SECTION IX.

WIRELESS TELEGRAPHY.

Appendix C. at page 126 of Annual Report for 1899, contains detailed instructions for installing a set of wireless telegraphy as designed by Captain H. B. Jackson, R.N.

This year the subject has been given a separate section, which is divided under the following heads, viz. :—

(*a.*) Additional information respecting the Jackson system and the instruments comprising it, also an account of the preliminary trials carried out with this apparatus.

(*b.*) A description of the Marconi system, the conditions of the contract between the Admiralty and the Company for the supply of 32 sets of instruments and an account of preliminary trials made with the apparatus.

(*c.*) General working instructions applicable to both systems installed in H.M. ships.

(*d.*) Reports of trials of both systems by the Torpedo Schools and seagoing ships.

(*e.*) A list of the ships fitted or to be fitted for wireless telegraphy, showing those supplied with Jackson and those supplied with Marconi's sets.

(*f.*) A list of the instruments and stores comprising each system of wireless telegraphy.

(*g.*) General Remarks.

(A.) Additional Information respecting Jackson's System and the Instruments comprising it, also an account of the Preliminary Trials carried out with this Apparatus.

Aerial Wire.

Fitting of double aerial.

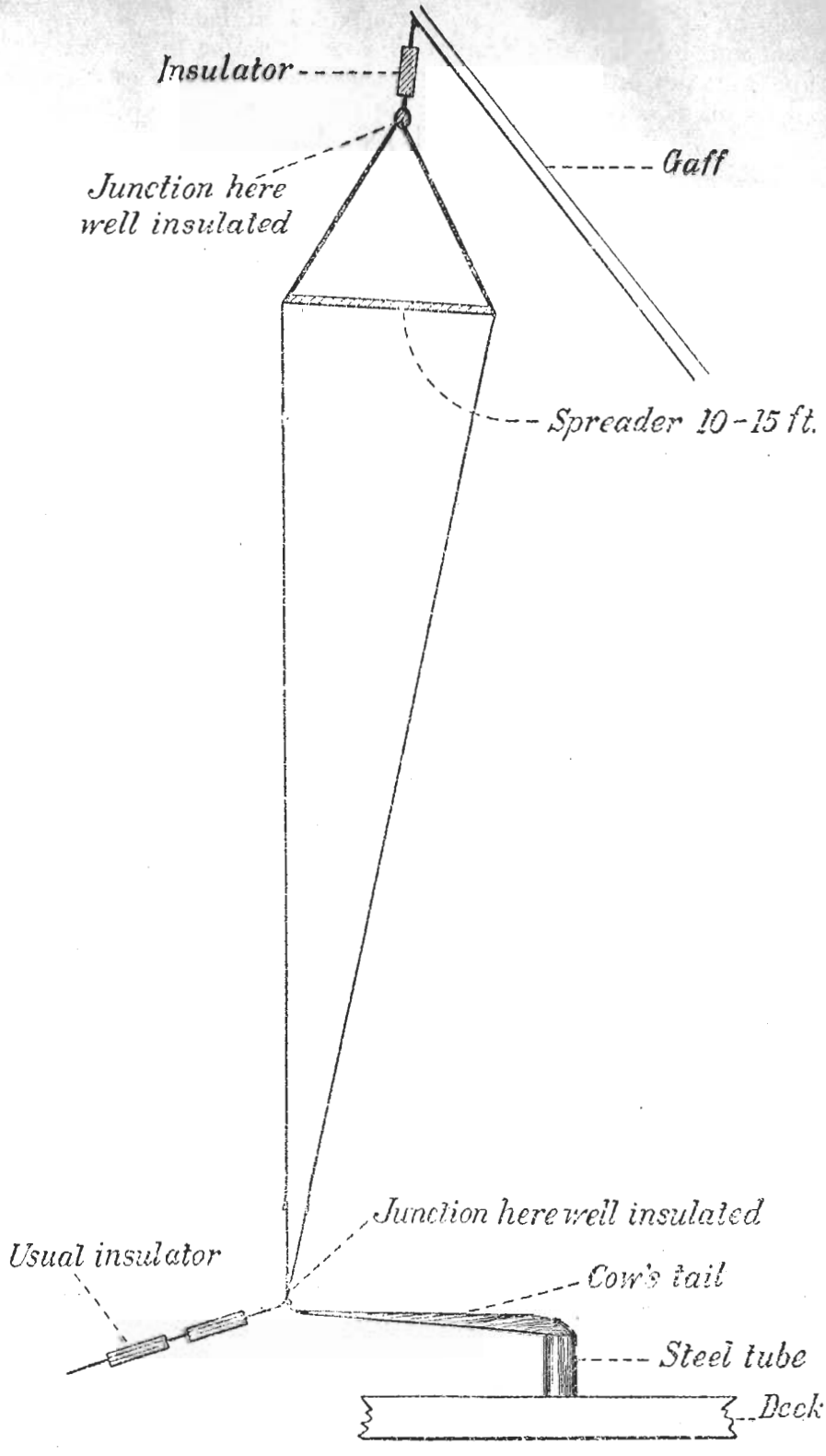
It has been found that doubling the aerial wire considerably improves the range of the apparatus, the probable reason being that, by so doing, the ships become more nearly tuned to one another.

