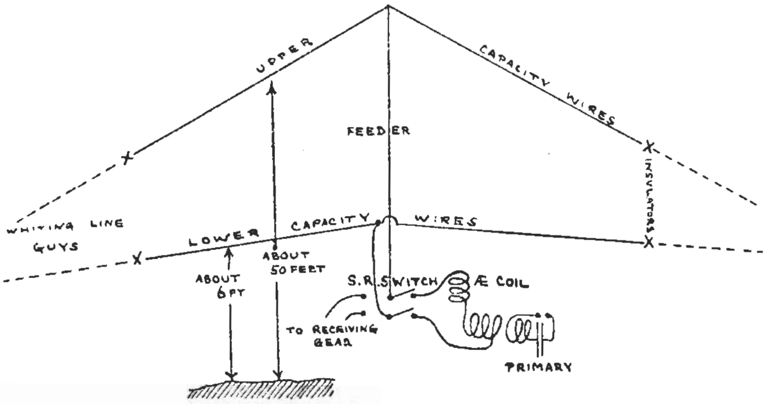
FIG. 2.

BALANCED AERIAL FOR SHORE W.T.



The capacity of this form of aerial is between the upper and lower sets of wires, instead of between the aerial and earth as in an ordinary aerial.

The mast is about 54 feet high, and the whiting line guys radiate out to a ring of pickets on 100 feet radius from the base of the mast. When used for portable sets, the upper aerial wires are each 70 feet long, and the lower aerial wires 65 feet long. Using six of each, radiating outwards at angles of 60°, the capacity is slightly under ½ jar, and the natural wave-length is about 720 feet. The wave required is 1,000 feet, and the mutual coil with a few turns of aerial coil suffices to give this.

The constants of the aerial will probably vary slightly with the nature of the ground.

Experiments have shown that this form of aerial is a very efficient radiator, and the tuning is sharp.

Preliminary trials with an extemporised portable set show that the range will probably be 100 miles over sea. Trials of extreme range and of range over hills and broken country have not yet been carried out.

When the mast is used for transmitting the 500 feet wave for harbour defence sets, only two upper and two lower aerial wires are used, and the former are shortened to 50 feet.

This arrangement appears to be efficient, very strong signals having been transmitted 25 miles, with every indication of greater ranges with fairly high aerials in small craft. Between steamboats with aerials not more than 12 feet high the range is expected to be 5 miles, and more is hoped for. For use in boats, a small aerial suitable for transmitting the 500 feet wave will be supplied. The range attained by small craft will depend entirely on the height of aerial obtainable.

The portable and harbour defence sets are quite suitable for use in a fleet auxiliary sending "S" wave. A special aerial must be rigged, and a former wound with a primary and secondary winding of Pattern 611 wire. It is advisable to wind two parts in parallel for the primary. If the adjusting arm is removed from the oscillator of the transmitter, the extemporised primary can then be joined between the condenser and spark gap terminals, and the condenser used as if it was that of a Mark I*. set. The aerial must be inductively and not directly coupled, as the centre point of the transformer secondary winding is earthed.

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## WIRELESS INSTALLATION FOR NAVAL AIR-SHIP.

### *Requirements.*

An installation suitable for the Naval air-ship has been designed during the year. The requirements of the installation are :—

(1) Lightness.
(2) Perfect safety of operation in an atmosphere containing gases of an explosive nature.
(3) A day range of 300 miles.

As regards (1), the total weight of the installation will be about 500 lbs. Weight.

As regards (2), the great difficulty has been with the earth employed. Difficulties with earth. It has been assumed that the average cruising height will be about 2,000 feet, probably it will often be more. This height precludes the possibility of using a trailing earth wire, a device which, incidentally, is open to many other serious objections, such as the difficulty of keeping the earth and aerial wires from fouling each other. This objection also applies to the case of a balanced aerial with no earth. The aluminium framework of the ship has therefore been used as a balancing capacity.

Frame-work of air-ship as counter capacity.

This framework consists of an inner and outer bottom, each composed of a number of aluminium longitudinal frames supported by transverse aluminium rings, each frame being further supported by diagonal phosphor bronze and aluminium bracing wires. These bracing wires are rove through the frames, which are of channel section. They are not secured to each other at their points of contact, and in this lies the chief obstacle to safe working.

