on the same principle, and had communicated an account of it to the society in 1699, but on search being made in the minutes it was only found that Newton had shown a new instrument “ for observing the moon and stars for the longitude at sea, being the old instrument mended of some faults,” but nothing was found in the minutes concerning the principle of the construction. Halley had evidently only a dim recollection of Newton’s plan, and at a meeting of the Royal Society on December 16, 1731, he declared himself satisfied that Hadley’s idea was different from Newton’s. The new instrument was tried in August 1732 on board the “ Chatham ” yacht by order of the Admiralty, and was found satisfactory, but otherwise it does not seem to have superseded the older instruments for at least twenty years. Hadley’s instrument could only measure angles up to 90°; but in 1757 Captain Campbell of the navy, one of the first to use it assiduously, proposed to enlarge it so as to measure angles up to 120°, in which form it is now generally employed.

Independently of Hadley and Newton the sextant was invented by Thomas Godfrey (1704-1749), a poor glazier in Philadelphia. In May 1732 James Logan wrote to Halley that Godfrey had about eighteen months previously showed him a common sea quadrant “to which he had fitted two pieces of looking-glass in such a manner as brought two stars at almost any distance to coincide.” The letter gave a full description of the instrument; the principle was the same as that of Hadley’s first octant, which had the telescope along a radius. At the meeting of the Royal Society on January 31, 1734, two affidavits sworn before the mayor of Philadelphia were read, proving that Godfrey’s quadrant was made about November 1730, that on November 28 it was brought by G. Stewart, mate, on board a sloop, the “ Truman,” John Cox, master, bound for Jamaica, and that in August 1731 it was used by the same persons on a voyage to Newfoundland. The statement that a brother of Godfrey, a captain in the West India trade, sold the quadrant at Jamaica to a Captain or Lieutenant Hadley of the British navy, who brought it to London to his brother, an instrument maker in the Strand, is devoid of foundation.@@1

The figure shows the construction of the sextant. ABC is a light framework of brass in the shape of a sector of 60°, the limb AB having a graduated arc of silver (sometimes of gold or platinum) inlaid. It is held in the hand by a small handle at the back, either vertically to measure the altitude of an object, or in the plane passing through two objects the angular distance of which is to be found. It may also be mounted on a stand. CD is a radius movable round C, where a small plane mirror *of* silvered plate-glass is fixed perpendicular to the plane of the sextant and in the line CD. At D is a vernier read through a microscope, also a clamp and a tangent screw for giving the arm CD a slow motion. At E is another mirror “ the horizon glass,” also perpendicular to the plane of the sextant and parallel to CB. F is a small telescope fixed across CB, parallel to the plane CAB and pointed to the mirror E. As only the lower half of E is silvered, the observer can see the horizon in the telescope through the unsilvered half, while the light from the sun or a star S may be reflected from the “ index glass" C to the silvered half of E and thence through F to the observer’s eye. If CD has been moved so as to make the image of a star or of the limb of the sun coincide with that of the horizon, it is seen that the angle SCH (the altitude of the star or solar limb) equals twice the angle BCD. The limb AB is graduated so as to avoid the necessity of doubling the measured angle, a space marked as a

degree on the limb being in reality only 30'. The vernier preferably of the extended type, *i.e.* a vernier whose divisions are twice the distance apart of those on the *arc,* should point to 0° 0' 0" when the two mirrors are parallel, or in other words, when the direct and reflected images of a distant object coincide.

The sextant was formerly much used on land for determining latitudes in which case an artificial horizon (see below) is required, but it has now been largely superseded by the portable altazimuth or theodolite, while at sea it continues to be indispensable.

