and a Rejoinder.

We have received from Mr. Kullman, of New York, a letter covering a cutting of the evening edition of the *New York World* of January 4th. Mr. Kullman remarks that the cartoonist "does not seem to agree with the editorial in THE WIRELESS WORLD of October last." This editorial, as our readers will remember, dealt with the subject "Britannia rules the waves," and the American artist depicts John Bull "hard at work patching up the legend." There may be something to be said from the cartoonist's point of view, but anyhow the work is proceeding apace, and when completed British sea-supremacy will be "as good as new"!

Poldhu Station Staff, December, 1914.

From left to right: M. B. Hunter, Major Wylde, R.M.L.I., Commander O'Brien, R.N., Lieut.-Commander Chambers, R.N., C. G. Rattray (Engineer in Charge), Lieut. Mason, C. H. Keith, H. E. Shaw, R. Keen.

The Marconi Telegraphists are in the second row, commencing with J. Dudden, behind Commander Chambers, and on Dudden's left are P. Treacy, A. Moore, F. Lyall, F. Miles, and G. Anderson. The Marconi Engineers are C. H. Keith, H. E. Shaw, M. B. Hunter, and R. Keen.

The Properties of Crystals used as Detectors in Wireless Telegraphy

By DE A. D.

IN the following list of the crystals commonly met with in wireless telegraphy are given their properties and the method in which they are used in connection with detectors.

Carborundum, as was pointed out in an article in THE WIRELESS WORLD in October last, is a product of the electric furnace and is known to chemists as carbide of silicon. Its colour ranges from a deep grey to a violet purple, but only those of a silver-grey hue are of use as detectors. It is an abrasive, and is the hardest substance known after the diamond, owing to the silicon it contains; glass can easily be scratched by it. Carborundum is used as a detector in contact with steel, and a small potential is required across it, to render it sensitive to wireless signals.

Bornite, often known as erubescite, is a valuable copper ore consisting of about 60 parts of copper, 14 of iron, and 26 of matrix crystals. It has on the fresh fracture a peculiar bronze colour (often called horse-flesh ore by miners) which soon tarnishes. It is used in combination with zincite as a detector.

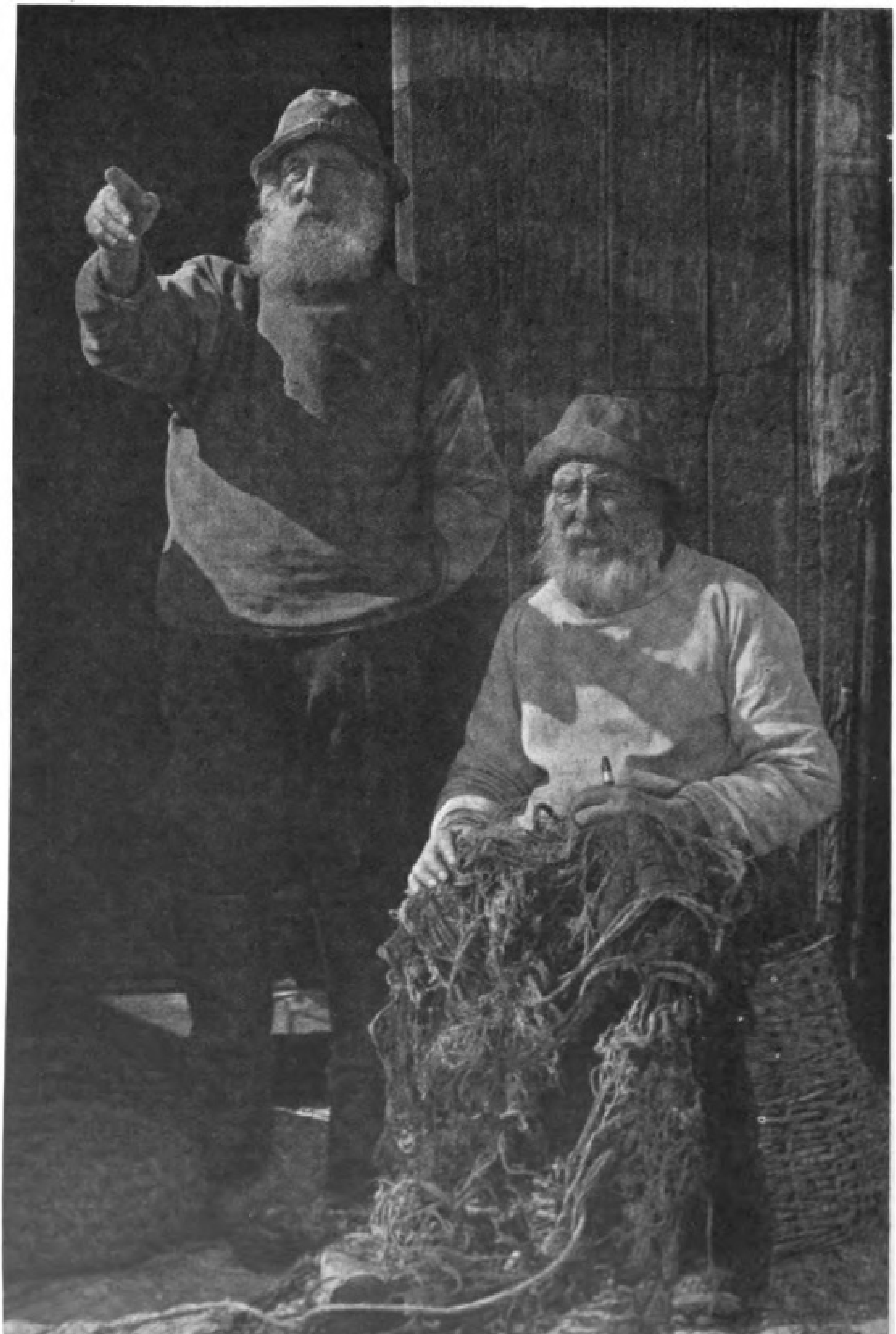
Zincite is a native oxide of zinc. It is a very brittle substance, of a blood-red colour due to the presence of manganese, and translucent in nature. Instead of being used with bornite, copper pyrites fórms an excellent substitute; this latter combination is the most general and is used extensively by amateurs, because of its sensitiveness, as it requires little or no potential across it.

Copper pyrites is a copper sulphide containing iron, occurring in the form of tetragonal crystals, but more generally massive. It has a brilliant brass-yellow colour, and on the fresh fracture a bright metallic lustre; it is easily distinguished from pure copper, which has a deeper colour (reddish brown) and inferior hardness.

Tellurium, one of the rarer elements. In the free state this element has been found in small quantities as crystals, also in combination with various metals, as with gold or silver in the form of graphic tellurium, or sylvanite with gold lead, and antimony as nagyagite, and in several other mostly rare mineral combinations. It is a brittle substance. Its chemical properties have made it a problem from an early time, when it was often called metallum problematicum. Klaproth, the German analytical chemist, demonstrated in 1798 that tellurium was not identical with any metal previously known. Although it has a marked metallic lustre and occurs in Nature almost exclusively in combination with decided metallic elements, it most closely resembles sulphur and selenium in its chemical reactions, and is generally classed at the present time among the non-metallic elements.

Galena is the natural sulphide of lead, generally found in the formation of cubical crystals. Its colour is a blue grey like that of freshly cut lead with a decided metallic lustre. It can be artificially formed by heating lead in sulphur vapour, or by passing sulphuretted hydrogen through a solution of a lead salt. Lead sulphide will melt and sublime in the form of cubes, when heated in either vacuo or in a stream of inert gas. Heating with a free access of air it will become lead sulphate. Galena is used as a detector with a graphite point resting on its surface, the pressure of which must be adjustable. This combination forms a thermo-electric detector and requires no potential across it.

Silicon is non-metallic and the most abundant element in Nature; after oxygen it is the most largely distributed, but it is not known in the uncombined state. At one time the octahedral crystals of silicon were thought to be the analogue of diamond. Exposing silicon to a high temperature out of contact with air, it becomes harder and denser, often being obtained in small nodules of steel-grey in crystalline form. That used in wireless telegraphy is fused silicon, which is a grey metallic-looking substance, used in contact with copper, and requires a potential across it to render it sensitive.



Wireless in the Fishing Trade

IT is a pleasing thought at this time, when the attention of the nation is riveted upon the work of our Navy, that the humble steam trawler, "a tireless toiler of the deep," should be receiving a share of recognition. That it will get the full share can hardly be expected, for the tasks upon which it is engaged, although hazardous in the extreme, are less theatrical in effect than those falling to the battleship, the speedy cruiser, or the submarine.

It is reasonable that we should claim a keener interest than the general public in the war work of these sturdy little fishing craft. Twice within the last eighteen months the trawler and its crew has emerged from its zone of comparative obscurity to make the acquaintance of the reader of THE WIRELESS WORLD. In the issues of September, 1913, and again in January, 1914, appeared some details of experimental wireless installations upon boats of this character engaged in fishery duties on the North Sea.

All those who have come into personal contact with the men who spend their lives in the arduous work of providing fish for British tables can hardly fail to accord no ordinary meed of admiration to their sterling qualities. They are a simple folk, retiring in their habits, and shrinking from contact with the outside world. The Psalmist, in one of his best-known Hebrew poems, speaks of the special way in which these men see "the works of the Lord, and His wonders in the deep," and, as a class, the deep-sea fishermen bear the marks of their close relationship with "the perils of the deep." The nation's indebtedness to them is too often forgotten, although our admirable lifeboat service relies mainly upon their aid in its magnificent work.

The immediate purpose of this article, however, is to draw attention to the latest development in the use of wireless on trawlers for purely business purposes.

For many years students of our fisheries have held that much money could be saved, and the working conditions of deep-sea fishing materially simplified, if wireless could be brought to their aid. Several years ago experiments were conducted in the North Sea with a system other than Marconi, but the results were such that for a considerable time afterwards any reference to wireless was tabooed by the fleet owners.

This prejudice was not broken until 1913, when the Marconi Company, through the courtesy of Messrs. Hellyer's Steam Fishing Co., Ltd., of Hull, had placed at their disposal the trawler *Othello* and the carrier *Cæsar*. The trawler was fitted with two Marconi ½-kw. sets of different design, and the carrier with two Marconi 3-kw. stations—one of the standard pattern used in the mercantile marine, and the other of a portable military description. Light topmasts were added to the trawler to carry the aerials, whilst the carrier had two new wooden masts, each giving a height of over 100 feet from the water-line. Power in each instance was supplied by steam and oil engines installed for purposes of comparison. The steamer *Othello* proved her ability to exchange signals with Cullercoats, 180 miles away, and with the carrier *Cæsar*, at a distance of 100 miles, even when the latter's aerial was only 65 feet above the water. The *Cæsar*, with her more powerful installation, found no difficulty in exchanging signals with Cullercoats when 270 miles distant.

These tests, conducted by operators who were by no means accustomed to life in small boats, gave results that were even better than were originally estimated. They were sufficient to satisfy Messrs. Hellyer that the Marconi Company had solved the difficulties experienced in trials elsewhere. Orders were placed without delay for one installation similar in power to that fitted on the carrier *Cæsar*, and three installations of ½-kw., such as was tried upon the *Othello*.

Before the end of November, 1913, three vessels—the *Bardolph*, *Columbia*, and *Cali-*

ban, of Messrs. Hellyer's fleet, were exchanging greetings between the fleet on the Dogger Bank and the President of the Board of Agriculture and Fisheries. The *Columbia*, being a "fleeter" or boat responsible for the carriage of the produce to the markets or the coast, was substantially equipped not only with an emergency set, but with a direction finder, a wireless compass, electric light, and a searchlight.

The success of Messrs. Hellyer's enterprise has been strikingly demonstrated to deep-sea fishers on the East Coast, and in addition to the vessels named Messrs. The Hull Steam Fishing and Ice Company, Limited, have had their trawlers *Filey* and *Bampton* equipped with wireless. Furthermore, every encouragement is being given to captains and fishermen at that port to master the essentials for an intelligent use of the apparatus. The joint Arbitration and Navigation Committee, of which Mr. H. Archer is Secretary, has fitted its signalling classroom with a complete installation, and instruction is also given at the new school for fishermen which has just been erected on the boulevard.

When Mr. Marconi first conducted his epoch-making demonstrations nineteen years ago, he little dreamed that he was introducing to the world an agent that would revolutionise industry. The Hull steam-trawler owners are agreed that the use of wireless will completely change the conditions of business, and that everyone will ultimately benefit thereby. Why this change is expected can be easily understood.

The fish trade, like all other commercial institutions, conforms to the laws of supply and demand. It often happens, therefore, that for some reason or another prices rule higher in one port than another on the same coast. Conversely, for reasons that at present entirely pass human understanding, one fleet will sometimes have a heavy catch, while its neighbour reports nothing but empty nets. These facts have always given to the fishing industry a degree of uncertainty. The lucky have profited, and the unlucky have had no alternative but to bemoan their fate.

With the advent of wireless there is bound to be a levelling up. "Scoops," as they would be termed in journalistic parlance, will be fewer, but the fleet owners and men will benefit from steadier trade. Whereas, in the past it was a case of "wait and see,"

Steam Trawler fitted with Wireless.

in the future it will be "Marconi and see," owners will be able to direct their incoming catches to such markets as are favourable, or, if necessary, advise their ships to remain on the fishing grounds until sale prices justify their return. What is equally important, too, will be the added facilities given by wireless for the exchange of working instructions between the fishing fleet units themselves. The old methods of signalling may have proved satisfactory in fair weather, but they were hopelessly unreliable in times of fog and storm. By the aid of wireless, the Hull fishing fleets will be able to manœuvre as easily in a thick fog as by clear moonlight. Not only will the trawlers be able to keep their "Admiral" continuously informed of their success, but he in turn will be able to report progress to the owners on shore or the merchants with whom they deal.

By entering deeply into the technicalities of the trawling industry, numerous other instances might be cited where the introduction of wireless intercommunication will undoubtedly prove advantageous. These, however, are beyond the scope of the present article. But it is impossible to conclude without pointing out the protection that will be afforded to life and material. The seamanship displayed upon our steam trawlers is probably without equal—the recent rescues of survivors from H.M.S. *Formidable* by the Brixham boat *Providence* affords an excellent example; but the reports of damage and loss of life are unhappily very frequent. Such boats as, in the future, are equipped with "wireless" will have the daily weather reports at their disposal, and be in a position to receive such local storm warnings as may be sent out from their headquarters, or from the Government boats detailed for their protection.

Sufficient has been written to show that the belief of the Hull fishermen, that this extension of the use of wireless will open up a new and successful era, is based on excellent foundations. It remains for us to express the conviction that these expectations will be so far exceeded that every trawler owner fishing in British waters will ultimately be classed amongst the converts.

Aerials and their Radiation Waveforms. X.

By H. M. DOWSETT.

THE BELLINI-TOSI AERIAL.—The field of electric strain generated round any aerial can be divided into two parts:

1. That which returns into the aerial in the form of current.

2. That which does not return, but leaves the aerial as electromagnetic radiation.

That which returns provides the energy for the field of electric strain generated by the *next* aerial oscillation, part of which again is radiated and part conserved.

Some aerials throw off their energy in a very few swings; they are good radiators, but bad conservers. A single vertical wire is an example.

Other aerials, of which the Lodge is typical, maintain their energy. They are good conservers, but bad radiators.

To this last class belongs the Bellini-Tosi directive aerial.

Its essential form is that of a triangle having two symmetrical sides, and as long a base as possible parallel to the earth. The apex may be either slightly open or closed.

Fig. 1 shows five diagrams of the transmitting arrangements used by Messrs. Bellini and Tosi in the Dieppe, Havre and Barfleur tests of 1908,* the approximate distribution of aerial charge when the circuits are oscillating being indicated.

Diagrams (*a*), (*b*) and (*c*) are of the same character. The apex of the aerial is open

* *The Electrician*, page 748, Feb. 28, 1908.

C

in each of them, but in (*a*) the excitation is direct by spark, in (*b*) by tight inductive coupling, and in (*c*) by loose inductive coupling. (S) indicates the spark-coil secondary.

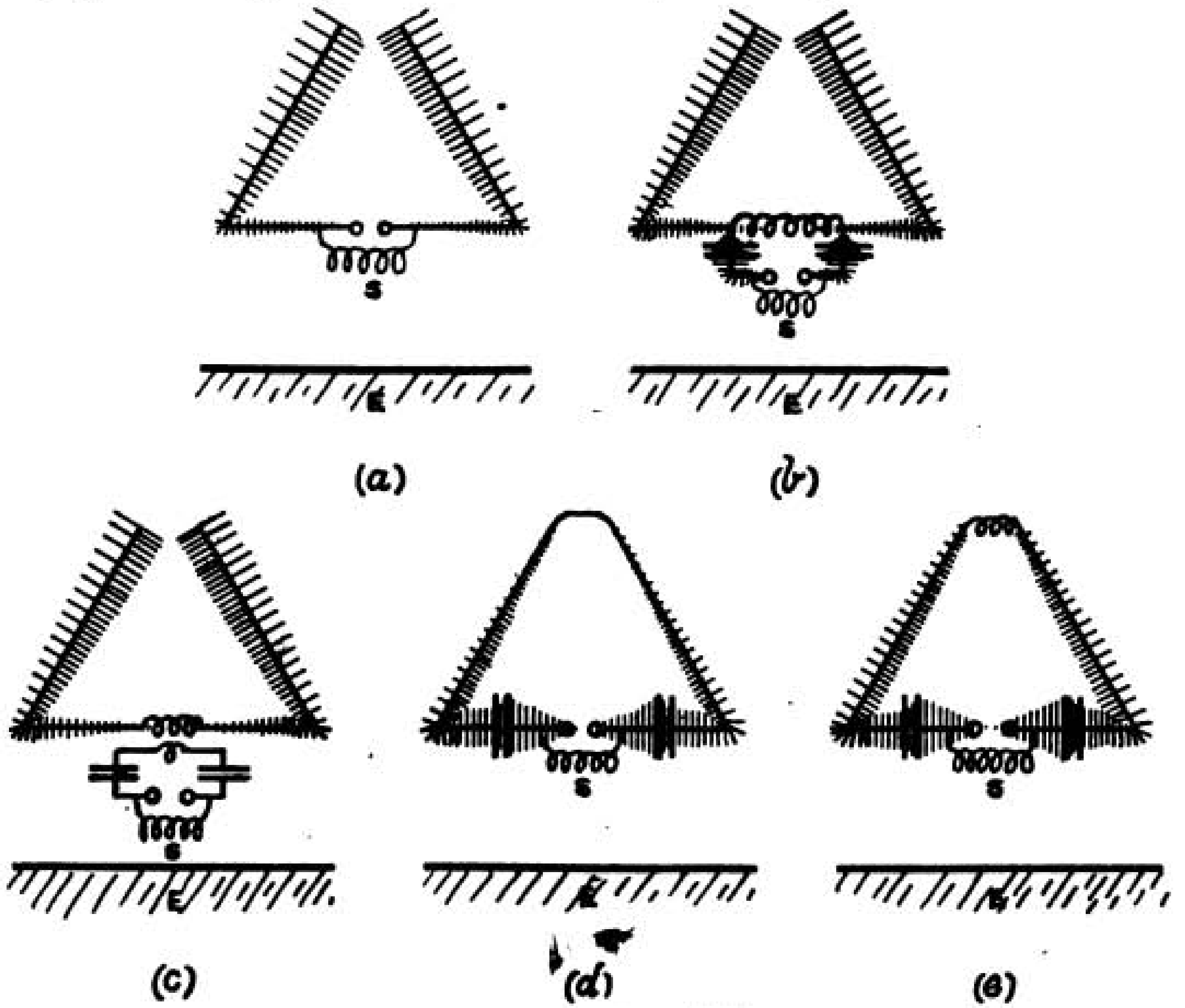


Fig. 1.

Diagrams (*d*) and (*e*) show two aerials each with a closed apex, and excited through a capacity coupling. It is the bottoms of the triangles now which may be considered as being open, instead of the tops.

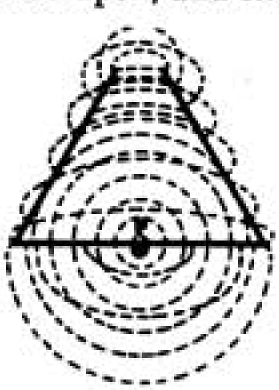


Fig. 2.

Arrangements (*b*) and (*c*) are said to have given best results. The amount of electromagnetic energy either of these aerial systems would tend to radiate in free space would be very small.

Fig. 2 indicates roughly the field of electric strain surrounding an open top aerial in free space, excited at a point, P, midway along the base. As the electric surge continues, nearly the whole of the

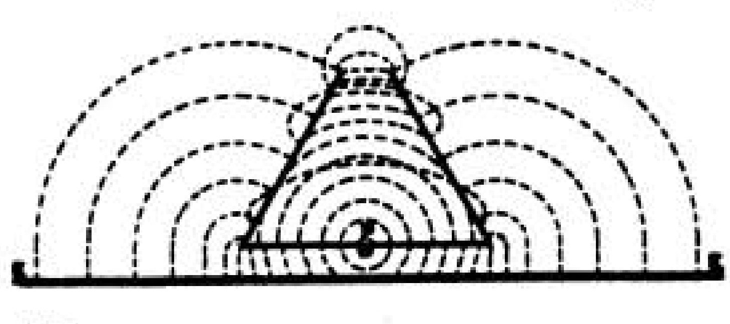


Fig. 3.

field tends to re-enter the aerial and to maintain its oscillations.

But let the base line of this aerial be brought near the earth. Immediately there is a change. Each side of the aerial now

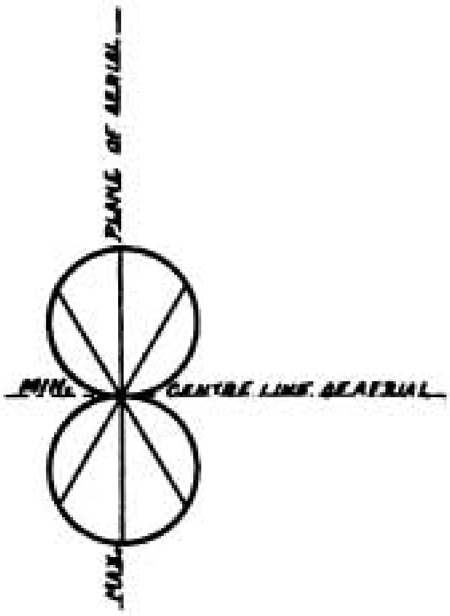


Fig. 4.

divides its field between the other side and the earth (Fig. 3), and whereas the first part re-enters the aerial again as before, the second part leaves the aerial as radiation.

The part played by the earth is very important. In my last article* I pointed out that it could be used to the best advan-

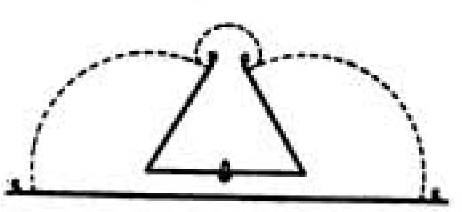


Fig. 5.

tage by erecting the aerial so that the height of its base line above the earth was such as to make the capacity of either half of the aerial to earth equal to the capacity between the two halves themselves.

