German utility model no. DE202022105905U1

Thermal Infrared Solar Cells for Day and Night with Higher Yield per Area than Conventional Photovoltaics

Description

Solar cells have been known for a very long time. They are becoming more efficient and cost-effective. However, photovoltaic modules primarily generate electricity during the day and produce little energy during the "dark" season.

Thermoelectric generators convert heat or a temperature difference into electrical energy. The efficiency of thermoelectric generators is currently low due to the small converted portion of the Carnot efficiency. The advantage is that there are no moving parts. For larger power generation, they currently play only a minor role.

If technical devices or processes produce unused energy such as waste heat or vibration, this can be converted into electricity through "energy harvesting" systems. For example, piezoelectric crystals generate electricity through pressure, thermoelectric generators through a thermal difference, electromagnetic radiation from radio waves with antennas, automatic wristwatches, etc. For example, the aforementioned thermoelements are becoming increasingly effective but are also too expensive, making them unsuitable for larger areas.

An ideal "solar cell" would be one that generates electricity day and night. An important report in this context was the publication by Tristan Deppe and Jeremy N. Munday (2020).

My invention is based on the further development of thermal infrared solar cells to obtain cost-effective generators that generate electricity day and night.

There are a few solutions related to the invention, such as:
- US000010197711B2, thermophotovoltaics in application for sunlight, and
- WO001998050964A1, combining photovoltaics and thermoelements for sunlight and thermal radiation.

The existing solutions fulfill their function according to the circumstances or are still in development but do not have the possibilities of the aforementioned invention.

A universally placeable and electricity-generating solution is desired, and the invention of thermal infrared solar cells specified in Claim 1, which produce electricity day and night in many stacked layers, meets these requirements.

An Example Embodiment:

Currently, it is assumed that thermal infrared solar cells can generate, for example, 10 to 50 watts per square meter.

To significantly increase the "efficiency" of so-called "anti-solar cells" 2 (including heat sinks), they must be stacked next to or on top of each other to form a module (according to Claim 2) (Fig. 1). As shown in Claim 3, an insulating layer 1 and a layer with a heat carrier can optionally be placed between the solar cells (Fig. 2). Additionally, an outer insulating layer is useful (according to Claim 4).

As shown in Claim 5, the modules can also be pushed apart vertically or horizontally and reassembled (Fig. 3), making the heating rods/heat plates/heat carriers easier to warm up.

As the top layer (according to Claim 6), a solar collector 4/thermal solar collector heats, for example, a solar fluid (heat carrier 3, e.g., water with glycol/propylene glycol or air or a metallic heat conductor) through solar radiation. Alternatively, tube collectors/vacuum collectors with a heat pipe and often CPC mirrors (Compound Parabolic Concentrator) can heat a fluid with a low boiling point. Thus, thermal energy is generated, which - as shown in Claim 7 - is used immediately or stored in a large thermally insulated water tank 5 as the bottom "layer." Another storage option would be latent heat storage/phase change storage.

Especially with larger heat storage units, they can (according to Claim 8) also be installed externally. This allows for better insulation, among other things.

As shown in Claim 9, the heat storage unit can be equipped with various materials (water, gravel, earth, steel, stone, lava rock, concrete, (liquid) salt, etc.) or designed as latent heat storage/chemical storage (e.g., sodium acetate, calcium hydroxide - calcium oxide).

Likewise, (according to Claim 10) the solar collectors can be separate from the system. This is advantageous for large systems, allowing all individual components to be optimized, operate independently, and together generate maximum electricity yield.

As shown in Claim 11, a water tank/heat circuit can be installed directly under conventional (also transparent) photovoltaics, cooling them and making them more efficient at high temperatures (Fig. 4). Additionally, the infrared solar cells below are supplied with heat during the day, generating electricity. If necessary, the pump can (according to Claim 12) be powered by the electricity generated from the modules.

Thus, the thermal infrared modules can be used day and night. The electricity yield per square meter of area is then significantly higher compared to conventional solar cells due to the many overlapping layers.

Reference

Tristan Deppe and Jeremy N. Munday: Nighttime Photovoltaic Cells: Electrical Power Generation by Optically Coupling with Deep Space, ACS Photonics 2020, 7, 1, 1–9.

