MARCONI DIRECTION FINDER

Type 579/354 N.

(Exhibited at the IVth International Hydrographic Conference, Monaco, 1937).

The Safety of Life at Sea Convention recognised the importance of wireless direction finding as an aid to navigation and regulations issued subsequent to that Convention state that in certain classes of vessels wireless direction finders of an approved type must be carried.

The MARCONI Direction Finder equipment Type 579/354 N, described in this article complies with Government requirements and has been approved by the British Administration for use on board compulsorily fitted ships.

The Direction Finder Type 579/354 N has been developed by The MARCONI International Marine Communication Co., Ltd., for use in those vessels where it is desired to instal a high grade navigational aid having a performance and degree of precision greater than that usually associated with equipment of this nature. It is essentially apparatus for use in high powered vessels and embodies facilities for the provision of sense and sharpening of scale definition at the point of zero signal.

All direction finding systems have in common the basic features of :—

(A) An aerial or collecting system that is capable of receiving to a greater or lesser extent depending upon its orientation in respect of the distant transmitter, and

(B) A means of detecting and amplifying the received signals.

It is the refinements and careful engineering design that make for precision in performance and in this respect it can be safely claimed that the equipment Type 579/354 N has no rival.

Referring to (A) above, the collecting system can be :—

(1) A rotating loop, or

(2) Two loops fixed at right angles to each other and connected to two small multiturn coils, known as field coils, also at right angles to one another. A third coil within the two small coils and arranged to rotate, known as a search coil, gives an effect in reception similar to that obtained by rotating a loop aerial.

The two small multiturn field coils and the search coil are made up into a unit known as a Radiogoniometer.

Theoretically, methods (1) and (2) should be equally effective, but a practical consideration shows that the second method scores heavily, when it comes to application on board ship. For instance, all vessels have an effect upon the performance of the direction finders installed in them ; also, in all ships there is nearly always a particular position at which this undesirable effect is at a minimum.

This position is obviously the correct position at which to fix the direction finding aerial, but it is generally found this is usually somewhat removed from the point at which it is desired to instal the direction finding apparatus. Method (2) permits the direction finder aerial system to be installed at a distance from the direction finding apparatus.

A further advantage of using method (2) is that the search coil is extremely light to manipulate, a fact that enables bearings to be obtained quickly. This is often a matter of some importance when taking bearings on commercial wireless telegraph transmitters, or making a landfall after being without sights for a number of days and wireless bearings are taken on beacons at extreme range when it is advisable to take the mean of a number of observations. With method (2) it is also possible to provide an extremely efficient electrical method of correcting quadrantal deviation instead of using the mechanical devices or correction tables usually associated with method (1). Method (2) is employed in the direction finding equipment described in this article.

A directional receiving system generally receives equally from two opposite directions so that no matter whether the method of determining direction by using a point where signals vanish, or the point of maximum signal strength is used, two minima and two maxima will be produced and the signal will appear to be coming from two directions 180 degrees apart. Such an arrangement will give direction but not sense. This does

not matter so much when bearings are being taken on known points when making a landfall, for the general relative positions will be known, but in other circumstances it becomes imperative that sense be given and the ambiguity of 180 degrees removed. In the MARCONI Direction Finder Type 579/354 N arrangements are provided whereby sense as well as direction is given.

Reference has been made to determining direction by noting either the point of maximum signal strength or the point at which signals vanish. Owing to the pecularities of the human ear, some difficulty exists in determining maximum signal strength and it has been found in practice that greater reliability in operation is obtained by using the method of making the point where signals vanish indicate the direction. The finer the point, the more accurate the results obtained will be. In the Direction Finder 579/354 N arrangements are embodied which enable this zero point to be made very fine, clear and sharply cut off.

DESCRIPTION OF EQUIPMENT.

AERIAL SYSTEM.

This consists of two shielded loops at right angles to each other supported on a pedestal. Two standard types are available, i.e., the long pedestal type or the short pedestal type, as shown in the illustration at Fig. 1. It is the long pedestal type that is shown in the illustration.

The approximate dimensions of the standard type are :—

Height overall	7 ft. 7 in.
Hoops	3 ft. 3 in. diameter.
Weight	1 cwt. 3 qr. 7 lbs.

and those of the smaller type :—

Height overall	4 ft. 7 ½ in.
Hoops	3 ft. 3 in. diameter.
Weight	1 cwt. 1 qr. 15 lbs.

