Photovoltaic solar cooking
without batteries and storage

General summary of the documentation :

Sites Web:
FR Français
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...and some news on

Each part is the subject of a PDF document. Each part has its own pagination.
The footers indicate, among other things, the name of the part, the page number, the date of last access for revision, and possibly the name of the chapter within the part.

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Part 5 GENERAL INFORMATIONS

page

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CHAP I - OHMMETER AND THERMOMETER

OHMMETER

Un multimètre

The multimeter is a versatile device that can be used to measure, among other things, electrical voltage and current, but it is mainly its use as an ohmmeter that interests us here.
The ohmmeter is used to measure the resistance of a body and to carry out continuity tests

The resistance of a body is its capacity to oppose the passage of electric current; it is measured in Ohm (Ω). The ohmmeter contains a battery, which sends out a small electric current; the user passes this current through the body whose resistance he wants to measure - for example, a ceramic -. The meter reads the resulting voltage drop, and calculates and displays the resistance in Ω.
An ohmmeter usually has several ratings depending on the size of the resistance; in our case, to measure the resistance of ceramics, set the selector switch to the lowest rating, often "200 Ω"; connect the leads correctly: the black lead to the "com" (= "common") terminal, and the red lead to the terminal marked (among others) "Ω"

The continuity test: if you connect the leads to the ends of an electrical circuit, or simply if you make the two ends of the leads touch, the ohmmeter displays almost 0 Ohm, and emits a "beep". If the electrical circuit under test is not continuous (cut cable, disconnected terminal, connection error...) the device does not emit a beep, and it is necessary to continue the investigations.
The ohmmeter allows to detect an erroneous connection if, by manipulating a switch, the current is sent in another direction than the one which was envisaged; it also allows to detect a short circuit: if the ohmmeter emits a beep whereas the current should not pass, there is a problem...
The ohmmeter is therefore the first tool to carry out the indispensable quality control of the control panel wiring, and the quality control of the heating plate wiring. Among other things, it can be used to check whether the (non-visible) connection of the wires inside the ceramic resistor is in good condition.
When testing ceramics, one can, out of curiosity, read their resistance in Ohm, but be aware that the latter varies according to the temperature, especially at low temperatures; the mere fact of holding the ceramic in the palm of the hand varies its resistance. As an indication, for a "35x21mm / 36 V" ceramic, at 20°C, the resistance is about 40 Ohm; it drops to about 13 Ω at 180°C.

If the ohmmeter does not have a "beep" function, which is rare, you must refer to the display each time to see if there is continuity or not.
When a digital ohmmeter is not connected, it displays "- - - -" or "1_____" or "OL" (for "Over load")
The ohmmeter produces its own very small current with the battery, so it should not be connected to an electrical circuit that is already powered...
An analogue ohmmeter with a pointer must be tared before use: when you reach the touch points, the pointer must indicate 0 Ω. There may be an offset, depending on the state of charge of the battery, so gently manipulate a knob (a potentiometer) until the needle is at the correct position, at the end of the green dial on the right. Digital ohmmeters usually have an automatic tare.

THERMOMETER

Un thermomètre et sa sonde K

The use of a thermometer is necessary when testing the ceramics, and occasionally to measure the temperature of the hotplate, or to check the performance of the cooker, but the user, in the context of the current use of the cooker, does not need it at all.

The model of thermometer shown here is very suitable for our purposes and can be easily found on the web by typing its reference "TM-902C" into a general search engine.

It is a thermocouple thermometer; on this subject, there is a quasi-exhaustive documentation on aviatechno.net "

It is on the solder, the small ball at the end of the wire, that the temperature is taken. "In a closed circuit made up of two conductors of different nature, a current flows when a temperature difference is maintained between the two junctions". In the case of this thermometer, it is a type K thermocouple. The black case contains a voltmeter. When connecting, respect the + and - poles, which are not easily readable on the small yellow plug. Additional probes can be purchased, but it is usually possible to repair a broken probe by re-soldering the end of the wire, see the documentation above for reference.
To check the thermometer, dip the probe between a few melting ice cubes, then into boiling water. There are almost identical thermometers with two probes, to be consulted alternately; it may be preferable to have two thermometers, one confirming the other.…

CHAPITRE II - ANTI RETURN DIODE AND INDICATOR LEDS

SECTION I - THE ANTI-REVERSE DIODE: RECOGNISING THE DIRECTION OF CURRENT FLOW

Three methods are available
Firstly... read carefully the datasheet that comes with every electronic component worth its salt.
Secondly, the official method is to use a multimeter equipped with the "diode" function. If you are lucky enough to have one, you can consult the many tutorials on the net on how to use it.
Thirdly, there is a much more rudimentary method, which consists of passing a small electric current through a diode, and checking the current flow with a bulb.

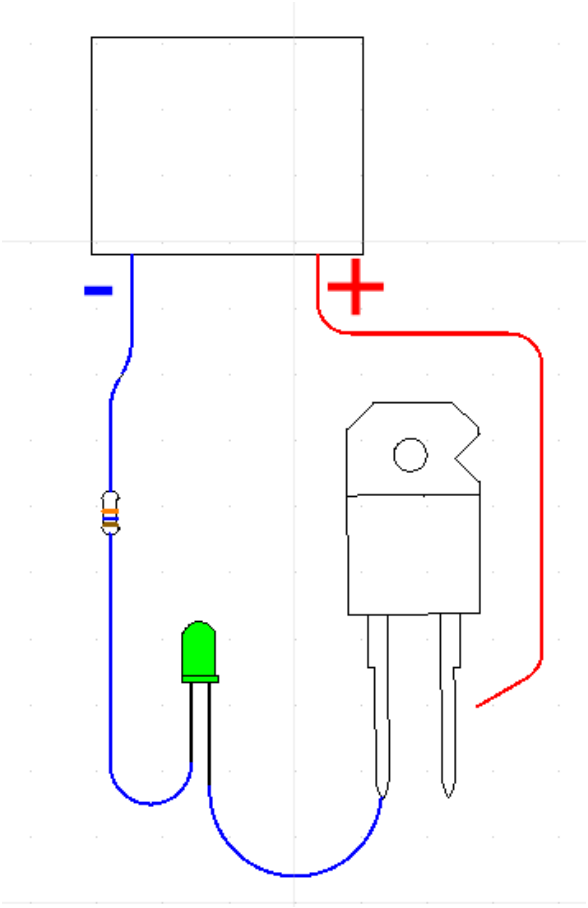
Let's say the small assembly below, including
- a power supply
- a diode
- a bulb
- and possibly a resistor.

Power supply :

- a 4.5 volt battery, for example three 1.5 volt batteries in series.
- an external mobile phone battery, in which case a USB cable must be cut in half. USB cables have four wires, two of which carry data, and two of which, the red and black, carry electrical power. Only the latter are of interest here. The external battery delivers 5 V.
  - Alternatively, a 9 volt battery can be used.

The diode

Once we have recognised the direction of the current flow, let's mark the side from which the current enters, with a small file stroke on the heat sink (= the small metal plate present on the power diodes).



The bulb

A 4.5 V bulb would be a very good solution; failing that, use an LED such as those discussed in the rest of this chapter. But be careful

a) an LED also has a direction of current flow; to put it simply: the current enters through the longest leg, and exits through the shortest leg. On the collar of the led, there is a small flat on the side of this shorter leg

b) a led can only support a certain amount of current, beyond which it "burns out".

The resistor

To limit the amount of current the solution is to interpose a resistor in the circuit.

In the case of a led and a 4.5 or 5 V supply: 220 Ω resistor

In the case of a led and a 9 V supply: 390 (or 330) Ω resistor

The order in which the components are inserted does not matter; the diode and the led must be well oriented; on the other hand, the resistor is not polarized, it "does not make sense".

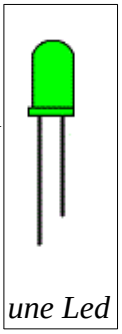
Complete the circuit and observe the bulb.

If there is no resistor, close the circuit fleetingly, and all the more fleetingly as the power supply is in 9 V. The LED will have time to glow briefly, but it will not have time to burn out...

Some wattmeters suitable for the cooker are presented as being protected against current reversals; in which case the diode would not be necessary for the cooker ?

In any case, be sure to install the diode, under the control panel, at the end of a 15 or 20 mm bolt, to facilitate its cooling.

SECTION II - INDICATOR LEDS



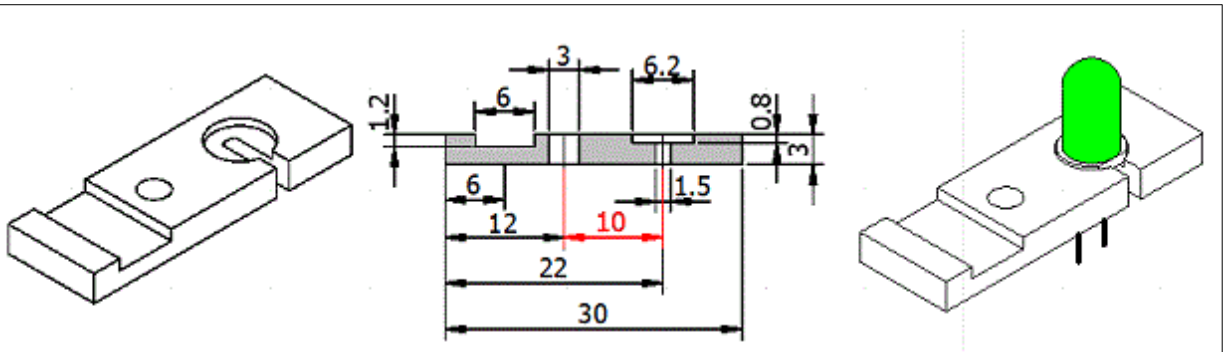
une Led

On the control panel, LEDs can optionally be installed to indicate the state of the switches. They are connected in parallel to the circuit to which they refer.
An LED is a luminous diode; as a diode, it only allows current to flow in one direction: a diode is polarised, it has a positive pole, to be connected to the "+" of the electrical circuit (usually a red or dark red wire), and a negative pole, to be connected to the "-" pole, usually a blue wire.

The negative pole of a led can be identified in two ways: the negative tab is shorter than the positive tab, and the lower collar, which holds the led in position, has a small flat spot.

The leds work with a voltage of about 2 volts, otherwise they may "burn out". It is therefore necessary to limit the current by a resistor whose value depends on the characteristics of the available current. On the electrical circuit, the resistor can be installed either "before" or "after" the diode; let us agree here to install the resistor on the positive pole. A resistor is not polarised.

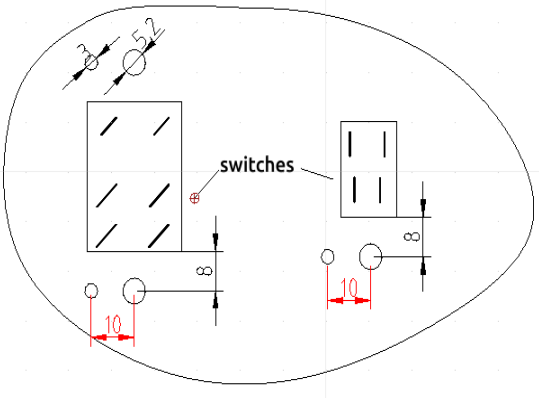
LED holders, to be made in PVC or wood, or by 3D printer



A proposal for a led support

Implantation of the LED support under the PVC plate

- a Ø 5.2 mm hole for the LED, in the axis of the switch
- a Ø 3 or 3.2 mm hole at 10 mm for the bolting on the plate



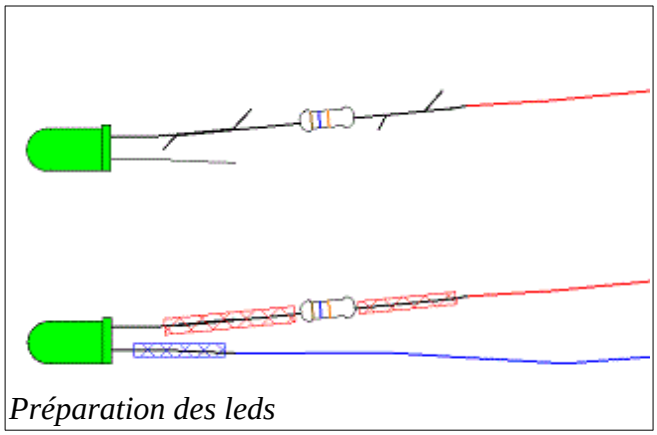
PVC plate seen from below

Preparing the leds before installation under the plate

"hand-twist" the legs or wires; in the case of flexible wires, tin the end for 15 to 20 mm beforehand