List of Reference Signs

1. Thermal insulating layer
2. Thermal infrared solar cells (including heat sink)
3. Heat carrier/heat conductor, e.g., water with glycol, air, metal, "heat pipe," etc.
4. Thermal solar collector
5. Heat storage, e.g., hot water/collector fluid/heat carrier/solar fluid

Claims

1. Thermal infrared solar cells for day and night, characterized in that electricity is produced in many stacked layers.

2. Thermal infrared solar cells for day and night, according to claim 1, characterized in that they are stacked next to or on top of each other to form a module (including heat sinks).

3. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that an insulating layer and a layer with a heat carrier are installed between the solar cells.

4. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that an outer insulating layer is attached around a module.

5. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that the modules can be pushed apart vertically or horizontally and reassembled.

6. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that a solar collector/thermal solar collector is installed as the top layer, which heats a heat carrier.

7. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that a heat storage unit is installed as the bottom layer.

8. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that the heat storage unit is installed externally.

9. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that the heat storage unit is equipped with various materials (water, gravel, earth, steel, stone, lava rock, concrete, (liquid) salt, etc.) or is a latent heat storage/chemical storage (e.g., sodium acetate, calcium hydroxide - calcium oxide).

10. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that the solar collectors/thermal solar collectors are installed separately from the system.

11. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that the heat circuit is installed directly on and under conventional (also transparent) photovoltaics.

12. Thermal infrared solar cells for day and night, according to one of the preceding claims, characterized in that a pump is powered by the electricity generated from the modules.

