Extract from Report of Lieut. J. A. Slee on the proposed Station at Fremantle, Western Australia.

This report deals with the proposed arrangements of the W.T. station for Fremantle, Western Australia.

It was stated by the contractor's engineer that the installation would be a replica of that at Nauen, with the two exceptions mentioned below.

Mast.—A steel lattice girder of triangular section, 100 metres high. The mast will be all in one piece, and not divided into sections by insulators. It will be stepped on a special insulating block mounted on a concrete foundation, the heel being a ball and socket joint.

It will be supported by two sets of rigging, at 50 and 75 metres up, having only three stays in each set.

The stays will have insulators at the top and bottom only. The rigging anchors will be large blocks of concrete, relying chiefly on their weight to withstand the pull of the rigging.

The estimated weight of the mast is 40 tons.

Site.—Five hundred yards square. It was desired to put the station on the foreshore, if possible, and, if not, to put it on the top of the highest hill available. Land effects seem to be much feared.

Aerial.—Umbrella type, fed at the masthead. The feeders are said to act as a shield for the iron mast. The ends to be hauled out to pegs in the ground, all round, the diameter of the wire part being not more than 400 feet. Capacity of aerial, about six jars.

Earth.—This will be an insulated counter capacity spread about 10 feet from the ground. This is expected to reach a high tension. The diameter will be about 500 yards.

There is also to be an auxiliary star earth, buried 2 feet under the ground ; diameter, about 400 yards.

This will be used as an alternative and as a protection against lightning.

(Nauen has an earth similar to this, and not a counterpoise.)

Lightning Discharger.—Is a small spark gap joined up between the metal of the mast and the auxiliary earth. When the station is not working, or when there is lightning about, this spark gap should be short-circuited.

Buildings and Foundations are all to be supplied by the Commonwealth to the contractor's designs. No information could be obtained about these.

Engine is to be a 30 H.P. horizontal benzine engine, coupled by a belt to a 20 kw. alternator. The engine to be of a standard Australian make, with a heavy flywheel, but having a special sensitive governor made by the Telefunken Company.

The benzine to have a specific gravity of 0·687.

(Nauen has a 30 H.P. *steam* engine.)

Alternator.—Output, 20 kw. at 440 volts, 500 cycles, 1,500 r.p.m. Armature to be wound so as to stand 75 ampères, so as to allow of a bad power factor. No attempt seems to be made to get into resonance. This point was brought in several times with always the same result. The alternator will have 20 pairs of poles and will work at 1,000 sparks per second.

The alternator voltage can be adjusted by a regulator. A small exciter is mounted on the alternator shaft, which also supplies current for the magnetic key, for the safety relays, and for the fans for cooling the spark gaps.

Primary Circuit.—The spark gap (quenched spark) consists of 32 gaps in series, each of 0·2 mm. All are provided with large gills and have fans playing on them, as it is essential to keep them cool. The condenser consists of large Leyden jars and has a capacity of 20 jars. (This figure was repeated several times.) The set is direct (or Slaby-Arco) coupled to the aerial,

all the primary turns being included in the aerial. The condenser will be charged to 30,000 volts at full power. It is not necessary to alter the capacity when altering the wave-length.

Magnetic Key is arranged to short-circuit a choking coil when working at or near full power. It is claimed that this will entirely extinguish the spark in the spaces. When working at about quarter power, with only eight gaps, and the primary voltage reduced to 100, the choker is removed and the magnetic key entirely breaks the circuit. It is also stated that the choking coil, by keeping some current flowing during the spaces, will steady the load and so improve the running of the engine.

Transformer is wound to give a step up from 440 volts to 30,000.

Send-Receive arrangements are similar to our old S.R. switch, and similar provision is made for breaking the circuits when the switch is in the receive position.

Receiving Gear is as shown in Plate XIII.

For receiving short waves the condenser and inductance can be put in series.

A contact or an electrolytic detector can be used at will, both being built to ship on to the same clips. For ordinary work the detector circuit is magnetically coupled to the inductance of the receiving circuit, the detector circuit being a-periodic, the condenser being large.

For very undamped waves, for fine tuning, or for cutting out interference, a second tuned circuit is interposed between the aerial circuit and the detector circuit. Nothing was said about moving the various parts away from one another so as to vary the coupling. No attempt is made to stop interference by atmospherics. The musical note of the transmitting station is alone relied upon. The specification requires an efficient call-up device, and this will take the form of an instrument similar to a telephone relay joined up to the detector.

It is fitted with a clockwork delay, which can be adjusted from 5 to 15 seconds, so that unless a prolonged dash of the requisite length is made the call-up will not ring. This is arranged so that the bell shall not ring for an ordinary atmospheric, or for ordinary signalling. It is claimed that this arrangement will work at 75 per cent. of the effective range of the station. This figure does not allow for the extra range to be obtained by a good operator reading a very faint signal, and no provision is made for a silent cabinet.

The following information was also obtained:—

If it is desired to increase the power to, say, 30 kw., the voltage would be increased to 40,000, and the number of gaps raised to 48. The gaps would then be reduced to 0·18 or 0·15 mm. each, and the primary capacity reduced to 18 or 15 jars. The whole object is to keep the gaps cool, and it has been found that a large primary capacity causes the gaps to heat. For small stations of, say, 5 kw., a primary capacity of, say, 50 jars can be used, the voltage being about 5,000. If a higher tension is used, the primary capacity must be reduced to keep the oscillatory current down to some limit proportionate to the number of gaps, so as to allow of the necessary cooling effect.

For ship stations only 20 jars are used, and 8 gaps are fitted of which 5 are worked, the others being regarded as spare.

Voltage is 5,000.

The voltage used should never exceed 1,000 per gap, and this figure is too high for the best working.

It was stated that the German rights for the Poulsen patents had been purchased by a German firm in Berlin, and that several field sets had been sold to the German army. It was also stated that most of the German field sets are Telefunken, and that the Poulsen sets are not a success on account of trouble in keeping the arc steady.

REPORT ON CLIFDEN AND POLDHU WIRELESS TELEGRAPHY STATIONS VISITED BY CAPTAIN CRAWLEY, R.M.A., ON 12TH AND 19TH AUGUST 1910.

CLIFDEN.

Aerial.

The aerial is exactly as reported in 1909. No extension has been made or commenced.

Earth.

