

*Practical Application :*

It would seem that the instrument may be used for accurate physical, geodetic and astronomical measurements of every kind. Its range of usefulness becomes particularly evident with the larger magnifications of the telescope. With well-defined marks within the limits of measurement, appreciably smaller mean errors are obtained than with the most accurately graduated circles. In particular, the instrument might possibly be advantageously used for scientific research work (for instance, measurement of the parallax, position of the stars, temperature coefficients), in common with the purely practical measurements.

## GOTHIC BUBBLE SEXTANT WITH DETACHABLE ARTIFICIAL HORIZON AND ELECTRIC LIGHTING.

constructed by the firm of HENRY HUGHES & SON, Ltd., 59, Fenchurch Street, London, E.C.3.

This sextant has been specially designed for use as an ordinary sextant for observations of altitude above the visible horizon, or by merely attaching the bubble gear, which, in effect, is an artificial horizon, to enable observations to be made when the natural horizon is not visible.

The principle of this apparatus has been described in *Hydrographic Review*, Vol. VI, No 2, November 1929, page 140. More detailed information on the same instrument will be found in *Hydrographic Review*, Vol. XII, No 1, May 1935, page 155. These two numbers of the *Review* describe the apparatus in the compact form provided for air navigation (Booth R.A.F. Sextant Mark VIII).

In its composite type, the Gothic sextant has a limb specially designed to be light and extremely rigid so that it is not affected in any way when the Bubble Horizon is secured in place.

The telescopes are of the very latest type with large fields of view and maximum light transmission. A high-power Prismatic Telescope with large field of view and an erect image is supplied for use with the Artificial Horizon. The mirrors are of ample size to match the telescopes.

The angles are read by means of a micrometer head instead of a vernier and magnifier so that an angle can be read in a few moments to the nearest ten seconds of arc by the naked eye.

The mounting on the index arm usually used for the magnifier is utilised to carry a small flash lamp bulb which is fed from a dry battery placed inside the handle and controlled by a switch on the handle, which is pushed in when the light is required at night to read the altitude observed.

The Bubble Attachment consists of the bubble system, two mirrors and a collimating lens, the optical parts being so arranged that the rays from the bubble always emerge horizontally from the lens whether the sextant be tipped up or down from its true position of pointing at the horizon. Thus, the instrument gives as much freedom in handling when used with the artificial horizon as when used with the natural horizon, and it is not necessary to bring the bubble to a fixed mark before making coincidence with the object observed.

The actual bubble system consists of three chambers, the pump chamber with flexible diaphragm operated by the control screw; the actual bubble chamber, which is connected to the pump chamber; and the third chamber, connected to the bubble chamber by a very small aperture. The pump and bubble chambers should be full of liquid, but the third chamber should only contain a little fluid, the remainder of the chamber being occupied by air.

Thus, the air space in the third chamber permits of thermal expansion of the liquid without rapid immediate effects on the bubble.

Owing to the three chamber system, a suitable bubble will maintain its size for quite a long time.

The bubble is sensitive to about one minute of arc.

The bubble should always be returned to the third chamber after use, and the attachment removed from the sextant and again secured in its place in the sextant case.

The accessories include the following gear: Limb divided on silver to 140° with excess divisions. Double Star Prism. Husun Patent Micrometer Tangent, reading to 10 seconds.

NOTE. — The Double Star Prism is to be used with the natural horizon only. The apparatus may be supplied with the new round hermetically sealed "Silix" mirrors. See *Hydrographic Review*, Vol. XI, N° 2, November 1934, pages 135 and 137.

The figure facing this page gives details of observations and the errors, apparent or real, obtained on board S.S. *Cepolis* with a sextant of this sort.

The fact should naturally be stressed that even an experienced navigator needs some practice to obtain good results regularly with a bubble sextant, and it is preferable, in calculating, to work always with the mean of 5 observations.