Fig. 1

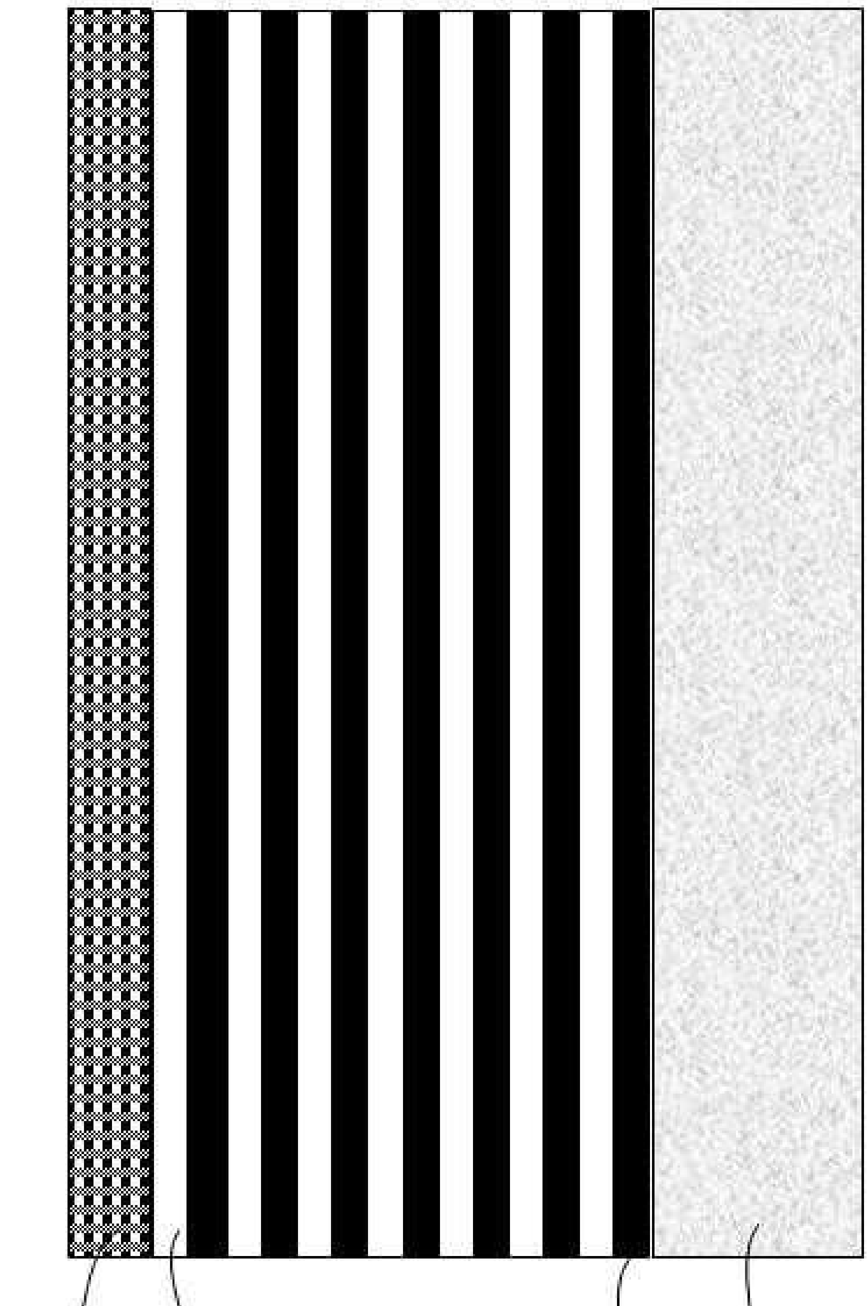

Fig. 2

