BROWN'S TELEPHONE RELAY.

Experiments with Brown's telephone relay, mentioned in last year's Annual Report (page 26), have been continued at Horsea W.T. Station, but, though many devices have been tried, the difficulty due to its sensibility to shock has not yet been overcome. Trials are at present in abeyance, but will shortly be continued with some new instruments and special reeds which have just been received in "Vernon." In view of the extremely good reports which are being received about the Dennis detector, the importance of the Brown's relay has, from the Service point of view, been greatly lessened, and the advantages in simplicity and cost of the former, when compared with those of the latter, are very great.

Telephone Leads for Headgear for W.T.

Referring to page 26 of the Annual Report, 1910, the new pattern leads therein referred to have been tried at sea, but the results have not been at all satisfactory, as it was found that, in use, the conductor became fractured at the end of the twine lashings, showing that stiffness in any part of the lead was a cause of immediate trouble. Those leads ordered subsequently to this discovery have been modified in order to eliminate as far as possible any sort of stiff lashing, and, where a lashing is essential, this has been made as narrow and flexible as possible. Trials will be carried out in "Vernon" and at sea with this modified type of lead as soon as possible, and it may prove necessary to entirely redesign the present type of telephone lead.

Several different types of telephone leads have been made up in "Vernon" for trial, consisting of Patt. 726 wire, also of Patt. 745 wire, but the latter is not considered very suitable, as each of the separate wires (brass) are laid up round a cotton heart which renders the wire unsuitable for soldering.

It is thought that some form of connection requiring no solder, of which there are many types on the market, may prove a solution to the problem, in which case the latter type of wire would be quite suitable.

TYPE "C" RECEIVING SETS.

Considerable delay has been experienced in getting these sets to sea, on account of the boxes, screening, not being delivered. The makers apparently have had great difficulty in getting the raw material for these instruments.

The sets have now, however, been issued, but it is too early yet to give any ideas as to the practical working results.

One point of importance has been noticed. When using a tight coupling in the induction tuner, *i.e.*, when the primary is less than 2 inches out, it is found that the adjustment of the acceptor capacity is appreciably different from what it would be if a weak coupling, say, 3 inches or more, were being used to receive the same wave. For example :—

Receiving "W" wave in "Vernon" from Aberdeen, induction tuner adjustments, Primary D, Secondary K, the following adjustments giving signals about R. 8—

Acceptor capacity - - - - -	3·7
Condenser No. 7 - - - - -	0·41

when the coupling is tight (primary coil close up), have to be modified to—

Acceptor capacity - - - - -	1·15
Condenser No. 7 - - - - -	0·24

when the coupling is weakened (primary coil 2 inches out).

If these modifications are not made, signals are reduced in volume from strength 8 to about strength 2.

This alteration in tuning adjustments is found to be very marked with the primary coil in positions between 0 inches (*i.e.*, close up) up to about 2 inches. From this point outwards the tuning adjustments remain very much more constant, and, in fact, hardly require any alteration.

This variation would appear to be a very great disadvantage when considering the Type C set in comparison with the Type B set, but it has been found that, as a general rule, no increase in strength of signals is obtained by tightening the coupling beyond a certain point; and this point is reached when the primary coil is up to about 2 inches, so that the above disadvantage would appear to be more apparent than real. At the same time it is pointed out that this is only a preliminiary statement as the result of the first trials of this gear, and it should not therefore be taken as a hard-and-fast rule.

QUENCHED SPARK SYSTEM OF W.T.

(*See also* p. 40, A.R., 1910.)

Experiments with the "Vernon's" quenched spark installation have been continued throughout the year.

The difficulties in obtaining a reliable gap, that is, one which will work continuously without attention for some months, have been very great.

A considerable amount of trouble in the form of pimpling of the sparking surfaces, and of irregularity in the results obtained, was experienced with a set of gaps purchased early in the year. These troubles were eventually traced to the impurity of the copper used, it being found, when a specimen was subjected to chemical analysis, that a very low grade of copper, containing a large proportion of zinc and tin, had been employed.

A number of gaps were then purchased in which the copper employed for the sparking surfaces was specified to contain not less than 99·3 per cent. of pure copper.

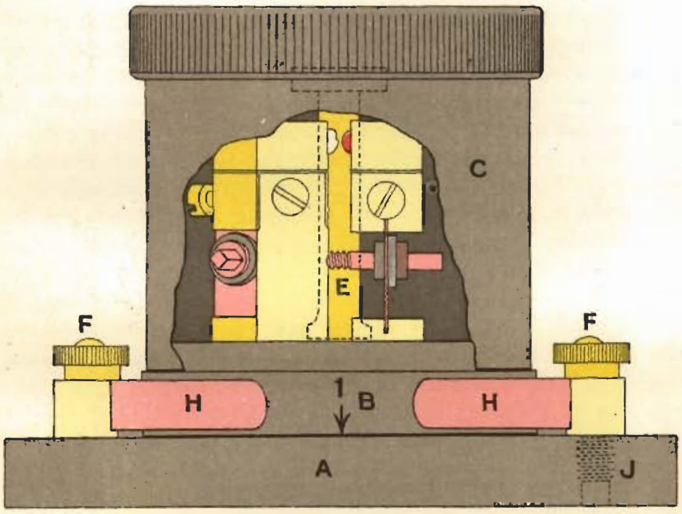
At the same time further endeavours were made to remove all trace of oxygen from the inside of the gaps. In addition to the oil seal mentioned in last year's Annual Report, a chamber containing oxygen absorbent was fitted, the air inside the gaps being bubbled through this liquid before sparking took place. It was found that in this case the oxygen was not entirely removed, the amount left being sufficient to disturb the correct working of the gaps. Difficulties were also experienced in rendering this circuit truly air-tight. It was then decided to fill the gaps after adjustment with hydrogen or nitrogen, and then to permanently seal them. This is the method now employed. In this connection trouble has been experienced owing to impure hydrogen being at first supplied, and also owing to deleterious gases being given off from the varnish placed round the sealing washers. These difficulties being overcome, a fresh start was made with the plates having the pure copper sparking surfaces. It was found that the gun-metal casting which comprises the base of the gaps, was of a very porous nature, and could not be made perfectly gas-tight, even when considerable time had been expended tinning the back and front of the gunmetal. The presence of even a very small leak makes it impossible to set up any of the results obtained as standards, and makes any detailed mathematical analysis of the measurements taken worthless and a waste of much valuable time.

