SUMMARY OF EXPERIMENTS IN CONNECTION WITH DESIGN AND PRACTICAL TRIALS WITH SERVICE MARK II.

In November 1906 two sets working at 250 cycles were set up, one in "Vernon" and one in "Furious," and "Furious" went to sea for a six weeks cruise to Madeira and Gibraltar.

Original trials.

These were nominally 12-K.W. sets, and great difficulty was found in keeping them in sufficiently good order to carry out the programme, the spark gaps being a continual source of trouble.

In these sets the spark took place at two gaps in series between three rapidly revolving discs.

The results of these trials were very irregular, due to the numerous small breakdowns, but some of the results were very promising, especially the ease with which the note could be picked out from among other signals or atmospherics. (*See* A.R., 1906, W.T. Appendix, p. 40.)

Choice of frequency.

As soon as Vernon's 400-cycle set was set up a series of experiments was carried out with Scilly, the first set being to determine the best frequency out of the considerable range provided by the 250 and 400-cycle machines.

350 cycles was selected as giving the most distinctive and penetrating note.

Developing clear note.

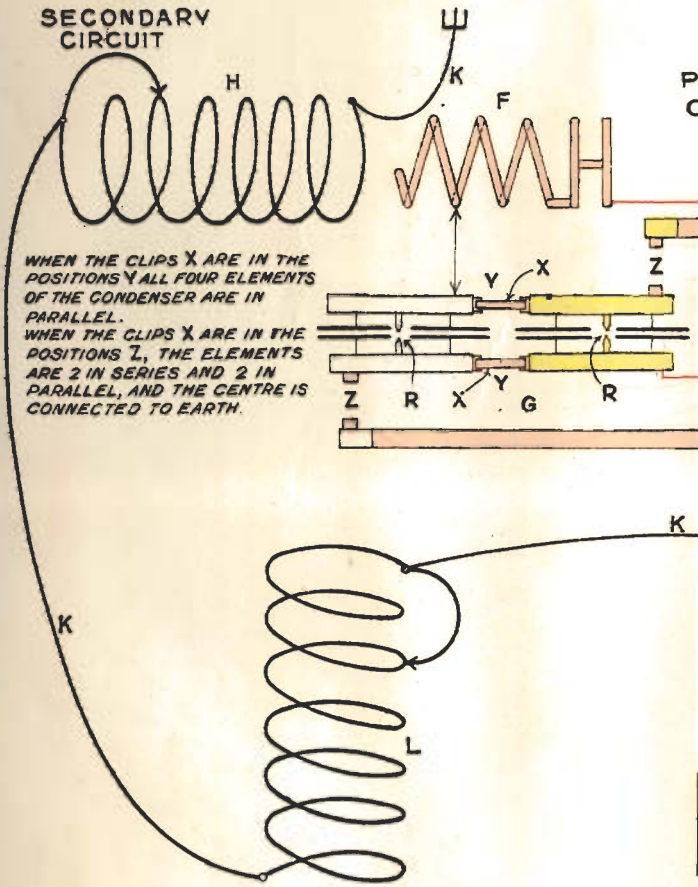
The next set of experiments was carried out with Scilly, with a view to finding the best way of developing the note clearly.

The theory which led up to the revolving discs is that unless the point at which the spark leaves the surface of the balls is changed for each spark, an arc will be formed whenever a high frequency is used.

Revolving balls.

The three discs were arranged to revolve very fast, their circumferences passing in opposite directions, but this was complicated, and the electrical connections very difficult.