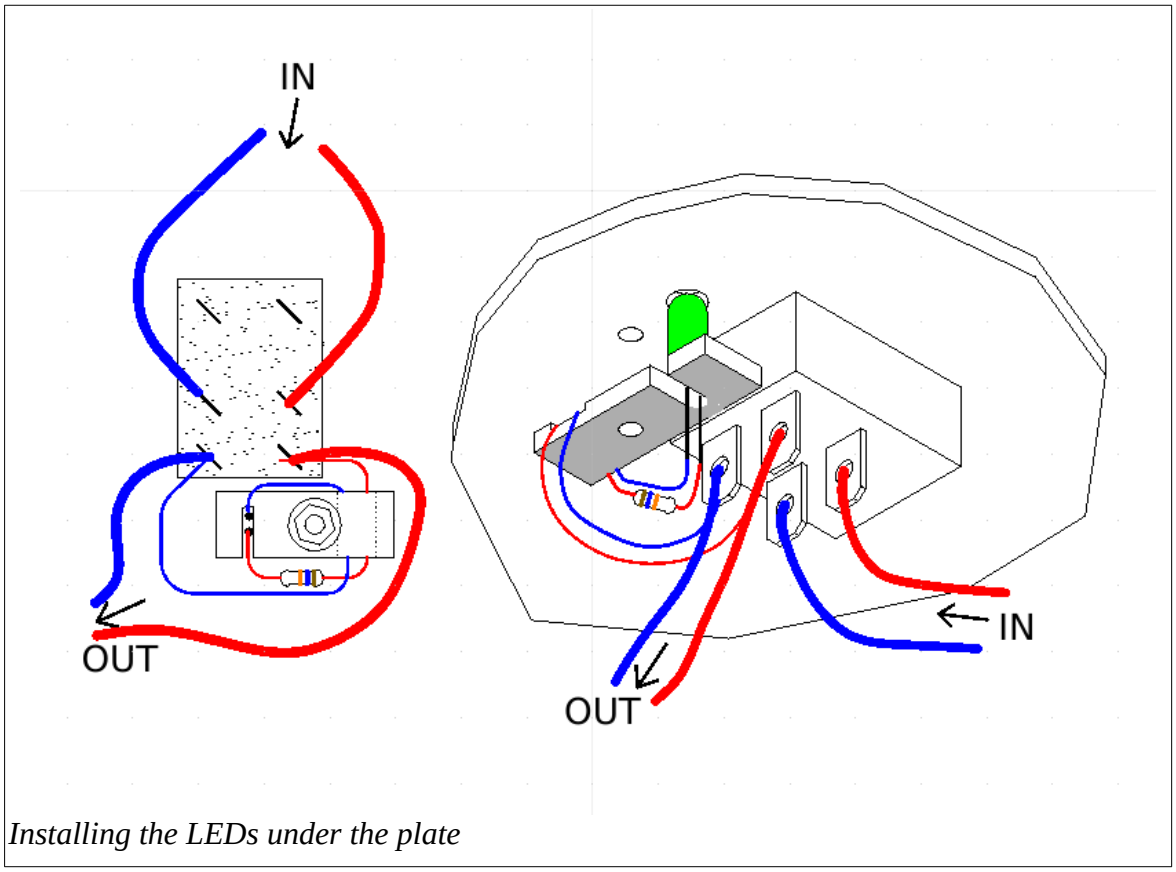
solder the assemblies, and cut the excess legs and wires

insert the heat-shrinkable sleeves, and lightly heat the sleeves with a match, candle or lighter. Be careful not to cover the resistor, which has heat to dissipate.



Préparation des leds

Installing the LEDs under the plate



Installing the LEDs under the plate

The principle is to avoid any untimely effort of the cables on the legs of the led.

Calculation of the resistance

On the control board, the current can reach 40 Volt; the led works correctly with 20 mA at 2 Volt

U = RI ; R = U/I U is the desired voltage drop, i.e. 40 - 2 = 38V

R = 38/0,020 = 1900 Ohm; we will take a 1,8 kΩ resistor.(or 2,2KΩ)

This resistor, like all resistors, will give off heat,

according to the law P = UI; P = 38 * 0.020 = 0.76 W.

The usual resistors available in electronics are 1/4 Watt resistors; they are therefore unsuitable for our use, we must supply 1 Watt resistors, for example Gotronic.fr ref RE1W1K8.

We can therefore see that the consumption of LEDs is not negligible. There are low consumption leds, in that case you can use 4,7kΩ resistor, and and parasitic consumption will decrease.

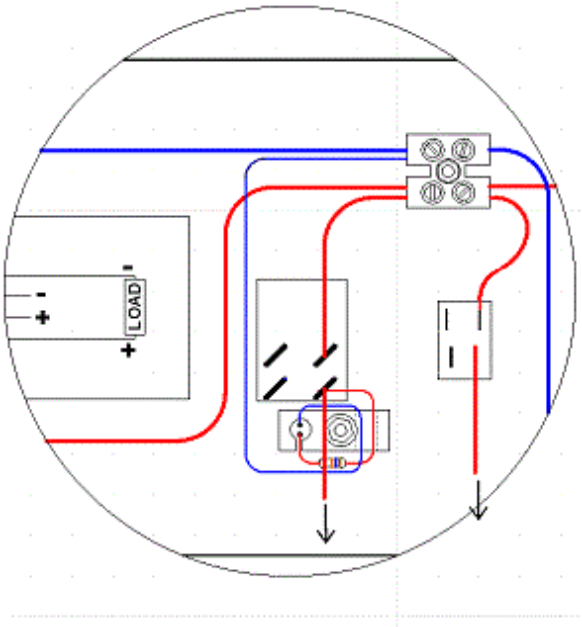
The calculation of the resistance has been done on the worst case. The consumption, therefore the light intensity, varies according to the voltage delivered by the solar collector.

3 remarks :

-the operating current of the indicator leds is taken from the "strong current" and not from the "weak current" that supplies the automatism (in case of automatically controlled cooker).

- The leds are connected in parallel with the circuit they are indicating. Therefore, the fact that a led is lit only informs about the ON or OFF state of the switch, but it is not the proof that the ceramic in question works. The LED lights up even if the ceramic is not working.

- in the case of the manually operated cooker, for the switches controlling the ceramics: only the positive cable is connected to the switch. It is therefore necessary to send the negative of the led for example on the domino supporting the ground cable, which will then have an electrical connection role in addition to supporting the cable.



Connection of the LED in the case of the manual cooker, for the switches controlling the ceramics

CHAPTER III - ELECTRICAL CABLES AND LINE LOSSES

ELECTRICAL CABLES

Power wires and cables

Section en mm²	Amperage en A
0,75	4
1	6
1,5	9
2,5	15
4	24
6	36

On the installation of the cooker, the voltage is not high, below the danger threshold, but on the other hand the current, also called Intensity or amperage, is relatively high.

Any electric cable is a resistance (very weak, certainly, but it is a resistance) and as such it produces heat (Joule effect) and it produces a voltage drop U proportional to its resistance, and to the intensity of the current which crosses it: U = RI, Ohm's law applies in the same way to the electric cables and resistors. Between the loss of power and the risk of fire, the question of the cross-section of cables is not to be taken lightly.

As a first approach, allow a maximum of 6 A per mm² of cross-section.

- between a solar panel and the cooker, over a distance of two or three meters, allow for 2.5 mm² cable; if there are two panels, prefer a 4 mm² section.

- To wire the inside of the cooker, use only flexible cable. A 1.5 mm² wire cross-section is suitable; if the ceramics are to be supplied individually, a 0.75 mm² cross-section is suitable.

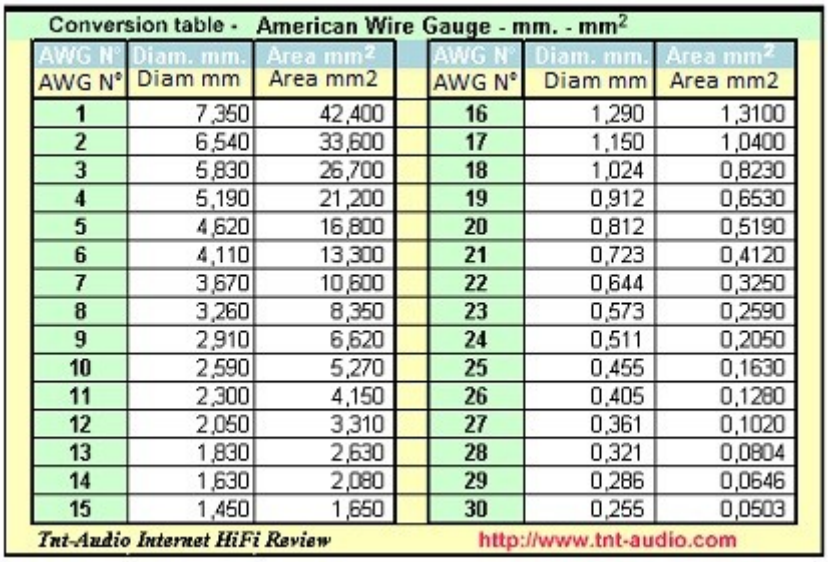
The 1 x 1.5 mm² single strand flexible cable, standard H07V-K, is perfect for our purpose. The "K" indicates that it is a flexible cable (a rigid cable, standard H07V-U, is of no use here). But its supply is sometimes difficult, except by large quantities on the Net. One can then supply a few meters of flexible cable "3x2,5mm²" or 3x1,5mm²", easily available in supermarkets (white cable) to extract the wire one needs; it is not very elegant, but it is simple. For the few meters needed here, the recovery of power cables from old household appliances is also very suitable, provided that the wire section is indicated on the cables. A power cable from a washing machine or dishwasher provides the necessary wires to wire a desk; the wires from a refrigerator power cable are too small.

Wires for "low current" circuits

- For the LED circuits or for the control circuits, very small wires of about 0.2 to 0.3 mm² are largely sufficient, avoid larger wires whose installation would be tedious. You can buy them on the net or ... in an old tower computer or other electronic device.

The cross-sections of electrical wires are expressed in square millimetres; in Anglo-Saxon countries, the old AWG American Wire Gauge system is still in use: "how many wires can fit through a hole of a given diameter?" The higher the AWG number, the thinner the wire.

Here is a table of correspondence (be careful not to confuse the diameter and the section)



Conversion table - American Wire Gauge - mm. - mm²

AWG N°	Diam. mm. Diam mm	Area mm² Area mm2	AWG N°	Diam. mm. Diam mm	Area mm² Area mm2
1	7,350	42,400	16	1,290	1,3100
2	6,540	33,600	17	1,150	1,0400
3	5,830	26,700	18	1,024	0,8230
4	5,190	21,200	19	0,912	0,6530
5	4,620	16,800	20	0,812	0,5190
6	4,110	13,300	21	0,723	0,4120
7	3,670	10,600	22	0,644	0,3250
8	3,260	8,350	23	0,573	0,2590
9	2,910	6,620	24	0,511	0,2050
10	2,590	5,270	25	0,455	0,1630
11	2,300	4,150	26	0,405	0,1280
12	2,050	3,310	27	0,361	0,1020
13	1,830	2,630	28	0,321	0,0804
14	1,630	2,080	29	0,286	0,0646
15	1,450	1,650	30	0,255	0,0503

Tnt-Audio Internet HiFi Review http://www.tnt-audio.com

The wires from Adafruit equipped with Dupont connectors, proposed for the wiring of the automatism, are 28 AWG, i.e. 0.08mm2. They can therefore carry 0.8 x 8A = 640 mA

LINE LOSSES

There are many pressure loss charts for electrical cables available on the web, but you may prefer to know how to calculate the losses.

Note that the length to be taken into account for the calculation of the losses is the double of the length of a cable: there is a loss in the outward journey... and the same one in the return journey: the voltage drops during the use of electricity in the resistor, but the current which returns to the collector-generator is equal to the one which left it, and the line loss is a function of the current, and not of the voltage

Knowing the resistance of the cable

First of all, you need to know the resistance of the wire; this is very easy by going to this calculator

Section du cable en mm²	(28AWG). 0,08	(24AWG). 0,20	(22AWG). 0,32	0,75	1	1,5	2,5	4	6
Résistance pour UN mètre, en Ω	0,213	0,085	0,0531	0,0227	0,017	0,0113	0,0068	0,00425	0,00283

Know the voltage drop it causes

Let's say a 2.5 mm² cable, 3 metres long, i.e. 6 metres round trip, through which 7 Amperes from the solar panel pass.

The voltage drop from one end of the cable to the other =

U = RI = 0,0068 Ω * 6 meters (round trip) * 7 Ampere=0,2856 Volt

Calculation of the power dissipated by Joule effect

P = UI = 0.2856 Volt * 7 Ampere = 2 W, i.e. approximately 1% of the power of the panel in current operation

Same with a 1.5mm² cable:

U = 0.0113 Ω * 6 metres (round trip) * 7 Ampere = 0.4746 Volt

P = 0.4746 Volt * 7 Ampere = 3.32 W It is only necessary to know this, and not to extend the cable too much

Same with a 6 meter cable, 4 mm² section

U = 0,00425 *12 meters * 7Ampere = 0,357 Volt

P = 0.357 * 7 = 2.5 W

CHAPTER IV - ELECTRICITY AND ELECTRICITY HAZARDS

ELECTRICITY: some useful reminders for the purposes of this documentation

An electric dipole is an electric component with two terminals: lamp, switch, battery, resistance, motor...

