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THE WIRELESS WORLD

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DECR 1916

The Arlington Radio Station

Simplified Calculations

Lady Operators at Work

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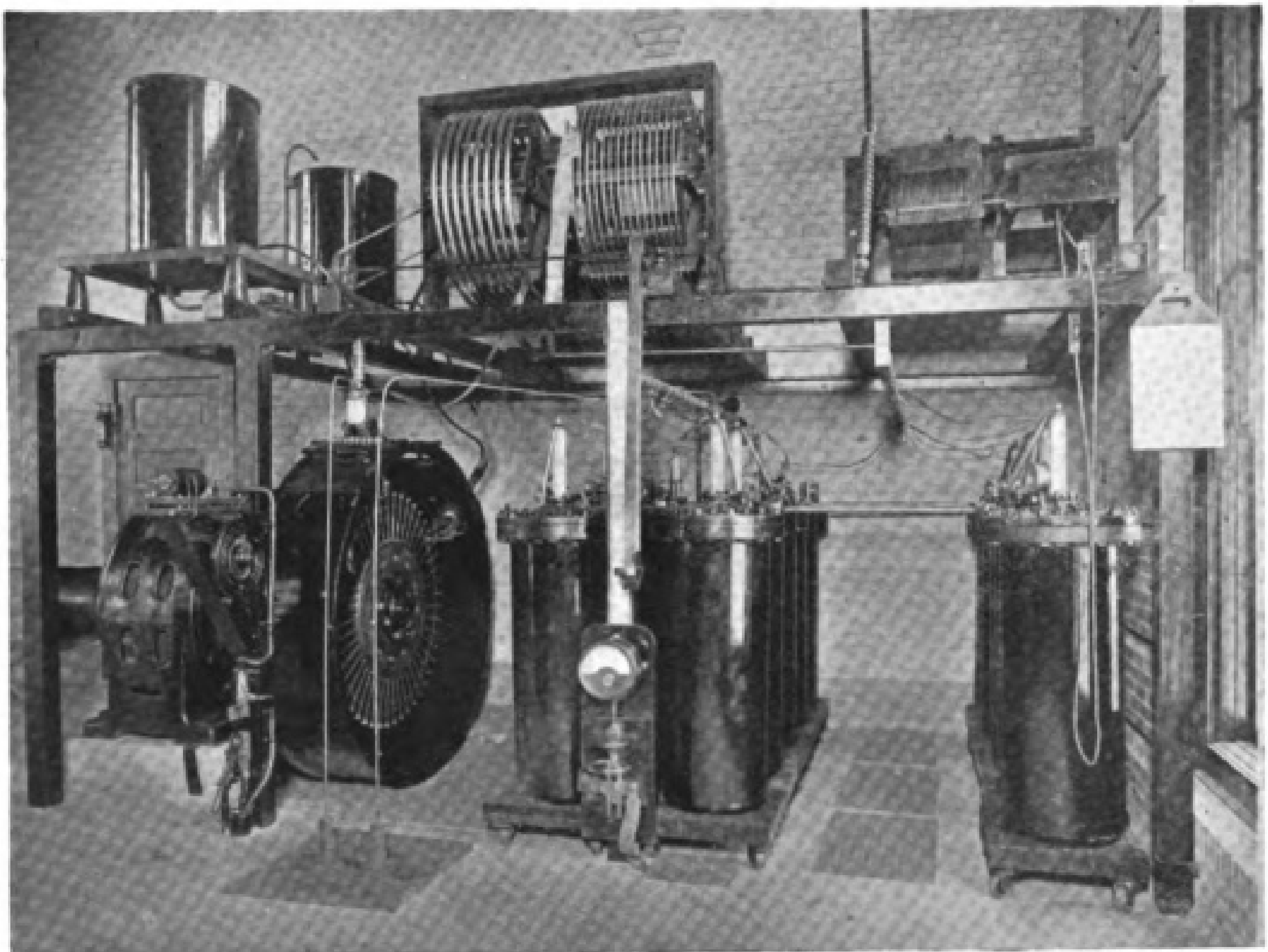


Photo] [Buck, Washington.

A VIEW OF THE 100-KW. SPARK TRANSMITTER AT WASHINGTON RADIO.

The United States Radio Station at Arlington

Its Erection and Equipment

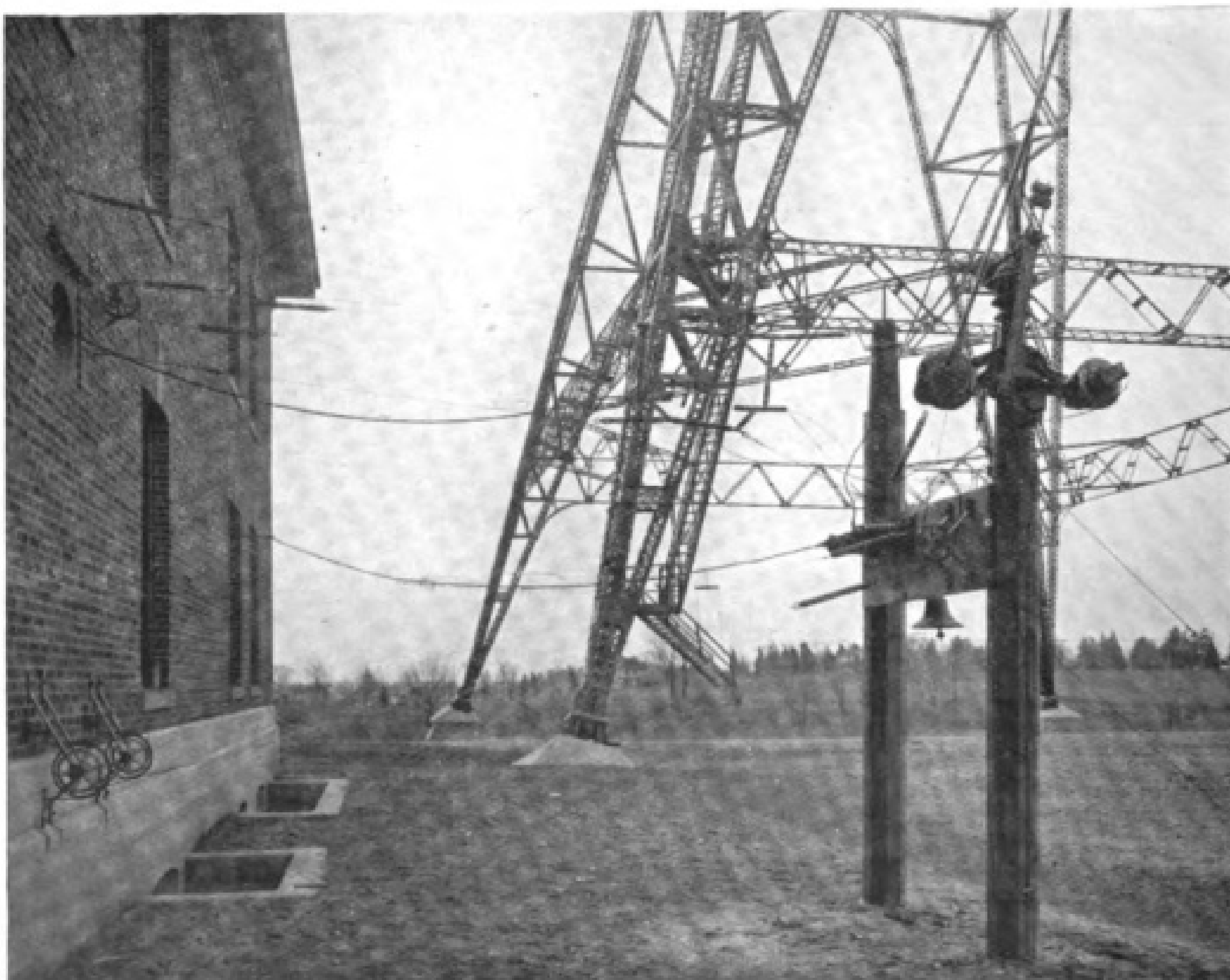
FEW wireless men are unacquainted with the name of the giant radio station at Arlington, now known as "Washington Radio," and thousands of amateur and professional operators listen each day to its time signals and news service. The following particulars of the equipment of the station and the photos which we are able to reproduce will, we are sure, be welcomed by the many wireless enthusiasts in this country.

Before the present site was finally selected a number of others in the vicinity of Washington were carefully examined. In erecting a large wireless station it is necessary to see that the ground is suitable for a good wireless "earth," whilst the surrounding country has to be such that there will be a minimum of absorption of electro-magnetic waves by mountains or buildings in the immediate vicinity. Certain military considerations have also to be taken into account in order that the station may be adequately protected from a possible invader. The site finally chosen was formerly part of what was known as the Fort Myer Military Reservation, and the ground, roughly 13½ acres in extent, was transferred to the Navy Department by Act of Congress.

In our large illustration we are able to give an excellent view of the three skeleton steel towers, one of which (that in the centre of the illustration) reaches a height of 600 feet. The other two are 450 feet high. The centres of the towers form an isosceles triangle, the base of the triangle being 350 feet long. The metalwork of the great structures is insulated from the ground, but switches are provided on each leg so that the towers may be "earthed" when required; 275 tons of steel were used in the construction of each of the smaller towers, and no less than 500 tons in the larger. The steel was furnished by the Carnegie Steel Company, and the erection undertaken by the Baltimore Bridge Company.

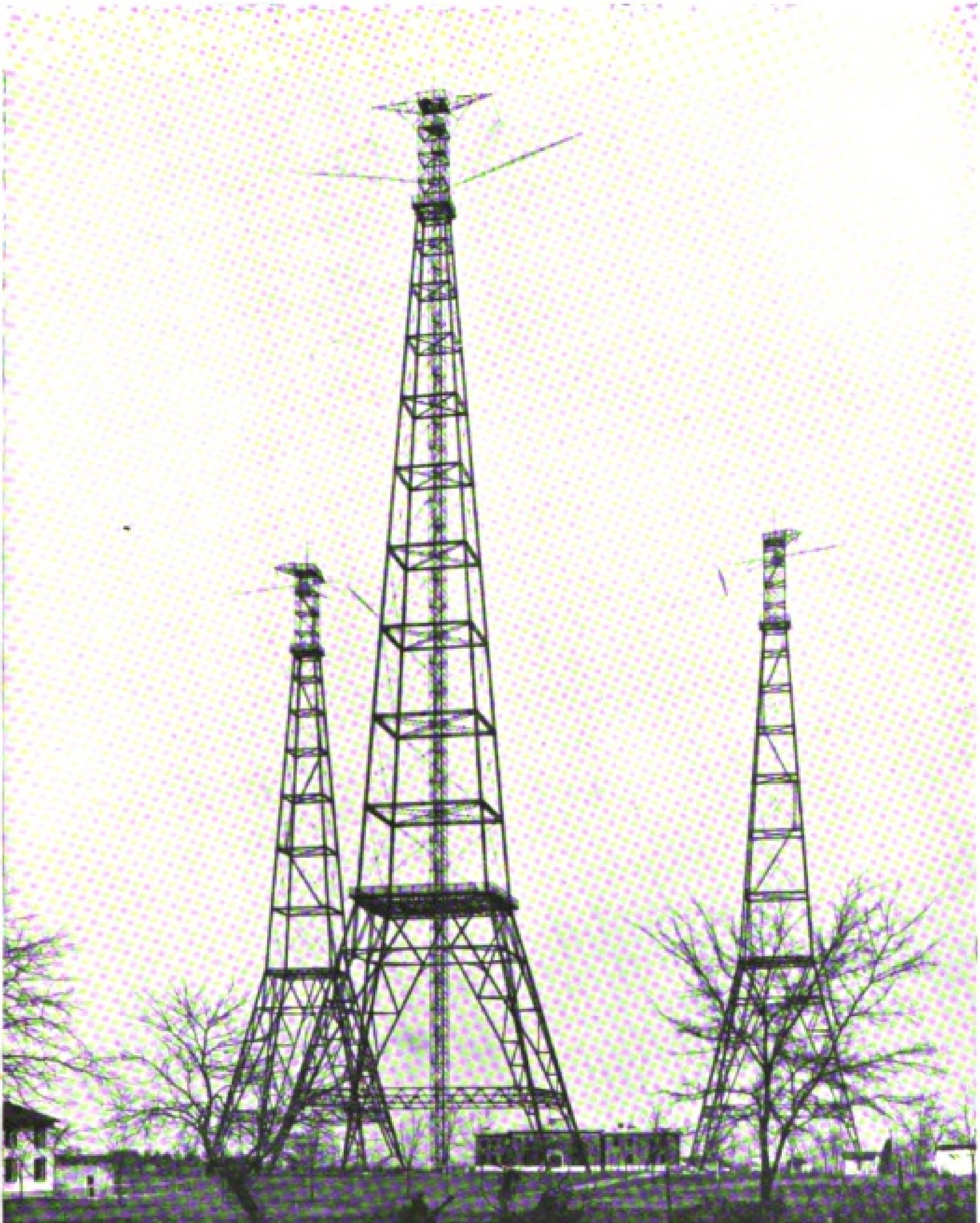
Three-phase 25-cycle alternating current is supplied to the station from the mains at 6,600 volts. It is then stepped down to 220 volts, and led to the wireless transmitter, of which there are three. The first is a 100-kw. spark set of the Fessenden system, the second a 5-kw. spark set manufactured by the Wireless Improvement Company, the third a 100-kw. Poulsen continuous wave plant.

The 100-kw. spark set, which is admirably shown in our illustrations, is very



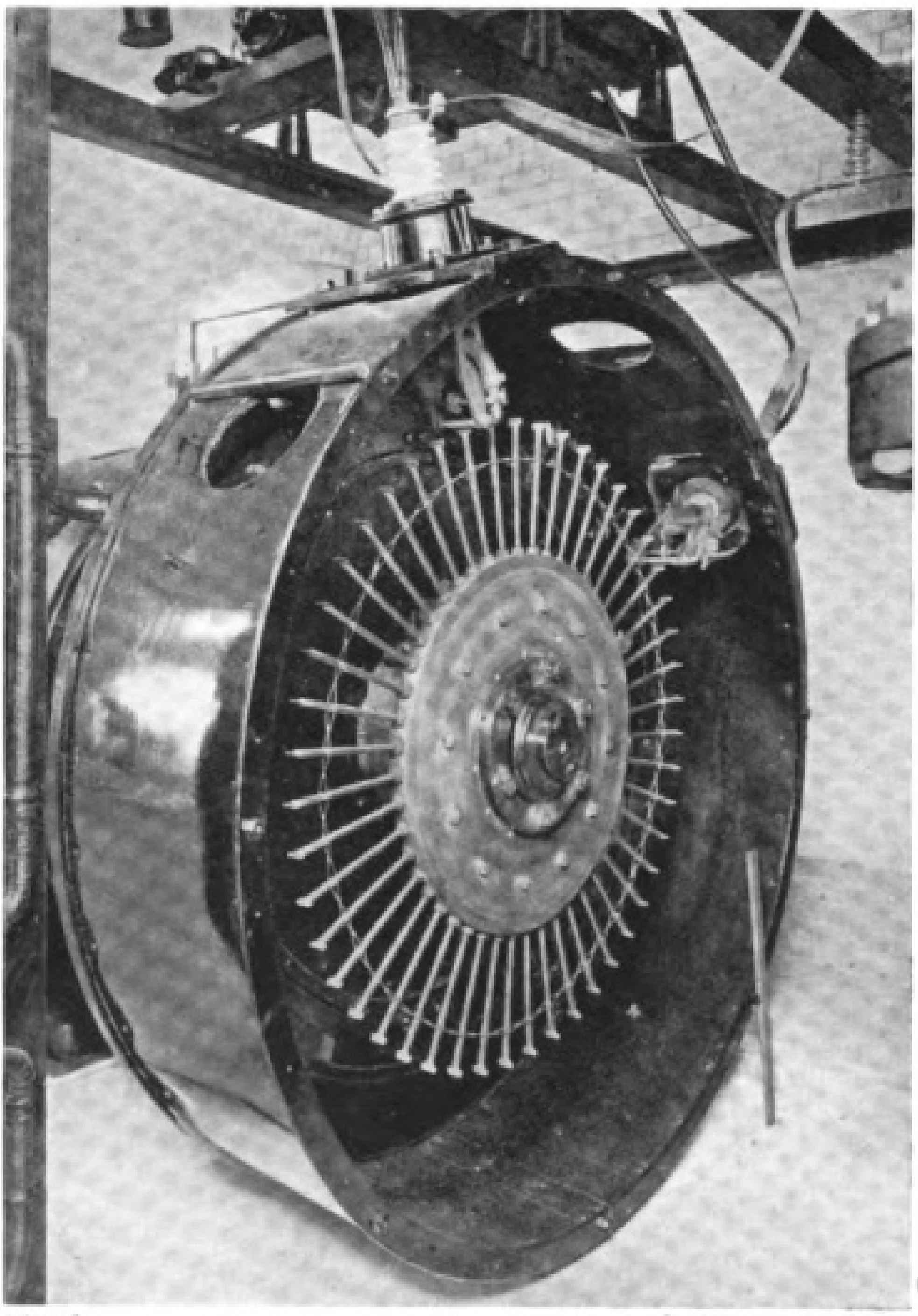
Photo] *[Buck, Washington.*

THE AERIAL SWITCH AND LEADING-IN WIRES. THIS PHOTOGRAPH WILL HELP THE READER TO REALISE THE IMMENSITY OF THE STEEL MASTS.



Photo] [*Buck, Washington.*

A VIEW OF THE THREE GIANT TOWERS AT THE WASHINGTON (ARLINGTON) RADIO STATION. THE NEAREST STRUCTURE IS 600 FEET HIGH.



Photo] [*Buck, Washington.*

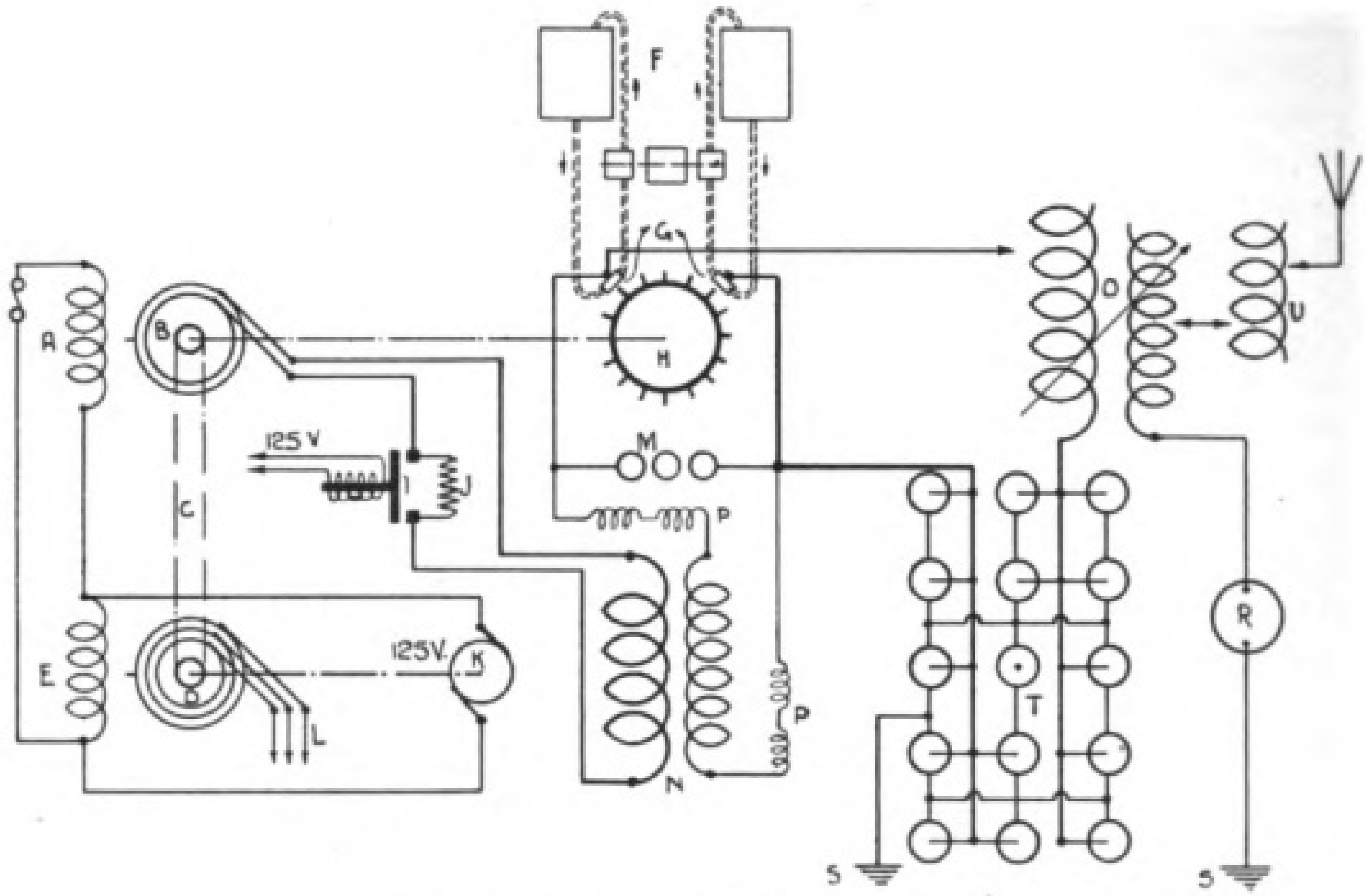
THE ROTARY DISCHARGER. THE STATIONARY ELECTRODES ARE WATER-COOLED.

similar in general design to a Marconi set, and, in fact, utilises several important Marconi patents. The illustration on page 661 shows the general arrangement of the apparatus, the alternator and rotary spark-gap being shown on the left, the condenser banks in the centre and right-hand side, and the primary and secondary of the jigger on the framework above. The transformer is situated underneath the floor, and the high - tension leads can clearly be seen.

Dealing now in detail with this set, we find that the main driving unit is a Westinghouse 200 h.p. 220 volt 25 cycle 3-phase synchronous motor, running at 300 revolutions per minute, and controlled by means of an oil switch with autostarter. On this motor shaft, and driven by it, is an 8-kw. 110 volt direct current generator which is used to excite the fields of both the 200 h.p. driving motor and the 100-kw. generator which furnishes the energy for the transmitting apparatus. The synchronous motor and 8-kw. generator are not shown in this photograph. The 100-kw. generator (on the left of the illustration) was built by the General Electric Company, and furnishes current at 220 volts, 500 cycles. It runs at 1,250 revolutions per minute, and is driven through a leather belt, just visible on the borders of the picture, from the 200 h.p. motor. The rotary spark-gap, shown in detail on this page, is attached to the framework of the generator, the rotary portion being bolted to the generator shaft. The gap is a synchronous one, and the rotor consists of a fibre wheel with a heavy brass ring on its outer circumference, from which protrude 48 copper electrodes, each about 10 inches long. The casing of the rotor which carries the stationary electrodes is fitted so that it can be moved backwards and forwards by a worm gear. Water is circulated through the stationary electrodes from the tank, which can be seen on the staging above. The small taps for controlling water supply are well seen in the large illustration. Phase adjustment with the spark-gap is made by slightly rotating the casing. The main leads of the generator run to a panel on the switchboard, and after passing through a circuit breaker one lead runs to the primary of the transformer and the other to a large relay key. The action of this key can be well seen from the wiring diagram on page 666. Shunted around the relay contacts is a large variable resistance grid which carries a large proportion of the current running to the primary. When the operating key is closed the relay cuts out this resistance, and the spark is made. When the key is opened, instead of the whole current being broken at the relay contacts, a great proportion of it runs through the resistance, and thus excessive sparking and wear on the relay contacts is avoided. The relay itself is worked from a small sending key, which is shown upon the table in the illustration on this page. The secondary leads carry current from the transformer to the stationary electrodes, across which are shunted the condensers and primary inductance of the jigger. The primary inductance is a helix made of eight turns of 1-inch copper tubing about 4 feet in diameter, fitted with suitable spring clips, by means of which the leads can be clamped to any turn for varying the sending wave-length. The condensers

Photo] [Buck, Washington.

THE OPERATING ROOM AT WASHINGTON RADIO. THE TRANSMITTING KEY CAN BE SEEN ON THE RIGHT OF THE CENTRAL RECEIVING APPARATUS.



WIRING DIAGRAM OF THE 100-KW. SPARK TRANSMITTER AT WASHINGTON RADIO.

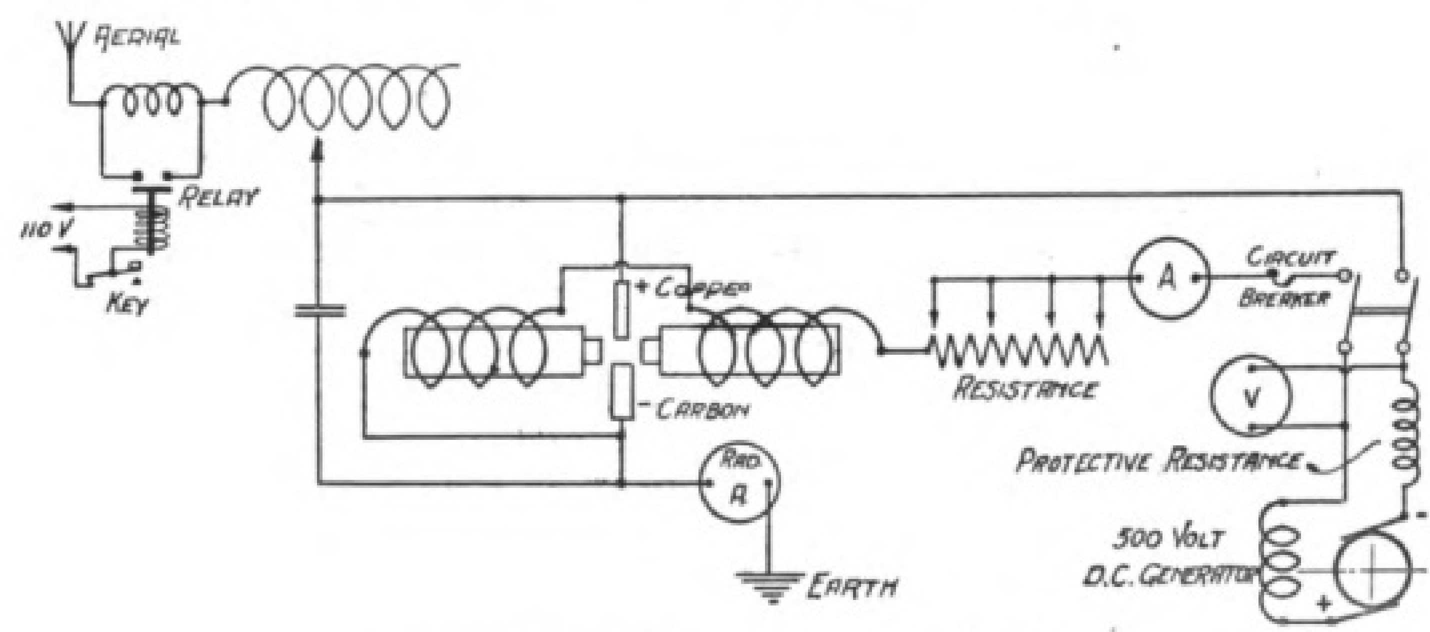
are of the compressed-air type, and each consists of a large cylindrical metal tank, in which about 200 plates are suspended. One set of plates is connected to the tank itself, and the other to a rod which runs through an insulator in the centre of each cover. These insulators can be clearly seen in the photograph. A lead washer under the rim of the cover and a lead bushing around the insulator ensure the tank being airtight. The plates are placed one-eighth of an inch apart and, of course, at that distance would not be able to withstand high voltage were it not for the compressed air. After the condenser has been assembled the air is compressed to a pressure of 250 lbs. per square inch. A safety gap is then set on the outside of the tanks between the rod through the insulator and a terminal on the tank cover, this gap being slightly longer than the distance between the plates. The primary current is then turned on intermittently, allowing sparking to take place inside, until the small particles of dust in the air are burned out, after which the spark will jump across the safety gap. The latter is then lengthened, and the operation continued until the safety gap is enlarged one inch. By this treatment a spark can be made to jump a 1-inch gap in air before it will traverse the one-eighth inch in compressed air. Each condenser has a capacity of 0.036 microfarad, the fourteen units being placed two sets of seven in parallel and two sets in series.

The secondary of the oscillation transformer is made up in the same manner as the primary, but of three-eighths inch copper tubing with twice the number of turns. One lead is led to the hot-wire ammeter (shown in the photograph) and thence to the ground, and the other to a spring clip which can be connected to any turn of the aerial-tuning inductance (shown in the top right-hand corner). The adjustment of the oscillation transformer is made as nearly correct as possible before the spark is turned on, and then the aerial-tuning inductance, which has a sliding contact, can be revolved while the spark is in operation by means of the cord and pulleys seen on the right-hand side of the illustration. By watching the hot-wire ammeter and observing when the highest reading is obtained, it is easy to see when the aerial is in resonance with the primary. The aerial lead is taken from the aerial-tuning inductance through an insulator fitted in a plate-glass window, 1 inch thick and 5 inches square, to a switch arrangement on short wooden poles, shown on the right-hand side of the photograph on page 662.

The aerial is made up of three sections, 23 wires in each section, each wire consisting of seven strands of No. 20 phosphor bronze. These wires are attached to spreaders 88 feet long, the spreaders themselves being attached to the towers by 10 electrose insulators. The aerial is open at the highest end (at the 600-feet tower), and two sections are brought down to the 450-feet towers, and two joined to the main section by "jumpers" made up of 23 wires bunched in the form of a rope. The main section is what is known as a "T" antenna, and the vertical part is taken from the middle. The 23 wires are brought down in the shape of a fan for 300 feet, and then in the form of a large cage the rest of the way to the switch on the tall mast.

