DESCRIPTION OF A REFLECTING CIRCLE.

devised by M. ROLLET DE L'ISLE, INGÉNIEUR HYDROGRAPHE GÉNÉRAL.

(From the *Annales Hydrographiques*, Paris, 1893, page 289.)

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1. With the ordinary reflecting circle, angles from 0° to 160° only can be observed. Besides they are very difficult to take between 150° and 160° as the field is extremely reduced as also is the amount of light reflected. The first is due to the reduced aspect of the large mirror in the position it then occupies and the second to the acuteness of the angle of incidence of the rays on to this mirror.

Now, it is extremely useful to be able to take angles up to 180°.

When sounding there are not always an unlimited number of marks by which the station can be fixed and, when the number is reduced to three, it is indispensable that the angles between them, no matter what they may be, should be taken. This may happen particularly when approaching close to the coast off which the survey is being made. However far from straight the coast may be, it is evident that if the marks to be taken lie on the same side of the observer, the angle becomes very small; while if they lie on opposite sides, it will become very great. With the ordinary circle these large angles cannot be taken. Very frequently one is prevented from using such marks on account of the impossibility of getting the angle between them, though they would greatly facilitate the fixing of position, for the large as well as the small angles are very favourable for this purpose, since they change considerably with the smallest movement of the observer in a direction perpendicular to the line joining the two marks.

If one moves so as to keep the angle between two marks at 180°, the line thus followed has the same advantages as a transit. When the coast off which soundings are being taken is very steep and does not allow a clear view into the interior, the ordinary method of running on a transit is not applicable; but, on the other hand, it is easy to run a straight line, if there be a mark astern, by keeping it and a point on the coast at 180°.

The method of sounding by following the segment of the circle containing the angle between two marks or prominent points, which surveyors have practiced for nearly eighty years precisely in those cases where transits are not available, may be made of more general application by the use of segments containing large angles; these segments, being nearly straight lines, are very easy to run.

This method of navigation by segments of circles containing angles, which was particularly advocated by Ingénieur Hydrographe en Chef BOUQUET DE LA GRYE and was described by him in his *Pilote de la côte Ouest de France* (1869), is of value for passing through straits and channels. It is frequently much better than a badly visible transit, but the number of such segments available is naturally small and it is better not to be limited in selecting the best segment by being unable to take angles over 150°.

2. The above considerations led me to seek an instrument which would allow every angle from 0° to 180° to be taken on one side of the observer.

When sounding, the fix must be taken as rapidly as possible. It is sometimes impossible, and in any case a long operation, to anchor for this purpose. Therefore, three or four angles between visible marks have to be taken rapidly with the boat under way or, at the best, stopped.

The object was to make an instrument differing as little as possible from that in use, in order that facility in its use might be easily acquired, based on the same principle and without complication in its construction.

3. Take the circle of ordinary type (Fig. 1) and let m_1 be the small mirror and M_1 the large mirror which turns about the centre O.

Let the large mirror M_1 be turned about the centre O in the direction of the arrow, so as to bring the point A, viewed directly, into coincidence with the image of point C which lies at 90° from the direction B A.

Let a second large mirror M_2 and a second small one m_2 be fitted so that the image from the mirrors M_2 and m_2 of the same point C shall coincide with the point A viewed directly.

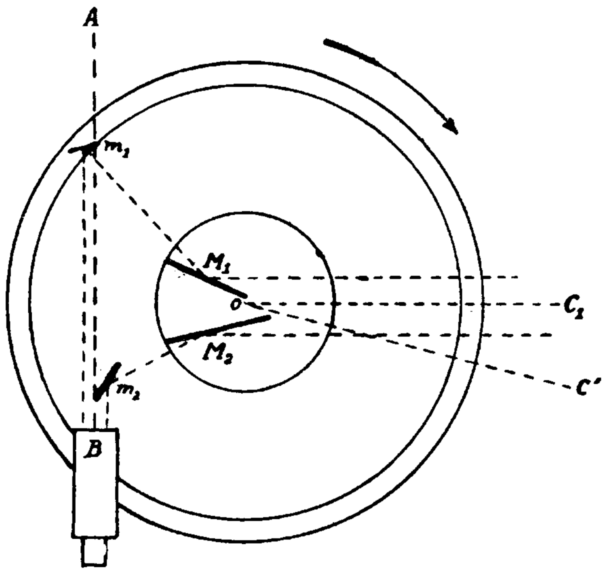

Fig. 1

If the pair of large mirrors be now turned in the direction of the arrow so as to cause the image of another point C' (to the right of C_1) given by the mirror system M_1 m_1 to coincide with the directly viewed point A, the other mirror system M_2 m_2 will give another image of C' which also will coincide with A. In fact, to make the image of C' coincide with A by means of the first mirrors M_1 m_1, the large mirror M_1 had to be turned through half the angle $C_1 OC'$, But the large mirror M_2 is turned simultaneously through the same angle and thus the pencil of light coming from C' which falls on M_2 will be reflected to m_2 and enter the telescope parallel to the direction AB.

If the pair of large mirrors be turned further in the same direction a point will be reached where M_1 m_1 will no longer give an image, but the other system M_2 m_2 will continue to give images of all points to the right of C', up to 180° from the direction BA.

Thus, from 0° to about 90° an image will be given by the M_1 m_1 system, thence to somewhat beyond 90° an image will be provided by both systems, and finally from there to 180° the M_2 m_2 system alone will give an image.

Hence, on the same side of the observer and with a continuous movement, all angles between 0° and 180° may be taken.

The two large mirrors are so placed that, when one of the small mirrors is not required to reflect, it is completely masked and does not reflect direct images which might lead to confusion.

