A UNIVERSAL DIAL BY G. WRIGHT

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The dial described in this article is an equinoctial dial of unusual appearance (Fig. 1). It was invented and first described by G. Wright in his booklet of 1781 entitled *The Description and Use of a New Universal Dial, or, Portable Equatorial Instrument*.

The model shown in Fig. 2 was made for him by Benjamin Martin of London around 1790. It stands around 12″ high, (the exact height depending on the settings of the four levelling screws labelled B). Figs 3–8 illustrate various parts of this model.

Its inventor, G. Wright, is believed to have been Gabriel Wright. The booklet describing the dial says that it is "Printed for the AUTHOR, and sold by Messrs. GREGORY and WRIGHT, Opticians, No. 148, Leadenhall-Street. MDCCLXXXI".

The dial's three main uses given by Wright in his booklet are:

> *First, to find the Latitude of any place.*
> *The Latitude of the place being known; to find Time, by the Sun and Stars with the Dial.*
> *To find the sun's Azimuth, by the Dial.*

Initially he gives the most important details which explain how to set up the dial before use. Refer to the letters that are marked on Fig. 1.

It is essential that the dial is set up perfectly level, which is done by the four adjusting screw legs, B. These are set so

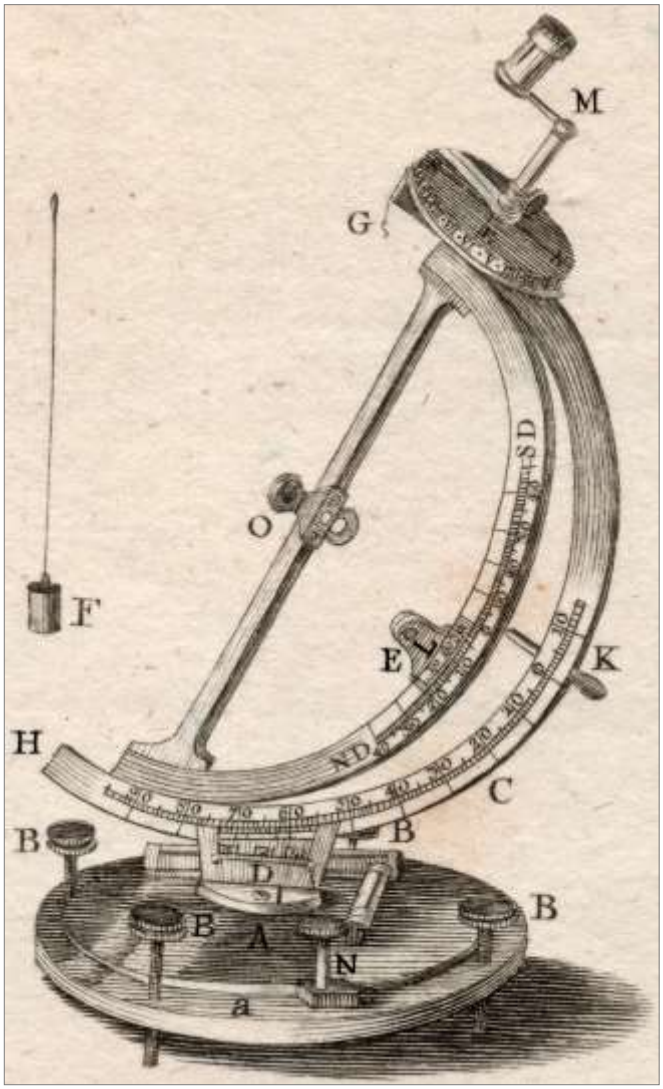

Fig. 1. 'A New Universal Dial for all Latitudes.' [1]

Fig. 2. Wright's dial as made by Benjamin Martin.

Fig. 3. View from above showing the spirit levels on the rotating base.

Fig. 4. The scale on top for reading the hours.

