No. 119

FOR THE INFORM[illegible] OFFICERS IN H.M. SERVICE ONLY.

Attention is ca[illegible]nalties attaching to any infraction [illegible]cial Secrets Act.

WIRELESS TELEGRAPHY.

INSTRUCTIONS

FOR

GUIDANCE OF OFFICERS

IN

FITTING UP LARGE POWER WIRELESS TELEGRAPHY INSTRUMENTS.

1907

CONTENTS.

NECESSARY PRECAUTIONS.

INSTRUCTIONS FOR FITTING UP LARGE POWER W.T. INSTRUMENTS.

(With special reference to "C" tune Mark II. Transmitting Instruments.)

ATTENTION IS CALLED TO THE FOLLOWING NECESSARY PRECAUTIONS

Discretionary pov is given to Officers, not below the position of Commanding Offrs of His Majesty's Ships, to communicate, in special cases, other persons belonging to His Majesty's Service any portio of this book with which it may be absolutely necessary for the to be acquainted in carrying out their duties. The Officers exercising this power will be held responsible that such information is imparted with due caution and reserve.

Transformer.

The transformer must be filled with vaseline oil before use.

A shock from the secondary winding will be instantly fatal.

When the primaries are in series, the connections through the switch should be—

$$\pm \; P_1 \text{——} P_2 \; - \; P_3 \text{——} P_4 \; \mp .$$

When in parallel, the connections through the switch should be—

$$\pm \; \left\{ \begin{matrix} P_1 \text{——} P_2 \\ P_3 \text{——} P_4 \end{matrix} \right\} \; \mp .$$

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Never attempt to increase the voltage at the primary terminals.

Choking coil. The choking coil must be filled quite full of vaseline oil before use.

The terminals are inside the galvanised iron cap, which is supplied only for protection during transport.

Spark gap. A spark is never to be made unless the safety spark points are in place across the spark gap, and the points *exactly* 1¼ *inches* apart. The points must be kept sharp.

If a spark takes place at the points under these conditions, the spark plugs are too far apart.

NOTE.—1¼ inches across points is equivalent to just over 10 mm. spark between the spark plugs, and 10 mm. is the maximum spark to be used with "C" tune.

Men aloft. No men are to be allowed aloft above the control platforms when sending.

CHAPTER I.

Instructions for Fitting up.

The wireless telegraphy office is built by the Dockyard. Inside, its principal feature is a safety cage for the transmitting instruments, 7 feet 3 inches long by 4 feet 6 inches wide, made of galvanised iron wire. Wireless telegraphy office.

It has two sliding doors, which allow an opening big enough to put the instruments in place.

The cage is earthed, and it, with the bulkheads, deck, and beams, must form a completely earthed structure.

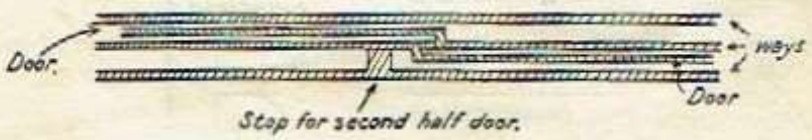
The Dockyard also wire the office and run the leads as laid down in their instructions. This only leaves the sweating on of end connections and joining up to be done. The Dockyard drill holes and bolt down instruments when they have been placed. The Dockyard also build and wire a silent cabinet.

They also cut a hole for the deck insulator, bore holes for securing the gunmetal deck fitting, and fix an iron guard screen round it on deck. Deck insulator.

They also drill holes and secure a zinc earthing ring round the deck insulator, and run two zinc strips from this ring along the bulkhead to two terminals for the sending and receiving earths to connect to. Earthing ring.

Points to be Attended to.

(*a*) See that the cage doors are properly interlocked, so that the second half cannot be opened unless the first half is already open. Cage doors.



Note.—Two safety bolts are supplied, one to each door.

Earthing ring.

(*b*) See that the upper surface of the zinc ring and the lower surface of the deck are scraped bright and the zinc ring screwed up taut.

The zinc ring should have two zinc strips running down the bulkheads to two terminals.

Guard screen.

(*c*) See that the deck insulator is approximately in the centre of its guard screen.

Wooden batten.

(*d*) See that a wooden batten, about 4 inches by 1 inch, is fixed round the inside of the cage about 3 feet 6 inches from the deck on the sides opposite the doors and silent cabinet to carry the safety chokers, &c.

Positions for electric lights.

(*e*) See that the two lamps inside the cage are placed at the two upper corners of the cage nearest the cage doors, and that they can be switched on or off from outside independently.

Aerial and earth terminals.

(*f*) See that the aerial and earth terminals are in place on the silent cabinet before it is erected, as they cannot be put in afterwards. A hole must be cut in the galvanised iron wire of the safety cage abreast them.

Condenser tanks to be bolted down to the deck.

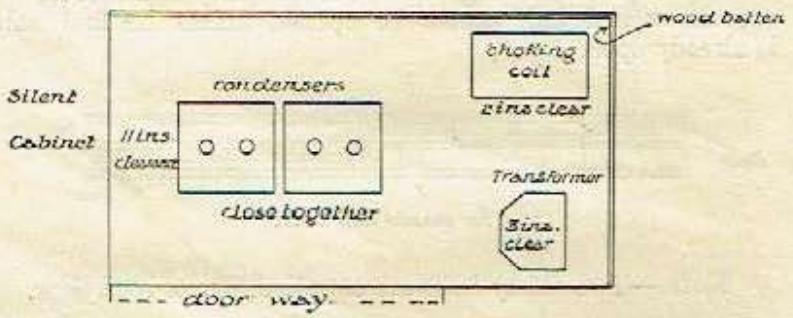
As soon as possible get the tanks properly placed so that the Dockyard can drill the holes for securing them.

At the same time measure off the positions for the holes for securing the secondary stand, and spark gap, to the ribs on the lids of the condensers.

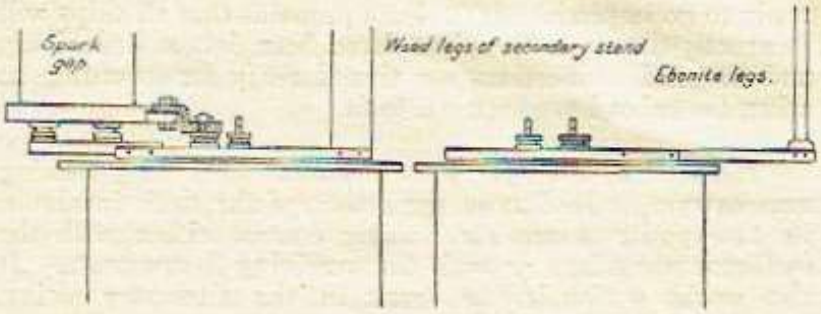
Do not take the lids off the condensers to make these holes.

Relative position of instruments.

The position of the tanks is as under—



Method of securing secondary stand and spark gap—



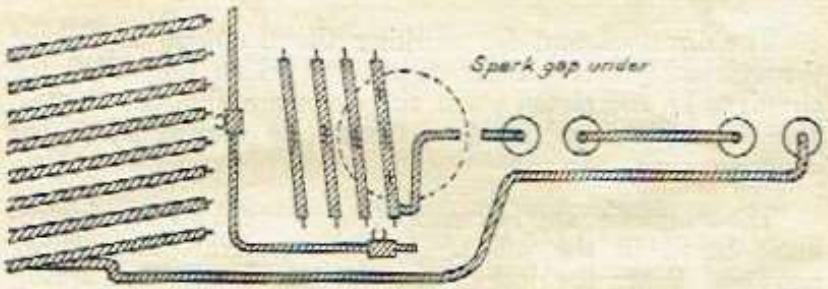
The spark gap has four ebonite legs, which must be secured to pieces of brass angle, which are in turn secured to the ribs on the lids of the condensers by screws.

