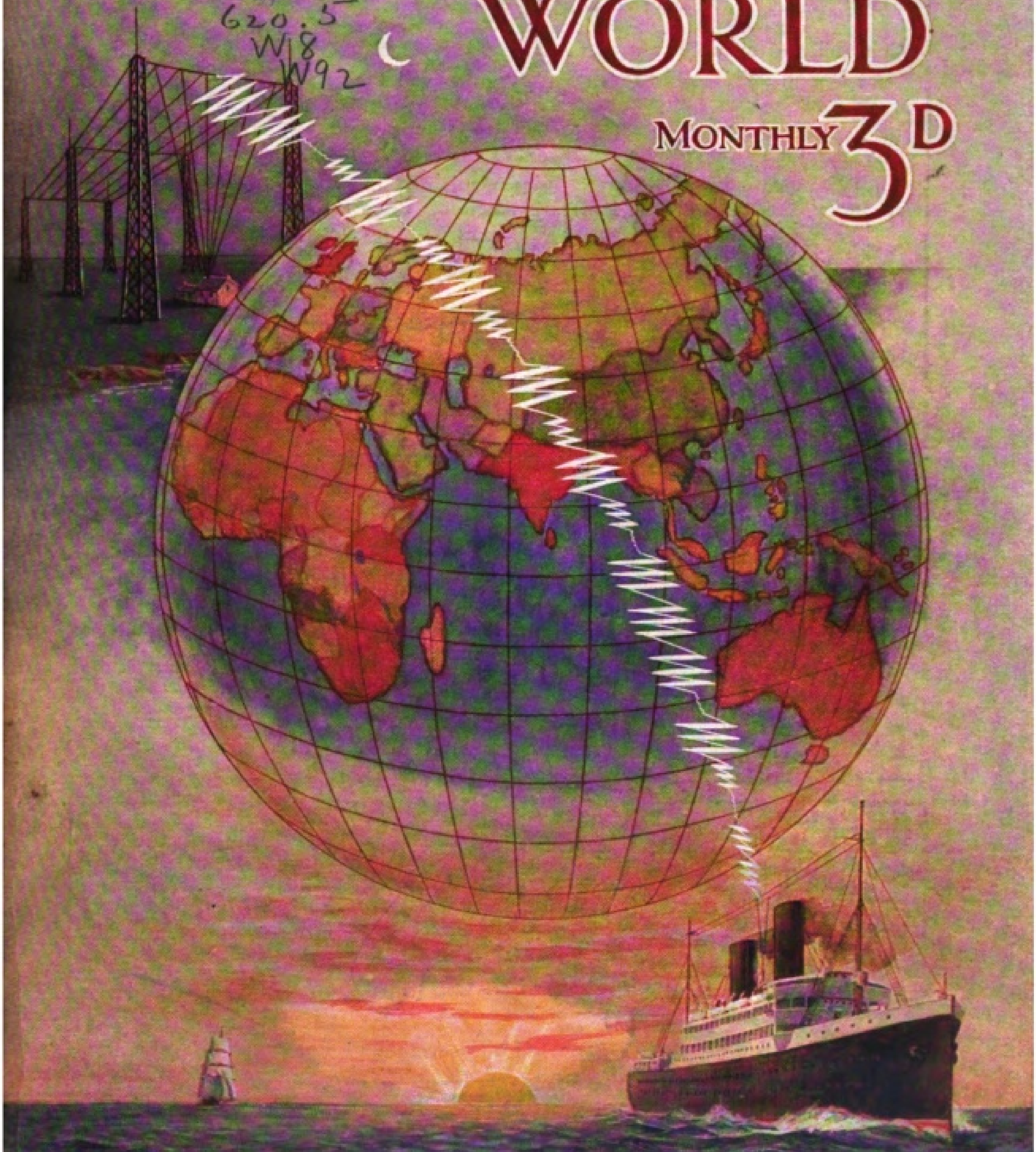
Vol. II. No. 21. (New Series). Registered at the G.P.O. for transmission to Canada by Canadian Magazine Post. DEC., 1914

WIRELESS WORLD

MONTHLY 3D



Sullivan Instruments

Sullivan "Universal" Galvanometers and Shunts for Land and Sea Use

Testing and Signalling Instruments of every description for Submarine Cables.

SULLIVAN TELEPHONE RECEIVERS for Wireless Telegraphy and Telephony, as used by the principal Governments and Wireless Telegraphy Companies—resistance values from 5 to 15,000 ohms.

Fast Speed Wheatstone Automatic Transmitters and Receivers, guaranteed at 400 words per minute, and Wheatstone Apparatus generally.

Precision and Standard Measuring Equipments for D.C. and A.C. (high frequency) determinations, Condensers of Low Power Factor, etc.

All instruments guaranteed, and accompanied, if desired, with Certificates of Accuracy from the National Physical Laboratory at cost price.

H. W. SULLIVAN,

Winchester House, London, E.C., England.

Works: Liverpool House, Middlesex Street, London, E.C.

Telegrams: "Deadbeat, London." Telephone { Office: 3518 London Wall. Works: 3518a " "

Codes: Western Union (Universal Edition); A.B.C. (5th Edition); Engineering (2nd Edition).

Silk and Cotton Covered H.C. Copper Wire, Resistance Wires, Fuse Wire, Binding Wires, Charcoal Iron Core Wire, Asbestos Covered Wire

P. ORMISTON & SONS, 79 CLERKENWELL ROAD

LONDON, E.C.

"Ormiston, London" Established 1793. 13259 Central.

Braided and Twisted Wires, Bare Copper Strand & Flexibles of any Construction, Wire Ropes & Cords, down to the finest sizes, in Galvanized Steel, Phosphor Bronze, etc.

NORMAN, SMEE & DODWELL

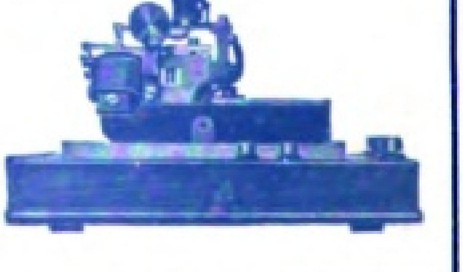
MANUFACTURERS OF HIGH-CLASS VARNISHES for Coach Builders and Decorators, Railway Carriage and Locomotive Builders, and Ship Builders Special Insulating Varnishes for Electrical Purposes

Offices and Factory: MILES LANE, MITCHAM, SURREY.

"Wireless" TELEPHONE RELAY

IMPROVED FORM will MAGNIFY CURRENT over 100 TIMES.

For INCREASING the RANGE of a Receiving Station.
For RECORDING Messages and TIME SIGNALS.
For operating LOUD SPEAKING TELEPHONES.
For working CALLS and RELAYS.



Also BEST RECEIVERS made for Wireless and other RELAYS and Loud Speakers.

For Particulars and Prices apply Patentee and Sole Manufacturer,

S. G. BROWN, 4 Gt. Winchester St., London, E.C.

THE WIRELESS WORLD

Vol. 2.—No. 21. (New Series) December, 1914. Subscription 5/0 per annum post free. Price 3d. Post Free 5d.

"Wireless—as Usual"

THE purpose of the above title is to urge wireless amateurs to keep up their practice and to strive for yet further proficiency in the science which they have taken up as a hobby. There is no saying when their knowledge may become useful to the State, and those who are endeavouring to master its difficulties are doing a service none the less important because it does not receive official recognition or public thanks.

If the members of wireless societies throughout the United Kingdom, or better still, throughout the Empire, will look upon their work in this light it is obvious that England will be possessed of a reserve corps of men more or less proficient in this system of communication, who, should they be called upon, will be capable as well as willing to take up service for their country. Other men are occupying all their spare time in endeavours to become efficient according to their personal aptitudes, and the following is a particular example of this quiet patriotism.

The members of the staff of one of the Departments of State have been forbidden to accept commissions at the present time, since their services cannot be dispensed with. Nevertheless they have organised an Officers' Training Corps on their own account, and although they are fully aware that they will only be required in the most desperate emergency. Such an occasion we hope will never arise and the members of this corps themselves do not expect it, but they are not going to leave anything to chance. If they can afford so much personal inconvenience for the sake of the "old country," wireless enthusiasts can do so also.

Because there is no opportunity of indulging in practical work that does not mean to say that all progress must cease. Even experts can always afford to be learning, and there is much to be gained by the study of the theoretical side of wireless telegraphy. The present is an excellent time for quiet reading and learning, because the temptation to do nothing but practical work no longer exists. Often the theory of wireless telegraphy is neglected for the more attractive work, and it is a great pity because the amateur by this neglect places himself at a disadvantage whenever a problem crops up. He is perforce, by reason of his want of theoretical knowledge, obliged to slur over the difficulty, and "muddle through somehow."

Most of the wireless societies have for the ensuing session organised a series of lectures, which we recommend all those interested to attend. The Barnsley Society has even gone one better; there a class has been organised for dealing with and explaining the instructional articles in THE WIRELESS WORLD. We are sure that the members who take up this class work will profit exceedingly. *They will be able to answer questions*—most difficult of all tests; for how many people think they know all there is to know about a subject until questions are put to them and they find themselves hopelessly unprepared to give concise and reasonable answers to them.

LT.-COL. G. O. SQUIER.

Personalities in the Wireless World

Lt.-Col. GEORGE OWEN SQUIER.

Military Attaché to the American Embassy in London.

IF you were lucky enough to obtain an introduction to Lt.-Col. Squier, of the United States Army, and found him with half an hour to spare for conversation, you would soon realise that you were listening to a man who knows his subject from α to ω.

Ask him about wireless telegraphy and he has excellent tales to tell of the infancy of this great invention. For instance, he was in the laboratory of Sir William Preece at the Post Office and was occupied in tests of the work of the synchronograph on the telegraph lines of the British Government, more especially with a view to ascertaining the efficacy of the Wheatstone receiver operated by the alternating current in transmitting intelligence, when Mr. Marconi first visited the then Engineer-in-Chief of the Post Office with a view to demonstrating the practice of Radiotelegraphy. Colonel Squier's interest in all matters relating to telegraphy extends to wireless telegraphy, and this interest has resulted in his introduction of a system of "wired wireless" which has already received notice in this magazine, and has been demonstrated before many learned bodies, including the Royal Society.

While still a major of the United States Army Signalling Corps he drew up in 1904 a report at the request of Major-Gen. Arthur MacArthur, on the "Absorption of Electromagnetic Waves by Living Vegetable Organisms," and one section of it deals with vegetable antennæ for wireless telegraphy. But perhaps another section is of greater interest to-day—viz., "Wireless Telegraphy for Military Field Operations."

An important treatise by Col. Squier is a paper which was read before the American Institute of Electrical Engineers, on June 28th, 1911. It deals with multiplex telephony and telegraphy by means of electric waves guided by wires, and in it he demonstrates his invention of "wired wireless" to which we have already referred.

Col. Squier was educated at the John Hopkins University, Baltimore, where, in 1893, he gained the degree of Doctor of Physics and where he was a research student and Fellow in Physics under the late Professor Rowland. He gained his military training at the famous academy at West Point and afterwards was attached to the Signal Corps. His authorship of "The Present Status of Military Aeronautics" placed him amongst the foremost authorities on this subject, and he was made chairman of the Joint Army and Navy Board, which tested the original Wright Brothers' aeroplane at Fort Myer, Va. He is a member of the American Physical Society and also of the American Institute of Electrical Engineers. Later he was placed in charge of the War Department Radio Research Laboratory at the National Bureau of Standards at Washington, an institution with functions similar to that of the National Physical Laboratory at Teddington. It was as representative of the United States that he attended the International Radiotelegraphic Conference held in London in 1912, and since that time he has been a well-known figure in London society, for the same year he was appointed Military Attaché to the American Embassy. Also, in 1912, he was awarded the Elliott Cresson Gold Medal, on the recommendation of an expert committee, for his researches in multiplex telephony.

On the Capacity of Radio-Telegraphic Antennæ*

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

PART I.

If a single straight wire is supported horizontally or vertically at a great distance from the earth, and brought to a potential above or below that of the earth, its electric charge will not be uniformly distributed over its surface, but will have a greater density near its ends. The calculation of its capacity is greatly simplified, however, by the assumption of a uniform distribution, and although such a distribution is impossible in a continuous wire, it would be quite possible if the wire were made up of a large number of short pieces, say 1 cm. long, stuck end to end but insulated from each other. Each centimetre of its length could then be given an equal charge, but the potential would vary from point to point along the wire in a way which is easily calculated. Thus, let

r=radius of wire in centimetres.
l=length of wire in centimetres.
σ=surface density of charge in electrostatic units per square centimetre,

then the potential at any point P on the axis of the wire, due to the charge on a small length dx at a distance x is equal to

$$\frac{2\pi r\,.\,dx\,.\,\sigma}{\sqrt{r^2+x^2}}.$$

The potential at the mid-point of the wire is

$$2\pi r\sigma\int_{-l/2}^{+l/2}\frac{dx}{\sqrt{r^2+x^2}} \text{ or } 4\pi r\sigma\int_0^{l/2}\frac{dx}{\sqrt{r^2+x^2}}$$

This is equal to

$$4\pi r\sigma\log_e\left(\frac{l}{2r}+\sqrt{\frac{l^2}{4r^2}+1}\right)$$

$$\text{or } 4\pi r\sigma\sinh^{-1}\frac{l}{2r}.$$

In all practical cases $\frac{l^2}{4r^2}$ is enormously greater than unity, and little error is made by putting $\sqrt{\frac{l^2}{4r^2}+1}=\frac{l}{2r}$ so that the potential at P becomes

$$4\pi r\sigma\log_e\frac{l}{r} \text{ or } \frac{2Q}{l}\log_e\frac{l}{r} \text{ where } Q=2\pi rl\sigma$$

is the total charge on the wire.

In the same way the potential at any point of the wire can be found, thus the potential at the point P, distant al from one end of the wire, is the sum of the potentials due to the two parts AP and BP considered separately.

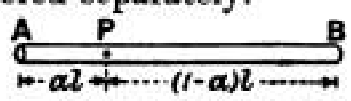


FIG. 1.

$$V_P=2\pi r\sigma\int_0^{al}\frac{dx}{\sqrt{r^2+x^2}}+2\pi r\sigma\int_0^{(1-a)l}\frac{dx}{\sqrt{r^2+x^2}}$$

$$=2\pi r\sigma\left[\log_e\frac{2al}{r}+\log_e\frac{2l(1-a)}{r}\right]$$

$$=2\pi r\sigma\log_e\left[\frac{4l^2}{r^2}a(1-a)\right]$$

$$=2\pi r\sigma\log_e\left[\frac{2l}{r}\sqrt{a(1-a)}\right]^2$$

$$=4\pi r\sigma\log_e\left[\frac{2l}{r}\sqrt{a(1-a)}\right]$$

$$=4\pi r\sigma\left[\log_e\frac{l}{r}+\log_e 2\sqrt{a(1-a)}\right].$$

This formula is not accurate very close to the ends owing to the approximation made above, but even at a distance from the end equal to twice the diameter the error does not exceed 1 per cent., while at the extreme end we have

$$V=2\pi r\sigma\log_e\frac{2l}{r}.$$

To obtain greater accuracy near the ends the rigid formula

$$V=2\pi r\sigma\left[\sinh^{-1}\frac{al}{r}+\sinh^{-1}\frac{(1-a)l}{r}\right]$$

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

can be readily used if one has a sinh table, and the values marked with an asterisk in the table were calculated in this way.

The value of $\log_e 2\sqrt{a(1-a)}$ is always negative, so that the potential is a maximum at the mid-point of the wire.

The following table gives the value of

$$2\left[\log_e \frac{l}{r} + \log_e 2\sqrt{a(1-a)}\right]$$

for different values of a; by multiplying this by $2\pi r\sigma$, *i.e.*, by the charge per unit length, the potential at any point is obtained:

If now we assume that all the insulated pieces of which the wire is composed are connected together to form a continuous conductor, electricity will flow from the central part toward the ends until all points have the same potential. The approximate value of this final potential is equal to the average potential of the various sections, that is, to the average ordinates of the curves in Fig. 2.

This average potential may be found from the curves or may be obtained mathematically, as follows:

TABLE I.

a	$\log_e 2\sqrt{a(1-a)}$.	Values of $2\left[\log\frac{l}{r} + \log 2\sqrt{-a(1-a)}\right]$.					
		$\frac{l}{r} = 200$	$\frac{l}{r} = 600$	$\frac{l}{r} = 2{,}000$	$\frac{l}{r} = 6{,}000$	$\frac{l}{r} = 20{,}000$	$\frac{l}{r} = 40{,}000$
0		5·99*	7·07*	8·28*	9·37*	10·59*	11·28*
0·001	—2·76	6·19*	7·64*	9·72*	11·84	14·28	15·66
0·01	—1·613	7·43*	9·54	11·96	14·14	16·58	17·96
0·05	—0·833	8·94	11·10	13·52	15·70	18·14	19·52
0·1	—0·51	9·58	11·74	14·16	16·34	18·78	20·16
0·2	—0·223	10·16	12·32	14·74	16·92	19·36	20·74
0·25	—0·1425	10·32	12·48	14·90	17·08	19·52	20·90
0·3	—0·0873	10·42	12·58	15·00	17·18	19·62	21·00
0·5	0	10·60	12·76	15·18	17·36	19·80	21·18

These values are plotted in Fig. 2, which, therefore, shows the distribution of potential on the assumption of a uniformly distributed charge.

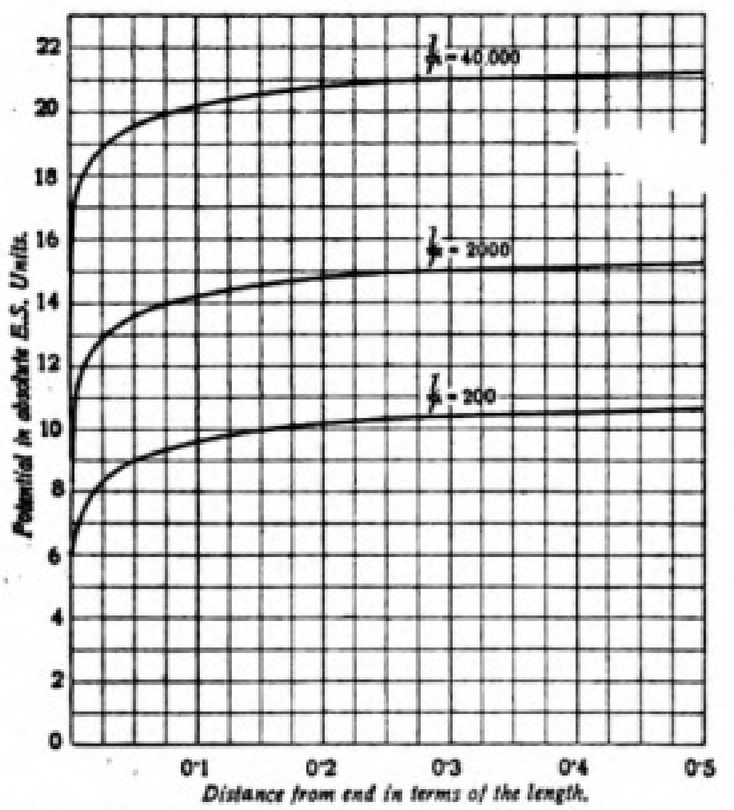


Fig. 2.—Single Wire with Uniform Charge of 1 unit per Centimetre.

$$\log 2\sqrt{a(1-a)} = \log 2 + \tfrac{1}{2}\log a + \tfrac{1}{2}\log(1-a)$$

Average value of

$$\log 2\sqrt{a(1-a)} = \int_0^1 \log 2\sqrt{a(1-a)}\, da$$

$$= \int_0^1 \log 2 \,.\, da + \int_0^1 \frac{\log a}{2} da + \int_0^1 \frac{\log(1-a)}{2} da.$$

$$= \log_e 2 + \tfrac{1}{2}(-1) + \tfrac{1}{2}(-1)$$

$$= -0{\cdot}309.$$

Hence the average value of the potential along the wire with a uniformly distributed charge is

$$4\pi r\sigma\left[\log_e \frac{l}{r} - 0{\cdot}309\right].$$

The following table shows the error made by neglecting this correction and taking simply $V = 4\pi r\sigma \log_e \frac{l}{r}$, as is usually done:

TABLE II.

$\frac{l}{r}$	$\log_e \frac{l}{r}$	$\log_e \frac{l}{r} - 0{\cdot}309$	Percentage difference.
200	5·30	4·99	6·18
600	6·38	6·07	5·1
2,000	7·59	7·28	4·25
6,000	8·68	8·37	3·7
20,000	9·90	9·59	3·2
40,000	10·59	10·28	3·0

The figures in the last column give the percentage by which the capacity as usually calculated is to be increased.

Although this result has been obtained from the formula which is incorrect in the immediate neighbourhood of the ends, the error so introduced is very small. The accurate expression for the average potential due to a uniformly distributed charge can be found as follows:

$$V_P = 2\pi r\sigma\int_0^{al}\frac{dx}{\sqrt{r^2+x^2}} + 2\pi r\sigma\int_0^{(1-a)l}\frac{dx}{\sqrt{r^2+x^2}}$$

$$= 2\pi r\sigma\left[\sinh^{-1}\frac{al}{r} + \sinh^{-1}\frac{(1-a)l}{r}\right],$$

$$V_{av.} = 2\pi r\sigma\left[\int_0^1 \sinh^{-1}\frac{al}{r}da + \int_0^1 \sinh^{-1}\frac{(1-a)l}{r}da\right]$$

$$= 4\pi r\sigma\int_0^1 \sinh^{-1}\frac{al}{r}da.$$

Integrating by parts

$$V_{av.} = 4\pi r\sigma\left\{\left[a\sinh^{-1}\frac{al}{r}\right]_0^1 - \int_0^1 a\,d\sinh^{-1}\frac{al}{r}\right\}$$

$$= 4\pi r\sigma\left\{\sinh^{-1}\frac{l}{r} - \int_0^1 a\frac{l}{r}\cdot\frac{da}{\sqrt{1+\frac{a^2l^2}{r^2}}}\right\}$$

$$= 4\pi r\sigma\left\{\sinh^{-1}\frac{l}{r} - \int_0^1\frac{a\,da}{\sqrt{a^2+\frac{r^2}{l^2}}}\right\}$$

$$= 4\pi r\sigma\left\{\sinh^{-1}\frac{l}{r} - \left[\sqrt{a^2+\frac{r^2}{l^2}}\right]_0^1\right\}$$

$$= 4\pi r\sigma\left\{\sinh^{-1}\frac{l}{r} - \sqrt{1+\frac{r^2}{l^2}} + \frac{r}{l}\right\}.$$

The difference between this and the approximate formula used above is negligibly small for all practical cases. Hence the capacity of a single wire far removed from the earth is given by the formula

$$C = \frac{Q}{V_{av.}} = \frac{2\pi rl\sigma}{4\pi r\sigma(\log_e\frac{l}{r} - 0{\cdot}309)}$$

$$= \frac{l}{2\log_e\frac{l}{r} - 0{\cdot}618}\text{ electrostatic units.}$$

The capacity per centimetre length

$$= \frac{1}{2\log_e\frac{l}{r} - 0{\cdot}618}\text{ E.S. units}$$

$$= \frac{1}{\left(2\log_e\frac{l}{r} - 0{\cdot}618\right)} \times \frac{1}{9\times10^5}\text{ mfds.}$$

Capacity per foot

$$= \frac{33{\cdot}9}{2\log_e\frac{l}{r} - 0{\cdot}618}\text{ micro-mfds.}$$

The capacity per foot for any value of l/r can be read off the curve in Fig. 3.

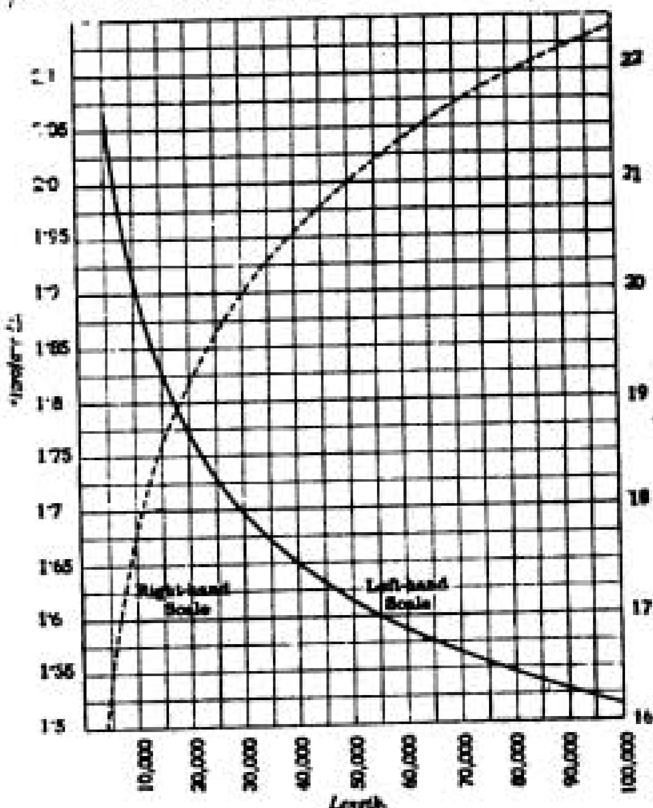


Fig. 3.—Capacity of a Single Wire in Millionths of a Microfarad per Foot.

It is noteworthy that the capacity per foot lies between 1·5 and 2·1 micro-farads. for all the cases likely to arise in practice.

The dotted curve in Fig. 3 gives the average value of the potential for a uniformly distributed charge of 1 unit per centimetre of length, *i.e.*, for $2\pi r\sigma = 1$.

The effect of the earth is considered later; we now turn to multiple-wire antennæ.

FLAT MULTIPLE-WIRE ANTENNÆ.

The most common type of antenna consists of a number of parallel wires in the same plane, usually the horizontal. The accurate predetermination of the capacity of such antennæ is a matter of some importance in the design of radiotelegraph stations. Papers on the subject have recently been written by Louis Cohen (*The Electrician*, February 14th and 21st, 1913) and Pedersen (*Jahrbuch der Drahtlosen Telegraphie*, Band VII., Heft 4, p. 434). The methods employed by these writers are quite different from those used in this paper.

If the antenna consists of a number of parallel wires connected together and, therefore, at the same potential, the distribution of the charge will not be uniform, either on each wire or between the several wires; but here, again, the problem is greatly simplified by assuming that the total charge is equally distributed between the wires and that the charge on each wire is uniformly distributed over its surface. The potential at any point of a wire is the sum of the potentials due to its own charge and the charges on the other wires. This potential will vary from point to point and from wire to wire, and would only be possible if each wire were made up of a number of insulated elements and the neighbouring wires insulated from each other. We shall make this assumption and calculate the average potential over the whole antenna. This average potential is a close approximation to the actual potential which the antenna would have at every point when carrying the same total charge.

Before doing this, however, we shall consider an approximate method which leads to a simple result, and which will be accurate enough for many purposes. In this method we find the potentials at the mid-points of all the wires and take their average value. This will give a value in excess of the true average potential taken over the whole lengths of the wires, and the capacity thus calculated will be smaller than the actual capacity by a percentage which will depend on the dimensions of the antenna.

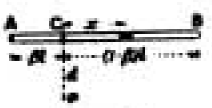


Fig. 4.

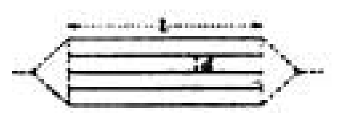


Fig. 5.

If V_P be the potential at a point P due to a uniformly charged wire in its neighbourhood,

$$V_P = 2\pi r\sigma\left[\int_0^{\beta l}\frac{dx}{\sqrt{d^2+x^2}} + \int_0^{(1-\beta)l}\frac{dx}{\sqrt{d^2+x^2}}\right]$$

$$= 2\pi r\sigma\left\{\left[\sinh^{-1}\frac{x}{d}\right]_0^{\beta l} + \left[\sinh^{-1}\frac{x}{d}\right]_0^{(1-\beta)l}\right\}$$

$$= 2\pi r\sigma\left\{\sinh^{-1}\frac{\beta l}{d} + \sinh^{-1}\frac{(1-\beta)l}{d}\right\} \text{ accurately}$$

$$= 2\pi r\sigma\left\{\log_e\frac{2\beta l}{d} + \log_e\frac{2(1-\beta)l}{d}\right\} \text{ approximately.}$$

If $\beta=\frac{1}{2}$, *i.e.*, if the point P is opposite the mid-point of the charged wire,

$$V_P = 2\pi r\sigma\left\{\log_e\frac{l}{d} + \log_e\frac{l}{d}\right\} = 4\pi r\sigma\log_e\frac{l}{d}.$$

If there are n wires the potential at the middle of an outside wire is $4\pi r\sigma\log_e\frac{l}{r}$ due to its own charge, $4\pi r\sigma\log_e\frac{l}{d}$ due to the next wire, $4\pi r\sigma\log_e\frac{l}{2d}$ due to the third wire, and so on, giving a total potential

$$V = 4\pi r\sigma\left\{\log_e\frac{l}{r} + \log_e\frac{l}{d} + \log_e\frac{l}{2d} + \dots + \log_e\frac{l}{(n-1)d}\right\}$$

$$= 4\pi r\sigma\log_e\frac{l^n}{rd^{n-1}|\underline{n-1}}$$

$$= 4\pi r\sigma\log\left(\frac{l^n}{d^n}\cdot\frac{d}{r}\cdot\frac{1}{|\underline{n-1}}\right)$$

$$= 4\pi r\sigma\left(n\log_e\frac{l}{d} + \log_e\frac{d}{r} - \log_e|\underline{n-1}\right).$$

Similarly the potential at the mid-point of the middle wire, if n is odd, is

$$4\pi r\sigma\left(n\log_e\frac{l}{d} + \log_e\frac{d}{r} - 2\log_e\left|\underline{\frac{n-1}{2}}\right.\right)$$

For the potential at the mid-point of any other wire, say, the mth of the group, we have

$$4\pi r\sigma\left\{\log_e\frac{l}{r} + \left(\log_e\frac{l}{d} + \log_e\frac{l}{2d} + \dots + \log_e\frac{l}{(m-1)d}\right) + \left(\log_e\frac{l}{d} + \log_e\frac{l}{2d} + \dots + \log_e\frac{l}{(n-m)d}\right)\right\}$$

$$= 4\pi r\sigma\left(n\log_e\frac{l}{d} + \log_e\frac{d}{r} - \log_e|\underline{n-m}\,|\underline{m-1}\right).$$

It will be noticed that the expressions for the potentials at the mid-points of the different wires differ only in the last term in the brackets and that this term is independent of the length and size of the wires; it can, therefore, be calculated once for all for antennæ consisting of various numbers of wires. For any given value of n, the average value of $\log_e|\underline{n-m}\,|\underline{m-1}$ for all values of m from 1 to n can be found. Call this average value B; then the average value of the potentials at the mid-points of the various wires is

$$4\pi r\sigma\left(n \log_e \frac{l}{d} + \log_e \frac{d}{r} - \mathrm{B}\right),$$

and the capacity of the antenna is given by the formula

$$\mathrm{C}=\frac{\mathrm{Q}}{\mathrm{V}}=\frac{2\pi r l\sigma \times n}{4\pi r\sigma\left(n \log \frac{l}{d} + \log \frac{d}{r} - \mathrm{B}\right)},$$

$$=\frac{nl}{2\left(n \log \frac{l}{d} + \log \frac{d}{r} - \mathrm{B}\right)} \text{ electrostatic units.}$$

TABLE III.

Table of Values of $\log_e (l n-m/m-1)$ and of B.

n=	3	5	7	10	12
m=1	0·69	3·17	6·55	12·8	17·5
2	0·0	1·79	4·775	10·6	15·1
3	—	1·38	3·861	9·275	13·49
4	—	—	3·58	8·35	12·39
5	—	—	—	7·95	11·67
6	—	—	—	—	11·325
B=	0·46	2·26	4·85	9·8	13·58

By plotting these values of B and interpolating, the following figures are obtained:—

TABLE IV.

No. of wires in antenna.	Value of B.	No. of wires in antenna.	Value of B.
2	0	8	6·40
3	0·46	9	8·06
4	1·24	10	9·80
5	2·26	11	11·65
6	3·48	12	13·58
7	4·85	—	—

By the aid of the above formula and the table the capacity of a multiple-wire antenna can be calculated as readily as that of a single wire.