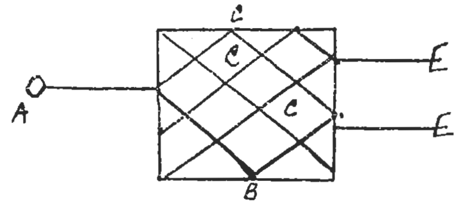
Danger of sparking in frame.

With the vibration which may be expected when the main engines are running, the bracing wires will make momentary contact with one another ; on separating, the path of the current in that particular wire will be broken, and the possibility of a spark taking place at once arises. The current flowing in the framework will be due to two causes, the currents induced in the metal framework and the earth currents.

Experiments in "Vernon."

Some experiments with a view to determining the extent of sparking due to these causes were carried out in "Vernon," a wooden frame with copper wires being used to represent the aluminium frame and the bracing wires of the air-ship. The transmitting earth lead of a Mark I*. installation was disconnected from the earthing ring in the office and led on deck through a second deck insulator. The upper end of this insulator was connected to the frame as shown in Fig. 1, the opposite side of the frame being earthed ; in this way, when sending from the set, the earth was only completed through the frame.

FIG. 1.



A. Deck insulator carrying earthing leads.
B. Wooden frames.
C. Copper wires.

The whole of the experiments took place after dark, and the number of frames was gradually increased. While signalling was being carried out, the frames were vibrated by hand. It was found that sparking took place at each junction of the wires when the number of frames employed was less than four. When four frames were used the visible sparking ceased. These frames were 6 feet by 4 feet.

Similar results were obtained using the Mark II. installation, the number of frames necessary to stop visible sparking being slightly greater. These tests were in excess of the actual working conditions, as the area of framework was small compared to the power used. It was also doubtful whether the sparks would be hot enough to ignite hydrogen.

Experiments at Barrow.

Early in November a trial section of the framework was erected at Barrow-in-Furness and similar experiments were carried out with a "C" tune set.

In this case three sections, each 12 feet square, were employed both in the inner and outer bottoms of the air-ship. The aerial was joined up in a similar manner to that already described. The whole framework was then vibrated, but no sparking took place. A number of these experiments was made, using the actual frames of the air-ship, but in no case could any sparking be detected. The sparking which may result from induced effects could not be investigated on this occasion, as the framework was built in an iron shed, which would shield it to a very large extent from inductive effects since by far the greater part of the aerial was outside the building.

Instruments.

All instruments have special arrangements to permit of their being safely worked in gases of an explosive nature.

Alternator and exciter.

The alternator and exciter are mounted on the same shaft and are of specially light design. The voltage is 200 volts R.M.S., the frequency 250 cycles per second, and the output 3 Kw. The weight of the alternator and exciter is about 100 lbs. The machine is placed in the after gondola close to the main engines and is driven by them at 1,000 revs. per minute.

Wireless room.

The remainder of the installation is placed in the wireless room some 200 feet away. A special concentric cable with aluminium outer casing is run between the alternator and wireless room.

Transformers.

Two transformers of light design are being purchased, one being air cooled and the other oil cooled ; these will be tried to determine the more suitable type.

Oscillating circuit.

The oscillating circuit consists of an aluminium primary, mica condenser, and a totally enclosed spark gap. The condenser is similar in design to the rejector capacity. It consists of a number of elements joined in series and having a total value of 50 jars. The condenser is placed in oil. The protecting points are placed in a light metal case made air-tight by means of a woodite washer ; this is necessary in view of the possibility of hydrogen being present.

**Spark gap.**

The spark gap will be totally enclosed and the design has presented many difficulties due to the high frequency of the power supply causing arcing. Many experiments have been carried out, but a final design has not yet been decided on. The use of a blower or of a rotating gap will be avoided if possible. A fixed gap of 4mm. is required.

**Mutual coil.**

The mutual coil is mounted on the same base as the primary and can be moved in or out to alter the coupling.