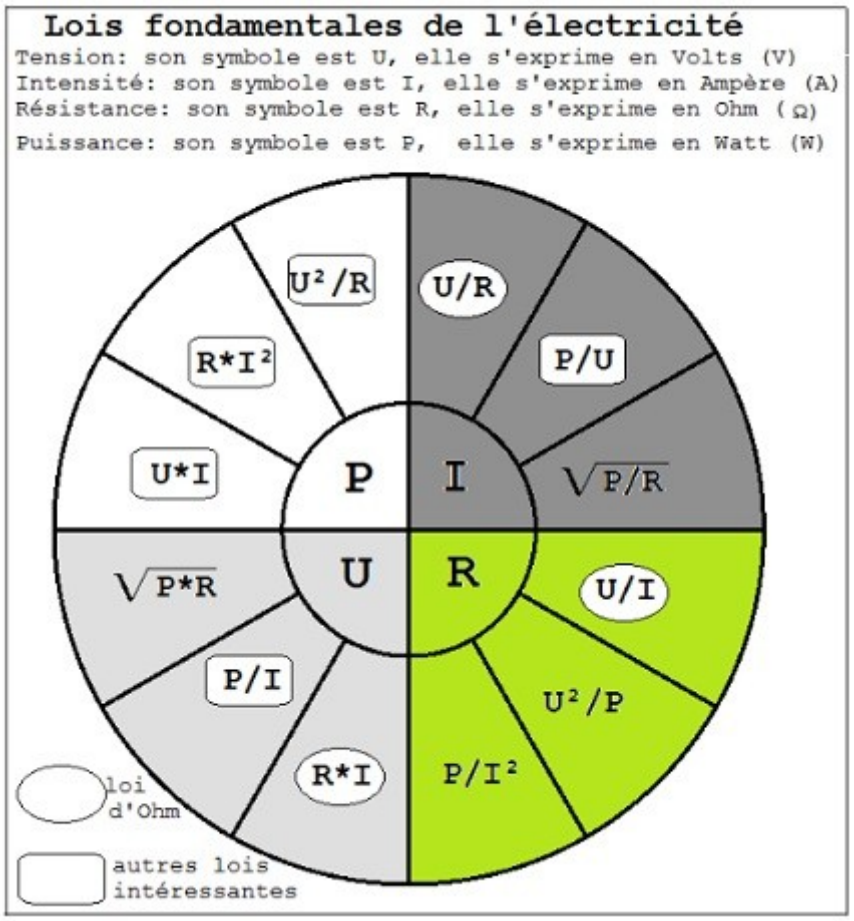
- The difference in voltage across an electric dipole, also known as "voltage" or simply "voltage", is noted U and measured in Volt (V)
- The quantity of electric current flowing through a dipole, called "Intensity", also known as "current" or "amperage", is noted I and measured in Ampere (A)
- The resistance of a body or dipole is its capacity to oppose the passage of electric current; it is noted R, and measured in Ohm (Ω).

For a given resistance value, a dipole will allow more current to pass through it the greater the voltage difference applied to its two terminals: I = U/R is Ohm's law, also known as U = RI

A dipole -for example: a ceramic- crossed by an electric current produces heat, it is the Joule effect. The higher the voltage and current, the more heat is released: P = UI

We therefore have a system with two equations:
U = RI and P = UI
In the second equation, let's replace I by U/R ;
P = U(U/R); therefore P = U²/R, which will be very useful later.

Similarly, in the second equation, replace U with RI:
P = (RI)*I; hence P = RI²



A resistor does not operate at a nominal voltage. Therefore, there can be no power rating. However, when the power consumption increases, the amount of heat released increases, which can heat up dangerously and destroy the component. The manufacturer indicates a maximum power that must not be exceeded: this is the maximum permissible power.

A comment is in order here: the usual reasoning in electricity implicitly considers that the Ohm value of a given resistor is a constant, to within a few percent. However, in the case of our ceramics, the resistance value is highly variable as a function of temperature, with an amplitude of the order of 1 to 3 in a range of 20 to 190°C. This somewhat confuses the usual reasoning. Furthermore, the usual reasoning in electricity implicitly assumes that the power supply is constant and very well regulated, whereas in our case the power supply from the solar panel is also highly variable. It is therefore useful, in the case of the solar cooker, to get rid of some pre-established patterns.

Electrical conductance is the capacity of a body, subjected to a potential difference [= Voltage] to let through a certain quantity of electric current. The higher the voltage, the higher the amount of current: "elementary, my dear Watson".
The conductance is noted G, its unit of measurement is the Siemens (S). Conductance is the inverse of resistance.

$$G = 1/R = I/U$$

If we reason in conductance, $P = U^2/R$ becomes $P = U^2 * G$

combination of resistors

- When resistors are combined in series, the R values of their resistors add up (they are successive bottlenecks)
- When resistors are connected in parallel, the G values of their resistors add up (the current has several points of passage at the same time); usually, the inverses of the resistors are summed.

If we have ceramics of identical unit power, and a given voltage,

- If two ceramics are connected in series, the resistance doubles, and the power $P = U^2/R$ becomes $P = U^2/2R$, and is divided by two.
- if two ceramics are connected in parallel, the conductance doubles, and the power $P = U^2*G$ becomes $P = U^2*2G$, it is multiplied by two

See among others: the course of the academy of Bordeaux

THE DANGERS OF ELECTRICITY

On the subject of the danger thresholds of electricity: see for example technipass.com, on the subject of the danger of electric current by contact.
Here is an article about low voltage
Taking into account the electrical resistance of the human body, and if the direct current voltage is lower than 48 Volt, then the quantity of electricity capable of passing through the human body is below the danger threshold: Ohm's law applies to the human body as to other bodies.
For example: on a public works site, the site current is distributed in 380 Volt AC. But to power a concrete vibrator, handled at arm's length in the concrete by an operator perched on top of a scaffold, the current is first converted into 42 V DC.

If we now consider electricity stored in batteries, the reasoning is no longer the same.
"Whether a container is dangerous depends on the amount of potential energy it contains", whether it is gas, steam, electricity (in the form of chemical energy) or dynamite cartridges wrapped in paper, and if this energy is released suddenly, for example by explosion, then it is dangerous. In the case of a battery, the sudden release of energy can come from a short circuit, caused for example by a metal tool that accidentally falls and remains on the two poles of the battery: the tool heats up (cf. the laws above...), so does the battery, with the risk of fire and explosion. A person in the vicinity may be burned or injured by the explosion, or by falling backwards, but his or her injuries will not be caused by electricity, there is no electrocution.

Even the 3.5 V batteries in our mobile phones are a potential source of danger; it is clearly stated, among other things, that they should not be pierced: the tool used to pierce the battery would cause a short circuit between the different elements, thus a sudden release of energy, with the risk of burns for the person - but this would not be electrocution.

In the case of our cooker, which wisely operates at around 30 V at cruising speed, with a peak at 38 V, and which has no battery, the potential risk due to electricity is to be considered as nil compared to that of a wood fire. The major risk is that of heat energy stored in the boiling cooking vessel - but this is, by definition, a risk inherent in any cooking operation.

CHAPTER V - THE COLLECTOR: SELECTION AND INSTALLATION

Section I CHOICE OF THE COLLECTOR

The collector used for the baking examples on the home page is a very ordinary collector, dimensions 1.00 m x 1.65 m high; peak power under 1000 W/m² sunshine: 280 W; power under 800 W/m² sunshine: 207 W; maximum voltage: 39 V. Designation: BMO 280 from the BISOL range. By the end of 2019, the same or equivalent can be found at one supplier for €100, and .... for three times as much at another.

Any panel with similar characteristics will do; however, be careful not to exceed 40 volts (although this is only an open circuit voltage, i.e. when the panel is not in use) for reasons of safety and principle.
There is no point in trying to buy a collector with dazzling efficiencies; the question here is: "How much does it cost me? How much do I get for it?
However, under a sunshine of 800 W/m² (under NOCT conditions), do not go below 207 Watt: one will never boil a litre of milk with the flame of a candle....
Cuisson-solaire-photovoltaique.org presents here a cooker with only one collector, but of course nothing prohibits to conceive and draw cookers with two or three collector or more.

Section II - THE CHOICE OF LOCATION

This is a strategic decision, with a very strong psychological component: with traditional energies, the user makes fire where he wants, when he wants, and how he wants. Here, the master is the sun.
Beyond the psychological aspects, there are the technical aspects, which are just as rigid.

FIXED OR ADJUSTABLE PANEL?
By adjustable panel we mean a panel that can easily be turned to face the sun, for example once an hour; see the model of support proposed below, which is suitable for all latitudes. To follow the sun high in the sky, the sliding tube with holes and a pin at the back of the panel is used; to follow the sun in its east-west course, the support is simply dragged along the ground with a suitable rope or hook.
In the case of an adjustable panel like the one proposed below, the collector can operate from sunrise to sunset, if there is no shadow effect, and if the weather allows it.

With a fixed panel, it would operate for about three to four hours a day. Before and after this daily period, the energy received would not be sufficient for the operation of the cooker proposed here - unless two panels were used, but this is not our immediate concern.

With a directional panel, the working range would be as long as the day - except for the effect of the shade during a certain period of the day (tree, building...). However, it should be noted that during the first and last hours of the day, the sun's rays have to pass through a much thicker layer of atmosphere than when the sun is high up, so they are less effective.
There are countless possible scenarios, and the final choice can only be a compromise.

A rather wise solution is not to rush into making a final decision right away. After a few weeks or months or a season, a compromise can be drawn up; until then, a removable support can be used to test different scenarios.

SOME FIGURES

When the panel is well oriented towards the sun, it receives 100% of the available sunlight.
If the panel and the sun's rays are at an angle of 15°, the panel receives only 96.6 % of the available sunlight
At an angle of 30°, the panel receives only 86.6%, etc.
Here is a table of the different values:

Mathematicians will immediately recognize the cosine table

Angle entre le panneau et le soleil	Pourcentage reçu par le panneau
0°	100 %
15°	96,6 %
30°	86,6 %
45°	70,7 %
60°	50,0 %
75°	25,9 %
90°	0,0

The percentage loss is valid for azimuth (east-west orientation) and elevation (height of the sun in the sky); if their orientations are not perfect, their percentages multiply, which makes even less solar flux.
In the East-West direction the sun travels 15° per hour (360° / 24 hours).

The question of the panel's orientation is a fundamental choice that brings into play the whole economy of the collector

CHAPTER VI - THE COLLECTOR SUPPORT SYSTEM

Section I - SOME SIMPLE BUT IMPERATIVE PREPARATORY RULES

Solar collectors are designed to have a long life, this is a requirement of the banks among others: banks accept to finance photovoltaic farms or power plants provided that the panels have a life longer than the duration of the loans they provide...
From the point of view of their mechanical resistance, the collectors are designed to be installed and then not to move during their entire lifetime.

Here the panel will be handled several times a day.

If you want to keep a panel for many years, there are a number of precautions that must be taken, otherwise solar photovoltaics will only bring disappointment. And if the panel was bought on credit, it would be unfortunate to break it before the loan is paid off…

1 - THE MAIN ENEMY OF THE SOLAR PANEL IS THE WIND

One should not say "the wind blew away the panel" but rather "the panel was not properly installed" or "the ballast on the support was not sufficient" or "the panel was not sheltered despite the threatening storm".

The figure for the wind uplift resistance of a structure is 100 kg per m².
This figure is valid for sheds, roofs, etc., but it is even more valid for collectors that can take the wind on both their front and back sides.
For a fixed collector of 1.5 m², the fixings, anchors, pegs or other devices must therefore withstand a total tension of 150 kg

In the case of a collector on a mobile support such as the one proposed below, to be moved about once an hour, it is not possible to leave 150 kg of ballast permanently. A solution: make the ballast with bags of sand or gravel of a dozen kilograms, easy to put / put on the base of the support. And when the wind becomes too threatening, the panel can be easily removed and stored under cover.

2 - THE PANEL MUST REST ON A FRAME

As designed, the panel is not self-supporting, at least if it is to be handled frequently. At the very least, the two long sides of the panel must rest on a wooden or metal frame, which will serve as a permanent cradle.

3- THE PANEL AND ITS FRAME MUST NEVER BE WARPED THEY MUST ALWAYS BE ON A PLANE

The collector is covered by a glass plate. It can therefore never be "twisted" or "warped", it is essential that its surface is always flat.
A plane is defined by two parallel lines, for example the two aluminium angles on the long sides of the collector. With a minimum of practice, it is possible to check at a glance whether they are parallel or not: the observer bends down as much as necessary to place his eye on the same plane as the glass surface of the collector, and observes, "aligns" the two angles; it is exactly the same operation as that of the carpenters who align "by eye" a row of posts. Here we are not talking about posts, but about the two long angles of the panel. If they are "crooked" to each other, then the surface glass is in a bad position.

A plane is also defined by a line and a point. In the proposed tilt panel arrangement below, the straight line is represented by the alignment of the two axes at the bottom, and the point is represented by the top attachment of the height adjustment.

During the orientation operations to follow the sun, the panel remains fixed on its cradle and rests on a straight line and a point, it does not run any great risk. It is the base, dragged on a more or less flat ground, which will deform somewhat, but without transmitting its deformation to the mobile cradle.

It is during handling operations to shelter the panel in the event of a gust of wind that there is the greatest risk: the two operators must take into account this notion of flatness and carry out all handling operations symmetrically in relation to each other.
The penalty for not respecting the flatness rules is quite simple: a more or less long, diagonal crack on the panel glass.

4- A GLASS PLATE IS TRANSPORTED AND STORED ALWAYS VERTICALLY, "on edge and not flat".

This is the most effective and easiest rule to follow, especially when it comes to putting the panel under cover.

Place the panel vertically on the same side as when it is in use, taking care not to rotate the aluminium frame profile as explained below.

When installed on a roof, the panels are "flat", but they are not handled as often as in the case of solar cooking, so they are safe, which is not the case with a panel handled several times a day.

