SERVICE INSTALLATION, MARK II.

Main features of the installation.

Service installation, Mark II., will make use of a very rapid succession of sparks, about 350 per second, which give a clear well-defined musical note at the receiving end. The note will be approximately the "F" next above the middle "C," it will be clear and penetrating, and quite different from the sounds usually heard in the telephones, whether these are other signals or atmospherics. It can therefore be easily distinguished from them, and over-read without difficulty.

The energy that will be available for each one of these sparks will be slightly greater than that available for each spark with "C" tune, Mark II.; it will be capable of charging the large aerial up to the maximum tension that can be used with advantage. To obtain this supply of energy 350 times a second will require between 20 and 25 kilowatts while signalling. There is apparently nothing gained by increasing either the energy per spark or the number of sparks per second beyond these values, this installation will therefore be the most powerful practicable for ship work with wireless telegraphy in its present state of development.

Many experiments have had to be carried out to settle on the design and details of the installation. The preliminary experiments with H.M.S. "Furious" are described in Appendix to A.R., 1906, pages 40 and 41. Further experiments with Scilly, and "Furious," and laboratory experiments with condensers, &c. are summarised in this report. These experiments have shown the great value of ebonite in thin sheets for transmitting condensers and the properties of a powerful air blast when directed at the spark, of giving a good musical note. These results and the high efficiency and small size of alternating current plant working at 350 cycles per second, have overcome all the chief difficulties met with in the design. They have made it possible to obtain a compact set with an ample factor of safety in all vital parts, and to quickly obtain, with full power, any wave-length between 1,800 and 6,500 feet in length; also after about 2 minutes preparation a wave of approximately 1,000 feet with reduced power. The maximum range for day signalling will probably be obtained with "T" tune.

General arrangements.

In the Wireless office the size and relative positions of the silent cabinet safety screen and instrument board will be the same as for "C" tune, Mark II., described in Appendix to A.R., 1906, Plates VII. and VIII.

The arrangement of the instruments inside the safety screen and on the instrument board will, however, be entirely different. The safety screen itself has been lightened, and the whole system of safety arrangements modified.

The transmitting apparatus has been completely altered and re-designed.

General arrangements.

Motor-driven alternators will be used instead of rotary converters. There will be two per ship, one acting as a stand-by. They will be placed below the water-line or under armour, and provided with a change-over switchboard so that either one can be connected up and used. The starter and controlling gear will be in the Wireless office.

The external arrangements, topgallant masts, insulated rigging, aerial, deck insulator and its screen will be exactly the same as for "C" tune, Mark II.

Fitting the installation.

Nearly every ship to which this installation has been allotted has already been provided with the necessary top-gallant masts, insulated rigging, and Wireless office fitted with one of the latest type large size silent cabinets, and arranged for conversion into a Service Mark II. office. When the installation is being put in, the present instrument bench will be removed and replaced by the safety screen, and the motor alternators, transmitting apparatus and instruments will be installed. The Wireless office will be re-wired and the cables run from the motor alternators to the "dummy switchboard" which will now become the change-over switchboard. Most ships will already have the special concentric cable and the other necessary cables connecting this switchboard to the Wireless office.

Work to be done by Dockyards.

The Dockyards will fit the two motor alternators on their teak beds, they will fit the safety screen and bolt into place inside it the transformer, inpedance coil, tank for condensers, the blower, and the stand for the spark gap; they will run the wires for adjusting the spark gap and fit the ventilator to take the exhaust gases away from it. They will fit the instruments on the instrument board and all the switches, starters, &c., shown on Plate No. IV., with the exception of the send receive switch; they will also do all the wiring shown on this plate, but have special instructions not to connect up the concentric cable to the transformer. This connection will be made by the ship's staff, and must on no account be made until the Torpedo Lieutenant is satisfied that the safety circuits are correct, that safety horns and protecting coils are correctly joined up, and the transformer properly filled with oil; if these matters are not attended to there will be danger to life, and the transformer will be liable to serious damage.

Work to be done by ship's staff.

The ship's staff will fit the condensers into their tank, also the primary, spark gap, secondary, aerial coil, send receive switch, and the other fittings, &c., shown in Plates Nos. II. and III., with the exception of the few articles mentioned above as being fitted by the Dockyard. The ship's staff will also run the wires and make the connections shown in these two plates.

Arrangements of instruments, &c.

The instruments on the instrument board in Plate No. IV. are shown approximately to scale and in their correct positions; they will be so arranged that they can be easily seen by the operator through the window in the door of the silent cabinet.

The two field regulators and a drum controlling the wires for adjusting the spark gap will be mounted on the outside of the silent cabinet, the handles will be inside the silent cabinet, within easy reach of the operator.

The safety screen will be of galvanised expanded steel with sliding doors. This screen will hold the transmitting gear, and as a shock from the transformer secondary terminals or the leads connecting them to the spark gap would be instantly fatal, and a shock from the primary terminals of the transformer or from the aerial would be extremely unpleasant, the doors of the screen will be fitted with switches that will automatically cut off the main supply current from the screen unless the doors are quite closed. The catch on each door has been so arranged that it cannot shut accidentally or be shut from the inside of the screen, making it impossible for a man to enter the screen and get a serious shock. The floor of the screen will be arranged to form an oil-tight saveall in case of oil leakage from instruments, and will be fitted with openwork steel mats to prevent oil getting carried out into the office. The transmitting instruments will be arranged inside the screen in either one of two ways (Plate No. II.). The arrangement that must be adopted will depend on the position of the deck insulator.

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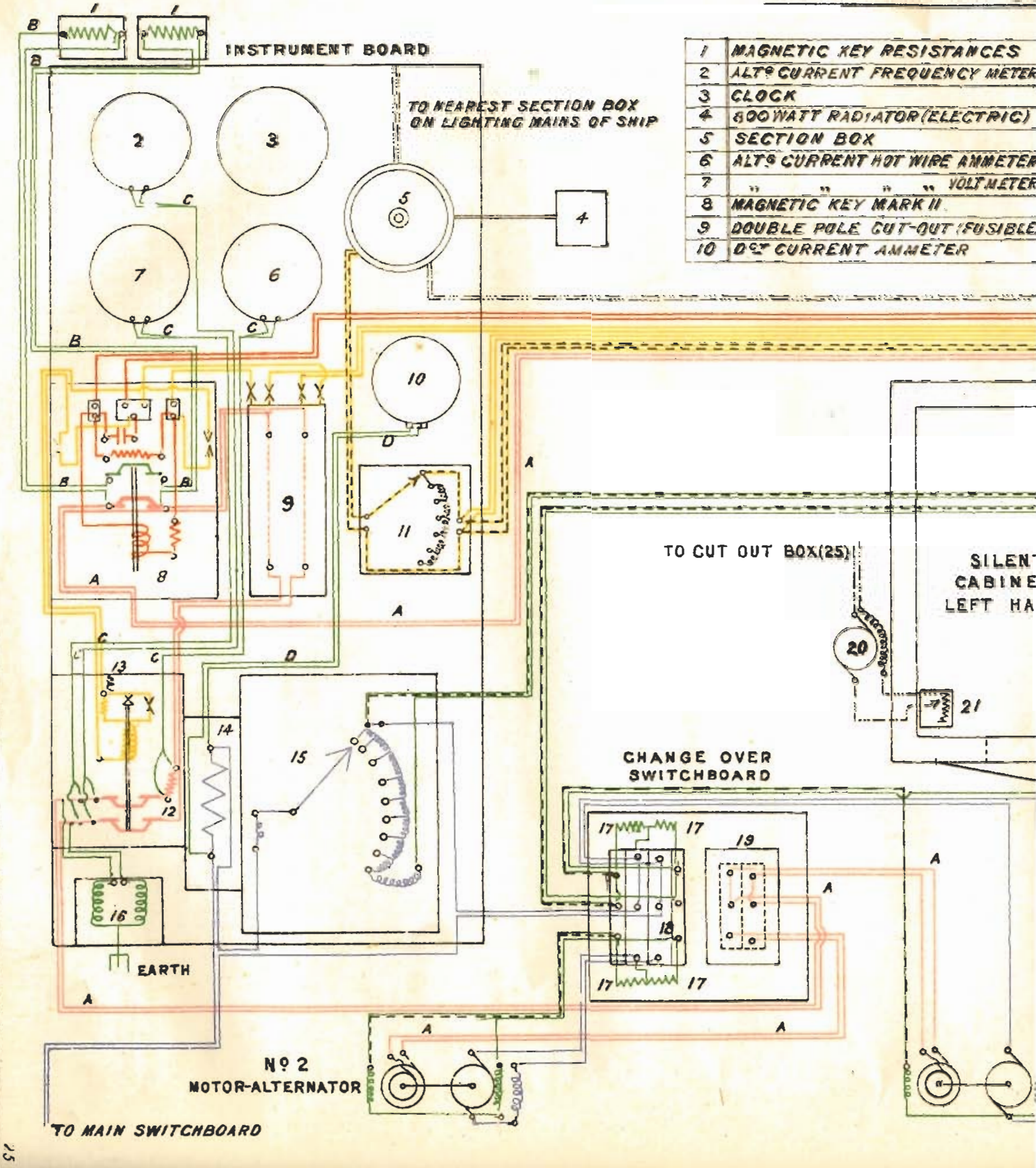
WIRELESS TELEGRAPH IN

