PRISMATIC ASTROLABE

of Messrs. CLAUDE and DRIENCOURT - S.O.M. Design.

Geodetic Model.

On the occasion of the last Extraordinary International Hydrographic Conference held in Monaco in April 1929, the Société d'Optique et de Mécanique de haute précision (*) forwarded to the International Hydrographic Bureau, information on various points concerning a recent model of prismatic astrolabe geodetic type.

We recall below the principal characteristics of this instrument, indicating the chief improvements introduced in the S.O.M. type of Astrolabe :

The prismatic Astrolabe is an instrument for observing the exact instant when the zenith distance of a star reaches a strictly invariable value, this value being about 30°.

It is more specially intended for the practical application of Gauss's method of equal altitudes and is for this reason used for the determination of geographical positions and the positions of stars as well as for the determination of time.

The results obtained are comparable, if not superior in accuracy, to those obtained with meridian instruments while the instrumental equipment is much less, dispensing with the installation of a temporary observatory comprising huts and stationary pillars.

The requirements which an instrument must meet in order to permit the application of the method of equal altitudes are the following :

a) The apparent zenith distance measured must be strictly invariable ;

b) The telescope must have a high magnification ;

c) The instrument must be so designed as to permit the observation of a large number of stars within a very short time.

The first condition is the most important ; if it is not fulfilled the method is not applicable.

The sextant can be employed as an instrument for the method of equal altitudes ; but it does not answer the purpose very well as the magnification of the telescope being low, the precision of the determinations suffers as a consequence ; also it permits observations only of stars of the first and second magnitude. The number of observations is therefore limited and the intervals of time between the observations of the several stars are very long.

It is moreover difficult to handle and it takes a great deal of practice in order to be able to observe with the artificial horizon.

The prismatic Astrolabe designed by Mr. Claude, Joint Director of the Observatory of the Bureau of Longitudes, and Mr. Driencourt, Chief Hydrographic Engineer of the French Navy, enables the observation of stars at an invariable altitude to be made very easily.

THE PRINCIPLE OF THE PRISMATIC ASTROLABE (Fig. 1).

The instrument is based on the following property ; first let *ABC* represent a vertical section of an equilateral prism. When two incident rays normal to the edge of the prism *A* of the equilateral prism enter the prism through the opposite faces *AC*, *AB* and after being reflec-

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(*) *Société d'Optique et de Mécanique de haute précision S.O.M.* - 125 à 133, *Boulevard Davout, Paris* (20e).

