THE TESTING AND ADJUSTMENT OF THE STATION-POINTER (PROTRACTOR)

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THE development of the last few decades in the direction of continuous augmentation of displacement and draft of ships (men-of-war as well as merchant vessels), has naturally resulted in greater accuracy being demanded in the methods and practice of nautical surveying. Thus, in order to ensure that the large and costly ships of the present day shall be able to reach harbour without risk of grounding it has been necessary, in many places, considerably to increase the scales of the charts in use. Consequently it is but natural that more is now expected of nautical surveyors as regards both the technique and the instruments employed by them, and that the desire should be felt for revised instructions for surveying, which shall embody an automatically checked surveying control. If that control is to be effective, it is clear that it must embrace the testing, and, if necessary, the adjustment of the nautical surveying instruments used. It cannot but be considered that a well-organized system of control is one of the essential prerequisites for ensuring satisfactory results in surveying.

The Station-Pointer.

During the last few years a number of experiments have been carried out at the Swedish Hydrographic Office with a view to arriving at a simple and reliable method for the testing and adjustment of this instrument. The directions given on pp. 31-34 of the "Handledning i Sjömätning" are, as matter of fact, unsatisfactory. To secure a simpler and above all a more reliable method is a crying need. In order to

arrive at such a method it became necessary to construct an apparatus, which should facilitate the testing as well as the adjustment, and make these reliable.

Before proceeding to give a brief description of the apparatus for testing and adjustment and of the method of use thereof, we venture to set out the requirements that the Swedish H. O. now insists upon with respect to a satisfactory station-pointer.

Requirements that a Station-Pointer must fulfil.

1. The graduation of the circle must be practically speaking absolutely free from errors in division. No error exceeding 2' will be tolerated.

2. The bevelled edges of the legs must be absolutely straight and true in all positions, *i. e.* with lengthening-pieces attached.

3. The two outer legs must be accurately centred, and the centre must lie in the line of prolongation of the bevelled edges of the legs and must coincide with the centre of the graduated circle.

4. The centre-pricker must be straight.

5. The centre-pricker must move perpendicularly to the plane of the circle and pass through its centre.

6. The bevelled edge of the inner leg, if produced inwards must pass through the centre of the circle and fall perpendicularly under the zero of the graduated circle.

7. The verniers of the outer legs must be so placed that their indices give the exact angles of setting.

The fulfilment of the above requirements can be tested and checked by means of the Swedish checking-apparatus.

As regards any adjustment that may be shown to be required, this can only be carried out by an instrument-maker if it is a question of insufficiency with respect to requirements 1 to 4. Any failure in connection with requirements 5 to 7 on the other hand, involves an adjustment of the station-pointer of more frequent occurence than can be carried out by the surveyor himself.

The Checking Apparatus. (*See* figs. 1 and 2).

Consists of a level plate of hard-rolled copper, 0.75 millimetre (·03 inch) thick, which is mounted on a board of cross-laid veneer 25 m/m (1 inch) thick. On the semi-circular copper plate a radius is drawn at every 10°. At its centre (B) and also at the two ends of the diameter (A and C) disks of diameter 30 millimetres (1.2 inches) are countersunk, into which may be