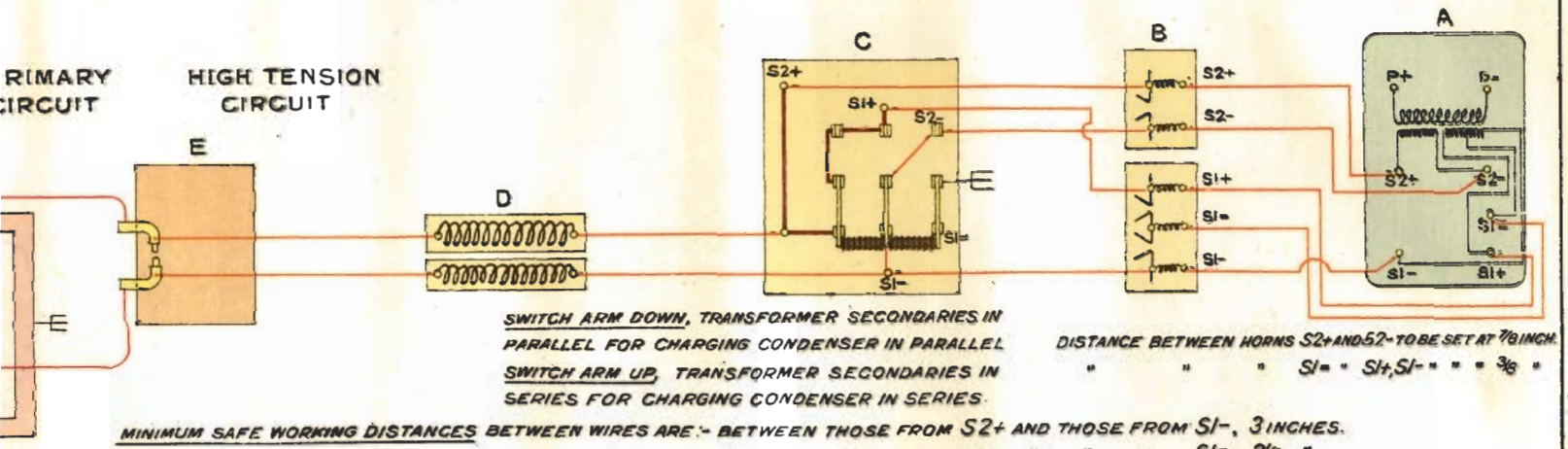
DIAG



Weller & Graham, Ltd. Litho. London.

SERVICE INSTALLATION MARK II.

RAM OF HIGH TENSION TRANSMITTING CIRCUITS.

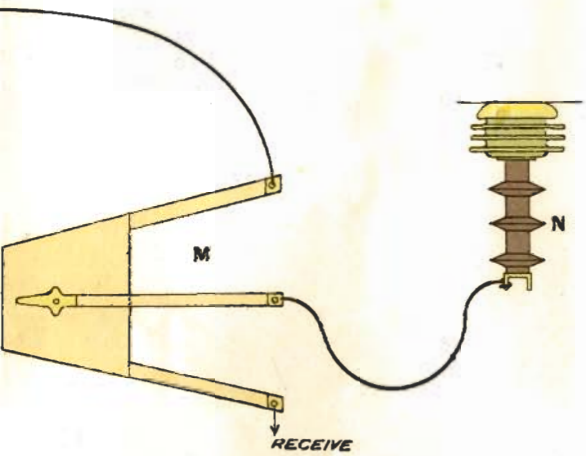


SWITCH ARM DOWN, TRANSFORMER SECONDARIES IN PARALLEL FOR CHARGING CONDENSER IN PARALLEL

SWITCH ARM UP, TRANSFORMER SECONDARIES IN SERIES FOR CHARGING CONDENSER IN SERIES

DISTANCE BETWEEN HORNS S2+ AND S2- TO BE SET AT 7/8 INCH.
" " " S1= " S1+, S1- " " " 3/8 "

MINIMUM SAFE WORKING DISTANCES BETWEEN WIRES ARE:- BETWEEN THOSE FROM S2+ AND THOSE FROM S1-, 3 INCHES.
" " " " " " " S1=, 2½ "
" " " S2+ AND S1- " " " S2- AND S1+, 1½ INCHES
" " " S2 - " " S1+, 1½ "
" " " S1 = " " S1+ " S1-, ¾ "



REFERENCE.

