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(54) **APPARATUS FOR SOLAR THERMAL COLLECTION AND SYSTEM OF THE SAME**

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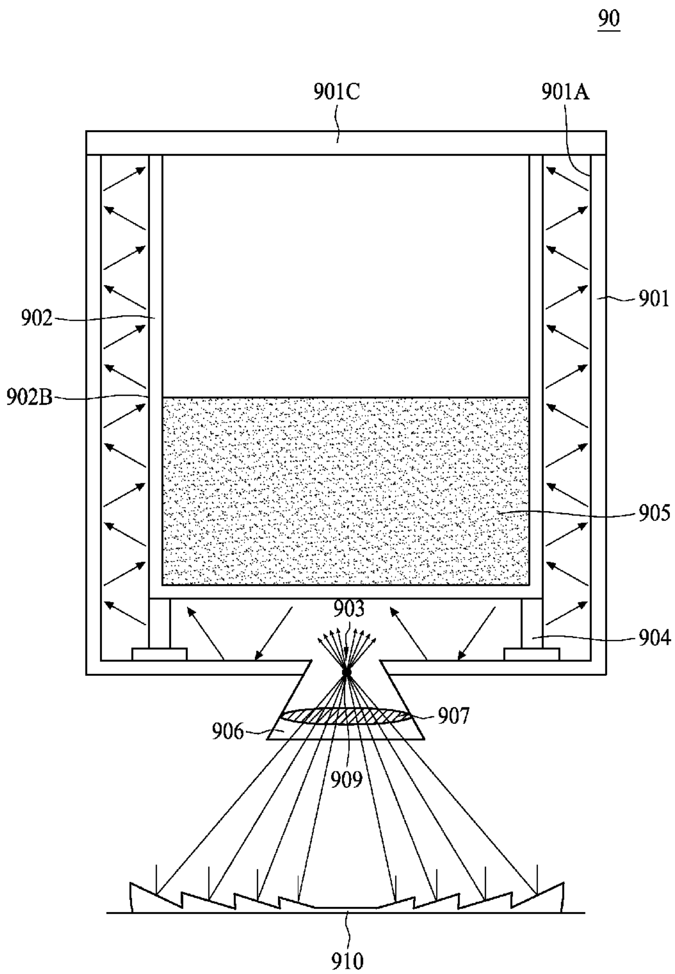
USPC **126/681**

(57) **ABSTRACT**

One embodiment of the present invention discloses an apparatus for solar-thermal collection. The apparatus includes a thermal resistance body; a solar-thermal converter disposed inside the thermal resistance body, wherein the volume of the solar-thermal converter is less than that of the thermal resistance body, so that a space exists between the inner wall of the thermal resistance body and the outer wall of the solar-thermal converter; and at least one opening disposed on the wall of the thermal resistance body, wherein the opening is a through hole only on the wall of the thermal resistance body



