MDF 3

DEPARTMENT OF TRANSPORT

RADIO DIVISION

REFERENCE DIAGRAMS

AND

OPERATING INSTRUCTIONS

FOR

MARCONI DIRECTION FINDER
TYPE M.D.F.-3 and TYPE M.D.F.3B

D E P A R T M E N T O F T R A N S P O R T

R A D I O D I V I S I O N

INSTALLATION AND OPERATING INSTRUCTIONS

FOR

MARCONI DIRECTION FINDERS

TYPE MDF-3 AND TYPE MDF-3B

I N D E X

Recd Nov 8/41

CANADIAN MARCONI DIRECTION FINDER

TYPE M.D.F. 3
TYPE M.D.F. 3-B

Para. I. OUTLINE OF PRINCIPLES OF DIRECTION FINDING AS APPLIED TO NAVIGATION.

The Canadian Marconi Direction Finder, M.D.F.-3B, is essentially a Radio Pelorus, that is, it may be used to measure or determine the bearing of a fixed point relative to the ship's head.

The one requirement is that the said fixed point be fitted with a wireless transmitter, which is either in operation or can be placed in operation by request.

The Direction Finder may be installed either in the W/T Cabin or in the Chart Room or Pilot House. Both installations will give the same accuracy in bearings, provided that the loop aerial is installed over the keel line of the vessel and is clear of any unsymmetrical metal superstructure.

The equipment, if installed in the Chart Room or Pilot House, is under the Master's supervision at all times, and is conveniently at hand for instant use. Moreover, owing to its location, the accuracy of bearings may be checked quickly in conjunction with the ship's pelorus, with a minimum of inconvenience to the Master or his Navigating Officers.

As an aid to navigation, the Direction Finder may be employed in several ways; for example, when, during foggy weather, a ship is proceeding towards a point on shore, equipped with a wireless transmitter, such as a radio beacon, the course may be checked - a bearing direct ahead, i.e., zero degrees from the ship's head, would indicate that the course is correct.

If the course of the ship were such that the Radio Beacon would be passed, say, five miles off when abeam, the Direction Finder bearings may be watched and the rate that the angle from the ship's head changes as the vessel approaches is a good indication of the accuracy of the course. This method leads up to the well-known four point bearing; such bearing may be taken by means of the Direction Finder as easily during fog as by the ship's pelorus in fine weather.

The Direction Finder may be used to advantage to avoid collision with an approaching vessel, for instant, when ships are nearing each other and by the interchange of wireless signals, relative bearings may be observed until the bearing has passed the beam.

It will readily be seen that in the case of a vessel in distress, providing that the transmitter is operated at short intervals, bearings can be taken and the course set to keep the relative bearing of the distressed vessel at zero degrees to the ship's head. Occasions have arisen where vessels sending out a distress signal have only been able to give an approximate position, but, by means of the Direction Finder, it was possible to

bear down on the vessel without loss of valuable time.

Frequent use of the instrument will enable the navigator to estimate approximately his distance from a transmitting land or ship station, such estimate being based solely on the strength of the signals. All that may be aimed at in this direction, however, is for the navigator, by careful manipulation of the volume control, to determine whether or not the transmitting station is in the immediate vicinity of his ship.

Another use, involving slightly more work, consists in getting a true bearing from a station to intersect with the course line, thus obtaining a position "fix". This application might prove useful when a transmitting station is somewhere near the beam.

By taking a series of bearings at predetermined intervals, and comparing the various crosses with the course line, against the known or estimated distance steamed during the intervals, it may be determined whether the ship's actual course is above or below the course desired.

An actual "fix" may be obtained by taking cross bearings on two or more stations and plotting their true bearing on the chart, due allowance being made for the distance steamed when the times are more than a few minutes apart.

It should be borne in mind that the accuracy of plotted bearings depends greatly on the accuracy with which the ship's head is converted to its actual bearing from true north. This point is particularly important when the ship is yawing, therefore, the Wheelsman should endeavour to keep the ship's head right on the course, or he should indicate how much it is off.

It will be apparent that if a bearing were taken on the beam from a station fifty miles distant, an error of one degree on the ship's head would make an error of one mile on the course line.

Bearings should be considered most accurate when they are nearly at right angles to the course line. If the true bearing is almost parallel to the course line, or cuts it at an acute angle, an error of, say, half a degree will produce quite an appreciable error in position along the course line.

As mentioned before, the radio Direction Finder can be compared to a pelorus, therefore, it is necessary to know the exact heading of the ship at the time the radio bearing is taken.

In order to facilitate handling of radio bearings, and to prevent, as far as possible, errors due to magnetic correction calculations, etc., the 0-360 degree compass scale is used throughout. Thus it will be necessary for the navigating officer to designate bearings not as N 20 E, but as 20 degrees, or again, not as S 20 W, but as 200 degrees.

If a true bearing from a distant transmitting station is to be laid off on a chart, the following procedure should be observed:-

1. Note the magnetic heading of the ship's head at the moment the W/T bearing is taken,

2. Ascertain the magnetic variation for the approximate position of the ship.

3. Ascertain the magnetic deviation for the particular course set.

4. Correct the magnetic ship's head to the true ship's head by adding Easterly variation or deviation and subtracting Westerly variation or deviation.

5. Add the wireless bearing to the true ship's head, which will give the true bearing from the ship to the transmitting station.

This bearing, when laid off on the chart, should cut the course line of the ship at the correct position for the time when the bearing was taken.

FOLLOWING ARE TWO EXAMPLES

SHIP'S HEAD BY COMPASS	74°	74°
VARIATION FROM CHART	3° E	3 Add
		77
DEVIATION FROM TABLE	4° W	4 Subtract
SHIP'S HEAD TRUE		- 73
OBSERVED W/T BEARING		24 -
		- 97 Degrees

SHIP'S HEAD BY COMPASS	113°	113°
VARIATION FROM CHART	0°	0°
DEVIATION FROM TABLE	3° E	3 Add
		116
OBSERVED W/T BEARING		273
		389
SUBTRACTING 360°		360
		- 29 Degrees

It should be observed that if the resultant of the true ship's head and the wireless bearing come to more than 360 degrees, it is simply necessary to subtract 360 from the total, the remainder being the true bearing required.

Para. II DESCRIPTION OF DIRECTION FINDER

The Marconi Direction Finder, M.D.F. 3 B comprises two main units, i.e., the Direction Finder Pedestal and the Direction Finder Loop Aerial.

The Pedestal assembly comprises all the electrical apparatus necessary for Direction Finding and includes the receiver proper, the quadrantal error corrector, the goniometer and the batteries.

The Goniometer, which is located at the top of the pedestal, is the component used for indicating the bearings of ship or coast stations that may be required. On the face of the goniometer are two scales, one fixed, and the other rotatable. The fixed scale is for indicating the bearing relative to the ship's head, and is always used with the pointer marked "Relative Bearing". The moveable scale is used for indicating the bearing relative to true north, and is used with the pointer marked "Pelorus Bearing". In order to accomplish the latter, the moveable scale must be set so that the arrow points to the ship's course corrected to true north. The pointer marked "Sense" is used to tell the absolute direction of the station being received.

The receiver operates on the well-known superheterodyne principle, and is very selective and sensitive. It may be swung out of the pedestal for service or inspection, and all units are readily accessible. At the top of the left side is the D.F. balance knob. This adjustment is for clarifying the zeros when taking bearings, especially when a bearing is being taken close to a transmitting station. On the right-hand side, near the top of the panel, is the Sense - D.F. switch. Below, at each side of the panel, are located the two station selectors. These must both be tuned to resonance with the station to be received. At the bottom of the panel, on the right-hand side, is the Off-On Switch; in the middle, the two telephone jacks, and on the left-hand side, the Volume Control.