A	TRANSFORMER	H	SECONDARY COIL (ADJUSTABLE)
B	PROTECTING HORNS	K	COPPER TUBING.
C	TRANSFORMER SWITCH	L	AERIAL COIL (ADJUSTABLE)
D	PROTECTING COILS	M	SEND RECEIVE SWITCH
E	SPARK GAP	N	DECK INSULATOR
F	PRIMARY COIL (ADJUSTABLE)	——	BARE COPPER WIRE 14 S.W.G.
G	CONDENSER	R	SAFETY SPARK POINTS
P	PRIMARY TERMINALS (TRANSFORMER)	S	SECONDARY TERMINALS (TRANSFM'R)

Changing the atmosphere in which the spark took place was then tried, the discs being left stopped, and a blast of air directed on the spark gap. A marked improvement was at once obtained, and a long series of experiments was gone into to settle the best form of spark plug.

Air blast.

A simple calculation shows the pressure of air necessary to completely change the atmosphere in which the spark takes place for every spark, and blowers capable of giving a pressure of 8 inches of water are used.

It was found, however, that when using the double spark gap that the note could not be got when using a short spark, because the gap between the plugs becomes so short that a sufficiently rapid stream of air cannot be got through it. A single spark gap was then tried, and a further general improvement in note resulted.

Dielectric for condensers.

At the same time laboratory experiments were going on to determine the best dielectric for Service conditions. It must be borne in mind that the limitations are peculiar, and that condensers of simple design and equal efficiency had to be discarded on account of lack of space, and that other types had to be discarded on account of the great cost.

Glass

The glass plate condensers used in C tune, Mark II., having shown themselves too liable to injury from shock, a series of experiments was commenced to find some more suitable dielectric.

Mica.

Some previous experiments had shown the high electrical efficiency of mica, and mica condensers had been tried in the first destroyer oscillator. It was found that mica of suitable quality could only be obtained in sheets about the size of a playing card, and also that even that was not reliable. A mica condenser had therefore to be built up in a large number of small sections which could afterwards be joined up, and it was found that the losses in all these connections more than counterbalanced the gain due to the electrical efficiency of the mica.

Still, the mica condenser was light and compact, but the price was very high.

Manufactured insulators.

A large selection of manufactured insulators was bought, and trials started. The whole series of oiled and varnished fabrics was found to be quite useless, and the artificial micas, though some of them were of considerable dielectric strength, were found to be inefficient.

Ebonite.

Ebonite was then tried, and the first set of experiments with it was so satisfactory that a large number of plates by different makers and of different qualities were purchased, and steps taken to compare their dielectric strengths, efficiencies, and specific inductive capacities.

It was found that all except the very worst ebonite was superior to glass in dielectric strength and efficiency.

It was also found that ebonite has a much greater dielectric strength per unit thickness with thin than with thick sheets.

Condensers without oil.

Many attempts were made to build a condenser up solid with Chatterton's compound and some similar compounds, so as to avoid the use of oil, but though all visible brushing could be done away with, there still remained numerous losses, and this type had to be discarded as unserviceable.

Construction.

One great source of loss was eliminated by doing away with all adhesive substances between the tin foil and the plate, and to keep the foil in place it was rubbed on to the ebonite with a thin film of vaseline oil, when it was found to stick well enough for building up, and was afterwards kept in place by being tightly compressed.

It was very early discovered that even the most minute trace of air bubbles between the foil and the ebonite could not be tolerated.

The scheme of compressing the condenser answered very well for small plates, as in a destroyer's condenser, but with the large plates (24 inches by 22 inches) used for Service Mark II., it is not suitable.

In the large plate condenser each piece of foil has two tabs, which are rigidly supported, so keeping the foil in place.

Completed condenser.