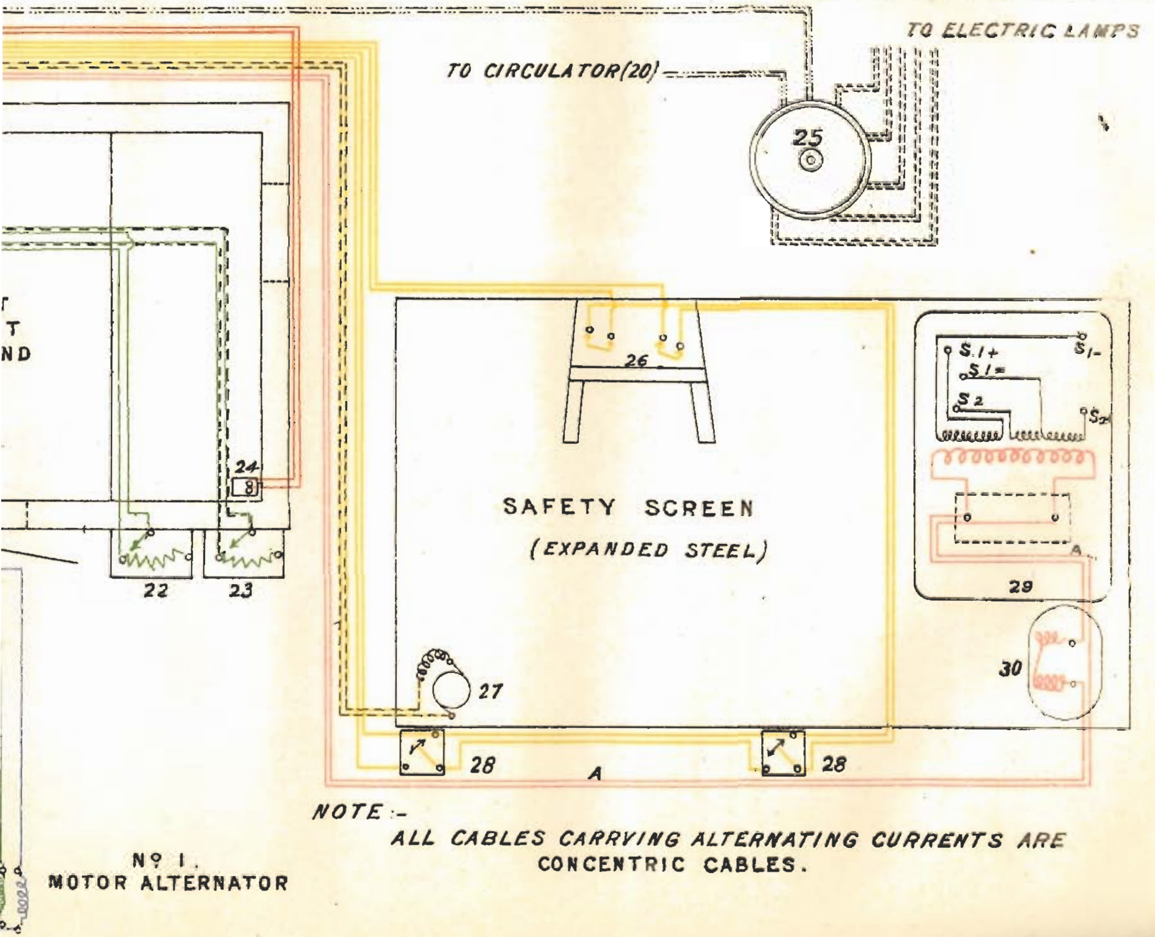
DIAGRAM OF CO

1	MAGNETIC KEY RESISTANCES
2	ALTᴳ CURRENT FREQUENCY METER
3	CLOCK
4	600 WATT RADIATOR (ELECTRIC)
5	SECTION BOX
6	ALTᴳ CURRENT HOT WIRE AMMETER
7	" " " " VOLTMETER
8	MAGNETIC KEY MARK II.
9	DOUBLE POLE CUT-OUT (FUSIBLE
10	Dᶜᵀ CURRENT AMMETER



STALLATION (SERVICE MARK II)
OMPLETE CIRCUITS.

11	BLOWER STARTER	21	CIRCULATOR REGULATING SWITCH		ALTERNATING CURRENT MAINS
12	ALTG. CURRENT AMMETER SHUNT	22	FIELD REGULATOR (MOTOR)		" " AUX'ES
13	SWITCH, DOUBLE POLE, RELAY	23	" " (ALTERNATOR)		DIRECT CURRENT MAINS
14	D. CURRENT AMMETER SHUNT	24	MORSE KEY		" " AUX'ES
15	STARTER (FOR M ALTERNATOR)	25	CUT OUT BOX		SAFETY CIRCUIT
16	BALANCER	26	SEND-RECEIVE SWITCH		BLOWER MOTOR CIRCUIT
17	KICKING COILS	27	BLOWER MOTOR		MORSE-KEY CIRCUIT
18	CHANGE-OVER SWITCH (D. CURRENT)	28	SAFETY SWITCH	A	CONCENTRIC CABLE ·83" DIA^R
19	" " " (A. CURRENT)	29	TRANSFORMER HIGH FREQUENCY	B	" " ·61" "
20	CIRCULATOR	30	IMPEDANCE COIL (LARGE SIZE)	C	" " ·5" "
				D	TWIN LEAD ·45" x ·2"



NOTE:-
ALL CABLES CARRYING ALTERNATING CURRENTS ARE CONCENTRIC CABLES.

The deck insulator should have been so placed above the office, that, after the screen has been built, it will project down inside the screen and have its lower end not less than 16 inches away from the side of the screen or the nearest earthed object. (If this is not so the deck insulator must be moved.)

The "primary" is mounted on the top of the condenser tank, and if placed near the deck insulator, will come within the 16 inches limiting distance, and cause serious brushing or possible sparking over from the deck insulator. The deck insulator and primary must therefore be kept well apart and in different halves of the screen; if the deck insulator is in the left-hand half of the screen the upper arrangement in Plate II. will be necessary; and if in the right-hand half, the lower arrangement. If the deck insulator is exactly in the centre of the screen, or within 2 inches of it, either arrangement is possible, but the upper is preferable if the silent cabinet is on left-hand side of screen, and the lower if the silent cabinet is on the right.

