



US 20110253128A1

(19) **United States**(12) **Patent Application Publication**
Nakamura(10) **Pub. No.: US 2011/0253128 A1**(43) **Pub. Date: Oct. 20, 2011**(54) **SOLAR HEAT EXCHANGER****Publication Classification**(75) Inventor: **Katsushige Nakamura**, Tokyo (JP)(51) **Int. Cl.**
F24J 2/30 (2006.01)
F24J 2/48 (2006.01)
F24J 2/04 (2006.01)(73) Assignee: **MITAKA KOHKI CO., LTD.**,
Tokyo (JP)(21) Appl. No.: **13/141,827**(52) **U.S. Cl. 126/645; 126/679; 126/610**(22) PCT Filed: **Dec. 24, 2009**(57) **ABSTRACT**(86) PCT No.: **PCT/JP2009/071427**§ 371 (c)(1),
(2), (4) Date: **Jun. 23, 2011**(30) **Foreign Application Priority Data**

Dec. 24, 2008 (JP) 2008-327647

A light receiving plate floating on the surface of tin, i.e., a low-melting-point heating medium and receiving solar beams is made of solid carbon material entirely coated with a silicon carbide film. Due to the silicon carbide film, the surface of the light receiving plate is black to realize a high absorption ratio of the solar beams. In addition, the light receiving plate is made of the silicon carbide film at least at the surface thereof, to demonstrate excellent heat resistance.

