

# Photovoltaic solar cooking without batteries and storage

General summary of the documentation :

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Websites:


[FR Français](#)

[DE Deutsch](#)

[EN English](#)

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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 1 : MANUALLY OPERATED COOKER : CONSTRUCTION

**The manually operated cooker proposed here is designed to work with a photovoltaic panel of about 300 Watt-peak, / 40 Volt Max / 10 Ampere Max**

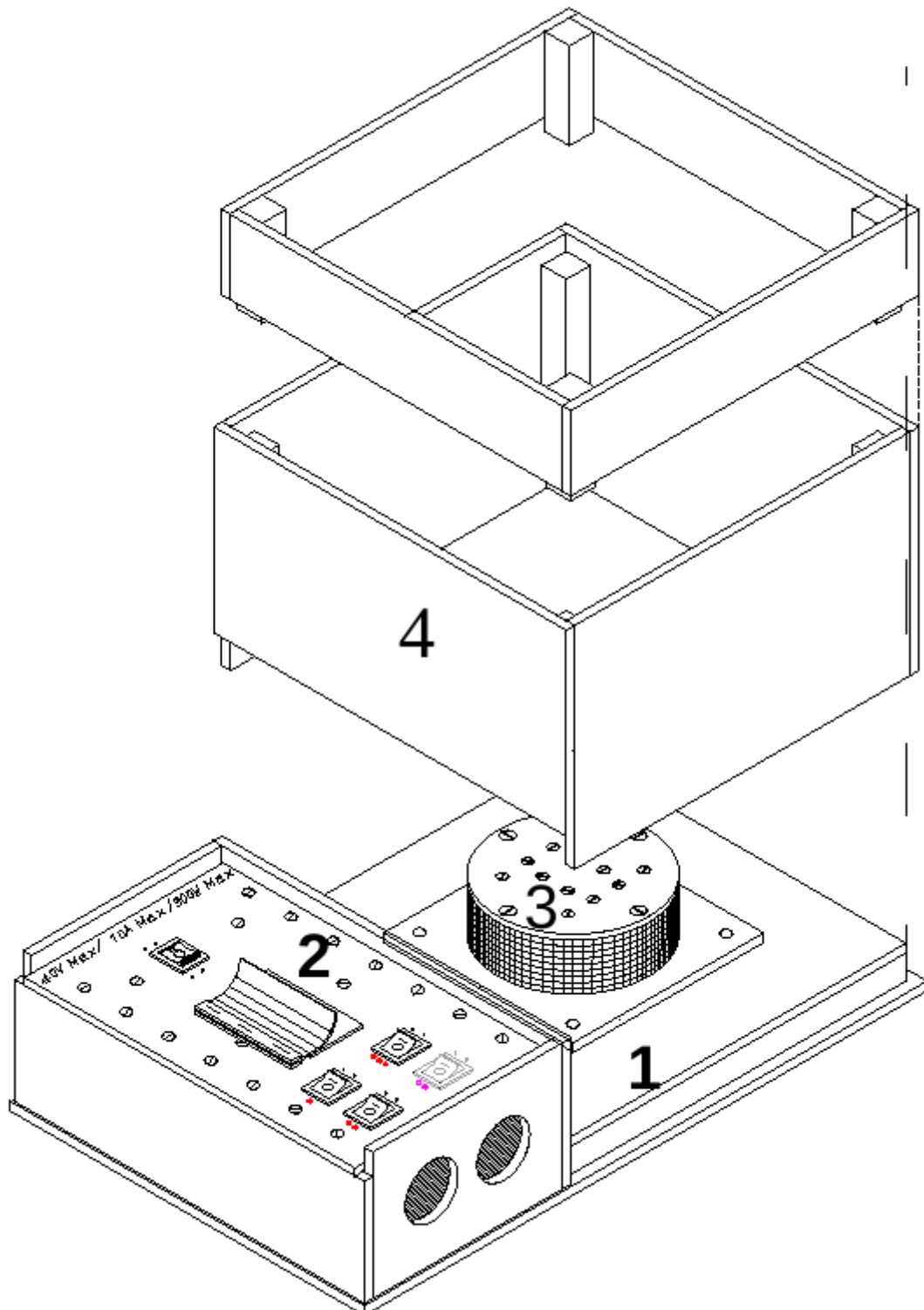
The construction takes place in about ten steps, designed to facilitate self-construction by a careful amateur, and therefore also by a craftsman or technician; the 2nd part "Appendices" provides additional details.

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3	1st STEP The base of the cooker
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Do not hesitate to consult systematically the 2nd part "Appendices" for additional information concerning in particular the reference of the materials, their possibilities of supply, etc.

Translated with the help of [www.DeepL.com/Translator](http://www.DeepL.com/Translator) (free version)

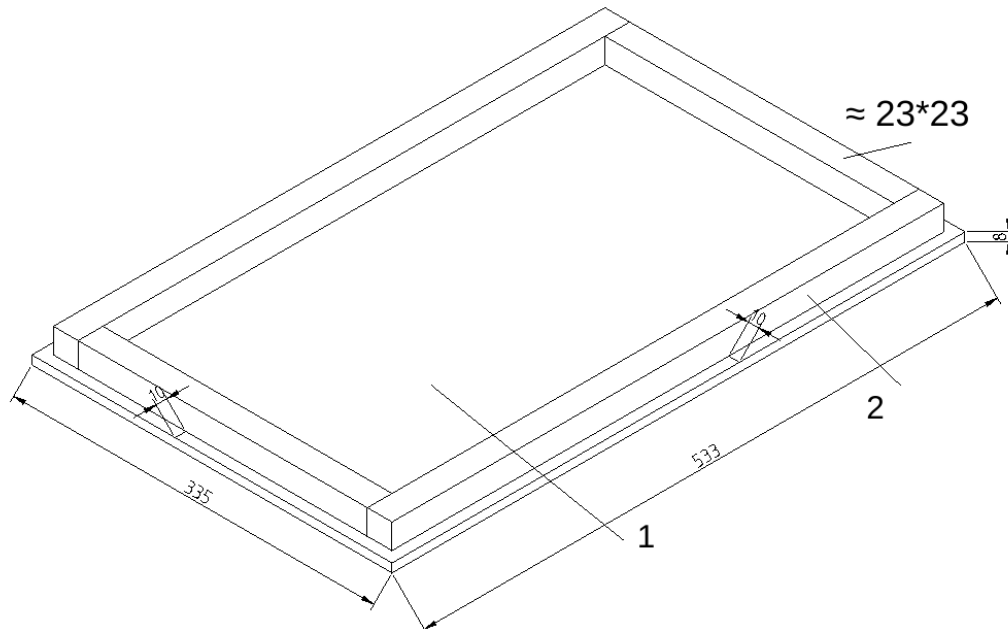


Overview of the manually operated cooker

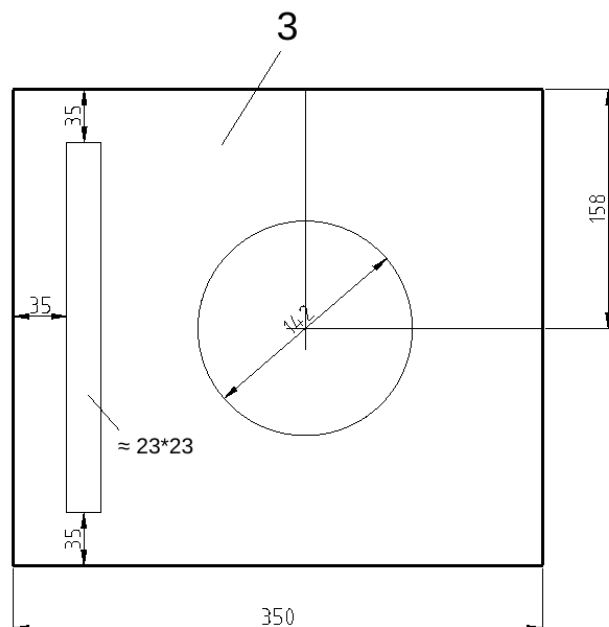
- 1- base
- 2 - control panel
- 3- heating block
- 4 - booster for insulation

## 1st STEP - THE BASE OF THE COOKER

Use 8 mm thick plywood, if possible of "exterior" quality.  
Line the bottom plate with cleats

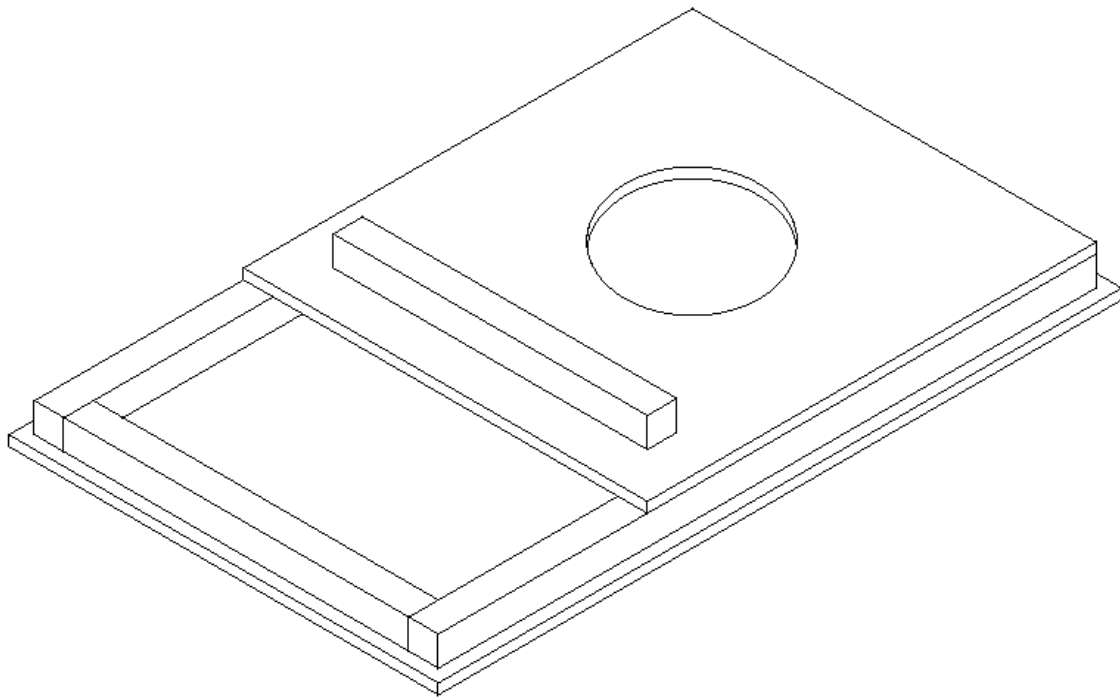


1 – bottom plate  
2 – cleats  $\approx 23*23$   
3 - top plate:

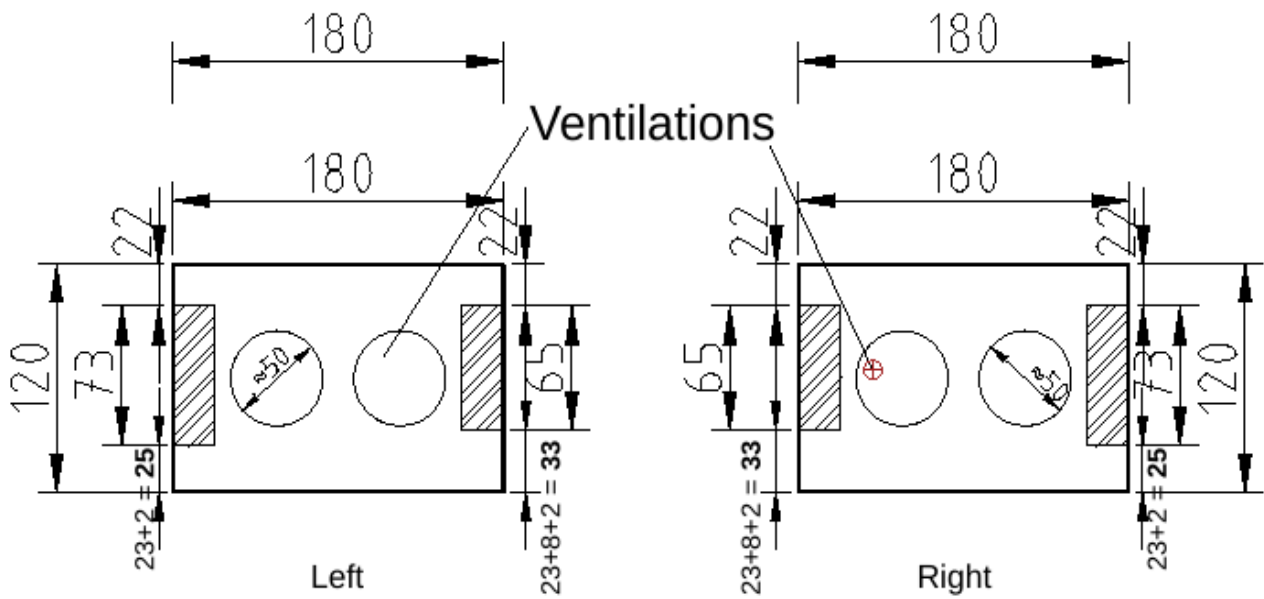


Prepare the top plate: make a hole diameter 142 mm, and install a cleat

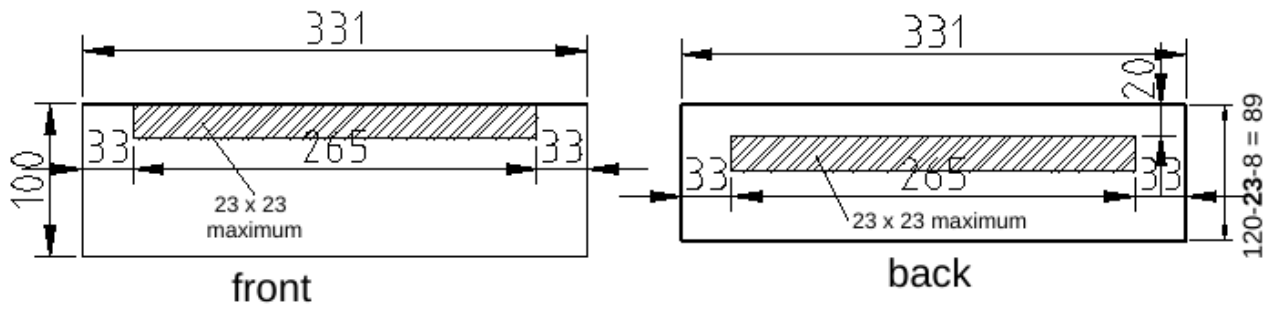
complete the assembly of the base



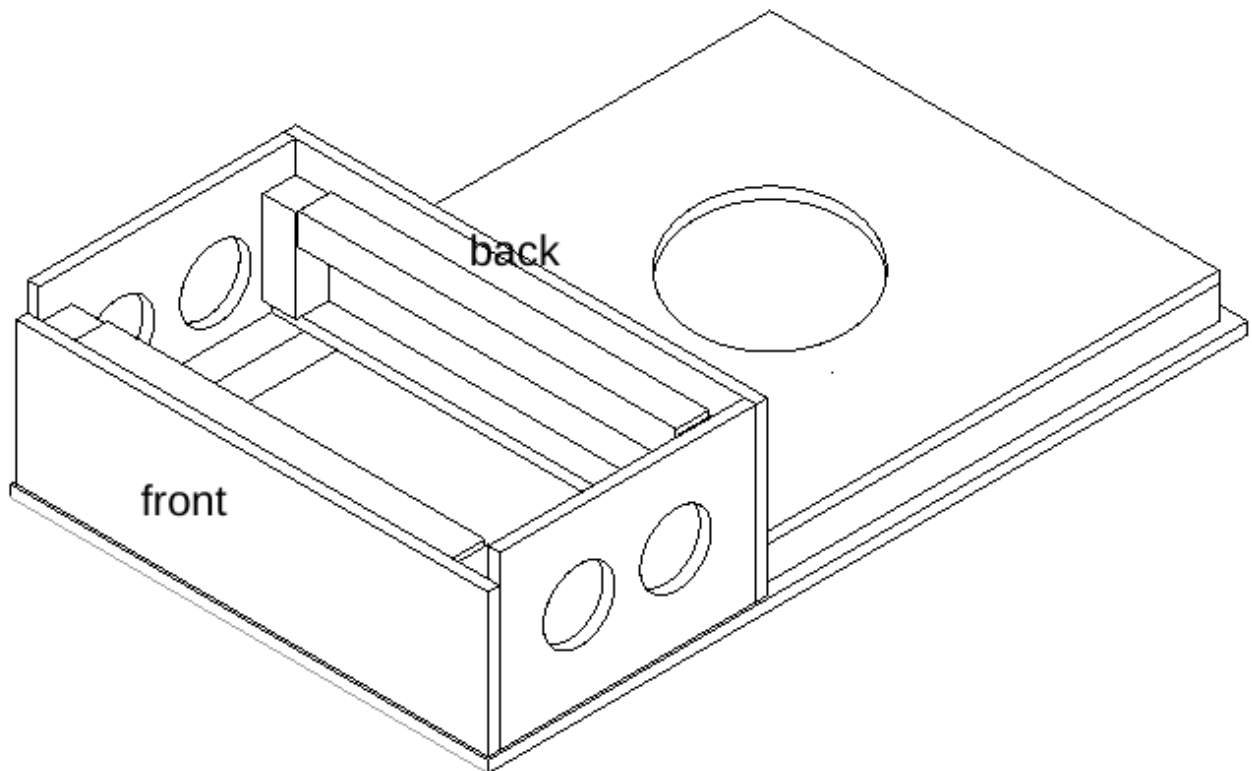
control panel support: prepare the two short sides



control panel support: prepare the two long sides



and assemble it all



## 2nd STEP - THE CONTROL PANEL

### The PVC plate

Cut out the control panel from a 3 mm thick PVC sheet.

The plan with the dimensions is available in the 2nd part "Appendices".

[A drawing in DXF format for cutting the PVC on a CNC](#) is also available.

In the case of a 300 W cooker, three switches are sufficient; for a higher power, a fourth switch can be provided.

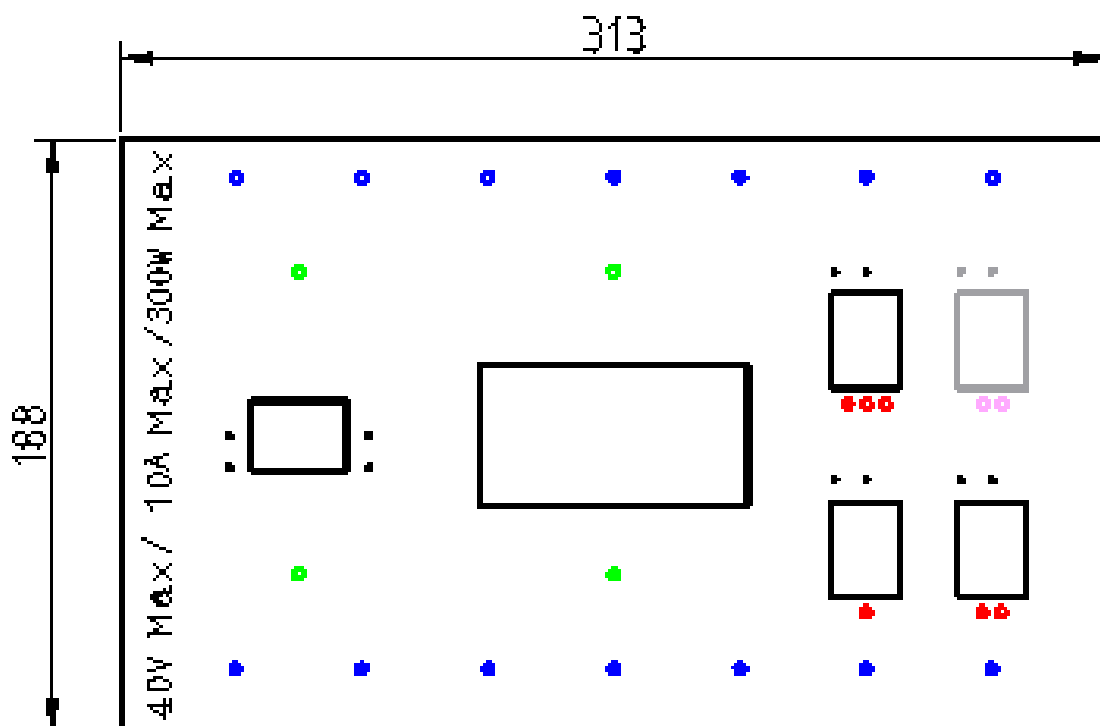
The small round marks, engraved and then painted, below the switches, indicate the number of ceramic resistors controlled by the switch: one, two, or three ceramics .

The blue holes are used to fix the control panel on the base of the cooker.

The green holes are used to attach components to the underside of the panel.

If flat head screws are used, the blue and green holes must be countersunk.