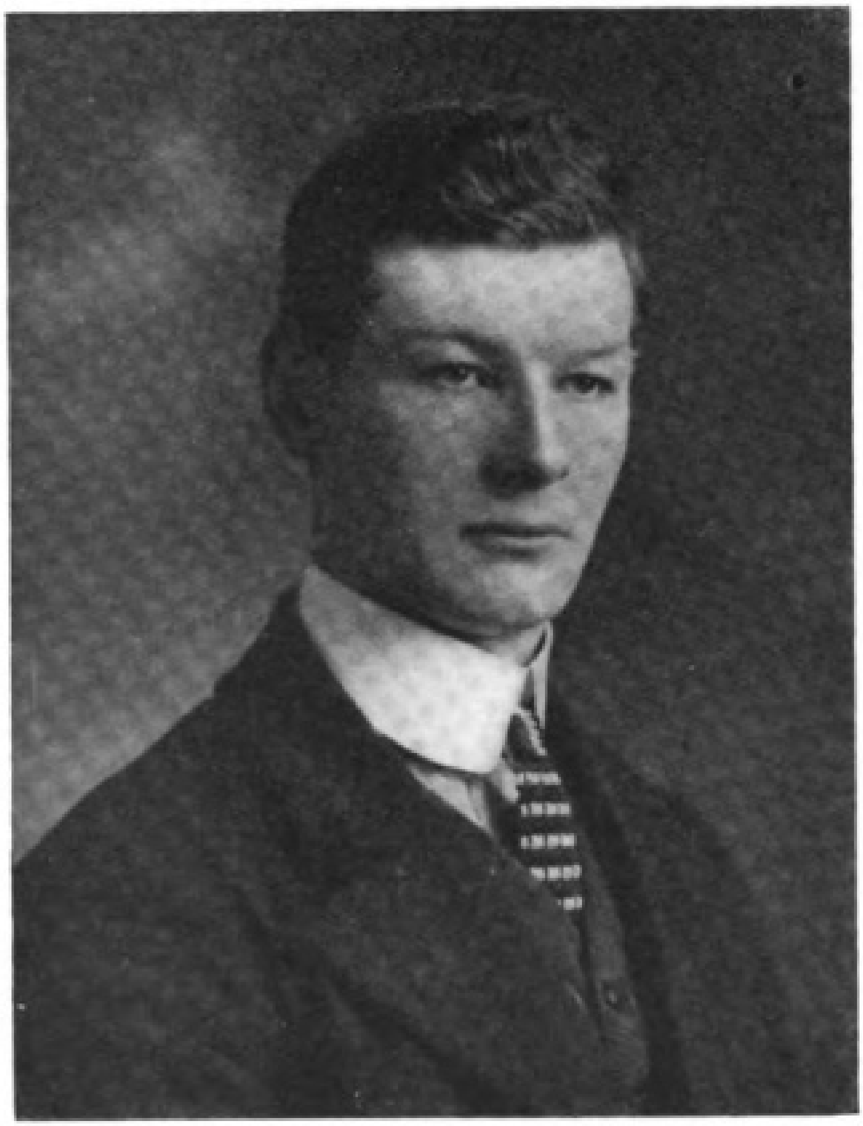
The ground connections consist of many lengths of wire buried in the ground at various depths in the space near the towers, and led in a "draught-board" pattern with soldered junctions. Many miles of wire were laid in making the large network, and, finally, wire leads were run down the slopes ending in a small stream that flows near by. The ground connection between the aerial and this network is through a large copper strip 6 inches wide and a quarter-inch thick.

For the description of the Arlington Station, above given, we have drawn freely from a paper presented to the Washington section of the Institute of Radio Engineers, by Capt. William H. G. Bullard, U.S.N., until recently Superintendent of the United States Naval Radio Service. Capt. Bullard's paper is reproduced in full in the Proceedings of the Institute of Radio Engineers, to the Editor of which we are indebted for permission to utilise the information therein contained.



WIRING DIAGRAM OF THE 100-KW. ARC TRANSMITTER AT WASHINGTON RADIO.

PERSONALITIES IN THE WIRELESS WORLD



Mr. N. W. McLACHLAN, B.Sc., A.M.I.E.E.

THE subject of our Biography, Mr. Norman W. McLachlan, was born at Long Town, Cumberland, on July 26th, 1888. He received his secondary education at Carlisle Grammar School, where he won a scholarship, and at the George Watson's College, Edinburgh. Entering the Heriot-Watt College at Edinburgh for a technical training, he soon distinguished himself, and at the age of eighteen stood first in the final year in electrical engineering, physics, and mathematics with unusually high marks. Before leaving this institution the brilliant young scholar had been awarded a diploma in electrical engineering and five medals. It was Mr. McLachlan's first intention to enter a manufacturing firm as an engineer, but he was soon attracted to the teaching profession, and in 1909 went to Newcastle-on-Tyne as a lecturer in engineering and mathematics.

In 1912 Mr. McLachlan graduated B.Sc. (Engineering), and in 1913 he was appointed superintendent to a branch technical institute and supervisor of classes in engineering subjects in the Liverpool branch Technical Institutes. For the past two years Mr. McLachlan has been carrying out research work in his spare time in the Applied Electricity Laboratories of the Liverpool University. As an author Mr. McLachlan has written *Practical Mathematics* (Longmans & Co.) and published several papers in the *Journal of the Institution of Electrical Engineers* and the *Electrician* on "The Magnetic Behaviour of Iron." In 1915 he read a paper and performed experiments before the Engineering Section of the British Association at Manchester on "The Heating of Iron when Magnetised at High Frequencies." His paper before this year's British Association meeting was reprinted in part in last month's WIRELESS WORLD, and is continued in the present issue.

The Accurate Calculation of the Inductance of Single Layer, Air Core Solenoids; Simplified by means of Tables

By BERTRAM HOYLE, M.Sc.Tech., A.M.I.E.E.,
Lieut. R.N.V.R., H.M.S. *Excellent.*

THERE are numerous formulæ available for different types of coils, but the limitations of each particular formula are not always made clear. At the best, these formulæ, when found, are cumbersome, and not easy to work out without practice. The object of the present article is to give tables of the more difficult functions calculated for the limits within which they can be accurately applied. The tables are given for all ratios of coil radius to coil breadth, likely to be encountered in receiver of transmitter primary or secondary coils in wireless stations.

The two formulæ which are discussed, and for which tables of the functions Q and X are given, are:

Lorenz's equation $Ls = an^2Q$ . . . . (1)

and Rayleigh's equation $Ls = 4\pi an^2X$ . . . . (2)

where Q and X are functions of the ratio $\frac{a}{b}$; the ratio of the radius of coil to coil breadth.

Symbols Used.

a = radius of centre line of turns in cms.
b = breadth overall, of coil in cms.
d = diameter of conductor in cms.
D = diameter over insulation in cms.
f = frequency, in cycles per sec.
n = total number of turns on coil.
K = capacity in micro-farads.
Ls = the inductance of the coil on the assumption that the current flows in a cylindrical sheet.
L = true inductance = $Ls - \Delta L$.
ΔL = a correcting factor for thickness of insulation and number of turns.
M = mutual inductance.
A and B = correcting terms for ΔL. See Tables.
Q and X = functions explained in context, and tabulated at the end.
ρ = radius of conductor.
λ = wave-length in metres.

Formula (1)—$Ls = an^2Q$.

Q is a complicated function involving elliptic integrals, and has for value

$$Q = \left[\frac{8\pi}{3}\left\{\sqrt{1+\frac{b^2}{4a^2}\left(\frac{4a^2}{b}-1\right)E} + \sqrt{1+\frac{b^2}{4a^2}F} - \frac{4a^2}{b}\right\}\right]$$

E and F being the elliptic integrals.

Values of Q are tabulated for $\frac{2a}{b}=0\cdot20$ to $3\cdot00$, whilst X is tabulated for values of $\frac{a}{b}$ from 1 to 55.

The limits given for $\frac{a}{b}$ embrace all cylindrical coils, or parts of coils, likely to be required in wireless telegraphy, that is from coils whose breadth (or axial length) b is ten times their radius a, to those whose breadth b is only $\frac{1}{55}$th their radius a.

Thus where $n=4$

$$Ls=4L_1+6M_{12}+4M_{13}+2M_{14}.$$

The values of L_1 and M are worked out by the formulæ of Rayleigh and Niven

$$Ls=4\pi a\left\{\left(1-\frac{\rho^2}{8a^2}\right)\log_e\frac{8a}{\rho}+\frac{\rho^2}{24a^2}-1\cdot75\right\} \quad . \quad . \quad . \quad (3)$$

$$M=4\pi a\left\{\log_e\frac{8a}{d}\left(1+\frac{3d^2}{16a^2}\right)-\left(2+\frac{d^2}{16a^2}\right)\right\} \quad . \quad . \quad . \quad (4)$$

This summation formula is very cumbersome, and especially so where n is greater than ten turns.

It is pointed out here, because an example of the exactness of the complete general formula is given in comparison with the summation method.

In formula (2) $Ls=4\pi an^2X$, the value of X is

$$\left\{\log_e\frac{8a}{b}+\frac{b^2}{32a^2}\left(\log_e\frac{8}{ab}+0\cdot25\right)-0\cdot5\right\}.$$

which gives Rayleigh's complete general formula

$$Ls=4\pi an^2\left\{\log_e\frac{8a}{b}+\frac{b^2}{32a^2}\left(\log_e\frac{8a}{b}+0\cdot25\right)-0\cdot5\right\}.$$

It must be pointed out here that whereas (1) and (2) need corrections applying; the summation formula does not, and it will be seen that the number of turns and their spacing apart is taken into account in that case as the work proceeds.

The correction formula for (1) and (2) is

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

and the true inductance is

$$L=Ls-\Delta L.$$

NOTE.—ΔL may be positive or negative.

The functions A and B are tabulated,

A being the correction for insulation space, whether air or solid.

B being the function depending on n, the number of turns.

Ls is the inductance that the coil would have if the current flowed in a cylindrical sheet of breadth b and radius a, and of no thickness.

Where L_1 is the inductance of a single turn (formula 3), and $M_{1\cdot2}$ is the mutual inductance between turns separated by 1. $M_{1\cdot3}$ is the mutual inductance between turns separated by 2, and so on; the values of M being obtained by formula 4.

Thus in the example given $6M_{1\cdot2}$. stands for :

(*a*) The mutual inductance of turn 1 on turn 2.
(*b*) The mutual inductance of turn 2 on 1 and on 3.
(*c*) The mutual inductance of turn 3 on 2 and 4.
(*d*) The mutual inductance of turn 4 on turn 3.

These summed up give six times the mutual inductance of two adjacent turns.

Similarly, it will be seen that $4M_{1\cdot3}$. stands for the mutual inductance of turns situated next but one to one another and so on.

EXAMPLE OF ACCURACY OF (2) COMPARED WITH THE SUMMATION METHOD.

(*Abstracted from Bulletin of Bureau of Standards, Washington, Vol. II., No.* 1.)

DATA.—$a=25$ cm., $b=1$ cm., $n=10$, $\rho=0{\cdot}040$ cm., $d=0{\cdot}080$ cm., $D=0{\cdot}100$ cm.

Working out formula (3) once and (4) nine times for these values, the following is obtained, π being left out for clearness and simplicity.

$10\times L_1$. =	.. .. ..	$6767{\cdot}196\times\pi$ cms.
$18\times M_{1\cdot2}$. =	.. .. ..	$10081{\cdot}664\times\pi$ cms.
$16\times M_{1\cdot3}$. =	.. .. ..	$7852{\cdot}535\times\pi$ cms.
$14\times M_{1\cdot4}$. =	.. .. ..	$6303{\cdot}439\times\pi$ cms.
$12\times M_{1\cdot5}$. =	.. .. ..	$5057{\cdot}868\times\pi$ cms.
$10\times M_{1\cdot6}$. =	.. .. ..	$3991{\cdot}888\times\pi$ cms.
$8\times M_{1\cdot7}$. =	.. .. ..	$3047{\cdot}787\times\pi$ cms.
$6\times M_{1\cdot8}$. =	.. .. ..	$2193{\cdot}465\times\pi$ cms.
$4\times M_{1\cdot9}$. =	.. .. ..	$1408{\cdot}982\times\pi$ cms.
$2\times M_{1\cdot10}$. =	.. .. ..	$680{\cdot}982\times\pi$ cms.
	By summation	$47385{\cdot}80\times\pi$ cms.

Working out formula (2) to the highest number of decimal places, the result is

$$Ls=4\pi\times25\times100\left\{\log_\epsilon 200+\frac{1}{20{,}000}(\log_\epsilon 200+0{\cdot}25)-0{\cdot}5\right\}.$$

$$=47{,}985{\cdot}77\times\pi \text{ cms.}$$

$$\Delta L=1000\pi\,(0{\cdot}3337+0{\cdot}2664)$$

$$=600{\cdot}1\;\pi$$

True L by this method $=Ls-\Delta L$ is

$$47385{\cdot}67\times\pi \text{ cms.}$$

The difference being quite within the limits of possible accumulation of errors in working out equations (3) and (4).

There are limitations to be observed in using formulæ (1) and (2), and the tables of Q and X given overlap somewhat in giving values of Q and X for equal ratios of $\frac{a}{b}$.

The following example will make clear the use of all the tables, and give a comparison of the results by each method (1) and (2).

Example.—Showing the working of both (1) and (2) and a comparison of the results.

Let $\frac{a}{b}=1{\cdot}25$ $n=100$

$a=12{\cdot}5$ cms. $d=0{\cdot}075$ cms.

$D=\ 0{\cdot}10$ cms.

Using (1) $Ls\ =a,\ n^2,\ Q.$

$=12{\cdot}50\times10{,}000\times23{\cdot}288$

$=2{,}911{,}000$ cms.

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

A for $\frac{d}{D}=0{\cdot}75$ is $0{\cdot}2691$

B for $n\ =100$ is $0{\cdot}3280$

$\therefore\ A+B$ is $0{\cdot}5971$

$\Delta L=4\pi\times12{\cdot}5\times100\ (0{\cdot}5971).$

$=9379$ say $9380.$

True $L\ =2{,}901{,}620$ cms. say.

Same example worked out by formula (2):

$Ls=4\pi an^2X$, where X is $1{\cdot}854$ from the table for $\frac{a}{b}=1{\cdot}25$ by interpolation between $1{\cdot}2$ and $1{\cdot}3$.

$Ls=4\pi\times12{\cdot}5\times10{,}000\times1{\cdot}854.$

$=2{,}911{,}700$ cms.

The same correction gives—9379, say—9380.

Whence true $L=2{,}902{,}320$ cms.

The difference of 700 cms. is equivalent to approximately 1 in 4300; which is quite as accurate as the accompanying tables are intended to be.

For all practical purposes the tables are given to fourth-figure accuracy.

NOTES.

The formulæ for inductance given above all evaluate L in cms.; the relation of the centimetre units to the henry, and its sub-multiples is as follows:

1 henry $=10^9$ cms.

1 milli-henry $=10^6$ cms.

1 micro-henry $=10^3$ cms.

The wave-length and frequency formulæ in wireless telegraphy become

$\lambda=59{\cdot}6\sqrt{L.K.}$ often taken as

$=60\ \sqrt{L.K.}$ = wave length in metres.

and $f=\frac{5{\cdot}033\times10^6}{\sqrt{L.K.}}$ often taken as

$=\frac{5{,}000{,}000}{\sqrt{L.K.}}$ the frequency in cycles per second

[*Continued at bottom of page* 675.

TABLE OF FUNCTION Q.

$\frac{2a}{b}$	Q	$\frac{2a}{b}$	Q	$\frac{2a}{b}$	Q	$\frac{2a}{b}$	Q
0·20	3·632	0·90	12·631	1·60	18·304	2·30	22·324
0·21	3·797	0·91	12·729	1·61	18·373	2·31	22·374
0·22	3·961	0·92	12·828	1·62	18·442	2·32	22·423
0·23	4·125	0·93	12·924	1·63	18·501	2·33	22·473
0·24	4·289	0·94	13·021	1·64	18·578	2·34	22·522
0·25	4·452	0·95	13·116	1·65	18·645	2·35	22·571
0·26	4·614	0·96	13·212	1·66	18·711	2·36	22·620
0·27	4·773	0·97	13·306	1·67	18·777	2·37	22·669
0·28	4·929	0·98	13·401	1·68	18·842	2·38	22·718
0·29	5·082	0·99	13·495	1·69	18·906	2·39	22·767
0·30	5·234	1·00	13·589	1·70	18·969	2·40	22·815
0·31	5·385	1·01	13·682	1·71	19·032	2·41	22·863
0·32	5·535	1·02	13·775	1·72	19·094	2·42	22·911
0·33	5·684	1·03	13·877	1·73	19·156	2·43	22·958
0·34	5·832	1·04	13·959	1·74	19·218	2·44	23·006
0·35	5·980	1·05	14·049	1·75	19·279	2·45	23·053
0·36	6·127	1·06	14·140	1·76	19·339	2·46	23·101
0·37	6·274	1·07	14·230	1·77	19·399	2·47	23·148
0·38	6·420	1·08	14·319	1·78	19·459	2·48	23·195
0·39	6·564	1·09	14·407	1·79	19·519	2·49	23·242
0·40	6·710	1·10	14·496	1·80	19·579	2·50	23·288
0·41	6·852	1·11	14·583	1·81	19·639	2·51	23·335
0·42	6·995	1·12	14·671	1·82	19·699	2·52	23·380
0·43	7·135	1·13	14·757	1·83	19·758	2·53	23·426
0·44	7·273	1·14	14·843	1·84	19·818	2·54	23·471
0·45	7·409	1·15	14·927	1·85	19·877	2·55	23·516
0·46	7·544	1·16	15·012	1·86	19·936	2·56	23·561
0·47	7·678	1·17	15·094	1·87	19·995	2·57	23·606
0·48	7·811	1·18	15·177	1·88	20·054	2·58	23·651
0·49	7·943	1·19	15·258	1·89	20·113	2·59	23·696
0·50	8·075	1·20	15·338	1·90	20·174	2·60	23·740
0·51	8·205	1·21	15·418	1·91	20·233	2·61	23·784
0·52	8·335	1·22	15·498	1·92	20·289	2·62	23·828
0·53	8·464	1·23	15·578	1·93	20·347	2·63	23·872
0·54	8·593	1·24	15·657	1·94	20·405	2·64	23·916
0·55	8·721	1·25	15·736	1·95	20·463	2·65	23·960
0·56	8·848	1·26	15·815	1·96	20·520	2·66	24·004
0·57	8·974	1·27	15·894	1·97	20·577	2·67	24·048
0·58	9·098	1·28	15·972	1·98	20·634	2·68	24·091
0·59	9·219	1·29	16·050	1·99	20·690	2·69	24·135
0·60	9·339	1·30	16·128	2·00	20·746	2·70	24·178
0·61	9·460	1·31	16·205	2·01	20·802	2·71	24·221
0·62	9·581	1·32	16·283	2·02	20·858	2·72	24·265
0·63	9·701	1·33	16·360	2·03	20·914	2·73	24·308
0·64	9·820	1·34	16·437	2·04	20·969	2·74	24·351
0·65	9·938	1·35	16·514	2·05	21·024	2·75	24·393
0·66	10·056	1·36	16·591	2·06	21·079	2·76	24·436
0·67	10·173	1·37	16·668	2·07	21·134	2·77	24·478
0·68	10·289	1·38	16·745	2·08	21·189	2·78	24·521
0·69	10·403	1·39	16·821	2·09	21·243	2·79	24·563
0·70	10·514	1·40	16·898	2·10	21·298	2·80	24·605
0·71	10·625	1·41	16·973	2·11	21·352	2·81	24·647
0·72	10·736	1·42	17·048	2·12	21·405	2·82	24·689
0·73	10·846	1·43	17·122	2·13	21·457	2·83	24·731
0·74	10·956	1·44	17·196	2·14	21·510	2·84	24·772
0·75	11·065	1·45	17·269	2·15	21·562	2·85	24·813
0·76	11·175	1·46	17·342	2·16	21·614	2·86	24·854
0·77	11·284	1·47	17·414	2·17	21·666	2·87	24·895
0·78	11·393	1·48	17·485	2·18	21·718	2·88	24·936
0·79	11·503	1·49	17·555	2·19	21·769	2·89	24·976
0·80	11·608	1·50	17·624	2·20	21·820	2·90	25·017
0·81	11·712	1·51	17·693	2·21	21·871	2·91	25·057
0·82	11·816	1·52	17·761	2·22	21·922	2·92	25·098
0·83	11·919	1·53	17·829	2·23	21·973	2·93	25·138
0·84	12·023	1·54	17·897	2·24	22·023	2·94	25·179
0·85	12·126	1·55	17·965	2·25	22·074	2·95	25·219
0·86	12·229	1·56	18·033	2·26	22·124	2·96	25·259
0·87	12·331	1·57	18·101	2·27	22·174	2·97	25·298
0·88	12·433	1·58	18·169	2·28	22·224	2·98	25·338
0·89	12·532	1·59	18·237	2·29	22·274	2·99	25·372
						3·00	25·416

TABLE OF FUNCTION X.

$\frac{a}{b}$	Function X	$\frac{a}{b}$	Function X	$\frac{a}{b}$	Function X	$\frac{a}{b}$	Function X
1·00	1·653	5·60	3·308	10·20	3·906	26·0	4·831
1·10	1·738	5·70	3·326	10·30	3·916	26·5	4·851
1·20	1·817	5·80	3·344	10·40	3·926	27·0	4·870
1·30	1·891	5·90	3·361	10·50	3·936	27·5	4·889
1·40	1·960	6·00	3·378	10·60	3·946	28·0	4·908
1·50	2·027	6·10	3·395	10·70	3·956	28·5	4·927
1·60	2·090	6·20	3·412	10·80	3·966	29·0	4·946
1·70	2·148	6·30	3·428	10·90	3·975	29·5	4·964
1·80	2·202	6·40	3·444	11·00	3·984	30·0	4·982
1·90	2·250	6·50	3·460	11·10	3·993	30·5	4·999
2·00	2·296	6·60	3·475	11·20	4·002	31·0	5·016
2·10	2·340	6·70	3·490	11·30	4·011	31·5	5·033
2·20	2·383	6·80	3·505	11·40	4·019	32·0	5·050
2·30	2·425	6·90	3·519	11·50	4·027	32·5	5·066
2·40	2·466	7·00	3·533	11·60	4·035	33·0	5·082
2·50	2·514	7·10	3·547	11·70	4·043	33·5	5·098
2·60	2·551	7·20	3·561	11·80	4·051	34·0	5·114
2·70	2·586	7·30	3·574	11·90	4·059	34·5	5·129
2·80	2·620	7·40	3·587	12·00	4·067	35·0	5·114
2·90	2·652	7·50	3·600	12·5	4·107	35·5	5·159
3·00	2·683	7·60	3·613	13·0	4·145	36·0	5·173
3·10	2·715	7·70	3·626	13·5	4·183	36·5	5·187
3·20	2·747	7·80	3·639	14·0	4·220	37·0	5·201
3·30	2·779	7·90	3·651	14·5	4·256	37·5	5·215
3·40	2·810	8·00	3·662	15·0	4·290	38·0	5·228
3·50	2·841	8·10	3·674	15·5	4·323	38·5	5·241
3·60	2·871	8·20	3·686	16·0	4·355	39·0	5·253
3·70	2·899	8·30	3·698	16·5	4·386	39·5	5·265
3·80	2·925	8·40	3·710	17·0	4·416	40·0	5·277
3·90	2·950	8·50	3·722	17·5	4·445	41	5·300
4·00	2·974	8·60	3·733	18·0	4·474	42	5·323
4·10	2·998	8·70	3·744	18·5	4·501	43	5·346
4·20	3·022	8·80	3·755	19·0	4·527	44	5·368
4·30	3·045	8·90	3·766	19·5	4·552	45	5·390
4·40	3·067	9·00	3·777	20·0	4·576	46	5·411
4·50	3·089	9·10	3·788	20·5	4·599	47	5·432
4·60	3·111	9·20	3·799	21·0	4·622	48	5·452
4·70	3·132	9·30	3·810	21·5	4·644	49	5·472
4·80	3·153	9·40	3·821	22·0	4·666	50	5·492
4·90	3·173	9·50	3·832	22·5	4·688	51	5·512
5·00	3·193	9·60	3·843	23·0	4·709	52	5·531
5·10	3·213	9·70	3·853	23·5	4·730	53	5·550
5·20	3·233	9·80	3·864	24·0	4·751	54	5·569
5·30	3·252	9·90	3·875	24·5	4·771	55	5·587
5·40	3·271	10·00	3·886	25·0	4·791		
5·50	3·290	10·10	3·896	25·5	4·811		

where

L = inductance in cms.
K = capacity in micro-farads.

Example.—Take the case of the inductance worked out above, call this 2,902,000 cms. Let this be oscillating with a condenser having $K = 0{\cdot}001$ micro-farads.

$$\text{Then } \lambda = 59{\cdot}6\sqrt{2{\cdot}902 \times 10^6 \times 0{\cdot}001}$$

$$= 3211 \text{ metres wave-length.}$$

$$\text{and } f = \frac{5{\cdot}033 \times 10^6}{\sqrt{(2{\cdot}902 \times 10^6 \times 0{\cdot}001)}}$$

$$= 93{,}428 \text{ cycles per second.}$$

TABLE OF CORRECTIONS FOR INSULATION.

NOTE.—For $\frac{d}{D}$ over 0·58 A is positive. For $\frac{d}{D}$ less than 0·57 A is negative.

$\frac{d}{D}$	A	$\frac{d}{D}$	A	$\frac{d}{D}$	A	$\frac{d}{D}$	A
1·00	+0·5568	1·75	0·2691	0·50	0·1363	0·25	0·8294
1·99	0·5470	1·74	0·2556	0·49	0·1558	0·24	0·8699
1·98	0·5370	1·73	0·2419	0·48	0·1758	0·23	0·9121
1·97	0·5268	1·72	0·2282	0·47	0·1966	0·22	0·9566
1·96	0·5163	1·71	0·2143	0·46	0·2183	0·21	1·0035
1·95	0·5055	1·70	0·2001	0·45	0·2406	0·20	1·0526
1·94	0·4947	1·69	0·1857	0·44	0·2632	0·19	1·1046
1·93	0·4839	1·68	0·1710	0·43	0·2864	0·18	1·1601
1·92	0·4731	1·67	0·1560	0·42	0·3102	0·17	1·2179
1·91	0·4623	1·66	0·1410	0·41	0·3347	0·16	1·2777
1·90	0·4515	0·65	0·1261	0·40	0·3594	0·15	1·3402
1·89	0·4404	0·64	0·1105	0·39	0·3846	0·14	1·4082
1·88	0·4292	0·63	0·0947	0·38	0·4106	0·13	1·4822
1·87	0·4178	0·62	0·0787	0·37	0·4374	0·12	1·5627
1·86	0·4063	0·61	0·0625	0·36	0·4647	0·11	1·6510
1·85	0·3945	0·60	+0·0460	0·35	0·4929	0·10	1·7451
1·84	0·3826	0·59	+0·0293	0·34	0·5219	0·09	1·8470
1·83	0·3706	0·58	+0·0123	0·33	0·5521	0·08	1·9642
1·82	0·3585	0·57	—0·0048	0·32	0·5831	0·07	2·0971
1·81	0·3463	0·56	—0·0226	0·31	0·6148	0·06	2·2550
1·80	0·3337	0·55	0·0410	0·30	0·6471	0·05	2·4389
1·79	0·3210	0·54	0·0597	0·29	0·6806	0·04	2·6952
1·78	0·3082	0·53	0·0787	0·28	0·7154	0·03	3·0250
1·77	0·2954	0·52	0·0980	0·27	0·7519	0·02	3·4620
1·76	0·2824	0·51	0·1173	0·26	0·7896	0·01	4·0483

TABLE OF CORRECTIONS FOR THE NUMBER OF TURNS.

NOTE.—All positive.

n	B	n	B	n	B	n	B
1	0·0000	31	0·3091	61	0·3219	91	0·3271
2	0·1137	32	0·3099	62	0·3222	92	0·3272
3	0·1663	33	0·3106	63	0·3224	93	0·3273
4	0·1973	34	0·3113	64	0·3227	94	0·3274
5	0·2180	35	0·3119	65	0·3229	95	0·3275
6	0·2329	36	0·3125	66	0·3231	96	0·3276
7	0·2443	37	0·3131	67	0·3233	97	0·3277
8	0·2532	38	0·3137	68	0·3235	98	0·3278
9	0·2604	39	0·3143	69	0·3237	99	0·3279
10	0·2664	40	0·3148	70	0·3239	100	0·3280
11	0·2710	41	0·3153	71	0·3241	105	0·3284
12	0·2753	42	0·3157	72	0·3243	110	0·3288
13	0·2791	43	0·3161	73	0·3245	115	0·3292
14	0·2826	44	0·3165	74	0·3247	120	0·3295
15	0·2857	45	0·3169	75	0·3249	130	0·3301
16	0·2885	46	0·3173	76	0·3251	140	0·3307
17	0·2910	47	0·3177	77	0·3252	150	0·3311
18	0·2933	48	0·3180	78	0·3253	160	0·3315
19	0·2955	49	0·3183	79	0·3255	170	0·3319
20	0·2974	50	0·3186	80	0·3257	180	0·3323
21	0·2990	51	0·3189	81	0·3259	190	0·3326
22	0·3005	52	0·3192	82	0·3261	200	0·3328
23	0·3020	53	0·3195	83	0·3263	250	0·3336
24	0·3031	54	0·3198	84	0·3264	300	0·3343
25	0·3042	55	0·3201	85	0·3265	400	0·3351
26	0·3053	56	0·3204	86	0·3266	500	0·3356
27	0·3062	57	0·3207	87	0·3267	600	0·3359
28	0·3070	58	0·3210	88	0·3268	700	0·3361
29	0·3077	59	0·3213	89	0·3269	800	0·3363
30	0·3083	60	0·3216	90	0·3270	900	0·3364
						1000	0·3365

Pioneer Lady Operators at Towyn Wireless Station

WITH its land operating staff cut down to a minimum, and an ever-increasing volume of traffic to handle, the Marconi Wireless Telegraph Co., Ltd., has for some time had under careful consideration the question of employing lady operators at some of its high-power land stations. A school for training them was therefore opened at special premises in February and closed on September 30th, 1916. Mr. C. W. Pain, late of the Clifden station, acted as instructor at the school, the curriculum of which included slip reading, punching, record reading, sending on long land lines, and the general duties appertaining to a commercial wireless station. All the ladies were obliged to undertake to perform night duty as well as day duty. As the experiment stands up to the present, the Wireless Company has been provided with a number of experienced lady telegraphists, specially trained in wireless work who—their course of instruction completed—have been appointed to certain duties at the important station at Towyn, in North Wales. These ladies have been carrying on their new work for some weeks now, and as time goes on they will in due course be given opportunities for working wireless instruments.