Adjustable primary.

The adjustable primary is carried in a teak frame above the spark gap. One end of the frame is secured to a batten carried by the two steel brackets on the spark gap end of the cage, and the other to a batten fixed across the spark gap end of the secondary stand. There are four turns, mounted to rotate, parallel to the secondary. These form the coupling. The turn nearest the secondary has lugs on it, dividing it into eighths, and the others are divided into quarters; that is to say, the coupling can be adjusted from $\frac{1}{8}$ turn to 1 turn in steps of $\frac{1}{8}$ turn, and thence up to 4 turns in steps of $\frac{1}{4}$ turn. The remaining 8 turns are mounted rigidly, at right angles to the secondary. A revolving arm allows contact to be made to any point on the end turn, and a slider allows of contact being made to any other turn.

Arrangements are made to short-circuit all turns not required to prevent them from sparking. This is done by a straight bar fitted over three terminals at the back.

Diagram of Primary Leads.



The adjustable primary is connected to the spark gap and condensers by copper tubes, which are, as far as can be, fitted ready to go in place. As it is not probable that all ships will be exactly the same, the pipes have been left a little long, and the end connections are tinned ready for sweating on when the tubes have been cut to fit.

Send and receive switch.

The send and receive switch consists of a long rocking arm, carrying a lead from the bottom of the deck insulator, its two positions are for making contact either with the oscillator secondary or with the receiving instruments. It also works a double-pole break in the alternator mains, breaking them when in the receive position.

The switch is kept in the "receive" position by a spring.

A lever in the silent cabinet operates this switch by a Bowden wire, and this lever, and so the switch, are kept in the "send" position by a catch which is engaged by pressing a pedal. As soon as the pedal is released the catch disengages, and the switch flies back to "receive." An air buffer is fitted to the lever to prevent the spring recovering too fast. It can be adjusted by a milled headed screw at the bottom of the cylinder, which regulates the escape of air. The length of the Bowden wires is also adjustable.

The switch arm works horizontally, and the "send" contact must be at least 12 inches clear of the beams and all metal work. No screws for securing the switch are to be placed within 12 inches of the "send" contact.

Magnetic key.

The magnetic key is placed in the alternator mains. It is a single-pole surface contact switch, giving a double break, and is worked off the lighting mains on the sucking magnet principle, by a Morse key in the silent cabinet.

A resistance of 20 ohms for a 100-volt ship is fitted in the key box, in series with the bobbin, a condenser is fitted across the terminals of the Morse key to prevent sparking, and a resistance of 160 ohms is placed across the series resistance and bobbin to absorb the inductive kick.

The direct current for working the magnetic key is led through safety bolts on the cage doors, which only allow the circuit to be completed when the doors are shut and bolted. The magnetic key, therefore, cannot be worked when the doors are open.

The magnetic key box should be secured to the instrument board in the office. All its terminals are plainly marked. When the door of the key box is opened, a spring

contact short-circuits the "no volt" release in the starter and the rotary is thereby stopped.

Oil leakage.

An angle iron is to be worked round the floor of the cage, in the case of an iron deck, so as to form an oil-tight well; in the case of a wooden deck, a wooden beading is worked round, and the floor and beading covered with sheet lead.

Wire mats.

Spiral wire mats are provided to prevent oil which may leak on to the floor inside the cage from being carried over the ship.

Deck insulator.

The deck insulator is an ebonite rod, reinforced with anti-spark discs, rove through a large porcelain insulator, Place one sheet of ½-inch rubber round the thinnest part of the porcelain and bolt the two halves of the gunmetal deck fitting together round it.

The india-rubber must be cut so as to just butt when wrapped tightly round the porcelain. It can be kept in place by a couple of turns of twine whilst getting on the deck fitting.

That end of the porcelain which has the most corrugations is the top.

The deck fitting is made watertight by a red lead joint between the flange and the deck, the flange being bolted hard down to the deck.

Guard screen.

Round the deck insulator an iron guard screen is fitted, and, if on a wooden deck, earthed to the zinc earthing ring.

The top rim of the guard screen has eyes fitted to take insulated guys to the feeder, if required, to keep the feeder central.

Earthing clip for aerial.

Two holes are drilled in the top rim to take the plate of the aerial earthing clip. The spring clip is clipped on to the nuts between the horns at the top of the deck insulator when it is required to earth the aerial.

When not in use the earthing lead is to be stopped up and down one of the vertical guard rails.

ÆRIAL AND RIGGING.

Top-gallant masts.

Top-gallant masts are fitted to each mast to give a vertical height of 180 feet truck to W.L., and all rigging leading to within 40 feet of wireless yards is insulated.

Insulation of stays. The arrangement of the rigging and position of insulators laid down in Dockyard instructions have been thoroughly tried and found both necessary and sufficient.

Wireless telegraphy yards. W.T. yards 18 feet long are fitted to the T.G. masts 4 feet below truck.

Arrangements are made for reeving a yard rope.

Nothing is to be left rove above the ærials.

Notes on rigging. The following is a copy of the "Notes" on the rigging drawing:—

"The top-gallant masts are to be fitted for housing. The ærial yards on each top-gallant mast should be shackled, at the bunt, to a band 4 feet below the truck in order to take the weight of the yard, the principal object of the lifts being to keep the yards square. The lifts are to be of F.S. wire rope insulated top and bottom, with globe strain insulators two at each end.

"Each yard-arm is to be fitted with a galvanised iron band having two eyes. One of these eyes, in the case of both yards, will be fitted on the upper side to take the yard lifts; the other eye, in the case of the main W.T. yard, is to be fitted on the under side of the band, and in the case of the fore W.T. yard on the after side of the band. These eyes are to be fitted with M.C.I. swivel blocks to reeve 2-inch ærial halliards.

"At the bunt of each yard two galvanised iron bands are to be fixed, having eyes on their under sides. These eyes are to be fitted with swivel blocks, to form fair leads for the halliards.

"The halliards, after reeving through these blocks, are to be taken down close to the masts and set up in a convenient place, either in the tops, fire control platforms, or lead through to the upper or shelter decks.

"In the position selected for setting up the halliards, in the case of the main, belaying cleats should be fitted. In the case of the halliards on the foremast, eye-plates should be fitted on each side of the mast instead of cleats, and the springs to which the ærial hallards will be set up, are to be shackled to these eyes.

"The T.G. stays should be secured to a band on the T.G. masts just below the point at which the W.T. yard is shackled. The stays are to be insulated, with lignum vitæ deadeyes and hemp lanyards. Should the position of any of

these deadeyes come within 60 feet of the tops of the funnels in the direction that the smoke and funnel gas are likely to take, the insulators should be placed so as to be clear of this.