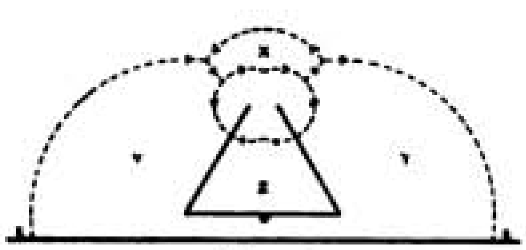


Fig. 6.

The radiation from this aerial in different directions is shown in the polar diagram of signal strength, Fig. 4.

The section of the radiation which concerns us most is that in which it is strongest. Fig. 4 shows this to be in the plane of the aerial, and the same plane also contains the maximum strength of the internal field, the part which sends off minimum radiation.

It is this section which is shown in Fig. 5. The open-top triangular aerial is supposed to have been excited at its mid-point, A, and the wave has just travelled as far as B and C, giving the outline of field in space and along the earth as shown—the distorting effect of capacity being omitted.

Fig. 6 shows the very small part, X, which breaks away as free radiation from between the aerials, the larger part, Y, which travels off as earth-bound radiation, and the remainder, Z (the major portion), which re-enters the aerial as current.

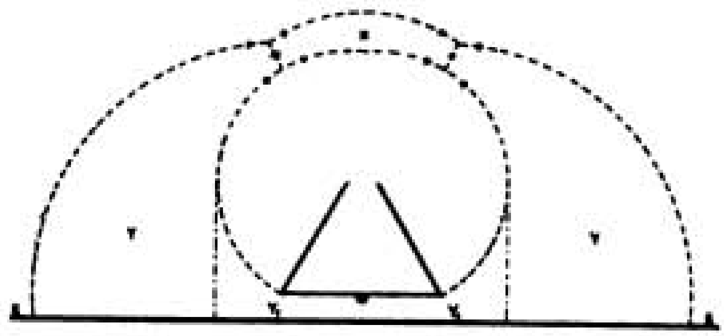


Fig. 7.

Now, the effective part, Y, is subject to considerable loss in getting away from the aerial, all the part, Y_1, between the dotted lines, Fig. 7, radiating earthwards and being dissipated by reflection, eddy-curcurrents, and earth resistance.

This would explain why better results were obtained when the aerial was excited so that potential nodes occurred at or near each end of the horizontal part of the aerial. For then it was possible to radiate at least a full half-wave from each symmetrical part of the aerial, which was weakened to a much smaller extent by initial absorption.

The longest aerial wave to give this result—at the same time creating 180° difference in phase between the free ends of the aerial—would be the second harmonic, a wave of three times the fundamental frequency.

The distribution of such a wave in the aerial is indicated in Fig. 8 (*a*), and the field

* THE WIRELESS WORLD, page 630, January, 1915.

section in the plane of the aerial, roughly in 8 (*b*).

The jigger secondary contains a half wave and radiates a negligable amount. The earth in this case cannot resonate to the aerial wave, as the two horizontal parts of the aerial have potential antinodes differing by 180°, situated at their inner ends, and therefore practically at the middle of the horizontal part, so that there is a tendency to neutralise any earth condenser effect immediately underneath. Such an effect, however, can come into play and become more appreciable the further one gets from the centre.

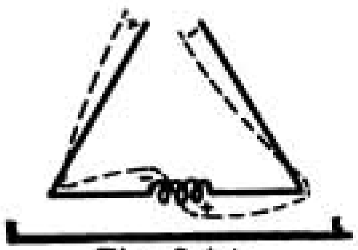


Fig. 8 (a).

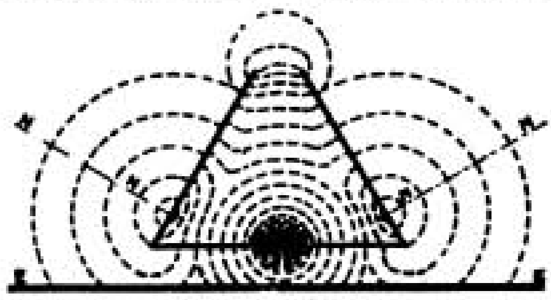


Fig. 8 (b).

From the symmetrical sides of the aerial the waves radiated have their nodal planes inclined upwards from the earth, as indicated by the lines NN.

The effect of earth absorption will gradually bend these planes earthwards, but if, by the time the wave has reached the receiving station, its nodal plane has not fallen lower than the horizontal, the receiving aerial will still have the potential of a half wave to draw on for its energy, the conditions, therefore, being much more favourable to good reception than if fundamental transmission were used.

CORRESPONDENCE.

Field of Force of an Electrostatically Charged Aerial.

To the Editor of THE WIRELESS WORLD.

SIR,—Permit me to comment briefly on Mr. Dowsett's reply to my letter on the question of the field of force of an electrostatically charged aerial. I take it that the fundamental thing on which Mr. Dowsett and myself disagree is his assumption of a charged aerial of no capacity. To my mind it seems necessary that the aerial should possess capacity before it can be charged. Except in the case of closed loops of electric strain, and these do not come into this question, I always considered that an electric charge was necessary to cause a strain in the medium, the strain being indeed the only indication we have of the presence of the charge. If the aerial has no capacity (being a mere line in the ether) it cannot be charged, and I am quite unable to imagine the ether put into a state of strain by a non-existing charge. Certainly I am not interested in the form the imaginary strain would take. As soon as the aerial possesses any capacity Mr. Dowsett's case breaks down. In the question of static action at a distance, I am quite content to leave Mr. Dowsett to Dr. Erskine-Murray, and other men abler than myself. I would like, however, to refer to a few of the particular points raised by Mr. Dowsett.

1. We are both agreed that lines and tubes of force are merely slightly different ways of representing the same thing, also I stated in my original letter that his diagram was a true representation of a mathematical plane section of the strain field, but I consider that it is liable to mislead students.

2. (*a*) I did not say what the drawers of the ordinary diagrams intended them to represent; I simply stated what the diagrams actually did represent; (*b*) the lines in my fig. 2 were meant to be equally spaced along the aerial.

3. Wedge-shaped Section.—First let me say that I took Mr. Dowsett's circular strain-lines as correct, since their shape was not here a primary consideration. Then, when the field is viewed in plan, all the strain-lines will appear straight, so that every one starting in any particular wedge-shaped section must remain in that section. If Mr. Dowsett will explain how he can draw the diagram, showing all the lines in that section, without making the lines equally spaced along the earth, I should be obliged to him; for it follows from their circular form that all lines beginning on a given length of aerial must end on an equal length of base-line.

4. The mistake in my diagram 2a, in which a line of strain is shown, not attached to the aerial, but with its two ends on the plate is simply due to a slip in the drawing, and is in any case quite incidental to the argument.

5. Finally, instead of talking vaguely of ether shear, will Mr. Dowsett state the fundamental law of electric force on which he bases his diagrams? Is it the Law of Inverse Squares? From this law will he (*a*) criticise my mathematical proof of the impossibility of the existence of such a state of static strain as is indicated in his diagrams; (*b*) prove the correctness of his diagrams.

Yours, etc.,
ERNEST GREEN.

A New Mode of Propulsion.

To the Editor of THE WIRELESS WORLD.

SIR,—I am President of the Wireless Society at Sparks Asylum, and the Committee note with a good deal of dissatisfaction that there have been no notices of our proceedings in your excellent magazine, of which, I assure you, we are all enthusiastic readers.

It may interest you to learn that several old engineers are members, having been "compelled" to come in to seek rest—so they say—from insulation troubles. Further, I understand that several more should be here and that others are qualifying for positions here. They may expect a hearty welcome.

I am sure our debates would be of interest to your readers, as the following report of a recent meeting will show. Last week, after a short paper on "Directional aerials," one of the members suggested that as action and re-action are equal and opposite there would certainly be in a directional aerial a force produced in the contrary direction to that in which the maximum energy was sent, therefore in his opinion if a good directional aerial were installed on a vessel, it would experience a force in the direction of the free end of the aerial, and so would be propelled. The free end, of course, would be generally over the bows of the vessel in order that she should move forward, but to move astern it could easily be arranged to shift the downleads to the other end. The speaker predicted that this would be the method of propulsion of the future—at any rate for small craft—and he became so excited, sir, over that prospect, that he wanted to communicate his idea to the Admiralty personally and without delay. He had great trouble, so we could hear at the porter's lodge, and was only persuaded to come quietly back on the promise of an extra bun for tea.

An old wireless man who has seen much service on battleships said it had been his experience that it was always impossible to carry out any tests on Saturdays as the rigging was on that day always full of sailors' washing. "Now," he said, "why should not the aerial be used as a clothes line, and so increase the capacity of the aerial, for that was a consummation devoutly to be wished"? He went on to say that it had only to be arranged for the total week's washing to be divided into seven, so that the aerial could have its daily share in order to have a constant capacity.

During the discussion that followed several members who have the reputation of being "old women" took it upon themselves to oppose this excellent and utilitarian scheme. One remarked that the Specific Inductive Capacity of a vest might differ from that of a pair of pants, and so cause inequalities of capacity during the week. It was left to me, sir, to point out that the consequent drying of the garments would upset all their nice calculations.

We have a fine experimental station here made from various scraps collected somehow or other! We carry out many experiments which are suggested at our weekly meetings. The trouble is, we find (or rather the authorities do so), that there is too much enthusiasm for one aerial, which is often caused to brush considerably thereby.

We get strange results sometimes. Our receiving expert gets occasionally slightly confused, saves his jam at tea-time and tries to carry out jamming experiments with the aerial. The sticky result is quite disliked by the others, who, one would imagine, would at least be sympathetic, but "that is another story," as Kipling says.

Sir, I thank you for your space.

Believe me,
Yours aerially,
O.K.C.

[The Wireless Society Sparks Asylum, April 1st (delayed in transmission).—ED.]

The Library Table

"TELEGRAPHY." By the late Sir W. H. Preece, K.C.B., F.R.S., and Sir J. Sivewright, K.C.M.G. *Revised* and *partly rewritten* by W. Llewellyn Preece, M.Inst.C.E., M.I.E.E. (London: Longmans, Green & Co. 7s. 6d. net.)

In this revised edition of "Preece and Sivewright" we welcome an old friend in a somewhat new guise, who for the past forty years has been a standard work on matters telegraphic, to which one has always turned for information on the subject. Though originally it was intended to be addressed mainly to students, this text-book has served the requirements also of engineers and operators, and in the days when the methods of telegraphy were much simpler than they are to-day it was a complete treatise on telegraphy as then practised. But with the many new advances in the science and art of telegraphy and telephony it must have become increasingly difficult to keep pace with these advances without producing an unwieldy volume and one unsuitable as a text-book.

The work of revising the latest edition was entrusted to Mr. W. Llewellyn Preece, who has performed his task in a manner worthy of his father. The book has been largely rewritten, and even in the increased size of the volume adopted it has been impossible to find room for the treatment of all directions of modern development. Mr. Preece has eliminated the chapter on submarine telegraphy and has limited his attention in this matter to river and coast cables. He has added new chapters on secondary batteries; on the Baudot system, and on comparative results obtainable with various high-speed telegraph systems. Modern practice in telephony is admirably sketched in a short chapter on the subject, and another chapter on wireless telegraphy is equally suggestive and free from redundant matter. A pathetic interest attaches to the re-written chapter on wireless telegraphy, for almost the last act of Sir William Preece was to read through and correct the proof of it.

"LA TELEGRAPHIE SANS FIL." By A. Berget. 200 pp. (Paris: Hachette & Co., 79 Boulevard Saint Germain.)

This is one of a series of books describing modern inventions and their application. The author rightly states in the opening chapter that, among the marvellous applications of science which have been developed during the past century, none more merits admiration than does wireless telegraphy. After describing the general principles underlying the subject, he briefly sketches some of their main applications and discusses the future possibilities in a manner which makes his book agreeable reading.

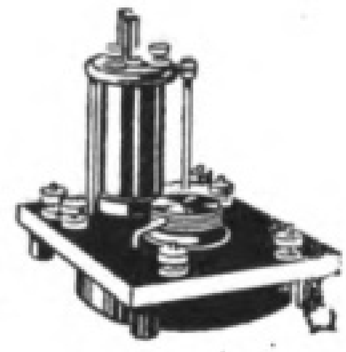
* * *

"THE PRACTICAL ELECTRICIAN'S POCKET-BOOK, 1915." 474 pages. London: S. Rentell and Co. 1s. and 1s. 6d. net, postage 3d.

The seventeenth annual issue of this handy budget of useful technical information for the practical electrician appears to have undergone careful revision. The chapters have been rearranged in a more systematic and logical sequence, while the blue pencil has evidently been used freely with a view to condensing the text and making room for new matter. It is a book which wireless station-engineers may find useful.

DECISION IN FAVOUR OF MARCONI COMPANY.—In the suit of the Marconi Company against the De Forest Radio Company and the Standard Oil Company for infringement of certain letters patent, in which Judge Hough recently granted the Marconi Company a preliminary injunction, the court has handed down another decision. It appears that subsequent to the former decision the defendants moved to suspend the injunction pending an appeal, in so far as it related to the boats of the Standard Oil Company, and also another motion to vacate or modify the injunction with respect to both the defendants. These motions were brought upon additional affidavits, but Judge Hough, in a decision filed December 15th, denied all of the motions, thus refusing to suspend the injunction as to the Standard Oil Company and to vacate or modify the injunction as to both defendants.

The ENGINEERS Note Book



[Under this heading we propose to publish each month communications from our readers dealing with general engineering matters of various kinds in their application to wireless telegraphy, and we would welcome criticisms, remarks and questions relating to the matter published under this heading. We do not hold ourselves responsible for the opinions and statements of our contributors.]

Two-stroke Engines.

TWO-STROKE engines are probably the most simple in construction of any internal-combustion engines, and, unfortunately, for this reason have been exploited by manufacturers, who have aimed solely at cheapness until the reputation of the engines as economic power producers has somewhat suffered. Simplicity may be carried to an absurd extreme, and this phase has actually taken place, much to the chagrin of users whose technical knowledge has not been sufficient to enable them to judge between good or bad system or workmanship. The only advice we can give to those in such a position is—scrap the unreliable and wasteful engine, and get one by a manufacturer whose reputation is a guarantee of satisfactory theory and practice. The theory of the two-stroke engine is this: The cylinder is prolonged until it embraces the crank chamber, which is enclosed in such a manner that the piston can act upon a charge in the crank case as well as upon one in the combustion end of the cylinder. Naturally it is difficult to reduce the clearances in the crank chamber to such a degree that any high pressure is obtained, but a sufficient quantity of air can be taken in and compressed to form the basis of a charge for the working side of the piston, and incidentally to act as an assisting scavenging charge for the expulsion of the spent gases. The latter are ejected through a port in the side of the cylinder, uncovered by the piston when nearing its outward stroke, and usually another port on the opposite side of the cylinder walls allows the inlet of the compressed charge from the crank chamber. This charge should consist only of air, and the fuel should be introduced into the cylinder at a more opportune moment than when the exhaust ports are open. The momentum of the flywheel carries the piston back, further compressing this charge of air, and, at the right moment, the explosive agent is introduced and fired, giving the outward working impulse. The term "two-stroke" therefore means that the piston makes two strokes for each impulse or revolution of the flywheel.

Four-stroke engines, sometimes called the Otto Cycle, are those in which the charge of an inflammable mixture is first drawn into the cylinder, then compressed by the return stroke of the piston, fired when it nears the inward position, giving an outward impulse, and exhausted during the next return stroke—therefore a cycle of four events takes place for each two revolutions of the flywheel or four strokes of the piston. A higher efficiency is attained by this system, but both two-stroke and four are now in common use, each having certain advantages chiefly connected with the methods of dealing with certain fuels.

The further constructional division of engines into horizontal, vertical and multi-cylinder need only be briefly touched upon, inasmuch as the shape has no great influence upon the use of the fuel, although it does to a certain extent modify the arrangement of valves, methods of introduction of fuel and governing. Usually horizontal engines run much slower than the vertical type, and have longer strokes, but in carefully-designed engines the piston speed, which is, of course, the important detail, will be found approximately the same for either; the actual number of feet per second having usually been decided upon by the manufacturers' careful investigation and analysis of results, for which reason it is obvious the best results are obtained by adhering as strictly as possible to the specified speeds at which the builder has scheduled his engine to be used.

Notes on the Erection and Management of Four-stroke Oil Engines.

ERECTION.

IN order to prevent rusting during transit from the manufacturer's works it is usual to coat all bright parts of the engine with special preservative compounds. These naturally collect a certain amount of grit, and should the engine be carelessly pulled round before they have been removed, seized joints, scored pistons, or even broken cogwheels may result.

The preservative should therefore be removed with the aid of paraffin or similar absorbent, and the parts carefully lubricated with the proper oil, before the moving parts of the engine are allowed to turn.

The next thing is to get the engine running, so that the attendant can get to be familiar with its behaviour, as adjusted by the makers, before he attempts to take it to pieces for the purpose of acquainting himself with its details. If this is not done, then, in reassembling, the adjustments may be badly out and difficulty may be experienced in starting up or maintaining power, which is not due to any faults in the engine or its design.

VALVE STEMS.

Although engines are invariably tested before despatch, it is not unusual for valve stems, more especially those of the exhaust valves, to stick up during the first few runs.

This may be due to rust which has accumulated in transit or to a thicker lubricating oil being used than that used on test, or to other small details of a similar nature. Although it would prove of no difficulty to anyone well acquainted with the engine, a few hints may be of service to a beginner in its management.

If the valve stems show signs of sticking up during a long and important run temporary measures may be of use in preventing the trouble. The handiest method is to splash on to the valve stem with a feather or brush sufficient ordinary paraffin to keep it clean, using little or no lubricating oil.

After the run, the valve should be taken out and the stem polished with No. 1 emery, several times if necessary, until the best working fit has been attained.

Another cause of exhaust valves sticking is over-lubrication, to which fault a beginner is very liable, causing the parts to gum up and necessitating their removal and cleaning with paraffin.

PISTON RINGS.

These are really circular spring-retaining valves, bedded for a seat on the front edge of the groove. If a groove is carefully examined it will be noticed it is undercut, which is for the purpose of allowing the ring to bed perfectly. Unless the rings are quite free in the grooves they are useless, but it would be a disadvantage if they worked round so that all the joints were in the same line, for which purpose stop pins are inserted. When taking out a ring it is wise to slip about six pieces of tin or hoop iron under it and then slide it off the piston. If an effort is made to stretch it open sufficiently it will almost certainly result in a breakage, as they are only cast iron, which material is found to give the best results, steel being too stiff and harsh for internal-combustion engines, except under special conditions. Naturally a ring wears itself and its groove to a more perfect fit the longer it is used, and the fallacy of putting in a new piston ring for the sake of obtaining a better compression is one that will be understood from the above remarks. If a new set of rings is imperative the same should be fitted only one at a time, and that "run in" to working condition before another is inserted.

CAMS.

The valve cams, being on the lay shaft enclosed in the engine, are frequently more or less neglected. It is wise, however, to occasionally remove the crank case doors and clean and examine the cams, seeing they are thoroughly oiled and not wearing abnormally. If signs of wear are manifest it is wise to make provision for a new set of cams being obtained and put in place at the earliest convenience; on the other hand if well looked after a set of cams will last for years.

Ignition.

There are several types of ignition and, although most engines have now either high- or low-tension magneto, there may be readers who have to use engines fitted with older forms, and a hint or two may be useful.

Tube Ignition.

This, although one of the oldest forms, is still serviceable for slow-running engines. The compressed gases are forced into the tube to a distance which varies with the amount of compression and the length of the tube.

It is usual to so arrange the heating burner that a sharp line of demarcation between the red hot and the colder parts is obtained.

This is termed the "ignition point," and by raising or lowering it the best position for perfect combustion may be found. It is best to commence by heating the tube for a large part of its length and to gradually raise the shield until the engine begins to thump or misfire, when a slight lowering of the shield will give the best working position. If the power can only be obtained by heavy thumping this may occasionally be remedied by the use of a longer tube. In modern practice tube ignition is usually confined to horizontal engines.

Battery and Coil Ignition.

This is one of the best-known systems. In early days a primary battery was used and often caused annoyance and mess. The accumulator was a great advance and many improvements have been made in this form of ignition until it has become a very reliable one. The chief objections are the need of recharging and possibility of running the battery down, due to a short circuit, at an inconvenient time. The form of plug used is similar to that of a high-tension magneto ignition equipment. The form of ignition is that known as a "jump" spark. Many engines are nowadays arranged for high-tension magneto ignition as their standard equipment, with battery and coil as a stand-by.

Magneto Ignition.

To obviate the necessity of recharging batteries electricians made investigations of methods for the production of a sparking device operated mechanically, the high-tension magneto being the outcome.

At first the instruments were of a delicate nature, but experience and practice have resulted in the manufacture of reliable ones.

Another form of ignition is the low-tension one, in which the spark is produced by the breaking of the circuit through which a low-tension current is flowing. It is possible to have a low-tension arrangement with dry cells and a solenoid, a system often adopted as a stand-by for engines fitted with low-tension magnetos.

The low-tension magneto has one advantage—viz., with engines of very high compression, such as those running on poor gas, the jump spark may be uncertain owing to the resistance of the space inside the cylinder, whereas with low-tension there is no trouble of this nature.

It is important, if a multi-cylinder engine be fitted with this system, for all cylinders to have the same amount of gap at the break, as otherwise erratic firing may take place.

AMONG THE OPERATORS.

CHAS. A. WELLER, operator on board the *Ruahine*, has communicated to us a long-distance freak signal which he recently received. While "listening in" for Teneriffe shortly after 2 a.m. on December 2nd, he heard good signals from a station using the same wave as Teneriffe, but owing to atmospherics he was unable to read the message. As a matter of fact, he was equally unable to receive Teneriffe on that occasion. On the following night, however, the atmospheric conditions gradually improved and at 3.20 a.m. the same signals which he had heard on the previous night came through and proved to be Arlington, Virginia, sending time signals and weather reports, and afterwards working with Key West, whose signals also were faintly distinguishable. The ship's officers computed the distance of the *Ruahine* from Arlington to have been about 3,100 miles. On another occasion when Mr. Weller was in the same locality, 15° 13′ N, 21° 22′ W., that was on February 26th last, he obtained excellent signals coming in for about an hour from Cape Race.

Say, Stranger, hev yew cast 'your ocular over our tall buildings yet?"—(See opposite page)

"The Weed"

By ALEC BAGOT

WE'VE been talking it over, the boys and I, and have unanimously decided that the least we can do for Browne is to relate the full facts of the case, so that everyone may know what really happened at Majeeba on September 20th, 1914.

Majeeba is one of those places that are described as "Outposts of the Empire"; little jungle towns where men eat and drink—mostly drink—and sometimes dream of cities, real cities where there are tramcars and theatres and white women. Majeeba, mind you, is an important town, being the capital of a territory boasting nearly twenty thousand square miles, although you wouldn't think so to look at the place, for it possesses scarcely a score of houses. But the *pièce de résistance* there is the wireless station, and the inhabitants are justly proud of it.

