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.

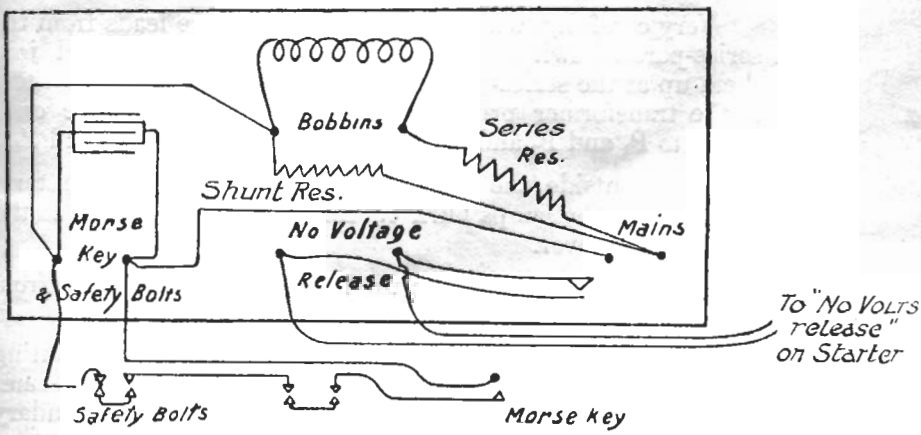
Stop the rotary and take its circuits off the switchboard.

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.



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 $\frac{4}{10}$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 -	- $\frac{7}{10}$ inches between points.
Transformers -	- $\frac{4}{10}$ inches between horns from each end of secondary to earth.

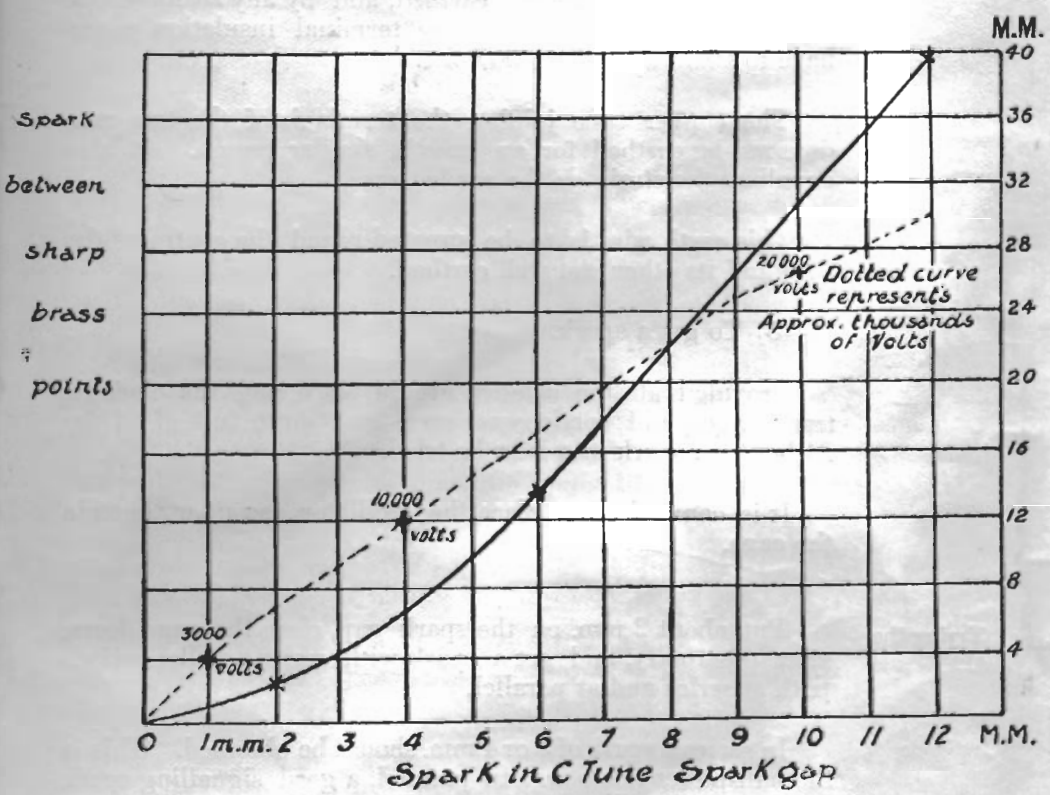
In the absence of transformer safety horns, pieces of 4 L.S.G. brass wire secured to the secondary terminals, and

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.

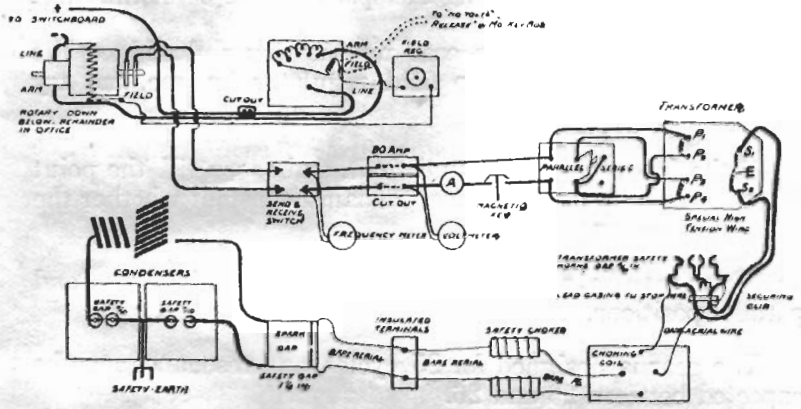
Take the thinner tail up taut to the send terminal of the send-receive switch. Make this connection so that it can be readily disconnected. A straight junction piece is convenient.