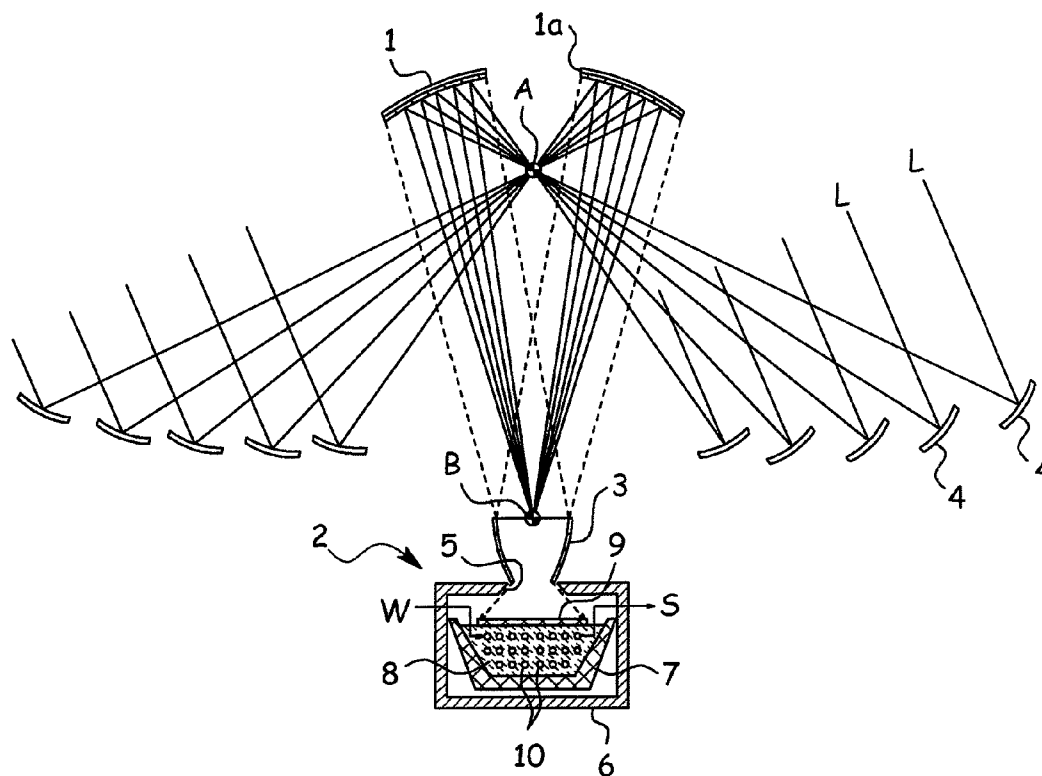


FIG. 1

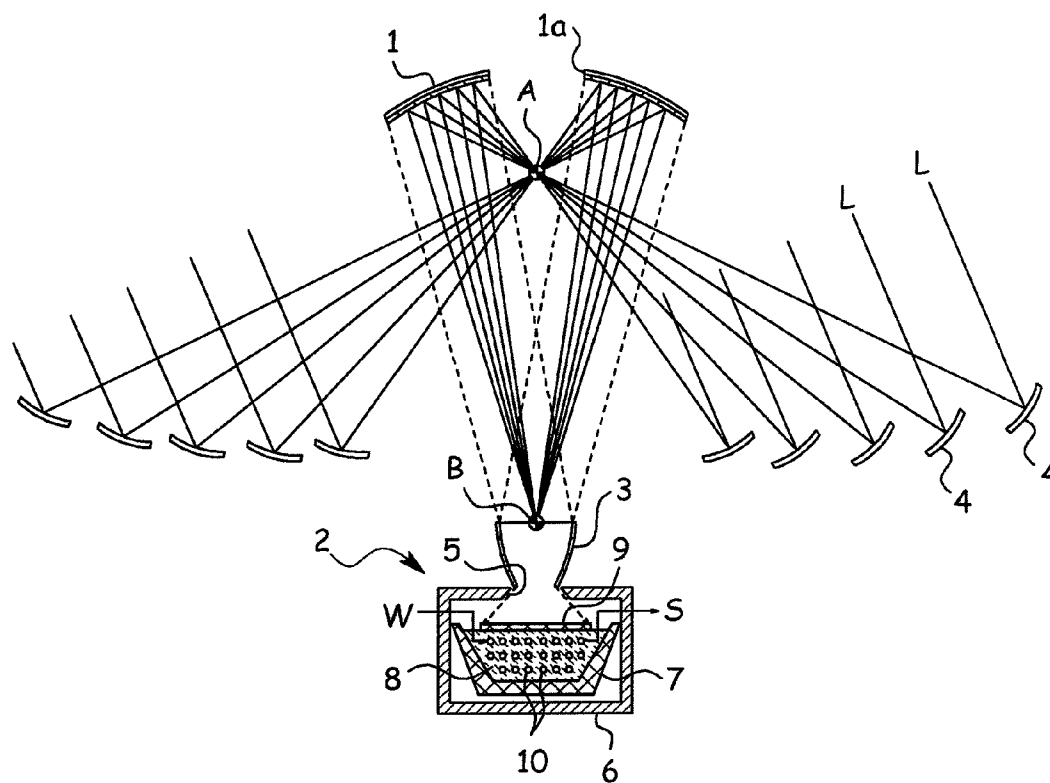


