(11) Application No. AU 2009101162 A4

(19) AUSTRALIAN PATENT OFFICE

(54) Title
Complete Solar Concentrated Photo Voltaic/Thermal System

(51)[6] International Patent Classification(s)
H01L 31/058 (2006.01)
F24J 2/06 (2006.01)
F24J 2/46 (2006.01)
F25B 17/08 (2006.01)
H01L 27/142 (2006.01)
H01L 31/058 20060101AFI20091117BHAU F24J 2/06
20060101ALI20091118BHAU F24J 2/46
20060101ALI20091118BHAU F25B 17/08
20060101ALI20091120BHAU H01L 27/142
20060101ALI20091117BHAU

(21) Application No: 2009101162 (22) Application Date: 2009.11.14

(43) Publication Date : 2009.12.17
(43) Publication Journal Date : 2009.12.17

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ABSTRACT FOR INNOVATION PATENT

Complete Solar Concentrated Photo Voltaic/Thermal System (CSCPV/TS)

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Abstract

The disclosed CSCPV/T system is a highly efficient solar powered configuration which embodies several units linked together via cooling and heating loops. A CPV panel generates both electrical and thermal energy. The electrical energy is fed to the grid, where the thermal energy is cycled to the Heat Exchange Tank (HET) and then returning back to the panel at a lower temperature to cool the PV cells.

The CPV arrays consist of powered troughs that rotate to follow the suns trajectory. As shown in Figure 2 by proper circulation of a fluid with a low inlet temperature, heat is extracted from the PV. At the end of each pipe array a thermal receiver with no PV cells is incorporated. This is to ensure that the temperature (as required by use of the adsorption heat pump) which is greater than what is required to be removed from the PV cells at optimum efficiency is fed to the HET.

The HET as it's same suggests exchanges heat via 3 coils, which are the cooling loop (loop 1), the adsorption loop (loop 2) and the evaporator loop (loop 3) as shown in figure 1. The HET is filled with static water and operates the conduction of heat between the 3 coils.

Loop 2 circulates through the adsorption heat pump to extract the thermal energy which will be used for hot water and heating/cooling provision, therefore increasing the total energy output of the system.

The adsorption pump simultaneously creates cooler water in loop 3 for feeding into the HET for further cooling of the HET and loop 1.

The complete solar efficiency of the CSCPV/T system can reach up to 86% comprising of a minimum 28% efficiency from the CPV panel and 58% efficiency of the thermal energy utilised. There are a myriad of applications possible, ranging from dwellings, industry and/or commercial.