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. λ σ of ærial.

Also measure its λ and σ.

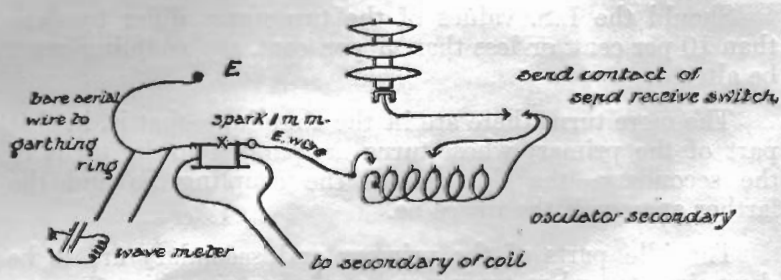
Use the induction coil with hammer make and brake and resistance, working it off the lighting circuits.

(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 $1\frac{1}{2}$ turns in that part of the primary whose turns are parallel to those of the secondary.

For the L.S. 476 start with $2\frac{1}{2}$ turns.

For the L.S. 713 start with $3\frac{1}{2}$ 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.

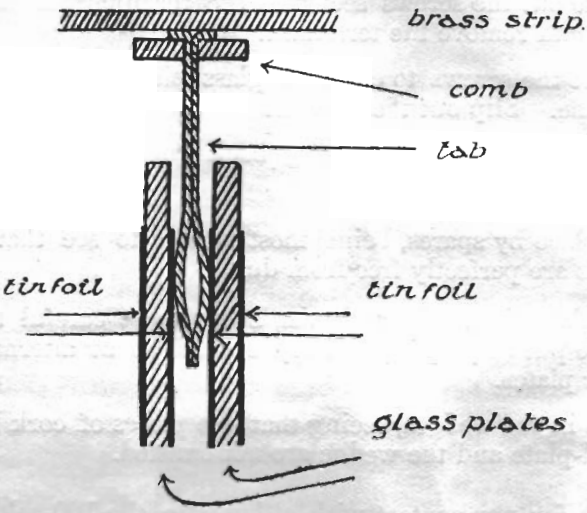
Number of glass plates.

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 ærial 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.

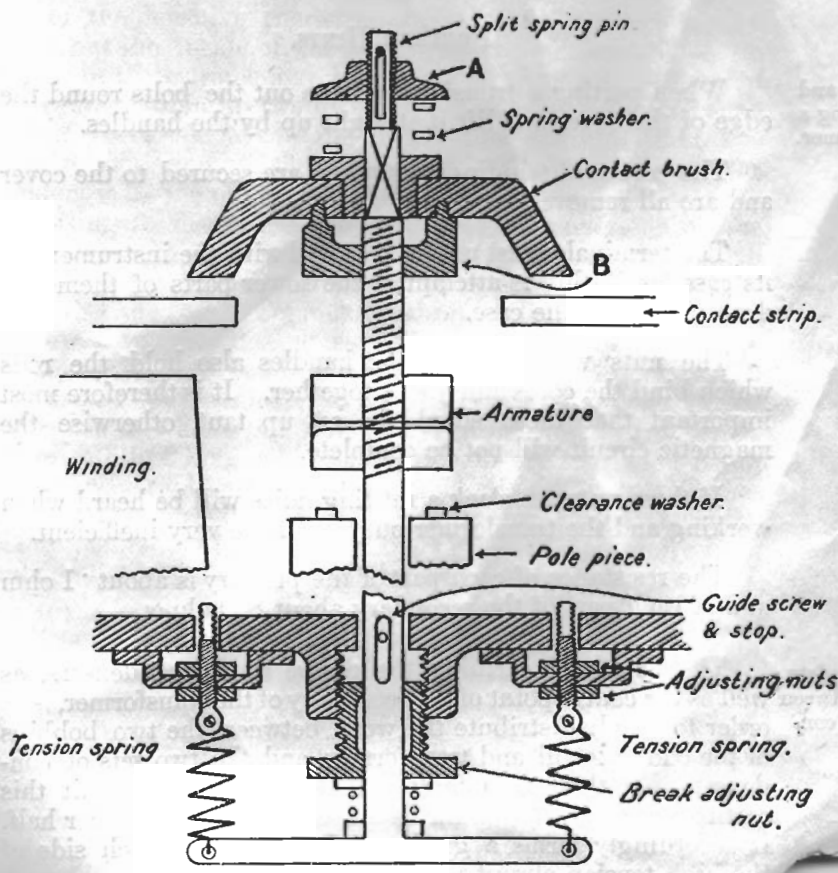
The air escape from the buffer must allow of the certain action of the spring, but must not allow it to be too violent. Air escape for buffer.

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 $\frac{3}{8}$ 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 $\frac{3}{16}$ 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 $\frac{7}{16}$ 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.