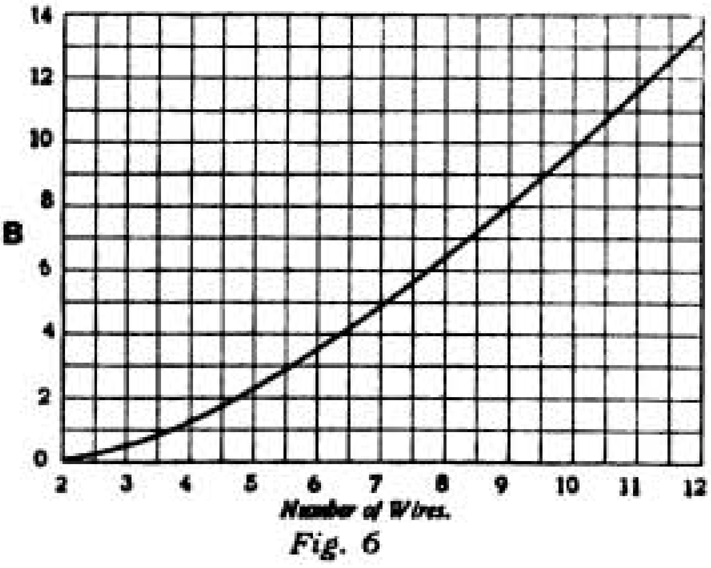


Fig. 6

As already pointed out, the capacity so calculated will be below the true value because the potential employed in the calculation is that at the mid-point of the antenna. Greater accuracy is obtained by calculating the average potential over the whole antenna, always assuming a uniformly distributed charge. To do this it is necessary in the first place to determine the average potential over a wire due to a uniformly distributed charge on a neighbouring parallel wire.

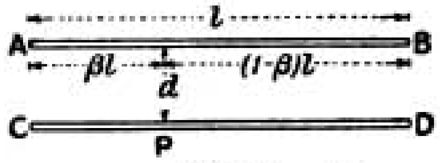


Fig. 7.

We have already seen that the potential at P due to the charge on AB (*see* Fig. 7) is

$$\mathrm{V}_P = 2\pi r\sigma\left\{\sinh^{-1}\frac{\beta l}{d} + \sinh^{-1}\frac{(1-\beta)l}{d}\right\}.$$

If V is the average potential of the wire CD, we have

$$\mathrm{V}=2\pi r\sigma\left[\int_0^1 \sinh^{-1}\frac{\beta l}{d}d\beta + \int_0^1 \sinh^{-1}\frac{(1-\beta)l}{d}d\beta\right]$$

$$=4\pi r\sigma\left[\sinh^{-1}\frac{l}{d} - \sqrt{1+\frac{d^2}{l^2}} + \frac{d}{l}\right]$$

$$=4\pi r\sigma\left(\sinh^{-1}\frac{l}{d} - 1\right) \text{ approximately, } \frac{d}{l} \text{ being small,}$$

$$=4\pi r\sigma\left\{\log\left(\frac{l}{d} + \sqrt{\frac{l^2}{d^2}+1}\right) - 1\right\}$$

$$=4\pi r\sigma\left(\log_e \frac{2l}{d} - 1\right) \text{ approximately}$$

$$=4\pi r\sigma\left(\log_e \frac{l}{d} - 0{\cdot}309\right)$$

If the antenna consists of n parallel wires, the average potential of the mth wire is given by the formula

$$\mathrm{V}_m = 4\pi\sigma r\Bigg[\log_e \frac{l}{r} - 0{\cdot}309 + \left(\log_e \frac{l}{d} + \log_e \frac{l}{2d} + \ldots + \log_e \frac{l}{(m-1)d} - 0{\cdot}309(m-1)\right) + \left(\log_e \frac{l}{d} + \log_e \frac{l}{2d} + \ldots + \log_e \frac{l}{(n-m)d} - 0{\cdot}309(n-m)\right)$$

$$Vm = 4\pi r\sigma\left[\log_e\frac{l}{r} + \log\left(\frac{l^{n-1}}{d^{n-1}}\cdot\frac{1}{\underline{|m-1}\,\underline{|n-m}}\right) - 0{\cdot}309n\right]$$

$$= 4\pi r\sigma\left[n\log\frac{l}{d} + \log\frac{d}{r} - \log \underline{|m-1}\,\underline{|n-m} - 0{\cdot}309n\right]$$

$$= 4\pi r\sigma\left[n\left(\log\frac{l}{d} - 0{\cdot}309\right) + \log_r - \log\underline{|n-m}\,\underline{|m-1}\right].$$

This formula for the average potential differs from that for the potential at the middle of the wire only by the term —0·309; hence to the degree of approximation here employed the difference between the average and the maximum potential is the same for each wire of the antenna.

The formula given above for the capacity of a multiple-wire flat antenna should therefore be modified as follows:

$$C = \frac{nl}{2\left\{n\left(\log_e\frac{l}{d} - 0{\cdot}309\right) + \log\frac{d}{r} - B\right\}} \text{ electrostatic units.}$$

This gives for the capacity per linear foot

$$C = \frac{n}{2\left\{n\left(\log_e\frac{l}{d} - 0{\cdot}31\right) + \log_e\frac{d}{r} - B\right\}} \times \frac{30{\cdot}5}{0{\cdot}9} \text{ micro-mfds.}$$

$$= \frac{16{\cdot}94n}{n\left(\log_e\frac{l}{d} - 0{\cdot}31\right) + \log_e\frac{d}{r} - B} \text{ micro-mfds. per foot.}$$

This formula has been obtained by an approximation which is inaccurate when the length of the antenna is not a large multiple of its width. For instance, if $\frac{l}{d} = 20$ and there are 12 wires, the ratio of length to width is only 20/11, and it is obviously very inaccurate to assume that 1 can be neglected when compared with $(20/11)^2$, or that $(11/20)^2$ can be neglected when compared with 1.

(*To be continued.*)

STOKE-ON-TRENT.—Mr. F. Pamment, Secretary to the Stoke-on-Trent Wireless Club, wishes it to be known that the Secretary's Office is now "Marlborough Office," Chancery Lane, Longton, Staffs.

ENGINEER'S NOTE BOOK.

Tension in Mast-Stays.

If T is the tension in a stay measured in lbs., and d is the line-density of the stay in lbs. per foot, then the velocity in feet per second at which a disturbance will travel along the stay is given by

$$v = \sqrt{\frac{Tg}{d}}.$$

Hence if the velocity v can be determined, it gives us the tension in the stay. By a sharp knock of a hammer on the stay we can create a disturbance that will travel to the top of the stay, and after reflection there will return to the bottom. If this takes a few seconds, it should be possible to determine the time fairly accurately, and so we can find the velocity, and hence roughly the tension in the stay.

$$T = \frac{d}{g}\left(\frac{2\,l}{t}\right)^2 = \frac{4d}{g}\frac{l^2}{t^2}$$

For a standard cable this gives the simpler form $T = kv^2$. Would some engineer, who has had the experience of erecting high masts please criticise and give actual methods of determining the tension, also the dimensions of cable and the tension usually employed? It will be noted that no allowance has been made for the modifications introduced by the attraction of gravity and the presence of insulators in the stays, as both will probably be small.

Australia.

According to the latest Australian newspapers the authorities are making arrangements for big improvements at the different lighthouses around the coasts of Australia, while new installations are to be provided where necessary. The question of communication with the shore is also under consideration, and, in this connection, it is understood that a low-power wireless system will probably come into operation. Enquiries have shown that the first cost of equipment and of maintenance is less than that of telephones and cables, so that in all likelihood the method will soon be adopted generally.

Digest of Wireless Literature

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

Determination of Wave-Length.—In the article entitled "Determination of Wave-Length in Radio-Telegraphy" reproduced from the *Electrical World* in the November number of THE WIRELESS WORLD, A. S. Blatterman investigates the transmission formula given by L. W. Austin with the view of determining the most suitable wave-length to be used for a given distance between stations. Louis Cohen, in a letter to the *Electrical World* on the subject, criticises the use of the graphical method described, as somewhat laborious and limited. The same results can be obtained in a simpler and at the same time more general form by an elementary mathematical consideration of the formula. The transmission formula given by Austin is as follows :—

$$I_r = 4{\cdot}25\, I_s \frac{h_1 h_2}{\lambda d} \epsilon . ad / \sqrt{\lambda} \qquad (1)$$

and the problem is to ascertain the value of λ to be used so that I_r shall have a maximum value. This can be readily determined by differentiating I_r with respect to λ and equating the result to zero, the usual method for maxima-minima determination. Thus :—

$$\frac{\delta I_r}{\delta \lambda} = \frac{4{\cdot}25 I_s h_1 h_2}{d\lambda^2} \left\{ \frac{ad}{2\sqrt{\lambda}} - 1 \right\} \epsilon . ad / \sqrt{\lambda} \qquad (2)$$

and the condition for I_r maximum is :—

or $$\lambda = \frac{a^2 d^2}{4} \qquad (3)$$

λ and d are expressed in kilometres, and $a - = 0{\cdot}00015$ is the absorption coefficient. When the relation between λ and d is satisfied by the equation (3), I_r will have its maximum value for any given values of I_s, h_1 and h_2. The above formula checks closely with the results obtained by Blatterman. In the table below the values of λ, corresponding to maximum value of currents, for different distances are given, as taken from Blatterman's curves in Fig. 6 and those calculated by formula (3). Considering that

VALUES OF λ

d		for Maximum.	Calculated by formula 3.
In miles.	In km.		
530	850	380 m.	406 m.
700	1,120	700	705
890	1,425	1,050	1,145
1,060	1,700	1,780	1,625
1,325	2.120	3,000	2,540

Blatterman plotted his curves on a comparatively small scale, and the maxima are not sharply defined; no great accuracy could be expected, which will account for the discrepancy of from 5 per cent. to 20 per cent. between the values obtained from the curves and those calculated by the formula.

Wireless in Australia.—In a paper read before the British Association, at Sydney, J. J. Balsillie explains that the system of radio-telegraphy employed by the various stations in the Commonwealth of Australia is a uni-directional impulse exciter system, in which the radiator is excited into oscillation by the use of three circuits permanently associated thereto, which three circuits and the radiator circuits, for the purpose of definition, are termed the primary, the charging, the exciting, and the radiator circuits. The primary circuit is connected to the charging circuit by means of a transformer, and arrangements are made so that the electrical period of oscillation of the charging circuit is in resonance with the forced period of oscillation of the primary circuit. The exciting circuit, which forms part of the charging circuit, is connected to the radiator circuit by means of a condenser, which is common to both circuits. The balance of the circuits is arranged so that there is no reaction between them. In operation, the primary circuit charges the condensers, and the gap is so adjusted that the charge has reached its maximum before the condenser discharges across it. The discharge is singular, and reverses the charge on the condensers. It is evident that the reversed charge cannot be of the same value as the original charge, because a certain part of the energy of the original charge has been absorbed by the radiator, and, on account of the charging circuit being in resonance with the primary circuit, the reversed charge in the condensers finds a path of less resistance through the secondary and the transformer than across the gap, as the potential of the reversed charge is not sufficient to break down the gap. The result is, therefore, that the energy not absorbed by the exciting circuit, by the radiator circuit, and reversed polarity off the single discharge of the exciting circuit, finds its way to the primary circuit *via* the transformer connecting the primary and charging circuits, wherein it is again utilised. In this system the tuning of the exciting to the radiator circuit is resorted to for the purpose of ensuring that the condenser discharge circuit was delivering a portion of its original flow of energy to the radiator at such a rate that the radiator may most efficiently absorb it, and after this has occurred there should be no further action and reaction between the radiator and the condenser discharge circuit.

The Insulating Properties of Solid Dielectrics. In the scientific papers of the Bureau of Standards, U.S.A., an account is given by Harvey L. Curtis of a research on the volume resistivity and the service resistivity of dielectrics. The volume resistivity of a material is the resistance in ohms between two opposite faces of a centimetre cube. The surface resistivity is defined as the resistance between two opposite edges of a centimetre square of the surface film which is deposited upon the material. In measuring the volume resistivity, mercury electrodes were employed in order to make good contact, and a guard-ring was used to prevent any errors on account of surface leakage. Some values of the volume resistivity are given below :—

VOLUME RESISTIVITY OF SOLID DIELECTRICS.

Material.	Resistivity. ohms. cm.
Special paraffin	over $5,000 \times 10^{15}$
Ceresin	over $5,000 \times 10^{15}$
Fused quartz	over $5,000 \times 10^{15}$
Hard rubber	$1,000 \times 10^{15}$
Clear mica	200×10^{15}
*Sulphur	100×10^{15}
*Amberite	50×10^{15}
*Rosin	50×10^{15}
*Mica (India ruby slightly stained)	50×10^{15}
Mica (brown African clear) ...	20×10^{15}
Bakelite L558	20×10^{15}
*Electrose No. 8	20×10^{15}
*Shellac	10×10^{15}
*Sealing wax	8×10^{15}
*Yellow electrose	5×10^{15}
*Yellow beeswax	2×10^{15}
Khotinsky cement	2×10^{15}
*Moulded mica	1×10^{15}
Unglazed porcelain	300×10^{12}
Black electrose	100×10^{12}
Mica (India ruby stained)	50×10^{12}
German glass	50×10^{12}
Paraffined mahogany	40×10^{12}
Stabilite	30×10^{12}
Plate glass...	20×10^{12}
Bakelite No. 150	4×10^{12}
Opal glass	1×10^{12}
Paraffined poplar	500×10^{9}
Paraffined maple	300×10^{9}
Bakelite No. 1	200×10^{9}
Bakelite No. 190	100×10^{9}
Italian marble	100×10^{9}
Vulcabeston	20×10^{9}
White celluloid	20×10^{9}
Hard fibre	20×10^{9}
Black galalith	20×10^{9}
White galalith	10×10^{9}
Red fibre	5×10^{9}
Marble, pink Tennessee	5×10^{9}
Marble, blue Vermont	1×10^{9}
Ivory	200×10^{6}
Slate	100×10^{6}
Bakelite No. 140	20×10^{6}

* Apparent resistivity taken after the voltage had been applied for 15 minutes.

Upon the surface of all insulators except the waxy materials a film of moisture collects from the surrounding air. The thickness and conductivity of this film depend upon the material of which the insulator is composed and upon the relative humidity of the surrounding air. For some materials the surface resistance at 1 per cent. humidity is 10^{11} times larger than 95 per cent. humidity, though for the majority of materials the surface resistance does not change by a factor of more than 10^{6} under these conditions. Since the change is not uniform, it has been found necessary to construct curves showing the change of surface resistivity with humidity.

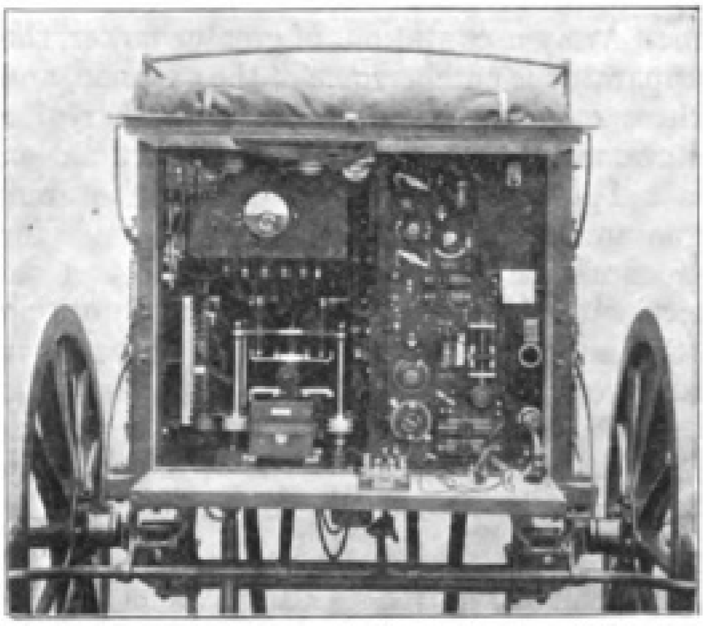
The Military Use of Wireless.

THE recent tests of Marconi Portable Stations in Argentina show that the Government of the Republic are intent on bringing up their military equipment to a high state of perfection. It is time that the inhabitants of this South American State realised that they were the possessors of a goodly heritage and that the Argentine with its rich cattle ranches, its fertile soil and mineral wealth is at least worth every effort to safeguard it. Such, too, is the opinion of the *Revista Telegrafica* of Buenos Aires, which uses the occasion to point out the important part that wireless telegraphy has doubtless played in the present European war. With what justice this remark is made it is at present inexpedient to discuss, though sufficient evidence is already available to show that it has had far-reaching effects on operations throughout the whole of the extensive battle line. Telegraphy by means of wires cannot be employed easily in fields which are constantly being crossed and recrossed by light and heavy cavalry and artillery. Add to this the serious inconvenience of the delay necessitated by laying wires, the ease with which such communications can be cut by the enemy, the constant movement of the armies and, furthermore, the long distance from the scene of action at which the commanders are obliged to be stationed in order to be out of range of the projectiles, and it will be seen that no other certain means of communication outside wireless telegraphy remains. The *Revista Telegrafica* uses similar contentions to support its appeal to the Argentine Government that the Republic should be adequately equipped with a wireless system and that the military authorities should pay greater attention to this important branch of field service. The journal then follows up its contention by giving a few details of the present condition of wireless in the Argentine Army and asserts that the quality and quantity of material available could not be more lamentably inadequate. According to present statistics, it possesses only a few out-of-date pieces of Morse apparatus, all based on the oldest model known, while the officers have no portable apparatus at all either for service use or for use as practice sets. This lack of material prevents the proper training of personnel and it is not too much to say that, except in one or two rare cases and those through no fault of the governing body, the Argentine Army is entirely without competent telegraphists.

Argentine telegraphists—that is to say, the men employed in this work for commercial and Governmental purposes—are known to be quick and intelligent; when required, they can transmit with great rapidity and can receive without much effort, but they are notoriously careless and idle, and so are content with a mere smattering of theoretical knowledge, so that in a time of emergency they cannot be relied upon. Now it is suggested that the Argentine Government should incorporate all young telegraphists of military age when they are called upon to do their term of service into a special Engineering Corps, where they would be given a course of engineering training and at the same time acquire proficiency in the use of wireless telegraphy for military purposes.

But it has not only been the war which has given rise to this wireless propaganda in the State. Just recently demonstrations have been carried out with four Marconi portable wireless sets under the supervision of the Chief of the Army Wireless Service, Major Meliton Diaz de Vivar, which produced extremely satisfactory results. Two of these stations were of the type known as Cart Sets and the other two were Pack Saddle Sets.

These latter were mounted on four carriers each and are of the usual 1½ kw. type. The weight of the entire apparatus is about 360 lbs. and the range obtained by them during the demonstrations was found to be about 260 kilometres, or about 140 miles. Such long-distance transmission creates something of a record in these stations, for the company who supply them only guaran-



The Receiving End of the Instrument Cart.

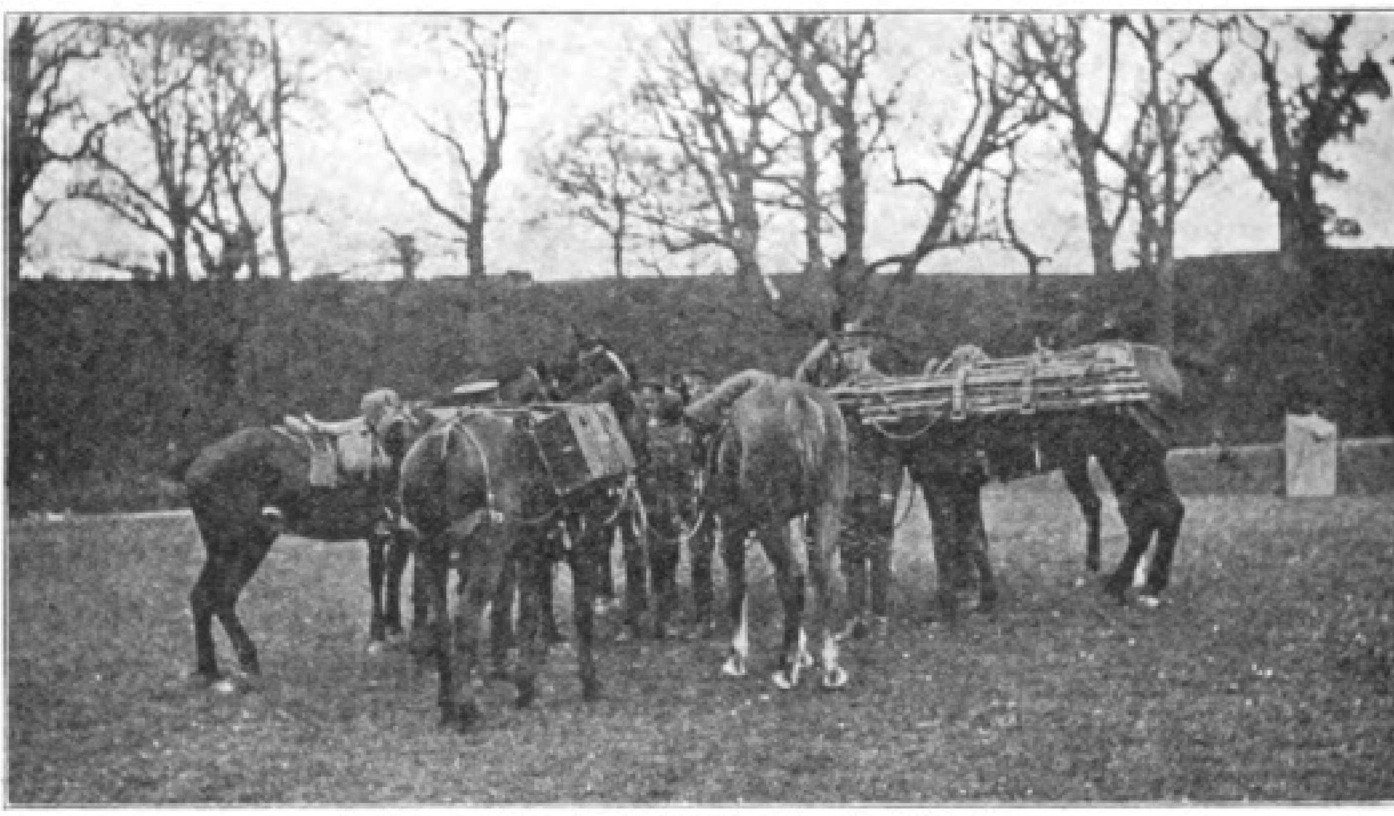
tee them to work over a distance of between 25 and 30 miles in ordinary country, although they have been known and often do cover distances of 100 miles without difficulty in England. No doubt the atmospheric conditions of the Argentine are favourable to the reception of signals over longer distances than they are in more northerly districts, where the barometric pressure is considerably greater. That this distance was not of a freak nature may be gathered from the report of the Marconi engineer, Mr. J. H. Welply, who was in charge of the demonstration. He mentions that in its initial stages shorter distances were tried, the first being the standard distance of 60 kilometres. One of the two cart stations was taken this distance from the stationary or "in" station and quickly set up, an operation which under normal conditions occupied only about ten minutes. Satisfactory messages were given and received, so that it was decided to move the "out" station to 120 kilometres, or about 70 miles, away, and on the following day the two stations again exchanged messages with equally good results. Once more the distance was increased, this time to 190 kilometres (about 120 miles), but still signals were so good that it was decided to push on to 260 kilometres, so that if signals were not strong enough to be exchanged the distance between the "in" and "out" stations could be reduced. But there was no need for that. At 260 kilometres signals, though not strong, were distinctly audible, but it was evident that the limit of capacity had been reached.

These stations, known as the "A" type, are very easy to erect and work. The mast, aerial and earth connection are of the simplest possible design in order to allow for easy erection in difficult country. The earth connection, by the way, is formed by a metallic net spread over the ground, which at the same time as providing contact at different points, avoids the danger to which operators on other systems are exposed. The generating set works in position on the pack saddle frame, the rigid saddle frame being removed from the horse and placed on the ground for working. The apparatus is not taken out of its case for working, the three cases being simply placed one on top of the other, the lowest resting on the ground. Only the top case is opened, and even this opening is made in such a way that the apparatus will be quite weather-proof while the operator will himself be under shelter. As far as possible everything on the station has been arranged so as to require no adjustment, but where adjustment is necessary it has been made as simple as possible. The framework of the station has been so designed that the weight of the load is carried on the horse's back only and gives no pressure on the sides, while its rigidity allows the load to be fixed entirely to the saddle without any over-all girth, which gives it the added advantage of being easy of removal from the horse's back. The load saddle can be deposited on the ground and used forthwith, but this is only done

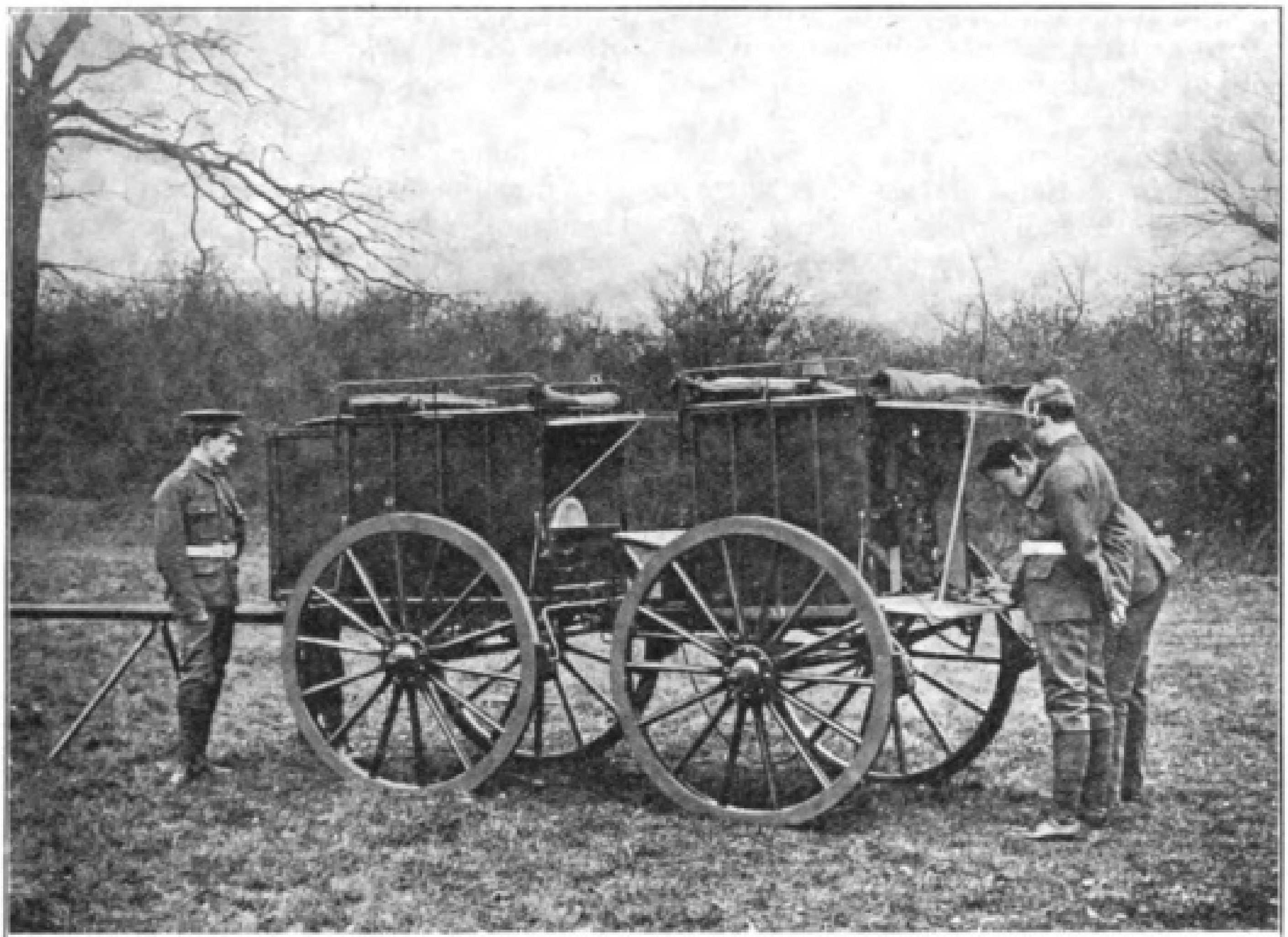
Cavalry Type Station, showing instruments.

in the case of the saddle carrying the engine and dynamo, for which the frame serves as a bedplate when it is put on the ground. In the case of the other loads the saddles are not removed from the animals because the loads are fastened to the saddles in such a way as to be instantly detachable. The saddle is capable of adjustment to any sized animal by reason of the telescopic crossbars at the top. If necessary the two halves can be drawn apart and packed flat for transport. The efficiency of the design of this station has already been demonstrated not only in this country, but all over the world. The Argentine demonstrations were no exception to the rule. It only required two soldiers to work each station throughout the whole of the tests and rarely outside assistance. At many times the horses were up to their withers in mud, but despite the severe conditions everything travelled in perfect order, even though one horse carrying the instrument load refused to consider himself honoured by the work he was called upon to perform and laid himself down in the mud.

Experiments of an equally satisfactory nature were then carried out with the two cart sets. The cart station is the largest portable station which is capable of rapid transport, and is the one most in use in English military circles. Although the German Army uses stations of greater power, the apparatus is cumbersome in the extreme, and these may be considered to be rather of a stationary nature. The Marconi cart station is a 1½-kw. station, and the manufacturers guarantee arange of from 150 to 200 miles for transmission purposes, although, as was the case with the pack set, the practical working often results in the transmission of messages to twice that distance. The cart station is designed for wheel transport only, and since for this kind of transport it is unnecessary to divide the loads into very small units, it has been possible in this type of station, besides using a more powerful transmitter, to include a number of more or less elaborate devices for increasing the value and convenience of the stations. These field stations work regularly over ordinary country and are capable of maintaining communication in war time between military posts which may require to change their positions frequently. They can also maintain communication, though at a reduced distance, between such military posts and cavalry stations. In all army work rapidity of movement is an essential, and this has not been lost sight of in designing the cart station. Simplification of detail has been reduced to a fine art; at the same time the need for the durability and strength of the apparatus has not been overlooked, so that it is possible to have the



A Marconi Pack Saddle (or Cavalry) Station.



The Marconi 1½ kw. Portable Military Wireless Station. Upper view shows the Engine and Instrument Cart. Lower, the masts and aerial being transported.

station in perfect working order, with mast set up and apparatus tuned between the points of transmission and reception, within twenty minutes. Again, lightness is an important consideration, and the fact that the Marconi stations of this type have a total weight, including carts and personnel, of something under sixty hundredweight is evidence of great constructive skill. The 1½-kw. station is normally divided into (*a*) not more than two horse units, and (*b*) not more than one self-propelled vehicle. In the first case the limber and wagon type of vehicle has been adopted as most suitable for military requirements. The first limber carries the generating plant, and the wagon carries the transmitting and receiving apparatus. The second limber carries supplies of spare parts, and the wagon carries the masts, earths, and aerials.

Such were the stations used in the demonstrations before Major Meliton Diaz de Vivar, who himself expressed the highest approval of the results obtained and reported his conclusions to the central Government by means of these very stations. There is a strong feeling in the country that the stations should be acquired by the Government, and the *Revista Telegrafica* considers that the cost of the stations will be small in comparison with the advantages to be gained by the purchase. For, as it points out, the Argentine Army cannot afford to be lacking in this rapid and sure means of communication in war, especially as the armies of all other South American nations are provided with abundant telegraphic material.

As regards the security of communication, it may interest our readers to know how the Marconi Company have in a large measure made provision in this direction. The first point to be considered in dealing with the question of secrecy is the desirability for giving a directional bias to the signals. Unfortunately no system of directional transmission and reception applicable to military work gives sufficient directional action to insure messages not being received by hostile stations which are in some other direction, but at considerably shorter distances than the friendly receiving station. Directional wireless telegraphy may be roughly compared to signalling by night with a lamp which is provided with a lens focussing the light strongly in the desired direction, while the direct light of the lamp is visible in other directions, but only at shorter distances.