Section II - A PROPOSAL FOR AN ORIENTABLE SUPPORT
GENERAL PRESENTATION AND PROCUREMENT

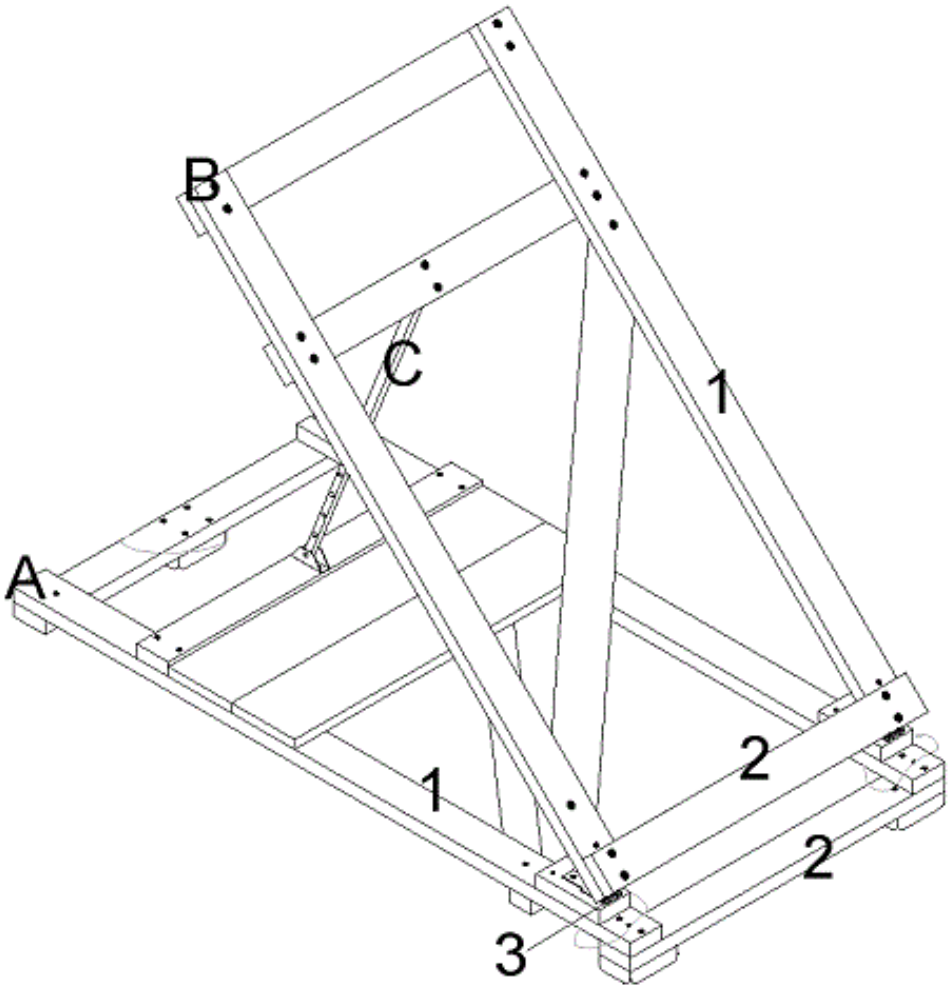
A multitude of adjustable supports and variants can be designed.

The choice here is a wooden support for a 991mm x 1645mm high panel. It consists of
- a base, resting on the floor
- a swivel cradle to hold the collector
- a telescopic support to orient the cradle according to the path of the sun in the sky.

To orientate the collector according to the path of the sun from East to West, the whole unit is simply pulled along the ground by a cord or a metal hook.

A small indicator, fixed on the support, confirms to the driver the correct orientation of the panel.
In view of the table of figures in the previous chapter, one handling per hour is more than sufficient.

Overall view of the bracket, without the collector.



A: Base B: Cradle C: Telescopic tube
1: Uprights 2: Crossbars 3: Hinges

Supplies:

Supply raw wood, it is not essential to plane it; it will be protected by a stain or, failing that, by paint.
The proposed plans were drawn up for a wood section of 100 x 40 mm. Other cross-sections can be adapted. Avoid pieces of wood with knots that would weaken them.

Base two uprights of 1.955 m for a panel of 1,65
three crosspieces length = exact width of the panel, plus 5 mm, i.e. here 0.991 + 0.005 = 0.996 m
Cradle: two 1.84 m uprights
three crosspieces of 996 mm
Diagonals: two lengths of 1.55m NB For the diagonals, a 50 x 40 mm section would be sufficient.

M8 x 100 mm round-headed "Japy" or "square neck" bolts; failing that, threaded rods can be used
M6 x 100 countersunk head bolts - express.co.uk Order no.: 3101610002 , or better still, stainless steel 8301610018, given the smaller diameter.
Wood screws, cross recessed head, partial thread Ø 4.5 mm, length 70 or 80 mm, vis-express.fr ref. 2008457002 or 2008458002; leroymerlin.fr Ø 4 mm L 70 mm ref 66931732

Fillet hinges, length 300 mm (when opened flat), width 50 mm (this is the length of the pin). Per example: leroy-merlin Ref 67555180

round-headed "Japy" and "square neck" bolts;

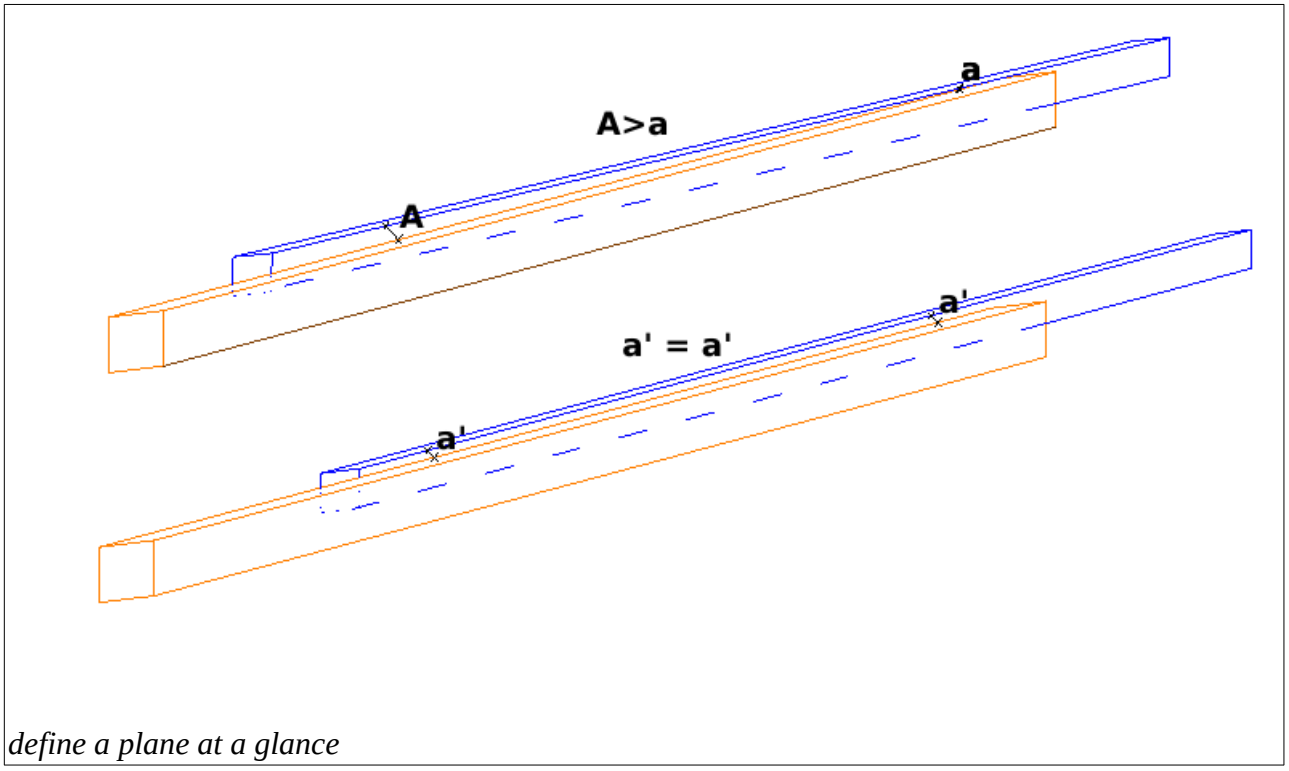
fillet hinge

When drilling with a hand tool, it is necessary to have a helper, or better still two helpers at 90°, check the perpendicularity of the drill for each drilling.

Once the assembly with wood screws is completed and checked, always install at least two bolts per connection between two pieces of wood.

The worktop

A good work surface is essential. Its first quality is to be... flat, in the sense defined above; if it is also level, it is all the easier to make holes perpendicular to the surface of the wood.
The work surface can be on a large table, or trestles, or on the floor, but it must be stable, and with as much shimming as necessary for good flatness.



define a plane at a glance

The top two rafters define a veiled surface, the bottom two rafters define a flat surface. It is the glance that allows the plane to be established perfectly, provided that the operator moves his eye to the same level as the plane to be defined. "Looking down" is useless...

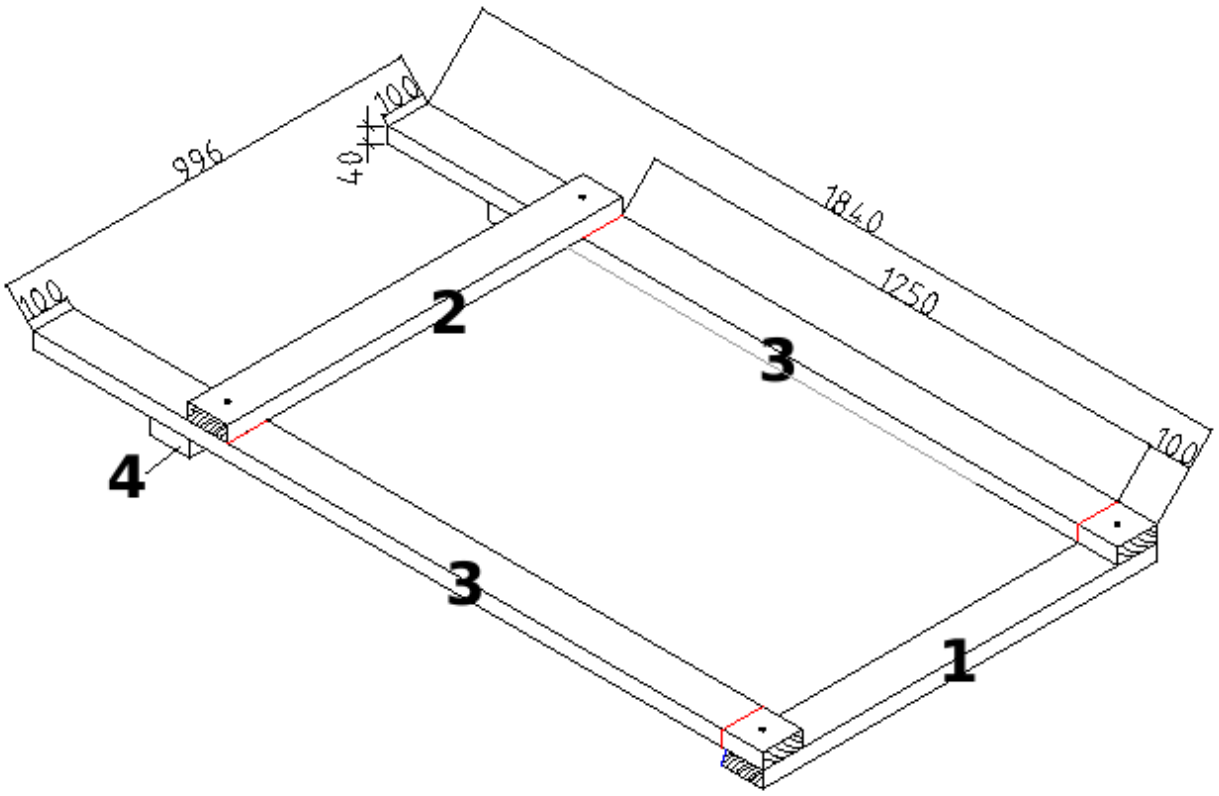
Almost all the assembly is carried out in two stages: first a wood screw assembly, with one screw for each connection, then a final assembly with bolts. To facilitate the use of wood screws, drill the first piece of wood to the "outside thread" diameter of the screw; PZ N°2 bit; if necessary, coat the thread with a little tallow or other grease.

SECTION III - THE SWIVEL CRADLE

The cradle is mounted "upside down", so that the hinges can be positioned correctly;

Present the two uprights, then the lower crosspiece below, and the intermediate crosspiece above. Wedge under the upright in line with the intermediate crosspiece, to make it easier to work.

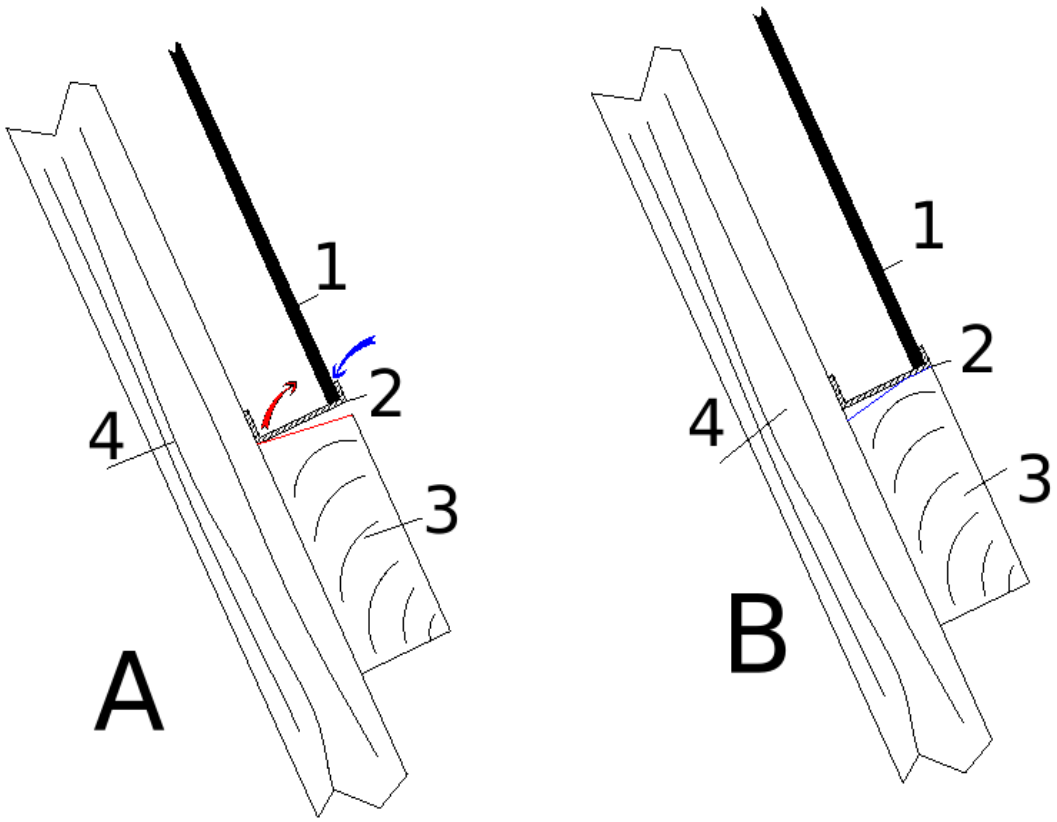
Draw a line 100 mm from the foot of the upright then at 1250; with a square, draw on the flat and on the edge of the upright, in red on the plan.



