CPVRS

Concentration Photovoltaics Reference System

U.S. Provisional Patent Application

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1 Background

One common kind of CPV systems (Concentration Photovoltaics) is based on the combination of primary refractive optics with CPV receivers arranged in a matrix pattern.

The optics and receivers must be protected from the environment and therefore the ensemble constitutes a shape similar to a box, its depth being basically determined by the primary optics focal length and its width and length determined by each primary optics dimensions and by the number of receivers arranged in each dimension. The volume filled by a refractive CPV module is therefore proportional to the primary optics focal length.

Given a specific concentration ratio (solar aperture to cell area ratio) and a primary optics F number (focal length to aperture ratio), it is obvious that the focal length and therefore the depth of the module is proportional to the cell size, and so the volume of the module.

So, the volume of CPV modules iis a function of cell size, concentration ratio and primary optics F number. The volume of CPV systems having medium to large CPV cells (4 mm side or more) is therefore significantly large.

This significant volume poses a logistic problem. Storing and transporting through long distances large volumes of air is not efficient. The larger the cells the larger this problem becomes, reducing CPV advantages in front of flat photovoltaic (PV) panels.

Some CPV manufacturers have decided to use very small CPV cells (in the order of 1 mm side) in order to alleviate this problem. This can increase the cost due to the multiplication of CPV receivers per power unit it implies.

Using larger CPV cells and thus reducing the number of components of each module would reduce the cost of CPV systems, but then the logistic problem arises.

A possibility to combine larger cells and reduce logistic costs would be to ship module components to the installation site and then do the assembly there, but this has not been possible because of the tight mounting tolerances and environmental protection required by CPV systems.

One key problem is being able to mount the modules as a kit respecting all geometrical requirements for the optical system to work properly.

The other difficult problem to solve is consistently obtaining IP65 or higher environmental protection for the assembled module.

2 Summary of the Invention

Our invention objective is to obtain a CPV module assembly system which allows for a decentralised manufacturing approach, such that the basic components (primary optics, receiver panels and structural end enclosure members) are basically flat and can be packed and shipped efficiently as a kit and be assembled locally using facilities and tooling requiring minimal capital investment, near the installation site.

We call this invention the CPV Reference System (CPVRS) because it essentially consists on creating a clear dimensional reference mounting system for the kit assembly of optics and receiver panels.

The CPVRS system is based on a construction method which yields very good mounting tolerances, in such a way that all module components are assured to fit together easily, even given the large size and tight tolerances required by the CPV application. Also, it uses an easy to implement sealing system, assuring high IP protection.

The key elements of the CPVRS are:

- Mounting brackets incorporated into primary optics panels.
- Receiver panel assembly system.
- Structural and enclosure members made using advanced metal sheet techniques.
- Riveting as fastening method.
- Electrostatic powder epoxy painting.
- Silicone sealing based on common construction technology.

3 Detailed Description

Figure 1 shows a general view of a CPVRS module.

Figure 2 is an exploded view.

A CPVRS module is made of a primary optics panel 1 including a plurality of mounting brackets 1a, a receiver panel 2 including mounting brackets 2a, short and long internal walls 3 and 4, short and long external walls 5 and 6, internal corners 7 and external corners 8.

Brackets 1a (figure 3) include mounting holes are glued to glass or plastic primary optics panel 1 using a very tight tolerance positioning method. These brackets are made of stainless steel or similar material and will be glued using pressure sensitive or UV curing acrylic adhesive.

Positioning method can be a 3 axis robot using vision recognition to recognize X, Y reference points in the primary optics panels, using optical features like lens centres or division lines between lenses, then using these points as reference for bracket positioning, and then sequentially mounting each bracket 1a.

An alternative method would be to use a special tool on which brackets 1a are temporally hold in place, then positioning X, Y axis of the primary optics panel to the tool (or the tool to the optics panel) then attaching the brackets in a single Z movement, and finally releasing brackets from the tool.

Yet another method would be to glue brackets to glass panels prior to optical features moulding or to insert brackets in the mould prior to moulding.