DETAILS OF OBSERVATIONS AND THE ERRORS, APPARENT OR REAL,  
USING  
HUGHES BOOTH BUBBLE ARTIFICIAL HORIZON

DATE 1935	SHIP'S TIME	OBJECT (SUN OR VENUS)	SHIP'S APPROXIMATE POSITION	LAST OR NEAREST FIX OR THE TIME OF THE POSITION LINE OF THE SAME OBJECT USING THE TRUE HORIZON.	APPARENT OR REAL ERROR OF OBS. (SEE NOTE)	NO. OF OBS.	CONDITIONS UNDER WHICH THE OBSERVATIONS WERE TAKEN
1. 8TH APR	0709	☉	O L O L 14:37N 119:09E	STAR FIX AT 0536	+ 1.5	5	EXCELLENT
2. 13TH ...	0742	☉	30:02N 128:24E	DO. 0509	+ 9.0	3	ROLLING EASILY
3. 25TH ...	1715	☉	23:11N 124:26E	DO. 1908	+ 14.0	5	DO.
4. 26TH ...	1837	♀	20:15N 121:41E	CROSS BEARINGS OFF BATAN ISLANDS	+ 11.7	5	ROLLING SLIGHTLY
5. 27TH ...	0739	☉	18:22N 120:25E	DO. OFF WEST COAST LUZON	+ 2.0	5	EXCELLENT
6. 28TH ...	0735	☉	14:32N 119:17E	☉ OBS. AT 0725	+ 0.7	5	DO.
7. 30TH ...	0722	☉	07:24N 115:46E	STAR FIX AT 0535	- 1.0	5	DO.
8. 9TH MAY	0709	☉	23:15N 124:30E	DO. 0502	- 0.2	5	PITCHING AND ROLLING SLIGHTLY
9. 7TH JUN	0720	☉	04:35N 98:29E	DO. 0517	+ 1.0	5	EXCELLENT
10. 8TH ...	0739	☉	05:59N 94:58E	CROSS BEARINGS OFF PULO WEH.	+ 2.2	5	PITCHING AND ROLLING SLIGHTLY
11. 10TH ...	0717	☉	05:45N 88:11E	STAR FIX AT 0517	+ 3.2	5	MODERATE TO FRESH MONSOON; PITCHING AND ROLLING.
12. 11TH ...	0729	☉	05:54N 85:12E	STAR FIX AT 0516 & ☉ OBS. AT 0738	- 3.5	5	FRESH MONSOON; PITCHING AND ROLLING.
13. 16TH ...	0734	☉	05:52N 82:42E	STAR FIX AT 0514	- 5.0	5	MOD. MONSOON; ROLLING 10' TO BEAM SWELL.
14. 17TH ...	0735	☉	05:59N 86:42E	DO. 0525	- 3.5	5	DO. DO.
15. 18TH ...	0734	☉	05:57N 90:31E	DO. 0519	+ 2.0	5	LIGHT MONSOON; ROLLING 7' TO BEAM SWELL.
16. 19TH ...	0726	☉	05:49N 94:12E	STAR FIX AT 0516 & ☉ OBS. AT 0734	+ 1.5	5	LIGHT MONSOON; ROLLING 5' TO BEAM SWELL.
17. 19TH ...	1820	♀	05:49N 95:41E	CROSS BEARINGS OFF PULO WEH.	- 2.7	5	EXCELLENT
18. 28TH ...	0719	☉	04:15N 112:40E	STAR FIX AT 0528	+ 2.7	3	UNSTEADY IN MODERATE BOW SEA.
19. 28TH ...	0733	☉	04:15N 112:42E	DO.	+ 0.6	5	DO. DO.
20. 8TH JUL	1620	☉	04:03N 118:45E	STAR FIX AT 1822	+ 1.2	5	PITCHING SLIGHTLY

NOTE: THE ERROR IS CONSIDERED APPARENT IF THE POSITION LINE OBTAINED IS COMPARED WITH A D. R. POSITION RUN UP FROM THE LAST OR NEAREST STELLAR FIX, OR WITH A POSITION LINE OBTAINED WITH THE SAME OBJECT USING THE TRUE HORIZON, AND THE ERROR IS CONSIDERED REAL IF THE POSITION LINE SO OBTAINED IS COMPARED WITH A TERRESTRIAL FIX TAKEN SIMULTANEOUSLY, ADDITIVE OR SUBSTRACTIVE TO OBTAIN TRUE ALTITUDE.

EDWARD ALLEN.

CHIEF OFFICER S.S. "CEPOLIS"