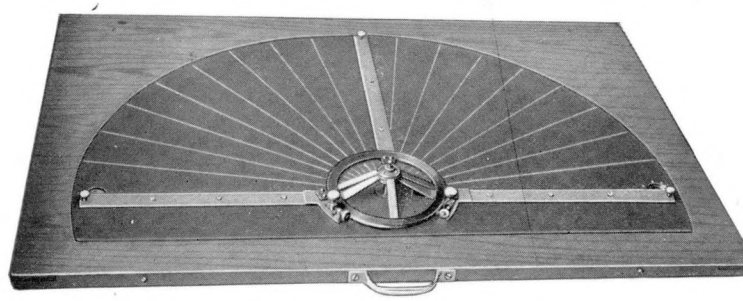

Fig. 2

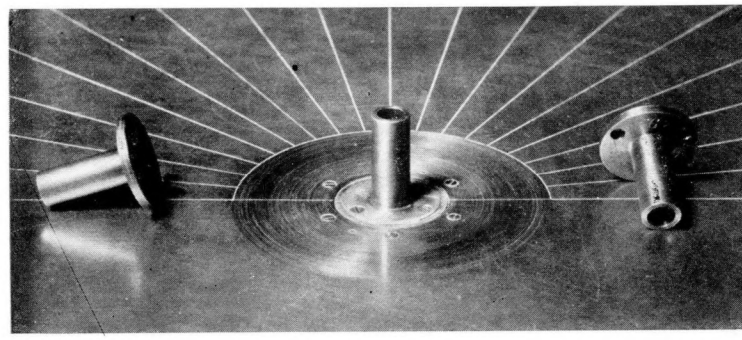

Fig. 3

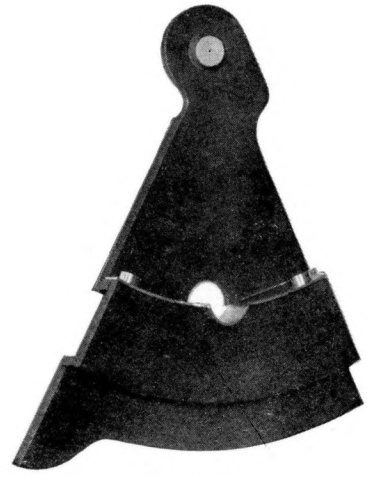

Fig. 5

screwed close-fitting Centre-Tubes. The centres of these three holes (A, B and C) are located on the diameter of the plate, B's position being such that it coincides exactly with the centre of the graduated circle.

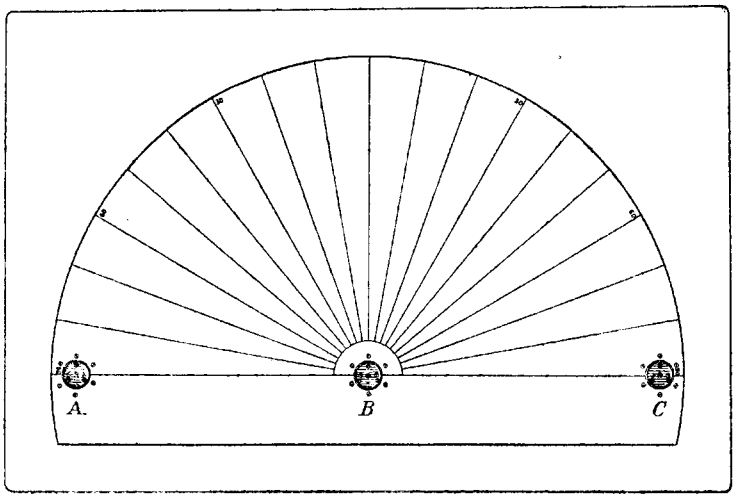

Fig. 1

THE "CENTRE-TUBE" (Fig. 3).

When the tube is fixed in position (at B) its axis is perpendicular to the plate and passes through the centre of the semi-circle. The thickness of the metal, and the inner diameter of the cylindrical journal of the tube are very carefully adjusted, so that the centre-tube exactly fills up the intervening space between the centre-pricker casing and the centre ring. (*See* fig. 4).

The testing and adjustment of a station-pointer of the type described below is carried out in the following manner and in the sequence stated.

THE ADJUSTEMENT OF THE NEEDLE-PRICKER.

A) Testing the straightness of the centre-pricker. (Requirement N° 4).

Place the station-pointer on a flat sheet of paper. Press the pricker down so that a minute perforation appears in the paper. Then turn the pricker through an angle of about 90° and press it down again. If the pricker is quite straight the two perforations will coincide.

B) Test for requirement N° 5.