In both the long and short pedestal types, the loops are identical. The short pedestal is used in certain cases where it is undesirable to have high mountings, but generally the long pedestal is advised. The whole system, i.e., the loop shields, loop conductors and pedestal are non-magnetic and may be fitted on the standard compass platform without exercising any adverse effect upon the magnetic compass.

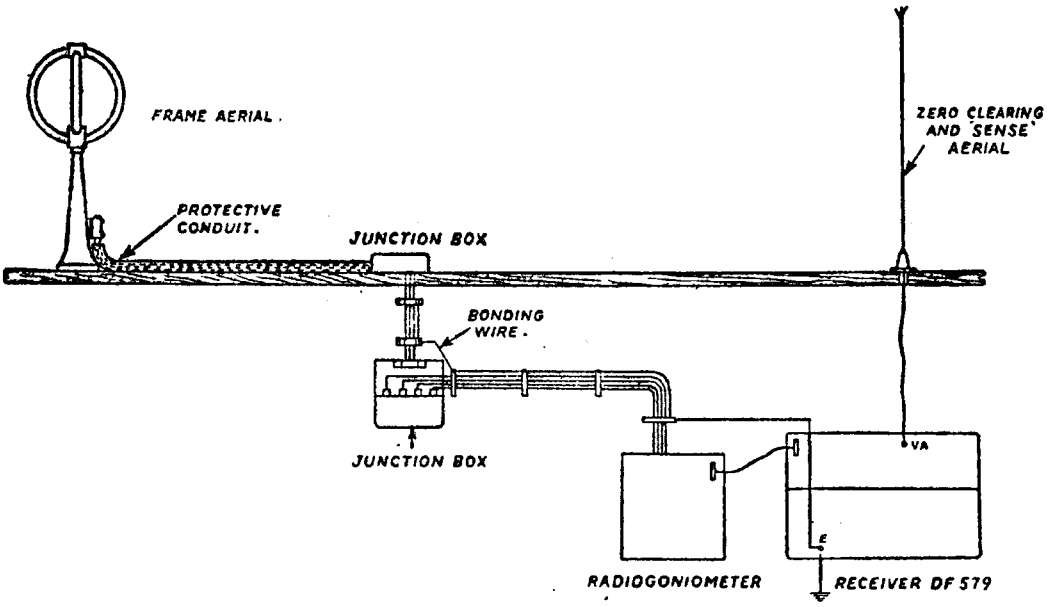

FIG. 2.

Outline Drawing of Marconi Direction Finding Installation, Type 579/354 N.

FIG. 1.

Frame Aerial,
Small Type.

Cadre d'Antenne,
Modèle réduit.

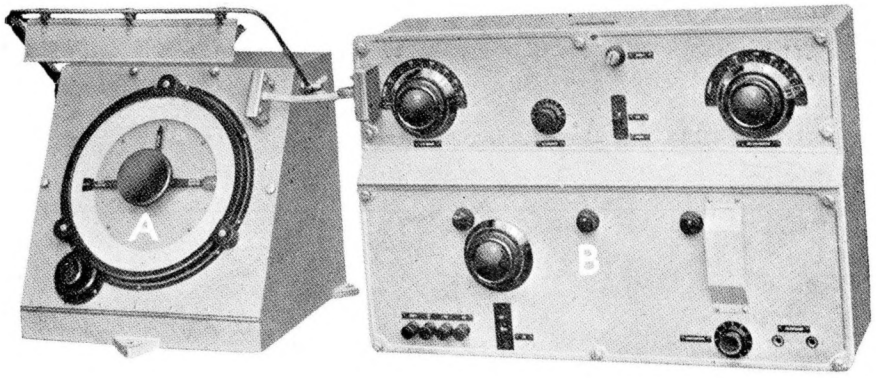

FIG. 3.