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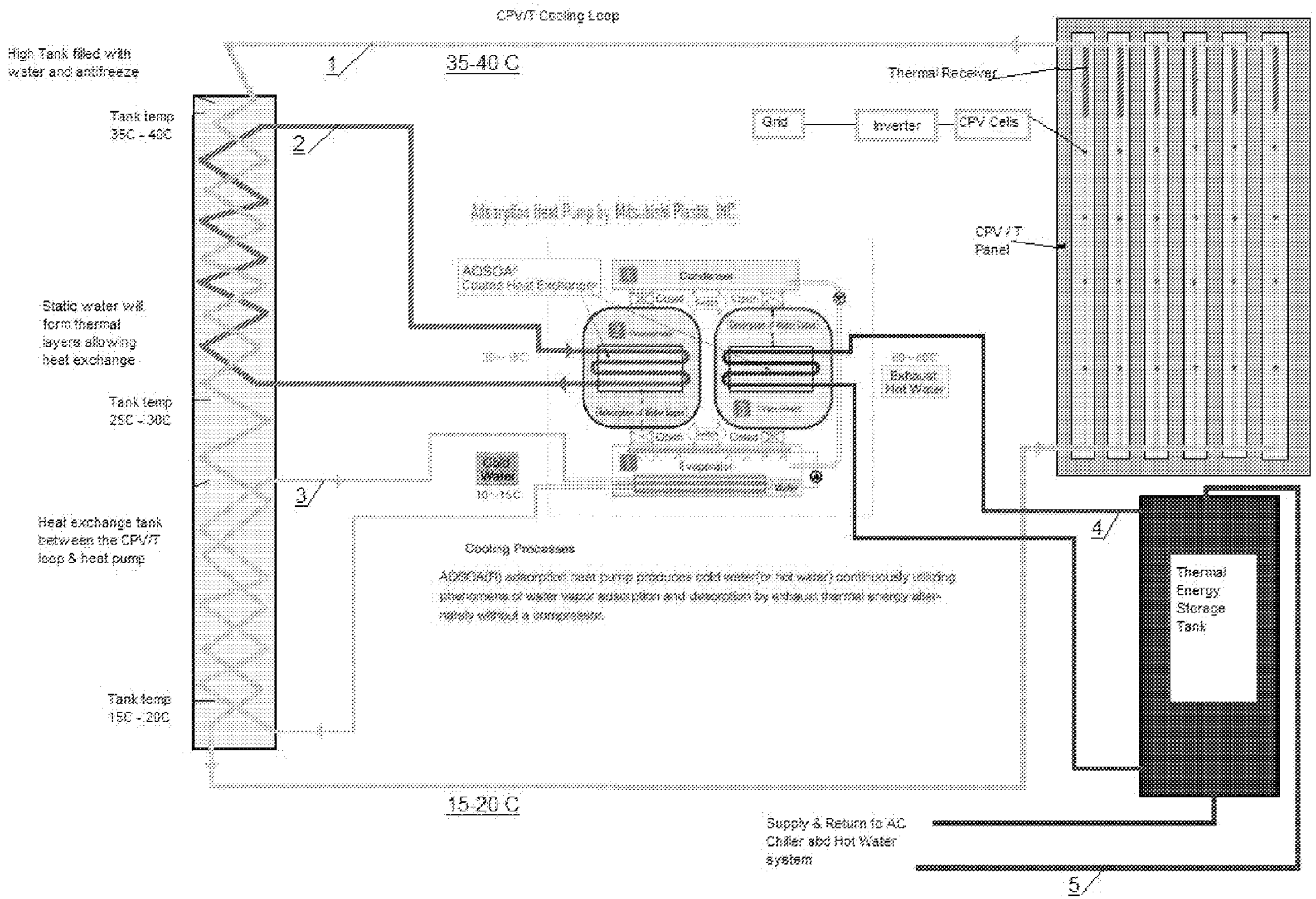
Figure 1



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COMPLETE SPECIFICATION
INNOVATION PATENT

Complete Solar Concentrated Photo Voltaic/Thermal System (CSCPV/TS)

The following statement is a full description of this Invention:

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Complete Solar Concentrated Photo Voltaic/Thermal System (CSCPV/TS)

Although the exemplification set out herein illustrates an embodiment of the invention, the embodiment disclosed below is not intended to be exhaustive or to be construed as limiting the scope of the invention to the precise form disclosed.

There are many stand alone products for the provision of green energy, however each has efficiency flaws. A PV panel for the provision of electricity is only efficient at set temperatures, therefore losing thermal energy or the cells themselves becoming inefficient. Hot water systems require electrical power or solar power to operate, again excessive energy is lost. This invention creates a unit that allows all major energy utilisations to co-exist and share/utilise excessive or wasted energy from each other and therefore increasing the efficiency of all units.

The invention is founded on cooling and maintaining a low temperature in the CSCPV/T collectors of the CPV array through a "Heat Exchange Tank" (HET), by reversed adsorption with a zeolite heat pump, and storing the resulting upgraded thermal energy from the cooling process. The upgraded thermal energy will drive AC chillers and be used in hot water system.

The complete solar efficiency can reach up to 86% with the CSCPV/T system described in this invention. There are a myriad of applications possible, ranging from dwellings, industry and/or commercial.

The complete CSCPV/T systems comprises of the following components that are all interlinked:

1. CPV array (CSCPV Fresnel lens with GaAs cells) with grid inverter;
2. CPV/T cooling loop;
3. Heat Exchange Tank;
4. Adsorption heat pump;
5. Heat storage tank.