The condenser tank and spark gap, as shown in the plate, must be placed as near to the front of the screen as possible, to allow plenty of clearance at the back between the secondary of the oscillator and the back of the office.

If these instruments and the transformer are correctly placed close up to the sides of the screen, as shown in Plate No. II., there will be no difficulty in finding suitable positions for the send receive switch and aerial coil where they will not spark over to one another, to earth, or to the other connections and instruments inside the screen. From the top of the aerial coil, the deck insulator and the send terminal of the send receive switch, the minimum safe working distance to earth, the receiving connections, any point on the connections between the transformer and spark gap or the earthed end of the mutual coil, is 16 inches.

The top of the aerial coil, deck insulator, and send terminal of the send receive switch are all at the same potential when sending, and can be placed quite near to one another.

From the lower end of the aerial coil and the unearthed end of the secondary, the minimum safe working distance to earth, the receiving connections, connections between transformer and spark gap, also to the deck insulator, send terminal of the send receive switch, or upper end of the aerial coil, is 8 inches.

The circuit from the high voltage terminals of the transformer, through the safety horns, transformer switch, and protecting coils up to the spark gap, is shown in Plate I. These instruments will screw up to teak battens placed round the back and sides of the screen, and high voltage porcelain terminals will be provided for running the connections, which must be so arranged that they are at no point within the minimum safe working distance of one another or earth, these distances are given in the plate.

Wiring.

Plate No. IV. gives a diagrammatic sketch of the circuits through the cables connecting up the motor alternator and instruments in the Wireless office as far as the transformer.

All the wiring shown in this plate will be done by the Dockyard (with the exception of the transformer connection).

All cables are lead-cased, the lead casing is continuous throughout, and is earthed to the frame of every instrument. This continuous lead casing will completely shield the wiring, and will prevent the formation of induced currents liable to damage the insulation of the instruments and interfere with the ship's lighting or telephone circuits.

The instruments on the instrument board are approximately to scale and in their correct relative positions.

It will be noted that there are six distinct circuits:—

(1) The main direct current circuit that supplies the motor alternators; this will take about 20 K.W. when signalling.

(2) The auxiliary direct current circuit, including the field regulators for both alternator and motor fields, which will be placed on the side of the silent cabinet. Their handles will be carried into the cabinet, thus giving the telegraphist complete control of the frequency and voltage of the alternating current, both of which require accurate adjustment to obtain a good note.

(3) The main alternating current circuit; this will take when signalling about 80 ampères at about 400 volts. It is broken at the double pole "relay switch," and at the magnetic key. Both of these are electrically operated; the former is controlled by the safety circuits, and the latter is worked by the Morse key in the silent cabinet.

(4) The auxiliary alternating current circuit supplies the different alternating current instruments, &c.

A shock from the alternating current circuit, which is at 400 volts, may be very severe, and possibly in some cases fatal, every instrument in connection with it is therefore enclosed. The alternator, the alternating change-over switch, and the relay switch have locked covers, which must only be opened by a responsible person when the motor alternators are not running. The other instruments in connection with the alternating current are protected by the safety circuit described below.

All cables carrying alternating current are concentric, and have their inner core completely surrounded by the outer. Ordinary lead-cased cables are not suitable, thus cable Pattern No. 821*a*, which has about the same current capacity as the main concentric cable, has an apparent resistance for the alternating current many times greater than that for direct current, which means a great loss of power. This is apparently due to eddy currents, produced in the lead casing by the rapidly alternating stray magnetic field. With a concentric cable the currents in the two conductors are in opposite directions, and completely neutralise one another; there is thus no stray field, and the resistance of the cable is practically the same for direct and alternating currents. Special fittings are necessary for making connections to the outer conductors of these concentric cables. If ordinary clamp or solder connections were used, the pressure of the clamp or the heat of soldering would damage the rubber insulation immediately below the layer of wires forming the outer conductor; this rubber would soon deteriorate, and a dead short-circuit would result. Two types of connection have been adopted, the one consists of an ordinary clamp with a short length of brass tubing, which is slipped over the inner core under the outer layer of conductors in the wake of the clamp; the clamp can then be tightened up without compressing the rubber. The other connection fitting consists of a short length of brass tube with a lug attached; the tube is slipped over the outer layer of wires, which are turned back over it and tightly bound to it with binding wire. The lug is used as a cable eye.

The balancer keeps the two alternating current mains at equal potential on either side of earth, and is arranged to give notice by a loud buzzing of any earth on the alternating current circuit.

Safety arrangements.

(5) The fifth circuit is the safety circuit, it passes through all the safety switches, and supplies the current that operates the relay switch and works the magnetic key. As will be seen from the plate, this circuit is so arranged that the relay switch can only switch on the main alternating current when the blower is running and supplying air to the spark gap; both safety switches down (which means that the doors of the safety screen are both closed); the send receive switch is over to send, and the covers of the alternating current cut-out, and magnetic key boxes are shut.

It will also be noticed that if the door of the magnetic key is opened, and the other safety switches are in the correct position for sending, the magnetic key can be worked, adjusted, &c., as the direct current that works it is switched on, but the high voltage alternating current is switched off at the relay switch.

All the important switches in the safety circuit are either double pole switches or short-circuit the two leads after one has been disconnected from the supply. This reduces the possibility of an accidental earth closing the relay switch.

(6) The sixth circuit is the Morse key circuit working the magnetic key from the silent cabinet.

MACHINERY AND INSTRUMENTS FOR SERVICE INSTALLATION, MARK II.

Motor alternators.

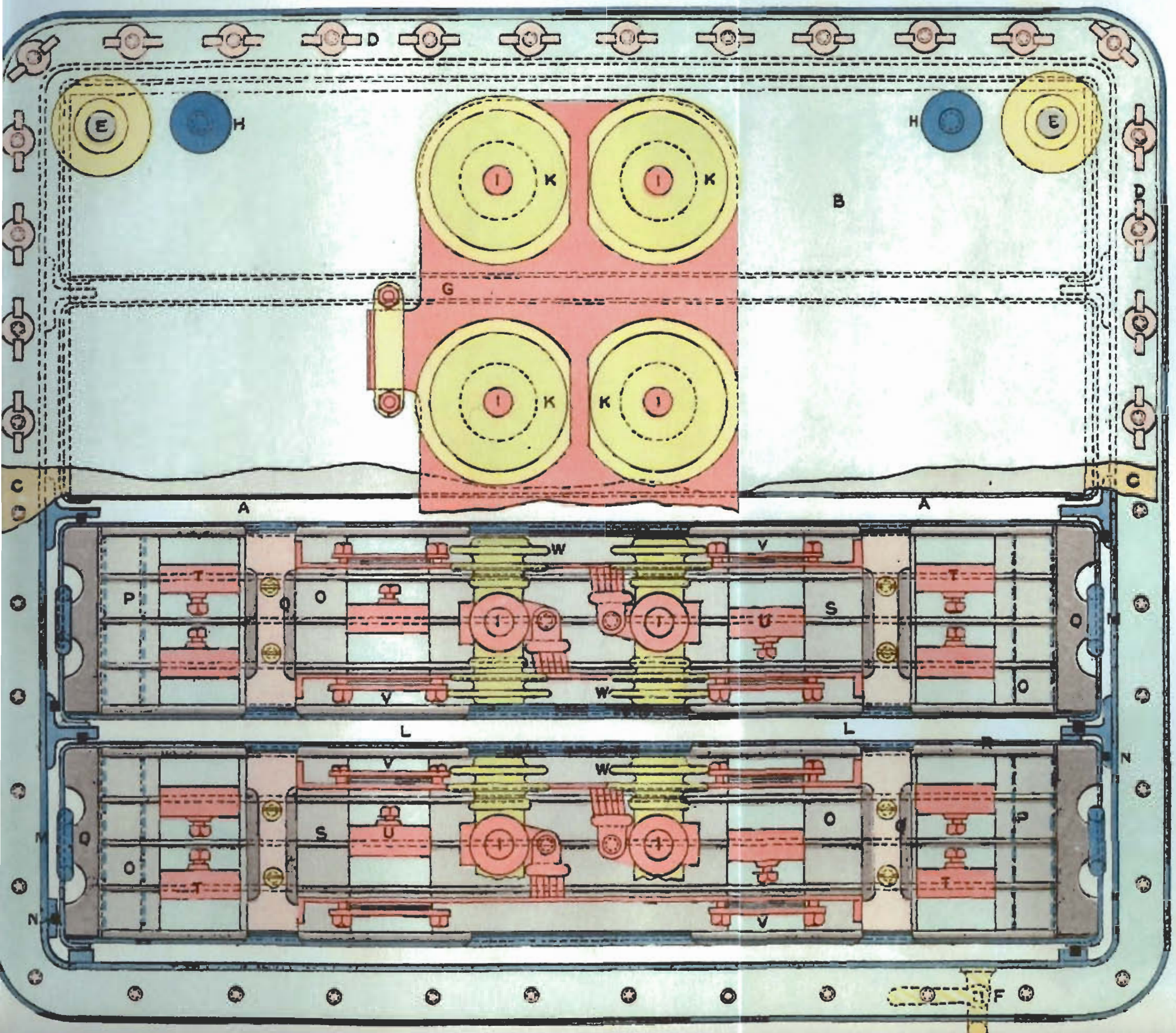
The alternator and its direct current motor will be separate machines, direct coupled, mounted on one bedplate. They will run at about 1,910 revolutions. This high speed will keep the machines running steadily while signalling. Balancing rings carrying small adjustable weights will be fitted to both machines to give a good balance. The adjustment of these weights is very difficult, and requires considerable experience; it should not be attempted unless absolutely necessary. The motor will be wound to give a constant speed, and will have small series wound poles fitted between the main pole pieces, to help commutation. If the supply volts vary, field regulation will enable the speed to be kept normal provided the supply voltage is not more than 10 per cent. below or 5 per cent. above the normal. The input with a 100-volt supply will be about 200 ampères while signalling, rising to 350 ampères for a few seconds for a continued long.