Receiver panels 2 including mounting brackets 2a are manufactured by attaching CPV receivers to an aluminium heat sink sheet, either using mechanical fasteners or adhesives, but in any case using very tight tolerance mounting systems.

An alternative would be to use a similarly stiff panel but using individual or row heat sinks on which CPV receivers are attached, then mounting the heat sinks on the panel.

It is recommended that the receiver panel is painted at east in its backside as a method to improve metal protection and increase radiative cooling.

Structural members and walls 3, 4, 5, 6, 7 and 8 are made in galvanized steel, aluminium or any other appropriate metal sheet.

Metal sheets are CNC punched or laser cut in order to obtain all necessary fastening holes with very high positioning accuracy.

Internal walls 3 and 4 and corners 7 and 8 incorporate several 90 degree bents that will provide high structural stiffness to the module.

The idea is to have all previous kit components manufactured using high tech machinery, and passing strict quality assurance procedures.

Kit components are then shipped to the final assembly workshop.

Structural members and walls 3, 4, 5, 6, 7 and 8 are riveted together using the already made holes, obtaining a module assembly frame 9 (figure 4).

Assembly frame 9 is painted with epoxy powder using an electrostatic deposition method or any alternative painting method. This paint cover improves metal part protection and covers any joint spaces left between the metal sheet parts in order to assure a high IP protection of the CPV module.

An alternative to this would be to use already surface treated or pre-painted external metal sheet parts 5, 6 and 8 and watertight rivets for any external joints. This would eliminate the need to have any painting equipment in the assembly workshop.

Next step is to fasten primary optics panels 1 and receiver panels 2 to module frame 9 through mounting brackets 1a and 2a.

Rivets are to be used in all fastening steps because they provide very tight mounting tolerances.

The final assembly step is to seal the module in order to render it water tight.

All components are designed in such a way that a channel 10 (figure 5) is formed between primary optics and receiver panels (1 and 2) and module frame 9.

Channel 10 is filled in with sealing silicone, sealing polyurethane or any other similar room temperature vulcanizing sealing material, making a continuous sealing joint 11. It is recommended that a joint base 12 made from extruded PE foam or similar flexible material is inserted in the lower part of the channel before applying the sealing agent.