**Aerial.**
**Wave length.**

The aerial consists of a single vertical wire hanging downwards. It will probably be 1,000 feet in length. The wave length transmitted will be approximately the fundamental wave length of this aerial. There will be no aerial coil and the tension at the deck insulator will therefore be kept low. The aerial is supplied on a revolving drum, and when in use it can be readily reeled up for purposes of tuning or when coming to ground. The mutual coil is connected by a brush to the revolving drum.

**Sending key.**

The sending key is combined with an earth break which performs the operations of a send and receive switch. The key and switch are combined in a box which is kept airtight by soft woodite washers.

**Earthing leads.**

The earthing leads are led up from the earth break to several points on the frame work of the ship and of the wireless room.

**Receiving gear.**

The receiving gear employed is a Crystalite detector set similar to the "Service Type B" receiving set.

The wireless room is divided into two parts, the transmitting and receiving rooms. In the latter are placed, besides the receiving instruments, the sending key, double pole switch, and field regulator.

**Double pole switch.**

The double pole switch is placed in the alternating mains between the transformer and the alternator. It is arranged so that—

(1) The cover of the case cannot be removed unless the switch is broken.
(2) The switch cannot be made unless the cover is on.

**Other instruments.**

The ammeter, voltmeter and frequency meter are all of usual design, but aluminium is employed as far as possible. It is anticipated that this set will be working early in 1910.

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## WIRELESS TELEGRAPHY FROM GERMAN AIR-SHIPS.

The following report has been received from the Military Attaché on wireless telegraphic communication from German airships. It should be observed that this report refers to a ship of the semi-rigid type, and not to one similar to that building for the Navy at Barrow-in-Furness.

"A wireless installation has been fitted to the German air-ship 'Gross II.' and successful experiments were carried out at Tegel on the 16th August 1909.

Communication was established between the wireless stations at Nauen, Frankfurt-on-Main, and Stuttgart. The metal portions of the ship were wrapped in canvas."

The approximate distances between the various stations are as follows:—

| | |
|---|---|
| Tegel to Frankfurt-on-Main | 250 miles. |
| „ „ Stuttgart | 275 miles. |
| „ „ Nauen | 14 miles. |

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## EFFECTS OF LIGHTNING CONDUCTORS AND RIGGING ON W.T. SIGNALLING.

**Effects when transmitting.**

The effect of a conducting body near to the aerial, when transmitting, depends on the size, shape and position of the body, but it is different under each of the following conditions:—

(*a*) When the body is highly insulated from earth (and from other conducting bodies).

(*b*) When the body is but indifferently insulated from earth or connected to earth through a conductor of comparatively high resistance.

(*c*) When the body is connected to earth through a conductor of comparatively low resistance.

Under conditions (*a*) the current induced between the body and earth will be very small, and its effects can be neglected; but if the body is fairly large or it is placed fairly near the aerial it can still have the effect of causing brushing.

Under the conditions (*b*) the currents induced between the body and earth may become great; as it flows through a path of high resistance there may be a considerable loss of energy; and under certain conditions there may be considerable local heating. The loss of energy will mean a reduction in the signalling range, and the local heating may in bad cases set fire to wooden masts, blocks, &c.

Under conditions (*c*) although the induced current would be greater than under conditions (*b*), the loss of energy will in general be less, because the current has a path of low instead of high resistance. The reduction of the signalling range will not be so great as under conditions (*b*), as a portion of the wireless energy (that is represented by the induced current) will be reflected back from the conductor and be usefully employed instead of being entirely absorbed in resistance, as it would be under conditions (*b*).

The lower the resistance, the less the loss and the larger the percentage of energy that is reflected back.

In addition to the losses caused by the induced currents just considered, conducting bodies near the aerial will cause it to brush. The loss of energy, and therefore of range, caused by brushing may be very serious, especially when the aerial is working at approximately its maximum power. If the conducting bodies are well insulated from earth they will not cause the same brushing as if they are connected to earth by either a high or low resistance path. Conducting bodies that are near the aerial and are also connected to earth may cause subsidiary waves to be transmitted; these waves may cause interference with the reception in a neighbouring ship, especially if receiving on a short wave such as D tune or "short distance." In a ship that is fitted with "short distance" they may lead to bad mutual interference between the main and short distance wireless.