The alternator will have 22 poles, a rotating armature, and small diameter slip rings shrunk solid over insulation on shaft. The normal output will be 75 ampères at 400 volts while signalling with full power, it will also give for one minute the 120 ampères required for a full-power continuous long. The output under these two conditions will be about 13 and 27 kilowatts respectively, the apparent discrepancy being due to the difference in phase between the volts and ampères.

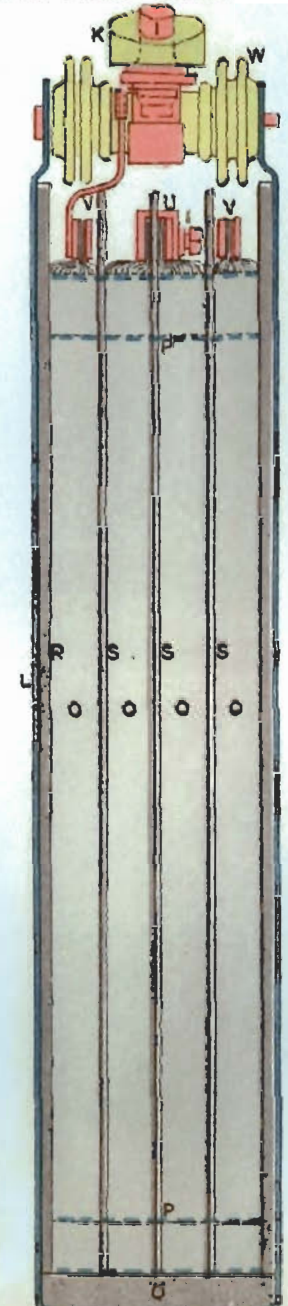
The machines must be mounted on a perfectly flat bed, and should, if possible, have their axis fore and aft to reduce to a minimum the strains on the shaft and bearings, due to gyroscopic action when rolling, and due to disalignment of the three

Transmitting Condenser for Service Installaton, Mark II.

SCALE 3" = 1 FOOT.



SECT.N THRO' SINGLE ELEMENT.



REFERENCE.

A. GALVANIZED STEEL TANK.
B. DETACHABLE COVER.
C. LEATHER WASHER.
D. STEEL STUDS & BUTTERFLY NUTS.
E. OIL FILLING HOLES.
F. BIBCOCK FOR EMPTYING OIL.
G. COPPER SHEET & EARTH CONNECTION TO PRIMARY.
H. PILLARS CARRYING PRIMARY.
I. MAIN TERMINALS.
K. INSULATORS TO MAIN TERMINALS.
L. GALVANIZED STEEL CONDENSER CASE.
M. LIFTING EYES.
N. WEDGES.
O. EBONITE CONDENSER PLATES WITH TINFOIL SHEETS ON EACH SIDE.
P. LIMITS OF TINFOIL.
Q. EBONITE BLOCKS SUPPORTING CONDENSER PLATES & PLATES ENCLOSING COND…
R. " " "
S. " " SEPARATING SECTIO…
T. CLAMPS JOINING TINFOIL CONNECTIO… OUTER SECTIONS TO INNER SECTIONS
U. " " THE TWO INNER SECTIONS
V. " " OUTER SECTIONS TO TERMINAL CONNECTIONS
W. INSULATORS SUPPORTING MAIN TERMINALS.

bearings if the bedplate is strained. If in good order the machine will run for between 2 and 3 minutes after switching off.

The slip rings will be enclosed with a hinged cover fitted with a spring catch opened with a section box key; as a very nasty shock can be taken from the terminals, the cover must only be opened by a responsible person. The connections to the concentric cable will be enclosed in the cover.

Change-over switch-board. The direct current change-over switch will have a quick break, and detachable iron cover; the kicking coils as shown in Plate IV. will be in parallel with the field regulators when the machine is running, and will take the kick from the shunt fields if the switch is opened while the machine is running.

The alternating current change-over switch has a slow break, is totally enclosed with an iron cover, which should only be opened by a responsible person and when both alternators are stopped.

Starter. The motor alternator starter has been made as full proof as possible. The special winding and high speed of the motor make it necessary to start it very slowly. The overload release and interlocking arrangements that have been provided are also absolutely necessary for safe running, and must not be tampered with.

Field regulators. The two field regulators are for the shunt field of the motor and alternator respectively. They have worm gearing giving a slow movement which will make accurate adjustment easy and prevent the severe strain to the machine that would arise from a very sudden change in speed; their handles project into the silent cabinet and are labelled "Speed" and "Volts" respectively; felt-packed sound-tight glands are provided. Both regulators are fitted with spring releases which automatically cut out all the resistance from the motor field and put it all in the alternator field when the motor is switched off; the motor will thus always start under the most favourable conditions. Both handles will re-engage without turning back to zero, if pulled inwards (or pushed outwards) after the motor has been started.

Reversible feet and handles have been so arranged that the regulators can be mounted in the correct positions on both left and right-hand cabinets.

The relay switch and fittings. The relay switch is a double pole switch which is closed by a small current, it works on the sucker magnet principle. A considerably smaller current is required to hold the switch closed than to lift it to the closed position, and a resistance is arranged in series with the winding, this is automatically short-circuited when the switch is open and put into the circuit when the switch makes.

The leads for the alternating voltmeter and the frequency meter are taken from inside the relay switch on the machine side, and the alternating ammeter shunt is fitted inside the box on the instrument side.

The relay switch is capable of breaking the full sending circuit without serious damage, but it would of course only have to do so in the event of the magnetic key sticking down, as when the safety circuit is broken the magnetic key will open far more rapidly than the relay switch. The lid of the relay switch box is arranged with spring locks which can be opened by a section box key, also a spring is arranged so that the lid will fly open if it is not properly locked. A notice is engraved on the lid of the box giving warning against opening it unless the alternators are stopped.