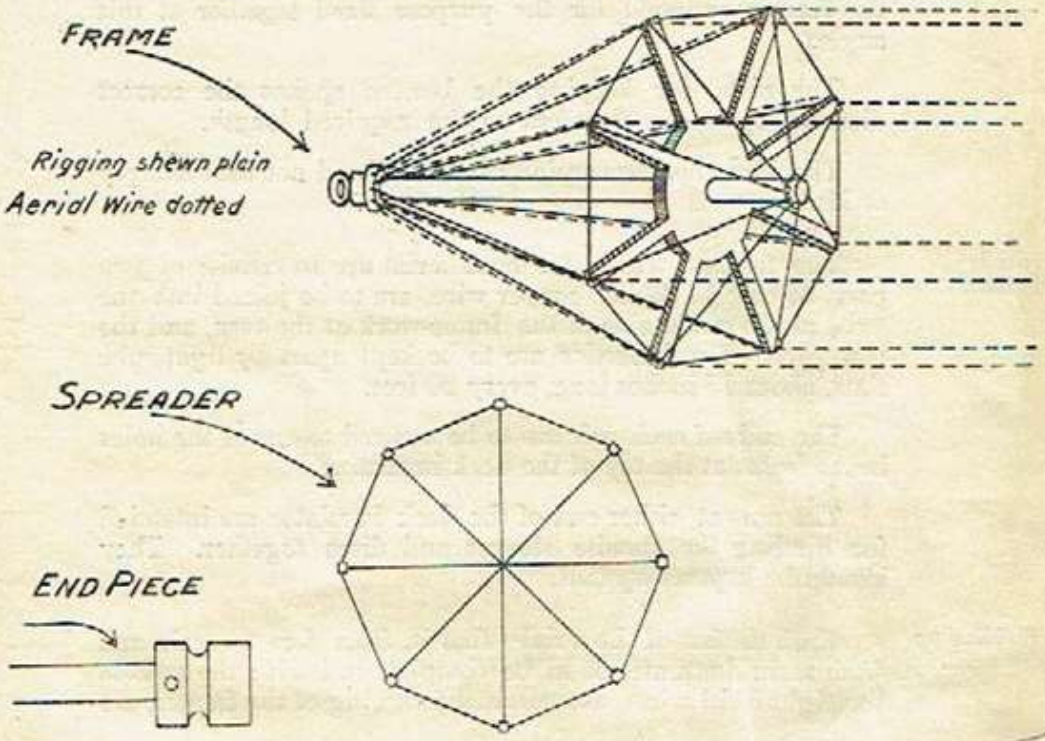
"The position of the aerial wire will be between the W.T. yards, brought aft, and stayed out to springs attached to eye-plates on the ship's sides not less than 20 feet apart in the athwartships direction, or more than 20 feet from the stern.

"A hemp Jacob's ladder is to be fitted to each top-gallant mast.

"Signal jackstay, if fitted, is to be of hemp. No signal halliards or hemp jackstay to be fitted higher up than at present, *i.e.*, no signal halliards to be taken to T.G. masts.

"Masthead semaphores to be removed, if not already done."

Each aerial consists of eight bare copper wires, 14 L.S.G., arranged axially on the surface of a cylinder 4 feet in diameter. At each end there is a wooden frame, and at the point where the aerial bends down, a special form of wooden frame-work is arranged to allow the wires to change their direction, and at the same time to keep the strains equally distributed between each of the eight wires. These special frames are triced up to the Main W.T. yard-arms. Aerial.



A spreader of four light canes is placed every 20 feet along the ærial, the canes having wooden end-pieces fitted with grooves to prevent the wire slipping.

The end-pieces are secured to the canes by the swifter being rove through a hole drilled through the end-piece and the cane.

The Æ. wires are to be given one round turn round these end-pieces and seized with waxed roping twine.

All swifters and stays for the frames and spreaders to be of bare copper wire.

Seizings to be of well-waxed roping twine, varnished over.

The frames with swivel eyes in the long member are for the foremost and aftermost ends, the others for the turn.

A twine seizing secures the centre.

The ærial wire is supplied in coils, and the turns must be carefully taken out of the wire whilst opening up the coils.

The angle at which the ærial bends at the Main W.T. Yard-arm must be measured from the ship's drawings, and the frames supplied for the purpose fixed together at this angle.

The slats, for keeping the bottom spokes the correct distance apart, are then cut to the required length.

The wire must be carefully handled, and not bent sharply or kinked.

Ærial feeders.

The feeders, which for each ærial are to consist of two parts of bare 14 L.S.G. copper wire, are to be joined into the ærial at the under side of the frame-work at the turn, and the two parts of each feeder are to be kept apart by light cane slats, about 15 inches long, every 20 feet.

The ends of each pair are to be secured to one of the holes in the horns at the top of the deck insulator.

The nuts at either end of the deck insulator are intended for binding the ebonite sleeves and discs together. They should be kept set up taut.

Building up the ærial.

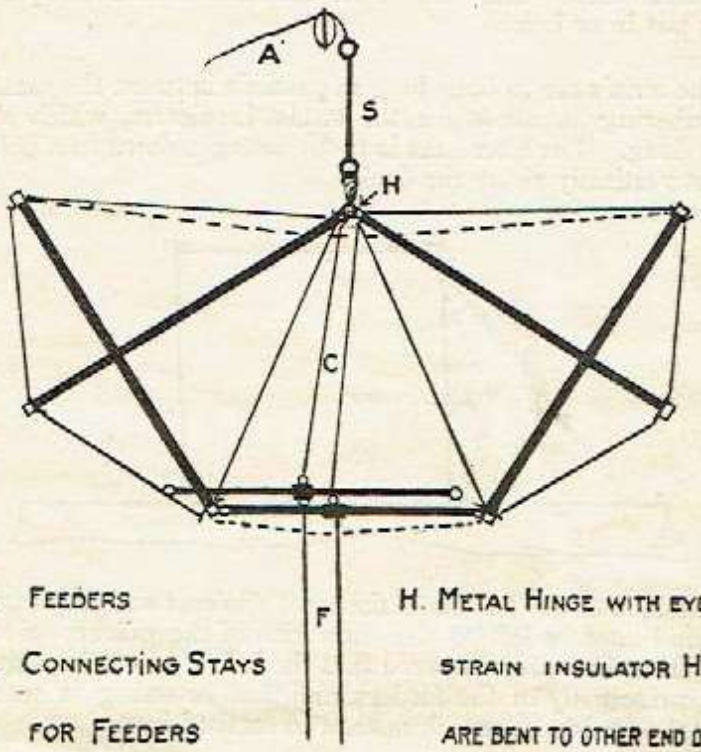
Each section of the ærial—that is, from fore to main and from main down aft—is to be complete in itself; the ends of the eight ærial wires, as well as the rigging of the frames, are

to be brought to the eye-plates on the long members of the frames.

At the turn, the parts of wire similar to the one shown dotted in figure below are to be put in after the frames are fixed in place, great care being taken with the connections.

No soldered connections to be used in the ærial.

One of the strain insulators is to be shackled to the hinge on the frames, and the halliards bent to it.



F. FEEDERS

C. CONNECTING STAYS FOR FEEDERS

A. ÆRIAL HALLIARDS

H. METAL HINGE WITH EYE FOR STRAIN INSULATOR HALLIARDS ARE BENT TO OTHER END OF INSULATOR

S. STRAIN INSULATOR

Hoisting the ærial.

It will probably be found easiest to trice the ærial up from before the mainmast and dip the after part and, if necessary, the feeders round the yard-arms.

Springs for automatically regulating the tension on the ærial.

Spring boxes, working from no extension at 100 lbs. to 2 feet extension at 300 lbs., are supplied for the ends of the ærial, and the secret of keeping the ærial standing in heavy weather lies in the proper use of these springs.

For the foremost ends a strain insulator is shackled to the swivel bolt in the end frame, and the foremost halliards bent to it.

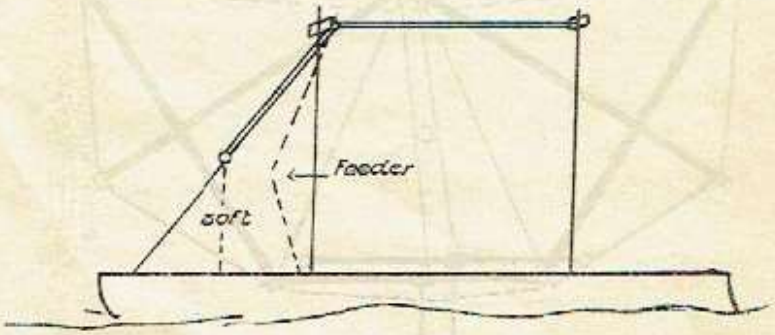
The foremast halliards are then hauled out taut, and a temporary eye turned in at a convenient place and the spring box put in vertical.