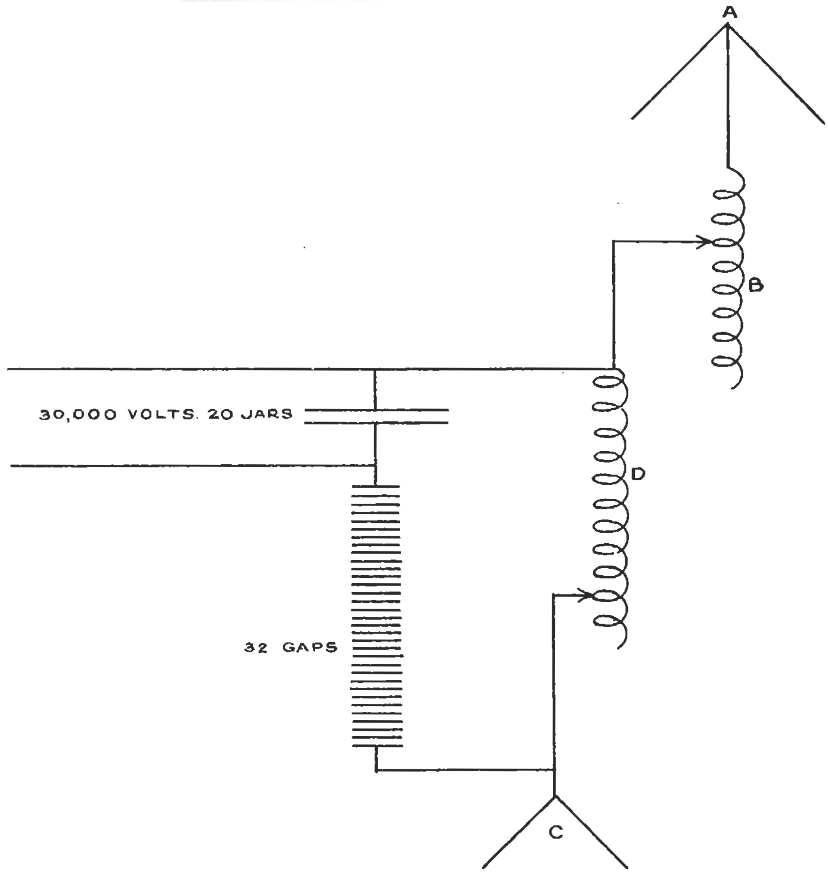
A number of galvanised iron wires, buried, have been added to the earth, and are laid out from the "*Receiving Hut*" end in the direction of the prolongation of the aerial. It was said that for reception an earth in this direction seemed important, but, for sending, an earth under the aerial was of greater importance. The whole earth is used for sending and for receiving.

Power.

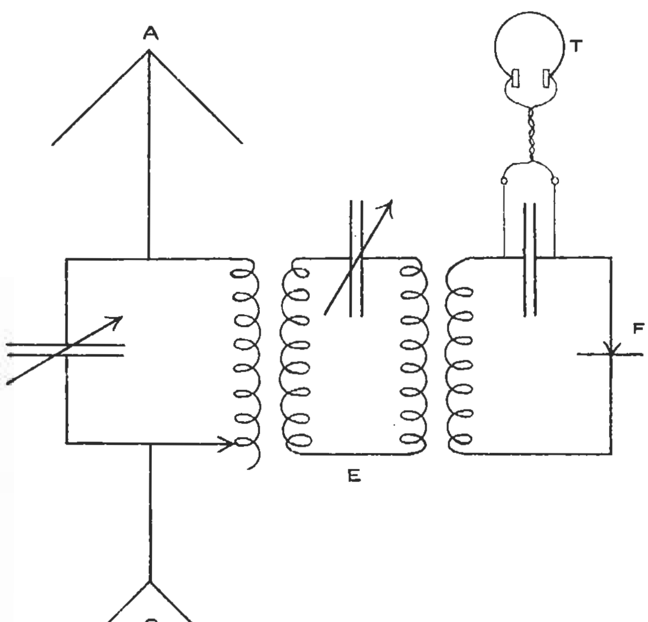
The power plant is as reported in 1909, but the A.C. plant is now looked on as an alternative only, D.C. from the cells being the primary arrangement. The 50 kw., 5,000 volts, dynamos, are now installed in the power-house, and are used for about 5 hours a day to charge up cells. The charging does not interfere with the working of the station. These dynamos are used for no other

CIRCUITS FOR TELEFUNKEN HIGH POWER SET AT FREEMANTLE.

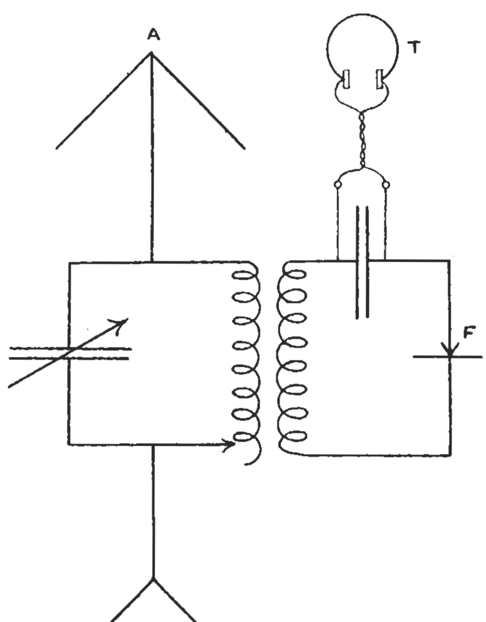
TRANSMITTING CIRCUIT.



SPECIAL RECEIVING CIRCUIT



ORDINARY RECEIVING CIRCUIT.



REFERENCE

A	AERIAL.
B	AERIAL TUNER.
C	COUNTERPOISE
D	PRIMARY INDUCTANCE
E	TUNED INTERMEDIATE CIRCUIT.
F	CONTACT DETECTOR (CIRCUIT, APERIODIC)
T	TELEPHONE

purpose than for charging the cells. The upkeep of the cells gives very little trouble. The dynamos are run by 175 h.p., 2,000 volts, single phase, induction motors, on the same shaft.

The battery gives 16,000 volts, and the current at the spark gap is about 17 ampères.

Turf is used as far as possible for fuel, and it is intended to install drying plant for the turf, as the difficulty of drying is the chief drawback to this fuel, which is otherwise satisfactory and inexpensive.

Condenser.

The condenser is as previously reported. A similar one, but smaller, with the plates as close as about 6 inches, is used at *Glace Bay*, where the arrangements are similar but rather less powerful than at *Clifden.*

On the whole, reception is better at *Clifden* than at *Glace Bay.*

Spark Gap.

The spark gap is that reported in 1909, but is now fitted with 6 copper studs, 3 inches by 1 inch at the sparking surface, and 5 inches long. The disc runs at 2,500 revolutions.

The sparking surfaces of the wheels are of copper.

The pressure formed by the revolution of the disc is no longer used as a blower for the key, as the extra load on the disc motor proved excessive.

Key.

The magnetic key, similar to that reported on in August 1909, forms a break in each of the high-tension charging leads.

The key really consists of two keys—one in each lead.

The surface of the copper contact pieces has been increased by having two arms with a contact on each of about ½ inch diameter.

The key was working very satisfactory without excessive sparking.

The blower motor supplied pressure equal to 8 inches head of water.

The speed of working was about 18 *words per minute*, but it was said that the key would be satisfactory up to 60 *words per minute.*

Earth Gap.

The aerial earth gap is still used. The gap is tested by the thickness of a piece of paper, and is frequently adjusted.

Oscillator.

The oscillator in use consisted of a primary of two rings similar to those reported on in 1909. The secondary, arranged to slide inside, consisted of turns of cable, the cable consisting of a number of wires laid on spirally over a rope core. The earth lead was similarly made up, and an oscillator, in use for experiments, was constructed on this principle. It appears that importance is attached to this matter, as it was stated that the cable for the oscillator had to be made to specification, and that there was considerable difficulty in obtaining it.

Wave.

The wave-length in use was 19,650 *feet*, which has proved so far, after many recent experiments, to be the most satisfactory.

The oscillator fitted in the alternative position was for about a 24,000-*feet wave.*

Experiments are not yet finished with regard to wave-length, and they seemed to point to a still further increase of length. It seems that some times, especially about dawn, there is a variation in the strength of signals ; that is, the signals go from strong to weak and from weak to strong in the same message ; the longer waves seem less affected, and experiments with long waves have taken up much time recently.

Reception.

Experiments to cut out atmospherics are still in progress, but apparently no great improvements on the arrangements described in Annual Report of 1909 have been arrived at.

Atmospherics.

The balanced circuit is still being used. The large inductance to earth is not now used, and it is said that the balanced circuit is giving excellent results.