The complete condenser consists of four elements, each of which is complete in itself, which stow firmly in an oil-tight steel tank, which must be kept completely full of vaseline oil.

Elements.

Each element consists of 92 ebonite plates with tinfoil on each side, the plates being $3\frac{1}{2}$ inch thick. They are built up in four sections, each of 23 plates in parallel, and the four sections are permanently joined in series.

The plates are lightly packed in a thin steel box, and when the element is completed, packing is put in if necessary, to fill the box, and the lid is screwed on.

The box, complete, is packed tightly in the tank.

Each element is tested to the equivalent of a 16-mm. spark, and they are arranged so that they never have to stand more than half that pressure.

Working limit.

It has been found that if ebonite is worked continuously near its limit serious heating takes place, though no sign of heating has been found at the normal working pressure.

All experience has shown the advantage of using the largest possible transmitting capacity.

Parallel connection.

The capacity chosen is 160 jars, as this allows of any wave above S tune being used with the 40-jar elements composing the condenser joined up in parallel.

Series connection.

By arranging the elements, two in series, two in parallel, a capacity of 40 jars is obtained, which will stand double the spark.

This allows of the primary being tuned down as low as 70 L.S., thus allowing for R tune and Q tune.

Working spark.

The full working spark is 8 mms. with elements in parallel, and 16 mms. with them two in series, two in parallel.

Primary.

The primary has been so arranged that it will give an unbroken chain of L.S. values, with the four elements in parallel from 1,000 L.S. to 240 L.S., and with elements 2 in series, 2 in parallel, from about 70 L.S. to 260 L.S., at the same time keeping sufficient inductance in the primary for coupling.

By making temporary connections it is also possible to send a 1,000-foot wave (L.S. 23·5) as a harmonic of the aerial.

Possible tunes.

This makes the available tunes.

Tune.	Wave-length.	L.S.	Elements.	Spark in Mms.	Remarks.
P	1,000 feet	23·5	Two in series	12	Short commercial.
Q	2,000 „	94	Two in series. Two in parallel	16	Long „
R	2,600 „	159	„ „ „ „	16	Service waves.
S	3,300 „	256	4 in parallel	8	„ „
T	4,200 „	415	„ „	8	„ „
U	5,000 „	590	„ „	8	„ „
V	5,700 „	760	„ „	8	Proposed new wave.
W	6,503 „	1,000	„ „	8	„ „ „

Brushing of aerial.

Recent trials have shown that directly the feeders commence to brush, no further increase of power will give any further increase of range.

As the largest aerial that can be carried in a Man-of-War can be made to brush with far less power than is now available, experiments were tried with looser couplings than have hitherto been found most suitable when the aerial was not brushing.

It was found that when using maximum power, signals increased in strength as the coupling was tightened till the feeders began to brush. After that no more improvement could be obtained, and signals usually fell off.

The couplings at which "Vernon's" aerial begins to brush ($\sigma = 1 \cdot 2$)—

R tune	8 per cent.
S tune	4 „
T tune	4 „
U tune	$2\frac{1}{2}$ „

Variation of spark and range.

It was also found that when using these loose couplings that the range could be regulated to a considerable extent by varying the spark length, the note being easily kept good all the time, the voltage of the generator being reduced by its field regulator as necessary.

It was also found that the D.C. input also varied approximately with the square of the spark length, as would be expected.

Summary.