1. CPV array

The CPV array consists of powered troughs in which the GaAs cells (5mm x 5mm) with a 500 times solar concentration sits. The troughs have to be of a small size in order to allow fitting of these units on roofs. The troughs rotate to follow the trajectory of the sun. The cells are attached to a pipe which is part of the cooling loop system. By controlling the flow of circulation of the fluid with a low inlet temperature, heat is extracted from the PV. The extracted thermal energy will be used in other components of the overall system. At the end of each pipe array a thermal receiver with no PV cells is incorporated. This is to ensure that the temperature (as required by use of the adsorption heat pump) which is greater than what is required to be removed from the PV cells at optimum efficiency is fed to the HET.

The CPV GaAs cells are 33% efficient at 25 C. By maintaining the temperature less than 40 C with the system described in this invention it is expected the efficiency to not drop under 28%. The thermal efficiency can reach up to 58% efficiency.

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2. CPV/T cooling loop

The cycle is similar to that of a solar absorption refrigeration system. The difference is that the adsorption pump is cooling the CSCPV/T loop in the HET and returning back to the panel at the desired lower temperature. The HET is used as a heat exchanger utilising thermal layering and stores the heat in the thermal energy storage tank. From the thermal storage tank the heat will be used for the provision of hot water and for heating and/or cooling with an adsorption chillier.

As per the embodiment of the present invention, an adsorption heat pump removes the heat generated by the CPV array in the HET, cooling the CPV and storing upgraded heat in a storage tank.

3. Heat Exchange Tank

The thermally isolated HET has at least a height to diameter ratio of 6/1 to maintain a thermal stratification in the water, hot on top and cold on bottom giving the 3 heat exchanger coil tubes ideal working condition. The HET comprises liquid (water) and at least one metal heat exchanger tube for each of the 3 loops immersed into the liquid, and wherein the metal heat exchanger tube forms at least one coil.

The metal heat exchange tube is a single continuous flexible coiled tube. The length, diameter and wall thickness of the metal heat exchange tube has a length, diameter and thickness to perform continuant 110% heat transfer of the maximum thermal output from the CPV. The metal heat exchanger tube is preferably made of copper.

4. An adsorption heat pump in heat communication with the CPV array

An adsorption heat pump is in continues heat communication with the CPV array via the HET. It therefore allows for the collection of solar heat, raise this temperature and store the higher thermal output whilst at the same time holding the CSCPV/T panel at the entry point of the loop at efficient temperature. This is achieved by means of an absorption system working in reverse. Some of the heat collected must be sacrificed, but it is possible to reach high enough stored temperatures to be utilised in non electric air conditioning chillers.

5. Heat storage tank

The storage tank comprise liquid or solid heat storage media and at least one heat exchanger for the supply from the heat pump and one for the removal of the heat to the AC chillier and one for domestic/commercial hot water. This unit collects excessive heat and stores it for use in either/or hotwater systems and AC chillers.

Description of Diagrams

Corresponding reference characters indicate corresponding parts. The above mentioned and other features and objects of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of the invention taken in conjunction with the accompanying drawing, wherein:

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Figure 1 – This illustrates a schematic including an Adsorption Heat Pump by Mitsubishi Plastic INC. The small pump needed to circulate the CSCPV/T loop is not shown in the schematic. The complete system only utilises water with the exception of places where the temperature falls below frizzing point. Only in such places will antifreeze be required to be added to the water.

The marked loops are described as follows:

Loop 1 – The CSCPV/T cooling loop delivers 30-40 C water to the top of the HET where the water is gradually cooled in the spiral on the way to the bottom. Water at 15-25 C is returned to the CSCPV/T panel where it cools the CPV cells.

Loop 2 – This loop circulates from the adsorption chamber of the heat pump and enters the HET halfway up the chamber travelling up through the thermal layers increasing its temperature (whilst removing heat delivered by the CSCPV/T loop) and returns through the top of the tank to the adsorption chamber and therefore becoming the driving power of the pump.

Loop 3 – This loop transfers from the evaporator the chilled water to the bottom of the HET where on the way up it will cool the lower part of the tank and will return to the chillier exiting from the tank half way up with the heat extracted from the tank. This delivers 10-15 C water from the heat pump to the lower part of the HET where it maintains a 15 C temperature.