Oscillation Valves.

The oscillation valve alone is used for reception, and it appears that there are very great differences in the sensitiveness of valves which look exactly similar.

The adjustments of potential is extremely critical and important. There are always two "best potentials" for a valve, and often more.

It was said that good valves have a long life, and that those in use had carbon filaments and had been in use continuously for the past three months.

On telephones in parallel with those of the operator, the strength of Glace Bay was 8, and the note excellent.

The circuit in Fig. 1 is the latest, but the older arrangement in Fig. 2 was in use.

Fig. 1.

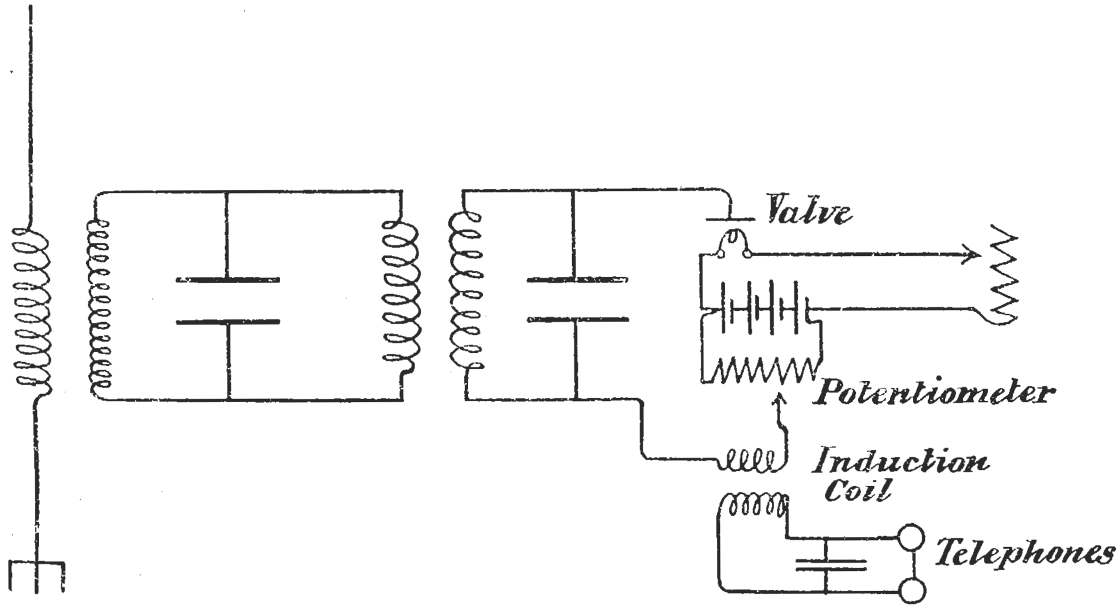
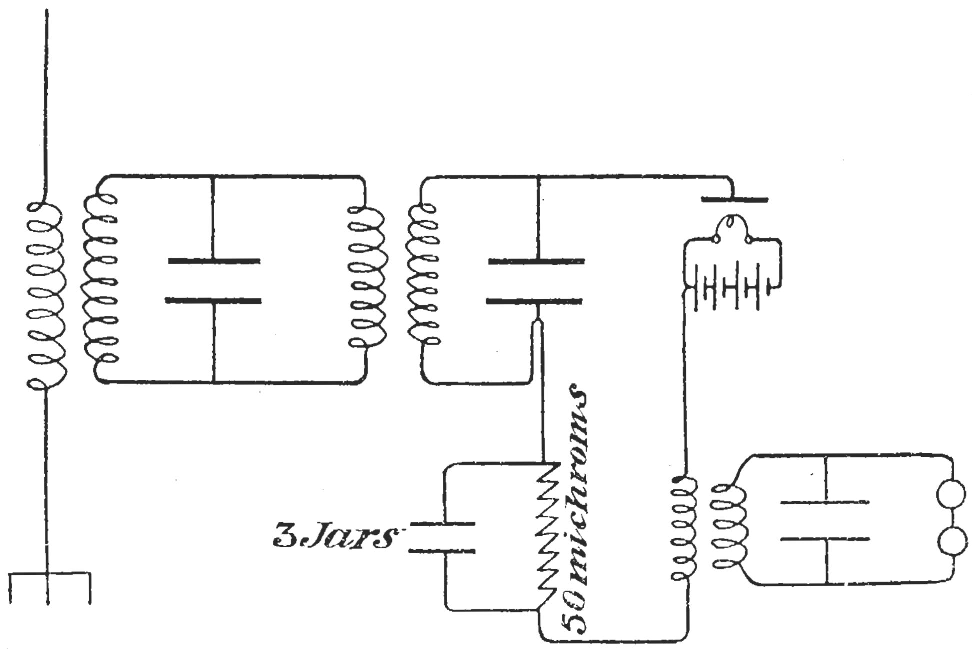


Fig. 2.



Einthoven Galvanometer.

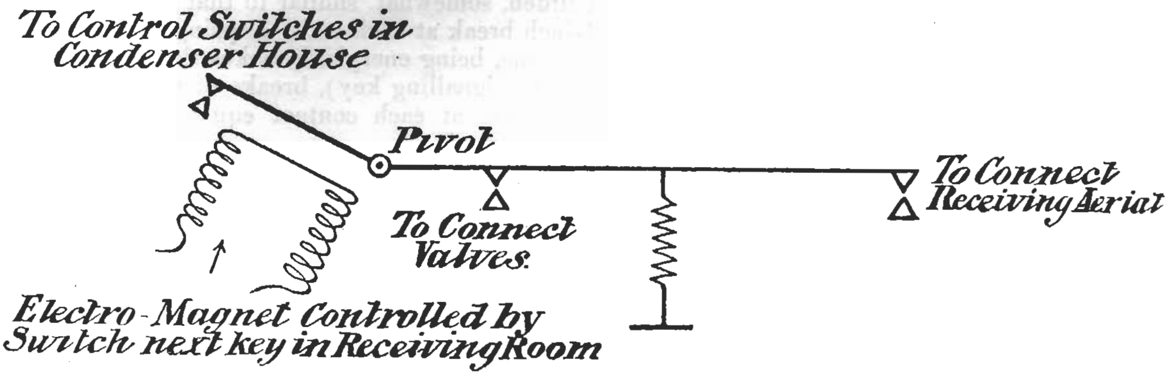
Some experiments have been carried out with the Einthoven galvanometer, but no attempt has been made to use it for commercial work, or even, apparently, to get photographic records. Signals are easily read with the galvanometer (from Glace Bay) by the deflection of the shadow of the wire on the screen, but the atmospheric difficulty is greater than when using telephones, and it is thought would be no better with the photographic record, as the high note would only increase the amplitude of the deflection in the same way as a strong atmospheric.

It is thought, apparently, that the only advantages would be the increased speed and the record, and that the necessity for these advantages is not pressing enough to justify extensive experiments at present.

Send-Receive Switch.

The transmitting gear was worked by a Morse key in the receiving room. The send-receive switch in this room is electrically operated and controlled by a switch next the sending key (*see* Fig. 3). In the receive position one set of mercury cup contacts connect up the receiving aerial, another set connect the valve, and a third set (copper contacts) breaks a circuit which controls two solenoid switches in the condenser house. These switches are in series with the magnetic key, one in each lead, and are also controlled by a switch in the condenser house, so that it is impossible to send unless this latter switch is made by a man in the condenser house.

FIG. 3.



Duplex Working.