The two small mirrors each occupy half of the field of the telescope, which is thus slightly reduced, though, whatever the angle observed, it is fully utilized.

Finally the amount of light reflected is at its maximum at 0° and 180° and gradually falls to the minimum at 90°. In this position the light reflected is equal to that obtained at the same angle with the ordinary reflecting circle.

4. Figs. 2 and 3 show the positions of the large mirrors when taking angles of 0° and 180° respectively.

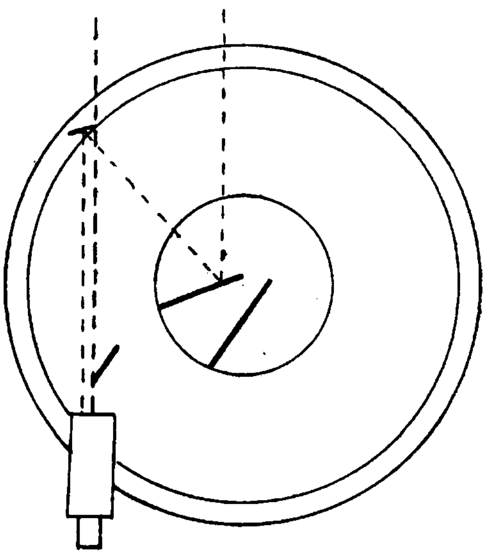

Fig. 2

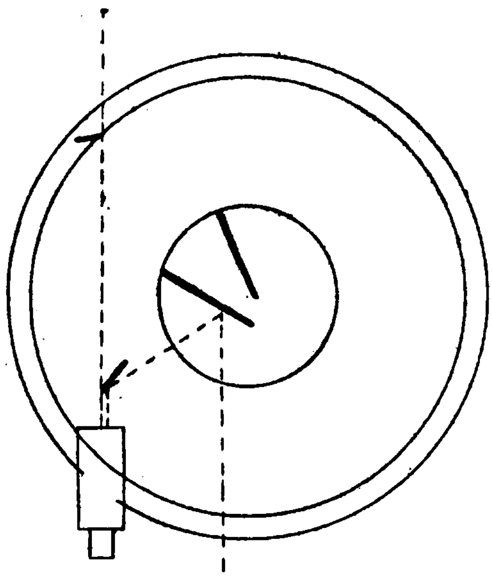

Fig. 3

The position of the index arm is such that it does not interfere with the view; it never lies in the direction of the incident ray (Fig. 4).

The graduation of the circle is identical with that of an ordinary circle and the vernier reads to 1'.

The two large mirrors are not adjustable for direction; there is, however, an adjustment for inclination with reference to the plane of the limb of the circle. No attempt has been made to construct them in one piece, for at sea they are easily spoilt and one should be able, should the necessity arise, to replace one of them without touching the other.

The small mirrors are adjustable both for inclination and direction. All such adjustments are made by means of screws which are identical with those of ordinary circles.

5. The adjustment of this circle is carried out as follows:

(1) First, the two large mirrors are set perpendicular to the plane of the limb as in an ordinary circle. Each is provided with an independent adjusting screw.

(2) The small mirror m_1 is adjusted, i. e. it is set parallel to the large mirror M_1 by the well-known method. Then the vernier is set to zero and the direction adjusting screw of m_1 is turned until the reflected image of some well-defined object coincides with the object when viewed directly.

(3) Select a point C (Fig. 1) at an angle of about 90° from the object viewed directly, A, so that its image appears in both small mirrors m_1 and m_2. The vernier is then set so that the image of C reflected by m_1 coincides with A, and the two adjusting screws of m_2 are turned until its image of C likewise coincides with A.

The circle is now adjusted.

6. This circle was invented and constructed in 1889 and is still used by the French Hydrographic Service.

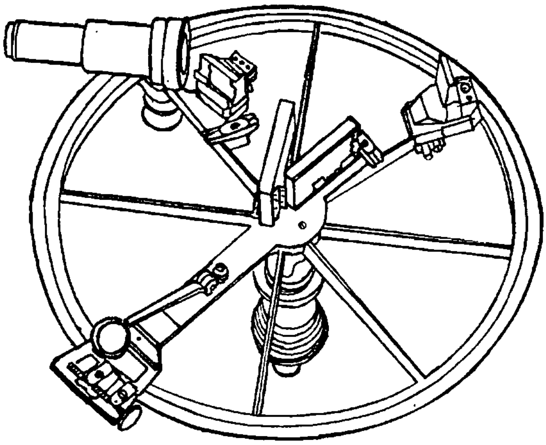

Fig. 4

THE RANGE OR DIRECTION INDICATOR

by

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The object of the indicator, so called for the want of a better name, is to enable the observer to determine when he is exactly on the line joining two points when he is between the points, and thus use these points as a «range» for his course with the same confidence as though both of the observed objects were ahead or astern, or to show when the angle between the objects measured at the position of the observer is 180°.

A and *B* are two sextant index mirrors secured firmly to and perpendicular to the wood or metal base *C*, so that the angle between their faces is 90° and their centres about 4 inches apart, just far enough so that a ray of light from the rear object will clear the observer's head and strike the mirror *B*. The mirror *A* should be secured permanently in place as shown in Fig. 1 at an angle of 45° with the line of sight, both *A* and *B* should be mounted on wood or metal supports; the one carrying *B* should have a central pin fitted with a thread and thumb and lock nuts on its lower end and pass with a neat fit through holes in brass plates secured to the upper and lower sides of the base *C*. Fit a short wooden handle to the under side of *C*. A sextant telescope may be fitted at *T* if desired.