I believe in Sydney the "Townies" are so fond of their sheet of water that every new arrival is welcomed with: "So glad you could come; what d'you think of our 'arbour?" And in New York the Yankee greets the stranger with: "Say, hev yew cast your ocular over our tall buildings yet?"—an absolutely ridiculous question, for one can't approach the city without seeing the soaring sky-scrapers. Well, it's something like that at Majeeba, only there the residents say: "Glad to meet you, old man. Have a drink and then come and look at the wireless."

The Government Radiotelegraph Station—to give it its full title—is situated a few miles out of town, and has quarters attached for the staff, which consists of seven men and three niggers. The immediate vicinity, for a radius of about a quarter of a mile, is cleared ground; all around is rather heavily wooded land.

When the station was turned over by the erectional gang to the operating staff, Browne was made Officer-in-Charge. It wasn't a popular appointment at all, as Browne was such a little "Weed." I don't know to this day who first gave him the nickname, but "The Weed" he was always called. It must have been his personal appearance that suggested the appellation, for Browne was one of the skinniest and smallest specimens of shrivelled-up humanity one would strike in many a day's march. The only thing that saved him from total insignificance was his head, which was large and "brainy"—out of all proportion to the rest of his mummified anatomy. There's no doubt that Browne's head got him his job, for what he didn't know about motor generators and oil engines; about transformers and condenser capacities, and selective tuning, wouldn't cover the size of a pawn ticket. And as for technicalities! Oh, Lord, he'd drive us crazy sometimes with his intricate calculations, especially when the monthly mail arrived with the latest copy of THE WIRELESS WORLD, when he would turn to the scientific section and ferret into the problems. He once found an error in a calculation made by a learned Professor, which the Editor admitted when Browne wrote to him.

So, you see, taken all round, he was quite different from the usual run of Wireless men, and, but for the fact that he was Officer-in-Charge, he would probably have had rather a tough time. As it was, we were getting pretty fed up with things in general, and Browne in particular, when the European War broke out and served to give us new topics of conversation.

Great was the excitement at Majeeba. Various defence schemes were proposed. The one most in favour suggested that, in the event of the town being attacked, the male population should assemble at the wireless station, in order to protect our only means of communication with the outside world. We all had rifles and a good supply of ammunition, whilst in a wave of patriotism we erected a forty-foot flag-pole and hoisted the Union Jack.

That ceremony was quite impressive. "The Weed," as Officer-in-Charge of the station, "broke" the flag after a short speech, and as the fluttering folds of the Jack floated out on the lazy tropical breeze, we, "The Majeeba Volunteers," fired a salute. Browne's speech was a masterpiece of pithy eloquence. We had never given him credit for such rhetorical powers, but when he began to talk about "a piece of bunting he wouldn't exchange for the most priceless roll of silk in all the world," and "a flag that we would guard with our lives because it represented Britain's honour," I tell you, it sent a shiver down one's spine, for we knew that we might be called upon to live up to those words at any time.

By September the first excitement that the news of war had caused had died down, and it seemed impossible to believe that thousands of men were fighting and dying in old Europe, while we pursued the even tenor of our way. "The Weed" was once more getting on our nerves, mosquitoes were bad, and what was far, far worse than anything else, there were rumours that the town's liquor supply was becoming dangerously small.

At noon on the 20th I had to relieve "The Weed" from duty, and was just about to put the telephones on my head, when we were surprised to hear a familiar "*dot, dot, dot, dash*" repeated in the receiver.

"By Jove," I said, "that fellow's pretty close; he almost blows one's head off. Who is he?"

"Don't know," Browne answered. "I havn't heard anyone to-day at all. Let's listen."

With the telephones between us, we both listened to that flute-like buzz.

"V. V. V.," it still continued.

"D—— the man," I exclaimed. "Why can't he be less long-winded? He'll spoil our detector points if he keeps up that racket much longer. Ah!"—the last exclamation because the station stopped sending for a second and then recommenced.

"VNM, VNM, VNM," he repeated, then his own signal, "XPD," three times.

"Who the devil's 'XPD'?" I asked; "Surely that's an amateur's call!"

"Yes, but it isn't an amateur sending; there's no one round here with a set. Besides it's a Telefunken note. D'you know, I believe it's a German battleship!"

"Gee Whiz! and so it must be. Listen, there he is again!"

Once more the call; shorter this time, and somewhat quicker. I ran to the engine room and started up the motors, but when I returned, Browne was leaning over the desk, writing. I watched his pencil as it traced that dramatic message:

"*Here German warship. You must leave the wireless station. In five minutes we shall shell it. XPD.*"

The poor little "Weed" turned as white as the paper upon which he wrote, and the pencil dropped from his nerveless fingers.

"My God!" he said. "The devils!"

Then the spasm passed, and he was his old, quiet, wizened self as he started up the alternator.

"What are you going to do?" I asked.

"Give 'em a farewell message," he answered, grimly. His fingers touched the sending key, and the noisy spark leapt across the gap, pulsating its retort to the foe across the belt of trees.

The reply was brief and to the point.

"Go to H——!" was what Browne sent.

Now it was very wrong of Browne to say such a thing, for rule 3 of circular 17 distinctly states that "Swearing and obscene language is at all times strictly prohibited, whilst officers guilty of using unparliamentary language on the Wireless will be promptly and severely dealt with"; so, you see, for the Officer-in-Charge to be guilty of such a heinous offence was a serious matter! Still, Browne then seemed very different from the Browne who always pottered for hours over THE WIRELESS WORLD's "latest" technical problem.

"Quick—the rifles, and tell the men. Send Joe down to the town. Don't expect they know there yet, as the German has probably come round the Cape."

I ran to the "Palace" (by which lofty name our quarters were known), and called the boys. It took some minutes to convince them that I was not joking; but before we had finished arguing something went whistling over our heads. Instinctively we ducked, and heard a dull boom. The bombardment had begun.

No need, then, to impress upon the others that this was grim reality and not a practical

"The 'Townies' of Sydney are proud of their sheet of water" (see p. 709), *particularly when the s.s. "Wildenfals," the first German prize captured in Australian waters was brought in, as depicted above.*

joke. We all went back to the station, secured our rifles, and took up our appointed positions outside. The black boys were nowhere to be seen, having disappeared like magic, but we knew the fellows in the town would be up as soon as they heard the firing.

The booming still continued, and some of the shells dropped rather too close for our comfort. We knew the Germans could not see the aerial, as the site had been chosen with a view to concealing our position, but, nevertheless, they appeared to have found their range with almost uncanny accuracy.

The shelling had continued for about ten minutes, when our foremost picket gave the "danger" signal, pointing towards the wood. A rifle shot rang out, then another, and another, and we realised that the Germans had succeeded in landing an attacking party of some strength.

After that, we were too busy picking off the enemy to consider how many there were, whilst I remember subconsciously wondering whether the men from the town would reinforce us in time, and whether they would be of any use against so many. We kept on potting away, and as soon as the enemy showed themselves from cover, preparatory to storming the station, they were bowled over.

Suddenly a well-placed shell snicked off the very top of the flag mast, and down came pulley block and Jack. The firing ceased immediately; we learnt later that the Germans imagined we had hauled down the flag and surrendered!

Browne had been lying under cover close to the mast; I was a few yards to the right, and wondering what was the cause of the lull, when up jumped "The Weed" and rushed into the station. He emerged again in a minute, carrying a large hammer and a packet of nails.

Seizing the flag, he rushed towards the pole, and, before you could say "D—— the Kaiser!" Browne was swarming up, for all the world like a monkey on a stick.

Then the shooting began again, as the Germans learnt what was happening, but no whistling bullets came our way now—they were all around that agile figure on the swaying pole.

Up, up he went, and then, as calmly as though there was no one with evil intentions on his life within a thousand miles of him, "The Weed" began tacking the flag to the wood.

Dozens of bullets must have buzzed all around him. I know now what it means when one reads of "a hail of bullets," but he didn't seem to mind a scrap.

Suddenly "The Weed" lost his grip, turned a somersault in mid-air, and partly landed on his feet. I rushed to his assistance, and, lifting him up, dragged him into shelter behind my cover, where I knelt down and supported his crumpled form in my arms. A red splash was showing through his khaki coat, and his poor little legs seemed all anyhow; whilst his face was, if possible, more dried and wizened than ever.

In a few minutes Browne groaned, opened his eyes, and recognised me.

"Awfully good of you, old man," he gasped, "but it's no use; they've done their worst!"

"Don't be an ass!" I said; rather roughly perhaps, but I dared not trust myself to speaking softly. There was a huge lump in my throat, and somehow, I felt myself the size of an undergrown threepenny-bit beside that little hero.

"It's true though," he answered; "and I don't seem to mind. You'll keep—the old—flag—flying, won't you?"

"Bet your life," I said, and continued to hold him for some time before I realised that he was dead.

After that events seemed very confused, but the chaps say I went raving mad. I only remember an insane desire to revenge Browne's death and a fierce longing to kill every German in the universe. The boys say I leapt up from the trench and rushed, firing at intervals, towards the enemy in the wood.

I suppose it was lucky for me that a shot laid me out before I got near enough to be sent to glory; anyway, when I woke up in bed, the doctor told me that the others had arrived just in time to outflank and partially surround the Germans, who, being at a disadvantage in their ignorance of their surroundings, were out-fought. Their survivors finally surrendered, but there were only eleven sound men out of thirty-four.

To complete our luck, the British cruiser *Irrepressible*, which had been on the Deutscher's track for days, came down post haste in time to sink our unwelcome visitor. No doubt you saw all about *that* in the papers. My brother forwarded me a copy of a newspaper with an account of the attack. This is what it said, and the paragraph was tucked away in a little corner on the "Second War News Page."

"*A party landed from the German warship and attacked the wireless station, but was defeated with heavy losses. The British casualties were slight, one man being killed and three wounded. The one killed was Mr. F. J. Brown, Officer-in-Charge of the wireless station. The station was only slightly damaged.*"

That's all about the land attack, although there was plenty about the duel between the two ships. You'll notice they didn't even spell Browne's name right.

. . . .

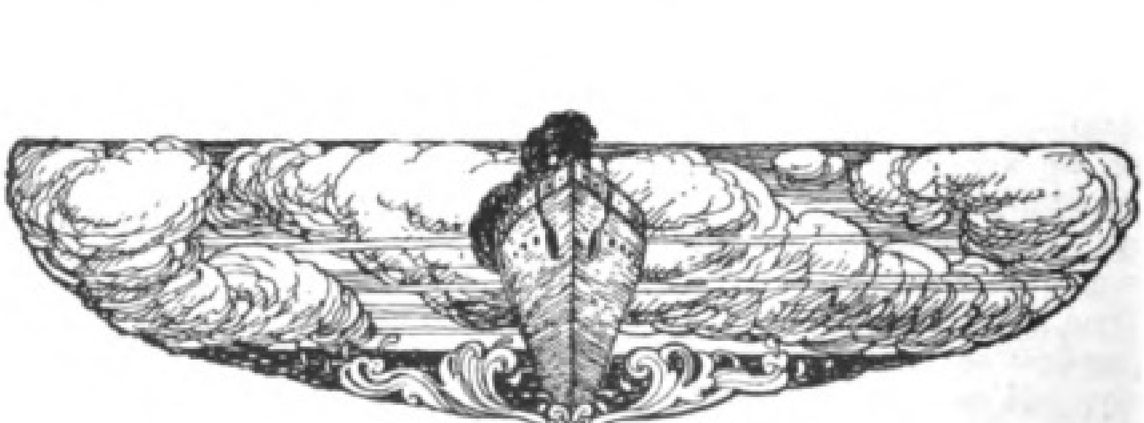
That's why we convened a meeting and decided to write a fuller account ourselves.

Before leaving we filled our glasses and stood up to drink a silent toast to F. J. Browne—*our* Hero!

"Boys," I said afterwards, "it's time we took up gardening."

"Gardening?" asked one of them in surprise.

"Yes, gardening. We may then learn to distinguish between a Weed—and a Flower."



NOTES OF THE MONTH

TO the numerous academic distinctions and International honours enjoyed by Commendatore G. Marconi, G.C.V.O., there must now be added his election to the Italian Senate. That such a reward would ultimately be accorded has been long evident, for the pride of Italy in Commendatore Marconi's world-wide fame is coupled with high personal respect. The conferment of this distinction at the earliest moment allowed by the Italian Constitution serves but to emphasise his country's goodwill.

The Italian Senate corresponds very nearly to the expressed ideal of many would-be reformers of the House of Lords. It consists of princes of the Royal House who have attained a majority, and an unlimited number of members above forty years of age who have filled high offices, or have acquired fame in science, literature, or other pursuits tending to the benefit of the nation. The nomination, which rests with the King, is governed by two conditions only. The senator-elect must have reached the age of forty, and must be contributing annually to the State at least 3,000 lire (£120). A seat in the Senate is held for life. In 1914 the Italian Senate consisted of 404 persons, exclusive of five members of the Royal Family. The addition of Commendatore Marconi to this number cannot fail to be beneficial to the scientific and industrial progress of the great Italian nation.

* * *

It is by some thought to be a pity that wireless telegraphy should deprive mankind of that peculiar form of humour which is extracted from the working of the older branches of telegraphy. Wireless has created a humour of its own, but we have to admit that we would not find in it such an incident as that which an officer serving with the East African Mounted Rifles mentions in a letter to the *Times*. We should imagine from the letter that the humorous side of war is very much in evidence in East Africa, as the following extract from the correspondent's letter will show:

> "The telegraph section with great speed and efficiency fixed up the field telegraph, 48 miles of it, on bamboo poles. Next day walking along the line I never saw such a mess. Wherever a giraffe had come across it in the night he seemed to have wound it round his neck and then started off at top speed."

This opens a vista of limitless possibilities to the wireless engineer working in tropical countries, and, even at the risk of provoking our "Irresponsible Expert," we must draw attention to the possibilities of the giraffe in connection with portable wireless stations. The "mast" is there; but whether the "portability" and the other qualities of that amiable animal will commend themselves to wireless engineers, we must leave the latter to decide.

* * *

Troubles with overhead telegraph lines are usually connected with climatic influences or the mischievous interference by enemies or malefactors. But the incident mentioned by the writer of the letter in the *Times* referred to above recalls that in Central Africa their exists a race near Karungu, on the eastern coast of Lake Victoria Nyanza, which apparently will not allow any other system than that of wireless telegraphy to exist in their midst. They are a primitive people, so innocently minded that they do not understand what theft is, and at the same time they have an unfortunate partiality for wire. As a result, it is impossible to erect telegraph poles with the necessary copper strands across the district, for once their erection is completed and the lines left unguarded a raid is made on the pretty toy by these negroes and the wire is converted into bracelets, necklaces, and other vain trifles. No bit of iron comes amiss to the men of this tribe, and it is said that they even twist wire into large spectacle frames in imitation of European travellers. (More evidence of the expansion of "Kultur"!) On this account it has not been found possible to run telegraph wires across the country, excepting along the Uganda Railway. The only means of linking up the outlying Government stations is wireless telegraphy, and in a paper before the Geographical Society some months ago Mr. F. Oswald stated a scheme for wireless communication was projected.

* * *

In imposing a tax on telegrams, the Government of the United States of America have adopted a means of raising additional revenue the effects of which will have to be carefully noted. The new War Tax, which came into operation on December 1st last, provides that duty at the rate of one cent per message be levied on telegrams (except United States Government messages) filed at telegraph offices in the United States on which the charge imposed is 15 cents or more. Wireless telegrams originating in the United States will also be subject to taxation at the rate of one cent per message, but wireless communications filed on board ship will be exempt. The tax will be collected from the senders of messages, at the telegraph offices, but in the case of messages filed with the American land line telegraph companies for transmission *viâ* the stations of the Marconi Wireless Telegraph Company of America, the land line telegraph company accepting the message collects the tax.

* * *

Whilst electrical science has rendered a great service to many other industries besides engineering—in teaching exactitude of measurements, and in making more widely known the underlying principles of the cost of production—the use of electricity has directly contributed to many of the improved conditions of living. Communication between peoples is really easier than our grandfathers ever enjoyed or even dreamt of; travel is safer; the pleasures of life are greatly increased; human suffering has been alleviated by electrical discoveries; even the conquest of the air has only been made possible through the assistance of electricity. There is much left to unravel, and electricity may yet enable mankind to make further great discoveries and lift the veil still higher, revealing to us more and more of those marvellous circumstances with which we are surrounded.

* * *

Keith Lectures.

Before the Royal Scottish Society of Arts, at George Street, Edinburgh, a highly interesting lecture was delivered on January 11th, by Dr. J. Erskine-Murray, F.R.S.E., M.I.E.E., Keith Lecturer for 1915. It constituted the opening discourse of a series of four on the subject of "Electric Waves and the Principles of Wireless Telegraphy and Telephony," and the popular character of the lecture was reflected in the audience.

Mr. Andrew Wilson, M.Inst.C.E., congratulated the Society of Arts on the high standard attained by the Keith Lectures and the eminence of their present lecturer, adding that anyone wearing the King's uniform would be welcomed at the Hall without payment.

After dealing lucidly with wave motion and illustrating his points by experiments before the audience, Dr. Erskine-Murray proceeded to show how Clerk-Maxwell was justified in his prediction that electrical waves would be proved to be identical with those of light, and promised to develop the subject further in a later lecture. He then proceeded to deal with the nature of resonance, or revibration, emphasising its great importance in wireless telegraphy. A number of illustrative experiments with mechanical vibrators were then shown in order to demonstrate the response of one tuned vibrator to another, and the possibility of sending two different messages simultaneously without mutual interference between neighbouring pairs of stations.

Maritime Wireless Telegraphy

THE first S.O.S. call in New Zealand waters has been sent out, and we take it as a good augury that not only did it receive prompt attention from the authorities, but that the vessel sending the call was able to extricate herself from the difficulties which beset her. This vessel was the Royal Mail steamer *Ruahine* of the New Zealand Shipping Company, which sailed from Wellington, New Zealand, at noon on Saturday, October 24th, bound for England *viâ* Cape Horn. Owing to the exigencies of war, the wireless operator on the vessel (Charles A. Weller) received instructions that no calls were to be sent out and the wireless only used for purposes of "listening in." All went well till Sunday, when Weller received instructions that the captain wished to see him. On obeying the summons he was informed that the *Ruahine* was leaking badly and that, with an increasingly heavy list to starboard, her condition was becoming such as might soon seriously endanger her stability and safety. The captain enquired whether any ships were in the neighbourhood, but on this point the operator could not satisfy him as most of the other craft in the New Zealand waters had adopted the same tactics as the *Ruahine* and were seeking security in silence; for it should be remembered that the *Emden* was still roaming the high seas and turning up in unexpected places. The captain, however, determined to chance his luck, and gave orders that the S.O.S. signal should be circulated, and should any boat reply, the operator was to inform them that the *Ruahine* required a vessel to stand by her in case of emergency, and that she was returning full speed to Wellington. This was at 6.58 on the Sunday morning and the first reply to be received was from the Wellington coast station, to whom particulars of the boat's position and course were given. Wellington thereupon immediately got into telephonic communication with the port authorities, and arrangements were made for the fast ferry steamer *Wahine* (which is also fitted with Marconi wireless and belongs to the Union Steamship Company of New Zealand) to leave Wellington and go to meet the distressed vessel in case assistance should be required. At that time the *Ruahine* was about 200 miles from port; by this time, however, the worst of the danger was over. A means was found of stopping the leakage and the ship was enabled to continue her return unassisted, although the list to port was very marked. The *Wahine* met her at 4 o'clock that afternoon and escorted her the rest of the way back, the two ships casting anchor at 2 a.m. the next morning. Amongst the passengers on board was the famous Antarctic explorer Sir Douglas Mawson and his wife.

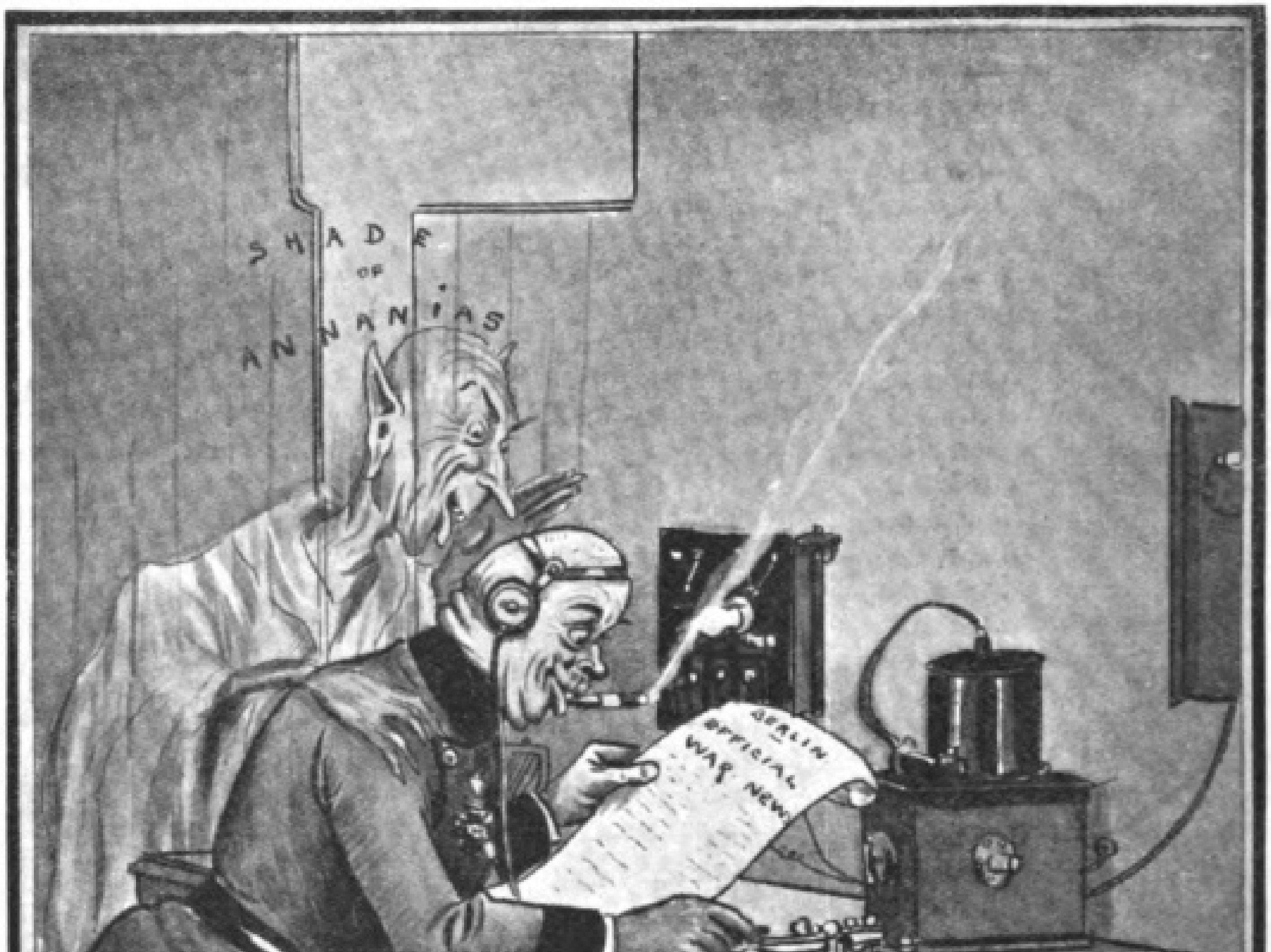
Recognition in connection with this incident must here be made of the operator on board the s.s. *Wahine*, who when he received the call for further duty had already completed a night watch, and consequently was called upon to take another fifteen hours' duty.