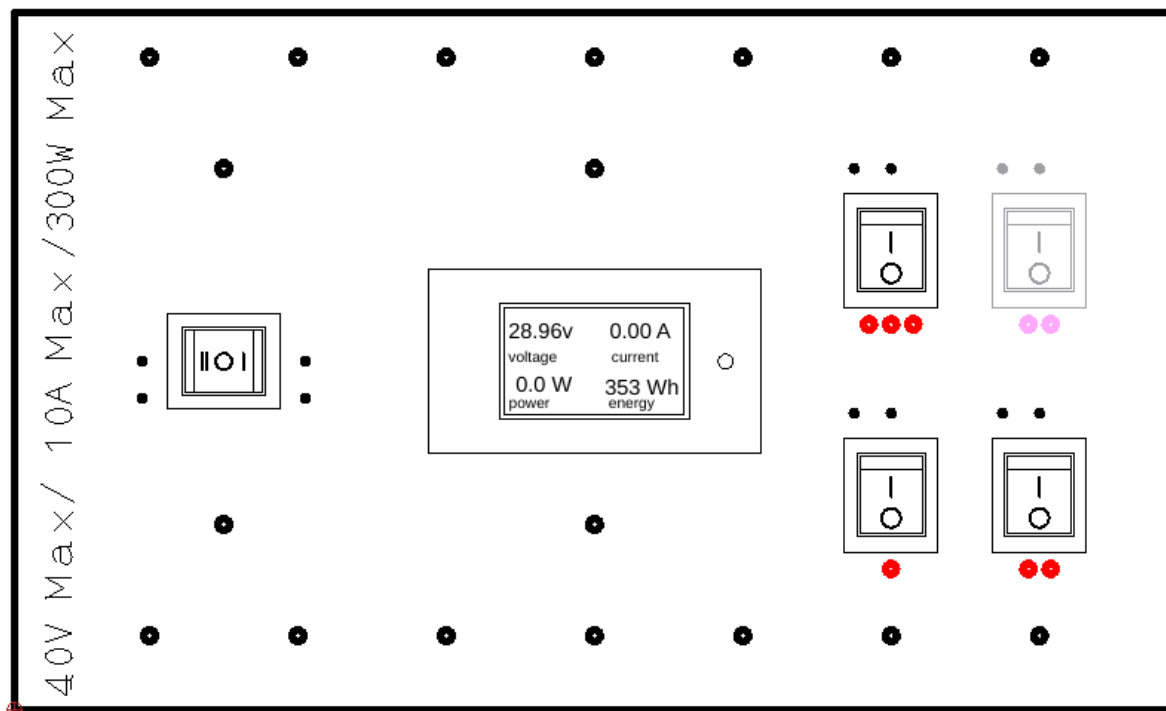
There are places for optional LEDs to indicate the operating status of the switches, see Part 5 Chap II



## Installation of the components on the PVC sheet

Before installing the components on the PVC sheet

- if necessary, square the right angles of the openings with a cutter
- cut the PVC at an angle in the thickness of the plate in front of the clips of the elements
- the dimensions of the components may vary slightly, and if an opening is a little too large, use a little mastic-glue.



from left to right:

- **Three-position switch:** This is the switch that receives the electricity from the photovoltaic panel. In position 0, nothing happens; in position I, the current is sent to the cooker; in position II, when the cooker is not in use, the electric current is directed to other uses or to a second cooker while the first one works in "Norwegian pot".

Designation: 3 position rocker switch 16 A 2 x on/off/on

- **Wattmeter:** it allows the driver to know if his heating setting is good, or if it can be improved. For the driver, the power meter is as important as a compass for a sailor.

The DC 6,5-100V, 20 A PZEM-031 (see back of the device), without shunt, up to 20 A, is very suitable.

- **Two-position switches:** they control groups of 1, 2 or 3 ceramic resistors

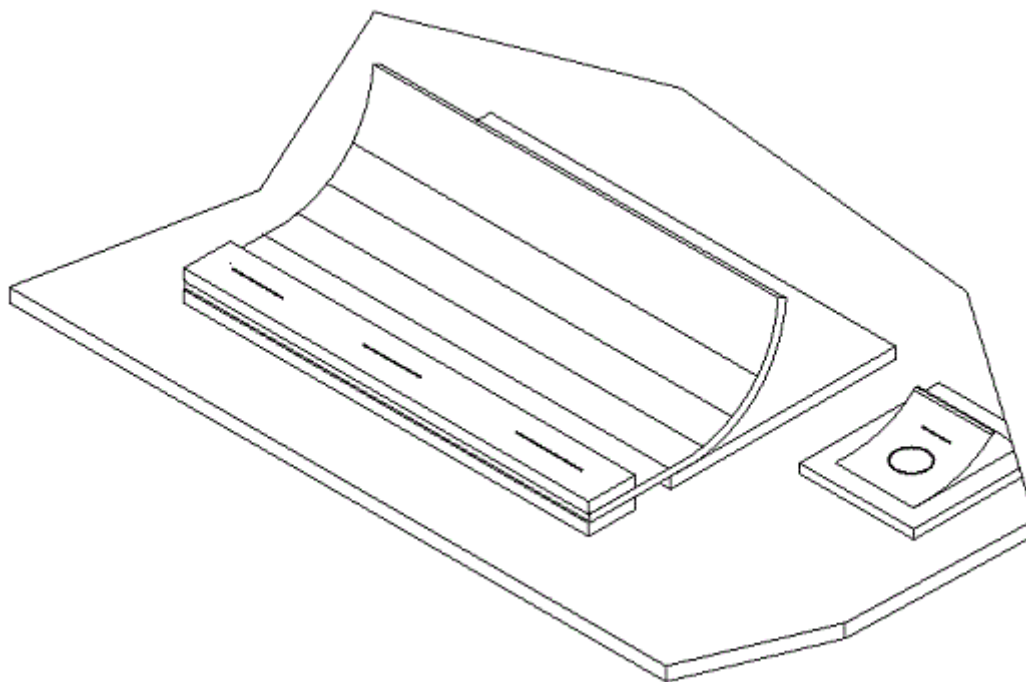
**ATTENTION** to the quality of the switch contacts. Considering the current (= Amperage), it is essential to use switches with good quality internal contacts.

Systematically avoid low cost switches easily available on the Net, but whose internal contacts may degrade rapidly and sometimes heat up dangerously.

One solution is to insert a diode to avoid the flash effect, see Part 5, chapter I

### **Protection of the Wattmeter screen**

It is advisable to protect its screen from the sun's rays, for example with a small piece of leather or other material, fixed with a few copper wires or screws. A light-colored or white protection would be preferable.



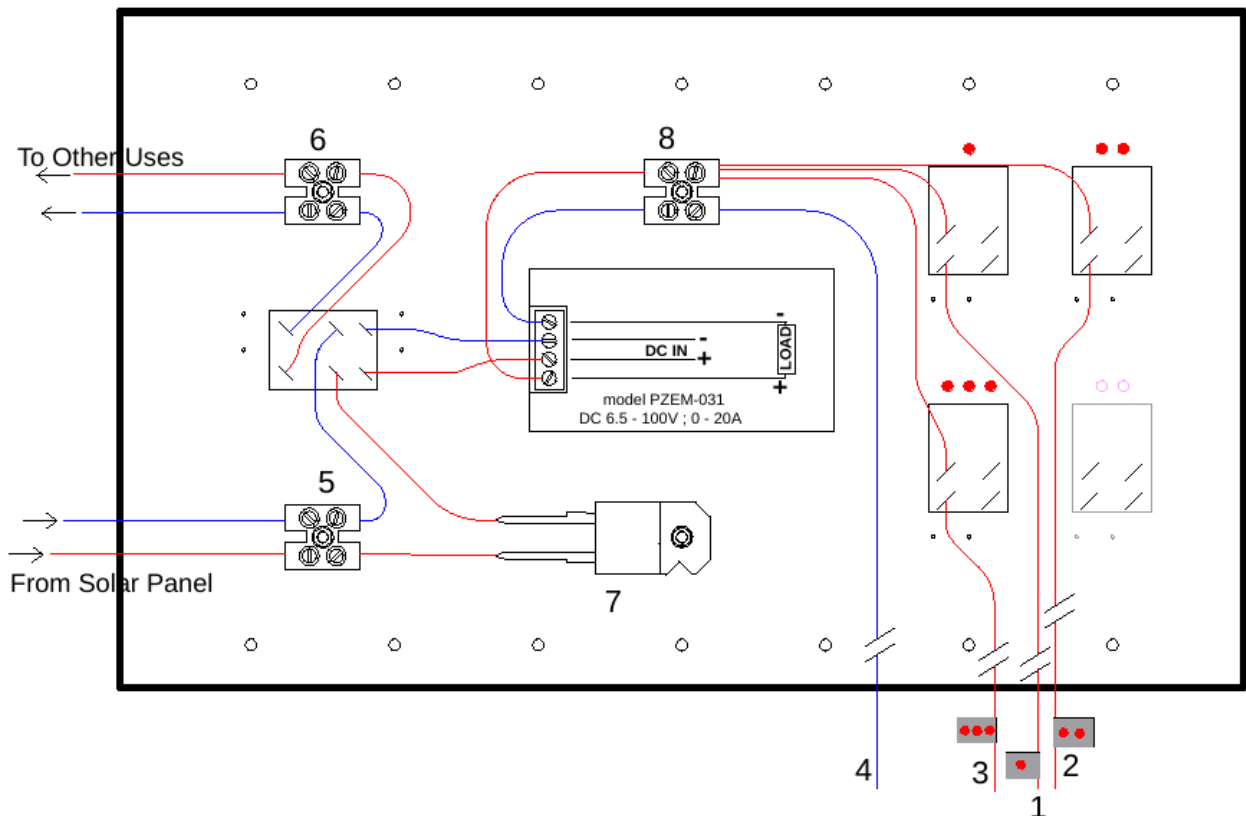


### 3rd STEP - WIRING THE CONTROL PANEL

Supply only flexible blue and red cable with a cross-section of 1.5 mm<sup>2</sup> (whereas for the connection between the panel and the cooker, which is longer, you must use cable with a cross-section of 2.5 mm<sup>2</sup>).

Pay particular attention to the crimping of the lugs, which should be done with special pliers.

Turn the PVC panel over. To work more easily, temporarily fix two brackets under the long sides.