Underneath the panel is located the switch for controlling the pilot lights, which are connected with the ship's mains. At the back of the receiver assembly, and attached to the main pedestal framework, is located the goniometer terminal board and the loop choke coil. This coil is used for correcting the error due to the mass of the ship's hull.

At the bottom of the pedestal, space is arranged for the batteries and the loop connections, and terminals are located for the aerial and earth connections.

The M.D.F. 3 is designed for the use of the new "Air Cell" filament battery. This battery will supply current to the tubes for approximately six to eight months with average usage. A new battery must then be supplied. As no charging equipment is required, considerable saving in service, time and labour is obtained. A feature of this battery is that it may be carried indefinitely as a spare, providing it is dry, and that it has been kept in a moderate temperature. When required for use, the seals are broken, and it is filled with plain water. Two 45 volt high tension batteries are also required.

The Loop Aerial system consists of two

shielded fixed loops at right angles to each other. The wires of each loop are threaded through metal tubes so as to form two circles, one fore and aft, and the other athwartship. The complete crossed aerial system is mounted on a metal pedestal which is bolted to the deck. Shielded cables are connected from the loop system to the receiver.

Para. III. OPERATION OF DIRECTION FINDER

The loop aerials are mounted exactly athwartship and fore and aft. The receiving powers of these two loops are made almost the same, and they are joined up to the goniometer field windings in such a way that when the goniometer pointer is rotated it is electrically the same as rotating the loops themselves. When a signal is intercepted by the loops, it produces a field inside the goniometer which is identical with the field of the radio wave in space. If the direction of the radio wave changes, the field inside the goniometer will change in like proportion. The search coil of the goniometer is arranged so that it may be rotated inside the goniometer, and, in this way, is cut by the field produced by the signal.

If the search coil is turned so that its plane is in the direction of the field, a voltage will be produced around the coil which causes a current to flow. The current is passed on to the receiver, is amplified and produces a sound in the telephone.

If the search coil is turned so that its plane is at right angles to the field, current is produced in both sides of the coil simultaneously. These currents, being in phase and of equal strength, cancel each other, and there is no circulating current to be passed on to the receiver. Consequently, there is no signal heard on the telephones. This is called zero position.

If the search coil is moved one way or the other from zero position, a signal will be heard, depending upon how much the loop is moved off the zero position.

The latter, or zero signal method, is the one used in nearly all types of direction finders.

If the search coil is rotated 180 degrees from its zero position, it will again show a zero signal position, because then it would be in exactly the same plane as regards the goniometer field as it was before, i.e. right angles to the field. Therefore, when taking bearings there are two zero signal positions shown on the scale,

Either of these positions would show a correct bearing, because, in the majority of cases, all that is wanted is a bearing line, as it is usually known if a station is ahead or astern. If, however, it were not known whether the transmitting station is ahead or astern, or on the port or starboard side, a "Sense" adjustment is provided, which will quickly differentiate between the two zero positions and indicate which quadrant on the scale to use. On the other hand, were

a station known to be, say, 10 degrees on the starboard bow, a radio bearing would give one position as 10 degrees and the other position as 190 degrees or reciprocal. It is usual to have the pointer so that the right quadrant is used when reading a bearing.

Para. IV HOW TO TAKE BEARINGS

MAIN AERIAL:

IT IS ESSENTIAL THAT THE SHIP'S MAIN AERIAL BE DISCONNECTED FROM THE SET IN THE WIRELESS CABIN WHEN BEARINGS ARE BEING TAKEN. IF THIS IS NOT DONE, THERE WILL BE SOME DIFFICULTY IN GETTING SHARP ZEROS, AND THEY WILL BE DISPLACED, THUS GIVING ERRONEOUS BEARINGS. IT WILL BE ADVISABLE TO HAVE SOME WORKING AGREEMENT WITH THE OPERATOR, WHEREBY HE WILL ALWAYS LEAVE HIS AERIAL DISCONNECTED AT THE SWITCH WHEN NOT WORKING. IN ANY CASE, WHEN BEARINGS ARE BEING TAKEN (OTHER THAN PRACTICE BEARINGS) THE OPERATOR SHOULD BE ADVISED TO FREE HIS AERIAL.

RECEIVER SWITCH: Turn receiver filament switch to "on position and turn on pilot lights.

HEADPHONES:

If headphones are plugged in either jack, it should now be possible to hear signals.

VOLUME CONTROL:

For maximum signal strength, the volume control should be turned hard to the right. Keep it at maximum volume position when searching for signals,

STATIONS:

Station Selector #2 is quite sharp, and should be carefully and slowly turned when searching for stations.

Station Selector #1 is not quite so sharp, but, nevertheless, should be carefully manipulated. Both these selector dials must be tuned to resonance with the incoming signal, and, as a rule, they will read approximately the same when correctly tuned. Both dials may be logged for future reference when picking up a known station.

D.F. SENSE SWITCH:

This should always be turned to D.F. position when taking bearings.

BALANCE KNOB:

Balance knob should be set at zero before commencing to take bearings.

TAKING BEARINGS:

With the volume control about two-thirds on, tune in a strong signal. Now rotate the goniometer pointer, starting at zero, through 90, 180, 270 and back to zero again. It will be noticed that the signals rise and fall in strength as the pointer is rotated. This, as previously explained, is due to there being two minima or zeros 180 degrees apart. If the station is known to be somewhere ahead, turn the pointer until a minimum is observed somewhere in the forward quadrants corresponding to 270-0 and 0-90 degrees. Now listen carefully, and turn the pointer until a minimum is observed.

SIGNALS TOO STRONG:

If the signal is too strong, it will be hard to decide just where the minimum is. In that case, adjust the volume control until the intensity of the signal is such that the position of minimum signal strength is well defined.

BALANCE:

Turn balance knob slowly to the left or right, as the case may be, and it will be noticed that the signals fade out altogether in the headphones, when the pointer is at position of minimum.

CHECK ZERO:

Swing the pointer back and forth over a few degrees and the signals will be heard again each side of the zero position.

INCREASE VOLUME:

Increase the volume control a little and the space over which signals are inaudible will close up until perhaps there is no position of zero signals left, but the position of minimum signal strength is much more clearly defined.

REBALANCE:

Now make another small adjustment with the balance knob, and, at the same time, turn the pointer of the goniometer back and forth over a small arc.

SHARP ZERO:

It willbe possible by a simultaneous adjustment of the balance and pointer, to narrow down the position of zero signals to one degree or less, so that if the pointer is turned one way or the other a loud signal is heard at either side.

RECIPROCAL:

If the pointer is now turned through exactly 180 degrees, the reciprocal zero will not be heard until the balance knob is turned an equal amount the other side of its zero mark. In some cases, a sharp zero will be obtained with the balance knob at zero, and then it will be possible to obtain the two zeros by merely swinging the pointer 180 degrees from each other.

WEAK SIGNALS:

If the transmitting station is a considerable distance away, and the signals are very weak, the position of zero signal may be quite wide even though the volume control is full on.

SWINGS:

It will now be necessary to take swings with the goniometer pointer in order to get two positions of equal strength each side of zero. Turn the pointer until the signal is just heard; now swing the pointer through zero until the signal the other side of zero is the same strength as before.

