Organisation of wave lengths.

(1) It is considered that, in order to arrive at the best organisation for W.T. communication for War purposes, it is essential to start without delay a progressive series of practical trials in the Fleet.

(2) At the present moment the question of personnel is a serious one, the operators are Signalmen who have no electrical training, and when a separate Branch is created a considerable time must elapse before a sufficient Staff for War purposes is available.

(3) This being the case, the organisation must be made as simple as possible, it must be continually practised, and modifications only gradually introduced.

The organisation under trial should, therefore, be rigidly adhered to for a definite period, say not less than three months, so as to allow the operators to become familiar with the procedure, and for the system to undergo a fair trial.

(4) It may be argued that during the process of practical trials our organisation may be watched by foreign countries, and provide them with information necessary for jamming purposes in war time, but, on the other hand, to suddenly try and organise a system of communication at the outbreak of War, which had never been previously practised with, would be far more disastrous.

(5) In order then to lay down a basis from which to start, it seems desirable to summarise all the facts at our disposal, the installations in use or shortly to be introduced, and the wave lengths they are capable of transmitting, the comparative ranges of the wave lengths and their liability to interference; this will enable the Officers concerned to follow the lines on which the organisation is worked out and to interest themselves in the question of W.T. communication, which it is not too much to say would be of the most vital importance from the outbreak to the close of a War.

(6) At present every ship in the Fleet is fitted with a W.T. apparatus, capable of transmitting five distinct wave lengths, named "Q," "R," "S," "T," and "U"; each of these wave lengths is separated from its adjacent ones by a sufficient amount to prevent interference with maximum power at a distance of 2 miles (Service receiving instruments being used).

Thus, for example, two ships at practically their limit of range could communicate in "S" wave length, whilst other ships distant 2 miles from either or both of them were sending with maximum power on "R" or "T" wave lengths.

It follows that if instead of "R" or "T" the interfering ships were using the wave lengths "Q" or "U," which are further apart in wave length, they would not interfere with the "S" communication at distances considerably less than 2 miles.

(7) Practical trials have shown that under favourable conditions in the open sea, signals on "Q" wave length can be exchanged up to a distance of 200 miles by day, and 400 at night, whilst with the "U" wave length 70 miles by day and 120 miles by night appears to be about the limit.

Between these wave lengths the ranges appear to steadily decrease, so that for "S" tune the day range may be assumed as 100 miles, and the night range 200 miles.

It is only fair to mention here that up to the present the attention given to "Q" wave length far exceeds that given to any of the other wave lengths, so that it is probable, with practice, the range of the others will be greatly improved. Organisation of wave lengths.

(8) "Q" wave length has one great drawback, which is, that it is the one in general use for commercial purposes, and accordingly is the least selective for Naval purposes.

With regard to the ranges of wave lengths, it is necessary to state that the distances given refer to communication between Battleships and large Cruisers, where a height of 175 feet from the water-line is obtainable, and the aerial is provided with a good spread well clear of wire stays, &c.

(10) For smaller ships the range is less, and for the "Scout" class the range of communication between Scout and Battleship may be taken as half that given for intercommunication between Battleships and large Cruisers.

(11) Some exceptional distances at night time with "Q" wave length have been recorded during the last nine months, but it is not intended at present to take these into consideration.

(12) Although all H.M. Ships and Naval Shore Stations are at present fitted with what is termed Service Installation Mark I., which is capable of transmitting the five wave lengths "Q," "R," "S," "T," and "U," certain ships and Shore Stations mentioned below are shortly to be fitted with what is termed "C" tune apparatus. This term "C" tune refers to the type of instruments, and not to any definite wave length.

"C" tune will only be capable of transmitting "S," "T," and "U" wave lengths, but its range should be greater than the Service Installation Mark I. with these wave lengths.

(13) The following ships and Shore Stations will have "C" tune apparatus :—

"Exmouth."	"Drake."
"Albemarle."	"Duke of Edinburgh."
"King Edward VII."	"Devonshire."
"Hindustan."	"Argyll."
"Dreadnought."	"Scilly."
"Good Hope."	"Angle."