The swivel craddle 1 crosspiece below 2 crosspiece above.
3 uprights 4 temporary wedge

Screw in the intermediate crosspiece above, making sure to check the 996 mm "outside uprights" dimension, and positioning the screw in the middle of the assembly so that you can then position two bolts per assembly. Drill the crossbar to make it easier to screw in. If the screw is to be left in place after final assembly, countersink the location of the head.

BEFORE placing the bottom crosspiece, it is worth taking a short break.
The panel weighs about 18 kg, it is surrounded by a 40 mm aluminium profile, but the panel itself is only 5 mm thick, so all the weight of the panel is on its front side. Let's look in detail at how the panel will rest on the bottom crosspiece.
If the crossbar has not been cut squarely, there is a 50/50 chance that the weight of the panel will be borne by the rear part of the angle; this will cause a slight tilting of the angle, which is not designed to work in this way (red arrow), and therefore a great risk of water infiltration between the top face of the glass and the angle (blue arrow); whereas if the front face of the panel rests on our crosspiece, the risk is eliminated.



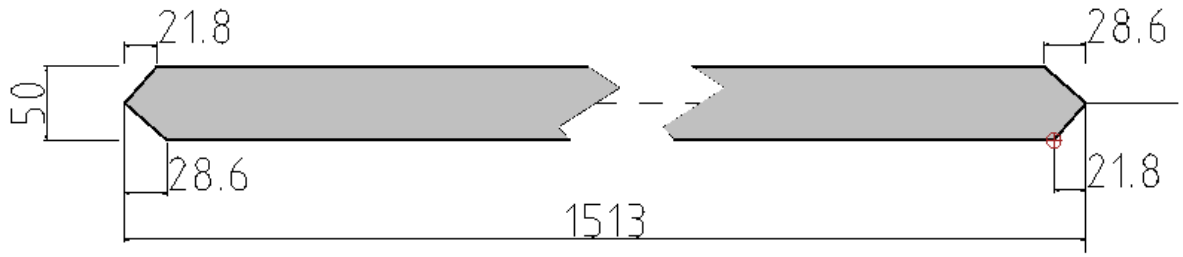
"*the devil is in the detail*" 1- solar panel 2- aluminium profile
3 bottom crosspiece 4 – craddle
A : before planing the bottom crosspiece B after planing

The solution is simple: a few strokes with a plane to "cut down" the top-rear angle of the crossbar by a few small degrees; a flat 5 to 10 mm can be left for the panel to rest.

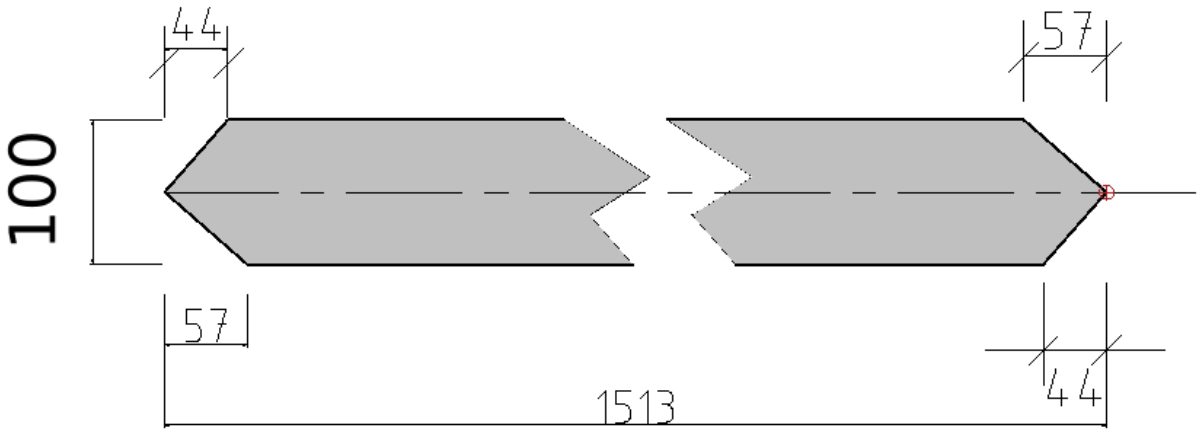
Install the bottom crosspiece, positioning the screw in the middle of the assembly. Countersink the hole to embed the screw head, which will later be covered by the fillet hinge.

Cutting the diagonal

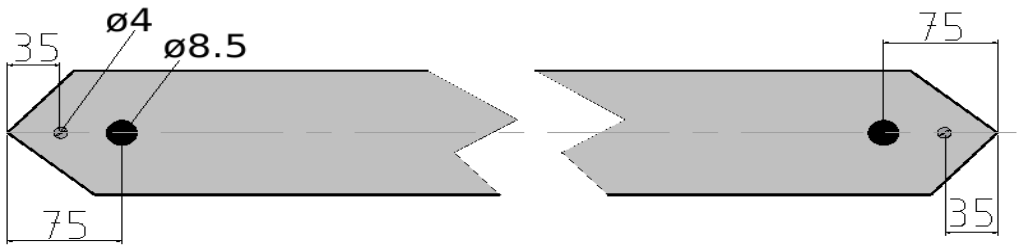
Below: dimensions for cutting the diagonal. The dimensions are given for a 50 mm wide diagonal on the one hand, and for a 100 mm wide diagonal on the other. Both solutions are good, depending on the wood available and its quality



cutting 50 mm wide diagonal



Cutting 100 mm wide diagonal

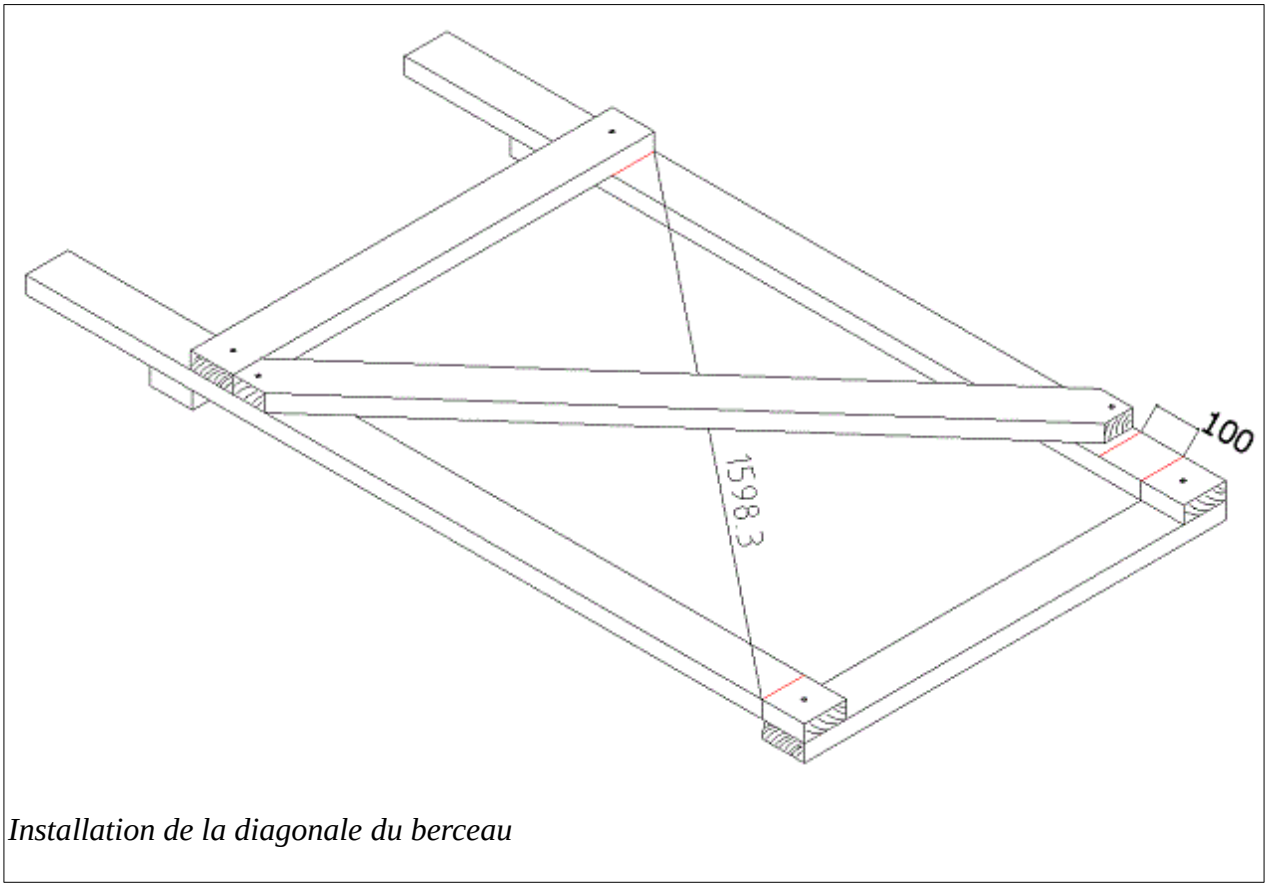


Drillings: diam. 4 mm for pre-assembly screws, and diam. 8.5 mm for the final bolt connection. The exact position of the holes does not affect the exact squareness of the assembly, which will be done by measuring the diagonals

To square the cradle, measure the diagonals between the two lines, which must be equal, the exact value is the average of the two; theoretically: (1250*1250) + (996 * 996) =
2 554 516; square root = 1 598.3.

When measuring with the end of a tape measure, the accuracy is not very good, it is better to measure from 10 cm away from the end.
Make sure that both operators use the same side of the tape measure.
The squareness can be adjusted with small hammer blows until it is satisfactory.

Screw on the diagonal, leaving the last 20 cm of the jamb free for the hinge to fit.



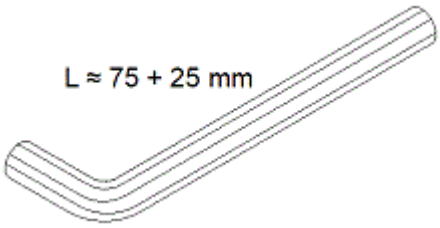
Installation de la diagonale du berceau

Check the squareness: turn the cradle upside down and install the photovoltaic collector (... to be handled horizontally...), by wedging it against the lower crosspiece. The long sides of the collector must remain within the 5 mm gap initially planned.

Turn the cradle upside down to install the half hinges

Preparing the hinges

- Remove the pin by filing off the riveted head, then hammer it out. This pin must be removed when the panel is put away. The original pin has a diameter of 7 mm; it can be replaced by a piece of concrete iron Ø 6 mm or even by a bolt Ø 6 mm (it is not very elegant) or by any other means



Let's agree that the half-hinge with one pin support will be installed on the cradle, and that the half-hinge with two pin supports will be installed on the base

enlarge the central hole of the half-hinge of the cradle to Ø 8.5 mm; be carefull : for safety reasons, to carry out the hole, fix the half-hinge with screws on a larger piece of wood to hold it firmly during the operation.

Check that the other holes in the hinge allow the passage of an M6 screw.

