REPORT OF INSPECTION OF MARCONI COMPANY'S WORKS AND WIRELESS TELEGRAPHY STATIONS.

In accordance with Admiralty Letter G. 11124/13520, dated the 15th September 1903, the following officers visited the Marconi Company's Works at Chelmsford, and their Wireless Telegraphy Stations at Niton and Poldhu.

Captain H. B. Jackson, R.N., F.R.S., H.M.S. "Cæsar."

Lieutenant (T.) C. R. Payne, R.N., H.M.S. "Vernon."

Lieutenant (T.) F. G. Loring, R.N., Naval Reserves.

The result of the inspection is shown in the following report.

H.M.S. "Cæsar," at Portsmouth,
29 *September* 1903.

SIR,

In compliance with Admiralty Letter G. 11124/13520, 1903, we have the honour to report as follows on our visit to the Marconi Company's Wireless Telegraphy Stations at Chelmsford, Poldhu, the Lizard, and Niton, observing that, as far as possible, technical details have been dealt with in appendix to this report.

(1.) Long distances station at Poldhu.

The work here recently has been limited to experiments with a view of finally settling on the best design of the installation for maintaining continuous communication with the Company's Canadian and American long-distance stations; it having been evident to the Company that the signals previously transmitted, both ways, were not sufficiently powerful and reliable to ensure commercial success, and the details of the transmitting apparatus were also liable to continued breakdown, owing to want of experience in designing such novel apparatus. These difficulties seem now to have been overcome, according to the statements of the Company's technical advisers and directors, and the most recent alterations, which were fully described and demonstrated to us, have enabled the details of an improved design to be settled, and it is anticipated that the station will soon be in good working order.

The details of the receiving apparatus, required by these recent alterations of the transmitter, are known only to Mr. Marconi, who intends returning to England early in October. Till his return the Company are unable to provide the receiving jiggers best fitted to the existing transmitter at Poldhu.

These jiggers will be easily applied to our Service installations at small cost, and we recommend that the Company be asked to supply ten of them, with instructions as to aerial wires, as soon as they are in a position to do so, and that these be issued for trial and report to "Vernon," Dover, Gibraltar, one each, and two each to Home, Channel, Mediterranean, Cruiser, and West Indies (one for Bermuda) Squadrons, and that signals then be sent out at pre-arranged times from Poldhu as arranged for in the contract with the Company, so that a practical trial may be made of the station for Naval purposes.

(2.) We are of opinion that the Company have been wise in continuing their experiments at Poldhu instead of attempting commercial signalling with apparatus not quite fully developed, and we consider that this station will shortly be a practical and useful one for the work for which it was designed, and our inspection has greatly impressed us with the boldness of the inventor's conception and the ingenuity of the design, in which new theoretically electrical problems have been brought out into a practical form in less than three years from their conception, in spite of the opinion expressed by many of the most scientific men of the age as to the impossibility of successfully solving the problem.

(3.) Wireless Telegraphy work for ordinary ship purposes.

The difficulties which the Company have had in developing their original untuned system into a tuned one are similar to those experienced by us in the experimental work carried out in His Majesty's Service with a similar object, but they have now succeeded in greatly improving their system and closely approaching the desired object, by dint of perseverance combined with the best expert knowledge obtainable, and by utilising a number of stations and large staff solely occupied in carrying out the necessary experiments. This subject is dealt with more fully below.

(4.) They have also improved the common-place details of their receiving and signalling keys, and remedied many of their original defects, and we see no objection to the introduction of the Company's new patterns into the Service (for Shore Stations particularly), except that they will introduce a few more store articles; if, however, the original 32 sets of receivers are to be brought up to date by the Company, so that all details of the Marconi sets are of the same pattern, this objection would no longer exist, and we recommend that the Company be asked if they will undertake this work, which would apparently not involve a heavy expenditure.

(5.) Another new feature the Company have recently introduced into some of their Shore Stations is a small dynamo (1½ h.p.) driven by a petrol engine, for charging their accumulators, in lieu of using primary batteries for this purpose. We consider this a great improvement, as it would result in greater efficiency, and also in economy, for though the prime cost of the dynamo and engine would be greater than the batteries, their life would probably be 10 times that of the latter, and the dynamo can be used for lighting the station by electric lamps in lieu of fitting gas in it, or candle lighting, and the attention required to the engine is within the capabilities of a torpedo instructor.

(6.) 5-h.p. installation, worked by a dynamo and engine, are also being erected by the Company, and have a practical range of about 500 miles. We consider that these would be of great strategical value in certain positions, such as Dover, Gibraltar, Malta, and possibly Hong Kong and Bermuda, and the question of their introduction should not be lost sight of for isolated important Naval centres, nor the fact that they can probably be fitted in large warships.

(7.) The masts erected by the Company at their Shore Stations appear lighter and cheaper than those erected by our Dockyards. At the same time they are better stayed to resist heavy gales, and the insulation applied to the rigging is also an advantage electrically. Their Shore Stations "earth" are worth attention on account of their apparent economy.