Not only has the *Ruahine* the distinction of sending the first distress call in New Zealand waters, but she is also the first ship to have sent public wireless messages into that country. This was on July 26th, 1911, the day when the first New Zealand coast station was opened at Wellington.

* * *

When it was ascertained that the steamer *Cairnhill*, which recently broke her tail shaft and lost her propeller, when four days out of Nauru in the Pacific, was being towed from New Ireland to Sydney, a distance of roughly 2,000 miles, negotiations were at once entered into with the companies concerned with a view of having wireless installations fitted on the *Cairnhill* and on the tug which was to bring the disabled vessel to Sydney. This would undoubtedly have been of very great assistance in the matter of the towing, but unfortunately the negotiations could not be completed.

CARTOON OF THE MONTH



"This is the way we make the news
All day long in wartime."

Adaptation of nursery rhyme to suit the present occasion.

Wireless Telegraphy in the War

A résumé of the work which is being accomplished both on land and sea.

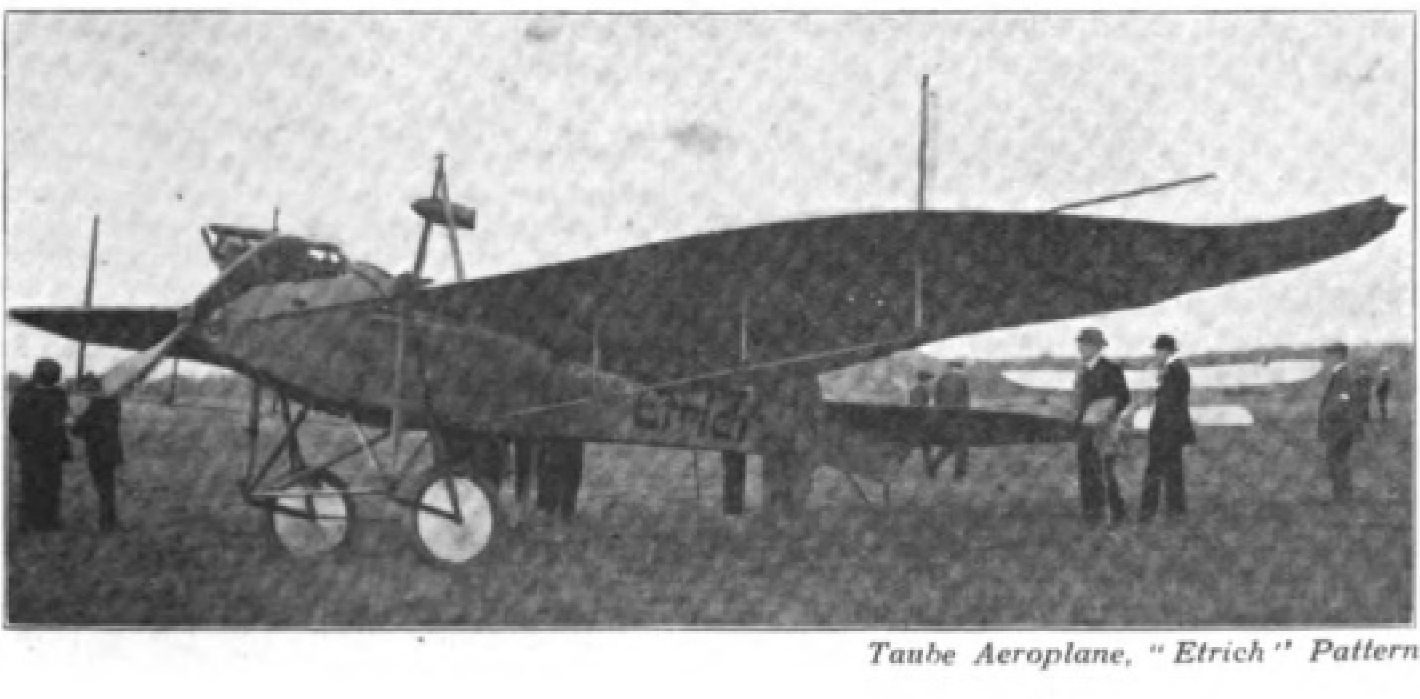
THE BRUSSELS STATION.

IN the neighbourhood of Brussels, upon a plot of ground given by King Albert, Mr. Robert Goldschmidt had erected a high-power wireless telegraphic station, which was to have played an important part in investigating the transmission of radio-signals. Before leaving Brussels, however, the Belgians destroyed this station so that it should not fall into the hands of the Germans, and the following is an account of the destruction furnished by Mr. Marcel G. de Gallaix :—

"On Wednesday, August 19th, the most contradictory rumours reached Brussels. Some folk affirmed that the Germans were at Louvain and would not stay to enter the capital. Others said that the town was protected by a ring of troops. Nevertheless, the hurried departure of the Queen appeared to support the views of the pessimists. Another event more unexpected and more convincing succeeded in persuading all that the enemy was at hand.

"About one o'clock in the afternoon a violent explosion was heard in the direction of the wireless station at Laeken. By chance I was close by. At first I thought that the bridge had been blown up, when suddenly I was astounded to see one of the wireless masts bend over and fall to the ground. I had scarcely recovered from my surprise when another explosion occurred more violent than the first, and a second mast fell. 'They are blowing up the station; the Germans must be near,' I said to myself. I tried to get nearer, but at 200 metres from the station I was stopped by a cordon of town guards. By making a detour I was able to skirt the station, and was then only separated from it by the Canal of Willebroeck.

"I waited for some moments, and then the characteristic throbbing of a Taube made me lift my eyes. It came slowly towards me, gradually descending until I could quite clearly see the black cross painted on its wings. It flew over the station, encircling it twice, and was starting in the direction of Louvain when suddenly a shot was fired near me; others followed and continued unceasingly for some minutes. The Taube, finding itself a target, turned slowly and disappeared. A group of military engineers ran to the other side of the canal and called out to me: 'Look out! run for your life!' Without knowing why, I ran back some yards. A third explosion occurred, and a third mast fell to the ground. The soldiers returned, and one after the other



Taube Aeroplane, "Etrich" Pattern.

the masts fell. The soldiers had cut the cables on one side so that the masts bent towards the other side; then, having mined the foundations, they fired the fuse and ran back as quickly as possible, whilst the light metal framework slowly crumpled up in the midst of volumes of thick, black smoke.

"Sometimes a mast was prevented from falling by the antennæ or a neighbouring mast. In other cases the first explosion only shook the mast, and the blasting had to be repeated once or twice until the mast was utterly destroyed. At about half-past three the antennæ were entirely destroyed, but the transmitting and receiving station was still intact. This station was situated in a tunnel under the Vilvorde Road, between the Willebroeck Canal and the ground where the masts had stood.

"It was only possible to carry away some of the light instruments; the remainder had to be destroyed. The most delicate parts were broken up with hammers, and to complete the destruction the station was blown up with dynamite. The explosion was so violent that part of the granite parapet was broken, and a large crack opened in the roof of the tunnel. Finally, so that even the ruins could not be put to any possible use, the station was filled with straw and hay and set on fire. A dense smoke rose from the tunnel. It was seen rising over the canal until the evening, and the last bursts of flame were not extinguished when a detachment of the enemy's cavalry appeared on the scene.

"We heard afterwards that the Germans had hoped to seize the wireless station, which would have put them into communication with the most distant points of the theatre of war. Orders had been given to a troop of cavalry to advance by forced marches to prevent its destruction, but the Belgian authorities, warned of this move, were able to forestall them. The German plans were frustrated, but the defeat cost Mr. Robert Goldschmidt not only an enormous sum of money, but also the patient research and labour of three years.

The Signal Service.

From an officer's letter, which was printed in the *Times*, we make the following extracts:—

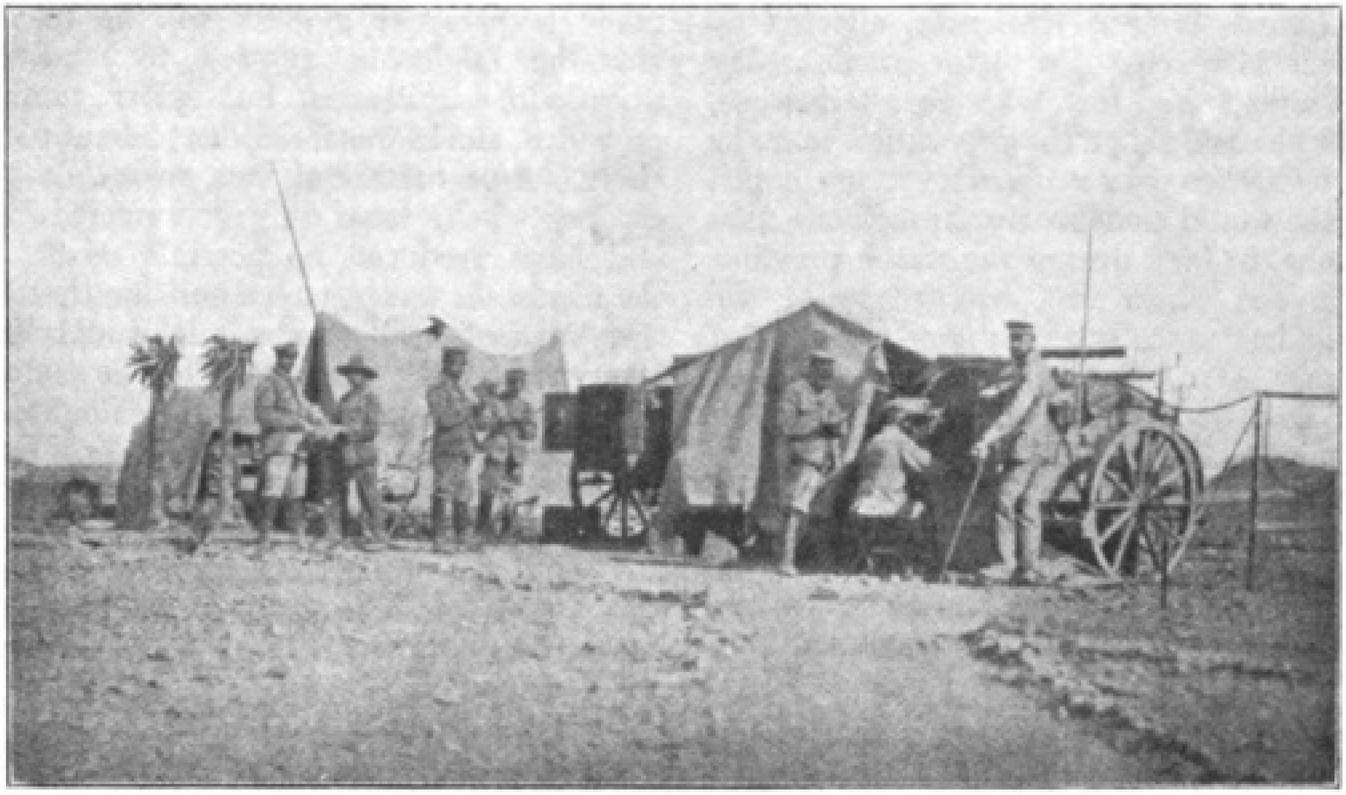
I am very much surprised to see in the English Press so little mention made of the field telegraphs, or signal service, as it is now known. In time of war the signal companies of the Royal Engineers are one of the most important and necessary arms of the service. They are the nerves of the Army.

Most of the important towns in the north of France and also London and Paris are in direct touch with General Headquarters. These are called the main lines of communication, and over their wires day and night pass a continuous flood of traffic for the hospital bases, ordnance, remount, and store depôts. From General Headquarters radiate wires to the various army corps headquarters, and again each army has its communications to the divisions, which, further, have wires right up to the brigades. It will thus be seen that in the space of a few minutes the War Office is fully and clearly informed of what is going on in the firing line. In fact, were the lines joined straight through it would be possible to hear the roar of artillery and the bursting of shrapnel in St. Martin's-le-Grand.

As the tide of battle turns this way and the other and headquarters are constantly moving, some means have to be provided to keep in constant touch with General Headquarters during the movement. This emergency is met by cable detachments. Each detachment consists of two cable wagons, which usually work in conjunction with one another, one section laying the line whilst the other remains behind to reel up when the line is finished with. A division is ordered to move quickly to a more tactical position. The end of the cable is connected with the permanent line, which communicates to Army Headquarters, and the cable detachment moves off at the trot; across country, along roads, through villages, and past columns of troops, the white and blue badge of the signal service clears the way. Behind the wagon rides a horseman, who deftly lays the cable in the ditches and hedges out of danger from heavy transport and the feet of tramping infantry with the aid of a crookstick. Other horsemen are in the rear tying back and making the line safe. On the box of the wagon sits a telegraphist, who is constantly in touch with headquarters as the cable runs swiftly out. An orderly dashes up with an important message; the wagon is stopped, the message dispatched and on they go again.

At Le Cateau the situation was so desperate that signal companies were sent to the trenches to assist the infantry in repelling a heavy attack. For this piece of work we were highly complimented by General Smith-Dorrien, who at the same time expressed his great satisfaction at the way in which his communications had been established throughout the campaign.

Telegraphists are often left on duty in the trenches and lonely farm houses, châteaux, etc., close to the firing line, and I leave it to your imagination to picture how difficult it is to concentrate one's mind on the signalling and reception of important messages while the air is filled with the deafening roar of artillery and the screaming and bursting of shells. An experience of this kind happened to me a short time ago in a lonely château on the Ypres-Menin road. The château was the centre of a perfect hell of German shrapnel for nearly a week, until it became almost untenable, and was abandoned by the Headquarters Staff. The general gave instructions that a telegraphist was to remain behind



A German Portable Wireless Station.

to transmit important dispatches from the brigades, and I was left in charge of the instruments in this shell-swept château for a day and a night. On the second day the Germans broke through our trenches, and the wires were cut up by shell fire. I was given orders to evacuate the building and smash up my instruments. These I saved by burying in a shell-proof trench, and then had to escape between our own fire and that of the enemy's across a field under a terrible tornado of shrapnel. On the early morning of the same day one of our cable detachments was cut up and another captured by the Germans only to be retaken by our sappers and drivers after a desperate and glorious fight.

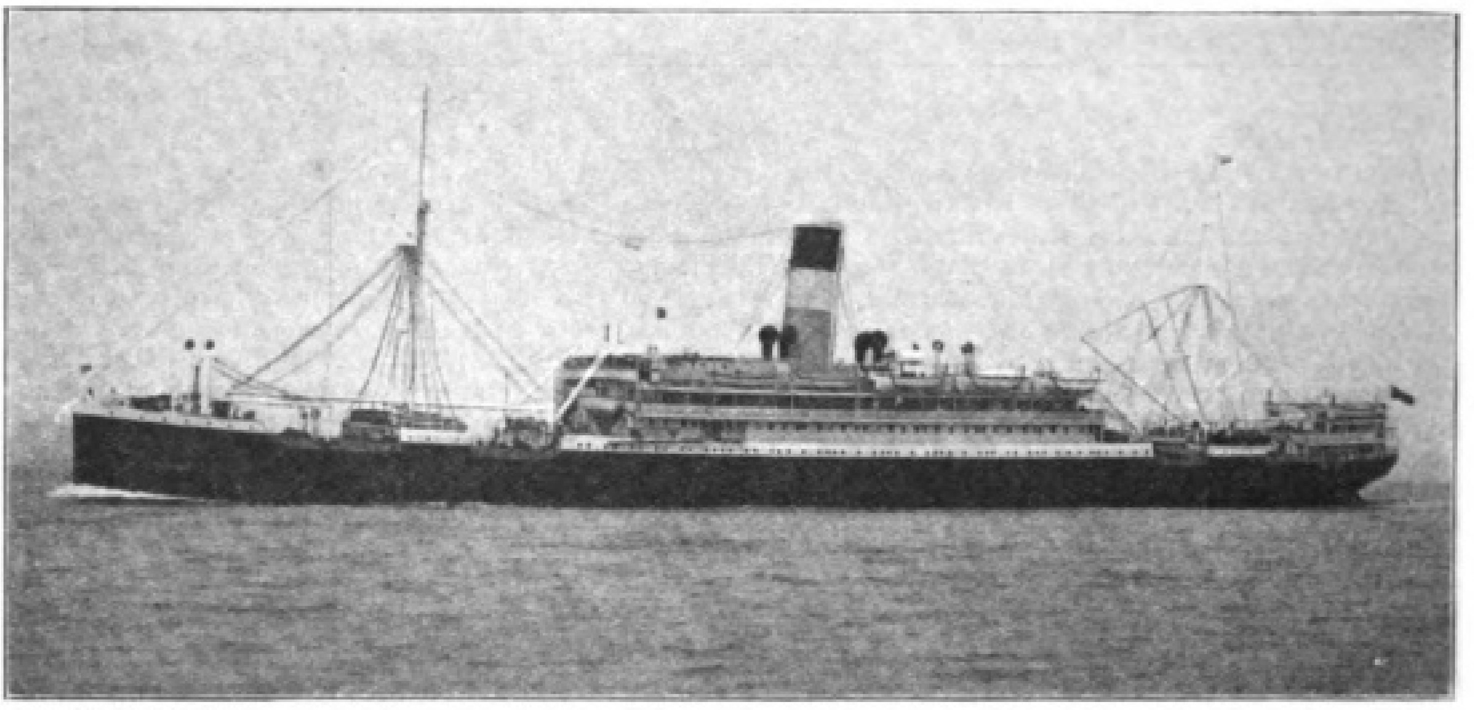
In the region of the Aisne, where the hilly and wooded nature of the country admitted of much cover, spies often took advantage of this to tap our wires. The lines are constantly patrolled by mounted linemen, whose duty is attended with much risk. On one occasion a lineman, in passing along his patrol, noticed that there was a quantity of slack cable lying on the side of the road. Dismounting to coil it up out of the reach of traffic he found to his surprise that a piece of spare wire had been tied into the main line, and upon investigating discovered that it led to the top of a haystack, the wire being cunningly hidden in the straw. Going further down the line he tapped it and reported the matter to headquarters, then, mounting guard over the haystack, he awaited the arrival of an armed escort, who discovered the spy, together with several days' supply of food, hidden in the depth of the hay.

Telegraphists of experience can often detect if anyone is tampering with the line. An operator on duty at Bavai, near Mons, was listening attentively to the buzz of the various stations in circuit on an important line when his attention was arrested by a very faint drone, which he knew immediately was caused by induction from another cable. He amused himself by writing down on a scrap of paper the signals as they faintly echoed in his receiver. Some French telegraphist, he thought, sending a cipher message. An officer looked over his shoulder, "Hello," he said, "so you understand German." When the excitement had subsided after the telegraphist's explanation, a scouting party was dispatched from ends of the wire, and succeeded in making a very neat capture. Wireless telegraphy, of course, plays an important part in this war, most of the larger aeroplanes being equipped with apparatus, by which means they swiftly communicate important observations to headquarters. The Germans also make elaborate use of this system.

A German lady, obliged to leave Togoland after the occupation of the colony by the British troops, has arrived in Berlin, and gave the following description to the *Berliner Lokal Anzeiger* :—

By means of our wireless station at Kamina, we knew everything going on in Germany during the time of mobilisation. On August 6th a British officer with a flag of truce arrived in a motor car from the British Gold Coast, and negotiated with the Deputy Governor, Privy Councillor and ex-Mayor Von Doering, regarding the surrender of the Colony, and allowed twenty-four hours' time for considering the proposal. Von Doering called together all the men capable of bearing arms, mostly officials and merchants, and made a stirring speech about the Fatherland's call to arms. By telegraph, he had received an order to defend the wireless station Kamina. All the married men were left behind at Lome, for the protection of women and children, while the unmarried men, about 160, and the native police corps, under Von Doering, went to Kamina in the night from August 6th to 7th.

Some interesting details have been received of the capture of the s.s. *Vandyck*, which the German cruiser, *Karlsruhe*, effected on October 26th last. Up to the previous day the *Vandyck* had met with no interference, and as she had taken the precaution to make as few wireless calls as possible it was hoped that she would come safely through the danger zone, in fact, during the watch previous to the one which was destined to be the vessel's last no calls of any kind were heard or sent. At 11.10 the chief operator took duty, and he had scarcely been on watch five minutes before he was informed that a cruiser, accompanied by what appeared to be a cargo boat, was bearing down on the vessel at full speed. Immediately he went on deck just in time to see the *Karlsruhe* hoist her German ensign and call upon the *Vandyck* to stop. By that time the enemy was almost abeam at about two miles distant. At 11.15 the operator received a telephone call from the bridge asking if any stations were working. As it happened, there were none, and already the *Karlsruhe* was proceeding to take up a position astern of the *Vandyck* and was lowering a boat to visit her. Just then a few faint signals came through the phones and were recognised as emanating from a British cruiser, which had been in communication with the *Vandyck* previously. This fact was immediately reported to the bridge, and the probable distance of the sender was calculated to be something between 500 and 600 miles. The operator made a personal request to the captain that he might be allowed to send out a call for assistance, but wiser counsels prevailed, and he was forbidden to do any such thing. As a matter of fact, so rash a proceeding would have only endangered lives and have produced no possible result, for the *Karlsruhe* was in such a position that had the *Vandyck* sent any call it would have been successfully "jammed" by the enemy's apparatus, while it would undoubtedly have enraged the *Vandyck's* pursuers. Even had a message got through, the distance to be traversed by a British cruiser before she could get up with them was so great that the *Karlsruhe* could easily have got away after sinking the *Vandyck*. At about 12 o'clock the *Karlsruhe's* boat came alongside and two officers, together with several men, boarded the vessel. First, they interviewed the "bridge," the next step was to take charge of the wireless cabin. As soon as they had done that they informed the wireless operator that they had taken charge of the *Vandyck* and henceforth no one was to enter the Marconi room except with special permission. From this time onward an armed marine kept continual guard at the door of the cabin, which was occupied by a German telegraphist. By this time a small flotilla of German ships had come up; they proved to be the s.s. *Rio Negro, Asuncion, Indrani* and *Farn*, two of which were actually German vessels and equipped



S.s. "Vandyck."

with wireless, while the two last named were captures, and were acting as colliers to the battleship. Later, passengers and crew of the *Vandyck* were informed that they would be transferred to the *Asuncion* on the following morning and would be landed at Para, Brazil.

The transhipment of personal effects commenced at 6 a.m. on the 27th. By nightfall everything had been arranged, and then the *Asuncion* parted company with the *Karlsruhe*.