Where much land intervenes, the use of the double wire is absolutely necessary. It is fitted as follows :—

The wire used is Pattern 1,308, as for the single wire.

A light wooden spreader, from 10 to 15 feet in length, is used to separate the wires at the top, as shown in sketch. Or an ebonite rod, one foot long, such as has been fitted in the Mediterranean ships, will also answer the purpose, its function being to prevent the wires becoming cable laid and so holding smuts from the funnels.

Double aerial.



The wires are joined together at the top, and the junction is well insulated and attached to the ebonite insulator in the usual manner. The doubled wire may be continued right down to the deck, but should be singled when passing through the deck or bulkhead into the telegraph office; it should be stayed clear of rigging, &c. in the usual manner.

Too much stress cannot be laid on the necessity for thoroughly insulating any junction made in the aerial wire; serious leakage to earth is bound to occur from uninsulated junctions, and the coil will not then give its full spark.

Fig. 1.

Diagram of Circuit.

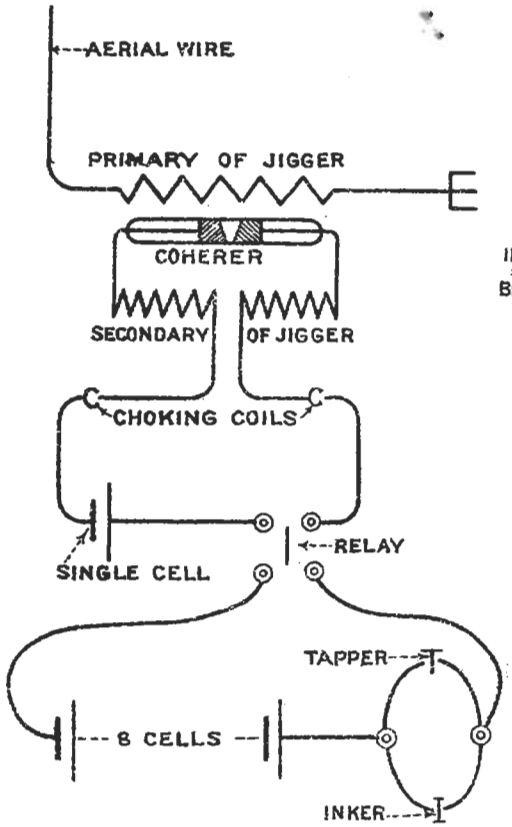
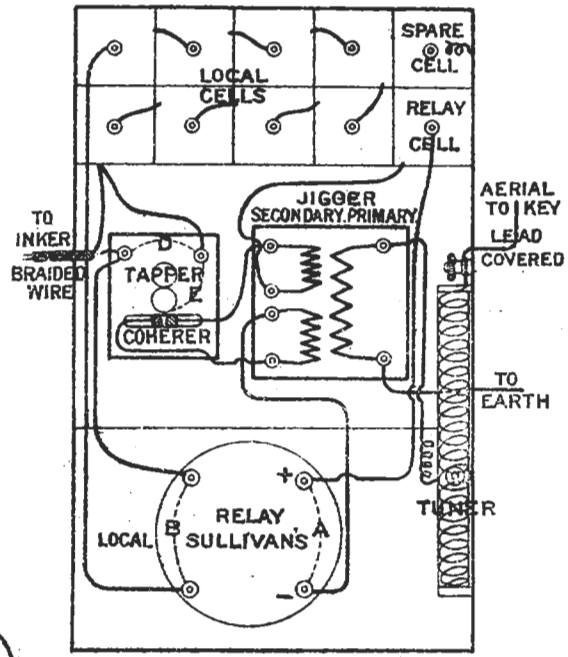


