THE LONGINES SIDEROGRAPH

(According to a communication received from the Longines Watch Company Ltd, Francillon St. Imier, Switzerland).

Formerly, in order to fix his position, the naval officer was obliged to make long and arduous calculations. The slow speed of his vessel, however, afforded him ample leisure for this purpose. But the pilot of an airplane travelling at 400 kms. per hour must be able to determine his position in a few minutes. The success of his flight depends upon it. There arose, therefore, the imperative necessity of adapting the navigational methods to the exigencies of aeronautics. The Navy also could but derive an advantage from such an improvement. What was done?

First it was necessary to make the ephemerides more practical. That was the task of the official agencies charged with their publication, such as the Bureau des Longitudes in France, H.M. Nautical Almanach Office in England. New tables have been published giving in degrees, minutes and tenths of minutes of arc, the "sidereal" or the Greenwich hour angle of the First point of Aires, and the right ascensions or versed ascension of the sun, moon, planets and the principal stars.

But a parallel simplification was demanded in the realm of chronometry. The Longines Company has just accomplished this. This should not surprise naval officers who know the quality of these instruments used aboard ship, nor the aviators, because the latter use instruments especially designed for them. To-day they have placed at their disposal a new apparatus, the SIDEROGRAPH. Formerly it was necessary to transform the measurements of time recorded by the chronometer into angular measures. Adjusted to sidereal time and divided not into hours, minutes and seconds, but in degrees, minutes and fifths of minutes of arc, the Longines Siderographs indicate directly the Greenwich hour angle of the First point of Aires.

Thanks to this double improvement in the ephemerides and the service instruments, the Greenwich hour angle of any star may now be obtained by simple addition or subtraction. Thus, from the sidereal time, graduated in minutes of arc on its face in the new Longines apparatus, we subtract the right ascension of the star under consideration, also expressed in angular units in the tables. In navigation, the same rules apply to-day to all stars, whether they are the sun, moon, or any star or planet. Or else one adds to it the versed ascension.

The dial of the Longines Siderograph shows three circles in different colours, over each of which move three different pointers having a corresponding colour. In black on white the divisions of the middle circle represent each ten degrees of arc, from 0° to 360°. The black pointer makes one revolution in 23 hours and 56 minutes. Its movement corresponds to the apparent diurnal movement of the stars.

On the interior circle, a red pointer indicates the degrees. It performs one revolution in the same interval of time that the black pointer covers one division on the middle circle.

Finally, each of the 300 divisions of the exterior circle represents an arc of 0.2 minute and the blue pointer which moves over it thus divides the degrees marked on the interior circle into minutes and tenths of minutes of arc.

This last pointer which we call the "runner" is doubled by a "stop" pointer. At the precise instant when the navigator makes his sextant observation, it is possible for him to fix this instant on the Siderograph by means of the "stop" hand. By pressing the stop the pointer's movement is arrested while the regular blue pointer continues its normal revolution. Once the time has been ascertained a second pressure on the stop releases this pointer which, thereupon, takes up its rotation together with the blue pointer. It should he noted that for practical expediency an arrangement is made for the starting and stopping of this hand

from a distance through the flexible cord analogous to that used with a photographic obturator(1). Further, the Longines Siderograph may be fitted with a movable rim carrying an index: by this means it becomes possible to determine the hour angle even when the stop watch hand is moving with the regular pointer.

The time setting of the Longines Siderograph — if such an expression can be used in connection with an apparatus which does not measure time — is accomplished without affecting the running of the mechanism. The blue knob is pulled out, and this, through the intermediary of a pinion, permits the setting of the hand on the exterior circle of the dial. The latter is turned in such a manner that on the signal the hand is exactly over the numeral 60. Finally, pushing in on the blue knob, the hand is allowed to continue its movement. There is a button permitting the starting and stopping of the watch mechanism. The words "start" and "stop" indicate the direction in which it should be moved.

Some of the apparatus are provided with an indicator which shows at any instant the number of hours the mechanism can continue to run without rewinding.

1st Example:

During the day of 13th April 1939, an aviator takes a sextant altitude of the sun. At the same instant he stops the stop-hand of the siderograph. How can he determine the Greenwich hour angle of the sun?

The Siderograph indicates :

Mean	pointer	290°
Interior	»	5°
Exterior	»	35',5
	Total :	295°35',5

On the sheet of 13th April 1939 (pages 205-206) of the Aeronautical Ephemerides, he finds with regard to the nearest sidereal time of 295°35'5 the versed ascension of 339°15'2.