In order to delay the news of the capture of the *Vandyck* the arrival of the *Asuncion* at Par was delayed until November 1st.

SIDELIGHTS.

A person who was present on one of the ships engaged in blotting out the German Colonies in the Pacific says that they found wireless installations in the most isolated and out-of-the-way places. In some cases they had to penetrate fifty miles into the interior, where the wireless apparatus was hidden among trees. The same informant states that the wireless message sent by the operators on Cocos Keeling Island reporting the presence of a hostile ship was received by the Australian warships *Melbourne* and *Sydney*, which happened to be only fifty miles away. The *Sydney* started at full speed, and in less than an hour and a half the *Melbourne* received a message from the *Sydney*: "Have engaged the *Emden* and finished her."

* * *

Chief Petty Officer Davis, South Queensferry, entered the North British Wireless School in Edinburgh at the age of seventeen. Seven and a half months later, and just a fortnight before the war was declared, he passed his examination. A few days after the declaration, he received a letter from the Admiralty asking him if he would take up the position of wireless operator during the continuance of the war, receiving on joining the rank of Chief Petty Officer. He accepted, reported himself to the Commodore at Chatham, received the rank of Chief Petty Officer, and was transferred to the Royal Naval Flying Corps as wireless operator.

* * *

Carpentier, the famous French boxer, is serving with the French Army as wireless operator signalling to aeroplanes. For a week he was engaged with the 3rd Siege Battery, when, at Soissons, one of its guns was put out of action through a German shell smashing the axle of one of the wheels.

Carpentier in Military Kit.

Shells were falling all around, and one of them smashed the apparatus with which Carpentier had been receiving messages from the aeroplanes telling the battery the range.

* * *

Our last issue contained, on page 653, a letter from Mr. J. B. Tucker, honorary secretary of the Birmingham Wireless Association, relating to the sentence of six months' imprisonment inflicted by a court-martial at Hull, on December 6th, upon Mr. Archer G. Cocks. The following letter has been received from Mr. Cocks, which speaks for itself :

Birmingham,
January 12th, 1915.

To the Editor of THE WIRELESS WORLD.

DEAR SIR,—I read with great interest the long letter in your last issue from Mr. J. B. Tucker, Hon. Sec. of the Birmingham Wireless Association, respecting my case. I would like, with your permission, to publicly thank that gentleman for his extreme kindness and untiring energy which he bestowed on my case. He went to the trouble of travelling to Hull to give evidence at my trial, and was instrumental in bringing the matter to the notice of Mr. A. A. Campbell-Swinton, President of the British Association Radio-Telegraphic Investigation Committee, who in his turn put it before Mr. H. J. Tennant, the Under-Secretary of State for War, who the same day ordered my release.

I would like to thank you, sir, for giving due prominence to my unfortunate case, as I hope it will serve as a warning to other experimenters to have every particle of their apparatus removed, sealed, or obtain a permit to keep component parts of apparatus on their premises, as part of the apparatus mentioned in my case was simply a buzzer set with which my wife and I had been keeping up our Morse practice. I, therefore, tremble to think what would happen to any unfortunate amateur who was found by certain Territorial officers to have in his possession a practice set as described by Mr. Cyril C. Barnard in your November issue.

Apologising for taking up your valuable space, I am, yours faithfully,

(Sgd.) ARCHER G. COCKS.

We have great pleasure in calling attention to the kindly action and activities of Mr. J. B. Tucker, as well as to the success which has attended them. We also wish to call attention to the warning contained in the second paragraph of Mr. Cocks's letter.

The Riddle of the Sands.

In view of the present war conditions and of the strategical positions of the German and Allied fleets in the Baltic and North Sea, the map which we reproduce on the opposite page should be of particular interest to our readers. Primarily it has an historical interest, for it shows the first Marconi wireless telegraph station which was ever notified by the cartographer. This station is just south of the lighthouse, and commands the enormously important strategical position of Borkum.

The map was published in Germany in 1900, and all who have read *The Riddle of the Sands* will appreciate the full significance of this reproduction. This marvellous book, which was published in 1902 (or two years after the publication of the map in question), deals with the possibility of the secret formation of a naval base among the Frisian Islands for purposes of the invasion of England by Germany. It is futile to surmise to what extent the revelations of *The Riddle of the Sands* influenced the tactics of our fleet during the first stages or the war. That is a matter of which the naval authorities will perhaps be enabled to enlighten us when the time comes for open speech. Suffice it to say here that the story of *The Riddle of the Sands* is not fiction, but serious fact, and is evidence of the enormous secret organisation of Germany, as the following quotation from the preface of the book will show :

"In October last," writes Erskine Childers, "my friend Carruthers visited me in my chambers and, under a provisional pledge of secrecy, told me frankly the whole of the adventure described in these pages. Till then I had only known as much as the rest of his friends—namely, that he had recently undergone experiences during a yachting cruise with a certain Mr. Davies which had left a deep mark on his character and habits.

"The result of this cruise was that information of enormous importance to England was wrung with much peril from, and labour from, the German Government and promptly transmitted to our own, but it was evident that it was having none but the most transitory influence on the English naval policy. Forced to the conclusion that the national security was really being neglected, Carruthers and Mr. Davies decided to make their story public. The great drawback was that an Englishman bearing an honoured name was disgracefully implicated. Indeed, troublesome rumours con-

taining a grain of truth and a mass of falsehood were already afloat. To present the case clearly to the common sense of the country at large it was determined that the *Riddle of the Sands* should be published. Carruthers gave his diary and recounted the history of his cruise in full detail, while Mr. Davies supplied charts and maps."

Erskine Childers adds that the year the adventure belonged to is disguised, the names of persons are throughout fictitious, and certain liberties have been taken to conceal the identities of the English characters. We advise all who can to secure and read this book with the utmost attention, making full use of the charts there displayed, and further of this hitherto unpublished map which we now produce. They will gain much enlightenment on a very serious question.

The story contains no mention of wireless telegraphy, a very important factor in the case there presented; although the map in our possession shows that this adjunct to the proposed organisation was not overlooked and that Germany, who "has a peculiar genius for organisation not only in elaborating minute detail, but in the grasp of a coherent whole," had developed a scheme which for magnitude and audacity is probably without parallel in the history of naval tactics.

Among the Wireless Societies

London.—A general meeting of the Society was held in the Lecture Hall of the Institution of Electrical Engineers, Victoria Embankment, on Tuesday, January 26th, at 8 p.m., when the President gave the Presidential Address for the coming year. The subject for the evening was "Some Electrical Phenomena"—illustrated by experiments. Details of the meeting were not to hand when we went to press, but an account of the proceedings will be included in our next issue.

* * *

The London S. M. and E.E. Society.—This society held its sixteenth annual general meeting last December at Caxton Hall, Victoria Street, London, S.W., under the presidency of Mr. W. H. Dearden. After the formal business a discussion arose upon the four principal points raised in the report. These points comprised the reduced attendances at ordinary meetings, the decreased applications for membership, the limited use of the society's workshop, and the question of conversazione and dance. The discussion was a lively one and the meeting seemed to favour by a large majority the employment of paid lecturers on scientific matters. The meeting was about equally divided with regard to the question of charges to users of the workshop, and the social function was abandoned in view of the present crisis in national affairs. After the award of the competition shield and other prizes (the former being won by Mr. Harold G. Eckert, and Mr. Conybeare's workshop prize falling to Mr. S. G. Bleakman), the meeting proceeded to consider various alterations in rules of which due notice had appeared. All the proposed alterations were carried with the exception of Mr. W. T. Barker's suggestion relating to rule 7. The following new members were elected on the committee: Messrs. C. S. Barrett, H. J. Ledger, J. C. Crebbin, F. H. J. Bunt, R. M. Weaver, J. P. Maginnis, and H. H. G. Denvil. Herbert G. Riddle, Secretary, 37 Minard Road, Hither Green, S.E

Barnsley Amateur Wireless Association.—The regular monthly meeting was held on January 6th at the new premises in the Y.M.C.A. buildings, Eldon Street. The association still retains their room at Straw Lane Cricket Ground, still the *locale* of their aerial and their instruments, although these are necessarily under present conditions in a state of "suspended animation," the instruments all being secured under Government seal. Apart from buzzer practice not much work has been attempted during the past months. This has been due partly to the holidays and partly to the extension of premises. The new arrangements made for working in unison with the local Y.M.C.A., which has involved securing a room in their building, is likely to promote the comfort of meetings and the convenience of study.

* * *

Bristol Wireless Association.—A meeting of the above association was held on January 16th at 13 Hampton Road, the Rev. W. P. Rigby being in the chair. The balance sheet of 1913-14 season was read. It was decided that a separate secretary and treasurer was unnecessary, and that the secretaryship and treasuryship should be combined. Instructional articles in THE WIRELESS WORLD are to be studied. Finally, owing to lack of members the "Model Engineers" have been approached with a view of amalgamation.

Anyone interested in "wireless" and desirous of joining the above society should communicate with the secretary, Mr. A. W. Fawcett, 141 Redland Road. The next meeting will be held at 13 Hampton Road, at 8 p.m. on February 13th.

* * *

Glasgow.—The annual report of the Royal Technical College records the fact that Mr. Duncan J. MacKellar, B.Sc., published papers during the most recent session on matters relating to wireless telegraphy. These papers were "Some Systems of Wireless Telegraphy," read before the Scientific Society, and "The

Syntonic Principle in Wireless Telegraphy," read before the Students' Section of the Institution of Electrical Engineers.

The latest addition to the rank of wireless societies is the Glasgow and District Wireless Club, which has been inaugurated with every promise of success. The secretary is Mr. Walter Stich, of Wohnfried, Riccartsbar Avenue, Paisley.

* * *

The Liverpool Wireless Association.—The following are the proximate arrangements made for this society for meetings at the Creamery Café, 56 Whitechapel, Liverpool, on alternate Thursdays, at 8 p.m.: February 4th and 18th, March 4th and 18th, April 1st, 15th, and 29th. Subscription, 5s. per annum. Free classes in "Electricity and Magnetism" and "Ordinary Wireless Telegraphy." Speed practice classes.—S. Frith, Hon. Secretary, 6 Cambridge Road, Crosby, Liverpool.

* * *

North Middlesex Wireless Club.—A meeting of this club was held on January 11th at which demonstrations were given with a harmonograph, the type used being that with two pendulums swung in planes at right angles to one another. The figures produced showed great variety, many being very curious. The next meeting will be held on Monday, February 8th.—E. M. Savage, Hon. Secretary, "Nithsdale," Eversley Park Road, Winchmore Hill, N.

* * *

Manchester.—The School of Technology possesses particulars of more than 550 students who were in attendance at the college during the academic year 1913-14, and who are now serving in various branches of His Majesty's Forces. With a view to the completion of a Roll of Honour, which shall also include the names of past students engaged upon military service, the Registrar will be glad to receive any information from such persons themselves or from their relatives or friends.

* * *

Institute of Radio Engineers.—The annual general meeting of this Institute was held on January 6th, in New York, when two papers were read: One by Mr. R. A. Weagent, on "The Design and Construction of Guy-Supported Towers for Radio Telegraphy," and the other by Mr. C. F. Elwell, on "Wooden Lattice Masts." Mr. Weagent described methods of determining the stresses in these towers, and of designing the tower to meet them. Mr. Elwell's paper gave in detail the design, construction, and guying of the much-abused type of lattice mast.

Administrative Notes.

ARRANGEMENTS have been made in the Union of South Africa for the transmission of radio time signals for the use of shipping in South African waters. A special clock at the Royal Observatory is adapted to give automatically a series of signals of a distinctive character extending over an interval of half a minute. The clock is brought into conformity daily with the Observatory standards shortly before the hour selected for transmitting the signals. (The hour chosen is 11 p.m. Union Standard time, 9 p.m. Greenwich mean time.)

The time signal is preceded by the usual warning signal from the radio coast station. The time signal proper consists of twelve dashes, each of about three-quarters of a second in duration in five groups, commencing at the following Greenwich mean times:

Group I.	Group II.	Group III.	Group IV.	Group V.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
8 59 30	8 59 38	8 59 41	8 59 48	8 59 54
0 0 32	0 0 40	—	0 0 50	0 0 56
0 0 34	—	—	—	0 0 58
—	—	—	—	9 0 0

the beginning of the last dash corresponding exactly with 9 p.m. Greenwich or 11 p.m. South African Standard time. By means of a special relay the time signal is simultaneously transmitted to Slangkop (Capetown) and Durban Radio stations, the signal to the latter station passing over the land telegraph wire connecting Capetown and Durban, a distance of about 1,100 miles.

* * *

Stations Opened and Closed.

The SOLLER Coast Station (Majorca, Balareic Islands) has been re-opened for Public Service. On November 25th, 1914, the MONTE-CAPPUCCINI Radio Station (Italy) was closed, and on the same date a new station, ANCONA RADIO, was opened. The following are particulars of the new station: Position, lat. 4·31′ North, long., 13·31′ East; Range, 270 miles; Wave lengths, 300, **600**, 1,200; Call letters, ICA; Service, Public general, Continuous; Coast charge per word, Lit. 0·30. Please note that the ISOLA-CHIESA Radio Coast Station has been renamed MADDALENA-RADIO. The call letters, ICH, remain unchanged. The station at ELLAMAR (Alaska) has been dismantled. The call letters of the station were KIS. Until further notice the following Canadian stations are closed to public correspondence: GROSSE ISLE, FATHER POINT, CLARKE CITY, CAPE RAY, CAPE BEAR, GRINDSTONE, HARRINGTON, ST. JOHN, CAPE SABLE, CAMPERDOWN, NORTH SYDNEY and POINT RICHE.

* * *

Canadian Rates.

On January 1st last the following radiotelegraph rates came in force on messages forwarded to vessels *via* the Canadian Government wireless telegraph stations on the west coast:

1. Ordinary messages for vessels engaged on trans-Pacific or ocean voyages, 20 cents per word, with a minimum charge per message equal to the charge for ten words International count.

2. Ordinary messages for vessels in the coastal trade on the Pacific Coast, 10 cents per word, with a minimum charge per message equal to the charge for ten words, International count; all such messages must have the prefix "C" inserted in the preamble.

3. Messages exchanged between the captain of any ship and the owners or agents of ships, in plain language and strictly on ships' business, 5 cents per word, with a minimum charge per message equal to the charge for ten words, International count; all such messages must have the prefix "SB" inserted in the preamble.

4. Messages for vessels engaged on the triangular ferry run between lower Vancouver Island ports, Seattle, Vancouver, Nanaimo, and Comox, 5 cents per word, with a minimum charge per message equal to the charge for ten words, International count; all such messages must have the prefix "FB" inserted in the preamble.

* * *

Coastal Rates on the Pacific Coast.

A new rate, to be known as the "Coastal" rate, of 10 cents per word with a minimum charge per message equal to the charge for ten words, International count, came into effect on January 1st last. The "Coastal" rate applies on ordinary messages forwarded through Canadian Government radiotelegraph stations on the west coast vessels, irrespective of nationality, engaged in the coastal trade on the Pacific Coast; all such messages must have the prefix "C" inserted in the preamble.

* * *

New Zealand.

An "Order in Council," dated June 8th, 1914, has been published in the New Zealand *Gazette*, empowering the Minister of Marine (if in his opinion the circumstances justify it) to exempt steamships plying within any prescribed limits in the home trade from the operation of the regulations of October 20th, 1913, as to ships being provided with wireless telegraphy apparatus. The regulations apply to the compulsory equipment with efficient apparatus for radio communication of passenger-carrying steamships registered in New Zealand and engaged in the foreign or intercolonial trade, and every home-trade steamship authorised to carry not less than 150 passengers at sea.

AN INTERESTING RECENT DEVELOPMENT.—Every day sees wireless telegraphy applied in a new direction. The two new Allan liners, *Calgarian* and *Alsatian*, carry motor lifeboats built by Messrs. Maclaren Brothers, of Dumbarton, fitted with 30-h.p. paraffin engines, and 28 ft. in length. These are intended to be ready on emergenc toy take in tow from eight to ten ordinary lifeboats, and have been fitted with complete wireless telegraphy apparatus. In case of accident at sea the fact that lifeboats conveying shipwrecked passengers are capable of receiving and sending wireless messages should go far to ensure the safety of those under their charge.

Practical Hints for Amateurs.

RADIO-PHOTOGRAPHY—II.

By MARCUS J. MARTIN.

In this, and in succeeding articles, the author will explain as simply as possible the various systems that have been devised for radio-photography, i.e., transmitting photographs, drawings, etc., from one place to another without the aid of artificial conductors.

* * *

THE method of preparing the photograph to be transmitted, described below, is perhaps not quite so quick and easy as could be desired. The would-be experimenter who has no previous knowledge of photography may feel alarmed at the amount of work entailed, but when he has understood the various operations, and with a little patience and practice, he should experience no very great difficulty. The simpler photographic operations, such as developing, fixing, etc., cannot be described here, and the beginner is advised to study a good text-book on the subject.

The camera used for copying must have a single line screen placed a certain distance in front of the photographic plate. The object of this screen is to break the image up into parallel bands, each band varying in width according to the density of the photograph from which it has been prepared. Thus a white portion of the photograph would consist of very narrow lines wide apart, while a dark portion would be made up of wide lines close together; a black part would appear solid and show no lines at all. The lines on the negative cannot be wider apart, centre to centre, than the lines on the screen. A good screen distance has been found to be 1 to 64—*i.e.*, the diameter of the stop is one sixty-fourth of the camera extension, and the distance of the screen lines from the plate is sixty-four times the size of the screen opening.

The line screens used consist of glass plates upon which a number of lines are accurately ruled, the width of the lines and the space between being equal; the lines are filled in with an opaque substance. These ruled screens are very expensive, and are only made to order, a screen half-plate size costing from 21s. to 27s. 6d. An efficient substitute for a ruled screen can be made by taking rather a large sheet of Bristol board and ruling lines across in pure black drawing ink, the width of the lines and the spaces between being one-twelfth of an inch respectively. A photograph must be taken of this card, the reduction in size determining the number of lines to the inch. A card 20 in. by 16 in., with twelve lines to the inch, would, if reduced to 5 in. by 4 in., make a screen having forty-eight lines to the inch. Preparing the board is rather a tedious operation, but the line negative will be found to give results as good as those obtained from a purchased screen.

The fixing of this screen into an ordinary camera must be left to the ingenuity of the worker. A half-plate back focussing camera will be found suitable for general experimental work, but if this is not available a large box camera may be used. The

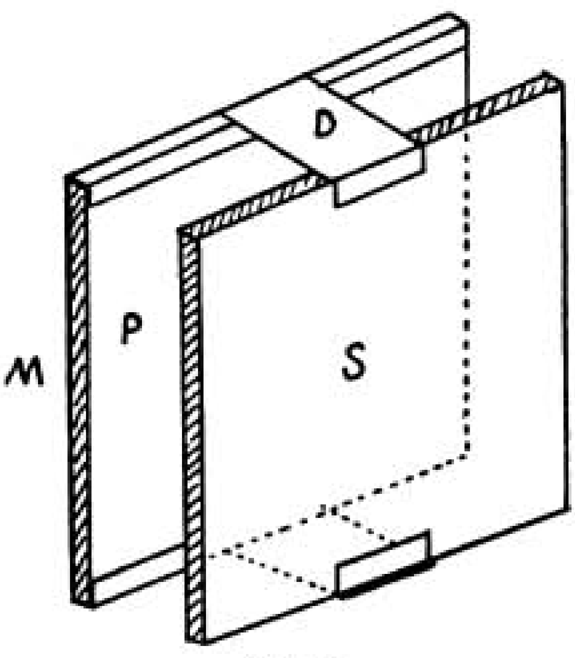


Fig. 3.

writer has never seen a half-plate box camera, but one taking a 5 in. by 4 in. plate can be obtained secondhand very cheaply. It is a comparatively simple matter to fix the line screen into a camera of this description, the drawings, Figs. 3 and 4, showing the method adopted by the writer. The two clips, D, made from fairly stout brass, about ½ in. wide, are bent to the shape shown (an enlarged section is given at C) and soldered at the top and bottom of one of the metal

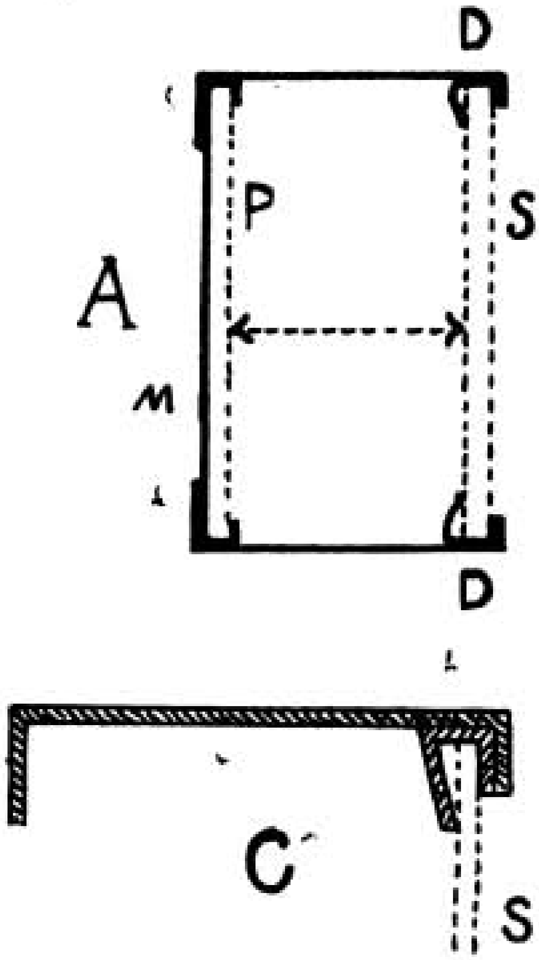


Fig. 4.
P, Plate. D, Clips. S, Screen. M, Sheath.

sheaths provided for holding the plates. The distance between the *front* of the photographic plate (the film side) and the back of the line screen (also the film side), indicated by the arrow at A, is determined by the number of lines on the screen. The distance for a screen having fifty lines to the inch will be 41/64ths of an inch. In all probability there will be enough clearance between the top of the sheath and the top of the camera to allow for the thickness of the clip, but if not a shallow groove a little wider than the clip should be carefully cut in the top of the camera, so that it will slide in easily. The screen should be placed between the clips, the film side on the inside—*i.e.*, facing the photographic plate. As with a box camera the extension is a fixture, and the size of stop to be used is a fixture also. The extension of a camera (this term really applies to a bellows camera) is measured from the front of the photographic plate to the diaphragm, and if this distance in the camera is eight inches, the diameter of the stop to give the best results would be one sixty-fourth of this, or one-eighth of an inch.

