CHAPTER XXVI

The Flying Boat Sextant

PRINCIPLES

The flying boat sextant is a marine type for measuring the altitude of the sun, etc., above the sea horizon. It has an index mirror, A (Fig. 37) and a horizon mirror, R. The index mirror can be rotated by moving the index arm, C, to which it is attached, and is adjusted so that rays from the star to be observed are reflected to the horizon mirror, R, and thence to the observer's eye, O. The horizon mirror is only half silvered, so that the observer can see the horizon, H, in the unsilvered half while viewing the star's image in the silvered half; he can then adjust the index mirror to make the star's image coincident with the line of the horizon. In Appendix A of Part II of this work, it was shown that if a ray of light is twice reflected the angle between the first and last directions of the ray is twice the angle between the mirrors. When the sextant is adjusted, the line of sight to the horizon, OH, is coincident with the last direction of the ray from the star. Con-

sequently the angle between the index and horizon mirrors will then be half the angle between the

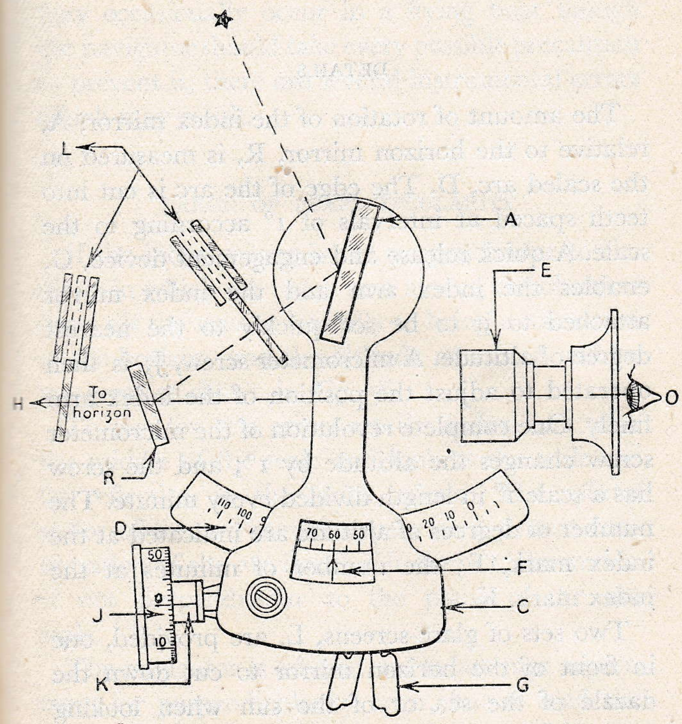

FIGURE 37

horizon and the first direction of the ray from the star, i.e. half the star's altitude above the sea horizon.

The angle between the two mirrors is measured at a scale, D, but the scale readings are doubled and therefore record the star's altitude instead of the angle between the two mirrors.

DETAILS

The amount of rotation of the index mirror, A, relative to the horizon mirror, R, is measured on the scaled arc, D. The edge of the arc is cut into teeth spaced at intervals of 1° according to the scale. A quick release and engagement device, G, enables the index arm and the index mirror attached to it to be set quickly to the nearest degree of altitude. A micrometer screw, J, is then operated to adjust the position of the index arm finely. One complete revolution of the micrometer screw changes the altitude by 1°; and the screw has a scale 1° in length divided every minute. The number of degrees of altitude are indicated at the index mark, F; the number of minutes at the index mark, K.

Two sets of glare-screens, L, are provided, one in front of the horizon mirror to cut down the dazzle of the sea or of the sun when looking directly at it, the other between the two mirrors to cut down the glare of the sun-image.

A telescope E, power 2, is fitted in front of the observer's eye.

POSSIBLE SEXTANT ERRORS

If the sextant is knocked, an accident which may occasionally occur in a flying boat though the navigator should take every possible precaution to prevent it, there are several instrumental errors which may result.