FIG. 2

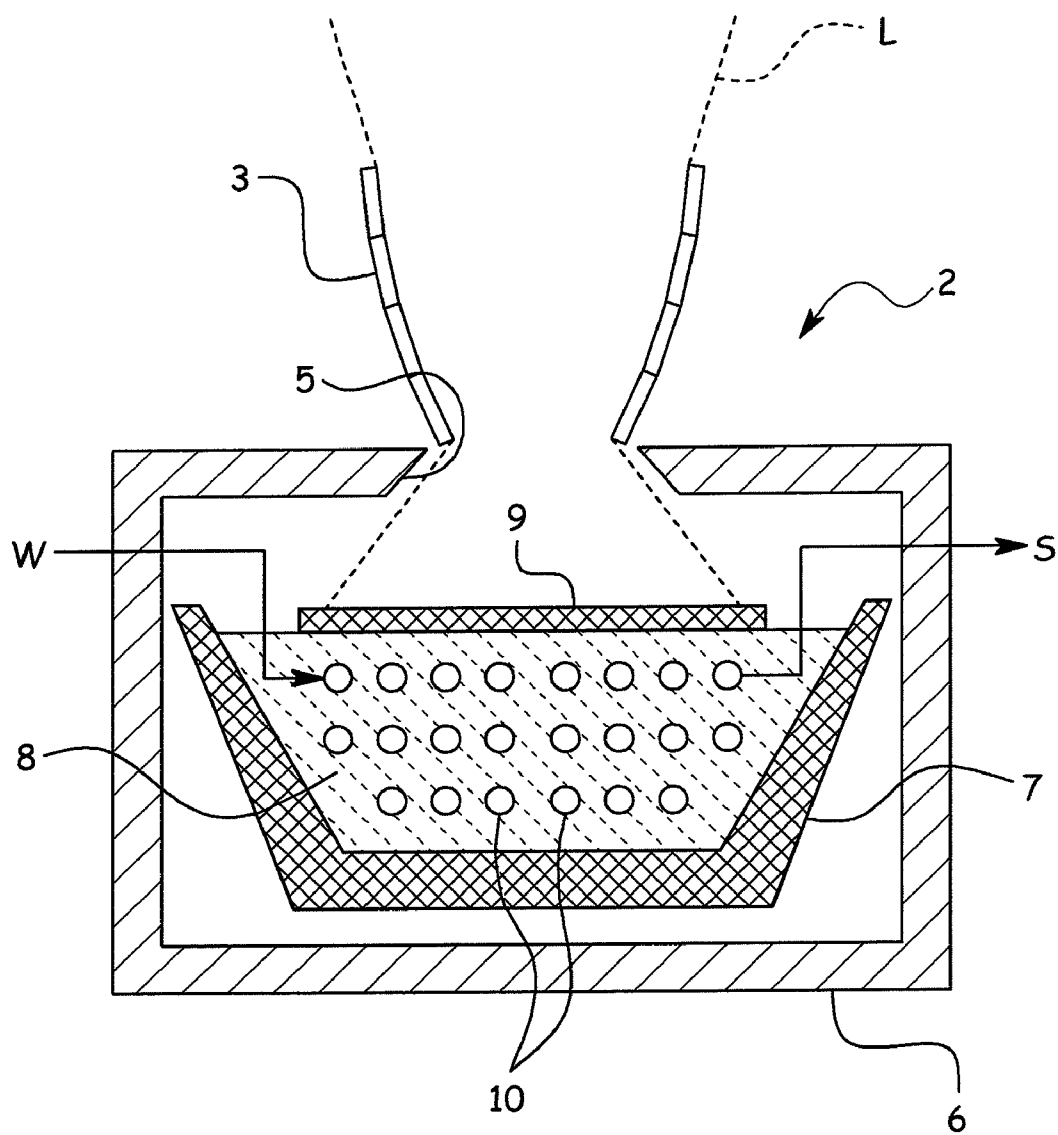


FIG. 3

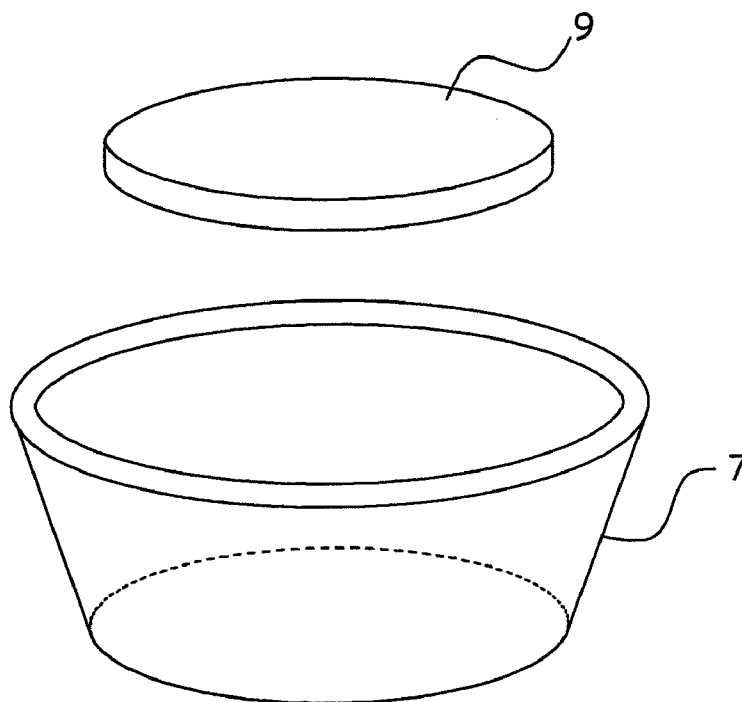