Both foremost ends must be hauled out together, as the yards have no braces.

The after ends must be shackled to strain insulators, and the out-hauls brought down conveniently to the eye-plates on the quarterdeck. They are to be hauled taut and the spring boxes put in as before.

Length of aerials.

The aerials are to be as long as possible between the masts, remembering to allow for the strain insulators, which are 5 feet long. The after part is to be brought down to a point 50 feet vertically above the deck.



Lead for feeders.

The lead of the feeders is the most difficult and important part, and must be left to the discretion of the officers on the spot. It must be remembered that the losses due to brushing occur principally in the feeders, and that brushing is worst where the feeders approach nearest to earthed iron.

The feeders for each aerial should be separated as far as convenient, and the lead should be fairly vertical. Sharp bends should be avoided, and the feeders kept as clear of smoke from the funnels as is practicable.

The feeders should be joined in to the aerial at the points on the slats of the cross-frames (which are hung from the main W.T. yard) as shown. The feeders may not divide the aerial into two equal parts, that is to say, there may be twice the length of aerial between the masts that there is leading aft, but still it is advisable to join the feeders in at this point as they are then well supported by the W.T. yard and will not

cause the ærial to sag, which would certainly be the case if they were forked in between the masts.

At the point where the feeders are joined in, all eight wires of the ærial are to be in good electrical contact with one another by means of the wire stays which secure the ends of the spokes to the hinge.

It is well to get the ærials up as soon as possible so as to get the stretch out of the gear before tuning.

It is advisable to get a plain spark into the ærials, from the coil supplied for tuning, as soon as possible, and this will form a fair test for insulation.

A coil will fail to spark when any other instrument will show perfect insulation.

It is necessary that the ærials be kept close up.

Filling the Instruments with Oil.

The condensers, choking coil, and transformer must be filled quite full of special vaseline oil, called Wakefield's patent insulating oil.

Too much stress cannot be laid on the necessity of absolutely clean oil, especially in the condensers. Clean oil necessary.

The least dirt or fluff in the oil will mean the failure of the condensers, and to remedy it the condensers will have to be parted, and every plate and contact carefully cleaned. This is a most ticklish and messy operation.

All oil must be poured into the tanks through a fine copper-wire gauze strainer. Straining the oil.

Condensers, choking coil, and transformer must have 24 hours to soak in the oil before they are used, in order to get rid of all air bubbles and allow the oil to get between the windings, &c. Time to be allowed for oil to soak in.

The greatest pains must be taken to see that the pump is kept perfectly clean inside. The slightest grit, fluff, or dirt in it will cause endless trouble. Oil pump.

Oil is supplied in 5-gallon drums, and about 4½ drums are required for each condenser, 3½ for the choker, and 2½ for the transformer. Oil drums.

Safety oil tanks.

Safety oil tanks are supplied for each tank, consisting of a copper vessel holding about half a gallon, which should be secured to the bulkhead about 2 feet above the tank.

A thin spiral copper pipe connects this safety tank to the nearest filling nipple on the tanks.

The object of these safety tanks is to allow for the expansion of oil due to changes in temperature, and also to keep the instruments quite full when the ship is rolling. They must be cleaned out and all sediment removed periodically.

An additional reason for keeping all gear quite full is that if the oil sinks till sparking can take place on the surface, it will vaporise, and the vapour mixing with air in the tops of the tanks will form an explosive mixture, which will be ignited by the next spark. The resultant explosion cannot be serious, as there is no compression, but it is sufficient to bulge the tanks and ruin the instrument.

Adapter for transformer.

A special adapter is supplied to enable the nut on the end of the spiral pipe of safety oil tank to be connected to the hole in the cover of the transformer.

Filling and air escape holes.

In the condensers, the holes in the corners are for filling, the holes in the centre for air escapes. A small float is fitted for one of them to show when the tank is nearly full.

CHAPTER II.

Instructions for Joining up.

The rotary

(1) Join up the rotary and starter according to the marking on them, putting the field regulator in the shunt circuit. Mount the field regulator on the side of the silent cabinet by hanging it with two bands, so that the handle is just outside the door and within easy reach of the operator, without his having to get up.

Whenever the rotary is stopped, put the field regulator back to its slowest position, and when the rotary has been got under weigh by its starter, speed it up gradually.

Put an earth lamp across the alternating mains, which are not to be joined up to anything else whatever, and start the rotary. The lamp should burn. As the alternating voltage is only 60 it will not burn brightly

Stop the rotary, and join up the leads from the no-voltage release to their terminals in the magnetic keybox. Shut the keybox door and see that the rotary will run properly. Open the keybox door and see that the rotary is stopped by its no-voltage release.

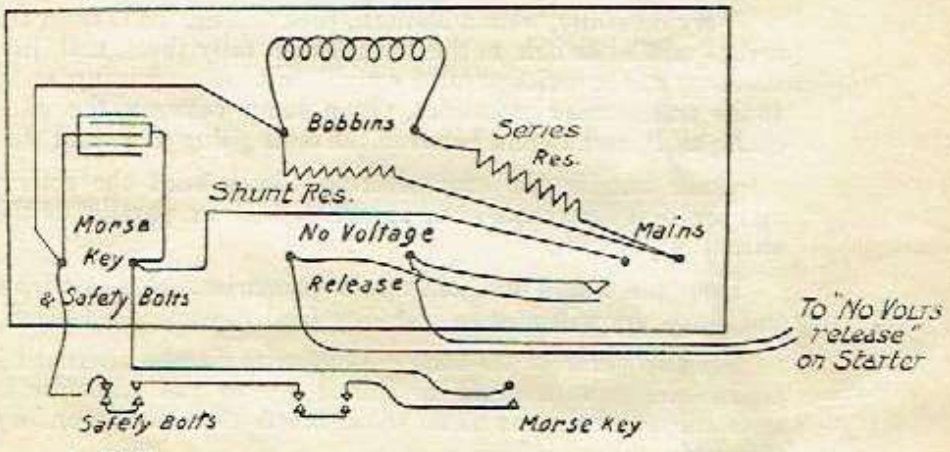
Stop the rotary and take its circuits off the switchboard.

Magnetic key.

(2) The magnetic key has 10 terminals.

The two large ones on top are for the alternating mains, the other eight are tallied.

They are arranged as under.



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Safety bolt.

Join up as shown, the safety bolts on the two doors being in series.

Each safety bolt is in two parts, the two breaks being in series in the direct current circuit between the morse key and the magnetic key.

The upper break is opened when the bolt is pushed down to disengage the door, and closed when the bolt is home.

The lower break is closed when the bolt is down, but being pressed upwards by a spring it will rise open if the bolt is lifted when the door is open.

When the door is closed a catch prevents the lower break rising with the bolt.

Low tension circuit.

(3) Join up the alternating mains to the cut-outs, magnetic key, send-receive switch, and series-parallel switch, and join up the ammeter, voltmeter, and frequency meter as shown in sketch.

Leave the leads from the series-parallel switch to the transformer disconnected.

Put the earth lamp across the ends of the alternator mains at the series-parallel switch, and start the rotary.

Test all gear. With the send-receive switch to send and doors closed, press the Morse key and the lamp should burn.

Work all the safeties one by one, and see that the lamp goes out each time.

See that the frequency meter and voltmeter are working, and that the frequency can be varied by the field regulator.

Stop the rotary, and take its circuits off the switchboard.

Very carefully, with a Menotti, pick out the leads from the series-parallel switch to the transformer, tally them, and join them up at the series-parallel switch, but before joining them to the transformer primaries, put a lamp between the ends going to P_1 and P_2 and between the ends going to P_3 and P_4.

Come outside the cage, shut the doors, start the rotary, and see that the lamps burn in series and in parallel as the switch is put over.

Stop the rotary and join up its primaries. A shock from the secondary will now be instantly fatal.