(14) All H.M. Ships and Naval Shore Stations are capable of receiving all the wave lengths, and also considerably longer wave lengths such as Poldhu.

(15) Necessity for detailing the wave lengths for special purposes. Taking the example of a Battle Fleet at sea with its attendant Cruisers spread, a Naval Shore Station as a base, and some large ships of the Mercantile Marine on the trade routes within signalling range of the Fleet, also a large power station such as Poldhu available, by what scheme of organisation of the wave length can the Admiral-in-Command of the Battle Fleet be best kept informed of all that is happening?

If the Flagship of the Battle Fleet is the centre to which all communication is directed, it is obvious that with the present W.T. instruments, unless the W.T. signalling is decentralised and distributed among the various ships of the Battle Fleet, there would be a considerable block at the Flagship end, and even if the rules were strictly obeyed, the organisation would become very complicated.

It is, therefore, necessary to consider the Battle Squadron as a control exchange with certain ships detailed to look out and communicate on certain wave lengths, and to inform the Flagship by visual signalling of all communication on their lines.

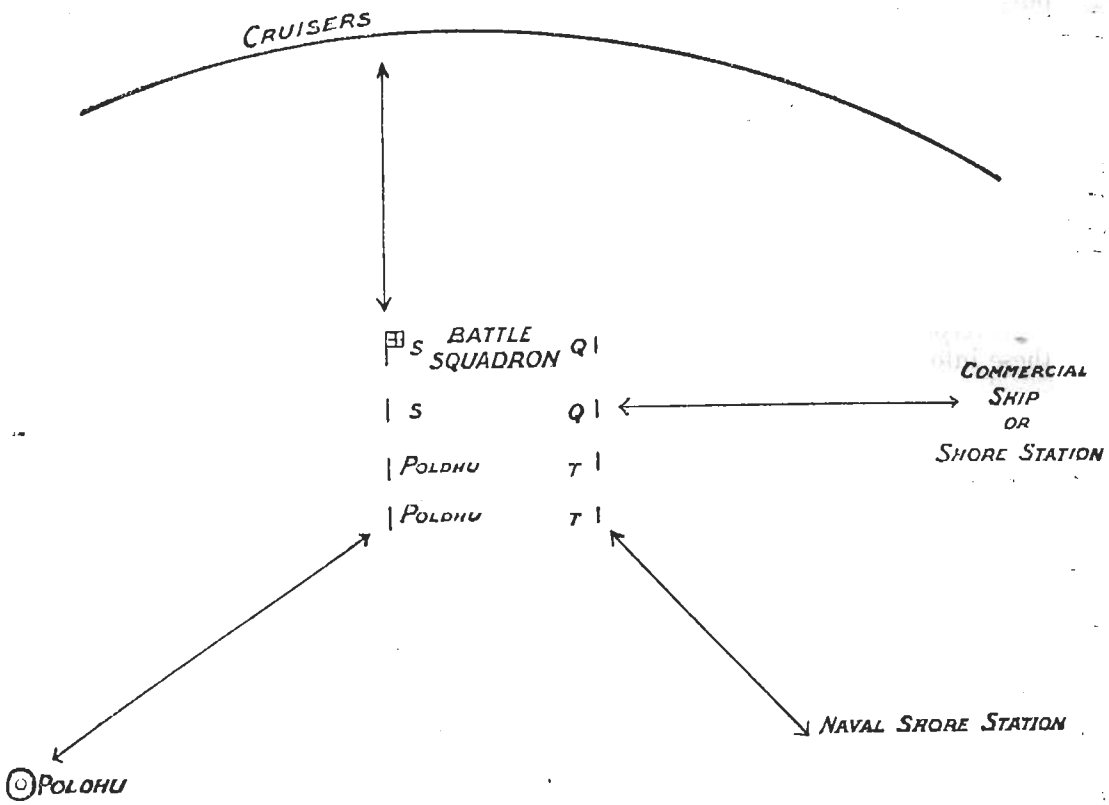
For example, take a Battle Squadron consisting of eight ships, two would be told off to watch for signals from the Cruisers, two for signals from commercial ships, two for signals from Naval Shore Stations, two for watching Poldhu signals.