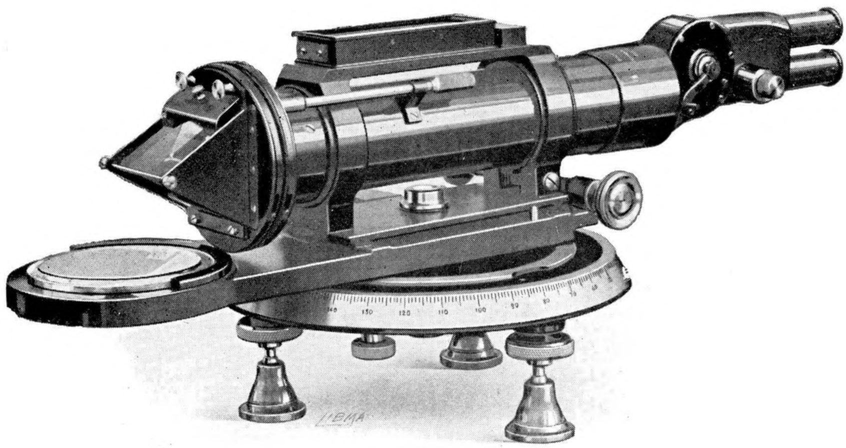

Fig. 2

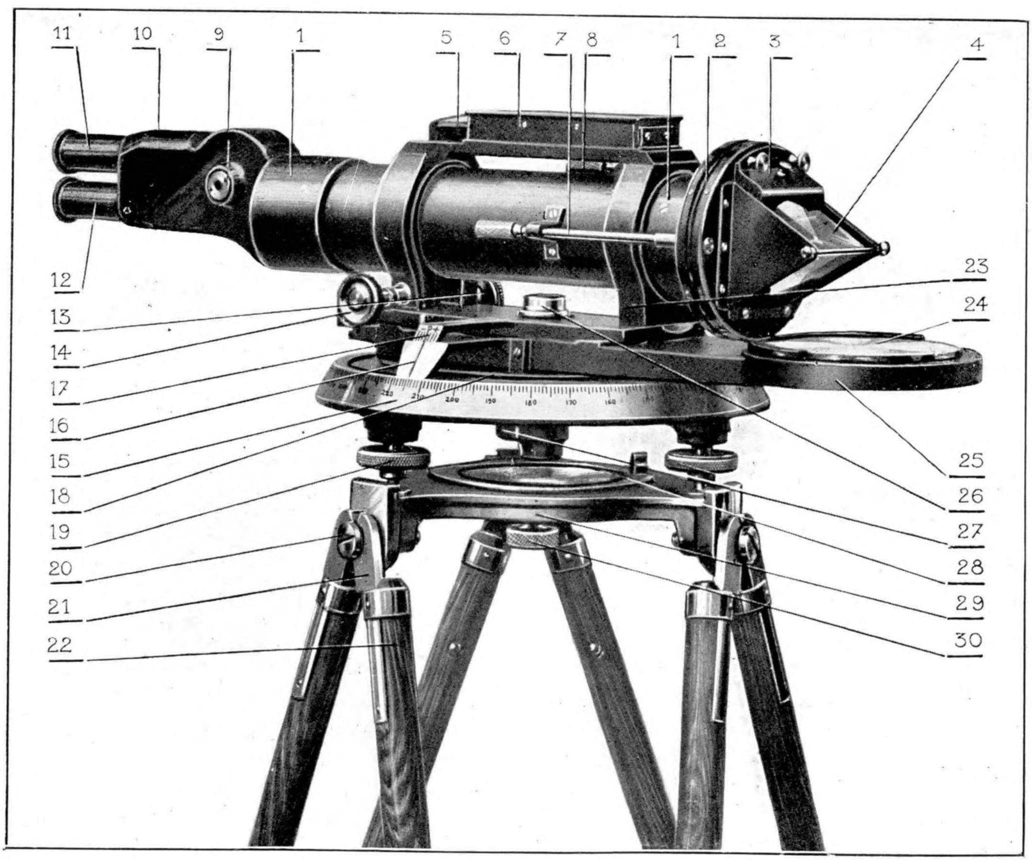

Fig. 3

(see legend opposite) (voir légende en face) ted on the inner faces *AB*, *AC*, are parallel in direction, the angle of the two incident rays is 120°, being double the angle of the prism.