Effects when receiving.

Earthed bodies near to a receiving aerial will also have injurious effects. If they are connected to earth by paths of low resistance they will screen the aerial and cause part of the incoming waves to be reflected away into space instead of being absorbed by the aerial.

If they are connected to earth by paths of high resistance, part of the incoming waves will be expended in inducing currents, the energy of which will be wasted in the high resistance path over which they flow.

Best working conditions for a ship.

From these considerations it follows the best conditions from a W.T. point of view are those of conditions (*a*), that is high insulation, but, if this cannot be obtained, perfect electrical connection (conditions (*c*)) are preferable to faulty insulation or imperfect connections (conditions (*b*)). In a ship the lower part of the mast is of steel. It is barely practicable to insulate the lower stays. Numbers of wires are taken up the mast, for instance cables to the masthead flashing lamp, fire control leads, &c. Also the masts, halyards, &c., are liable to receive a semi-conducting coating of salt, carbon, &c.

It is impossible, therefore, to obtain the best conditions (*a*), and it is desirable to obtain the next best (*c*). This can be done by fitting lightning conductors of low resistance, and with thoroughly good connections. These lightning conductors will take a large proportion of the currents that would otherwise take the other paths that are available and that are of higher resistance.

It is most desirable, however, to obtain the best conditions, (*a*), wherever possible. As there are a large number of stays and they come in many cases very near to the aerial or feeders, it is a decided advantage to insulate them in as many places as practicable. If they are not insulated the loss in range, due to their screening effect on the aerial, and the waste caused by brushing, would have a marked effect on the range of the ship.

Wherever lightning conductors are fitted, it is most important to see that they have good low resistance connections made between them and all mast bands, metal fittings, &c. that come near to them; or, where in any particular instance connection is undesirable, the lightning conductor should be kept well insulated and outside the limits of any sparking likely to be caused between the fitting and the lightning conductor by induced W.T. effects. If these precautions are not taken, loss of energy and local heating will probably occur at all places where there are faulty connections or bad insulation, with possible resultant damage.

It would also be desirable, wherever possible, to avoid any imperfect contacts between different conducting bodies; for instance, the hemp serving which separates the wire from the thimble, at the ends of wire stays, is very liable to get sparked through and set on fire by induced W.T. currents; while this sparking is going on, and afterwards when the connection through the burnt yarn is one of high resistance, there is a continual waste of energy. To obtain the best effects, therefore, such imperfect contacts should be short circuited where they exist. It may be found, however, that short circuiting them will in some cases decrease the receiving efficiency, showing that the insulation had previously been fairly good for receiving voltages, and that the screening has been increased by short circuiting it. On the other hand, the sparking that occurs when transmitting may be more harmful than a slight decrease in receiving efficiency, especially in ships fitted with "short distance," and the sparking and burning away of the yarn may be considered objectionable.

In some cases when short waves are being used and long lengths of wire are concerned, it will be found better to earth the ends of the wires instead of insulating them; the earth connection throws the wire further out of resonance with the wave. It has been found better when receiving D tune on a small aerial, to earth the main aerial rather than to insulate it.

Conditions at shore stations.

The conditions at shore stations differ from those in ships, and if lightning conductors are not fitted it is possible to approach nearly to the best conditions (*a*) above. If there is a good earth connection at the shore station, one approximating to that obtainable in a ship, the shore station should be more efficient than a ship fitted with a similar installation.

It has been approved to fit portable lightning conductors, only, to the masts at medium and large power stations; these conductors are triced up whenever the aerial is lowered. When the aerial is up it forms an efficient lightning conductor and affords sufficient protection for the masts; the buildings are further protected by being screened by the earth wires.

### INSULATION OF RIGGING.

Complaints having been received as to the burning away of the old lignum vitæ rigging insulators, due to sparking taking place across them when the transmitting gear is in use, porcelain rigging insulators have been introduced. N.S. 16/1382, 28.1.09.

The porcelain rigging insulators will not burn away, but sparking across the insulators may still occur in some cases. The sparking in the rigging is undesirable for several reasons, among others that the flash may give away the position of a ship at night, and the noise is objectionable and may interfere with other work in the ship.