The picture or photograph from which it is desired to make a print should be fastened out perfectly flat upon a board with drawing pins, and, if a copying stand is not available, it must be placed upright in some convenient position. The diagram Fig. 5 gives the disposition of the apparatus required for copying. A simple and inexpensive copying stand is shown in Fig. 6. The back board, A, should be about 30 inches square, and must be fastened perfectly upright upon the base, B. The stand, C, should be made so that it slides without side play between the guides, D, and should be of such a height that the lens of the camera comes exactly opposite the centre of the board, A. The camera, if of the box type, can be fastened by means of a screw and wing nut, the screw being passed from the inside as shown. The beginner is advised to photograph only very bold subjects, such as black-and-white drawings, or enlargements.* It is not safe to trust to the view-finders as to whether the whole of the picture is included on the plate, a piece of ground glass the same size as the plate sheaths and used as a focussing screen being much more reliable.

The make of plates used is also a great factor in obtaining a good negative, and

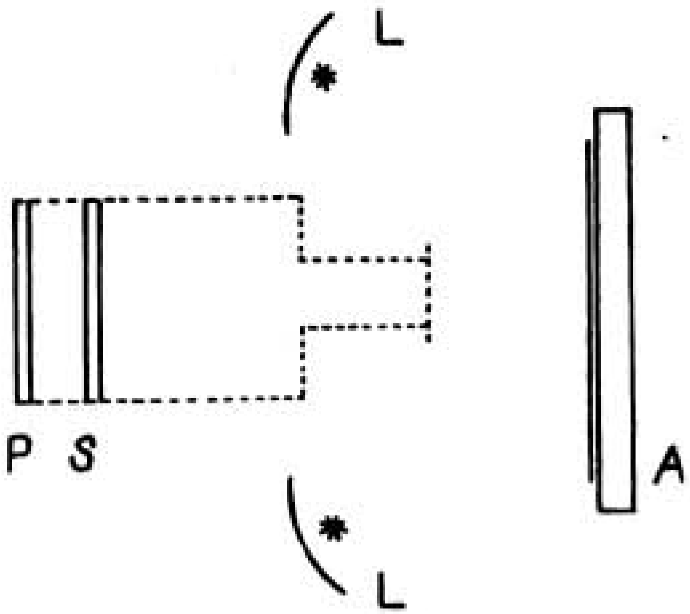


Fig. 5.
LL, Lamps. A, Board with picture. S, Line screen P, Photographic plate.

Wratten process plates will be found suitable. With an arc lamp the exposure is about twice as long as in daylight; but the exposure varies with the amount of light

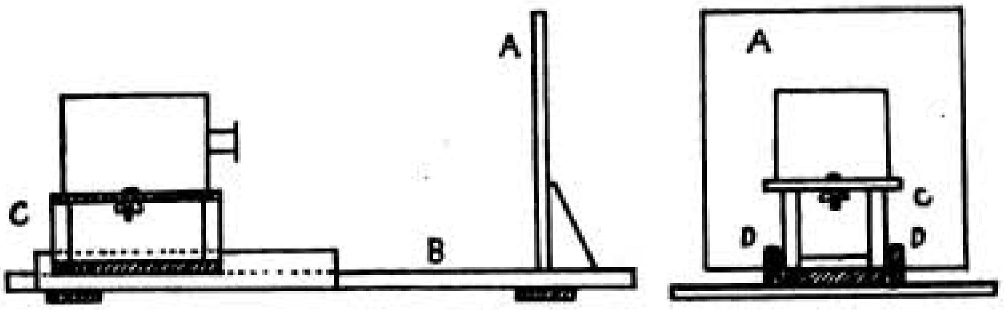


Fig. 6.

admitted to the plate, the character of the source of light, and the sensitiveness of the plate used, etc. The writer has used acetylene gas lamps for this purpose with great success. The beginner is advised to use artificial light, as this can be kept perfectly even. With daylight, however, the light is constantly fluctuating, and this renders the use of an actinometer a necessity for correct exposure. After development, if the plate is required for immediate use, it can be quickly dried by soaking for a few minutes in methylated spirit.

Having obtained a good negative, our next operation is to prepare what is known as a metal print. For this we shall require some stout tinfoil or leadfoil (about 12 or 15 square feet to the pound), and this should be cut into pieces of such a size that it allows a lap of three-sixteenths of an inch when wrapped round the drum of the transmitting machine. Obtain some good fish glue and add a saturated solution of bichromate of potash in the proportion of 4 parts of potash to 40 or 50 parts of glue. Pour a little of this prepared glue into a shallow dish, lay a sheet of foil upon a flat board, and with a fairly stiff brush (a flat hog's hair as wide as possible) proceed to coat the sheet of foil with a thin but perfectly even coating of glue. The thickness of the coating can only be found by trial, but if the coating is too thick a longer time will be required for printing. After the coating has been laid on, a soft brush, such as photographers use for dusting dry plates with, should be passed up and down and across and across with light, even strokes to remove any unevenness. A glue solution used by professional photo-engravers is as follows :—

Fish glue	12 oz.
Bichromate of ammonia	¾ oz.
Water	18 to 24 oz.
Ammonia (·880)	30 minims

The coating may be done in a good light, not bright sunlight, but *it must be dried in the dark*, because, although insensitive while in a moist condition, it becomes sensitive immediately on desiccation. If allowed to dry in the light the whole coating will become insoluble, and for this reason the brushes used should be washed out as soon as they are finished with. The sheets will take about 15 minutes to dry in a perfectly dry room, but it is not advisable to prepare many sheets at once as they will not keep for more than two or three days.

The prepared negative must now be placed in an ordinary printing frame and a print taken off upon one of the metal sheets in the same way as a print is taken off upon ordinary sensitised paper. In daylight the exposure varies from 5 to 20 minutes, but in artificial light various trials will have to be made in order to get the best results, the exposure varying with the amount of bichromate in the coating. The printing finished, the metal print should be laid upon a sheet of glass and held under a running stream of water. The washing is complete as soon as the unexposed parts of the glue coating have been entirely washed away leaving the bare metal, and this will take anything from 3 to 7 minutes, depending upon the thickness of the film. As soon as it is dry the print is ready for use.

As already mentioned, the negative from which the metal print is made requires that the lines be perfectly sharp and opaque, and the spaces between perfectly transparent. Ordinary dry plates are too rapid, a rather slow plate being required. Wratten Process Plates give good results, and the following is a suitable developer to use with them :

Glycin	15 grm. ...	1 oz.
Sulphite of soda	40 grm. ...	2½ oz.
Carbonate of potash ...	80 grm. ...	5 oz.
Water	1,000 c.c. ...	60 oz.

The developer should be used for 6 minutes at a temperature of 50° F., 3½ minutes at 65°, and 1¾ minutes at 80°. It is best only used once. If an intensifier is required the following formula will be found to give satisfactory results :

Bichloride of mercury ...	1 oz. ...	60 grm.
Hot water...	16 oz. ...	100 c.c.

Allow to cool, completely pour off from any crystals and add :

Hydrochloric acid ... 30 minims ... 4 c.c.

Allow negative to bleach thoroughly, wash well in water and blacken in 10 per cent. ammonia (·880), or 5 per cent. sodium sulphide.

In preparing the negatives and metal prints, the following points should be observed :

A good negative should have the lines perfectly sharp and opaque ; there should be no "fluff" between the lines even when they are close together.

A properly exposed and developed negative should not require any reducing or intensifying.

If the lamps used for illuminating the copying board are placed two feet away and the exposure required is five minutes, the exposure, if the lamps are placed four feet away, will be 20 minutes, as the amount of light which falls upon an object decreases as the inverse square of the distance.

The coating on the foil should be as thin as possible and if anything should err on the side of over-exposure. The unexposed sheets should not be placed near a fire, otherwise their coating will become insoluble. In washing the print should be kept moving so that the stream of water does not fall continually upon one place. It is best to hold the print so that the water runs off in the direction of the lines.

To dry the prints after washing they can be laid out flat in a moderately warm oven or before a stove, the heat, of course, not being sufficient to cause the coating to peel.

To render the glue image more distinct, the print should be immersed for a few seconds in an aniline dye solution. These dyes are soluble either in water or alcohol. A dye known as "meganta" is good. The process of coating the metal sheets must be performed as quickly as possible (about 10 seconds), as, owing to the peculiar nature of the bichromated glue, it soon sets, and once this has taken place it is impossible to smooth down any unevenness. The negative and metal sheet should make good contact while printing. If the glue solution does not adhere to the surface of the foil in a perfectly even coating, but assumes a streaky appearance, a little liquid ammonia rubbed over the surface of the foil will remove the grease which is the cause of the difficulty.

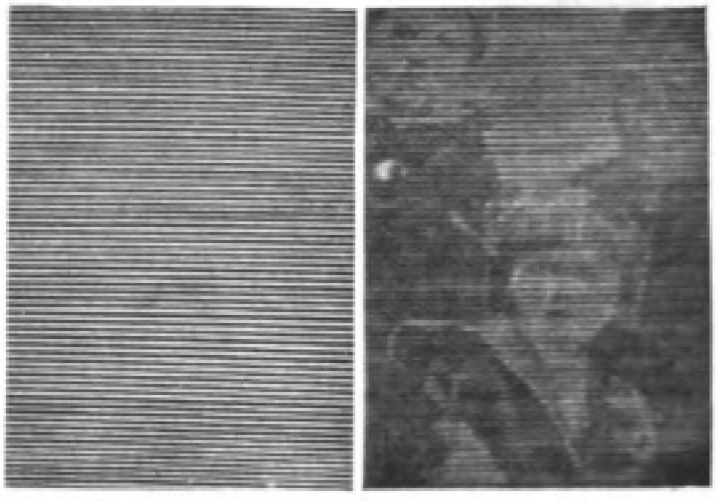


Fig. 7.
Portions of photographs (full size) of single-line screen, and single-line print for transmitting. Screen 40 lines to the inch.

A photograph of a picture prepared from a line negative is given in Fig. 7. This method of preparing the photographs is practically the only one available for wireless transmission, and although the manner given of preparing is perhaps not strictly professional, having been modified in orders to suit the needs of the ordinary amateur experimenter, satisfactory results are obtained.

For many experiments, and in order to save time, trouble and expense, sketches drawn upon stout lead-foil in an insulating ink will answer the purpose admirably, but if any exact work is to be done a single-line print is necessary. The insulating ink may

Fig. 8.

be prepared by dissolving shellac in methylated spirit, or ordinary gum can be used. A very fine brush should be used in place of a pen, as the gum will not flow freely from an ordinary nib unless greater pressure than the foil can safely stand be applied. A sketch prepared in this manner is shown in Fig. 8. A little aniline dye should be added to the ink to render it more visible, or a mixture of gum and liquid india ink will be found suitable.

The transmitting apparatus for making use of the prepared photograph will be described in the next article.

LAND STATIONS RECENTLY ESTABLISHED.

The Berne Bureau announces the opening of the following land stations :—

Name.	Call Signal.	Normal Range in Nautical Miles.	Wave-lengths in metres (the normal wave-length is in heavy type).	Nature of Services performed.	Hours of Service (showing time according to the region or meridian).	Coast Charge. Per Word.	Coast Charge. Minimum per radio-telegram.
ARGENTINE (REPUBLIC).					Meridian of Cordoba.	Francs.	Francs.
Comodoro Rivadavia ..	LIP	275	600	PG	9 m.—11 m. 2 s.—4 s. 8 s.—12 s.	0.60	6.0
CANADA.							
Digby Island [4,5]	VAJ	250	300, **600**	PG	N	0.60 [6]	6.0 [6]
Gonzales Hill [4,5]	VAK	250	300, **600**	PG	N	0.60 [6,7]	6.0 [6,7]
Grindstone Island [1,2] ..	VCN	200	300, **600**	PG	8 m.—6 s.	0.30	3.0
Halifax Dockyard ..	VAA	—	—	O	—	—	—
Kingston, Ontario ..	VBH	350	300, **600**, 1,600	PG	N	0.15	1.50 [2]
Lurcher Lightship [8] ..	VDB	100	300	O	X	—	—
Pas (Le) [3]	VBM	600	900, **1,800**, 2,400	O	X	—	—
Port Burwell [1,2]	VBF	350	300, **600**, 1,600	PG	N	0.15	1.50
Port Nelson [3]	VBN	150, 600 [9]	300, **600**, 1,800	PG	N	0.60	6.0
Toronto [1,2]	VBG	350	300, **600**, 1,600	PG	N	0.15	1.50
CHINA.							
Canton	ZCN	Day, 650; night, 1,300	600, 1,200, **1,600**, 2,100	PG [11]	8 m.—10 s.	0.50	5.0
Foochow	ZFW	Day, 650; night, 1,300	600, 1,200, **1,600**, 2,100	PG [11]	8 m.—10 s.	0.50	5.0
Woosung	ZWS	Day, 650; night, 1,300	600, 1,200, **1,600**, 2,100	PG [10,11]	N	0.50	5.0
FRANCE.							
Havre TSF	FFU	—	—	—	—	0.40	— [12]
GREAT BRITAIN.							
Dundee	BZW	—	—	O	—	—	—
Fort George	BZV	—	—	O	—	—	—
Inchkeith	BZA	—	—	O	—	—	—
Kingsnorth	BZS	—	—	O	—	—	—

[1] Owned by the Department of the Naval Service and operated under contract by the Marconi Wireless Telegraph Company of Canada, Montreal.

[2] Receives weather forecasts from the Canadian Meteorological Service at 10 s. These advices will be transmitted free to any ship station upon request. In addition, the station transmits, without coast charge, radiotelegrams of the following kind :

1. Any message concerning the navigation of a vessel sent by the captain of the vessel and intended for any department of the Government, any officer of the Government, or the officer in charge of the coast station.
2. Messages exchanged between the captain of any vessel and any person whatsoever concerning the state of the weather, the conditions of tide or ice, or reports on aids to navigation.

[3] Owned and operated by the Department of Railways and Canals, Ottawa.

[4] Belongs to the Canadian Government; it is operated and controlled by the Department of the Naval Service, Ottawa.

[5] Accounts should be rendered to the District Superintendent, B.C. Division, Government Wireless Service, Victoria, B.C.

[6] For radiotelegrams sent from or addressed to the commander of a ship and relating to the service of the ship, the coast charge is 25 centimes per word, with a minimum of 2.50 fr. per radiotelegram. The preamble of such radiotelegrams should contain the service instruction S B.

[7] For radiotelegrams sent from, or addressed to, ships engaged in the local service between Victoria, Vancouver and Seattle, the coast charge is 15 centimes per word, with a minimum of 1.50 fr. per radiotelegram. The preamble of such radiotelegrams should contain the service instruction F B.

[8] Owned and operated by the Department of Marine, Ottawa.

[9] With the length of 1,800 metres.

[10] The station also transmits on the wave-length of 1,600 metres typhoon warnings according to the Typhoon-code used by the Ziccawei Observatory.

[11] The station also communicates with the other coast stations in China.

[12] The coast charge is reduced to 0.15 fr. per word for correspondence with ships whose home ports are on the coast of the English Channel and the Straits of Dover and which are engaged in a regular service between France and England.

E

and G make contact, and so set the coil working. H dips into the mercury cup, J, and so joins the aerial to the transmitting helix. K and L are in contact and so short the detector. On the other side of the tapper the contact AC is broken and the dipper D rises out of the mercury in E. The receiving set is therefore isolated. Care should be taken that K touches L just before F comes in contact with G, so that the detector is shorted just a little before the coil starts working. H should dip into the mercury just before F touches G. Similarly the other wire, D, when the key is released should enter the mercury before A and C meet. The air gaps between the contacts AC and DE should be sufficiently great to prevent any sparking during transmission. On releasing the key it resumes its normal position and everything is ready for receiving signals. The contacts FG, HJ, and KL are all broken and A and C make contact while D dips into the cup, E. The various connections to the apparatus are shown in the figure.

The tapper is about 9 in. in length, but in spite of this and the extra fittings a speed of 30 words per minute may easily be obtained on it. If sending to a station, any other station working can be heard in between the dots and dashes and so interference may be greatly reduced. The great advantage however of using a tapping-key of this description is the saving of time generally spent in changing over switches and the much greater facility of communication.

A LOUD SPEAKING TELEPHONE.

By "L.W.P." (Pomponne, France).

I HAVE now completed a loud speaking telephone for use with a wireless receiving set instead of using the head 'phones. The idea first came to me when reading your article ("Instruction in Wireless Telegraphy"), where you explained the action of a telephone.

I took a thin copper tube and soldered it to the centre of the diaphragm of a 6,000 ohm receiver, taking great care not to overheat the diaphragm, and so deform it. In this I fixed the lead of an HH pencil and approached a small block of carbon armed with a copper spring $\frac{3}{10}$ mm. × 1 mm. This microphone is connected to another receiver of about 25 volts, which is again armed with another microphone exactly similar to that on the 6,000 ohm, which in its turn works a receiver of 10 ohms fitted with a trumpet.

I get all F.L. signals very clearly; they can be heard nearly all over the house. I have had KAV, but to be able to be certain of getting him every time I am making a sound-proof box so that the microphones will not pick up outside noises.

HOME-MADE INSTRUMENTS.

The accompanying illustration shows Leader W. Collard of the Third Taunton St. Andrew's Troop of Boy Scouts with the wireless instruments which he made entirely alone. Leader Collard distinguished himself at the recent Imperial Scout Exhibition held in Birmingham, when he won first prize in the wireless section. He has an installation at his house, with aerials 65 feet in height. The patrol of which he is leader has just commenced to follow a course of instruction in wireless telegraphy and it is their intention to erect an installation at the drill hall. Leader Collard has just passed the Post Office Learners' Examination, and it is his intention to study wireless telegraphy with a view to joining that branch of the service

Leader W. Collard of the Third Taunton, St. Andrew's Troop of Boy Scouts, and Wireless Instruments made by himself.

THE AMATEUR HANDYMAN.

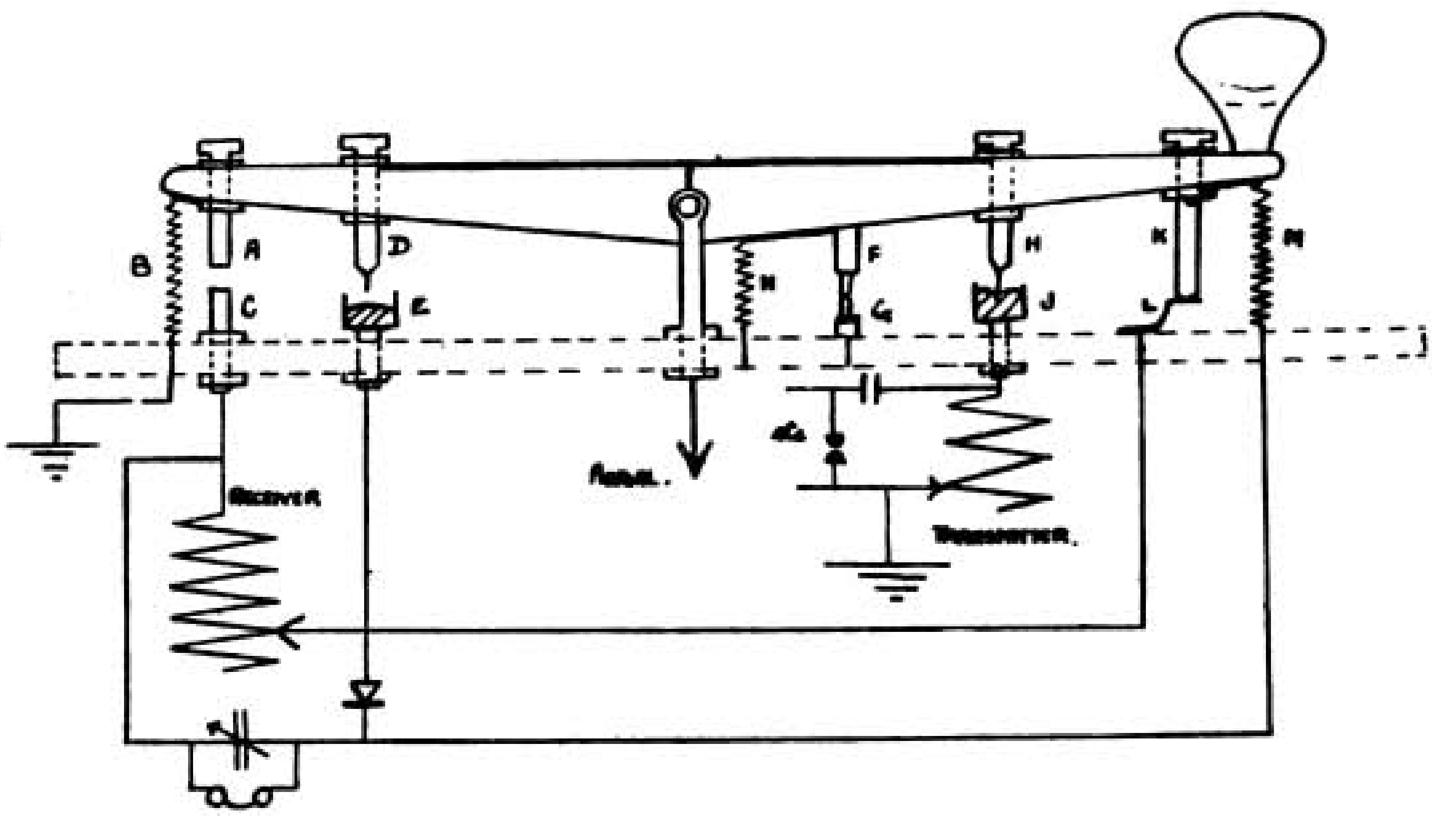
A BREAKING-IN SYSTEM FOR AMATEURS.

By J. SCOTT-TAGGART.

THE advantages of a breaking-in system are apparent, and the following description of one which has been used with success should prove of interest. The system is essentially for small-power stations for which the arrester gap is not suitable, and is practical for rapid and efficient short-distance communication.

A tapping key of special design takes the place of the various switches usually used. When it is at rest the aerial and earth are included in the receiving circuits, but if the key is depressed the transmitting apparatus is automatically switched in and the primary circuit of the induction coil is closed. On releasing the key again the apparatus is once more in a condition for receiving and the transmitter isolated. The disadvantage of the action of the crystal being impaired after transmitting is overcome by having contacts on the tapper which, on depressing the key, short-circuit the detector.

The diagram shows the circuits used in conjunction with the tapping key and illustrates the additional fittings necessary. The arm and base should be made of hard and well-oiled wood to prevent any leakage of high-tension current between the metal parts. A, D, H, and K are $\frac{3}{16}$ in. cheese-headed brass screws $1\frac{1}{2}$ in. long, screwed into the arm of the tapper, where they are held secure by nuts, above and below. All these screws must be adjusted before using the key. C is another screw fixed in the base, and when the key is in its normal position A rests on and makes contact with C. B is the usual steel spring used on all tappers; it is electrically connected to the screw A. At the end of the screw, D, is soldered a copper wire which dips in and out of a metal cup, E, containing mercury. In the same way H dips in and out of the cup, J. Adjustments should be made so that when D is in the mercury H is out, and *vice versa*. The screws are connected to each other by



a wire running along the top of the arm. To this wire is soldered another connected to one of the metal pillars which support the axis on which the arm turns, and this in turn is connected to the aerial. F and G are the usual silver contacts for making and breaking the primary circuit of the coil, and, as these connections to the key are well known, they are not shown on the diagram. N is a weak copper spring for carrying the current from F to a terminal on the board. M is another weak spring connected to K at one end and to a terminal on the base at the other. L is a piece of springy brass. On depressing the key, K comes in contact with L, and so shorts the detector.