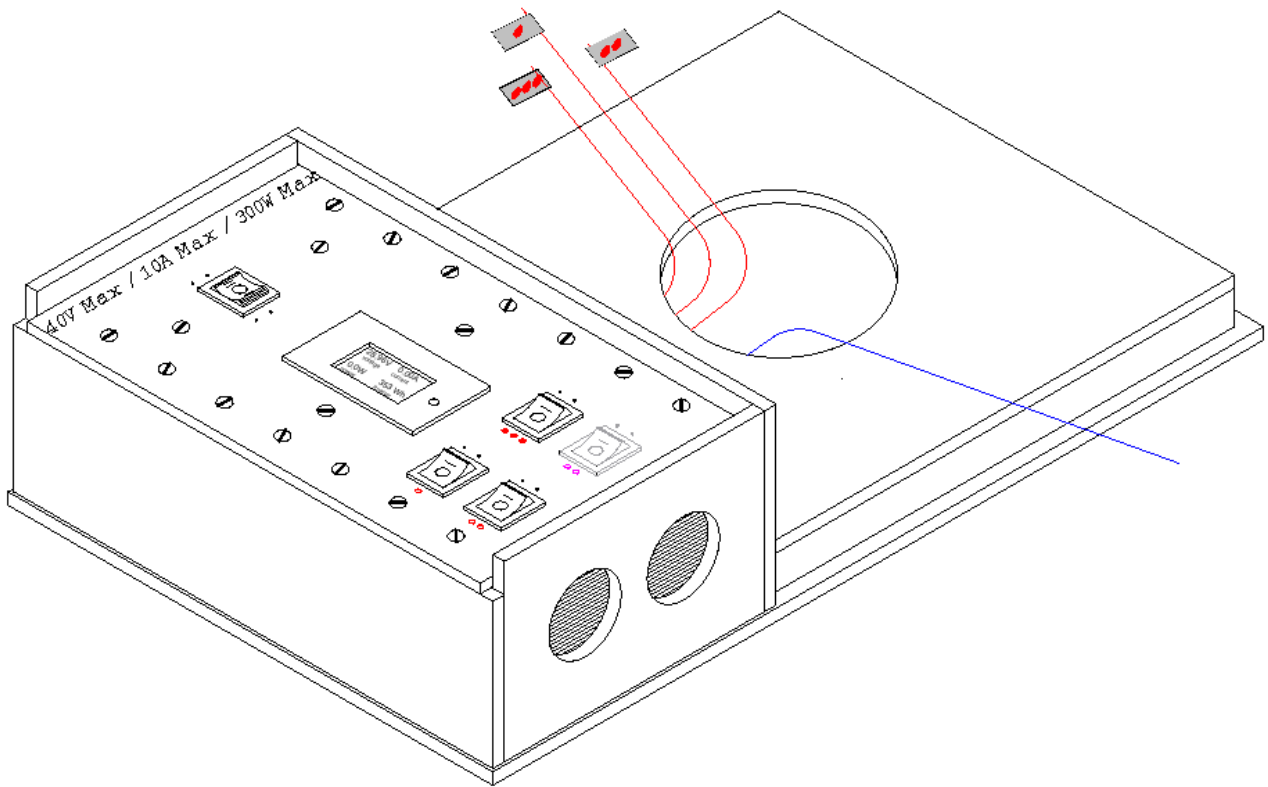
1, 2, and 3: locate the cables, to match the switches and the groups of resistors,  
5 and 6: these dominoes are only used to support the cables, they have no role in electrical connection

7 Diode: to avoid connection errors between pole + and pole -. A connection error would have no consequences for the cooker, except for the operation of the Wattmeter.

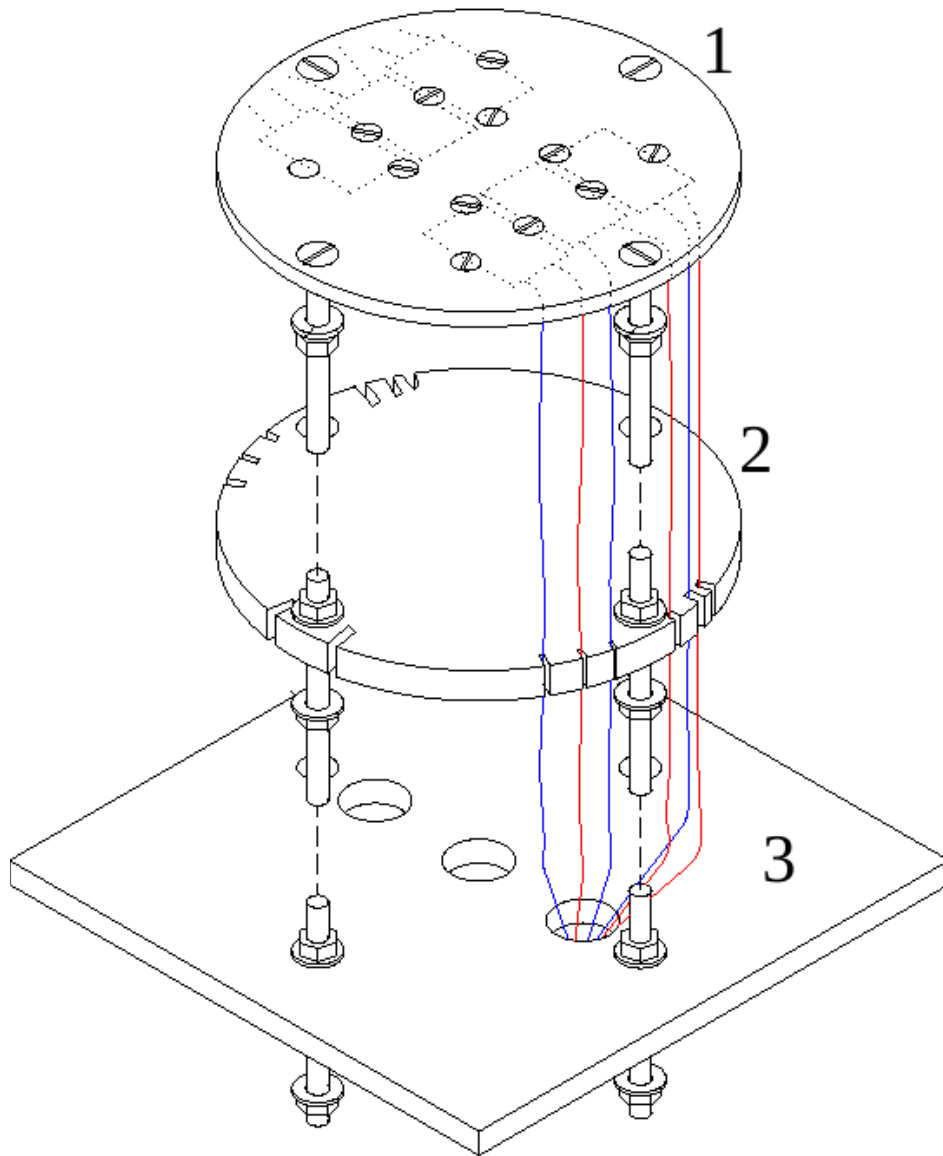
The "To Other Uses" wiring is optional, but it is essential to immediately isolate its ends by any means (domino, insulating adhesive tape...) to avoid an untimely short-circuit later.

About "other uses" : when the cooker is not used, or when the power of the solar panel is not high enough to cook, it is nevertheless possible to use the electricity produced for small uses such as solar lamps, cell phones, or emergency batteries with a 5 Volt USB plug. See on this subject the 5th part, chapter IX.

The base is ready to receive the heating block



## OVERVIEW OF THE HEATING BLOCK



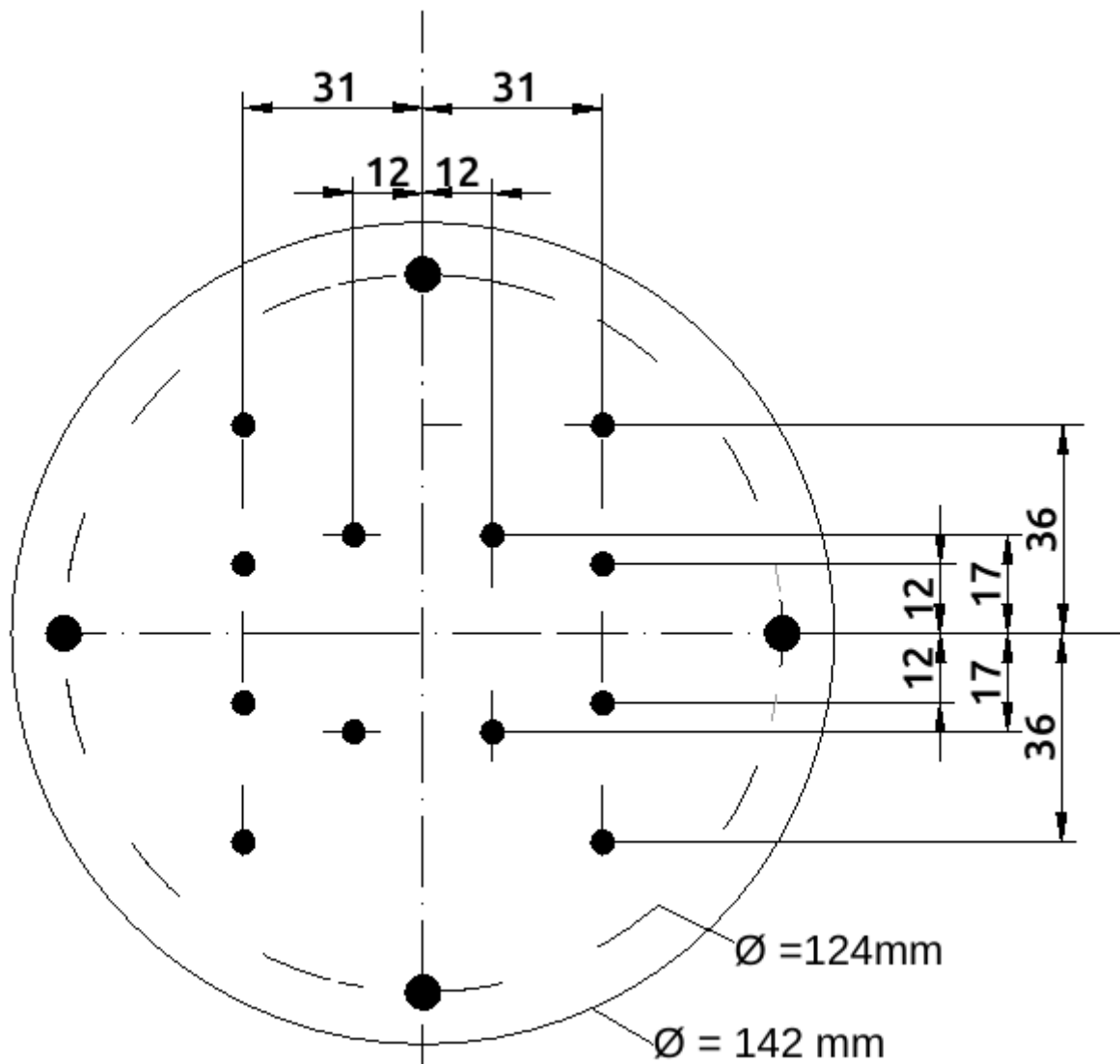
1 Heating plate

2 Cork plate

3 Heating block support

#### 4th STEP - PREPARATION OF THE HEATING PLATE

**Round plate** diameter 142 mm thickness 5 mm cut in an ordinary aluminium sheet by any means (jigsaw, or to be cut by water jet, laser...). The plate must be perfectly flat.  
Four holes with a diameter of 6.2 mm (or alternatively 6 mm) for the plate supports, on the periphery  
12 holes with a diameter of 4.2 mm (or 4 mm if not available) to fix the ceramic resistors



A drilling template is available in the second part "Appendices".