But there is one means which has been found to give the best results in this direction—that is, rapid and frequent changes of wave-length; for if the receiving and transmitting stations are designed in such a way that these wave-lengths may be altered sympathetically, confusion is practically impossible and communication uninterrupted, for by one of the Company's patents the wave-length may be changed without interrupting communication.

Perhaps the following analogy will present the matter more clearly:

Take a note—for argument's sake, A. We will suppose both Marconi transmitting and receiving stations are tuned to this note. At a given interval both stations tune to F sharp. Now we will suppose the enemy has been able to get in touch with the stations on the A note; when the note is changed he is disconnected and must needs search about the whole gamut before he picks upon F sharp. By this time he has lost several words of the message he was overhearing, and possibly he has no sooner got fixed on F sharp before the other side have changed their note to B, so that the whole message to him is hopelessly confused and absolutely of no military value at all. (Readers will, of course, understand that by taking the example from musical notation we are not referring to the musical note employed in wireless telegraphy, which is determined by the high-frequency or low-frequency oscillations.)

As far as the equipment of Marconi portable stations goes, full provision is made for rapidity of change of wave-length without risk of confusion. The adequacy of such provision has already been demonstrated, not in army manœuvres or on parade ground, where everything should work without a hitch, but in actual warfare, notably in the case of the station which was used at Adrianople in the first Balkan War, when, in spite of the fact that three or four hostile operators were hard at work endeavouring first of all to overhear and then to interrupt communications, the city was able to keep in communication with Constantinople throughout the whole period of the siege.

Aerials and their Radiation Waveforms. VIII.

By H. M. DOWSETT.

THE LODGE AERIAL.—It is characteristic of the Marconi system that the transmitting aerial is earthed, and *well* earthed.

Fig. 1 represents the normal arrangement for good soil, where EE is a circle of earth-plates trenched vertically in the ground with their connecting wires, PE, radiating from the foot of the aerial.

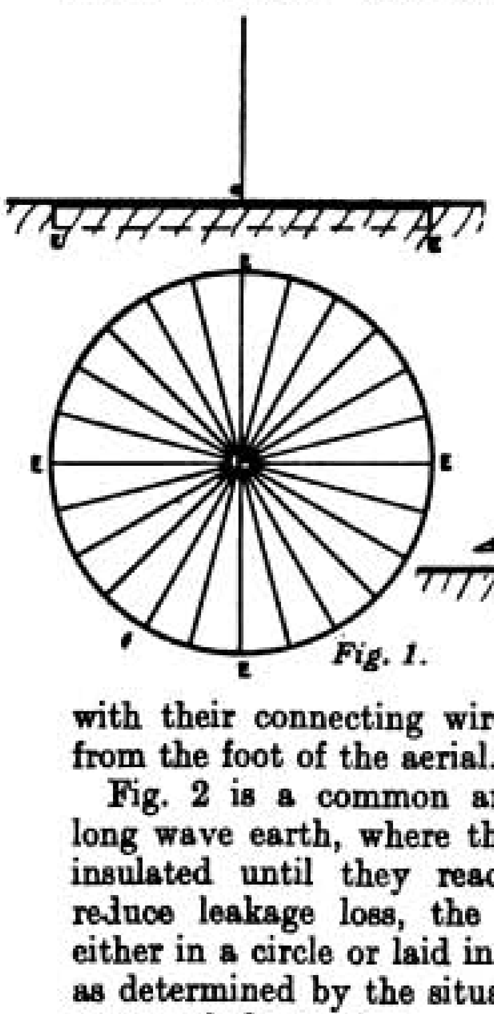


Fig. 1.

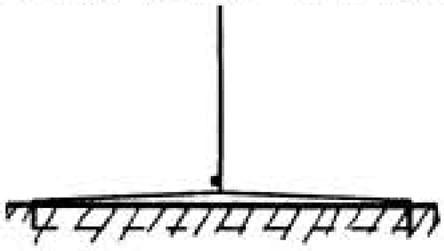


Fig. 2.

Fig. 3.

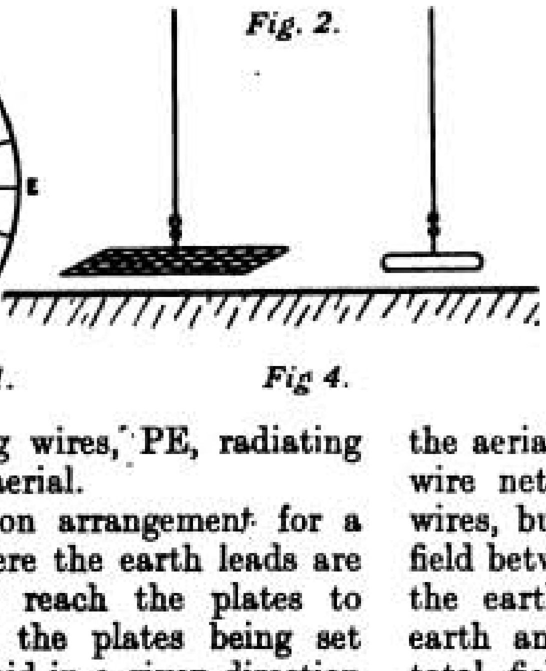


Fig 4.

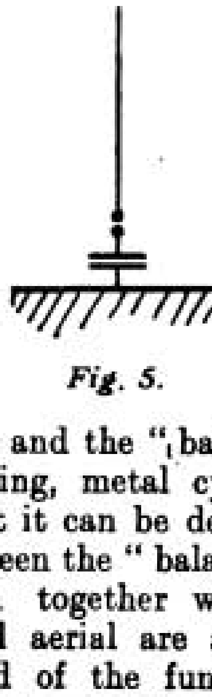


Fig. 5.

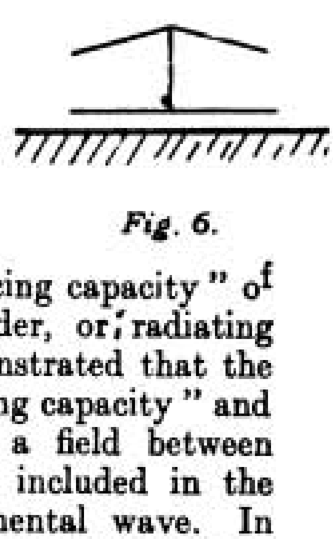


Fig. 6.

Fig. 2 is a common arrangement for a long wave earth, where the earth leads are insulated until they reach the plates to reduce leakage loss, the plates being set either in a circle or laid in a given direction as determined by the situation and requirements of the station.

Fig. 3 shows a third arrangement suitable for a bad conducting earth, the plates being laid flat on the ground, as much of the ground as possible in the neighbourhood of the aerial up to a quarter-wave distance being covered by them. This last type is similar to the earth used by Marconi portable stations, which consists of strips of small mesh wire netting laid along the ground.

The original transmitting arrangements of Professor Braun (Fig. 4), of Slaby Arco (Fig. 5) and the present arrangement of the Telefunken (Fig. 6) have been claimed to be different from the Marconi earthed system.

hey are so in degree only, for in every one of these arrangements the earth is included in the circuit of the first fundamental wave sent off by the aerial, as it is in the fundamental radiation from the Marconi aerial.

It was contended that in cases Fig. 4 and Fig. 6 the field of electric strain generating the fundamental wave resided between the aerial and the "balancing capacity" of wire netting, metal cylinder, or radiating wires, but it can be demonstrated that the field between the "balancing capacity" and the earth together with a field between earth and aerial are also included in the total field of the fundamental wave. In fact, Fig. 4 and Fig. 6 can equally well be represented by Fig. 5.

The three arrangements are such that the capacity to earth of the balancing capacity, or the capacity of the condenser in the earth wire, is large compared with the capacity of that part of the oscillating system which generates a quarter wave.

When this is the case the oscillation can pass through to earth with only a small change of phase on the way.

Fig. 7 (*a*) illustrates a practical case in which oscillations can be shown to pass through condensers in this manner. Fig. 7 (*b*) gives the sparks in millimetres measured across each condenser, compared with the spark measured across the jigger coil, which demonstrate that the distribution of the wave in the aerial must be somewhat as shown in Fig. 7 (*c*).

Then if we compare the radiation from a typical Marconi aerial, Fig. 1, as shown in Fig. 8, with the radiation from an aerial of type Fig. 5, the aerial, however, being inductively coupled to the transmitting circuit, the waveforms, as shown in Fig. 9, are seen to be very similar.

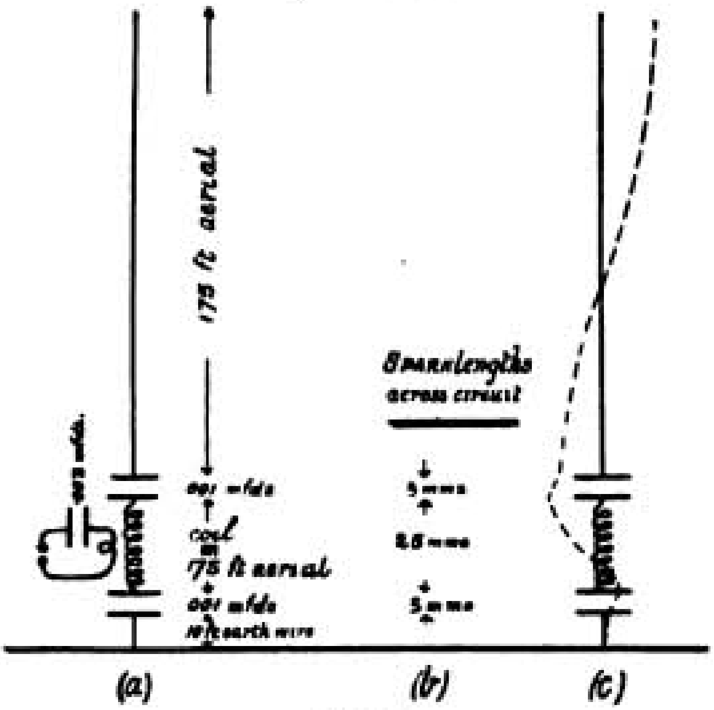


Fig. 7.

The main difference is that the potential node of the wave is shifted away from the earth somewhat up the aerial, and that the foot of the wave on the earth is drawn in towards the aerial, which causes a good deal of radiation earthwards, so that generally the circuit is a less efficient space radiator than the well-earthed standard Marconi aerial.

There is, however, an aerial circuit similar to Fig. 6 which has quite different characteristics—the Lodge aerial circuit.

Its properties are due to the careful adjustment of the aerial and the balancing capacity relative to the earth. Quoting from "Signalling Through Space with Wires," by Sir Oliver Lodge, page 134:

"The first point to be attended to in arranging for accurate tuning is to employ two capacity areas, both insulated from the earth, with the lower one such a distance above the earth as nearly to avoid earth disturbance—a best position being found, above which elevation would bring it too near the upper aerial, while depression would bring it too near the ground."

On page 136 he describes the increased damping which results if the lower capacity area is moved away from the best position either towards the earth or towards the upper capacity area. And on page 141 he states that this best position is the one which gives minimum capacity measured between the two capacity areas.

Let us examine the conditions prevailing. Suppose A and B, Fig. 10, to be capacity areas, supported above the earth, C. Then if the height "h" of A above C is fixed, but the height "l" of B above C is altered, the capacity measured between A and B will go through a cycle such as is shown in columns (1) and (2) of the table and in the full line curve, Fig. 11. These values were obtained with plates A and B, each 12 in. square, and an unearthed plate, C, to represent an indifferent earth, 36 in. square; "h" being 6 in.

Height, B, above C = "l."	Effective Capacity, AB. Measured.	Calculated from $K = m\left(\frac{1}{h-l} + \frac{1}{l}\right)$
in.	mfds.	mfds.
5·75	20·9 × 10-5)	20·9 × 10-5)
5·5	8·74 ,,	10·92 ,,
5	4·28 ,,	6·01 ,,
4·5	3·06 ,,	4·46 ,,
4	2·53 ,,	3·76 ,,
3	2·1 ,,	3·33 ,,
2	2·27 ,,	3·76 ,,
1	3·41 ,,	6·01 ,,
$\frac{1}{2}$	4·81 ,,	10·92 ,,
$\frac{1}{4}$	7·43 ,,	20·9 ,,
—	16·0 ,,	—

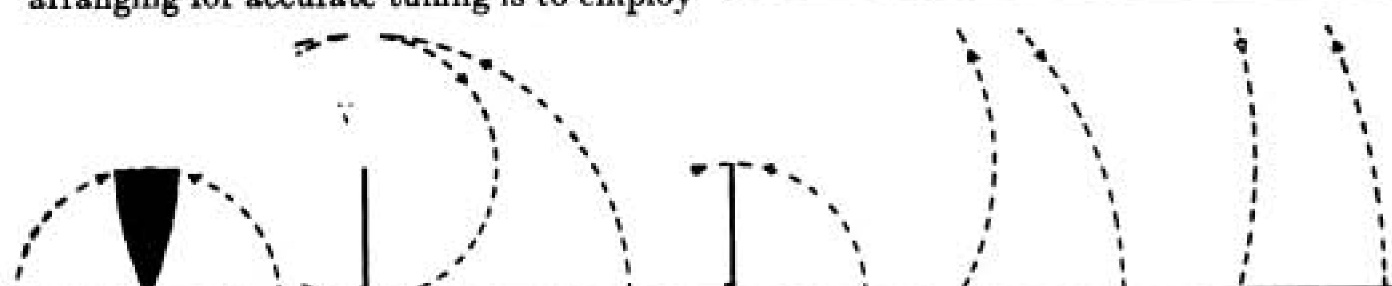


Fig. 8.

The full-line curve shows that the minimum capacity in this case occurs when B is half-way between A and C.

A simple explanation of the general results obtained is suggested as follows:

When the condenser, AB, is charged, the gain or "+" charge on the plate, B, is equal to the loss or "—" charge on the plate, A. The capacity of the condenser, AB, in fact determines the total charge moved. It does not, however, entirely

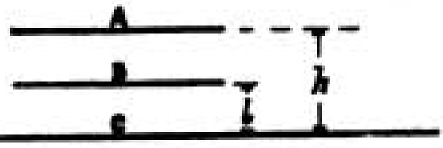


Fig. 10.

determine its distribution. The charge on the plate, B, influences the plate, C, by induction, so that immediately under B there is a charge of opposite sign, a charge of the same sign being driven away to the limit of C, or to earth if C is earthed. Thus the charge on B tends to divide itself between A and C, and it does so in the

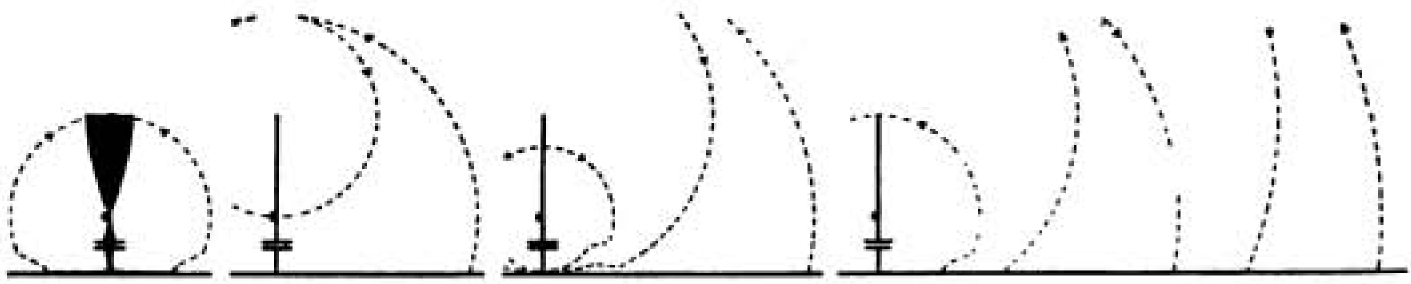


Fig. 9.

inverse proportion of the distances BA and BC, and thus the *effective* capacity, BA, will be that of the two condensers, BA, BC, in parallel, with the charge due to condenser, BA, distributed between them.

The charge on AB $\propto \frac{1}{h-l}$

The charge on B $\propto \frac{1}{l}$

Then the *effective* capacity of AB

$$\propto \frac{1}{h-l} + \frac{1}{l}$$

or $k = m\left(\frac{1}{h-l} + \frac{1}{l}\right)$

where "m" is some constant. This expression does not include a correcting factor for the leakage field, which becomes considerable when "l" is small compared with "h." It is, however, sufficiently accurate for the present purpose.

It is clear that the *effective* capacity is not the *real* capacity of AB, and as AB is the oscillating condenser *which determines the wave-length because it supplies the moving charge*, it is necessary that a distinction should be drawn between the two.

Taking the measured value of "k" from column (2) in the table when l=5·75 in. and using the above formula we get a value of "m" of $5{\cdot}01\times10^{-5}$. Using this value of "m" and substituting different values of "l" in the formula we get column (3) in the table which is plotted in the dotted curve, Fig. 11.

If the correction for leakage were introduced the two curves would coincide.

However, the dotted curve shows us:

(1) That the minimum effective capacity is obtained when B is half-way between A and C; that is, when the charge on B divides equally between the two condensers, BA and BC; or, in other words, when the capacity between the top and bottom capacity areas equals the capacity between the bottom area and earth.

It also shows us:

(2) That the position of B for minimum effective capacity is the only position at which the *effective* and the *real* capacity, AB, have the same value.

And from (1) we arrive at:

(3) That this same position of B is the only one *at which an oscillation started in AB will tend to induce the same period oscillation in BC.*

Now we have the reason for the sharpness of tuning, smaller decrement, and more efficient radiation when an aerial system is arranged in this manner, as noted by Sir Oliver Lodge, than when the lower capacity area is arranged in any other position.

But Lodge's statement that at the best position for the lower capacity area it is at "such a distance from the earth as nearly to avoid earth disturbance" obviously requires modification. There is considerable reaction between the lower area and earth, but it is a reaction which tends to assist by resonance the oscillation between the two capacity areas. In any other position of the lower capacity area the earth reaction tends to have a damping effect because it is not in resonance, and the unequal division of energy in the double-condenser system lowers the combined radiation efficiency.

We have now determined those characteristics which it is necessary to know before drawing out the radiation of a Lodge aerial—namely:

(*a*) That the capacity between the areas should equal the capacity between the lower area and earth.

(*b*) That the two capacity circuits are in resonance and are simultaneously excited, the one by direct charge, the other by induction.

(*c*) That as a result there is no surging of the aerial oscillation through the lower area and earth condenser, and

(*d*) As can be shown by diagram, the induced oscillation, as long as the ground surface allows it to exist, actually prevents the aerial oscillation from reaching and spreading into the earth so that the energy of the aerial oscillation tends to be conserved by it.

Fig. 12 (*a*) shows the effective field of electric strain with a half-wave in the aerial at the moment it commences to break away; the leakage field is not shown. The capacity of the aerial is supposed to be negligible in order to simplify the diagrams. The breaking away has begun in 12 (*b*), and is continued in 12 (*c*), where it is seen that the absence of a connecting wire from the lower capacity area to earth does not prevent the induced earth oscillation from com-

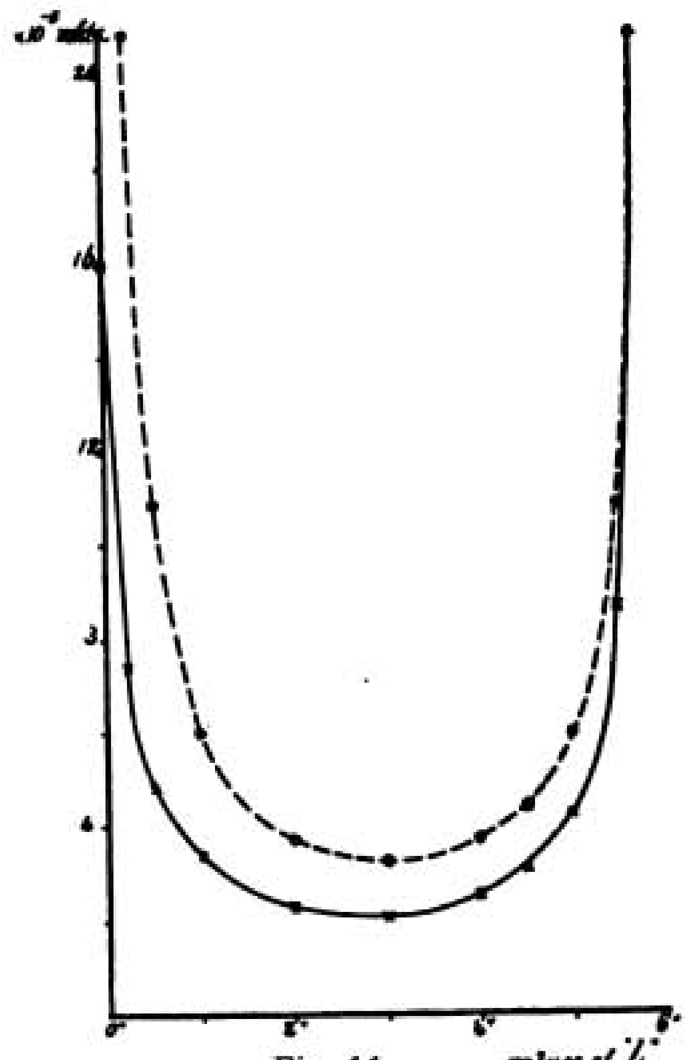


Fig. 11.

pleting its circuit on the earth. It does this in due course as a result of the normal expansion of the waveback. Fig. 12 (*d*) shows two waves getting away.

The general resemblance to tune "A" radiation* is marked; but whereas the Lodge aerial obtains its earth-bound wave, and free wave, by means of an insulated capacity system conveying energy downwards by induction to an earth capacity system—Tune "A" gets a similar result by means of an earthed inductance transferring its energy by conduction upwards to a resonant aerial. This results in the radiation in the two cases having certain points of difference.

*THE WIRELESS WORLD, October 1914, page 419.

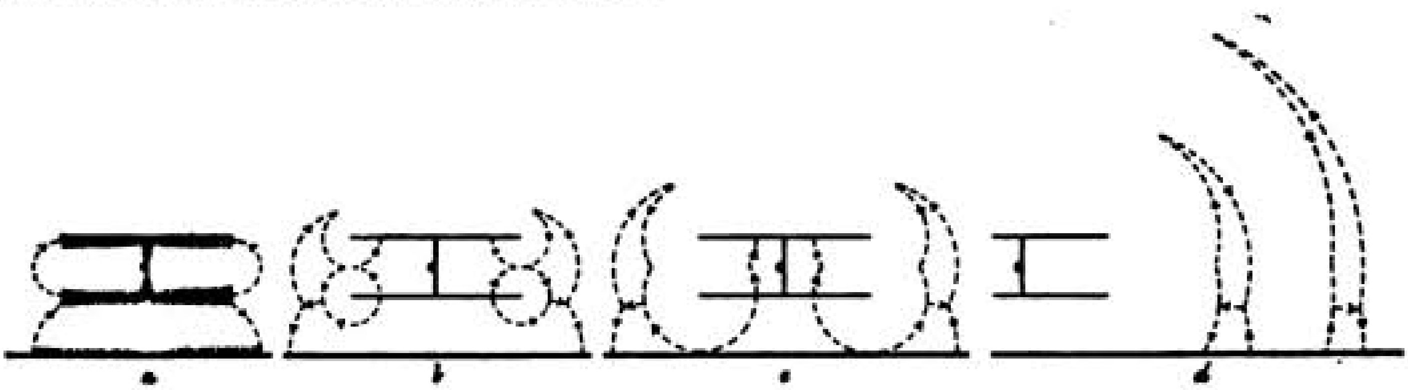


Fig. 12.

CORRESPONDENCE.

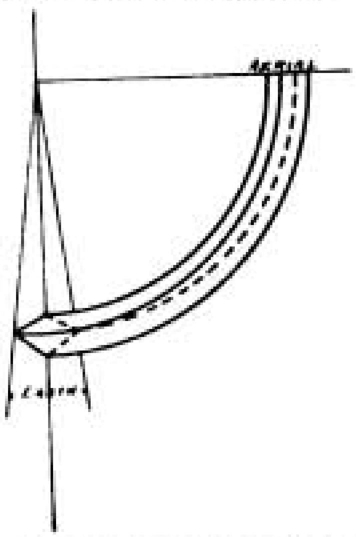
Aerials and their Radiation Wave-Forms.

To the Editor of THE WIRELESS WORLD.

SIR,—May I reply to the points raised in Mr. Green's letter? Mr. Green's point of view is the standard method which introduces "tubes of force" instead of "lines of strain" to explain every electrostatic problem.

Neither lines nor tubes have any real existence; both are arbitrary inventions—and very useful inventions—introduced to obtain a clear mathematical idea of force in a fluid medium.

Now the only form of "tube of force" which will suit the case of a static charged vertical aerial is one having a rhomboidal section on the earth, which alters its shape as it approaches the aerial, and finally on the aerial itself has length and no breadth (see accompanying diagram). Also the shape of the tube section on the earth alters with its distance from the foot of the aerial.*



It therefore follows that in this type of field "tubes of force" are more difficult to manipulate than are "lines of strain." In fact, it is only when Mr. Green takes a section through his tubes and represents each tube in the section by a line—that is by a "line of strain"—that he can get on with his argument.

Mr. Green is unable to see the use of my diagram. I contend that it clearly shows the difference of electrical intensity on earth and aerial and it shows how that intensity alters with increase of distance from the centre of disturbance.

Mr. Green states that diagrams in text-books are similar to his Fig. 2 (*a*), and that they all represent wedge-shaped sections and not plane sections through the field. I think that he will find, on the contrary, one is led to infer that the diagrams represent plane sections.

However, a wedge-shaped section through the field of a static charged aerial would be different from Mr. Green's diagram. The lines would be equally, and not unequally, spaced along the aerial, also—owing to the fact that on the aerial they start practically from a line, whereas on the earth they end on an area—some of the lines would get behind each other as they reached the earth, so that on the diagram they would appear to run into each other; again, the spacing along the earth line would not be equal, but inversely proportional to the distance from the foot of the aerial. (See Figs. 7 and 9† in my article).

Further, Mr. Green declares that there can be no strain in the ether due to a charge on the aerial which does not have its strain lines actually attached to the aerial. If so, what is meant by the strain line in his diagram 2 (*a*) which is shown above, and detached from, the aerial?

I cannot agree that in the plane section diagram the number of lines shown reaching the earth should be proportional inversely to the distance from the foot of the aerial. This would correctly give the intensity on the earth section considered as a line, but it has to be considered not as a line but as a section through an area, and therefore the density should be proportional inversely to the square root of the distance.

Finally, as regards my explanation of the action at a distance of a static charged aerial, I agree that the expression I gave for the intensity above the aerial requires to be considerably modified. In fact, the *total* shear strain on the ether beyond the aerial-earth field would probably be more nearly represented by the product of the potential at the top of the aerial ×, the surface of the ether shell of radius equal to the length of the aerial.

But this is a modification in degree only, for I cannot agree with Mr. Green that the known property of the strain lines to expand is sufficient to account for all static action at great distance. We are not at all justified in assuming that they can have unlimited expansion.

The first and most important characteristic of the lines is that they appear to be in tension, which gives them a tendency *to contract*. The second characteristic they have is that a pressure appears to be exerted across them, giving them a tendency to

* *The Wireless World*, October, page 364, Fig. 7.

† *The Wireless World*, October, pages 364–5.

expand. These two forces reach a natural equilibrium. If the lines of force from an aerial have an uneven expansion, and therefore are not parallel curves, this must be due to capacity. Indeed, in a homogeneous medium one can suggest no other cause for it, and in the hypothetical case I have considered of an aerial of no capacity —a mere line in the ether—there should be no greater tendency for the strain lines to expand along the earth than up the aerial; their paths therefore should be practically quadrant curves struck from the foot of the aerial.

If this is admitted, then an aerial having capacity will show a certain amount of uneven expansion in the strain lines of its field, somewhat as shown in Mr. Green's Fig. 4, which, however, will be quite insufficient to account for static action at a great distance. Some other explanation must then be sought, which I suggest is to be found in ether shear.—Yours, etc.,

H. M. DOWSETT.

Chelmsford.

Dr. Erskine-Murray's View

To the Editor of THE WIRELESS WORLD.

SIR,—Mr. Dowsett's criticism of my diagram Fig. 14, page 367 of your September issue, is somewhat surprising in view of the fact that he thereby contradicts the fundamental fact that if a conductor be charged with one sign the charge of the opposite sign is distributed over all other conductors in the field. I remember Lord Kelvin in the course of a lecture placing a piece of chalk on the table and saying, " When I put that piece of chalk there it strains the whole earth " ; but Mr. Dowsett denies this power to an electrically charged body, and imagines that the opposite electric charge restricts itself to a circular area having a radius equal only to the height of the aerial! He states that this must be so because the capacity of an aerial measured statistically is not appreciably different from that obtained by high-frequency current. Even if this experimental observation were strictly true, he has not taken into consideration two essential factors—viz., the different distributions of the lines in the static and kinetic cases and the difference in the areas of ground round the aerial on which these lines end. It is also known that true radiation does not begin until outside a sphere having a radius of about three-quarters of a wave-length, and that therefore all the ground inside this is in the aerial-earth circuit. Hence, even in the kinetic case, an area considerably more than nine times as great as that of his Fig. 7 should be shown as connected by lines to the aerial conductor.

My diagram is roughly drawn on a small scale, and does not show the perpendicularity of the lines to the surfaces of the conductors at the points where they meet, but it does show the reason for the fact it was intended to illustrate—namely, that it is possible, as I have found by experience, to obtain a signal from a plain aerial transmitter, although there is no spark at the gap. My diagram is in agreement with Mr. Green's Fig. 4, p. 424, and with the fact, admitted by Sir Oliver Lodge in a public discussion in which I stated it, that a plain aerial wave train does commence with a wave of much greater length than those which follow. The length of this initial wave depends, of course, on the time which elapses between the commencement of charging of the aerial and the occurrence of the spark.

In other respects the most striking thing about Mr. Dowsett's article is the remarkable diagram, Fig. 15, p. 367, in which we have lines of force above the aerial commencing and ending on electric charges of the *same sign*; lines of force *tangential* to the conducting surface of the top of the aerial; and a statement that the electric stress is at a *maximum* at some distance above the aerial; just, in fact, where electromagnetic theory and practice both indicate that it is less than it is at the same distance from the aerial in any other direction.

Mr. Dowsett's Figs. 2, 3, and 4 must also be taken with a considerable grain of salt. In Figs. 2 and 3 none of the lines shown should be anything like straight, except the central one, and in Fig. 4 none of the curves should even approximate to circles except those between two small areas near the centre of the line of intersection of the plates.—Yours, etc.,

J. ERSKINE-MURRAY.

ADMINISTRATIVE NOTE.

We have received a copy of the amendments to the Provisional Regulations made by the Commonwealth Government to the Wireless Telegraphy Act of 1905.

Australia.

These Regulations were issued on August 3rd, 1914, and came into operation forthwith. Regulation 5 (*see* YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1914, page 107), which formerly contained five clauses, remains substantially as before, but the fifth clause, which permitted two land stations to be included in one Experimental Licence, has now been altered, and reads as follows :—

"Only one land station may be included in any one Experimental Licence, and no person shall be granted more than one Experimental Licence."

A further clause has been added to Regulation 5, and this reads as follows :—

"Clause 6. A person who is the registered holder of an Experimental Licence may, with the permission of the Postmaster-General, and on payment of the fee prescribed by paragraph (D) of Regulation 7 (1), transfer the station in respect of which the licence has been granted from one address to another without the issue of a fresh licence."

The fee prescribed in Regulation 7 remains as before—namely, 5s. for each ship included in a general or supplementary licence, or for any renewal thereof. For an Experimental Licence for land stations 21s. for each year, or part of a year, for which the licence is in force is now charged, and for the transfer of a station in respect of which an Experimental Licence has been granted from one address to another the charge is 5s.

Regulation 11 (*see* YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1914, page 108), which relates to the renewal of a licence, is repealed, and the provisions of the new regulation are the same as those of the old except in respect of Clause 4, which now reads as follows :—

"The memorandum is to be written on both parts of the Licence, but in the case of the Licensee's part it shall be in the form of a receipt for the renewal fee signed by the Postmaster-General or by some officer authorised by him, which receipt is to be attached by the Licensee to his part."