FIG. 4

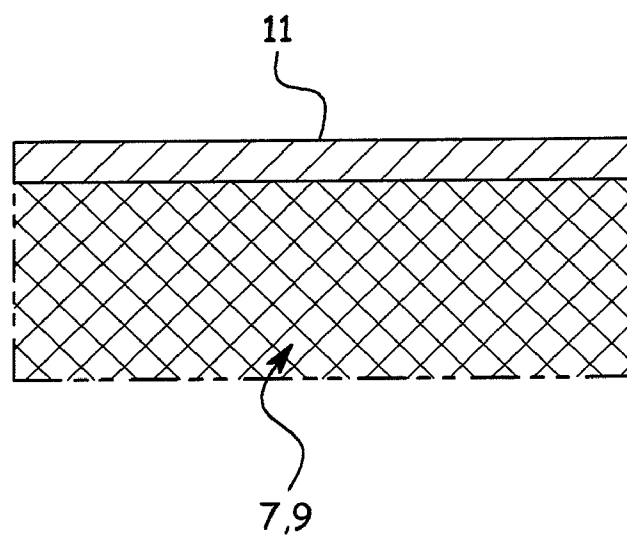
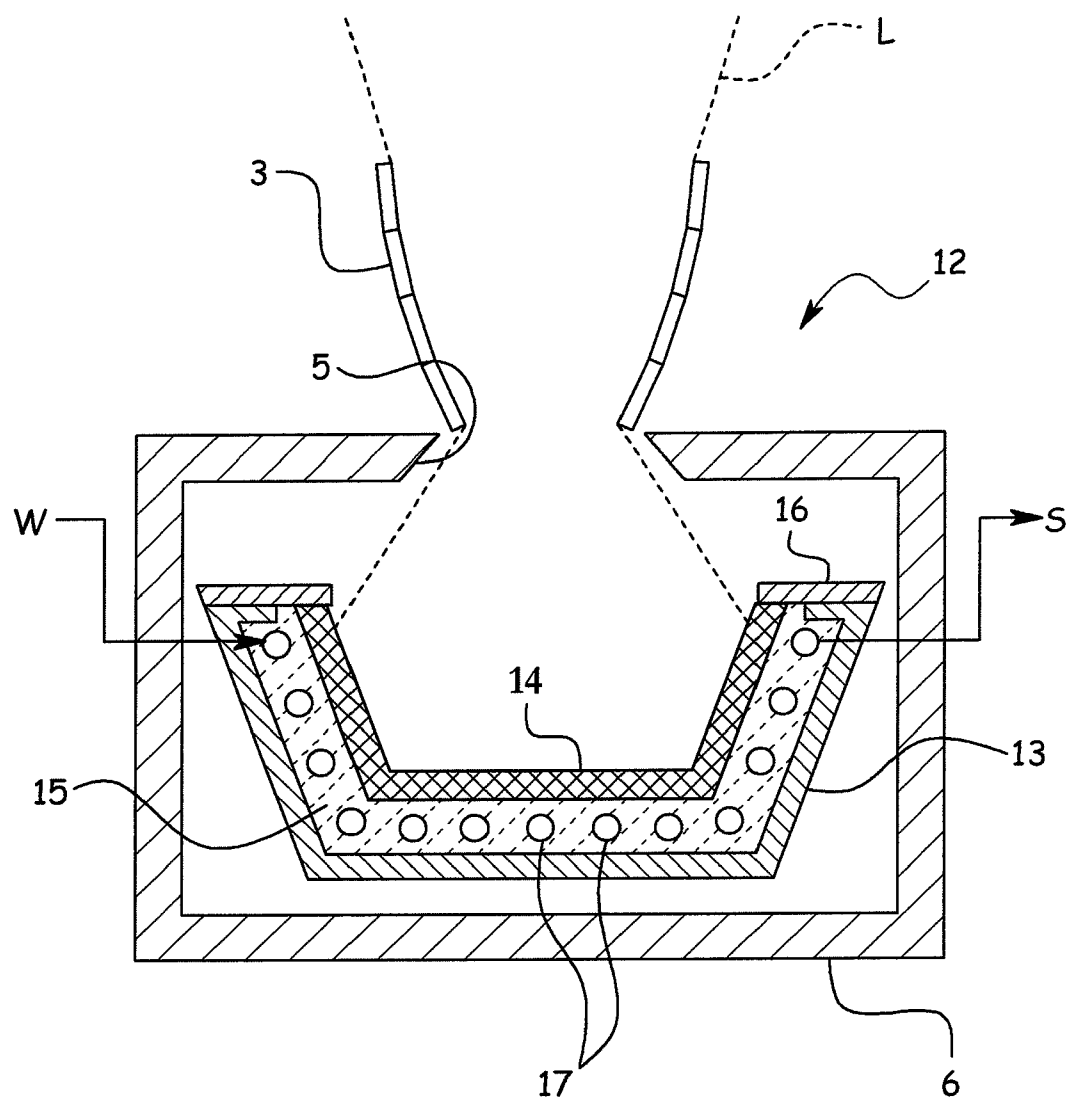


