ANALEMMATIC SUNDIAL

by Fer J. de Vries

An analemmatic sundial is very suitable on a square or on a school yard.
A person acts as a shadowcaster and needs to stand on the correct date in the middle of a date strip.
His or her shadow than points to time points on an elliptical scale.

Example of an analemmatic sundial at Opheylissem (Belgium)

An advantage of an analemmatic sundial is that it doesn't need vertical elements.
Although, vertical elements can be added as may be seen in the above example

Much more about analemmatic sundails can be read at the website of Frans Maes.
See "Links" in www.zonnewijzerkring.nl.

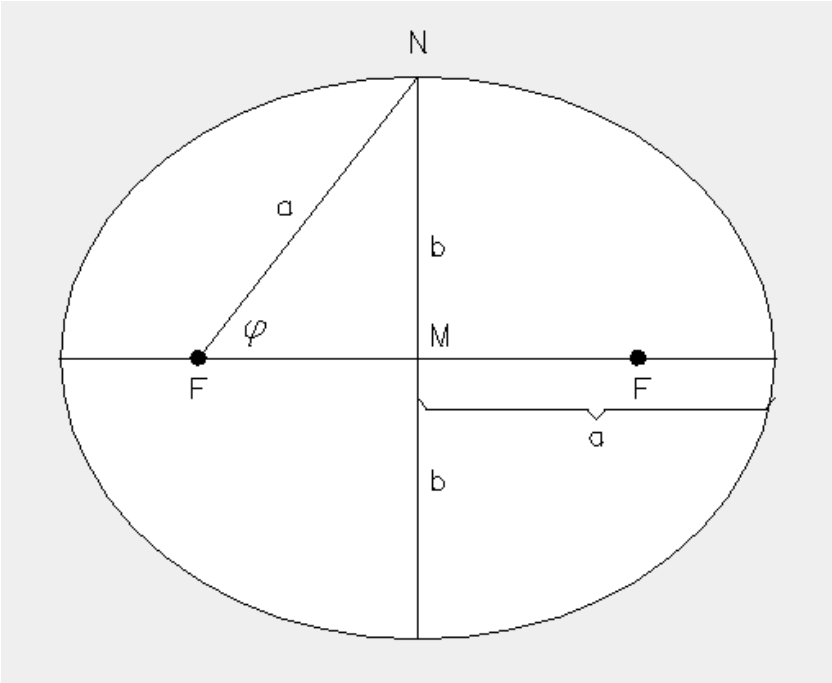
Procedure

Below the construction of an **analemmatic** sundial is described.
The discription is restricted to the horizontal dial for which purpose this type of dial is very suitable.

The ellipse

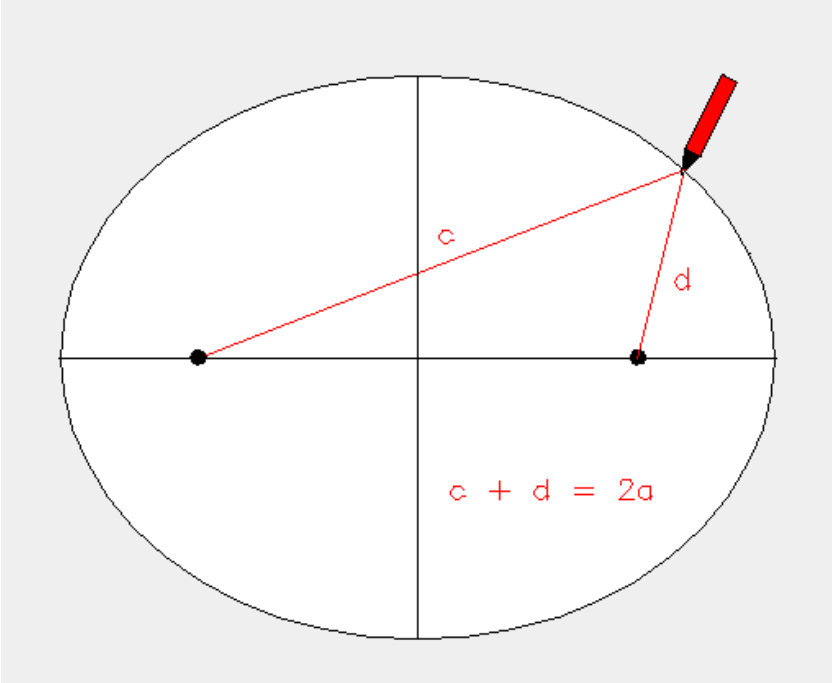
Draw a rectangular triangle FMN in with the angle near F equals the latitude φ. *(phi)*
The line NF than equals half the large axis a of the ellipse and line MN equals half the short axis b.
Draw a second point F at the same distance from the short axis. These two points F are the foci of the ellipse. In formulas:

$b = a \sin \varphi$
$MF = a \cos \varphi$

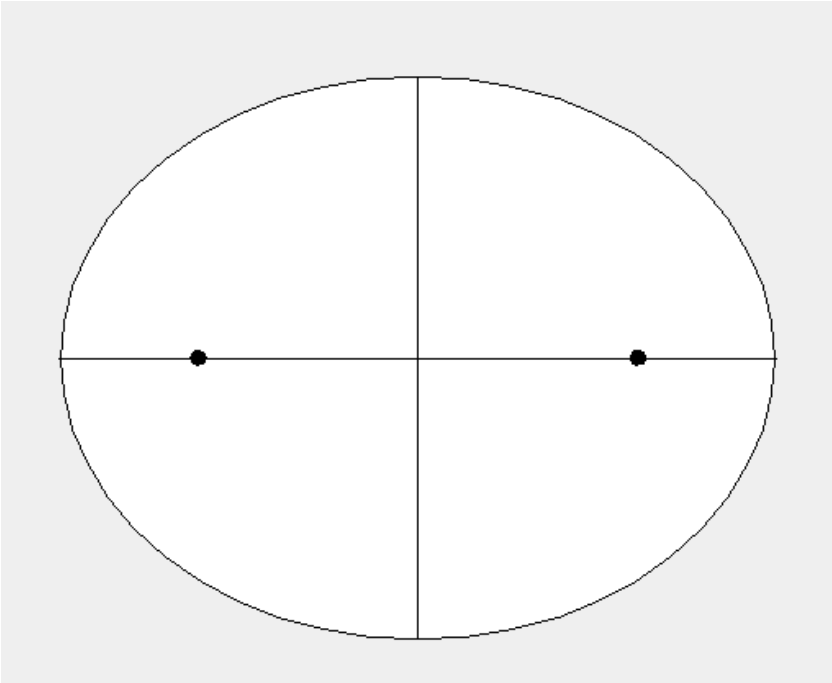


Drawing the ellipse

Connect to the two foci F a non elastic cord with a length of 2 times half the long axis = 2a. Keep this cord tight with a pencil and draw the ellipse.



The ellipse we finaly need is shown in the next picture.