To obtain general results as to range and conditions of working, a small set consisting of four gaps immersed in oil has been installed. It has been found that the oil seals the very small holes in the casting, but does not penetrate to the inside. This condition, although permitting some general conclusions being drawn, is not sufficiently stable to warrant implicit reliance being placed on the measurements obtained. In the course of the experiments, sparking surfaces made of silver, and of copper, coated with various types of "galvanit," have been tried, but in every case the only conclusion arrived at was the paramount importance of excluding all traces of oxygen from within the gap.

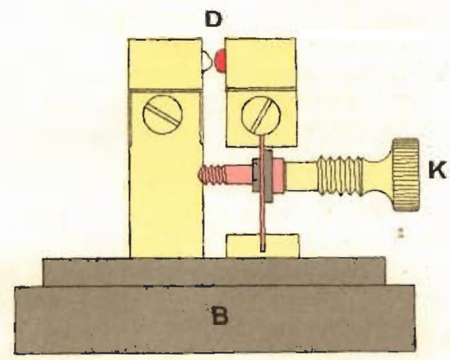
All the difficulties mentioned above having been traced down to their origin, and steps having been taken to avoid their recurrence, it is hoped that a reliable experimental set for trial

NEW DENNIS DETECTOR.

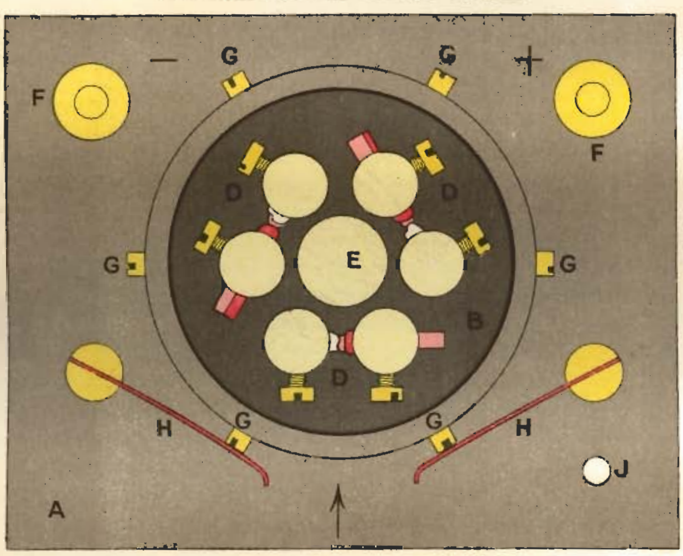
ELEVATION.



DETAILS OF ONE DETECTOR.



PLAN (Cover removed)



REFERENCE.

A	MAIN EBONITE BASE.
B	REVOLVING EBONITE BASE.
C	EBONITE COVER.
D	DETECTORS. (THREE IN NUMBER.)
E	CENTRAL SPINDLE. (SECURING REVOLVING BASE.)
F	TERMINALS.
G	CONTACTS FOR DETECTORS.
H	SPRING CONTACTS
J	HOLE FOR STOWING KEY.
K	KEY FOR ADJUSTING PRESSURE BETWEEN STONES.

Malby&Sons.Lith.

at sea will shortly be issued. With this object in view a number of gaps of improved design have been ordered, and the design of the other parts of the circuit has been proceeded with. In the new gaps, the arrangements for cooling the sparking surfaces (a matter of first importance) have been greatly improved. The sparking surfaces are now relatively thin, and so arranged that a current of air is thrown directly on to their non-working faces. The gap is much lighter and handier than in the previous designs, and the arrangements for connecting up the steadying resistances, removing faulty gaps, &c. are much improved.

The general idea of the new set is that the complete spark gap shall consist of a number of units, each unit comprising eight gaps joined in series. These units, with their steadying resistances, are arranged to slide into a carrier, and, when in place, are joined in series with any number of other units. Thus a set consisting of 48 gaps (*see* Plate VI.) would consist of six units placed in three tiers, two units lying alongside each other in each tier. Forty-eight gaps arranged in this manner, when the necessary clearances and sparking distances are maintained, would occupy approximately the same space as the Mark II. spark gap and blower. With 48 gaps the capacity used would probably be 10 jars, made up of two 20 jar condensers in series, arranged so that they would be charged up in parallel and discharged in series.

Proceeding simultaneously with the experiments in ships, trials will be carried out at Horsea in order to obtain information required for the design of the sets for large power shore stations.

It has been found in the "Vernon" that a very good, pure, note can be obtained when the gaps are in proper condition, the only factor then requiring attention is the A.C. voltage of supply, the adjustment of the latter for a pure note being sometimes rather critical.

The arrangement alluded to above in which four gaps were placed in oil, was, for "W" tune, 160 jars (Mark II. condensers); the voltage across each gap for a 700 cycle note (Mark II. alternator being used) was about 1,200 to 1,500 volts. Under these conditions, when using a signalling power of about 2 K.W., signals were usually strength 6–7 at Aberdeen. The coupling employed, as explained in last year's Annual Report must be tight, of the order of 20 per cent.