The following Regulations have been added :—

24. The rates for messages transmitted to or received from ship stations shall be as follows :—

(1) For ordinary messages : (*a*) Coast station transmitting or receiving charge, 6d. per word ; (*b*) ship station transmitting or receiving charge, not exceeding 4d. per word ; (*c*) land line charge, 1d. per word.

(2) For Press messages : (*a*) Coast station transmitting or receiving charge, 1½d. per word ; (*b*) ship station transmitting or receiving charge, not exceeding 4d. per word, as determined by the ship authorities concerned ; (*c*) the land charges for Press telegrams within the Commonwealth :

—	Within the State in which the wireless station is situated.	Other States.
	s. d.	s. d.
Not exceeding 25 words.. ..	0 6	1 0
Exceeding 25 words, but not exceeding 50 words	0 9	1 6
Exceeding 50 words, but not exceeding 100 words	1 6	3 0
Every additional 50 words, or portion of 50 words	0 6	1 0

(3) For official messages to or from ships of the British or Australian Navies : (*a*) Coast station transmitting or receiving charge, 1d. per word ; (*b*) there shall be no ship station charge ; (*c*) land line charge, 1d. per word.

(4) For messages consisting of reports to Lloyd's agents concerning casualties and overdue vessels : (*a*) Coast station charge, 6d. per word ; (*b*) land line charge, 1d. per word.

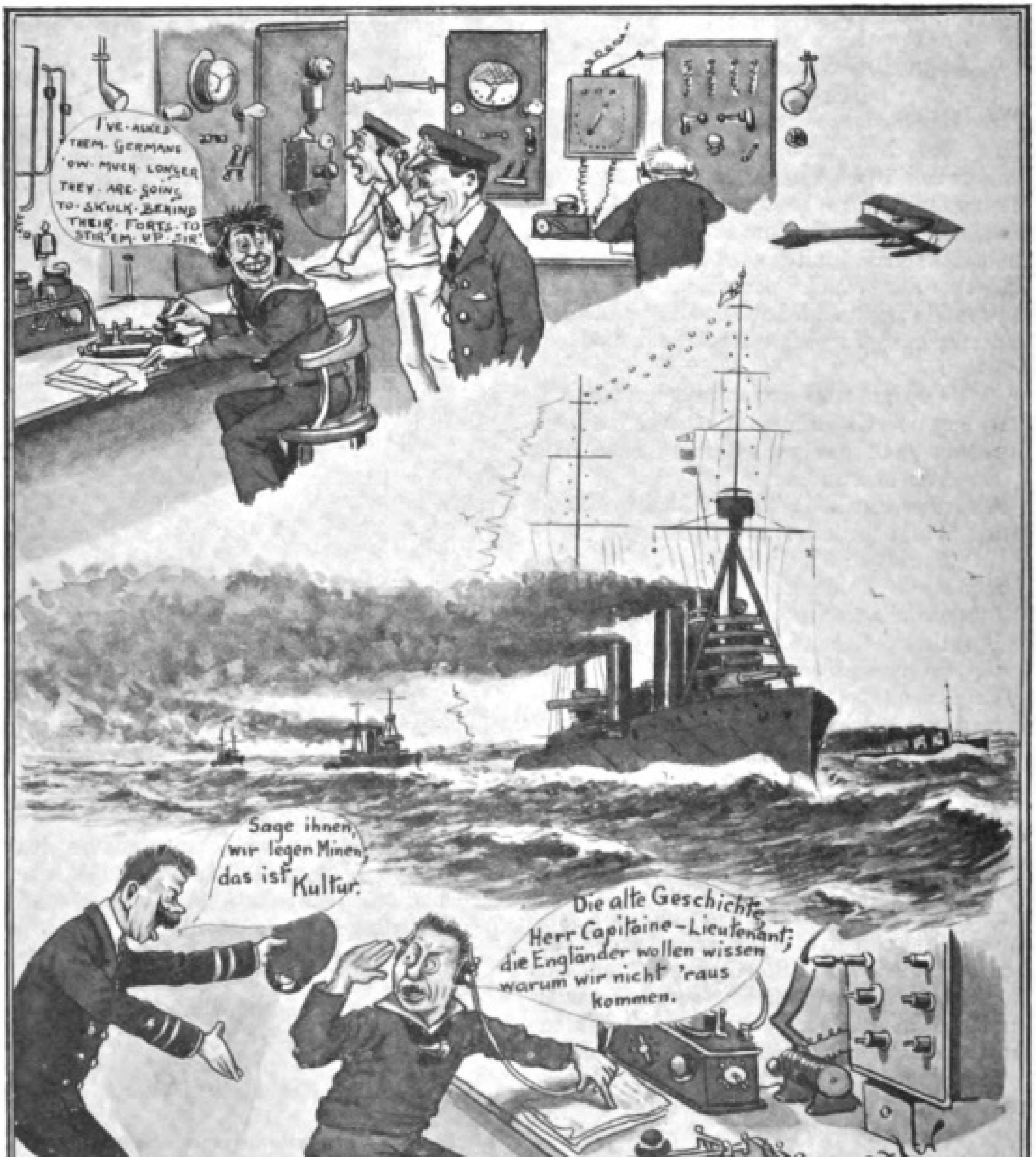
The following Regulation is inserted after Regulation 24 :—

24A (1) Radiotelegrams conveying Christmas or New Year greetings may be lodged at any telegraph office in the Commonwealth for transmission to New Zealand or to vessels registered in Australia or New Zealand. In addition to the address and signature, such radiotelegrams may contain a text consisting of any one of the following phrases : (*a*) "Christmas greetings" ; (*b*) "New Year greetings" ; (*c*) "Compliments of the season."

(2) The total charge for such radiotelegrams shall be : (*a*) For those addressed to New Zealand, 4s. ; (*b*) for those addressed to vessels registered in Australia or New Zealand, 3s.

(3) Radiotelegrams containing the text "Christmas greetings" must be lodged on or before December 23rd, and those containing the text "New Year greetings" or "Compliments of the season" must be lodged on or before December 28th.

CARTOON OF THE MONTH



WIRELESS PERSUASIONS.

Operator on British Battleship : I've asked them Germans 'ow much longer they are going to skulk behind their forts, to stir 'em up, sir.
German Operator (receiving message) : The same old message, sir! The English want to know why you don't come out and fight.
Officer : Tell them, we lay mines. That's Kultur.

Wireless Telegraphy in the War.

A résumé of work accomplished during the past month.

German influence in South America.

THE principal event of the past month in which wireless telegraphy has figured is the much-discussed naval engagement in the Pacific, concerning which there is still a good deal of mystery. The Admiralty have issued the report of Captain John Luce, of His Majesty's ship *Glasgow*, which seems to set beyond doubt the fate of Rear-Admiral Sir Christopher Cradock and the two ships of his squadron. During the action there was an immense explosion on board the *Good Hope*, the flagship, "the flames reaching 200 feet high"; when the *Monmouth* was last seen she was badly down by the bow, and an hour and a half later the flashes of the enemy's guns were seen in the darkness, seventy-five flashes, signifying, "no doubt, the final attack on the *Monmouth*."

The Pacific Engagement.

Captain Luce's narrative is terse, clear and straightforward. On November 1st the *Glasgow*, which was detached from the *Good Hope*, the *Monmouth*, and the *Otranto* (armed merchant cruiser), left Coronel to rejoin the squadron at a rendezvous. She sailed at 9 o'clock a.m., apparently proceeding at economical speed, ten or twelve knots, for five hours. At 2 o'clock p.m. Captain Luce received a wireless signal from the Rear-Admiral to the effect that, judging from intercepted wireless calls, there was an enemy to the northward, and that the squadron were to spread north-east by east at 15 knots in order to find the enemy. The *Glasgow* proceeded at 15 knots for two hours and twenty minutes, when she detected smoke on the horizon, and soon afterwards she perceived the enemy. These were the German cruisers *Scharnhorst* and *Gneisenau* and a light cruiser, either the *Dresden* or the *Leipzig*. These were reported by the *Glasgow* by wireless to the Admiral, whose flagship was not yet in sight. The information was communicated to all the ships of the squadron, which were then ordered to close upon the flagship. Half an hour later, at 5 o'clock, the *Good Hope* was sighted by the *Glasgow*, and the squadron was formed in line ahead (single file), the flagship, Captain Francklin, leading. Then came *Monmouth*, Captain Brandt, *Glasgow*, Captain Luce, and *Otranto*, Captain Edwards. A full gale was blowing, and there was a heavy sea. By this time the German squadron had turned south, and was formed in line ahead, the *Scharnhorst* and *Gneisenau* leading, followed by the light cruiser. It was now nearly 6 o'clock, and the dusk was gathering. A little after 6 o'clock Admiral Cradock increased the speed of his squadron to 17 knots, probably the utmost which the *Monmouth* could accomplish against the sea. At the same time the Admiral signalled by wireless to the *Canopus*, battleship: "I am going to attack enemy now."

The German squadron was now seven or eight miles distant from the British squadron and steaming upon a line converging slightly towards the British ships, the Germans attempting to jam British wireless signals, probably to prevent the *Canopus* learning the exact situation, if she was within range of the *Glasgow's* wireless station. At the going down of the sun the dying light shone upon the German ships, steaming upon a background of dark water. But the old guns of the British ships could not touch them at the range. By 7 o'clock the sun had dropped below the sea-line, and the German vessels faded into the dusk, while the British ships were graven dark upon the glow. Then the enemy opened fire at between six and seven miles, a range at which their modern 8·2 in. guns were effective, whereas the only British guns in the squadron effective at that range were the two 9·2 in. guns of the *Good Hope*. Each of the two German armoured cruisers was firing six guns on a broadside, twelve in all. There were three ships against three ships, but there were twelve German guns against two British guns. The two German armoured cruisers fired their whole broadsides together, and at the third salvo the *Good Hope* and the *Monmouth* were on fire forward. For three-quarters of an hour did the British seamen serve their guns, their ships on fire, and then the *Good Hope* blew up, a column of flame shooting above her mastheads in the darkness. She was no more seen.

The *Glasgow* could not make out the *Monmouth* in the dark, but she saw the flashes of the *Monmouth's* guns, and presently the *Glasgow* received a signal that the *Monmouth* was down by the bows and had turned away to get her stern to the seas. It was then 8 o'clock, and the action had lasted for an hour. Half an hour later the *Glasgow* signalled to the *Monmouth* that the enemy were in pursuit. There was no answer. The *Glasgow*, perceiving by the light of the moon that the German ships were chasing her, and knowing that she could not help the *Monmouth*, made off at full speed. What became of the *Otranto* does not appear. In twenty minutes the enemy were out of sight of the *Glasgow*. Half an hour later the *Glasgow* saw the far flashes of guns, and counted them. There were 75 flashes, lighting the *Monmouth* to her death. So ended one of the most gallant fights against disastrous odds recorded in all the crowded and heroic chronicles of the Royal Navy.

German Influence in South America.

There have been many suggestions as to the means by which the German ships obtained information in the naval battle off the coast of Chile, one of them being the use of wireless stations. The Chilian Government have vigorously and effectively repudiated the charges made in irresponsible quarters that they allowed their wireless stations to be used for the purpose of communicating with belligerent battleships, and we were glad to find the complete vindication of the Chilian Government in a statement issued by the Foreign Office which disposed of the few suggested rumours of acts violating neutrality. As the wireless situation in South America is so little understood in this country, we publish below a communication from a correspondent who explains the situation as it appears to him in the light of the recent naval engagement.

The following notes have been contributed by an engineer who, until recently, was resident in South America.

"A good many people have perhaps wondered how it was that our Pacific squadron engaged the German squadron, off the coast of Chile, with vastly inferior ships, both as regards their number and armament, instead of waiting for the battleship *Canopus* to join them. One hypothesis that has only vaguely been touched on is, in my opinion, a most important one—namely, the information obtainable by the Germans through the wireless coast stations as to the whereabouts and number of our ships, both warships and merchantmen. It is apparent that the Germans have, for some time past, arranged their Imperial wireless chain of stations in a very clever manner and without hardly any cost to themselves, at any rate in South America, and probably in the East Indies also. This was done by a combination of absurdly cheap contracts and unnecessary mechanical or electrical complications in their wireless plants.

"In South America, up to 1912, the vast majority of the coast stations were constructed by Germans, because cheapness is a deciding factor in South America, and the German prices for wireless stations were considerably lower than those of their competitors. I imagine, however, that the loss to the contractors which, no doubt, occurred was made good by the German Government, as it was the object of that Government to have German stations all over South America.

"Now comes the next step—namely, the introduction of the German wireless expert, who had to be brought in because of the installation of complicated receiving gear in the stations. The German receivers are by no means foolproof and require careful adjustments. The stations were erected by German agencies and, as is usual in South America, were worked by the contractors for three months and then handed over to the Government, who paid the contractor and placed the station in charge of native operators.

"In a few weeks' time something goes

wrong and a breakdown occurs. The receiving apparatus or the generator no longer works and the station is out of action. Naturally, the Government goes to the German contractor who supplied the station and asks for the return of the expert. The latter returns, puts things right and is asked to stay on, at a good salary; eventually he becomes naturalised, enters the Government service and takes charge of the station. By these means a very large number of the South American coast stations are in charge of naturalised Germans, thus ensuring the working of the Imperial German chain erected at the expense of the various Republics. In some cases the chief technical officials of the various Government telegraph administrations are Germans also.

"An expert operator is able to distinguish quite easily, when listening in for signals, between the various makes of ship stations, as the sounds produced in the telephones are quite different. Some installations give a grunting noise, others a musical sound, and so on. A ship sending a wireless message to another ship, if within range of a coast station, is immediately heard, and, even if the message is in code, the station operator can tell at once what make of installation is being used. Practically all English merchant ships are fitted with the Marconi stations, British warships are fitted with a modified type of Marconi apparatus, and German ships with Telefunken apparatus. The operator at the coast station can tell at once not only the probable nationality of the ship talking, but also, by the strength or weakness of the signals, the approximate distance and whether it is approaching or going away from the coast station. This is quite sufficient to tell the German cruisers, either by wireless or cable, and to enable them to take appropriate action, be it in order to intercept a merchant ship or to engage an enemy cruiser.

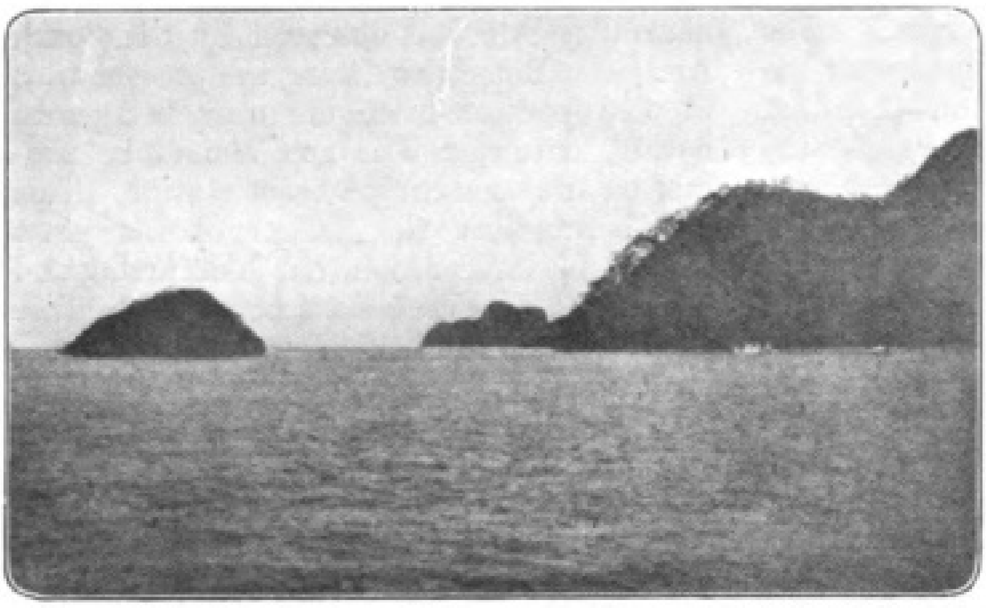
"As long as there are any German or other enemy cruisers still at large, no British merchant ship when within possible range of a South American coast station should use the wireless station and all British warships should adopt the use of a 'Bridge' transmitter, that has a range of about 20 miles, so that when signalling between the members of a squadron the coast stations would be unable to overhear them. If strict neutrality is to be observed by the South American Republics during the present war, then all operators belonging to any belligerent nation, naturalised or not, should be prohibited from entering a coast station. This would minimise the danger of the great leakage of information that is occurring and prevent the coast stations being used either for or against the belligerent nations."

Trapping the "Emden."

The end of the German cruiser *Emden* has come at last, and the depredations which for three months she had committed upon British shipping will no more be repeated by her. Clever use of wireless enabled her to retain her freedom as long as she did, and it was this agency also which helped towards her undoing on November 9th. As befits one of the romances of this war, the *Emden's* enterprise ended in a romantic spot, in that remote island group of the Cocos, where the surge of the Indian Ocean beats upon the beach with continuous reverberation of breakers. Here it is that Mr. Clunies Ross rules a Utopian community and that monster land crabs which can climb trees, cut wire netting, rip tin with their pincers, and perform other disconcerting pranks, keep eternal holiday.

The captain of the *Emden* was fully alive to the advantages of wireless. By its means he was able to obtain news of the movements of merchantmen in the Indian Ocean. Many are the stories that are told of his exploits on the high seas. He is said to have offered, by wireless, to carry the Rangoon mails to Calcutta! He called one of his earliest victims (still out of sight, of course) and asked: "Have you seen a German cruiser in the Bay?" "No such thing," replied the poor innocent. "Oh yes, there is," replied the captain of the *Emden*, as, making twenty knots to the tramp's ten, he dawned upon the horizon, "I'm *It*!"

Apparently Commander von Müller had come to the conclusion that his career was nearing its end, otherwise he would not have embarked upon his last two exploits. On October 21st, in a weak moment, he attacked a Russian cruiser and a French destroyer at Penang. He caught them, apparently, unprepared for action, and sunk them with torpedoes. Encouraged by success in this new field of activity, he then made for



Cocos Island. A view of the shore showing adjoining island.

Keeling, one of the coral islands in the Indian Ocean.

Commander von Müller seems to have concluded that he had a charmed existence. He anchored his ship and landed an armed party to destroy the wireless station and cut the cable. It was a foolhardy enterprise, because too daring. It differed from his other exploits, which were lightning thrusts at our commerce. His whereabouts soon became known, with the result that the *Sydney*, one of the two light cruisers of the Australian fleet unit, was speedily on the scene, and forced the captain of the *Emden* to fight. In the engagement the *Emden* was sunk.

The Telegraphist's Share.

The story of the naval battle which sealed the German cruiser's fate has been well told by the *Daily Chronicle* special correspondent, from which we make the following extracts :

"At 6 a.m. on Monday, November 9th, a four-funnelled cruiser arrived at full speed at the entrance to the lagoon. She was flying no flag, and her fourth funnel was obviously a dummy, made of painted canvas. The cruiser at once lowered away an armoured launch and two boats, which came ashore and landed on the coral beach three officers and 40 men, all fully armed and having four Maxim guns.

"The Germans—for all doubt about the mysterious cruiser was now at an end—at once rushed up to the cable station and, entering the office, turned out the operators, smashed the instruments, and set armed guards over all the buildings. All knives and firearms found in the possession of the staff were at once confiscated.

"I should state here that, in spite of the excitement outside, all work was carried on in the cable office as usual right up to the moment when the Germans burst in. A general call was sent out just before the wireless apparatus was blown up.

"The whole of the staff was placed under an armed guard while the instruments were being destroyed.

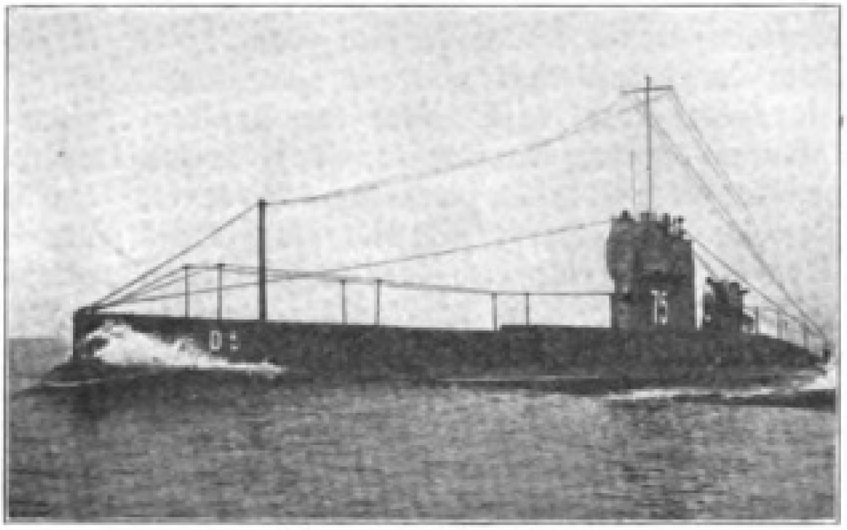
"While the cable station was being put out of action the crew of the launch grappled for the cables and endeavoured to cut them, but fortunately without success. The electrical stores were then blown up.

"At 9 a.m. we heard the sound of a siren from the *Emden*, and this was evidently a signal to the landing party to return, for they at once dashed for the boats. But the *Emden* got under way at once, and the boats were left behind. Looking eastward, we could see the reason for this sudden departure, for a warship, which we afterwards learned to be the Australian cruiser *Sydney*, was coming up at full speed in pursuit.

"The *Emden* did not wait to discuss matters, but, firing her first shot at a range of about 3,700 yards, steamed north as hard as she could go.

"Both blazing away with their big guns, the two cruisers disappeared below the horizon, the *Emden* being on fire aft. So the great naval duel passed from our sight, and we could turn our attention to the portion of the German crew that had been left behind.

"These men had put off in their boats, obedient to the signal of the siren, but when their ship steamed off without them they could do nothing else but come ashore again. On re-landing, they lined the shore of the lagoon, evidently determined to fight to a finish if the British cruiser sent a party ashore. But the duelling cruisers disappeared, and at 6 p.m. the German raiders embarked on the old schooner *Ayesha*, which belongs to Mr. Ross. Seizing a quantity of clothes and stores, they sailed out, and have not been seen since."



The submarine D5

A fuller report states that on the morning of Monday, November 9th, before six o'clock, the cable operator at Singapore was talking to Cocos Island, when suddenly he was astonished to decipher this message :

" *Emden* at Cocos landing armed party."

Then Cocos was silent, but Singapore was not idle. There was no more news from Cocos throughout the day, but at 9.15 p.m. Singapore suspecting that the regular cable instruments had been thrown out of gear, got going with the old mirror instrument, which had been out of use for a considerable time. It is a relic of the system by which the otherwise almost imperceptible movements of a needle are magnified by means of a mirror which reflects them on to a screen with the assistance of a strong artificial light. This brought a response from Cocos, which said :

> Been unable to communicate : Everything smashed : No light : Will get an instrument up at daylight : Report us all well : *Emden* engaged by British cruiser : Result unknown : Landing party commandeered schooner *Ayesha* : Good-night.

The wireless telegraph station on Cocos Island was erected by Marconi's Wireless Telegraph Co., Ltd., for the Eastern Telegraph Co.

Cocos Islands.

In a letter which has just reached London the writer gives the following details of life on Direction Island, one of the lovely little Cocos group :—

" These are typical coral atolls, linked together with reefs of new coral and sand spits, while the lagoon is split up into 'blue patches,' otherwise deep water, 'light blue patches,' where there is about two fathoms, and beds of live coral, which make sailing difficult, as they are just above the surface at low tide, and just under at high water. The water itself is vivid blue—the Mediterranean is green beside it.

" The war seemed very far away. Official bulletins passed through the station, but they gave us very little real news, and the only excitement was when it was rumoured that the company was sending rifles, in case of a raid on the station, and that the beach must be patrolled by parties on the look-out for Germans.

" Then we heard from Singapore that a German cruiser had been dispatched to these islands, and towards the end of August one of the cable staff thought he saw searchlights out over the sea.

" The islands grow little but coconut palms, a few papaya trees that have been imported, and a few hardy shrubs and grasses. The inhabitants have come from Java and talk Malaya. They are busy making copra, and spend all their spare time in or on the water.

" The animal life is not a flourishing concern here. In fact, very few of the imported animals and birds can thrive on this particular soil. Dogs and rats seem to be the chief items.

" For amusement we have fishing, swimming, tennis, and boating. You can roam about all day in practically nothing, do what you like, go where you like, need not shave. The fellows at the cable office grow flowing beards, and have their hair cropped to save brushing it."

The Cocos-Keeling Islands have several times figured in the newspapers in recent years, especially in connection with the Ross family, who claim to be kings of this lonely group.

When, eighty-five years ago, the first Ross, who was a British naval officer, came on the Cocos-Keeling Islands, he beheld a group of twenty coral islets, with wonderful lagoons flashing in the sun.

Ross conceived the idea of forming an ideal State in these ideal conditions, and went to Scotland for his population. On returning to the islands in two years, however, he found that another adventurer, Alexander Hare, with about two hundred followers—slaves, the presents of the Rajah of Bandju—had taken possession. However, Ross landed his party, and the two factions lived on bad terms with one another until eventually Hare was deserted by his supporters, and they gave their allegiance to Ross. In 1854 Mr. Ross died.

In 1886 the territory was proclaimed part of the Straits Settlements, but Mr. Clunies Ross, a grandson of the founder of the "kingdom," was permitted to continue the absolute chieftainship.

Mr. Ross aimed at embodying that "best of all government, a benevolent despotism," and he evidently believed that money was the root of all evil. He would not permit a metallic currency on the grounds that it was not wanted, and might lead to gambling and other crimes, of which the place is now free. The Cocos currency guilder is a sheepskin note worth about 1s. 4d. There is no police force, but the islanders take it in turns to keep watch and ward at night over the boats and for fires.

The present "king" is Mr. John Sidney Clunies Ross, who succeeded his father in 1910. He spends much of his time in London.

Wireless News for the "Karlsruhe."

It is generally believed that the few German cruisers afloat have been receiving wireless communications which have enabled them to escape capture. In the course of a long account of his experiences published in the Press by one of the passengers on board the steamer *Cervantes*, which was seized and sunk by the German cruiser *Karlsruhe* while on a passage from the west coast of South America to Liverpool, there appear the following statements:

"There is no doubt that the *Karlsruhe* and other German ships are in wireless communication with the Canary Islands, and, in fact, the Germans have practically got control of the Canaries. For instance, the *Crefeld* got into Santa Cruz without being caught. As an instance, a certain English ship, in accordance with International Law, had to take her wireless communications down, although two other German steamers were communicating at night and early morning with their wireless, and the general opinion of nearly all the English residents in Santa Cruz is that Germans on the islands are in constant wireless communication with the German ships at sea at the present time.

"It was the general opinion amongst the crews captured that most of the ships were sold to the Germans by wireless. As an instance, the skipper of one of the ships captured was asked to give an explanation why his ship was a day late, and also of several other ships the Germans knew what time they left the last port of call, how many knots they could steam; and in one instance, I believe, they knew the number of crew."

The notorious *Goeben* and *Breslau*, on the other hand, owe their escape from the clutches of the Anglo-French fleet to wireless; at least, so a German officer on board the *Goeben* is reported to have declared. In an interview he said:—

"Two days before the outbreak of hostilities the *Goeben* was at Fiume loading coal, while the *Breslau* was in the southern part of the Adriatic Sea. We got orders to meet her at a fixed spot in the open Mediterranean, and we sailed, leaving ashore a few of our men who had obtained short leave. Even our wireless operator was ill, and had to be left in the hospital at Fiume, but luckily enough we had somebody else on board who understood wireless as well as he did. If not, I don't know how we could have managed it, as when we were in the Ionian Sea the meeting-place with the *Breslau* was suddenly changed on account of some English ships which were reported leaving Malta that day, and likely to discover our route.

"As the declaration of war was expected at any moment, we were trying to go as far westward as possible in order to be able to do some damage either on the Algerian or Tunisian coast. We got another wireless message, and the order to show ourselves on the African coast and to retreat as soon as possible to the Dardanelles."

The East Coast Raid.

The appearance of a German squadron on a hasty raid and the fall of shells within a mile of Great Yarmouth on November 3rd must be regarded in its true perspective.

It is impossible to guarantee that at every point chosen by our enemy for a momentary appearance in the fog we shall have a superior force. Without wireless we should imagine that something very near this impossibility would be required under modern conditions of warfare. But wireless has wrought a change, a change in which the "incident" off the East Coast shows up to our advantage. What happened was that H.M.S. *Halcyon*, an old fishery protection cruiser stationed near Lowestoft, was able by its wireless to summon assistance from the nearest naval base, and a British force proceeded to chase the flying Germans, without, however, catching them before dusk. The first effort of the German fleet was to destroy the wireless of the *Halcyon*, and it was only when that was accomplished that they directed their attention to the hull of the vessel. When, however, the wireless was repaired and the *Halcyon* signalled for help and gave her location, the Germans made off. One lesson which this use of wireless teaches is the impossibility of bringing across the North Sea a fleet of enemy transport ships.

In the case of the sinking of the light cruiser *Hermes* by a German submarine on October 30th, the ill-fated vessel was able to send out wireless messages before going under, and in this way ships' boats were brought up to take away survivors.

The Admiralty and Amateurs.

We referred last month to the proposal to allow certain selected amateurs to reopen their stations in order to assist in the steps which have been taken to prevent private wireless installations owned by aliens from being used to the advantage of the enemy. In a reply to this proposal the Secretary of the Admiralty made the following announcement on November 3rd:

> Many letters have been received from wireless amateurs throughout the country, suggesting they should be permitted to use their apparatus for the detection of secret wireless stations. In considering this question it must first of all be remembered that there are several thousands of holders of wireless licences, and since it is impossible to make distinctions, the rule must be all or none.
>
> The successful detection of illicit wireless telegraphy stations depends on the careful collation of relevant observations, and it is obvious that a small and select body of observers can give much better results than a very large number who have not the necessary knowledge of the circumstances.
>
> Illicit wireless telegraphy stations, to be dangerous, must be capable of sending a considerable distance, and although it is true that reception can be carried out to some extent without a formal and visible aerial, yet transmissions to any serious extent would be impossible.
>
> Under the present rule, where all private stations are closed, any aerial seen to be hoisted must be either Government or illicit, a very great help to the police, who are saved all trouble of discrimination.
>
> It is therefore to the common good that all known private stations should be closed and rendered reasonably incapable of being used.

We have already expressed the opinion that the steps taken by the authorities are adequate to prevent the illicit use of wireless, and others who have had an opportunity of investigating the question are convinced of the impossibility of aliens using their wireless stations. Mr. A. A. Campbell Swinton, President of the Wireless Society of London, in the course of an interview stated:—

> We are satisfied that the authorities are taking every possible step for preventing telegraphy without wires being employed to the national detriment. We have also found the authorities most ready to consider any suggestion made by competent experts in regard to maintaining the necessary precautions.

Amateurs might perform useful work in helping the police to investigate cases where the illicit use of wireless is suspected. The average policeman has probably never seen any of the instruments used in wireless—even among amateurs—and if a special force of competent persons were recruited throughout this country they could give their services when called upon by the police to do so. Mr. Swinton suggested that this was being arranged in London, where it will be most useful.

Wireless Courtesies.

To the "wireless" observer the war is not without its humorous side, as the following account, published in the *Temps* of Paris (to the authenticity of which we are able to vouch), of an amusing wireless dialogue which actually took place between the Eiffel Tower in Paris and the Nauen Tower, the German wireless station, shows. The wireless stations of these towers receive one another's messages, and one night recently a German operator sent the following message to the receiver on the Eiffel Tower :

AN EIFFELTURM.

Wo brachtet Ihr der Plan zu scheitern ?
Wo warft Ihr unsere Truppen 'raus ?
Die Nachricht war doch unwirklich und spärlich,
O Eiffelturm, und wenig ehrlich.

TRANSLATION.

To the Eiffel Tower.

Where did you spoil our plan ?
Where did you drive back our troops ?
The news is improbable and thin,
O Eiffel Tower, and far from honest.

The French telegraphists replied :

AN NAUEN V. EIFFELTURM.