Fig. 2.

Captain Jackson's Box.



A = 8000 ω NON-INDUCTIVE SHUNT
B = 3000 ω " " "
C = 150 ω CU. INDUCTIVE CHOKING COIL
D = 1000 ω NON-IND. SHUNT ACROSS TERMINALS OF TAPPER.
E = 1000 ω NON-IND. SHUNT ACROSS MAKE & BREAK OF TAPPER.

INKER HAS 2000 ω NON-IND. SHUNT ACROSS ITS TERMINALS

COMPLETE WIRE CIRCUITS THROUGHOUT.

Fig. 3.

Transmitter Circuit.

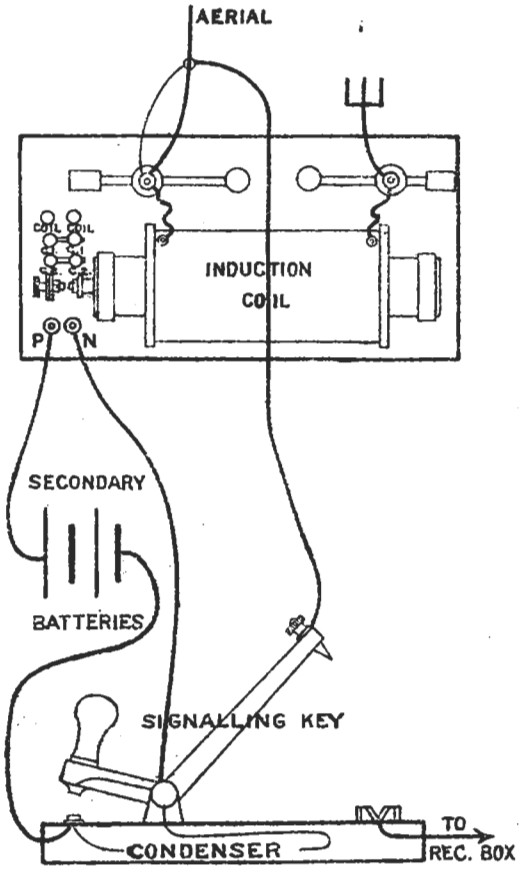
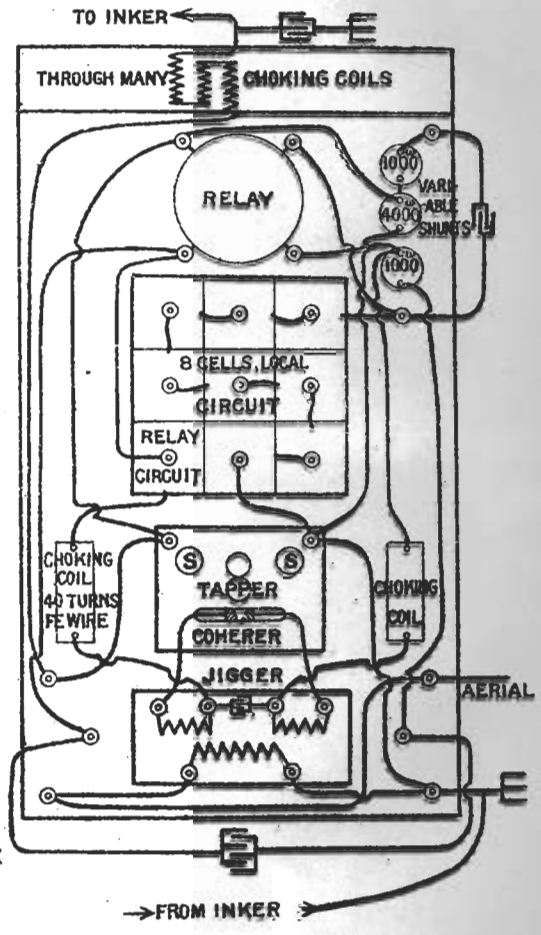