Fig. 1

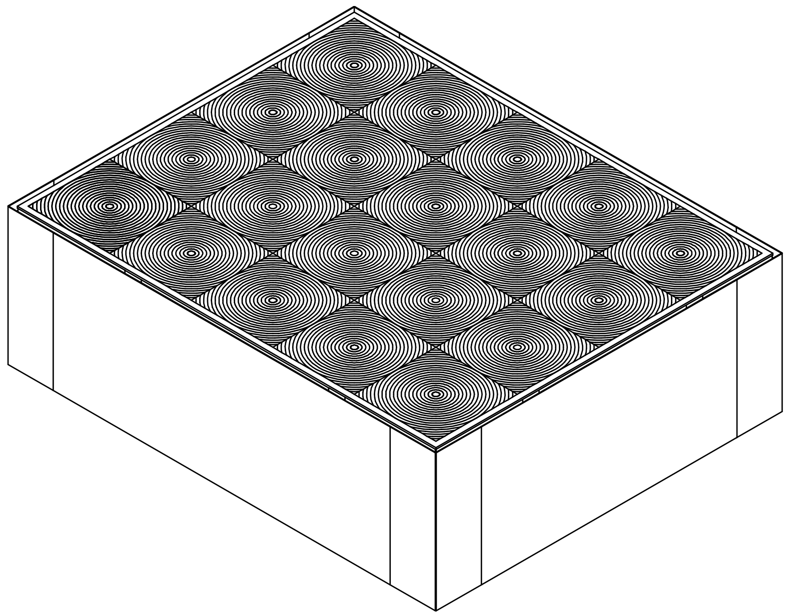

Fig. 2

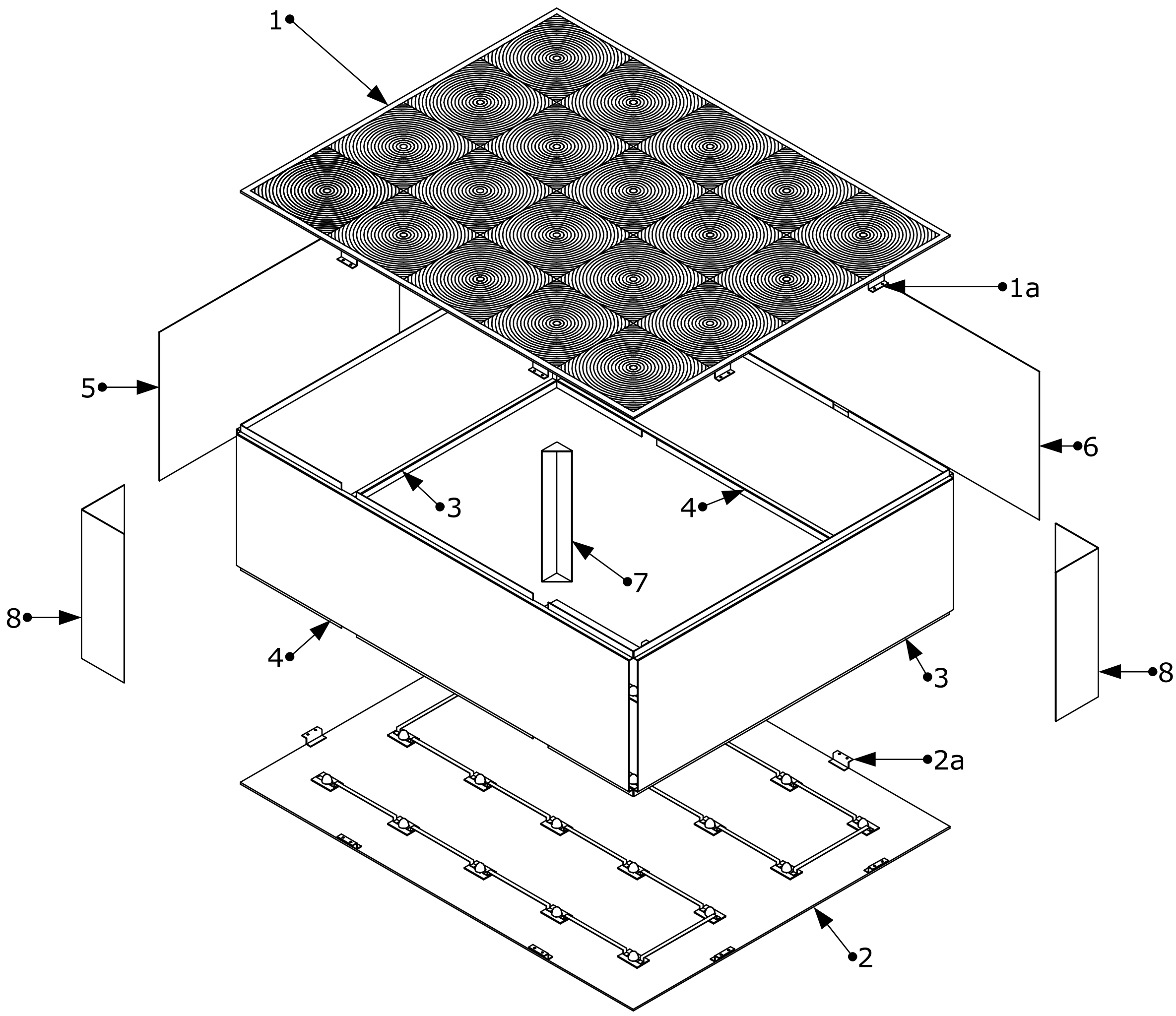