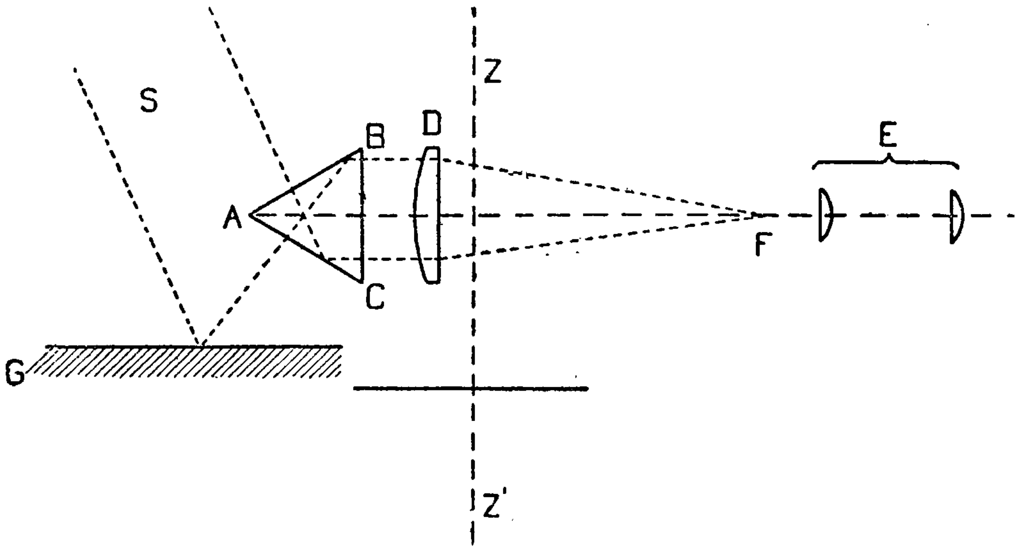

Fig. 1

The instrument consists of an equilateral prism *ABC* placed in front of the objective *D* of a telescope of which the eyepiece is composed of a microscope *E*, and of a mercury bath *G* forming an artificial horizon, the whole being suitably mounted so that it can be turned on a vertical axis *zz'* in order to bring the optical axis into the vertical plane of the star to be observed.

This star gives in the telescope two images, one from the reflection on the face *AC* of the prism, the other from double reflection on the artificial horizon *G* and on the face *AB* of the prism.

By reason of the property of the equilateral prism these two images will be superimposed if the beam of light from the star on the instrument makes an angle of 30° with the vertical, that is to say if the zenith distance $\zeta = 30° +$ atmospheric refraction.

Legend of Fig. 3

1. — BODY OF THE TÉLESCOPE.
2. — PRISM MOUNT.
3. — PRISM SUPPORT.
4. — 60° PRISM.
5. — SPHERICAL LEVEL.
6. — TROUGH COMPASS.

7-8. — PRISM ADJUSTING RODS. ADJUSTMENT BY AUTO-COLLIMATION.

9. — AXIS OF THE EYEPIECE CHANGING LEVER.
10. — LIGHTING DEVICE.
11. — LOW POWER EYEPIECE.
12. — HIGH POWER EYEPIECE.
13. — SLOW MOTION SCREW FOR TURNING TELESCOPE IN AZIMUTH.
14. — SLOW MOTION SCREW FOR ROTATING THE TELESCOPE AROUND ITS OPTICAL AXIS, FOR THE PURPOSE OF BRINGING THE TWO IMAGES OF THE STAR IN THE SAME VERTICAL PLANE.
15. — HORIZONTAL CIRCLE.
16. — INDEX FOR THE HORIZONTAL CIRCLE BEING AN INTEGRAL PART OF THE SUPPORT FOR THE ARTIFICIAL HORIZON.
17. — SECTOR CIRCLE BEING AN INTEGRAL PART OF THE TELESCOPE SUPPORT.
18. — BASE OF ASTROLABE.
19. — LEVELLING SCREWS.
20. — FITTINGS FOR TRIPOD LEGS.
21. — TRIPOD LEG LUGS.
22. — TRIPOD LEGS.
23. — TELESCOPE BRACKET AND COLLAR.
24. — ARTIFICIAL HORIZON.
25. — ARTIFICIAL HORIZON SUPPORT.
26. — VERTICAL AXIS OF THE ARTIFICIAL HORIZON SUPPORT.
27. — HORIZONTAL CIRCLE CLAMP SCREW
28. — LOCKING PLATE FOR FIXING THE ASTROLABE ON THE TRIPOD.
29. — TRIPOD HEAD.
30. — LOCKING PLATE CLAMPING SCREW.

Hence a little before reaching the zenith distance ζ the star will give two distinct images. These two images will draw closer and closer following the diurnal movement of the star and will come together and coincide at the exact moment when the zenith distance will be ζ.

