Marine Sextant and Bearing instruments

Marine sextant

- An optical instrument used for measuring angles between any two points horizontally and vertically.
- The first instrument developed for measuring the altitude of celestial body “CROSS-STAFF”.
- In 1590, the ‘BACKSTAFF’ or ‘Davis’s quadrant’ was invented by John Davis , which was the advanced stage of cross – staff.
- Sextant derives its name form the fact that its arc is approximately one-sixth of a circle, he cause of its optical principle it can measure angles upto to about 120^{o} or twice the value of the arc itself.

Working principle

- When a ray of light suffers reflection by two mirrors in a same plane, the angle between the original incident ray and the final emergent ray is twice the angle between the mirrors.
- The optics of sextant are based on the system of double reflection, in that the image of the body is reflected from the upper or index mirror to the lower or horizon mirror and then into the field of view of sextant telescope, where it is brought into co-incidence with the sea horizon which is seen through the clear portion of the horizon mirror.

Important Parts of a sextant

- **Main frame** on which the other parts are mounted.
- **Limb:** the lower part of the frame and carries the arc graduated in degrees.
- **Index arm:** Used to indicate the readings in degrees on the arc.
- **Micrometer drum:** Used to make find adjustment of the index arm.
- **Index mirror :** mounted at the upper end of the index arm. It is perpendicular to the plane of the instrument.

- **Horizon glass :** Also perpendicular to the plane, when the index arm is set to exactly zero degree, the horizon glass is parallel to the index mirror. The horizon glass is parallel to the index mirror. The horizon glass is divided into two halves vertically.
- **Telescope :** Mounted parallel to the plane.
- **8) Index shade glass :** These glasses are used to dim the bright celestial bodies.

- **Error of sextant**
- There are two types of errors.
- 1) Adjustable errors.
- 2) Non-adjustable errors.
- Adjustable errors are of four types.
- **i) Error of perpendicularity:**
- If the index mirror is not perpendicular to the plane of sextant the error is found and it is called error of perpendicularity.
- **Side error**
- If the horizon glass is not perpendicular to the plan of the sextant, this error is formed.
- **Index error**
- When the index arm is at zero mark, the index mirror and horizon glass should be parallel to each other. If they are not parallel, the error is found and it is called index error.

- **Collimation error:**
- **When the telescope is screwed in place, its longitudinal axis should be parallel to the plane of the sextant. If not, the error is found called Collimation error.**
- **Non-adjustable errors**
- The index bar should be fitted at the geometrical centre of the circle of which the arc follows part of the circumference. Otherwise, the error is formed called **centering error**.
- If the two sides of the coloured shades are not parallel, the **shade error** will be formed. If the surface of the mirror is not exactly eve, the **prismatic error** will be formed.
- If the graduation on the arc is not correctly made, the **graduation error** is formed.
- The sextant is used for measuring the angle at the observer's eye between.
- (i) The top of some object such as lighthouse, tower etc. and the waterline (horizon) when the sextant is held vertically. This is called Vertical Sextant Angle (VSA).
- (ii) Two objects on different bearings on shore with the sextant held horizontally is called Horizontal Sextant Angle (HAS).
- (iii) A celestial object and the horizon.

- **Sextant altitude**
- The following formula are used to calculate the distance between the vessel, from which the sextant angle is taken and the structure (light house/church/chimney/ any structure on shore with known height),
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$$\text{Distance in nautical miles} = \frac{\text{Height of the object in meters}}{1852 \times \tan \text{VSA}}$$

$$\text{Distance in nautical miles} = \frac{\text{Height of the object in feet}}{6080 \times \tan \text{VSA}}$$