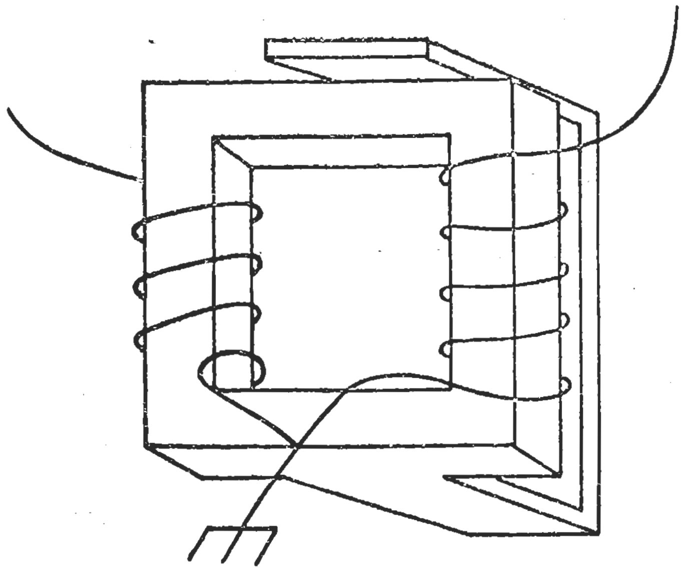
This box is only to be opened by a responsible person acting on the immediate instructions of the Lieutenant (T).

The balancer. The balancer is a double wound inductance joined up between the alternator mains, its centre point is earthed. The magnetic circuit is arranged as in Fig. A.

When there is no earth on the alternator mains, no current will flow through the earth connection, and the current flowing in the two halves of the balancer will be equal. The magnetic lines will flow round the closed iron circuit provided for them; they will be of equal strength in the two halves, and the back e.m.f. will thus be equally divided between the two halves, and the two alternating mains will be kept at equal voltage above and below earth. The induction of the balancer, on account of its closed magnetic circuit, will be very high, and only a small current of less than $\frac{1}{20}$ of an ampère will flow through it, so that the waste will be negligible.

Should an earth develop on the alternating current circuits one of the windings of the balancer will be short-circuited, and the currents induced in this winding will prevent the alternating magnetic lines threading it, so that return path for the lines that flow through the other half of the balancer will be across the air gap down the iron tongue. The self-induction of this second winding will not be great, as there is an air gap in its magnetic circuit, and it will take an appreciable current; this will be above 8 ampères if the first winding is dead short-circuited. The tongue contains a stiff steel spring that will make a loud buzzing sound when the balancer is disturbed, calling attention to the fact that there is an earth on the circuit. If it is not absolutely necessary to continue signalling, the alternators should be stopped and the earth found and removed before damage is done. The balancer will also prevent the whole of the alternating current circuit getting charged up to a high voltage should the secondary connections inside the safety screen make accidental contact with any of the primary leads.

FIG. A.



Alternating current cut-outs.

The alternating current cut-out box contains two fusible cut-outs mounted in treated fibre holders of the quick replacement type. The lid of the box is fitted with a double pole switch, so arranged that it will break the safety circuit when the lid is removed, and ensure the terminals being dead when a cut-out is being replaced.

Magnetic key.

The magnetic key is shown in Plate VI.; it consists of a single pole switch electrically operated by a small signalling key. This magnetic key is especially intended to work rapidly, and to break the full alternating current. To reduce the sparking and wearing away of the contacts, and to prevent an arc from forming, the key is fitted to break the circuit at two places in parallel. The first break leaves a reduced current flowing through non-inductive resistances, and the second break opens the circuit altogether. On the key being pressed, the main circuit is first closed through the resistances, and then the resistances are short-circuited. The extreme rapidity with which this key has to work makes a powerful magnet necessary, and the kick on break due to its large induction is absorbed by a non-inductive shunt resistance.

A condenser is fitted to stop the sparking at the signalling key terminals; the non-inductive resistance also protects this condenser.

To limit the current in the bobbin the series resistance A is fitted.

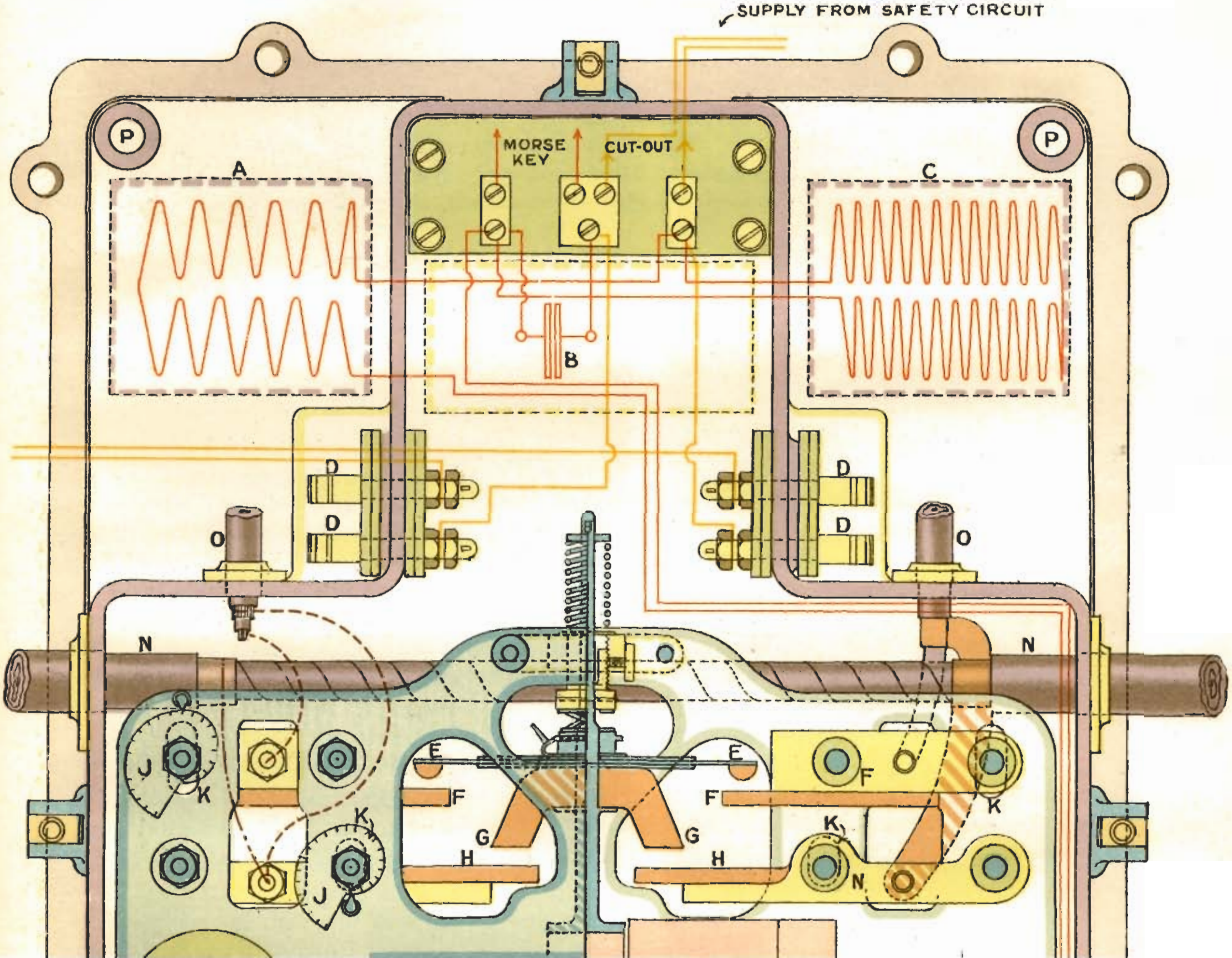
The switches DD are closed by insulated metal tongues fixed in the cover of the box; they are thus opened when the cover is removed and break the alternating current at the relay switch so that the key can be adjusted. The operating current of the key is not broken by these switches, and the key can be worked with the door open. As can be seen, when the signalling key is pressed, a current will flow in the bobbin provided all the safety contacts are made, and the spindle will be pulled down against its recovery spring. The upper contacts EE will be made first, and so complete the main circuit in series through the two non-inductive resistances which are joined up by the two cables OO. The upper contacts are springy, and immediately after they make the lower contacts GG will make and short-circuit the resistances.