The telescopes employed in sextants are of two kinds : the directs for the more ordinary observations; and the inverting, for astro­nomical work, one of the eyepieces of which should be of high magnifying power, not less than 15 diameters. Each eyepiece has two pairs of wires, each pair perpendicular to the other, and dividing the field of view into nine divisions, of which the central is square. Contacts should be made as nearly as possible in the centre of this square. It is convenient if the telescope is fitted with an interrupted thread to screw into the collar of the up and down piece. Both mirrors are supplied with coloured shades of different degrees of shade, and may be used either singly or combined for sea observa­tions; they are subject to errors of refraction, due to non-parallelism of the sides of the glass. Coloured eyepieces of neutral glass of different intensities are fitted to slip on and off the conically ground surface of the eyepieces of the telescope; they are used for index error and for observations in the artificial horizon. Introducing no refraction error, they also ensure the suns being of the same brilliancy; a very important point. The up and down piece, when adjusted to equalize the suns, will bring the axis of the telescope nearly exactly in line with the edge of the silvered surface of the horizon glass, which is the best position for observing, and from this it must never be moved until the equal altitude or other observations are complete.

For observations on shore the sextant should be mounted on a stand. In an improved form of stand, the bearing which carries the sextant is square, and the whole bearing revolving on a centre is controlled by a clamp and tangent screw. The counterpoise should exactly balance the sextant, and they may be fitted to allow for adjustment. A small spirit-level fixed on one of the arms of the sextant stand, and another level pivoting round the pillar on the index bar of the sextant carrying the microscope, working in a plane parallel to that of the instrument, and fixed by means of a set screw, are of use in placing the sextant exactly in the required position when observing faint stars. With the telescope pointing to the centre of the artificial horizon, the direct and reflected images of the sun at any convenient altitude are made to coincide. The levels are then adjusted and permanently fixed by their set screws. To observe a faint star, it is only necessary to set its double altitude on the sextant, turn the instrument and the stand to bring the bubbles of their respective levels in the centre of their runs, and move the stand until the telescope points to the centre of the artificial horizon and in the direction of the star, when the direct and reflected images will be seen in the field. A small electric light fitted on the arm carrying the microscope, and worked by a dry battery, enables the sextant to be read at night.

The artificial horizon in common use consists of a glass trough containing mercury and protected from the wind by a glass roof. The glass in the roof should be of the best quality, and the faces of each pane of the trough accurately parallel. A new form of horizon consists of a shallow rectangular trough of metal gilt. After cleansing the surface by wetting it with a few drops of dilute sulphuric acid, a drop of mercury is rubbed on until the whole surface is bright, when a very small quantity of amalgamated mercury added will form an even horizontal surface. The dross is wiped off with a broad camel-hair brush. In this shallow trough waves are killed almost instantaneously.

The horizon is placed upon a stand, consisting of two iron plates, the upper resting on the lower, supported by three long large-headed screws, by means of which it can be levelled. If the stand is raised off the ground a foot or so, on a firm foundation, thus bringing the artificial horizon closer to the telescope, faint stars are more easily observed, and the movement of the sextant necessary to keep the star in the field, owing to its motion in the heavens, will be lessened. A lantern placed on the ground behind, or a little on one side of, the observer, and faintly showing on the artificial horizon, will suffi­ciently illuminate the wires of the telescope on a dark night.

*Adjustments.—*The planes of both the index glass and the horizon glass should be perpendicular to the plane of the instrument, and they should also be parallel to one another when the vernier is set to zero. The line of collimation of the telescope must be parallel to the plane of the sextant. This adjustment, though less liable to alter than either of the others, should be examined from time to time as follows:—With the sextant mounted on a stand, move the index so as to separate the direct and reflected images of a star by a distance nearly equal to the length of the parallel wires of the telescope, and turn the eyepiece until, the direct image of the star coinciding with one extremity of the wire, the reflected image coincides with the other extremity; the wires will then be parallel to the plane of the sextant. Select two bright stars and make a coincidence of the reflected and direct images on the middle of one wire, and then on the middle of the other. If the two readings agree, the

@@@l See Professor Rigaud, *Naut. Mag.* vol. ii. No. 21*.* John Hadley was a country gentleman of independent means, and the fact that he was the first to bring the construction of reflecting telescopes to any perfection has made many authors believe that he was a professional instrument maker. His brother George, who assisted him, was a barrister.