If it is found that sparking across occurs at any particular point, this can be obviated by inserting another insulator in series with and close to the one at which sparking is experienced.

The tendency to spark in any particular part of the rigging will depend on local conditions, and as it is impossible to foresee exactly where these conditions will be bad, the number of insulators has not been increased, but ships in which bad sparking is experienced should demand the necessary extra insulators to get rid of the sparking as described above.

### COUPLINGS AND SELECTIVITY.

With regard to the Service II., it was fully realised in the design of the set that, with a coupling of 7 per cent., the aerial even in the largest ships would be overloaded, and brush badly with the maximum power available in the primary circuit. In the preliminary experiments carried out, it was found that this tight coupling gave the maximum range, using the magnetic detector and Service circuit. It was, however, considered that future developments in the receiving circuit would tend towards looser couplings than 7 per cent. becoming the most efficient for range with the added advantages of selectivity. Even with the Service receiving circuit and the magnetic detector a sufficient range for all practical purposes would be obtained with the Mark II. set, if a considerably looser coupling than 7 per cent. were used.

Up to the present very small attention has been paid to this most important matter of sending with loose couplings so as to obtain selectivity and non-interference between ships in company on the various service wave lengths, more attention being naturally at first paid to getting the maximum range with the new instruments, and much valuable information has been obtained by so doing. The time, however, has now arrived for loose couplings to be adopted, and definite rules laid down to prevent interference.

Some interesting experiments have been carried out by the Channel Fleet, and also by "Vernon," to ascertain how loose a coupling is necessary when using full power, in order to allow the organisation of W.T. signalling to be carried out by ships in company, without interference.

It was found that, by using a large condenser value in the rejector circuit, a 1 per cent. coupling was required for the sending circuit to enable the organisation to be carried out without interference. With this coupling the range is reduced considerably with the magnetic detector, but with the crystalite receiver the range between ships carrying large aerials should be as much as 500 miles by day. Another advantage of using a loose coupling of 1 per cent. is the decreased tendency to brush. The brushing, besides having the disadvantage of making a noise and tending to burn insulators, discloses the position of the ship at night, so that from this point of view alone, the introduction of loose coupling with large power is necessary. To a great extent, brushing can be decreased by increasing the number and spread of the feeders for the aerial, but, at the same time, it must be remembered that the less the tendency to brush, the more efficient is the circuit, and that, directly brushing starts energy is being wasted, and no increase of range is obtained.

As regards the Mark I*. installation, it is very important to prevent sparking in the rigging, which is most likely to occur in small ships; in order to do this it is necessary to loosen the coupling, and increase the impedance as laid down in the Mark I*. handbook, page 43, remembering that a standard mutual strength of 7 should be maintained between inter-communicating ships.

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## RECEIVING CIRCUITS AND DETECTORS.

During the last two years a number of new devices for the detection of electro-magnetic waves have been placed on the market, many of which were stated by their inventors to be remarkably sensitive. These claims have undoubtedly been based to a certain extent on "freak" distances, obtained at night on comparatively short waves, but it has been considered desirable that the capabilities, under Service conditions, of the more promising of the various detectors should be definitely ascertained with a view to the introduction of some more sensitive receiving device, either in addition to, or in lieu of, the magnetic detector, and comparative trials of the various receiving devices are now being made.

By the introduction of a new detector it is hoped to obtain, in addition to an increase in range, greatly increased selectivity, and also the efficient use of a lighter coupling of our transmitting circuits than has hitherto been possible without serious loss of range.

This may be explained as follows :—

It is very desirable that the type of receiving circuit used shall be adaptable to the particular persistency of the waves emitted by the transmitting station.

The magnetic detector is primarily influenced by the amplitude of the first wave of a train of oscillations, and the duration, or persistency, of the waves has comparatively little effect in increasing the strength of signals. On the other hand, a thermo-electric detector experiences an accumulative effect from the whole wave train, and is consequently better adapted for the reception of comparatively undamped waves than the magnetic detector. It is evident that the tuning will be sharper, and consequently the selectivity greater, if the transmitted waves are fairly persistent, *i.e.*, if the transmitting apparatus is lightly coupled.