MEAN BEARING:

The mean of these two readings will be the correct bearing, i.e. first reading 45, second reading 57. Half the difference between these two readings added to 45, or subtracted from 57, will give the bearing, or 45 plus 6 would give the correct bearing at 51.

WIDTH OF SWING:

Swings may be considered accurate up to 50 degrees difference, but practice is required in judging intensities of signals so that they may be matched correctly.

AMBIGUITY OF DIRECTION:

As before mentioned, a bearing on a station will give the line of bearing only, but will not give the actual direction. If a bearing is read on the scale at 10, also at 190, and it is required to know which is the right direction, it may be accomplished quickly by means of the D.F. Sense switch,

SENSE OF A STATION:

To arrive at the direction of a station after a bearing has been taken, turn the switch to the "sense" position. The D.F. zero will now be obliterated, but if the goniometer pointer is slowly rotated, a minimum will be found approximately 90 degrees from the D.F. zero.

SENSE INDICATOR:

The actual direction of the station will be indicated by the pointer marked "Sense". This will point to a position on the scale, corresponding to the actual direction of the station relative to the ship's head or to the true north, depending upon which scale is being used.

SHARPNESS OF SENSE MINIMUM:

Sense minima will not be as sharp as those obtained when using the D.F. adjustment, but there should never be any doubt, as there is only one minimum for a complete revolution of the pointer.

SENSE VOLUME:

If the signals are too strong, it will be necessary to reduce volume, otherwise it will be difficult to pick out the minimum position.

SIGNAL:

For about half an hour before and after sunrise and sunset it will very often be found that bearings become erratic. This uncertainty is quite noticeable when taking bearings; the effect is that it becomes difficult to decide on any minimum and the whole operation gives a feeling of uncertainty. The errors introduced in this way are unlikely to be more than five degrees, and are generally about three degrees, but they are constantly varying both in direction and magnitude, so it is impossible to allow for them. These errors are generally called "night effect", and are due to the effect of sunlight or the absence of sunlight on the upper atmosphere. They sometimes occur at odd moments during night, but very rarely by day.

MAINTENANCE OF GEAR:

LOOP AERIAL:

The loop outside metal work may be painted whenever necessary, but care should be taken that the four main loop insulating gaskets and the cross strut bushings are kept free from paint. The gaskets are located between the ends of the round loop tubes and the

center castings, while the strut bushings serve to insulate the struts from the small inter-connecting castings located on the tubes. All conduit work connecting the loop to the receiver may also be painted.

BALANCE AERIAL:

The small balance aerial used when the D.F. installation is located on the bridge or pilot house should not require much care other than periodically making sure that the connections at the aerial lead insulator are kept clean and tight. Do not allow aerial to become grounded by contact with swinging wires or halyards.

GROUNDS:

All ground connections to the frame of the vessel should be inspected periodically and kept clean and tight.

RECEIVER:

The receiver uses three type UX 232 and four type UX 230 tubes. They are rugged, and should have a long life with careful handling.

Towards the end of their life, the electronic emission falls off, which causes the receiver to lose its sensitiveness. It should be arranged that tubes are periodically checked at a radio service station, and if the emission is found to be low, the tubes which are low should be replaced with new ones. If it is suspected that any particular tube is low, a good check may be made by interchanging it with a good spare and noting whether there is any difference in signal strength.

All connections should be periodically checked through the receiver and tightened where necessary Vibration is quite severe on some vessels, and will sometimes cause loose or broken connections. Trouble of this sort will usually give variable signals or bad noises in the headphones when the receiver is knocked or shaken. It is best located by swinging out the receiver panel, switching the set on, and, while listening in the headphones, shaking or pulling each individual wire in sight. Noises would indicate trouble with that particular wire or circuit.

BATTERIES:

As in other parts of the installation, all battery connections should be kept clean and tight. Periodically the radio inspector, or a representative from a radio service station, should check the battery voltages. Low 45-volt high tension batteries should be replaced with new ones. For heating the filaments of the tubes, an Eveready Air Cell battery, Type 600, is used. The Type 600 battery has been especially designed for the UX 230 and 232 tubes. It has a long life, almost constant voltage, and does not require charging. The battery will last, with average usage, from six to eight months before it is necessary to replace with a new one. A spare should always be carried for replacement. To place the spare battery in use, the airtight seals should be removed and the battery filled with fresh water, as per instructions located on side of battery. Spare batteries

should be kept in a moderate temperature, and should not be allowed to stay in freezing or very hot temperatures.

CALIBRATION CHOKE:

The calibration choke is located on the back of the pedestal, just underneath the base of the goniometer. This is adjusted by the installing engineer when the vessel is calibrated. Upon the adjustment of this choke depends the accuracy of the direction finder; consequently it should not be altered unless the vessel is recalibrated by a competent operator or engineer. Particular care should be taken to keep the terminals and connections tight. If the connections were broken or loose, there would be an error of anything up to five degrees which would not be apparent to the operator, and which could not be noticed until a number of faulty bearings had been taken.

PILOT LIGHTS:

Spares should be carried and put in circuit in case of failure. The pilot light is connected to the ship's mains and does not constitute a load on the D.F. batteries. It may be left lighted as long as required without damage.

D.F. CABLES:

In normal installations, the special cables which are used to connect the loop aerials to the D.F. receiver are protected by conduit. If, in special installations the cable is exposed, great care should be taken to keep these cables from damage. They must be kept water-and air-tight, but may be painted, if desired.

Para. V INSTALLATION OF DIRECTION FINDER

The first point to be decided is a suitable position for the loop aerial and the receiver pedestal. As a general rule, the position of the loop aerial is the most important, as it has a direct bearing on the accuracy of the direction finder as a whole. It should be placed exactly over the keel line of the vessel, to ensure that all metal superstructure is located symmetrically around it, and it should be as clear as possible from large metal ventilators, stays or tanks, etc. Its distance from the fore or aft end of the ship is not very important, providing, as before mentioned, it is exactly amidships.

If an amidships position for the loop aerial is not available, a position as near as possible over the keel line should be chosen, but, in this case, it is probable that a calibration chart will have to be supplied, giving the corrections for the errors occasioned by the non-symmetrical position of the loop.

Another important point to bear in mind is the distance from the loop aerial to the receiver. When absolutely necessary, it is possible to work with the loop aerial as much as 60 feet away from the receiver, but as a general rule, the shorter the distance, the better the results will be.

The distance is measured in length of cable required to join the loop aerial and the receiver together, not the physical distance between the two units.

The position of the receiver pedestal is not very important, but care should be taken that whatever position is chosen, it will lend itself to a neat layout of cables and wires. In some cases, it will be possible to place the pedestal against a bulkhead and bring cables and other wiring down behind the partition, and again the cables may have to be run in conduit direct from the receiver to the loop aerial, and the other wiring clipped on the outside of the wall or bylkhead.

A plain aerial of about 25 or 30 feet is required in addition to the loop aerial, so consideration should be given to the position of the aerial insulator. This may have to be put through the deck above or through the side of the cabin. In any case, it should be located as near the receiver as is convenient.

LOOP AERIAL:

In cases where the loop aerial is installed on the deck above the room in which the receiver is located, it will be possible to take the cables down through the deck from the centre of the loop pedestal. This will necessitate the installation of a small water-tight tube or gland under the centre of the loop extending down into the cabin. When the cables have to be run any distance, they will probably have to be taken out from the side of the loop pedestal and run in 1 1/4 conduit.

The loop should be installed with the smaller of the two crossed loops in a fore and aft direction, The small loop should be lined up exactly fore and aft by sighting on a distant part of the ship, such as a mast or funnel. The pedestal part of the loop aerial should be bolted to the deck, and a good water-tight joint made by means of white lead and a rubber gasket.