Fig. 3

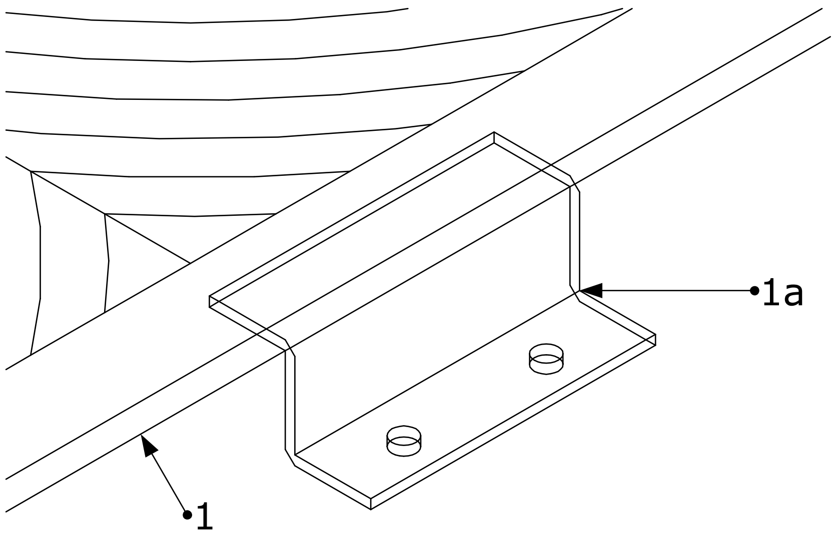

Fig. 4

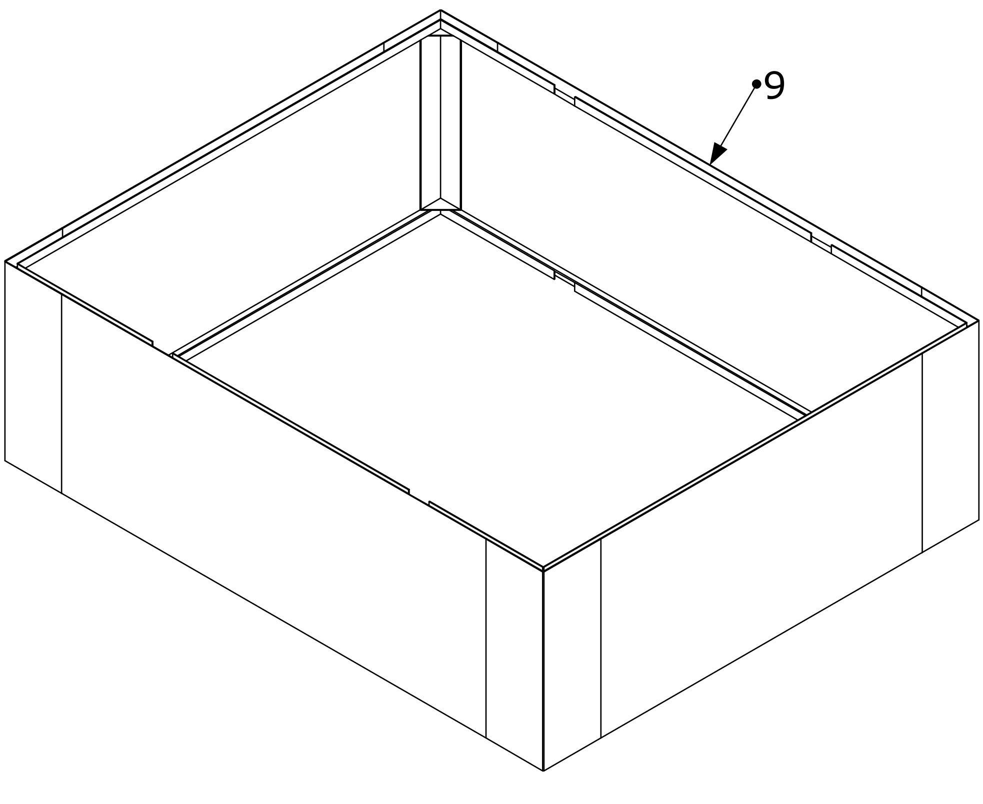

Fig. 5