The three small screws which fasten the needle-pricker casing to the instrument, are slightly slacked back and the station-pointer is laid on the plate with great care and in such a way that the lower part of the pricker-casing fits into the cylindrical journal of the centre-tube (B)

(*See* fig. 4). When the instrument has reached its appointed place on the plate, the three screws are tightened so that the casing is fixed in such a position that the centre-pricker, if straight, passes through the centre of the graduated circle of the plate and through that of the centre-tube. The axis of the pricker must however also pass through the centre of the *station-pointer.* In order to be able to verify that this

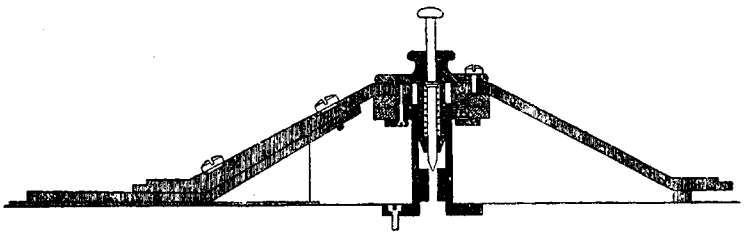

Fig. 4

is so at once, a casting is used that has been very accurately constructed in the form of a sector of a circle (*See* Fig. 5).

The station-pointer is lifted off the centre-tube and is placed in a suitable position on the plate of the checking-apparatus. The sector-casting is placed in position (*See* Fig. 6) and a test is made at at least two different positions on the graduated circle, about 90° from each other, to ascertain whether the pricker, on being pressed down exactly covers the centre of the sector which, owing to the construction of the casting, exactly coincides with the centre of the graduated circle of the station-pointer. If the point of the pricker does not coincide with the centre of the matrix, it is evident that the axis of the station-pointer does not pass through the centre of the arc. This error can manifestly only be removed by an instrument-maker and, once adjusted, will not again be introduced unless the instrument is subjected to undue usage.

THE INNER LEG (Requirement N° 6).

As already mentioned the bevelled edge must coincide exactly with the zero of the graduated circle, and, if produced inwards, must pass through the centre of the circle. The leg is placed with its bevelled edge exactly along the 0° radius and a weight is placed on its extreme end. Then it must be ascertained whether the bevelled edge lies exactly below the zero of the graduation (or arrow). To make this test reliable a "zero-indicator" is used (*See* Fig. 7), consisting of a piece of steel with a member set at an angle of 90°, and made so as to slide on the graduated arc. The indicator is placed on the arc and is moved so