It was said that no advance had been made in the last year with regard to duplex working, and the "foundations for the commutators," noted in last year's Reports, are the only signs of the system.

Sparkless System.

No further information with regard to the "Small Power Sparkless System" could be obtained, but it was said that, so far as was known, no sets of this sort had been fitted.

Traffic.

The average traffic at present is about 15,000 words a week, the possible traffic with present arrangements being estimated at 6,000 a day.

The station was working continuously during the visit, *i.e.*, forenoon of the 12th August 1910.

Experiments.

The experiments at present in progress are with a view to reducing atmospherics, and the variation in strength of signals, referred to above.

Coltano.

The station at Coltano is said to be on the same lines as Clifden, and is expected to commence work shortly.

POLDHU.

Aerial.

The aerial is as described in Annual Report, 1908.

Earth.

In addition to the earth arrangements, reported in February 1908, a number of galvanised iron plates have been buried close to the transmitting house under the aerial.

Power.

The power plant is as described in Annual Report, 1909.

Transformer.

The four 50-kw. transformers are used: primaries in parallel, secondaries in parallel. The nine smaller transformers are not used at all.

Condenser.

The condenser consists of Poldhu pots arranged three in series, total capacity 1·8 m.f. The connections have been improved, copper strips being used throughout except for connecting the pots together, for which purpose "bare aerial" is used.

Chokers.

The main chokers are as previously reported.

Spark Gap.

The disc spark gap is as previously reported, but the disc is fitted with six cylindrical copper studs of 1½ inches diameter, and is driven at 2,400 R.P.M. by a 5-h.p. motor; the wheels, which spark to the studs, revolve at 10 R.P.M.

Key.

The magnetic key is one formerly used at Clifden, somewhat similar to that reported on in August 1909. The contacts are copper, with a 1-inch break at each end ; a spring keeps the key in the safe position, and the coils are arranged so that one, being energised, makes the contacts, and the other, being energised (by the back contacts on the signalling key), breaks them. The key is fitted horizontally, and the blower supplies an air blast at each contact equal to a pressure of 4½ inches of water.

Oscillator.

The primary consists of one ring exactly similar to those described in Reports on Clifden, 1909. The wire is 7/18 cotton insulated. The secondary, wound on a 4 feet diameter wooden former, is arranged to slide inside the primary, and is fixed for a 3 per cent. coupling.

Reception.

No arrangements are made for reception.

Wave.

The wave-length is 9,000 feet, with a 3 per cent. coupling, and is never altered.

Times of Sending.

The daily press messages and messages for ships are sent twice at about 15 words per minute, between 1 and 3 a.m. every morning ; no signals are sent at other times.

Range.

The range for good ships is about 1,900 miles.

Staff.

An Engineer in charge, an Assistant Engineer, two Operators, and a working party (stokers, labourers, &c.) form the staff.

Experiments.

The station is well kept, connections, &c. are now good ; in fact, the arrangements altogether are more standardised than formerly, and no experiments are carried out.

Cape Cod.

Cape Cod station does the same work as Poldhu, is similarly fitted, but is rather less powerful. There seems to be no immediate intention of altering these stations.

SPARK PHOTOGRAPHY.

Captain R. ff. Willis, R.M.L.I., has carried out a large number of most interesting and valuable experiments in Spark Photography at the High-Power Station at Cleethorpes. By means of a specially constructed camera he has been able to photograph each individual spark which passes while the condenser in the primary circuit is discharging. An actual record of what happens under various conditions of the primary and aerial circuit is thus obtained. The film shows the frequency, coupling, duration of spark group, duration of total spark train, &c., thus affording visible confirmation of theoretical results and opening up a new means of research in wireless telegraphy. The method used and the results obtained are outlined in the following report received from Captain Willis. A similar camera is being constructed for use at Horsea.

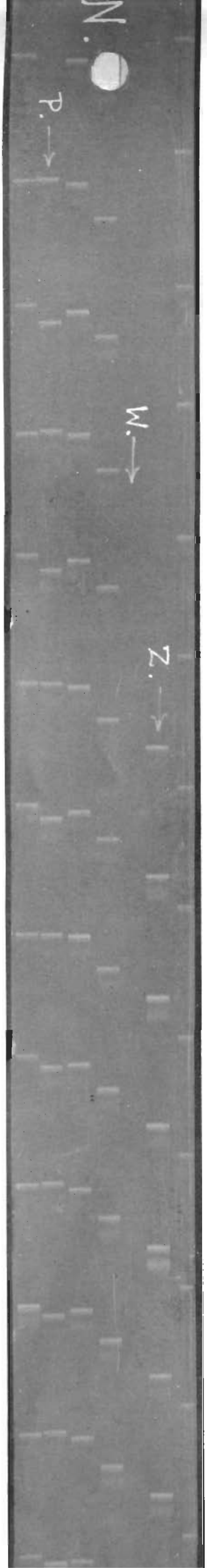
Work done with a Spark Recording Camera at Cleethorpes.

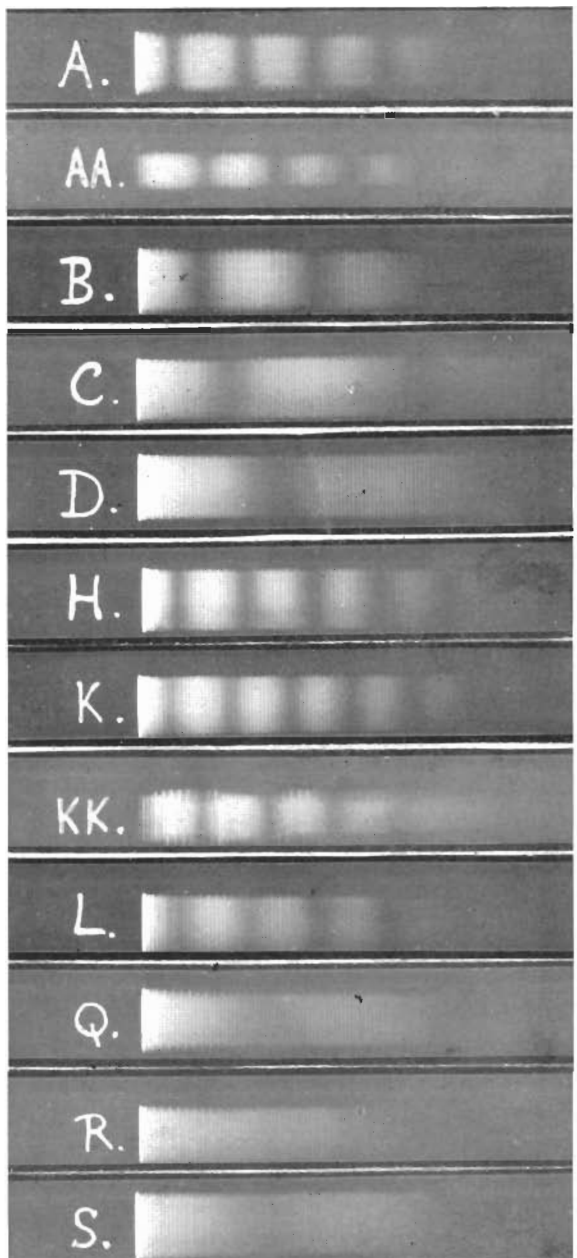
The work of constructing an experimental camera, with an 18-inch diameter wheel, was commenced at Cleethorpes in December 1909, and the first record was taken February 5th, 1910 ; this and subsequent records obtained from it warranted the construction of a larger camera, of a more permanent type, consisting of a 36-inch diameter wheel running on ball bearings and firmly held in an iron stand of heavy construction, the base of which has been bolted down to the concrete floor of the Transmitting Instrument Room, and records were obtained with the new camera in September 1910.