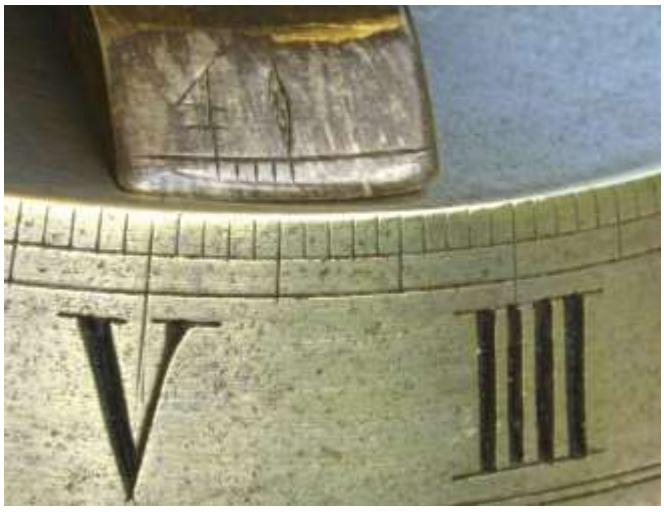

Fig. 5. The vernier scale for the hour readout, divided for every four minutes or one degree.

Fig. 6. The vernier scale on the support D, here set to 52°.

that the air bubbles in the glass tubes (spirit levels) are at their centres (Fig. 3). The dial assembly is then rotated by releasing the clamping screw N so that the horizontal plate, A, which supports the whole assembly, can rotate on top of the main base. If, in rotating the dial, any of the bubbles are then not centred, there are small adjusting screws on each tube which will allow them to be set correctly. It seems to be quite a difficult process as this will need repeating several times, certainly during its first set up, until the whole assembly is correctly set.

The next adjustment is to set the latitude arc, C, in its support, D. At first it is set to exactly 90° and is tightened by a screw at the back (not visible in the sketch). Then a plumb line is suspended from the hook at the top, G, and is checked against a line inscribed on the lower end of the latitude arc at H. This is a double check to make sure that the dial assembly is absolutely level. The plate, A, is again rotated and any errors with the bubble levels may be corrected.

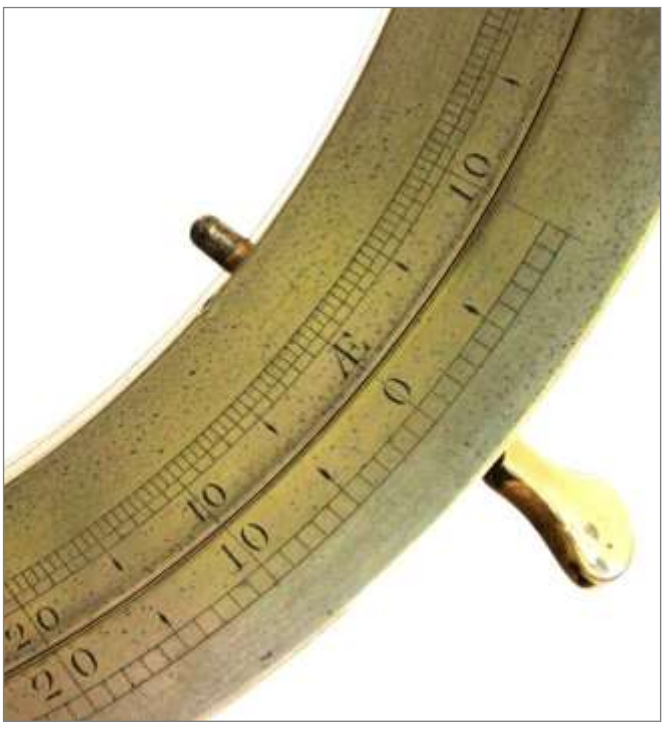

Fig. 7. The pin, K, for holding the two scales together.

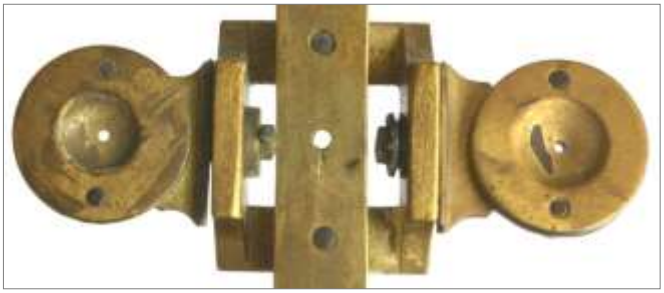

Fig. 8. The sights fitted to the central bar.

