



### **Description**

The Campbell Stokes sunshine recorder is a self-recording instrument for the continuance of sunshine. The effect of heat of the sun is used as recording medium. No drum is necessary as the recording medium itself is moving.

The instrument essentially consists of a base plate, a stand, a support for the sphere with attached metal bowl (spherical zone) and a glass sphere.

The metal bowl has been provided with three pairs of grooves. These serve to taking up the cards provided with an hourly division. The inner side of the bowl and thus the applied card are situated concentrically to the glass sphere and in its focal distance. The way of the focus will be recorded as a line corresponding to the apparent course of the sun.

Two taps for screws have been provided for the support of the glass sphere, the connection line of which runs parallel to the earth's axis after the final adjustment of the recorder. The alignment to the geographical latitude of the place of observation is made by shifting the whole bearing cap. The scale attached laterally to the instrument, serves to adjusting the degree of latitude. Shape and size of the piece of the spherical zone have been chosen in such a way that the glass sphere may unchecked be exposed to the sunrays.

## Installation

When choosing a place for installation of the sunshine recorder, care should be taken that it will be freely exposed to the sunrays all day long.

The base surface must be very stable, so that influences of temperature, wind and humidity or vibrations cannot affect its levelling. Therefore, wood should be avoided as foundation, whereas it is advisable to choose stone, solid masonry or even metal.

Rigid adjustment of the base plate is effected on the provided foundation. The opening of the bowl has to show to the equator, i. e. when setting up the instrument on the northern hemisphere it has to show to the south, when setting up the instrument on the southern hemisphere it must show to the north.

The stand with the support of the sphere has contrary to the base plate been installed in such a way that it might be moved easily so that by shifting the retaining nut alternatively according to the spherical level, being attached to the instrument, a coarse levelling can be made. For the purpose of adjustment to the north-south-direction, the stand may additionally be turned by  $\pm 5^\circ$  contrary to the base plate connected rigidly with the foundation. The exact adjustment will be fully described in the following.

After that the glass sphere has to be placed into the stand. It has to be put between the two taps for screws, which serve to fastening the sphere. The milled ring has to be turned until the sphere is well fastened. The other ring is locked by a nut and must by no means be moved. Otherwise, the central position is not guaranteed.

## Putting in of the cards

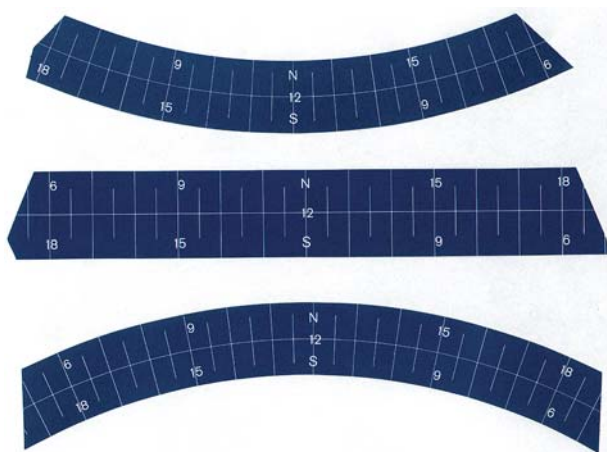
The cards made of stiff dark-blue cardboard provided with an hourly and semi-hourly division have different shapes according to the time of the year. The straight cards are destined for the middle pair of grooves, the short, curved cards for the upper and the long, curved cards for the lower pair of grooves.

The cards are used as follow:

The short curved cards - from mid-October to the end of February.

The straight cards - from the beginning of March to mid-April and from the beginning of September to mid-October.

The long curved cards from mid-April to the end of August.



The putting in of the cards has to be made in such a way that the noon-line exactly coincides with the white marked noon-line on the bowl. At a certain point (approx. corresponding to the 14.00 or 10.00 line, respectively) the bowl has been provided with three boreholes. According to the card, the metal pin suspended at the bowl by a chain, has to be inserted from the outside into one of the three boreholes, so that it also perforates the card, thus tightening it.