(8.) The Company seems to possess a well-organised staff and system, and to be ruled by a firm hand. Their ordinary operators are probably better electricians and telegraphists, but, owing to their youth, less experienced men than ours, especially in maritime matters, and economy is evidently a great consideration in all but experimental work, in which very skilled electrical engineers are employed. The work carried out by the Company in maritime signalling and sea telegraphy is becoming large and increasing, and is evidently a bonâ fide business; and a thorough and complete understanding between them, Lloyd's, the Board of Trade, and the Admiralty seems to us imperative, and to the interest of all departments.

This particularly concerns the number and positions of Wireless Telegraphy Stations on our coasts, especially in the Channel, where the number now erected seems in excess of all maritime requirements; for instance, round Portsmouth there are three, viz., Haven (Poole), Niton, and Culver, whereas one would suffice, and Niton appears to us the most suitable one, but a station near Beachy Head, to fill up the gap between Niton and Dover, might well be established. Near the mouth of the Thames there are three, viz., Dover, North Foreland, and Felixstowe, the second one of which might well be abolished. There are also other Marconi stations in the vicinity.

(9.) The installation at Porthcernu also may become detrimental to our interests, being, as it is, in the hands of persons openly inimical to the Company, whose interests it is now our best policy to safeguard, but owing to the want of legislation on the subject, we are at present powerless in the matter, though the development of the tuned system will evidently render it more difficult than formerly to ascertain if new stations are being erected on our coasts, with a view of communicating with a possible enemy. This matter appears to us of great importance, and deserving of serious consideration.

(10.) We consider our visits have been of great value in showing to us that the Company are really endeavouring to perfect Wireless Telegraphy in all its details, and that their business is developing and is well managed and a bonâ fide one, and when their long-distance stations are finally completed, their financial success may be assured, and it must be noted that this work has been done in face of the most determined opposition of those whose vested interests are threatened by the success of the system. Much valuable technical knowledge has also been obtained by the Company.

(11.) Regarding the Syntonic System of Wireless Telegraphy for ship work, designed and now being manufactured by the Company, it may be stated that it has the following advantages and disadvantages compared with the existing untuned system in H.M. Service.

Advantages.

(*a.*) Not interfered with at moderate distances by any station not transmitting signals with a similar or nearly similar wave length.

(*b.*) Insulation of aerial wire is a secondary importance, and enabling signals to be sent when this insulation is faulty.

(*c.*) More reliable at extreme ranges of signalling.

(*d.*) Less strain is brought on the induction coil, though more power is got out of it.

Disadvantages.

To get the best efficiency for transmitting, a different aerial wire should be used with each tune.

Slightly increased cost, and extra space required in office for the apparatus.

(12.) After a short experience, probably less skill is required on the part of the operators with the tuned than with the untuned system, and at special tuning, trials on fitting out appear necessary, the Company stating that they can supply the apparatus complete to fit any particular and suitable aerial wire adopted.

They are now manufacturing two sets of apparatus, called Tunes "A" and "B"; the former A is fitted or being fitted to all their Shore Stations and merchant ships; the latter is specially supplied to some for extra long distance signalling, and is less affected by screening from masts, funnels, and land than A, but as regards interference from untuned stations and atmospheric effects, is less satisfactory.

The efficacy of A tune was fully demonstrated to us in the presence of the Captain of the "Vernon," and the Assistant Director of Naval Intelligence at Niton, Isle of Wight, when it was found impossible to interfere from Naval Stations at Portsmouth and Culver with signals from distant ships and stations fitted with the tune, though communication with the "Hector" at Portsmouth could be carried on, but only with the untuned system. The trials were, in our

opinion, quite conclusive that the Company's claims to have established a practical system of Syntonic Wireless Telegraphy are well founded.

(13.) The adoption of this system would enable two ships in one squadron (M) and two ships in another squadron (N) (the two squadrons separated by, say, 10 or more miles), to communicate with each other, whilst two ships in (M) and the other in (N) were also communicating, or to allow clear communication between two pairs of ships, one with A and the other with B Tune, all in the vicinity of each other, and would prevent interference from other adjacent or distant ships not actually sending out signals of the same wave length.

The power of sending untuned signals, if required, would not be lost by the introduction of this system, which we stongly recommend for immediate introduction into H.M. Service, as follows:—

A and B Tunes.

All Shore Stations used for purely Naval purposes, such as Malta, Gibraltar, Hong Kong, Rame Head, &c. All sea-going flagships, first-class cruisers, special ships such as the "Vulcan," and in large battle squadrons two extra battleships in addition to the flagship.

A Tune only.

All British commercial stations.

All other ships.

The long-distant receiving jigger for Poldhu signals would be an additional one, fitted temporarily only when required for receiving from that station.

All vessels and stations with A and B tunes to be supplied with two Morse inkers.

(14.) We submit that the supply of Wireless Telegraphy to ships might also be reconsidered, though fully agreeing with the present instructions as to the fitting of ships by the Dockyards to reconsider the instruments if required.