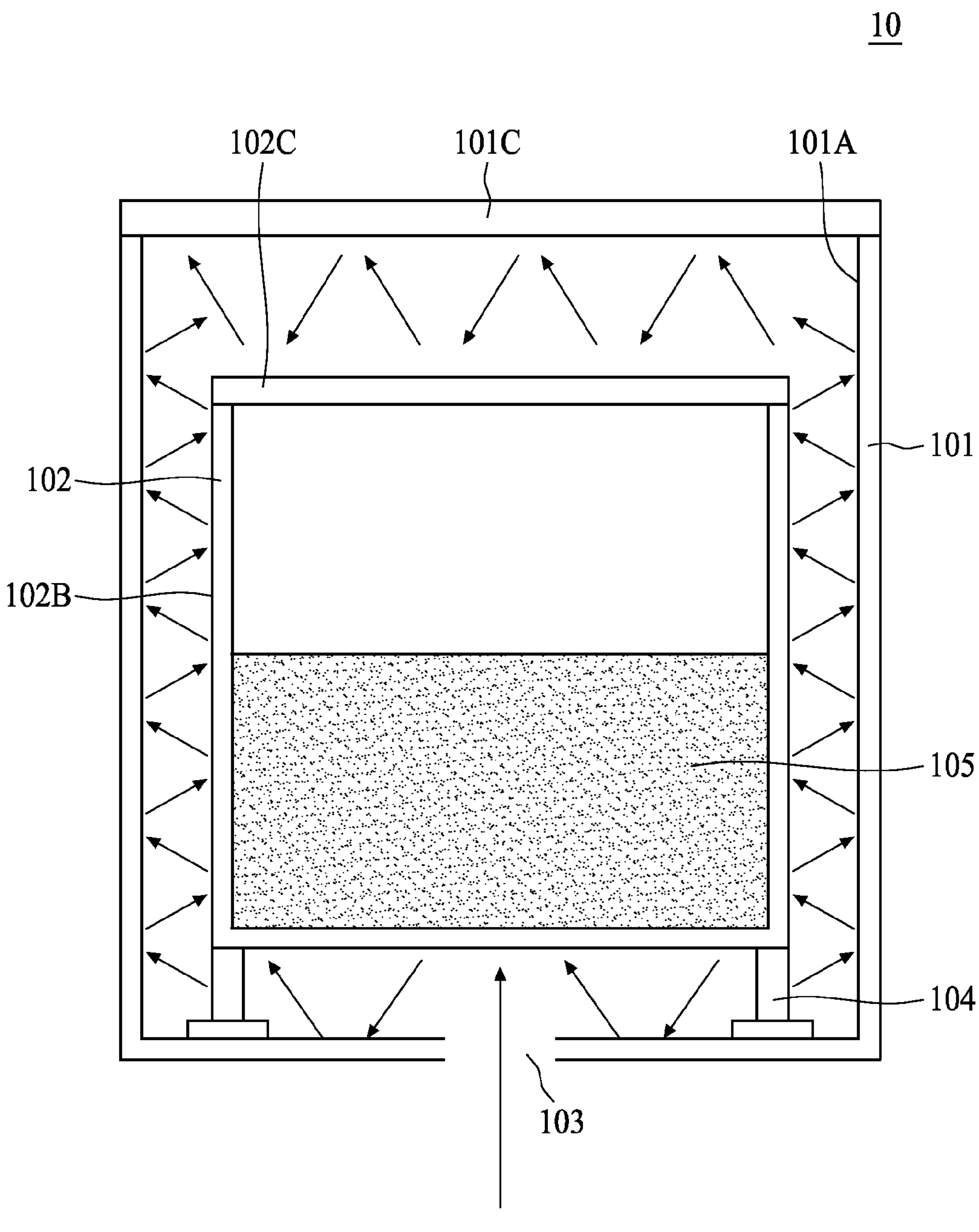


FIG. 1

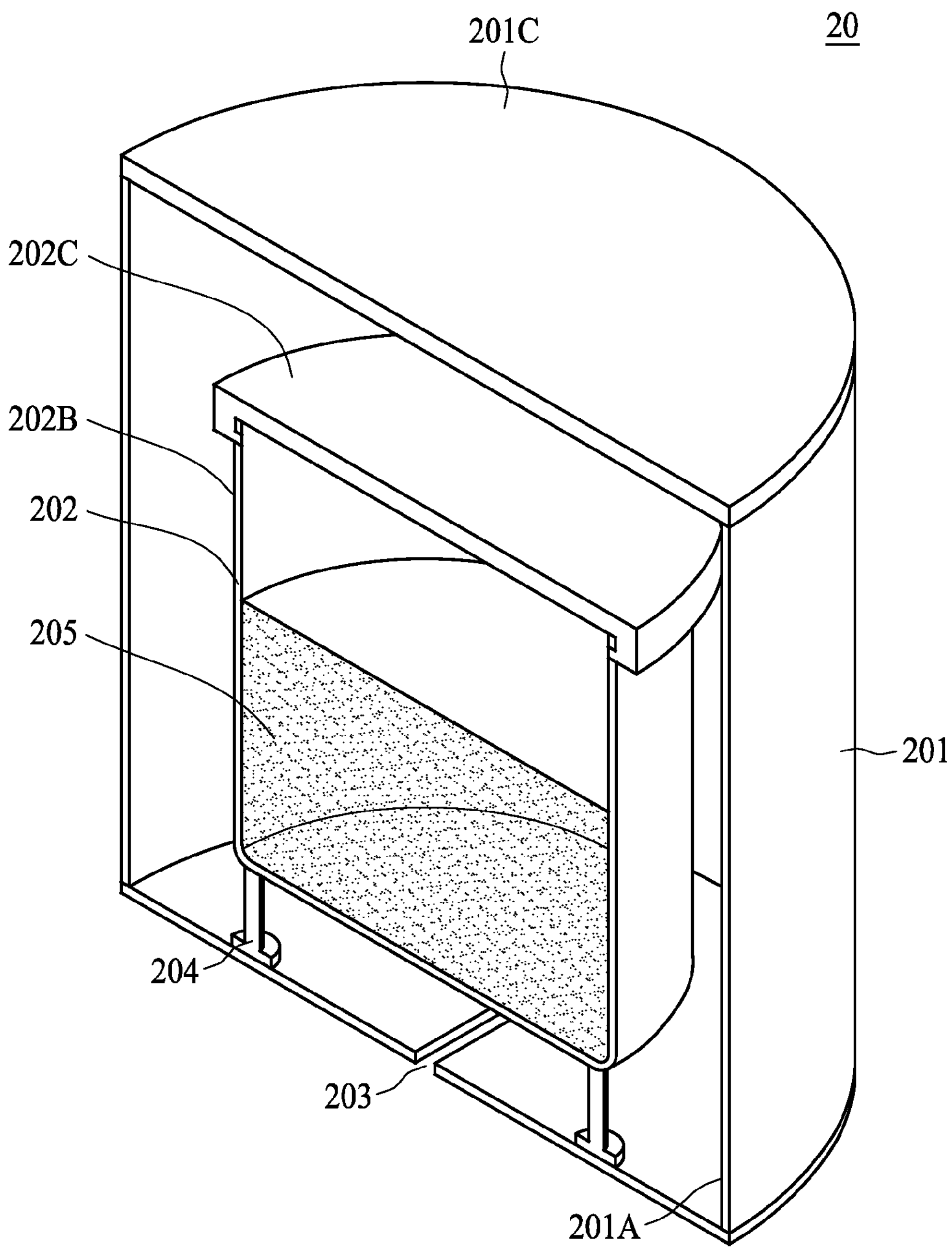