It is, therefore, desirable to adopt a detector which is influenced by the mean value of the complete train of oscillations rather than by the amplitude of the first wave.

The following remarks on receiving circuits, which specially refer to the design of the receiving set type B, may make this point clearer :—

The characteristics of each detector determine the rate at which it is best adapted to absorb energy from the circuit to which it is coupled, and the rate at which a circuit imparts its energy to a detector is controlled by the relative proportions of capacity and inductance. The best capacity and inductance in the intermediate oscillatory circuit of the receiving set type B, for the reception of signals on a given wave length, are, therefore, fixed, and this circuit is designed so that the best relative values of capacity and inductance for all waves from " D " to " Clifden " are available.

The considerations which govern the coupling of the intermediate circuit to the aerial circuit depend both on the characteristics of the detector and on the persistency of the incoming waves,

It has been seen that there is a particular rate of absorption of energy which is best suited to the detector.

Now, if the intermediate circuit is very tightly coupled to the aerial, the detector cannot absorb the energy fast enough, and it passes backwards and forwards between the intermediate and aerial circuits, the surplus being wasted in damping losses in these circuits.

If, on the other hand, the intermediate circuit is too lightly coupled to the aerial, the aerial circuit is unable to part with its energy as fast as it receives it and rapidly reaches a state of equilibrium, only sufficient of the energy of the incoming waves being absorbed by the aerial to maintain its oscillations, the remainder of the energy of these waves passing on in the form of ordinary electro-magnetic waves in the ether.

Considering the effect on the receiving circuit of the persistency or otherwise of the waves emitted by the transmitting station, it is evident that sharp tuning can be best obtained by selecting a detector whose best rate of energy absorption is slow, and which is therefore preferably coupled fairly lightly to the aerial. Such a detector will undoubtedly receive heavily damped signals efficiently, and is therefore no worse in this respect than a detector which is principally influenced by the amplitude of the first wave of a train of oscillations. At the same time its superiority for the reception of persistent, or particularly undamped waves, whose initial amplitude is probably small, is very evident, provided the coupling of the intermediate circuit to the aerial be arranged so that the detector is absorbing energy at its best rate.

For the above reasons the receiving set type B has been arranged with a sliding primary in order that this coupling may be adjustable, so that the maximum effect may be obtained with the detector for waves of various persistencies.

It is found in practice that the actual variations of the coupling of the receiving circuit for reception from different stations fitted with spark telegraphy is very small. When, however, signals are received from stations fitted with so-called continuous wave systems, the effect of loosening this coupling is very marked, and the tuning is found to be much sharper.

It may be of interest to consider shortly the more important of the detectors which have been tried during the year or are now on trial.

Electrolytic detector.

*The Electrolytic* is well known and has been given an extensive trial both in the " Vernon " and at sea. The main objections to its use are the difficulty of making efficient " points " and the danger of these burning out due to external interference.

The following are probably both thermo-junctions and rectifiers.

Carborundum detector.

*The Carborundum* consists of a single crystal of carborundum in contact with some suitable metal. It is rather more sensitive than the magnetic detector, but requires a potentiometer of the order of 12 volts. which is an undesirable complication.

Radian detector.

*The Radian* consists of a thin metallic wire, the point of which rests on a substance which is thought to be galena. Its adjustment is rather difficult and there is a marked deterioration in its efficiency after a short period of use.

Pyron detector.

*The Pyron*, the composition of which is unknown, consists of two substances in contact. It is rather difficult to adjust and is not quite so sensitive as the crystalite.

Graphite-galena detector.

*The Graphite-Galena* is composed of these two substances and is the detector used by Baron Von Lepel for his system of W.T. It is not as sensitive as the crystalite, but appears to be slightly more selective and stable. The main difficulty is to obtain really sensitive galena (a sulphate of lead), different samples being found to vary considerably in this respect.

The two following detectors depend for their action on the unilateral conductive properties of the rarified gas in an ordinary incandescent lamp when burning. It is doubtful how far it is correct to consider these "valves" as pure rectifiers or if they merely become momentarily conductive when exposed to high frequency oscillations, so allowing a slight leakage current to pass through the telephones from an external battery.