For instance, in a large battle fleet in which the ships are practically always in company, two ships in each division appear ample for the purpose, and owing to vessels always being in company, efficient practice amongst them is most difficult to arrange. Again, in small cruisers, generally detached, and the Wireless Telegraphy in continual use with a small staff, the strain on the latter is too great to expect really efficient service, though in a battleship with a large signal staff, and the same number of Wireless Telegraphy ratings, the Wireless Telegraphy is rarely used. A better distribution of these Wireless Telegraphy instruments and signal ratings is therefore desirable, and we consider all ships fitted should have three Wireless Telegraphy ratings in peace, and an additional one in war, and that it is unnecessary to supply permanently to battleships. It is our opinion that a few (speaking generally) efficient sets of Wireless Telegraphy well cared for, and with sufficiently large staff kept in continual practice, are better than three times the number of sets with an insufficient staff, seldom practised and overworked in times of emergency, and we strongly recommend this point for consideration, as there is no doubt that there can be too much Wireless Telegraphy in a fleet, in which case it is practically useless.

It must be also borne in mind that without careful organisation and continual practice, no good results can be expected from this system, however efficient and well tuned the installations fitted may be, and that intelligent men, well trained and interested in this work, will make more use of fairly good instruments than untrained and unpractised men will make of the best installations that can be fitted.

A large number of ships fitted in company makes training and regular practice very difficult, which emphasizes the advisability of limiting the number of sets in any one squadron. A reduction of the number of sets fitted would not only effect an economy in original supplies, but allow a reduction in the quantity of spare gear kept on the different stations.

(15.) We feel sure that the recent invention of Mr. Marconi, if well applied, will enormously increase the efficiency of Wireless Telegraphy in H.M. Service.

We have the honour to be, &c.

(Signed) H. B. Jackson, Captain H.M.S. "Cæsar."
" C. R. Payne, Lieut. (T.) H.M.S. "Vernon."
" Fred S. Loring, Lieut. (T.) Admiralty.

The Commander-in-Chief, Portsmouth.

Appendix.

Chelmsford Works.

All Wireless Telegraphy instruments supplied by the Company are made at these works; the number of hands employed vary with the amount of work, but the average number is about a hundred, chiefly consisting of boys and women trained by the Company, considerable difficulty having been found in obtaining trained men.

A tall mast, 180 feet high, stands in the grounds adjoining the works, the aerial wire from it being led directly into the Wireless Telegraph Office close to the foot of mast.

The "earth" consists of a number of galvanised iron plates (surface area of plates 1,000 square feet) buried vertically in the ground round the Wireless Telegraph Office. Great stress is laid on

the importance of having "the earth" so that the leads from the receiving and transmitting instruments may be as short as possible, and of equal length.

The Wireless Telegraph Station at the works is a small power one, and is used principally for experimental and testing purposes in connection with Marconi's station at N. Foreland.

The following are the names of the head officials at the works :—

Mr. Grey, Chief of Electrical Staff.

Mr. Priddle, Engineer in Chief.

Mr. Ashley, Overseer and Instructor.

Tuned System.

Two tunes, a short-wave tune and a long-wave tune, have been perfected by the Marconi Co. In this report the short-wave tune will be called "A" Tune, and the long-wave tune will be called "B" Tune, and the ordinary method at present in use in H.M. Service will be called the untuned system.

"*A*" *Tune :—*

Advantages as stated by the Company's Officials.

(1.) Non-interference from untuned system.
(At a distance of 10 miles untuned system using maximum power cannot interfere with this tune.)

(2.) Non-interference from atmospheric discharges.

(3.) Non-interference from "B" Tune even at quite short ranges.

(4.) Under favourable conditions, ships at sea can communicate at a greater distance than with untuned system.

(5.) Only a comparatively short mast is required.

Disadvantages.

(1.) Easily screened, either by ship's mast, funnels, &c., or by land.

(2.) Not easily adaptable to the existing Service (receiving) instruments, without slight alterations.

"*B*" *Tune :—*

Advantages.

(1.) Good for all-round ship signalling and getting through land.

(2.) Greater signalling range than either untuned system or "A" tune.

Disadvantages.

(1.) More liable than "A" Tune to be interfered with by untuned system and atmospheric disturbances.

(2.) Only suitable to ships with tall masts, about 160 feet high.

Both tunes offer distinct advantages over the present untuned system, and it is satisfactory to know that in practice the signalling range of a tuned system is nearly double that of the untuned for aerials of equal lengths.

INSTRUMENTS SEEN.

Single Cell Accumulators, made by the Chloride Company to the Marconi's Company design.
These are great improvement on the 5-cell Chloride type at present in use in the Service.

Special Induction Coil for Field Service Use.—This coil is enclosed in a strong wooden case, and thus protected from the weather. It appeared well suited for the purpose for which it was designed.

Magnetic Detector.—This instrument is the most sensitive receiving apparatus yet invented, but it is not suitable for ship work, as it depends on the receipt of message by telephone, and any noise in the vicinity prevents the signal being heard; also no permanent record is obtained, and great skill is required on the part of the operator.

Apparatus for testing Coherers.—The transmitting aerial, 3 feet in length, is placed at one end of a table and excited by a buzzer, the receiving aerial and coherer are placed at the other end of the table. A metal tube connected to earth can be lowered over the transmitting aerial, and so screen the waves from the receiver. By the position of this tube the sensitiveness of the coherer can be gauged.

Insulators.—A special form of porcelain insulator is used for the top of aerial wire. All wire stays for mast are insulated in three places by wooden dead eyes set up with hemp lanyards, which prevents signalling range falling off in wet weather.