Fig. 4.

Marconi Box.



Great trouble has been experienced in the "Vernon" from snow collecting upon the aerial wire and its insulators and thus practically earthing the aerial, experiments are now in hand with a view to prevent this.

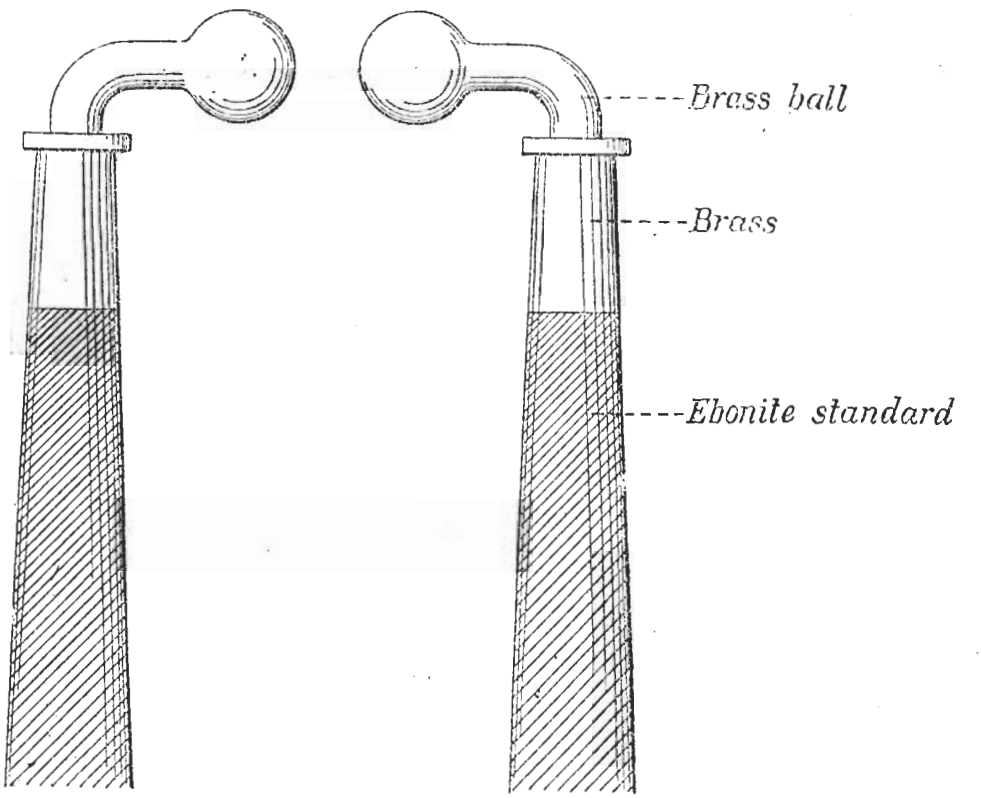
A new pattern of deck tube has been designed and will shortly become the universal pattern. A new pattern of insulating frame has also been designed, and both of these new designs employ, as an essential part, the cow's tail used by the Marconi Company.

It has been decided that, in cases where the aerial wire has to be led between decks, it is to be protected in trunks to preserve passers-by from heavy shocks.

Transmitter.

Modified spark balls.