We reproduce below a photograph of these pioneers, only one of whom (Miss Bruton) has at the time of writing fallen out. The names of the ladies run as follows: Top row—Misses W. F. Bruton, A. V. Edgar, D. M. Jarred and F. M. Rogers. Bottom row—Misses E. A. Pugh, M. Beresford, R. Perry, G. A. March, and M. Murphy.

A GROUP OF PIONEERS:—LADY OPERATORS AT THE TOWYN WIRELESS STATION.

Digest of Wireless Literature

THE DISTRIBUTION OF STANDARD TIME IN THE UNITED STATES.

INTERESTING particulars regarding the distribution of time in the United States were recently published in our contemporary the *Telegraph and Telephone Age*.

Time is obtained accurately by the astronomers at the United States Naval Observatory at Washington, D.C., observing the transit of certain stars every clear night, which are due to cross the meridian at a known time. The exact instant of their transit is recorded electrically by means of a chronograph, which also records the seconds from a sidereal clock. The difference between the time the stars cross and the time of the sidereal clock, as recorded on the chronograph, shows the error of the clock.

Time is transmitted daily from Washington to the Panama Canal for the purpose of correcting ships' chronometers. Correct time is highly important for a vessel, because in making observations of heavenly bodies a variation of one second means an error of about one-fourth of a nautical mile in location. The time signal is sent by wire from Washington to Key West, whence a relay transmits it by wireless. The Darien wireless station in the Canal Zone in turn transmits the signal by ordinary telegraph to the port captains' offices.

The signal is sent from Key West in a series of dots. Five minutes before noon the wireless begins counting off the seconds by dots. After the twenty-eighth second there is a pause, the 29th dot being omitted; similarly there is a pause from the 54th to the 60th second. The count is resumed exactly on the minute. This procedure is kept up until 10 seconds before 12 o'clock, when there is a pause followed by a long dash at exactly 12 o'clock. The aerial transmission is recorded at Darien by a current too slight to permit ordinary relaying. Consequently an operator with a wireless receiver at his ears sends dots through an ordinary telegraph wire to the port captains. With practice he can strike the dots on his sending key in almost perfect synchronism with the dots received. The principal difficulty is in sending the final dash after a wait of 10 seconds. Here the tests show that the lag is between two-tenths and three-tenths of a second. By making allowance for this lag the chronometers in the Canal Zone can be adjusted to within about one-tenth of a second of the correct time. Arrangements are being made to instal a clock at Darien which will transmit the time exactly as received from Key West.

* * * * * *

MILITARY WIRELESS ON THE MEXICAN RAILWAYS.

When the United States troops went into Mexico, says the *Popular Science Monthly*, they were forced to meet a number of unusual conditions. In Vera Cruz, for example, they found new and difficult situations, and their ingenuity in overcoming some of these handicaps is interesting.

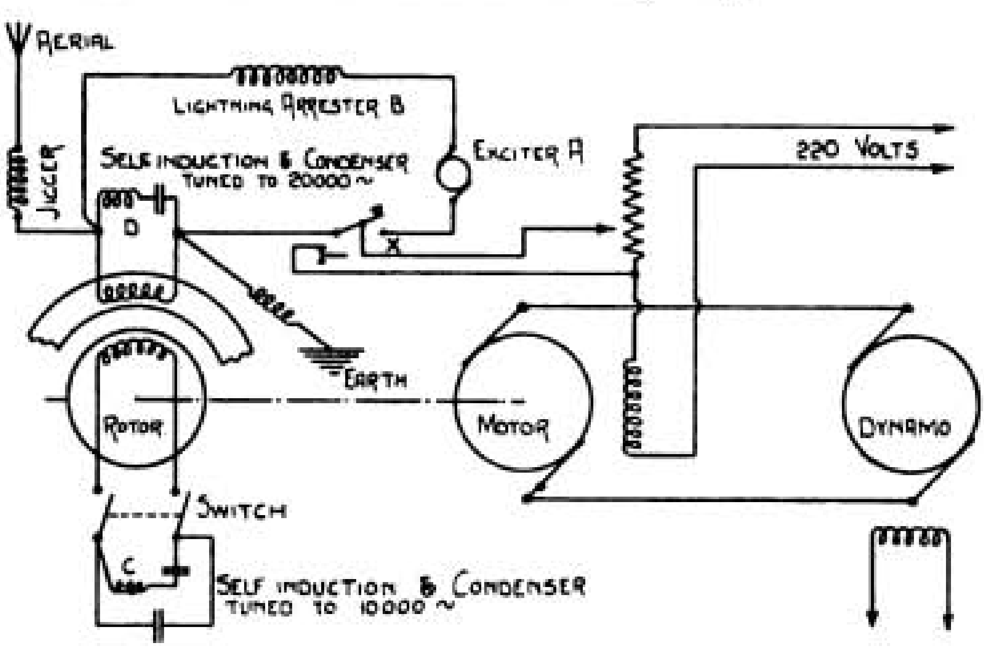
A train was run twice daily under a flag of truce from Vera Cruz to the Interior. This was always accompanied by a small guard. Inasmuch as a treacherous attack upon the cars was likely to occur at any time, it was considered desirable to keep in communication with the trains. Since this could not be accomplished in any other way than by wireless, a complete installation was made in one of the passenger coaches. An upright was erected at each end of the car, and the aerial wires were strung between cross-arms mounted upon these. The instruments themselves were placed upon the cushioned seats within the car, thus avoiding difficulty from vibration. The ground connection was made through the trucks of the car, and the power for the transmitter was supplied by a small hand-power generator. A fixed wireless station was also installed at headquarters in Vera Cruz, and messages were exchanged between this plant and that on the train, even when the latter was in motion.

* * * * * *

THE GOLDSCHMIDT HIGH-FREQUENCY ALTERNATOR.

In an article published in the *Annales des Postes, Télégraphes et Téléphones,* entitled "Radiotelegraphy over Great Distances," Mr. W. Duddell, the well-known wireless investigator, deals with the various methods employed at high-power wireless stations. Speaking of the Goldschmidt high-frequency alternator, he says that if we take a three-phase machine excited by continuous current, this machine giving a current of frequency N, then the current produced in the rotor of a second machine similar to the first will produce a current of frequency 2N. One is able to add a third machine, in which there will be a current of 3N.

Goldschmidt's idea was to combine these machines in one, and put the different portions in resonance for each of the apparatus dealt with. To obtain the same result one may use a single-phase alternator. The stator is energised by continuous current, and it produces in the other a current of frequency N, which is led into a circuit comprised in the rotor tuned to this frequency. The field produced reacting on the stator gives a current of frequency 2N. This current reacts on the rotor and gives a current of frequency 3N, which reacts again on the rotor and gives another current of frequency 4N; this serves to excite the antenna.



Small machines of this type have given good results. As an experiment, says Mr. Duddell, an alternator of 150 kw. has been built, but it is still on trial.

Our illustration will make Mr. Duddell's explanation clear.

* * * * * *

THE ALKALINE STORAGE BATTERY.

The effect of variations of temperature upon the performance of the Edison nickel-iron storage battery is the subject of a paper presented recently at the New York meeting of the American Electro-chemical Society by L. C. Turnock, of the

Department of Chemical Engineering of the Carnegie Institute of Technology in Pittsburgh. The *Electric World*, in a summary of the paper, says that the author's rather extensive tests were made with an auxiliary test electrode consisting of a portion of one of the nickel hydrate tubes which compose the positive plates of the battery. In order to complete a cycle of charge and discharge within a convenient length of time a current rate of 15 amp. was employed; this is about twice that recommended as a "normal" rate, but the author thinks that the results obtained therewith under variable temperature conditions should be entirely comparable to those obtained at a lower rate.

Two cells were tested. Tests were carried out at temperatures varying between 20 and 90 degrees C. (68 and 194 degrees Fahr.), and the results are given in the original paper in a series of tables and diagrams. The chief results are summed up as follows:—

The available current efficiency of the battery at charge and discharge rates twice the value of the recommended "normal" rates increases up to 50 degrees C. (122 degrees Fahr.), after which it begins to fall off rapidly with further increase in temperature.

The current efficiency on discharge is higher than on charge, as evidenced by practically no gas evolution during discharge even at rates higher than "normal."

A more effective input into the battery is possible by keeping the temperature below 50 degrees C. (122 degrees Fahr.). The best electrical efficiency is obtained by charging at a low temperature and discharging at a higher temperature.

The operation of the battery at temperature above 50 degrees C. (122 degrees Fahr.) is detrimental to the life of the battery. The capacity of the positive or nickel hydrate electrode may be restored by an overcharge at a low temperature. The capacity of the iron or negative electrode will continue to be lost with operation at high temperatures, and the lost capacity cannot be restored with overcharging.

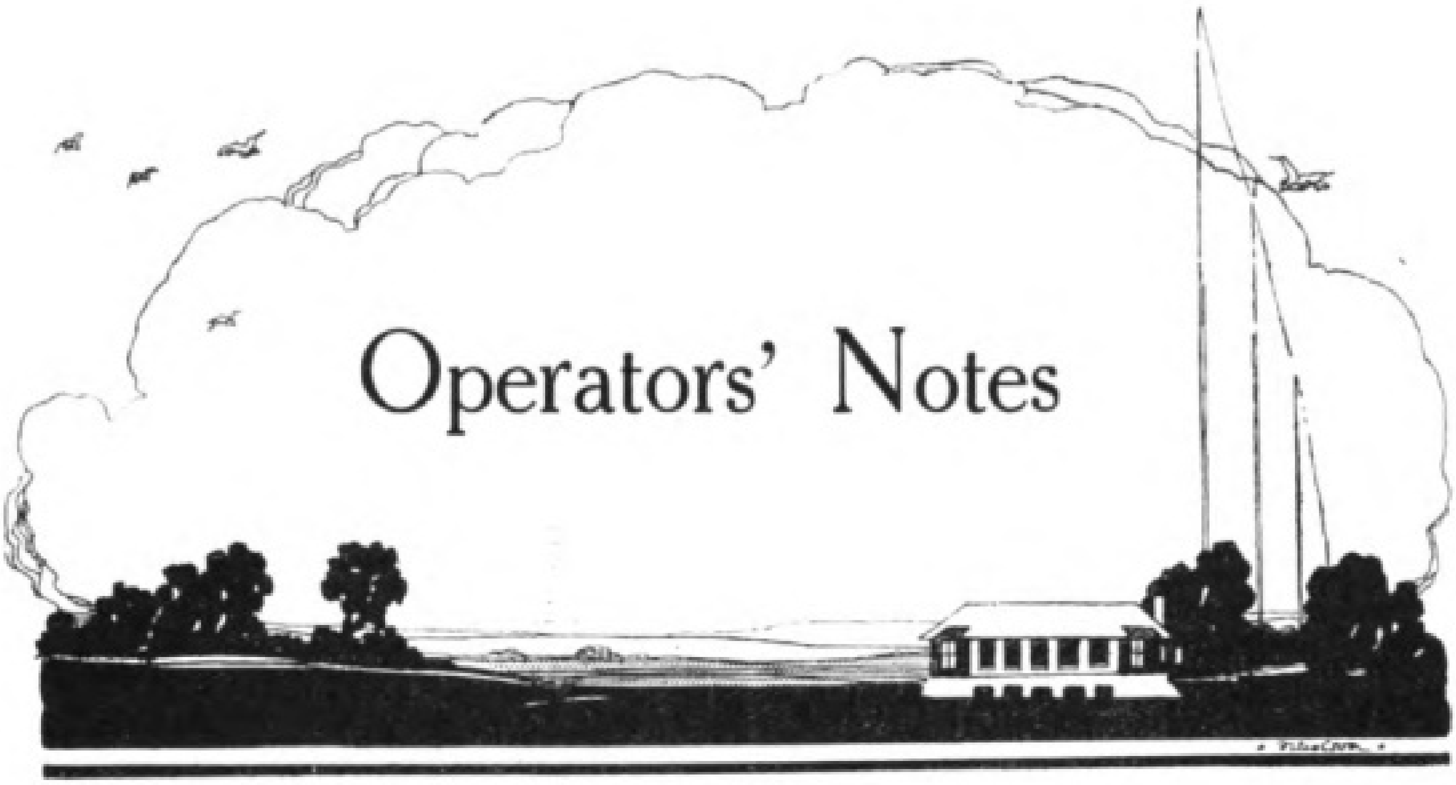
The presence of hydrogen peroxide in the electrolyte during the various states of charge of the battery may account for the low capacities experienced with the battery allowed to operate at high temperatures. On charge it functions as a reducing agent towards the positive electrode, and has the effect of an oxidising agent towards the negative electrode.

Another view explaining the low capacity of the positive and negative electrodes, and which the evidence so far obtained seems to support the more strongly, is as follows:—

On charge the nickel peroxide (NiO_2) and nickelic oxide (Ni_2O_3) form a solid solution, in which the concentration of NiO_2 in the equilibrium phase decreases with increase in temperature.

The highly active metallic iron of the charged negative plates is soluble in the electrolyte, and the rate of solution increases with increase in temperature. Solution of the iron in the electrolyte results in a permanent loss of capacity.

It is dangerous to allow the battery to become overheated and stand even on open circuit in a place that is not sufficiently ventilated, artificially or otherwise. Evolution of hydrogen and oxygen, in the proper proportion to form in themselves a highly explosive mixture, is evident at 50 degrees C. (122 degrees Fahr.), and the rate increases rapidly with increase of temperature.



Operators' Notes

Faults on 1½ kilowatt set

(*Continued from page* 605.)

By W. D. LACEY

Three-Hundred-Metre Wave.—To connect for 300-metre wave, put transformer secondaries in series, main condenser in series, adjust amount of aerial-tuning inductance in accordance with engineer's diagram, and connect the short-wave condenser between the Bradfield insulator and the top-plate of a separate earth arrester gap. Lengthen the spark gap to 7 or 8 mm.

Emergency Set.—The procedure for getting a spark on the 10-in. induction coil is as follows:

First, try to get a voltmeter reading on marine switchboard. If the voltmeter gives a reading of slightly over two volts per accumulator connected, it proves the cells to be correctly joined and that current is being delivered to the switchboard. If no voltmeter reading is obtained, look to the fuse at bottom of switchboard, examine the accumulator connections and see that each cell is properly connected in series. Also note that the leads from the two bottom right-hand terminals of marine board are connected to the ends of the battery. A voltmeter reading should then be obtained. Next see the leads from the two bottom left-hand terminals of the marine board are connected to the back pair of terminals on the coil.

These coil terminals are marked *D*.

The manipulating key connects to two terminals on coil, marked *A*, immediately behind the commutator. The base condenser is connected by joining two pairs of terminals (marked *B* and *C*) with short copper rods.

These condenser terminals lie between the hammer break and the manipulating-key terminals.

The two ends of the primary winding are brought through the ebonite caps at either end of the coil and connect to two terminals, one on each support of the coil.

When all these connections have been attended to (which should occupy only a few minutes), adjust the hammer break until it has a break of about $\frac{3}{32}$ or $\frac{1}{8}$ in. Note the connections between the secondary terminals and discharge rods are joined. Take care the key contacts are not screwed together.

All should now be ready to produce a spark.

First put the single-pole switch (on marine board) over to the left position (cells), put down commutator (on coil) and side lever of key. Upon working the key a spark should take place between the discharge rods.

Plain Aerial.—To work plain aerial, connect one discharge rod direct to the aerial and the other discharge rod to earth. A good plain aerial spark is very white, clear of furryness and gives a sharp crackling noise.

Tuned Emergency.—The plain aerial spark has several disadvantages, not the least of which is its effect upon the aerial insulators and platinum contacts. Therefore, it is desirable to provide means whereby the emergency gear can be coupled to the main transmitting apparatus. This is accomplished by disconnecting the transformer secondaries from the choke coils, and joining a wire from each discharge rod of coil to each choke coil. The spark length in the closed oscillatory circuit should be reduced to about 2 mm. as there is not the same amount of energy available for charging the condenser.

Extra Condenser.—For working the coil from the ship's mains (usually 60 or 100 volts) it is necessary to increase the size of the base condenser in order to minimise sparking at the hammer break. This is done by using an additional condenser of large value. It is connected to two terminals affixed to the interrupter and back-contact pillar.

Extra Charging Panel.—It is unlikely any faults will be placed on this piece of apparatus, but the student will do well to memorise the connections as given in the various diagrams.

The Receiver.—To correct faults on the receiving set is probably the easiest of the whole set.

The following procedure should be adopted.

First, connect leads from the top and bottom plates of the earth arrester gap to the " aerial " and " earth " terminals of the multiple tuner.

Connect the " detector " terminals of tuner to the *A* and *E* terminals of the magnetic detector. Join the *T* terminals of the detector to the telephone condenser and connect telephones. The buzzer should be adjusted for working, and the *A* and *E* terminals connected to the aerial and earth terminals of the multiple tuner. The reason for connecting the buzzer in this manner is that it gives indications of fault on tuner, which will be dealt with later.

Magnetic Detector.—Place the magnets in position (like poles together), wind the detector, and note if band rotates. Should the band remain stationary, see if the starting lever is in the " stop " position, or if there is too much tension on the band. If the band is too tight, slacken the adjusting screw until the band moves.

Now listen in 'phones and press buzzer key ; if all is in order signals should be obtained. If the buzzer " clicks " it denotes a short circuit across tuner. It may be a short on the earth arrester gap, the micrometer gap screwed down, or the aerial tuning condenser at " short."

After examining all these points and still no signals are heard, run over all connections once more, making sure each makes good contact with its terminal. Test primary and secondary of detector for continuity with cell and galvanometer. Test telephone receivers by placing the tags across a cell or buzzer.

Note that all switches of the multiple tuner are in the correct positions; the change-over switch should be in the "stand-by" position, the aerial tuning inductance should be at zero or a very small value, the tuning switch should be on the first position, and the intensifier handle at 90°. The aerial tuning condenser should be at a midway value.

In sets where the telephone short circuit device is connected on the manipulating key, take careful note that the key is not depressing the springs and thereby shorting the 'phones.

With all the foregoing points attended to the set will be in good working order.

The student need not expect to find all the faults mentioned in these articles, but may expect to find any of them, and a perusal of the foregoing methods of fault-finding will give him an idea of the correct procedure.

Administrative Notes

AZORES

The Portuguese Administration advises that service through the coast station at Flores, the interruption to which has been previously advised, has again been renewed.

* * * * * *

FRANCE

Under date September 23rd, 1916, the French Administration advises that the coast stations Saintes Maries-de-la-Mer (France), Fort-de-l'Eau (Algeria) and Cap Bon (Tunis) are closed to public correspondence except for radiotelegrams exchanged between the master of a ship and the shipowners or charterers.

* * * * * *

GOLD COAST

We are advised that radiotelegrams originating in or destined to countries other than the Gold Coast and transmitted through the Accra coast station are subject to a land telegraph charge of 2d. per word, in addition to the usual radiotelegraph and cable charges.

The land telegraph charge is for the service between the Accra coast station and the connecting cable office at Accra.

Example.—The total tax on a radiotelegram destined to London and transmitted from a ship to the Accra coast station would be assessed :—

Ship station tax : Radiotelegraph Service.
Coast station tax : Radiotelegraph Service.
Land telegraph tax : Accra coast station to Accra cable office.
Cable tax : Accra to London.

* * * * * *

PERU

The Peruvian Administration advises us that it has modified the call signals assigned for the radiotelegraphic service to Peruvian coast stations, naval stations, and ships of the National Mercantile Marine.

The new call signals have been assigned as follows, and will be brought into use immediately :—

COAST STATIONS.	*Call Signals.*
Callao	OAA
Chala	OAC
Ilo	OAL
Iquitos	OAY
Masisea	OAM
Orellana	OAO
Pisco	OAP
Putumayo	OAU
Puerto Bermudez	OAE
Requena	OAQ
San Cristóbal	OAZ

NAVAL STATIONS.

Almirante Grau (Warship)	OBG
Chalaco (Transport)	OBC
Constitución (Transport)	OBO
Coronel Bolognesi (Warship)	OBB
Explosive Deposit	OBD
Ferré (Submarine)	OBF
General Staff of the Navy	OBM
Iquitos (Transport)	OBY
Lima (Warship)	OBL
Palacios (Submarine)	OBP
Submarine Station	OBS
Teniente Rodríguez (Warship)	OBR

NATIONAL MERCANTILE MARINE.

Huallaga	OCH
Mantaro	OCM
Pachitea	OCP
Ucayali	OCU
Urubamba	OCR

UNITED STATES

OFFICIAL notification has been received of a change in the names of two important American coast stations.

" Arlington Radio " and " Mare Island " stations are now known as "Washington NAA " and " San Francisco NPH " respectively, the call signals having been added to distinguish them from other stations of the same names.

No alteration is made in regard to the transmission of time signals, weather reports, navigation warnings, and other services performed by these stations.

"A Text-Book of Practical Physics"*

By H. S. ALLEN, M.A., D.Sc., and H. MOORE, A.R.C.S., B.Sc., Lecturers in Physics at King's College, London. Reviewed by Professor G. W. O. HOWE, D.Sc., M.I.E.E.

ALTHOUGH intended primarily as a book of instruction for the course in Practical Physics at King's College, the volume under review will undoubtedly prove of great service to all teachers of the subject. It covers a wide range, starting with simple elementary experiments and including the greater part of the practical physics required for a pass degree in science at most universities. The fact that engineering students in the University of London are required to take a practical course in applied mathematics, explains the presence of a larger number of experiments in practical mechanics than is usual in a text-book of practical physics.

Most of the experiments described are such as can be carried out with simple apparatus. The authors very properly deprecate the use of elaborate semi-automatic apparatus in a laboratory intended for teaching students the fundamental principles of physics. Stress is laid throughout on the degree of accuracy obtainable with the apparatus employed. The course mapped out and the methods employed are certainly calculated to develop the capability of carrying out original investigation and research.

The book is divided into six parts, dealing respectively with properties of matter, sound, light, heat, magnetism and electricity. The first part is sub-divided into eleven chapters, the first of which is introductory and describes the methods preferably employed in recording, working out, and finally writing up the results of an experiment, the accuracy of observations, null versus deflection methods, the use of graphs, etc. All teachers of applied science know the weakness of students for working out results to four or five decimal places when some of the observations have a probable error of 1 per cent. The authors caution students against such misplaced zeal. Attention is rightly directed to the necessity of mastering the theoretical principles involved, and of thoroughly understanding the purpose of the experiment, also of studying carefully the apparatus employed and the details of setting it up and adjusting it.

Chapter II. deals with fundamental measurements—i.e., of mass, length and time. Chapter III. with areas, including the theory and use of the planimeter, and with radii of curvature of lenses, etc. Chapter IV. embraces the various methods of determining the specific gravity of solids and liquids. Chapter V. deals with forces in equilibrium, levers, centre of gravity, inclined plane, etc. Chapter VI. with the efficiency of simple machines, and Chapter VII. with elasticity and Young's modulus. Chapters VIII. and IX. are devoted to dynamics, including the oscillation of pendulums, magnets, etc. Chapter X. to the barometer and Boyle's law, and Chapter XI. to surface tension and capillary phenomena.

The section on Sound consists of three chapters and covers the usual

* "A Text-Book of Practical Physics." By H. S. Allen, M.A., D.Sc., and H. Moore, A.R.C.S., B.Sc. London, 1916. Macmillan & Co., Ltd. 8s. 6d. net.

experiments on resonance tubes, determination of pitch by a siren, by Kundt's tube, vibration of stretched strings, etc.

Part III., Light, contains eight chapters, of which the first deals with simple reflection and refraction, the second, third and fourth with mirrors and lenses, the fifth with the optical bench, the sixth with microscopes and telescopes, the seventh with the spectroscope, and the eighth and last with photometry.

The section on Heat contains seven chapters, dealing respectively with thermometry, coefficients of expansion, calorimetry, cooling, thermal conductivity, the mechanical equivalent of heat, and hygrometry.

Part V. deals with Magnetism, and is subdivided into five chapters. Chapter I. contains simple experiments with magnetic needles, such as mapping out magnetic fields; Chapter II. is on magnetometry, and Chapter III. on the oscillation of a magnet in a magnetic field. In Chapter IV. simple methods are described of determining the various elements of the magnetic field of the earth.

Last, but certainly not least to the readers of this journal, are the chapters devoted to Electricity. In accordance with classical precedent, the first chapter deals with electrostatic experiments, which have become of increasing importance with the growth of wireless and other branches of high-frequency work. Chapter II. deals with the mapping out of the magnetic field due to conductors and coils carrying current. In Chapter III. are described methods of calibrating galvanometers and ammeters. Chapter IV. deals with potential difference, electromotive force, and the potentiometer, Chapter V. with the measurement of resistance, Chapter VI. with voltameters, and Chapter VII. with the heating effect of the current. Chapter VIII. is more ambitious and deals with induced currents, induction coils, transformers, dynamos, and motors. Three methods of comparing the capacities of condensers are given in Chapter IX. The concluding chapter consists of a number of notes on various pieces of electrical apparatus—e.g., keys, switches, galvanometers, rheostats, etc.

At the end of every section is given a very useful list of additional exercises. A number of tables of useful physical constants is given in an appendix, which also includes a table of logarithms.

The general get-up of the book is good, important points are brought out by being printed in heavier type, and the book is well illustrated with practical diagrams. It is a book which can be unreservedly recommended to all students of physics.

Searchlights

THERE must be few readers to whom the beams of the searchlights are not a familiar sight, and considerable interest has been aroused, since the perfection of England's anti-aircraft defences, on the wonderful instruments which pierce the sky and ferret out the aircraft of the enemy. We have recently received from Messrs. Crompton & Co., Limited, of Chelmsford, the well-known searchlight specialists, an illustrated list of searchlights of all types ranging in size from 12 inches to 84 inches in diameter, and fitted with every device to facilitate their operation. Messrs. Crompton have developed their present searchlights as a result of many years' experience, and will be pleased to forward to all interested full information as regards price, weights, measurements, etc.

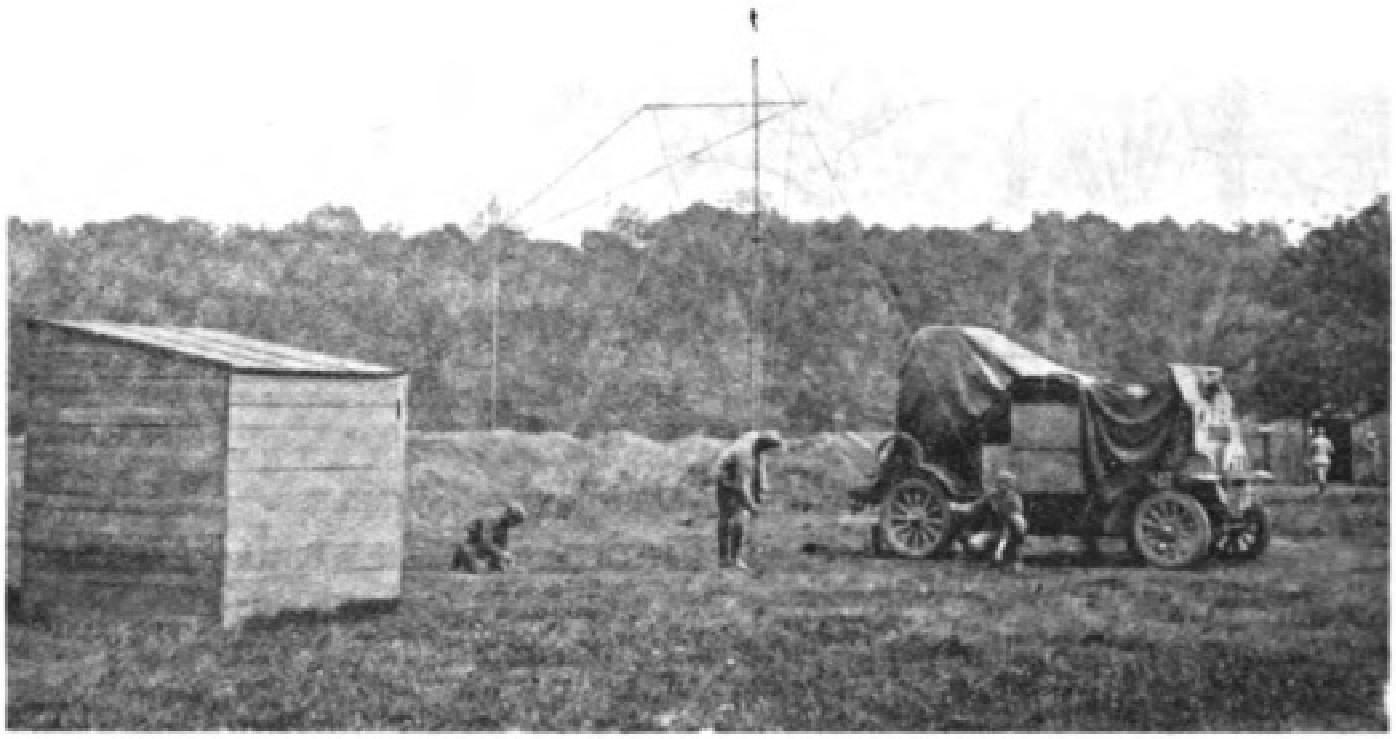
Wireless Telegraphy In the War

RUDYARD KIPLING ON DESTROYERS' WIRELESS.

