The display zone

The display zone, onto which the digits of the hour stripe are projected by the sunlight, has two sides and can be turned by 180° so that either True Local Time is displayed (display zone with line) or conventional Standard Time (display zone with the 8-shaped loop giving the equation of time). More details on this are given at the end of the assembly instructions.

Step 10: Fold the half-round flaps at the two sides of both parts of the display zone [C1] and [C2] to the front. Then glue the two parts against each other in such a way that the lettering on both sides points in the same direction. The half-round flaps are not glued onto each other.

Step 11: Detach the two small disks [C3] and [C4] from the axis bearings [C9] and [C10] and glue them with the printed side onto each other to form a round block-shaped axis.

Step 12: Fold apart the two round flaps at one end of the display zone so that they form a disk and glue on this the cover disk [C5] with its non-printed side. Allow to dry well.

Step 13: Glue the small axis block [C3/C4] centrally onto the cover disk [C5] which is located at the end of the display zone. Because the gluing location is small, it can be helpful to scrape off some print lacquer beforehand with a knife. Then glue on this the cover disk with a knife. In this way, the glue has a better penetration into the cardboard. If some glue runs out next to the axis block, remove it with a knife. Otherwise the axis will not turn properly in its bearing. Allow to dry well. This end of the display zone now has an axis block.

Step 14: As described in the last three steps, make also an axis block from the small disks [C6] and [C7]. Glue the cover disk [C8] onto the round flaps at the other end of the display zone and, onto it, the axis block [C6/C7]. Now the display zone has an axis on each end.

Step 15: Fold the foot of the outer axis bearing [C9] forwards and glue the part onto the rear side of the inner axis bearing [C10]. Make sure that the two holes are exactly in line over each other. Allow to dry well.

Step 16: Place the axis bearing [C9/C10] onto your working surface in such a way that the folded foot is lying below. Place the display zone with one of the axes onto it and carefully press the axis into the hole in the axis bearing. Check and make sure that the axis on the other side is approximately in flush with the axis bearing. If the axis cannot be pushed fully into the axis bearing, it may be necessary to widen the hole carefully. Check to see if the axis bearing can turn around its own axis.

Step 17: Then glue the cover disk [C11] with its non-printed side onto the axis. IMPORTANT: make sure that no glue gets into the axis bearing, but only onto the axis. After drying, ensure good movement of the axis by turning it carefully as required.

Step 18: As described in the last three steps, make the second axis bearing from the parts [C13] and [C14] and then secure it in the same way with the help of the cover disk [C15] at the other axis of the display zone.

Step 19: Fold out and place the display zone with the turning axis bearings into the recess of the console. The rounded ends on the inner side of the axis bearings project into the trough and touch with the flaps with which the trough closes above and below. The folded gluing flaps on the outer side of the two axis bearings are folded onto the other side of the display zone flaps. The display zone should be aligned in such a way that the months of December and January are located above on the side with the timing loop.

Step 20: Glue the axis bearing of the display zone solidly in this position, meaning, the outer foot flaps of the axis bearings are glued onto the console upper surface, the round inner sides of the axis bearings against the flaps which close off the trough.

Step 21: On the inner side of the console, glue the edges of the trough bluntly against its closure flaps.

Assembly instructions

Before you start, read each section to the end. The assembly itself is not difficult because all parts are pre-punched to fit exactly together.

For the assembly, you will need a sharp knife in order to cut out the punched parts accurately from the cardboard sheet, a thin rod to assist gluing (pencil, Chinese chopstick), a plain rule and a folding instrument (or blunt knife) for re-grooving as well as a good all-purpose glue. A solvent-containing all-purpose glue is more suitable than so-called non-solvent glues on a water basis because it does not produce any waviness in the cardboard.

Each part is marked with a part number ([A1], [A2], [B1], [B2] etc.) and with its name in German. The letter of the part number is the same within an assembly group. Remove only those parts from the cardboard plate that you require for assembly, or write the number of the part on its rear side.

"Fold to the rear" means: I fold along the groove away from me when I look onto the printed side. The result is a "mountain" crease. "Fold to the front" means: I fold towards myself. The result is a "valley" crease.