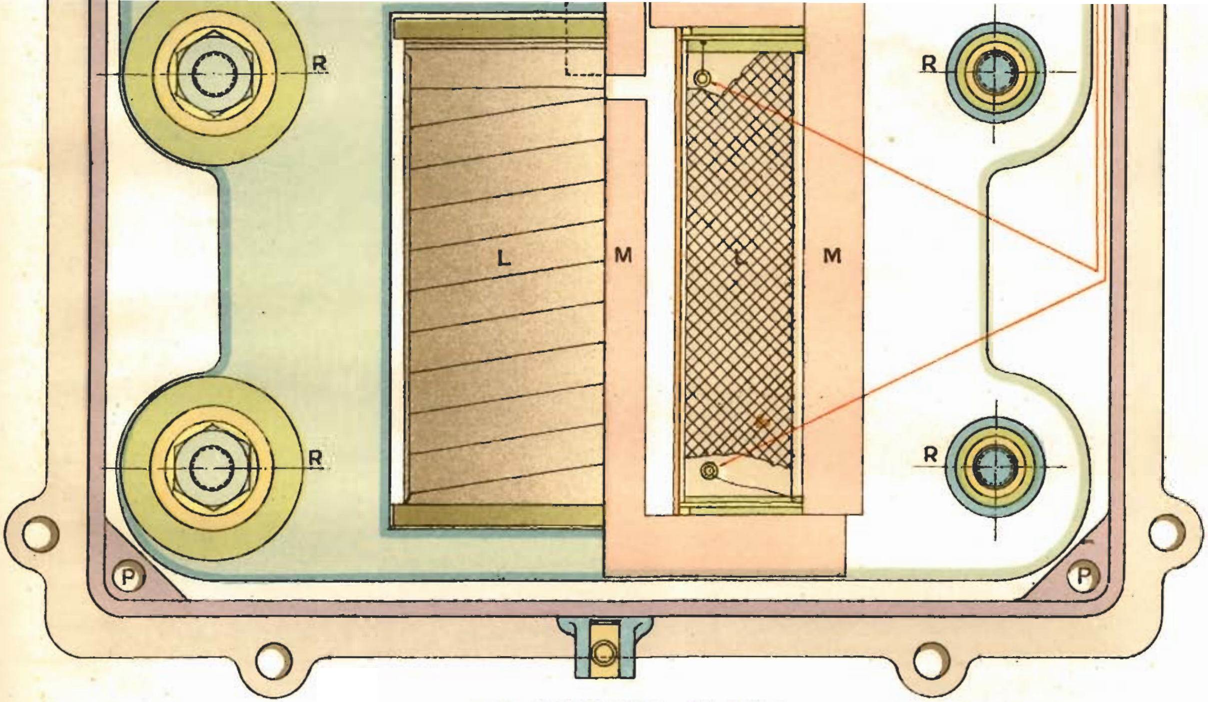
The key is fitted with one permanent adjustment consisting of the screw gland and set screw shown immediately below the spiral spring that lifts the spindle; it limits the travel of the moving part. The height of each contact piece is also separately adjustable by one of the four cams J which tilts up the copper contact and its brass support. The whole working of the key depends on the adjustment of these contacts. If once properly set the key will require no attention beyond the lifting up of all contacts one or two notches about once a week and a little oil on the spindle and the parallel guides at the lower end of the moving part.

To adjust the key: first put the contacts down to their lowest position, then press the Morse key, bringing the moving part right down to the bottom of its travel. Bring up the contacts HH until they just touch the brush G. Allow the brush to lift out of the way and lift up the contacts HH, until their tips are between $\frac{3}{32}$ and $\frac{1}{8}$ inch higher up. Press the spindle down gently with finger and the brush G begins to touch the two contacts HH at the same time, making any

MAGNETIC KEY, MARK II. COVER REMOVED.

SCALE 5" = 1 FOOT.





REFERENCE TABLE.

A	SERIES RESISTANCE	J	ADJUSTING CAMS
B	CONDENSER TO MORSE KEY	K	SLOTS IN PLATES TO ALLOW FOR CAM ADJUSTMENT
C	SHUNT RESISTANCE	L	OPERATING BOBBIN
D	SAFETY CONTACTS TO COVER	M	MAGNETIC CIRCUIT
E	UPPER BRUSH	N	MAIN CONCENTRIC CABLE (INNER CORE CONTINUOUS)
F	" " CONTACTS, AND SUPPORTS	O	CONCENTRIC CABLES TO "KEY RESISTANCES"
G	LOWER BRUSH	P	HOLES TO TAKE STUDS IN COVER
H	" " CONTACTS, AND SUPPORTS	Q	INSULATED STEEL BOLTS SUPPORTING KEY

MORSE KEY AND SAFETY CIRCUITS, PATT. Nº 798 A CABLE ARE COLOURED THE SAME AS ON DIAGRAM OF COMPLETE CIRCUITS PLATE Nº

SUPPLY ENTERS THROUGH CUT OUT TERMINALS.

ALL INSULATION COLOURED LIGHT GREEN.

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To face page 28.

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slight readjustment necessary until this is so. Lock these contacts in this position. Then so set the permanent adjustment that the full travel of the moving part is $\frac{1}{4}$ inch. And finally so set the two contacts FF that as the moving part is pressed by finger the spring brush E just touches both of them when the brush G is $\frac{1}{16}$ inch clear of the two contacts HH The key is now in adjustment.

The whole moving part can be lifted out together with the upper guide, after taking out the two screws that secure this guide; the brushes G and E can then be renewed without altering the permanent adjustment.

After undoing the four nuts R, the four bolts making connection to the contact holders and the connections to the bobbin, the whole key can be removed from the box.

The four copper contacts are easily replaceable, and are reversible, so that both sides can be used.

Key resistances. The two key resistances are connected to the key by the two leads of concentric cable and are mounted together in the same framework, which should be placed nearer to the switchboard. With the magnetic key properly adjusted these will stand continuous work at full power without overheating.

Measurement instruments. The alternating current ammeter and voltmeter are of the usual hot-wire pattern. The frequency meter is very similar to those previously supplied. It does not, however, require any direct current connections, and each reed has been split into three; the centre one is tuned to the frequency marked above it, and the two outside ones have been tuned, one a little lower and the other a little higher than the centre one; this arrangement makes adjustment more easy. The direct current ammeter has its shunt mounted in a separate case. All these instruments have been fitted in strong metal cases with special lugs which are secured to the instrument board with "spring bolts" which will take up shocks due to gunfire with springs and soft leather washers.

The terminals of the instruments have been placed behind, and the lead casing of the cable connections earths the cases of the instruments.

Impedance coil. The impedance coil consists of two coils of wire large enough to carry the primary current wound over a laminated iron case.

The magnetic circuit is not complete and the air gap can be varied to make the inductance suitable for various ships.

The object of this coil is to bring the primary circuit into resonance with the frequency of the alternator.

Transformer. The transformer is enclosed in a strong cast-iron case which must be kept brim full of oil.

The transformer is bolted to the under side of the cover and the seven terminals are fixed in insulators in the cover.

The two primary terminals are marked P & P, and are enclosed in an oil-tight box which must be kept quite free from oil.

The lead casing of the concentric cable must come right up to the gland of the box, where an oil-tight junction must be made.

