A Mariner's 'equinoctial dial' of 1634?

Gordon E. Taylor

RECENTLY the author was asked to suggest how an old (Scottish?) sun-dial, inscribed on a slate slab about 50 cm across and 3 cm thick, could be put into working order and set up correctly to tell the time. Upon examination the dial was found to be of considerable historic interest. Although it was quite a well-known type of dial—an equatorial—the furniture and inscriptions suggested a definite connection with the sea. Moreover, no other identical instrument is known to exist; possibly the publication of this note may help to bring other specimens to light. For this reason it is felt that a description of the various features of this multi-purpose dial will be of some interest.

Both surfaces of the dial are shown in the accompanying photographs. For clarity, a fine talcum powder was sprinkled on the dial to fill all the incised markings which would otherwise be invisible. Unfortunately the gnomon is missing. This gnomon would have passed vertically through the dial extending on either side for not less than 10 cm. Probably two circular discs with pointers were mounted centrally on the upper surface, with one of these discs bearing an arm with the 'dioptera', but unfortunately these items are also missing. The discs would have been capable of rotating around the gnomon. It would appear that some modifications became necessary after its construction as the four holes around the inner circle have spoilt the lettering. Indeed any obstruction above the surface at these points would have prohibited the use of the instrument as an astrolabe and also prevented its use as a volvelle.

The furniture on the dial will be described in order, working from the outside to the centre.

Upper surface (full circle).

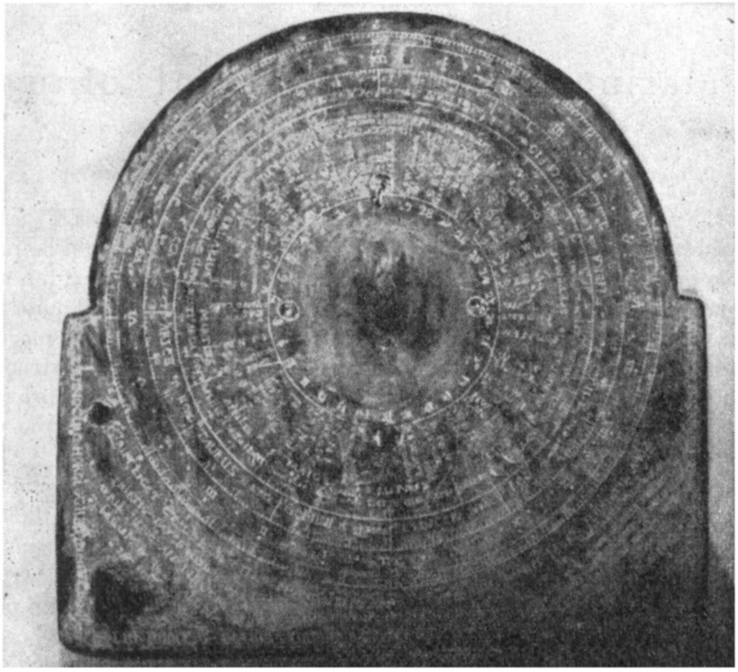
The outermost ring of figures gives the hours 1–12 (twice) in arabic numerals.

Immediately inside these figures is a circle inscribed in degrees, starting at 0° due E. and W. and increasing to 90° due N. and S.

Then there is a ring of 24 large dots to give the time in hours, marked I–XII (twice) in Roman numerals. Note that smaller dots indicate the half-hours and that even smaller dots mark the quarter hours. The time is indicated by the centre of the shadow of the gnomon which will fall on the upper surface of the dial in spring and summer and on the lower surface in autumn and winter.

The next inner circle is divided into the twelve zodiacal signs, each of 30° in extent. The numbers and names of the signs are given, also their symbols. That part of the body affected by the sign (according to astrological belief) is also given.[1] Due to an error of construction, the sign of Pisces is shorter in length than the others. This has led to a displacement of the beginning of the sign Aries so that the Sun enters Aries on the wrong date (March 8) according to the dates on the next circle inside. In 1634 the date of the equinox was March 10 in the Julian calendar which was then still in use in the British Isles.

Inside the circle of the zodiac is a circle of the days of the year (365 days). Knowing the day of the year, one can read off the position of the Sun in the zodiac



Upper surface

on that date. The numbers and names of the months, with the number of days at 10, 20 and 'last day of month', are given, and also other wording in Latin. Unfortunately there are 31 days in November on the upper side! Inscribing a dial on slate does not permit the correction of errors at a later date! Also, Feburary is given 29 days but 28 is written by the last one.

In the wide gap before the inner circle are written the 32 points of the compass. Against these points are written the names of various ports. It was the custom, for navigational purposes, to give the 'establishment' of the port as a compass point (which corresponded to a time on the outer circle). The establishment was the interval of time between the passage of the Moon over the meridian of the port and the high tide at that port. Strictly speaking, each port would have two compass points, 180° apart, giving high tides 12 hours apart. Thus the high tide at 'Needles of Wight' occurs when the Moon is 'SE. by S.' Following a radial line outwards on the dial a time of 10^h is given, indicating that high tides occur 10^h after the meridian passage of the Moon and also $12-10=2$ hours before. Although the list of ports shows a strong Scottish bias, it should be remarked that ports as far away as Antwerp and Dunkirk are also given.