ERROR OF PERPENDICULARITY

If the index mirror is not perpendicular to the plane in which the index arm moves, the observer must tilt the sextant laterally to bring a star down to the horizon, and the altitude measured will be too great as shown in Fig. 36.

To test for this error, set the index arm near the middle of the scale and look at the scale arc by reflection in the index mirror. The *reflected* sector of the arc should appear as a perfect continuation of the arc itself; if it doesn't, the mirror is not perpendicular to the plane of the arc scale.

The navigator is advised not to attempt adjustment for perpendicularity error, but to send the sextant to the makers. If this is impossible, the necessary adjustment to the index mirror *can* be made by turning a screw at the back of the mirror.

SIDE ERROR

This is a perpendicularity error in the horizon mirror. To test for it, set the sextant to true zero, i.e. so that a star and its image are level when the sextant is held upright. If there is a lateral interval between the star and its image, i.e. unless they are both in the same vertical plane, the horizon mirror has side error. The mirror can be trued up by adjustment of a screw at the back. A slight side error is negligible, or even an advantage.

INDEX ERROR

Index error is due to the mirrors not being parallel when the instrument is set to zero on the scale. To test for it set the sextant to zero and observe the sea horizon or a star. If the star and its image coincide or the horizon and its image make a straight line in the horizon mirror, there is no index error. If they don't coincide make them do so; the scale reading is then the amount of the index error. If the scale reading is $-5'$ (i.e. $5'$ "off the arc") a correction of $+5'$ must be made to all sextant readings. When testing for index error never observe any object nearer than the sea horizon, otherwise parallax error may be present.

Another method of observing index error is to read the scale when the upper limb of the image of a weak sun is brought into contact with the lower limb of the sun itself; then read the scale when the lower limb of the sun's image is brought into contact with the upper limb of the sun itself; take the mean of the two readings, the difference between it and zero is the index error.

The horizon mirror can be reset to correct for index error by adjustment of one of the two screws at the back of the mirror; the screw to use is the one which will rotate the mirror in the same plane as that in which the index mirror rotates.

The navigator, however, is strongly advised never to make sextant adjustments for small errors if the sextant reading can be corrected for them. Adjustment of screws may loosen them sufficiently for vibration to change their setting unknown to the user. In any case it is difficult to eliminate index error completely when "in the field," and there will still be some correction to make afterwards even if adjustment is attempted.

COLLIMATION ERROR

The line of sight through the telescope should be parallel with the plane of the sextant frame. To test for it bring the image of one star into coincidence with a second star about 90° in angular distance away from it in the heavens. Move the sextant about so that the observed stars are seen through different parts of the telescope's field. There is no collimation error if the star and star-image remain in coincidence. This is an unlikely error and, even if present, is scarcely worth worrying about unless large altitudes are being observed. Adjustment is made by altering the setting of the telescope collar.

DEFECTIVE SHADES

A glare-screen may be bent by pressure from the metal frame gripping it. If the two faces are not parallel, rays passing through will be deviated from their true path. The weakest screen can be tested by first observing a planet without the screen, then with; the two readings should agree (if allowance is made for any change of altitude during the interval). No. 2 shade can be tested by observing first a weak sun with only No. 1 shade, then with No. 2 added to No. 1, and so on. The horizon screens can be tested in the same way by bringing a planet and its image into coincidence and observing whether they are still in coincidence when a horizon screen is interposed.

CHAPTER XXVII

Running Down a Position-Line

OBSERVATIONS RESTRICTED BY DAYLIGHT

For most of the time in daylight only the sun can be observed. Occasionally the sun and a planet are both visible and on a few days in the month the sun and the moon can be observed together during part of the day. Actually the moon is "up" during nearly half the month's daylight, but for several days on each side of "new moon," it is too close to the sun for its position-line to make a worthwhile cut with the sun's, and these few days account for the greater portion of its daylight appearance.

In short, for most of the time in daylight only one heavenly body is available for observation. What effect does this have on daylight astro-navigation?

WHEN ONLY THE SUN CAN BE OBSERVED

If only one body can be observed, only one position-line can be determined at each obser-