FIG. 2

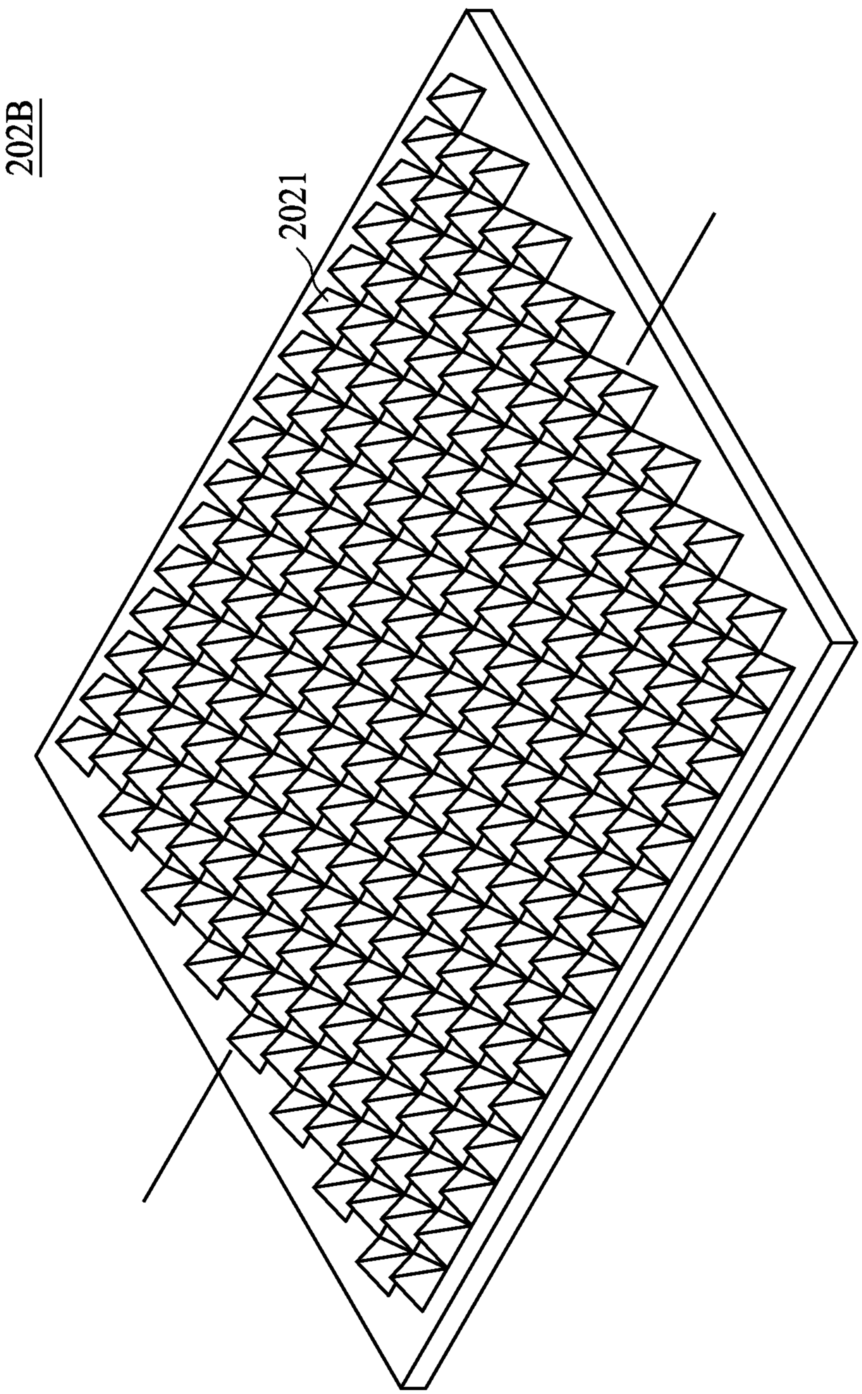