O Deutsches Heer ! hast du vergessen
Dass dich Paris am Sedantag
Erwartete zum Mittagessen,
Wo hast du dich verspätet ? Sag !
Wahrscheinlich hattest du Vorliebe
Mit unserem Sekt, im Marnethal,
Doch guter Wein wird schlecht für Diebe
Und Feinden passt nur unser Stahl !
Ja glaubt Ihr dass die ganze Welt
Eure Prosa für Wahrheit hält,
Und das all' eure Flunkereien
Die Deutschen vom Feinde befreien ?
Trotz eure schön fingierte Siege,
Sinkt Deutschland langsam in die Tiefe.

TRANSLATION.

The Eiffel Tower to Nauen.

German Army, have you forgotten
That Paris expected you
To lunch on Sedan day ?
Tell us why you're late.
Probably it pleased you better
To drink champagne in the Marne Valley,
But good wine is bad for a thief,
And our steel alone is good for the foe.
Do you imagine that the whole world
Takes your prose as truth,
And that all your messages
Can free Germany from the enemy ?
Despite your well-imagined victories,
Germany is sinking slowly into the depths.

It seems that so far at any rate the French telegraphists have had the last word.

The Comic History.

There is scarcely an issue of *Punch* without an allusion to wireless in the war. Under the heading "Wireless" there recently appeared the following lines :

There sits a little demon
  Above the Admiralty,
To take the news of seamen
  Seafaring on the sea ;
So all the folk aboard-ships
  Five hundred miles away
Can pitch it to their Lordships
  At any time of day.

H.M.S. "Halcyon" when attacked.

The cruisers prowl observant;
  Their crackling whispers go;
The demon says, "Your servant,"
  And lets their Lordships know;
A fog's come down off Flanders?
  A something showed off Wick?
The captains and commanders
  Can speak their Lordships quick.

The demon sits a-waking;
  Look up above Whitehall—
E'en now, mayhap, he's taking
  The Greatest Word of all;
From smiling folk aboard-ships
  He ticks it off the reel:—
"An' may it please your Lordships,
  A Fleet's put out o' Kiel!"

In "*Studies in Discipleship (In humble Imitation of the exploits of the German Wireless Service)*," our famous contemporary is not scarcely up to its usual form, but the following examples are typical of the satire on the wireless war news which has been a feature of daily journalism since the war began.

Mr. Ramsay MacDonald and Mr. Keir Hardie have joined Mr. Blatchford in a recruiting campaign, with most gratifying results. In the course of one of his speeches Mr. Ramsay MacDonald announced that the experience he had gained while tiger-shooting in India had enabled him to organise an elephant-gun battery with which he was shortly about to proceed to the front.

It is reported that, at the instigation of the Chevalier William le Queux, the Republic of San Marino has declared war on Germany, and appointed the Chevalier as *generalissimo* of its forces, which are estimated at 250 men.

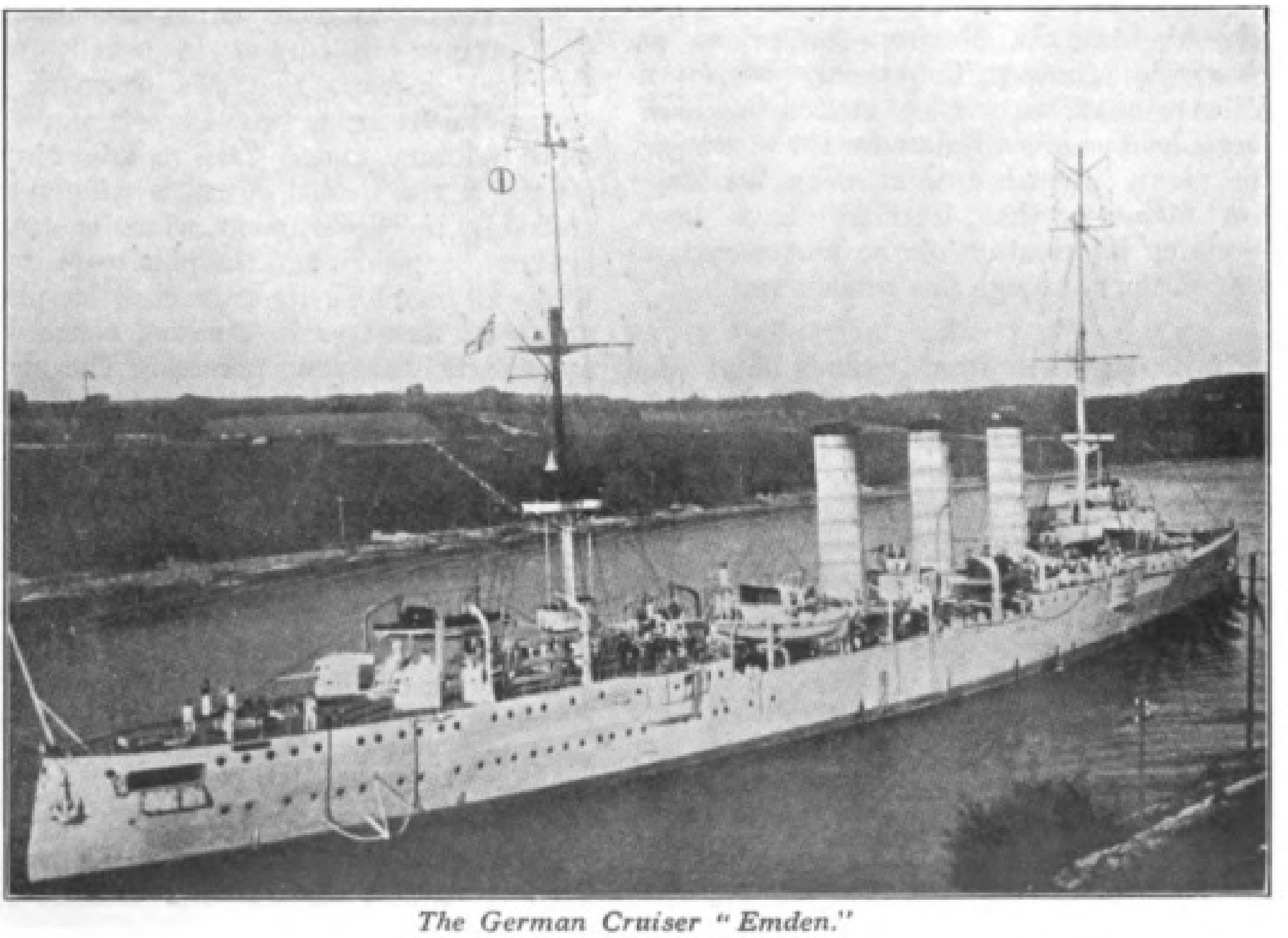
The transports of enthusiasm caused in Berlin by the announcement that Mr. G. B. Shaw had decided to be known in future as Mr. Bernhardi Shaw have given place to bitter disappointment on the peremptory denial of the rumour by the famous comedian himself. As a matter of fact he is hesitating between Benckensdorff, Balakirev and Bomboudiac.

War Sidelights.

The new wireless station at Madras has been completed and opened.

* * *

In the House of Commons Captain Norton informed an inquirer that since August 5th no licence for wireless telegraphy installations had been issued.



The German Cruiser "Emden."

Materials for wireless telegraphs and telephones have been scheduled as articles that will be treated as conditional contraband of war by the British Government.

* * *

A telegram from Skutari to the *Corriere D'Italia* states that some unknown individual set fire to the Italian wireless station. However, it was soon repaired. A very powerful French wireless station was said to have been opened at Podgoritza.

* * *

A report from Kobé alleges that the *Emden* was enabled to sink the steamer *Troylus* through a wireless message sent out from Manila, the information, it is stated, being dispatched privately by a German merchant at Kobé, who has since been arrested.

* * *

Three Germans have been arrested at Halifax, Nova Scotia, for operating a wireless telegraphy installation, the antennæ of which were not supported, as usual, by a pole, but, in order to escape observation, trailed from a third-storey window, concealed amid vine branches.

* * *

The United States Navy Department is advised that the Mexican authorities at Ensenada (Lower California), where a hitherto unknown wireless station has been located, have given orders for the closing of the plant. British authorities in Washington maintain that Germans have been receiving information of the movements of British ships through this wireless station.

* * *

It is reported from Sydney that the Germans at Nauru, the capital of the Marshall Islands, were informed by wireless telegraphy of the imminent outbreak of war as early as August 1st. They immediately warned the German officials in the Marshall and Caroline Islands, and this resulted in the trapping of five steamers. Only the Germans were aware of the outbreak of hostilities.

* * *

Commander Lupcke and the wireless operator Voltz, of the German warship *Preussen*, who are interned at Sabang Bay, were arrested at Batavia on November 17th by the naval authorities. The communication between the antennæ of the wireless rooms had been broken off, but it was found that a wire had been passed along the mizzen mast from the antennæ to a receiver under the pillow of the wireless operator, who declared that the wire was a lightning conductor. It is, however, believed that it was connected with a hidden apparatus. The judicial authorities have ordered Lupcke and Voltz to be sent to Medan, where they will be tried for violation of Dutch neutrality.

* * *

The R.S.S. *Jerusalem*, which arrived at Odessa on November 14th, reports that she had a narrow escape in the Black Sea from capture by the Turks. While on her course the *Jerusalem* received a wireless message ordering her to go to the Crimea instead of to Odessa, and she altered her course accordingly. Shortly afterwards, however, she received a second message, instructing her to return to Constantinople. The captain's suspicions were now aroused, however, and he decided to ignore both orders, and proceeded to Odessa. His suspicions were justified, as it was later ascertained that both the messages had been sent by the Turks.

* * *

The *Times* New York correspondent states that stories are current in usually well-informed quarters that the Germans are systematically using wireless telegraphy to serve military ends. The radiotelegraphy service in the United States is strictly controlled by the Government, whose neutrality is above suspicion, and the plan seems to be to install secret plants in inaccessible places and send messages to cruisers, couched in apparently harmless phrases. The newspapers recently had something to say about one such plant which was alleged to be situated among the almost unexplored tumble of mountains, forests, and water which cover most of the State of Maine. There is reason to suspect the existence of another installation tucked away among the even wilder mountains of the State of Washington on the Pacific coast. The code employed is said to make the messages resemble harmless business telegrams of quotations, prices, etc.

* * *

At Woolwich on November 17th there was a court-martial on Harold Fochtenberger (*alias* Falconer), a German wireless engineer, employed at Messrs. Siemens, for being in possession of wireless telegraph apparatus without the written authority of the Postmaster-General. He was recently charged at Woolwich Police-court with being an unregistered alien enemy and being in possession of a revolver and wireless apparatus, and was then handed over to the military authorities. Evidence was given that four cases of wireless telegraph apparatus, bearing the name of Falconer, were found at Messrs. Whiteley's repository, West Kensington, and in one of the cases was a memorandum book (dated 1904) bearing the name of Fochtenberger and containing ciphers and codes. Wireless apparatus had also been found at Fochtenberger's address at Thorpe Bay.

Mr. Pitman (for Fochtenberger) pleaded guilty, but urged that defendant was unaware of the regulations made on October 16th under the Defence of the Realm Act. His client, who was born in Germany, was brought to England when he was five years of age, and was brought up in this country. Wireless telegraphy was his profession and his hobby, and the apparatus found at Whiteley's had been there more than a year, while the apparatus at Thorpe Bay was not assembled or connected up.

The President announced that the decision of the Court would be made known in due course.

AN INTERESTING LECTURE.

One of the several free public library introductory lectures being given at University College, London, on subjects of topical interest connected with the war, was delivered recently by Dr. J. A. Fleming, F.R.S., on "Wireless Telegraphy in War." The chair was taken by Major W. A. J. O'Meara, C.M.G. There was a large attendance.

Dr. Fleming said that one of the characteristics of the present terrible and stupendous world-war was the extent to which recent scientific knowledge was being employed in it. The magnitude of the forces engaged and the wide extent of the field operations rendered it necessary to utilise every possible form of inter-communication. Wireless telegraphy had given, as it were, a new organ of sense to commanders both on land and on sea to enable them to determine without delay the state of affairs at very distant points of the field and issue orders accordingly. Having explained the elementary principles of the subject, Dr. Fleming illustrated first by a number of lantern slides the appliances of wireless telegraphy as used on battleships of all types. Views were also shown of the receiving and transmitting apparatus. Turning then to military applications, Dr. Fleming explained that several different types of apparatus were employed. First, a portable set capable of communicating about forty miles, all parts of which could be carried on horseback and could be transported wherever a horse can go, and erected for use in ten minutes by four to six men. Similar short-distance sets were fitted up in horse-drawn carts. For longer distances up to 150 to 200 miles the wireless equipment was carried either in horse-drawn carts or else in motor cars. The long-distance sets, as generally used, could be erected in twenty minutes by six to eight men. In conclusion, a brief reference was made to wireless telegraphy as used by aeroplanes and dirigible balloons. In the latter case there was no difficulty in suspending a wire to act as the antenna and in carrying long-distance apparatus. In the case of aeroplanes the space was more limited and also the weight-carrying power; still, light sets had been fitted on aeroplanes suitable for communicating thirty or forty miles.

A Special Committee has been formed by the St. John Ambulance Association, with offices at Marconi House, London, W.C., to raise funds for the Ambulance Department. It consists of Mr. F. S. E. Drury (chairman), Viscount St. Cyres, Commendatore G. Marconi, G.C.V.O., Hon. W. H. Goschen, Sir Joseph Lyons, Mr. A. A. Gordon, Colonel Gentle (Chief Constable of Brighton), Mr. H. Gordon Selfridge, and Mr. F. W. Baker.

The British steamer *Remuera* reported on reaching Plymouth last week that a German cruiser had attempted to trap her by means of a false S.O.S. signal. We ought not, we suppose, to be surprised at a low trick like this from the s.o.s.sidges.—*Punch.*

NOTES OF THE MONTH

Although Sir John Snell's presidential address to the Institution of Electrical Engineers touched upon many interesting topics, we must single out for special mention his references to electrical engineers' admirable response to the country's call. When the immediate Past President, Mr. Duddell, who rendered most patriotic and untiring service to this cause, circularised the members of the Institution at the instance of the specially appointed National Service Committee, about 500 members of the Institution offered their services. A large majority volunteered either for service at home or abroad. Acting in company with the President and Secretary of both the Institution of Civil Engineers and the Institution of Mechanical Engineers, it was first suggested that these three Institutions should form an "Engineering Institutions" Battalion for service in the field, and that the Institutions should clothe, house, feed and train the recruits, so that when ready the battalion could be handed over to the War Office in a condition of complete readiness. There then came an unexpected proposal that the three principal engineering Institutions should recruit the Engineer Units for the Royal Naval Division, just then authorised to be formed. The response from members of all classes of all three Institutions was so spontaneous that the corps was formed within a few days by men not only of splendid physique, but also of highly skilled intelligence, professional men skilled in various branches of engineering, and forming a personnel of the highest value to the Admiralty, particularly in the telegraphic and wireless services.

* * *

The inauguration of the 161st session of the Society of Arts suggests a comparison between the present war conditions and those of 1814–15. There is nothing in the Transactions of the Society which shows such interest in the circumstances of the war a hundred years ago as is indicated in the present crisis by the programme just issued. There is just an echo of warfare, however, in the inventions of Alexander Law, of Deal, who in the winter of 1814-15 received the Society's silver medal for an improved method of securing ship's guns and carriages, and a second medal for an improved semaphoric telegraph or method of conveying intelligence to and from sea and land. Law had been a midshipman on board the *Monmouth* of that day, and, being discharged "in consequence of hurts received," was given duty with the Signalling Service at the Port Admiral's office at Deal, where his invention was adopted. The semaphore was capable of some thousand of signals, "at a saving of one hundred and sixty yards of bunting," and it gave the signals more distinctly at a distance of a mile and a half. But with the peace, the semaphore system along the coast fell into disuse, though probably it was still Law's invention which the Admiralty of a later day found "amply sufficient" when the advantages of the electric telegraph were first submitted to its notice. With these exceptions the awards of the Society (as it seems now) were indifferently pacific in the session of 1814–15.

* * *

We thought that the fear of wireless telegraphy seriously influencing the quantity and incidence of rainfall had been effectively disposed of some years ago by the only weapon worth applying to it—ridicule. Apparently, we were mistaken, for we find that it has awakened from its Rip Van Winkle sleep and made its presence felt in India. A correspondent has sent us a copy of the *Sind Gazette* containing a long article in which the possible influence of wireless upon rainfall is discussed and the connection made clear. Indeed, so deep-rooted seems to be the apprehension in the neighbourhood of Karachi that a local gentleman, who uses the somewhat significant *nom de plume* of "De Wet," and who is described by the editor as "one of the most thoughtful and observant of Karachi's merchants," has propounded in the columns of the *Sind Gazette* a formidable list of questions, with the view of eliciting positive information concerning "an apprehension which is beginning to haunt many commercial minds."

* * *

The method of reasoning employed by the *Sind Gazette* may be summarised as follows: During the last two or three years the rainfall in Karachi has been above the normal in respect of both the total quantity and the number of wet days. It is during the last two or three years that the "newly installed, very powerful wireless telegraph in Karachi has been active." Now what is easier than to connect these two circumstances and to conclude that the apparently heavier rainfall in the locality may have its cause in "the prodigious electrical energies developed by the wireless telegraph." This is just what the inhabitants of Cornwall suggested when the Poldhu station was erected about twelve years ago, and a similar outcry was raised not long ago when a Marconi Station was erected at Aden.

* * *

Much of the prosperity of Karachi, it appears, is due to the immunity from rain, so that the presence of the wireless station is a matter of vital concern to the local community. According to the *Sind Gazette*, Karachi is, or was, almost a rainless port. That means that Karachi's busy shipping activities in the wide purlieus of its harbour could be carried on in the open air without need for protection from the elements. That again means that, as no other great port in India is rainless, or nearly rainless, but on the contrary all the other great ports —Calcutta, Bombay, Madras and Rangoon —are subject to heavy, flood-like downpours and must count on numerous wet days in the course of the year, Karachi, relatively to the other great ports, is in this respect a cheap port. The necessity for costly structures of vast extent to give constant shelter from the weather to commodities passing through the port is reduced to a minimum.

* * *

This anxiety finds expression in the following questions which "De Wet" (the letter was written a few days before the outbreak of war) propounds in the *Sind Gazette*: "(1) Is there any scientific ground for supposing a connection between the local installation of a powerful wireless telegraph and the quantity and incidence of the local rainfall? (2) If so, are observations on the subject being conducted anywhere; and, if not, is it not desirable that they should be instituted with the greatest care forthwith? (3) If observations are already in progress, where and under what conditions are they being conducted, and with what ascertained result so far? (4) What was the average annual rainfall in Karachi prior to the installation of the wireless telegraph, and also what was the actual rainfall in each year (for 25 years back)? (5) What was the average number of wet days in the year (meaning days when the rainfall amounted to more than a harmless sprinkling) in Karachi in the same period, and also what was the actual number of wet days in each year? (6) What has been the total rainfall in Karachi in each year since the wireless telegraph was installed? (7) What has been the total number of wet days in Karachi in each year in the same period?"

* * *

The result of this searching investigation will be awaited with interest. Meanwhile we can set "De Wet's" mind at rest in regard to the first question. There is absolutely no connection between wireless and rainfall. If electrical energy of thousands of horse-power were poured into the air it might during foggy weather cause very slight rain within a few feet of the aerial. But, as we need hardly point out, a wireless station does not send electrical power through the air; therefore the fear of the innocuous electromagnetic waves generated at the Karachi station interfering with the material prosperity of the district has no foundation in fact.

Maritime Wireless Telegraphy

IT was not to be expected that our naval tactics against Germany would be accomplished without our suffering some loss, but the mishap which happened to H.M. hospital ship *Rohilla* was additionally unfortunate in that it interfered with the noble work of bringing relief to our suffering soldiers.

The *Rohilla* was on its way from the Firth of Forth to Dunkirk to take part in the shipment of wounded to England when she ran aground off St. Abb's Head and became a total wreck. The vessel was a twin-screw steamer of 7,400 gross tons, and had been chartered for its purpose by the Government from the British-India Steam Navigation Co., Ltd. Luckily the vessel was on the outward journey; had she been homeward bound with her full complement of wounded the loss of life must have been infinitely greater. As it was some 30 lives were lost, or so it must be presumed, for the exact list has not yet been published. There were two Marconi operators on board the vessel: Senior Operator Robert T. Utting and Junior Operator Wilson.

* * *

At the time of the accident (4.15 a.m., Friday, October 30th) there was a very heavy beam sea running, and the position of the vessel was perilous in the extreme. Immediately S.O.S. signals were sent out, and answer was received from the Cullercoats coast station. No vessels were near enough to assist, and, as under the present conditions of martial law no mercantile vessel may possess a working wireless apparatus in home waters, it was impossible to reach those out of signalling range.

Nevertheless, all that could be done was done; news was sent from Cullercoats to Whitby, and there the lifeboat was put out, but the seas were so heavy that the craft could not face them. Finally, however, the boat was taken across the harbour and thence made her way through the outlet between the East Pier and the cliffs to the doomed vessel. She successfully accomplished two journeys, and brought about thirty people ashore, including all the nurses and some of the doctors. Already the shore people were wakened by the booming of the *Rohilla's* guns. Rocket apparatus was secured, and attempts were made to fire a line across to the wreck, but despite every effort nothing could be done. Finally, Captain Neilson of the *Rohilla* despatched one of his boats with a line to establish communication with the shore, but the breakers did not allow of sufficient line to be paid out, and the boat's crew were at length forced to cut it to prevent themselves from being swamped. Many of the crew of the *Rohilla* were by this time taking shelter in the wireless cabin which was situated on the deck. Most of them were clad only in the scantiest attire, and were glad to accept the operators' offer of spare clothes. It was well they did so, for they had not been long in shelter when the wireless room became untenable owing to the tremendous seas on the port side, until at last one gigantic wave swept the whole cabin, together with the wireless plant, away.

* * *

Almost as soon as the *Rohilla* had struck the rock the dynamos of the ship had ceased to work, and the wireless operator was forced to make use of the emergency set, which worked very well until the heavy sea destroyed everything.

About 8.30 the vessel broke in two, and by this time the Whitby lifeboat had been put out of action, for a large hole had stove in the bottom. Cullercoats had fortunately sent messages to Scarborough, Middlesbrough and West Hartlepool to send tugs and lifeboats, and a little later motor-lifeboats from Southgar and Redcar were also requisitioned. Throughout the whole time a gale was blowing furiously, the force of the wind being estimated at about 70 knots per hour.

The shore people now attempted a splendid piece of rescue work. The Upgang lifeboat was brought to the sea by road and lowered down over the cliff from a height of 200 ft., but despite every effort it was impossible to launch it owing to the tremendous breakers. Captain Neilson and the remainder of the crew were by this time in a perilous condition. Nevertheless, all through Friday night they clung to the wreck, but when Saturday morning broke, and the sea had somewhat abated, Captain Neilson gave the order that all who could should attempt to swim to shore. The distance was only some 700 yards, but the surf made the task one of the greatest danger. About fifty men attempted the journey, and forty of these reached land in an exhausted condition; amongst them was Junior Operator Wilson.

At 10 o'clock the Scarborough lifeboat arrived, towed by a steam trawler, but nothing could be done, so the captain signalled to shore, "Have ambulance parties ready to-night at low water. All leaving ship on rafts. She cannot last out much longer." All hands were set to work to construct these rafts, using any material available from the captain's bridge and the cabin. Just as the final plunge was about to be made the wind freshened and the sea rolled up more threateningly than ever. The captain countermanded his order to float the rafts, and decided that while anything remained of the vessel it was more expedient to stay where they were than trust themselves to the elements. Nevertheless, thirteen sought and obtained permission to attempt to get off, but only three of them reached shore. The chief officer was one of them.

* * *

About midnight on Saturday a powerful searchlight arrived from Newcastle by special train, and was immediately set working. This gave great heart to the shipwrecked men as it lit up the chart room, where all were huddled together, soaked to the skin, cold and hungry—the majority of them had tasted neither food nor drink since the Thursday evening. On Sunday morning the South Shields lifeboat was seen making its way to the wreck. After a tremendous struggle it succeeded in coming alongside the *Rohilla*, pouring oil on the sea, and the gallant crew by almost superhuman efforts succeeded in taking off the fifty survivors.

It was with this last shipload that Senior Operator Utting left the vessel. He describes the behaviour of all concerned in

R. T. Utting. F. E. Wilson.
Marconi Operators on the "Rohilla."

the disaster as beyond praise. In the face of imminent danger not a grumble nor so much as a whisper of fear was heard. The men who possessed tobacco shared it with their comrades, and the leaves of some magazines found in the chart room were used to improvise cigarette paper. Those who had pipes in their possession filled them, took a whiff and handed the treasure to the next man, who likewise took a whiff, and so the pipe of good comradeship was passed round.

The readers of THE WIRELESS WORLD will rejoice with us in the safe return of the two Marconi operators. Had they been called upon to lay down their lives, as some of their comrades have already done in the service of the country, we doubt not that they would have done so like men, and that there would have been others willing, nay eager, to face the same danger and take the same risks as themselves. But we are thankful that this last obligation was not required of the Marconi operators on the *Rohilla*, for however many there may be to take their place the Service cannot afford to lose any one of her "good men and true."

From the *Faraday House Journal* we note with interest that the Old Faradians who are engineers in the service of the Marconi Company are very enthusiastic about their work, and we also notice with interest that the Carnarvon station has made an impression upon a writer in the *Journal*, who remarks that "from the tops of most of the mountains in North Wales wireless posts make excellent landmarks for fixing the geographical positions of the various mountains, lakes, islands, etc., which can be seen in the distance."

The Berne Bureau announces the Opening of the following Land Stations.

Name.	Call-Signal.	Normal range in nautical miles.	Wavelengths in metres (the normal wave-length is in heavy type.	Nature of Service.	Hours of Service.	Coast Charge per word in francs.	Coast Charge minimum per radio telegram in francs.
ALASKA							
Ellamar	KIS	—	—	—	—	—	—
BELGIAN CONGO							
Kinshasa[1]	OQL	300	3,800	—	7 a.m. to 11.30 a.m. 4 p.m. to 5 p.m. Sundays and Bank Holidays, 7 a.m. to 10.30 a.m., 4 p.m. to 5 p.m.	—	—
HAWAIIAN ISLANDS							
Koko Head, KIE[2] ..	KIE	—	—	—	—	—	—
ITALY							
Capo Sperone Radio ..	ICR	270	300, **600**	PG	N	0.30	—
Genova Radio	ICB	160	300, **600**	PG	N	0.30	—
Messina, ICF	ICF	—	—	O	—	—	—
Napoli Radio	ICN	270	300, **600**	PG	N	0.30	—
Palermo Radio	ICP	270	300, **600**	PG	from sunrise to sunset	0.30	—
Roma	ICD	—	—	O	—	—	—
Spezia	ICS	—	—	O	—	—	—
Taranto	ICT	—	—	O	—	—	—
Venezia	ICZ	—	—	O	—	—	—
JAPAN[3]							
Komonto (Lighthouse) ..	JKM	By day, 200; by night 300	—	—	N	—	—
Mokpo (Lighthouse) ..	JMP	do.	—	—	N	—	—
Shogetsubito (Lighthouse)	JSB	do.	—	—	N	—	—
Shoseito (Lighthouse) ..	JSS	do.	—	—	—	—	—
UNITED STATES OF AMERICA							
Angeles, California, KLS (Los)	KLS	—	—	—	—	—	—
Belmar[4]	WII	—	—	—	—	—	—
Bolinas, California[4] ..	KET	—	—	—	—	—	—
Burrwood	WBW	—	—	—	—	—	—
Dover, New Jersey[5] ..	WBX	—	—	—	—	—	—
Eureka, California, KPM[1]	KPM	—	—	—	—	—	—
Fort Terry, New York[5] ..	WUW	—	300	O	—	—	—
Hoboken, New Jersey[5] ..	WBU	—	—	—	—	—	—
Miami, Florida[4]	WST	—	300, **600**, 1,800	PG[6]	N	0.30	3.00
Newport, Rhode Island, WCI	WCI	50	300, 400, 500, **600**	PG	7 a.m. to 5 p.m.	0.15[7] 0.30[8] 0.60[9]	1.50[7] 3.00[8] 6.00[9]
New York City, WHD[10]	WHD	—	—	—	—	—	—
Phœnix, Arizona ..	KHQ	—	—	—	—	—	—
S. Diego, California, KSD[1]	KSD	—	—	—	—	—	—
Tuckerton, New Jersey ..	WGG	—	—	—	—	—	—
Washington, NZY ..	NZY	500	250, 650, 1,000	O	X	—	—

[1] Station open for public correspondence in the inland service of the Belgian Congo.
[2] Operated by the Marconi Wireless Telegraph Company of America.
[3] In connection with the stations mentioned here, correspondence is restricted to the exchange of wireless telegrams with the other lighthouses in Chosen, with the ship *Kosai Maru* and with Japanese warships.
[4] Operated by the Marconi Wireless Telegraph Company of America.
[5] Military Station.
[6] The station also exchanges correspondence with Nassau (Bahamas). Charge, fr. 0.30 per word, without a minimum.
[7] For radiotelegrams exchanged with ships making voyages between Newport (Rhode Island) and ports not exceeding 200 miles distant.
[8] For radiotelegrams exchanged with ships making voyages between ports on the American continent more than 200 miles distant from Newport (Rhode Island).
[9] For radiotelegrams exchanged with ships in transoceanic service.
[10] Controlled by the New York City Fire Department.

Wireless Telegraphy in New Zealand

New Zealand Arms.

EVEN as far back as 1860 over six hundred and forty books had been published about New Zealand; at least so Anthony Trollope informs us in his book about these, the British Isles of the Antipodes. Since then the output of literature on the subject has increased tenfold, and it will be found on examination that every year a score or more books appear in the press. But we are concerned with New Zealand and its particular relation to wireless telegraphy, and in this branch published matter is not so prolific. Practically the only source of information is the Blue Book which contains the Annual Report of the New Zealand Minister for Posts and Telegraphs. A report cannot be but tedious reading, and its significance must always be an unknown quantity to the general reader; he cannot tell what influence the establishment of this or that station may have on the general trade of the country, and it is the purpose of this article to give a brief sketch of the relation of wireless telegraphy to the prosperity of the country.

We may assume as a matter of course that if there were no need for the installation of this means of communication the Government would save itself this unnecessary expenditure, for the erection of high-power stations such as those at Awanui and Awarua means a considerable outlay of money and material. Again, the expense incurred must be covered by a saving of expense effected by the working of a wireless station, and in the case of New Zealand such saving has been very considerable. The prosperity of the country depends chiefly upon its export trade with Great Britain, and as most of the cargoes of ships are those requiring cold storage and apparatus which is both expensive to install and to keep up, it will be recognised that even a day's saving in shipment will be a considerable benefit alike to producers, shippers and consumers. Take, for instance, the enormous revenue produced by the export of Canterbury meat. Cold storage in this case is essential, and in the course of a year an aggregate of many days are saved now that it is possible for the transport ship to be in wireless communication with both export and import markets. Furthermore, the navigation of the vessel is simplified to a very remarkable degree, and this means a general saving in insurance rates—no inconsiderable item in the consignees' accounts.

All branches of industry are, of course, vitally affected by the conditions of shipping, and here, as elsewhere, New Zealand is making advancement. There was a time, not so very long ago neither, when the shipping companies of New Zealand were only rich enough to buy at second hand vessels which had been discarded by the more important steamship lines of Great Britain and America. With the increased demand for transport and with the greater security rendered to vessels on the high seas, and with the introduction of such efficiencies of navigation as wireless telegraphy, the wireless compass, submarine signalling and other inventions, the companies soon found themselves able to purchase vessels suited to the

A View of Wellington.

more immediate needs of specialised transport. Especially has this been the case with regard to meat cargo vessels, where a most elaborate system of chamber storage is required. Already results have more than compensated for the original outlay, and the maritime trade of these two isles of the south was never in a more flourishing condition. As a corollary to the perfection of the cold storage system, fruit growing has developed in the islands, and New Zealand apples especially are keen rivals with the produce of Tasmania in British markets. With the growth of trade the demands on the wireless service have proportionately increased, and, as will be seen in the report with which we conclude this article, it has been found necessary to erect several new stations.