Loop 4 – This loop transfers the higher temperature (60-80 C) excess hot water from desorption chamber of the heat pump to the thermal storage tank.

Loop 5 – This is the supply to the hot water system and AC Chillers for heating and cooling of dwellings and commercial/ industrial complexes. From the thermal storage tank to the AC chillier, existing adsorption chillers manufacturing technology and requirement apply.

Figure 2 This illustrates the CPV/T array panels which are made from small power troughs to avoid high wind loads. They are rotated from east to west mounted on a frame following the trajectory of the sun. The frame itself will make the seasonal adjustment by lifting or lowering on the opposite of the hinged point. The water circulates in a copper or thermoplastic pipe big enough to remove all the heat from the small GaAs 500 time's concentration PV cells which are attached to it. At the end of the pipe, within the panel, a thermal received is incorporated. This is needed to lift the temperature of the water to a level that is required by the adsorption heat pump to function. There are no cells attached to the pipe in this section of the panel. The pipe is thermally insulated all the way to/from the heat exchange tank.

Figure 3 – This shows a flowchart of the Complete Solar CSCPV/T system.

While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

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**COMPLETE CLAIMS FOR
INNOVATION PATENT**

Complete Solar Concentrated Photo Voltaic/Thermal System (CSCPV/TS)

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The claims defining the invention are as follows:

1. The Complete Solar Concentrated Photo Voltaic/Thermal system (CSCPV/TS) can comprise a CPV array panel, a cooling loop, a heat exchange tank, an adsorption heat pump and a heat storage tank.
2. The CPV array panel as claimed in claim 1 can comprise an inverter to the grid, powered troughs which contain GaAs cells, an inlet for low temperature fluid, and a thermal receiver.
3. The cooling loop as claimed in claim 1 forms the link of the overall system. The loop cycles liquid through the CPV panel and the Heat Exchange Tank.
4. The liquid as claimed in claim 3 includes water of all grades and types, oils, fuels, gases, and mixtures thereof. In preferred embodiments, the liquid is water.
5. The Water as claimed in claim 4 wherein the water can be but is not limited to tap water, hard water, soft water, mineral water, dematerialized water, filtered water, steam-distilled water, salt water, fresh water, distilled water, etc. and may have antifreeze added.
6. The Heat Exchange Tank as claimed in claim 1 can be thermally isolated, with a height to diameter ratio of 6/1 and containing 3 heat exchange coil tubes.
7. The Heat Exchange Tank as claimed in claim 4 wherein the metal tubes length, diameter and wall thickness perform at a 110% heat transfer ratio.
8. The Heat Exchange Tank as claimed in claim 4 wherein the tube is made of copper.
9. The adsorption heat pump as claimed in claim 1 wherein the pump is to include any type of Zeolite heat pump driven by low thermal input to exchange the thermal energy.
10. Metal" or "metallic", as used herein, is meant to include any heat conducting and heat not conducting metals and/or alloys including but not limited to aluminium, copper, gold, iron, lead, silver, titanium, magnesium, zinc, and various alloys thereof. The "metal" or "metallic" components in the present invention are most preferably copper or alloys of copper.
11. Plastics as used herein, is meant to include heat conducting and heat not conducting thermoplastics' and foam.
12. Circulating pump, used herein, is meant to include any type of pump to circulate the fluid.
13. The CSCPV/TS substantially as herein before described with reference to figures 1 – 4 of the accompanying drawings.