See two parts of 25-amp. cut-out wire in the alternating mains, see that nothing is joined up to the transformer secondary, and that no metal work is left near the secondary terminals.

Clear the cage, shut the doors, start the rotary, and press the key with the series-parallel switch both ways.

If there is a wrong connection the alternating cut-outs will go. If they do not all is correct.

Stop the rotary, and put a single piece of 100-amp. cut-out wire, nicely flattened at the ends, in the alternating and direct cut-outs.

(4) To join up the high tension circuit.

High tensio circuit.

With a Menotti pick out the terminals of the choker. The resistance of each bobbin is about 1,100 ohms, so the Menotti will only swing about 40°.

Join up the secondaries of the transformer to the transformer safety horns, fixing them at a convenient place over the choker.

Special high tension lead-covered wire is supplied for these leads. If there is none available, use bare 14-gauge ærial, carefully bent clear of all earths, and keep the transformer terminal cover off.

The lead-covered wires are to be secured under the clip on the transformer safety horns, and from the clip to the terminals on the horns the lead covering is to be removed.

Join up from the transformer horns to the ends of the two bobbins of the choking coil, using 14-gauge bare wire, and carefully bending it so as never to be less than 3 inches from earth. Join up so that the bobbins of the choking coil are in series with the transformer secondary, one at each end.

Set the transformer safety horns to exactly $\frac{1}{10}$ths of an inch from the centre part. See the centre part efficiently earthed to the cage.

Join up the other ends of the choking coil bobbins to the inner ends of the safety chokers, using wire as before.

Place the pair of insulated terminals near the spark gap, and connect them by bare wire to the safety chokers.

The object of these terminals is to carry the high tension wires clear of earth.

Join up these terminals to the spark gap, using bare 14-gauge wire.

This wire is easily handled, and is sufficiently stiff to retain its shape where bent to be clear of earths.

Take great care to keep all high tension leads at least 3 inches clear of earth. *See* diagramatic sketch of circuit.

Safety chokers.

The object of the safety chokers, which are small inductances, is to prevent the high-frequency currents of the primary surging back into the main choking coils. If this were to occur there would be grave risk of the insulation of the windings being perforated.

Adjustable primary.

(5) To join up the variable primary, cut the connecting pipes to the right length, and sweat in the end connections.

Safety spark gaps.

(6) To adjust the safety gaps.

All portions of the circuit which run any risk are protected by safety gaps.

A spark will take place at these gaps before the voltage between them is sufficient to penetrate the insulation.

The distances laid down are the maximum that is safe.

If the two sides of the gap are not quite sharp and exactly opposite one another the insulation will be damaged when using full power.

In the case of the condensers the plates will break.

Where the current is oscillatory, as in the condensers and spark gap, sharp points form a reliable safety arrangement.

Safety horns.

In the case of the secondary of the transformer, where the current is not oscillatory, horns are fitted. They are pieces of bent wire, flattened out and sharpened where they approach one another.

If points were used an arc once formed would be maintained, but due to the property of a flame rising, the action which takes place with horn protectors is as follows:—Directly an arc is formed it tries to climb up the horns, which opening outwards, increases the air gap, and the arc automatically breaks.

Length of safety gaps.

The length of the safety gaps for "C." tune is as under :—

Spark gap -	- $1\frac{1}{4}$ inches between points.
Condensers -	- $\frac{3}{16}$ inches between points.
Transformers -	- $\frac{4}{16}$ inches between horns from each end of secondary to earth.

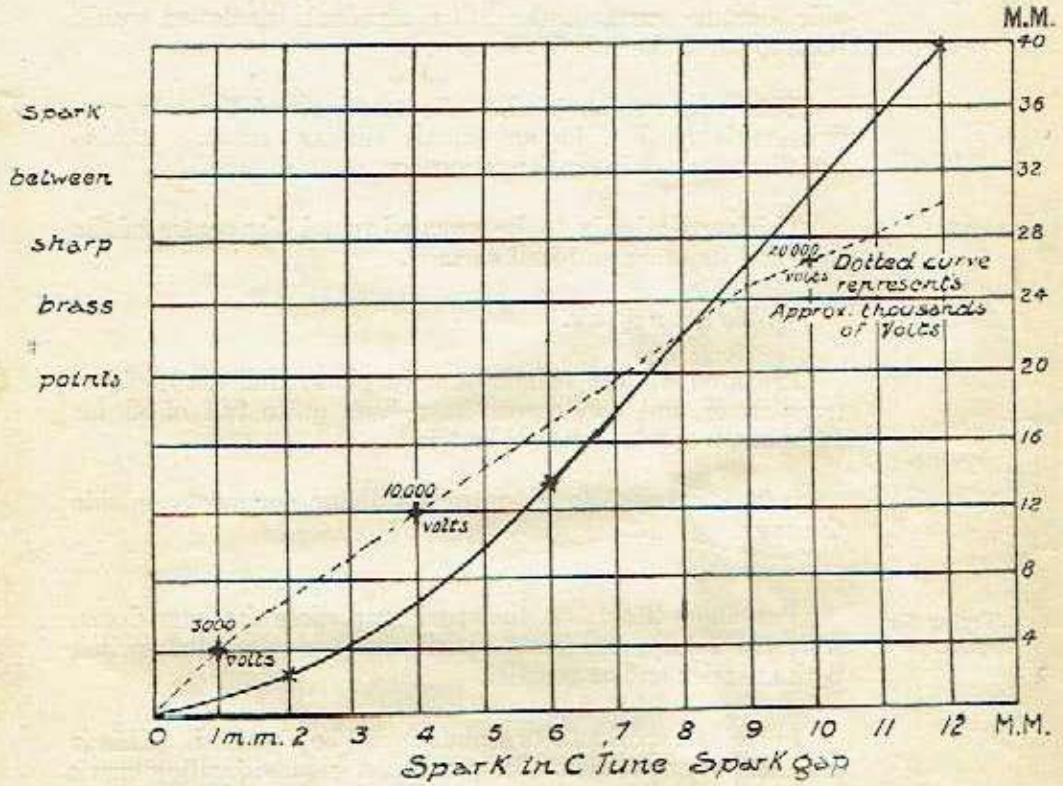
In the absence of transformer safety horns, pieces of 4 L.S.G. brass wire secured to the secondary terminals, and

sharpened at the edge where they approach nearest to the edge of the transformer case, are quite efficient.

A spark at the safety points causes a sharp report.

The length of the safety gaps require to be frequently checked, and the points must be kept quite sharp, as they burn away rapidly and soon get blunt if a spark takes place between them.

Curve of spark lengths and safety points.



(7) The safety earths.

Earthing the cases of the transmitting instruments.

To avoid, as far as possible, the cases of the instruments becoming charged, or their sparking to one another, due to induced currents when sending, which would be wasteful, all the tanks are to be earthed by a separate lead of 611 running direct to the cage.

The tanks of the two condensers and the choking coil are also to be joined together.

The centre of the secondary of the transformer is also earthed, with the following object.

The insulation of the terminals has only to stand 3,000 volts.

If an accidental earth now develops, one side of the secondary will be short circuited, and the cut-outs in the alternating mains will go in time to save the insulation.

If the centre were not earthed, and by any accident one side became earthed, the other terminal insulation would have to stand the full 6,000 volts.

The copper tube joining the terminals of the two condensers is earthed for an exactly similar reason. It also equalises the strain on the condensers.

This earth wire is to be sweated round the centre of the tube and its other end well earthed.

(8) To get a spark.

Provided all the safeties are in place, and the chokers, transformer, and condensers have been quite full of oil for 24 hours, a spark may now be tried.

It is convenient to place the oscillator secondary outside the cage.

Trying the spark.

Put about 2 mm. on the spark gap, close the cage doors, start the rotary, and get a spark with series-parallel switch both at series and at parallel.