It has now been decided to discard the large balls in future Service induction coils, replacing them by smaller ones placed as shown in sketch :—



Altered signalling key.

It has also been decided to modify the present type of signalling key. The length of the arm is to be considerably decreased, the vertical guide of the key removed, a chopper contact and C connexion fitted for receiving wire, and a spring to keep key down in the receiving position. A condenser is also to be fitted to the key.

Detailed instructions will shortly be issued to ships having the Jackson gear on board with regard to these alterations.

The connexions with the modified key will be slightly different, and are shown in Figure 3, Plate 21 (Marconi transmitter).

Mechanical interruptors.

An interruptor, made by Isenthal & Co. on the mercury jet principle, has been tried with the transmitter, but sufficient experience has not yet been gained to warrant its adoption, the instrument allows the coil to be worked direct off the electric light circuits, and has so far given good results.

Another interruptor of the Mackenzie-Davidson type is shortly to be experimented with.

The safety contact to prevent sending when the receiving box is open has been tried, but so far the results are unsatisfactory.

The Receiver.

Receiving earth.

It has been decided to earth the receiving box in a more thorough manner.

This is accomplished as follows :—

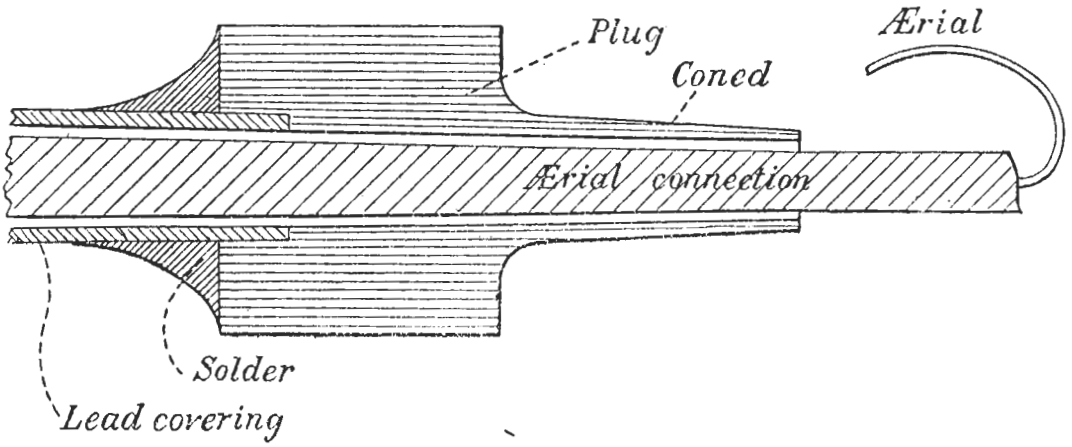
A solid brass coned plug, to which is soldered the conductors of a double lead of Pattern 600, is fitted into the earth-wire hole in the box and tightly jammed there.

A wire on the other end of this plug is used for the earth connexion of the jigger.

The double lead of 600 is attached to the selected receiving earth.

Similar coned plugs, but hollow, are used for introducing the Aerial and Inker leads into the box, the lead covering and braiding being soldered to the plugs.

A rough sketch of one of these plugs is shown below :—



The system more thoroughly protects the coherer from the effects of heavy induction, and is mechanically very sound.

The primary tuner has been removed from the box, it being unsuitable for the present pattern of jigger.

The original jigger has also been discarded as it is found that it is not the best type to use.

Type of jigger.

The jigger to be used in future is known as the 140-foot jigger, and is wound as follows (similar to the unnumbered jigger of Marconi Company) :—

Size of wire - - - - -	42 L.S.G.
Length of primary - - -	14 feet.
Length of secondary - - - -	140 feet.

Secondary is wound in two halves, primary is wound on the secondary, and is confined to the middle part of it.

Directions for winding jigger.

Select a cardboard cylinder of not less than 2 inches diameter (Ilford P.O.P. cylinders are very good), on this wind 140 feet of 42 L.S.G. wire in a close spiral (*i.e.*, the turns touching one another).