[A DXF drawing for the machining of the heating plate on CNC](#) is available here

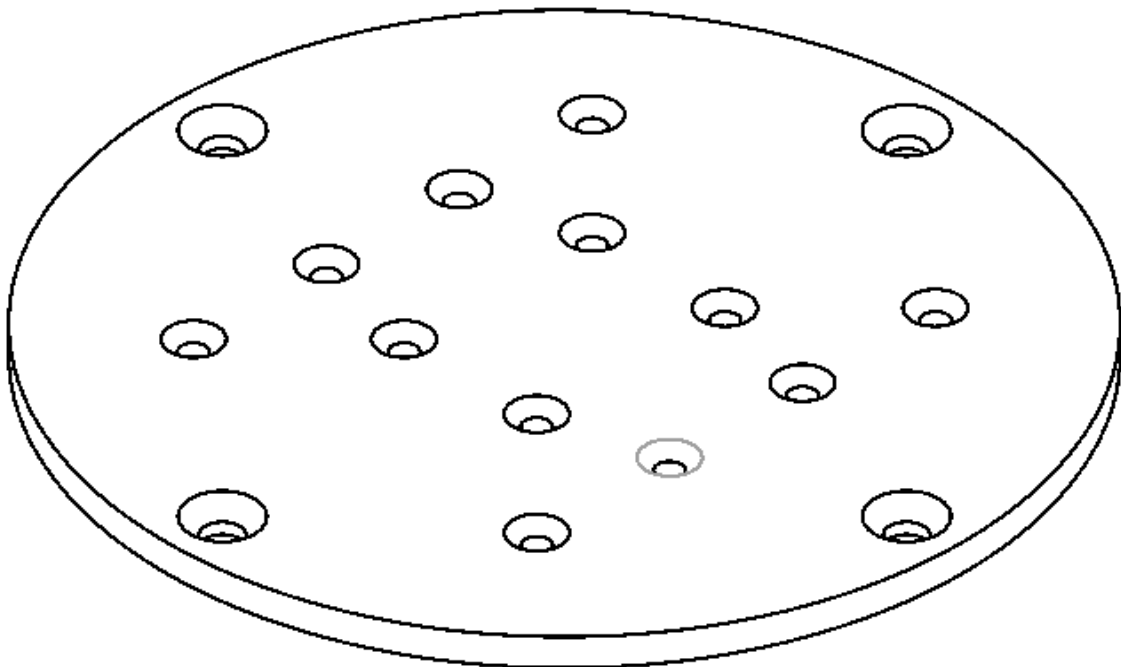
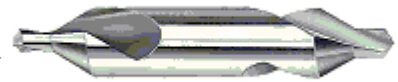
To start the drilling, it is advisable to use a centering drill

**The milling** should preferably be carried out on a drill press; in any case, hold the part very firmly; use milling cutters with a standard angle of 90°.

It is essential to check that the screw heads are correctly embedded in the sheet metal; a slight indentation is preferable and perfectly acceptable. At the end of the operation, gently deburr the milling holes with a fine abrasive cloth, 180 grain or more, and check the surface condition so that the firing vessel can rest perfectly on the hot plate.

Any imperfection in the surface condition will slow down the heat transfer: 1 mm of air (still) = 7.42 meters of aluminum... See part 2 on this subject. A good heat transfer is one of the keys to the good functioning of the cooker.

If the work is done with a portable machine, the operator can have the verticality of his tool checked by a helper, or better by two helpers placed at 90° from each other.



Above: the heating plate after drilling and milling

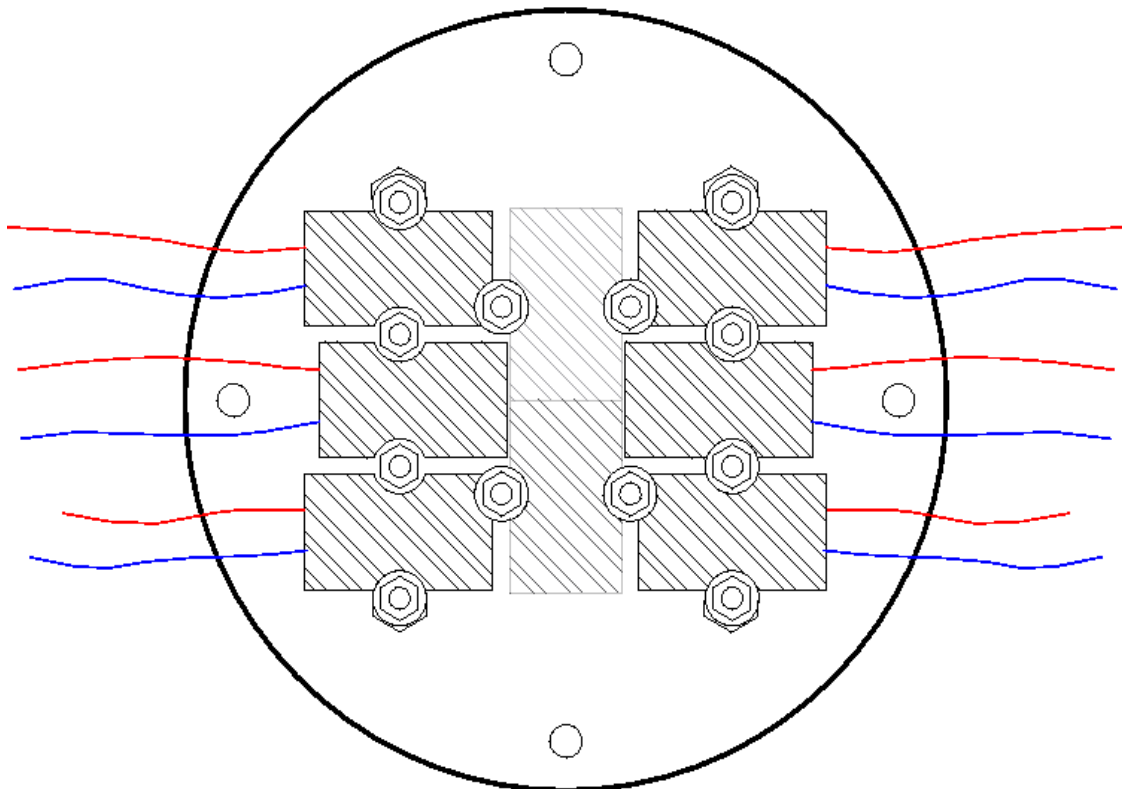
## 5th STEP - THE CERAMIC HEATERS

The ceramic heaters are the heart of the functioning of the cooker. We use here "36 Volts" 35\*21 mm ceramics, thickness 5 mm. For their supply, see the 6th part "Design elements".

Before installing the ceramics, it is advisable to tin the end of the wires with a soldering iron.

The ceramics are held in place by M4 countersunk screws, length 16 mm. In order to ensure a good heat transfer, they must remain in close contact with the aluminum plate. It is therefore essential to use Belleville spring washers. See the Wikipedia article on Belleville washers.

In ceramic heaters, the most fragile part is the soldering (not visible) of the wires to small aluminum plates inside the silicone insulator; therefore, one should not handle the ceramics carelessly, especially by holding them by the wires, in order not to weaken or even destroy the soldering. A check with an Ohmmeter is a wise precaution. About the use of the Ohmmeter, see 5ème partie, Chapitre I . For all practical purposes: the resistance of a ceramic like those used here is about 40  $\Omega$  at 21 °, but it varies very quickly with the temperature, if necessary see 6ème partie. Make sure that the surfaces are clean before assembly.

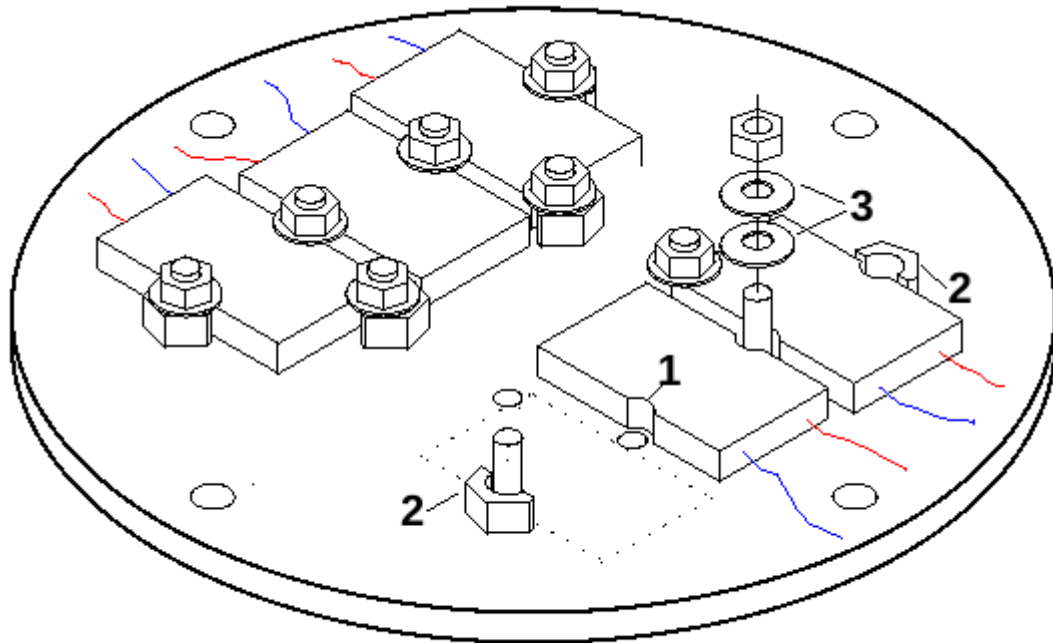


Above: distribution of the ceramics on the heating plate. In grey: the place for additional resistors

About the supply of ceramics, see Part 6, Chap II.

In front of each screw, it is necessary to make a notch with the file on the side of the ceramics, which will be thus maintained in all the directions. Once the notch is completed ... carefully remove the burrs left by the file.

On the perimeter of the group of ceramics, it is necessary to install a shim under the Belleville washers; an M6 nut cut in half with a hacksaw is perfectly suitable



1 : notches

2: shims (M6 nut sawn in half)

3 : two Belleville spring washers superimposed; tighten the Belleville washers with care, they must not be crushed, but must retain a certain elasticity to be able to do their job properly.

During the cabling, the ceramics will be divided into three groups: a group of three ceramics, a group of two ceramics, and a group of only one ceramic

Before and/or after installation of the ceramics, perform a continuity test with an Ohmmeter.