In series a spark of 3 or 4 mm. should be obtained. This is the half-power position. In parallel, a good signalling spark of 10 mm. should be obtained. This is the maximum that is ever to be used.

Adjusting the speed of the rotary for resonance.

(9) Resonance.

When getting the spark, note the exact reading of the frequency meter when the rotary is in resonance.

To get this, put about 7 mm. spark on, place the field regulator arm at the middle stop, and make a long, and note if the frequency rises or falls.

If the frequency is wrong the spark cannot be maintained.

If the frequency rises, ease up the key and reduce the frequency by means of the field regulator by one, and try again.

If the frequency falls, increase it, and so on till the point is reached when the frequency remains constant whether the key is pressed or not.

There may be a slight difference between the series and parallel positions.

The gear is designed for 25 cycles, and resonance may be expected between 23 and 26.

The resonance effect is very marked, and it will only be found possible to maintain a large spark when exactly in resonance.

(10) To place the oscillator secondary.

Fitting the oscillator secondary in place.

Place the oscillator secondary in its stand, with the thinner end of its winding remote from the spark gap and the spills towards the doors. The spills are each fitted with an ebonite cover, which is supplied in place. The contacts on the tails are arranged to grip the spills tightly when the outer part of the cover is pressed home.

To disconnect them the outer cover should be slipped back a little, before attempting to pull the contacts apart.

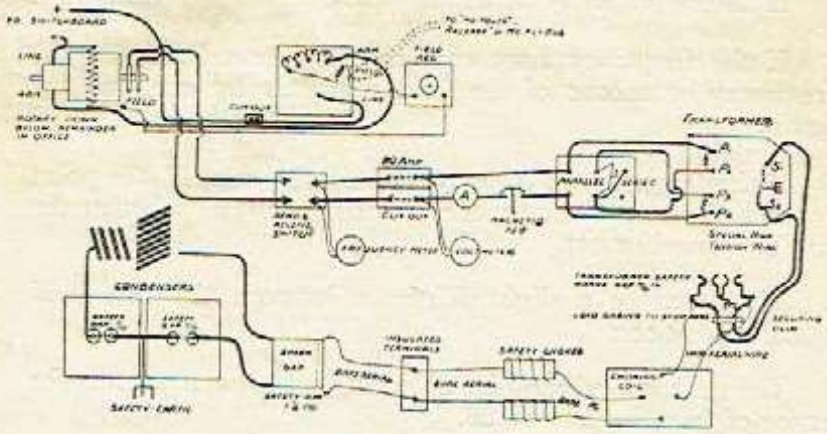
Take the thinner tail up taut to the send terminal of the send-receive switch. Make this connection so that it can be readily disconnected. A straight junction piece is convenient.

Take the unfitted tail from the spark gap end up taut to the most convenient earth strip. See that it does not pass within 12 inches of the end of the deck insulator.

Take the spare tail and join it up to the send contact of the send-receive switch, so that it will just reach any of the spills on the oscillator secondary.

This lead must be arranged so that it does not pass near the rest of the spills, or it will spark across.

The ends of all high tension wires, secured to terminals, should be bent back, or have eyes formed at their ends, to prevent brushing.



CHAPTER III.

Tuning.

(1) Measure the λ σ value of the ærial from the send connection of the send-receive switch. $\lambda\ \sigma$ of ærial.

Also measure its λ and σ.

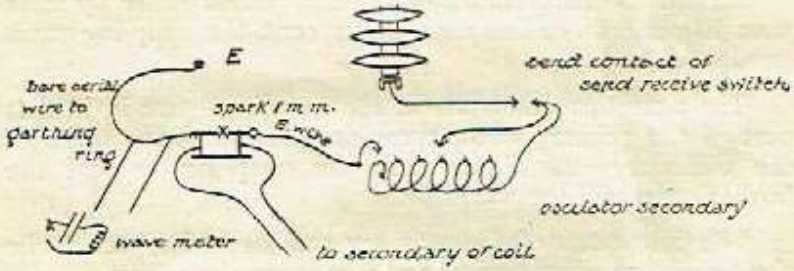
Use the induction coil with hammer make and brake and resistance, working it off the lighting circuits.

(2) Tune the ærial to 290, 476, and 713 L.S. with the coil and hammer make and break as nearly as the fitting of the oscillator secondary will allow. Tuning the ærial and secondary of oscillator.

The oscillator secondary has a spill in every turn, and adjustment to half-turns can be got by moving the plug on the free end of the earth wire to the spill at the back or to the end spill in front.

Allow about two mics for the earth lead and one mic for the mutual. Vary the mutual so as to get convenient readings.

Connections as under.



Tie labels on to the spills selected.

(3) Tune the primary. Tuning the primary.

Fit up the wavemeter outside the cage, and reeve a lead of patt. 733 in through the cage to form a mutual and out again to the wavemeter.

Remove the oscillator secondary. See that the 733 mutual in no place approaches within 12 inches of the primary pipes or any high tension leads. If it does it may spark across, with probably fatal results to the operator.

Close the cage, start the rotary, and tune the primary to exactly the same L.S. values as were obtained for the secondary after making the deductions as directed. Use a spark of about 2 mm. for this operation.

For the L.S. 290 start with 1½ turns in that part of the primary whose turns are parallel to those of the secondary.

For the L.S. 476 start with 2½ turns.

For the L.S. 713 start with 3½ turns.

Use about 6 feet of 733 for a mutual, and allow 3 mics for it.

Measuring the outgoing waves.

(4) To measure the outgoing waves.

Replace the oscillator secondary and join it up. Put on the plug to the proper spill.

Rearrange the same patt. 733 mutual, placing it close back to the cage, and in no case within 12 inches of the oscillator secondary, primary pipes, or high tension leads.

Put on about a 4 mm. spark, varying it as necessary to get a convenient reading, and measure the two waves.

If the two circuits have been accurately tuned to the same L.S. value (say 290), the two resultant waves should come exactly an equal amount on either side of this value (say 278 and 302).

Should the L.S. values of the two waves differ by more than 10 per cent. or less than 5 per cent. the coupling must be altered.

The more turns there are in the coupling—that is, in that part of the primary whose turns are parallel to the turns of the secondary—the tighter will the coupling be and the farther apart will the waves be.

The idle parts of the primary and secondary are to be short-circuited when tuning and also when signalling.

Arrangements are made for doing this, in the case of the primary, by the bar at the back of the variable primary, and in the case of the secondary by the tail of the oscillator secondary being taken up to the send contact of the send-receive switch.

CHAPTER IV.

Hints on Instruments and Instructions for Repairs.

List of Safety Arrangements.

(1) Alternator mains broken at send and receive switch unless operator has his foot on the pedal and his lever over to send.

(2) Rotary is stopped if magnetic keybox is opened, due to the no-volts release being short-circuited.

(3) Direct current circuit of magnetic key cannot be completed unless both cage doors are shut and bolted.

(4) Double-pole cut-out in alternator mains, 100 amp.

(5) Single-pole cut-out in direct current, 100 amp.

If the Spark Fails.

Causes of failure to obtain a spark.

1. Ammeter, voltmeter, and frequency meter all reading correctly.

Spark too long. Shorten spark gap, and sharpen and reset all safety gaps.

2. Voltmeter all right, ammeter very low.

Frequency does not rise.
High tension leads broken.

If frequency rises—

Choking coil or a condenser failed.
Spark gap short-circuited.

3. Voltmeter all right, ammeter nothing.

Frequency meter all right.
Magnetic key not making.
Series-parallel switch not making.

4. Voltmeter and ammeter nothing, frequency meter all right.

Cut-outs gone.

5. Voltmeter, ammeter, and frequency meter all nothing.
   Send-receive switch not making.
   Rotary brushes want adjusting.
   Rotary stopped.