If any oil is allowed to enter this box or get at the rubber insulation of the cable, the rubber will soon perish and a fault will develop.

As stated above, these terminals must only be connected up by a responsible person acting under the direct orders of the Lieutenant (T), after he has satisfied himself that all the circuits are correct and the various safety switches work, that the protecting arrangements between the transformer and spark gap have been properly set, and the transformer is brim full of vaseline oil.

The five secondary terminals are labelled S_1+, $S_1=$, S_1-, &c., as shown in plate, which also shows the connections of these terminals to the ends of the two secondary windings and to the middle point of one winding respectively.

The transformer has two laminated iron cores connected by laminated iron yokes, which close the magnetic circuit. A special high efficiency iron alloy called "Stalloy" has been adopted. The primary winding is in two halves, wound for the full length of the two cores. Outside the primary two heavily insulated cylinders are placed, and the two secondary windings are mounted on these, in former wound sections, which are joined up in series.

Transformer switch, &c. The transformer switch, protecting horns, protecting coils, and high voltage terminals, make use of a standard porcelain insulator for all insulation.

The general form of these instruments is shown in Plate No. II.

They are attached by wood screws to the wooden batten round the screen. When at series the two secondaries of the transformer are in series with their centre point earthed, and are then suitable for charging the condensers, two in series and two in parallel, or simply two in series.

When at parallel the transformer switch connects the two secondaries in parallel and earths the centre of one secondary; this arrangement is suitable for charging condensers all four in parallel.

The protecting coils cut down any high frequency surges that are liable to travel back from the primary to the transformer.

The protecting horns allow any surges that come back to spark over, forming an arc between the horns; this arc travels up to the tips of the horns, where it spreads out and breaks; as the arc will extend up 2 or 3 inches above the tips of the horns, these should not be placed near to any inflammable material. If the horns start going while sending, it is certain there is something wrong with the gear inside the screen. The horns must on no account be opened out beyond their proper distances, as given in Plate No. I. The small coils between the horns and the transformer protect the transformer while the horns are arcing across.

Transmitting instruments.

The oscillating circuit is in five principal parts :—

The condenser,

The primary oscillator, generally called the "primary,"

The spark gap,

The mutual coil, generally called the "mutual," and

The aerial coil, which, together with the "Mutual," is in connection with the aerial, and forms the secondary circuit.

With the exception of the aerial coil these are shown together in Plates II. and III.

The condensers.

The condensers for the Service Mark II. installation are built up of ebonite sheet and lead foil.

The condenser consists of four elements stowed in oil in a steel tank, as shown in Plate No. V. This tank must be kept brim full of oil.

All tanks are tested with a small head of oil, and are provided with suitable fittings for filling and emptying, and for showing the level of the oil.

To allow the oil to expand, a small tank (not shown), holding about one gallon, is provided.

Each element consists of four sections joined in series. Each section is built up of 23 sheets of ebonite joined in parallel. The sheets of ebonite are $\frac{1}{32}$ inch thick, and have a sheet of lead foil on each side.

The foil is not fixed to the ebonite in any way. There is a very thin layer of oil between the ebonite and the foil, which is pressed firmly against the ebonite. All traces of air between them are removed, and they stick together fairly firmly. This method of construction is free from the serious loss of energy and other objections arising from the use of sticking materials. The ebonite sheets with the foil on them are packed in light steel cases, in which they fit snugly.

To prevent the foil shifting, each sheet is provided with two tabs, both of which are rigidly secured. The electrical connections are also made through these tabs.

Each sheet of ebonite is subjected to an electrical pressure equivalent to a spark of 5 mms. before building up, and the whole element is subjected to a pressure equivalent to 16 mms.

Flexible connections to the outer sections of each element join them up to the main terminals which project through oil-tight glands in the cover of the condenser tank, and are there connected to the primary.

By readily removable clips shown Plate No. VII., the elements can be joined up, either all four in parallel, or two in parallel and two in series with their centre point earthed. Also by making special connections they can be joined two in series. As the capacity of each element is 40 jars, the different transmitting capacities are 160, 40 and 20 jars respectively, which are suitable for the different wave lengths as given in the table on page 22.

The connections are shown diagrammatically in Plate No. VII. When the two movable clips are shipped in the billets PP, the four elements are in parallel, when they are in the billets SS, the four elements are in two in series two in parallel, and the centre point is earthed.

Primary connections.

The primary (*see* Plates III. and VII.) consists of five turns of stout copper, three turns are of 1-inch tubing in a spiral, and the other two are circular castings of square section, the circle lying all in one plane.

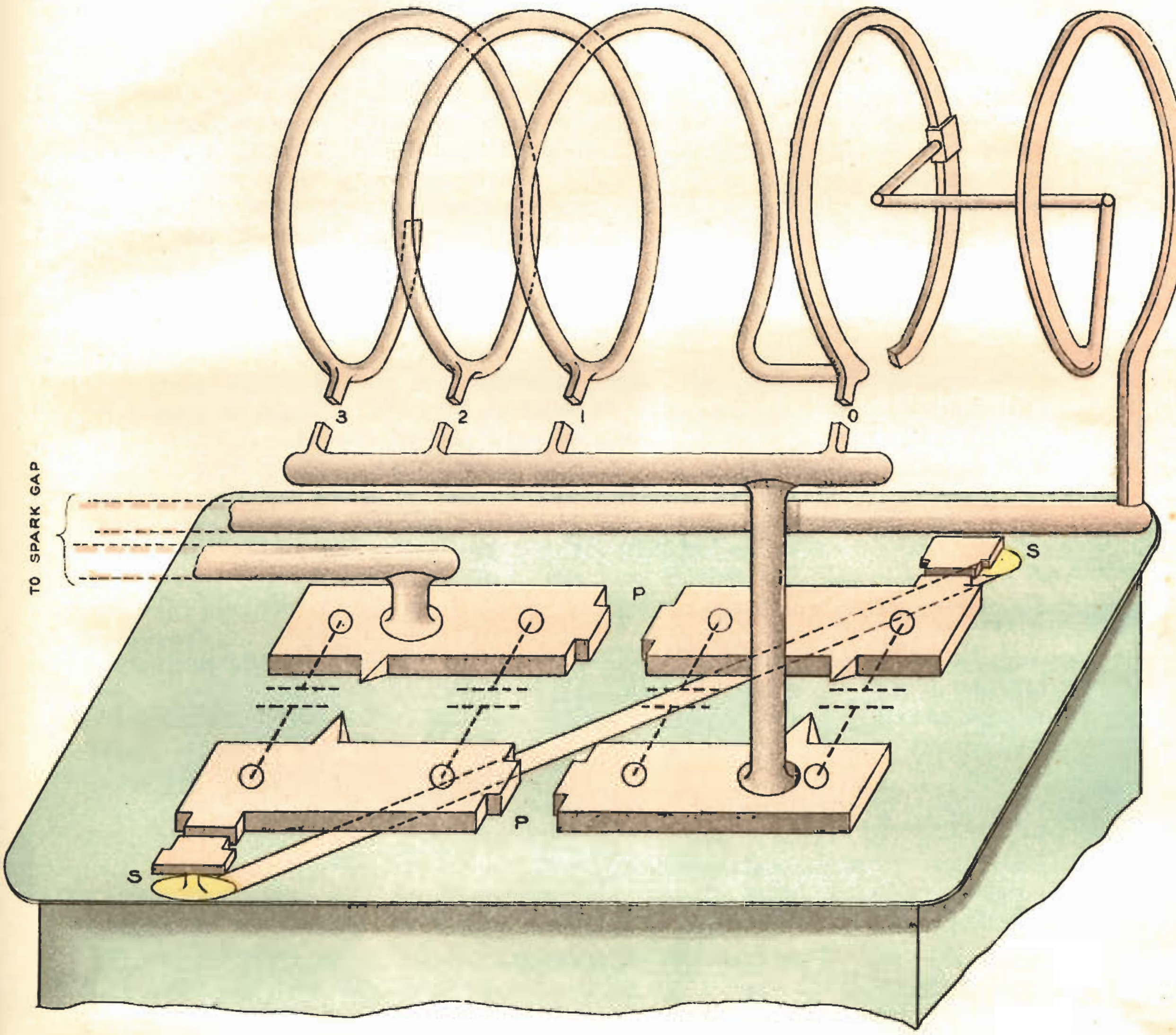
The end turn, usually called the coupling turn, is kept entirely in one plane, so as to have the maximum effect on the "mutual coil," which is next to it.