In his recent delightful articles on " Our Destroyers in the Battle of Jutland," the most distinguished of British journalists puts forward a possible solution of the way in which the Germans may have acquired the belief that they sank certain British vessels. This explanation is that, owing to the difficulty of distinguishing friends from foes, an enemy vessel may have " finished off " one of their own vessels and wirelessed the information to headquarters, utterly oblivious of the fact that the victim was not British at all. If this very plausible theory be correct, we have in the German version of Jutland yet farther examples of the way in which our enemies select from their " Wireless Reports " only such items as happen to suit the purpose of the moment.

In the same series, Mr. Rudyard Kipling draws a very vivid sketch of the dangers that may be involved if " Jos jambs wireless orders at the last moment." It is quite " on the cards " that more than one actual happening may be adumbrated in the picture drawn as a "draft on fancy " by the famous Anglo-Indian writer. What the verbal sketch limned by his imaginative pen amounts to, is this: British destroyers are out on a cruise, and have been " wirelessed " that a certain class of warships is being kept out of the business in hand. Therefore, if they see any vessels bearing the distinctive appearance of this class, they can assume that they are Germans masquerading as British, and " strafe " them accordingly. A later wireless message correcting the stay-at-home order for this type of British vessel fails to reach them. When the destroyers sight such vessels what are they to do ? Kipling answers the enquiry in his own characteristic style.

At another point in this same thrilling set of articles, the creator of *Soldiers Three* dwells upon the powers of British Naval improvisation. He is describing the terrible scenes on board a badly battered British ship, when the First Lieutenant " took charge of affairs whilst his Commander was being extricated from the bridge " wreckage." The imagination of Wireless men will be able to riot over the possibilities suggested by the description of how this lieutenant " in his leisure, improvised " means of signalling "; for we read a little further on that " the searchlight and "wireless were tangled together and the electricity leaked into everything." Yet



Newspaper Illustrations.

FIELD WIRELESS ON THE WESTERN FRONT.

in the midst of this "leakage" the lieutenant was at work bringing order out of chaos, and the surgeon—a probationer—performed an amputation single-handed.

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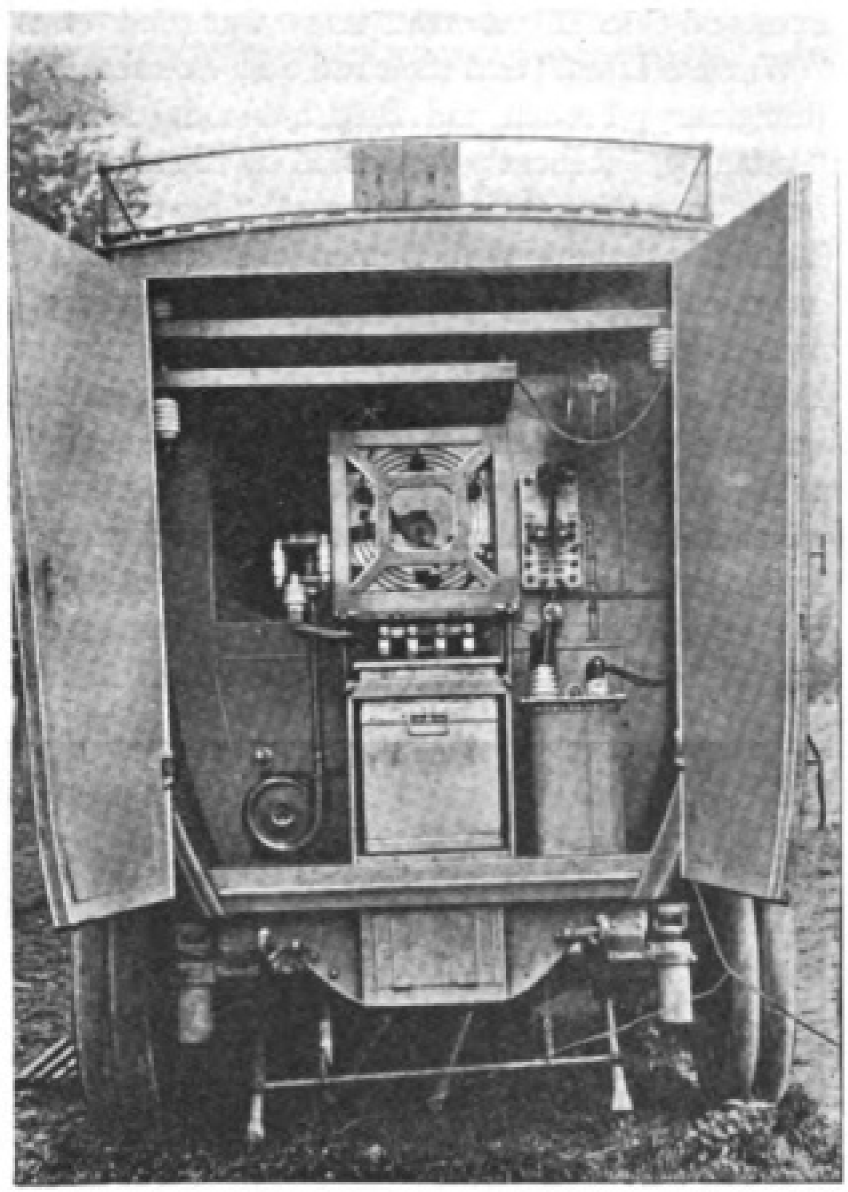
TEUTONIC "PROSTITUTION OF SCIENCE."

Nothing is more striking, when we come to review the "manners and customs" of our enemies than what we may call "their prostitution of science." They have systematically employed poison gas in various hideous forms, despite a formal peace-time agreement amongst civilised nations that such means should not be employed in warfare. They have introduced chemical poisons into drinking wells and rendered them death-traps for men and beasts. Discoveries recently made at the German Embassy in Bucharest show that the German Diplomats had there amassed a large store of the serum of anthrax, with a view of introducing that virulent disease into Roumania by inoculation, as soon as she should have declared herself on the side of the Allies, and we understand that a German plot was recently discovered for similarly infecting animals destined for Canada and turning them loose in the Dominion. We all of us remember how, a short while ago, when the Roumanian bulletins contained a reference to poisoned sweets thrown down from German aircraft, the Enemy Press "explained," and the Enemy Wireless circulated the "explanation" that the sweets referred to did not contain poisons, but explosives! All these things are the result not of hasty resolve, but of careful preparation spread over a large number of years, during which German hypocrisy was busily engaged in framing International Rules against such proceedings and inducing other nations to subscribe to them. The dates upon the poison apparatus captured by the British speak for themselves.

Perhaps of all modern applied sciences the most completely exploited for their evil purpose has been, and is, wireless telegraphy. This invention conferred upon their Zeppelins powers which otherwise could never have been theirs. Not content, however, with employing those really wonderful examples of ingenuity in their legitimate function as air-scouts, they despatched them upon raids which even their would-be-apologists can scarcely differentiate from murder-tours. The German Government induced the representatives of other Powers to agree in the universal interest to the limitation of the power of steamship installations. Their State-controlled and State-subsidised shipping lines straightway utilised these restrictions for putting their own vessels in a state of wireless superiority. There can be little doubt that this practice was responsible for enabling the *Greif* to blanket the wireless of the *Alcantara*, so long as the installation on the German ship was capable of working. Everywhere Germany has endeavoured to utilise the immunity from attack secured them by the benefit of neutrality to violate every wireless regulation of their hosts. Over and over again Swedish, Dutch, American, and other authorities have had to discover and suppress fresh attempts in this direction. No respect either Divine or human appears to restrain them.



L.N. Newspaper Illustrations.

A FRENCH PORTABLE EQUIPMENT ON THE WESTERN FRONT.

Over-reaching Themselves.

The fact that wireless alone enables the Central Powers to keep in direct touch with the world outside their own territory and that of their immediate neighbours, necessarily forces them to utilise radio-telegraphy for their propaganda work. No one can find any fault with them for that. But they have so prostituted the opportunity given them by this most modern of sciences, that the British Censors are enabled to pass a considerable proportion of their accounts for publication in our own newspapers, secure in the knowledge that their misrepresentations are so patently ridiculous as to defeat the object of their originators. An interesting analysis of the German wireless *communiqués* was recently issued. The analyst therein exposed our enemy's attempt to dwarf the real successes of the French and British by the invention of a whole series of imaginary battles which never had any existence except in the wireless waves radiated into the ether from German stations. From day to day, throughout the end of October and the beginning of November, these fictional wireless battles " continued," or " went on with great severity," or " are " still maintained with undiminished acerbity." The actual battle-line scarcely exceeded three miles. But this " war zone " was totally inadequate for the German " Wireless Liars," and their radio service accordingly inundated the whole front with (imaginary) French and British blood. According to these fabulists " our brave " infantry, excellently supported by the artillery and airmen " were kept continually busy " repulsing," " smothering," " beating off," or " breaking down " the reckless British onslaughts with tremendous slaughter. Having created these vast conflicts in which they assigned themselves the victory, it became comparatively a simple matter to slip in such little affairs as the recapture of the Verdun positions by the French, or the taking of the Stuff and Regina trenches by the British. We might go on multiplying instances indefinitely ; but enough has been said amply to support the point, which we have endeavoured to bring home before our readers, of the extent to which science has been debased by its utilisation in the present war by our enemies. Is it a matter of wonder that—only the other day—an independent member of the House of Commons, when asking about an aged German scientist, unnaturalised, yet alleged to be still doing work for the British Government, protested in advance

[Newspaper Illustrations.

A POILU WORKING WIRELESS IN A DUG-OUT

against the favourite official justification of "an aged and innocent Professor"? Science to Germany means but fresh methods of destruction, and German scientists are so corrupted through and through by this spirit, that we should hesitate to believe any one of them to be "simple" or "immersed solely in technical pursuits."

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German Vapourings and British Reticence.

The voyaging of the *U*53 to and from the United States does not demonstrate any new facts; British submarines have performed cruising exploits of a more remarkable nature, and we recently saw a photograph taken on board a British submarine in mid-ocean, whilst she was in the course of performing a 5,000 mile voyage. What it *does* do, is to furnish a fresh indication of the complete nature of Germany's subjugation at sea, and a fair illustration of the German's estimate of President Wilson's notes. Our foe is fully as well aware as ourselves of the drawbacks of under-water craft as substitutes for surface vessels; and would never so employ them if they could help themselves.

[Underwood & Underwood.

ON A BRITISH SUBMARINE IN MID-OCEAN

We notice that press accounts of the wireless on these up-to-date submarine cruisers is described as being of a specially powerful nature. We have seen no direct evidence that this is so, for the fact that *U*53 wirelessed messages in code to Count Bernstorff as soon as she neared American neutrality waters is not in itself inconsistent with her being fitted with the ordinary submarine wireless apparatus. Such installations are capable of transmitting over a radius of sixty miles. Assuming, however, that the printed reports are accurate in this respect, it would tend to show the way in which Germany, unable to employ submarines in their proper rôle as subordinate units acting in conjunction with surface vessels, is obliged to introduce modifications into the construction of the former, in order to give them a fair chance of playing a part for which they are radically unsuited. It is significant of the supreme importance of wireless at sea that the wireless warnings issued in all directions as soon as the shipping people on the other side realised what was going on, resulted in the preservation of many possible victims. No more eloquent justification of the recent Government action with regard to the compulsory wireless could possibly have been afforded. The only wonder is that any compulsion should have been necessary.

War Notes

Outrages against Hospitality.

We refer on another page to the violation of neutral hospitality by German illicit wireless. There have been many cases in point all through the war, but the instance of the North German Lloyd Steamer *Willehad* possesses some characteristics of its own. It would appear that, although the vessel was brought to New London (Conn.) from Boston on August 25th, and her Wireless Apparatus sealed by the American authorities, the resourceful Teuton was able to organise an ingenious device for getting round the American Regulations. A floating barrier and a gate 30 feet high were erected, ostensibly for screening from observation any German submarines which might arrive. Under the cover of this structure, wires were stretched between the piling under the pier and that to which the *Willehad* was made fast in such a way as to create a Wireless Aerial. Such installations as these, which owe their immunity from destruction to location under a neutral flag, cannot be otherwise characterised than as outrages against hospitality.

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Some Chicago "Mustard."

Our readers will be amused by the following pungent American suggestion that President Hughes may utilise Wireless and "damn the expense!" We cull the passage from the *Chicago Tribune*, part of whose sarcastic editorial runs as follows :—

"We said *tweet* to Germany over our 'strict accountability' about "the *Lusitania* and *Sussex*; we *chirp* to Great Britain about 'mail "'interference.'

"Tweet and chirp to Germany and Great Britain. Why? Because we have "nothing but a tweet and chirp in our organisation. We must tolerate things "because we are not strong enough to remedy them. We have the price of ink and "cable-tolls. We can use the Wireless if necessary. Ding the expense of trans-"mitting what we think of Powers which do us injury!

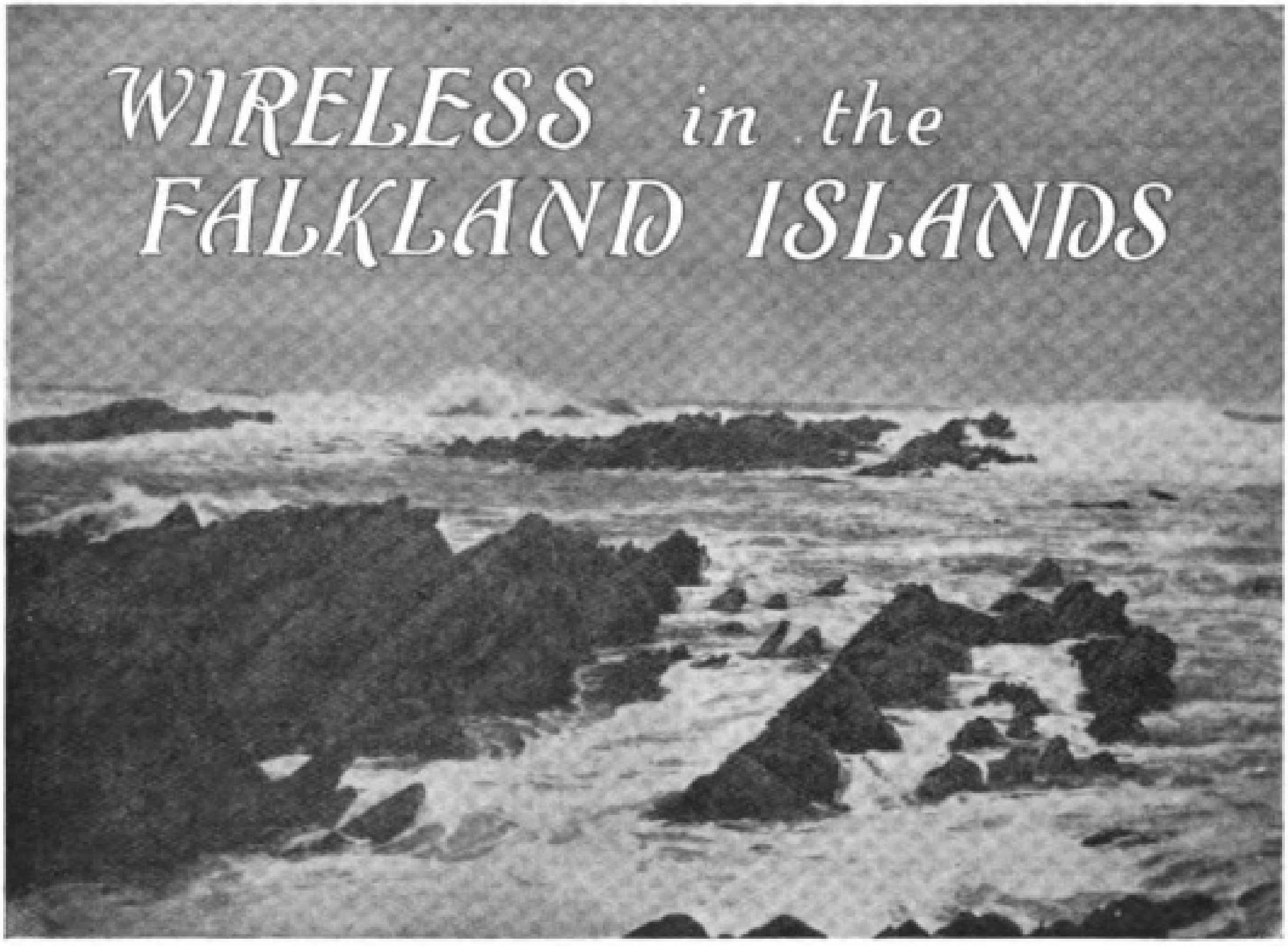
"But as for making it inconvenient for Powers to do us injury—China and the "United States are companions in unhappiness."

* * * * * *

Wireless Spoils of War.

Amongst the list of miscellaneous material captured by the French from the Germans in their recent successes on the Verdun front, the official bulletin includes two Wireless Telegraphy posts, besides a number of heavy guns, 51 trench mortars, 144 machine guns, and a large quantity of rifles, grenades, shells and *matériel*. Such losses of the enemy are becoming of increased importance, in view of his difficulty in making up deficiencies. We have already had occasion to comment upon the lack of Wireless equipment referred to in Von Arnim's report.

WIRELESS in the FALKLAND ISLANDS



By W. D. LACEY

It may be of some interest to readers to learn a little of the manner of life led by the operators on far distant radio stations, both before and since the war.

Before the war the writer, with one assistant, was appointed to the station at Port Stanley, in the Falkland Islands, and proceeded thence in August, 1912. After a pleasant voyage lasting a month, the ship arrived late at night off the East Island, and the only sign of life to be observed was the flashing of the lighthouse on Cape Pembroke. All that could be seen of the island were the black forbidding outlines of the hills behind the harbour. Not wishing to form a prejudiced opinion of the position before making a closer acquaintance with the place, I thought the best thing to do would be to retire until daylight. Upon waking the following morning we found the vessel had entered the harbour, where one small and one smaller tug were making the seven miles of harbour appear to be hustling " some." About three miles east from the township (I mustn't call it a village), the masts of the wireless station could be clearly discerned together with what appeared to be two stone buildings.

It looked rather a pretty station from a distance, but appearances are often deceptive, as after acquaintance proved. At breakfast, before going ashore, we were approached by a Customs officer, who inquired after us by name, with a request not to go ashore until His Excellency sent off the Government pinnace for our conveyance, whereat visions of an elegant and smartly manned launch flashed across one's mind.

The disillusionment came when someone pointed out a black-painted launch approaching at about five knots, and said : " That is the Governor's launch." After circling the ship to find the gangway, the aforementioned launch " tied up " alongside and was seen to be manned by a longshoreman and a labourer, whilst the engineer's head protruded through a manhole, surveying things in general with the aid of a pipe.

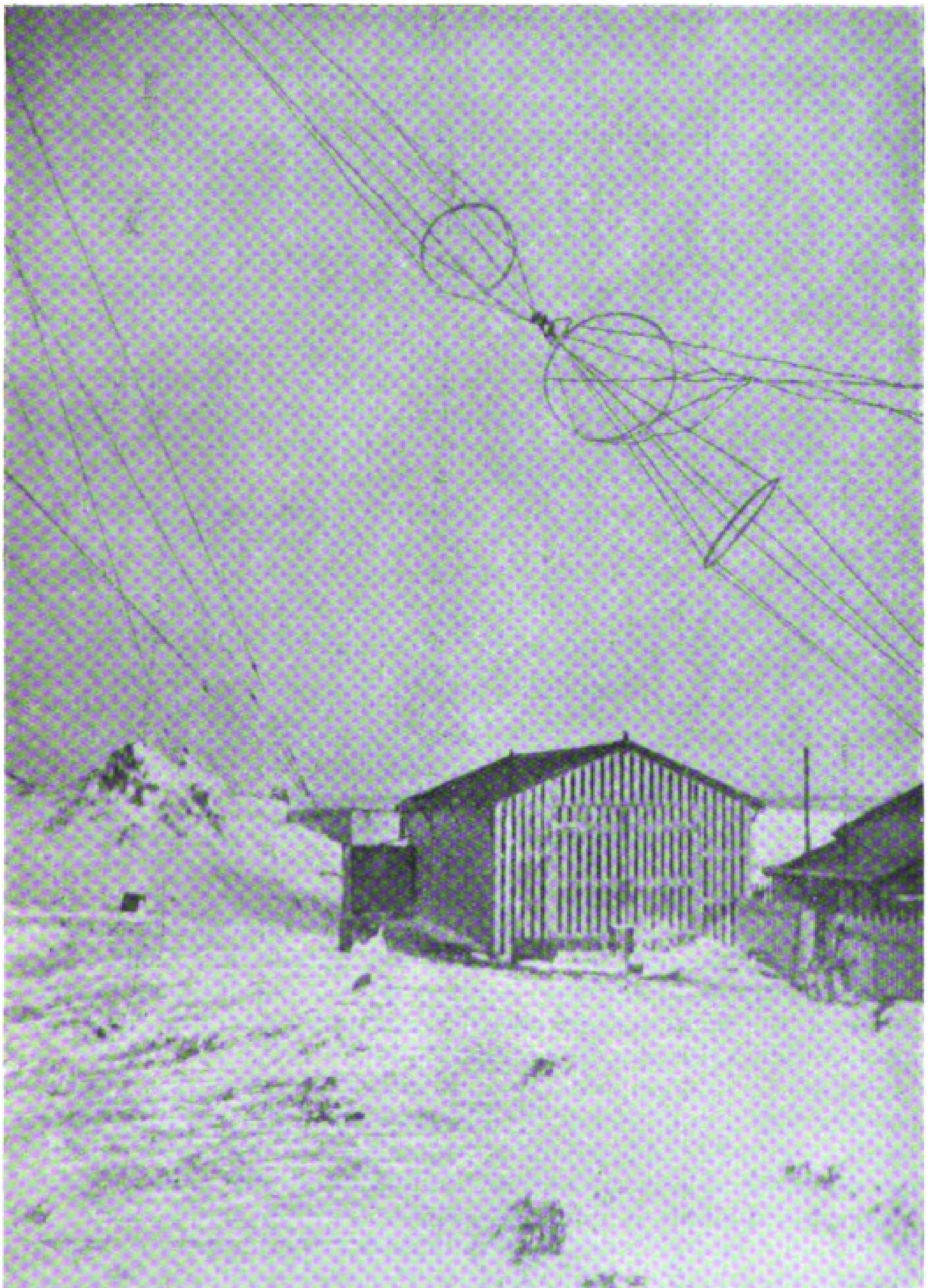
Eventually arrived ashore, we were there met by the Chief Constable, who had been deputed the duty of seeing to our accommodation in the town until such time as the station quarters were ready for habitation.

There are two main " roads " in the township, which extend for about two miles, the houses dotted here and there apparently wherever their owners' fancy dictated. Each house possesses a garden, in which is grown potatoes and such other vegetables (principally root crops) as can be persuaded to endure the climate. Hens and chickens wander about the roads at leisure, and carry out a systematic survey of the gutters in the hope of supplementing their rations.

A PLEASANT EXPRESSION FOR THE BENEFIT OF THE PHOTOGRAPHER.

SEAL PUPS ON THE SHORE.

On the day following our arrival we were taken to the wireless station in the Government launch, and landed at a crazy wooden jetty about a quarter of a mile



A PORTION OF THE AERIAL WHICH WAS WRECKED IN A BLIZZARD.

from the site. Arrived at the station we made tests with the departed mail steamer, and then proceeded to inspect our surroundings. The station power-house was a corrugated iron building lined with wood, and consists of an engine room, store room, and operating room. The quarters provided was a wooden bungalow of six rooms built up on piles over a peat bog. The water supply consisted of two large tanks to collect rainwater from the roof, but these were not erected until some time after our arrival. The quarters were not ready for four weeks, so we had the pleasure of walking to and from the station each day. It is when one begins walking that it is realised what sort of proposition one is up against. The " Camp," as it is called, is pure unadulterated country, and consists of a succession of bog pools dotted with irregular tufts of coarse grass. " Walking " really means jumping from one tuft to another to avoid wading through the ponds, and when one has to do a succession of jumps and get a balance on each tuft before hopping off at a tangent for the next hump, one really begins to realise that it is no holiday. After " walking " to town one feels as though it is about six or eight miles, especially in view of the necessity of carrying or (usually) wearing an oilskin.

The climatic conditions do not lack variety. Rain averages 250 days in the year, high winds at least 150, snow, hail and frost at frequent intervals, and sunshine about five days per annum. From these details it will be seen that, being only 365 days in the year, some days had more than their usual share of bad weather. It usually had to either blow and rain together, or otherwise some equally unpleasant combination.

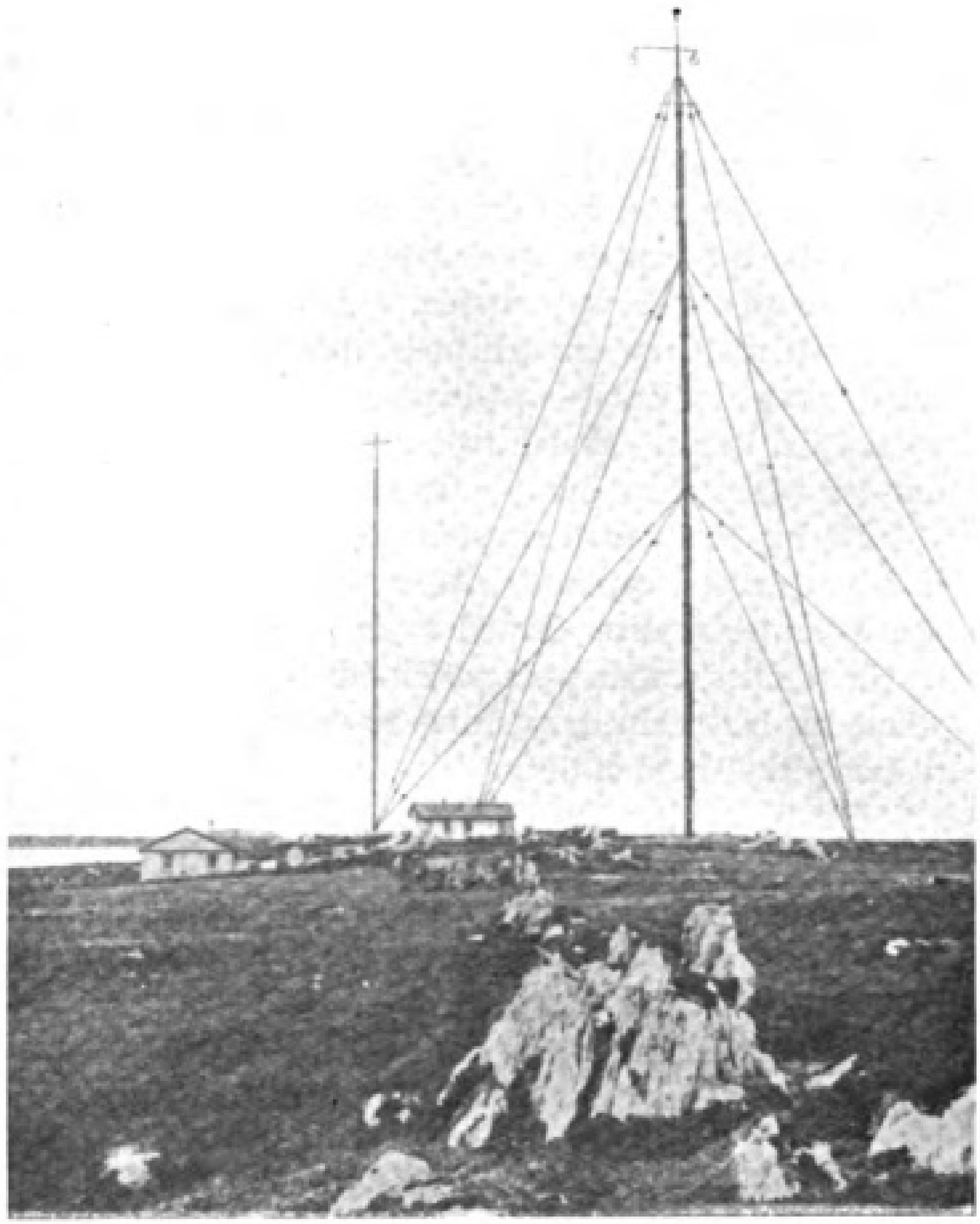
We were duly installed in the quarters, and then had to wait for rain to come in order to be provided with liquid. Under any normal circumstances it would rain immediately, but contrary to our expectations it did not rain for some days, so we were forced to collect water from a hole dug in the ground. As this water filtered through peat it was very richly illuminated dark brown, and with which we were obliged to be content. Of course, as usual, when rain did come it didn't seem to know how to stop.

As previously mentioned, walking is not exactly delightful, and in order to extract some pleasure from this exercise one needs a stout pair of boots and a gun or camera. The gun enables one to bring home a brace of ducks or geese with which to enliven the festive board, and also forms a welcome change from " 365 " (local name for mutton, signifying every day of the year).

Shortly after our arrival the monotony of the life was broken by a shipwreck only four miles from the station. The vessel was the Pacific liner *Oravia*, outward bound. Fortunately no lives were lost, although the work of rescue was carried out throughout under very trying weather conditions. The problem of finding accommodation for the 600 passengers and crew in the town was no light one, and the survivors were glad of beds made up on floors wherever room could be spared, The two ship's operators were more fortunate, finding quarters on the wireless station. and they were also able to give valuable assistance in dealing with the pressure of work. Communication was established with another vessel of the same line which put into Stanley, and took some two hundred refugees away, the remainder waiting for another relief ship.

From that time onwards we pursued the usual routine of the station without anything exceptional occurring until the outbreak of war.

The war came as no sudden surprise, as by wireless we were kept in very close touch with the trend of events in Europe. Being a British colony, precautions had to be taken against attack, so the local Volunteer force was mobilised, forming perhaps one of the smallest forces in existence. A call for volunteers was sent to the surrounding islands, and reinforcements gradually came in.