In each of these pairs one would be told off to carry out the transmitting duties on her line of communication, the other would be the stand-by ship to act as a check for the reception, and to be ready to take on the transmitting duties should anything occur to her opposite number.

For the purpose of exercise the ships would be probably told off in watches for transmitting duties in order to gain experience, and for the same reason the pairs would also change rounds.

Organisation of wave lengths.

Organisation of Wave Lengths.



The diagram represents a Battle Squadron of eight ships with Cruisers spread, and communication between Flag and Cruisers being carried out on "S" wave length.

"T" wave length is used for communication between Naval Shore Stations and a communication between H.M. Ships and Naval Shore Stations.

"Q" wave length is used for communication between Commercial Ships or Shore Stations and the Battle Fleet.

NOTE.—In ordinary peace cases where the ships of the Battle Squadron may not be in company, all H.M. Ships are to look out on "S" wave length.

Taking for granted that this organisation is being used, it is necessary to consider the procedure in certain special cases.

Suppose, for instance, it were necessary for a Naval Shore Shore Station to communicate direct with a cruiser. The Shore Station would know that the Cruiser was looking out for signals on "S" wave length. She would, therefore, call her up on "S" wave length.

The Cruiser would answer on "S" and the message from the Naval Shore Station would be transmitted on "S."

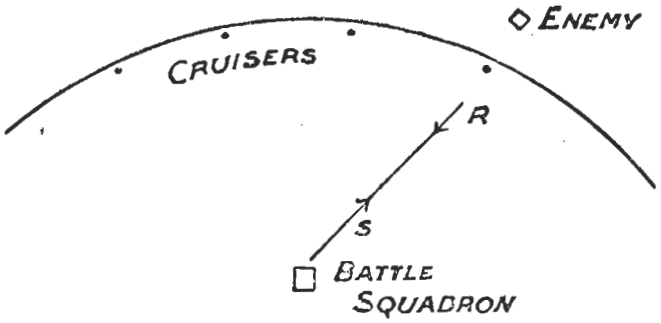
It may be argued that the message should be sent by the Shore Station on "T," but it is considered that at present, with the operators unaccustomed to tuned shunts, the message would be got through quicker if the operators do not have to hurriedly change their receiving instruments to another tune.

Conversely, if it were necessary for a Cruiser to call up a Naval Shore Station she would call up on "T," the Shore Station would answer on "T," and the Cruiser would send her message on "T."

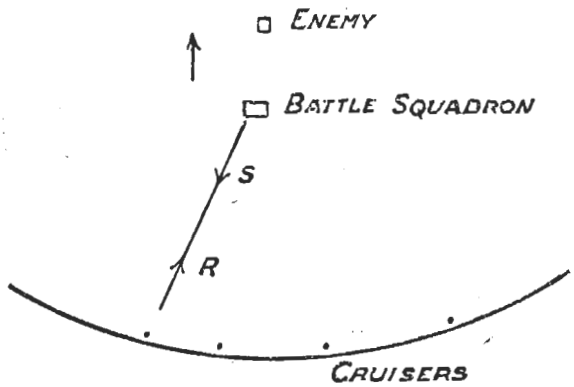
(17) The above is a very simple organisation, and the one it is recommended to introduce for at least the coming three months or until experience has shown that it needs modifying.

(18) It is matter for practical trial to ascertain whether, at the present moment, with operators unaccustomed to the use of tuned shunts, advantage is gained by complicating the general organisation by taking interference into consideration. A proposal for dealing as simply as possible with interference is given below, and should be tried as an exercise.

Example I. Suppose the Fleet to be searching for an enemy and a Cruiser sights him as shown in Fig. II. Organisation of wave lengths.



The enemy would try to jam the Cruiser by interfering in the wave length she is using. If, however, the Cruiser were to receive on a different wave length to the one she was transmitting on, the interference would not affect the reception of messages by her from the Battle Fleet, nor is it likely that the enemy, being at least as far away from the Battle Fleet as the Cruiser reporting, would be able to seriously jam, as her instruments would in all probability only be roughly tuned, and the Cruiser's messages would therefore be very much stronger.