## 6th STEP - OTHER HEAT BLOCK ELEMENTS

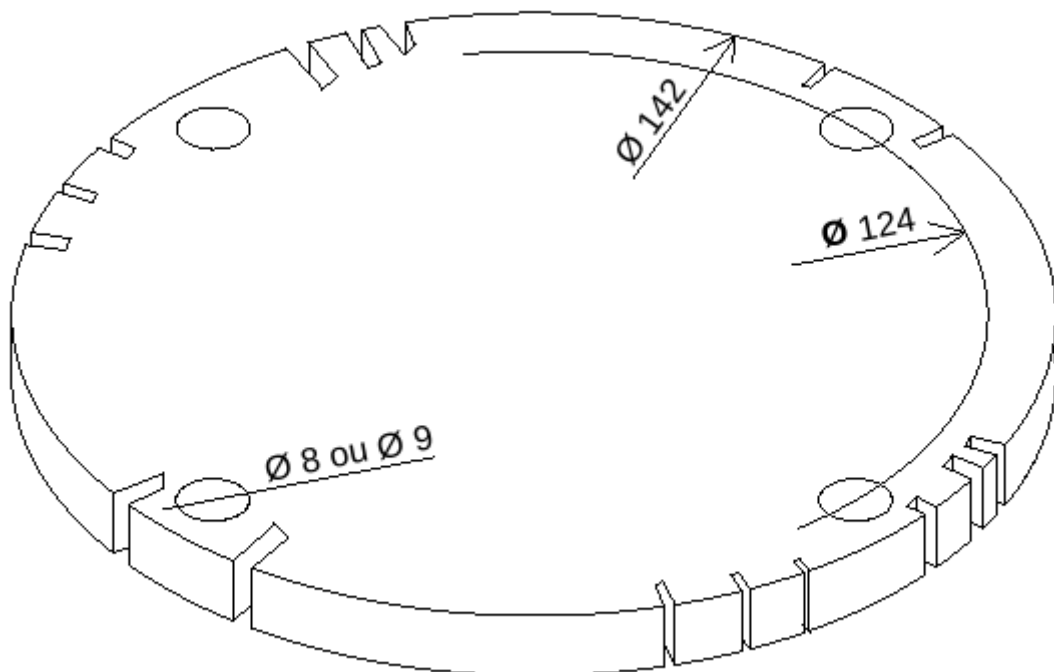
This is a cork insulating plate and a plywood plate supporting the heating block

**The cork insulating plate**, thickness 10 mm,

Supply: you can find cork trivets in some household goods stores, or large surface plates on the Net.

The difficulty lies in the machining of the material, which does not have much hold; use a saw with very fine teeth, for example the scroll saw suggested for cutting the PVC plate. A perfect rounding is preferable, but not essential...

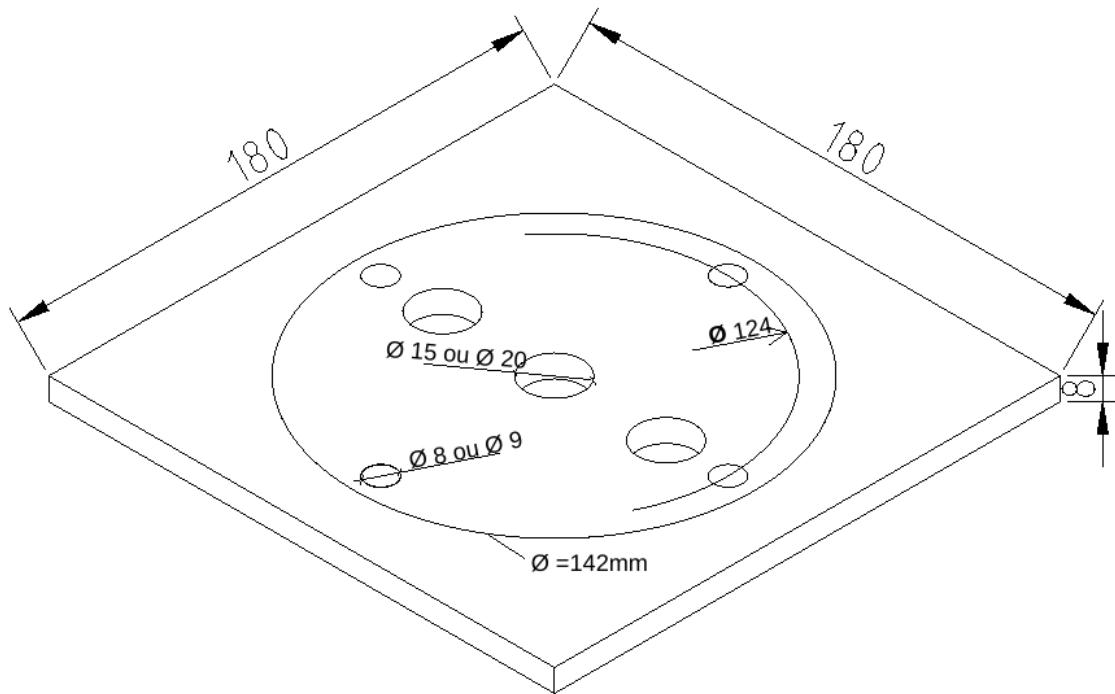
- Make notches for the passage of the cables. The notches must be deep enough for the cables to stay inside the heating block. -
- Make 4 holes for the M 6 screws to support the heating plate. If the material does not allow for holes, make notches that will be covered by washers.



A good solution is to use a small tabletop CNC milling machine, like for cutting the PVC plate. This can be the occasion to contact a Fablab. If you have a CNC, then the notches for the cables can be replaced by holes to pass groups of 2 or 3 cables



**The support plate of the heating block** is to be cut out of 8 mm plywood

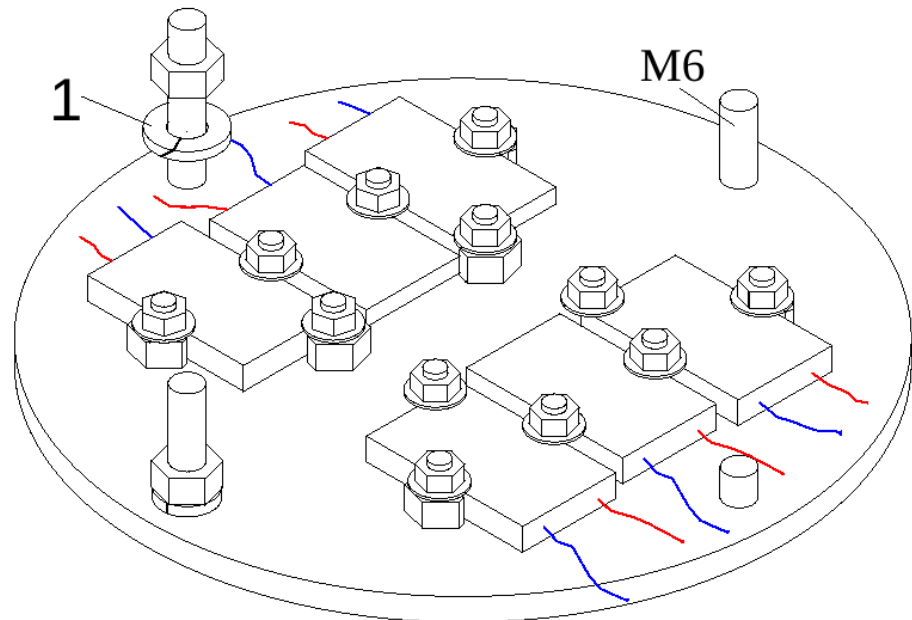


Draw a circle  $\varnothing 142$  mm which will be used later as a reference for the wiring of the ceramics  
Make 4 holes  $\varnothing 8$  or  $\varnothing 9$  mm for the passage of the M 6 screws supporting the heating plate, and three holes for the passage of the cables of the three groups of ceramics.

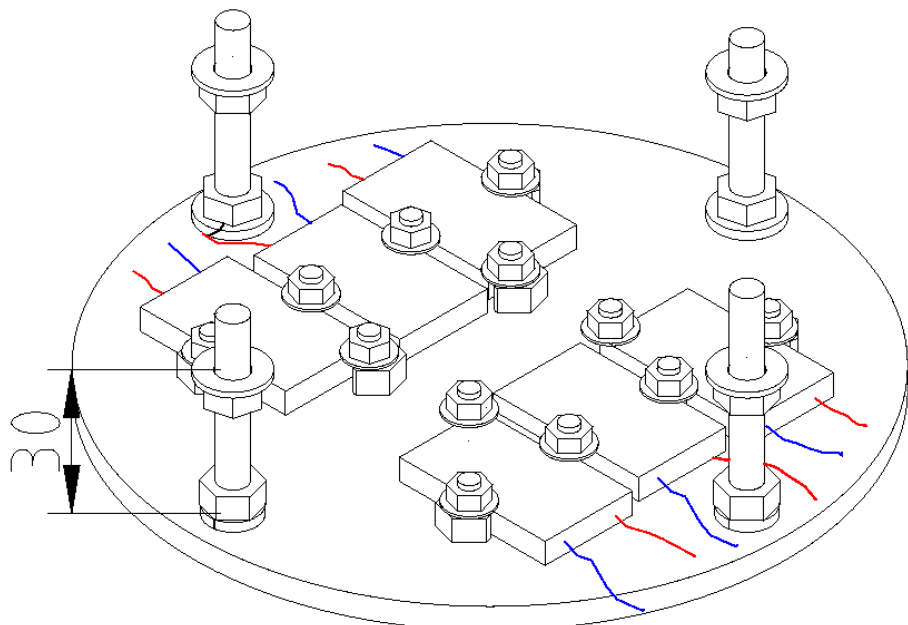
## 7th STEP - ASSEMBLY OF THE HEATING BLOCK

The heating block is assembled with four M 6 flat head screws, length = 80 mm  
Install and bolt the screws to the heating plate, making sure to insert a lock washer for each screw to prevent them from loosening. Tighten the nuts firmly and permanently; the lock washers must be completely flattened (unlike the Belleville washers)