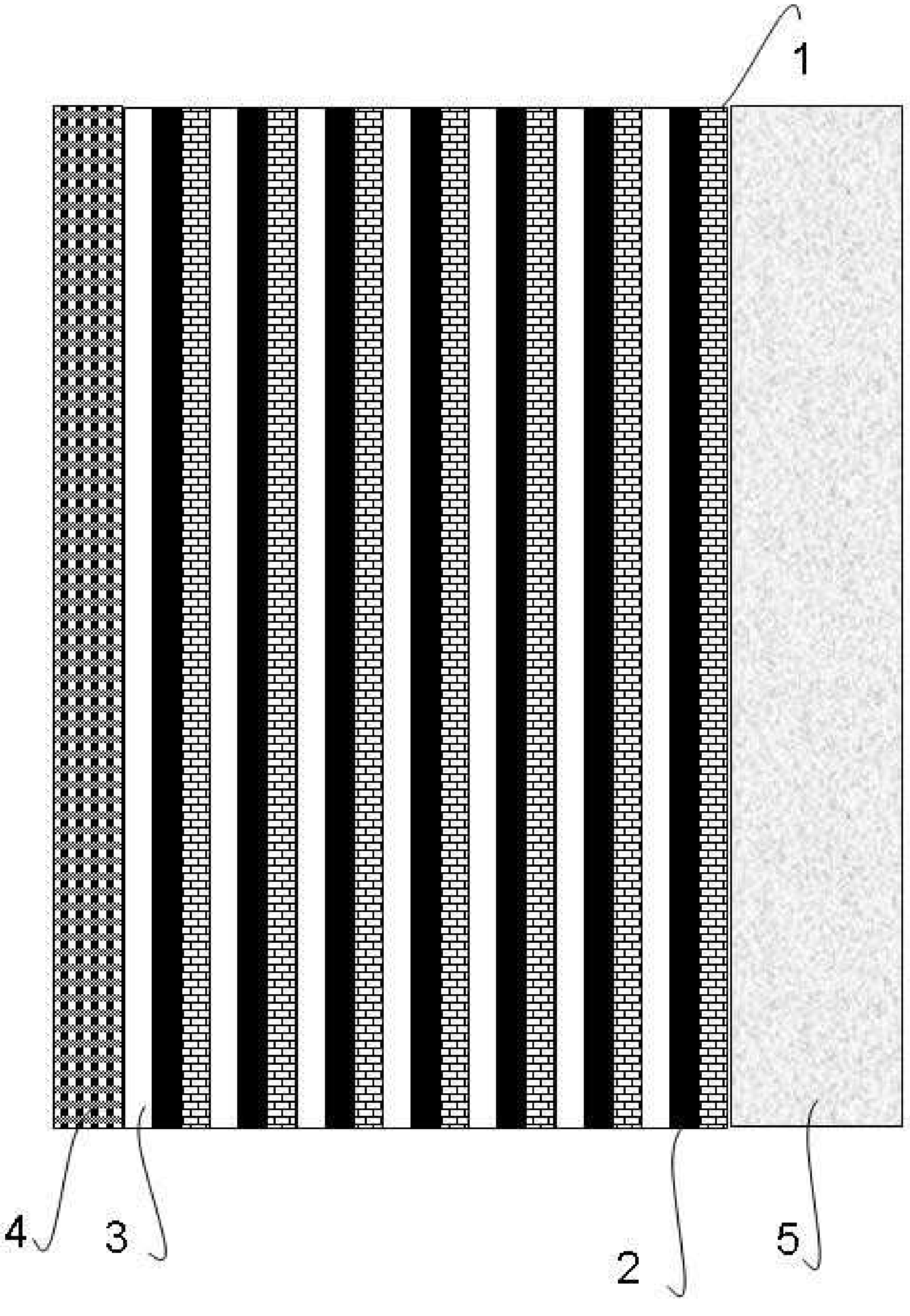

Fig. 3

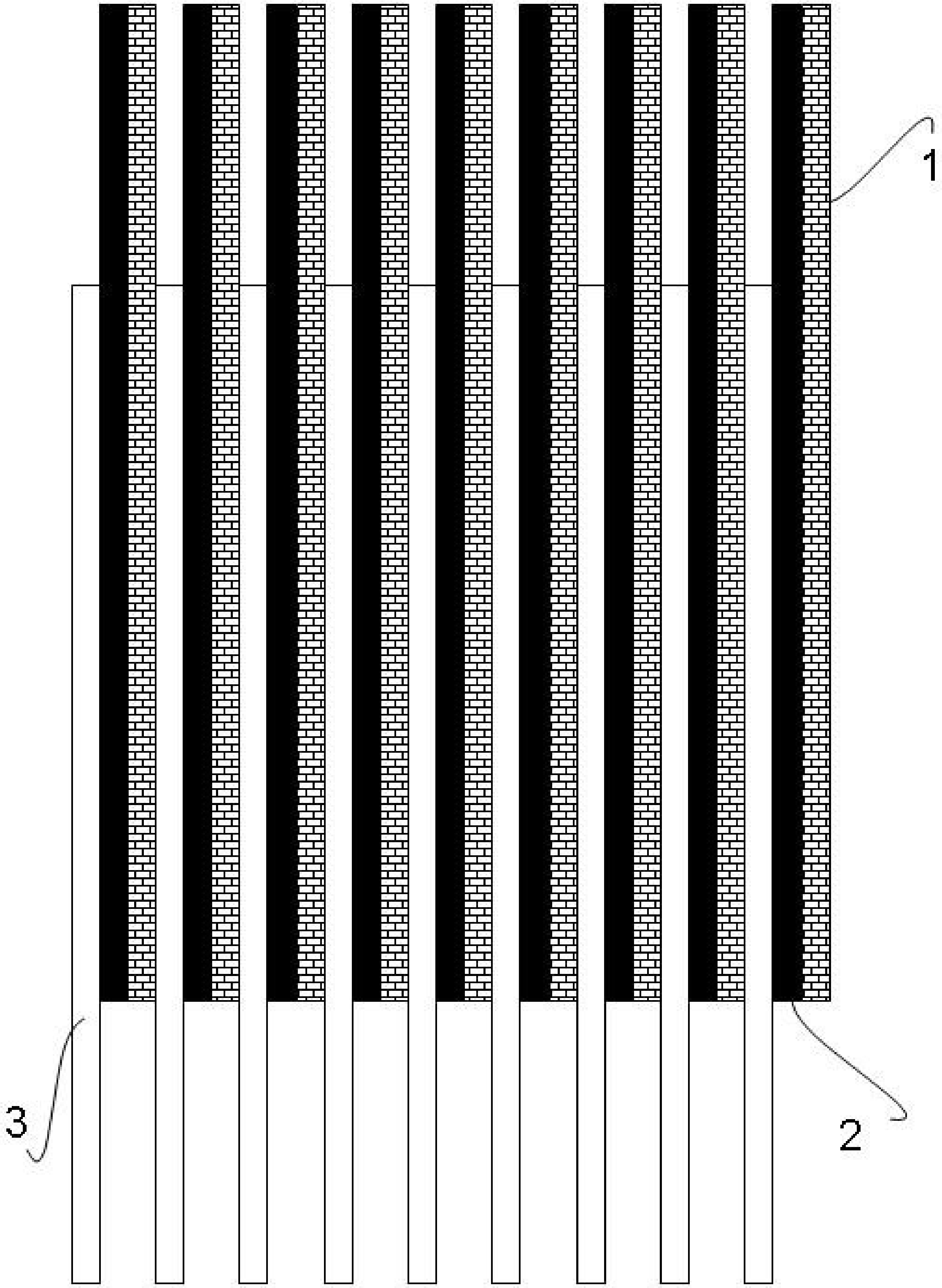

Fig. 4