Example II. Or suppose that the Battle Squadron are in chase of the enemy and the Admiral is trying to collect his Cruisers, the enemy may pick up the wave length he is using and try to jam, but if he is receiving on another wave length they will not interfere with his reception, nor should the Cruisers be seriously affected.

The disadvantage of having the Cruisers on one wave length and the ships for communication to Cruisers of the Battle Squadron on another is that a Cruiser may not know when another Cruiser is signalling, and so they may jam one another. This, however, could be got over by practice, with the receiving instruments. Another point about using two wave lengths as above is that the Cruisers cannot communicate amongst themselves, but this might be rather an advantage than the reverse, as it would stop the unnecessary conversation which so often goes on between Cruisers, and would tend to rivet the attention of the Cruisers on the central object, "the Battle Squadron," which is the first principle in communication by W.T. in a Fleet during war.

(19) Another use that "R" wave length might be put to during exercise would be as a "stand-by tune." In this case all ships and Naval Shore Stations in touch with the Battle Squadron would revert to "R" for a specified time, every hour, at which time the Flagship would make a general signal in this wave length as to the organisation he intended to pursue, or other information of general importance.

(20) Nothing has been said up to the present concerning the uses of "P" and "U" wave lengths.

It is intended at present to reserve "P" wave length for Destroyers, and "U" wave length for communication between Battle Squadron and Destroyers.

Short-Distance Signalling and Harbour Exercises.

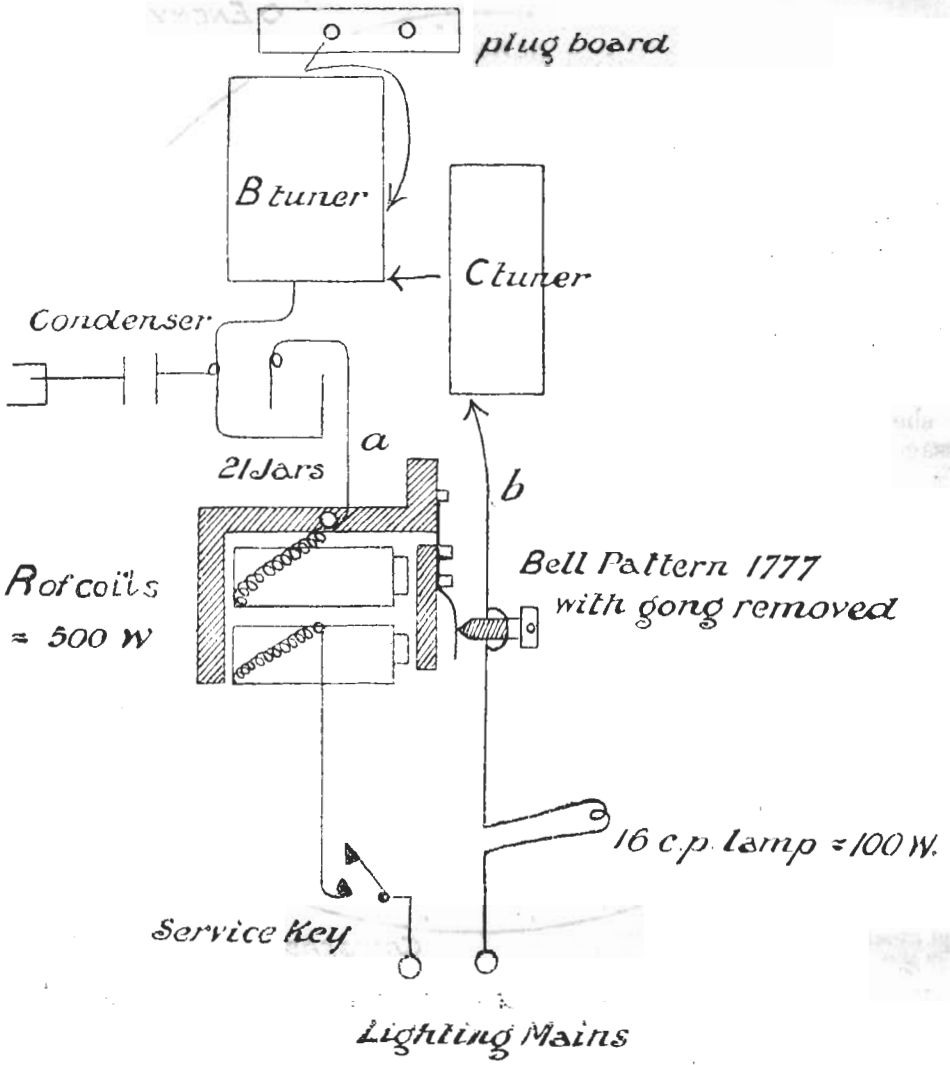
It is important that harbour exercises in all tunes should be carried out constantly without interfering with other wireless signalling in the Fleet. Short distance method used in Channel Fleet.