Fleming oscillation valve.

*The Fleming Oscillation Value* consists of an incandescent lamp with a Tungstein filament surrounded by a metal cylinder. The filament and the cylinder form the terminals of the detector. It is about as sensitive as the magnetic detector, but is extraordinarily selective.

Audion detector.

*The Audion*, invented by Dr. Lee De Forest, employs the sam principle as the Fleming valve, and is somewhat similar.

## CRYSTALITE DETECTOR.

"Perikon."

In addition to the detectors described above, the Perikon detector, referred to on page 40 of W.T. Appendix to Annual Report, 1908, has had further trials, and in consequence of the satisfactory results obtained in "Vernon" it has been decided to issue a number of these detectors to ships for further trial at sea.

"Crystalite" detector.

This detector has been renamed the "Crystalite Detector," and a new receiving set known as the "Type B receiving set" has been designed for use with this and other sensitive forms of detector.

N.S. 3558/9729
6.7.09.

It has been approved to issue 45 "B type receiving sets," each including two crystalite detectors, for trial in ships and shore stations.

Instructions for the use of these sets are given below and will be issued with each set.

## INSTRUCTIONS FOR THE USE OF RECEIVING SET, TYPE B.

This receiving set has been designed to enable experience, under sea-going conditions, to be obtained with detectors more sensitive than the magnetic detector. The crystalite detector has been selected as being, at present, the most suited to Service requirements.

General considerations.

It is anticipated that this detector will enable signals to be read with ease, which would be completely inaudible on the magnetic detector. At the same time, it is hoped that increased selectivity, possibly accompanied by a certain reduction of the maximum range, may be obtained by the use of the variable coupling and the introduction of an oscillatory circuit between the aerial circuit and that in which the detector is placed.

All sensitive detectors, which have yet been tried, suffer to a greater or less degree from instability when exposed to very powerful external interference and also from the effects of the ship's own transmitting apparatus.

An electrically controlled "protecting switch" is being provided which automatically breaks the circuit to the detector when sending.

The following are the main points on which information from sea is required :—

### 1. *Reliability.*

(*a*) Can the detector be relied on for watch-keeping?

(*b*) With ships in company whose transmitting circuits are adjusted for a 1 per cent. coupling, can the organisation of Service wave lengths be used without interference?

(*c*) With ships in company, does the detector suffer when a ship is sending on the same wave length as the receive-circuit of another is tuned to?

(*d*) Do atmospherics tend to make the detector insensitive?

(*e*) Can atmospherics be cut out to a greater or less extent than with the magnetic detector?

(*f*) Can the Telegraphist ratings be relied on for getting the circuit into accurate adjustment?

### (2) *Comparison between the Crystalite Detector and the Magnetic Detector.*

(*a*) How do they compare with regard to sensitiveness, reliability, and selectivity?

(*b*) Do the extra complications in adjustment of the circuit warrant the introduction of the detector into the Service?

(*c*) If so, should it be supplied in lieu of or in addition to the magnetic detector?

(*d*) If in addition to, when should the one or the other be used?

The receiving set consists of the following :—

Description of receiving set.

*The Induction Tuner* wound with a primary of about 170 mics., a switch being arranged to put in 20 mics. only, for "P" and "D" tunes. The secondary is provided with a fourway switch, the maximum inductance being about 2,500 mics. The stops of this switch are marked A to D ; for "P" and "D" tunes the switch should be put on stop B, for tunes "Q" to "W" on stop C, and for large power shore stations on stop D. The coupling between the primary and secondary is adjustable.

*The Strengthener*, consisting of a variable inductance in series with the secondary of the induction tuner. The maximum value is about 5,000 mics.

*The Telephone Condenser* has a capacity of approximately five jars. The dielectric is mica, and importance is attached to its insulation resistance.

*The Crystalite Detectors*, with containers, are supplied mounted, one on either side of the two-way switch.

Method of connecting up.

This is shown diagramatically in Plate VII. A two-way switch is provided so that either the magnetic detector or the crystalite detector can be used. The tuned shunts are common to both.