But we have only considered the wireless system of New Zealand from the standpoint of its commercial advantage. There is another point of view, and one which, though not of equal interest to the world at large, is yet of very considerable value, indirectly to the general public, but more particularly to the scientific world. In the Polar regions admirable opportunities are gained for the study of meteorological phenomena, and this fact was demonstrated when the Antarctic Expedition under Dr. Mawson achieved world-wide fame for its valuable scientific researches in this direction. Readers of THE WIRELESS WORLD will remember the article which appeared some time last year on the work of this expedition, and more particularly on the wireless station which was erected at the expedition's base on Macquarie Island. By this means the several exploring parties of the expedition were able to keep in touch, not only with headquarters, but with the world in general through Wellington, Sydney and Melbourne. This, however, does not complete the tale of usefulness either of Macquarie Island Station or the station at Wellington. So helpful was the daily service of meteorological observations that the Australian Government decided to take over the Macquarie Island Station from Dr. Mawson, and to continue its service from Wellington and Sydney. By this means the world at large is kept continually in touch with the Antarctic, and science is enabled to continue its quiet quest of knowledge.

How strange in this period of turmoil, when wars and the rumours of wars assail our ears to the exclusion of all other considerations, to think that out there in the farthest corner of the western hemisphere the peaceful work of progress continues, and the echoes of a world-wide war are scarcely able to trouble, even by a whisper, the gentle rule of Australasian peace.

It is, indeed, a relief to read the record of progress which the Minister for New Zealand reports. There they are building up a fabric of commercial prosperity, while with us it is as much as we can do to guard our heritage from the destroyer.

The increase in the number of radio-telegraphic messages passing through New Zealand stations during the past year was, according to the Annual Report of the Post and Telegraph Department, 54 and 87 per cent. for the forwarded and received respectively. The increase, especially of messages received, can be partially accounted for by the opening of the high-power stations at Awanui and Awarua and the station at Chatham Islands. There are now five New Zealand coast stations. These provide adequately for the needs of ship-stations in all directions around the coasts, and also secure communication between Chatham Islands and New Zealand.

The Chatham Islands Station (opened on September 18th, 1913) established a much-needed link with the mainland of New Zealand. It also serves to extend the range of communication with ship stations to the eastward. The position of the station is 47°57′S., 176°31′W.—416 miles from Radio-Wellington. The wireless set is a 2½-kw. set, with a normal range of 300 miles by day and 600 miles by night. An oil engine is employed to provide motive power; a storage battery of considerable capacity ensures additional reliability. The aerial is of the T type, and is suspended at a height of 150 feet from two tubular steel structures 300 feet apart. An earthed counterpoise completes the aerial equipment.

The high-power stations at Awanui and Awarua were both opened for commercial work on December 18th, 1913. Awanui is situated in 34°54′S., 173°18′E., and Awarua

The Post Office, Auckland.

in 46°30′S., 168°23′E. The tests made of these stations prior to their being taken over by the department proved them capable of fulfilling all requirements and of ensuring wireless communication with Australia at any hour of the night.

The radio station at Auckland is now used only for daylight work.

When weather disturbance is expected a free weather telegram is sent out for the benefit of shipping from Awanui, Awarua and Wellington, at 8, 9 and 10 p.m. respectively.

A continuous "listening" service is maintained at Awanui, Awarua and Wellington, the latter station being open continuously for commercial work. The wireless coastal stations are connected with the land-line systems, and arrangements exist for promptly transmitting wireless messages over the land lines and immediately communicating distress signals to the proper authorities.

Twenty-two ship stations are registered in New Zealand.

The compulsory equipment of certain New Zealand vessels commenced to operate on July 1st, 1914. Regulations were prepared by the Marine Department under the powers conferred by the Shipping and Seamen Amendment Act, 1909, and were gazetted on October 23rd, 1913. Provision is made, *inter alia*, for the installation of wireless telegraphy on every steamship registered in New Zealand and carrying passengers which is engaged in the foreign or inter-colonial trade (except steamships trading to Chatham, Campbell, and Antipodes Islands), and every home-trade steamship which is authorised by her ordinary survey certificate to carry not less than 150 passengers at sea. Such vessels are to be placed in the third class, wherein they have no fixed working hours, are not bound to perform any regular "listening" service, and are not required to carry an emergency installation.

The regulations governing the use of wireless telegraphy on ship stations registered in New Zealand, and licensed by the Minister of Telegraphs, have been revised and brought into conformity with the recommendations of the International Radio-telegraphic Convention, London, 1912.

The Post and Telegraph Amendment Act, 1913, provides for regulating the use of wireless telegraphy on British and foreign ships, not registered in New Zealand, while within its territorial waters. Regulations giving effect to this supervision have been prepared.

It has been arranged that the wireless coast stations of New Zealand shall cooperate with the British Association for the advancement of science in the collection of data of atmospheric electrical disturbances which interfere with the receipt of wireless signals. Observations will be made simultaneously in many parts of the world, and it is expected that this joint action will produce results of practical scientific value.

Amended radio-telegraphic regulations came into force on January 1st, 1914. The charge for the transmission of radio-telegrams to or from ships trading exclusively between Australia and New Zealand or between ports on the coast of New Zealand from or to any telegraph office in the Dominion was reduced from 10d. to 5d. a word.

Provision was made in the Post and Telegraph Amendment Act, 1913, for fuller powers to restrict the erection and maintenance of stations by amateur experimenters.

By Order in Council dated April 24th, 1914, permission was given to the Corporation of Canterbury College to install a radio station and plant in the college buildings for scientific and experimental purposes in connection with the investigation of "strays" on behalf of the British Association for the Advancement of Science. Suitable conditions have been imposed as to the use and control of the station, which is to be used only for the reception and not for the transmission of signals. Its use is to be confined to members of the scientific teaching staff of the college and their assistants, and no telegraphic message received is to be communicated to any person other than an officer of the department. The department has reserved the right to inspect the station and plant at any time, and to suspend its working during any period. The permission given is revocable at any time by His Excellency the Governor. This is the first occasion on which an Order in Council has been made authorising the installation of a private wireless telegraph station.

Radio Traffic

How Public Wireless Telegrams are Handled.

THE paper on the subject of "Radio Traffic" read by Mr. David Sarnoff before the Institute of Radio Engineers of New York is a timely and valuable contribution to the literature of wireless telegraphy. It may be said without offence that the general public have little appreciation or knowledge of the difficulties involved in the purely traffic aspect of wireless telegraphy—the aspect which directly concerns their work—and little information can be obtained from the text-books now available, nearly all of which deal with the engineering branches of radio-communication.

The opening portions of the paper explain how to communicate from shore to ship. All that is necessary in the United Kingdom is for the sender to enter any post office and make known his wishes to the telegraph clerk, who then refers to the list of sailings and ascertains therefrom the coast station with which that particular ship is in communication. The message is then despatched over the land line to that coast station, and when it reaches there it is transmitted by wireless to the vessel. Mr. Sarnoff explains the method of accounting, which is somewhat complicated, as charges on a Marconigram are divided into three classes, namely, ship tax, coast tax and land line forwarding charges. The ship tax is the charge the ship makes for transmitting or receiving the message; the coast tax is the charge the shore station makes for transmitting or receiving the message; the land line forwarding charge is the amount charged by Post Office, or, as in the case of the United States, by the connecting land-line telegraph company, for transmitting and delivering the message. The accounts are duly audited and credited to the various parties.

A difficulty which seemed insurmountable for a long time and which was successfully overcome eventually by the Marconi organisation, was the method of accounting and charging of radio messages The Berlin Convention of 1906 stipulated that wireless telegrams should be counted and charged for on a word rate basis pure and simple, but for a long time the land-line companies in the United States refused to consider wireless messages in a class different from their ordinary domestic telegrams—that is, a fixed charge for a ten-word minimum. To accept and forward wireless telegrams over the land wires on a message basis and to forward them by wireless on a word rate basis would have caused endless confusion in accounting. It was, therefore, necessary to have all the Marconi companies agree to handle wireless messages on a message basis throughout until such time as the American Marconi Company could prevail upon the United States land line telegraph companies to accept its point of view. This was successfully accomplished in 1912, and at the present time the Western Union and Postal Telegraph companies handle Marconigrams on a word rate basis, thereby simplifying to the greatest extent the method of accounting.

From the very first it was realised by the parent Marconi Company in England that when wireless equipments were installed on merchant vessels a thoroughly practical means of regulating traffic was needed, in order to make wireless communication successful. It is significant to note that the system originally adopted by the Marconi companies is still in vogue; and, in fact, so reliable has it proved that the London Radio Telegraphic Convention practically adopted it, and stipulated that wireless traffic should be so handled.

With the increased number of ship and shore stations, with the present government regulation of wavelengths and with the constant increase in the volume of traffic, it is most desirable to so regulate the transmission of wireless telegrams that they may be accurately received with maximum efficiency during a minimum of time. To accomplish this result three factors must be given constant consideration: (1) Efficient operation, which, among other qualifications, calls for a competent telegraphist; (2) Efficient apparatus; (3) System and brevity in transmission and the elimination of all superfluous words and symbols.

The importance of the human element in radio communication cannot be overestimated. With regard to the question as to which of the following combinations is preferable: An older, and within reasonable limits less efficient type of equipment, in the hands of a skilled operator, or a modern and more efficient set in the hands of a poor operator, Mr. Sarnoff favours the skilled operator, but he appreciates the necessity and desirability of having the ideal combination, namely, the good operator and the good set. There is no gainsaying that a proficient operator with an old set is preferable to an indifferent one working a new set. The experienced man has been specially trained to read by sound and, as a rule, his shrewd commonsense overcomes many difficulties due, perhaps, to faulty sending and atmospherics.

We are at one with Mr. Sarnoff's remarks on speed and cannot too strongly support the view that telegraphists must always work at top speed, even if there be only one telegram to be sent, for to do otherwise would only tend to decrease their efficiency and "telegraphic instinct," by which we mean the feeling that a telegram is urgent or it would not be sent, and, therefore, must be expedited so that it reaches the hands of the addressee in the least possible time. The desirability of speed, not only in ordinary commercial work but in cases of distress, is emphasised by the wreck of the *Empress of Ireland*. There were only six or seven minutes available in which to communicate, but during this time the operator gave the Father Point station full particulars of the collision and received from that station the assurance that assistance would come to him in time. But it must not be forgotten that while in telegraphy the sending speed should be as fast as possible, it should not be faster than the other operator can receive, for if one tries to rush the other, quarrelling and unnecessary talking, delay and errors result.

Mr. Sarnoff considers that present wave-length ranges provided for commercial work are insufficient; that they are not conducive to the highest radiating efficiency, and are productive of unnecessary interference; more so, perhaps, than was the case before the adoption of the regulations. He says, "It helps very little to stipulate that the logarithmic decrement of the emitted waves shall not exceed two-tenths per complete oscillation, and at the same time limit the wave-length range so as to bring about a condition where 600 metres is adopted as the normal wave-length by nearly all commercial ship and shore stations."

Mr. Sarnoff would have a special wave-length reserved for calls from ships in distress, and he suggests that if the present limits were modified to permit the use of all wave-lengths below 1,000 metres for commercial ship and shore communication, a single wave-length—possibly 600 metres—might be used for general calling and in the case of ships in distress.

This is a question upon which there is room for difference of opinion. If a special wave-length were adopted for calls from ships in distress the effectiveness of a wireless installation on a ship as a means of life saving would be largely destroyed. The incident of a United States Radio Inspector calling ship and shore stations on a 300-metre wave-length for two hours without getting any response would appear to prove that if a special wave-length were allocated for distress calls, most, if not all, ships would be listening in on the commercial or particular wave of stations or ships with whom they desired to speak, and ships in the immediate vicinity of a sinking or distressed vessel might be as ignorant of impending disaster as vessels hundreds of miles away. It is true the Radio Telegraphic Convention or any law might legislate on the point and make it a condition that all stations should "listen in" on, say, a 450 metre or other standard wave, but unless this were done at very frequent intervals it would not be satisfactory, even if it were carried out. Confusion and delay in ordinary working may, under present conditions, be vexatious and trying, but perhaps it would be more satisfactory that this be so when perhaps a thousand valuable human lives are in danger and awaiting anxiously for succour.

For the dissemination of Press bulletins and warnings also a standard wave-length, such as now exists, is of importance.

Wireless Telephony

New Short Distance Apparatus

IN the endeavour to arrive at a practical system of wireless telephony, the resources of the physicist and of the engineer have been severely taxed. Throughout the investigations and experiments successes and failures have been fairly well balanced, and the task has proved as perplexing as it is attractive. The modern line telephone came some time after the telegraph, and it has been a surprise to many that speech should be so difficult by radiation without wires. The essential difference between speech and telegraphic signals is, of course, the duration of the consecutive impulses which have to be dealt with. A wireless operator sending through code messages at the rate of 20 words a minute makes on the average, perhaps, about 250 actual signals a minute. In speaking, the number of signals dealt with each minute runs into hundreds of thousands and even millions. In other words, to transmit speech satisfactorily, there must be available a stream of radiated oscillations of a very high frequency, and one of the problems that have had to be faced was that of maintaining continuous oscillations.

EARLY EXPERIMENTS.

The earliest experiments in transmitting speech were carried out by means of beams of light. A microphone drum, if placed so as to vibrate at some spot past which gas is flowing to a sensitive burner, will sufficiently modify the passage of the gas to put the flame in a state of vibration, corresponding to the speech wave. A large beam of light so controlled can be projected by means of a mirror to a considerable distance in the form of parallel rays, and at the receiving station can be concentrated upon a photo-electric cell of crystalline selenium, the resistance of which will vary according to the illumination and so affect a telephone receiver in series with or shunted across it. This old but picturesque method is of interest, a searchlight beam being employed for the light path. The searchlight telephone seems to have reached little more than 3 km. in actual practice, and owing to the great power of the light required at the transmitting station to affect a photoelectrical cell at a practicable distance of this order, it is hardly likely to find any application except where powerful searchlights are readily available, as, for example, between a battleship and smaller craft lying within a radius of a mile or two. One point in favour of searchlight telephony is that a message cannot be picked up except by those who are in line with the light beams, so that for naval warfare a practical system would possess distinct advantages. No aerial wires or masts are needed, but the vagaries of selenium cells are such as to make the uniformity of the results doubtful, unless the receiving apparatus be under the supervision of a skilled operator.

NATURE AND THE INVENTOR.

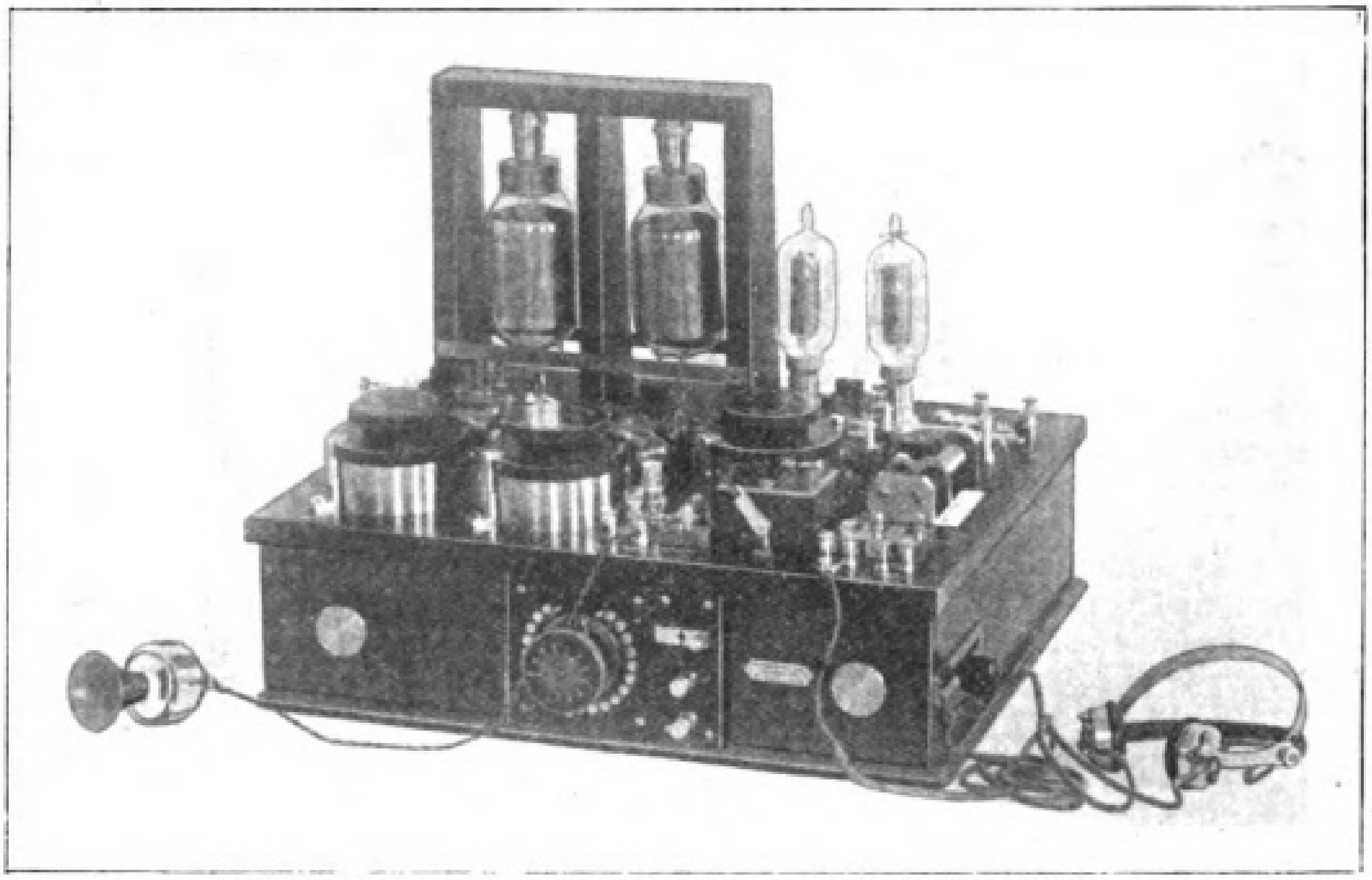
It is no small thing to contrive the means for transmitting articulated tones along a beam of light, for, apart from difficulties in the apparatus, the inventor is confronted by the inherent differences in the nature of the perceptions associated respectively with the eye and the ear, and by the corresponding differences in the media through which light and sound are propagated. Nevertheless, he finds that the ear has a power of resolution exceeding that of the eye, that it is astoundingly clever alike at analysis and synthesis, that it can imagine if it cannot physically restore some of the lost components of an utterance, that it possesses the means of accommodating itself to minute delays or accelerations, and that it can as a result convert acoustical sketches and even caricatures into finished tone pictures. All this helps the inventor, and in addition, from her mysterious laboratories Nature has given him knowledge of a set of dynamical and resonating phenomena resulting in movements transcending anything that he could derive from mere theory. The microphone, the telephone, the electrolytic interrupter and other instruments are all steps towards the attainment of his purpose, and from the description of the Marconi short distance wireless telephone it is seen that further substantial progress has been made in the direction of establishing wireless telephony as a permanent and trustworthy means of communication.

Mr. Marconi has recently directed much attention to this subject, with the object of improving the speech transmission and simplifying the apparatus. He has invented for this purpose new and effective transmitters and receivers, and the demonstrations conducted by him between ships of the Italian Navy (described in THE WIRELESS WORLD, April, 1914) were consistently successful.

PRACTICAL ACHIEVEMENTS.

The complete short distanced wireless telephone set comprises a transmitter and receiver fixed in a case, as shown in the accompanying illustration, and weighing only 59 lbs. The transmitter is a specially constructed Marconi valve, shunted with condensers and self-induction coils in such a way that a continuous stream of oscillations is produced.

The frequency of these oscillations is controlled by means of variable ebonite condensers, shown in the illustration in front of the transmitting valves. The oscillations produced are induced into the aerial wire through a variable coupling,



Marconi Short Distance Wireless Telephone, showing Combined Transmitter and Receiver, and Telephone Receiver.

any tuning required being effected by means of the lamp. The oscillations produced by the valve, being quite continuous and of constant amplitude (unless independently varied), give no sound in the receiver, even if the latter is only a hundred metres away. The variation required for transmitting speech is produced by means of a microphone.

Either of two methods of using the microphone can be adopted with this set. The first and simpler method gives remarkably clear speech of a quality superior to that obtained with any wire telephone. The second and more complex method gives speech which is not quite the equal in quality of that obtained with the first method, but is still equal to that given on any wire telephone, and at the same time the speech is very considerably stronger than that obtained by the first method. The advantages of this second method are that no special care need be taken to speak loudly into the microphone, and that the microphone and receiving telephone may, if necessary, be used at any distance from the set, thus making it possible to speak to other stations from any part of a ship—for example, from the Chart Room while the set itself remains in the Wireless Cabin. A simple change-over switch is arranged to switch from talking to listening. The switch can be controlled from a distance in the case of the microphone being placed at a distance from the set. A low-voltage current is used to heat the filaments of the valves, and for this purpose an 80-ampere hour accumulator is provided.

The high tension (500 volts) required to give the necessary current through the vacuum of the transmitting valve is supplied from a dry battery. Five cases of dry cells are provided; four of these connected in series are usually necessary, but the fifth can be used for emergencies or when the first four have dropped in voltage. The vacuum current is very small in value, from 10 to 20 milliamperes being the usual value, thus making it quite practical to use dry cells for intermittent purposes.

The receiver consists of a Marconi valve and crystal set having a very high degree of sensitiveness and reliability.

The connections to be made in setting up the telephone are of the simplest, and from the time of receipt of the set, provided aerial and earth connections are ready, the whole arrangement can be in working order in half-an-hour. The set can at once be adapted for continuous wave telegraphy—the only addition necessary being a telegraph key—and a telegraph range of 100 miles with the above-mentioned aerials can easily be obtained.

The apparatus described above has been designed to work over comparatively short distances, but it by no means exhausts the limits over which wireless telephonic communication is possible. Dr. J. A. Fleming in a recent lecture said, "lineless telephony up to 500 or 600 miles is now possible, and there appears to be no insuperable obstacle to prevent it from being conducted across the Atlantic Ocean." If this were ever done, and the New York to San Francisco line telephony accomplished, it might be possible with one repetition of a message to speak articulately from London to places in California. The Marconi apparatus shows that long before this is achieved, however, wireless telephony will have come into use for moderate distances between ships and ship and shore.

The Annual Report of Lloyds' Register of Shipping has just appeared. It contains an abundance of information on all that concerns maritime affairs; so abundant, indeed, that all the statistics and columns of figures there set forth are apt to give the lay reader a bad attack of vertigo. Such mental pabulum is often a deterrent to those who would profit by enquiry into these matters, so for the benefit of our readers we extract the information regarding wireless telegraphy for maritime purposes.

It appears that the past year has witnessed a remarkable increase in the use of wireless telegraphy and also of submarine signalling. On the Society's Register Book there are now recorded 2,750 vessels fitted with wireless installations as compared with 1,932 at the corresponding date last year. Recent legislation has no doubt something to do with this phenomenal increase, but it is gratifying to think that the need which was apparent to everyone that all vessels should be supplied with this safeguard has secured so much more adequate a measure of fulfilment, for the equipment of any one vessel with wireless telegraphy means, not only security for itself, but an additional security for all vessels travelling the high seas. As regards submarine signalling apparatus, 930 vessels were equipped in 1914 as compared with 806 in the preceding year.

The Marconi Company of Canada notify us that they have equipped for the Donaldson Line the liner *Laconia* with a 1·7 kilowatt set, and that the Marconi International Marine Communication Company are fitting the *Kastalia* for the same company with a 1½ kilowatt set.

Practical Hints for Amateurs.

Factors of Efficiency.

By J. SCOTT-TAGGART.

THE three most important factors which govern the receiving range and efficiency of an amateur wireless station are the aerial, the detector, and the telephone receivers. Of these the aerial is of the greatest consequence, and, since it is usually erected in the open, it should be strongly constructed to withstand the weather. An aerial should be both as long and as high as possible ; if it is desired to receive short waves of about 600 metres an aerial 150-200 ft. long is suitable, while for longer wave-lengths aerials of greater length may be used. The disadvantage of long aerials, however, is that a condenser is necessary in the earth-lead to reduce the natural wave-length, and this invariably lessens the strength of signals. Height, on the other hand, is essential for long-distance receiving. Fifty feet high at both ends is suitable for general work, but, if possible, the aerial should be well above neighbouring houses and trees, since every few feet makes an appreciable difference to the range of the station.

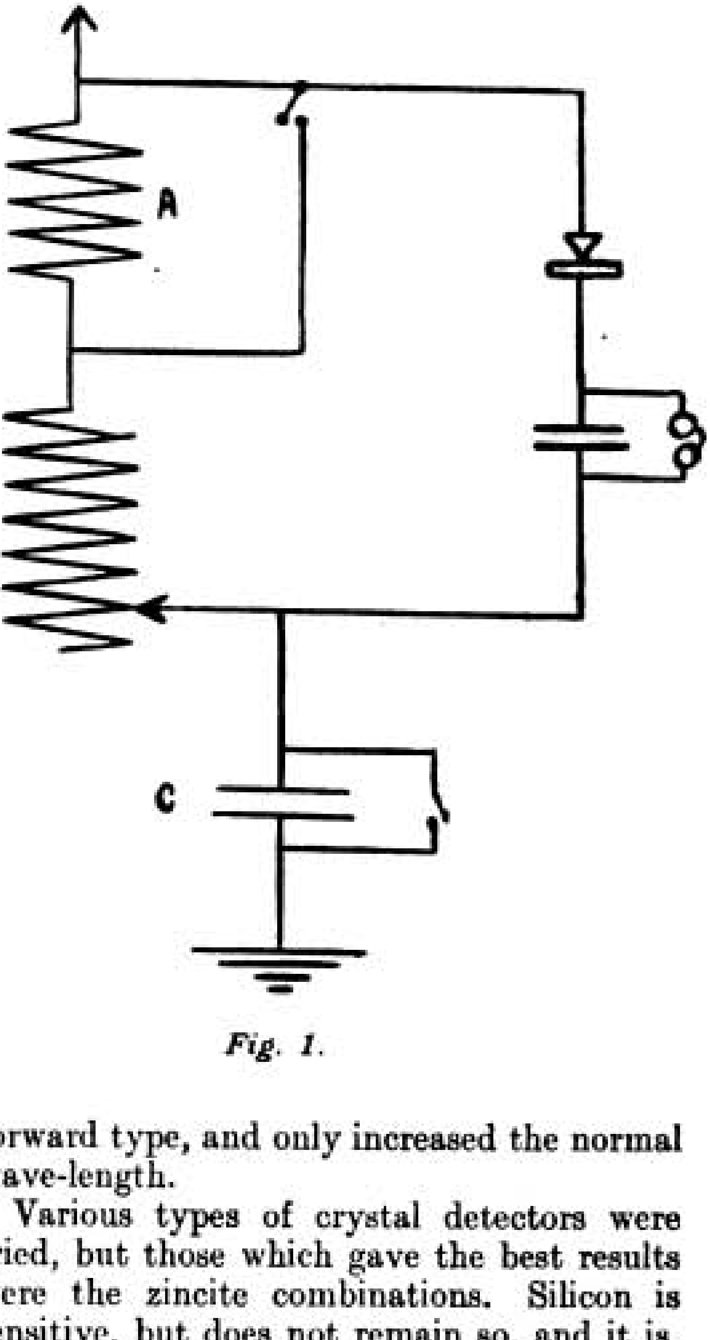


Fig. 1.

The aerial on which the following results were obtained consisted of two galvanised iron wires (S.W.G. 18) separated by 6-ft. spreaders, and 130 ft. long. The lower end was 42 ft. high, while the higher end, from which a leading-in wire 60 ft. long was taken, was 52 ft. from the ground. Experiments with several other aerials were made, but the high aerials gave the best results, although long, low aerials were very successful. Galvanised-iron wire gave as good results as copper, and it is moreover considerably cheaper. Single wire aerials were almost as good as those with two wires, and were more suitable where great length was obtainable. A number of different aerials connected together were also tried, but possessed little advantage over the straightforward type, and only increased the normal wave-length.

Various types of crystal detectors were tried, but those which gave the best results were the zincite combinations. Silicon is sensitive, but does not remain so, and it is, moreover, difficult to obtain a sensitive adjustment. Carborundum, without a doubt, when used with a potentiometer is very reliable, and is useful as a stand-by, but it is hardly as sensitive as zincite-tellurium or zincite-bornite, which remains adjusted for days. Zincite-galena gave equally good results. A film of lubricating oil improved the action of these combinations, both crystals being covered with a thin layer of oil. The same good effects were produced by immersing the whole detector in oil.

For long wave-lengths a single-slide inductance, 1 ft. long and 3½ in. diameter, wound with No. 26 cotton-covered wire was found very suitable. The 600-metre stations required in the earth-lead a condenser consisting of two sheets of tin-foil, one on either side of a half-plate photographic negative. Even with this in series with the inductance coil the results were poor compared with those obtained with the oscillation transformer. An extra inductance, A, also formed part of the aerial circuit, and both this and the condenser, C, could be shorted when required (Fig. 1). The oscillation transformer consisted of a fixed primary 3 in. long and 4½ in. diameter wound with No. 22 enamelled wire. Inside this slid one end of the secondary, which was 9 in. long and 3½ in. diameter, wound with No. 32 cotton-covered wire; it was tapped off into six sections, and was shunted by a small condenser. The high-potential end of the secondary farthest from the primary was connected to one side of the detector. The tuning of the primary was effected by means of a variable aerial-tuning inductance entirely separate from the actual transformer. The objection to sliders on the primary of transformers is that the coupling between the aerial and detector circuits is

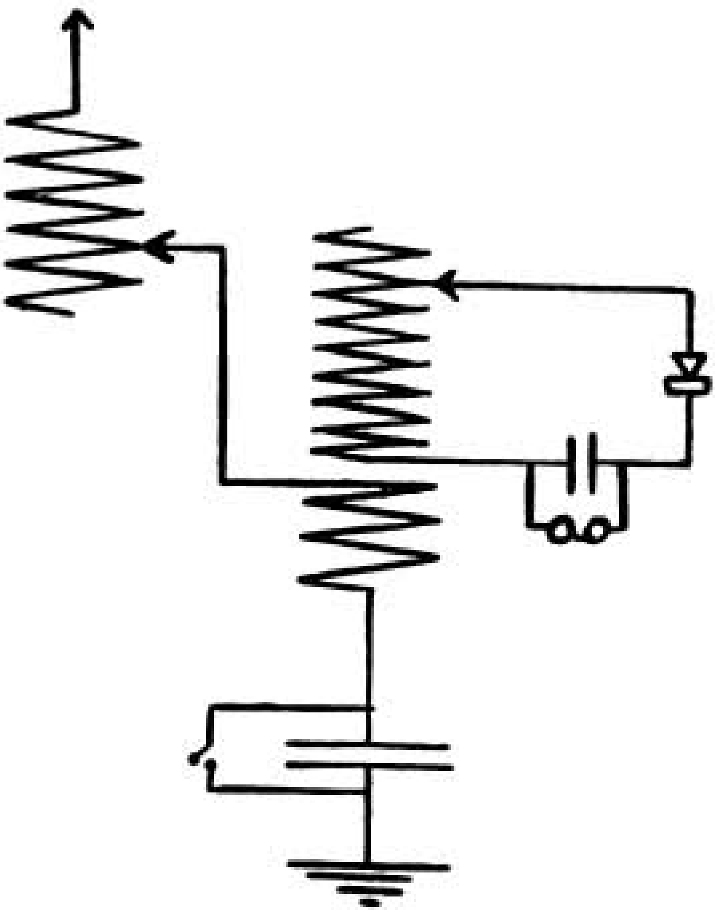


Fig. 2.

varied at the same time as the inductance of the primary. The connections are shown in Fig. 2, and were found especially efficient on low wave-lengths. In the case of long waves there was little difference in the actual strength of signals between the inductively tuned set and the auto-transformer, although the former eliminated interference to a greater extent.

Glass was found to be the best dielectric for condensers, giving a good, clear note, while paraffined paper gave a more muffled note. The telephone condenser consisted of two sheets of tin-foil separated by a half-plate negative. It was found very useful to vary the size of the telephone condenser, as its capacity considerably affected the note in the 'phone, which was of the Lucas 1,000 ohm pattern.

The receiving range of this station was considerable for the size of aerial. All the usual stations have been heard, as well as Bergen (Norway), Scheveningen, Dunkirk, Rochefort, Marseilles, Nauen, Madrid, Cadiz, and many other European wireless stations. Paris could just be heard at from five to eight feet from the 'phones, and Cleethorpes at about the same distance. Marseilles could at times be heard nearly a foot away.