To sum up, it appears:—

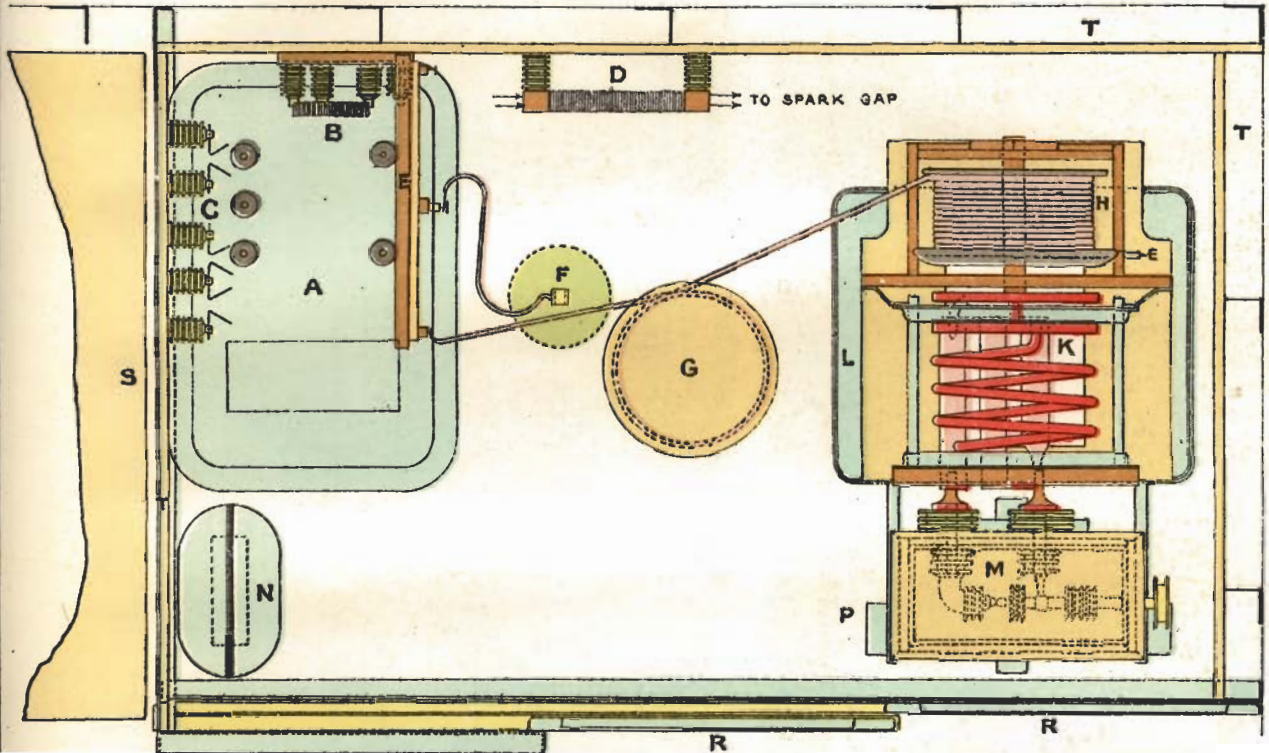
(1) That the present receiving circuit is best suited to collecting energy from the form of waves transmitted with the 8 per cent. coupling.