FIG. 5



SOLAR HEAT EXCHANGER

TECHNICAL FIELD

[0001] The present invention relates to a solar heat exchanger.

BACKGROUND TECHNOLOGY

[0002] There is known a beam-down solar concentration apparatus that reflects, with a plurality of reflection mirrors called heliostats, solar beams toward a center mirror supported at the top of a high tower and concentrates downwardly reflected solar beams from the center mirror on a point to obtain heat (for example, Japanese Unexamined Patent Application Publication No. H11-119105).

[0003] In the case of the beam-down structure of this sort, the downwardly reflected solar beams directly heat, for example, a metallic coil to change water circulated inside the coil into vapor.

OUTLINE OF INVENTION

[0004] According to the structure of the related art of directly heating the metallic coil with solar beams, however, a metallic color of the surface of the metallic coil reflects solar beams to hinder efficient heat exchange. The surface of the metallic coil is heated with solar beams to very high temperatures, and therefore, a black coating, should it be applied to the surface, will easily peel off.

MEANS TO SOLVE THE PROBLEMS

[0005] In consideration of the related art, the present invention provides a solar heat exchanger capable of efficiently converting solar beams into heat.

[0006] According to a technical aspect of the present invention, a structure includes a top-open, heat-resistant container that holds a low-melting-point heating medium and a light receiving plate that is supported on and is in contact with the surface of the low-melting-point heating medium. It is characterized in that the light receiving plate is made of solid silicon carbide, or solid carbon material entirely coated with a silicon carbide film.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 is a general view illustrating a solar concentration apparatus according to a first embodiment of the present invention.

[0008] FIG. 2 is a sectional view illustrating a heat exchanger.

[0009] FIG. 3 is a perspective view illustrating a light receiving plate and heat-resistant container.

[0010] FIG. 4 is an enlarged sectional view illustrating a silicon carbide film on the surface of the light receiving plate and heat-resistant container.

[0011] FIG. 5 is a sectional view illustrating a heat exchanger according to a second embodiment of the present invention.

MODE OF IMPLEMENTING INVENTION

First Embodiment

[0012] FIGS. 1 to 4 are views illustrating a first embodiment of the present invention. Numeral 1 represents an elliptic mirror serving as a center mirror that is supported with a

support tower (not illustrated) at a predetermined height in a downwardly oriented state. A circular opening 1a is formed at the center of the elliptic mirror 1. The elliptic mirror 1 has a mirror surface that is defined as a part of an ellipsoid, and under the same, there are a first focus A and a second focus B. Under the elliptic mirror 1, a heat exchanger 2 is arranged to convert solar beams L into heat energy. At an upper part of the heat exchanger 2, there is a collector mirror 3 substantially having a tapered cylindrical shape. On the ground around the heat exchanger 2, many heliostats 4 are arranged to surround the elliptic mirror 1.

[0013] Each of the heliostats 4 is controlled by a sensor system (not illustrated) so that solar beams L reflected by the heliostat 4 may pass through the first focus A. Once the solar beams L reflected by the heliostats 4 pass through the first focus A, the solar beams are downwardly reflected by the elliptic mirror 1, are always collected at the second focus B, and reach the heat exchanger 2 through the collector mirror 3.