To avoid faulty measurements, the bowl of the sunshine recorder has been provided with a groove, which allows the rain water to flow off immediately.

This groove does not hamper the putting in of the card if the twice cut end of the card is introduced first.

## North-South adjustment and levelling

After having set up the instrument, levelled it coarsely, put in the sphere and inserted the cards, the exact adjustment will be made on a sunny day.

It has to be taken care that the adjusting mark at the upper base plate shows exactly to the number of grades, which corresponds to the present place of installation (geographical latitude) on the scale of the bearing cap.

If necessary, the bearing cap may be moved after having loosened the lateral setscrew until the correct adjustment is obtained. The exact north-south-adjustment and levelling may now be effected.

The reliable characteristic for a correct levelling and adjustment is a burning trace running parallel to the long middle line of the card.

If the width of the burning trace varies, the sphere is put in eccentrically. If it does not run parallel to the long middle line, either the levelling or the north-south-adjustment are incorrect. The burning trace deflects downwards at the right side, if the front of the instrument (opening of the bowl) has been turned to east seen from south, or if the western side is too low.

When installing the instrument on the southern hemisphere, the relations are inverse. In this case, the burning trace deflects downwards at the right side, if the front of the instrument (opening of the bowl) has been turned to west seen from north, or if the eastern side is too low.

The sunshine recorder is a kind of sundial, which the corresponding burning point should indicate the true solar time.

Therefore, when adjusting the instrument it has to be turned round its vertical axis until the focus comes upon the place of the card put in as prescribed, which corresponds to the true solar time.

It is:

**medium local time = time of running  $\pm$  longitudinal correction**

**true solar time = medium local time - equation of time**

In order to obtain the true solar time (= true local time), the longitudinal correction and moreover the equation of time (*table 1*) have to be deducted from the read time (= running time). The longitudinal correction depends on the number of the meridians, which are between the place of observation and the degree of longitude competent for the corresponding medium local time. This number multiplied by 4 shows the longitudinal correction in minutes. It has to be deducted from the read time, if the place of observation is situated to the west of the corresponding meridian of time. It should be added, if the place of observation is to the east. This correction is necessary, as the sun reaches the degrees of longitude one after another, but for larger areas the same running time has to be considered.

*For instance*, for Germany is applied the Central European Time, i. e. the medium time of the 15th degree of longitude to the east of Greenwich or of the meridian of Stargard, respectively. As e. g. Göttingen is 5° to the west of Stargard, the longitudinal correction amounts to  $4 \times 5 = 20$  min. Thus, the medium local time for Göttingen = Central European Time - 20 minutes.

### *Example for the determination of the true solar time*

On 23rd September at 12 o'clock Central European Time, a sunshine recorder shall be set up at Göttingen. To which marking of time must the sunray be focussed for a determination of the true local time?

True local time =  
 medium local time for Göttingen - equation of time

True local time =  
 12 o'clock - 20 min. - (-7.3 min.) = 12 o'clock - 12.7 min.

Thus the focus must be at 11.47 instead of 12 o'clock.

The equation of time is due to the different velocities of the earth on its elliptic way round the sun. It indicates the difference between the local time divided to equal time intervals and the nonuniform true solar time. Consequently, the equation of time is medium local time - true solar time. The equation of time for every fifth day of the year may be taken from the following *table 1*.

The instrument should then be fixed in the correct position.

**Table of the equation of time**

(Medium local time minus true solar time)