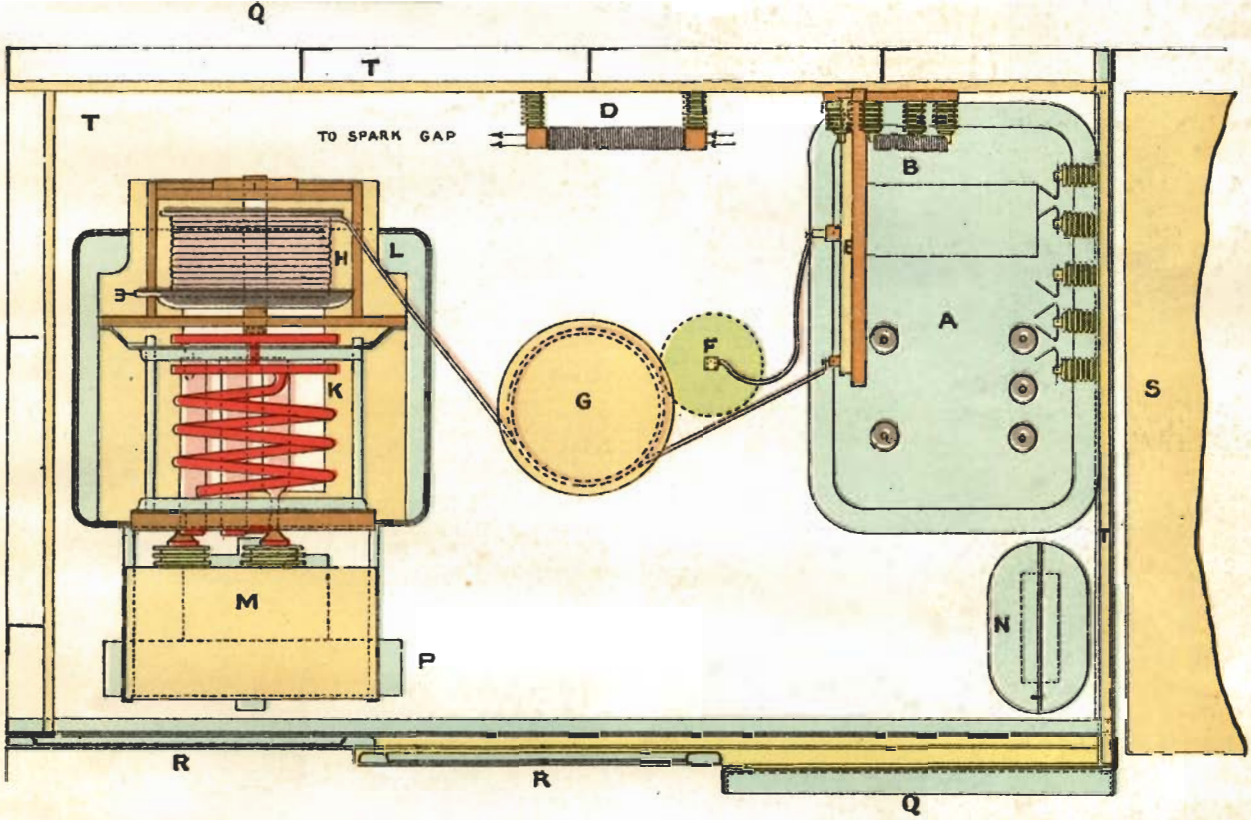
(2) That when the aerial commences to brush, the limit of effective power, with the particular coupling then in use, is reached.

SERVICE INSTALLATION MARK II

PLAN

ARRANGEMENT OF INSTRUMENTS INSIDE SAFETY SCREEN





REFERENCE

A Transformer	L Condenser Tank
B ,, Switch	M Spark Gap
C Protecting Horns.	N Impedance Coil.
D ,, Coils.	P Blower
E Send Receive Switch (Overhead)	Q Fixed Screen
F Deck Insulator	R Sliding Doors
G Aerial Coil (Adjustable)	S Silent Cabinet
H Secondary Coil ,,	T Wood Battens
K Primary ,,	

NOTES

1 When the Deck Insulator is towards the Left-hand side of the Screen, the Upper Arrangement will be adopted, and when the Deck Insulator is towards the Right Hand side, the Lower Arrangement will be adopted.

2 The Arrangement is independent of the position of the Silent Cabinet, which may be on either side

To face page 22.

Weller & Graham, Ltd Litho London.