The following circuit has been found to be a satisfactory arrangement to use for this and other short-distance work.

Short-distance signalling.

All tunes and the Service aerial are used.

A buzzer is used, a suitable type being the old inker bell, which is capable of good adjustment of make-and-break.



The make-and-break of buzzer takes the place of the spark gap in the ordinary transmitting circuit.

A condenser of about 100 jars is placed between the bottom of the jars and earth to prevent an earth leak in the lighting mains burning out the coils of the buzzer. The range is approximately 5 miles; the make-and-break requires careful adjustment to get clear signals. Care must be taken that the leads marked *a* and *b* are the same as those used in the Service circuit so as not to alter the tuning.

The receiving circuit does not have to be altered; a long-distance call received can therefore be quickly answered by substituting the spark gap for the buzzer and joining up the coils.

The bell, Pattern 1777, lends itself for adjustment of various vibrations of the make-and-break, and it has been found that musical notes of a very distinct character can be produced by its means.

Short-Distance W.T. on Mediterranean Station.

The following is an abstract of report by Lieutenant Usborne Moore, R.N., H.M.S. "Venerable," on this subject, dated October 2nd, 1906:—

Transmitting circuit.

The transmitting circuit is shown in Fig. I.

The aerial used was 50 feet long from earth to either point E.F.G. The mutual inductance consists of 16 inches of 22-gauge wire; the range is varied by altering the length of spark and number of jars, the power used never exceeds $\frac{1}{4}$ kilowatt.

Receiving circuit.

The receiving circuit is shown in Fig. II.; the Service roof aerial being used. The low-frequency waves have little or no effect upon the magnetic detector, but pass through the tuner to earth; the high-frequency waves used, however, strongly affect the magnetic detector, the LS value being about 2.

Provided the adjustment of the tuner is kept low, this is a very effective method of cutting out atmospherics.

It was found by practical trial that— Practical results.

(1) This short wave method was practically unaffacted by atmospherics.

(2) The range was about 4 miles, and that unless the method of reception is known, an enemy 3 miles off would not be able to read the signals sent.

The buzzer system was tried, but was discarded on account of atmospheric interference. Further experiments will be carried out with a view to obtaining a set of short-distance W.T. independent of the main arrangements and not interfering with them. Buzzer system.

An insulated contact is arranged at the side of the Sending key, so that all signals made are received in a buzzer on the fore or after bridge. The sound of the buzzer is enhanced by placing it in a box with a megaphone mouthpiece. Communication between bridge and office.

Bridge can communicate with W.T. office by means of a Morse key actuating an inker in the office.

A reliable system of short-distance W.T. for use in a Battle Fleet would be invaluable when cruising without lights, and also in a fog. It is essential that the system should not in any way interfere with the use of long-distance Wireless. Remarks by Commander-in-Chief Mediterranean, 1598/5871 of 22nd October 1906.

FIG. I.