	min.		min.		min.
Jan. 1.	+3.2	Febr. 5.	+14.0	March 2.	+12.4
Jan. 6.	+5.6	Febr. 10.	+14.3	March 7.	+11.3
Jan. 11.	+7.7	Febr. 15.	+14.3	March 12.	+10.1
Jan. 16.	+9.6	Febr. 20.	+13.9	March 17.	+8.7
Jan. 21.	+11.2	Febr. 25.	+13.3	March 22.	+7.2
Jan. 26.	+12.5			March 27.	+5.7
Jan. 31.	+13.4				
Apr. 1.	+4.2	May 1.	-2.9	June 5.	-1.8
Apr. 6.	+2.7	May 6.	-3.4	June 10.	-0.9
Apr. 11.	+1.3	May 11.	-3.7	June 15.	+0.1
Apr. 16.	$\pm 0.0$	May 16.	-3.8	June 20.	+1.2
Apr. 21.	-1.1	May 21.	-3.6	June 25.	+2.3
Apr. 26.	-2.1	May 26.	-3.2	June 30.	+3.3
		May 31.	-2.6		
July 5.	+4.3	Aug. 4.	+6.1	Sept. 3.	-0.4
July 10.	+5.1	Aug. 9.	+5.5	Sept. 8.	-2.0
July 15.	+5.7	Aug. 14.	+4.8	Sept. 13.	-3.8
July 20.	+6.2	Aug. 19.	+3.8	Sept. 18.	-5.5
July 25.	+6.4	Aug. 24.	+2.5	Sept. 23.	-7.3
July 30.	+6.4	Aug. 29.	+1.2	Sept. 28.	-9.0
Oct. 3.	-10.7	Nov. 2.	-16.4	Dec. 2.	-10.9
Oct. 8.	-12.2	Nov. 7.	-16.3	Dec. 7.	-8.9
Oct. 13.	-13.5	Nov. 12.	-15.9	Dec. 12.	-6.7
Oct. 18.	-14.6	Nov. 17.	-15.2	Dec. 17.	-4.3
Oct. 23.	-15.5	Nov. 22.	-14.1	Dec. 22.	-1.8
Oct. 28.	-16.1	Nov. 27.	-12.6	Dec. 27.	+0.7

*Table 1*

## Care of the instrument

Now and then the glass sphere should be cleaned from dust and dirt. With due regard to the instructions it will be removed from the stand and after having cleaned it, the glass sphere should be put back carefully.

It should in case be considered that grooves in the glass caused by the taps for screws lie again beneath the retaining nut when putting back the sphere, so that there will not be an attenuation of the transparency.

If a hoarfrost is threatening, it is advisable to rub in the sphere with an anti-freeze, which prevents it from hoarfrost or ice coating. Glycerin has proved an appropriate auxiliary means, which, in cold times of the year, is to be put onto the sphere with a soft, clean brush in a thin film.

Also the grooves of the bowl get gradually dirty and it may be that this dirt hardens. From time to time these grooves have, therefore, to be cleaned with a pointed wooden stick, in order to be able to put in the cards easily.

## Technical data

### (1603) Sunshine recorder

Id-No.	00.16030.000 000
Measuring element	Cut glass sphere • burning glass • optical principle
Rang of application:	In northern and southern equatorial zones between 0...40°
Housing:	non-corrosion materials • RAL 5009 (azure)/ black • integrated circular spirit level on the base plate • with additional mounting plate
Dimensions	Approx. 200 x 180 x 250 mm
Weight	Approx. 5.7 kg

### (1604) Sunshine recorder

Id-No.	00.16040.000 000
Data like (1603), but	
Rang of application:	In northern and southern equatorial zones between 25...60°

## Accessories

<b>(1603 D1)</b>	<b>Set* of recording cards for 0...40°</b>
<b>Id-No.</b>	<b>34.16030.001 000</b>
	140 pieces for winter time 140 pieces for summer time 100 pieces for spring and autumn
<b>Weight</b>	Approx. 1 kg
<b>(1604 D3)</b>	<b>Set* of recording cards for 25...60°</b>
<b>Id-No.</b>	<b>34.16040.003 000</b>
	140 pieces for winter time 140 pieces for summer time 100 pieces for spring and autumn
<b>Weight</b>	Approx. 1 kg
<b>(1601-15)</b>	<b>Spare glass sphere</b>
<b>Id-No.</b>	<b>33.16010.015 000</b>
<b>Weight</b>	Approx. 1.3 kg

\* 1 set is included in the scope of delivery at each main device.



Quality System certified by DQS according to  
DIN EN ISO 9001:2000 Reg. No. 003748 QM

Subject to change without notice.

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