The adjustment of the gap is still a matter requiring considerable skill and practice, it being essential (especially when taking quantitive observations) that the sparking surfaces are truly parallel to one another, and as the spark length employed is only 0·008 inch, the adjustment is one requiring considerable accuracy.

It is proposed in the near future to place a set in the "Furious," and also to issue four sets to sea for trial under sea-going conditions.

WAVEMETERS.

New Design of Wavemeter.

With the primary object of lessening the inconsistencies referred to in the "Remarks on Calibration of Wavemeters," and of eliminating sources of error due to extraneous influences, also of obtaining a more handy and compact instrument, the Service wavemeter has been entirely re-designed throughout, the new design being shown in Plate VIII. The wavemeter condenser, with the inductance screen secured on one side of it, is carried on a metal base, and between this base and the bottom of the condenser is fitted a wooden drawer for carrying the soldering iron, &c. for the repair of thermo-junctions. This space also carries two fixed air vane condensers, having a capacity of about ·6 jar each, fitted with two small switches to enable either one or both of these condensers being connected in parallel with the moving vane condenser, thereby obtaining a total capacity of about two jars which, in conjunction with the 2,000 mic inductance, enables the tuning of circuits up to an L.S. value of 4,000. The top of the adjustable condenser is protected by means of a brass plate which is earthed to the framework, and in which plate a semi-circular slot has been cut to show the end of the pointer. The scale is engraved round the edge of the slot, and the pointer so arranged that the arrow is on the same level as the scale, thereby doing away with any error in reading due to parallax. An ebonite lengthening piece, in order to avoid any capacity effect between operator's hand and the current carrying parts, serves the purpose of the adjusting handle; this lengthening piece, ordinarily stowed inside the inductance screen, ships over the fitting on top of the bar carrying the moving vanes.

The inductance screen, secured to one side of the condenser frame, consists of a brass box, both ends of which are hinged to enable the inductance to be placed in position therein; the object of this box is to prevent the inductance, when in use, being acted on by any outside influences. This screen also makes electrical connection with the body of the instrument.

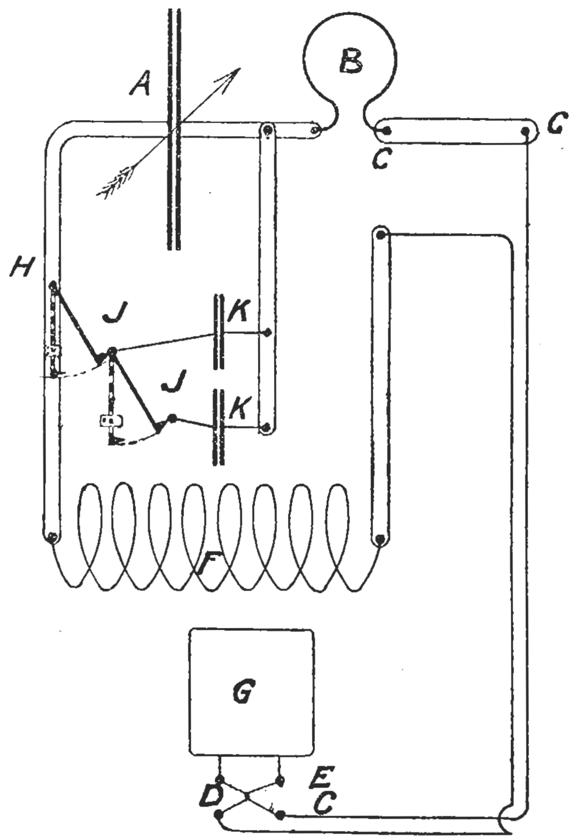
The galvanometer is carried on top of the inductance screen and is so situated that the scale of the condenser and that of the galvanometer are close together, enabling both scales to be read at the same time. The galvanometer is enclosed in a metal case and carries at one end of it the thermo-junction, which is also metal enclosed, the cases being insulated from the wavemeter frame; one terminal of the galvanometer is earthed to the enclosing metal. The junction is so arranged that, when damaged, it can be quickly and easily replaced by a spare junction which is supplied for that purpose, and stowed in the drawer previously mentioned.

The whole instrument is fitted with handles so that it can be easily removed from the wooden box in which it is stowed.

The inductances, 10 in number, are wound on ebonite tubes of two sizes, so that those wound on the smaller tubes can be stowed inside the others, thereby enabling a Box "B" of much smaller dimensions than that at present in use being employed. The windings of the inductances consist of highly stranded enamelled copper wire, each separate strand being enamel insulated; but, even with these precautions, experience has shown that the capacity of each inductance is certain to be of sufficient value to be taken account of.

FIG. 1.

Diagram of Connections for Wavemeter.