THE TWO STEEL MASTS AND STATION BUILDINGS.

Early in October the gallant Admiral Cradock with his squadron visited Port Stanley, and left shortly afterwards. Upon Admiral Cradock's advice the women and children were sent away from Stanley to the outlying settlements. The exodus was such that local transport facilities could not stand up to, and every possible means of transport was resorted to. My wife had the unpleasant experience of spending the night on the tiny bridge of a steam whaler swept by seas every few moments. Thirty women were on board and perforce had to remain on deck throughout a bitter night. I observed another schooner being towed which was rolling terribly. In this case the women were battened below, and even the sailors on board were sea-sick.

Others preferred to go on horseback, and I am inclined to think they had the better bargain.

The duties at the wireless station were very arduous, all traffic having to go to Monte Video, 1,030 miles away. Messages totalling about 2,000 words in one night were often dealt with.

Fortunately for us the enemy delayed their appearance through various causes until December 8th, arriving off the islands just eighteen hours after the squadron commanded by Admiral Sturdee. The consequences are sufficiently well known, the Germans suffering up to that time the greatest naval disaster of the war. (A full account of the battle appeared in our March, 1915, issue.—ED.)

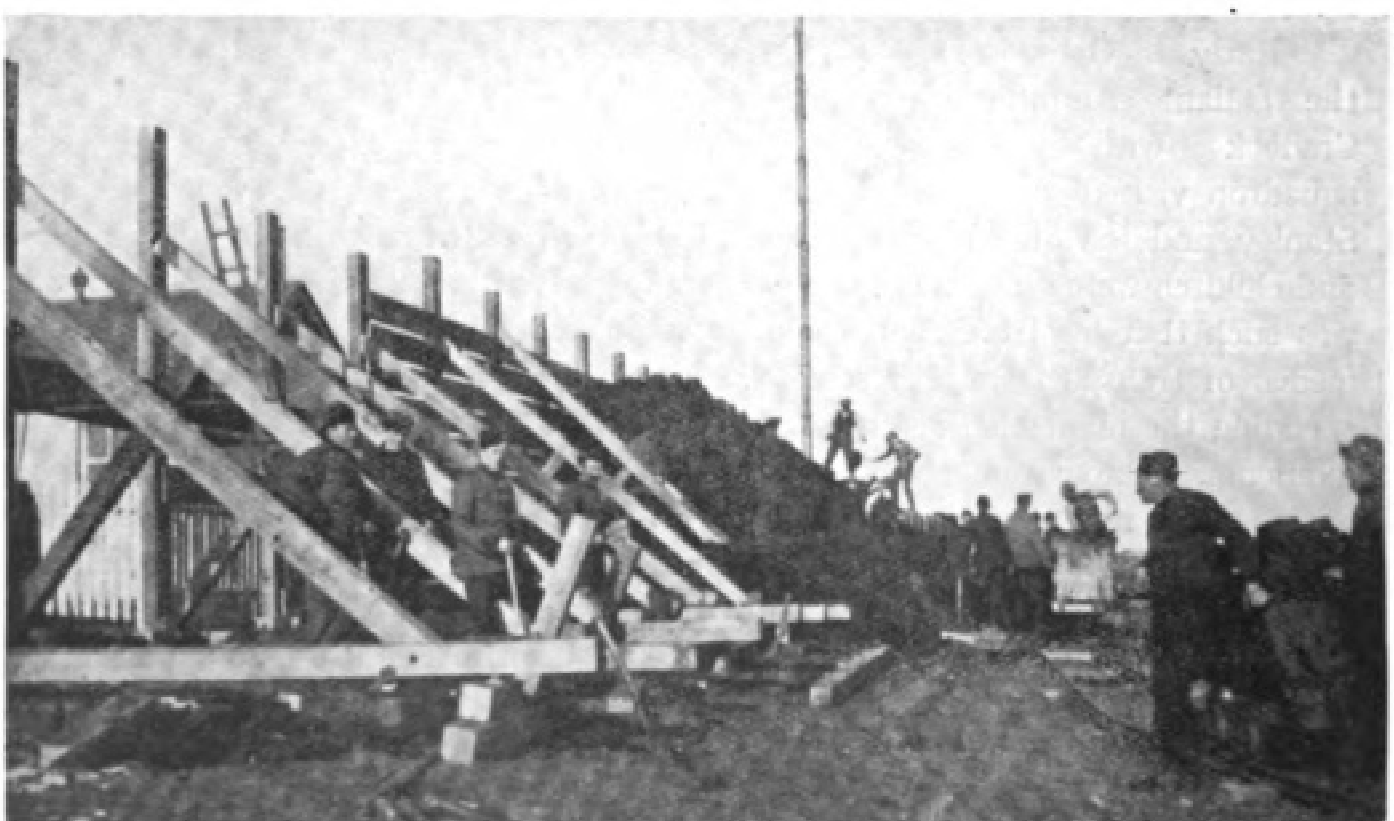
After the battle we looked for some relaxation from such arduous duties as we had been doing, but owing to the British squadron remaining in the vicinity to hunt the *Dresden* we were obliged to keep the watches as before.

While the women were absent we were obliged to mess with the Volunteers. The fare was not very varied, but certainly had novelty. Mutton chops for breakfast, roast mutton and bread for dinner, and cold mutton for tea. No vegetables were obtainable—not even potatoes. Sometimes as a luxury we were served with dried beans. Owing to a shortage of sugar we were reduced to sweetening our tea with golden syrup. Tinned or fresh milk was not obtainable.

During this period we suffered the loss of eight men, whose duty took them in a punt which capsized. After the *Dresden* was accounted for, the majority of the Volunteers were allowed to resume their civil employment, but the watches on the wireless station were not diminished in any way. Fortunately a local operator, whom we had trained, was able to take a regular watch, which greatly assisted in reducing the hours of duty.

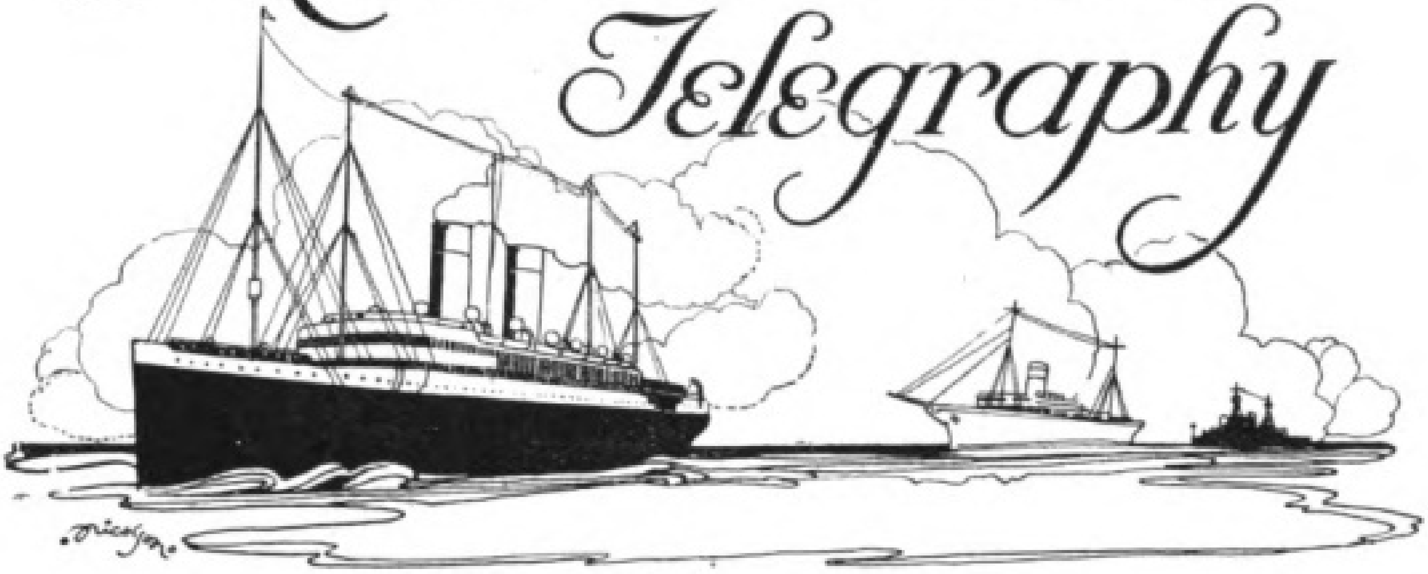
Before leaving the Falklands, Admiral Sturdee wrote in the following terms of the work carried out by the station :

" I have the honour to inform Your Excellency that the W/T Station at Port Stanley has been absolutely invaluable to the squadron during its stay in the Falkland Islands. The work was most efficiently carried out under great difficulties, due to atmospheric conditions, the comparatively low power of the station, and the distance to be covered—namely, 1,010 miles to Monte Video."



PREPARING TO PROTECT THE STATION AGAINST ENEMY BOMBARDMENT.

Maritime Wireless Telegraphy



Danish and Swedish Activities.

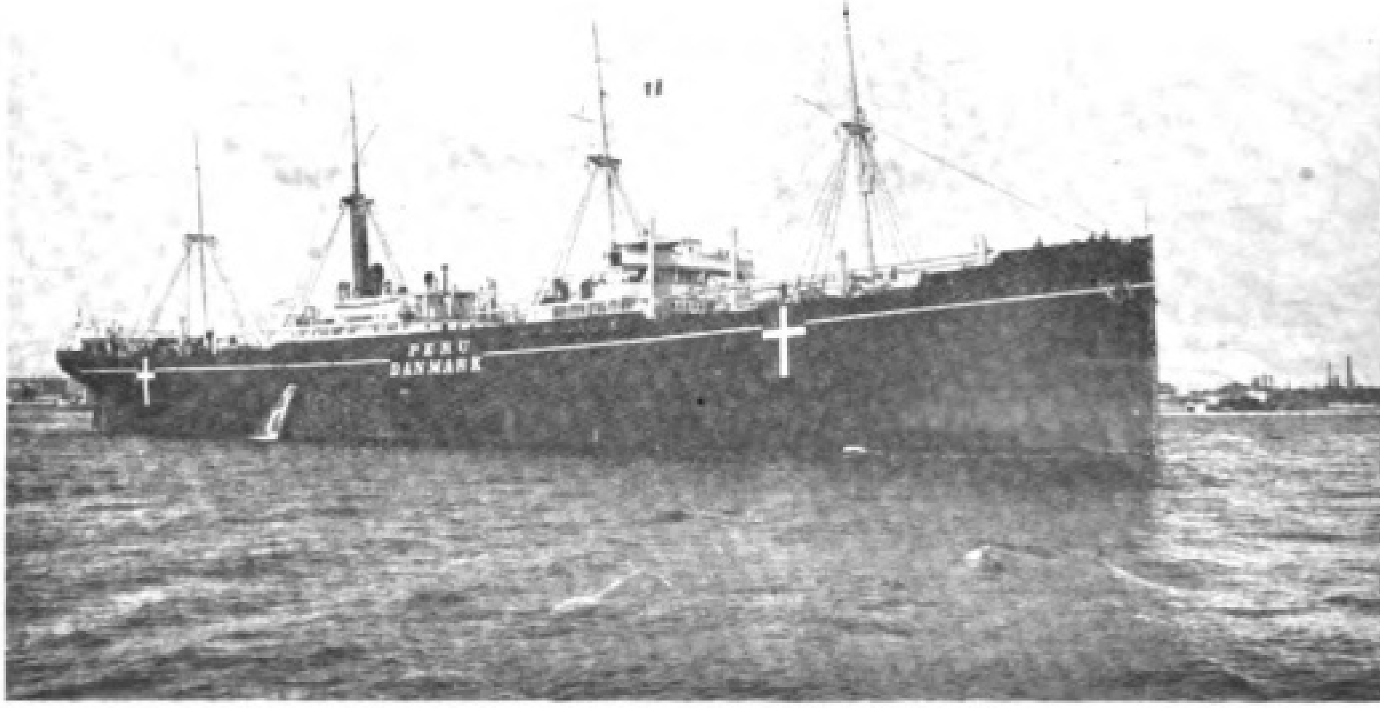
Amongst the various problems which will face British shipbuilders and steamship owners at the close of the war is the impetus given to the constructional and shipping activities of the various Scandinavian countries. The twin-screw motor-vessel *Peru*, possessing a gross tonnage of 5,584, is the twentieth motor-ship of this description launched from the yard of Messrs. Burmeister & Wain, of Copenhagen, for the East Asiatic Steamship Co., of the same city. The Marconi wireless installation consists of an aerial of the standard steamer pattern, with a " lead " down to the radio room situated amidships at the top of the boat deck. Our illustration of this vessel (on the following page) we owe to the courtesy of *Engineering*, which also publishes complete drawings of the ship and machinery.

Denmark is very far from being alone in the new and rapidly progressing field of motor ship construction, for Swedish yards also are busy, and have recently turned out the *Hamlet*, whose builders claim her to be one of the best-equipped vessels of her type, and which includes amongst her fitments a complete wireless installation. This vessel, with a capacity of 6,800 tonnage and of 5,093 gross, has been engined with two-cycle Diesel machines, totalling 4,700 h.p.

* * * * * *

A Notable British Transport.

The *Queen*, recently reported sunk by German destroyers on October 27th, during their recent dash upon our Channel communications, was one of the best-known boats of the Channel service and the property of the South-Eastern and Chatham Railway. A vessel of abnormal speed, she was equipped with a wireless installation and fitted with turbine engines. The *Queen* was the first steamer so engined to be placed on the Dover-Calais service. By a curious coincidence, it was two years and one day since she had answered a wireless call and succeeded in rescuing 2,500 Belgian refugees, passengers on board the *Amiral Ganteaume*, which, with characteristic barbarity, the enemy had torpedoed. And now the *Queen* has herself fallen a victim to Teutonic violence. It is an open secret that she had proved herself one of the most valuable transports plying between Great Britain and the Continent, and we all feel it to be a matter of congratulation that, at the time when the enemy sank her, she was without the valuable human freight so often and so safely entrusted to her care.



A NEW DANISH MOTOR SHIP.

TWO DONALDSON-LINE VICTIMS.

Amongst the too numerous victims of German submarine piracy which have been recorded in recent days mention must be made of the s.s. *Cabotia*, belonging to the Donaldson Line. She was reported sunk at the end of October, and, at the time of going to press, two boats laden with her officers and crew had not been heard of. She was fitted with a wireless installation, and amongst the list recently published of the persons who it is feared have perished in consequence of her sinking is Mr. Henry, the senior Marconi operator, of whom a notice will be found on page 719.

Survivors from yet a further Donaldson-Line victim were landed on the last day of October at Cork. We refer to the *Marina*, which was sunk without warning by a German submarine on the previous Saturday, and has attracted more than usual attention on account of the fact that it contained a number of American citizens, six of whom lost their lives, whilst two were injured. It would appear that, either two torpedoes successively found their target in the ill-fated ship, or else that the explosion caused by one torpedo resulted in the blowing up of the boilers In consequence of the double explosion the ship broke in two. The two wireless operators, following the Marconi tradition, stuck to their posts until they were ordered to leave, with the result that the junior telegraphist lost his life.

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THE "FRANCONIA" AND "ALAUNIA."

Since we went to press with our last number, we have to record the loss of the two fine Cunard steamers, *Franconia* and *Alaunia*. The former, built by Swan, Hunter & Richardson, Ltd., has ever since her maiden voyage in February, 1911, remained one of the most popular vessels on the Liverpool-Boston service. With a tonnage of 18,150 gross, she was from the start fitted with a five-kilowatt wireless installation, the highest power carried by British mail steamers, a fact which has enabled her to be of considerable assistance at various times to other vessels on the North Atlantic route and which has resulted in her achieving at times some remarkable long-distance transmission. She was at the time of her destruction employed in the Mediterranean on Government transport service, although, fortunately, on that occasion no troops were being carried.

The *Alaunia* was engaged in the Cunard Canadian trade. A fine vessel of 13,000 tons, fitted with wireless, she was capable in normal times of finding accommodation for 2,140 passengers. The passengers, about 180 in number, who included a substantial percentage of women and children, were landed a day in advance of the captain and his crew, numbering 164 in all.

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Radio Indispensability Exemplified.

As a general rule it may be confidently asserted that, in all cases of disaster at sea, the carrying of wireless adds immeasurably to the chances of those on board being rescued; indeed, we have heard it said by an experienced marine officer that he would rather travel without lifeboats than without wireless. We have seen during the past few weeks a long list of German submarine victims, but the greater number of those in which loss of life has occurred were not vessels equipped with radio apparatus. The United States steamer *Lanao*, for instance, which, trusting to her

Photo] THE WELL-KNOWN CROSS-CHANNEL PACKET, S.S. "QUEEN." [*Topical*

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American nationality, "stood by" a Norwegian steamer, for the purpose of picking up the crew, might have been able to notify other vessels for a considerable distance of what was going on, and might have stood a good chance of being rescued from the fate which subsequently overtook her.

* * * * * *

What happens when no wireless installation is carried, may be illustrated from a case where the torpedo launched from the submarine caused an explosion which smashed the wireless apparatus and put the vessel in the position she would have occupied had no radio been installed. This occurred in the case of the liner *Gallia*, which with about 2,000 French and Serbian soldiers on board was recently sunk by a submarine. This was the well-known French triple-screw steamer, built in 1913 and owned by the Cie. de Navigation sud Atlantique of Paris. She was 14,966 tons burden, and possessed a speed of twenty knots. The number of men saved out of the 2,000 was 1,362. The destruction of the wireless resulted in her being isolated, so that it was not until a French cruiser came across rafts and boats with survivors from the wreck that patrol vessels were despatched to the rescue.

Transpacific Wireless

FURTHER IMPORTANT DEVELOPMENTS.

AN interesting sequel is announced to the recent establishment of wireless intercommunication between Japan and the United States.

The Japanese Government and the Marconi Wireless Telegraph Company of America will inaugurate on Thursday next a commercial "wireless" service between California, Honolulu, and Japan. This service will offer considerable reductions upon the existing cable rates. The new Trans-Pacific tariff will be 80 cents (3s. 4d.) per word full rate, and 40 cents (1s. 8d.) deferred plain language rate, as compared with a cable rate of 1.21 dollars (5s. 0½d.).

The benefit of this new service will be extended and placed at the disposal of all countries, including the United Kingdom, so soon as arrangements can be made.

The departure affords additional proof of the usefulness of trans-oceanic wireless communication as a means for reducing telegraphic rates.

It is hoped eventually to make the new "wireless" route available for Far Eastern telegraphic correspondence.

Two Notes from New Zealand

THE Auckland wireless station, which has been closed since May, 1915, has been reopened.

The Government has decided to erect a wireless station at Rarotonga, which will constitute another link in the Empire, as many islands in the Pacific, such as Samoa and Fiji, will be brought into closer touch with New Zealand, and consequently with other portions of the Empire. The work will be carried out by the Post and Telegraph Department.

NOTES OF THE MONTH

Wireless on L.33.

THANKS to the completeness of the investigations carried out by Government and other experts into the construction and equipment of L.33, brought down in Essex on September 23rd, Germany's new Super-Zeppelins hold no secrets for us. In view of the detailed attention which these investigations have received in the general Press, we have thought it unnecessary to publish special particulars ourselves. Such of our readers as desire to have a record of the evolution and construction of modern Zeppelins, we would refer to our esteemed contemporary *Flight*, whose issue of October 26th contains a very complete account, profusely illustrated with specially drawn diagrams. As far as the wireless installations are concerned, it would appear that the operator's cabin is located in the forward gondola, just aft of the commander's room, and that generators for electric current capable of being used either for wireless or other purposes are attached to each of the six engines, located in the four or five gondolas, with which each of this newest type of Zeppelins seems to be equipped. The total weight of the radio equipment and the various instruments carried has been calculated to amount to three tons.

* * * * * *

Wireless in the Services.

In our last issue we published, under the title of "Naval and Military Wireless Telegraphists," an account of the status and conditions of training affecting radio men in the shore Services of his Majesty's fighting forces. This article has already brought us a number of inquiries for further particulars, and we understand that the wireless station of the Royal Engineers desires it to be known that they have vacancies for a number of electricians and instrument repairers with good practical knowledge. These men will be engaged for the period of the war only, and applications for enlistment, stating qualifications, should be forwarded to the Commanding Officer, Wireless Training Centre, Worcester. As notified in last month's article, men will be required to enlist as sappers in the Royal Engineers' Wireless Section, but will be given opportunities for early promotion.

This is the situation at the time we go to press ; but such requirements as the above often become satisfied quite rapidly, and it is impossible for a monthly publication to keep its readers posted up to date with *the passing needs* of the War Office. We would recommend any young men who are interested in wireless telegraphy to search the daily Press for such announcements as we have above referred to.

* * * * * *

Treatment of Neutral Powers.

The contrast between British and German methods of treating Neutral Powers has been strikingly exemplified in the recent submarine action of our enemies off the American coast. In September, 1914, objection was taken by Washington to the action of our own warships in *wirelessing for supplies and newspapers* to the American coast. The sensitive Washington authorities saw in this action a sort of suggestion of violated neutrality! *Their* view was that this might possibly be construed as a utilisation of the American coast for a base of operations. Representations to this effect having been made, Viscount Grey caused instructions to be given to British vessels to meet the United States' views as far as possible, and from that date British warships ceased patrolling near the American coast. The Germans sent their U.53 across the Atlantic, utilised American neutral waters as a harbour of refuge, and induced the Americans to afford them facilities for taking in supplies *directly*, and not as a result of wireless instructions. Then they obtained from newspapers and other shore sources information which enabled them to ascertain the movements of vessels and pick their choice of targets for their torpedoes. They signalised their gratitude for these facilities by destroying vessels on their way to the shores whose hospitality they had just received, thus causing most serious loss and damage to their American hosts.

* * * * * *

A Recluse.

There recently died at his house, "Atherton," Sydenham Road, Croydon, Mr. D. H. G. Chambers, who appears to have spent the whole of his latter days in conducting investigations into radio-telegraphy and aerial navigation behind the iron bars which secluded his house. His sister, Miss J. M. Chambers, B.Sc., shared his labours until her death, which occurred four years ago. Mr. Chambers was a recluse of the most uncompromising type; he screened all his basement and semi-basement windows with iron bars strongly cemented in. All the inner doors were bolted or padlocked and the windows screwed up. The door was kept on the chain whenever he opened it, and no one was allowed to enter, except a crossing-sweeper from the adjacent street corner, who executed occasional errands for him, when he was himself too unwell to perform them.

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Examinations and Text-books.

Our attention has been drawn by our contemporary *Electricity* to the contrast between the excellence of the various electrical examinations conducted by the City and Guilds of London Institute, and the lists of books of reference given in the "Programme" of the Institute under the syllabus of each subject. Some of the volumes recommended would appear to be unobtainable, having been out of print for some years; whilst others are out of date. We understand that our contemporary has requested its readers to inform the Editor of such volumes as they have in practice found useful in the course of preparing for electrical examinations, and at the same time to state the grade for which they worked. The Editor of *Electricity* purposes collating and examining the suggestions thus made, and from them he intends to compile representative lists, which should certainly prove both interesting and useful. Doubtless many readers of the WIRELESS WORLD will take an interest in this undertaking; and any who do so may care to communicate with our contemporary at 36 Maiden Lane, Strand, London, W.C.

The Professor Goes to Sea

Some more Achievements of Professor Sparkington Gapp

By P. W. HARRIS

" WIRELESS telegraphy," said the night-watchman, knocking out his pipe on an empty packing-case, " wireless telegraphy is what you might call——"

" Thank you," I interrupted, " that is enough ; this is not a Jacobs story. What *I* want to know is, where is Professor Sparkington Gapp's steam yacht ? "

" D'you mean old chin whiskers ? "

" If you are referring to my friend's patriarchal beard," I replied with some show of dignity, " it is true that to a vulgar mind such a name might appear suitable."

" Oh ! his old tub is round the corner by that further derrick," replied the old salt. " It is in the dry dock."

" Thank you," I said, and passed on.

" You notice I said it is in the *dry* dock," the night-watchman shouted after me when I had progressed a few yards.

" What of it ? " I queried.

" Nothing, except it is not the only thing that's dry round here."

But not to be caught by this futile attempt to be funny, I proceeded on my way, followed by a string of personal remarks regarding my face, feet and form.

Two days before I had received from my old friend Professor Sparkington Gapp a note begging me to accompany him on a short sea voyage on his new yacht the S.Y. *Ether Wave*. The invitation indicated the dock in which the vessel was to be found, but the present censorship prohibits my divulging the exact locality.

Although nothing had been mentioned in the professor's brief communication, I knew that for some months past he had been engaged upon important research work for a Government department, and I had no doubt that this invitation would enable me to see some of the most recent inventions of this learned gentleman, particularly in the realms of ether waves and wireless telegraphy.

In what little light remained on this autumn evening I could just observe the outline of the graceful yacht, differing little from those palatial vessels which we are accustomed to associate with American millionaires, munition makers and milk vendors. The only point of difference which I could distinguish was that the masts were inordinately high.

At the foot of the gangway my old friend, dressed in the uniform of a naval lieutenant, approached me with extended hand.

" You are just in time," he exclaimed, as I grasped the proffered palm. " Steam is up, and I hope to leave within a quarter of an hour. Meanwhile I will show you round the vessel."

As is usual on all vessels associated with the British Navy, all the metalwork gleamed and shone, and it would have been possible to eat one's food from the snow-white decks. In point of fact a number of the crew were actually disposing of fish and chips in this manner. With admiration I gazed upon the rows of gleaming binnacles, the rolls of hose-pipe and the boxes of sheet anchors.

In due course my friend led me to the saloon, in which I saw all preparations for a sumptuous meal.

As soon as I had disposed of the first seven courses and imbibed the necessary quantity of refreshment, I ventured to enquire of the professor just what was our mission for this voyage.

"Hush!" said Professor Gapp, holding up a warning finger, "that I cannot divulge until we are away from the shore. Let me see, we are due to start in two minutes," he continued, consulting his watch. "The Chief Officer has orders to cut the strings that tie us up immediately the clock strikes the half-hour."

As the professor ceased speaking, a deep boom from the deck's side announced the time for which we were waiting, and a loud snapping noise accompanied by a thrill through the vessel acquainted me with the fact that we were on the move.

"Now come on deck," requested the professor, "and I will outline to you our little plan. First of all let me tell you that although we have to a large extent conquered the German submarine menace, yet there are still one or two of these evil craft which give us a little trouble. This vessel," went on the professor, his countenance suffused with pride, "is equipped with every modern convenience and many pieces of apparatus which I think I may describe without undue pride as ingenious. Some, indeed, I have specially devised for this voyage, and I hope you will have the opportunity of seeing them tried for the first time."

"THE CREW . . . WENT INTO PAROXYSMS OF ANGUISH AND FEAR."

The number of streaks of light which continued to whiz by us afforded me some bewilderment, and I turned to the professor for an explanation.

"Those are the lights of passing ships," he explained. "We are now out in the Channel, you know."

"They must be going very fast," I said.

"Oh, no," replied the professor airily, "not at all; in fact, most of them are at anchor. It is we who are going fast, some 80 knots or so."

"THE GERMANS, SEEING NO HOPE OF SALVATION, PLUNGED INTO THE WATER."

"Good gracious," I said, "there is no vibration or noise to indicate we are moving at that speed."

"No," answered the famous scientist, "I have balanced all that out by means of capacity and inductance. In this way, of course, I have been able to increase the knottage."

"Capacity and inductance are usually calculated by Nottage, are they not?" I next asked, seeming to recollect something familiar in his words.

"Precisely," was the reply. "Now if you will stand aside, I shall be able to show you one of the most important drills which the crew has had to practise each day. It has been my endeavour to create in the crew under my command a perfect simulation of fear. The purpose of this you will see later on."

And now, to the accompaniment of a tune piped by the bo'sun, the crew, who had previously been lying on deck, went into paroxysms of anguish and fear, some kneeling to say their prayers, others wringing their hands in a way pitiful to see.

"Most excellently done," I remarked. "How did you manage to achieve such a result?"

"Quite simple," replied the professor, "each member of the crew is allowed 6d. per day with which to visit the picture palace approved by his superior officers. By careful study of films of the wild and woolly west variety most of the men were able to reach the present high stage of perfection in a fortnight.

Highly interested, but still mystified as to the purpose to which such a drill could be turned, I next espied, in the centre of the ship, a large deck structure from which came a sharp hum similar to that heard in the vicinity of a large transformer.

"It is by means of that instrument," explained Professor Gapp, "that we are able to cause the submarines to rise to the surface. I have reason to believe that one enemy craft is lurking beneath the surface within a mile of where we are situated at present. Bo'sun," ejaculated my friend, " tie this gentleman's knees together, their rattling prevents me hearing myself speak."

An alert seaman jumped from his station near by to carry out the professor's order, although I regret to say he had quite misunderstood the movements of my legs, which were solely due to the strong wind which happened to be blowing.

" From the concealed poles of this device," continued my friend, " there radiates in the vicinity of the ship an intensely strong alternating current field which causes all iron within a mile to heat by reason of the eddy currents generated therein. The submarine, being largely constructed of iron, becomes warmed up and naturally the commander rises to the surface to get a breath of air. We will now prepare for action."

At the word of command a score of sailors unrolled many yards of painted canvas and erected wooden screens, so that in a few moments the yacht became converted from its palatial splendour into what appeared to be a cargo tramp ploughing the seas at a speed of some eight knots. Next, stepping to a controlling switchboard, the professor pressed the button, whereupon the hum from the large structure increased some tenfold in intensity. And sure enough within one hundred yards from our bow the periscope of a submarine rose through the waves, to be followed by the dark superstructure of the well-known enemy craft. Once more a sharp order was given, and the crew, perfect by their long practice, commenced to show every evidence of acute fear and anguish. Sailors dressed as firemen and stokers ran out from various doors, howling for mercy and beating their heads with open palms.

A dark figure now appeared in the moonlight upon the deck of the submarine and placed a large megaphone to its mouth.