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Figure 1

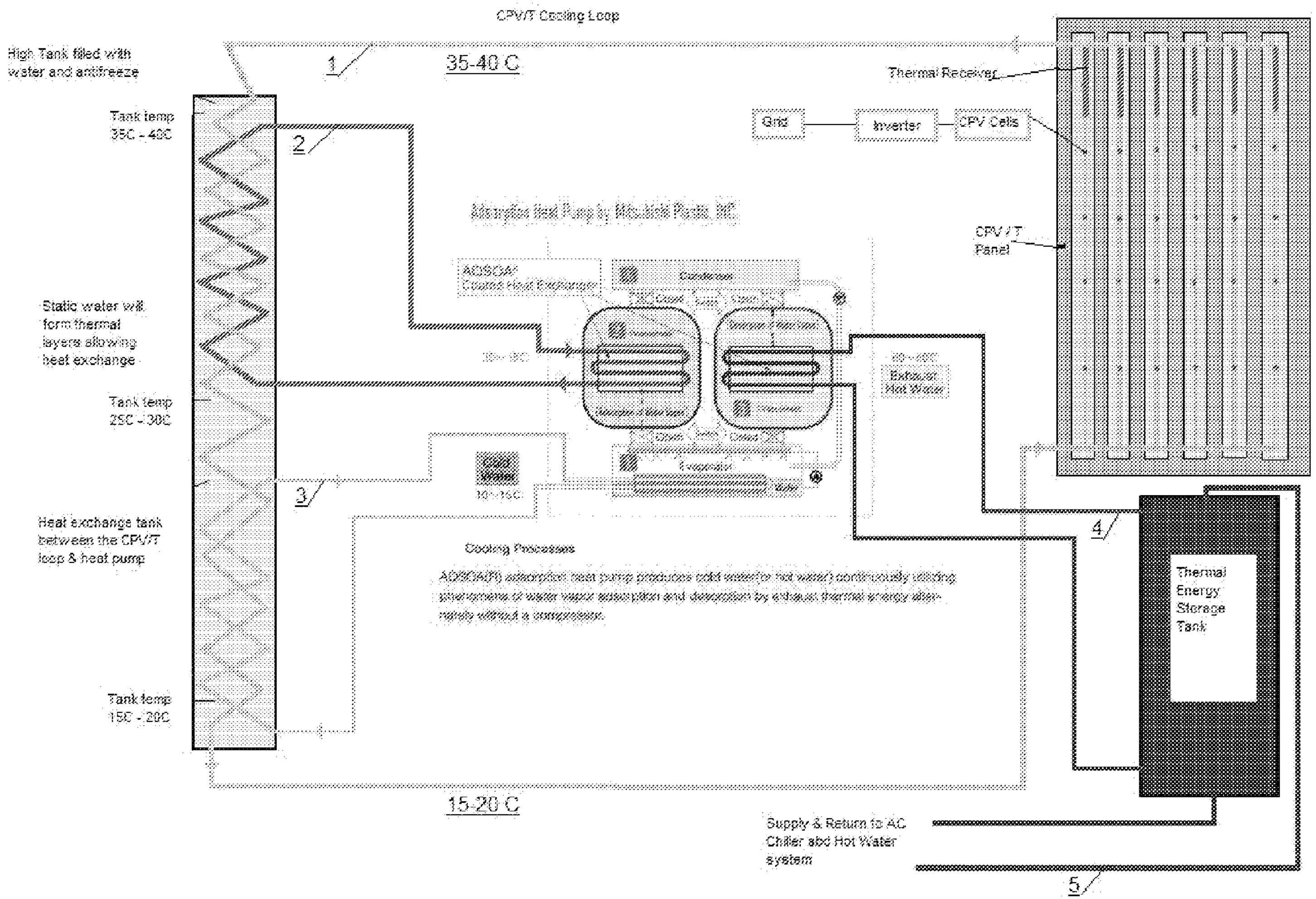

Figure 2

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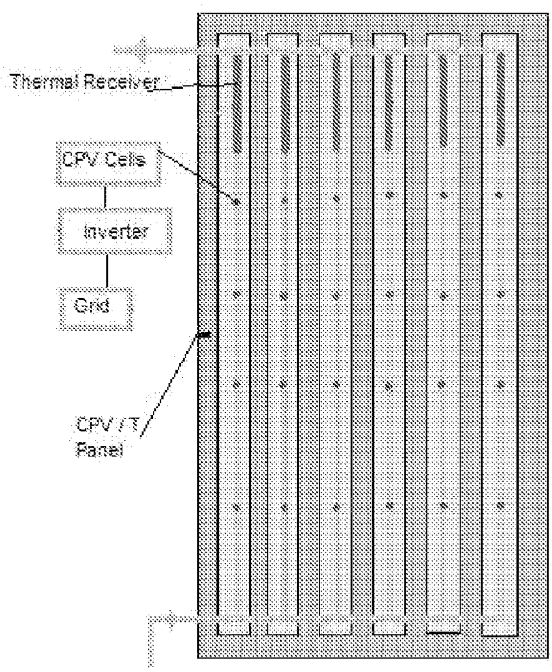