[0014] The heat exchanger 2 has a box 6 that has an opening 5 at the top thereof and is made of autoclaved lightweight concrete (ALC). The collector mirror 3 is arranged at the opening 5. In the box 6, there is a heat-resistant container 7 made of black carbon material. Inside the heat-resistant container 7, there is held tin 8 serving as a low-melting-point heating medium. On the surface of the tin 8, a light receiving plate 9 made of black carbon material floats. In the tin 8, a heat exchanging pipe 10 meanders. In the pipe 10, water W serving as a heat conducting medium is supplied from one side and vapor S is discharged from the other side.

[0015] The heat-resistant container 7 has an open top shape having a tapered side face that upwardly widens from a circular bottom. The black carbon material that forms the heat-resistant container 7 is entirely coated with a silicon carbide (SiC) film 11.

[0016] The light receiving plate 9 floating on the surface of the tin 8 has a disk shape and is made of black carbon material entirely coated with a silicon carbide film 11. The silicon carbide film 11 itself is black, and therefore, the solar beams L collected by the collector mirror 3 and received by the light receiving plate 9 are absorbed at a high absorption ratio (about 95%) and are changed into heat.

[0017] The heat changed by the light receiving plate 9 is conducted to the tin 8 that becomes molten when the temperature thereof reaches a melting point (232° C.). The molten tin 8 in a wet state contacts the light receiving plate 9 and pipe 10, to increase heat conduction efficiency to surely convert the water W passing through the pipe 10 into vapor S.

[0018] The black carbon material that forms the light receiving plate 9 is smaller in specific gravity than the tin 8, and therefore, the light receiving plate 9 floats on the surface of the tin 8 and never sinks into the tin 8 even if the tin 8 becomes molten. The light receiving plate 9 is entirely coated with the silicon carbide film 11. The silicon carbide film 11 itself is highly heat resistive and prevents the inside black carbon material from contacting air, and therefore, the black carbon material never burn even if the light receiving plate 9 is heated to high temperatures.

[0019] The heat-resistant container 7 is also coated with the silicon carbide film 11, and when an exposed part thereof receives solar beams L, the part absorbs the solar beams L and converts the same into heat to heat the tin 8.

[0020] In a first stage of the tin 8 receiving heat from the light receiving plate 9, the tin 8 is solid and expands due to the heat. At this time, if the tin 8 and an inner face of the heat-

resistant container 7 are tightly attached to each other, stress may concentrate on part of the tin 8 and heat-resistant container 7, to partly distort or break the container.

[0021] For this, the embodiment forms the heat-resistant container 7 with black carbon material coated with the silicon carbide film 11. Compared with making the heat-resistant container 7 from metal, contact force between the tin and the container is weaker so that the tin 8 may easily slide on the inner face of the heat-resistant container 7. In addition, the heat-resistant container 7 has an upwardly widening tapered shape to allow the solid tin 8 to slide upwardly. As a result, the tin 8 and heat-resistant container 7 will have no part where stress concentration occurs to cause partial distortion or breakage.

[0022] According to the present embodiment, the light receiving plate 9 and heat-resistant container 7 are made of black carbon material coated with the silicon carbide film 11. Instead, they may entirely be made of silicon carbide. Although one piece of the light receiving plate 9 is floated on the surface of the tin 8, a plurality of small light receiving plates 9 may be floated thereon.

[0023] According to the present embodiment, water W passes through the pipe 10 and is converted into vapor S. Instead, the pipe 10 may pass air as the heat conducting fluid. The air passing through the pipe 10 is heated to high temperatures and is circulated through another apparatus to conduct the heat from the tin 8 to the apparatus.

[0024] Instead of the tin 8, low-melting-point metal such as lead and solder may be used as the low-melting-point heating medium.

Second Embodiment

[0025] FIG. 5 is a view illustrating a second embodiment of the present invention. This embodiment and embodiments that follow employ structural elements that are similar to those of the first embodiment. Accordingly, similar structural elements are represented with common marks to omit overlapping explanations.

[0026] A heat exchanger 12 according to the present embodiment has a heat-resistant container 13 that is made of stainless steel. A light receiving plate 14 is of an open-top type having a tapered side face that upwardly widens from a circular bottom. Between the light receiving plate 14 and the heat-resistant container 13, there is molten salt 15 serving as a low-melting-point heating medium. The molten salt 15 is a mixture of potassium nitrate and sodium nitrate and becomes liquid at a melting point of about 140° C. At an upper end of the heat-resistant container 13, a flange 16 is fixed to press from above the light receiving plate 14 that may rise due to buoyancy. In the molten salt 15, there is a pipe 17.