1 - Grover washer



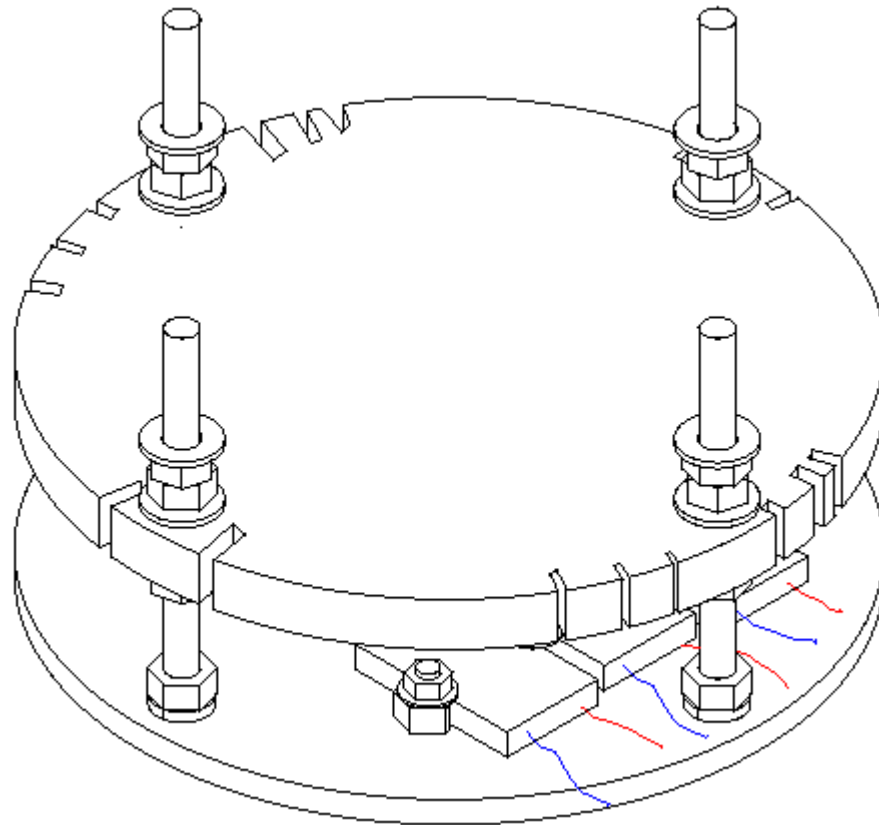
Install on each screw a nut and a flat washer, so as to leave a 30 mm gap between the underside of the heating plate and the top of the cork disc



Position the cork disk; if necessary, feed the wires through the holes. Be sure to handle the wires very carefully.

Install a washer and nut on each M6 screw and tighten moderately on the cork disc.

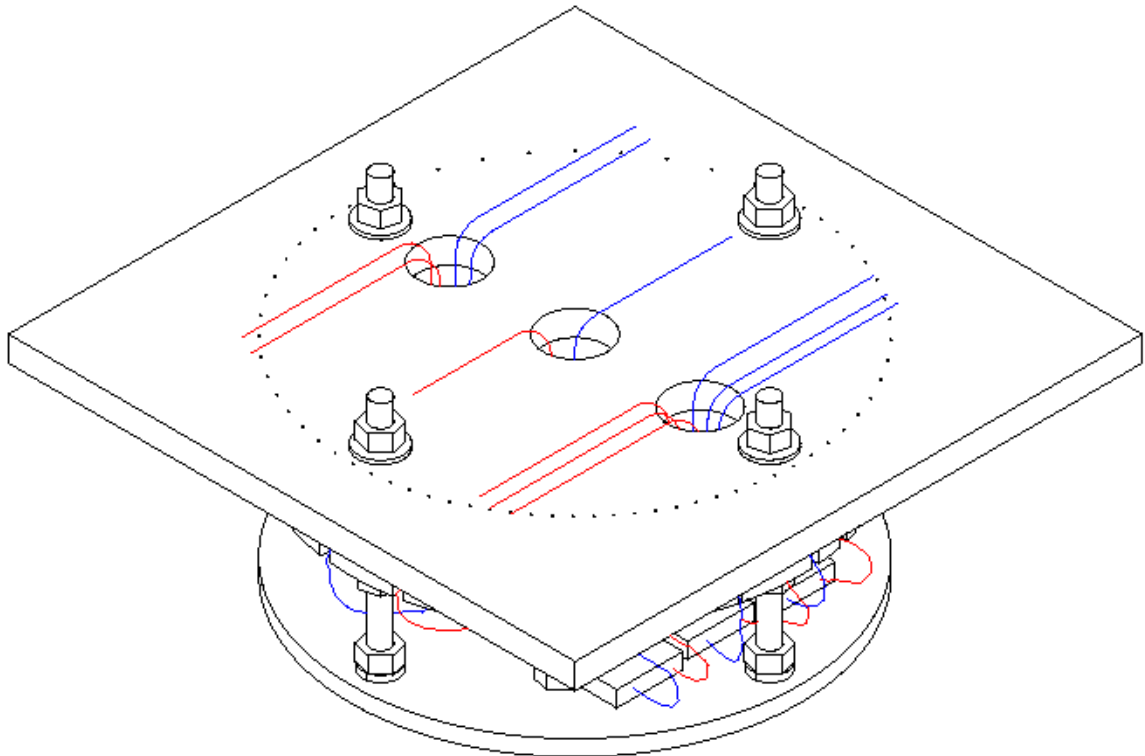
Install a nut and washer on each screw again, to receive the support plate of the heating block; on the same screw, the two nuts touch each other back to back, they can even be locked against each other



Install the support plate of the heating block, passing the wires through the holes provided for this purpose, with all the necessary precautions.

If necessary, to keep the wires in the notches of the cork disc, the disc can be encircled with bare copper wire.

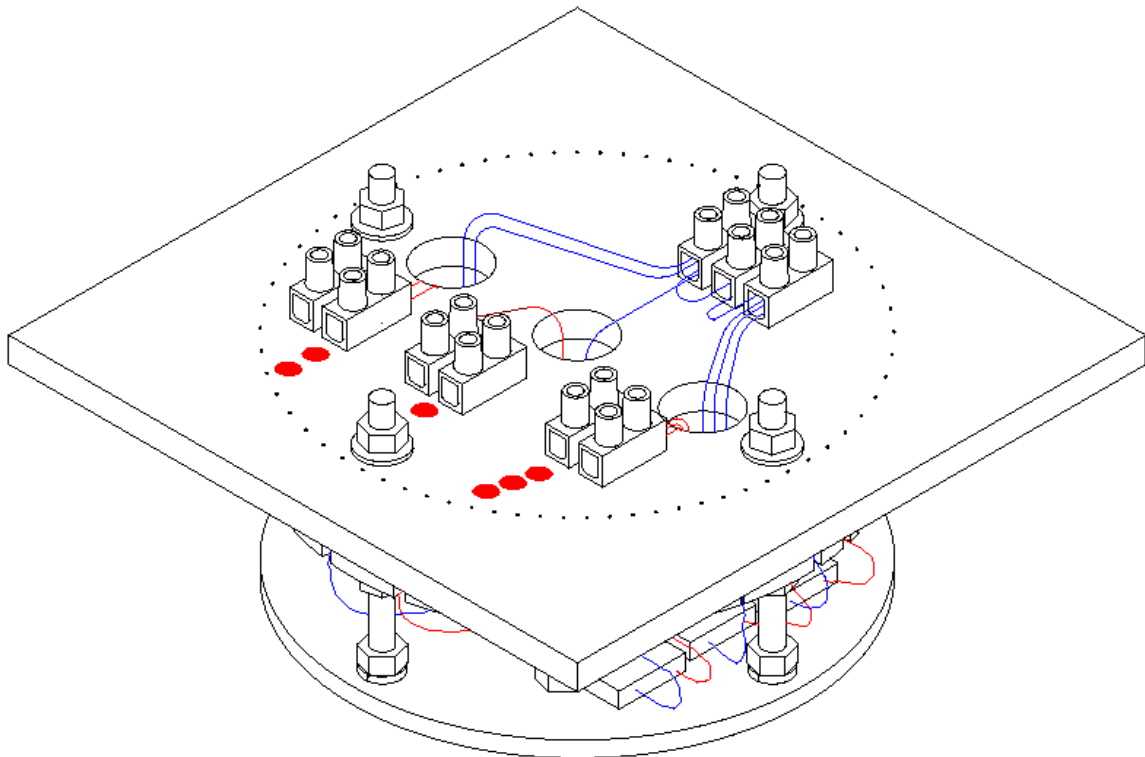
Fix the plate with washers and nuts; between the washer and the nut, insert a fan washer (or a Grower washer), to limit the risks of loosening



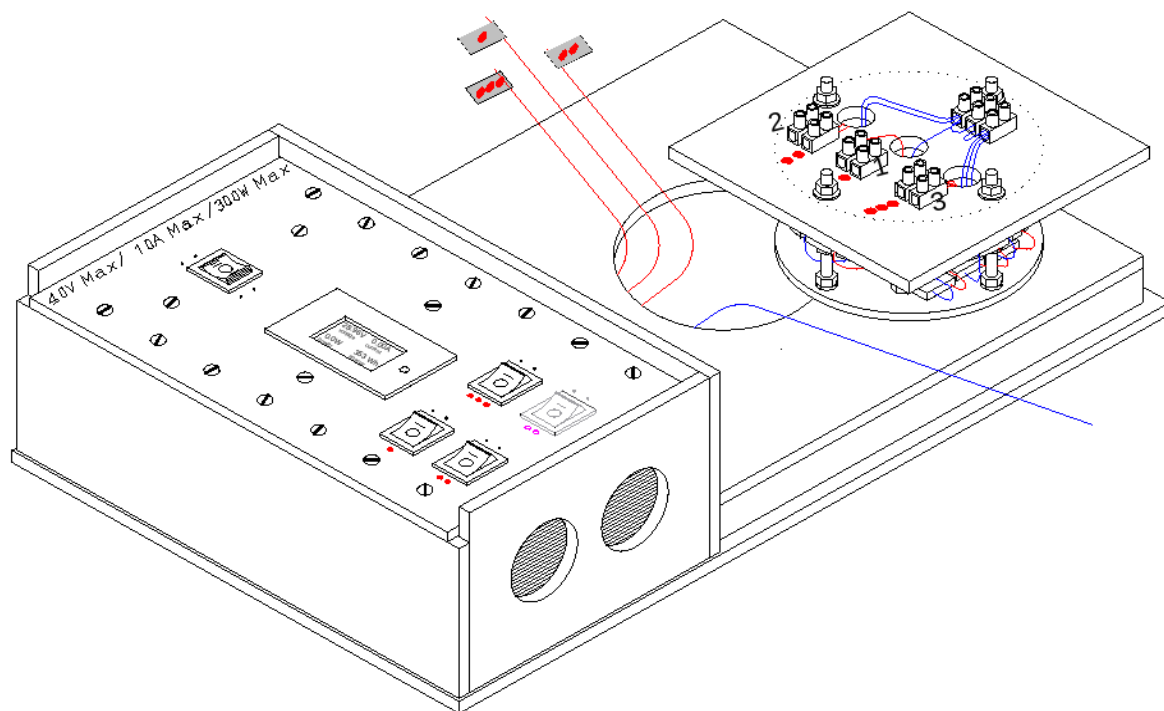
Position and screw the dominoes into the plywood, making sure to stay within the Ø 142 mm circle drawn earlier. Use dominoes adapted to the size of the wires, if the domino is too big, the wires may escape.

