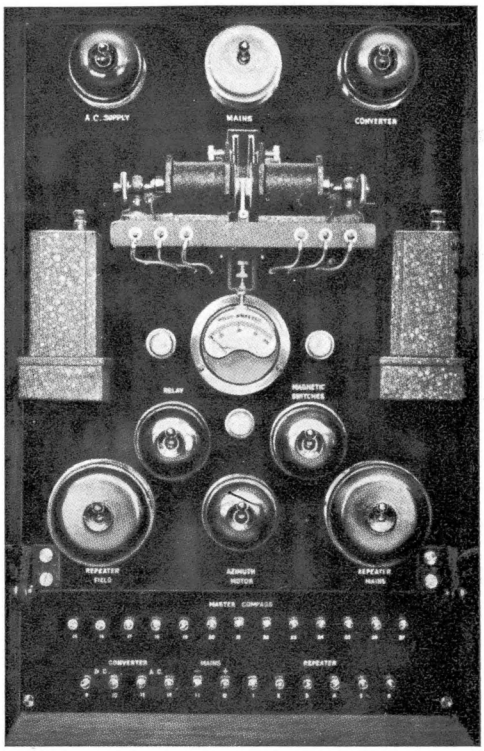
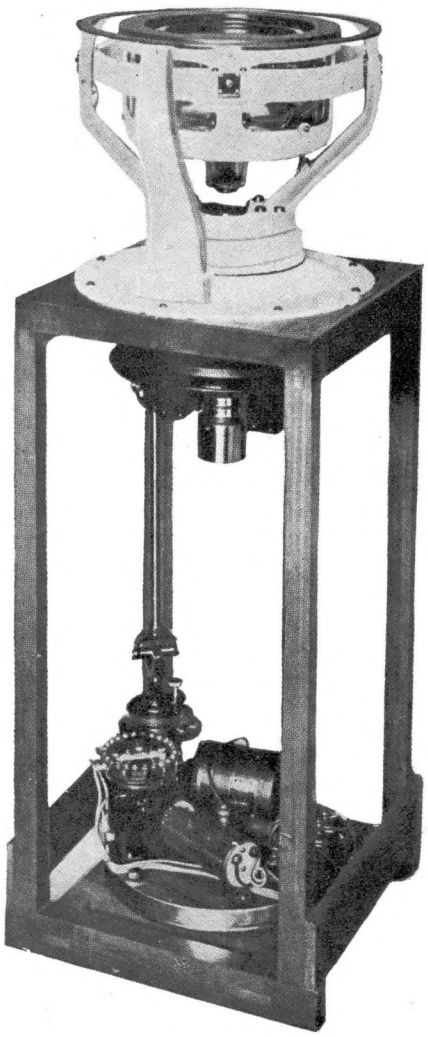


Control Panel - Tableau des Commandes



Master Compass dismounted
Compas Principal démonté

Path Indicator - Indicateur de Route

THE HOLMES MASTER MAGNETIC COMPASS AND PATH INDICATOR.

(Extract from pamphlet published by Messrs. HENRY HUGHES & Son LTD., 59, Fenchurch Street, London, England).

The apparatus comprises the following devices :

1) The master magnetic compass,
2) The repeater compasses,
3) The HOLMES Path Indicator.

1) *GENERAL DESCRIPTION OF THE MASTER MAGNETIC COMPASS.*

This is a special design of magnetic compass adapted to operate any required number of repeater compasses at different stations for various uses, such as for steering and recording purposes. The Standard Repeater Compasses are used as a substitute for the usual auxiliary compasses that are more or less unsatisfactory and have to be constantly checked by the ship's standard compass.

This design is based upon the radically new invention of Edward L. HOLMES which solved the following problem: How can the sensitive magnetic compass needle be used, without disturbing it in any way, to precisely control external apparatus ?

The compass card is transparent and is illuminated from beneath the bowl by electric lamps that are regulated by a knob from the exterior of the binnacle, which controls a rheostatic dimmer.