The sum of the two arcs diminished by 360° gives the required hour angle :

Sidereal time.....	295°35'5
plus versed ascension	339°15'2
Total:	634°50'7
—	360°
Greenwich hour angle of sun	274°50'7

NOTE: It one sets the Siderograph to G.A.T. — 180°, one obtains this Greenwich hour angle of the sun directly and without calculation.

2nd Example:

The next day this aviator measured the altitude of alpha Taurus (Aldebaran). What was the Greenwich hour angle of this star? The Siderograph indicated on the stop hand:

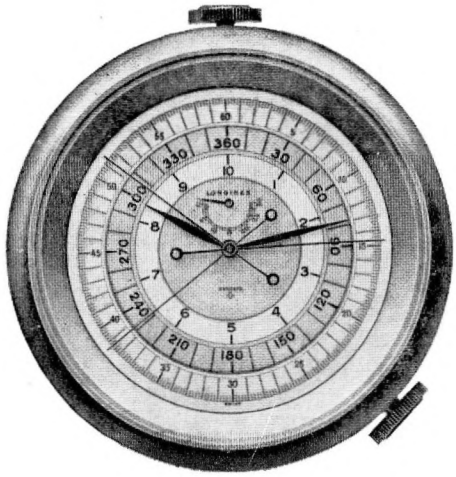
Mean	pointer	270°
Interior	»	7°
Exterior	»	4'7
	Total:	277°4'7

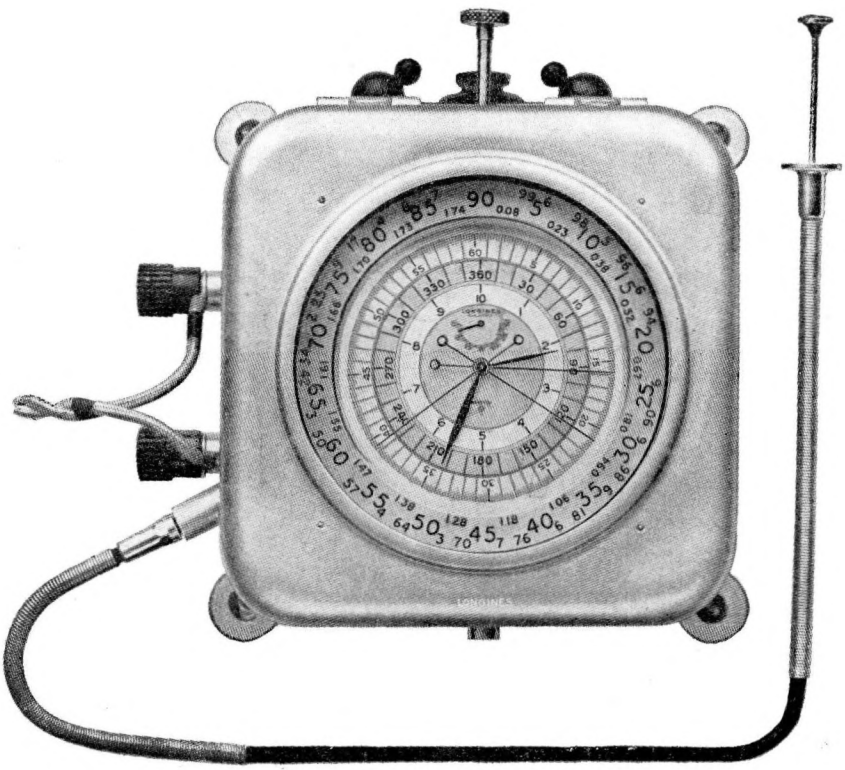
Table 1 of the Aeronautical Ephemerides gives the verse ascension as 291°53'5.