Apparatus for reducing Noise of Spark.—The spark balls are enclosed in a glass tube with wooden ends, through the centre of which the rods carrying the balls pass. A small quantity of

quicklime is placed in the glass tube to absorb any moisture which may collect on the inside of the tube.

New Pattern Receiver Box.—This is a great improvement on the old pattern box. The size of the iron box and the wooden base board for instruments is the same as the old pattern, so that the old pattern may be easily brought up to date with the latest improvements.

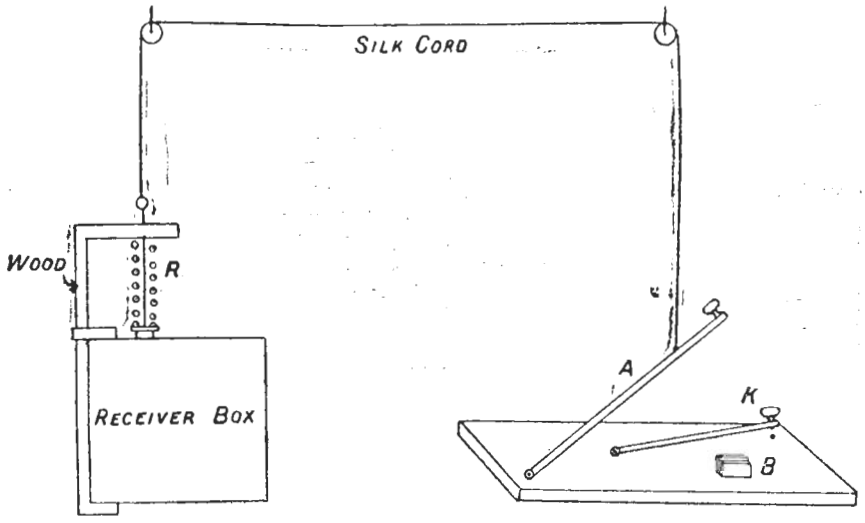
The lid of the box opens so as to allow the instruments to be easily manipulated. All leads have been simplified and are led under the base board. A new form of tapper has been introduced, in which the armature is balanced, and thus a more regular working of hammer has been obtained under sea-going conditions. The method of adjusting the coherer holder has also been greatly improved.

The relay wheel has a chain on it which prevents it being turned too much one way or the other.

The testing shunts are arranged under the wood base board, and a small hole in the iron case allows a push to be worked for testing the sensitiveness of the relay instead of the method now employed of wetting the fingers and pinching the jigger terminals.

There is a hole in the top of iron container box, which allows a brass rod to be forced between two metal contacts inside the box. This rod is connected to aerial wire, and thus the receiver circuit to the jigger is completed. When sending a signal, the rod has to be raised (and accordingly the receiver circuit broken) in order to complete the transmitting circuit.

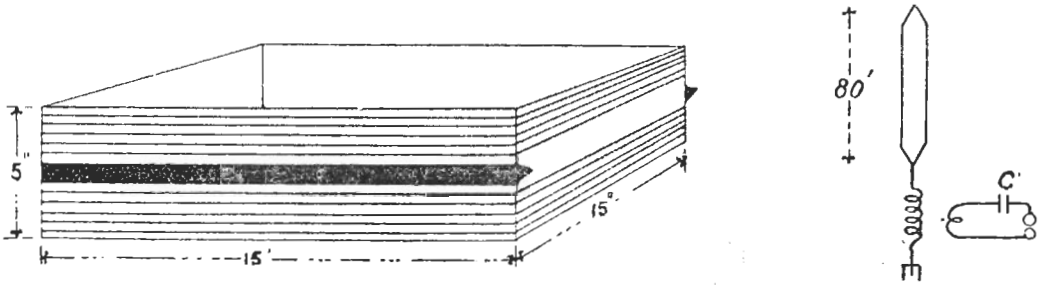
Method of breaking Aerial Connection to Receiver Box when sending.



The lever A has to be pressed down between the contacts B in order to complete the transmitting circuit. In so doing the rod R is raised, which breaks the connection of aerial to receiver box. The signalling key K is small and very convenient for signalling, having a very short travel.

The induction coil condenser is joined between the key contacts, so that no special key condenser is required. This arrangement is specially designed to be used with "A" Tune, as the lead of aerial to receiver box must not be protected by lead casing, the capacity of which cannot be permitted with this tune.

Details of Aerial, Oscillator, and Jigger for "A" Tune, Method of Winding Transformer of Oscillator.



Broad black line represents the primary winding.

The former is made of wood 15 inches by 5 inches; thickness of wood ¼ inch.

Wire used for primary and secondary windings is very similar to Admiralty Pattern 611. Primary (4 parts of this wire in parallel) ¾ of a turn; secondary 15 turns single for 80 feet wire; the number of turns depending on the length and form of aerial in all cases.

Aerial wire 80 feet double to 180 feet single in length, made of bare copper wire, 7 strands of 20 S.W.G.

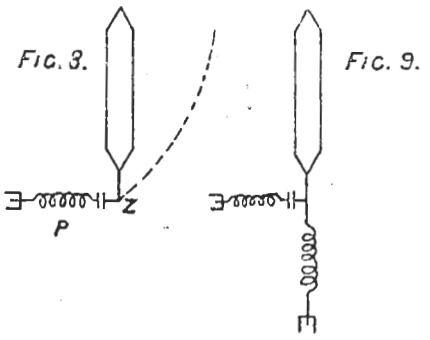
Wave length 350 feet approximately.