In the accompanying figure the master compass is shown dismounted so that a better view of the mechanism may be obtained than when it is enclosed in a binnacle.

The "Control panel" contains the differential relay, the switching gear, resistances and fuses. The master compass is located in the usual standard compass position above the ship's bridge, and the control panel is placed in the chart room or upon some other convenient inside wall.

The compass bowl contains the conventional arrangement of magnets, float and card supported upon an iridium pivot and sapphire bearing, together with a lubber line, and is filled with a nonfreezing alcoholic liquid. In general, this compass is similar to the most approved type of present-day liquid standard compass.

The bowl is hung in roller-bearing gimbals from a frame which is rotatably mounted upon a vertical ball-bearing spindle.

This arrangement permits the frame, together with the gimballed compass bowl, to be smoothly revolved in the horizontal plane either way and concentrically around the compass card which remains stationary in the magnetic meridian, supported upon its own pivot inside the bowl.

The frame carrying the compass bowl is connected by a vertical driving

shaft and suitable reduction gearing to a reversible electric azimuth motor at the bottom of the binnacle.

A large metal compass card is attached to the revolvable frame outside and clear of the gimbals on a level with the top of the compass bowl and concentric therewith.

This large card is called the master card, to distinguish it from the magnetic card. The master card revolves with the compass bowl and is read against a lubber line inscribed upon the stationary vertical bracket shown in the foreground of the illustration.

The compass bowl, together with the master card, are revolved upon their spindle by the azimuth motor whenever they are turned by the turning ship, but in a contrawise direction, so as to maintain the bowl and master card stationary in azimuth and synchronous with the magnetic card. The powerful master card thus behaves exactly like the magnetic card and is therefore an electric compass, capable of transmitting its movements to distant stations.

The imponderable control. — The liquid in which the magnetic card is suspended in the compass bowl is ionized with an acid and utilized as a high resistant electrical conductor.

The control of the repeater system is effected by the variations of the electrical resistances of two liquid paths for alternating current circuits which pass through the compass bowl and operate a differential relay upon the control panel.

The paths referred to lie between electrodes fixed to the bowl and electrodes attached to the magnetic card.

The interior of the bowl and the magnetic card float are made of insoluble insulating materials and metals that are unassailable by electrolysis.

The compass bowl is equipped with four "bowl electrodes" led in through insulator tubes and equally spaced around the bowl, the ends being bare, vertically disposed and clear of the compass card.

The magnetic card carries two parallel insulated wires with exposed ends bent into the vertical, forming four "card electrodes" equally spaced around its edge.

As arranged, the card can rotate freely and the bowl and card electrodes pass each other with a clearance of about one-sixteenth of an inch.

An additional wire, to serve as a lubber line, is mounted inside the bowl.

The bowl electrodes are electrically connected to the external portion of the circuits by flexible leads disposed about the roller gimbal bearings so as not to restrain their action and through substantial sliprings at the lower end of the spindle of the bowl frame bearing.

Each of the two alternating current circuits passing through and across the compass bowl includes an alternating current generator, a pair of bowl and card electrodes, two short high resistant liquid gaps between the two pairs of bowl and card electrodes and one magnet coil of a HOLMES Differential A.C. relay.

The differential relay is located on the control panel and is controlled by the variations of the electrical resistances of the two circuits within the bowl,

where their paths pass through the high resistant liquid gaps between the bowl and card electrodes.

The system is so arranged, that when the north point of the magnetic card is opposite to the lubber line within the bowl, the card electrodes are opposite their respective bowl electrodes and the two electric paths have equal resistances. The current in these two paths is led to the differential relay. When the electric balance is disturbed by a rotation of the revolvable bowl about the magnetic card, the variations in the current intensities of the two circuits close the differential relay, which in turn operates one of the two electro-magnetic switches that control the reversible azimuth motor that drives the bowl.