The observer simply notes the time of this coincidence on a chronometer.

In this way, a great number of observations is collated in the course of a few hours; the most probable values of the unknown elements are then obtained by method of the least squares.

For the determination of the equations of conditions, the graphic method known as that of lines of position, is employed, which simplifies the problem to a considerable extent.

Fig. 2 represents the Prismatic Astrolabe CLAUDE and DRIENCOURT, type S.O.M., geodetic model, of which the following are the principal characteristics :

OPTICAL PARTS.

Clear aperture of the objective		53 m/m	(2"1)
Focal length		380 m/m	(15"2)
Prism	Faces	57 m/m	(2"3)
	Height	57 m/m	(2"3)
High magnifying power.	Magnifying Power	80	
	Field	36'	
Low magnifying power.	Magnifying Power	30	
	Field	96'	

PRECISION.

The latitude is obtained with a precision of 0"2.

The time is obtained with a precision of $\frac{0.03^s}{\sin \lambda}$ (λ being the colatitude of the place).

WEIGHT.

Instrument alone	29 1/2 lbs.
Instrument with box and accessories	41 lbs.
Stand	10 1/2 lbs.

PARTICULAR DETAILS.

The telescope has two magnifications by mean of the double eyepiece composed of two microscopes : one in line with the optical axis corresponds to the magnification of 80 ; the other parallel to the first and a little above it corresponds to the magnification of 30.

The change of eyepiece is obtained through a lever on the right side of the telescope. By means of this lever a prism is turned in the rays coming from the objective and these rays are reflected in the prism to the upper eyepiece; by turning the lever in the opposite direction the prism is removed from the path of the rays of light and the rays pass directly to the lower eyepiece.

The telescope is furnished with a diaphragm consisting of four wires forming a rectangle about 5' in width and 20' in height.

It is inside this rectangle that the junction of the images is to be observed.

A lighting attachment placed in an enlargement of the eyepiece mounting on the left side of the telescope serves to illuminate the wires of the diaphragm which may be made to either appear bright on a dark background or black on a lighted background.

A rotating movement of the telescope support is governed by a screw and a sector-shaped gear ; thus giving the telescope a slow motion and thereby enabling a star to be followed without it being necessary to move the mercury bath during the observation.

By means of another movement both the telescope and prism are turned at the same time. It is used during the observation to bring the two images in the same vertical plane in order that they may coincide when they arrive at the same height.

The artificial horizon consists of a copper circulate plate the upper surface of which is in the form of a flat bottom trough. A circular drain surrounding the trough is provided to collect excess mercury. During the observations the horizon is sheltered from the wind by a small wooden box which fits over it.

The Astrolabe consists of a single compact instrument the size of which has been reduced to a minimum ; the parts are adjusted once for all and require no further adjustment during the course of the observations.

For transport purposes the whole instrument together with all the accessories is placed in a single box.

INSTRUCTIONS FOR USE.

For everything connected with the preparation for the observations we refer to the special books on the subject and especially to that of Messrs. CLAUDE and DRIENCOURT · "Description et usage de l'Astrolabe à prisme. (Description and Use of the Prismatic Astrolabe) (*).

The hour angle and azimuth of a star at the instant of its passage across an altitude circle of 60° in a place of approximately known latitude can be taken out with sufficient accuracy by means of an abacus (**).

Nomograms prepared by Lieutenant PERRET, of the French Navy, simplify the preparation for circum-meridian stars. (**).

Finally tables prepared from the formula of Captain JORDAN and calculated by Messrs. CLAUDE and DRIENCOURT shorten the calculation of the determination of the lines of altitude (**).

(*) *Librairie* GAUTHIER-VILLARS, **55,** ***Quai des Grands-Augustins, Paris.***

(**) *Service Hydrographique de la Marine,* **13,** ***Rue de l'Université, Paris.***