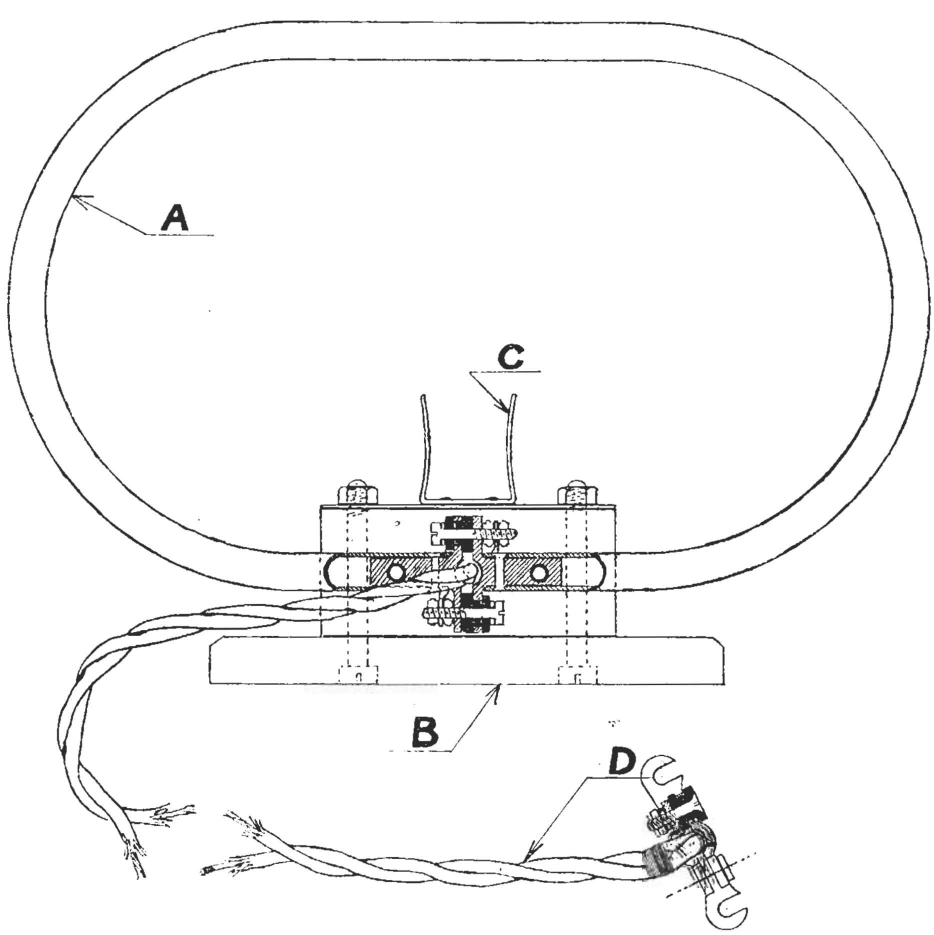


A = Variable condenser.
B = Mutual.
C = Terminals earthed to frame of wavemeter.
D = Thermo-junction.
E = Terminal of thermo-junction earthed to its frame.

F = Inductance.
G = Galvanometer.
H = High tension lead.
J = Switches for additional condensers.
K = Additional condensers.

FIG. 2.

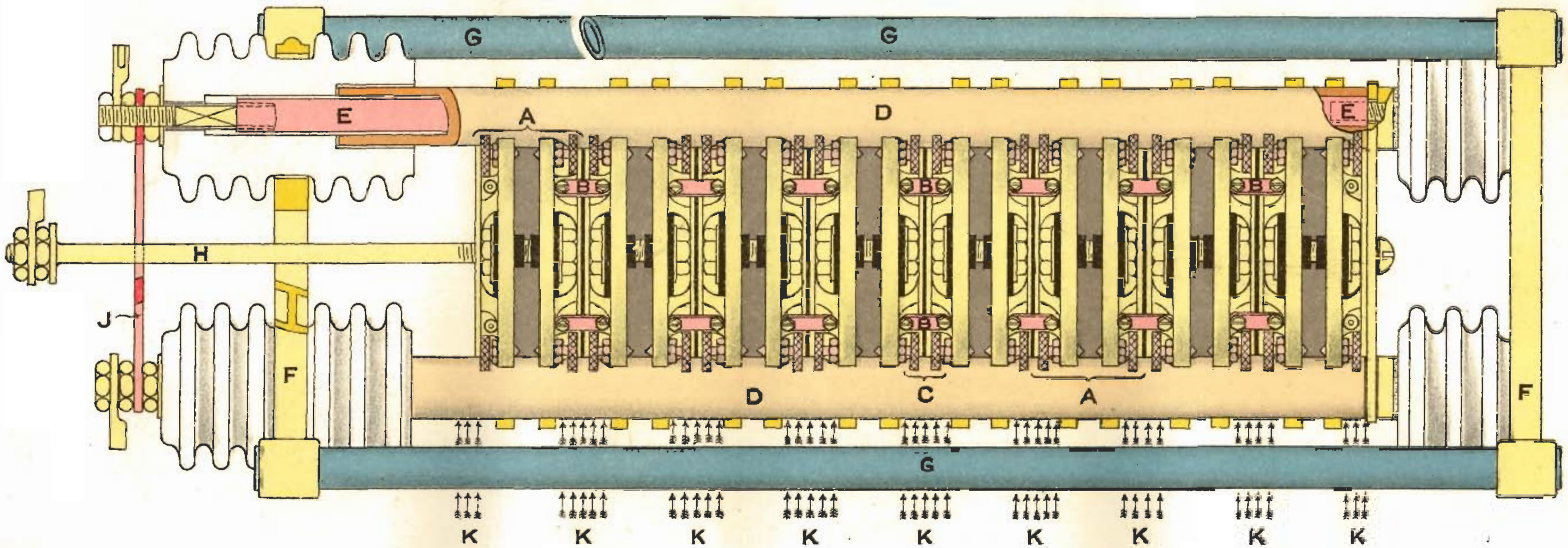
Mutual for Wavemeter.



A = Mutual (to be placed inside safety screen).
B = Detachable stand (in position as used for Mark II.).
C = Spring clip for supporting mutual when stand is reversed for Mark I*.
D = Flexible for passing through screen and connecting to wavemeter.

ELEMENT OF QUENCHED GAPS.

Scale _ ⅓ Full Size.