Frequency = 3,300,000.

The oscillator condenser C consists 6 Leyden jars, arranged 3 in parallel, 2 in series; each jar has capacity 1,300 cms.

Fig. 8 shows aerial connected to primary of receiving jigger with a condenser in series. This condenser is found to reduce atmospheric disturbances. Dotted potential curve shows that the point Z is best place for P of jigger.

Fig. 9 shows the receiving circuit as actually used, the secondary winding of oscillator is not disconnected.



Jigger for "A" Tune.

Length primary, 7 feet, 36 S.W.G. for 80 feet aerial. (The number of turns depends on length and form of aerial.)
Length secondary, 70 feet, 40 S.W.G.

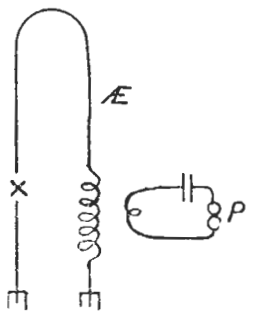
Secondary is wound on a 1-inch diameter cardboard cylinder in a single layer, turns close together. The primary is wound on top of secondary and in the centre of it, exactly similar to the method of winding Service jigger.

NOTE.—It is important that the bottom of aerial should be taken directly to condenser (in series of primary of jigger) and not lead through lead-covered wire.

The aerial, including secondary of oscillator, is tuned to the primary of oscillator by measuring the length of spark obtained from the top end of the aerial.

The secondary turns of oscillator are varied until a maximum spark is obtained at X, the circuits then being in tune with one another. For convenience, the top of the aerial, during this process of tuning, is brought down as shown in Fig. 10; the period of the circuit being practically unaltered if the top is not brought too close to "earth."

FIG. 10.



Maximum spark at P is used so as to obtain a value of the energy of the tune from the length of spark at X.

Bare copper wire 7 strands 20 S.W.G. is now universally used by the Company for aerials.

Details of oscillator for "B" Tune.

DIAGRAM OF AUTO CONNECTIONS. Fig. 1.