It is essential that the metal framework of the loop be thoroughly earthed to the metal framework of the ship's hull. If the deck is metal. the bolts will make the earth connection. If the deck is of wood, a special connection must be taken from the loop framework to any part of the metal hull of the ship.

LOOP CABLES:

In cases where the cables are under 20 feet in length, #18 twin Cab Tyre may be used. If the length is over 20 feet, a special lead covered paper insulated cable supplied with the set must be used. This special cable requires very careful handling in order to prevent any possibility of damp getting at the paper insulation. Whenever a length is cut off the main supply, the ends of the lead cover must be pinched together and soldered up at once, and great care must be taken not to work at the ends in any place exposed to damp. When the paper insulated cable is used, connections to the loops must be made in special junction box at the foot of the loop pedestal. This is then filled with the special compound supplied, The compound should be heated slowly over a stove and poured into the junction box when soft. The connections from the loop windings are brought down to the base of the loop pedestal by means of four rods. If Cab Tyre cable is used, connection may be made direct to these rods, but if the paper insulated cables are used it will be necessary to take connections from the rods into the junction box where they make connection to the cables at a small terminal board. The lead covered cables should be protected by conduit or casing of some sort if they are to be run where

any hard and fast rules for running the special cables, as conditions vary on every ship, and the installing engineer will have to make different arrangements for every job. The special cable must not be bent round any curves of less than nine inches radius, and it must always be realized that the utmost care should be taken in carrying out these instructions, as if any damp penetrates to the inside of these cables, the cable will be destroyed, and the direction finder will be useless until it is replaced. One cable should be used for the Fore and Aft leads and the other for the Port and Starboard leads. As the two wires in either the Cab Tyre or the special paper insulated cables are marked with different colours, there should be no trouble in keeping trace of the loop connections when joining up to the receiver. In any case, record should be kept when the connections are made to the loops so that there can be no mistake after the connections are covered with compound.

RECEIVER:

The wood crib at the base of the Receiver pedestal should be used as a pattern for drilling the holes necessary for holding down the receiver. The crib should be cut and fitted to the slope of the deck, so that the receiver will be perpendicular when in place.

The studs should be either tapped into or bolted to the deck with enough length above the deck to project through the crib and the flanges at the base of the pedestal. A washer and nut should be screwed down to the deck to hold the stud firmly in place. The crib should now be placed over the studs and the receiver pedestal on top, Another washer and nut should be screwed down on each stud, bolting the receiver pedestal and crib firmly to the deck.

Provision is made so that the loop cables and other leads may be taken into the receiver at either side of the pedestal, duplicate holes being arranged for this purpose.

The loop leads from the Fore and Aft, and Port and Starboard loops should now be joined up to their respective wires in the receiver pedestal as shown in Blue Print 30589. Care must be taken at this stage that the cables are correctly connected as shown in the Blue Print, otherwise bearings will not be correct,

If Cab Tyre cable has been used, an ordinary soldered and tapped joint willbe satisfactory, but if the paper insulated cables were used, the soldered joints should be tucked into the pan provided inside the pedestal, and compound then poured over the joints to make them damp proof. The same care should be exercised in handling the paper insulated cables as before, when making the connections to the loops. The flexible leads inside the receiver pedestal may be swung over to either side of the set to accommodate whichever side the loop cables were brought in - the cleat holding the wires to the side of the pedestal being changed over with the wires. The 110-volt line should now be run to the ship's mains, and the earth leads from either of the two earth terminals on the pedestal to the ship's hull. The earth lead should be made with heavy wire, and should be as short and direct as possible.

AERIAL:

The aerial insulator should be installed in a convenient place, and should be made water-tight by

means of white lead. The aerial should be about 25 feet long, measured from the deck insulator to the free end. The lower end should be sweated into the special lug provided. The upper end should be secured to any convenient stay or triatic. Three aerial insulators are provided for staying or suspension. The lead from the inside of the aerial deck insulator should be run over to the receiver and connected to the terminal on the side of the pedestal. This lead should be kept clear from the loop leads unless they are in conduit, in which case, they are adequately shielded. The earth arrester should be installed near the deck, insulator inside the cabin and a short lead taken to the ship's hull.

BATTERIES:

The Eveready Air Cell battery should be prepared for service exactly as per instructions on the side of the container. Failure to follow these instructions will result in poor service and short life. Blue Print No. 30589 shows clearly the battery connections to the receiver. These connections should be made and checked before inserting the tubes.

The receiver should now be ready to operate, and should be checked for sensitivity and general quietness of operation. A preliminary test may now be made as follows:-

With about one hundred turns in the calibrating choke, get a bearing from a station in a known direction. If the cable and loop connections have been carefully followed through, the station should appear in its right quadrant, but. if through some mistake, either of the loop leads have been crossed, it will appear in the wrong quadrant (Port bow instead of Starboard bow, or Port Quarter instead of Starboard Quarter). If this is so, the leads at the terminal board at back of Goniometer will have to be changed. Cross either the Port and Starboard or Fore and Aft leads from the loops.

When certain that stations appear in their right quadrants, observations should be taken on all quadrants, if possible, at least in two adjacent quadrants, as a check.

Now proceed to set the phasing unit as follows:-

Get a zero in the D.F. position and switch to Sense. One of five things willbe found, viz:-

(1) Switching to sense obliterates the D.F. zero without showing any signs of moving it. This means that the plain aerial is not aperiodic and more resistance is required.

(2) The weakest point is moved 90 degrees but is not zero. This means that the all round component is too strong, and the coupling must be weakened. With very strong signals there is too much direct reception for a true sense zero, so reduce volume control until the signal is of reasonable intensity.

(3) Two weak points can be found close together and moved about 90 degrees from the D.F. zero. This means that the all round component is too weak, and that the coupling must be tightened, or, if necessary, the resistance

slightly reduced.

(4) A good sharp zero will be found 90 degrees from the D.F. zero, and signals opposite to the zero much stronger than the D.F. maximum positions; this is correct.

(5) Switching to Sense makes no difference at all. Phasing circuits broken or aerial not connected.

To make certain that all is well, it should be possible to go from 2 to 3 of the above by moving the coupling. Set the coupling for best results on the normal bearing wave, and lock the moving coil by tightening the lock screw. Finally, see that the sense is in the right direction. If not, the two leads going to the terminals marked SC-1 and SC-2 on the terminal board should be reversed. This will reverse the sense direction 180 degrees.

A check should also be taken on the balance adjustment at this time. It is impossible to predict the magnitude of the re-radiation signals that have to be balanced out in any particular ship; consequently, an adjustable reduction choke is shunted across the variable balance coils, so that part of the plain aerial component may be shunted to earth if found to be too much.

In some quadrants, more balance willbe required than in others, and, when adjusting the balance choke, it should be so arranged that the balance pointer is about three-quarters to the right or left for maximum compensation on any of the quadrants. This ensures that, for the smaller compensations, the balance adjustments will not be crowded in towards the centre position too much.

If the plain aerial is too long and has too much pick-up, the balance will have to be almost short circuited by the reduction choke. In this case, the length of the plain aerial should be reduced. If there is not enough pick-up in the plain aerial, the reduction choke should be disconnected, or the length of the plain aerial should be increased.

The length of the plain aerial may be considered ideal when the reduction choke requires to be about half to three-quarters in.

Any change to the length of the plain aerial will necessitate a slight readjustment of the sense circuits. It will probably be found that a slight variation of the coupling willbe sufficient.