A. *Radiogoniometer.*
A. *Radiogoniomètre*

B. *Receiver.*
B. *Récepteur*

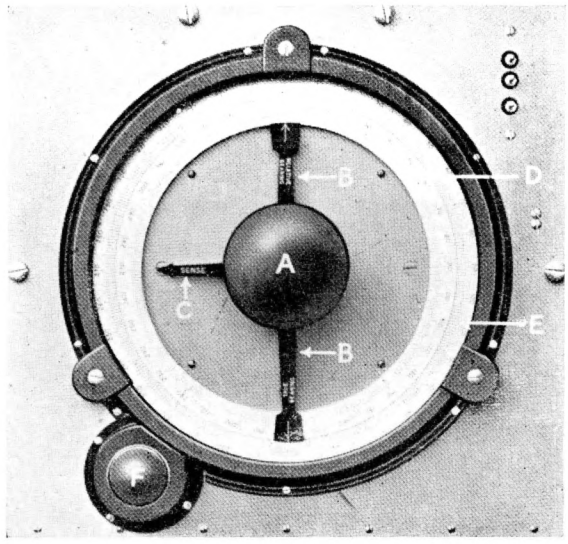

FIG. 4

Radiogoniometer Dial.

A. Control Knob.
B. Direction Pointers.
C. Sense Pointer.
D. Relative Scale.
E. True Scale.
F. True Scale Control.

Cadran du Radiogoniomètre

A. Bouton de manœuvre.
B. Index de direction.
C. Index de sens.
D. Echelle relative.
E. Echelle vraie.
F. Commande de l'échelle vraie.

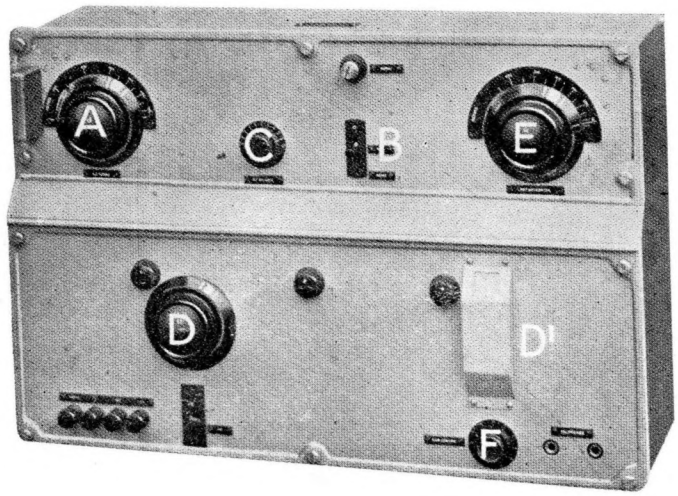

FIG. 5

A. *Search Coil Tuning Control.*
B. *D. F. Sense Switch.*
C. *Zero Clearing Control.*
D. *Signal Frequency Control and Frequency Scale* (D1).
E. *Oscillator Tuning Control.*
F. *Volume Control.*

A. *Commande d'accord de la bobine chercheuse.*
B. *Interrupteur de sens radiogoniométrique.*
C. *Commande de fin de zéro.*
D. *Commande du signal de fréquence et échelle de fréquence* (D^1).
E. *Commande d'accord de l'oscillateur.*
F. *Réglage d'intensité sonore.*

The fitting of the directional aerial Type 354 N is a simple matter, consisting as it does of mainly bolting the whole down to the deck on the centre line of the ship in such a manner that the smaller of the two loops is in line with the fore and aft line of the vessel. The flange at the base of the pedestal has a diameter of 14½ in.

In addition to the loop aerials, a small vertical aerial is employed to introduce the vertical component into the received voltages in order that sense and zero clearing may be provided.

Connection between the aerial system and the apparatus is by means of specially constructed lead sheathed paper insulated cables having extremely low electrostatic capacity per foot run. The general idea of connection between the aerials and apparatus is shown at Figure 2.

THE DIRECTION FINDING APPARATUS.

This part of the equipment is made up in two units :—

(1) The Radiogoniometer, and
(2) The Receiver.

The two are installed close together as shown in Figure 3.

The Radiogoniometer.

The Radiogoniometer is fitted with a large open fixed scale *D* marked off in degrees, 0 to 359, in a clockwise direction, so that 0 represents the ship's head, 90 degrees the starboard beam, 180 degrees the stern and 270 degrees the port beam. A second scale *E* which is rotatable is also provided. This can when desired be coupled to the gyroscopic compass system via the control *F*, so that it always follows the ship's head. When this is done readings obtained are true bearings. When the radiogoniometer is not connected to the gyroscopic compass system the readings taken from the fixed scale *D* indicate the angle in relation to fore and aft line of the ship from which the signals are coming and are known as Relative bearings.

A double-ended pointer *B* with another one at right angles *C* completes the dial arrangement. The long pointer indicates direction and the one at right angles is used for sense.

The radiogoniometer scale is shown at Figure 4.