To Find the Latitude

Both arcs are now brought together and are held in this position by the pin K. The piece L (next to E) is then set to the sun's declination for the day, this being found from published tables. Then, about 15 to 20 minutes before noon get the sun's light to pass through the aperture at O and adjust the latitude arc until the spot of light falls upon the centre point of L. Then, looking carefully, watch as the sun gets slightly higher and eventually stops climbing and set the clamp, reading off the latitude from the 'nonius' or vernier scale at D. If the sun is low, Wright recommends that a correction is made for the refraction of the atmosphere. To do this, at the back of his booklet, he gives "*A* TABLE *of* REFRACTIONS *to be subtracted from the Apparent Altitudes, and added to the Zenith Distances*". The table starts at ½°, then increments in individual degrees from 1° to 90°, showing the refraction errors from 27′ at ½°, 24′ 29″ at 1° and 5′ 15″ at 10° until 90° where the error is zero.

To Find the Time

Firstly, find the sun's declination for the day "From the Nautical, or any other Ephemeris, or book that hath a correct table of the Sun's declination". Set this declination for L on scale E. Then set the latitude on the outer ring at D. On the top at M, there is a magnifying glass (but not on the Benjamin Martin model shown), to allow accuracy in setting the pointer exactly at XII against its vernier scale. Then the brass pin, K, is removed and the clamping screw at N is loosened. The dial is then rotated and the declination arc is swung until the spot of sunlight falls perfectly on L. The time can then be read from the top dial, the short vernier scale allowing it to be read to an accuracy of one minute of time. The latitude arc, C, should now be in a position which is perfectly North–South. If the sun is too weak to throw a shadow, it is also possible to sight it through the apertures from L to O to get the time, using a filter to protect the eye, if necessary.

To Find the Sun's Altitude and Azimuth

The sun's altitude may be found with the two arcs pinned together. The screw, N, is loosened and the whole assembly is rotated until the spot of light falls on a line marked vertically inside E. The part L may then be moved up or down until the spot of light is at its centre. The altitude may now be found by taking the latitude figure at D and subtracting this from 90° to give the colatitude. Finally add the declination indicated on scale E to the colatitude. This gives the altitude but note that the indicated declination is negative if the altitude is less than the colatitude. If a wider swing is required, such as when finding the altitude of a star, set L at 0° declination and move the whole assembly. Note the figure on the vernier scale at D and subtract that from 90°. The declination scale is larger than usual, being ±45°.

For the sun's azimuth, set both rings together using the pin at K and then set the latitude arc, C, in its support, D, so that it is exactly 90°. Set the top dial to XII. Remove the pin and then swing the arc, E, until the sun's spot of light falls onto the line marked vertically inside E. The azimuth may be found from the time scale, allowing 15° for each hour.

At the back of his booklet he also gives '*A* TABLE *of the Equation of Time*' for every day of the year in minutes and seconds.

The model in the photographs was made by Benjamin Martin who followed the design by Wright quite closely, with just a few small differences. Unfortunately it is now missing the two sights, L, that go on the declination scale. These are necessary for setting the declination and may be used in reverse for sighting stars etc. However, the small hole in the central bar is used for most of the measurements. This is countersunk at the back so that the rays of light are not restricted when the sun is higher or lower, such as during the periods of winter and summer. Note also that the two sights at O may be made to swivel vertically in the case where the sun (or a star) is at some distance above or below the ecliptic.

One particular difficulty is the setting of the four levelling screws. Three screws would make things easier but four, when correctly set, give a more stable instrument. Therefore, the best way to set these is to turn the spirit levels on plate A in line with these screws, then shorten one of the screws a little and adjust the level on the remaining three, using a hand to support the instrument, if necessary, where the foot has been shortened. After levelling has been achieved, the fourth foot can then be returned to be in contact with the mounting surface.

In all, this is a very precise instrument and may be used for the important tasks noted.

NOTE

1. The illustration used is not that used in Wright's booklet but is from an almost identical copy taken from an unidentified old print about dialling.

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