As soon as the bowl moves through the slightest angle in either direction away from the magnetic card, as when carried by the turning vessel, the electrical balance in the bowl is disturbed, the relay operates one of the switches, the electric motor is started, and the bowl is rotated back to its initial relationship with the magnetic card, electrical equilibrium is restored and complete synchronism is re-established between the bowl, the master card and the magnetic card.

The lubber line inside the bowl is used as an index point to show when the bowl and the master card synchronize with the magnetic card.

The ship's heading is indicated by the large master card that revolves with the bowl and is read against the external stationary lubber line. Thus precise control of the external apparatus is effected by the sensitive magnetic card without harnessing it or disturbing it electro-magnetically.

The compass card lies free and quiescent in the magnetic meridian. Due to its inertia the card is undisturbed by the rapidly alternating magnetic field superimposed upon the earth's field by the alternating current.

The function of the card in the transmission system is merely to carry the light metallic conductors which provide the two low resistant paths across the high resistant liquid in which the card is immersed for the alternating current which operates the differential relay.

The system draws no energy from the magnetic compass card.

Alternating current. — As it is essential that no electro-magnetic influences affect the magnetic element of the master compass, alternating current is employed in the relay control circuits, and also for operating the azimuth motor.

Alternating current is obtained from a small rotary converter (75 volts, 50 cycles, 200 watts). It is run off the ship's direct current mains and may be located in any convenient place.

2) *GENERAL DESCRIPTION OF THE REPEATER COMPASSES.*

The repeater compasses are electrically operated by direct current taken off the ship's mains through appropriate resistances.

These are operated by the master standard compass in steps of one-sixth of a degree. A positive step-by-step transmission is effected by means of a rotary transmitter connected to a suitable part of the reduction gearing between the azimuth motor and the revolvable compass bowl.

They may be located at any desired station, supported either upon a wall bracket or in gimbals. Standard repeater compasses are made in several patterns and may be used for the following purposes: steering, taking bearings from the bridge wings, radio direction finding and tell-tale indicating. The repeater mechanism may be incorporated in any device which requires the control of the master compass, such as a course recorder, an automatic pilot, or the HOLMES path indicator.

The standard repeater compasses are of the direct current step-motor type and are actuated by the master compass in steps of one-sitxh of a degree at an adequate follow-up speed, and operate smoothly with no appreciable lag.

They are housed in waterproof cases and have an external stem for setting them in step with the master compass.

They are internally lighted and equipped with an adjustable dimmer.

Standard Steering repeater plus the Path Indicator. — There are two patterns of steering repeater compasses. The preferable pattern is combined with the Path Indicator, making it possible for the helmsman to eliminate all the steering errors as previously described. It presents a vertical 9-inch card to the helmsman which is extremely easy and comfortable to read.

The other pattern is a plain 7-inch repeater compass mounted either on a wall bracket or on a tripod, and may be fitted with a magnifying glass which gives a large clear vertical reading.

Standard Bearing repeater. — This may be located upon the wings of the bridge equipped with an azimuth mirror. Thus from his usual station the bridge officer can take standard compass bearings, watch how the steering is done, how helm orders are executed, and the response of the ship to the helm.

The bearing repeater is hung in gimbals and is mounted on a substantial pedestal. The compass card is translucent, lighted from beneath and provided with a rheostatic dimmer. The verge ring takes the HUSUN azimuth mirror.

The HOLMES master compass may also be used in combination with the SPERRY Course recorder or even with the automatic pilot which the HOLMES master compass operates with the same degree of precision as that with which it controls repeater compasses.

3) *GENERAL DESCRIPTION OF THE PATH INDICATOR.*

The Path Indicator enables the helmsman to keep the vessel right on the prescribed track. Furthermore, if the vessel should depart therefrom it records the actual distance run away from the prescribed track to port or starboard for the information of the navigating officer.

The Path Indicator is controlled by the master standard compass and is located in front of the steering wheel. It is mounted in a sealed waterproof case together with a steering repeater compass and requires no attention or upkeep whatsoever. It merely has to be set to the prescribed track.