FIG. 3

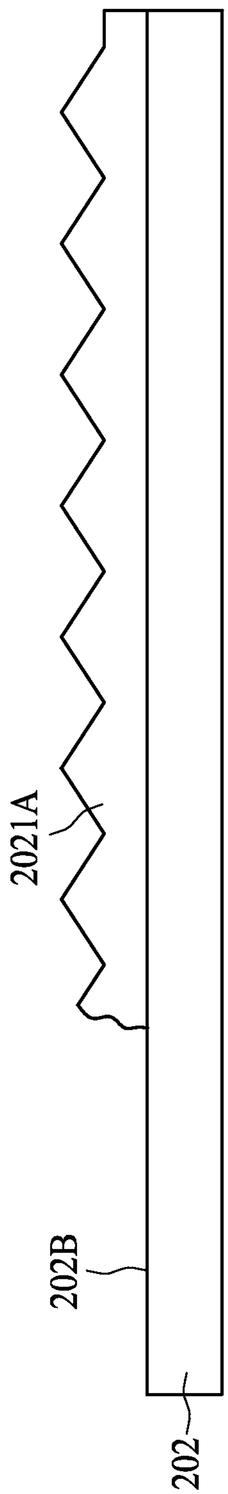


FIG. 4

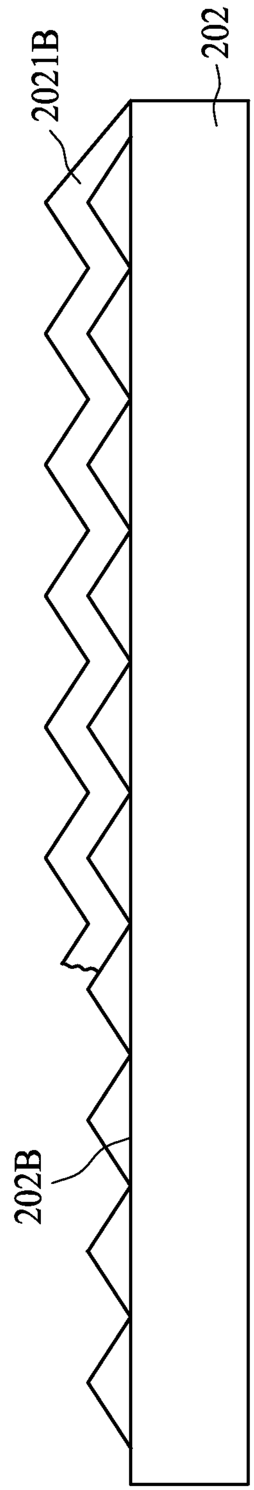


FIG. 5

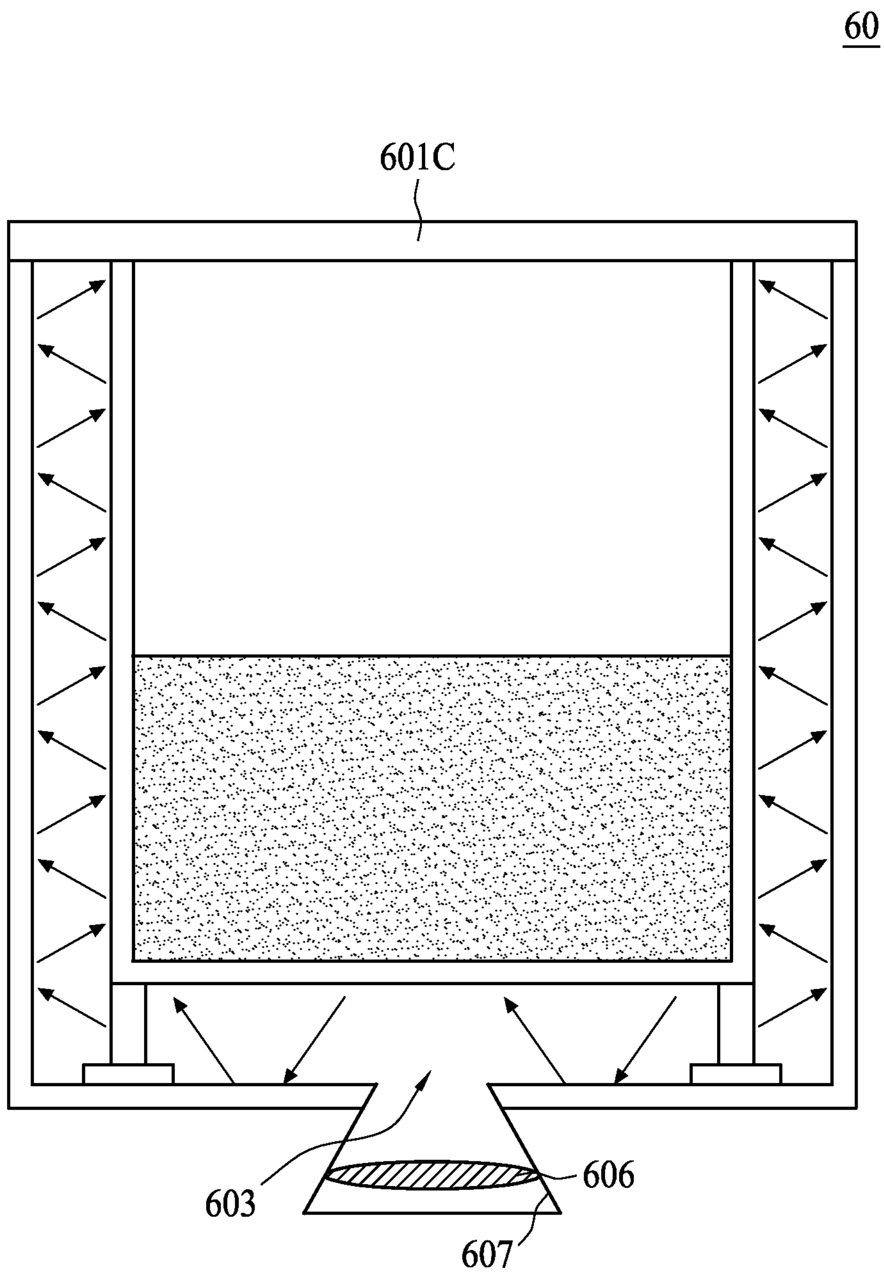