The diagram shows the connections and circuits; when the tapper is depressed F

INSTRUCTION IN WIRELESS TELEGRAPHY

(Second Course)

(VII.) Design of Transmitting-Jiggers.

[The article in the March number completed the first course of instruction. The present is the seventh of a new series of articles, which will deal chiefly with the application of the principles of wireless telegraphy. Those who have not studied that series are advised to obtain a copy of "The Elementary Principles of Wireless Telegraphy," which is now published, price 1s. net, and to master the contents before taking up the course of instruction. An announcement concerning the second examination appeared on page 333 of the August number of THE WIRELESS WORLD.]

737. Jigger Primary.—The design of a primary circuit for an amateur set is somewhat different from that for a large commercial station. The wave-length, on which the amateur will transmit, is fixed for him, and he has to design his primary circuit to give that wave-length. If we consider the primary circuit alone, it would seem from general considerations that it would be best designed with a certain fixed ratio between the inductance and capacity of the primary circuit. Thus, if we wished to double the wave-length of a given primary circuit, the best plan would be to double both the inductance and capacity, and, since

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

this would produce the required effect. In practice we would, however, only alter either the inductance or the capacity, on account of convenience.

It is not possible to give any hard-and-fast rule on the best ratio of capacity and inductance; indeed there is, in practice, a wide variation in the value of the ratio. For convenience of coupling, the jigger primary is usually made of two or three turns of the same size as those of the jigger secondary. In designing the primary circuit in any given case, the amateur must rely chiefly on a sense of the electrical proportion, between the two parts of the circuit; this will be aided by a comparison of the ratio L/C in his circuit with that used in some actual working sets. For example, in the Marconi 1½-kw. set we have

Wave-length. metres.	Capacity. mf.	Inductance. mh.*	L/C.
600	·065	1·6	25
300	·016	1·6	100

* Mh = microhenry.

The following are the figures for the amateur set dealt with in the article in the January WIRELESS WORLD: 200 metres, ·03 mf., ·35 mh., whence L/C=10. As the condenser was not in this case oil immersed, the losses in it would be larger in proportion, and this, to some extent, justifies the use of the larger condenser, which makes L/C smaller. In this last example, if the wave-length to be used were 300 metres, the same condenser might very well be used, in conjunction with a jigger primary of about ·8 mh., when L/C=21. This example will be used later.

738. Jigger Secondary and Aerial Tuning Inductance.—By means of the jigger secondary and aerial tuning inductance, the aerial circuit is tuned to the wave-length to be used. In the usual amateur set these two things will be combined in one coil, making a jigger secondary of sufficient inductance to give the wave-length required. To calculate the inductance required, it is necessary to know the natural wave-length of the aerial alone and also its capacity. These can both be determined experimentally, but as this is not at present possible, it is useful to have some method, no matter how approximate, of calculating these two things from the dimensions of the aerial.

First let us make a rough estimate of the natural wave-length of the aerial itself. In the case of a vertical, or inverted L aerial, consisting either of a single wire or several wires in parallel, provided the width of the aerial is not great compared with its length (a width of 12 feet to a length of 100 feet would not be excessive), the wave-length may be taken as 4¼ times the actual length of the aerial itself. In the case of a T aerial, the multiplying factor will be about 4·8. The length of a T aerial is the length measured along the wire from a free end to the bottom of the down-lead, and is therefore half the horizontal span + the length of the down-lead. From this we obtain an estimate of the wave-length.

Next we have to find the capacity. For a single wire aerial we can safely assume that the capacity lies somewhere between 1·5 and 2·1 mmfs. (micromicrofarads = millionths of a microfarad) per foot of length, and about 1·8 mmfs. per foot would be a good value to take. If the aerial is a twin, with the wires 6 feet apart, the value of the capacity for the corresponding single wire aerial should be multiplied by about 1·6 to give the capacity of the twin aerial. Should the wires be more than 6 feet apart, or if there are several wires in the aerial, this multiplying factor should be increased, but should never be taken to be greater than 2. Thus, if the aerial consisted of three wires 4 feet apart, 1·8 would be about the value to take.

Example: Twin T aerial, wires 6 feet apart, horizontal span 150 feet, length of down-lead 80 feet.

Natural Wave-length of Aerial.

Length of aerial = 75 + 80 = 155 feet.

Therefore, wave-length = 155 × 4·8 = 750 feet = 228 metres.

Capacity of Aerial.

Length of wire = 150 + 80 = 230 feet.

Capacity for single-wire aerial = 230 × 1·8 = 414 mmfs.

Capacity for twin aerial = 414 × 1·6 = 662 mmfs. = ·00066 mfs.

Inductance of Aerial L_0.

We have $228 = 1885\sqrt{L_0 \times \cdot 00066}$

$$L_0 \times \cdot 00066 = \left(\frac{228}{1885}\right)^2 = \cdot 0146.$$

$$L_0 = \frac{\cdot 0146}{\cdot 00066} = 22 \text{ microhenries}$$

We are now in a position to determine the inductance of the jigger secondary that will tune this aerial up to 300 metres. If the value of this added inductance is L, the total inductance of the aerial circuit is $(L + L_0)$, whilst the capacity is still C_0.

Therefore

$$300 = 1885\sqrt{(L + L_0) \times \cdot 00066}$$

$$L + L_0 = \left(\frac{300}{1885}\right)^2 \times \frac{1}{\cdot 00066} = \frac{254}{6\cdot 6}$$

38 microhenries.

That is, the added inductance must be 38 − 22 = 16 mh.

If this value of the inductance is increased by 50 per cent. or 100 per cent., it will ensure it being large enough. Let us say, then, in this case, that the inductance of the jigger secondary is to be 24 mh.

739. Calculation of Inductance of a Coil.—It now only remains for us to show how to determine the inductance of a coil, so that we can design a coil, or coils, suitable for the jigger primary and secondary considered.

The inductance of a coil is generally determined by the aid of a curve such as shown in Fig. 1. The curve applies to circular coils of a single layer, provided that the ratio of the radius "r" of the coil to the axial length "l" is greater than (>) 0·1, and less than (<) 1,000. The inductance of any given coil is given by

L = (radius) × (total number of turns)² × k, and it is then in centimetres. If the result is divided by 1,000, we get the inductance in microhenries.

The use of the curve is to enable us to find the value of k, which depends on the ratio "r/l" (radius/length) for the coil in question. In the curve, the horizontal distances give the ratio r/l, while the vertical height of the curve above the zero line gives the value of k.

Each curve applies to a certain range of values of r/l, which are given on the horizontal line crossing it. Having found r/l, we can obtain (k), and we are then in a position to determine the inductance of the coil.

740. *Examples.*—To find coils suitable for the jigger primary 0·8 mh. and the jigger secondary 24 mh. The method used is to assume a coil that it is thought will give about the right value for the inductance, and correct it, if necessary, after calculation. After one or two trials a suitable coil will be found.

Let us take the diameter of both jigger coils as 15 cms., and the turns on each, spaced 1 cm. apart. This latter condition allows the wire to be bare, which is very convenient for purposes of tuning up, especially if the auto-jigger is used, as it allows tappings to be taken off at any points. No. 10 gauge copper wire will do very well, though an even thicker wire could be used with advantage, since the current keeps to the surface of the wire.

Jigger Secondary.

Let there be 16 turns on the coil, so that its length is 15 cms.

$r/l = 7 \cdot 5/15 = 0 \cdot 5$, so "k" $= 13$.

Hence $L = 13 \times 7 \cdot 5 \times 16^2 = 25{,}000$ cms. $= 25$ mhs.

Such a coil would therefore be quite suitable for the jigger secondary.

Jigger Primary.

Let there be 3 turns, the length of the coil being 2 cm.

$r/l = 7 \cdot 5/2 = 3 \cdot 75$, whence $k = 36$.

Therefore $L = 36 \times 7 \cdot 5 \times 3^2 = 2{,}400$ cms. $= 2 \cdot 4$ mhs.

We only require an inductance of 0·8 mhs., so that two turns of such a coil would be sufficient. If the auto-jigger connection is used these are tapped off the jigger secondary.

Stranded wire consisting of 7/19 cotton-insulated wires twisted together is even more suitable than a single thick wire. The final tuning in this case can be done by pressing the turns of the coil nearer to one another, or further away, according as a larger or smaller value of the inductance is required.

741. Whilst on the subject of the calculation of inductance, we might make a few further remarks on the use of the curves and formula given. They will give a correct estimate of the inductance of a single-layered coil of circular cross-section, provided that the electro-static capacity

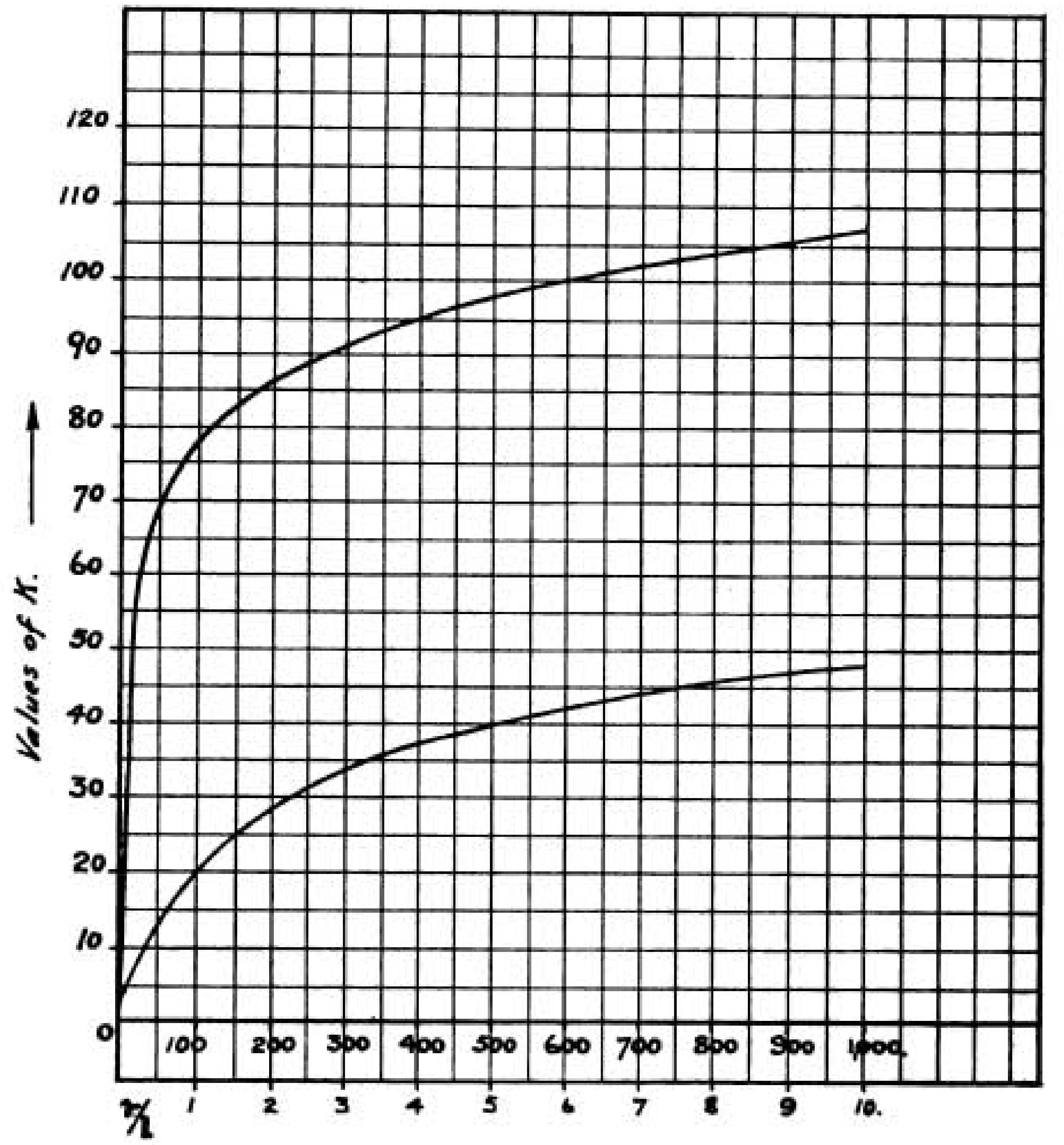


Fig. 1.—Calculation of Induction of a Coil.

between turn and turn of the coil is small, compared with the external capacity in the circuit. The only case in which this is not likely to be so is that of the jigger secondary used in crystal receivers. This is wound of very fine wire, the turns being close together, with the result that the coil has a considerable self-capacity. Such a coil has, therefore, a definite wave-length of its own, without the addition of any external capacity. When oscillating to what may be called its fundamental wave-length, from analogy with the case of an aerial, the current amplitude is a maximum at the earthed end and zero at the free end. Hence the turns near the free end of the coil do not contribute their full value to the inductance of the coil; the effective inductance is therefore diminished. If, however, the coil is used with a proportionately large external capacity, the current amplitude is approximately constant in all parts of the coil, and the inductance in this case can be got by the aid of the curves given. Another point to notice is that for a coil of given length and diameter the inductance is proportional to the square of the number of turns. A further example of the calculation of inductance may be given:

Coil, 20 cms. long, 10 cms. diameter, wound with the turns close together of No. 20 copper wire.

Diameter of No. 20 wire = 0·091 cm., so that with cotton insulation we shall get about ten turns to the centimetre.

Total number of turns = 200.

Radius/length = 5/20 = ·25.

$k = 8$.

L in cms. $= 8 \times 5 \times 200^2 = 1{,}600{,}000$ cms. $= 1{,}600$ mhs.

If such a coil were put in the aerial before considered, the capacity of the aerial being .00066 mfs., the resulting wave-length of the aerial circuit would be

$$1{,}885\sqrt{1{,}600 \times \cdot 00066} = 1{,}900 \text{ metres}$$

approximately.

So far we have only dealt with coils of circular cross-section, but the formula can easily be extended for use with coils of square cross-section. The method is to calculate the inductance as for a coil of circular section, with diameter equal to the side of the square, and multiply the result by 1·25 to get the inductance of the square coil.

742. Tuning the High Frequency Circuits.—The best method of tuning the transmitting circuits is by the use of a buzzer and a wave-meter. The use of these two for tuning a circuit to a required wave-length is described in *Elementary Principles*, pp. 134–136. To tune the primary circuit the aerial should be disconnected and the primary spark-gap shorted. Then, either the jigger primary itself, or an extra auxiliary inductance, is varied until the wave-length required is obtained. The aerial circuit is then tuned to the same wave-length with the spark-gap of the primary circuit open, so that the aerial circuit is independent of primary circuit. With a suitable coupling between them, the circuits are now ready for transmission. If the coupling between the two circuits is too tight, then, when transmitting on power, a double wave will be radiated (*Elementary Principles*, p. 91). If λ_1 and λ_2 are the two wave-lengths radiated, and λ_0 the natural wave-length of each circuit by itself, $\frac{\lambda_1 - \lambda_2}{\lambda_0}$ is a measure of the tightness, or closeness, of the coupling. On account of the jamming which a station working on too tight a coupling will cause, it has been made illegal to work with a closer coupling than 15 per cent., $\frac{\lambda - \lambda}{\lambda_2}$ being taken as the measure of the coupling.

Apart from this the double wave means the loss of a considerable portion of the available energy when using a sharply tuned receiver, as this will only take account of one of the waves.

Although the buzzer method is the best method of tuning the circuits, the more usual one is to tune up on power. In this the aerial is disconnected in the same way as before, and the power is applied to set the primary circuit in oscillation. The wave-length is measured, and the circuit tuned up as before. To tune up the aerial circuit a small electric glow-lamp is connected in the aerial circuit. Power is applied to the primary circuit and the aerial tuning inductance is varied until the lamp glows brightest. Various couplings and retunings should be tried to get the final adjustments giving the best all-round results. When once these have been obtained the lamp should be taken away, as its presence considerably increases the resistance of the aerial.

It may be that the power used would be sufficient to burn out the lamp if it is placed direct in the aerial. In this case the lamp can be connected across 6 or 8 feet of the earth-lead, as shown in the figure, a small adjustable inductance being placed in series with the lamp. This inductance serves to regulate the lamp current, and it should be set so that the lamp only just glows when it is in the most sensitive condition. When

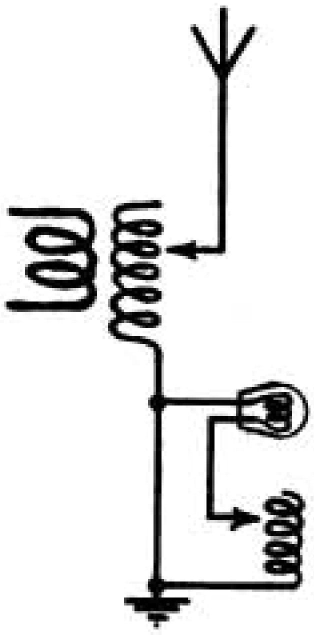


Fig. 2.

tuning up on power that adjustment of the aerial circuit is best which produces a sensible glow on the lamp with the largest amount of inductance in series with the lamp. In this arrangement it is not so essential to remove the lamp after the tuning is accomplished, and it serves as a very useful indicator as to how the set is working.

Referring to our article "Wireless on Trawlers (see page 697), it is an interesting fact, in view of what we say regarding recognition by the nation of men engaged in the fishing industry, that Mr. E. Stafford Howard, chairman of the recent Committee on Inshore Fisheries, contributed a letter to the *Times* of January 19th calling attention to the unanimous opinion of his Committee in favour of forming a Fisheries Organisation Society. Mr. Howard and his Committee consider this to be "one of the most effective ways of helping them." It is clear that something must be done in this connection unless we are willing to face a continued diminution in their numbers and prosperity, leading to their ultimate disappearance.

RUBÁIYÁT OF A WIRELESS OPERATOR.

By BERNARD C. WHITE.

(*With apologies to Omar Khayyám*).

AWAKE, for Poldhu calls; stay not to dress
In regulation rig, but take the press
Now coming through at a terrific rate—
Five hundred words: it's sure not to be less.

Listening when Dawn's left hand is in the sky,
Upon the 'phones I hear a far voice cry,
"King visits Lady Donohu for lunch"—
They like this kind of stuff. I wonder why?

And, as the breakfast bell is ringing loud,
I see the cabin boy amid the crowd
Selling the news, for which I spent the night
At watch with heavy eyes and shoulders bowed.

Now, the new day reviving sleep's desires,
A weary "sparks" to solitude retires,
Kicks off his boots, takes to his bunk, and soon
In Morpheus' arms his gentle soul suspires.

Poldhu, indeed, is gone for one brief hour,
Gone, too, the signals from the Eiffel Tower;
But still in dreams I hear confusèd sounds,
And still Marconi wave-lengths hold their power.

And "Buttons'" lips are closed; but I confuse
Snatches of distant song with "News, News News,
Fresh News!" that daily through the corridors
He shouts to urge the seasick to peruse.

Come, sleep while you've the chance, you fool, and fling
Away Marconi news, and everything:
The Bird of Time has but a little way
To go—and lo! the Bird is on the Wing.

Ah! use the time that still is yours to spend,
Before once more to work you must descend,
Reluctantly to listen in the 'phones—
Sans Wire, sans Wit, and, seemingly, sans End!

Digest of Wireless Literature

ABSTRACTS OF IMPORTANT ORIGINAL ARTICLES DEALING WITH WIRELESS TELEGRAPHY AND COMMUNICATIONS READ BEFORE SCIENTIFIC SOCIETIES.

Wave-length in Air.—Professor J. A. Pollock made a communication before the British Association on "Some Measurements of the Wave-Length in Air of Electrical Vibrations Associated with a Thin, Straight, Terminated Rod." He drew attention to a discrepancy in the theory of electric radiation. According to Rayleigh and J. J. Thomson, the wave-length should, under certain conditions, be twice the length of the rod; but according to MacDonald (theory and experiments) the coefficient should be 2·53, and not 2. Rayleigh had recently returned to this old controversy. Professor Pollock had some time ago made experiments supporting MacDonald. Using the coherer method for detecting nodes, he had recently found the value 2·09, which agreed with the 2·1 of American experimenters. The theory was very difficult on account of the discontinuities at the edges of the rod and for other reasons, and he did not understand why he found different values, 2·5 and 2·09, in different experiments.

* * *

Mechanical Analogue and Coupled Circuits.—Professor T. R. Lyle, of Melbourne, gave a demonstration of an "Exact Mechanical Analogy to the Coupled Circuits used in Wireless Telegraphy" before the meeting of the British Association. Having derived a simple formula expressing the coupling angle between two inductively coupled circuits in terms of the inductances, he showed his model. It consisted essentially of a steel beam, M (Fig. 1), built up of two parallel straight edges, 4 ft. long, 3½ in. apart, connected rigidly by aluminium distance-pieces and clamps, and resting with its edges on the overhanging axles of two pairs of steel discs, which were 1½ in. apart and made from 5-in. slotting cutters (⅛-in. thick), by grinding off the teeth. The wheels rested on a carefully-levelled plate of glass, all friction being so well reduced that the beam system, when once set in motion, would continue to oscillate to and fro for a long while; x indicated the distance of the beam from a stationary origin. Two pendulums, of masses $m1$ and $m2$, were suspended from cross-boards by means of V's, so that they could swing in the longitudinal space between the two members of the beam. Dr. Lyle showed that the angular displacements of the two pendulums, θ, were mutually connected by equations identical in form with those connecting the potential differences of the condensers in

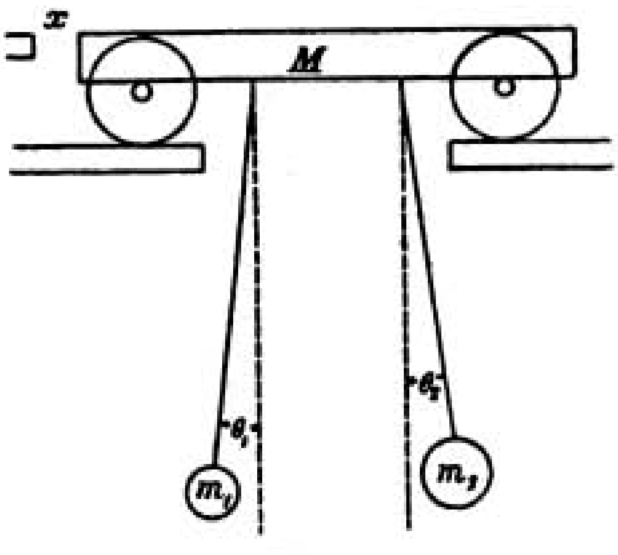


Fig. 1.

the corresponding electrical system. The relations of the resultant frequencies were best presented by the aid of a triangle, the apex of which was the coupling angle. As described so far, the mechanical system was the analogue of the coupled circuits of a radiotelegraphic transmitter. The beam might itself be considered to represent the ether. The variation of the coupling was imitated by placing masses on two platforms at the ends of the beam; by increasing the load on the beam the coupling was diminished. When the beam was first steadied and then started by hand, and the one pendulum let go simultaneously, the second pendulum began to swing with increasing amplitude, whilst the amplitude of the first pendulum diminished; after a certain time the conditions appeared reversed, and so the transfer of energy forward and backward changed many times. These surgings could be calculated, and the advantages of loose coupling were demonstrated. The pendulum model also explained the theory of the quenched spark; as it was impossible to " break " the primary circuit, without disturbing the whole mechanical system, if the bob of the primary pendulum was not placed on its platform, but taken in the hand so as to slacken the string. In order to imitate the conditions of a receiver when receiving signals, the first pendulum was made compound, and disturbances were transmitted to it from the beam by means of a simple electromagnetic device energised through flexible wires, for instance, by attaching one permanent bar magnet to the pendulum between two electro-magnets on the beam. The model would also elucidate some of the problems arising in connection with the paralleling of alternators. The many models that others had described utilised rubber cords and steel springs, whilst inertia forces should alone be resorted to.