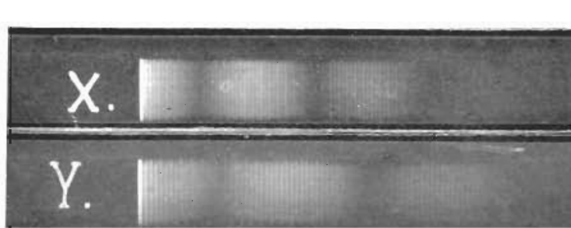
This camera has two extensions (carrying the lens and slit) for high and slow speed work, and with the former arrangement the wheel revolves normally at 2,370 R.P.M., and carries a photographic film 111 inches long by ½ inch wide ; with the second arrangement the wheel revolves at 246⅔ R.P.M. and carries a film 112½ inches by 1⅜ inches ; the first arrangement is for the actual exploitation of a train of sparks, and the second is for recording the number of such trains of sparks and the intervals of time occurring between each train ; again with the first arrangement the film lying on the perimeter of the wheel is allowed to pass in front of the uncovered lens only once, whereas in

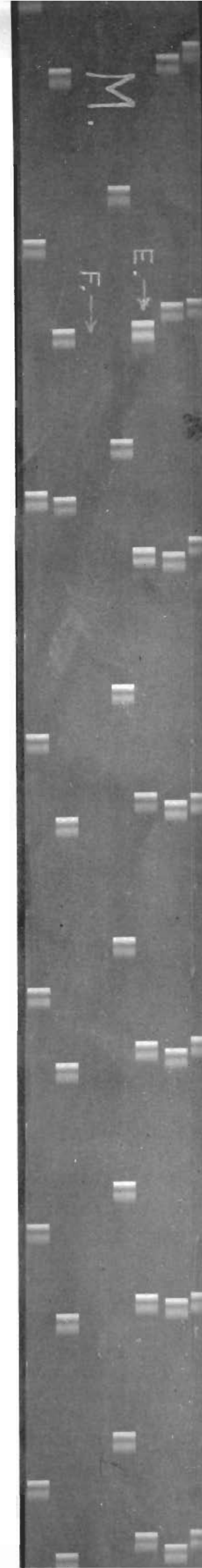
SPARK

PHOTOGRAPHY.









the second case it passes seven times, which permits of a full letter signal being recorded in a spiral form round and round the wheel, the exposure for this latter work being timed for about 2 seconds.

The "high-speed" record gives—

(1) Duration of each train of sparks in the primary circuit.
(2) Number of actual sparks in each train.
(3) Wave-lengths of the two radiated waves and of the common wave.
(4) Percentage of the coupling between the primary and secondary circuits.
(5) Accuracy of the tuning of these circuits with each other.
(6) Value of any alterations for the improvement of the transmitting arrangements.

The "slow-speed" record gives—

(1) Number of trains of sparks occurring per second.
(2) Intervals between the commencement of successive trains.
(3) Possibility of obtaining a high musical note.
(4) Cause of a note being variable or broken.

The general arrangements are that the primary spark is allowed to illuminate a fine horizontal slit cut in thin ebonite sheet, and this slit is brought to a focus through a cinematograph lens on to the photographic film, which is attached to the rim of the revolving wheel and is moving in a vertical direction when the impression is received; thus causing a line to be recorded across the film for every spark.

In the high-speed records each spark is recorded by a separate and clearly defined line, and as the frequency of "X" wave is 100,000, these lines will be shown on the film as occurring at the rate of approximately 200,000 per second; and in the case of "Y" wave, where the frequency is 82,000, the rate of lines will be recorded as approximately 164,000 during the time that the primary condenser is discharging itself backwards and forwards across the spark gap.

On Plate XIV. are shown prints taken from actual film records made under varying conditions of spark length, transformer primary voltage, and coupling.

"Prints," however, do not give the amount of definition and detail shown on the original "films," and consequently all measurements and calculations are made direct from the latter.

Prints marked X and Y show a comparison between a train of sparks from an "X" and "Y" wave-length record respectively, spark length being 10 mm., transformer primary voltage 500, and coupling about 7 per cent. in each case.

It has been observed that for coupling percentages below $12\frac{1}{2}$ per cent., the percentage that the difference between the frequencies of the long and short radiated waves bears to half the sum of these two frequencies (*i.e.*, to the mean frequency) is actually equal to the "coupling percentage" of the two wave-lengths; and also that for coupling percentages below $12\frac{1}{2}$ per cent., the *spark* frequency is equal to the sum of the frequencies of the two radiated waves very nearly.

If f_1 = frequency of the long wave radiated,
and f_2 = frequency of the short wave radiated,

$$\text{then coupling percentage} = \frac{100\,(f_2 - f_1)}{\frac{1}{2}\,(f_2 + f_1)} = \frac{200\,(f_2 - f_1)}{(f_2 + f_1)}$$

and spark frequency $= (f_2 + f_1)$.

Also the time represented by the length of film from the middle line of one dark interval to the middle line of the next dark interval (which is hereafter called "one group") in the train of sparks must obey the formula—

$$\text{Time} = \frac{1}{(f_2 - f_1)}.$$

Therefore, in the X photo, by measurement it is found that one such group of sparks in the train occupies ·6 inch in length of film, and therefore—

$$\frac{1}{(f_2 - f_1)} \text{ is represented by } \cdot 6 \text{ inch of time.}$$

Also by measurement it is found that 32 individual sparks occupy ·7 inch, and therefore—

$$\frac{1}{(f_2 + f_1)} \text{ is represented by } \cdot 7/32 \text{ inch of time,}$$

$$\text{and, therefore, coupling percentage in X} = \frac{200\,(f_2 - f_1)}{(f_2 + f_1)} = \frac{(200 \times \cdot 7)}{(32 \times \cdot 6)} = 7 \cdot 29 \text{ per cent.}$$

Coupling percentage observed with wavemeter = 7·7 "

Similarly in the Y photo one group of sparks occupies ·78 inch, and, therefore—

$$\frac{1}{(f_2 - f_1)} \text{ is represented by } \cdot 78 \text{ inch of time.}$$

Also 30 individual sparks occupy ·8 inch, and, therefore—

$$\frac{1}{(f_2 + f_1)} \text{ is represented by } \cdot 8/30 \text{ inch of time,}$$

$$\text{and, therefore, coupling percentage in Y} = \frac{200\,(f_2 - f_1)}{(f_2 + f_1)}$$

$$= \frac{(200 \times \cdot 8)}{(30 \times \cdot 78)}$$

$$= 6 \cdot 84 \text{ per cent.}$$

Coupling percentage observed with wavemeter = 7·7 ,,

It will be seen in the above calculations that there is no necessity for knowing the speed of the wheel, and that coupling percentages can apparently be calculated with a much greater degree of accuracy and certainty than with the wavemeter.