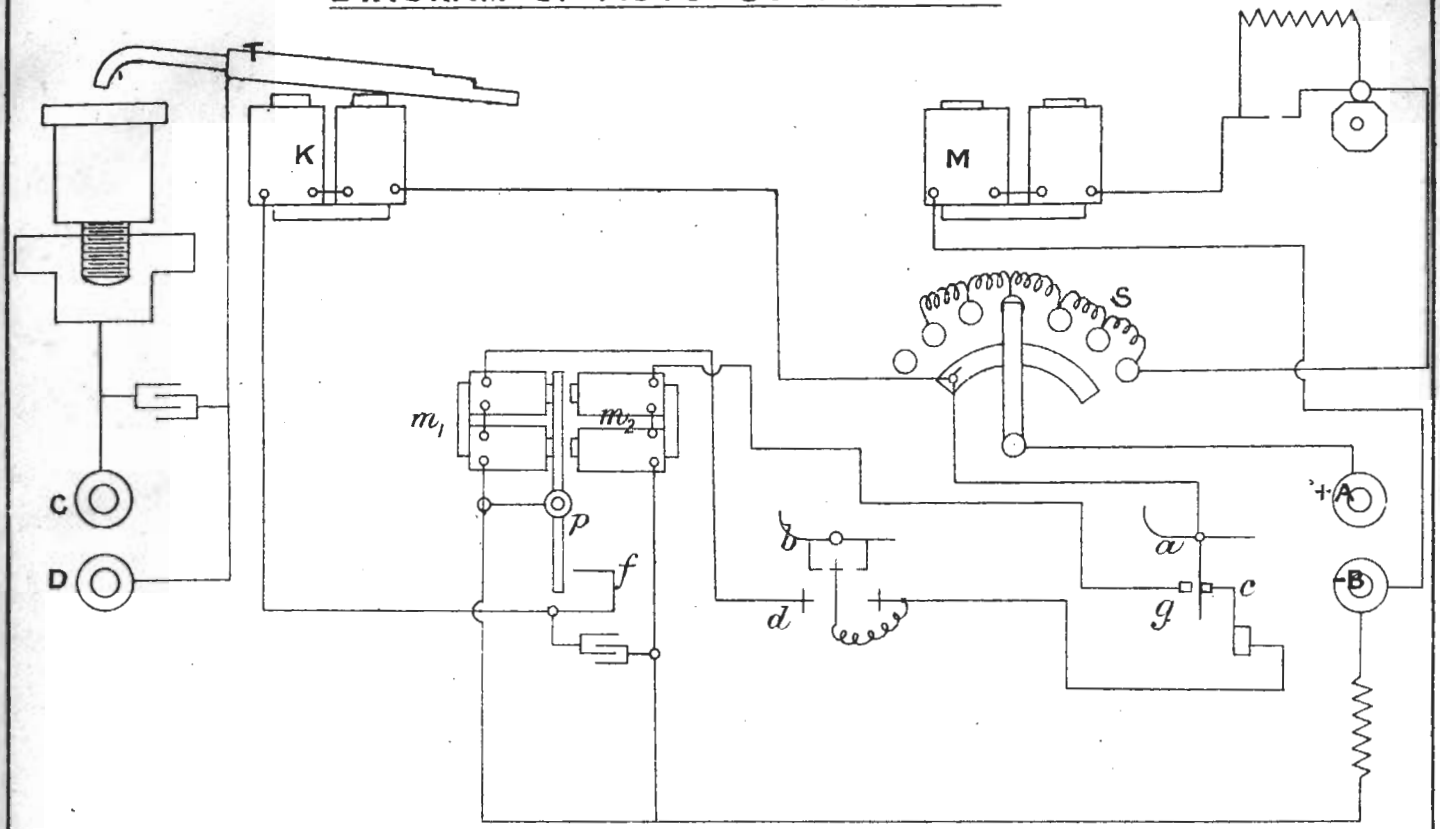
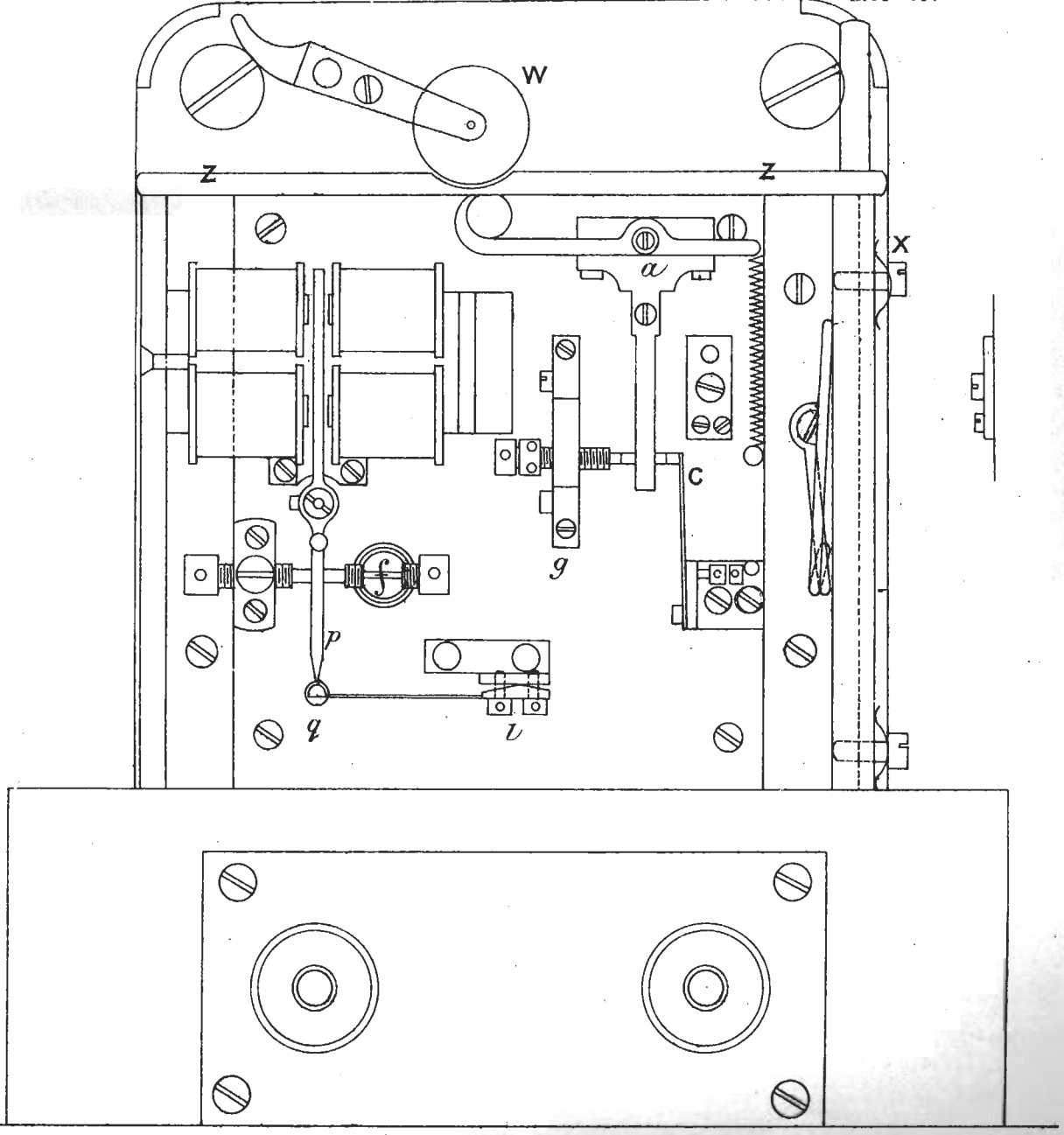


Fig. 2.