Telephones.

To obtain the best results from the set, it is necessary to use telephones of a higher resistance than those provided for the magnetic detector. One pair of telephones, wound to a resistance of approximately 1,000 ohms per receiver, is supplied with each set.

Crystals.

The crystalite detector consists of two crystals, one being zincite and the other bornite. Four or five of the former are provided, set in a metal cup, and one of the latter fitted to a spring rod.

The sensitiveness of the detector depends on the nature of the contact between the two crystals, and it will be found that this varies very considerably as the bornite crystal is shifted to different spots on the zincite.

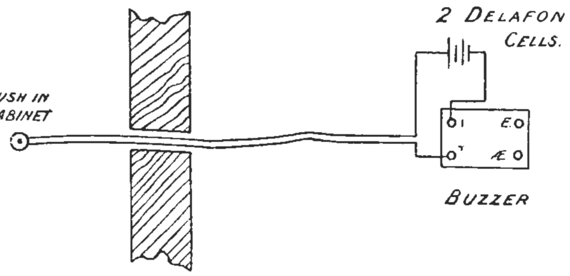
Should the bornite become smooth, the detector is found to be very insensitive. It is therefore *essential* that there should be no grinding action in making the contact, but the bornite crystal should always be *lifted clear of the zincite*, and then gently touched against it until a sensitive spot is found.

Testing for sensitiveness.

To test if the detector is in a sensitive condition a buzzer must be fitted, as shown on Fig. 1.

FIG. 1.

DIAGRAM OF BUZZER CIRCUIT



This buzzer must be placed outside the silent cabinet, but should not be fixed to it. Two leads are brought inside to a push within easy reach of the operator, and the sound of the buzzer is conveyed to the receiving instruments through these leads.

Various positions of the bornite crystal should be tried until the buzzer sounds loudest in the telephones, and both detectors should be made equally sensitive.

Explanation of the circuit.

The complete circuit for use with the crystalite detector is shown in Plate VII. It will be noticed that the primary of the induction tuner is inserted in the acceptor circuit in place of the magnetic detector. Since the crystalite detector requires a fairly high voltage for obtaining the best results, a step up transformer known as the induction tuner is provided, the coupling between primary and secondary being variable between wide limits.

Various forms of circuit have been tried, but the one best suited to selectivity is that shown in Plate VII. where an intermediate oscillatory circuit, consisting of the secondary of the induction tuner, the strengthener and the small acceptor condenser, is tuned to the same L.S. value as the remainder of the oscillatory circuits (viz., aerial and tuner, rejector circuit, acceptor circuit) for the wave-length it is desired to receive. The crystalite detector with the telephone condenser in series is placed across the terminals of the No. 4 Condenser.

The *Strengthener*, which is merely a large adjustable inductance, of approximately 5,000 mics., is fitted to perform the functions of keeping the dimensions of the secondary within reasonable limits and of enabling the coupling to be loosened, without sliding the primary, by the transference of part of the inductance from the secondary to the strengthener.

If no strengthener were used it would be necessary for the secondary to be very large indeed to make the intermediate circuit suitable for the reception of long waves such as are sent out from high power stations, and further, on account of the necessity for the proportions of inductance to capacity of the intermediate circuit having to be in the ratio of about 6,000 to 1 in Service units, which is found in practice to be the best proportion when working with the crystalite detector. In addition, such a large secondary would entail a long travel of the primary on its slide to reduce the coupling to the required amount.

The action of the crystalite detector is both that of a thermo-junction and of a rectifier ; for the purposes of explanation it is easier to consider it as acting in the former capacity only.

The oscillations set up in the aerial and acceptor circuit during the reception of a signal are communicated to the intermediate circuit, the potential across the small acceptor condenser being considerably stepped up both by the induction tuner and also by the comparative dimensions of inductance and capacity in the circuit. This potential acting on the detector heats the minute point of contact between the crystals, thus setting up a certain difference of D.C. potential, the bornite becoming the positive and the zincite the negative pole of a thermo cell. A small current, due to this thermo cell, will flow through the telephones, the circuit being completed through the