REFERENCE	
A	ONE QUENCHED GAP
B	COPPER STRIPS CONNECTING GAPS
C	SCREWS FOR GAUGING GAP LENGTH
D	PERTINAX TUBE SUPPORTING GAPS
E	COPPER TUBE CONNECTING END GAP WITH TERMINAL
F	BRASS CARRIER FOR ELEMENT
G	STEEL TIE RODS
H	TERMINAL CONNECTED TO FIRST GAP
J	TERMINAL RING CONNECTED TO END GAP
K	SUPPLY OF COOLING AIR

Two mutuals for tuning purposes, and suitable for use with any Service installation, are supplied, and the wavemeter should always be used in conjunction with one of these mutuals, when tuning any circuit, to obtain accurate results. One mutual consists of a copper tube bent oval shape so as to be suitable for stowing in the wavemeter box; in conjunction with this tube is a reversible base, to be stowed, when the wavemeter is not in use, inside the inductance screen; this base has been designed so that it can be adapted for suitably carrying the copper tube mutual when tuning Mark I*. or Mark II. installation. The second and smaller mutual is suitable for use in tuning destroyers, short distance, &c. installations.

A small number of this new design of wavemeter will be first ordered for trial in "Vernon" and at sea, and, if found satisfactory, the old type of wavemeter will be superseded by this new type as the former become unserviceable.

It is anticipated that some of the new type of wavemeter will be ready for issue to sea about June 1912.

Calibration of Wavemeters.

In August 1910, "Vernon" forwarded a wavemeter set to the National Physical Laboratory for calibration for use as "Vernon's" standard, but the results afterwards obtained with this instrument were found to be very inconsistent, a variation of as much as 5 per cent. being found when measuring the L.S. value of a circuit, (*a*) when using a large wavemeter inductance and a small wavemeter capacity, and (*b*) when using a small inductance and large capacity.

This inconsistency was gone into with the N.P.L. authorities, who put it down to an insufficient allowance having been made for the distributed capacities of each of the wavemeter inductances, which capacity they had calculated to be so small as to be negligible in practice.

They promised to go more deeply into the matter, and "Vernon" forwarded them another complete wavemeter set for calibration. In the meantime the N.P.L. carried out very exhaustive experiments in order to obtain a method of measuring the capacities of the wavemeter inductances under Service conditions, *i.e.*, when being used in conjunction with very high frequencies; and the method finally adopted by them is as follows :—

Their standard calibration circuit was so arranged that the spark taking place at the spark gap could be photographed, thereby obtaining the true frequency, and therefore true L.S. value of the standard circuit. At the same time the L.S. value of the circuit was being obtained by the wavemeter, using their own standard wavemeter condenser, but with the wavemeter inductance coil to be calibrated.

Suppose L to be the virtual inductance of the coil,
K the wavemeter condenser capacity,
k the distributed capacities of the coil,

then frequency $= \sqrt{L(K + k)}$ multiplied by a constant depending on the units employed.

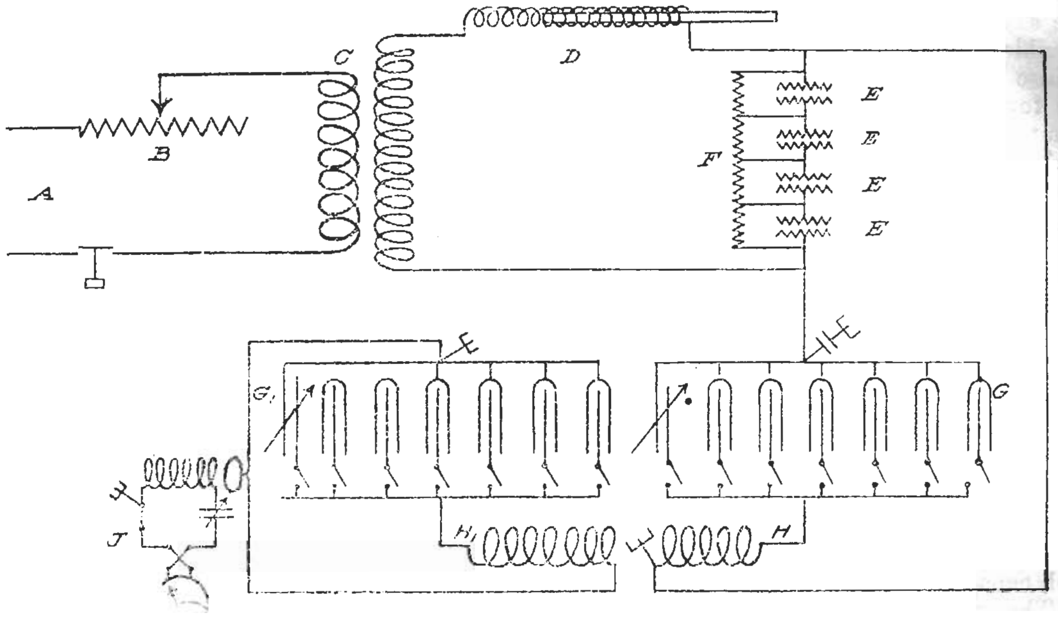
The frequency is accurately known by photography, and K is also an accurately known quantity leaving two unknown quantities in the equation. If now the same procedure be carried out for different frequencies, but using the same wavemeter inductance, the values of L and *k* can be found and repeatedly checked.

In practice, five different frequencies were taken for the calibration of each coil, varying from about 3,000,000 to 1,000,000 for the 10 mic coil, and from 200,000 to 100,000 for the 4,000 mic coil, and even with "Vernon's" coils wound with specially stranded wire, each strand being separately insulated, it was found that each coil had a very considerable capacity, the lowest being ·002 jar, and the highest ·02 jar. This distributed capacity of each coil must be taken to include other effects, such as variation of inductance with frequency (due to eddy currents or insufficient stranding) and leakage in the coils; so it can be understood that, in the present pattern of Service inductance, consisting of single strand wire, these effects would be greater than in the case of "Vernon's" standards. These distributed capacities, neglected up to the present, due to their not being properly valued, should have been added to the wavemeter condenser capacities.