FRONT VIEW OF TRANSMITTER

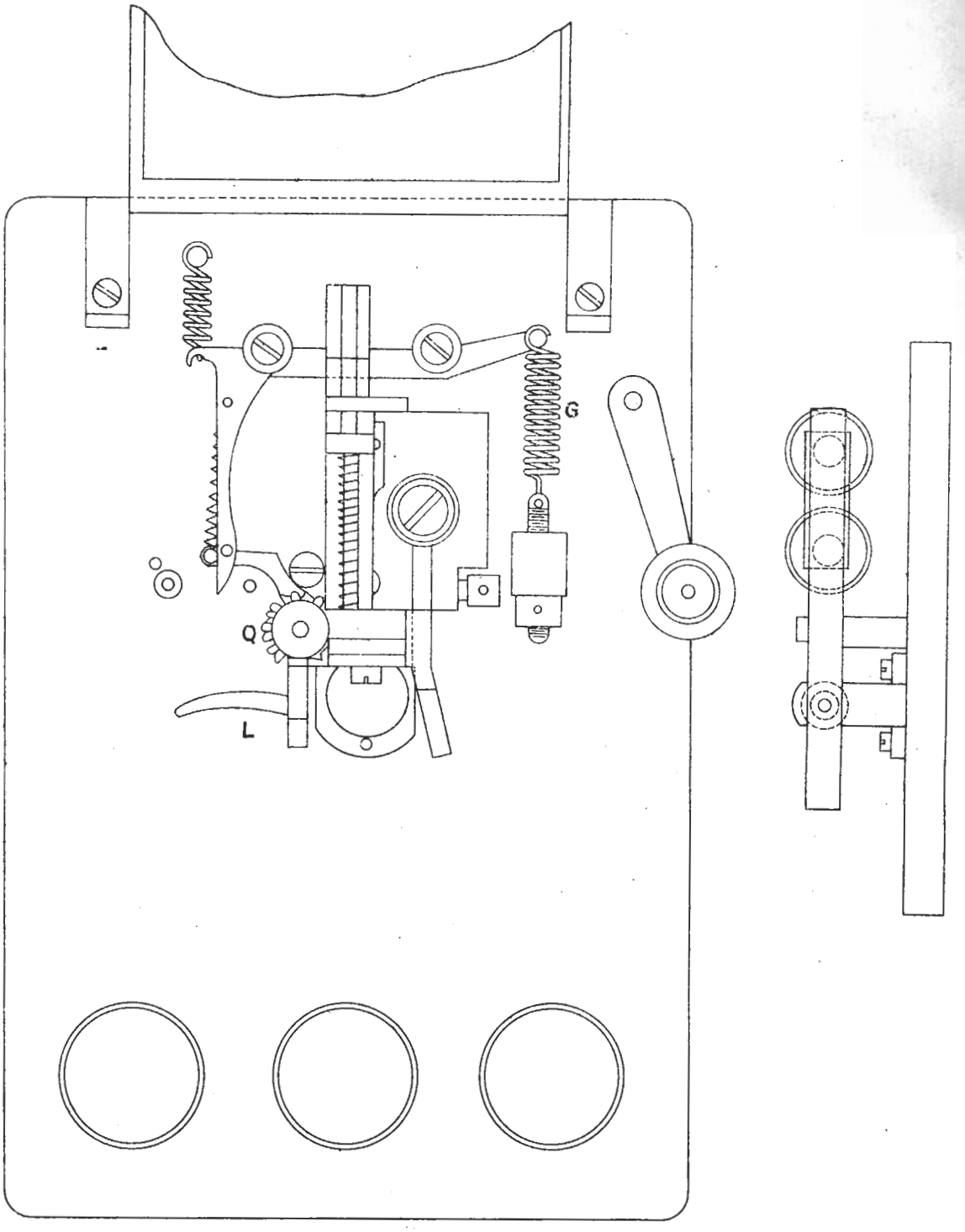
Note, The lever "b" is behind "a", and is not shewn.



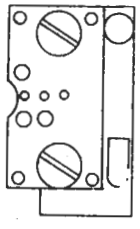
4566.12.03.

To face page. 120.

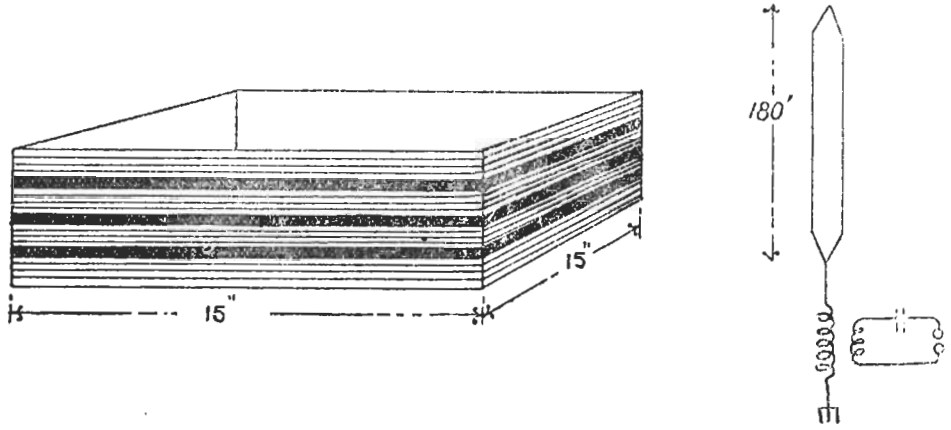
Weller & Graham, Ltd. Litho. London.



PERFORATOR.



Method of winding Transformer of Oscillator. (*Broad black lines represents primary winding.*)



Same pattern wise used as for "A's" oscillator.