Installation of the half hinges on the cradle

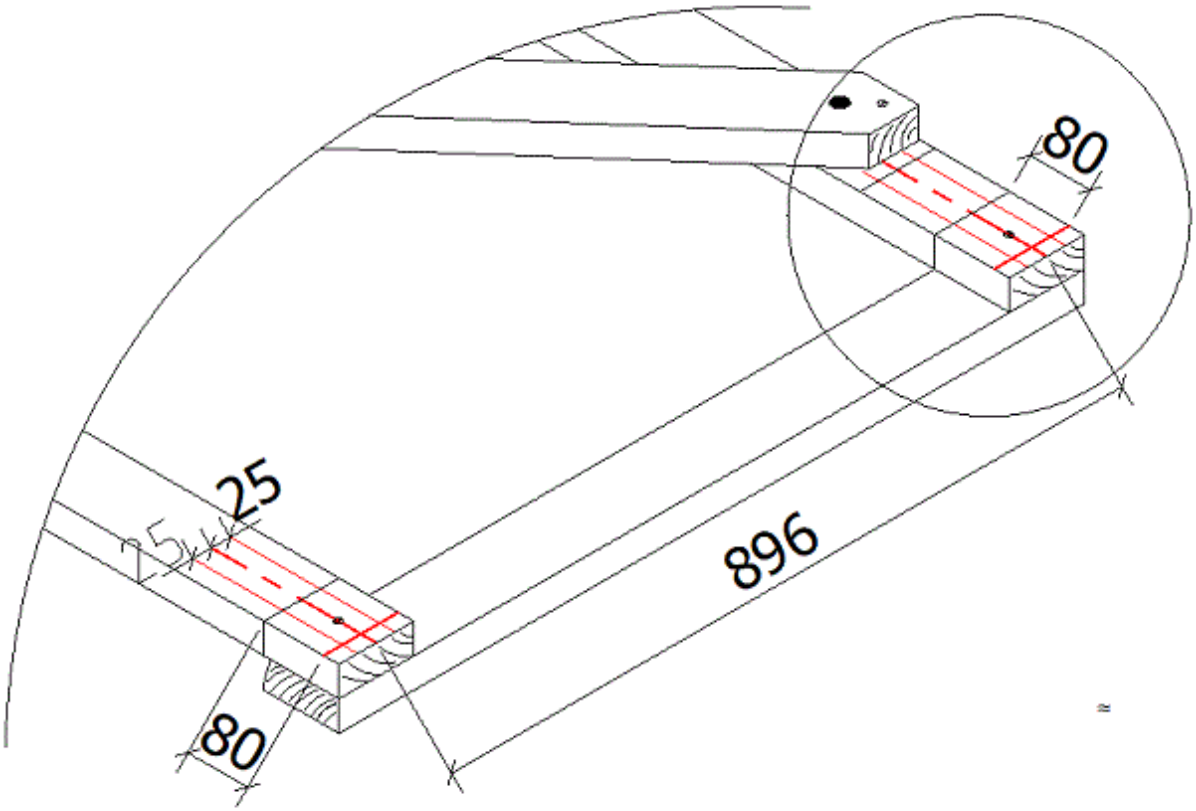
see diagrams on next page.

- Trace the axis of each jamb, and check the 896 mm dimension; an error of a few millimetres is acceptable
- make two lines 25 mm from the axis, to align the hinge correctly
- make a square trace 80 mm from the previous trace
- provisionally fix the plate with three screws, using the line as a reference, see drawing
- drill the crosspiece and the upright to Ø 8.5 and bolt with a round head bolt
- unscrew and drill the other holes of the plate and bolt with two M6 x 100, and one M6 x 60; the M6 are necessarily flat-headed, round-headed bolts would risk bumping into each other when the hinge is fully closed.

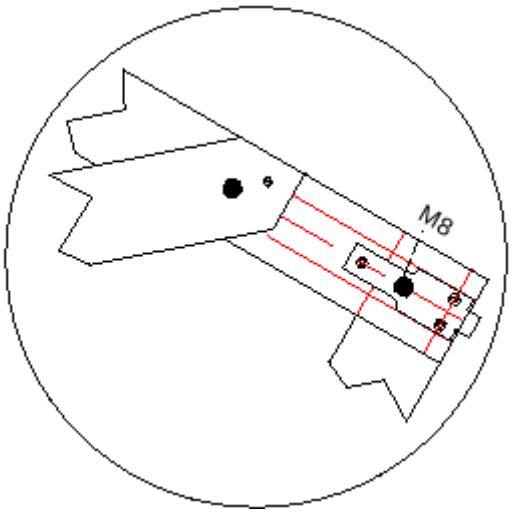
Beware that the nut of the small M6 x 60 bolt would be a nuisance each time the panel is installed and removed; to remedy this

- embed the nut in the jamb
- or turn the bolt upside down, with the head on the panel side (although the head should be somewhat countersunk), and the nut on the hinge with a washer; in this case, cut off the excess length of the bolt, so as not to interfere with the closing of the hinge.

Install the top crossspiece with M6 or M8 bolts.



Drawing for the installation of the half fillet hinges on the cradle, rear side



Detail of the positioning of a half hinge on a cradle upright - plan view

SECTION IV - THE BASE

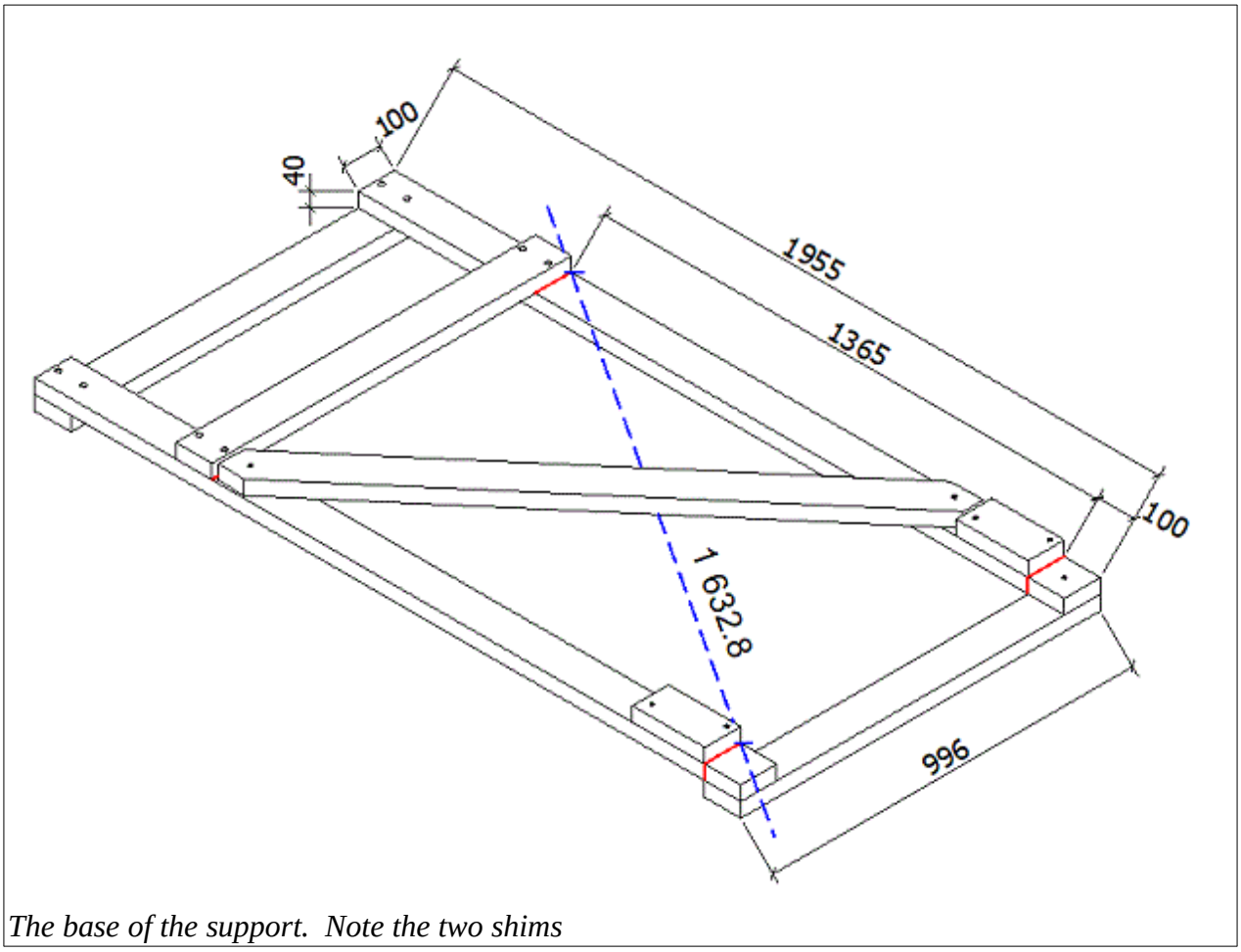
The base is mounted "right side up".

On the two uprights make the marks at 100 and 1365 mm

Screw on the intermediate and front crosspiece

Carry out the squaring. The length of the diagonal between the blue dashed lines (outside of one upright, then inside of the other): 1632.8 mm.

The wooden diagonal is to be installed on the underside of the base; for the time being, install a provisional diagonal, leaving 200 mm free between the provisional diagonal and the line of the front crossbar, in order to install the shims;

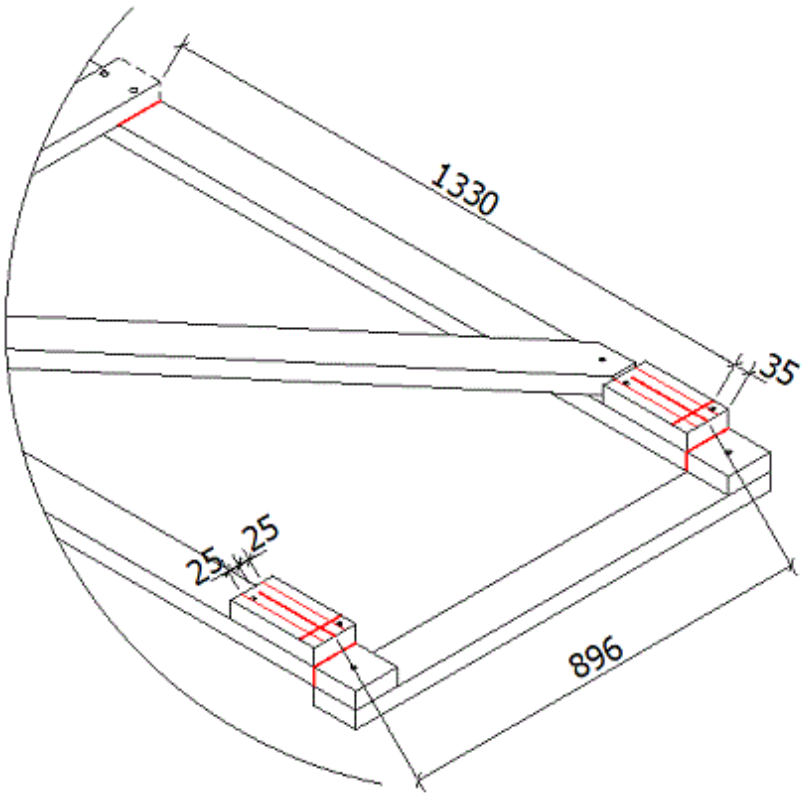


The base of the support. Note the two shims

Bolt the intermediate crosspiece permanently in place.

Install the two shims measuring 180 x 100 x 40; distribute the screws taking into account the installation of the half hinge.

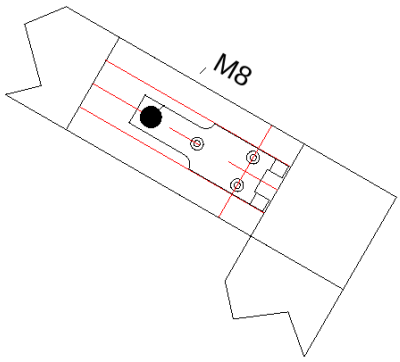
Draw a square line on the two shims at 1 330 from the intermediate crossbar, then draw the axis of symmetry and the width of the half-hinge; check that the dimension between the axes of symmetry is identical to that of the mobile cradle. A difference of a few millimetres is acceptable.



Implantation des demi charnières sur les cales d'épaisseur

Prepare the hinge halves: enlarge the last hole to Ø 8.5, and the others for M6

Install a half-hinge as shown in the plan view opposite, with screws; present the cradle, insert the pin in the half-hinge just installed, and position the second hinge; there is a slight gap between the half-hinges, which should be evenly distributed to facilitate later installation and removal of the panel.



Détails d'implantation sur les cales de la base – vue en plan

Install the final diagonal on the underside, length: 1530; for the end cuts, refer to the previous diagonal.

The hooves

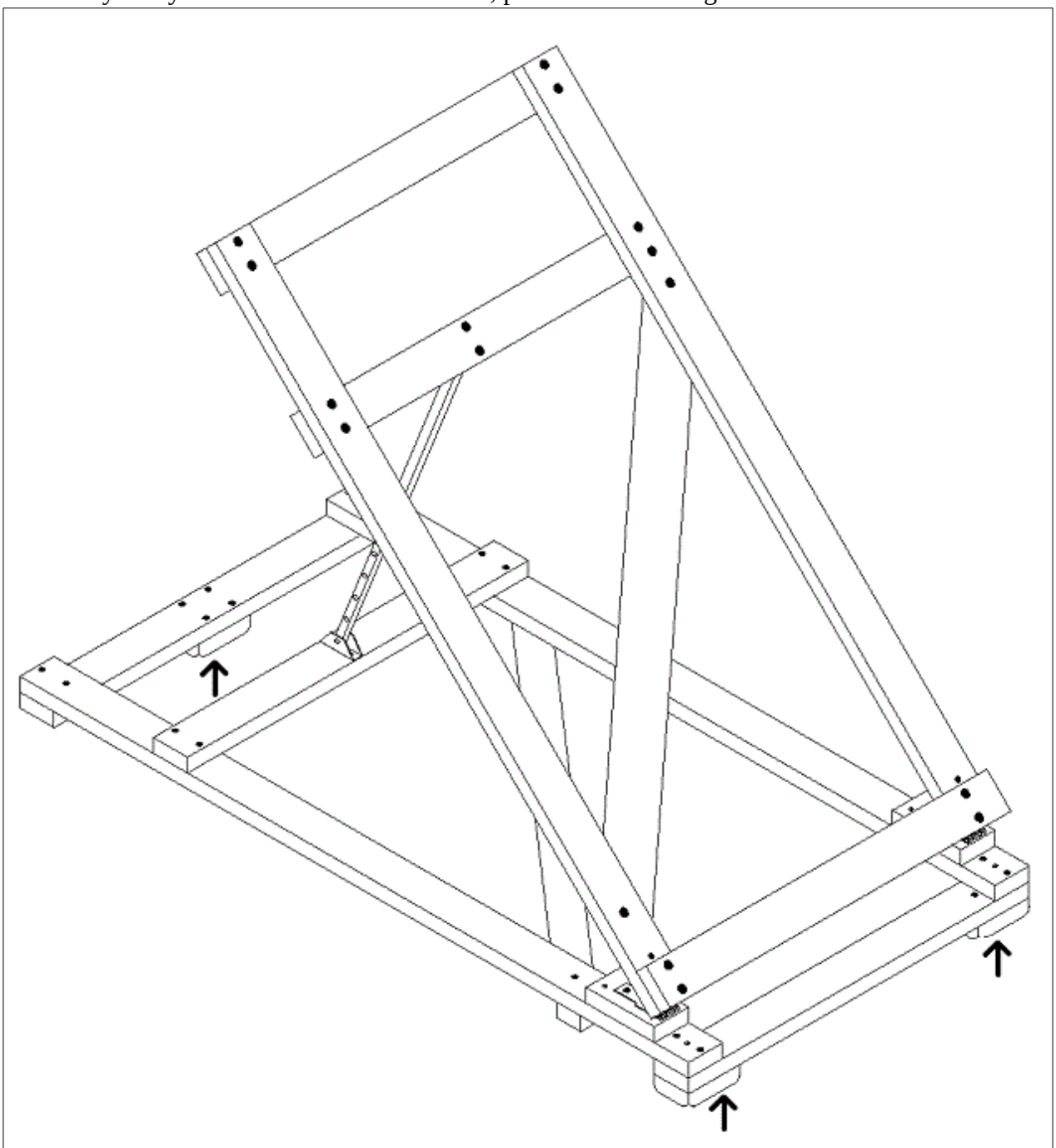
Turn the base over;

The hooves are wear parts installed under the base: two under the front crossbar, and one under the rear crossbar

Prepare three shoes, dimensions ≈150 x 100 x 40.