It presents two vertical dials to the full view of the helmsman: the repeater compass dial and the Path Indicator dial.

After the ship's course has been determined and the departure made, the instrument may be readily set by the navigating officer to indicate the ship's position in relation to the prescribed track. The vessel is then steered in the usual way from the indications of the repeater compass except that the helmsman is required, at short intervals, also to observe the indications of the Path Indicator dial to see whether the vessel is being kept upon the prescribed track as well as on the proper heading.

The Path Indicator dial carries two hands, one large, star-shaped hand and another smaller hand similar to a clock except that they revolve either way from their normal upright zero position and read distance to port or starboard.

The star hand is sensitive and active and is designed for the especial use of the helmsman. It points the way, either to port or starboard, that the vessel must be steered to bring it back to the prescribed track whenever it has departed therefrom. The star hand indicates a departure of even a few yards, and thus ensures straight and economic courses by the elimination of the steering errors that inevitably occur in a seaway when the steering is done by the compass alone.

The small hand of the path indicator moves more slowly than the star hand and records the dimension of the larger departures that may occur. This hand is for the use of the navigating officer and indicates when the steering errors have not been corrected by the helmsman or when the vessel has departed from its prescribed track to execute some manœuvre.

The dimension of the distance of the vessel away from the prescribed track either to port or starboard is plainly recorded in figures by the small hand in decimals of a mile. This information enables the navigating officer to return the vessel accurately to its proper track or to use it for correcting the position by dead reckoning.

The distance away from the prescribed track resulting from the accumulation of the innumerable deviations made by a vessel in a seaway cannot be estimated and often amounts to many miles a day. This steering error constitutes a risk and considerable operating expense for all classes of vessel.

Principle of operation. — The Path Indicator is controlled by a repeater compass and a small time motor which continuously runs at a uniform speed. The instrument is set in the following manner: By means of a knob a red pointer is moved over the face of the repeater compass card and set upon the prescribed compass course. By a separate knob the hands of the Path Indicator dial are set at zero. This indicates that the ship is on the prescribed track.

Thereafter when the ship is pursuing a more or less devious course the distance away from the prescribed track either to port or starboard is computed by an automatic integrating mechanism. The sine of the angle of departure from the prescribed track as set off by the repeater compass is integrated with time, or more properly speaking with the uniform speed of the time motor.

In this integration the uniform speed of the time motor represents a

ship's assumed uniform speed at a rate of one knot and the dial is calibrated accordingly. The dial thus shows the distance in miles for an assumed speed of one knot. It therefore follows that the actual dimension of this distance in miles for any other uniform speed, such as for a ship travelling uniformly at the rate of twelve knots, may be found by simply multiplying the dial reading by the ship's speed in knots.

The Path and Position Indicator. — The principle of the Path Indicator has been applied to another instrument, the Path and Position Indicator.

This instrument shows the actual position of the ship in relation to any established point of departure, and thus furnishes a complete check upon dead reckoning, with all steering errors eliminated.

The indications are obtained by the automatic integration of both the sine and cosine of the various angles of departure from the prescribed track, as set off by the repeater compass, with the ship's speed, as electrically registered by a log.

GENERAL REMARKS.

By virtue of the action of the revolvable bowl, as previously described, the bowl and the magnetic card are both maintained stationary in azimuth and the bowl does not revolve around the card when the ship is turning as it does in the ordinary compass. Consequently, the turning forces generated by the bowl and transmitted by friction through the pivot and the liquid to the card as in the ordinary compass, causing drag, lag and overswing, are wholly eliminated and the magnetic card is held more truly in the magnetic meridian.

Should the transmission system of the master compass be interrupted for any reason, the compass bowl can be readily disconnected from the control of the azimuth motor and be manually rotated until its interior lubber line is lying fore and aft, and rigidly clamped for use as a stationary compass.