FIG. 6

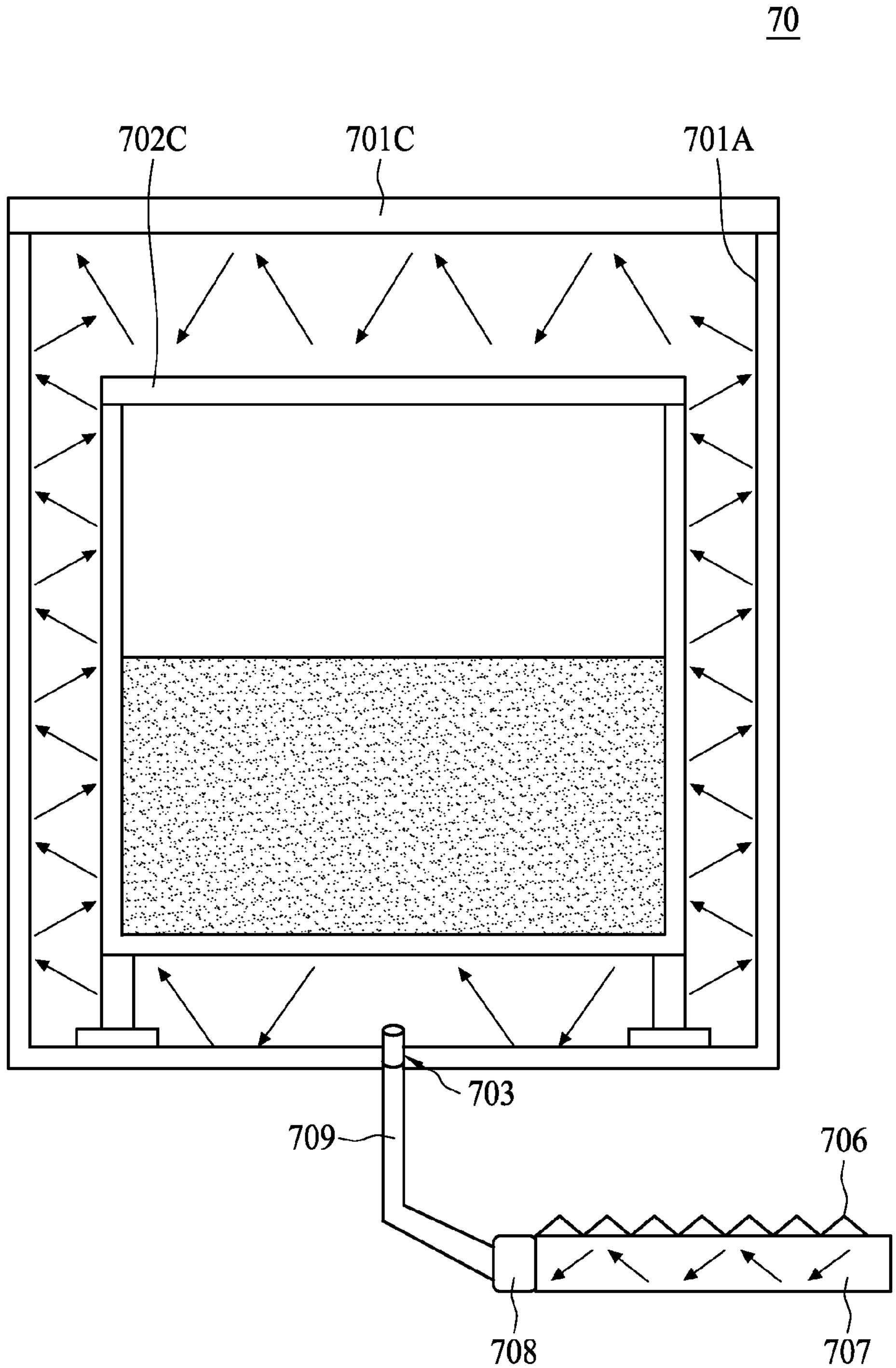


FIG. 7