The comparison between X and Y, showing measurements from the film and calculations to be made from such measurements, may be tabulated as follows :—

Detail.	Measured or calculated.	X.	Y.
Total length of film (circumference of wheel)	M.	111 inches	111 inches
Speed of wheel by tachometer—			
R.P.M.	M.	2,370	2,370
Time for 1 inch of film	C.	$\frac{1}{4384}$ second	$\frac{1}{4384}$ second
Duration of total spark-train	M.	2 inches	1·9 inches
Duration of spark-group, $1/(f_2 - f_1)$	M.	·6 inch	·78 inch
Difference between wave frequencies, $(f_2 - f_1)$	C.	7,300	5,600
No. of sparks in 1 inch	M.	45·7	37·5
No. of sparks in each train	C.	91	71
No of sparks per second, $(f_2 + f_1)$	C.	200,400	164,400
Frequencies of radiated waves—			
Long, (f_1)	C.	96,550	79,400
Short, (f_2)	C.	103,850	85,000
L.S. of radiated waves—			
Long	C.	2,452	3,627
Short	C.	2,118	3,163
L.S. of common wave (*i.e.*, mean L.S.)	C.	2,285	3,395
Wave lengths of radiated waves—			
Long	C.	10,202	12,403
Short	C.	9,485	11,582
Wave length of common wave	C.	9,850	12,000
Coupling percentage	C.	7·29 per cent.	6·84 per cent.

Prints marked A, B, C, and D have been given to show the effect of varying the coupling whilst other conditions remain unaltered, spark length being 10 mm. and transformer primary voltage 350.

By measuring the film it is found that A has a 12 per cent. coupling, B 7·3 per cent., C 4·9 per cent., and D 3·2 per cent.

Coupling percentages observed with the wavemeter gave A 11·1 per cent. coupling, B 7·7 per cent ., C 5 per cent., and D 3 per cent.

Prints marked H, K, and L show the marked effects of bad tuning ; these have all been taken under the same conditions as A, except that in H one turn (*i.e.*, 7½ mics.) was taken off aerial coil, in K two turns (15 mics.) off, and in L two turns (16 mics.) were added so as to purposely throw the tuning out.

It will be seen that the sparking is continuous between the 1st, 2nd, and 3rd groups of sparks in K and L ; K also shows a tighter coupling, but this is probably due to the coupling co-efficient $\frac{M}{\sqrt{L_1 L_2}}$ being increased.

Prints marked Q, R, and S have been taken under the same conditions as D, except that in Q half a turn (4 mics.) was added to the aerial coil, in R one turn (8 mics.) added, and in S one turn (7½ mics.) taken off.

This further illustrates the effect of bad tuning, and shows that for loose couplings of 3 per cent., even with half a turn out on the aerial coil, very little energy goes into the secondary circuit, and demonstrates the importance of accurate tuning when using such loose couplings.

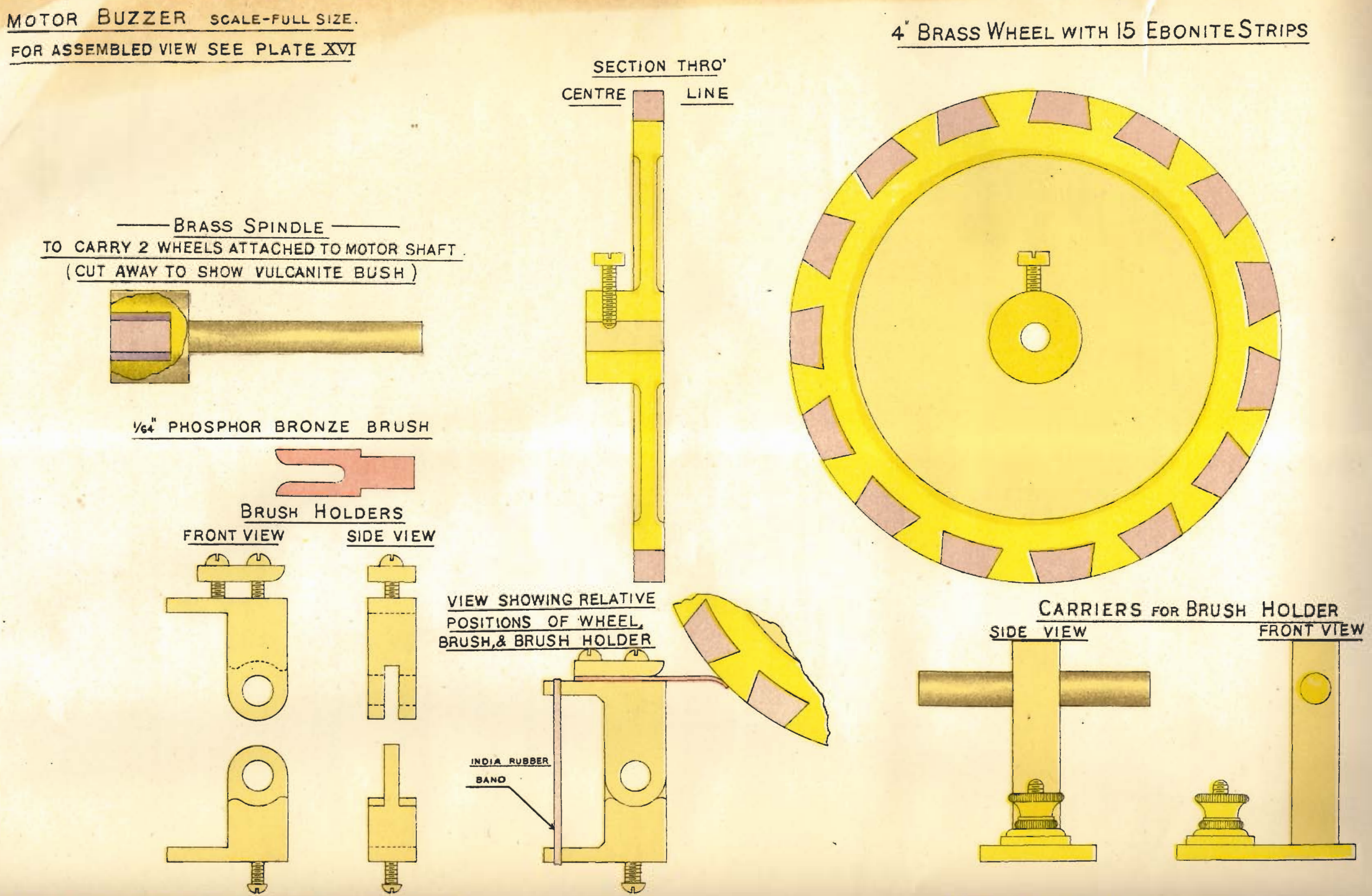
It further shows that the accuracy of tuning can at any time be definitely checked by taking loose coupling photographs.

Prints marked AA and KK are the same as A and K, except that they are taken of a small spark gap placed in the secondary circuit.

It is interesting to note that primary trains of sparks begin with a half-group period of sparks, and that the secondary trains begin with a whole group, and that the latter sparks are at full brilliancy when the former are nearly suppressed, and *vice versâ*.

KK is, of course, very much upset by the bad tuning.