" You must shtop was," came the bellowing voice.

" I am stopped is," replied the professor through a still larger megaphone.

" Then I upon your ship coming am," answered the submarine commander in a tone of authority.

" Good was," replied the professor, speaking the dialect perfectly

A small boat now put off, approaching our side, bearing in it the commander, two officers, and a commercial traveller. An obedient but still trembling crew assisted the Germans up the companion ladder. The commander of the submarine upon reaching deck raised himself to his full height (five feet three).

" I the commander of submarine am," explained the German. " You English dog are. Your ship I sink must."

" That is very kind of you," answered the professor, " but (indicating the commercial traveller) who is this gentleman ? "

" I sell lifebelts do," explained the greasy German, smiling affably and producing from a black bag a number of devices marked in large letters, " D.R.P., made in Nuremburg." " This one four shillings value is. Perhaps we can make some beesness."

" Ah, yes," said the professor smilingly and winking at me over his shoulder, " please step down to my cabin. I have much money there, and we complete the business will." The professor and I thereupon marched off, followed by the German

"I WILL NOT YOUR BOAT UPGEBLOW!"

officers and the commercial traveller, whose smile spread across the whole width of the ship. Upon reaching the bottom of the opening outside the saloon the professor opened the door and, politely allowing the Germans to precede him, promptly locked it again.

"That settles them," said the professor as we remounted the deck. "We will now finish their boat."

Proceeding to the switchboard, the professor pushed two more buttons. "That intensifies the eddy currents," remarked the professor; "300 kilowatts are now being used. If you will watch the craft you will see some interesting events."

Assisted by a pair of binoculars I concentrated my eyes on the half-submerged submarine, which soon became suffused with a pink glow as the eddy currents made it red-hot. Fourteen other Germans came running out of the conning tower and commenced to dance along the decks of the incandescent craft, and then, seeing no hope of salvation, plunged into the waters which were now furiously boiling for many yards around the submarine. Then, with a violent explosion caused by the torpedoes, the submarine disappeared beneath the waves. "Result No. 1," said the professor smilingly.

Below we could hear a furious battering on the door of the room in which the German commander and his confederates were in prison, and a loud and squeaky voice through the keyhole announced to the world at large that the price of lifebelts would now be reduced to 2s. 3½d. (5 per cent. discount for cash). However, we took no notice of this slight disturbance, and orders were given to go full speed upon our way.

In an hour or two we reached a secluded spot off the coast of ——, where the professor announced to me that a second submarine was known to be lurking. Again the ship was disguised, and once more the eddy currents were used to bring the under-sea pirate to the surface. For the second time we were hailed, and in due course the German commander set off in a boat to row over and inform us of our fate. This time, knowing that we should be quite safe, I watched every proceeding with interest. Suddenly, to our surprise and horror, a white-faced and perspiring electrician rushed to the professor's side, and announced that the eddy-current apparatus had broken down. Here was a pretty state of affairs!

"Dear me," said the professor as the electrician explained the disaster, "that is very annoying. However, I think we shall be able to overcome the difficulty."

In a few moments we were boarded by a German officer, who explained his mission and our relation to the canine tribe, and once more the professor was all politeness. Not only was he polite, but he also explained to the officer in voluble German that his sympathies were all with Germany and her allies. "In fact," said the professor, patting the German commander on the back, "if you wish any proof of how much I love your dear fatherland, please come below and I will show you my collection of valuable German sausages which I have provided for myself and all the crew."

At the sound of the word "sausages" the commander's heart softened, and followed by his lieutenants, he proceeded below. In a few moments the party returned, their arms, pockets and hats full of some splendid specimens of this particular form of nourishment.

"As you good friend of Germany are, and as you sausages provided have, I will not your boat upgeblow."

With these words and with every endeavour not to drop a single sausage, the Germans returned to the submarine, entered the conning tower and closed the hatches.

Wiping the perspiration from my forehead, I turned to the professor with a sigh of relief. "That was a very narrow squeak," I said.

"Yes, perhaps it was," replied my friend, "but the fun is only about to commence. Each of those sausages has a time fuse, and is filled with high explosive. They will not wait long before commencing to eat them, and——"

But before the professor could say any more a mighty explosion rent the air, and pieces of German submarine and sausage skin fell, like a hailstorm, upon our gleaming decks.

"Result No. 2," said the professor. "We will now return to port."

In a few minutes more we were tied up alongside the quay at ——, all filled with a sense of lively satisfaction and a knowledge of duty done.

American Boys' Brigades

MOBILISING WIRELESS ENTHUSIASTS.

WITH the idea of mobilising the wireless and signal enthusiasts of Brooklyn, Queens and Nassau Counties in the State of New York, there has been organised the Signal Corps Regiment of the New York Division of the United Boys' Brigades of America. Besides individual stations of amateur members, the regiment possesses equipment consisting of field wireless telephones and buzzer carts and the necessary equipment for flag-wagging and semaphore signalling. At prearranged times signals and military messages are exchanged between stations, a system which will teach the requirements of military work much better than the usual inconsequential talk that amateurs generally send through the air. Alternating with social meetings of the various units are others where lectures and special work on army wireless fill the programme.

Correspondence

The following letter, regarding the article in the October issue entitled "A New Abac," has been received from our contributor Mr. Samuel Lowey. We take the opportunity of pointing out that we welcome correspondence of this nature.

October 11th, 1916.

Dear Sir,—The article by Mr. Baillie in this month's Wireless World is very interesting, but certain assumptions have been made which are not always applicable.

If by means of the formula on page 514—viz. $R = \frac{2\pi\sqrt{\mu n \rho}}{10^9 . p}$ the resistance per cm. length (at a frequency of 250,000) of wires 30 S.W.G. (0·0315 cm. diam.) of copper, manganese-copper, and aluminium-bronze, are worked out, and compared with the resistances of the same conductors to steady currents, it will be obvious that the results cannot be correct.

30* S.W.G. 0·0315 cm. diam.	Resistance per cm. length (ohms).		Ratio. $\frac{(a)}{(b)}$
	(a) n—250,000.	(b) To steady current.	
Copper	0·00132	0·00221	0·6
Manganese-Copper	0·01008	0·129	0·078
Aluminium-Bronze	0·00352	0·0158	0·222

The error has arisen through the method of calculating the cross-sectional area of the conducting part of the wire.

Multiplying the thickness of the " skin " by the perimeter will give the approximate area, when the perimeter is very large compared with the thickness of " skin."

The depths to which a current of frequency 250,000 will penetrate the conducting materials above mentioned are : copper 0·01322 cm., manganese-copper 0·1010 cm., and aluminium-bronze 0·0354 cm.

In the case of manganese-copper wire 14* gauge this penetration reaches to the centre of the wire, so if the skin thickness be multiplied by the perimeter an area is obtained which is equal *to twice the area of the wire itself*, and if the formula first referred to in this letter is applied the resistance will be found one half of what it should be.

The amount of this error changes with the frequency, the specific resistance, and the area of the conductors ; with large conductors and for very high frequencies the amount would be small, but enough has been said to demonstrate that the amount of error is such that it cannot in most cases be neglected.

Even assuming the formula to be correct for all cases, it is found in working out from the diagram the example given at end of the article that the result, viz., 0·000052 ohms, does not agree with the result (0·000021 ohms) obtained by using the formula, but that, if the " diameter " scale be used as a " perimeter " scale, the result is then roughly correct to the formula, and it would appear that the "diameter" scale may have been so marked in error.

Considerable ingenuity has been displayed in working out the diagram, and it is unfortunate that the formula that it is based on is not universal in its application.

I am, Sir, yours faithfully,

(Signed) SAMUEL LOWEY.

Jutland Battle Awards

IN our August issue we referred to the distinguished part played by radio-telegraphists in the Jutland battle, and since that time a List of Naval Honours has been issued as a supplement to the *London Gazette*, in which figure the names of officers and men who distinguished themselves on that occasion in radio service. The chief of them is Commander R. L. Nicholson, who "controlled the "wireless telegraph work with great coolness and most marked efficiency, and "reaped the reward of the excellent organisation for which he is responsible." Then we have Lieutenant.-Commander G. C. Candy, recommended for promotion to Commander for "work in connection with the wireless telegraphy of the squadron."

Captain R. C. S. Waller, R.M.L.I., was recommended for promotion on the grounds that he "has been in charge of the wireless organisation of a battle squadron "since the beginning of hostilities. This squadron was composed of new ships of "various types which had been hurriedly completed, and the work entailed in "bringing the wireless installation of vessels designed for foreign Powers into working "order was carried out by him entirely satisfactorily."

Amongst those on the lower deck in receipt of awards, Chief Petty Officer Telegraphist P. McEvoy was granted the Conspicuous Gallantry Medal for "working "on deck almost continuously throughout the action. Four times he repaired or "cleared the main aerial under fire in a cool and efficient manner. The smoke on "the mess deck was so intense that he had to feel his way up on deck."

On the promotion list of men belonging to the R.N.V.R. Section we find the name of Warrant Telegraphist S. Lewington, mentioned in despatches as "in charge "of the auxiliary wireless telegraphic cabinet during the whole operations, and "carried out his work with conspicuous coolness and ability."

An earlier *Gazette* (under date of September 7th) announced the awarding of the D.S.O. to Acting-Lieutenant F. S. Lofthouse, R.N.R., for gallantry in the Adriatic on the occasion of the attack upon drifters made by an Austrian cruiser. In view of the danger attached to working the wireless apparatus (always a target for enemy gunfire) he took charge of it himself and continued wirelessing for assistance till his ship was in a sinking condition. Then he had a four-hour swim to an Italian destroyer, and brought her back to the rescue of the six men composing his crew, who had been clinging to the "wireless" mast. This constitutes a most notable feat of courage, athleticism, and endurance.

The Editor takes this opportunity of wishing his readers the Compliments of the Season.

Some Characteristic Curves of a Poulsen-Arc Generator

By N. W. McLACHLAN, B.Sc.Eng., A.M.I.E.E.

Read 7th September at Newcastle-on-Tyne, before Section G of the British Association.

(*Continued from page* 599, *November issue*.)

EFFICIENCY OF ARC AS A CONVERTER OF DIRECT INTO OSCILLATORY CURRENT.

The efficiency of the arc itself (apart from the loss in the field coils) as a converter of direct current into oscillatory current can be dealt with from two points of view: (1) The efficiency of the arc in respect of the oscillations of fundamental frequency, this being important in wireless telegraphy from the standpoint of radiation from an antenna; (2) the total efficiency, including the energy derived from the oscillations of fundamental frequency and the various harmonics.

The efficiency of the arc was obtained from the formula

$$\% \ e = \frac{100 \text{ (Power absorbed in shunt circuit)}}{(V - IR)I}$$

$$= \frac{100 \ I_s^2 R_s}{(V - IR)I},$$

where $I_s = R.M.S.$ value of shunt current, R_s=total resistance in shunt circuit, V=direct current voltage across the arc and field coils, I=direct current (assumed constant) supplied to generator, and R=resistance of the field coils. The power supplied to the arc from the external circuit is a maximum when $I = \frac{V}{2R}$, *i.e.*, when the power supplied to the arc is equal to the power expended in the field coils. In order to test the accuracy of the denominator in the formula for the efficiency of the arc, the power factor of the arc was measured under working conditions by means of a wattmeter. It was found that the ratio Watts-volt-amperes was nearly unity.*

Thus the power supplied to the arc is given by the expression $(V - IR)I$.

Case 1.—With a given resistance, the efficiency of the arc at any particular frequency increases with the capacity in the shunt circuit.

The curves in Fig. 6 show the total † efficiency of the arc plotted against the frequency for a capacity of 0·00195 mfd., and various values of the resistance. As in Fig. 2, each curve has a maximum ordinate, showing that, with fixed capacity and resistance, there is a certain inductance and therefore frequency, for which the efficiency of the arc is a maximum. This maximum corresponds to the maximum power and current in the shunt circuit under the same conditions.

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* *See* J. A. Fleming, "The Poulsen Arc as a Means of Obtaining Continuous Electrical Oscillations," *The Electrician*, Vol. LIX., p. 614, 1907.

† *See* footnote to Fig. 2.

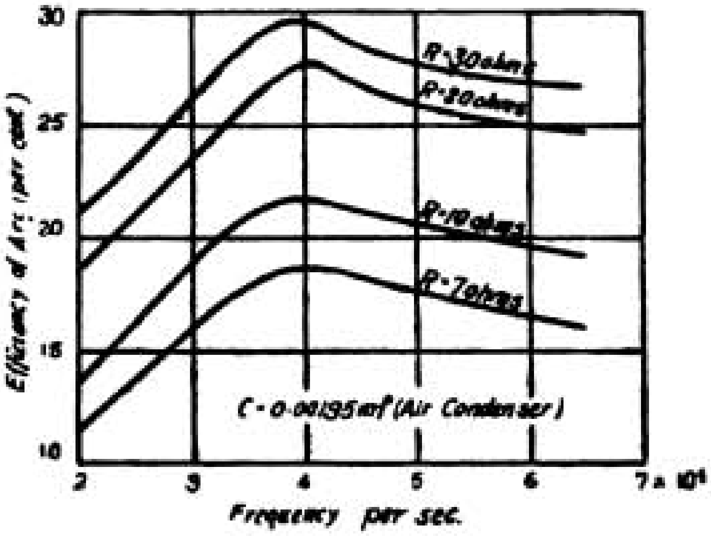

FIG. 6.—CURVES SHOWING THE TOTAL EFFICIENCY OF THE ARC PLOTTED AGAINST THE FREQUENCY FOR VARIOUS VALUES OF THE RESISTANCE IN THE SHUNT CIRCUIT.

Fig. 7 shows the efficiency obtained with various resistances for different values of the frequency and a capacity of 0·00195 mfd. For resistances between 20 and 60 ohms the variation in efficiency is small, but the shape of the curves is such that at a given frequency there is a certain value of the resistance for which the efficiency is a maximum. This resistance, however, is larger than that corresponding to maximum power in the shunt circuit—*i.e.*, the maximum efficiency is obtained when the shunt current is slightly less than that giving maximum power for the given capacity.

It should be mentioned, however, that for given conditions the efficiency depends to a certain extent on the length of the arc, and it is sometimes possible (with large resistances and in general under conditions causing irregular burning) to vary this in such a way that the proportionate alteration in the current through the arc is greater than that in the shunt circuit. By increasing the arc length, with a resistance of about 50 ohms in circuit (capacity=0·00195 mfd.), the direct current supplied to the generator diminished, the efficiency increased, but the burning was very noisy and irregular. Hence a very accurate determination of the efficiency in the case of a hand-operated arc is out of the question. The highest efficiency obtained for oscillations of fundamental frequency was approximately 38 per cent. (capacity 0·00924 mfd.), which indicates that a considerable amount of energy is wasted in heating the electrodes and in creating the arc itself by volatilisation of the copper and graphite, the latter material burning away very rapidly with large currents. Some approximate data bearing on these remarks are given in Table I.

TABLE I.

(MOSCICKI CONDENSERS) OSCILLATIONS OF FUNDAMENTAL FREQUENCY WITH NORMAL MAGNETIC BLAST.

Capacity.	Maximum Power Absorbed in Shunt Circuit.*	Efficiency Corresponding to Maximum Power.	Power Corresponding to Maximum Efficiency.*	Maximum Efficiency of Arc.
Microfarad.	Watts.	Per Cent.	Watts.	Per Cent.
0·00924	220	36	200	38
0·00368	175	26	160	30

TABLE II.

(MOSCICKI CONDENSERS) OSCILLATIONS OF ALL FREQUENCIES WITH NORMAL MAGNETIC BLAST.

Capacity.	Largest Power Absorbed in Shunt Circuit.*	Efficiency Corresponding to Largest Power.	Power Corresponding to Largest Efficiency.*	Largest Efficiency of Arc.
Microfarad.	Watts.	Per cent.	Watts.	Per Cent.
0·00924	280	39	268	42
0·00368	185†	28†	165†	31†

* This does not include the loss in the condensers. The power absorbed in the shunt circuit and the efficiency of the arc will, therefore, be greater than the values given in Tables I. and II.

† These are maximum values.

Case 2.—In Table II. approximate data are given with reference to the " total " efficiency of the arc. Since the power obtained from any harmonic depends on the square of the root-mean-square value thereof, the power obtained from the harmonics for capacities of 0·00091 mfd. and 0·00195 mfd. was small enough to be neglected. The figures in Table II., therefore, relate to the largest capacities only. It will be seen that the total power and efficiency are larger than the same quantities for oscillations of fundamental frequency, and that they increase with the capacity.

According to Barkhausen,* to obtain the greatest possible efficiency, it is necessary for the voltage to rise very rapidly to the highest possible value after the arc has been extinguished. This is effected by water-cooling the copper electrode and removing the ionised gases quickly, the latter being accomplished by using a magnetic blast or a gas of high diffusion velocity, or both of these. Thus, if the copper electrode in these experiments had been water-cooled, the efficiency of the arc might have been greater than that indicated by the figures in Tables I. and II. and Figs. 6 and 7.

Conclusions.

1. With fixed capacity and frequency there is a certain resistance giving maximum power absorbed in the shunt circuit. There is also a certain resistance for which the efficiency of the arc is a maximum ; but the resistance corresponding to maximum power is smaller than that corresponding to maximum efficiency.†.

2. With fixed capacity and fixed resistance in the shunt circuit there is a certain inductance, and therefore frequency, for which the power obtained from oscillations of fundamental frequency is a maximum. For capacities of limited value the total power from oscillations of all frequencies has a maximum value, but for capacities beyond a certain limit there does not appear to be any definite maximum value. The same conclusion applies in connection with the efficiency of the arc, but the resistance corresponding to maximum power is smaller than that corresponding to maximum efficiency.

3. With given resistance and frequency the power obtainable in the shunt circuit (both total power and that due to oscillations of fundamental frequency) and the efficiency of the arc increase with the capacity ; but with the larger capacities (of the order of 0·00368 mfd. and upwards) the burning, especially with

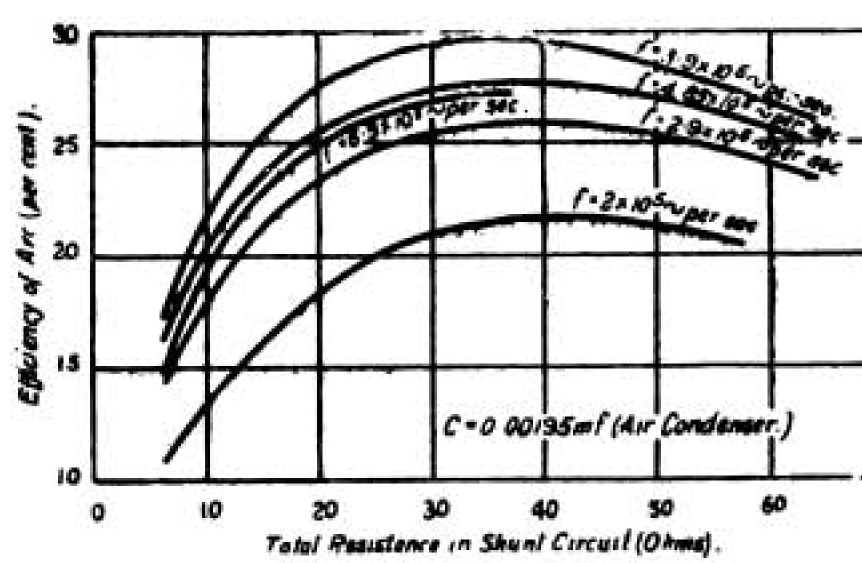

FIG. 7.—CURVES SHOWING THE TOTAL EFFICIENCY OF THE ARC PLOTTED AGAINST THE RESISTANCE IN THE SHUNT CIRCUIT FOR DIFFERENT VALUES OF THE FREQUENCY.

* *See* W. H. Eccles, *Wireless Telegraphy and Telephony*, p. 201 ; also E. Ruhmer, *Wireless Telephony*, translated by J. Erskine Murray, p. 200.

† Efficiency based on oscillations of fundamental frequency or total efficiency. Both efficiencies occur with the same resistance.

small inductances, is apt to be irregular and noisy—*i.e.*, when the ratio L/C is small.

4. When the power absorbed in the shunt circuit is very small, the capacity being fixed and not exceeding a certain limit, there is a certain inductance, and therefore frequency, for which the shunt current is a maximum. For capacities beyond a certain limit there does not appear to be any definite maximum value. With diminished blast, the maximum value of the shunt current occurs at a lower frequency than with normal blast, and it is possible to maintain the shunt current approximately constant and the burning regular over a fairly wide range of frequency by suitably varying the strength of the magnetic blast.

5. A diminution in the strength of the magnetic blast does not cause any appreciable alteration in the maximum power and maximum efficiency. The maximum power occurs at a lower frequency, and more power is obtainable at lower frequencies than with a stronger blast. It is possible to keep the power approximately constant and the burning regular over a certain range of frequency by suitably varying the strength of the magnetic blast.

6. A diminution in the strength of the magnetic blast does not cause any appreciable alteration in the fundamental frequency of the oscillations in the shunt circuit; but there is a tendency for the second harmonic to increase with capacities of 0·00368 mfd. and upwards.

7. The most prominent harmonic in the shunt circuit is the second, thereby showing the existence of an asymmetrical current wave. This harmonic for any given capacity increases with decrease in inductance, and therefore increase in frequency. For a given frequency the second harmonic increases with the capacity.

8. The insertion of resistance in the shunt circuit causes the burning to be less regular than it is without resistance. The irregularity of the burning increases with increase in the resistance. At the higher frequencies the burning is more irregular with diminished blast than with normal blast, but at the lower frequencies the reverse is the case. If the blast is diminished beyond a certain limit, the oscillations are irregular.

The author's best thanks are due to Professor E. W. Marchant, D.Sc., for reading over and criticising the MS.

The experiments were conducted in the Applied Electricity Laboratories of the Liverpool University, and the author gratefully acknowledges the facilities which have been provided for carrying out this and other research work.

APPENDIX.

NOTE ON CONDENSERS.

At the beginning of the Paper reference was made to the loss which occurs in the Moscicki condensers. That the loss in such condensers carrying large high-frequency currents is appreciable has been shown by Dr. Fleming and Mr. Dyke.* It is also shown, in the same Paper, that there is a loss with air condensers if the electrostatic force is large enough to cause appreciable ionisation of the air between the plates. In order to ascertain whether the loss in the Moscicki condensers had

* *Proc. Phys. Soc.*, London, Vol. XXIII., p. 117, 1911; also *The Electrician*, Vol. LXVI., p. 658, 1911.

any considerable effect on the power obtained in the shunt circuit, an air condenser was arranged to have the same capacity at high frequencies as one of the Moscicki condensers. The capacity of the air condenser was adjusted until, with given inductance (comparatively large) and the least resistance possible in the shunt circuit, the same frequency was obtained with each condenser. A sandstone resistance (about 15 ohms) was connected in the shunt circuit and a series of readings of power and frequency taken with each condenser. It was found that the loss in the Moscicki condenser was sufficient to cause a diminution in the power expended in the shunt circuit (as found by voltmeter and ammeter readings), in some cases exceeding 15 per cent.; but this did not invalidate any of the conclusions given above. It was thought more satisfactory, however, to give results, as shown graphically in the diagrams, for an air condenser. The effect of the condenser loss was greatest when the current was largest for the given conditions—*i.e.*, when the sandstone resistance was not in circuit (*see* Fig. 5). In this case the voltage, and therefore the dielectric stress, especially at the lower frequencies, was greater than with resistance in circuit.

The capacity of each condenser was tested at 500~ per second by Carey Forster's method, using a Campbell mutual standard and a Duddell vibration galvanometer. An air condenser was arranged so that the frequency of the oscillations in the shunt circuit was approximately the same as that obtained with a Moscicki condenser. The capacity of the air condenser was then measured at 500~ per second, and its capacity at high frequencies assumed to be equal to this. From this value of the capacity and the frequency of the oscillations obtained with each condenser, the capacity of the Moscicki condenser at high frequencies was calculated.

The capacities of the condensers were then found ballistically by charging up to about 210 volts, using 100 small secondary cells, and discharging through a ballistic galvanometer. The galvanometer was calibrated, using a Weston cadmium cell and a standard mica condenser having a capacity of 1 mfd.

As a check on the method, it was found that an air condenser 0·00175 mfd. had the same capacity when measured both ballistically and at 500~ per second. The results of some of the experiments are given in Table A.

TABLE A.

MOSCICKI CONDENSERS.

Capacity (Microfarad).			Percentage Difference between Capacity at 500~ per Sec. and Ballistically.
Ballistically.	500~ per Sec.	$1\cdot75 \times 10^5$~ per Sec.	
0·00354	0·00278	0·00272	21·5
0·00377	0·00295	0·00284	21·7

It is clear that the capacity found with alternating currents is much smaller than that found ballistically, the percentage decrease being almost the same in each case. There is, however, only a comparatively small difference between the capacities at 500~ per second and $1\cdot75 \times 10^5$~ per second. The decrease in the measured capacities is doubtless due to diminution in the dielectric coefficient, which occurs with alternating currents of increasing frequency.*

* *See* J. A. Fleming, *The Principles of Electric Wave Telegraphy and Telephony*, pp. 183-186.

One condenser, thought to be faulty, gave some remarkable results which are tabulated in Table B.

TABLE B.

MOSCICKI CONDENSER.

Capacity (Microfarad).			Percentage Difference between Capacity at 500 ~ per Sec. and Ballistically.
Ballistically.	500 ~ per Sec.	2×10^5 ~ per Sec.	
0·00341	0·00185	0·00173	46

By allowing a short interval of time to elapse between breaking circuit with the charging cells, and making the galvanometer circuit, it was possible to obtain a rough estimate of the relative leak with various condensers. The rate of leak with the condenser in Table B was much larger than that with the other condensers, although the insulation resistance of each condenser, as found by an ohmmeter (using direct current), was "infinite."

The conductance or alternating current conductivity of dielectrics has been thoroughly investigated by Dr. Fleming and Mr. Dyke.* They found that in the case of glass as a dielectric the conductance and the capacity (and therefore the dielectric coefficient) at a given frequency increased with the temperature. At a given temperature the conductance increased but the dielectric decreased with increase in frequency (900 – 5000 ~ per sec.). The extent of the variation in the conductance and dielectric coefficient will, of course, depend on the nature of the glass.

The results in Table A confirm observations made some years ago by Dr. E. W. Marchant, using plate-glass condensers. The conditions were slightly different, since the condensers were charged up to about 9,400 volts by a Wimshurst machine, and then discharged through an oscillatory circuit having a free period of $\frac{1}{100000}$th second. Under these conditions the capacity was 15 per cent. less than that obtained ballistically.

Wireless on the Ranch.

A NOVEL USE FOR RADIOTELEGRAPHY.

THE following paragraph appeared in our American contemporary, ***The Electrical Experimenter***, recently. The last sentence is particularly interesting :—

" Major James Ormsby is completing the installation of wireless telegraph plant " at his home in Casper, Wyoming, and at his ranch 50 miles to the north-east. When " the system is in operation he intends to direct his large sheep business by wireless. " The two plants are of sufficient power to receive messages from points up to 700 " miles distant, and the lonely ranch, therefore, will be in constant touch with " Denver, Omaha, Salt Lake, and other cities of the region. The aerials of the Casper " Station are suspended from two poles, each 150 feet high. It seems as if there is " no locality where wireless has not been utilised."

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* *Journal I.E.E.*, Vol. XLIX., p. 323, 1912.

Among the Operators

THE LATE OPERATOR J. HENRY.

LOSS OF THE S.S. "CABOTIA."

THIS vessel, particulars of the loss of which appear under the heading of "Maritime Wireless Telegraphy," carried as senior operator Mr. John Henry and as junior Mr. John Weir Crichton. It is with the deepest regret that we have to inform our readers that Mr. Henry lost his life in the disaster, although fortunately Mr. Crichton was saved.

The late senior operator was of Scotch birth, having been born at Newcraighall, Midlothian, on September 26th, 1897. Upon leaving school in Midlothian Mr. Henry took up a position in the mines, and later entered for a course in wireless telegraphy at the North British Wireless School, Edinburgh, where he obtained his first-class certificate. Upon completing his training at the Marconi House School Mr. Henry was appointed to the s.s. *Cabotia* a year ago and remained upon that vessel up to the time of the disaster. We take this opportunity of expressing our sincerest sympathy with the late operator's relatives in their sad bereavement.

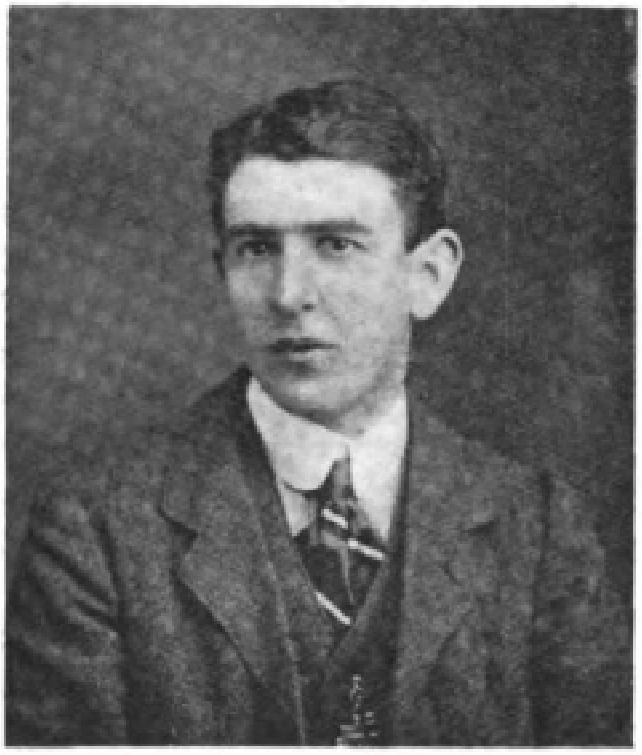
The junior operator, Mr. J. W. Crichton, is also of Scotch birth, hailing from Lanark. He is 19 years of age, and also received his preliminary wireless training at the North British Wireless School. Joining the Marconi House School in March of this year, Mr. Crichton completed his training and was only appointed to the *Cabotia* just before she started on her last voyage. We understand that Mr. Crichton was rescued uninjured, and we congratulate him upon his fortunate escape.