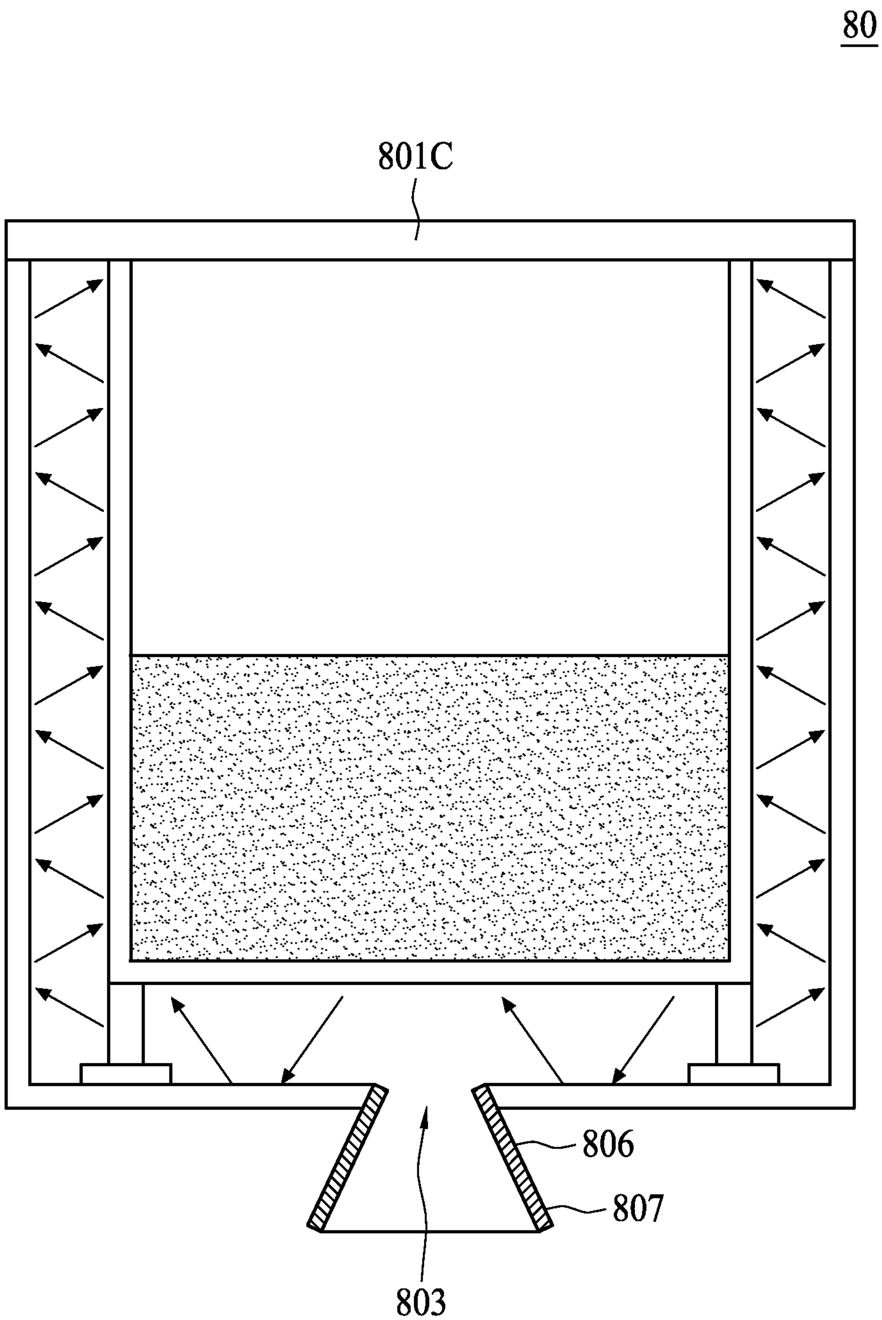


FIG. 8

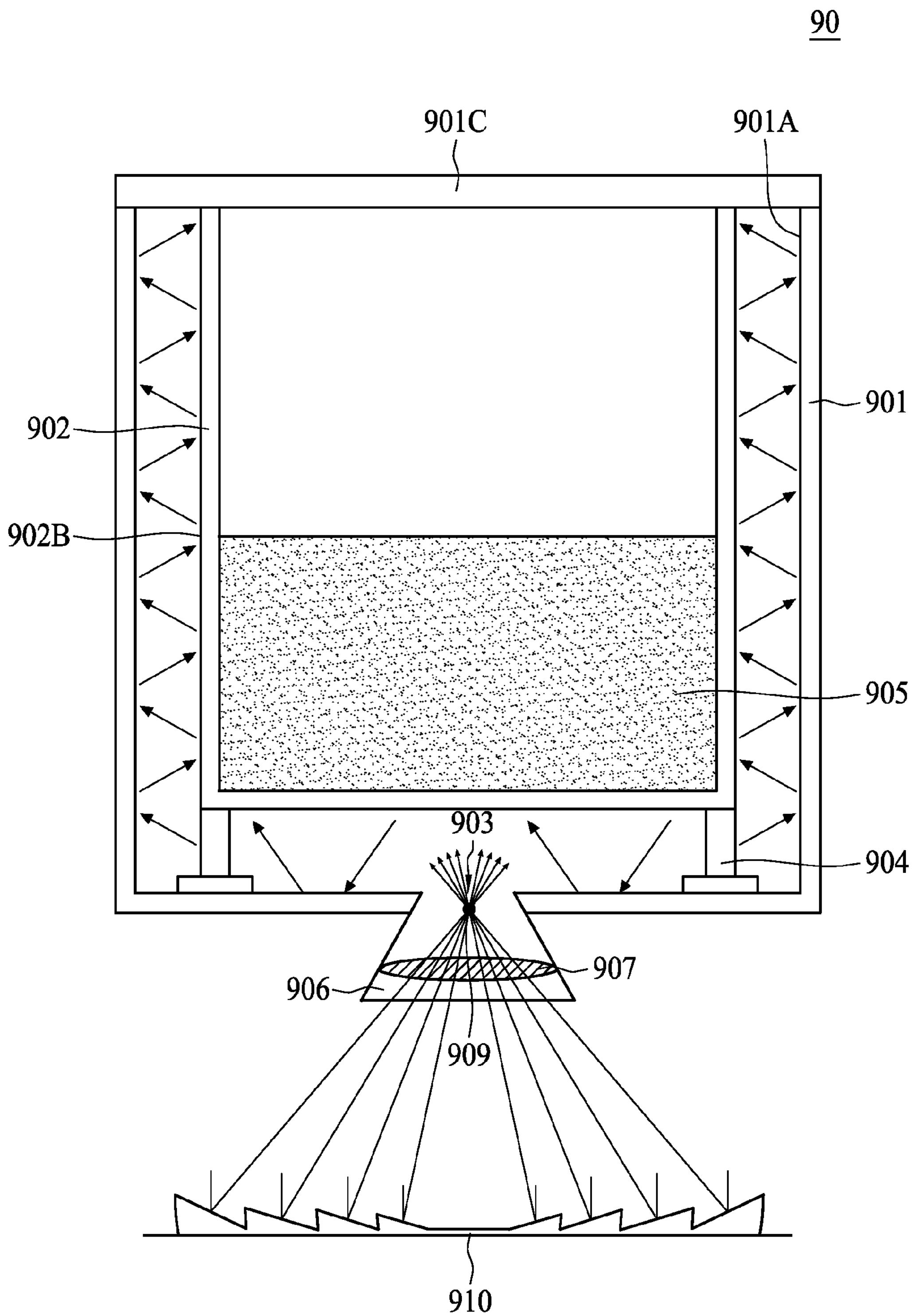