The transmitting apparatus was of the usual auto-transformer type, and consisted of a helix 1 ft. in diameter, and wound for six inches with ¼-in. strip copper with holes at every turn, in which plugs fitted so that tuning could be varied. The condenser consisted of two pint Leyden jars, which were charged by a 3-inch spark-coil fitted with a Vril break. Very good plain aerial results were obtained with a ¼-in. motor coil, the aerial and earth being connected across the spark-gap. An interesting effect was produced by placing a coil of No. 30 wire in series with the aerial. The coil was 1 ft. long and 3 in. diameter, and a well-tuned wave of about 2,000 metres was produced. This wave could be tuned out on either side. although only plain aerial was being used. Communication could also be held across a distance of half a mile by means of a small buzzer, the aerial and earth being connected across the make and break.

These results show that even with a moderate aerial any amateur can receive from considerable distances provided he has suitable apparatus.

The Amateur Handyman

A Syntonic Buzzer Device.

By J. W. RELLIM.

THE disadvantage with the ordinary buzzer circuit for testing crystal is that it does not prove to the amateur that his aerial is oscillating. Thus, if the aerial or earth-leads are disconnected in any way signals are still heard in the 'phones when the buzzer is switched on. This misleads the amateur, and he wonders why outside signals are not heard. After studying this problem, I have devised the following arrangement :—

On a cardboard tube about 1½ in. diameter wind about 150 turns of No. 22 S.W.G. (*B*), and on another tube about 2 in. diameter wind about 250 turns of 24 S.W.G. (*C*), this one being the secondary and open circuit.

These two tubes should now be fixed permanently, one inside the other, to a baseboard (*G*) about 6 in. square, and a piece of brass strip arranged to touch the open circuit winding to finely adjust it (*E*).

Two pieces of brass strip must be screwed to the baseboard, as shown in Fig. 1, which constitute the switch (*F*).

The buzzer (*D*) should next be fixed, and the whole arrangement enclosed in a box large enough to hold the apparatus, a condenser and three dry cells. This box must be damp-proof.

The connections can now be made, as shown in Fig. 2. The condenser should have a capacity of about 0·05 mf., and may be made of tin-foil and paper. The box must be fixed on a wall, fence, or mast at least 60 ft. away from the receiving apparatus, and a cord attached to "screw-eye" (*A*), and taken by means of "pulleys" or "screw-eyes" to the receiving room. A single-wire aerial about 20 ft. long and 10 ft. high, insulated, and an earth about 2 ft. deep will complete the apparatus, which will now have to be adjusted, by means of the selector (*E*), to give maximum sigs in 'phones.

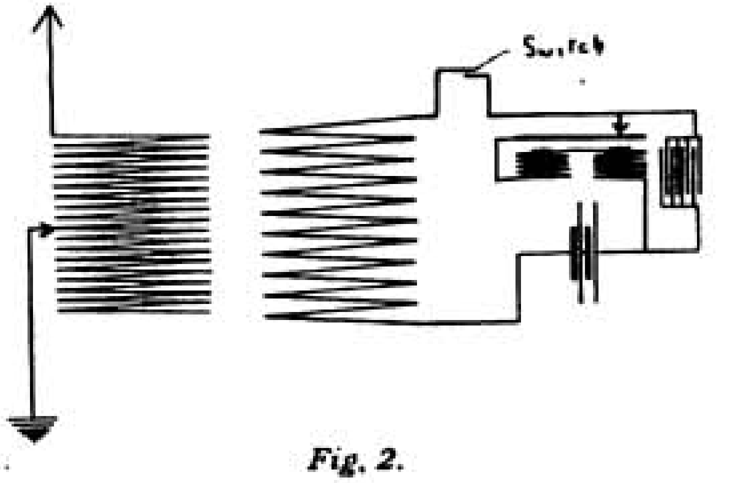


Fig. 2.

With this device the amateur will know that if he hears sigs when he pulls the cord everything is O.K.; while if he doesn't, he can check the circuits in a methodical manner until he does hear them.

A word of advice will not be out of place: do not have the cord too tight, as the first shower of rain will shrink it and switch on the current. It is annoying to have to loosen it about 3 a.m.

Should the signals be too strong, reduce aerial and increase open-circuit inductance, and *vice versa*.

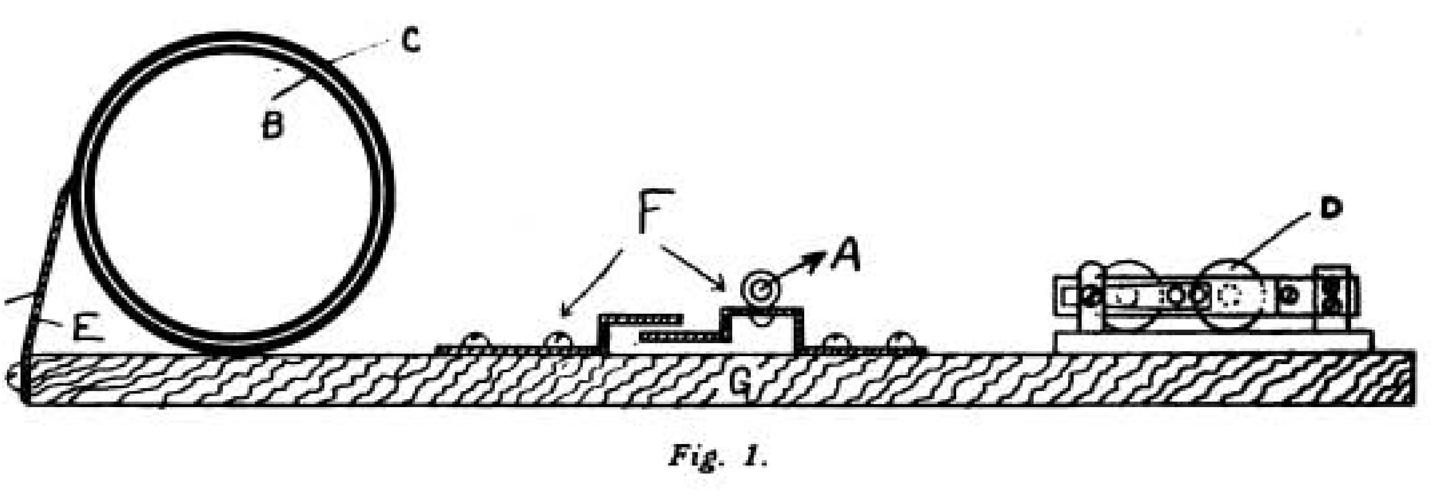


Fig. 1.

Design for Rotary Gap.

THE amateur's greatest difficulty in making rotary gaps of the general design is that a lathe is needed to "true it up." Below is the description of a gap that can be made without the use of a lathe, and is suitable for power up to about $\frac{1}{4}$ kw. Fig. 1 shows the complete gap and motor.

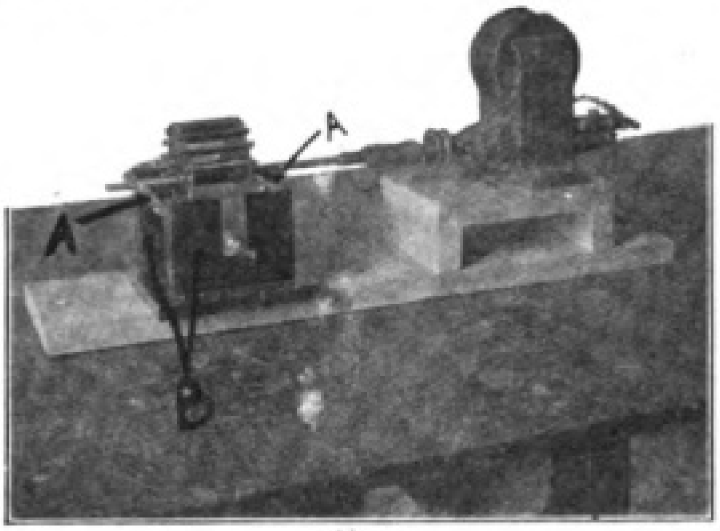


Fig. 1

Cut from $\frac{1}{32}$-in. thick sheet brass two discs $2\frac{1}{2}$ in. diameter. Divide both into 18 or 20 equal parts, and at these divisions cut slots in the discs about $\frac{3}{16}$-in. deep. Solder the discs on a $\frac{1}{8}$-in. spindle through the centres at a distance of $2\frac{1}{2}$ in. apart, taking care to have the slots opposite to one another. Out of $\frac{1}{4}$-in. wide and $\frac{1}{8}$-in. thick brass strips cut 18 or 20 pieces (according to the number of slots in the discs) $2\frac{3}{4}$ in. long. Solder these strips into the slots. The bearings are made out of brass tube that is a working fit to the spindle of the discs. To line up bearings: Place the two pieces of tube one on each end of the spindle, leaving enough length of spindle protruding at one end for connecting to motor. Place the whole in position on the bearing supports (A, Fig. 1) and solder down. By this means easy running is assured. For the spark electrodes cut two pieces of $\frac{1}{16}$-in. thick sheet brass to shape and size as shown in Fig. 2.

Screw these on the frame of the gap (B, Fig. 1), which should be of ebonite.

To "true up" gap: Set the electrodes and revolve gap, noticing which studs decrease the size of the gap. File these until the length of gap is the same for all studs. A gap of the above dimensions will run off an 8-volt motor, giving a good note, the pitch of which will depend partly on the speed of motor and partly on the frequency of the supply current.

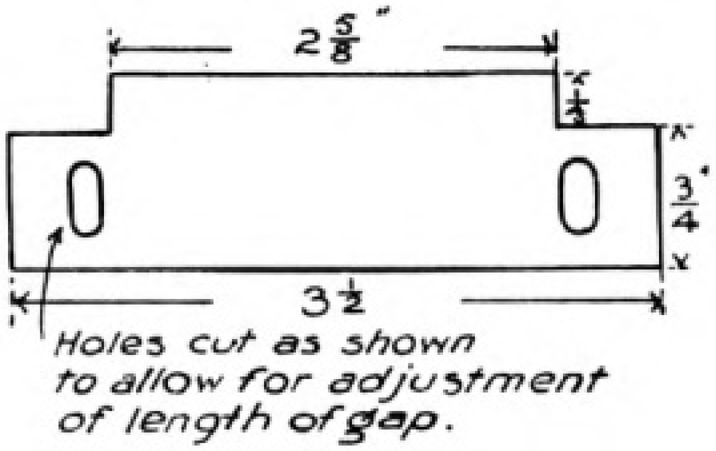


Fig. 2.

Make a direct connection between the motor shaft and the gap spindle by means of a piece of rubber-pressure tubing so as to insulate the one from the other, and also to give a flexible connection.

Connect gap in the transmitting circuit, as shown in Fig. 3.

A question frequently occurring among amateurs is: "Why can a rotary gap not be used with an ordinary trembler coil?" The reason, however, is not far to seek. The speed of the trembler on any coil is comparatively slow when compared with the frequency of an alternating current, and if the current in the coil is not made or broken when a pair of studs on the gap are opposite to the fixed electrodes then there will be no spark. This, with a trembler, frequently occurs, owing to the very low "frequency" given by the trembler, and so renders the use of a rotary gap quite out of

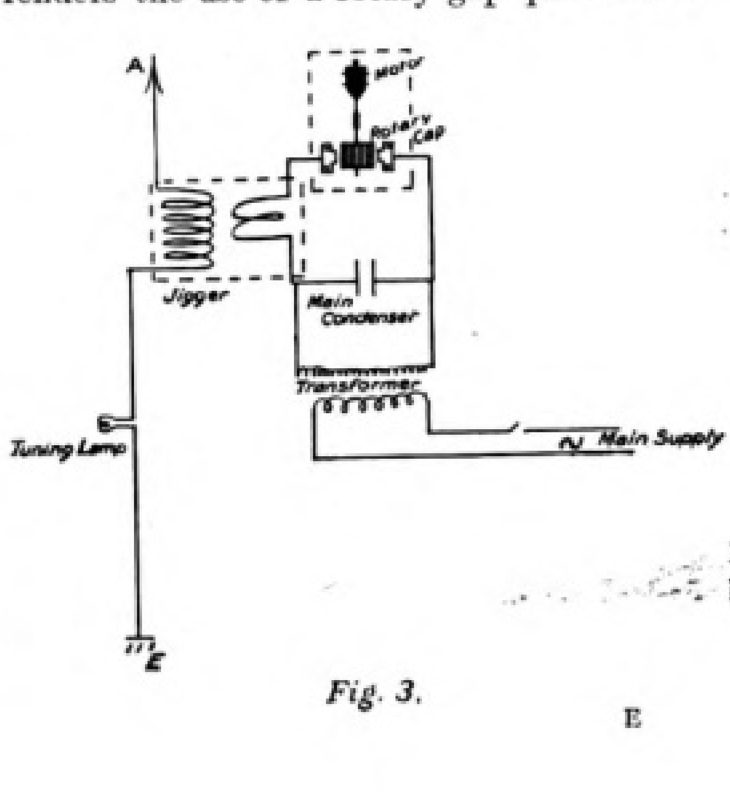


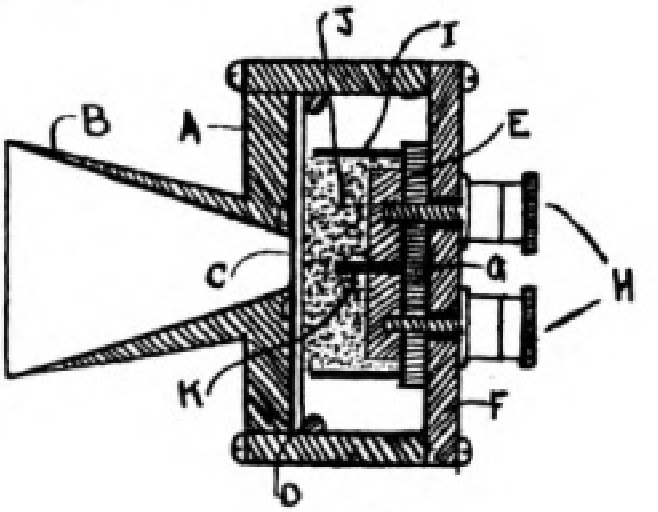
Fig. 3.

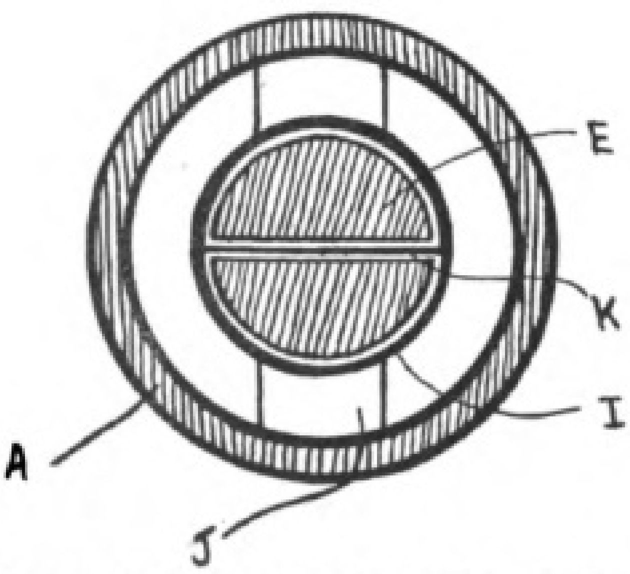
the question. On the other hand, with the alternating current with a frequency of, say, 60 ~, there will be a considerable number of discharges take place on each stud as it is passing the electrodes, and thus regular sparking is given at every stud.

A Small-Power Wireless Telephone Transmitter.

By S. W. PILLING.

AMATEURS who are interested in wireless telephony might find a description of my transmitter of service.





In the diagram A is the casing, having a mouthpiece, B, which may be of any approved pattern, the interior tapering towards the diaphragm, C, which may be of glass, aluminium, or any other suitable material. The diaphragm has rubber rings, D, near its periphery, on its opposite sides. The carbon electrodes, E, are secured by screws or otherwise to the bridge, F, and are insulated from the latter by any suitable insulation, G. The electrodes have the terminals, H, secured thereto, and are encircled by a fibrous cotton wall, I, which forms a cup for holding the granular carbon, J. This fibrous wall relieves the diaphragm of the pressure that would result from using a hard substance for the wall, hence a free vibration of the diaphragm is obtained. The electrodes are separated by a strip of mica, K, which projects into the body of the granular carbon contained in the cup. This mica separator causes the current to follow a course or circuit extending farther into the body of the carbon granules, as it must pass over or around the separator, and thus affords the diaphragm a better opportunity to disturb the path of current and produce a greater resistance to it. The construction described relieves the diaphragm of weight, deflects the path of the current, and enables the vibration of the diaphragm to better disturb the path of the current and cause a greater resistance to it, all of which results in a greater range of vibration, greater sensitiveness, absence of metallic tones, and clearer and more distinct production of the waves of vibration. This form of transmitter affords opportunities for providing high-current carrying capacity, such as is required in wireless telephony.

Institute of Radio Engineers.

At the meeting of the Institute of Radio Engineers, held at Fayerweather Hall, Columbia University, October 7th, Dr. Alfred H. Goldsmith, of the College of the City of New York, read a paper entitled "Radio Frequency Changers," in which he outlined the development of radio frequency changers and described in detail some of the more efficient methods, including in the paper frequency changes brought about by the use of chemical and magnetic valve arrangements, arc converters and reflection alternators.

At the Washington Section of the Institute of Radio Engineers, held at the Bureau of Standards, October 14th, Capt. W. H. G. Bullard, Superintendent of the U.S. Naval Radio Service, read a paper on "Commercial Traffic of the Naval Radio Service."

On November 4th Mr. H. E. Hallborg, of the Marconi Wireless Telegraph Co. of America, read a paper on "Resonance Phenomena in the Low-Frequency Circuit" at Fayerweather Hall, Columbia University

Among the Wireless Societies.

Barnsley.—At the November meeting of the Barnsley Amateur Wireless Association the members studied the first of THE WIRELESS WORLD series of Instructional Articles, dealing with electricity and magnetism, which, we are informed, was found "interesting to the uninitiated and refreshing to the memory of those who had studied the principles of electricity some years ago."

* * *

Liverpool.—A meeting of the Liverpool Wireless Association was held on October 29th for Morse sounder and buzzer practice. The question was raised as to the adoption of wireless telephones to serve as house telephones, and diagrams of connections for telephone receivers were shown. A further meeting of the Association was held on November 12th.

* * *

London.—Prof. J. A. Fleming, F.R.S., gave a most interesting address on the function of the earth in wireless telegraphy at a meeting of the Wireless Society of London, on November 13th, in the Lecture Theatre of the Institution of Electrical Engineers. Mr. A. A. Campbell Swinton was in the chair. Prof. Fleming, in his introductory remarks, regretted that, owing to the war, practical research in wireless telegraphy had had to be stopped, but urged that the opportunity should be taken of perfecting our knowledge of theoretical considerations.

The nature of the surface of the earth was extremely variable, and experiments had shown that very different proportions of the energy radiated were absorbed by the earth in different places and in different circumstances. By comparison with the calculated energy that should be received, according to the law of inverse squares, as much as 95 per cent. of the energy was in one case shown to be absorbed when short waves were employed, and very little with long waves between the same stations. It had been well known in practice for some time that short waves were better over sea than land.

In order to understand these phenomena it was necessary to consider the penetration of electric waves into conducting materials, and the lecturer went into the matter mathematically and showed that the depth of the penetration was directly proportional to the square root of the specific resistivity of the material while inversely proportional to the square root of the permeability and the square root of the frequency. That the permeability had a considerable effect was shown by the fact that, whereas for a certain frequency of the radio-telegraphic order, oscillations which would sink in to a depth of $\frac{1}{4}$ mm. in copper, would only penetrate $\frac{1}{50}$ mm. in iron. The subject was well illustrated by an experiment in which similarly dimensioned coils of different materials were included in an oscillatory circuit, and a cymometer with neon tube was employed to indicate the oscillations produced. The tube glowed brightly when copper and brass coils were introduced, but an iron coil damped the oscillations out so much that hardly any glow could be obtained. A galvanised iron coil, however, showed that the effect was only skin deep by conducting well, but a galvanised coil with part of the zinc surface purposely corroded away by acid behaved like uncovered iron. Coverings of sealing wax or paint had, of course, no effect. Incidentally, Prof. Fleming pointed out that these experiments showed that while new galvanised iron wire was nearly as good as copper for an aerial, care must be taken not to allow the zinc coating to corrode away.

The majority of the materials forming the earth's crust, with the exception of oxides of iron, were pretty good insulators when dry. Thus the problem of earth conduction was not as simple as the case of a metallic conductor already investigated, for the earth behaved more like a conducting dielectric. The lecturer developed this part of the subject a little further mathematically and showed how attenuation of the penetrating wave was produced in both horizontal and vertical directions, while the waves penetrated much further than in metallic conductors. There was a particular intermediate value of the conductivity at which the dissipation of energy was a maximum. This subject had been gone into by Zenneck, who showed that over sea water there was very little longitudinal attenuation, but with dry soil the greatest amount of dissipation of energy was produced.

There was another very important consideration, and that was that the conductivity of such substances for alternating current was not a constant as it was for direct currents, but was a function of the frequency. This had been demonstrated by himself and others experimentally, and could be perhaps explained on the electron theory by assuming that certain internal electrons in the atom capable of short range action only are able to take part in the conduction at the higher frequencies as well as the free electrons between the atoms. His original experiments were conducted up to telephonic frequencies and had shown, in the case of many materials, an increase in conductivity as the frequency rose, but later investigations showed that through still higher frequencies of the radio-telegraphic order the rise continued, but eventually a maximum value was reached, after which the conductivity slowly declined. This was true for glass, slate, and even moist blotting paper. The importance of these results lay in the indication that at radio-telegraphic frequencies the conductivity of the earth's crust was very much higher than in ordinary circumstances, but experimental confirmation and quantitative research were badly needed in the case of real earth connections, large bodies of sea water, etc.

Passing on to a consideration of the action on the earth of the radiated wave, Prof. Fleming showed how the foot of the wave, where it penetrates the earth, is distorted by the refraction produced by passing from one medium to another of different dielectric constant. A considerable horizontal component results in this way near the surface, and a surface wave is produced which travels with the aerial wave, and in the lecturer's opinion this was bound to contribute something to the result as well as the real aerial wave. It was only by that assumption that he could explain the cases of antennaless reception with which they were all familiar, such as when the Eiffel Tower time signals were received by connecting a receiver to the earth, and to any mass of metal, such as a bedstead, or a dust bin, as he had done himself. A simple experiment illustrated the effect to some extent. An elementary form of tuned oscillator of a badly radiating design sent a wave along a long metal strip to a receiver equipped with a vacuum tube and also connected to the strip. The tube was seen to light up even when the direct aerial waves were screened off by a bend in the metal sheet. The propagation of these waves was in some ways analagous to mechanical earthquake waves.

Another interesting subject was the bending of the course of the waves in long distance wireless telegraphy to conform to the curvature of the earth's surface. The extent to which this could be due to diffraction had been mathematically investigated by several workers, but it had been shown that no more than 10 per cent. of the effect in actual cases could be due to this cause, the remainder being partly due to the surface wave already referred to, and partly to phenomena of the atmosphere. The higher strata of the atmosphere some 50 miles up were not of the same composition as down here, and the lighter gases, such as hydrogen and helium, were present in large proportions. Thus the top of the wave progressing through these gases moved faster than the lower part, and so a bending over of the whole wave was produced. There was also a further possible cause of this curving of the waves due to the ionisation of the upper air, as had been suggested by Dr. Eccles. Indeed, the circumstances fitted together in a way which pointed to the likelihood of the earth being the only planet on which long distance wireless telegraphy was possible.

* * *

Newcastle.—At a meeting of the Newcastle-on-Tyne Wireless Association, held on November 5th, Mr. N. A. Drysdale lectured on wireless telephony, and dealt with the production of undamped waves as applied to this particular means of communication. After a brief account of the progress achieved up to date, Mr. Drysdale described the various ways and means used for the production of undamped waves, and he exhibited various parts of apparatus, which were inspected with keen interest.

INSTRUCTION IN WIRELESS TELEGRAPHY

(Second Course)

(V) Transmitting Condensers.

[The article in the March number completed the first course of instruction. The present is the fifth 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.]

733. Before going into the question of the actual design of a transmitting condenser it will be well to consider a few of the points involved.

The main object is to get as large a capacity as possible combined with a high dielectric strength and good insulation. It must always be remembered that it does not necessarily follow that because a condenser has a very high insulation resistance it has also a high dielectric strength. The exact meaning of the dielectric strength of an insulating material has been fully explained, and as an example, a condenser with air insulation has an extremely high insulation resistance, but the dielectric strength is only about one-thirtieth of what it would be if the same condenser had mica substituted for the air.

Insulating materials, in addition to possessing the above properties, must not deteriorate in use. For instance, ebonite is a very suitable material when quite new, but it is liable to deteriorate. Also, as will be seen later, it is usual to fill transmitting condensers with oil, and it is found that this oil has a bad effect on ebonite. It is for these reasons that **glass** is almost universally used for the dielectric of transmitting condensers. On reference to a table of the electrical properties of insulators it will be found that glass has many desirable qualities. It has a very high specific inductive capacity, does not deteriorate with age, and has a high dielectric strength. It has the disadvantages of being brittle and its surface is hygroscopic. This peculiar property which glass has of retaining moisture on its surface renders it necessary to keep it out of direct contact with a damp atmosphere.

Dielectric Hysteresis.—When a transmitting condenser is in action the dielectric is subjected to a rapidly alternating electrical strain. It is first charged up to a comparatively high potential, say 10,000 volts, then when the spark occurs a rush of current takes place which does not cease until the charge on the condenser plates has been reversed. This means that the direction of the lines of electric force has been reversed as well. The frequency of these reversals is inversely proportional to the wave-length to which the circuit is tuned, so that in the case of very short wavelengths they are extremely rapid. It is found that we get a similar effect to that which occurs when a changing magnetising force is applied to a piece of iron, and which has been described in the previous articles under Magnetic Hysteresis or Retentivity. There it was explained that the actual magnetism in the iron did not exactly follow changes in the magnetising force, but that it lagged a little behind it. This effect is called "Hysteresis." A similar thing happens in the dielectric of a condenser, only in this case we have electric force instead of magnetic, and a dielectric instead of the iron. The actual change in the state of the dielectric does not accurately correspond to the changes in the potential of the plates, but it occurs a little later. This effect is very similar to the mechanical effect of friction and like friction **it results in a loss of energy.** The result of this is that when the condenser is in use its temperature rises. Now, when a dielectric is heated its electrical strength is reduced, hence the necessity of the oil previously referred to.

Condenser Oil.—The oil used in condensers must be a special quality mineral oil, free from water. It has several functions; it keeps the condenser cool by circulating between the plates, and condensers have been designed with corrugated plates for the purpose of allowing a free circulation of the oil; it also increases the capacity of the condenser by filling up all the spaces between the metal and glass plates due to surface irregularities. It has a specific inductive capacity of from 2 to 3. It maintains the insulation of the condenser by protecting the glass plates from direct contact with damp air and prevents surface leakage and sparking round the edges.

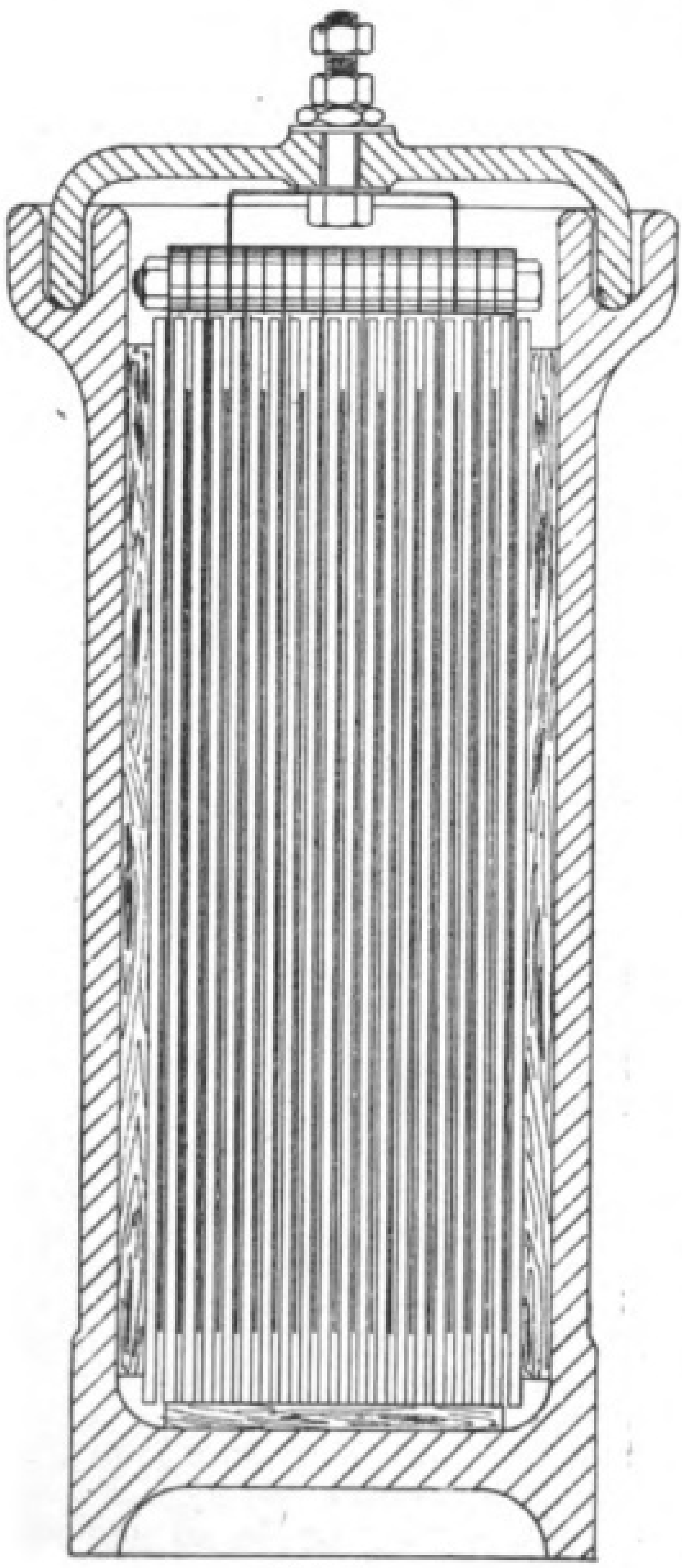


Fig. 1.

CONDENSERS FOR PERMANENT STATIONS.

The condenser of a transmitting station is made up of a number of units which are connected up in series or parallel or a combination of both, so as to give the required capacity combined with the necessary dielectric strength. It is clear that if we take a single condenser unit consisting of a number of zinc plates interleaved with glass and it has a dielectric strength of, say, 10,000 volts, and if we connect two such units in series we shall double the potential to which the condenser can be raised before puncture occurs. The effect of connecting two condensers in series is just the same as if we put two glass plates between zinc plates instead of only one. A condenser bank, then, consists of groups of units in series, as many of these groups being connected in parallel as is necessary to give the required capacity. The section of a unit commonly used is shown in Fig. 1. The containing vessel is made of either porcelain or galvanised iron. In the case of the porcelain container no special insulators are necessary for the condenser terminals, the terminal simply consisting of a brass rod provided with lock nuts for securing it in a hole in the lid. When a galvanised iron container is used an ebonite insulating bush is provided for the terminal as shown in Fig. 3. The glass plates are often supported in a zinc cradle for convenience in withdrawing from the container.