Primary, 3 turns of threefold wire wound in between secondary turns, as shown in figure; secondary, 9 turns single wire for 180 feet double aerial.

Condensers, 12 Leyden jars, arranged all in parallel.

Each jar capacity 1,300 cms.

Wave length 700 feet approx.

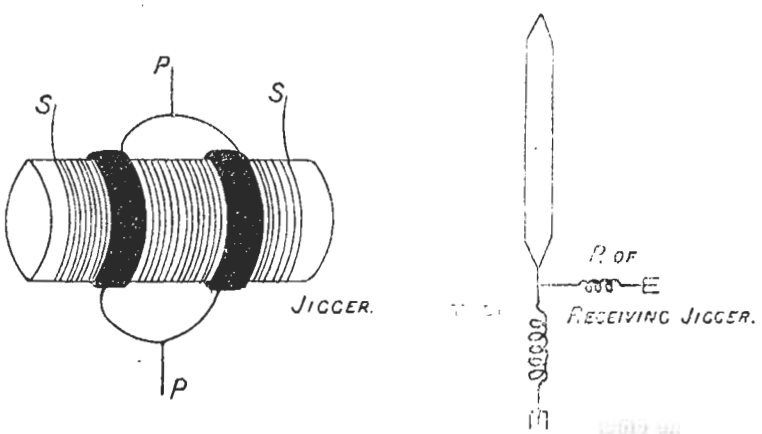
Receiving Circuits.

Jigger 2½-inch diameter, cardboard cylinder.

Length primary, 12 feet double 36 S.W.G., for double aerial 180 feet.

Length secondary, 300 feet 40 S.W.G.

FIG. 11.



The secondary is first laid on in a single layer.

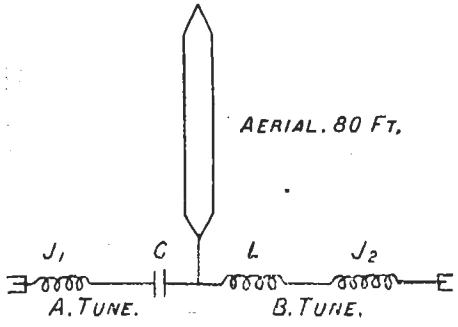
The primary consists of two parts of 36 S.W.G., each 12 feet long, wound on two cylinders of slightly larger diameter than the secondary cylinder, so that they can slide over the secondary and can be opened out one from the other, as shown in Fig. 11. By regulating the distance apart of the primary rings, sharper tuning is obtained.

Double Reception.

Both "A" and "B" Tunes can be received on the same aerial, at the same time, without interfering one with the other.

For this purpose the receiving circuit is arranged as shown in Fig. 12.

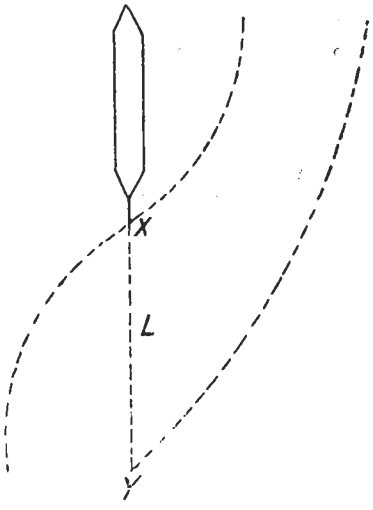
FIG. 12.



J_1 is the primary of "A's" jigger with the condenser C in series with it as previously described.

J_2 is the primary of B's jigger, with an inductance L between the aerial and primary; it is in this manner that the circuit of shore aerial, with the inductance L, is made to represent the long aerial, which is best suited to this tune.

A glance at the potential curves explains why the point X is the most suitable place for A's primary of jigger, and an unsuitable place for B's, and vice versâ, the point Y is the best place for B's primary, but unsuited for A's. X and Y are points of maximum current for their respective tunes, whilst the current induced by "A" Tune at the point Y is practically nil, and vice versâ with reference to the point X for "B" Tune.



This double reception on the same aerial wire is more of an interesting experiment than of practical use, because in order to get the best results a special aerial for each tune has to be used.

General Information.

The signalling range of Shore Stations cannot be depended on to be as good as that from other ships, on account of the inferior "earths."

The question of the efficiency of Shore Station "earths" is one of money. The greater surface of metal buried in the ground, the better will the "earth" be. In all cases the "earth" should be as close to the station as possible, and the minimum surface area about 600 square feet of metal.

The hammer make-and-break of the induction coil is preferred to the Isenthal interruptor, the latter instrument being disliked on account of the mercury vapour given off. No inconvenience, however, has been noticed in this way in the Service, and it is thought the objection is really one of preference for instruments made by the Company to those made by other contractors.

Mercury Coherers (Castelli Type).

This instrument is a very sensitive one, and is used for detecting signals when trying to establish communication between distant stations.

It cannot, however, be used for ordinary work, as it is very unreliable in its action.

Horizontal aerials for field service work have given satisfactory results.

The advantage of this form of aerial is the reduction in height of mast, which makes the latter more portable and less conspicuous to an enemy. With an aerial as shown, supported by 30-feet poles, signals have been exchanged over land a distance of 30 miles.