As this secondary winding is to be cut in the centre, when 70 feet have been wound on, wind the wire out towards the end of the cylinder for about half a turn and fasten with wax, then wind back to the centre, and put on the other 70 feet, and fasten that end down with wax. It will be found convenient to use a magnifying glass whilst doing this, and to mark every tenth turn wound on.

The secondary winding is now complete, and the whole should be well bathed in paraffin wax. Winding jiggers.

Cut the bight of the centre of the secondary which was secured with wax, this will give two centre ends, withdraw these carefully from the film of wax until they are quite free to the centre of the winding.

These middle ends of the secondary winding are to be led through the primary turns.

Take a piece of tape from the Morse inker, and cut a slit about 1 inch long down the centre from one end.

The centre ends of secondary are to be brought through this slit. Soak the tape in paraffin wax and wrap round the centre part of the secondary winding leading the centre ends of the secondary up through the slit, secure both ends of the centre secondary winding temporarily.

The primary winding is now to be put on; this is wound on over the piece of tape, care being taken that there are the same number of turns each side of the centre secondary ends, the jigger is now complete as far as the actual winding is concerned.

The ends of the fine 42 L.S.G. wire are soldered to coarser "tailings," which are first hitched to holes bored in the ends of the cylinder, care being taken to insulate the primary from the secondary ends by means of wax-soaked tape where these ends cross over the other winding.

A condenser which may be conveniently placed inside the cylinder, must now be constructed (seven sheets of copper foil, $3\frac{1}{8}''$ by $1\frac{3}{8}''$, separated by waxed paper), this condenser is placed between the two centre ends of the secondary. The two centre ends of the secondary are also to be connected to two choking coils made of iron wire, these may be conveniently wound on small bobbins, and also placed inside the cardboard cylinder. A standard size of iron wire is supplied for this purpose, and the resistance should be roughly 25^{w} for each bobbin.

The jigger is now complete.

The connexions are:—

Primary winding to Aerial and Earth.
Secondary (outer) to coherer.
Secondary (inner) to choking coils, relay, and battery.

This jigger requires no secondary tuners and they may therefore be discarded.

Very many experiments have been made with different kinds of jiggers, but it has been found that for all-round work the 140-foot jigger is the best at present known to the Service.

The "Vernon's" experience of coherers up to date is distinctly in favour of the Marconi type; it should be remembered that all coherers are not sensitive enough for the limit distance. Coherers.

This question is still in the experimental stage, and nothing definite can be laid down as to which coherer to use.

One of the faults of the Sullivan relay is a want of sensitiveness; modifications are now being tried to overcome this. "Sullivan" relay.

A larger coil has been fitted, but with poor results.

Another fault of the original instrument is the chattering of the contact (due to the instrument's insensitiveness); a spring contact arm has been fitted with good results, but the instrument is not sensitive enough yet, and further experiments with larger and stronger field magnets are in progress.

A rather peculiar fault has been discovered by Mr. Sullivan himself, this is the sticking of the coil, and it has been found to be due to the attraction of the magnets on the wire of the coil, due to iron impurities in the copper.

The relay will also be enclosed in a water-tight case, as it is found that damp is very liable to affect the contacts.

The Tapper.

The tapper.

The instrument as originally supplied is found to be capable of considerable improvement.

The following alterations have been carried out in "Vernon" with very good results.

The brass sliding frame carrying the magnets and armature has been cut through just below the magnets and at right angles to its length.

This allows the lower stop to be removed with its part of the brass frame independently.

The armature, which was formerly attached to the magnet yoke, has now been screwed to the lower part of the brass frame so cut.

The armature itself has been considerably lightened, a weaker spring fitted, and the hammer has been much shortened.

The result of these alterations is to make the armature and its make and break stop a standing part of the instrument, the top adjusting screw now moves the magnets relatively to the armature.

The present coherer clip has been replaced by an adjustable clip holding the coherer at one end only, and it is possible by means of an adjusting screw fitted to this clip to vary the distance between hammer and coherer.

These alterations has had the effect of considerably improving the tapper.