Wavemeter Calibration Set.

Experiments have for some time past been carried out in "Vernon" to design an efficient wavemeter calibration and testing set. It was at one time thought that calibration of wavemeters and inductances at the National Physical Laboratory would best meet the requirements of the Service, but the price quoted for this, as well as the time which would be taken (the laboratory requiring about a month for each wavemeter set), rendered this procedure prohibitive. It was noticed that the wavemeter adjustment, when tuning the secondary of the quenched spark transmitting set, was extremely critical, and that a very steady deflection of the galvanometer was obtained; it was therefore decided that in this direction lay the best chances of success. The quenched spark testing set now designed, and of which a diagrammatic circuit is shown in Fig. 3, gives promise of being all that is desired, and there should be no difficulty in being able to calibrate wavemeters set to a degree of accuracy of within 1 per cent.; but, when used for tuning installations, in order to obtain full advantage of this accurate calibration, it will be necessary for a wavemeter condenser to be used only with the inductances with which it has been calibrated, and the use of any other set of inductances will lessen the degree of accuracy to perhaps 5 per cent., and, in extreme cases, as low a degree of accuracy as 10 per cent. may be obtained. To guard against such a contingency it is proposed that every box of inductances shall be marked with the number of the wavemeter condenser with which it has been calibrated, FIG 3.

Wavemeter Calibration Set.



A = Supply of 100 volts R.M.S. at 300 cycles.
B = Adjustable resistance 20 ohms.
C = Transformer 45 to 1 step up.
D = Impedance coil, adjustable to 750 henries.
E = Quenched spark gaps, ·008 inch each.
F = Resistances, 100,000 ohms across each gap, for equalising voltage.
G_1 and G = Primary and secondary condensers, ½ jar to 32 jars.
H_1 and H = Primary and secondary inductances closely coupled.
J = Wavemeter under test.

or recalibrated, and the two boxes shall be issued together as a wavemeter set. Where any damage occurs, necessitating the repair of a portion of the set, it will be necessary for the whole wavemeter set to be returned, and a new complete set drawn in lieu. It must be understood that the values stamped on the inductances are of a more or less arbitrary nature, and may, under certain conditions, be as much as 5 per cent. at fault, especially when the condenser reading is away from the middle of the scale. To provide against the inductance values having to be relied on in tuning installations, each wavemeter set is being provided with a table setting forth the wavemeter condenser readings which should be obtained when the different inductances are used for tuning to the different Service wave-lengths, and, as these readings are obtained by means of standard circuits tuned to the Service wave-lengths, it is hoped that all wavemeters will give identical results for the purposes of tuning. It is also essential that, when the wavemeter is in use, the earth terminal be connected to earth, and that the mutuals supplied with the instrument be employed.

REMOTE CONTROL AUTO-STARTERS.

A remote control auto-starter, as mentioned in the 1910 Annual Report, page 16, has been in use on board "Vernon" for a considerable time, and has worked satisfactorily; but these starters are expensive, and it is not considered that any saving in cost would be effected by fitting these, especially now that the W.T. offices are all being fitted below the upper deck. In view of this decision the auto-starters will not be brought into the Service for W.T. purposes.

INTERFERENCE PREVENTER.

An instrument which has been named the "*Differential Interference Preventer*" has been designed by Lieut. J. A. Slee, R.N., for the purpose of reducing interference from powerful stations and also for reducing atmospherics.

It has been, and is being employed with considerable success in shore stations, but its application to ship stations is not nearly so easy a matter, for the reason that an auxiliary aerial is required.

For the purpose of explaining its principle, the term "signal" will be used to indicate the actual message which it is desired to receive. The term "interference" will be used to indicate other sounds heard in the telephone, when the red plug is in, caused by a station sending, and the term "atmospheric" will be used to indicate sounds heard in the telephones when the red plug is in, caused by atmospheric disturbances.

The instrument consists of three windings, two of which are mounted on sliders so that their relative positions may be altered. One of these, called the main primary, is joined up as the inductance of the acceptor circuit; the second, called the secondary, is joined to the detector circuit, *i.e.*, it is equivalent to the secondary of the induction tuner in a type B or type C receiving circuit; and the third, called the auxiliary primary, is joined between the auxiliary aerial and earth in series with a tuner.

Under the conditions when interference, as defined above, is strong enough to be troublesome, it is clear that the wave in the other causing it must be more powerful than the wave causing the signal; so, if the auxiliary aerial is of the right size and shape, currents will flow in it comparatively freely due to the interference, and only very feebly due to the signal. This result is brought about partly by the auxiliary aerial being deliberately disposed so as to be a bad receiver, and partly by the use of a tuner in its base.

When this condition has been reached there will be currents flowing in the main primary due to interference, and also due to signals, and in the auxiliary primary there will be currents due to interference only. If the main and auxiliary primaries are wound in opposition, the currents due to interference in these two will tend to neutralise one another, and a fine adjustment of the sliders will completely neutralise their joint effect on the secondary.