Faulty condenser or choker.

If condensers or choker fail, smoke will usually come out of safety oil tank, with a strong and unpleasant smell.

Failure of magnetic key.

If the magnetic key does not make.

If key is working up and down, it requires re-adjustment.

If key is not working—
   It is jammed.
   Safety devices are open.
   Cut-out in distributor box gone.
   Leads broken.
   Key bobbin or resistance burned out.

If the key will not break—
   Mechanical troubles.
   Condenser perforated.

The magnetic key should be re-adjusted if it commences to show signs of arcing; take this opportunity to re-face the contacts.

Particulars of and Instructions for Parting and Repairing Glass Plate Condensers.

Do not attempt to part any of the high tension gear unless you have conclusively localised the fault.

They are not to be parted for instruction.

Before parting a condenser that has failed, make sure it is quite full and try again.

Number of glass plates.

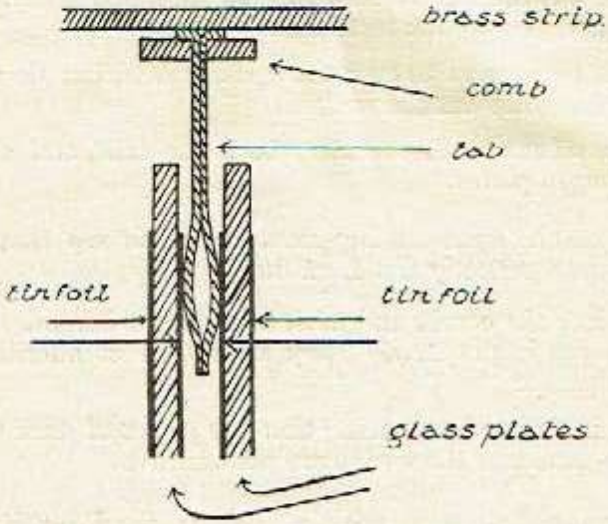
Each contains 80 glass plates, having tinfoil stuck by the edges on each side. Capacity, 160 jars.

The glass plates are separated by thin strips of cork.

The external terminals are soldered to copper plates inside, and the edges of these copper plates are sweated to brass strips, which are each secured to the top of a brass comb.

Between the teeth of these combs, and kept in place by the brass strips, are a row of thin spring brass tabs, as in sketch.

Method of connecting the plates together electrically.



These tabs are at alternate ends of the plates.

The glass plates are held in an iron frame, and are secured by teak wedges faced with felt.

Frame for holding glass plates.

The frame is lined with teak, and is secured inside the tank with similar wedges.

To part a Condenser.

Pump out the oil, take off the safety oil tank, take off the primary connections, safety spark points, and securing bolts.

Parting a condenser.

With great care tap down the terminals with a mallet. When they are started, let go the fly nuts and lift the lid, tapping the terminals down.

Leave the insulators in the lid.

When the lid is off, join up the secondaries of the induction coil to the terminals and try a 1 mm. spark.

This will show which plates are damaged.

The plates generally go at one side.

Coax out the wedges securing the frame to the tank. Lash a short spar on to the eyes in the iron frame and hoist it up.

Put some pieces of plank on the top of its tank and land it on them.

Lay it carefully on its side with the damaged plates nearest the top.

Take out the screws securing the terminal plates to the combs, and remove the terminals.

Start the screws to ease the glass plates, but do not part the frame. Slip out the wedges.

Take off the combs, turning back the tabs, and slide out the damaged plates.

Rebuilding condenser.

Replace by spares, being most careful to see that all the surfaces are perfectly free from dust.

Replace the combs and tabs, being most careful that the tabs are put in properly. They should be at alternate ends of their plates.

Put in the wedges, seeing that the pieces of cork between the end-plate and the wedge are not omitted.

Testing the condenser.

Test for non-contact with a lamp in the 100-volt circuit. This will break down the insulation of the oil films, though a lower voltage might show insulation with a tab in the wrong side.

Replace the terminals with their plates, &c.

Replace the frame in the tank and put in the wedges.

Temporarily join it up in its proper place in the primary circuit, being especially careful of the safety points; pour oil in through a strainer till the terminal plates are submerged. See the aerial disconnected, and work up to a full spark. Put out the lights in the office, and see that there is no sign of brushing. If the safety points are not properly set and sharp, you will have all your work to do over again.

If all is well, stop the rotary, disconnect, and put the lid on, using great care, and pulling the terminals well up through their insulators, put on the fly nuts, fill up with oil, join up the primary and safety points and try again. If all is well, replace bolts and safety tank.

Causes of failure of condenser.

Condensers will fail due to grit or dust or fluff in the oil. It does not take much to spoil their necessary resistance of 20 megohms. This will be shown by brushing all over the surfaces of the plates, and every part of the condenser must be got adrift and carefully cleaned, and the tank cleaned out.

If a condenser breaks down badly, the oil will be discoloured.

If carefully filtered, it may be used again for the choker or transformer, but not for the condensers.

Only clean oil may be used for condensers.

Be very careful about cleaning the pump.

If the tabs appear slack, open them out gently with a screwdriver, taking care not to start the little rivets that secure them.

Particulars and Instructions for Parting and Repairing Choking Coils.

Chokers are not likely to fail unless the terminals are knocked about, in which case they will spark or brush badly round the necks of the insulators. Internal sparking will be apparent by smoke and smell issuing from the safety tanks.

The tank contains two bobbins, wound in sections like a large induction coil secondary, in a teak frame.

The laminations of the iron cores must lie in the same plane.

Parting a choking coil.

If a choker fails, pump out the oil, remove the safety tank, ease back the gland nuts, and carefully remove the terminals and insulators, by pulling them vertically upwards. Unless great care is taken the insulator is liable to be broken.

They will come quite easily when the glands are completely unscrewed. Remove the lid. Coax out the wedges securing the frame in the tank, man-handle the former, hoist it up, and land it on planks laid on top of its tank.

Examine the windings for signs of charred insulation.

Place the terminals into their sockets again, noting that the shorter pair should go into the sockets nearest to the central point of the cover.

Take the opportunity to slightly open the split ends of the terminals.

Temporarily join it up in its proper place again, not forgetting the safety chokers, arrange mirrors so that you can see all round it, put on about 4 mm. spark, clear the cage, out lights, try a spark, and watch for brushing.

Do not try a long spark, as it is not now in oil.

If one section is damaged, cut it out and leave it on open circuit. Join the ends of its neighbours across it.

Building up a choking coil and testing it.

When all is well, replace the frame and wedges in the tank and get a full spark, first filling the tank with oil till the top of the frame is submerged.

If all is well, replace lid and then proceed to get the terminals in again as follows :—

Get a piece of 4 L.S.G. brass wire, split the end, and put it down through one of the holes into a terminal socket. Turn it round once or twice to make certain of a good contact with the socket. It will then be in electrical connection through a bobbin, with the terminal socket at the other end of this bobbin. Take the terminal that should go into this second socket and join the leads from a Menotti to it and to the brass wire. Put the terminal through the correct gland in the lid and work it into its socket; the Menotti will show contact when it is in its socket. Screw up the gland tightly. Take the brass wire out of the first socket, shift the lead from it to the terminal for this socket, and work this terminal into place in the same manner.

Then fit in the terminals for the other bobbin in a similar manner. Fill right up with oil, join right up properly, and try a full spark. If all is well put on the safety oiltank connections.

If there has been a breakdown the oil will probably be discoloured. If carefully strained it may be used again, but not for condensers.

A key is supplied for tautening up the bobbins in their frame should they have worked slack due to vibration.

Ohmic resistance of choking coil.

Each bobbin should balance at about 1,140 ohms, and the two together should be less than 2,300 ohms.

The maximum current it has to carry is 0·33 amp.

Transformer.

Faulty transformer.