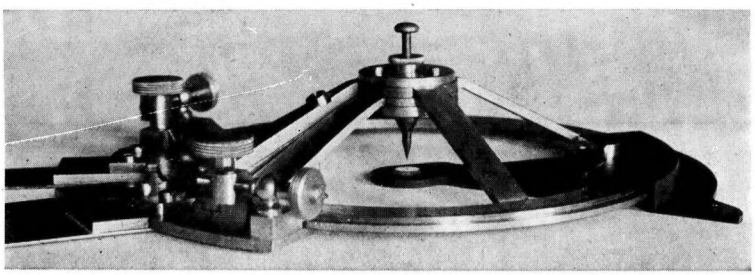

Fig. 6

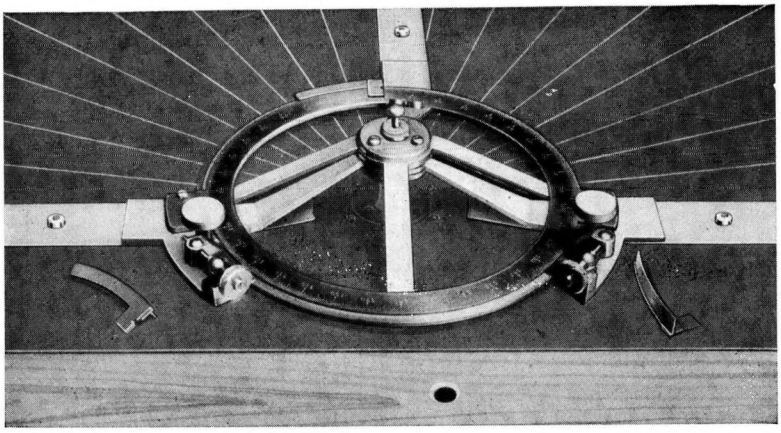

Fig. 7

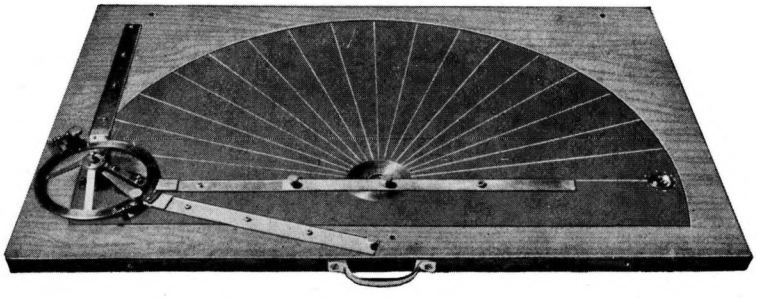

Fig. 8

far to the right that the lower edge of the vertical side is brought up against the bevelled edge of the inner leg. In this position the zero (edge) of the indicator must coincide with the zero of the graduated circle. Should this not be the case, the screws are loosened and the graduation-circle is turned slowly in the direction required, until the two zeros coincide.

Directly after this test an examination is made as to the coincidence of the bevelled edge with the 0° radius on its entire length. Should this not be the case, the inner end of the leg is moved in one direction or the other, until the whole leg is in the right position, whereupon the circle is again shifted until the zeros coincide. When these two requirements have been fulfilled the screws are carefully tightened to their full extent. In general it is unlikely that a satisfactory result will be obtained at once.

The Outer Legs (Requirements Nos 3 and 7).

While the weight is still on the inner leg along the 0° radius, the left (right) leg is moved to the 90° radius of the plate. When the bevelled edge has been accurately placed along the outer edge of the 90° radius care must be taken to see that the zero on the vernier coincides with the 90° line on the graduated circle of the instrument, and furthermore that the bevelled edge throughout its entire length exactly coincides with the 90° radius of the plate. Non-coincidence of the index of the vernier with the 90° line on the circle, if within 1°, can be at once corrected by shifting the vernier. If, on the other hand, the bevelled edge does not coincide with the 90° radius, the instrument-maker must be called to rectify the error.

Testing and Dividing of the Graduated Circle (Requirement N° 1).

When the vernier has been carefully adjusted and the leg is correct in every other respect, the testing of the division of the graduated circle can be made. The leg is shifted from the 90° radius to the 80° radius, where its outer end is made to lie exactly on the radius. The angle that the index of the vernier indicates on the arc is then read off. No

error exceeding 2' is permissible. The testing is carried out in the same manner from the 80° radius to the 70° radius and so on successively to 0°, the readings being recorded.

Simultaneously with this checking of the division, attention must be given as to whether the tightening-screw on the leg works satisfactorily in each position.

When the left (right) leg has been tested in the manner described above and the position of the vernier corrected, the checking of the correctness of the other leg is carried out if necessary.

Checking of the bevelled edges of the legs : to see that they are straight when the lengthening pieces have been screwed on. (Requirement N° 2).

The station-pointer is lifted off the centre-tube, which is then moved to position A (*See* Figs. 1 and 8) where it is fixed by the screws. The instrument is then placed on the plate, in such a position that its centre part falls into the centre-tube. The lengthening piece of the inner leg is screwed on and the leg is moved so that its bevelled edge exactly coincides with the further end of the diameter. An examination is then made to see whether the leg coincides throughout its length with the diameter on the plate. When the inner leg has been tested in this respect, the same procedure is carried out with the right leg, care being taken that all the positions, with the lengthening piece added, are tested. The corresponding test of the left leg is then carried out with the centre-tube in position C.

To some surveyors the description given above may perhaps seem to deal with a problem capable of being solved in a much simpler manner. We frankly admit that this was at one time our own opinion. While endeavouring, however, to evolve a satisfactory method which would win the approval of less experienced surveyors, we have found that the problem has taken on quite a different aspect.

The nautical surveyor's work is very full of small details of this character which are intimately correlated. If surveying work as a whole

is to be brought ever nearer to perfection, it will be necessary to devote close study to its various phases one by one, and to try to develop and improve them. With this object in view and hoping that it may be of value to the furtherance of our joint endeavour, it has seemed well worth while to publish an account in this Review of the results which we have obtained from experiments extending over several years.