[0027] According to the present embodiment, the light receiving plate 14 has an open top shape to realize a large area to receive solar beams L. In addition, a contact area thereof to the molten salt 15 is also large. Accordingly, the molten salt 15 can quickly be put in a molten state. Side faces of the light receiving plate 14 and heat-resistant container 13 are inclined into a tapered shape and the molten salt 15 is heated even around the bottom of the heat-resistant container 13. Due to this, the molten salt 15 in a molten state easily circulates due to convection, to relax temperature variations and further improve heat exchanging efficiency. In addition, the molten salt 15 is inexpensive compared with, for example, tin, to provide an advantage in terms of cost. The molten salt 15 may

be used alone, or may be mixed with solid heat storage material that does not melt when heated.

EFFECT OF INVENTION

[0028] According to the present invention, the light receiving plate floating on the surface of a low-melting-point heating medium and receiving solar beams is made of solid silicon carbide, or solid carbon material entirely coated with a silicon carbide film. Due to the silicon carbide film, the surface of the light receiving plate is black to improve an absorption ratio of solar beams. The light receiving plate is formed with the silicon carbide film at least at the surface thereof, and therefore, demonstrates excellent heat resistance. The low-melting-point heating medium melts to become a liquid heat source that may take any shape depending on the shape of the heat-resistant container. This increases a contact area and improves heat exchange efficiency.

[0029] The low-melting-point heating medium may be low-melting-point metal selected from any one of tin, lead, and solder, to serve as a high-temperature liquid heat source.

[0030] The low-melting-point heating medium may be molten salt that is advantageous in terms of cost.

[0031] The heat-resistant container has a tapered shape that upwardly widens. Even if the low-melting-point heating medium causes in a solid state a volume change due to thermal expansion during heating or cooling, the low-melting-point heating medium easily slides on the inner face of the heat-resistant container, to cause no stress concentration at any part of the low-melting-point heating medium and heat-resistant container. Accordingly, the low-melting-point heating medium and heat-resistant container never cause partial distortion or breakage.

[0032] Further, the heat-resistant container is made of solid silicon carbide, or solid carbon material entirely coated with a silicon carbide film, and therefore, even the heat-resistant container can absorb, at its exposed part, solar beams and can change them into heat. Compared with the case of making the heat-resistant container from metal, contact force (a mutual action at an interface) between the solid low-melting-point heating medium and the container is weaker so that the low-melting-point heating medium may easily slide when thermal expansion occurs, thereby reducing stress on the heat-resistant container.

[0033] Moreover, the light receiving plate has an open top container shape, to increase a light receiving area and an area in contact with the low-melting-point heating medium, so that the low-melting-point heating medium may quickly be put in a molten state.

UNITED STATES DESIGNATION

[0034] In connection with United States designation, this international patent application claims the benefit of priority under Article No. 119(a) of United States patent Law to Japanese Patent Application No. 2008-327647 filed on Dec. 24, 2008 whose disclosed contents are cited herein.

1. A solar heat exchanger having a structure including a top-open, heat-resistant container holding a low-melting-point heating medium and a light receiving plate being supported on and in contact with the surface of the low-melting-point heating medium, wherein

the light receiving plate is made of solid silicon carbide, or solid carbon material being entirely coated with a silicon carbide film.

2. The solar heat exchanger according to claim 1, wherein the low-melting-point heating medium is low-melting-point metal selected from any one of tin, lead, and solder.

3. The solar heat exchanger according to claim 1, wherein the low-melting-point heating medium is molten salt.

4. The solar heat exchanger according to claim 1, wherein the heat-resistant container has an upwardly widening tapered shape.

5. The solar heat exchanger according to claim 4, wherein the heat-resistant container is made of solid silicon carbide, or solid carbon material being entirely coated with a silicon carbide film.

6. The solar heat exchanger according to claim 1, wherein the light receiving plate has an open top container shape.

* * * * *