**Red "positive" wires:** each group of resistors has its own domino.

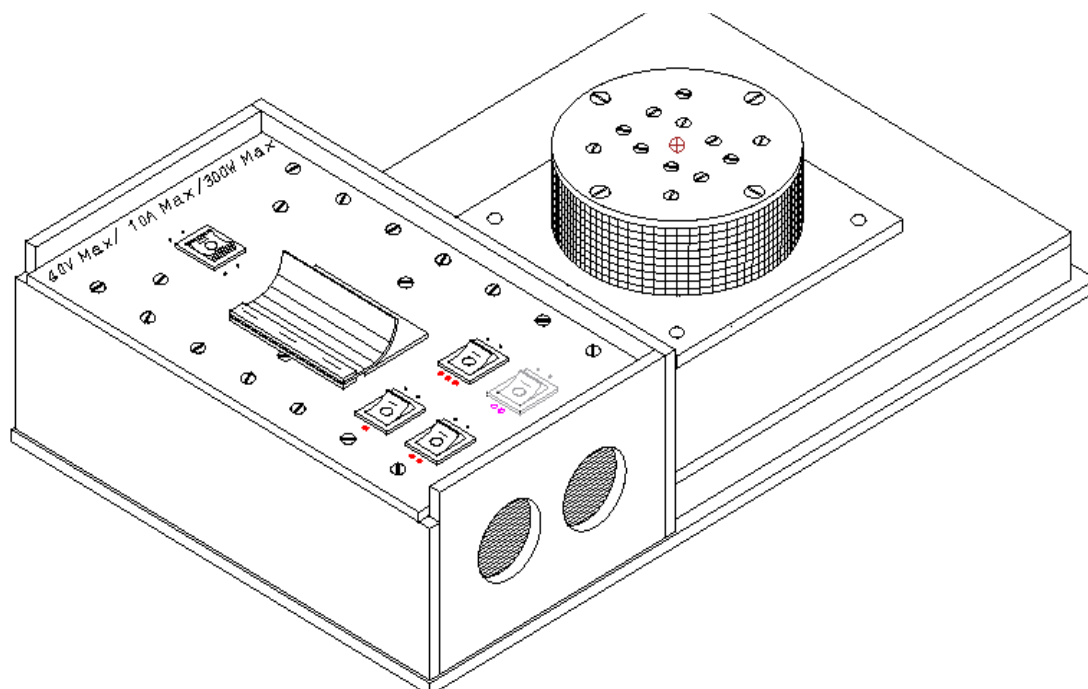
**Blue "ground" wires:** they are all joined in one domino.



## 8th STEP - INSTALLATION OF THE HEATING BLOCK ON THE COOKER



After completion of the wiring, the heating block is turned over and fixed to the base with 4 screws. The heating block can be surrounded with a fine wire mesh called "pantry wire".

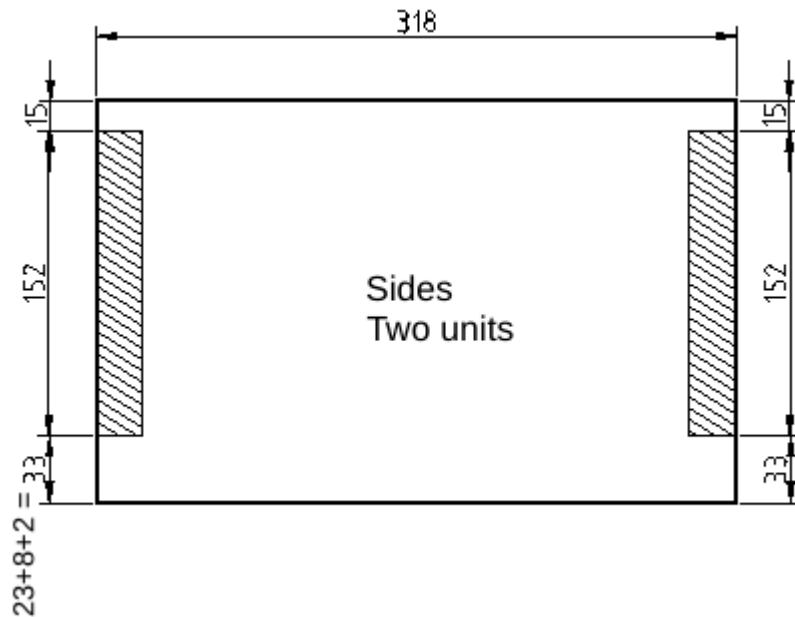


## 9th STEP - BOOSTER FOR INSULATION

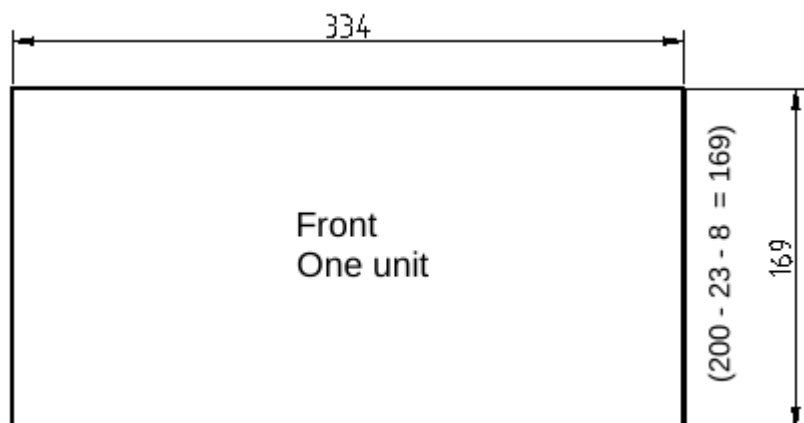
Booster in 8 mm plywood.

Left and right side (seen from the desk): 318 mm \* 200 mm high, 2 units

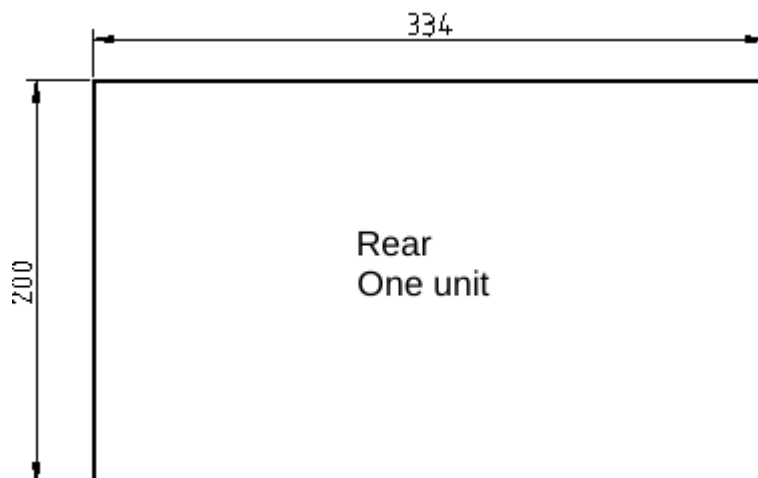
Fill the sides with cleats L = 165mm (to be adapted if necessary), preferably glued and screwed.



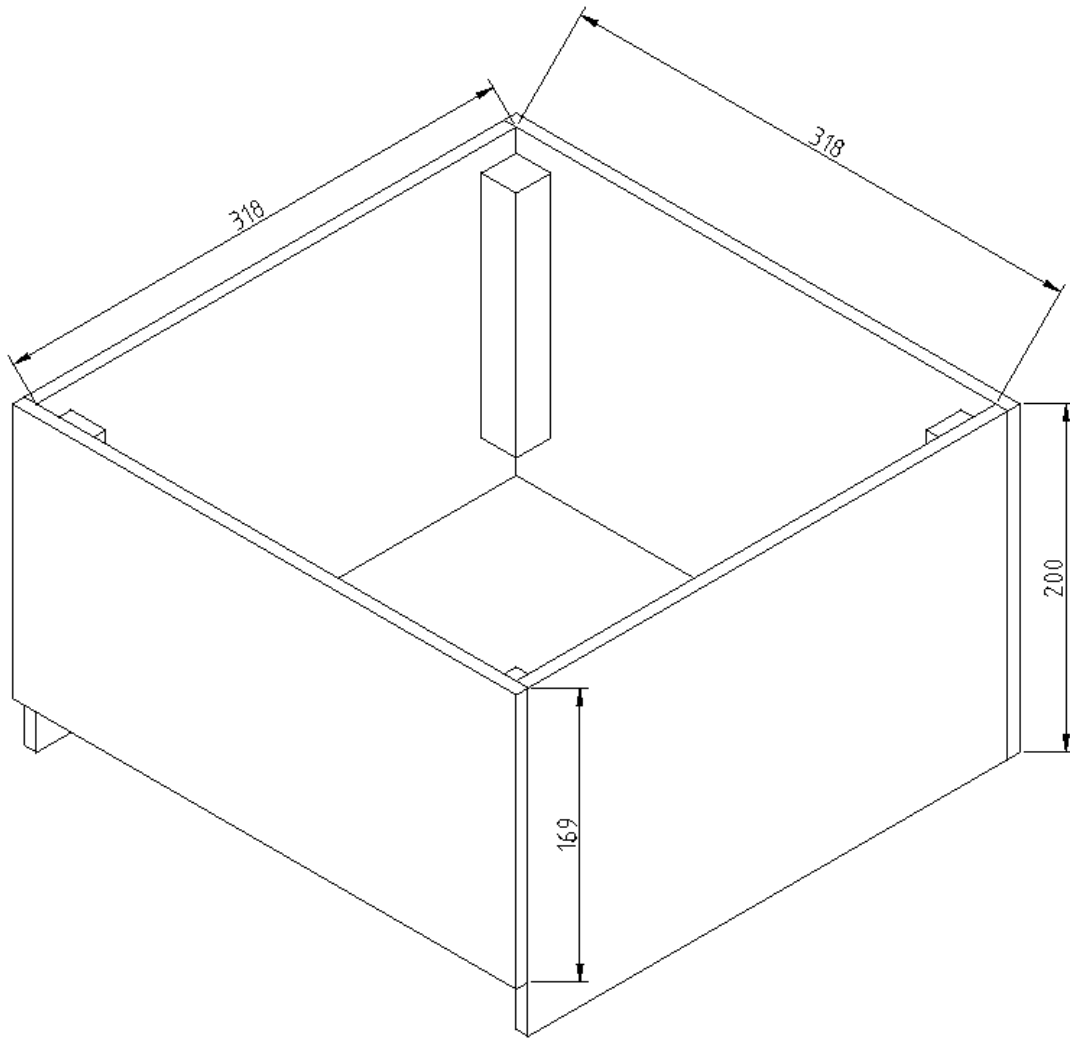
Front side: 334 mm \* 169 mm high, 1 unit  
the height is to be adapted according to the thickness of the base of the cooker.



Rear side 334 mm \* 200 mm high, 1 unit;



# Booster assembly





**Overhang**, in 8 mm plywood