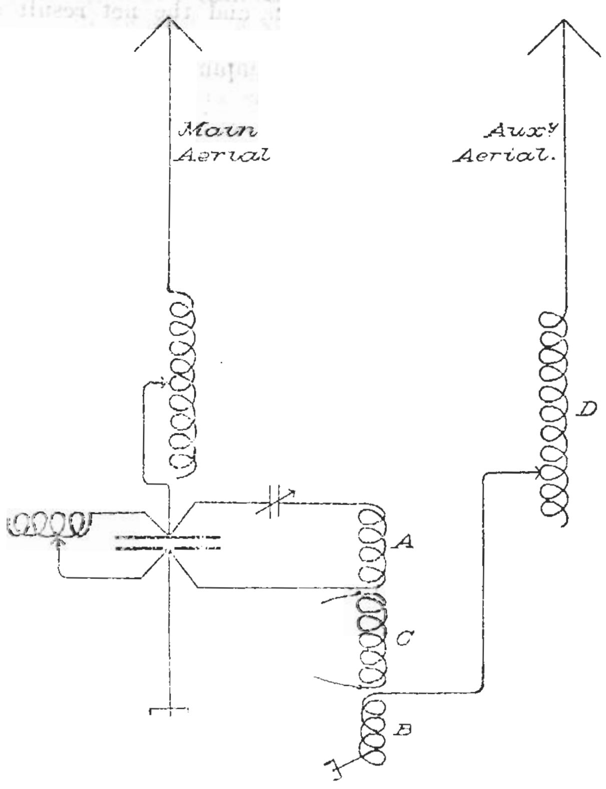
From these conditions it can be seen that it is possible to cut out any interference, even if it is on exactly the same wave-length as the signals, provided it is strong enough. If interference is caused by a wave of exactly the same length and strength as the signal, then nothing can be done, but it may be possible to over read. If interference and signals are caused by waves of different strengths, the interference can be cut out.

To get perfect results, *i.e.*, the complete exclusion of interference without in any way weakening signals, it is necessary to exactly proportion the auxiliary aerial so that it shall not receive the signal at all, but shall receive the interference fairly strongly. If the auxiliary aerial is too large, strong signals will be weakened; if very much too large, weak signals will also be weakened. If it is too small it will not be possible to completely cut out interference because the auxiliary primary will not be able to completely neutralise the interference in the main primary, as its reception is too feeble.

To show what can be done with this type of instrument "Aberdeen" or "Pembroke" can be read at Whitehall, when sending on "W" wave, although "K N D" is also sending on the same wave. Also "K N D" can be read at Felixstowe when Ipswich is sending at full power on "W" wave.

The diagrammatic arrangement of the circuits is shown in Fig. 1.

FIG. 1.



A = Main primary.
B = Auxiliary primary.
C = Secondary.
D = Auxiliary tuner.

The question of cutting out atmospherics is more difficult. It is first necessary to consider the causes of atmospherics, which can be broadly divided into two classes, those which have a definite wave length and those which have not.

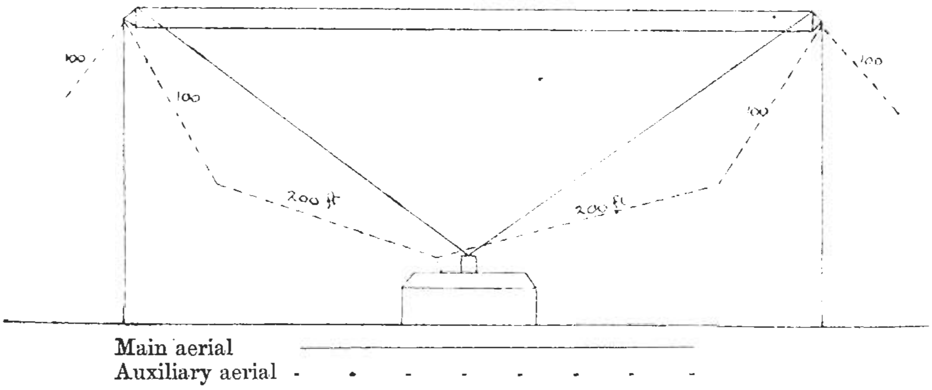
The first of these can be to a great extent cut out by the use of the rejector, and can therefore be dealt with as interference, but the second class pre-ent a different problem. A great proportion of them are said to be due to the constant presence in the atmosphere of minute particles of water in the form of mist and cloud which become charged with electricity by reason of friction with the air.

When one of these small patches of charged vapour passes over the aerial, which is a good conductor and connected to the earth, which can be regarded as at zero potential, the vapour discharges itself down the aerial.

It is possible to greatly weaken atmospherics of this second class by the use of the D.I.P., provided the following points are attended to.

In the first place, the top of the auxiliary aerial should be at the same height as the top of the main aerial. The auxiliary aerial should also be disposed in the form that experience teaches to be affected the most readily by atmospherics. It will be noticed that this necessitates a rather larger auxiliary than is required for dealing with interference only. It will thus be seen that the shape, size, and disposiiton of the auxiliary aerial are of paramount importance. Fig. 2 shows the best arrangement of auxiliary aerial for medium power shore stations where the main aerial consists of three cylinders of eight parts of wire, of the Service Mark II. type, 350 feet long.

FIG. 2.



In the second place, it is necessary that the auxiliary aerial should be tuned to exactly the same wave-length as the main aerial. If this is not done, the first two or three loops of current due to atmospherics may be neutralised, but then the currents in the main and auxiliary primaries will come into phase instead of being in opposition, and the net result on the secondary will be worse than ever.

In the third place, it is necessary that the damping should be the same in the main and auxiliary aerials. That is to say, that oscillations once started should continue for the same number of loops in each. Supposing that the damping in the auxiliary aerial is much the greater, then although the frequency of the currents in the main and auxiliary aerials is the same, and they start and continue in opposition, yet the oscillations in the auxiliary will cease sooner than in the main, and a considerable effect will be left un-neutralised.

These conditions are shown graphically in Plate IX., where the main aerial is supposed to be adjusted to a 3,000 foot wave, and to be set in oscillation by an atmospheric; its coefficient of damping is taken at 75 per cent. The blue curve at the top shows the currents set up in the secondary due to the main primary alone.