CALIBRATION:

The principles on which the accuracy of a Direction Finder depends are as follows:-

(1) That the receiving power of the two loops shall be equal,

(2) That they are exactly fore-and-aft and athwartships and vertical.

(3) That the top of each loop shall be electrically exactly opposite to the earthed centre of the field coils of the goniometer.

(4) That the capacity between the search coil circuit and the rest of the amplifier shall be kept very small.

(5) That the D.F. as a whole be adequately shielded.

The first of these is assured by arranging the sizes of the two loops. The receiving power of a loop depends upon its area, its width being more important than its height. The bigger the loop, the better the signals, less amplification need be used, and less trouble is experienced from direct pick-up in the receiver and other kindred evils. It must be remembered, however, that the ship herself also acts as a receiver and assists the fore and aft loop. Therefore, the calibrating choke is normally shunted across the leads from the fore and aft loop. Provision is made at the terminal board, so that the leads to the choke may be connected across the Port and Starboard loops if ever required, as, in some cases, due to the design of the ship, there may be more pick-up athwartships than fore and aft.

The effect of the calibrating choke, when properly adjusted is to slightly reduce the output from the loop across which it is connected until the receiving power of both loops is the same.

The second point is assured by careful and accurate fitting and can always be verified. It is essential that both loops be exactly at right angles to each other.

The third, fourth and fifth points are assured by accurate fitting of the aerials and by the proper construction of the calibrating choke and direction finder.

The calibrating choke is an inductance connected across the loop output leads. It is not to be regarded as a tuning inductance, but as an absorption choke; the less the number of turns, the more effect it has, and the less the receiving power of the loop. In the limit, when the turns are reduced to zero, the receiving power of the loop would be reduced to zero as the loop leads would then be short circuited. Therefore, the effect of reducing the turns in the parallel choke is to effectively reduce the size of the loop. In this way, the receiving ability of the loops on any particular ship is made substantially the same.

Nearly all direction finders on board a vessel have an error, due to the ship herself acting as a large aerial, causing an effect which tends to pull the signals in a fore and aft direction. The greatest amount of pull is noticed at 45, 135, 225 and 315 degrees while at 0, 90, 180 and 270 degrees there is no appreciable pull. The error is negative in the first quadrant (0-90), positive in the second (90-180), negative in the third and positive in the fourth. The error may be plotted on graph paper as a sine curve, that is, zero at 0 degrees, gradually increasing up to 45 and decreasing back to zero again at 90 degrees.

For example, consider a station transmitting signals and bearing 45 degrees on the Port bow. The direction finder, if there was a fore and aft error of 5 degrees, would show an apparent direction of only 40 degrees. If the station was bearing 135 degrees, the direction finder would show it at 140 degrees.

As a general rule, the installing engineer will have to make a trip with the ship, unless the Master can swing the ship on a nearby transmitting station and then land the engineer.

The best method of calibration is carried out in conjunction with simultaneous sight and D.F. bearings. For this method, a Pelorus is used. This instrument is usually found on any ship's bridge or chartroom.

The ship should be about two miles or more away from the transmitting station, consistent with good sight bearings on the masts of the station, and should be well clear of land or anything which is likely to cause refraction or shielding. The Pelorus should be set with its zero aligned with the ship's head so that sight bearings taken on the station will be in relation to the ship's head only and entirely independent of magnetic effect or direction.

The ship should be manoeuvred so that the station bears about 45 degrees on the bow or quarter, and simultaneous bearings taken by sight and D.F. Any discrepancy between the two bearings will be the error on the direction finder, as the Pelorus will give a dead correct bearing with relation to the ship's head.

The calibrating choke should be altered until bearings by sight or D.F. are exactly alike. If the observed D.F. bearing is being pulled fore and aft, the turns in the choke should be reduced, but if the bearing is pulled athwartship, the choke should be increased.

If the bearing is still being pulled athwartship with the choke completely disconnected, the choke will have to be connected across the Port and Starboard loop and turns decreased until the error is eliminated.

If the loop aerial is installed exactly amidship, it can be presumed that when the error is eliminated at 45 degrees, there will be no error at any other point on the quadrants. As a check, however, simultaneous sight and D.F. bearings should be taken about every 10 or 15 degrees around the four quadrants.

In cases where the loop aerial is installed off the centre line of the ship, it will nearly always be found that the calibrating choke will not entirely compensate for quadrantal error due to the fact that there is a slight error at 0, 90, 180 and 270 degrees. This, of course, is caused by the loop aerial not being symmetrically placed with respect to the hull and superstructure of the vessel. The only remedy under these circumstances is to reduce the error at 45 degrees as much as possible with the calibrating choke, then take a record of the error at every 10 degrees around the quadrants. With this information a correction chart can be made up at the factory and forwarded to the ship at a later date.

It will often be possible to calibrate while steaming by a station as long as sight bearings

can be taken. In the first quadrant, the difference between sight and D.F. bearings should be ascertained, and by making quick adjustments to the calibrating choke, the calibration can be checked in the second quadrant. This requires wuick work, and should only be resorted to when it is impossible to swing the ship.

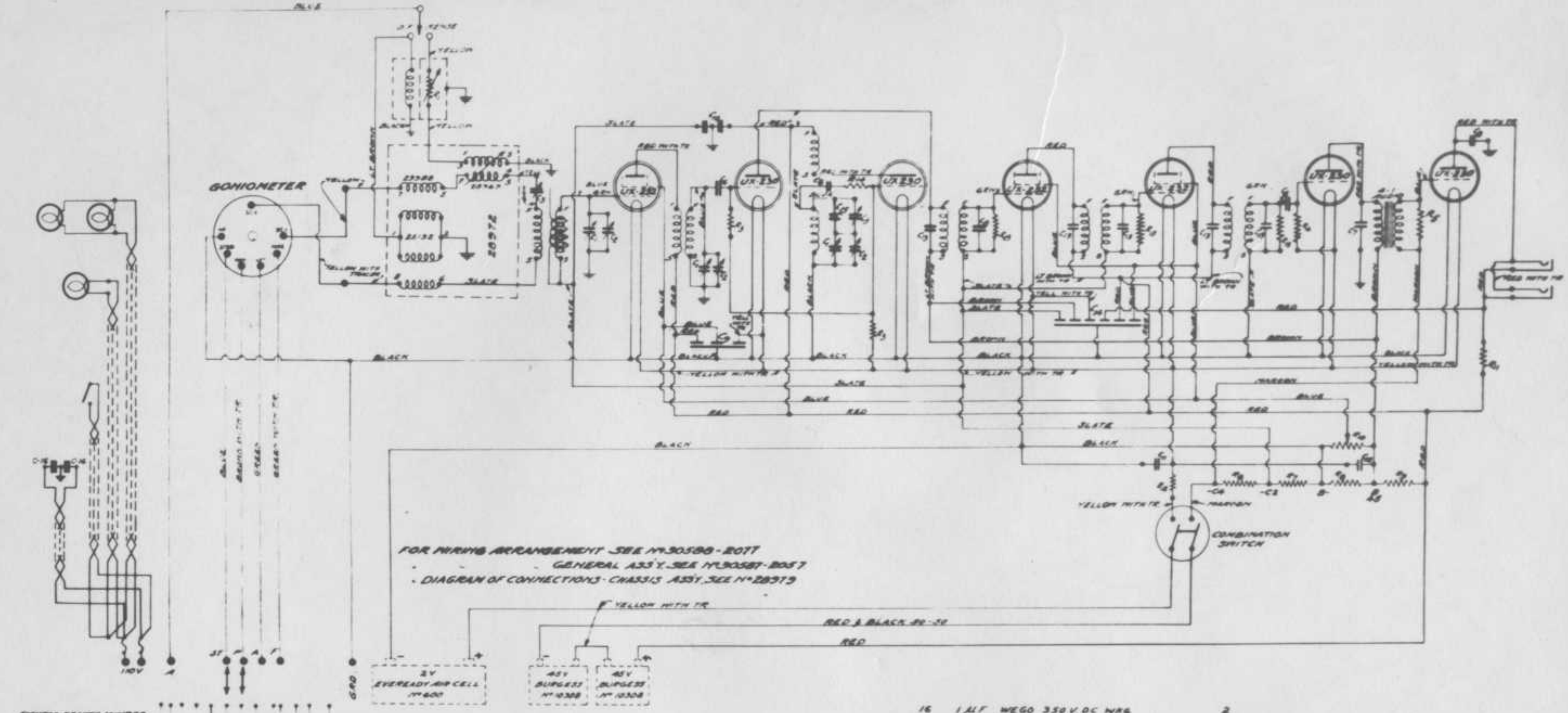
In fine weather, calibration may often be accomplished without taking sight bearings. This requires an exact knowledge of the ship's position, together with accurate corrections for variation and deviation. Bearings should be taken from stations at moderate distances away, and compared with the correct true bearings as taken from the chart. This latter method will, however, be a somewhat long and tedious task, and should never be resorted to unless sight bearings are impossible.