The field coils are spaced windings on rigidly constructed formers of non-hygroscopic material and the search coil which is loosely coupled to the field coils is wound on a former of similar construction and mounted within the field coil former. The search coil is rotatable by the control knob *A* to which are firmly attached the pointers *B* and *C*, and is tuned by means of the control *A* on the receiver.

Provision for the necessary adjustment for the correction of quadrantal deviation is made in the radiogoniometer unit.

The whole unit is housed within a substantially made metal case that provides efficient screening to the circuits.

A lamp is provided to illuminate the dial.

Connections between the aerial and goniometer are led into the back of the unit and do not have to be disconnected or disturbed when opening up the unit for inspection or adjustment.

Connection between the goniometer and the receiver is effected by means of a short screened lead terminated at each end in plug fittings. These plug fittings are inserted into appropriate sockets on the faces of the goniometer and receiver. Arrangements are also made to enable the goniometer to be mounted above the receiver in cases where space is restricted.

The Receiver.

The complete receiver is accommodated in a robust casting of sea air-resisting alloy, and consists of two principal units mounted one above the other.

The top unit contains input, sense, zero sharpening and oscillator circuits. The lower unit is the main amplifier. Both these units may be withdrawn from the containing case without disturbing either the bonding leads between them or the exterior lead to the goniometer.

The general appearance of the receiver is as shown at Figures 3B and 5.

The wave range of the equipment is from 545 kilocycles a second (550 metres) to 250 kilocycles a second (1,200 metres), and adjustment between those limits is effected by means of the controls *A* and *D*, the actual adjustment being shown on the frequency scale D1 and the eyebrow scale above control *A*. This wide waverange enables bearings to be obtained on other vessels and coast stations emitting signals within the marine mobile waveband and on radio beacons.

When it is desired to take bearings on transmitters emitting continuous wave signals the local oscillator is brought into action and adjusted by means of the calibrated control *E*.

The receiving circuits incorporate three stages of tuned radio frequency amplification (employing screened grid pentode valves), adjusted by means of the controls *A* and *D*, a detector stage, and two stages of audio frequency amplification. An output transformer is used to isolate the headgear telephones from the high tension supply. A local oscillator circuit is also embodied; this is adjusted by the control *E*. The circuits are calibrated in metres. Seven MARCONI valves are employed as follows :—

Valve	No.	1.	Type	VP21	metallised.	1st radio frequency.
"	"	2.	"	VP21	"	2nd "
"	"	3.	"	VP21	"	3rd "
"	"	4.	"	HL2	"	Detector.
"	"	5.	"	HL2	"	1st audio frequency.
"	"	6.	"	P2	"	2nd " and Output stage.
"	"	7.	"	HL2	"	Local oscillator.

The whole receiver is arranged for bench mounting and shock absorbing buffers are provided.

The radiogoniometer and the receiver are efficiently screened against the pick-up of undesired signals and interference from other electrical machinery. With regard to the latter, cases may occur where the most efficient screening fails to eliminate interference and it then becomes necessary to fit anti-induction units to such circuits or machines as may be found to be the source of trouble.

PERFORMANCE.

The Direction Finder is designed to take bearings on transmitters emitting continuous wave, interrupted continuous wave and spark signals within the frequency limits mentioned above.

Under normal conditions of daylight a direction finder accuracy of not less than $\pm 1\frac{1}{2}$ degrees may be expected, and under good conditions a direction finder accuracy of $\pm \frac{1}{2}$ degree can be obtained.

The selectivity of the receiver is at least twice as good as the standard demanded by the British Administration.

The sensitivity of the apparatus is such that under normal conditions bearings having an accuracy as stated above may be obtained at ranges of the order of 150 miles from a standard British radio beacon, and 220 miles from the higher powered British radio beacons. In practice it will be found conditions often make it possible for these ranges to be considerably exceeded, on the other hand conditions will at times curtail these distances.

EQUIPMENT.

The normal equipment for the direction finder Type 579/354 N comprises the following main items :—

1. Frame Aerial.
2. Radiogoniometer unit.

3. Receiver complete with valves.
4. Spare valves for item (3).
5. High tension anode battery.
6. Low tension filament battery.
7. Charging board for items (5) and (6).
8. Junction boxes and supply of special low capacity paper insulated cable.
9. Headgear telephones.
10. Supply of cables, screws, etc.
11. Single stroke bell and push.
12. Instructions for the care and operation of direction finder.