IN THE SHADE OF A SUN DIAL

By Captain H. BENCKER

The building assigned to the International Hydrographic Bureau, located on the Quai des Etats-Unis (formerly Quai de Plaisance) in the port area of Monaco, was equipped from the start with a special type of sun dial whose indications tally to within two minutes with the time shown by the town clocks.

A description of this sun dial and its geometrical basis and calculation appear on pages 190 to 194 of Volume IX, N° 1 of the *Hydrographic Review*, Monaco, dated May 1932. Particular attention was directed towards providing the data required for regulating the proper setting of the movable style, through use of a template which supplies the σ S measurement of the point of the stylus in relation to a reference mark σ permanently engraved in the centre of the dial surface (Fig. 1). σ S = 205 millimetres ; PS (the style length) = 287 millimetres.

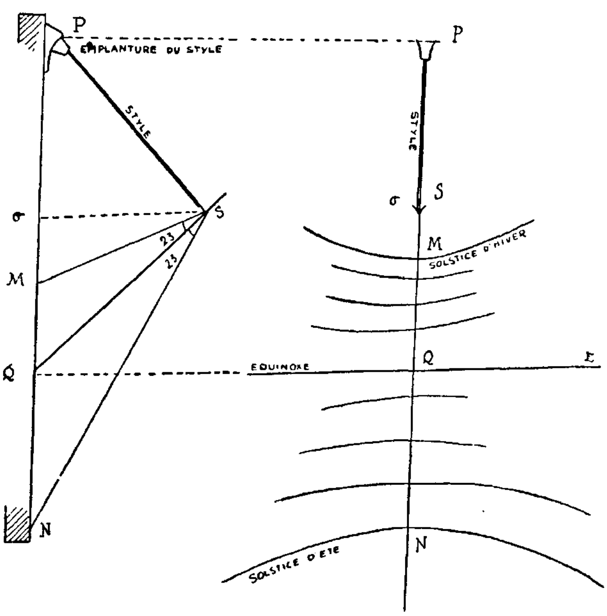

Fig. 1.

At the time dial was set up on the front of the International Hydrographic Bureau, daylight saving time was used in summer, and the dial had been so graduated as to show automatically the time change-over at the required dates during the year.

The hour-lines of apparent time PX were replaced on the dial (Fig. 2 and 2a) by hour-lines of mean time to allow for the equation of time. These latter curves are commonly known as mean time meridian curves (shaped as a figure-8) (Fig. 3).

The dial was divided into two projections : the one on the left side of the building is valid from January to June ; the one on the right from June to December. The purpose of this device was to avoid plotting on the same projection an intricate pattern of figure-8 hour-lines (Fig. 3) representing the mean time equation, but it has the disadvantage of requiring the style to be moved on the appropriate dates (21st June and 22nd December) from the left-hand dial to the right hand dial. It is as if the dial had to be wound like a clock, but this operation can be carried out fairly easily owing to a special setting instrument devised for the style's seasonal change.

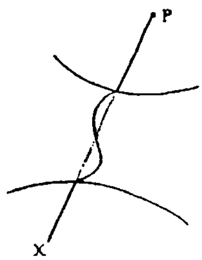

fig. 2

DU SOLSTICE D'HIVER AU SOLSTICE D'ETE

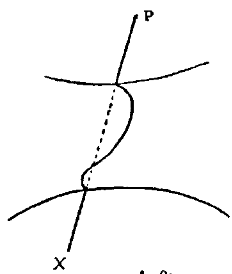

fig. 2bis

DU SOLSTICE D'ETE AU SOLSTICE D'HIVER

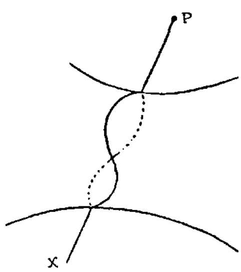

fig 3

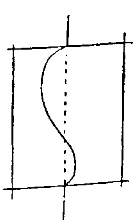

fig 4

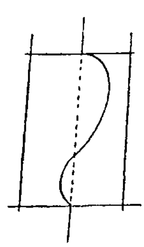

fig 4 bis

Civil (legal) time in Monaco is the same as in France, and is equivalent to Universal Time plus one hour (former so-called « summer » time). Civil (legal) time was subjected to many changes during the war years from 1939 to 1944. During this period it was accordingly impossible to adjust the Bureau's dial in such a way that it would indicate automatically the correct local time to passers-by along the Quai de Plaisance.

Operation of the dial during this troubled period was therefore halted, thus verifying the adage « Horas non numero nisi serenas » — as if in recognition of the fact that in Monaco the hours marked by a dial should never be other than serene.

Legal conditions as affecting civil time having returned to normal, advantage was taken of repairs to the Bureau's façade necessitated by bombings to graduate the dials in accordance with Universal Time plus one hour. It sufficed to assign the same hour-number to the two graduation systems engraved on the lower and upper parts of each dial.

An hour-line of mean time reproduced herewith shows the slight change on each dial required to put it « back on time ».