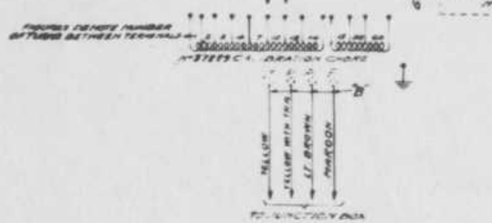
Calibration should not be attempted if the ship is alongside a wharf where there are metal buildings or structures, as these masses of metal will cause considerable errors.

Para. VI CONDENSER & RESISTOR LIST FOR (MDF-3) MDF-3E DIRECTION FINDER

"C" No.	CONDENSERS	Req.
1	3 Gang 17.5 to 405.5 mmf - No. 58217	1
2	30 mmf Vernier for 3 Gang	3
3	500 mmf GR type No. 247-f-No. 30302 (less gear)	1
4	1000 mmf - Mica, Aerovox	1
5	800-2100 mmf Variable - No. 88344	1
6	250 mmf Fixed "Aerovox"	3
7	5000 mmf Fixed "Aerovox"	1
8	2000 mmf Fixed "Aerovox"	1
9	3 x .3 MF. Fixed - No. 30008	1
10	2 x .5 MF Fixed - "Aerovox" Type 207	1
11	25 MF. Fixed "Aerovox" Electrolytic	1
12	1 MF. Fixed "Wego" - 200 V. D.C. Working	1
13	70-140 mmf - No. 29950	6
14	6X.3MF. Fixed - No. 30007	1
15		
16	.5 MF-400 V. Aerovox type 460	2

"R" No.	RESISTORS	Req.
1	10,000 ohms. Taps at 500,1000,2000,3000, & 5000 ohms	1
2		
3	50,000 ohms. "A-B" type "B"	2
4	2 Meg. ohms "A-B" type "C"	1
5	250,000 ohms"A-B" type "C"	1
6	168 ohms No. 28974	1
7	142 ohms.No. 28975	1
8	100,000 ohms"A-B" type "B"	1
9	10,000 ohms "A-B" type "B"	1
10	50,000 ohms. Potentionmeter No. 30303	1
11	15,000 ohms. "A-B" type "B"	1
12	0.74 ohms No. 30138	1
13	100,000 ohms. "A-B" type "C"	3
14	5,000 ohms. ½ watt - insulated	1





IN JUNCTION BOX CONNECT OUTSIDE LOOP LEADS (PAPER INSULATED CABLES) TO INSIDE LEADS & FILL JUNCTION BOX WITH PITCH
FROM F TO MAROON
"C" - A TO LT BROWN
- P TO YELLOW WITH TR.
- ST TO YELLOW

Nº	CONDENSERS	REQ.
16	1 MF WEGO 350 V. DC WKG	2
15	.001 MF. FIXED "AEROVOX" - Nº 23987	
14	6 x .3 MF. FIXED "HYDRA"	1
13	70-140 MMF. - Nº 23350	6
12	1 MF. FIXED "HYDRA"	1
11	25 MF. FIXED "AEROVOX" ELECTROLYTIC	1
10	2 x .5 MF. FIXED "MICAMOLD"	1
9	3 x .3 MF. FIXED "HYDRA"	1
8	2000 MMF. FIXED "AEROVOX"	1
7	5000 MMF. FIXED "AEROVOX"	1
6	250 MMF. FIXED "AEROVOX"	3
5	X.L. VARIODENSER [illegible]	1
4		
3	500 MMF. G.R. TYPE 8847-E (WITHOUT GEAR)	1
2	30 MMF. VERNIER FOR 3 GANG.	3
1	3 GANG - 15 - 370 MMF. - RADIO COND. CO.	1