The same shunts are retained as in the original instrument.

All these alterations to the tapper can easily be carried out by an armourer.

Many designs of decoherer have been tried, but up to the present time this form of tapper has proved superior to all others.

Inker circuit earthed.

With a view to more thoroughly preventing the sending spark from injuring the coherer, the inker circuit has been connected to earth through a condenser, both parts of the circuit being thus treated where they enter the receiving box.

Choking coils have also been added in the inker circuit, the results, however, do not at present warrant the universal adoption of this system.

Testing the Apparatus.

Buzzer for testing receiver.

The gas lighter supplied for this purpose has been found mechanically weak and to possess many disadvantages, it has, therefore, been decided that a small buzzer shall be used in future to excite the apparatus.

The buzzer used is of the ordinary type, actuated by a push and one Obach cell. The armature should be connected to the receiving earth (*i.e.*, the box) and the contact screw should have a short lead of wire (about 4 feet of patt. 733) attached to it, and led parallel to the aerial wire in the office, and not more than 10 feet from it, preferably nearer. On the buzzer being worked, it will be found that the receiving instrument will respond if in adjustment.

As the first introduction into the Naval Service of the wireless telegraphy apparatus has not hitherto been dealt with to any extent in the Annual Reports, the following brief account is appended :—

Two sets of instruments were purchased for "Vernon," the tapper, coherer, and tuners being made in the ship under the personal supervision of Captain Jackson. Two ships, "Hector" and "Jaseur," were fitted to take the instruments; a topmast carrying a long gaff was fitted to each in order to get a great height of masthead, "Hector" having 162′ and "Jaseur" 100′, and a cabin in each ship was fitted up for the reception of the instruments. On December 1st, 1899, the ships were ready and the instruments were set up in each vessel, communication being at once established across a space of about three quarters of a mile.

First two sets made, December, 1899.

The next day, December 2nd, the gunboat was taken out into the Solent, and signals were received by her up to a distance of 10 miles. The "Hector" received no signals at a greater distance than three quarters of a mile owing to the insensitive adjustment of the relay.

"Hector" and "Jaseur's" trials.

These experiments with "Jaseur" and "Hector" were continued until the 15th December, with no greater distance than 11½ miles, and on the 16th December, the "Canopus," which had been fitted according to Captain Jackson's specification to receive the apparatus, was about to run a steam trial off Portsmouth Harbour.

The "Jaseur's" instruments were shifted to "Canopus," and communication was at once established to "Hector," half a mile distant.

"Hector" and "Canopus" trials.

The "Canopus" went out of harbour and ran her steam trial between St. Catherine's Point and Ower's Light. The communication was not continuous, but whenever the ship was in such a position that little or no land intervened, the signals were well recorded in "Hector," although they entirely disappeared, *at the same distance*, when the straight line between the two ships passed over much land or many houses. The distances attained were :—

Signals received by "Hector" from "Canopus" at 16½ miles.
,, ,, "Canopus" from "Hector" at 12 miles.

When inside 12 miles, communication was perfect, and no difficulty of any sort was experienced.

On December 20th Captain Jackson left the "Vernon" prior to sailing for the Mediterranean, and since then the work has been carried on by the Torpedo School, the experiments being mainly confined to bettering the design of the coherers and producing a reliable jigger; the gunboat going out nearly every day for experimental purposes.

The distance gradually increased owing to the operators getting more knowledge of the adjustments of the instruments, and on February 14th signals were passed from "Hector" to "Jaseur" at 20 miles, but nothing was recorded on this occasion in "Hector" at a greater distance than 15 miles, the difference being due to the smaller height of aerial wire in "Jaseur," 100 feet, compared with that in "Hector," 162 feet, as the height of aerial is much more important to the sender than to the receiver.

These experiments showed that with an aerial 100 feet high we could not expect to get truly reliable signals beyond 13 miles, and attention was devoted to producing a better form of jigger. These experiments were carried out until May, but no real advance in distance was made.

Effect of height of aerial wire on distance limit.