Getting the glue to dry quicker: put a suitably thick layer of glue onto one of the sides to be glued, then press together so that the glue spreads out evenly on both sides, and then take the parts off each other again. Then blow 2 or 3 times over the surfaces and press the parts together again, making sure of a good fit – the glue holds immediately.

Contents of this assembly kit:

- 4 printed and punched cardboard sheets,
- 1 transparent hour stripe

The base

Step 1: Detach the main part of the base [A1] from the cardboard and fold all grooves sharp-edged to the rear.

Step 2: Detach the two side parts [A2] and [A3] from the cardboard. Each side part is surrounded on all edges with gluing flaps, four of which consist of peaked triangles. The two peaked triangle flaps at the lower end of the side part must be separated from one another with a knife or scissors cut. After this, fold all flaps sharp-edged to the rear.

Step 3: Glue each of the side parts with its longest gluing flap right and left onto the rim of the non-printed internal side of the base main part. Ensure that the printed sides face to the outside and that the second longest flap of the side parts is lying at that location where the main part has its rear side (with longitude and latitude details).

Step 4: Then glue the rear side of the base onto the corresponding flaps of the two side parts, then the front side of the base.

Step 5: Finally, the peripheral rim of the base is solidly glued. It is formed from the 4 approx. 1.4 cm wide sections, of which the side parts have one each and the main part has two. The front and the rear base rim are glued to the small triangular flaps at the side parts which are to be bent beforehand into the correct position. It is recommendable to re-fold the base rims once again with sufficient force before gluing so that they form a right angle to the base sides. Then the gluing flaps from the rims into the interior of the base, later have the task of holding the console in position when it is set to a particular geographical latitude.

The console

The pivoting console holds the display zone and the two feet for the digit stripe. Its inclination has infinitely variable adjustment whereby the sundial can be adapted for any geographical latitude between 30° and 60°.

Step 6: With the console [B1], detach the cardboard residuals from the two narrow slots and the big recess in the middle, and fold the two round flaps in this recess to the rear. Draw the back of the console, on which the latitude scale is printed, with its non-printed side carefully over a table edge so that it curves somewhat. Fold the two triangular side parts of the console and the 180°-like gluing flaps at the side parts to the rear.

Step 7: Glue the curved back of the console onto the flaps at the rounded edges of the side parts. Ensure that the rounded edges of the side parts are flush with the curved back of the console. At this point, the console is not yet glued into the base.

Step 8: Detach the trough [B2] from the cardboard. In order to give it the best possible uniform curvature, use the rule and the folding instrument (or blunt knife) to press between 9 and 12 additional groove lines with a spacing of 3 to 4 mm into the printed side of the cardboard, parallel to the two groove lines of the gluing flaps.

Step 9: Then draw the printed front side of the trough [B2] over a table edge so that it easily and uniformly curves with the help of the additional groove lines. Here, the printed side is lying inwards. Fold the gluing flaps to the rear and glue the trough onto the non-printed side of the console, at that position where the rectangular cut-out with the two rounded flaps is located. The gluing flaps of the trough should lie exactly at the rim of the cut-out. The rounded flaps at the two ends of the cut-out will later be glued bluntly onto the edges of the trough.

The Digital Sundial

The sun is the simplest and most natural timepiece that we know. It is therefore not surprising that sundials have been known for a very long time. The various forms of sundials are quite fantastic in their unique feature of this digital sundial is, however, the spot that wanders on a scale with hour lines. The sundial can display the time as given directly by the sun or even simply the shape of a human being standing in the centre of a living sundial and who can read the time by observing his or her own shadow. The large variety of sundials is quite fantastic indeed. Almost all of them have one thing in common: they display the time as given directly by the sun (True Local Time) by means of a shadow or a light spot that wanders on a scale with hour lines. The unique feature of this digital sundial is, however, the fact that it not only indicates True Local Time but also selectivity Standard Time (Zone Time) and even Daylight Saving Time with the help of digits that are projected by the sun onto a display zone.
What is the difference between Standard time and Solar time?

