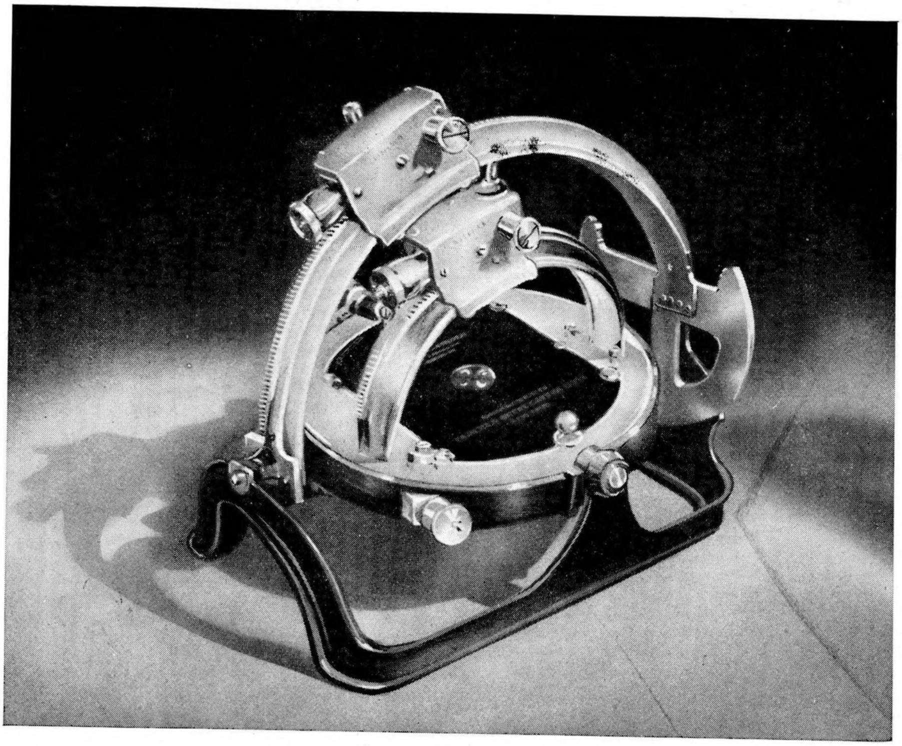


The Hagner Position Finder.

Machine Hagner pour déterminer le Point.

THE HAGNER POSITION FINDER

ITS CONSTRUCTION, USE AND OPERATION.

(Reproduced from pamphlet N° A. 412 issued by the makers Messrs. Henry HUGHES & SON, Ltd. 59, Fenchurch Street, London, England).

Although designed primarily as a navigation instrument, the Hagner Position Finder has many other uses in different fields. Originally intended for Marine navigation it is equally well adapted to aerial navigation as well as many terrestrial applications.

The Hagner Position Finder is a small, compact instrument of high precision, which may be considered a miniature celestial sphere. It consists principally of a horizon plane, declination arc, latitude arc, altitude arc and hour angle circle.

The horizon plane carries the altitude arc, azimuth circle and spherical level bubble.

In the centre of the level bubble mounting is located a 1/8 inch diameter circle which is the geometrical centre of the instrument and corresponds to the observer's position on the earth when making an observation of the celestial body. The graduated azimuth circle rotates inside. The horizon circle, when the instrument is properly set, gives the azimuth of any heavenly body sighted.

The declination arc is graduated in degrees and pivoted at the North and South poles of the finder frame. Thus, when the declination of the observed body is set on this circle, the motion of the body across the heavens can be followed by rotating this arc. By reading the hour angle circle which indicates the angular position, the exact longitude can be determined.

The latitude arc is a part of the horizon plane and is at all times perpendicular to it. When proper settings are made, the exact latitude of the place of observation can be read directly, from the graduated arc. At noon when the sun is at the zenith, the plane of the declination arc and the plane of the latitude arc are one and the same plane.

The altitude arc is mounted on the horizon circle and has its plane perpendicular to it. When the position finder is properly sighted, the observed altitude of any body can be read directly.