* * *

Damped or Undamped Oscillations.—In the *Elektrotechnische Zeitschrift* H. Rein discusses whether wireless telegraph stations should be operated with damped or undamped oscillations; that is, whether they should be operated by a spark system or by high-frequency machines. In favour of the spark system (damped oscillation) there is only one fact, namely, the ease with which the wave-lengths can be varied quickly and continuously over a wide range. As in most large wireless stations it is sufficient to generate one or only a few different wave-lengths, this advantage of the spark system is not decisive. With respect to the efficiency to the sending end, or the energy absorption in the ground and in the atmosphere, or the nossibility of using a sound receiver, there is no essential difference between stations using damped or undamped oscillations. With respect to all other important points the comparison is in favour of undamped oscillations (high-frequency machines). With the latter, generation of the largest amounts of oscillation energy is possible without any fundamental difficulty. At the same time the transmitting antenna is utilised to the fullest extent. Moreover, the energy absorption of the receiving indicator is always greater with undamped oscillations than with damped ones. Finally, stations with high-frequency machines do not disturb adjoining installations using spark systems in their mutual intercourse.

OVERSEAS NOTES.

United States.

An examination for expert radio aid was recently held by the United States Civil Service Commission and from the register of eligibles certification was made to fill a vacancy in the Navy Yard, New York, at $6 per day. The duties attaching to the post are to direct and assist in the laboratory standardisation tests of all circuits, instruments and apparatus relating to wireless telegraphy, and in the development of special apparatus and methods suited to special conditions and of new forms of sending and receiving circuits, to inspect the various radio stations, and to carry out such work as may be necessary for the development of radio apparatus.

Austria-Hungary.

Shortly before the outbreak of war, the Austro-Hungarian Government organised a wireless weather service through the intermediary of the coast stations at Castlenuovo (OHC), Sebenico (OHB), and Trieste (OHT) for the benefit of ships subscribing to the service at the rate of 4 kronen. A report was issued from the Trieste observatory through the coast stations mentioned above at 9 o'clock every morning indicating the barometric pressure, the direction and velocity of the wind, the state of the sky, the temperature and state of the sea for the following ten localities: Trieste, Posen, Fiume, Lissa, Punta d'Ostro, Venice, Brindisi, Palermo, Corfu, and Alexandria.

Automatic High-Speed Transmission.

MACHINES WITH "BRAINS."

TO assist in coping with the rapidly increasing business between the London offices and the British transmitting stations in the Transatlantic services, the Marconi Company have recently installed sets of automatic high-speed printing instruments. As stated in the article entitled "From Continent to Continent," on pp. 687-692, the high-speed principle will be employed from the outset on the new Transatlantic services between Norway and the United States.

The machines put into service in London and at Towyn during 1914 belong to what is known to-day as the Creed system of high-speed telegraphy. The system, although used but little as yet in the telegraphic department of the postal service of the United Kingdom, is gaining great favour in the colonial services and amongst private companies at home and abroad. The inventors of the Creed system have abolished manual work in all departments where high speeds are in operation. The only human aid required is in the original translation of the message from the script of the sender to the Morse code.

The Creed telegraphic equipment consists of a keyboard perforator, used for preparing Wheatstone perforated tape, with a working speed of 60 words per minute; a transmitter; a receiving perforator, capable of reproducing Wheatstone perforated slip at 200 words, or 1,000 letters, per minute; and a printer, which, under the control of Wheatstone tape obtained from the perforating receiver, prints in large capitals at a maximum speed of 775 letters per minute. The printer permits of a message which in the first instance is prepared at double the speed of hand working to be transmitted at from five to eight times the speed of hand and printed in Roman characters on a tape, and pasted by means of a semi-automatic process on a form ready for delivery.

The keyboard perforator, which is not an essential to the system, resembles a typewriter in appearance and may be operated as fast as a typewriter. It performs the same functions as a Wheatstone perforator with absolute accuracy and high speed. The Creed and Bille receiving telegraph perforators afford alternative means of saving manual labour in the reception and transmission. Their main difference lies in the fact that one utilises compressed air and electrical power for its action, whilst the other, as mentioned above, relies entirely upon electricity for its operation.

The instrument upon which interest generally centres is the Creed printer. This instrument translates the Wheatstone tape into messages in Roman character. As the Wheatstone tape suffers no damage in this machine it can be run through a Wheatstone transmitter after leaving a legible translation for handing the message on to a distant station.

In action, the perforated tape is led forward, letter by letter, in a guide way in front of a series of ten pairs of selecting needles, one needle of each pair being mechanically connected to a series of ten slide valves. Each of these valves can be made to occupy one of two positions, thus providing a number of different combinations, every one of which opens one complete and particular passage through the ten slide valve plates. Air pressure can thus be admitted to any one of a number of small cylinders, each containing a piston acting on the end of a lever connected to a type bar. The machine prints satisfactorily at any speed up to 125 words per minute; but this, according to the inventors, is not a maximum, it being considered possible to reach 150 with the present form of machine. This speed will probably be increased with improvements in details.

The inventors claim that their system requires no revision of codes, but can be introduced gradually without disarranging any of the existing Morse methods. This point is particularly borne out by the big British newspapers, which have installed the system. Amongst the performances recorded are those of an eight hours' non-stop run at 140 words a minute without a hitch of any kind, and the transmission between London and Glasgow of over forty columns of matter in a single night.

Such performances show how great has been the recent advance in high-speed working, and these advantages have an important bearing upon the future of wireless.

QUESTIONS AND ANSWERS

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.*

A National Appeal.—We should like to direct readers to the advertisement on page xvii calling attention to permission granted by the Admiralty for raising a Public School Battalion of the Royal Naval Division.

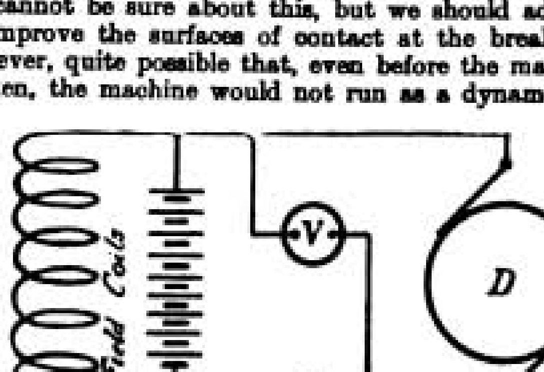
E. R. M. (Sierra Leone) asks us to suggest (1) a portable aerial for use with ignition coil. *Answer.*—The size must depend very much on local conditions. We should suggest a twin-wire inverted L aerial, with the masts anything from 50 to 100 feet apart. Height of masts 30 feet, built of 6-ft. or 8-ft. sections; 7/19 stranded copper wire is suitable for the aerial wire, as it has not so much tendency to kink. It may be necessary to alter the size of your primary condenser, in order to make the oscillation transformer primary of suitable dimensions when the circuits are in tune. This can best be decided by experiment.

(2) Why is it that, even when the crystal is not making contact, powerful stations working within a mile or so of the receiving station can still be heard in the 'phones? *Answer.*—To such a question as this nothing definite can be said; we would suggest that it is an electro-static effect between the telephone diaphragm and the winding. These two may be regarded as the two sides of a condenser, the diaphragm usually being more or less earthed. The high frequency oscillations charge up this condenser, and since the force between the two sides of the condenser is proportional to the square of the voltage, this results in an average attractive force on the diaphragm while the oscillations are passing. The telephone diaphragm will therefore vibrate to the train frequency of the oscillations.

(3) "A gentleman who resides here was speaking from Hill Station (800 feet above sea level) to Freetown, by telephone, five miles land-line, single galvanised, earth return, carried on ordinary insulators, no joints were soldered. The telephones were of the ordinary pattern. Suddenly to his astonishment he heard a German boat calling Conakry, 68 miles away. The signals were absolutely distinct, and as the gentleman understood Morse, he took down the message. He subsequently found that the German boat was about 30 miles away at the time." *Answer.*—This is a very interesting phenomenon, and our explanation coincides with that made by our correspondent. Probably the line is so situated that the ether waves set up corresponding stationary waves in the line—that is, the line was set into oscillation on one of its harmonics. Any imperfect contact, especially if filled with mineral dust, would have some rectifying action, and if situated near the telephones, but it rather surprises us that it should be sufficient to allow the signals to be heard in the telephones.

E. J. (Enfield), has a shunt motor, which runs perfectly off 20 or 30 volts, but refuses to work as a dynamo when tested up to 3,000 r.p.m. To aid us in locating the trouble he gives the following information: For working off 30 volts the armature resistance is 1·24 ohms, and that of the two field coils in series is 8·25 ohms. For working off 50 volts the armature resistance is 1·8 ohms, and that of the two field coils in series is 18·6 ohms. Also, he adds, that the field magnet has been broken in two, and is now more or less closely bolted together.

Whether a shunt dynamo will excite itself or not depends on three factors: (1) the existence of a residual magnetism in the poles; (2) the total resistance of armature and field coils (which is practically that of the field coils); (3) the extra flux that will be produced by the small initial current resulting from the residual flux. If this extra flux is not above a certain value, depending on the field resistance, the current will not increase, and so the machine will not excite itself. The initial extra flux depends on the reluctance of the magnetic circuit, and as this will be increased by the break in it, it is possible that this is the cause of the trouble. As you do not state whether the machine has ever run successfully as a dynamo we cannot be sure about this, but we should advise you to improve the surfaces of contact at the break. It is, however, quite possible that, even before the magnet was broken, the machine would not run as a dynamo, as the



field coil resistance is too high. You might try putting the field coils in parallel so as to lessen their resultant resistance, care being taken that they are connected to give the same polarity. Thus if the series connections are now A——B—A——B the two ends A should be together in the parallel connection. If the machine will not excite then, it would seem fairly hopeless to rewind the field coils, as they would have to be wound to less than a quarter of their present resistance, and have more turns on. You might also try connecting the field coils across the /30 volt supply (presumably accumulators), and then running your machine up to such a speed that the dynamo volts are slightly greater than those of the supply across the field. When this occurs, you can connect the dynamo across the supply. You must make absolutely sure that the voltage of the dynamo will oppose that of the supply before closing the switch. The connections are correct if when the terminal, B, of the voltmeter is connected to the dynamo or to the supply the voltmeter deflects in the same direction in both cases. It should now be possible to cut out the supply, or, by increasing the speed of the machine to charge the accumulators of the supply. We should like to hear how you get on.

O. H. (Veendam, Holland) sends us sketch of the arrangement of his aerial and receiving set, and asks for suggestions for improving these.

Answer.—The receiver described on page 593 of the December number of the WIRELESS WORLD appears to be of good design, but we should prefer to connect a small variable condenser of capacity of, say, ·0005 microfarads across the secondary coil. With regard to the aerial, the simpler the design the better it will be, so we recommend that, instead of the four wires to the short poles with a single long wire to the leading-in wire, shown in your sketch, two wires be taken from the top of the mast to the leading-in wire, being separated by a wooden spreader of four or five metres in length. In any case, the wire joining the two wires, which are hung from the centre pole to the two small poles, should be removed, as closed loops are usually detrimental. It is also advisable to make all the four wires from the centre pole to the small poles as nearly as possible of equal length. From the dimensions given your aerial should have a wave-length of about eight hundred metres.

P. S. (Roanne, Loire) states that he notices a film of oil increases the sensitivity of a zincite tellurium detector, as mentioned in an article by Mr. Scott-Taggart which recently appeared in THE WIRELESS WORLD. He asks why receiving aerial tuning inductances are wound in single layer coils and not in several layers; also if there is any objection to using the whole of the aerial tuning inductance to couple with the detector circuit instead of using a separate primary.

Answer.—The action of a crystal in rectifying alternating current and also making it available as a detector of wireless signals depends on several properties of the materials which form the contact. The current passing through the contact will give rise to an evolution of heat by Joule's law. Moreover, since most of the materials are bad conductors of heat, there will be a rise in temperature at the contact; hence there will be a thermo-electric force due to the Peltier effect. The Thomson effect due to the current will also come into action. The sensitivity of any particular detector depends upon the relationship between voltage and current which holds due to the combination of all the above. A film of oil would probably act by modifying the temperature at the contact, and this in turn causes changes in some of the effects above mentioned: since this modifies the voltage-current curve it will alter the sensitivity. It is not advisable to wind inductances for wireless telegraphy in several layers. By doing so the capacity between the turns of wire is increased. This capacity acts as a shunt and reduces the current which would otherwise go through the inductance. For the high frequencies used in wireless telegraphy the shunting effect of even a small capacity may be very great. Due to the capacity, the inductance has a "natural wave-length" of its own, and if this is near the wave-length of the signals it will absorb most of the current which would otherwise pass through the circuit and give signals. There is no objection, from the point of efficiency, to couple the whole of the aerial tuning inductance with the detector circuit, the only reason why it is not done regularly being the great distance which may be required to give weak coupling. It is the most efficient method of coupling that can be used, and, if required, gives much tighter coupling than can be obtained with a separate primary coil for every arrangement required to tune to the various wave-lengths.

G. P. (Widnes).—On p. 144 of THE WIRELESS WORLD of May, 1914, "H. E. A. (London)" is informed that the self-inductance of a coil of wire may be calculated from the formula

$$L = l(\pi DN)^2 \text{ C.G.S. units.}$$

The querist had evidently taken some trouble comparing several formulæ, and was anxious to ascertain which formula was correct, even to the extent of stating that the answer could be in terms of the calculus.

He was informed that the formula given was *sufficiently accurate.*

On p. 671 of January, 1915, issue, in reply to "J. A. W. (Eccles)," the same formula is again given, with the addition of a factor, *K*—

$$L = \frac{\pi^2 n^2 d^2 l K}{1000} \text{ microhenries}$$

If the inductance of a coil of wire 10 cm. diameter and 5 cm. long is calculated by each of these two formulæ, the values found are in the proportion 100 : 53, therefore, *one* or both of these formulæ must be wrong. Which is the correct formula, and if the latter, how are the different values of "K" found?

Answer.—The formula $L = l(\pi DN)^2$ is only true for coils of which the length is many times the diameter. If the length be four times the diameter, the inductance given by the formula will be 10 per cent. out, if it be 20 times the error is about 2 per cent., and so on. We are afraid that this was overlooked in the reply given in May, 1914. The other formula is exactly the same, with the addition of a factor, *K*, which corrects for the ratio of length to diameter. It is not as well known as it should be to radiotelegraphists, and we are preparing an article for insertion in an early number of THE WIRELESS WORLD on the subject. The values of *K* have been calculated by Professor Nagaoka to six decimal places, but the formula from which this was done is very complicated. Further particulars will be found in the article above referred to.

PATENT INTELLIGENCE.

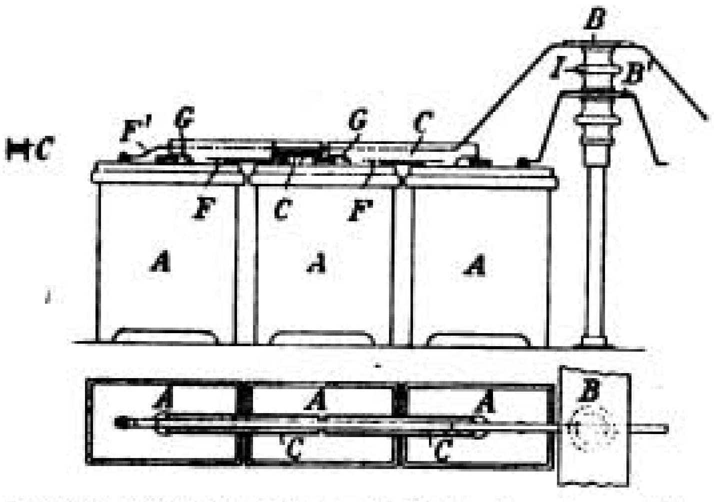
(The date given is that of the advertisement of the acceptance of the Complete Specification.)

17,487. November 19th, 1914.—IMPROVEMENTS IN OR RELATING TO RECEIVING SYSTEMS FOR RADIO TELEGRAPHY OR TELEPHONY, Lieut-Col. George Owen Squier, 43 Park Lane, Mayfair, London, W.

This invention relates to a receiving system for wireless telegraphy and telephony, in which horizontal conductors used for ordinary telegraphic or telephonic purposes, or for the transmission of electrical power by direct or low-frequency current, are employed as antennæ for the reception of wireless high-frequency impulses. With the long horizontal conductor is combined a vertical conductor or antenna, connected at a convenient point, preferably at or near the junction of the vertical and horizontal conductors, to the earth through a high-frequency bridge including a condenser of not more than about 0·01 microfarad capacity and a variable inductance. The bridge is opaque to frequencies of or below the order of the audible sound, but allows frequencies, or a selected frequency, of the order used in the transmission of wireless messages to pass freely. With the bridge is associated a tuned detector circuit of any suitable type. While the long horizontal conductor serves by itself as an efficient means for guiding the high-frequency waves reaching it to the receiving apparatus, it has been found that the efficiency is substantially increased by the addition at the receiver of a vertical component which may, especially when a telephone wire is used, consist simply of a length of ordinary insulated wire attached in any convenient manner along the walls of a house running from the telephone, from one part of the house to another.

21,672. October 14th, 1914.—IMPROVEMENTS IN THE CONNECTIONS OF ELECTRICAL CONDENSERS, Marconi's Wireless Telegraph Co. (Ltd.), and Richard Norman Vyvyan, both of Marconi House, Strand, London.

The object of this invention is to provide improved connections for electrical condensers especially such as are used in wireless telegraph transmitting apparatus. The units of which the whole condenser is composed, and which consist of a few, say, three, condenser jars A in series to the main busbars B B¹ by connections which are identical in every respect. The adjacent terminals of the jars in a unit are connected together by means of straight pieces of copper strip F, the inner terminal being connected to the busbar B¹. This copper strip is covered by a porcelain insulator C of H-section, the ends of which are recessed back as at G to prevent leakage. The long copper strip F¹ from the outer terminal to the busbar B lies in this insulator, and is thus brought as close as possible to the connecting pieces between the condensers without any danger of flashing over. The distance between the long copper strip F¹ and the interconnecting pieces F is also kept constant in all the condensers, thus preventing the surging spoken of above. The whole



condenser is usually made up of eight nests each consisting of a number of units of three condenser jars in series. There are three other illustrations.

28,431. December 9th, 1914. — IMPROVEMENTS IN RECEIVERS FOR USE IN WIRELESS TELEGRAPHY. Marconi's Wireless Telegraph Co. (Ltd.) and Henry Joseph Round, both of Marconi House, London, W.C.

This invention relates to improvements in receivers for wireless telegraphy in which a vacuum tube of the type having a hot filament, a grid and a third electrode is connected to the oscillation circuit coupled to the aerial. Across the hot filament and the third electrode, and in addition to the ordinary telephone and battery, is connected an oscillation circuit which is preferably tuned to a frequency slightly different from that of the first oscillation circuit. By suitably adjusting such circuits, signals produced by continuous waves can be heard in the telephones, provided there is sufficient capacity between the grid and the third electrode. If the capacity is insufficient, a small condenser may be connected across the grid and the third electrode, or the two oscillation circuits may be made to inter-act by so arranging them that there is mutual inductance between them. In vacuum tubes of this type, moreover, even where the grid has entirely separated the hot filament from the third electrode, the glass has hitherto been exposed to the cathode stream and has become electrified, producing a polarising effect which necessitated varying the potential between the electrodes and the filament. To obviate this disadvantage both the grid and the third electrode are according to this invention made in the form of cylinders which completely surround the hot filament These cylinders effectively protect the glass from electrification, and possess the capacity above referred to as desirable

Personal.

Mr. J. G. Balsillie will continue the management of the radiotelegraph branch of the Postmaster-General's Department of the Commonwealth of Australia during the term of the war.

The following have been elected members of the Wireless Society of London: Lieut. Frederick C. Cross, R.N.R., 60 Ramillies Road, Chiswick; Basil M. Davis, 12 Hyde Park Place, W.; Walter Edwin Nicoll, A.M.I.E.E., F.C.I.S., Tramway Offices, Scarborough; Lieut. A. W. Tate, The Black Watch, Jamestown, Dumbarton; Capt. R. J. T. Trew, R.E., 38 Woolwich Common, Woolwich.

Associate Members.—Herbert Thomas Cogger, 12 Mill Street, Maidstone, Kent; John Peed, High Causeway, Whittlesey, near Peterborough; Sidney Smith, Malling Road, Snodland.

The Construction Department of the American Marconi Co. (Southern District) have been actively at work installing the new type of antenna switch on board a number of vessels during the last month, and taking out the ground plates. During the month G. O'K. Kendrick returned from East San Pedro. He was relieved by P. J. Townsend. W. A. Vetter, one of the old-timers in the shop, left for the north on the s.s. *City of Topeka*, to make repairs to the s.s. *George W. Elder*.

Mr. N. Johnson, eldest son of the Rev. J. E. Johnson, lately engineer in charge of the Marconi stations in Spain, has been recalled to take up an appointment at home under the British War Office.

FAREWELL DINNER TO MR. MARRIOTT.—Mr. R. H. Marriott, radio inspector, New York, has been transferred to Seattle, Wash. A farewell dinner was tendered to him at Mouquin's up-town restaurant, New York, on the evening of December 23rd, by the Board of Direction of the Institute of Radio Engineers, New York, of which Institute he is past president and one of the managers. There were about sixty of Mr. Marriott's friends present, and the affair was very enjoyable. The toasts were both amusing and entertaining, Mr. John Stone Stone being the toastmaster.

It is with much regret that we have to announce the death of Mr. Ernest E. Richards, until lately an engineer on the staff of Marconi's Wireless Telegraph Co., Ltd. Mr. Richards joined the Company from the Royal Navy in 1911, and after spending a short time at Chelmsford and Poldhu, was transferred to the Canadian Company. In March, 1914, he was invalided home suffering from tuberculosis, after having done good work in connection with stations on the Great Lakes and on the Gulf of St. Lawrence. The funeral took place on January 22nd at Wimbledon Cemetery. A wreath was sent by members of the engineering staff of the Company as an expression of their regard for their late colleague.