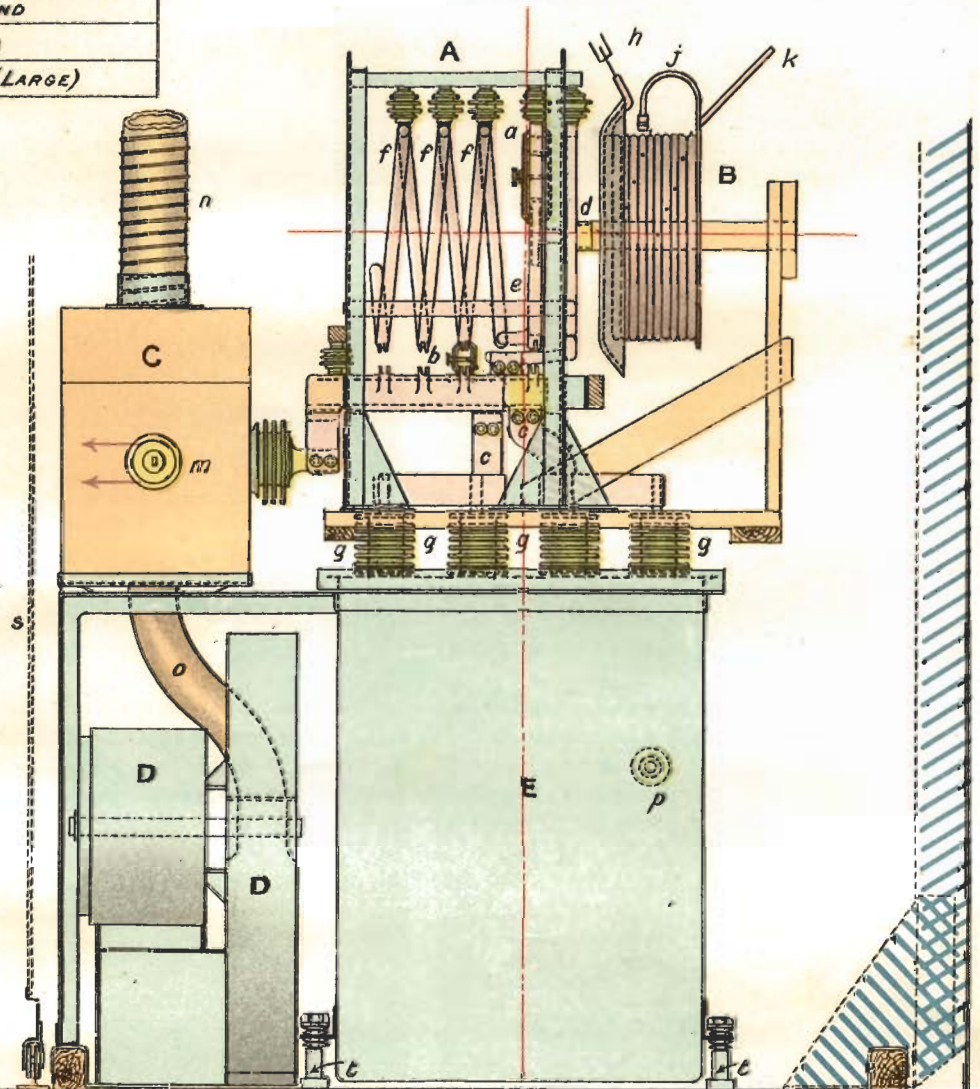
WIRELESS TELEGRAPH INSTALLATION SERVICE Mk II.

TRANSMITTING INSTRUMENTS

SCALE 1 INCH = 1 FOOT

A	ADJUSTABLE PRIMARY
B	" " SECONDARY
C	SPARK GAP ON STAND
D	BLOWER & MOTOR
E	CONDENSER TANK (LARGE)