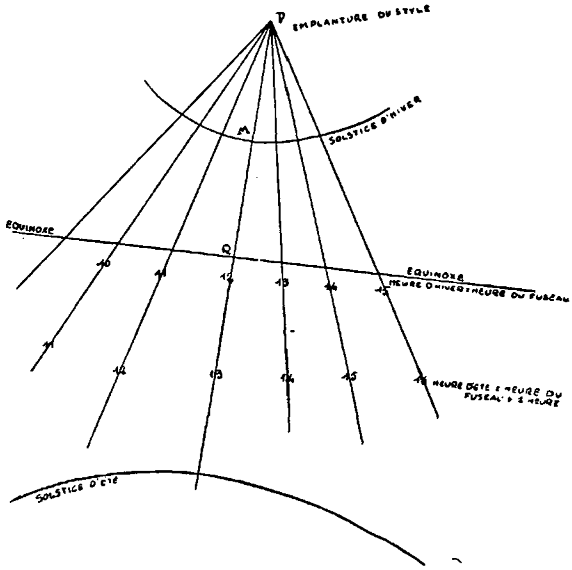

fig 5

Figures I and 5 show the arrangement of the dial.

P is the adjustable pitch of the detachable stylus.

At the equinox, the track of the shade of extremity S of the stylus on the marble plate of the dial is a straight line. It is a hyperbola in all other cases, particularly at the summer and winter solstices when the sun's declination is $\pm$ 23°.5.

Q is the central point of the dial.

σ is the orthogonal projection of extremity S of the stylus on the dial plane.

Figure 5 shows the method of graduation in winter, or zone, time, and the advance of one hour given by summer time, i.e. zone time plus one hour for the same position of the sun.

Table I gives the value of the time equation in round minutes for every day of the year, as well as the declination of the sun in round degrees for certain days of the year and for the first day of each month.

TABLE OF THE EQUATION OF TIME AND OF DECLINATION

December	22	-.... 0 min.	— 23°5	June	23	.... + 2	+ 23°5
			(winter				(summer
	27	.... + 1	solstice)		28	.... + 3	equinox)
	29	.... + 2		July	1	.... + 3.5	+ 23°1
	31	.... + 3			3	.... + 4	+ 23°
January	1	.... + 3.2	— 23°		9	.... + 5	
	3	.... + 4			18	.... + 6	
	5	.... + 5			26	.... + 6.2	+ 19°5
	7	.... + 6		August	1	.... + 6	+ 18°1
	9	.... + 8	— 22°		3	.... + 6	
	12	.... + 8			11	.... + 5	+ 15°
	14	.... + 9			17	.... + 4	
	17	.... + 10	— 21°		21	.... + 3	
	20	.... + 11			25	.... + 2	
	24	.... + 12	— 20°		29	.... + 1	
	28	.... + 13	— 18°	September	1	 0	+ 8°4
February	1	.... + 13.2	— 17°2		4	.... — 1	
	6	.... + 14	— 16°		7	.... — 2	
	12	.... + 14.5	— 14°		10	.... — 3	+ 5°4
	20	.... + 14			13	.... — 4	
	28	.... + 13	— 8°1		16	.... — 5	
March	1	.... + 12.8	— 7°7		19	.... — 6	
	4	.... + 12			22	.... — 7	0°
	8	.... + 11	— 5°				(autumnal
	12	.... + 10			24	.... — 8	solstice)
	15	.... + 9			27	.... — 9	
	19	.... + 8	0°		30	.... — 10	
			(vernal	October	1	.... — 10.3	— 3°
	22	.... + 7	equinox)		6	.... — 11	— 4°
	25.	.... + 6			7	.... — 12	
	29	.... + 5	+ 4°6		10	.... — 13	
April	1	.... + 4			14	.... — 14	
	4	.... + 3			19	.... — 15	— 10°
	8	.... + 2			27	.... — 16	
	11	.... + 1		November	1	.... — 16.2	— 14°3
	15	 0	+ 9°		3	.... — 16.3	— 15°
	20	.... — 1			10	.... — 16	
	25	.... — 2	+ 15°		17	.... — 15	
May	1	.... — 3			21	.... — 14	— 20°
	14	.... — 4	+ 19°		25	.... — 13	
	28	.... — 3			28	.... — 12	— 21°6
June	1	.... + 2.5	+ 22°	December	1	.... — 11	— 21°8
	4	.... — 2	+ 22°4		3	.... — 10	— 22°
	9	.... — 1			6	.... — 9	
	15	.... — 0	+ 23°		8	.... — 8	
	19	.... + 1			10	.... — 7	
	23	.... + 2	+ 23°5		12	.... — 6	— 23°
			(summer		15	.... — 5	
			solstice)		17	.... — 4	
					19	.... — 3	
					20	.... — 2	
					21	.... — 1	
					22	 0	— 23°5
							(winter
							solstice)

These values allow for the drawing of Table 2, which determines the yearly curve of the « Mean Time Meridian ». Each half of the curve, plotted point by point on the scale of the sun dial, allows for the tracing of the hourly curves of each hour on the dial (Figures 2 and 2a), as deduced from Figures 4 and 4a.

The Bureau's sun dial, which dates back to 1931, still ranks with other instruments in this field, and these few lines have been set down in order to provide the Monegasque State Building authorities in charge of Bureau maintenance with a record of the geometric essentials required to ensure the sun dial's continued accurate operation.