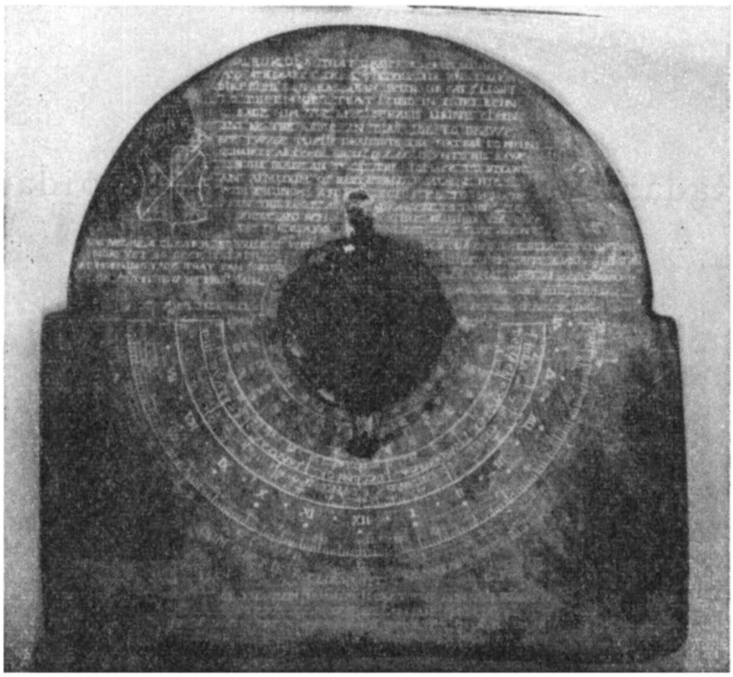
The innermost circle of figures go from 1–30 in an anti-clockwise direction and were used to indicate the age of the Moon (30 being an approximation to 29^d53—the synodic period). These figures could have been used with two inner revolving discs and pointers to work out the position of the Moon in the zodiac and determine the elongation from the Sun. Such an instrument is called a volvelle. The difference in transit times between the Sun and Moon so obtained would have enabled the dial to be used as a moondial and it would also have enabled tidal predictions to have been made in cloudy weather.

Lower surface (half circle).

The outermost half-ring of figures gives the hours 1–12 in arabic numerals.

Immediately inside these figures is a semi-circle inscribed in degrees, starting at 0° due E. and W. and increasing to 90° due S.

Then there is a half ring of 13 large dots to give the time in hours, marked VI–XII–VI in Roman numerals. Smaller dots indicate the half-hours. The quarter hours are not indicated on this surface.



Lower surface

The next inner semi-circle shows the zodiacal signs, each of 30° in extent, through which the Sun passes between September 10 and March 10. The numbers and names of the signs are given, also their symbols. The names of the parts of the body are omitted on this surface.

Inside the semi-circle of zodiacal signs is another semi-circle, giving the days of the year from September 10 to March 10.

In the wide gap before the inner circle are given the points of the compass E → S → W.

The innermost circle of figures (Arabic) go from 5 to 25 in a clockwise direction to indicate the age of the Moon.

A translation of part of the Latin inscription states that 'This universal equinoctial time-piece, containing the course of the sun and moon and sea, as well as the dioptera of an astrolabe, was engraved by John Bonar, Master of Chronology'. The course of the Sun and Moon and sea clearly suggest a nautical connection—was it made for a retired sea-captain's garden or was it erected on a jetty at a port? However, the mention of 'the dioptera of an astrolabe',

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together with the divided circle on the dial, suggests that the instrument might have been designed for use at sea.

REFERENCE

1 See, for example, the title page of Digges's *A Prognostication everlastinge* . . . (1576), as reproduced in *The Art of Navigation in England* . . ., by D. W. Waters, Hollis & Carter, 1958.

A Radar Display for Collision Avoidance

G. Wikkenhauser

(*Kelvin Hughes*)

In the October issue of the *Journal* (19, 529), Commander Clissold puts forward a type of radar display which might be useful for collision avoidance, as it intends to show the aspect of the ship representing the danger. To achieve this a long afterglow screen would be used and the display would be oriented head-up, i.e. ship's head at the top of the picture to correspond as closely as possible with a possible visible situation. An electronic cursor, bearing line, would indicate a danger of collision if on constant bearing. This type of display is said to show tracks true relative to own ship's course.

Apart from the fact that 30 seconds afterglow, decaying exponentially as an excited phosphor screen would, might be too short for showing up tracks efficiently, there are some other difficulties as well with such a display. Obviously aspects of target ship would not be shown but implied only by the afterglow track. Furthermore, a display of this kind would be a true-motion type display not necessarily north stabilized but nevertheless showing all motion of other ships in true, if own ship's speed is compensated for in displacing the origin of the radial scan. The difficulty will arise if own ship changes heading and unless this heading change is also compensated for, like in a north-up stabilized true-motion display, smearing of all echoes will occur. A heading change of own ship, therefore, will produce additional apparent tracks of other ships and the apparent displacement of fixed targets.

A north-up stabilized true-motion display, as it is usually known, would provide all the necessary information except the smearing of the electronic bearing line due to the long afterglow phosphor. What is really wanted is that some information should show remanence, i.e. show up the tracks of the target ships. On the other hand, some others, like bearing line, should not have an afterglow at all, or very short only. Technically, this cannot be achieved with a single display and several suggestions have been mentioned in the *Journal* where instantaneous recording of radar signals is divorced from a stored display. I am referring to the scan conversion technique described by B. W. Manley in the *Journal* (15, 172),