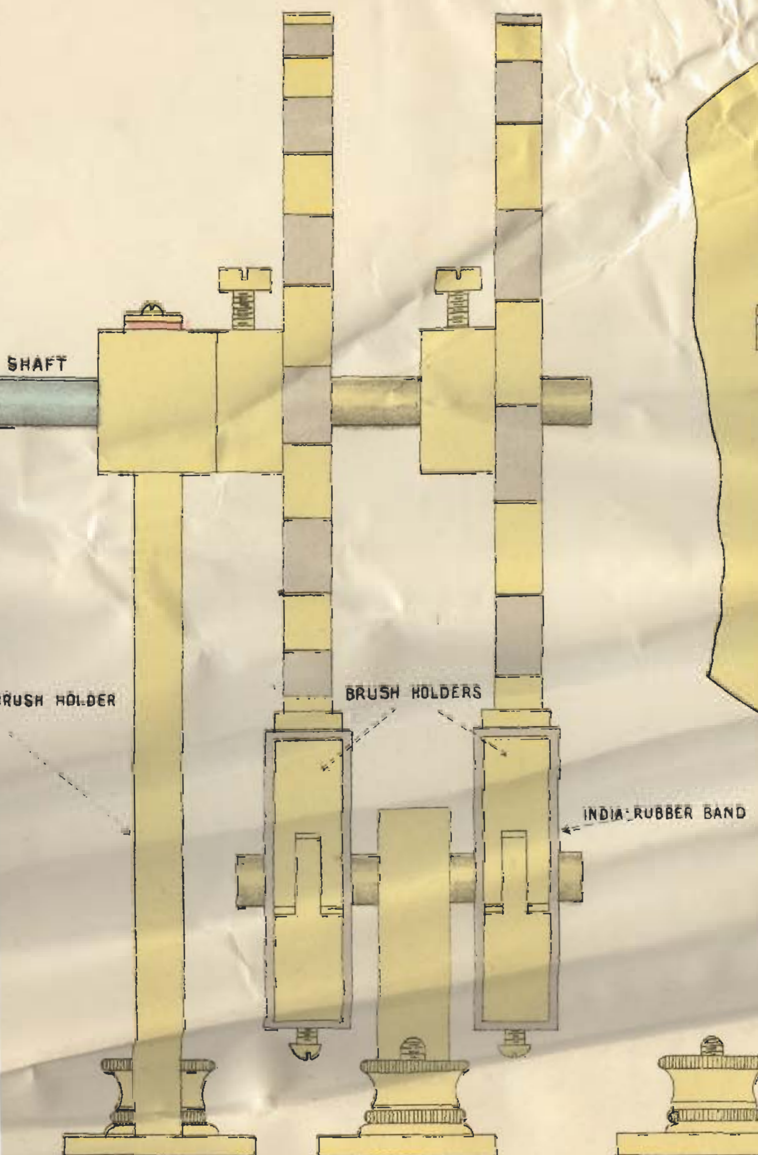
Prints marked M and N are 12-inch lengths only out of the 112½-inch "slow-speed" photographs, and record numbers of trains of sparks occurring per second, and intervals between the commencement of successive trains.


MOTOR BUZZER SCALE-FULL SIZE.
FOR ASSEMBLED VIEW SEE PLATE XVI
4" BRASS WHEEL WITH 15 EBONITE STRIPS
SECTION THRO'
CENTRE LINE
BRASS SPINDLE
TO CARRY 2 WHEELS ATTACHED TO MOTOR SHAFT.
(CUT AWAY TO SHOW VULCANITE BUSH)
1/64" PHOSPHOR BRONZE BRUSH
BRUSH HOLDERS
FRONT VIEW
SIDE VIEW
VIEW SHOWING RELATIVE POSITIONS OF WHEEL, BRUSH, & BRUSH HOLDER
INDIA RUBBER BAND
CARRIERS FOR BRUSH HOLDER
SIDE VIEW
FRONT VIEW

MOTOR BUZZER

FOR FURTHER DETAILS SEE PLATE XV.

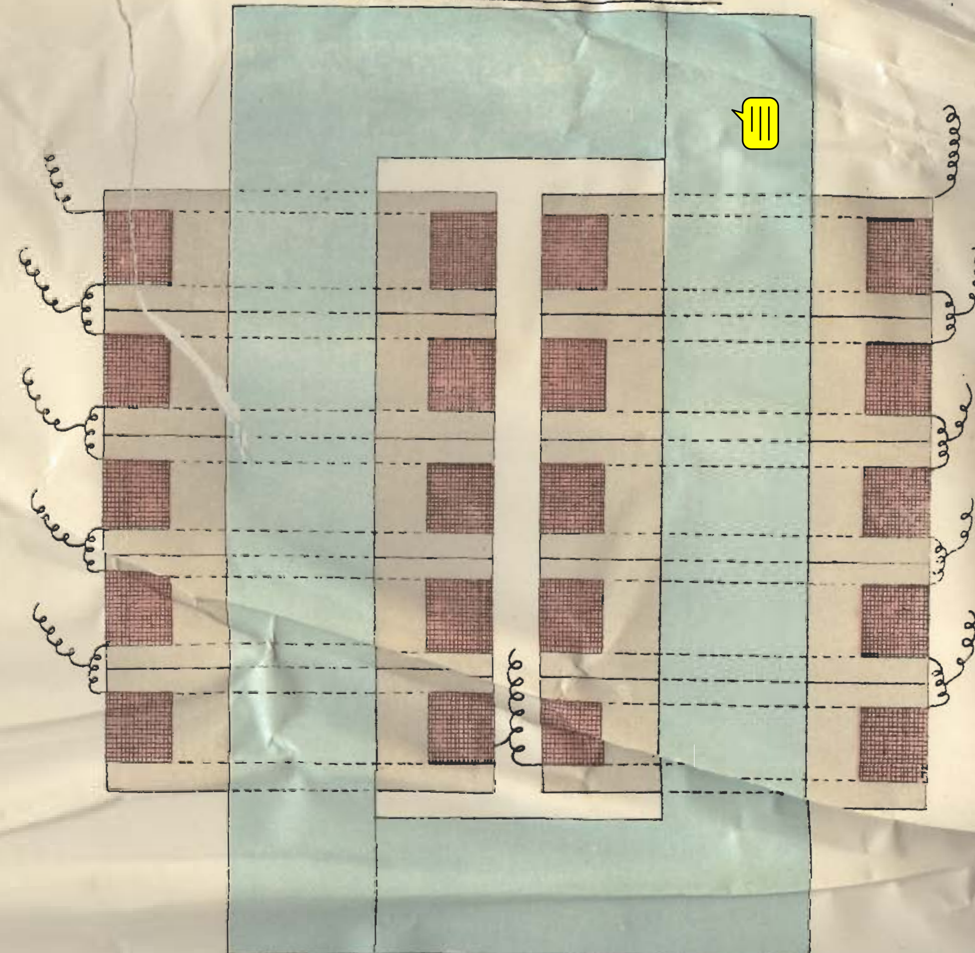
SCALE: FULL SIZE

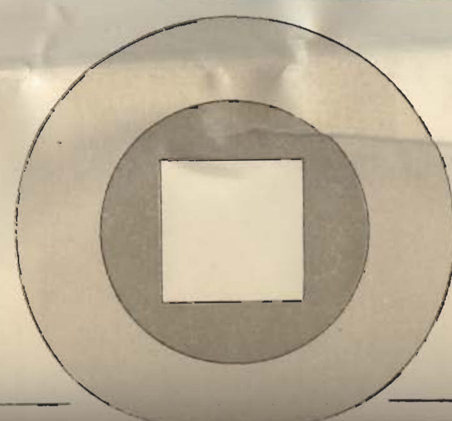


SIDE VIEW SHOWING 15 & 12 STRIP WHEELS, AS MOUNTED COMPLETE WITH BRUSHES, SPINDLE & BRUSH HOLDERS

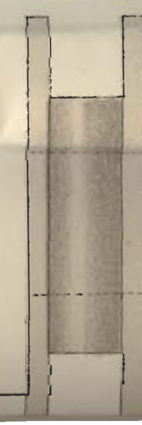
FRONT VIEW OF CENTRE BRUSH & HOLDER

IMPEDANCE COIL





SECTION OF EBONITE BOBBIN



SIDE VIEW OF EBONITE BOBBIN

A complete letter "D" (▬ • •) is twice recorded spirally round each film, of which only an extract is here shown. A comparison between the two photos is given as follows:—

—	M.	N.
Wave length	9,800 feet	12,000 feet
Length of spark	8 mm.	3 mm.
Transformer primary voltage	500	500
Coupling percentage by wavemeter	5 per cent.	5 per cent.
Total length of film (circumference of wheel)	112½ inches	112½ inches
Speed of wheel by tachometer (R.P.M.)	246⅔	246⅔
Average No. of trains per second	250	500
Average distance on film between sparks	1·85 inches	·925 inch
Whether note was high or low musical (as heard at Gibraltar)	Low	High
Whether note was variable or broken	Broken sometimes	Steady

In M print, E marks the commencement of a "short" consisting of 21 trains of sparks, and F marks a blank interval when key was not pressed.