* * * * *

OPERATOR J. W. CRICHTON.

SINKING OF THE S.S. "MARINA."

Still another wreck in which a Marconi operator has unfortunately lost his life was that of the s.s. *Marina*, the torpedoing of which figured so prominently in recent newspaper reports. In this case the two operators were Mr. David Murray Sproat, senior, and Mr. David Richmond, junior. Mr. Sproat was fortunately saved after



OPERATOR D. M. SPROAT.

some exciting experiences, but it is to be deeply regretted that Mr. Richmond was unable to get away from the ill-fated vessel, his body being washed ashore in Bantry Bay a few days afterwards.

Mr. Sproat, the senior operator, is 26 years of age and was born at Ayr. He was educated at Ayr Grammar School and upon leaving that institution entered the service of the Glasgow and North Western Railway, where he was employed in the telegraphic department. Conceiving an interest in wireless telegraphy, Mr. Sproat took a course of training at the Warrington Wireless Training College, where he obtained his Postmaster-General's First Class Certificate. In 1912 he entered the school at Marconi House, and on completion of his training was appointed to the s.s. *Hydaspes*, from which he transferred to the s.s. *Mendi*. He later served on the s.s. *Elmina*, *Wayfarer*, *City of Marseilles*, for a number of voyages, s.s. *Kastalia*, *Elysia* and *Tritonia*. He was appointed to the s.s. *Marina* in the early part of this year and had sailed for several voyages on this vessel before she met her fate.

Mr. David Richmond who, as above mentioned, has lost his life in the services of his country, was born at Preston in November, 1891. He was educated in Glasgow, and wishing to enter for the career of a wireless telegraphist undertook a course of training at the North British Wireless School, Glasgow. Joining Marconi House School in February of this year, he completed his training and was appointed shortly afterwards to the s.s. *Fremona*, from which he transferred to the *Marina* in May. He had made three voyages before the vessel met with disaster. Deep sympathy is felt with the late Mr. Richmond's relatives in their terrible bereavement.

* * * * *

THE CHASE OF THE S.S. "GLENGYLE."

Many of our readers will have noticed in the daily press an account of the exciting chase by a German submarine of the s.s. *Glengyle*, which succeeded in evading the pirate by clever seamanship. Mr. Thomas Smith, the operator on this vessel, is a native of East Lothian, and is 19 years of age. Prior to entering the Marconi service he was engaged in the post office as a telegraphist, and upon completing his

THE LATE OPERATOR D. RICHMOND.

OPERATOR T. SMITH.

training at the Marconi House School was appointed to the s.s. *Pomeranian*. From this ship he transferred to the s.s. *Circassia*, afterwards sailing on the s.s. *Grampian*, *Narragansett*, *Mamari* and *North Point*. He was appointed to the s.s. *Glengyle* in April of this year.

* * * * *

S.S. "ROWANMORE."

Two operators were carried on this vessel, Messrs. O. S. Kinipple and G. W. Sail, both of whom, we understand, have been rescued uninjured. Mr. Oscar Stanley Kinipple, who is 22 years of age, was born in London and educated at Greenwich. Taking an interest in radiotelegraphy he entered the Marconi House Evening Classes and in due course obtained his Postmaster-General's Certificate. His first appointment was to the s.s. *Sagamore* in June, 1914, and later he sailed on the s.s. *Celtic* and a number of other vessels. Prior to joining the ill-fated *Rowanmore* he had made a voyage on the *Clan McNab*.

OPERATOR O. S. KINIPPLE.

OPERATOR G. W. SAIL.

Mr. William George Sail, junior operator, was born at Highgate in 1897. After leaving school he entered the service of the Midland Railway Company as telephone operator, and in April, 1916, joined the Marconi Company's London School as a learner. After completing a training course he was appointed to the s.s. *Memphian*, and after serving one trip on this vessel transferred to the *Rowanmore*. We congratulate both of these men upon their lucky escape.

Instructional Article

NEW SERIES (No. 16).

The following series, of which the article below forms the sixteenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

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101. In Article XV we proved the following formulæ:

(i) $$\text{Sin } C + \sin D = 2 \sin \frac{C+D}{2} \cos \frac{C-D}{2}$$

(ii) $$\text{Sin } C - \sin D = 2 \cos \frac{C+D}{2} \sin \frac{C-D}{2}$$

(iii) $$\text{Cos } C + \cos D = 2 \cos \frac{C+D}{2} \cos \frac{C-D}{2}$$

(iv) $$\text{Cos } C - \cos D = -2 \sin \frac{C+D}{2} \sin \frac{C-D}{2}$$

or $$\text{Cos } D - \cos C = 2 \sin \frac{C+D}{2} \sin \frac{C-D}{2}$$

These formulæ are best remembered in words, as follows:

(i) The sum of the sines of two angles is equal to twice the sine of half the sum into the cosine of half the difference.

(ii) The difference of the sines equals twice the cosine of half the sum into the sine of half the difference.

(iii) The sum of the cosines equals twice the cosine of half the sum into the cosine of half the difference.

(iv) The difference of the cosines equals twice the sine of half the sum into the sine of half the difference.

In the case of (iv) it must be remembered that by the difference of the cosines of two angles, we mean the cosine of the *smaller* angle *minus* the cosine of the *larger*.

102. We can obtain some more useful formulæ from the $(A+B)$ formulæ as follows:

(*a*) Put A for B in the $(A+B)$ formulæ.

Then $$\sin (A+B) = \sin (A+A)$$
$$= \sin 2A = \sin A \cos A + \cos A \sin A$$

or $$\sin 2A = 2 \sin A \cos A.$$

Also $$\cos 2A = \cos A \cos A - \sin A \sin A$$
$$\cos 2A = \cos^2 A - \sin^2 A$$
$$= \cos^2 A - (1 - \cos^2 A)$$

and $$\cos 2A = 2 \cos^2 A - 1$$

or $$\cos 2A = \cos^2 A - \sin^2 A$$
$$= (1 - \sin^2 A) - \sin^2 A$$

and $\cos 2A = 1 - 2\sin^2 A.$

Lastly, $\tan 2A = \frac{\tan A + \tan A}{1 - \tan A \tan A}$

or $\tan 2A = \frac{2\tan A}{1 - \tan^2 A}.$

(b) Put $\frac{A}{2}$ in place of A in these latter equations :

Then $$\sin 2\left(\frac{A}{2}\right) = \sin A = 2\sin\frac{A}{2} . \cos\frac{A}{2}$$

$$\cos 2\left(\frac{A}{2}\right) = \cos A = \cos^2\frac{A}{2} - \sin^2\frac{A}{2}$$

$$\cos A = 2\cos^2\frac{A}{2} - 1 = 1 - 2\sin^2\frac{A}{2}$$

and $$\tan 2\left(\frac{A}{2}\right) = \tan A = \frac{2\tan\frac{A}{2}}{1 - \tan^2\frac{A}{2}}$$

Examples.

1. Prove $\frac{\sin 2\theta + \sin\theta}{\cos 2\theta + \cos\theta} = \tan 3\frac{\theta}{2}.$

Applying the ($\sin C + \sin D$) formula to the top line, and the ($\cos C + \cos D$) formula to the bottom line, we get

$$\frac{2\sin\left(\frac{2\theta+\theta}{2}\right)\cos\left(\frac{2\theta-\theta}{2}\right)}{2\cos\left(\frac{2\theta+\theta}{2}\right)\cos\left(\frac{2\theta-\theta}{2}\right)} = \frac{2\sin 3\frac{\theta}{2}\cos\theta}{2\cos 3\frac{\theta}{2}\cos\theta}$$

Cancel out $2\cos\theta$ and we have left—

$$\frac{\sin 3\frac{\theta}{2}}{\cos 3\frac{\theta}{2}} = \tan 3\frac{\theta}{2}$$

Q. E. D.

2. Prove $\cos^2 A\,(1 - \tan^2 A) = \cos 2A$

$$\cos^2 A\,(1 - \tan^2 A)$$
$$= \cos^2 A\left(1 - \frac{\sin^2 A}{\cos^2 A}\right)$$
$$= \cos^2 A - \sin^2 A = \cos 2A.$$

Q. E. D.

3. Prove $$\left(\sin\frac{\theta}{2} - \cos\frac{\theta}{2}\right)^2 = 1 - \sin\theta$$

$$\left(\sin\frac{\theta}{2} - \cos\frac{\theta}{2}\right)^2 = \sin^2\frac{\theta}{2} - 2\sin\frac{\theta}{2}\cos\frac{\theta}{2} + \cos^2\frac{\theta}{2}$$
$$= \left(\sin^2\frac{\theta}{2} + \cos^2\frac{\theta}{2}\right) - 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}$$
$$= 1 - \sin\theta.$$

Q. E. D.

Examples for Practice.

23. Prove $\cos(60^\circ + A) + \cos(60^\circ - A) = \cos A.$

24. Prove $\dfrac{\sin 2\theta - \sin\theta}{\cos\theta - \cos 2\theta} = \cot\dfrac{3\theta}{2}.$

25. Prove $2\,\text{cosec}\, 2A = \sec A \,.\, \text{cosec}\, A.$

26. Prove $\dfrac{\cot^2 B + 1}{\cot^2 B - 1} = \sec 2B.$

Solutions to Examples in Article XV.

21. (*a*) $\text{Cos } 75^\circ = \cos(45^\circ + 30^\circ)$

$$= \cos 45^\circ \cos 30^\circ - \sin 45^\circ \,.\, \sin 30^\circ$$

$$= \frac{1}{\sqrt{2}} \,.\, \frac{\sqrt{3}}{2} - \frac{1}{\sqrt{2}} \,.\, \frac{1}{2} = 0{\cdot}259 \text{ (nearly)}.$$

(*b*) $\text{Tan } 75^\circ = \tan(45^\circ + 30^\circ) = \dfrac{\tan 45^\circ + \tan 30^\circ}{1 - \tan 45^\circ \,.\, \tan 30^\circ}$

$$= \frac{1 + \frac{1}{\sqrt{3}}}{1 - 1 \times \frac{1}{\sqrt{3}}} = \underline{3{\cdot}73}.$$

(*c*) $\text{Sin } 105^\circ = \sin(60^\circ + 45^\circ)$

$$= \sin 60^\circ \cos 45^\circ + \cos 60^\circ \sin 45^\circ$$

$$= \frac{\sqrt{3}}{2} \,.\, \frac{1}{\sqrt{2}} + \frac{1}{2} \,.\, \frac{1}{\sqrt{2}} = \underline{0{\cdot}966}.$$

(*d*) $\text{Sec } 195^\circ = \dfrac{1}{\cos 195^\circ} = \dfrac{1}{\cos(135^\circ + 60^\circ)}$

$$= \frac{1}{\cos 135^\circ \cos 60^\circ - \sin 135^\circ \sin 60^\circ}$$

$$= \frac{1}{\left(-\frac{1}{\sqrt{2}}\right)\frac{1}{2} - \frac{1}{\sqrt{2}} \,.\, \frac{\sqrt{3}}{2}} = \underline{-1{\cdot}034}.$$

22. (*a*) $\text{Sin } 55^\circ = 0{\cdot}82.$

Therefore, $\cos 55^\circ = \sqrt{1 - \sin^2 55^\circ} = \underline{0{\cdot}57}$

$$\tan 55^\circ = \frac{\sin 55^\circ}{\cos 55^\circ} = \underline{1{\cdot}43}.$$

Similarly, from $\cos 20^\circ = 0{\cdot}94$, we get

$\sin 20^\circ = 0{\cdot}34$

and $\tan 20^\circ = 0{\cdot}36.$

Then $\sin 75^\circ = \sin(55^\circ + 20^\circ)$

$$= \sin 55^\circ \cos 20^\circ + \cos 55^\circ \sin 20^\circ$$

$$= (0{\cdot}82 \times 0{\cdot}94) + (0{\cdot}57 \times 0{\cdot}34) = 0{\cdot}96.$$

(*b*) $\text{Cos } 35^\circ = \cos(55^\circ - 20^\circ)$

$$= \cos 55^\circ \cos 20^\circ + \sin 55^\circ \sin 20^\circ$$

$$= \underline{0{\cdot}82}.$$

(*c*) $\text{Tan } 75^\circ = \tan(55^\circ + 20^\circ)$

$$= \frac{\tan 55^\circ + \tan 20^\circ}{1 - \tan 55^\circ \tan 20^\circ}$$

$$= \underline{3{\cdot}73}.$$

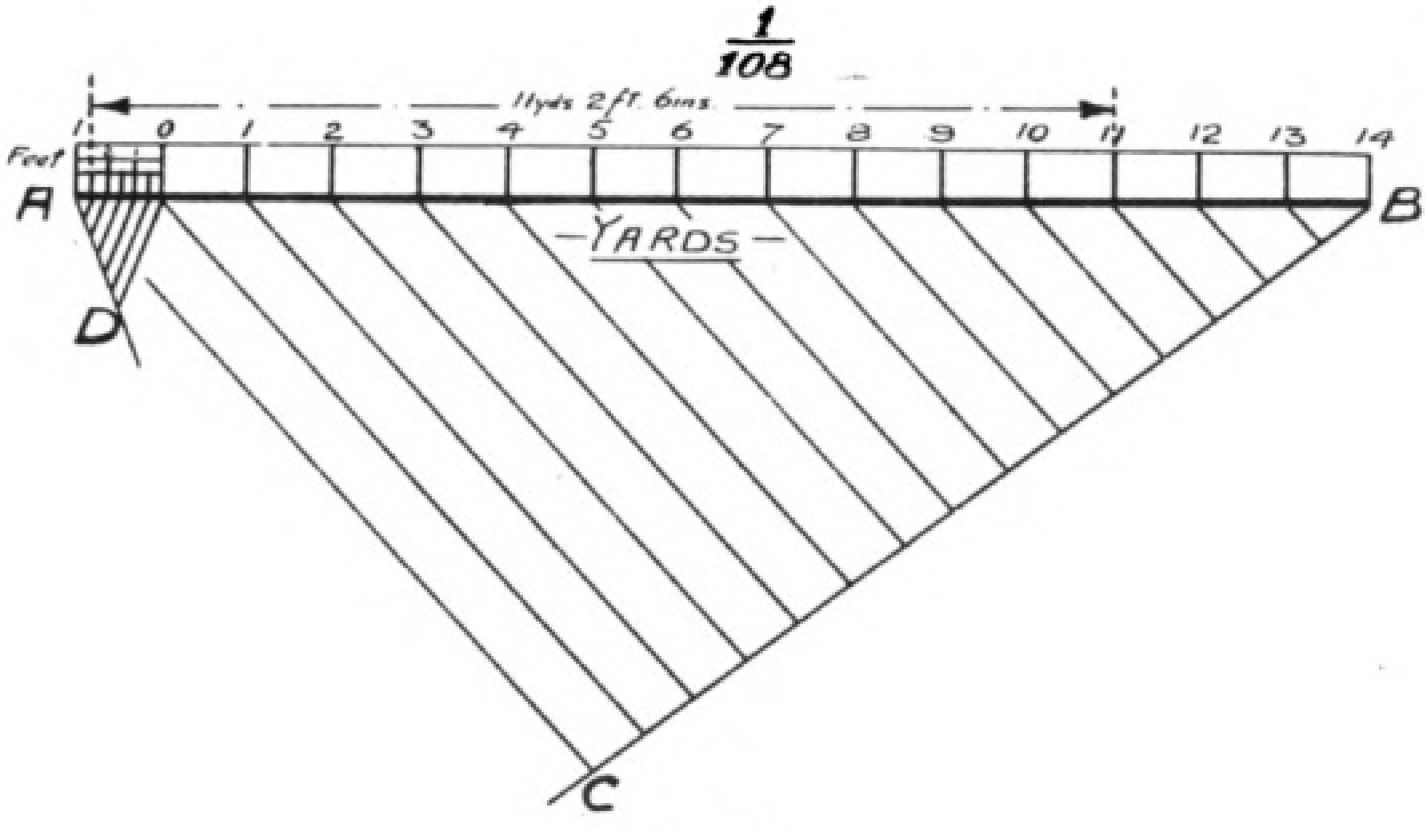


FIG. 91.

GEOMETRY.

Under this heading it is not proposed to carry out anything like a systematic study of geometry, but simply to run over a few constructions and problems which are of general utility.

103. *Scales.*—In Fig 91 we have a method of setting out a scale of 3 yards to the inch. Since 3 yards are equal to 108 inches, this scale is $\frac{1}{108}$, meaning $\frac{1}{108}$th of full size.

In this case a convenient length of 5 inches, representing 15 yards, has been taken for the scale. This length, *AB*, could have been divided by trial or by measurement into 15 equal parts, each representing 1 yard, but in this case the division has been made by the method explained in Article V. *BC* was drawn at a convenient angle to *AB*, fifteen equal divisions of some convenient length were measured off from *B* along *BC*, and parallel lines drawn, as shown, to divide *AB*. In a similar manner *AD* was used to divide the end fifteenth at *A* into feet and half feet. These parallels should, of course, be omitted from the final scale.

The zero for the scale is not at *A*, but is at the other end of the subdivided "yard," as shown. A scale marked in this way is every bit as useful as a scale subdivided all along into feet and half feet. Suppose a distance on a map or plan has been measured off with a pair of dividers, and it remains to find the length represented. Using this scale we must put one point of the dividers on a main scale division, such that the other point will fall either at 0 or amongst the small sub divisions. We will suppose that we have to place one point on the "11 yards" line, when the other point falls at 2 feet 6 inches—as shown by the dotted lines. Then the distance we require is read off directly, without any subtraction, as 11 yards 2 feet 6 inches.

104. In Fig. 92 we have a *Diagonal Scale*.

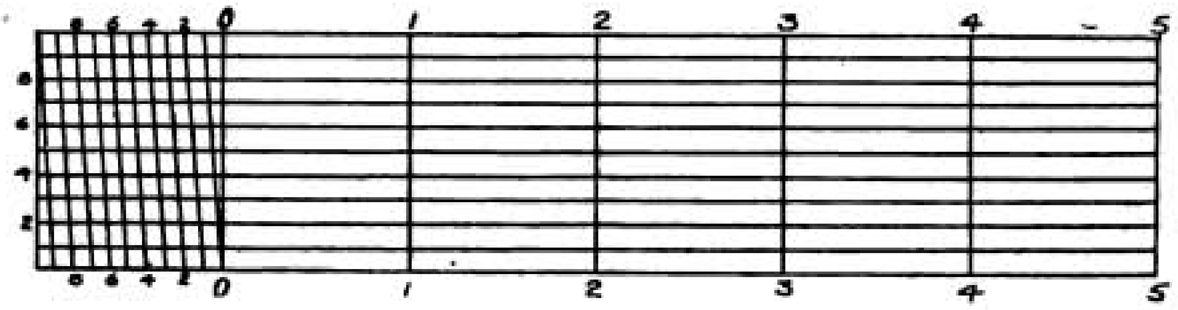


FIG. 92.

This particular scale is 6 inches long and about $1\frac{1}{4}$ inches wide. It is divided by horizontal lines into 10 "layers" of equal width, and by vertical lines into six equal compartments, each 1 inch long. The left-hand end compartment is divided along its top and bottom edges into tenths of an inch, and straight lines are then ruled across diagonally, as shown.

In Fig. 93 we have the sub-divided compartment shown considerably enlarged, and also the right-hand end, the middle of the scale being omitted. Let us imagine a point travelling upwards from *b* to *d* (along the straight line *bd*). At *b* it will be at a distance *ab*=5·10 inches from the right-hand end of the scale, and when it reaches *d* it will be at a distance *cd*=5·20 inches away, an increase of 0·10 inches. Therefore, since all the ten vertical spaces are equal, we see that as it crosses each space it must increase its distance from the right-hand end by one-tenth of 0·10 inches, or by 0·01 inches. In this way we get lengths on our scale equal to 5·10, 5·11, 5·12 . . . 5·19, 5·20 inches, as shown. This reasoning, of course, applies to any of the diagonal lines, and so we are enabled to scale off lengths correct to $\frac{1}{100}$ inch.

When scaling off lengths in this way, the even inches will be quite obvious, but the decimal portion will require a little thought. To make this more clear the following points have been marked in Fig. 93

	a', the decimal for which is				0·35
	b'	,,	,,	,,	0·71
	c'	,,	,,	,,	0·80
	d'	,,	,,	,,	0·02
and	*e'*	,,	,,	,,	0·49

It will be seen that the safest way to read off the decimals is to follow the ***diagonal to the bottom*** for the first decimal place, and follow the ***horizontal to the left*** for the second place.

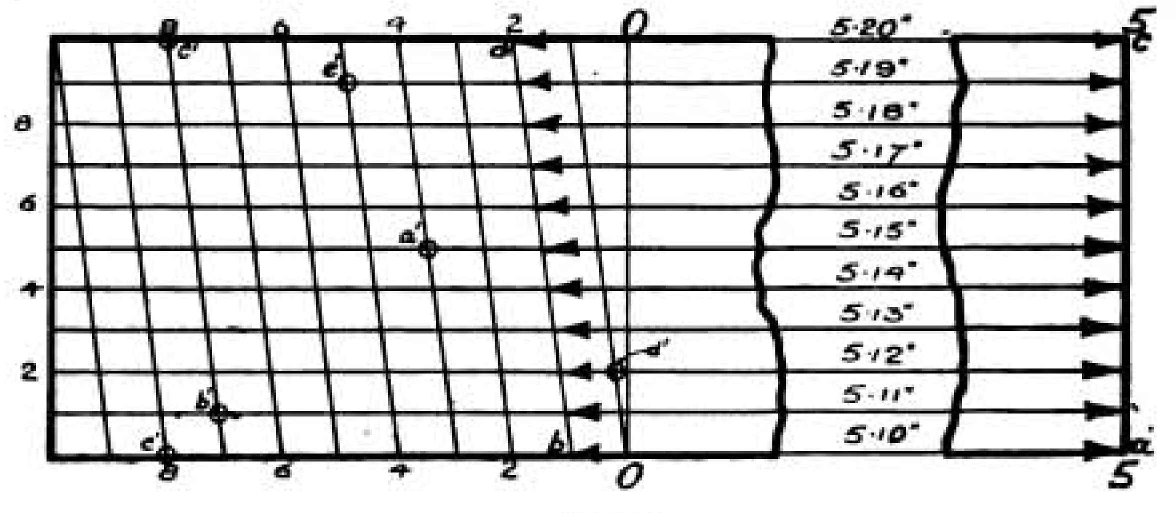


FIG. 93.

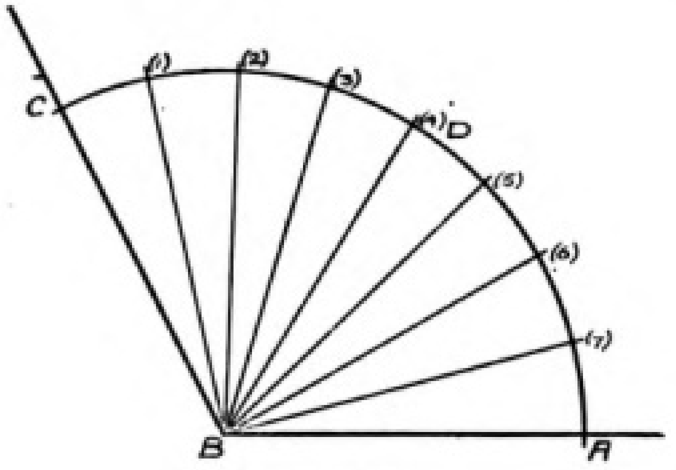


FIG. 94 (A).

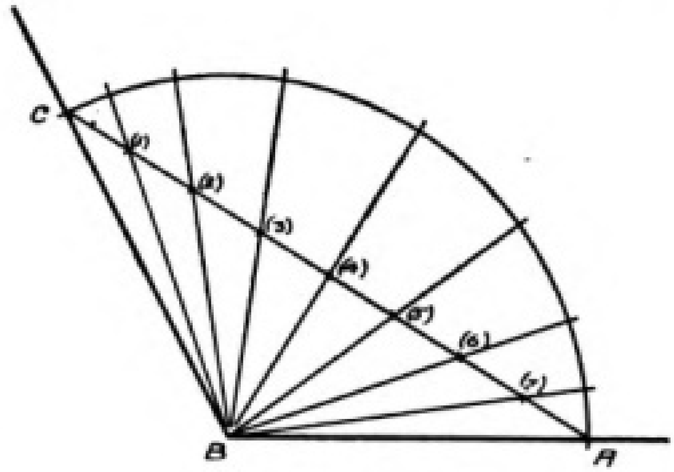
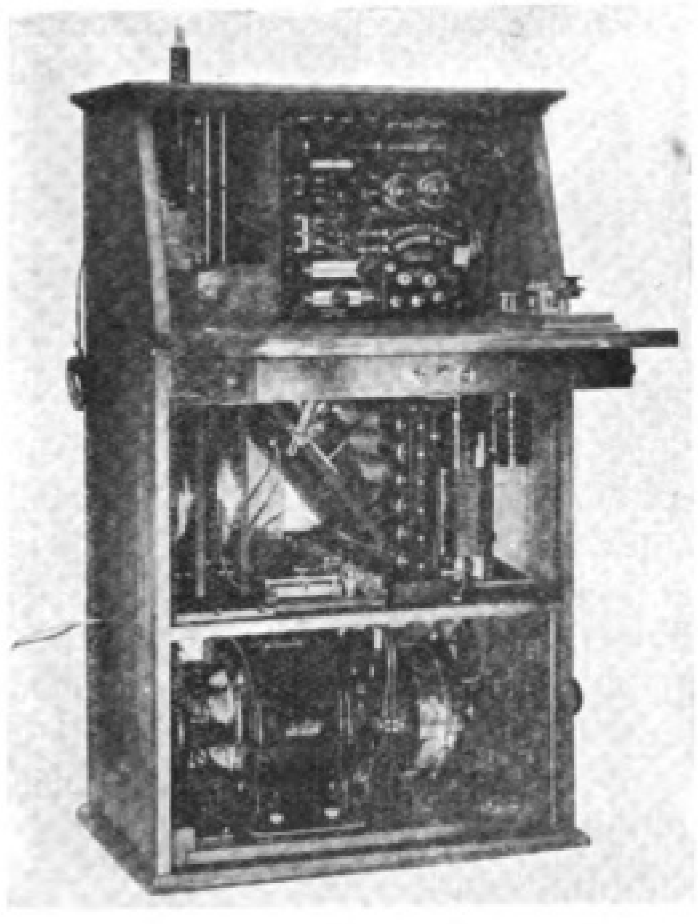


FIG. 94 (B).

105. The *Division of Angles* into a number of equal parts is most readily done by trial, except in a few very simple cases such as bisection or where a protractor can be readily used.

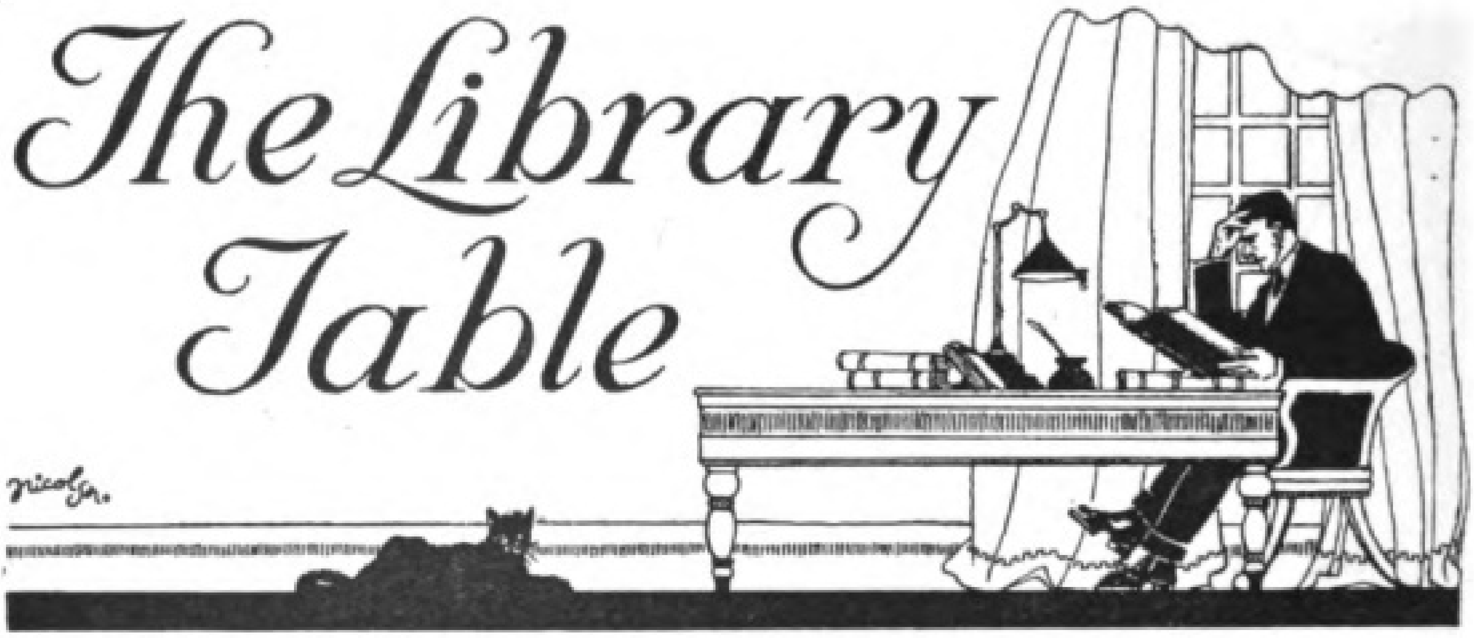
In Fig. 94 (*a*) the angle *ABC* is divided into 8 equal parts. The arc *CDA*, of some convenient radius is drawn with centre *B*, and divided into 8 equal parts, by trial, at the points (1), (2), (3) . . . By joining *B* to each point of division the angle is divided as required. It should be noticed that dividing the straight line *AC* into 8 equal parts, and using these points of division gives a very unequal division of the angle—see Fig. 94 (*b*).