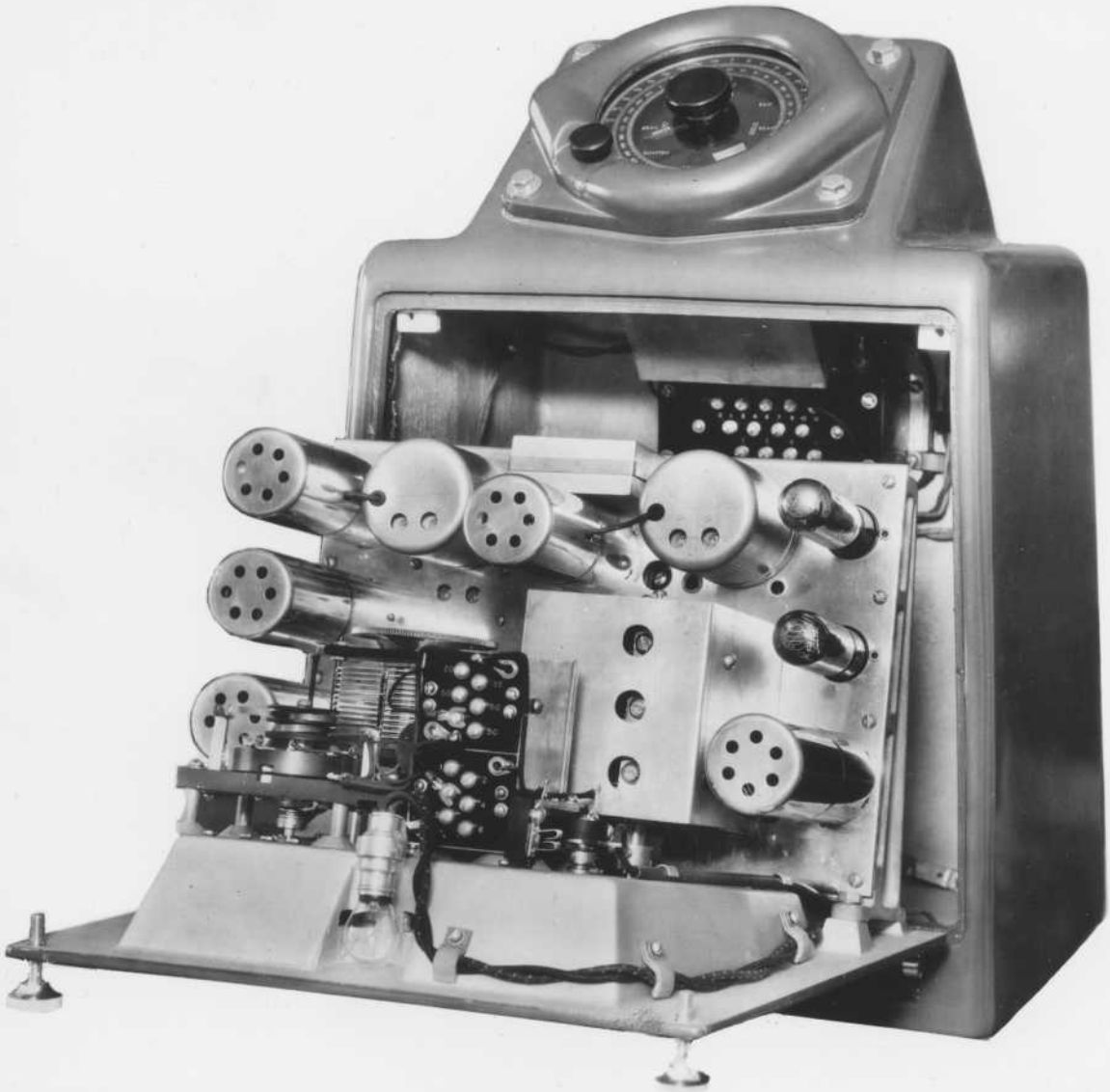
Nº	RESISTORS	REQ.
14	5,000 ω - ½ WATT - INSULATED	1
13	100,000 ω - "A-B" TYPE "C"	3
12	0.74 ω - Nº 30138	1
11	15,000 ω - "A-B" TYPE "B"	1
10	50,000 ω - POTENTIOMETER "ELECTRAD"	1
9	10,000 ω - "A-B" TYPE "B"	1
8	100,000 ω - "A-B" TYPE "B"	1
7	142 ω - Nº 28975	1
6	168 ω - Nº 28974	1
5	250,000 ω - "A-B" TYPE "C"	1
4	2 MEG - "A-B" TYPE "C"	1
3	50,000 ω - "A-B" TYPE "B"	2
2		
1	10,000 OHMS [illegible]	

RADIO DIVISION
DEPT. OF TRANSPORT,
OTTAWA, - ONT.

FEB 1935

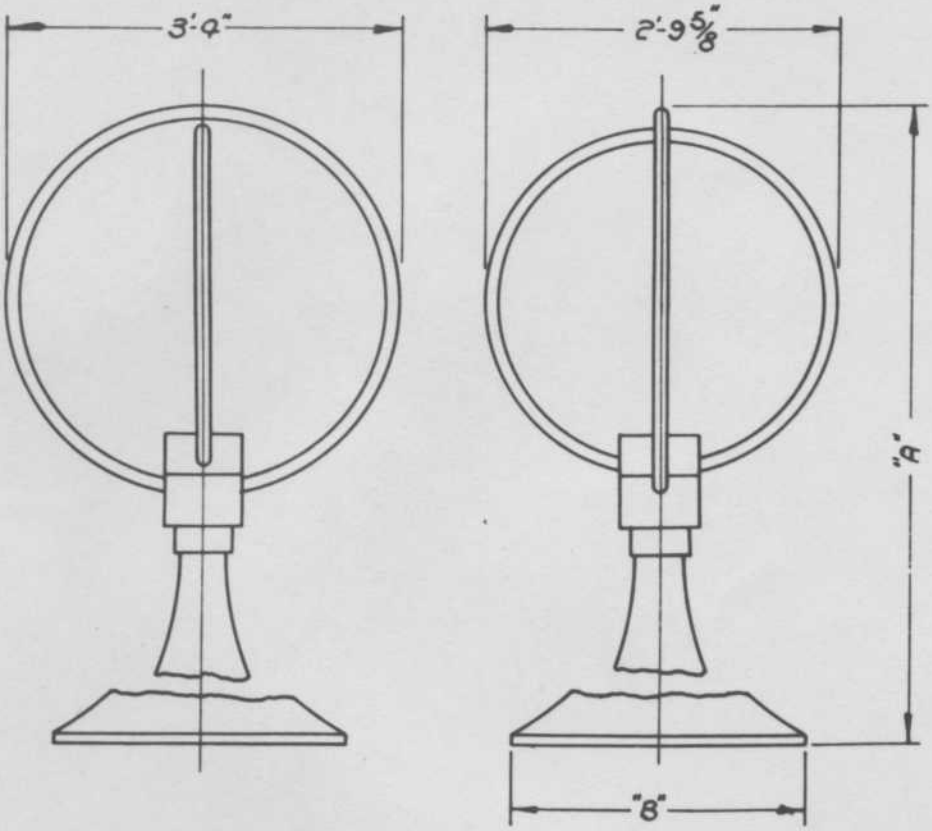
DEPARTMENT OF TRANSPORT RADIO DIVISION	MARCONI MARINE DIRECTION FINDER TYPE MDF-3B (DIAGRAM) TYPE MDF-3

Marconi Marine Direction Finder
Type MDF-3.



Marconi Marine Direction Finder
Type MDF-3 and Type MDF-3B.

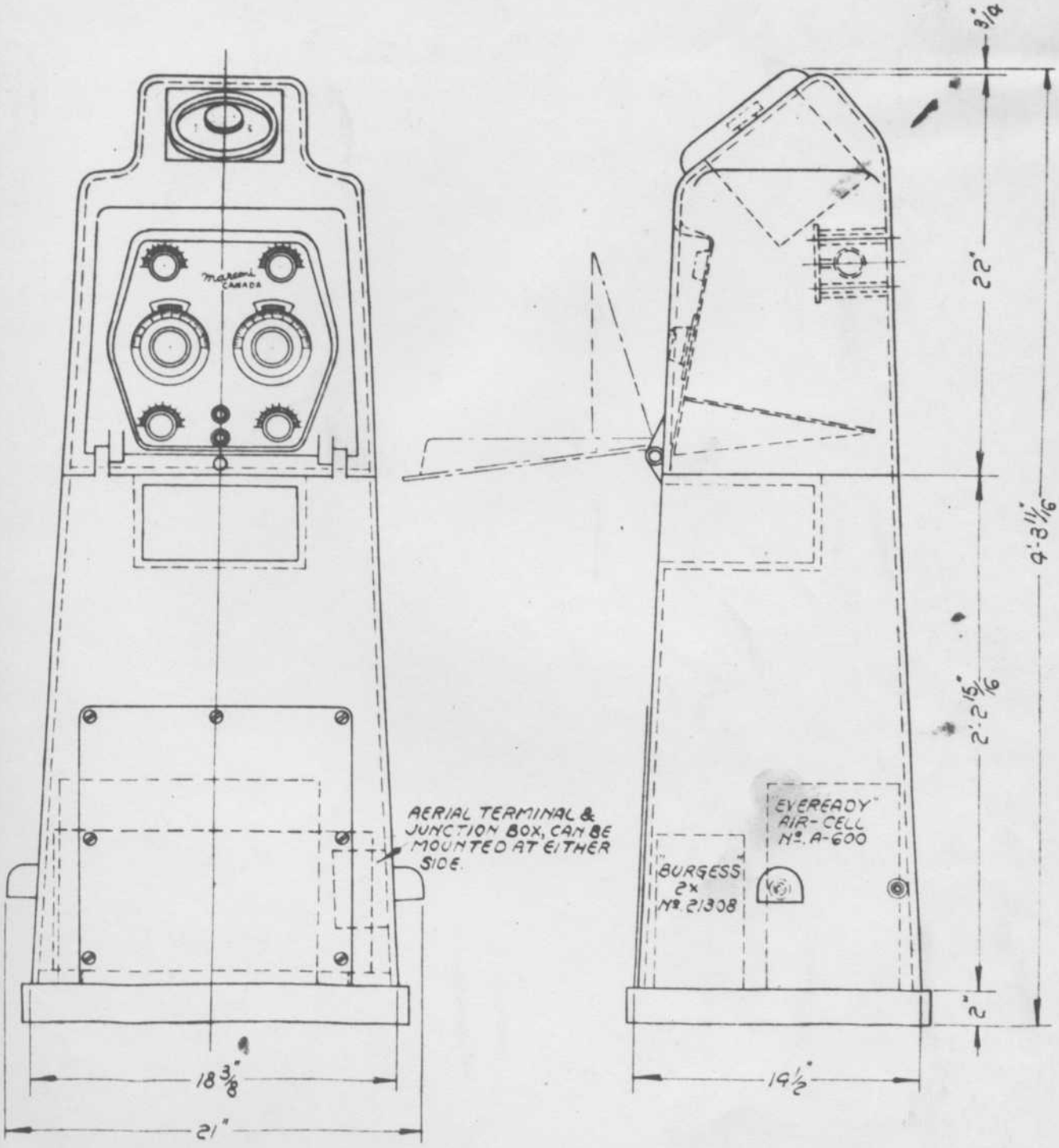
Marconi Marine Direction Finder
Type MDF-3B.



