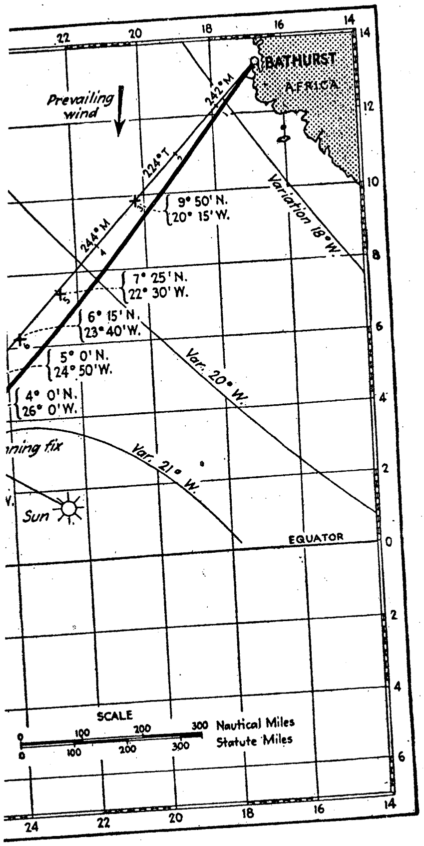

Aviation

ndbergh Flight
ıe navigation accomplished by Colonel 3 Trans-Atlantic Flight. The Colonel dbergh the navigation, which included ıe Gatty instrument, keeping the log, ations, Mrs. Lindbergh took the controls :d the lines of position.
cessfully utilized. Since the prevailing ıal and opposite to that over the western se for wind, which accounts for the track ed route.
teamwork between pilot and navigator igation. The third *S.S. Westfalen* radio se was set to the small island of Fernando

AIR NAVIGATION

BY

P. V. H. WEEMS
Lieutenant Commander, United States Navy, Retired

SECOND EDITION
EIGHTH IMPRESSION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK AND LONDON
1938

ably the most convenient mechanical computer for obtaining position lines from sextant observations. The solution of the spherical triangle is made to depend on that of two subsidiary right-angled spherical triangles in such a way that all trigonometrical functions occur in the form of products and quotients, thus rendering them amenable to logarithmic calculation in a continuous form.

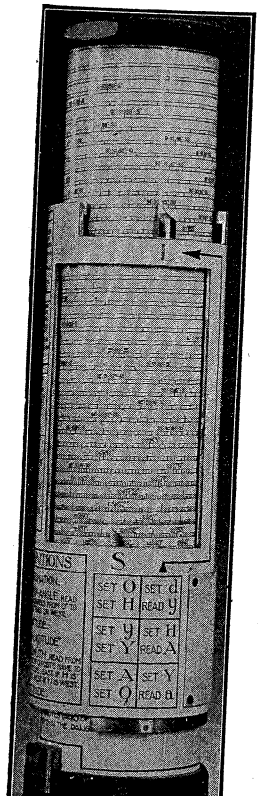

FIG. 220.—Bygrave slide rule.

The rule consists of three concentric tubes, the smallest carrying a long spiral scale of logarithmic tangents. The outer tube carries two pointers, and the middle tube carries a long spiral scale of logarithmic cosines.

The accuracy obtainable is limited by the size of the instrument but is in the vicinity of one minute of arc. Full instructions for use are given on the instrument itself, and the time for each computation is not more than one to two minutes.

The notation and formulas used are as follows:

$$d = \text{declination}$$
$$H = \text{hour angle}$$
$$l = \text{latitude}$$
$$a = \text{altitude}$$
$$A = \text{azimuth}$$

We first find an auxiliary angle y from

$$\tan y = \tan d \sec H$$

Then a second auxiliary Y is found from

$$Y = 90° - l + y$$

if l and d have the same sign, or

$$Y = 90° - l - y$$

if l and d have opposite signs.

Finally, the azimuth and altitude are found from

$$\tan A = \cos y \tan H \sec Y$$
$$\tan a = \cos A \tan Y$$

2. Nomogram Slide Rule (*Wimperis and Horsley—British*).—This is a special slide rule to solve the astronomical triangle on the same principle as the D'Ocagne diagram.

3. Poor's Line-of-position Com of the circular slide-rule principle i is not particularly suited for use in

4. Spherotrigonometer.—This d on which are set values of declinati which is read directly the correspo local hour angle applied to the ob the assumed latitude. This instru It solves the triangle in from 1 to 2 of arc. Due to its size and weight craft.

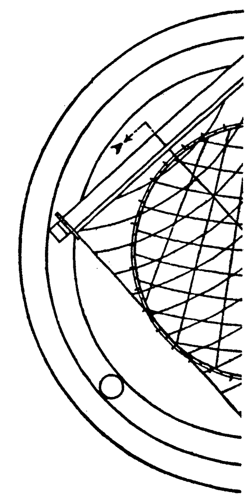

FIG. 221.—Th

5. Favé's Protractor Method protractor with curved rulers for us by means of which the position lir

6. The Brill Instrument (*Gern* same principle used by Favé to solv It is shown in Fig. 221.

7. The Voigt or "Orion" Ins mechanical device based on the pri of the triangle.

8. Baker Navigation Machine makes use of the same principle A transparent sheet with altitude the altitude curves on the transpa the time scale, the position line

3. Poor's Line-of-position Computer.—This computer makes use of the circular slide-rule principle for the solution of the triangle. It is not particularly suited for use in the air.

4. Spherotrigonometer.—This device has several scales with verniers on which are set values of declination, latitude, and altitude, and from which is read directly the corresponding value of the hour angle. The local hour angle applied to the observed time gives the longitude for the assumed latitude. This instrument was used in the *Graf Zeppelin.* It solves the triangle in from 1 to 2 min. time with an accuracy within 1′ of arc. Due to its size and weight, it is not suited for heavier-than-air craft.

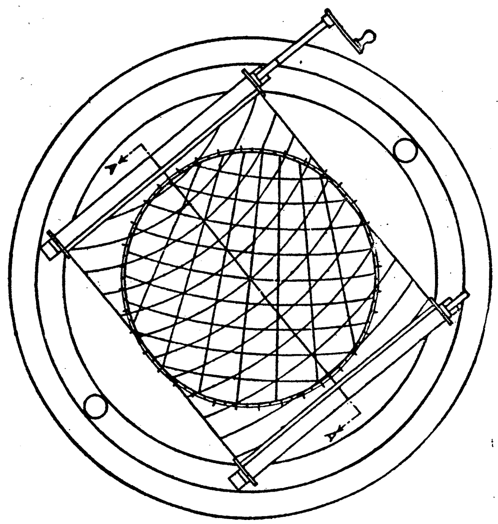

FIG. 221.—The Brill instrument.

5. Favé's Protractor Method (*French*).—Favé devised a special protractor with curved rulers for use with his chart, previously mentioned, by means of which the position lines may be found mechanically.

6. The Brill Instrument (*German*).—This device makes use of the same principle used by Favé to solve the astronomical triangle graphically. It is shown in Fig. 221.

7. The Voigt or "Orion" Instrument (*German*).—This is another mechanical device based on the principle outlined by Favé for the solution of the triangle.

8. Baker Navigation Machine (*British*).—This machine (Fig. 222) makes use of the same principle as is used in the *Star Altitude Curves.* A transparent sheet with altitude curves is moved over a chart. When the altitude curves on the transparent sheet are properly placed regarding the time scale, the position line is shown at once. Being constructed