Marconi $\frac{1}{4}$ k.w. Set with Receiver.

In our September issue we gave an account of the new Marconi $\frac{1}{4}$ kw. Transmitter which has been prepared to supply the need for moderate power installations on board ship. We are now able to publish a photograph of a further $\frac{1}{4}$ kw. cabinet set into which a receiver has been built, so as to make the whole apparatus self-contained. As will be seen from the illustration the transmitting portion is identical with that already described, and occupies the lower portion of the cabinet. The door of the upper section is so hinged that when brought forward it forms a table, the transmitting key being placed on the right-hand side. On the panel at the back of the cabinet will be seen the controlling switches, starter, fuses, etc., on the right, and the crystal receiver with its potentiometers in the centre. On the left-hand side is placed the receiving inductance.

The Library Table



"SUN, SAND AND SIN." By Joan Kennedy. London: Hodder & Stoughton. 1s. net.

With South-West Africa so far distant, and with the European conflict practically at our doors, it is not strange that the wonderful march of General Botha into what was known as German South-West Africa has not received the attention it deserves. To the stay-at-home reader the brief reports from the great Boer General conveyed little, indicating as they did merely a progress of so many miles. Only occasionally did we have a glimpse of some of the difficulties and horrors of that great march through blinding sand and burning sun; a laconic despatch would mention the poisoning of wells and defiling of the few oases which the barren land afforded. Miss Joan Kennedy, in the book before us, sets out to tell in a series of graphic stories some of the wonders of this famous expedition. "This is not a history," says Miss Kennedy in a foreword. "The history of the campaign in South-West "Africa has yet to be written. It will make good reading—that tale of how 322,348 "square miles of territory came to be added to the red patches on the map of the "world. . . . Rightly did Botha call it the land of sun, sand and sin."

Some good stories are enclosed within these covers, and some, such as that which describes how a trooper who dropped out exhausted in the desert march and managed to keep himself alive are gruesome in their vivid detail. Of wireless stories, too, here are a few, including one which has already appeared in the columns of "Wireless Telegraphy in the War" in our magazine.

Miss Kennedy has a fine sense of the dramatic in telling her tales, and the book will certainly help to bring home to many who had not given the matter much thought how much we owe to the great South African General and the faithful, hardy and heroic force which accompanied him across the great deserts of gleaming sand to a victory perfect and complete.

* * * * * * * *

"GAS, OIL AND PETROL ENGINES." By A. Garrard. London: Whittaker & Company.

The importance of the internal combustion engine in our daily life can be realised when we consider that upon it depends the running of practically every motor-car, aeroplane, airship and motor-boat. Further, an interesting number of motor-ships are traversing the great ocean highways, and this form of engine has also invaded the railways, for the running of local trains and of small branch lines. The wireless operator, too, is not unacquainted with it, for a number of emergency dynamos driven by internal combustion engines are in use on board ship. The book under review is devoted to the explanation of various forms of gas, oil and petrol engine, and with the aid of a number of excellent diagrams makes the whole subject quite clear. Commencing with a chapter on history and development, we are next treated to a description of general principles followed by explanations regarding the fuel and combustion. Gas engines, large and small and of various types, are then explained, petrol engines coming next in treatment. The comparatively recent invention of the Diesel engine, making possible large power units with comparatively crude fuel, was the first device to bring the motor-ship within the realm of economical running, and in the chapter devoted to this type of power plant much interesting matter will be found. The older type of oil engine comes next in the book, and producer gas plant is not forgotten. In chapter 10 the recently invented " explosion pump " of Mr. H. A. Humphrey is clearly explained. This pump is of very high efficiency, and a great many of the usual parts of the internal combustion engine and pump are dispensed with. Lastly, the important subject of ignition is treated in a separate chapter, both the elementary principles upon which such device is worked and their practical application being thoroughly dealt with. Altogether this is an excellent book, which should be in the hands of all who desire to make themselves acquainted with any of the forms of engine to which we have referred.

* * * * * *

" DYNAMOS AND MOTOR ATTENDANTS AND THEIR MACHINES. By Frank Broadbent, M.I.E.E. (Eighth Edition). London : S. Rentall & Company, Limited. 2s. 6d. net.

The success of this well-known book can be judged from the fact that this is the eighth edition, and the author has taken the opportunity of thoroughly revising the book and bringing the matter right up to date. It can be recommended to all who desire to have a good sound and general knowledge of dynamos and motors, and our experience has shown us that there are a very large number of people to whom the perusal of the volume would be of great help. For instance, at sea on small cargo vessels where an electrician is not carried, it is the exception rather than the rule to find that the chief engineer understands electrical matters. For some reason or other few engineers on such vessels run the dynamo at the proper voltage, and as a consequence the lights are sometimes brilliant, sometimes dull, and generally unsatisfactory. Excellent dynamos are in many cases ruined by mismanagement, and sparking brushes left to burn unhindered, ruining the commutator in the process. This little book not only explains the principles upon which the dynamos and motors work, but also deals with such matters as faults and how they may be remedied, how to choose a dynamo or motor, accumulators and all matters which a dynamo and motor attendant should understand. We notice in the chapter on accumulators that the Edison battery is clearly illustrated and explained, whilst a number of practical points on battery maintenance are given. The price of the book is reasonable, and it should be within the reach of all.

* * * * * *

"A TREATISE ON THE THEORY OF ALTERNATING CURRENTS." By Alexander Russel, M.A., D.Sc., M.I.E.E. Volume 2 (Second Edition). Cambridge: The University Press. 15s. net.

This excellent treatise, the first volume of which was reviewed in our January, 1916, issue, is designed, in the words of the author, "to give a sketch of the theory of "the working of alternating apparatus, in the hope that it will prove helpful to "engineers, teachers and advanced students." In the 550 odd pages which go to make up the volume the reader will find the subject very fully treated, mathematical explanations being given on practically every page. Whilst not a book for the elementary student, it will yet appeal to the ever-growing circle of readers who are not content with skimming the surface of alternating current theory, and these will appreciate the numerous clearly drawn diagrams which are interspersed throughout the book.

* * * * * *

"A MANUAL OF PRACTICAL PHYSICS." By H. E. Hadley, B.Sc. London: Macmillan & Co., Ltd. 3s.

This book is designed to fulfil the need for a manual of elementary practical physics of reasonable size and moderate price, suitable for students working to the standard of the intermediate examinations of various British Universities. The matter is presented in a clear and interesting manner and could profitably be studied by all senior students in secondary schools who propose to specialise in science.

A sound knowledge of physics is not without value to the wireless student and operator, particularly to those who desire to understand more fully the principles upon which many parts of the apparatus are based. In fact, one may go so far as to say that no student of applied electricity can hope to make much progress until he has first obtained a good grounding in physics.

We are glad to see that the numerous experiments described and illustrated throughout the book are of such a nature that they can be easily carried out without the aid of expensive apparatus. Altogether this is an excellent little book and can be thoroughly recommended.

* * * * * *

"DREAMS: WHAT THEY ARE AND WHAT THEY MEAN." By a Member of the Norbury Literary Society. Price 1s. 1d., post free. From J. W. Wickwar, 81 Kilmartin Avenue, Norbury, London, S.W.

Dreams and dreaming are as old as the hills, and have always supposed to have had some mysterious significance about them. The enquiring mind asks "What can they mean?" and an attempt has been made in this little work to elucidate the problem. Almost every kind of dream ranging from the "day-dream" to the "night-mare" is dealt with, and under "prophetic dreams" we have a complete account of that wonderful dream known as Mother Shipton's, in which every vision has come to pass, except the last one, which was—the end of the world.

Personal Notes

THE LATE
PRIVATE R. W. R. FLETCHER.

FROM Australia comes the news of the death of the Rev. Father Archibald John Shaw, of the Sacred Heart Order of Missioners. As a young man he was employed for some time in the General Post Office at Sydney as a telegraph operator, and after entering the Sacred Heart Monastery he still retained his interest in matters telegraphic. Experimenting in wireless telegraphy, he produced what was known as the "Shaw Wireless System," and with the support of a syndicate entered into the business of motor and dynamo manufacture as well as wireless telegraphy.

* * * * * *

In connection with the paragraph which appeared in our October issue, regarding the sad death of Private R. W. R. Fletcher, we are now able to reproduce a photograph, although no further particulars have come to light regarding the manner in which he met his death. Private Fletcher was very popular with his fellow workers in the Wireless Press, and his loss will be severely felt by his old comrades.

* * * * * *

With reference to Lieut. Bernard C. de B. White, who was killed in action on July 1st of this year, Major W. A. Farquhar, of the Royal Scots Fusiliers, says:

"Mr. White took part in the general offensive July, and died a soldier's " death in France, where he was buried decently, and, although I have not " heard it, I have every reason to believe that a cross has been erected over his " grave to mark the spot. I hope it may be some consolation to his friends and " people that he gave his life nobly for his King and Country, and no one can do " more.

"The battalion, and everybody connected with it, behaved magnificently " under the most trying circumstances."

* * * * * *

We regret to announce that Petty Officer William Herbert Hodgson, of Scarlet Heights, Queensbury, near Halifax, who was well known to many of our readers as an operator in the service of the Marconi Company prior to the war, fell with a seaplane into the sea on October 12th and lost his life. Petty Officer Hodgson was an air mechanic and observer, in which capacity he has

THE LATE LIEUT. A. C. STYLES.

served for some time, having joined the Air Service about two years ago.

On behalf of his many friends in the Marconi Company, we offer our sincerest sympathies to the late Mr. Hodgson's parents and five sisters in their terrible bereavement.

* * * * *

We also regret to announce the death, in action, of Lieut. Alfred Cornwall Styles, of the Cheshire Regiment, on July 18th last. Lieut. Styles was but 26 years of age, and was married as recently as December last.

Educated at Dulwich College, Lieut. Styles became a Marconi Engineer, and went abroad for the company to fill various appointments. He had previously been a Territorial, and on returning home at the outbreak of war was granted a commission in the Cheshires, and went to the front about nine or ten months ago. Letters received show that his battalion had been in very heavy fighting for some days. During a lull, and whilst some rest was being snatched in the trenches, a shrapnel burst and killed him while he was asleep. His Colonel writes, saying he was a very efficient officer, and we take this opportunity of expressing our deep sympathy with his bereaved widow in her sad loss.

* * * * * *

Congratulations to Warrant Telegraphist Herbert Thomas Little, of Eltham, on his marriage to Miss Laura Gladya Dye. The bridegroom, who is well known in Ramsgate, was a wireless operator in the service of the Marconi Company prior to the war, and we are sure his old comrades will join with us in offering the heartiest congratulations to the happy pair.

* * * * * *

Mr. Henry W. Allen, Secretary and Deputy Manager of Marconi's Wireless Telegraph Company, Limited, and the Director and Manager of the Wireless Press, Limited, was re-elected a member of the Council of the Chartered Institute of Secretaries at the General Meeting, held on November 9th.

WARNT. TELEGRAPHIST H. T. LITTLE.

Pastimes for Operators

Sketching

By "REDAX."

SITTING down to write on the subject of sketching as a hobby for wireless operators, I am faced with the fact that the majority of my readers will glance at the heading and say, " Ah, yes ! Sketching is all right for some, but it's not the " hobby for me. *I* can't draw. Artists are born, not made ! "

To all of these I would say : " Read this article through to the end, for it is " quite possible that you will find that you have abilities in this direction which " you had not previously thought of." I am convinced that a very great number of people cannot sketch because they have never seriously tried.

The advantages of being able to sketch are so numerous and to such a degree obvious that it may almost be considered a waste of time to enumerate them. Wireless operators as a body enjoy exceptional facilities for travel—facilities far greater than those of the average Mercantile Marine officer, who is usually tied to one ship for many voyages, and perhaps for years. Seeing many lands, the operator will naturally wish to keep some record of these ever-changing scenes, and if he is a camera enthusiast he may turn to photography to help him, but there are many to whom photography makes no appeal, who count it " messy," and, not an unimportant fact, expensive ! But if he is able to sketch he may bring home a note-book full of interesting drawings and impressions, which will serve to remind him throughout the rest of his life of the foreign lands and scenes he has visited. On the score of expense there is little to be said, for a pencil and paper are always available and cost practically nothing.

Many operators have gained quite considerable fame by their little humorous sketches and caricatures. There is a great deal of fun to be obtained in this way, provided the boundaries of good taste are not overstepped. It is true that this type of sketching can rarely be taught—it comes as a natural gift ; but it can be developed to a great degree in those who possess the rudiments of humorous expression.

Lastly, there is a form of drawing greatly neglected by most operators, and capable of being readily acquired by practically all, and that is the making of diagrammatic sketches of apparatus. Many a time we have known an operator to be asked some question on his apparatus, and, owing to his inability to draw a clear and lucid diagram, he has floundered on for an hour or more in an endeavour to give the information required. Even to those who possess no artistic gifts, and to whom the beauties of such expression mean nothing, the ability to draw diagrams can be easily acquired.

On this point the reader may say, " Yes, I agree with all you have written, but " how am I to find out whether I have this latent ability you speak of, and how " can I improve the almost negligible ability I already have ? " In an endeavour to answer this we must consider first of all what lies underneath the power of expression.

To be able to draw we must be able to *observe* clearly ; we must be able to form a clear perception in our minds of that which lies before us. Have you ever noticed how some men have travelled between, let us say, London and New York for years on end and yet seem unable to describe anything of importance in either of these ports ? The reason is not that they have not *seen* the places on which they are questioned, but that they have never given any thought to the sights which come before their eyes. In a phrase they lack the power of observation. If you want any proof that most people see a great deal but observe very little, just ask the next friend you meet if he can describe the pattern of the wallpaper in his bedroom, if the point of the well-known red triangle in the Y.M.C.A. sign is at the top or bottom, and a few other questions of a like nature. You might, at the same time, ask him whether the hour of six on his watch is shown in Arabic or Roman numerals. He will probably say at once in Roman numerals, but when he looks he will find that the dial of the second hand completely covers the space where the six should be, so that there is no figure at all.

Having realised the difference between seeing and observing, the reader should practise observation at every possible opportunity. If when reading this he happens to be on board ship, I would suggest that he sit down with a sheet of paper in front of him and a pencil, and endeavour to make a simple drawing of the ship on which he is serving. After drawing a straight line for the deck he will probably find that he has no clear idea of the exact position of the masts, their height in proportion to the length of the deck and the methods by which they are stayed. A few minutes on deck should give him the necessary information, and enable him to proceed with his little sketch. By careful observation of every feature and by taking notice of such points as the diameter of the funnel in proportion to its height, position of capstans, well-decks, hatchways, and the like, he will soon find himself with a very presentable outline of his ship.

By this time he will have noticed many points regarding the vessel which he had not previously remarked, and will seek to compare his present ship with others upon which he has served. Once his interest has been aroused he will notice many points of difference upon passing vessels which have previously escaped his observation, and in a short time should be able to make a sufficiently accurate sketch for others to be able to identify the vessel from his drawing. Ability to do this may prove of great value.

The art of sketching rapidly depends not only upon the skill and training of the artist's hands, but also upon the power of perceiving at a glance the essentials of the object in view, and the operator should ask himself when on deck watching passing ships, " What features on that steamer differentiate it from the vessel " on which I stand ? " This is a particularly interesting exercise when comparing ships of the same line where the colour of the hull and funnels is the same in each case. How many North Atlantic operators, I wonder, knew of the differences between the *Lusitania* and the *Mauretania*—differences which were sufficiently marked to enable the observer to see which ship was which, even on the distant horizon ?

One of the dissimilarities was in the deck ventilators, which were of the mushroom type on one vessel and the ordinary type on the other.

Space will not permit me to deal at all fully with the methods of practising sketching, but I think sufficient has been said to give the keen operator a start on the right road. There are a number of small handbooks on drawing to be had from which one can learn the elements of perspective, and to all who are sufficiently keen to take up the study seriously there are always the correspondence courses in drawing, which are quite good and widely advertised. In these courses the student is required to make sketches and drawings of certain objects, which are criticised by the skilled instructors at the correspondence school. By having his errors pointed out to him and by receiving a few words of encouragement here and there, when it is found he is proceeding on the right lines, the student will soon be able to overcome the initial difficulties, and may possibly achieve considerable success in one or other of the branches of sketching. It may not be without interest to mention here that Captain Bairnsfather, whose humorous sketches from the front have attained such popularity, has admitted that he owes much to one of the correspondence courses in drawing.

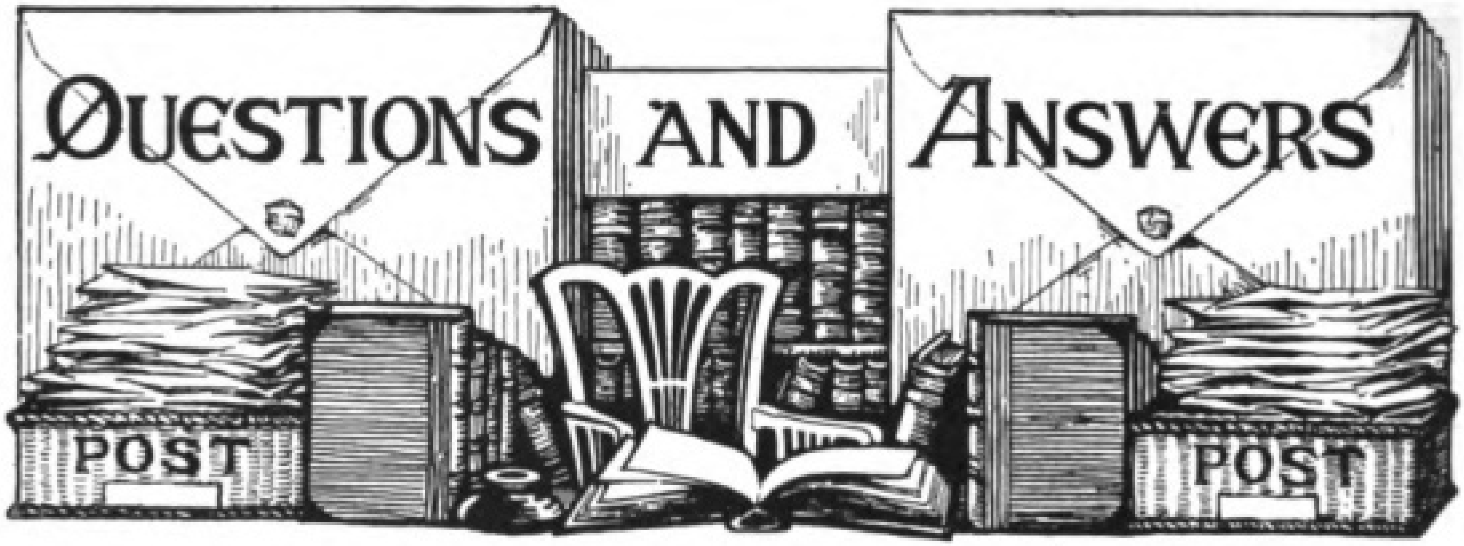
As an example of what some operators are doing in the way of sketching, we would refer readers to page 294 of the July issue, on which appears the reproduction of a water-colour painting of H.M.H.S. *Aquitania*, by Mr. P. Aris, who is well known among his friends for his excellent sketches and water-colour painting on maritime subjects. In our June number on page 202 there appeared a pen-and-ink drawing of the Quebec Station by Mr. Douglas R. P. Coats of the Canadian Marconi Co., and the small black-and-white illustration at the foot of page 203 is also by the same artist. In February of this year we published a highly interesting description on page 742 of "The Wireless Equipment on German Submarines." Mr. Percival Denison, the operator on the torpedoed *Den of Crombie*, had the presence of mind to make a couple of rough sketches, one of the s.s. *Den of Crombie* sinking, with the German submarine alongside, and the other of the peculiar aerial equipment carried on the enemy craft. These sketches, although very rough, contained all the essential features, and our artist, Mr. W. A. Cross, was able to work up from them the excellent illustrations which appear in the article in question.

Altogether I think I have said enough to show that sketching as a hobby is well worth "working up," and, even when no great success is attained, the additional facility in observation which is developed in the practice is bound to be of great value in one's other pursuits.

Share Market Report

London, *November 13th*, 1916.

The share market has been very quiet during the past month, and there is little change to report. Prices, as we go to press, are : Marconi Ordinary, £2 16s. 3d. ; ...i Preference, £2 6s. 3d. ; Marconi International Marine, £2 2s. 6d. ; American ... ; Canadian Marconi, 9s. ; Spanish and General Wireless Trust, 9s.



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

POSITIVELY NO QUESTIONS ANSWERED BY POST.

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

J. R. (Middlesbrough).—We regret we cannot answer questions regarding the cable service and their stations, as matters such as these are outside our province. With regard to your question whether it is possible for young lady post office assistants with good telegraphic capabilities to obtain permanent situations in either wireless or cable offices, and if so whether it is not possible providing their telegraphic qualifications are satisfactory to obtain employment in either the wireless or cable offices without the necessity of first entering a school for tuition, we can only speak with regard to the wireless service. A certain number of skilled lady telegraphists have been engaged by Marconi's Wireless Telegraph Company, Limited, for service at some of their wireless stations, and these have been given permanent appointments. They have, however, in all cases been given wireless training in the Company's own school before taking up their duties. In reply to your last question we would refer you to the wireless map of the world published in the *Year Book of Wireless Telegraphy and Telephony* for 1916.

"UNDULATOR" (R.F.C.)—Wireless engineers are mostly recruited from fully trained electrical engineers who have been through a full course at a recognised technical college. For a list of these approved institutions you should apply to the Chief Engineer, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, W.C., who will also forward you conditions of appointment for wireless engineers if you ask for it. You are apparently studying the right subjects, and if you obtain the particulars above referred to, you will see just what a wireless engineer is required to know. Thank you for your good wishes.

A. W. (London, S.W.)—We are glad you were interested in the article on the Goldschmidt Transatlantic Station in the October issue. In the Digest of Wireless Literature we give further particulars of the Goldschmidt Alternator. The wireless station near Brussels which was blown up to prevent it falling into the hands of the Germans was a private installation. The following particulars regarding it appeared in the *Cambridge Magazine* for November 21st, 1914: The station was erected at Laeken near Brussels, on a plot of ground given by King Albert. The station was erected by a Mr. Robert Goldsmith (*not* the Professor Goldschmidt of High Frequency Alternator fame. ED.). Current was supplied by a high frequency alternator driven by a 400 H.P. motor. The aerial consisted of eleven wires supported by eight steel masts, two of these being 135 metres high and the remainder 90 metres high. The maximum wavelength was 8,000 metres. On Wednesday, August 19th, 1914, the station was blown up by the Belgians. The amount of damage done was estimated at about £200,000.

W. G. C. (Papua).—Your informant is quite correct. It is the standard practice to measure the output of the station on the long dash. Many thanks for your very interesting letter. We are glad to hear that our magazine gives so much pleasure in such a far distant part of the world.

L. C. A. (Norwich).—The Marconi Company can only accept for its operating staff men who are physically fit, and the fact that you have a slightly paralysed right leg would, we are afraid, debar you from being accepted for that Company's service.

G. L. P. (London).—We cannot pass an opinion upon which is the best course for you to take, unless you inform us which profession you are likely to take up. If you intend to enter upon the career of a wireless telegraphist we do not think you will gain much solid advantage by taking a combined cable and wireless course. If, on the other hand, you think of entering the cable service, you might with advantage take the combined course as a number of Cable Companies have repair ships fitted with wireless telegraphy, and a knowledge of wireless would probably be useful to you. If you care to write to us again stating more fully your intentions with regard to a career, we may be able to give you further assistance.

N. S. W. (Wallington).—We cannot say which is the *best* book on dynamos, motors and alternators, or which is the best book regarding installations and design of apparatus used on aircraft. Everything depends upon the extent of your present knowledge. If you have no knowledge of elementary electricity and magnetism it is useless buying such a specialised book as one dealing with dynamos and motors alone. Again with regard to alternators, if you have a good knowledge of alternating current, we can advise you of a book devoted exclusively to alternators and their work. There is no book devoted exclusively to the design of wireless apparatus used on aircraft, nor is there likely to be one published before the end of the war as great advances have been made in this direction by naval and military experts and commercial firms engaged on apparatus used in the war. All this is of course secret for the present. We would take this opportunity of asking our readers to make their queries as full as possible, as we are often severely handicapped by not knowing exactly what our correspondents require to know and the extent of their present knowledge. This will be evident from one or two replies given above.

H. W. (Rotherhithe).—As it is evident from your letter that you have only an elementary knowledge of wireless telegraphy we would suggest that you obtain *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, and *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, which are advertised in this issue. By studying these books you will get all the knowledge you require and gain considerably more information than we could give you here, as it would be impossible for us to answer your questions with the limit of space we have at our disposal.

C. A. (Birmingham).—Yes, we should think that the Royal Naval Air Service could make excellent use of your knowledge of motors, and we would suggest that you apply to the nearest recruiting office for any further particulars you require.

Ambitious (Barrow-in-Furness).—For particulars regarding the conditions of employment and prospects of a Marconi operator, we would suggest that you apply to the Traffic Manager, Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C. In answer to your second question we cannot of course pass an opinion as to which is the best wireless school, but if you apply to some of the institutions advertising in our pages and ask them to send you particulars, you should be able to make the choice yourself. In answer to question 3 it is necessary for a wireless operator to have a good general education.

G. L. (Hunstanton).—The rotary spark gap and the quenched gap are both highly efficient, but whether one is more efficient than the other depends upon the general design of the circuits connected thereto. In answer to your second question you have apparently mistaken the purpose of a potentiometer. A potentiometer and battery used in connection with a crystal detector does not amplify the receive signals, but merely enables the detector to be brought into the most sensitive condition by giving the required potential difference across the point of contact. Some crystals do not require the us . of this piece of apparatus. Question 3. We cannot answer any questions of this nature nor reproduce any diagrams of circuits such as those you show while the present restrictions are in force.

A. B. G. (Glasgow).—You do not say whether you hold a P.M.G. certificate or not, nor do you say whether you are conversant with the construction and manipulation of Wireless Apparatus. If the answer to any of these queries be in the affirmative you can enter the Royal Naval Air Service (applying to the R.N.A.S., Central Training Establishment, Lincolnshire) or the Royal Engineers or the R.F.C. If you wish to join the Royal Engineers, you should communicate with the Commanding Officer, Wireless Training Centre, Worcester. If you desire to join the R.F.C., communicate with the Recruiting Officer, R.F.C., The Polytechnic, Regent Street, London, W. In either case you would enlist for the period of the war only.

L. W. B. (Dover).—Your question is really answered in the "Note of the Month" dealing with this matter, which appears in our present issue. For admission into the R.F.C. you would have to apply to the Recruiting Officer, R.F.C., The Polytechnic, Regent Street, London, W. But in any case we understand it will be necessary for you to obtain leave from your Commanding Officer before applying for a transfer.

Signalman (Granton).—Applications for entry into the R.F.C. should be made to the Recruiting Officer, Polytechnic, Regent Street, London, W. You should obtain leave from your Commanding Officer before applying for a transfer.

A. H. F. (Bishops Waltham).—With reference to your first question asking how to determine the correct condenser capacity for a given inductance coil, do you mean the condenser in the base of the coil or the condenser in the oscillating circuit, which the coil is used to charge? Question 2. To test the condenser in the base of the coil to see whether the dielectric has broken down, a galvanometer is connected across the condenser terminals. If the dielectric is unpunctured there will be no reading of the galvanometer, but if the insulation is broken down there will of course be a reading.

F. P. (Banbridge).—Your first question we cannot answer while the present restrictions are in force. In reply to your second question everything depends upon the particular station, the disposition of the earth plates and the position of the building with regard to aerial and earth. In some cases it might improve the earth to have it connected with the galvanised iron of the building, and in any case no harm would result from the fact that the earth lead were not insulated from the side of the shed. We much regret that owing to pressure of work and the fact that we have a great number of questions and answers to attend to, we are unable to answer your queries by post.

AJAX (Abercynon).—We regret that we cannot pass opinions as to the relative merits of the various wireless training institutions, but we may say that the school you mention is a genuine training institution and the correspondence classes conducted by it are, we believe, quite good.

A. A. (Malta).—We would suggest that you obtain a copy of one of the English electrical papers, such as the *Electrician* or the *Electrical Review*, in which you will find advertisements of the leading electrical firms. If you write to some of these they may be able to help you. If you apply to the Chief Engineer, Marconi's Wireless Telegraph Company, Limited, Marconi House, Strand, London, W.C., for conditions of employment for Wireless Engineers, this will also help you.

RADIOGONIOMETER (Liverpool).—The articles to which you refer will not be reprinted in book form, so far as we know at present. (2) We do not know of any book on advanced wireless similar in style to the publication you mention. If you will let us know more exactly the type of book you require, we will endeavour to advise you further. (3) The information in your third question is insufficient for us to answer your query. Are you referring to the Marconi-Bellini-Tosi Direction Finder or to some other form of direction finding aerial?

W. C. S. (H.M.T. ——).—The station with call-letters "W.S.T." is the land station at Miami, Florida, as given in the 1916 edition of the *Year Book*. We cannot account for the phenomenon you mention, and in any case do not think it is due to the cause you suggest. (2) The type of atmospheric you refer to is well known to the writer. It frequently precedes a squall of sleet, and is referred to in this connection in the article on "Some Problems of Interference" (1916 edition of *Year Book of Wireless Telegraphy and Telephony*).

W. H. L. (Timaru).—The book we are publishing shortly, entitled *The Measurement of Capacity and Inductance*, by W. H. Nottage, B.Sc., will deal fully with the points raised in your letter, and we would strongly advise you to obtain it. Your second query cannot be answered, as you do not say how far apart the two aerials are placed.

SPECIAL NOTICE.

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