Under the front crosspiece you have to assemble three layers of wood; Japy bolts M8 x 150 and M8 x 130 are available (vis-express.fr 8414811518); you may prefer to use M8 threaded rods. Under the shoe, countersink the nuts or bolt heads by drilling to diameter 22 or 24.

To reduce the thickness of the bolts, the shoes can be shifted slightly inwards, but this is not very satisfactory. They can also be shifted outwards, provided that a longer crossbar is used.



Installing the three shoes

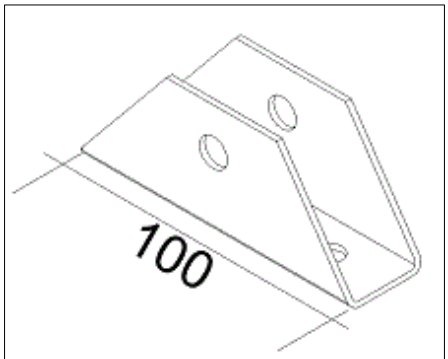
SECTION V OTHER ELEMENTS OF THE COLLECTOR SUPPORT

§ 1 THE TELESCOPIC ADJUSTMENT TUBE

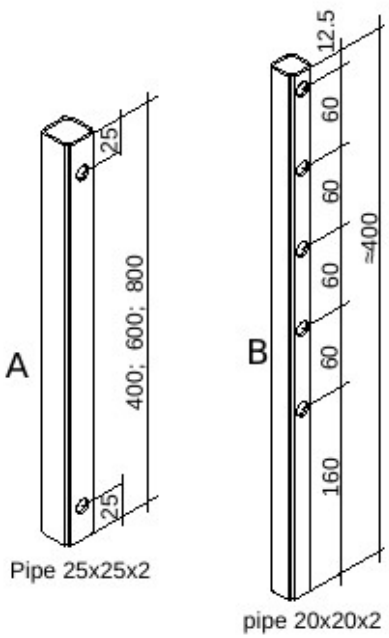
Many solutions are possible. We propose below a version in metal tube, which could very well be a reconstituted wooden tube (two cleats clamped between two strips of plywood), or a mixed solution with wooden tube and metal slides.
In order to have a sufficient range of adjustments, it is necessary to provide two or three central sections of different lengths, and two slides drilled every 60 mm
Pins Ø 6 mm are very suitable
Drill to a much larger diameter than the pin, to facilitate the adjustment process.
Check that the foot and the head of the telescopic tube articulate well in the brackets

For the brackets, you can also use any material available. Below: a one-piece support made from a 27 x 40 tube; a two-piece support is also very suitable.

When the sun is high in the sky, you may prefer to install the tube on the end crosspiece.



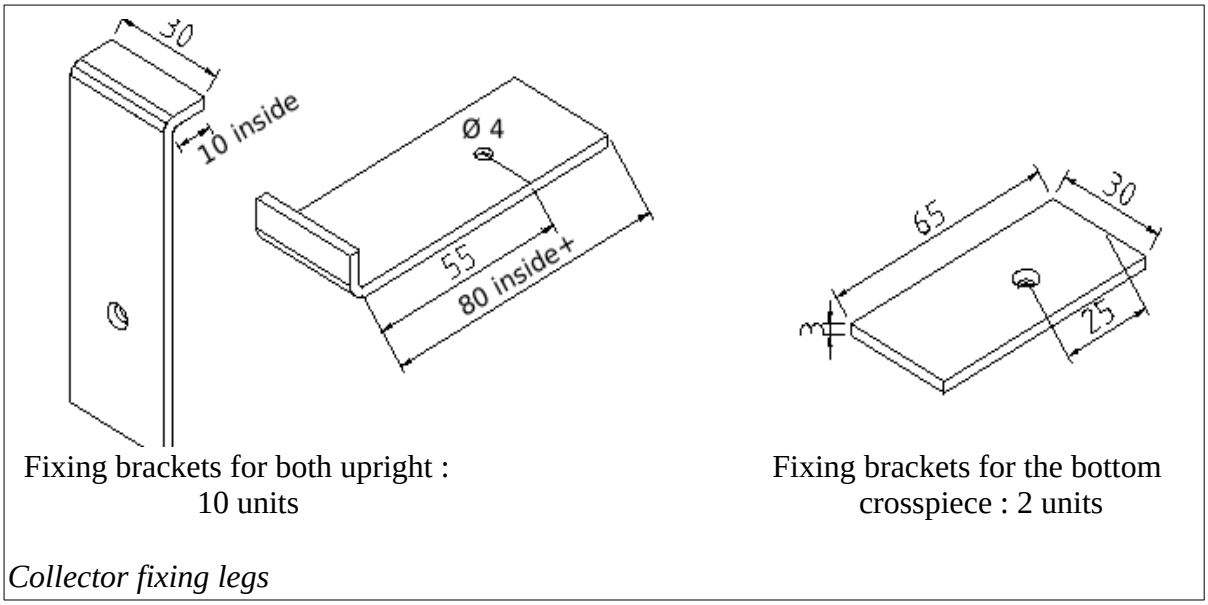
Brackets for end tubes ; 2 units



Sliding tube, to be adapted to the latitude
A : Central tube; provide several different lengths
B : end tubes, 2 units

§ 2 COLLECTOR FIXING LEGS, to hold the collector on its cradle

They should be made, for example, from a flat iron or aluminium strip, section 30x3 mm, and fixed with screws of at least 4 x40 mm.



Fixing brackets for both upright : 10 units

Fixing brackets for the bottom crosspiece : 2 units

Collector fixing legs

§ 3 WEIGHTS AND THEIR SUPPORT

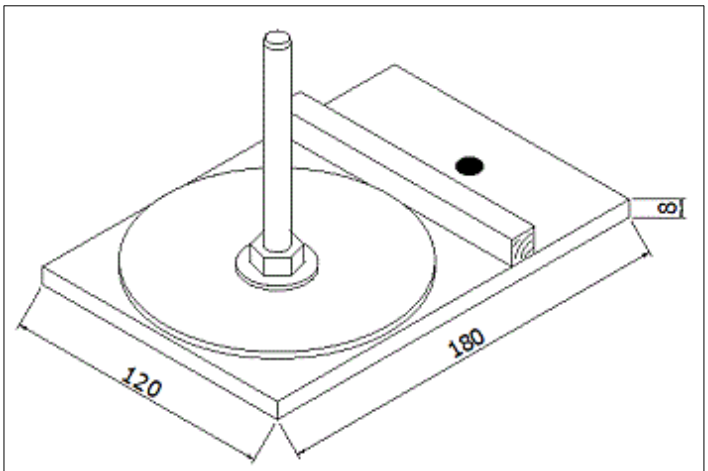
Bags of gravel weighing about 10 kg are a good choice.
When not in use, especially at night, spread the bags on boards placed on the base. During periods of use, the weights are removed to make it easier to drag the collector along the ground.
If there is a fear of a gust of wind during the day, the top crosspiece of the collector can also be tied to a stake with a rope.

§4 THE ADJUSTMENT INDICATOR

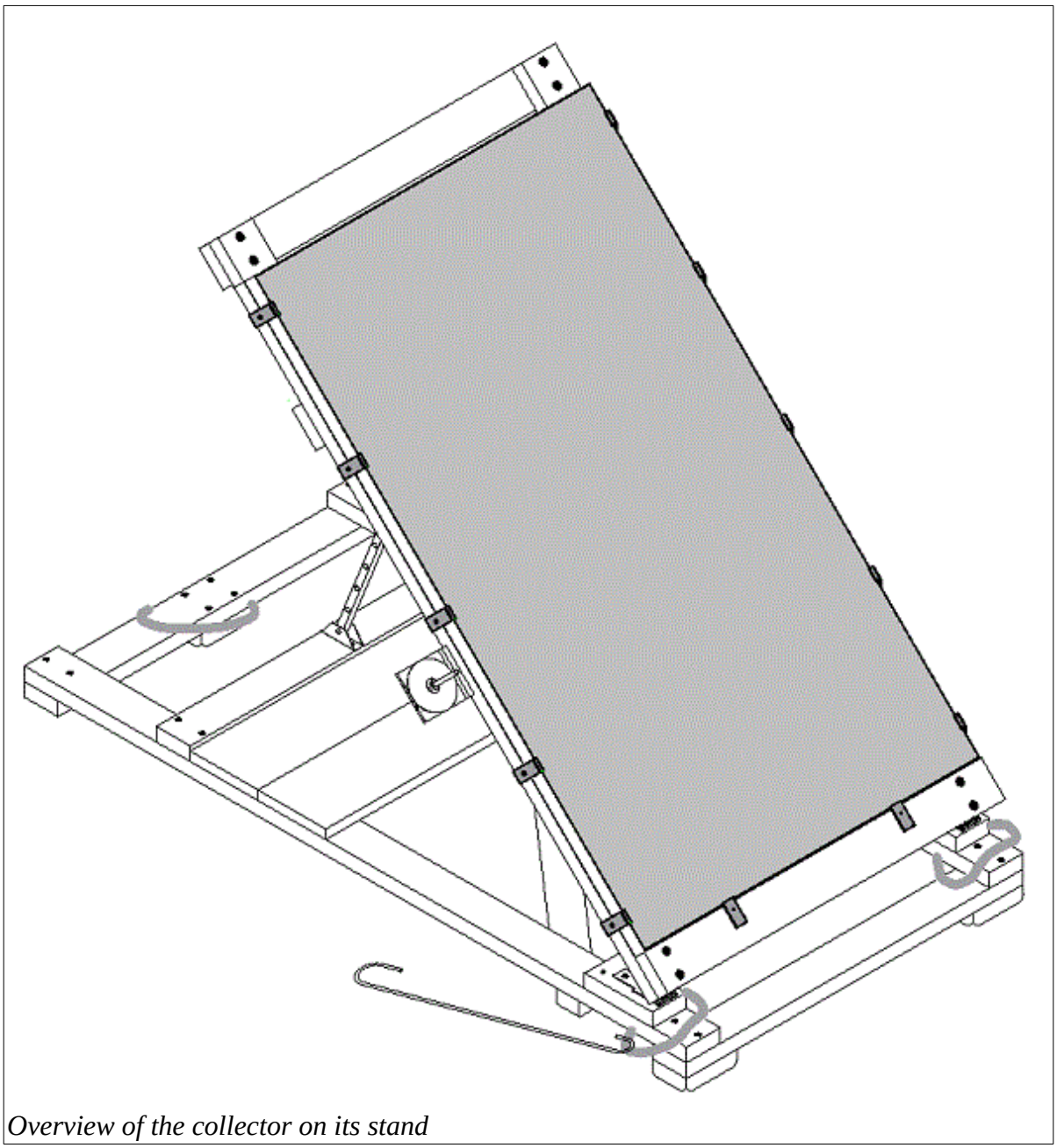
This is a rod, positioned perpendicular to the surface of the collector. The length of the shadow cast by the rod indicates how well the collector is positioned.

- 8 mm plywood plate
- rod (the gnomon) made from a Ø 10 mm bolt L = 120 mm with the hexagonal head cut off
- to facilitate the reading of the shadow, install a white PVC sheet ; here : a round cover.

The small strip blocks the plate correctly against the upright.
The whole thing is screwed under a cradle upright.

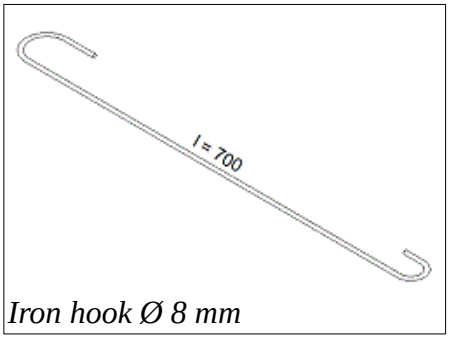


the adjustment indicator



Overview of the collector on its stand

§5 INSTRUCTIONS TO BE GIVEN TO THE USER



Iron hook Ø 8 mm

During the hours of use

To follow the sun in its East-West course, the collector can only be dragged along the ground by **pulling the base** with a cord or a hook, for example made of 8 mm diameter concrete iron. It is strictly forbidden to push or pull on the mobile cradle

If the collector is not used for a long period of time, it must be stored in a safe place with its cradle, handled vertically and stored on its lower crosspiece.