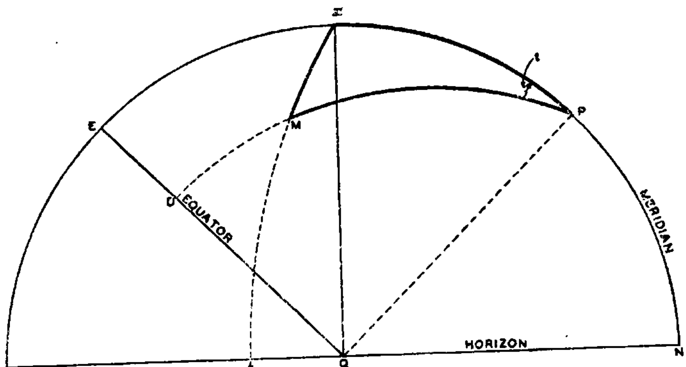


FIGURE 1

A clearer conception of the Hagner Position Finder and its operation may be obtained from a comparison of the schematic drawing in Figure 1 and the photograph of the instrument. Figure 1 shows the conventional spherical triangle PMZ, the plane of the horizon NQS, and the celestial equator EDQ.

P is the elevated pole, *M* is the position of the observed celestial body, *Z* is the zenith of the navigator, and *t* is the hour angle (HA) of the observed celestial body. The arc *PM* is the co-declination of the observed celestial body and is commonly called the *polar distance.* The arc *ZM* is the co-altitude of the observed body and is known as the *zenith distance.* The arc *PZ* is the co-latitude of the observer. Arc *MD* is the declination of the observed body, arc *ZE* represents the latitude of the Navigator and arc *MA* is the altitude of the observed body above the horizon. The arc *PZS* represents the upper portion of the meridian of the navigator and the arc *PD* represents the hour circle of the observed body.

The data shown in Figure 1 are graphically represented on the instrument as follows :

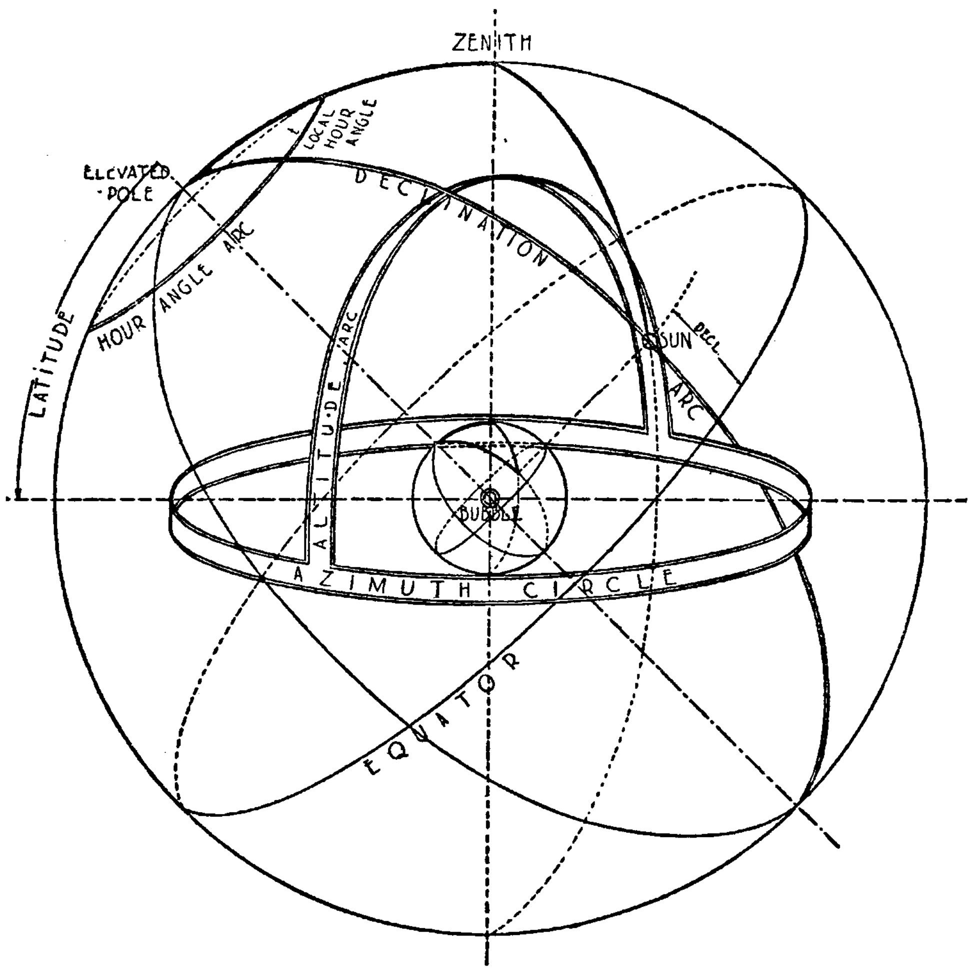
NQS is represented by the flat plate of the instrument that carries the bubble and its outer rim is graduated in azimuth. *P* is represented by the elevated pole of larger semi-circle that carries the hour angle scale. *M* is represented by the index of the rider which is mounted upon the larger semi-circle that is graduated for declination. *Z* is represented by the 90 degree graduation on the smaller semi-circle that is graduated for altitude.