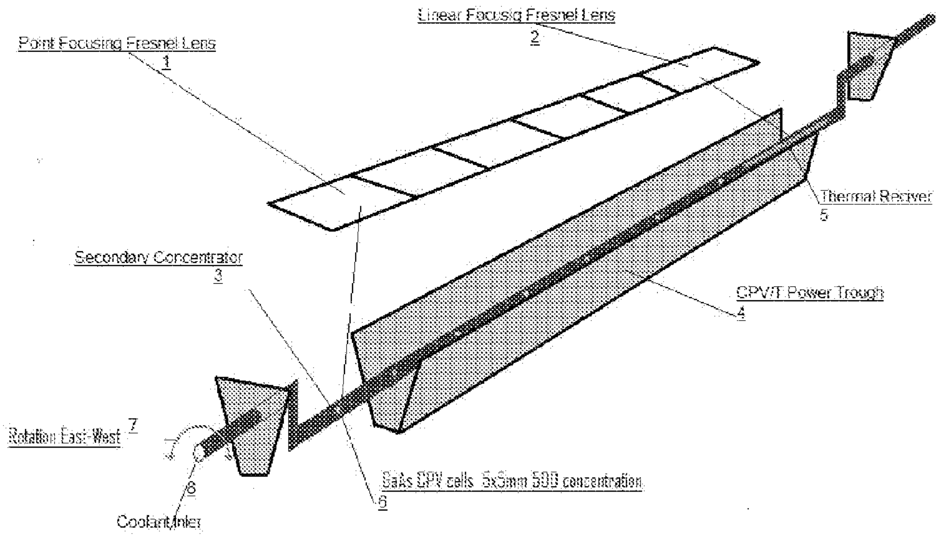

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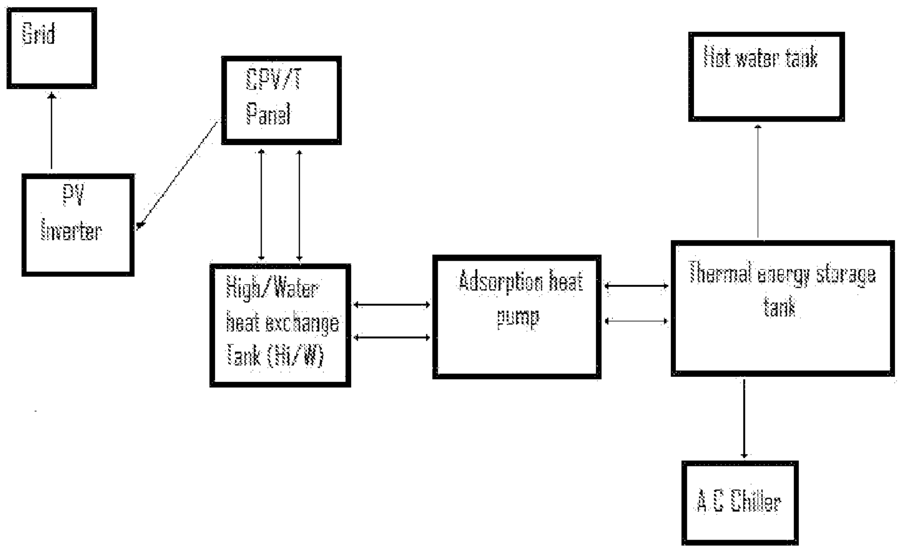
Figure 3



Complete Solar CPV/T System

Roof mounted CPV/T using adsorption pump to store heat for cooling/heating and hot water