CHAPTER VII - THE COOKER: INSTALLATION AND USE

INSTALLATION OF THE COOKER

The cooker can be installed anywhere according to the user's wishes, on one condition: to be as close as possible to the photovoltaic panel, so as not to dissipate energy in the electric cable. Given the characteristics of the electrical current supplied by the panel, this is an unavoidable problem, unless the following rules are followed

For a SINGLE panel of about 300 Watt:

Cable of maximum length 3 metres: use a cable with a cross-section of 2.5 mm².

Cable of maximum length 6 metres: use a cable with a section of 4 mm².

If the cooker is outside, protect the screen of the small electric meter from sunlight.

To connect the cooker and the collector, you can use banana plugs Ø 4 mm, For example: conrad.fr ref 1582242; check the admissible amperage; banana plugs for audio-visual are not usable here.

- red colour for the positive cable, female plug on the collector side, and male plug on the cooker side.
- black or blue for the negative cable, plug on the collector side, and socket on the cooker side;

This reduces the risk of polarity reversal by the user, in addition to the protection provided by the diode installed in the cooker.

Fiches banane 10 Ampere pour le raccordement du capteur au cuiseur

CHOICE OF CONTAINER

Its first quality must be a flat bottom; a container with a convex bottom will not work.

Its second quality is not to be too big: when it comes to heating food, the power of the cooker is not very high; on the other hand, if it is possible to orientate the panel, it can work all day. It is better to cook several times in a row than to cook too much and for too long.

A saucepan with a diameter of 16 or 18 cm is very suitable. There is no point in using a large pan that is only half full: the top half of the pan will only serve to cool the bottom half unnecessarily... The tail of the pan is a great hindrance to the insulation, so it is best to remove it or cut it off.

An aluminium pan with an "electric bottom" like the one shown below is very suitable. If there is no tail or handle, the rounded edge allows you to grip the pan with potholders.

saucepan on aluminium

A good saucepan base

A container base such as the one shown here, which is becoming more common, is very satisfactory;

The lid is of course essential; a glass lid allows you to observe the cooking process from time to time without opening the container. It is necessary to track down all opportunities to lose heat!

Why not use a pressure cooker? A pressure cooker of up to 3.5 litres seems a reasonable size; smaller ones are available, starting at 1.5 litres. With two cookers working alternately in a "Norwegian pot", the Norwegian pot effect would start at 110°C (or 120°C depending on the model), instead of starting at 100°C with ordinary containers.
But this requires intensive use of the cooker; initially, one can start with intensive use with ordinary pots, taking advantage of all the hours during which the sun offers its energy.

INSULATION

This is the condition without which it is useless to operate the cooker. Small cotton towels are the best choice, to be dried between each use and washed regularly. They are not likely to catch fire, as the temperature of the electric resistors does not allow this; however, a small chicken wire or mesh wire around the heating block would be welcome.

THE SURFACE CONDITION OF THE HOTPLATE

The cleanliness of the hotplate: any dirt on the hotplate prevents the heat from passing through. It is useless to heat the plate if the heat does not reach the bottom of the container, which must be as clean as the plate. Before placing the container on the hot plate, check that there are no grains of sand or other debris. A thin layer of air between the plate and the bottom of the container acts as an insulator; a few grains of sand are enough to prevent the cooker from working.
If there is any doubt about the flatness of the hot plate or the container, pour a spoonful of oil onto the plate, place the container on it and turn it around a little, then observe the distribution of the oil on the bottom.

TYPES OF COOKING

When cooking, there are two periods: the heating of the food, and then the actual cooking, which requires much less heat since it is sufficient to compensate for the losses in order to maintain the temperature. Since the container is insulated, the cooker is at ease during the second period; but as it is not very powerful, the heating period is longer than with other means of cooking (at the cost of a much greater expenditure of energy, but that is another problem).
We know that water is the most difficult substance to heat. It is therefore when cooking with water (tubers, pasta, etc.) that the cooker will be the least efficient.
When cooking pasta, it is necessary to uncover the lid, which causes a lot of heat to be lost, and when cooking couscous, the usual couscoussiers are too big for a small cooker like the one proposed here. This type of cooking can be reserved for traditional means.
For cooking rice, the cooker is more efficient for cooking pilaf rice (one and a half to two times its weight in water) than for cooking rice in water (which requires 5 measures of water for one measure of rice).
Until larger cookers are available - which is quite feasible - the preferred cooking methods are those where the food is cooked in its own water, without the addition of liquid. It is possible to combine foods that produce a lot of juice (tomatoes, courgettes, etc.) with those that do not produce any (potatoes, carrots), the latter being cut into small pieces.
In the end, all the above indications are just common sense remarks.

OPERATING THE COOKER

On the control panel, the driver has on his left, a button with three positions: a position 0, where nothing happens, a position I for the starting of the cooker, and a position II allowing the use of the solar panel for other needs (recharging of mobile phones or a small power bank...) during the hours of non-use of the cooker, or when the sun is not sufficient.
Once the cooker has been started, the driver turns on the heating elements using the three buttons on the control panel on his right. It is up to him to find the best combination, taking into account the sunshine. To help him in his choice, the driver has an electrical measuring device, on which he has to read the power in Watt, at the bottom left of the device.

The variations in sunlight are incessant, as is the power it delivers; there is no point in trying to keep track of them minute by minute. Once a good choice has been made, the driver will only return to the cooker if there is a noticeable variation in sunlight.

The Wattmeter is essential to drive the collector correctly, but its screen, like most electronic screens, does not appreciate the sun's rays: it must be covered at all times.

AN ORIGINAL CASE

The ceramic electric resistors installed under the heating plate have a different behaviour from the usual electric resistors. They regulate themselves and do not exceed 190°. Once they have reached this temperature, they consume very little electricity, just enough to keep them warm.

You can try this out: in very good weather, run the cooker without a container; it will consume all the electricity available to bring the hot plate up to temperature. Once 190°C has been reached, the Wattmeter will drop significantly while the sun continues to shine, which makes you wonder whether the collector is not malfunctioning. If you put an empty container on the plate, the consumption increases rapidly, then starts to stagnate again; and by adding one or two glasses of water to the container, everything returns to normal.

In order for the cooker to work properly, the heat supplied by the heating elements must be extracted continuously, otherwise consumption will stagnate. It is interesting to repeat the operation by placing a few large grains of sand between the plate and the container: the heat is not transmitted and the same phenomenon occurs. The cleanliness of the plate and the bottom of the container are therefore essential for the collector to work properly.

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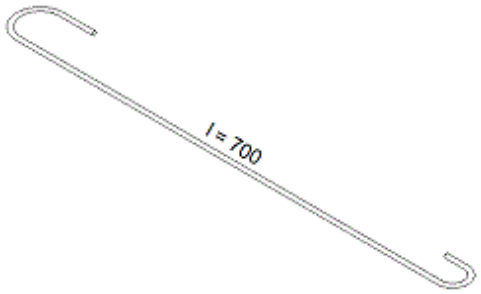
Reminder of the end of the previous chapter:

INFORMATION TO BE GIVEN TO THE USER

During the hours of use
To follow the sun in its East-West course, the collector *can only be dragged along the ground* by pulling the base using a cord or a hook made of 8 mm diameter concrete reinforcing bars. It is strictly *forbidden to push or pull on the mobile cradle.*

If the collector is not used for a long period of time, it must be stored in its cradle, handled vertically and stored on its bottom crosspiece.



8 mm Ø concrete bar hook for reorienting the collector

CHAPTER VIII - MEASURING COOKER PERFORMANCE

To measure the performance of the cooker, there is a simple method: place a litre of cold water in a container and measure the time needed to bring the water to the boil.
The measurement should be carried out in good conditions, not necessarily in perfect conditions, but the cooker should not be penalised, otherwise the performance measurements are meaningless.

-sunshine: it is desirable to measure the sunshine; 920 to 960 W/m2 would be a good value
- orientation: the panel must be correctly oriented in both directions; a 15° offset on either side of perfect orientation can be accepted.
- Insulation: Correct insulation, including above the cover, is a prerequisite
- the use of a thermometer is essential, to measure the temperature of the water at the beginning and end of the operation.
- The small problem with this method is to define the boiling point perfectly: is it a simmering, strong or violent boil? The time between one and the other can be more than a few minutes, which biases the measurement. The correct solution is to stick to a temperature rise to 97 or 98°C, and to announce the result as follows: "to raise one litre of water from a temperature of 17°C to 97°C, XX minutes were necessary".
- If a thermometer like the one proposed in Chapter 1 is used, it is not necessary for the probe to be immersed in the liquid; due to the insulation, the ambient temperature inside the container is approximately equal to that of the liquid.

Some basic thermal calculations

By definition, the Joule is the unit of measurement for energy, whether thermal, electrical, mechanical, etc.
Water is the most difficult body to heat, 4.18 Joule are needed to increase the temperature of 1 gram of water by 1° C. This is the definition of the mass heat of water.
Thus, raising the temperature of one kilogram of water from 17 to 97°C is equivalent to doing work of 1,000 grams * (97-17°C) * 4.18 Joule = 334,400 Joule (excluding thermal losses…)

By convention, when a thermal, electrical or mechanical machine produces work of 1 Joule per one second, it is said to have a power of 1 Watt.
In our case, this means a temperature rise in 35 minutes. 35 *60 = 2 100 seconds
As the work of 334,400 Joule was done in 2100 seconds, the useful heating power was 334,400/2,100 ≈ 160 Watt.

Let's not rush to draw any great qualitative conclusions from these figures, until we have other elements of comparison...
And it is always possible to add photovoltaic collectors...

And the 160 watts seem small compared to the 1200 watts of a gas cooker burner. But the 160 Watt represents the work done, whereas the 1200 Watt represents what you will pay to the energy supplier, regardless of the use you make of it and all the heat that will pass around the pan.
These are figures where everyone sees noon at their own door, and which can fuel discussions until very late at night.

As far as sunshine is concerned, it is possible to measure it with a solarimeter such as this one, available from Conrad.fr, reference 101 038, for about 60 Euros; its accuracy is + or - 5%.
But it is not essential.

The cooling measurement also provides a good indication of the quality of the insulation; the order of magnitude is a decrease from 100 to 90°C during the first half hour after the heating has stopped.

CHAPTER IX - CHARGING MOBILE PHONES

AND "USB LANTERNS

When the collector is not being used for cooking or when there is not enough sunlight, it can be used to charge mobile phones, or "USB lanterns", or external back-up batteries (= "power bank ") for mobile phones.
Two methods are available:
1- a classic method, with a charge regulator, a 12V lead-acid battery, and then a "12V" mobile phone charger
2- a lighter method, using only a "Direct Current Converter.

THE DC DC CONVERTER

It is a small electronic component, fully encapsulated, which admits a variable DC supply voltage between 8 and 50 Volts generally, and which produces a voltage of 5 Volts identical to that of the chargers that are connected to the network.
They are available on the Net under different names: power converters, voltage down converters, buck converters, etc.
There are many models, so check the characteristics carefully.
The "48V-24V-12V to 5V" models generally accept all voltages between 48 and 8V

A MINI-INSTALLATION

The converter is to be connected to the output of the control panel of the "other uses" cooker, respecting the + and - poles .
The user will always want to use the electricity supplied by the panel "to the last drop", but the inverter still requires a minimum voltage. A good practice is to have a small voltmeter, either electronic or with a needle, and to set a threshold below which the inverter should not be used, for example 8 V.

The voltmeter and converter could be installed on a plywood plate (with a switch?) on which the devices to be charged would also be placed.
NB the minimum threshold of 8 Volts is understood to be after the converter has been plugged in during operation, as plugging in causes an inevitable voltage drop.

EXTERNAL BATTERIES

Also known as back-up batteries, these are sophisticated components which, in addition to the battery itself, include a Battery Management System to manage battery charging, cell balancing, discharging, etc. It is therefore advisable to buy a good quality external battery.
For example, here are the safety standards presented by Asus :

Normes de sécurité

Protection contre la chaleur
Protection contre les courts-circuits
Protection réinitialisation
Entrée OVP (protection contre les surtensions)
Sortie OVP (protection contre les surtensions)
Protection de sens inverse d'entrée
Protection surtension pendant la charge et déchargement
Sortie OCP
Protection des cellules PTC
Protection de l'adaptateur
Protection Jeita*

The front panel includes
- a micro USB socket for charging the battery using a standard USB cable to be installed between the converter and the battery
- a usb socket, to use the phone or other as usual
- four leds, to display the state of charge
- a push button to activate the state of charge display, among other things.

Avoid getting an external battery without this display button: it is always frustrating to have a battery in your hand whose state of charge you cannot know.

For a 10 000 mAh battery, a manufacturer indicates a charging time of 6 hours with a 5V-2Ampere charger (i.e. 5*2 = 10W), or a charging time of 9 hours with a 5 Volt-1Ampere charger (i.e. 5*1 = 5W), to be compared with the power of the cooker of the order of 230 W approximately in continuous regime; but one can prefer external batteries less powerful.

CHARGING PHONES

As a precaution (perhaps superfluous) it is better to charge a phone from the external battery, rather than directly from the DC-DC converter, as the current delivered by the battery may be of better quality than the converter.

USB LANTERNS

These have a lithium battery that provides many hours of lighting, and are recharged like a telephone.