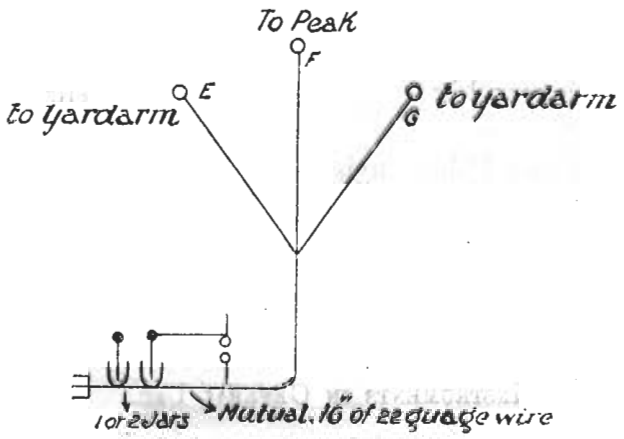
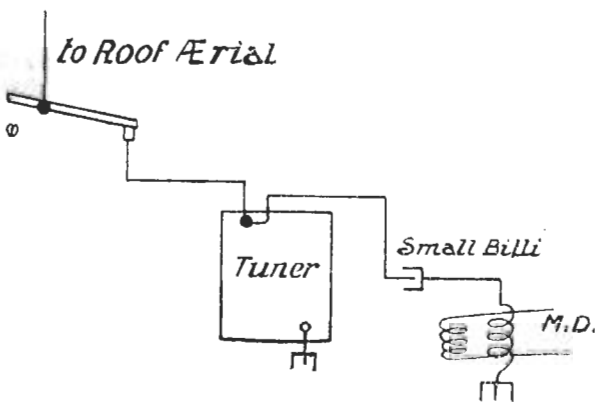


FIG. II.



The disadvantages of the system proposed in this report appear to be as follows:— "Vernon's" remarks on Mediterranean short-distance W.T. report.

(1) Extra complications due to the use of a separate aerial wire for transmitting, and extra wires and instruments for receiving.

(2) Interferes with the use of long-distance W.T. This, as pointed out in the Commander-in-Chief of Mediterranean's Minute, shows that the system is of little value in its present form. The fact that the wave length transmitted is so different to any of the Service wave lengths means that while the Battle Fleet is using the short-distance W.T. it will be entirely cut off from communication with its cruisers, &c. by long-distance W.T.

"Vernon's" remarks on Mediterranean short-distance W.T. report.

(3) Difficulty in changing from long to short-distance W.T.—Not only has the aerial and transmitting circuit to be altered, but also the receiving circuit has to be connected up in an entirely different way to that for long distance.

An advantage claimed for this system is that it is free from atmospheric disturbance; but this has to a great extent been overcome in W.T. work by the use of a musical note; and it is hoped that atmospherics will shortly be entirely got rid of with the aid of a tuned telephone. The arrangements for short-distance W.T. now in use in the Channel Fleet appears to be very greatly in advance of this system. In the Channel Fleet, the only alteration in the circuits necessary for going from long distance to short is the substitution of a buzzer spark for the long-distance spark. The same wave lengths are employed, and there is no disturbance to the organisation whether short or long-distance W.T. is being used. This buzzer system for short-distance W.T. seems to be on a really sound principle, consisting purely of cutting down the transmitting power until signals can only be sent a short distance; whilst the receiving instruments remain in normal adjustment, and ready to receive long-distance signals.

Recent experiments in the Channel Fleet have shown that the old type of Bells, Alarm, Pattern 1777, used as buzzers, are capable of adjustment so as to give out several different musical notes, and that by this means no difficulty is found in reading messages through atmospherics, while it has the additional advantage of giving immediate information that short-distance W.T. is being used.

Shore stations.

High-power W.T. stations are to be installed at Fraserburgh and Cleethorpes, on the East Coast.

The following stations will have 5-h.p. oil-engines: — Felixstowe, Scilly, Anglo (S. Wales), Corkbeg (Ireland).

The following will have 1¼-h.p. engines:—Dover, Portland, Alderney.

It is proposed to fit the stations as above during 1907.

Gibraltar and Malta will eventually have high-power stations.