The arc *PM* is represented by that portion of the larger semi-circle between the elevated pole and the rider set to the declination of the observed body, when the hour angle of the observed body is set on the hour angle scale of the instrument.

The arc *MZ* is represented by that portion of the smaller semi-circle between the elevated pole and the rider set to the declination of the observed body, when the hour angle of the observed body is set on the hour angle scale of the instrument.

The arc *PZ* is represented by the imaginary meridian of the navigator between the elevated pole of the larger semi-circle and the 90 degree graduation on the smaller semi-circle, when the latitude of the navigator is set on the latitude scale of the instrument.

The design of the Hagner Position Finder is such that the instrument can be attached to a tripod when used on the ground. If used in a boat or airplane it can mounted on a gimbal mount or held in the hand. A 2.5 volt, N° 1 Mazda bulb for illuminating the level bubble at night is located inside the hand grip. Current for this bulb is received from a 1.5 volt dry cell battery.



WHAT THE HAGNER POSITION FINDER WILL DO.

Primarily, the purpose of the Hagner Position Finder is to eliminate much of the complicated trigonometric computation necessary in the usual methods of determining a

" fix " and in the solution of the spherical triangle. Once its operation has been mastered, it is possible to secure a " fix " in a few minutes with the Hagner Position Finder, whereas an hour may be required with an ordinary sextant and attendant complicated computations.

Its simplicity of operation and accuracy, however, have greatly increased its field of application and it can be used for numerous other purposes besides those mentioned above. Some of its applications are enumerated below :

1. — Determines a line of position.
2. — Determines the angular altitude of any heavenly body.
3. — Solves mechanically all spherical triangles.
4. — Measures angles between any two heavenly bodies.
5. — Locates true North.
6. — Corrects compass for both deviation and magnetic declination.
7. — Gives initial course.
8. — Gives distance in nautical miles between two places in great circle course.
9. — Gives a " fix " (latitude and longitude).
10. — Gives bearing from true North.

In all of these applications all astronomical data required to properly set the instrument can be found in the Nautical Almanac. The other known factor required is Greenwich Civil Time (GCT), which may be obtained from a good chronometer.

HOW THE HAGNER POSITION FINDER WORKS.

Several methods may be used in solving the astronomical triangle by the mechanical means of this instrument. One that can be readily used is the solution by the line-of-position method known as the new navigation. The procedure for this solution only is given here, but the navigator is reminded that the instrument is astronomically sound and can mechanically solve the triangle in various ways depending upon data given and data desired, by mechanical computation.

Observe the altitude of the celestial body, noting the correct Greenwich Civil Time (GCT) of observation, reduce observed to true altitude, then find declination and Greenwich hour angle corresponding to this GCT from Nautical Almanac.

Set declination on declination scale. Assume a latitude and longitude (generally the dead reckoning position). Set latitude on latitude scale of instrument. With GHA from Almanac, combine with assumed longitude for the local hour angle (LHA).

Set this LHA on instrument.

Bring indices of altitude rider and declination rider into coincidence by moving *only* the smaller semi-circle in azimuth and altitude rider along altitude scale.

Read altitude and azimuth. This altitude is known as the *calculated altitude* and, if the assumed position were correct and the observation made at the time corresponding to the hour angle, this would be the actual corrected observed altitude.

Find the difference between the true observed altitude and the calculated altitude. This difference in minutes of arc (or nautical miles) is known as the intercept.

Plot as follows :

Mark the assumed position on the chart and draw a dotted line through this position in the direction of the azimuth of observed body.

On the azimuth line, lay off the intercept. If the observed altitude is greater than the calculated altitude, lay off the intercept *toward* the observed body, and if the observed altitude is less than the calculated altitude lay off the intercept *away* from the observed body, and through this new position draw a line at right angles to the azimuth line. This line is the line-of-position and the navigator is located somewhere along it.

This line-of-position can be crossed with another line-of-position taken at a different time and carried forward in the direction, and for the distance made good during the interval run between sights. The intersection of the two lines-of-position will determine an accurate " fix ".

Two lines of position may be obtained almost simultaneously from two separate heavenly bodies and these will determine an accurate " fix ".

There are many methods of using the instrument inasmuch as it faithfully reproduces the relationship of the heavenly bodies, in a mechanical simulation. The navigator will find that the Hagner Position Finder is completely versatile.