The next turn, called the adjusting turn, is also all in one plane; a moveable connecting arm travels round it and will make contact with any point on it. The heel of this arm is pivoted on a projection mounted on the centre of the ebonite stiffener of the coupling, and connection is made through this projection to the coupling turn.

The three remaining turns are spiral, and a movable clip allows connection to be made at any turn at the points 0, 1, 2, and 3 in Plate No. VII.

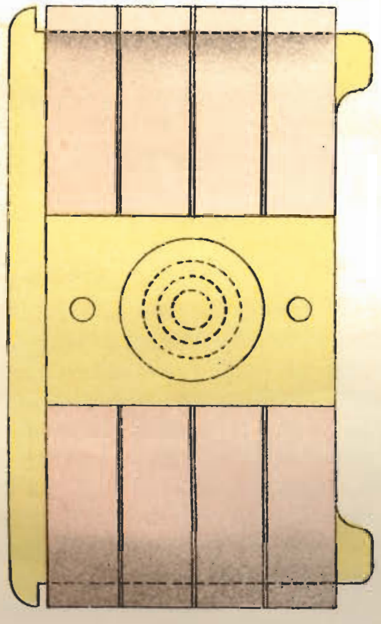
The sizes of the rings have been so chosen that the primary can be adjusted to any L.S. value within its limits, 75 to 1,000.

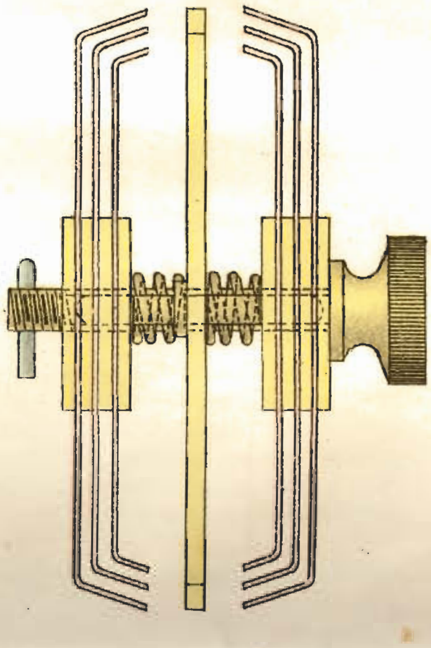
DIAGRAMMATIC SKETCH OF PRIMARY CONNECTIONS.



DETAIL OF CLIPS.

FULL SIZE.





The large size of the section is due to the fact that the currents in the primary circuit when the spark is passing amount to several thousands of ampères, though of course only momentarily.

This current, being of high frequency, flows only on the surface. Hence the somewhat peculiar form of the contacts.

All the parts of the primary are rigidly supported by porcelain insulators.

To prevent accidents in the condensers due to too high a voltage, permanent sharp points are fitted on the primary, which will spark over if the safe voltage is exceeded.

A movable safety disc is arranged over the standing points, whereby the safety gap can be set to any less distance if required. These safeties are made circular, so that they can be turned round a little as they burn away.

Spark gap.

The ends of the leads from the primary are attached by an easily removable connection to two tubes which are led through porcelain insulators into a sound, tight box, which is lined with fireproof substance.

The ends of these tubes carry holders into which the spark plugs are screwed.

A strong air-blast is arranged to blow at the spark, and the radiating gills which are fitted to dissipate the heat from the spark.

The air-blast, which issues from a triple nozzle of porcelain, combined with the shape of the spark plugs, prevents arcing and keeps the note true.

The air-blast enters at the bottom of the spark gap through an easily detachable hose and leaves the spark gap through a silencing device fitted in the cover of the box, and is led through a hose, also easily detachable, to a mushroom ventilator in the top of the office. The foul gases, which are objectionable, are thus removed.

Arrangements are made for adjusting the spark gap from the silent cabinet. The two flexible steel cords as shown in Plate No. III. pass round the drum that adjusts the gap, and are led over pulleys to a similar drum fixed on the outside of the silent cabinet. The second drum is turned by a handle inside the cabinet, where an indicating device is provided.

Blower.

The blower is a centrifugal fan driven by a series motor; it supplies air through the standard nozzle at the pressure of 8 inches of water. It must not be run with the nozzle blocked up or with the nozzle disconnected, as the motor will race under the former and be overloaded and tend to burn out under the latter conditions.

Send receive switch.

The send receive switch will be the same as used for C tune, Mark II., shown in A.R., 1906. It has been found necessary to make slight modifications to the switch, as its working was not altogether satisfactory, in its original form.

The mutual coil.

The mutual coil consists of 14 turns of bare 12-gauge copper wire wound over a hexagonal former built up as a lantern frame.

The ribs are of porcelain, corrugated, to stop the wire sparking from one turn to the next, and the end discs are treated fibre.

At the primary end a dished ebonite shield is fitted to prevent all chance of the secondary sparking to the primary, or the primary sparking to the earth lead.

The turns are 0·4 inches apart, and connection can be made anywhere clear of the ribs by a special clip.

The coil is supplied with the wire coated with black varnish to prevent the formation of a film of high resistance copper oxide or dirt.

The varnish must be cleaned off where the contacts are to be made, and when tuning is completed any bare patches must be covered up with japan black.

The coil is fitted to slide on a central bar in line with the primary, so that the coupling can be altered readily, and thus make the process of tuning much less laborious.

A rack and spring catch are fitted to hold it in place against the motion of the ship.

The aerial coil.

The aerial coil is similar in construction to the oscillator secondary, but has 22 inches of winding, the bottom 11 inches being ·4 inch spacing and the top ·25 inch spacing.

This wire is also supplied varnished over, and must be cleaned where necessary for tuning and patched with japan black afterwards.

Special clips are placed on the coil in the positions required for the different tunes, connections are made to these clips through a length of flexible wire the spare part of which can be coiled up in a fitting provided at one end of the coil.

The two ends of the former are provided with swivels, and the aerial coil is to be hung up by a special prepared cord, which is supplied, to bolts in the deck.

Its lower end is also to be stayed out from the swivel to prevent the coil swaying about with the motion of the ship.

The upper end of the coil must be 18 inches and the lower end 8 inches from the nearest earthed metal.

The widely spaced end is the high potential end, and is connected to the Send-Receive switch.

Both coils are arranged to work, without sparking over, when the aerial is charged to the maximum spark the deck insulator will stand without sparking over; and if properly connected up will work with this spark.

If, however, they are wrongly joined up they will spark freely, probably from one end of the winding to the other, but this can do no harm, as the air insulation at once repairs itself.

Copper tubing and a special flexible wire, both of about $\frac{5}{8}$ inches diameter, are provided for the connections in the circuits between the aerial, the aerial coil and mutual coil. The large diameter of these connections will reduce brushing, inside the Wireless office, to a minimum.

80, 100, and 220-volt ships.

The following instruments, &c., have been provided in three different patterns to suit ships with supply voltages of 80, 100, and 220 volts respectively; and the particular pattern suitable for the ship's supply must be used.

Motor alternator.
  Starter for.
  Field regulator (motor) for.
  ,, ,, (alternator) for.
Blower.
  Starter for.
Change-over switch (direct current).
Kicking coils.
Relay switch.
Magnetic key.
Ammeter and shunt (direct current).