If the transformer fails, smoke and smell will come out of its safety oiltank.

Pump out the oil, take off the top, and see if the damage is repairable.

The centre of the secondary is earthed, and after repairs test by balancing to make sure it is the centre.

The oil, if carefully strained, may be used again, but not for condensers.

Spark Gap.

Cleaning the spark gap.

The spark gap should be cleaned out and the spark plugs polished up about once a week, or after four hours' continuous sending.

When assembling, reset the index plate and also the safety spark points.

The Send and Receive Switch.

If badly handled the contacts may grip their tongues too tightly, and so prevent the spring from recovering, or they may not make properly.

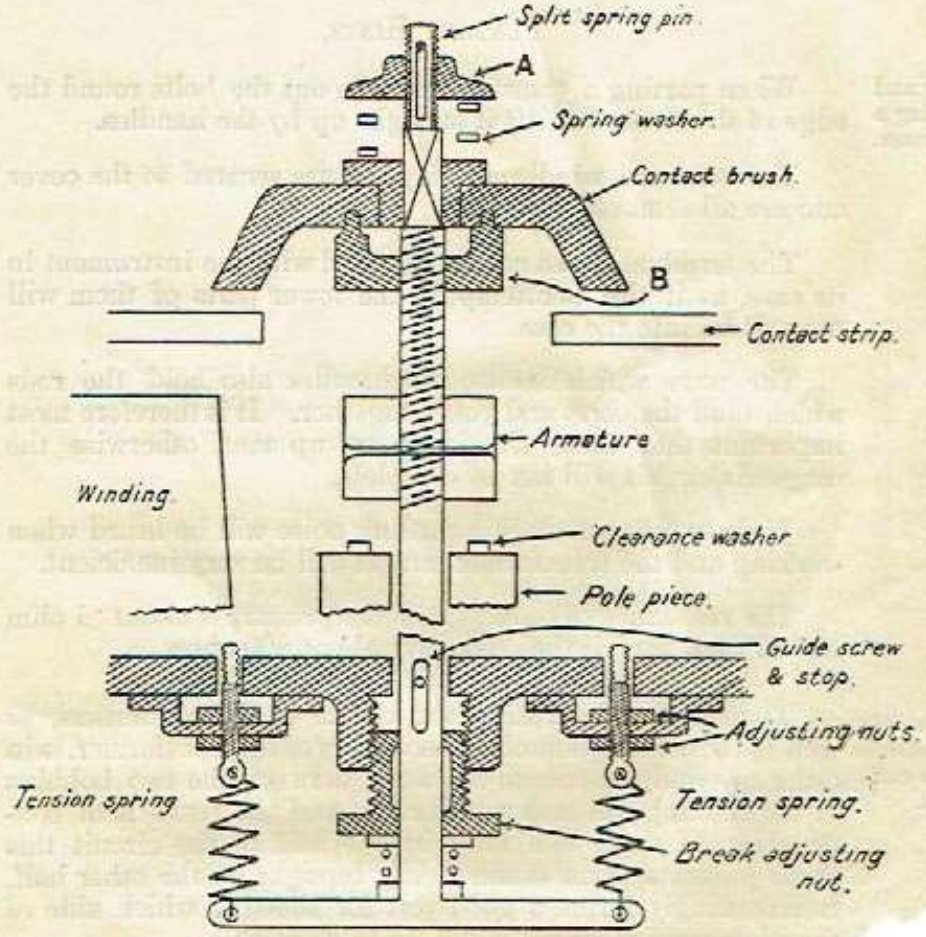
The air escape from the buffer must allow of the certain action of the spring, but must not allow it to be too violent. Air escape for buffer.

Remember that Bowden wires stretch considerably when new.

The wire must be kept lubricated.

The cut-outs are placed between the send-receive switch and the load, so that if they go they can be replaced in comfort by putting the send-receive switch to receive. Cut-outs.

The Magnetic Key.



Adjustments of Magnetic Key.

Magnetic key.

Adjust the tension spring adjusting nuts, and break adjusting nut, so that the contact brush is just held up high enough to keep the armature $\frac{3}{4}$ inch above the clearance washer.

Pull out the split spring pin, take off the cap A and spring washer, and lift the contact brush off the squared part of the spindle.

Screw up the nut B till the contact arms make firm contact on the contact strips just before the armature touches the clearance washer.

This adjustment can only be made to half turns.

Replace the spring washer, cap A, and split spring pin.

Further Hints.

Parting and rebuilding a transformer.

When parting a transformer, take out the bolts round the edge of the cover and lift it straight up by the handles.

The core and windings complete are secured to the cover and are all removed together.

The terminals must not be removed with the instrument in its case, as if this is attempted the lower parts of them will drop down into the case.

The nuts which secure the handles also hold the rods which bind the cores and yokes together. It is therefore most important that these should be set up taut, otherwise the magnetic circuit will not be complete.

If these nuts are slack a rattling noise will be heard when working and the transformer output will be very inefficient.

The resistance of each part of the primary is about ·1 ohm and of each part of the secondary about 800 ohms.

Use of safety earth between the two condensers.

The object of earthing the centre of the condensers, as well as the centre point of the secondary of the transformer, is in order to evenly distribute the work between the two bobbins of the choking coil and transformer, and the two sets of condensers. If there is a fault in one half of the circuit this earth prevents extra strain being brought on the other half. It accordingly forms a good test for showing which side of the high tension circuit is not up to its work.

Locating a fault in the high-tension circuit.

If when trying to get a long spark, the safety spark gap of one particular condenser always goes, proceed to investigate the trouble as follows. Change over the high-tension leads at the spark gap and try again. If the same condenser still sparks the fault lies in the condenser whose safety points will not spark. If, however, the spark now occurs at the other condenser, the fault must lie in the transformer or choker. Change over the leads between the transformer secondary and the choking coils, and try again. This will show if it is the choking coil; if not, it must be the transformer. Part of the choker or transformer being short circuited will, however, probably be made apparent by an alteration in the frequency necessary for resonance.

Faulty condenser.

If the fault has been brought down to a condenser and there is no alteration necessary in the frequency for resonance, the trouble is due to a low resistance in the condenser (probably hairs or fluff in the oil), and can be most easily got rid of in the following manner. Pump all the oil out of the defective condenser tank, carefully strain it, and clean out the inside of the tank. Hoist the glass plates up bodily in their frame and land them on planks on the top of their tank. Join up two legs of the choker in parallel to one end of the secondary of the transformer and the other two legs to one side of the condenser, the other side of the condenser to the other end of the transformer secondary, not forgetting to insert the safety chokers on each side of the condenser. Fit up temporary safety spark points $\frac{1}{8}$ inch apart, put the transformer primaries in series, clear the cage, and press the key. Copious brushing will now occur, due to the dust, &c., on the plates. Should the condenser safety points spark over before the brushing ceases the points may be opened out slightly, as no harm can be done to the instruments whilst the transformer primaries are in series. When all brushing has ceased, due to the particles being burnt away, replace the condenser and oil, put the transformer primaries in parallel, and try to get a spark between the safety points the full $\frac{1}{16}$ inch apart, watching carefully from outside the cage for any brushing under the oil.

When all is well replace the cover of the condenser and join up in the usual manner. The full 10 mm. spark should now be obtained.

When working one condenser only and the two parts of the choker in parallel, resonance will still be obtained at about 25 cycles.

When cleaning the plates, as above, the effects of the ozone given off are very unpleasant. The office should accordingly be well ventilated during the process.

Building up a glass plate condenser.

When assembling a condenser, it is necessary for the heads of the tabs to lie perfectly flat on the combs, otherwise the terminal plates cannot be fixed in position.

The heads of the spare tabs supplied are rather large, and require to be cut down slightly before use. The combs are fitted to take one more tab one side than the other; it is necessary to remember this when rebuilding the condenser.