Solar time / True Local Time (TLT): When the sun culminates at one location, which means it reaches its highest point for that day, it is exactly in the south as observed from that location and at this position it is exactly 12:00 hours Solar time or True Local Time (TLT), respectively. (Note: on the southern half of the globe the sun has its midday highest point in the north).

The east-west-difference, as seen from the earth, the sun circles once every day from east to west. For this reason it has its midday highest point at all locations east of our position earlier than with us and later at all locations to the west of our position. Even though the east-west-difference of two locations is only small, these places have a measurable different local time. For example: the eastern city periphery of the city of Kassel is only 10 arc minutes (1/60 of a degree) away from the western city periphery. This minor distance leads to a difference of 40 seconds True Local Time.

Calculating the local time difference: the difference of the True Local Time between two locations results from the difference of the degree of longitude of these locations:

$$\text{Local Time Difference} = |\Delta \lambda| \times 4 \times \frac{360}{24} \times \frac{60}{24}$$

Of the 360 degrees of longitude of the earth, the 0°-degree-line runs through Greenwich near London, the so-called zero-meridian.

From that location, we count 180° positive to the west (0° to +180°) and 180° negative to the east (0° to −180°), added together 360°. For one circulation of the earth with its 360°, the sun requires 24 hours. This is one hour for 15° or 4 minutes for 1°. If a place is located 2° further to the east, the midday highest point of the sun takes place 4 minutes earlier per degree of longitude, meaning, 4 x 2 = 8 minutes. If a place is located 2° further to the west, it takes place later, meaning, by 4 x 20 = 80 minutes.

An extreme example: The geographical longitude of Warsaw is −21°, that of Barcelona −2°, the difference is therefore 19°. In Warsaw the sun reaches its highest point 4 x 19 = 76 minutes earlier than in Barcelona, even though the same time of day (Central European Time) applies for both locations.

The annual fluctuations of Solar time: Solar time varies not just with respect to the east-west-location of a place but also with within a year. Compared with a very precise mechanical watch, it can be stated that the sun is delayed by about 10 minutes on the 30 March, by 20 minutes on the 15 May and it is slow by a total of 18 minutes, and that it accelerates its course up to the 27 July again by 10 minutes, up to the 4. November it slows down again by 23 minutes, and accelerates by 31 minutes up to 12. February. This speed-ahead and retardation is expressed in the timing loop on the one side of the display zone.

The duration of a Solar day is therefore not rigid. You could say that it breathes with two breaths annually. Our standard time, on the other hand, is a calculated mean time with a fixed constancy, from which the True Local Time / Solar time can deviate by up to 1½ minutes and with which it coincides only on 16 April, 14 June, 2 September and the 25 December, that is at the lowest and at the highest point as well as in the vicinity of the intersection point of the timing loop. Well into the 19th century, people all over the world lived their lives according to the pulsating Solar time which they read from nature. Every town and city had their own time and set their timepieces according to the sun. Time differences were practically insignificant and were unnoticeable because travel in those days was quite a slow process.

Time of day and time zones: with the arrival of rail travel, time zones were introduced as we know them today, and time zones you have a uniform daylength and equal time — otherwise it would never have been possible to draw up binding travel schedules for major regions. Normally, the zone times do not depend on the degree of longitude but rather in a practical manner on the boundaries of the states. CET and CEST: the central European zone time CET is derived from the mean Solar time at the 15. eastern degree of longitude, where the city of Görlitz lies. In former times in Germany, this was also known as “Görlitz Time”. Except for the central European states, it also applies today in Norway, Sweden, Poland, Hungary, France, Spain, Morocco, Libya, Tunisia, the central African states and Angola. The furthest east European location in the zone of CET is Strzyzow at the Polish eastern border with −24.1° geographic longitude. The furthest west location is Fiestarre on the Spanish west coast with +9.25°. This means a degree of longitude of difference of 31.35°, which corresponds to a local time difference of 2 hours and 5 ½ minutes. In common use the Central European Summer Time applies, an hour is added to the CET. We simply pretend that it is an hour later. Originally, the idea behind it was to save energy but this hope did not materialise. Nobody knows exactly why everybody goes to the trouble of changing the clocks around every year. The most likely reason: daylight is prolonged for leisure time in the evening.