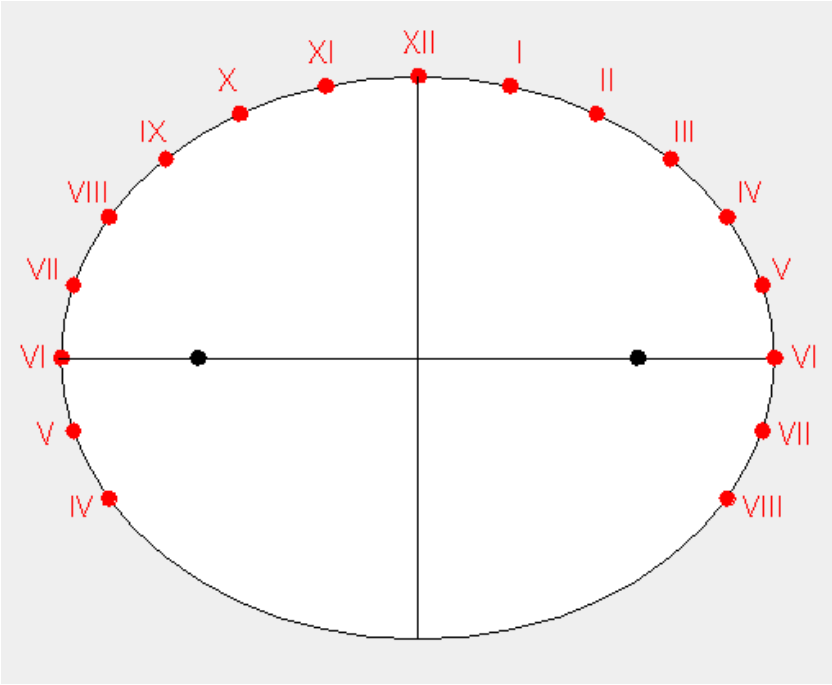


The hour points

The easiest way to draw the hourpoints is by calculation of the x,y coordinates. The formulas for this are:

$$x = a \sin t$$
$$y = b \cos t$$

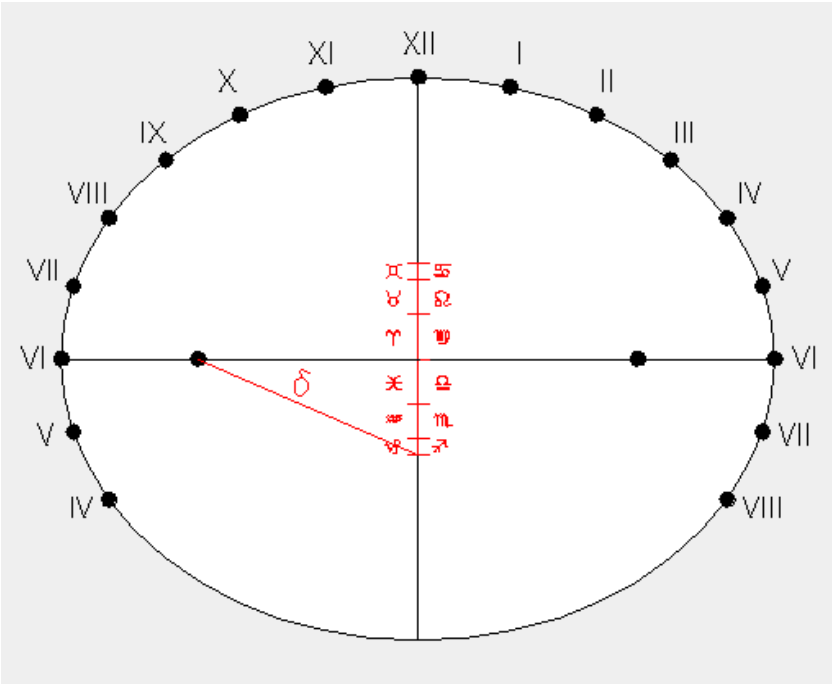
in which t is the hourangle of the sun.



The date scale

The scale of dates may be constructed as for our calendar but also as for a zodiacal calendar.
In this example a zodiacal calendar has been choosen.
Look for each point of the scale for the declination of the sun δ. *(delta)*
For the zodiacal calendar these values are about:
-23.5, -20, -11.5, 0, 11.5, 20, 23.5 degrees and these values are used twice.
Draw for each point a line from one of the foci on to the short axis with an angle equal to the appropriate declination δ. *(delta)*
In formulas:

$$x = 0$$
$$y = a \cos\varphi \tan\delta$$



Rise and setting of the sun

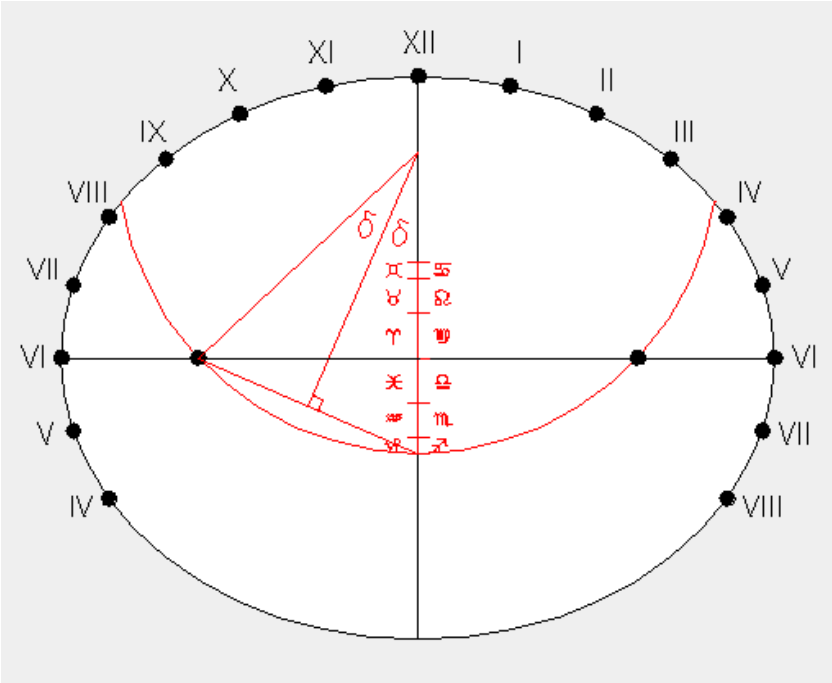
On an analemmatic sundial it is easy to show the times of the sun's rise and setting.
For this the so called circles of Lambert are used.
Draw a line from one of the foci to the appropriate point on the scale of dates.
A line form the midpoint and perpendicular to the first line intersects the short axis at the center of the circle of Lambert for this date.
Draw an arc through the two foci and the point on the scale of date and look where this arc intersets the ellipse. At those points the times for the sun's rise and setting may be read.
The shown arc is for the winter solstice at Northern latitude.
In formulas:

radius of the circle:

$$R = MF / \sin(2.\delta) = a \cos\varphi / \sin(2.\delta)$$

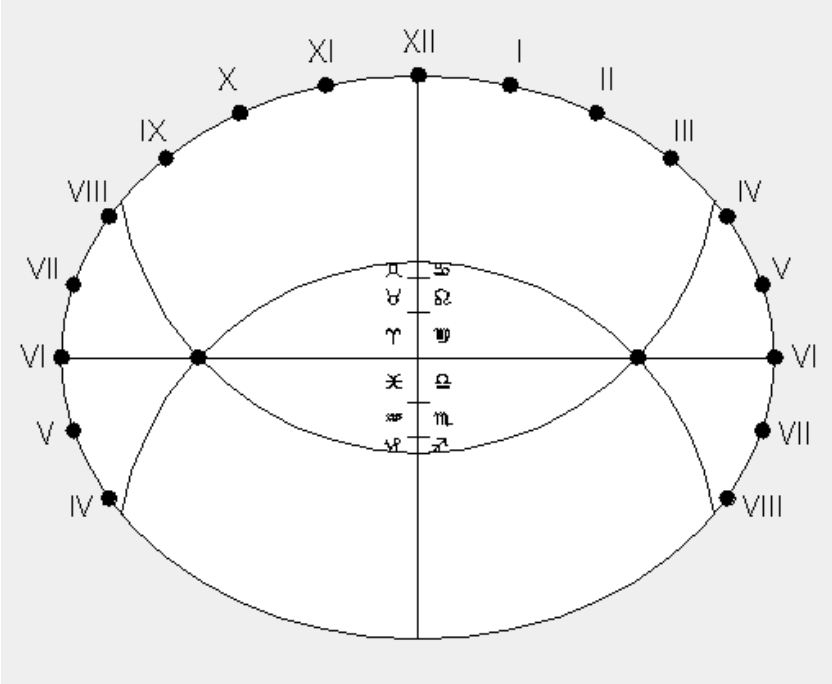
y coordinate of the center:

$$y = MF / \tan(2.\delta) = a \cos\varphi / \tan(2.\delta)$$



The result

The final result of the analemmatic sundial is shown below.
This eaxample is for a latitude of 52 degrees North and reads local suntime.
For both the solstices the circles of Lambert are drawn.
The straight line is the circle of Lambert for the equinoxes.
In this case the circle has an infinite radius and changes into a straight line.



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English translation: Ruud Hooijenga