The blue curve on the second line shows the current in the secondary due to the auxiliary primary alone when in correct adjustment. That is to say, the damping and frequency are the same as in the main primary, and the sliders have been adjusted so as to get the value of the current in the secondary due to the auxiliary to be equal and opposite to the value of the current in the secondary due to the main at every instant of time. The resultant current in the secondary is always zero, as shown by the straight line at the bottom.

The red curve on the second line shows the currents in the secondary caused by the auxiliary aerial if it is adjusted to a wave of 3,600 feet, the damping being the same as before; and the red curve on the bottom line shows the resultant current in the secondary. It will be noticed that it is more violent than the current due to the main primary alone. This demonstrates the necessity for tuning the auxiliary aerial to the same wave-length as the main aerial when dealing with atmospherics.

The green curve on the second line shows the currents in the secondary caused by the auxiliary primary if adjusted to the correct wave-length, but assuming the coefficient of damping of the auxiliary aerial to be 50 per cent., that of the main aerial remaining 75 per cent., as before. In this case it will be noticed that the atmospherics, though much reduced, are not entirely suppressed.

As regards the practical working of this instrument, preliminary experiments have disclosed the following few points.

To cut out interference from any particular station the auxiliary tuner should be adjusted so that the interference can be read most readily on the auxiliary circuit; the main aerial should be disconnected at the main tuner for this. Then put on the adjustments for the wave which it is required to receive, and find the position for the sliders which will cut out the interference.

When working with the D.I.P. it will sometimes be found that in cutting out interference from one source it is let in from another. This can generally be put right by the use of the auxiliary tuner. Thus, suppose signals are on " W " wave, and interference is on " U " wave, and when adjusted to cut out the interference a third station is heard on " S " wave. If inductance is added in the auxiliary aerial this " S " wave will be lost and the " U " wave interference weakened ; so to get good results the auxiliary slider must be moved until the interference is lost again.

For every interference there are a multitude of combinations of positions of the auxiliary tuner and the two sliders which will cut the interference out. It is only a matter of using the best one.

It is generally found that the results can be considerably improved, after the best adjustments of the D.I.P. have been obtained, by slightly altering the adjustments of the receiving circuits. When working on the wave-lengths with which the shore stations are principally concerned, and when using the standard adjustments, it has been found that an increase of one stop of the box inductance of the rejector will generally improve matters considerably. The reason for this is not obvious.

As regards the difficulties with the auxiliary aerials, these show themselves very particularly when transmitting, and it has been found in the shore stations that, when transmitting, it is necessary either to earth or to insulate them.

With the low power stations, it apparently makes no difference to the transmitting range whether the auxiliary aerial is at insulation or whether it is earthed.

With medium power stations, the auxiliary aerial must be left at insulation with a very long break switch. A spark of as much as 7 inches has been obtained at Whitehall. If the auxiliary aerial is earthed, the transmitting range is sensibly reduced.

With high power stations the auxiliary aerial must be left at insulation. It has been tried at Cleethorpes connected up to the main aerial when transmitting, but for some reason it has, it is understood, led to a reduction in the signalling range. If it is earthed it also reduces the range.

The chief difficulties, therefore, in applying this principle to ships will probably be in the method of leading the auxiliary aerial into the office. Where the office is on or above the upper deck this difficulty is not very great ; but where the office is situated below decks and behind armour, the question of a second deck insulator and possibly a larger trunk may arise. No experiments have yet been tried in ships with this invention.

BUZZER TRANSMITTER.

Referring to page 29 of last year's Annual Report, all the latest orders of buzzer transmitters are being supplied with the coils joined in parallel. It has been found that, with this arrangement, the platinum contacts wear away very quickly, due to the extra current which is taken ; to overcome this defect the contacts of the new instruments, and all the latest orders of spare contacts, have a $\frac{3}{16}$ inch diameter platinum tip, in lieu of the $\frac{1}{8}$ inch previously fitted, thereby giving more than double the contact surface. New orders for buzzer transmitters also include in their design a lock-nut for the contact screw, and an improved method of maintaining the presspahn discs, covering the ends of the cores, in place.

MOSCHICKI CONDENSERS.

No further steps have been taken with a view to superseding the present type of auxiliary condensers of the Moschicki pattern with those manufactured by Schultz (*see* Annual Report, 1910, p. 40), other work having necessitated the abeyance of this matter.

It is anticipated that the Moschicki condensers, as at present in use, will continue to be the Service pattern of auxiliary condenser until the introduction of the quenched spark installations necessitates the institution of an improved method of transmitting short waves.

NEW DESIGN OF RIGGING INSULATOR.

A new design of rigging insulator is being experimented with, primarily with the object of producing an insulator for $3\frac{1}{2}$-inch stays. Due to the difficulty of manufacturing so large a piece of porcelain, it is not possible to produce an insulator of this size on the same lines as the existing Service insulators. At the same time it is hoped that the new design which is shown on Plate X. will have the following advantages over the present design for all sizes of insulator :—

(1) Greatly increased insulating value, combined with a decrease in weight.
(2) The shape of the porcelain is much simpler and easier to make from the manufacturer's point of view.

(3) Should the porcelain break in the rigging no large lumps of porcelain will fall down to the danger of persons below.

(4) It will be possible to insert an additional insulator in any stay without scrapping the whole or part of the stay. With the existing design this is impossible.

Insulators of the new design are being purchased for all the various sizes of rigging, and experiments will be carried out to ascertain their merits.

It is proposed ultimately to supersede as many of the existing sizes of rigging insulator as the experiments prove to be desirable.

INDUCTION CURVES FOR AERIAL AND MUTUAL COILS.

These curves (*see* Plate XI.) are useful for calculating the approximate number of turns required for tuning an aerial, the induction and capacity of which are known, to any required wave-length; and, conversely, for determining the induction and capacity of an aerial when the number of turns required for varions waves are known.