DIMENSION, "A" IS 9"-8", "B" IS 19 3/8"
DIMENSION, "A" IS 8'-10", "B" IS 2'-0"

LEADS
YELLOW & YELLOW WITH TRACER TO OUTER LOOP
LIGHT BROWN & MAROON TO INNER LOOP

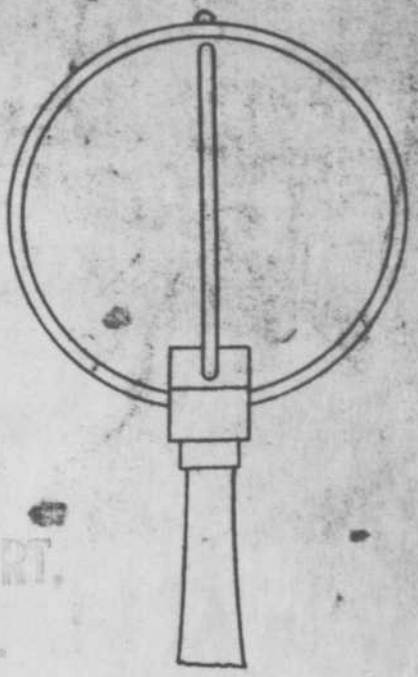
RADIO DIVISION
DEPT. OF TRANSPORT,
OTTAWA, - ONT.

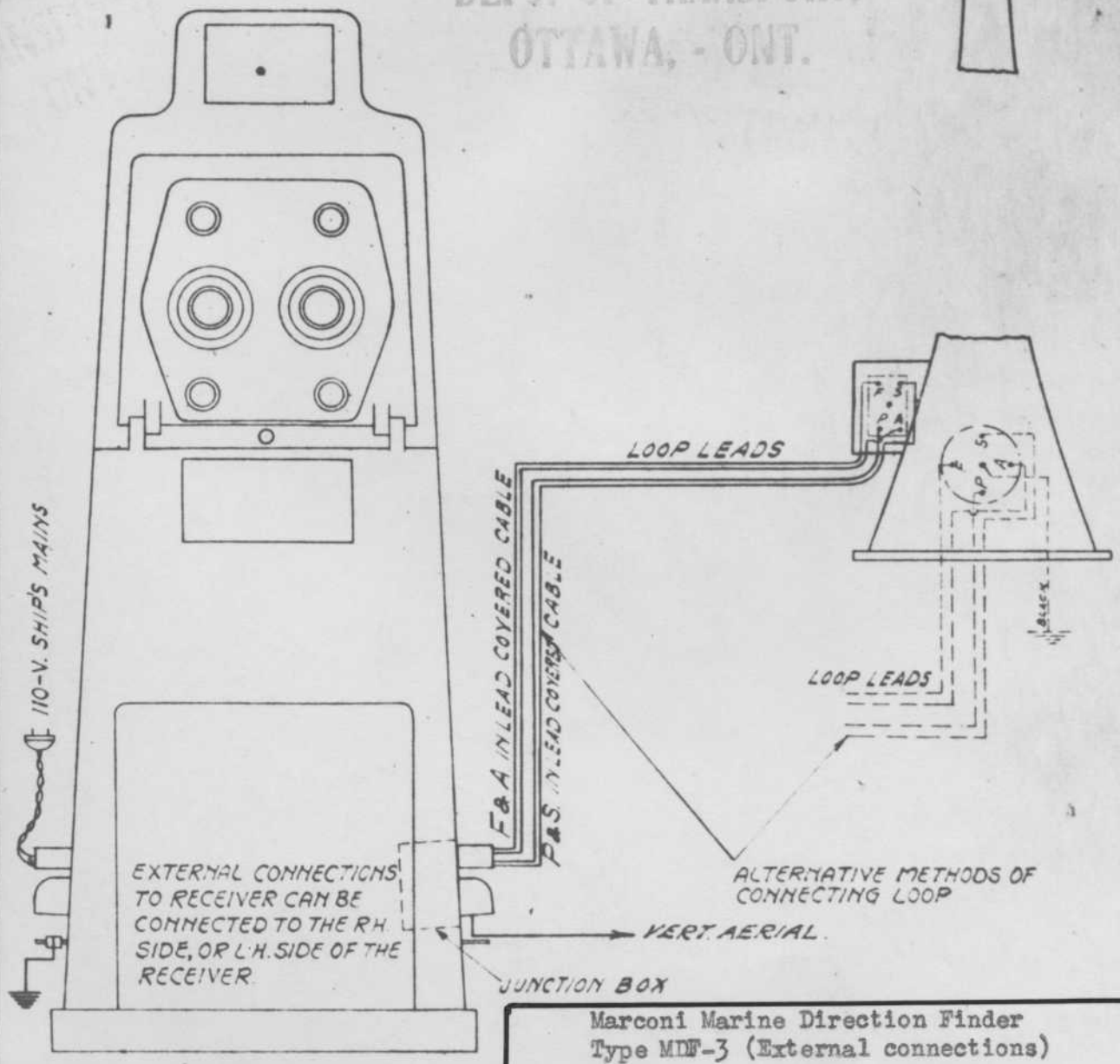


Dept. of Transport,
Radio Division.

Marconi Marine Direction Finder
Type MDF-3 (Receiver)

IN JUNCTION BOX CONNECT OUTSIDE LOOP LEADS
(PAPER INSULATED CABLES) TO INSIDE LEADS, AS FOLLOWS.
FROM "FORE" TO MAROON
FROM "AFT" TO LIGHT BROWN
FROM "PORT" TO YELLOW WITH TRACER
FROM "STARBOARD" YELLOW
AND FILL JUNCTION BOX WITH PITCH.
BLACK TO PEDESTAL FRAME OR GROUND.





Marconi Marine Direction Finder
Type MDF-3 (External connections)

2209