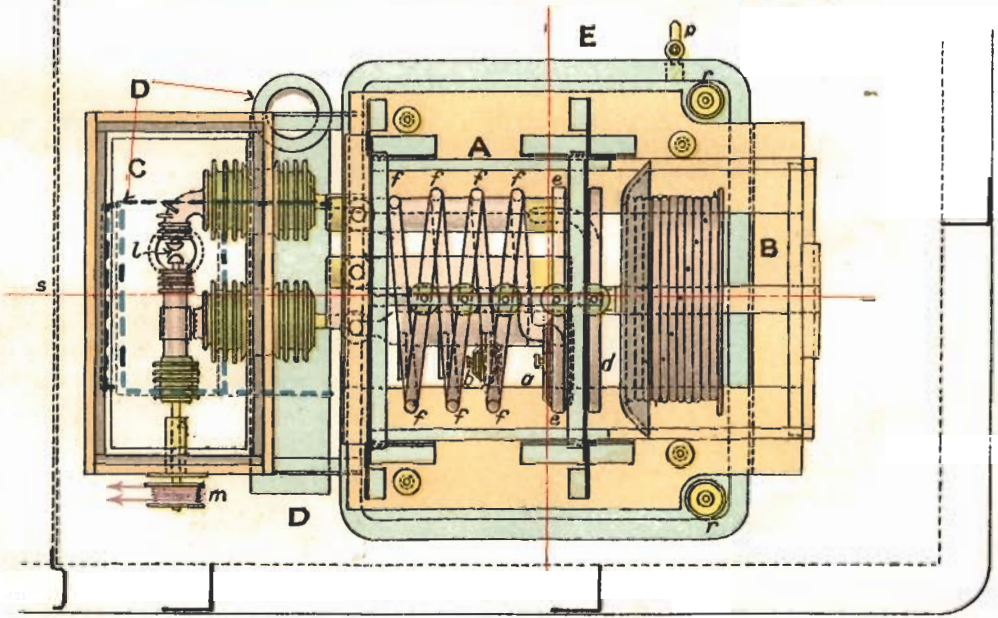
ELEVATION



a	Fine Adjustment Switch	k	Connection to Aerial Coil
b	Coarse ,, ,,	l	Spark Balls
c	Connections to Condenser.	m	Drum for Adjusting Spark Length.
d	Coupling turn.	n	Exhaust from Spark Gap.
e	Variable Turn for Fine Adjustment.	o	Flexible Hose from Blower.
f	,, Turns ,, Coarse,, ,,	p	Oil Emptying Cock.
g	Condenser Terminals.	r	Oil Filling Connection.
h	Earth Connection.	s	Sliding Door
j	Variable Connection.	t	Spring Supports (Belleville Washers)

Note
All Porcelain Insulators are shewn Green

Plan



1686

Weller & Graham, Ltd Litho. London.

(3) That to take advantage of the extra power available, the coupling must be loosened until the aerial just ceases to brush.
(4) That there is at present a considerable range of couplings which will give equally good results in range provided the aerial does just not brush.
(5) In order to obtain (4) the power must be increased as the coupling is loosened.

The conclusions arrived at from the above are, that although by loosening the coupling the receiving circuit is getting less and less suitable for the reception of the more persistent waves, yet owing to the total energy received increasing, due to more power being used with the looser couplings, the range remains constant. Hence it follows that an increase of range may be looked for in the direction of making the receiving circuit more suitable for collecting the energy from the form of waves emitted by a looser coupled transmitter, and experiments are now being carried out in "Vernon" in this direction.

EXPERIMENTS TO INVESTIGATE CHANGE IN CAPACITY AT VARIOUS FREQUENCIES.

It has often been stated that the specific inductive capacity of most dielectrics except air, changes with the frequency, and experiments were carried out in "Vernon" to investigate to what extent this applied to the dielectrics in use for transmitting condensers in the Service.

The capacities of glass and ebonite condensers were measured at frequencies between 25 and 400 cycles, at the frequencies of various Service waves, and also at still higher ones.

It was found that there was no measurable change between the low frequencies, and also no appreciable change between one high frequency and another, but there is a great difference between capacity at the high and low frequencies.

That is to say that in designing a set so as to give a resonance at a certain frequency, a different value must be assigned to the capacity of a condenser to that which must be used when calculating the L.S. of the outgoing waves.

Thus, the comparative capacities were found to be :—

Dielectric.	Charging Frequency, 25 to 400 cycles per second.	Oscillating, 100,000 to 1,000,000 cycles per second.
Glass - - -	180 jars.	160 jars.
Ebonite - - -	200 „	160 „