In N print, P marks the commencement of a "short" consisting of 41 trains of sparks, W marks a blank interval when key was not pressed, and Z marks the commencement of a "long."

It is suggested that the work done with such spark-recording apparatus is still in its initial stage, only portraying some of the possibilities and opening the door to a new field of W.T. research.

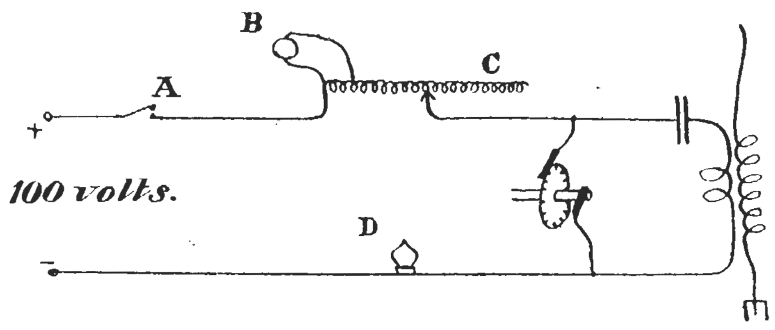
REPORT ON MOTOR BUZZER DESIGNED BY LIEUT. J. K. IM THURN, AND USED IN H.M.S. "DREADNOUGHT."

The motor buzzer described in the following report had been in constant use in the "Dreadnought" for three months before the Annual Report of Torpedo School, 1909, was received. On page 48 of W.T. Appendix to that report a description of a similar buzzer, with which Mr. Marconi was experimenting, is given.

The buzzer in use in "Dreadnought" was designed primarily to get over the difficulties experienced in obtaining a good note and strong signals from the Service type of buzzer. It consists essentially of a motor-driven commutator revolving at such a speed that the circuit is broken 350 to 500 times a second, according to the note desired.

The electrical connections of the circuit are shown in Fig. 1.

FIG. 1.



A = Key,
B = Telephone receiver.
C = Variable inductance.
D = 50 or 100 c.p. lamp.

Details of the various parts of the buzzer are shown to scale in Plates XV. and XVI.

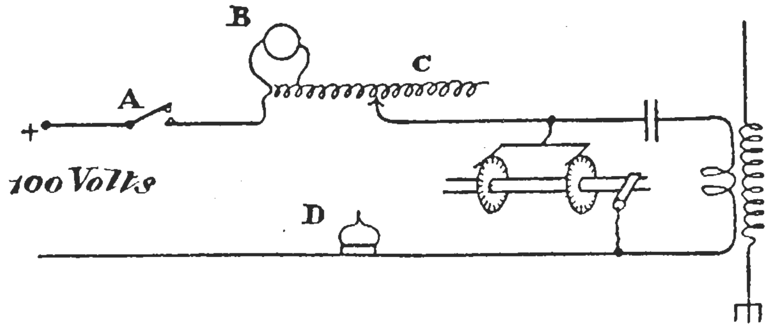
In the first buzzer of this type, a 3-inch wheel, with 12 ebonite strips, was attached to a table fan motor, but a series type of motor was found unsatisfactory on account of its variations of speed, and a G.M. type ¼ H.P. shunt motor was obtained from Messrs. Siemens and substituted for it. When this wheel was run at 1,800 revolutions, a very clear note was obtained of about the same pitch as Service Mark II.

As it was then thought that a double note, consisting of one note and its first harmonic, might be easier to read through interference, a second wheel, having 15 ebonite strips, was attached to the same spindle as the first wheel. The resulting note was compared to Mark I*., but apparently much more power was used than with one wheel, and signals were consequently stronger.

Using one wheel, "Dreadnought" has worked all day with a ship 20 miles off, and, with two wheels, signals have been intercepted all day at a distance of 40 miles.

The arrangement with two wheels is shown on the left in Plate XVI., but here the wheels are of equal diameter. The electrical connection with two wheels are similar to those for one, *vide* Fig. 2.

FIG. 2.



A = Key.
B = Telephone receiver.
C = Variable inductance,
D = 50 or 100 c.p. lamp.

The impedance coil contains a core made up of transformer stampings—$\frac{3}{4}$ inch × $\frac{3}{4}$ inch in cross-section. It is wound in 10 sections on ebonite bobbins, all 10 sections are connected in series; each section is also joined to a stud on a variable switch, so that any number of sections may be put into circuit. The impedance of this coil is not known, but the winding is 24 L.S.G., and total resistance 30 ohms.

For long distances the whole of the impedance coil is used, but, for shorter distances, signals can be reduced in strength by reducing the impedance. As no sound can be heard when signalling with this buzzer, it was found necessary to permanently join up a telephone receiver across one bobbin of the impedance coil, in order to check the quality of the note.

At first, a certain amount of difficulty was experienced in obtaining a clear note. This was eventually traced to the use of too stiff a brush, and, finally, a brush consisting of $\frac{1}{64}$-inch phosphor-bronze was found suitable and adopted.

This buzzer has been in constant use in "Dreadnought" since January last, and gives absolutely no trouble; the wheels are lightly skimmed down occasionally at intervals of about one month, and the brushes will last through two days' heavy work—it is, however, a matter of a few seconds only to replace a worn brush by a new one.

It was found by trial that apparently no advantage was gained by inserting inductance into both leads feeding the commutator, hence, it being more convenient to place it in one lead only, one inductance only is used.

It is thought that with a more efficient impedance coil, *e.g.*, one designed with greater regard to theory, and with a higher voltage than the 100 obtainable in "Dreadnought," this type of buzzer would prove more powerful. Even in its present form it has saved much wear and tear to the alternators and condensers, and has given far less trouble and a better note than the new Service type.

It is further observed that, if necessary, a small mica condenser could be substituted for the present Mark II. Service condenser without weakening signals.

Extracts from "Vernon's" Remarks.

It is proposed to experiment with commutator systems on somewhat similar lines, in connection with the improved short-distance sets.

It is considered very possible that some such system may prove most useful for this purpose.

2. It may prove desirable at a later date to bring out a new instrument on this principle to supersede the present "buzzer transmitter," but as the latter instrument appears to meet requirements at present it is not considered desirable to further complicate the store question or to expend time that can ill be spared from other work on bringing out such a design now.

3. It would appear desirable to protect this invention by secret patent if possible, but in this connection it is necessary to consider the position of the Admiralty as regards the Marconi Company, observing that while Lieut. im Thurm brought out this invention quite independently, the idea was mentioned to Admiralty representatives by Mr. Marconi as far back as May 1909, during a visit to Clifden, and was referred to in Annual Report of 1909 (W.T. Appendix, page 48). It is suggested that Mr. Marconi be informed that the idea has been brought out independently by a naval officer, and that unless Mr. Marconi has patented or intends to patent the invention the Admiralty propose to protect it.