It had been fully recognised by this time that with a low height messages could not be sent over long distances, although they could be received with ease, consequently advantage was taken of the presence of the Channel Squadron at Spithead prior to the gunnery experiments on H.M.S. "Belleisle," to carry out a trial between two ships of the "Majestic" class, in which the necessary gaffs and offices had been prepared.

The ships selected were "Jupiter" and "Hannibal," and the instruments were sent out to them at Spithead in a torpedo boat, transferred in a gig, in a choppy sea, to the ships, and were set up by "Vernon's" staff.

"Jupiter" and "Hannibal" experiments.

Communication was established at two cables distance, and arrangements were made to carry out distance trials the next day.

These trials proved very satisfactory, and results were obtained as follows:—

"Jupiter" at anchor. "Hannibal" running seaward, with no land intervening.

On the run out—

	Signals good.	Signals fair.	Signals lost.
From "Jupiter" to "Hannibal" -	20 miles.	25 miles.	Above 25 miles.
" "Hannibal" to "Jupiter" -	30 "	32 "	Above 32 "

On the run home—

	Signals partially recorded.	Signals fair.	Signals good.
From "Jupiter" to "Hannibal" -	24 miles.	22 miles.	19 miles.
" "Hannibal" to "Jupiter" -	27 "	25 "	22 "

The above shows that signals could be exchanged with certainty at 19–20 miles between these ships, and possibly at a greater distance.

On this occasion the "Hannibal" was given her anchoring orders by wireless telegraphy at a distance of 19 miles, on a misty day, when out of sight of the squadron, a state of affairs in which no other system of communication would have been of the slightest use.

Experiments during the salvage of "Belleisle" at Medmery shoal.

During the salvage operations on H.M.S. "Belleisle," on the Medmery shoal, about 14 miles from Portsmouth, orders were given to establish communication by wireless telegraph. The "Jaseur" was first sent out, with orders to anchor as close to the shoal as the water and "wireless" would permit, *i.e.*, to keep in touch with Portsmouth.

It was found that signals could not be exchanged and relied on beyond $12\frac{1}{2}$ miles with the small height of "Jaseur," consequently the apparatus was again placed on board H.M.S. "Hannibal," at anchor off the Medmery Shoal, and communication with Portsmouth at once became certain.

This installation was kept in constant work for a week, it never required readjustment, or any electrical work done on it after it had once been correctly adjusted, and during the week many hundreds of messages were passed from "Hector" at Portsmouth to "Hannibal" off Selsea Bill, without a single repetition being required.

This clearly demonstrated the durability of the installations, and their fitness for practical work, as the conditions were in every way those which would be experienced by a ship at sea.

Three sets sent out to China.

Soon after the successful conclusion of the experiments with the Channel Squadron, the steamship "Jelunga," on going out to China with the naval drafts, took out three sets of instruments, two from "Vernon," and one from "Defiance," in charge of a torpedo gunner from "Vernon"; these sets are now working from the Taku forts to H.M.S. "Barfleur," over a distance of 13 miles, with every success.

During the naval manœuvres three sets were issued to each squadron engaged.

Experiments during the Naval Manœuvres, 1900.

In the "A" fleet the gear worked remarkably well, signals being passed over 20 miles, *vide* report on page 112.

In the "B" fleet, the sets were a complete failure, mainly owing to bad insulation and short aerial, well shielded by wire stays, &c., in "Alexandra." Although, on one occasion, signals were sent to one of the cruisers at 20 miles in "B" fleet, yet, as a general rule, nothing could be passed further than 7–10 miles, and often not even at that distance, *vide* report on page 114.

Experiments in the Mediterranean.

In the Mediterranean, Captain Jackson has been experimenting with sets of which many parts of the apparatus, notably tapper, jigger, and choking coils, were made by ships' artificers. With ships of suitable height of masthead, signals are constantly exchanged over 20–25 miles, but the shielding effect of the hills around Malta is very noticeable, reducing the distance at which signals can be exchanged, by from 15–25 per cent., *vide* reports on page 115.