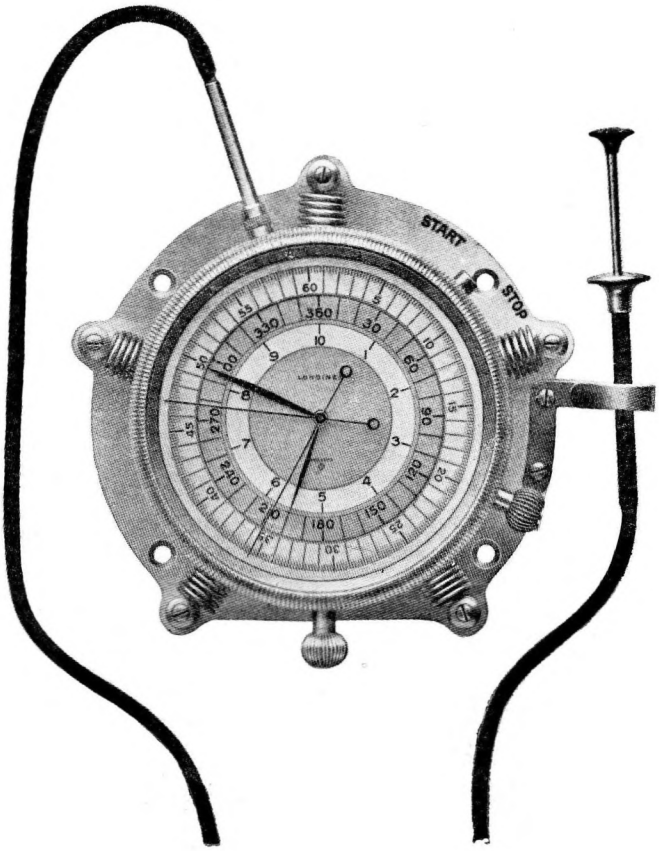
As in the former example we add the two values:

Sidereal	277° 4'7
plus versed ascension	291°53'5
Total:	568°58'2
—	360°
Greenwich hour angle of Aldebaran	208°58'2

(1) *If it is too long, the flexible cord can be replaced by a distant electric control: through the intermediary of a lever, an electric magnet acts on the button of the stop watch.*






START
STOP
LONGINES

THE LONGINES SIDEROGRAPH MOUNTED ON THE SEXTANT

The altitude of the star, determined by the sextant, varies with the sidereal time indicated by the Siderograph. To each value of the sidereal there is a corresponding altitude. Otherwise stated, the altitude H is a function of the "sidereal" α and we may write :

$$H = f(\alpha)$$

This is why the sidereal and altitude should be recorded simultaneously. The Longines Company manufactures a model of the Siderograph which mounted on the sextant, forms a unit which satisfies these requirements. For night flights the dial of the Siderograph is illuminated by an electric bulb fed either from an independent dry cell or else by the cell already provided for the light bulb of the sextant.

THE LONGINES SIDEROGRAPH WITH TWO STOP HANDS.

Here again is another variant of the Siderograph. In addition to the "runner", we have here two stop pointers operated by a single push button. What is the advantage of this extra pointer?

The sextants utilised in aerial navigation are equipped with an air bubble. This bubble serves as an artificial horizon. Now, the rapid movements of the airplane exert an influence on it which diminishes the accuracy of the observations. The aviator who has such à Siderograph with two stop pointers can eliminate this source of error by the following procedure.

He measures, for the same star, a series of six successive altitudes, from h_1 to h_6 during an interval of three minutes. At the instant when he takes the altitude h_1 he presses upon the button thus stopping the first pointer and obtaining the value of the sidereal α 1. He repeats the operation when measuring h_6 by a second pressure on the button, thus stopping the second pointer and recording α 2. To this altitude there corresponds the sidereal:

$$\alpha = \frac{\alpha_1 + \alpha_2}{2}$$

This arc is none other than that subtended between the two stop hands on the dial of the Siderograph and can be found without difficulty — often this mean can be read off directly by estimation with sufficient accuracy.

Once the calculations are terminated, the aviator then sets the stop hands in movement again by another pressure on the button.

Example:

Sidereal α_1 marked by the first pointer ..... 77°51'4

Sidereal α_2 marked by the second pointer ..... 78°38'6

$$\text{mean} = \frac{77°51'4 + 78°38'6}{2} = 78°15'$$

For the high altitudes where the temperature sometimes drops to around — 30°C., the Longines C° has constructed an aluminium case which protects the Siderograph. In the lower part there is an electric heater connected with the electric circuit of the airplane. A thermostat automatically prevents the temperature from dropping below 20°C. This heating, which is indispensable to the accuracy of the instrument, also prevents the formation of fog on the adjusted glass cover of the case. The electric bulbs fed from the same source serve to illuminate the dial in the dark.

The case can be closed with a key. It is secured to a table or to the instrument board. Rubber gaskets help to protect it against the vibrations of the airplane. The instrument itself is fixed or suspended with cardan suspension.