It is absolutely necessary that a wide margin should be left all round the glass plates. That is to say, the glass plate must be considerably larger than the zinc plate. At least two inches should be allowed at every edge. If this is not attended to leakage will occur and actual sparking may even take place. Means must also be provided to prevent the zinc plates from slipping down and reducing the margin at the bottom. This is accomplished by inserting wedges between the top of the glass plates and the bars joining all the zinc plates of one side of the condenser. Sometimes the lugs at the tops of the zinc plates are turned over so as to hook on to the tops of the glass plates and are thus prevented from falling. Another reason for allowing a sufficient margin is that it is necessary to keep the losses due to brushing at the edges of the zinc plates as small as possible, or considerable heating of the condenser will result. The glass plates should be given a coat of shellac varnish and mounted dry in a box, due consideration being given to insulation. It is usual to let the condenser have an extra end plate on one side as shown in the figure, where there are three plates on one side and four on the other. This is simply to get the maximum capacity for a given number of plates; both sides of the plates of the smaller half are then used. A useful formula for the calculation of the approximate capacity of a condenser is:—

$$C_{mfds.} = \frac{N \times A \times S}{2 \times \pi \times d \times 900{,}000}$$

Where N = number of plates in smaller side of condenser.
A = area of single zinc plate in sq. cms.
S = specific inductive capacity of dielectric.
π = 3·14.
d = thickness of dielectric in centimetres.

It must be remembered that this formula will only give a rough estimate of the capacity, because of the irregularities in the plates, etc. Also the specific inductive capacity of the particular sample of dielectric will probably not be accurately known. It can be determined approximately by reference to a table of the electrical properties of dielectrics. For small amateur stations where efficiency is not very important an oil-immersed condenser is not necessary.

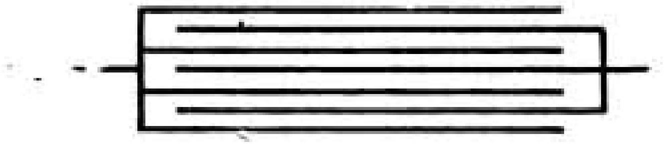


Fig. 2.

For portable stations a different type of condenser is generally used. It is not oil immersed, and it is arranged so that when mounted it is not liable to breakage due to rough handling. Briefly, it consists of a very long Leyden jar of small diameter like

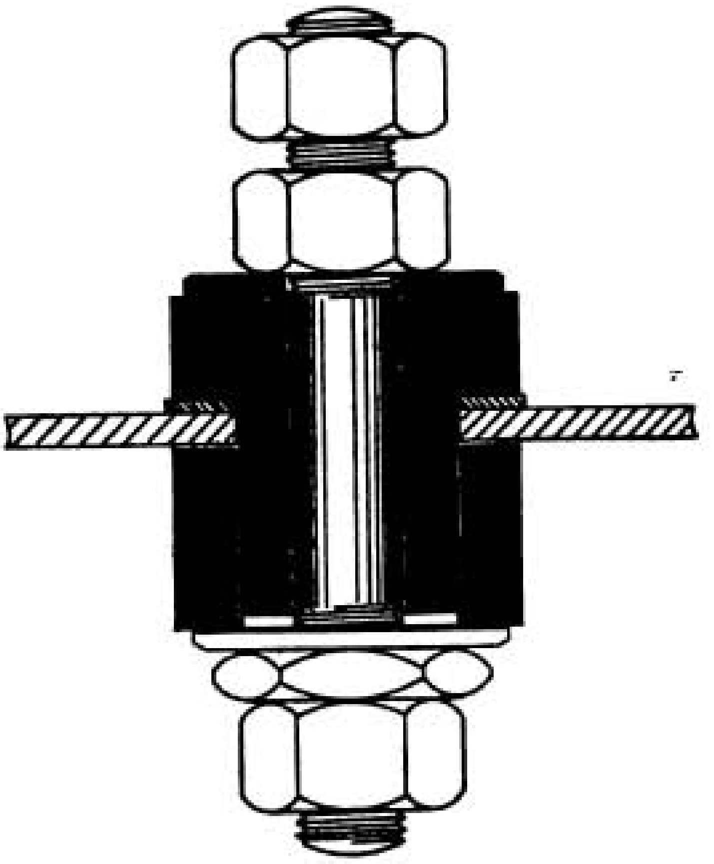


Fig. 3.

a very large test-tube. It is coated inside and outside with copper by a special process, a large margin being left at the top to minimise brushing. A spring screw connection is provided at the top (the tube being closed by an ebonite plug) for making the contact with the inner coating. In use the tube is screwed into its holder by the screw connection at the top and the spring presses it down on to a soft copper-asbestos washer. The condenser unit is thus held quite securely and will withstand a large amount of rough handling.

Diary of Meetings.

WEDNESDAY, DECEMBER 2ND.

Barnsley Wireless Association.—Meeting Shaw Lane Cricket Ground, 7.30 p.m.

THURSDAY, DECEMBER 3RD.

Newcastle Wireless Association.—N. A. Drysdale on "Wireless Telephony," at 29 Ridley Place, Newcastle-on-Tyne, 7.30 p.m.

WEDNESDAY, DECEMBER 9TH.

Birmingham Wireless Association.—N. Leas, B.S.C. (L.X.H.), on "Wireless Telephony," at the Midland Institute, 7.30 p.m.

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.*

PLOWES (Leeds) writes: "Taking the efficiency of a single wire as one, by putting up two wires would the clearness of received messages be doubled, and, again, by putting up four wires would the same be quadrupled, and so on?" Unfortunately, no. The effect of adding another wire to a single wire aerial is to increase the capacity of the aerial. It does not, however, double the capacity, on account of the influence of the wires on one another. If the wires are very close together, the total capacity is only slightly greater than that of a single wire: with the two wires 6 feet apart, their capacity may be about 1·6 times that of a single wire, while when they are far apart it will be practically twice as much. Six feet is a suitable distance apart for the wires of an aerial, though possibly three wires with 4 feet between each would be slightly better. Of course intermediate wires between the outer ones have an even less effect on the capacity. Increasing the aerial capacity means that a smaller inductance will be required in the base of the aerial to tune it up to the required wave length. This means less resistance loss in the aerial. The ideal capacity would be such that all the inductance in the base would just provide enough jigger to give a suitable coupling to the secondary. This hardly ever occurs with the amateur, so that he is justified in making his aerial capacity as big as possible by the use of several wires, providing the individual wires are at a sufficient distance apart to be of use. In the case of the receiving aerial on a big station, it will usually contain less wires than the corresponding transmitting aerial, as it then has a capacity big enough to tune to the required with a suitable jigger.

H. H. I. (Manchester).—In your instructional articles you state that for a given substance the waves in it travel at a definite speed, and that the speed is greater the greater the density of the substance: thus waves in the air travel at the rate of 1,040 feet per second, in water at 4,700 feet per second, in steel 16,400 feet per second, and in the ether the velocity is 1,000,000,000 feet per second. Therefore according to this I take it that the ether is 200,000 times as dense as steel. Is this correct?

Answer.—The complete expression for the velocity of a wave in a medium is $V^2 = \frac{\text{Elasticity}}{\text{Density}}$

velocity $\sqrt{\frac{\text{Elasticity}}{\text{Density}}}$

In the case of the ether, the only thing that we can determine is this velocity. We are not entitled to say anything about the separate values of either the density or the elasticity. A high wave velocity can be accounted for either by assuming a high value for the elasticity, or a low one for the density. Or, again, the density may have as high a value as we like, providing the elasticity is correspondingly higher. In the case of electro-magnetic waves in the ether, the elasticity concerned is not that which resists compression, but that which resists shear. An example of this elasticity is given by a pack of cards fastened together by an elastic band. The cards if pushed sideways over one another will resist and return to their normal position on release. Corresponding to this, the density is not the density given by the mass per unit volume of the ether, which is the ordinary definition of density. It is more akin to the rotatory inertia of gyroscopes. That is, the inertia that makes it necessary to apply force to twist a rapidly rotating wheel out of its plane. Readers who are interested in this question can easily convince themselves of the existence of this form of inertia by spinning the detached front wheel of a bicycle, holding the axle in their hands. They will then find that it requires the exertion of considerable force to suddenly twist the axle round, the force required increasing with the speed of rotation.

RELLEW (Sevenoaks) has seen it stated in a contemporary that it is possible to get signals so loud that they will be audible with the telephones 30 feet away. (We ourselves have had Clifden and Hanover loud enough to be heard at twice this distance). He then gives us details of his apparatus (but no diagram) and asks us to put him in the way of getting such loud signals for himself. His aerial is 100 feet long and 40 feet high, and his receiving set is a direct coupled one, operating a silicon gold-point detector with a telephone wound to 2,000 ohms.

Such loud signals as our correspondent has in mind are only obtained by arrangements in which the received signals are magnified some hundreds of times by the aid of relays, such as those advertised by S. G. Brown in THE WIRELESS WORLD, or by some equivalent device.

We suggest the following improvements in his apparatus: Make the aerial of L type, if it is not so already, and see that the earth is a good one, such as soldered connections to the water pipe system or to galvanised iron plates, buried in the groun'. The substitution of a loose coupler for a direct coupled arrangement would be a distinct improvement for the reception of shorter waves. Finally, get some good crystals of carborundum, and use them in connection with a potentiometer and his high-resistance telephones. It is only by sticking to a detector like carborundum that combines sensitiveness with constancy that he can hope to testpossible improvements in his apparatus. When once he has got that working satisfactorily, he can test new crystals until he finds one thatsuits him.

J. K. H. (Plymouth) asks for a description of an "Interrupter" as used in receiving circuits. Probably the instrument is the Tone Wheel invented by Dr. Goldschmidt for the reception of continuous waves. It consists simply of a high-speed commutator, and is connected in the secondary of the receiving circuits as in the figure 1, so that it stands exactly in place of a crystal. Now suppose this tone wheel is run at such a speed that one tooth makes contact during each oscillation of the high-frequency current in A—*i.e.*, the frequency of the make and break is the same as that of the current in A. Fig. 2 (p) shows this case. From this it will be seen that the voltage of the condenser, A (given by the curve (a)) will be the same at each contact of the commutator. Hence the condenser of B will be charged to the same voltage at each contact. This gives a steady current through the telephones which would not make the diaphragms vibrate.

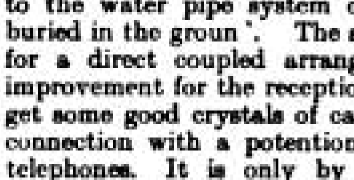


Fig 1.

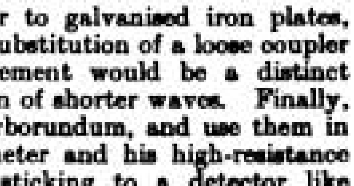


Fig 2.

If, however, the tone wheel is run at a slightly different speed, the instants at which the contact will fall will be as n i_1, i_2, i_3, etc., in Fig. 2 (q), so that the voltage to which the condenser of B will be charged will be given by the curve (b). The frequency of this variation will be $(n_1 - n_2)$ where n_1 is the frequency of the current in A and n_2 is the frequency of contact of the tone wheel. Hence the curve (b) may represent a voltage of audible frequency (say 1,000). When the condenser, B, discharges through the telephones it will make the diaphragms of the telephones vibrate, and this will give rise to an audible note. For best results the circuit of the telephones and condenser should be tuned to this note-frequency.

L. D. (Nice).—With reference to your answer to my previous question, I do not understand why you advise me to make one coil slide inside the other, as you do not intend it to be an inductively coupled receiving set. My house is a large one, and situated at the top of a hill. My earth consists of water pipes, and the instrument room is on the top floor. When the instruments are not in use, I disconnect the aerial from them, and connect it to earth. During a recent violent thunderstorm signals were heard in almost every room in the house. Would these be caused by my aerial? An independent earth connection would be difficult and expensive to instal owing to the nature of the ground. Would it be better and safer to take as an earth instead of the water pipes the lightning conductor which passes near the instrument-room window?

Answer.—The set for receiving Clifden was meant, as you say, to be a direct coupled one. By sliding one coil inside the other the total inductance of the pair could either be made greater or less than their inductance when apart, according as the windings of the two coils went round the same or the opposite way. This gave one method of varying the wave length of the aerial. Providing the coils were coupled the right way, it also enabled less wire to be used.

It will be far safer during thunderstorms to connect the aerial direct to the earth of the lightning conductor, not bringing it into the interior of the house at all. The earth of the lightning conductor should consist of a plate at least 3 feet square or an equivalent area. If it does not, it will be better to bury a separate plate of about this area (say 8 sq. ft.) edgeways on, with its upper edge at least a foot below the surface. A copper wire soldered on to this will then give a good earth connection for the aerial.

Finally, we must apologise for the long delay, as your letter has only just come under our notice.

C. M. (Longsight).—We do not understand your question. The secondary of a receiving oscillation transformer is wound in one coil and not in sections. The actual dimensions depend upon the capacity of the tuning condenser and the wave-length it is desired to receive, and not on the length of the aerial.

A. W. (New Brighton) has read our answer to his previous query in THE WIRELESS WORLD, and sends us two diagrams of connections for a single-slide tuning coil. In one the crystal, etc., is placed right across the whole of the inductance, which has a condenser in parallel with it, and in the other the crystal is across the inductance included between the top end of the coil and the earth slider. He also enquires (1) how to make a tuned buzzer circuit as described in THE WIRELESS WORLD for February, and (2) how to work a cheap coherer with an aerial left distant from a corrugated iron roof situated on a hill overlooking the transmitting station.

Answer.—We are always pleased to hear from enquirers who have been assisted in their work by replies given in these columns, especially when, as in your case, they also read the answers to others as well as their own. From the particulars you give you should be able to tune up to Poldhu, but the wave-length of Clifden is too great for your circuit. When using a single-slide coil there is not much to choose between your two methods of connecting. For a tuned buzzer circuit such as you mention a condenser of about ·003 to ·01 mfd. capacity is suitable, this giving you wave-lengths up to about 2,000 or 3,000 metres with an inductance of moderate size. A coil of large inductance is not suitable as excessive sparking is liable to occur at the contacts of the buzzer. Taking a condenser of ·01 mfd. capacity as a basis, for a wave-length of 2,000 metres a coil of 25 to 30 turns on a former 6 inches in diameter would be suitable. The former should not be too small, 6 inches square or circular is about right. The winding should be of No. 20 or 22, so that the resistance is not large. The value of the non-inductive buzzer shunt is best found by trial, but as a first attempt you might try about 20 ohms. Everything will depend upon the design of the buzzer.

(1) A sensitive coherer should work under the conditions you name, but whether the kind "one buys for 3s. 9d." falls under that description we are unable to say.

(2) You do not give enough details of the range of a transmitting aerial worked by an ignition coil. The range depends so much upon the actual design and arrangements both of the receiving and transmitting stations that it is impossible to give even an estimate without either a personal inspection or a very complete account.

E. R. W. F. (Southport).—We should say that you had not a sufficiently large inductance to tune your aerial to a wave-length of 6,000 metres. For fairly long waves compared with the natural wave-length of the aerial, the inductance required increases as the square of the wave-length it is wished to tune to. This follows from the fundamental wireless formula $\lambda = 1885 \sqrt{CL}$ or $\lambda^2 \alpha\, CL$. As the capacity of the aerial is fixed, and the inductance of the aerial is small compared with the aerial tuning inductance, it follows that "L" must vary as the square of the wave-length. That is, we should require nine times as much inductance to tune a given aerial to 6,000 metres as to tune it to 2,000 metres. These are roughly the wave-lengths of Clifden and Cleethorpes respectively. Wind another inductance 6 in. diameter, and 24 in. long, but of No. 28 wire, and try again for Clifden when circumstances permit, either with the new coil alone or with the two coils in series. For a small aerial, the direct coupled receiver is probably as good as a loose coupled one for the reception of long waves.

S. R. (Kensington) asks for the most efficient aerial for transmission and reception on a wave-length not exceeding 100 metres.

Answer.—So far as we know, no experimental work has been done on the efficiency of an aerial when working on its third harmonic. The first harmonic has been tried in order to get a shorter wave-length, but the method was abandoned. From general considerations we should say that on such a harmonic very queer interference effects may occur, and these may make the interpretation of experimental results a difficult matter. Secondly, it is not possible to bring the wave-length of an aerial down to less than half its natural wave-length by means of a series condenser in the aerial. For if we take the extreme case, when this condenser has zero capacity,—*i.e.*, when it is a simple break in the base of the aerial—the aerial then oscillates with antinodes of potential at both ends, and a maximum of current in the middle. Hence the wave-length emitted will be the same as that of an earthed aerial of half the length. The effect of a series condenser can go no further. We should therefore recommend the four-wire vertical aerial, using its fundamental wave-length. Nevertheless we should be very interested to hear of the results of any experimental work on an aerial working on one of its harmonics. In reply to the further queries: The bottom of the jigger is connected to the middle point of the battery in order to be able to send current in either direction round the circuit, and thus suit different crystals. With any particular crystal, once the direction of the sensitising potential is found, it would not be necessary. A variable condenser across the telephones is useful for a kind of note tuning, but nothing wonderful is to be expected from it.

Among the Operators

WE learn with great regret of the death of Marconi operator Basson, which occurred as the result of a boating fatality in Cowes Road on Wednesday, November 11th.

James William Basson was 20 years of age, and had recently been appointed to duties on the *Armenian*, one of the Leyland liners, which is now being used as a transport. Previously to this he was operator on the *Minnehaha*, and proved himself efficient in every way. His service, however, with the company has been a short one, for he was only appointed to the staff on June 28th of this year. Nevertheless, the work that he had already done had been accomplished with thoroughness, intelligence, and promptitude, which gave great hopes that his career would be a successful one.

J. W. Basson.

The first officer of the s.s. *Armenian*, in giving evidence at the inquest, which was held on the following Friday, stated that he and four other men, including James Basson, came ashore for the mails in one of the vessel's small boats. On their return journey the weather was very stormy, and just as they were lowering the sail when they were about 150 feet from the ship a big sea struck their boat, and two other waves following in quick succession first rolled her over and then capsized her. All but Basson clung to the ship, and immediately cries were raised of "Where's Basson?" The witness commenced a search for him, and finally reached him and dragged him to the boat's keel, but he seemed powerless to raise an arm or assist them in their efforts to save him. Finally the capsized boat righted herself, and all the men were taken to the s.s. *Basil*, who, with the s.s. *Minneapolis*, had sent out rescue parties. Immediately the doctor on board the *Basil* did all he could to resuscitate the unfortunate operator, but without avail. Death was found due to shock following exposure.

The funeral took place at Cowes Cemetery on Saturday, November 14th, in the presence of the deceased's relatives, besides the captain, officers, engineer, and senior operator of the *Armenian*, and Inspector Robinson, who represented the Marconi Company.

* * *

It is with much regret that we have to announce the death in Baltimore from appendicitis of Mr. Wilfred Holdsworth, Marconi operator of the s.s. *Maryland*. Mr. Holdsworth, who was 20 years of age, was a comparatively new member of the Marconi operating staff, having joined the Company in August last. He first saw service as assistant operator on board the s.s. *Andania*, and was appointed as operator-in-charge of the *Maryland* on September 10th.

Wilfred Holdsworth.

* * *

A promising career was prematurely cut off in the loss of George Halliday Finlay, who was one of the operators on board the ill-fated *Aboukir*. Mr. Finlay volunteered for service on the outbreak of war, and his letters home and to his friends revealed a cheerful spirit. At the time the *Aboukir* was torpedoed he was waiting his turn to go on duty in the wireless room, and was talking to Massey (who, as announced last month, also lost his life), when the ship was struck. The Chief Operator, Mr. Dansey (the only one of the operators of the *Aboukir* to be saved), spoke to Finlay shortly before his death, and in a letter to the deceased's relatives he expressed his high appreciation of Finlay's services.

A Theory

By W. B. COLE.

THE following article, though not dealing directly with any wireless subject, discusses one of the fundamental principles on which modern wireless telegraphy is based, and in regard to a very old story, so that it seems not out of place to include this article in this magazine.

A few preliminary remarks and examples cannot fail to be of interest to those who are not familiar with the principle of Resonance, and it will serve to lead up to the " theory " propounded at the end of this article.

Broadly speaking, every material body will vibrate—and that most easily—at a certain definite rate called its natural period. If impulses are given to it at exactly this rate then the effect is cumulative, that is, the second impulse increases the effect derived from the first, the third from the second, the fourth from the third, and so on, just as a little child by giving even feeble, but properly timed impulses can cause a heavy man in a swing to oscillate violently in a short time.

There are limits, of course, to the extent to which the oscillations or swings can reach, generally either the body becomes so agitated that it breaks or the extra energy given to it after a certain point is reached is dissipated in various ways. A well-known example is the following acoustical experiment—the natural tone (vibration number) of a wineglass is noted. Someone with a powerful voice now leans over the glass and sings that same note strongly, when the effect of the accumulation of impulses will often cause the glass to break. The voice is stated to be in resonance with the natural period of the glass.

As suspension bridges have natural periods of vibration, soldiers marching across them are always ordered to break step, as there is a possibility of their regular impulses approximating to the natural periods of the bridges and so cause damage. I think it was Prof. S. P. Thompson who suggested that it is extremely likely that this phenomenon of resonance might have been the cause of inexplicable losses of vessels at sea where it was known that they did not encounter bad weather. One has only to assume that the vessel broke her propeller or in some way became unable to steer, and that she was caught on broadside by a swell having a period equal to the natural period of the ship. The ship would gradually oscillate more and more until it would capsize.

Prof. Perry in his book " Steam Engines " mentions how the young engineer receiving a complaint from a householder regarding the excessive vibration of a certain room in a house due to the traffic of a near railway would contrive to give the room another vibration number by moving slightly a heavy piece of furniture—an easier solution than making alterations to the railway track.

Sir Oliver Lodge tells in his book " Signalling Across Space Without Wires " how a certain stone at Stonehenge was found to be sensitive to vibration, and consequently warning notices were posted up forbidding sudden noises to be made in its vicinity. A military officer once disregarded this warning and fired his pistol, whereupon the whole mass, weighing several tons, fell to the ground, and it had to be replaced at the officer's expense.

It might be mentioned in passing that successful modern wireless telegraphy is based upon this principle of resonance, but in an electrical manner, for the aerial suspended from the masts of a vessel can oscillate electrically at a certain definite period and will do so if the electrical impulses of the same period are given to it. The usual wave transmitted from the mercantile vessels is that of 600 metres, which corresponds to a frequency at the rate of half a million impulses per second. If this wave radiated out from one aerial, strikes another having the same period of half a million, then the same phenomenon takes place—energy is accumulated, and is accumuated until it is sufficient to operate the instruments in the wireless cabin to which the aerial is connected. The total aerial is not only that seen above the decks of the vessel, but it is carried down into the wireless cabin, where it can be electrically lengthened or shortened by the manipulation of suitable instruments by the operator. It is his function to so change the length until it is in resonance with the incoming wave, when maximum effect is immediately recorded on the instruments.

After this preliminary exposition and these examples, the writer wishes to refer his readers to the following passages in Holy Scripture :

(1) Acts, vii. 22 : "And Moses was learned in all the wisdom of the Egyptians and was mighty in words and in deeds."

(2) Deut. xxxiv. 9 : "And Joshua the son of Nun was full of the spirit of wisdom ; for Moses had laid his hands upon him."

Josh. vi. : This gives the account of the preparation for and the fall of the city of Jericho.

The chapter describes in detail how the city was regularly compassed during the week, and how on the seventh day when the priests blew with the trumpets the people shouted with a great shout and the wall of the city fell flat.

In light of the above examples, it seems quite clear to the writer that Moses, who was learned in all the wisdom of the Egyptians, imparted to his successor Joshua the knowledge of the principle of resonance, and that Joshua discovering that the wall of Jericho responded to a certain note made use of this principle.

During the week he kept his men busy walking round the city in order to keep the inhabitants within (verse 1). The Israelites were strictly enjoined to maintain silence, so that the priests who blew with the trumpets might make the necessary acoustical experiments, and to tune all their trumpets to the same pitch. The seventh day all was ready. The people completely encircled the city and at a given signal the priests blew with their trumpets, the people shouted, *the same note*, and the effect of this choir of 40,000 men (Josh. iv. 13) caused the wall to collapse.

N.B.—Suffragettes are earnestly requested not to make injudicious use of this important phenomenon as the hands of the prophet have not imparted to them the spirit of wisdom.

LIBRARY TABLE.

According to the new regulations set out by the International Convention for the Safety of Life at Sea, a printed copy of the code of urgent and important signals must be placed in a prominent position in the chart-room of every ship. Messrs. James Brown & Son, of Glasgow, the well-known nautical publishers, have just issued a set of signal cards designed to meet these new requirements. The signals, which are printed in clear type, are divided into four sections: (1) urgent and important signals ; (2) general signals with instructions ; (3) nationality signals ; (4) the Morse code of signals. They are mounted on strong boards with eyelet holes either for hanging or pinning on the cabin wall. Nothing more serviceable could be devised. They are priced at 1s. each. Messrs. Brown have also brought out a handy folding chart of the Flags of all Nations, supplemented with notes on flag signalling and distress signals. Diagrams are also included of the rigging and sails of a ship. The whole is bound in a canvas cover, and is published at the equally low price of 1s.

"TELEGRAPHO SEM FIO" (Wireless Telegraphy). By Ricardo Frederico de Lima. Published by Officina Typographica da Escola Gerson, Estrada Nova do Engenho da Pedra 601, Rio.

Mr. Lima is instructor at the Marconi School in Rio de Janeiro, and the text-book on wireless which he has published will fill a long-felt want in Portuguese-speaking countries, where there has hitherto been no elementary treatise on the subject. The Portuguese or Brazilian student desirous of taking up wireless as a profession can find in Mr. Lima's book the necessary explanations and rules. The first chapters deal with the elementary principles of electricity and magnetism, followed by chapters treating of the practical application of electricity to wireless communication. The text is made additionally clear by the diagrams of the ½-kw. and 1½-kw. Marconi installations. De Forrest and Telefunken installations are also described. The usefulness of the text-book is enhanced by the translation into Portuguese of the international regulations relating to wireless telegraphy.

COMPANY MEETINGS.

The Spanish and General Wireless Trust, Limited.

THE third Ordinary General Meeting of The Spanish and General Wireless Trust, Ltd., was held at Marconi House, Strand, London, W.C., on October 23rd, Mr. Godfrey C. Isaacs, managing director, presiding.

The Chairman, in moving the adoption of the report and accounts, said the past year had not been a very propitious one for any financial transactions as would normally come within the province of this company's affairs, and therefore it had done little or nothing in that direction. The principal assets of the company consist of the shares held by the company in the "Compania Nacional de Telegrafia sin Hilos" of Spain. That company's business had certainly made some progress. The receipts at the stations had shown quite an appreciable increase, but they had not increased to that extent which alone would enable the company to work upon profitable lines. The main source of revenue for that undertaking would be from a telegraphic business between Spain and other parts, mainly internal, and the Canary Islands. Unfortunately since the Spanish Government had granted the concession under which the Spanish company works, it had made certain changes in legislation which had materially impaired the value of the concession granted to this company. Under those circumstances representations have been put before the Spanish Government, and he, Mr. Isaacs, went to Madrid to personally take part in that work. He was satisfied that the Spanish Government appreciated the fact that it has very seriously impaired the property which this company held, and he thought the result would be that the Government would purchase the stations held by the Compania Nacional at a proper price, and pay them such other compensation, in consequence of the harm which had been done to the concession, as should place the Spanish and General Wireless Trust in a fair intrinsic position. That was to say, the compensation and price to be paid to the Compania Nacional would, he hoped, place it in the position of holding its capital intact, in which case, of course, the business which it would in future conduct would require a very much smaller capital than that which it had. Consequently there would be some change, in all probability, when the proper time came, which would enable a very considerable return of the original capital invested.

The service which was intended to be opened up between this country and Spain had been ready for some time, but in consequence of the war it had been found impossible to start that service.

The resolution was carried unanimously, and the retiring director, Major S. Flood-Page, was re-elected.

* * *

The Amalgamated Wireless (Australia) Co., Ltd.

The first annual general meeting of the Amalgamated Wireless (Australasia), Ltd., was held at Sydney on August 27th last.

The Directors' Report states that the amalgamation of the Australasian Wireless Company, Ltd., with the Australian branch of Marconi's Wireless Telegraph Company, Ltd., London, was brought into operation as from November 30th, 1912, so that the actual working of the present company extends over a period of nineteen months.

Ships subsidies have increased from £2,350 for the quarter ending March, 1913, to £3,650 for the quarter ending June, 1914, and traffic receipts have increased from £300 for the quarter ending September, 1913, to £400 for the quarter ending June, 1914. The company now controls under subsidy agreements for fixed terms 75 passenger and cargo vessels, and the directors state that no opportunity of securing the development of new business is being lost sight of.

From the net profit standing to the credit of the profit and loss account, the directors recommend the distribution of a dividend of 4 per cent. on the capital of the company, absorbing £5,600, passing £3,000 to patents reserve account, and carrying the balance of £16 7s. 8d. forward to next account. The profit and loss account shows that the gross profit from trading account, radiotelegraphic traffic, ships subsidies, royalties, etc., amounts to £29,344 5s., and after deducting all expenses (including depreciation) amounting to £20,727 17s. 4d., there is a net profit of £8,616 7s. 8d.

PERSONAL.

David Sarnoff, the Traffic Manager of the Marconi Wireless Telegraph Company of America, is an interesting personality.

When first he applied for a position in the Marconi Company, which at that time had its offices in William Street and not in the famous Woolworth Building, he was told that the only vacancy was amongst the staff of boy messengers. But the applicant was not above taking the humbler position, for he trusted to his own merits to make his way.

He was not long waiting. It happened that the manager on one occason had an urgent message to despatch and no operator was available. This was Sarnoff's opportunity. Already before entering the Marconi service he had acquired some knowledge of telegraphy, and volunteered to send the message. Results were satisfactory and the "new boy" made so favourable an impression that when, a few weeks later, a vacancy occurred he was assigned to take the place of the operator whose post he had temporarily filled. This was a good step up and Sarnoff made the most of it. He gained permission to work in the Research Laboratory, spending most of his spare hours absorbed in the study of the technical side of his work.

He was found to be a reliable and accurate operator, and shortly afterwards was appointed to the Marconi Station at Siaconsett, Mass. After eighteen months' service here he was transferred to Sea Gate Station, where he ultimately became manager, an important position for so young a man, but results showed that the confidence of his company had not been misplaced. Then he was appointed operator to a sealing vessel and made a long cruise in the Arctic in this capacity. At the conclusion of the voyage he again took up duties in New York, and when the famous Wanamaker's store wireless station required a manager he was detailed to take up the post. The new duties gave him regular leisure hours, and these he employed in attending night classes at the Pratt Institute, Brooklyn, where he successfully completed a special course of electrical engineering.

His next promotion was to that of inspector, and ultimately he became chief inspector. It was then that he performed important services for the Marconi Company when he took charge of the initial tests of the direction-finder and the installation of wireless on the Lackawanna Railroad.

Throughout his business career Mr. Sarnoff had shown great business instincts, and when the question arose as to the appointment of a new contract manager, the aforetime "boy messenger" was selected to fill the post, and there is no one who will deny that David Sarnoff deserves the success he has achieved.

Captain Arthur Bray, of the Northern Wireless Signal Company, Royal Engineers (T.F.), has been promoted to the rank of Major.

On November 4th the staff and students of the City School of Wireless Telegraphy, Ltd., Manchester, were entertained at supper by the Principal, Mr. J. R. Halliwell, at Sellers' Restaurant, Market Street. The after dinner toasts, the King (Mr. Grocott), the Army and Navy (Mr. Halliwell), the Students (Mr. Thornton, instructor), and Mr. Halliwell and the School (Mr. Jones, a student) were duly honoured, and the party passed the remainder of the evening at the Hippodrome, where seats had been booked for the performance.

P. A. Hitchcock (late Sergt. R.E.) has been promoted to be Second-Lieutenant in the Northern Wireless Signal Co., Royal Engineers (T.F.)

TRADE NOTES.

There is no lamp better adapted for Morse signalling than the Stevens-Lyon Patent Self-Contained Portable Lamp. Its flashes can be distinctly read at a distance of eleven miles. It has been designed on a scheme combining both electric and oil fuel, for the signal itself is electric, but the lamp includes also a separate oil reading lamp. The whole apparatus is wonderfully compact, and weighs about 6½ lbs. It is fitted with a standard Morse key, and supplied by Graham & Latham, of Victoria Street, London, S.W.

Messrs. Norris, Henty and Gardners, Ltd., inform us that the United States Government have modified the very stringent rules relating to the carrying of inflammable oils on passenger vessels. The prohibition will no longer hold good in cases where gasolene or petroleum products are necessary for the working of engines supplying power for auxiliary lighting or wireless systems. As this type of power plant is increasing in public favour, the action of the United States Government in the matter will have a direct influence on American maritime trade.