FIG. 9

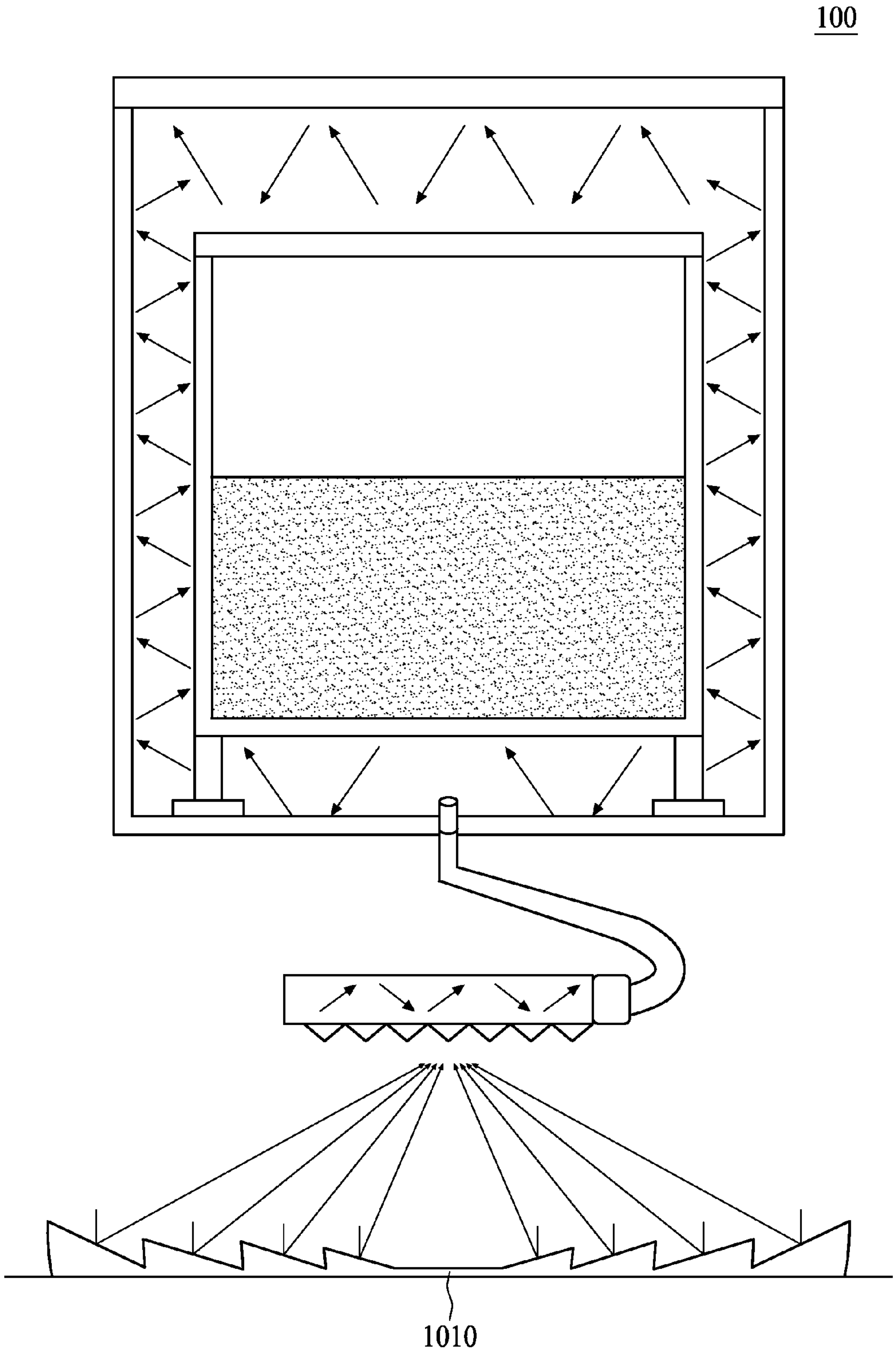


FIG. 10

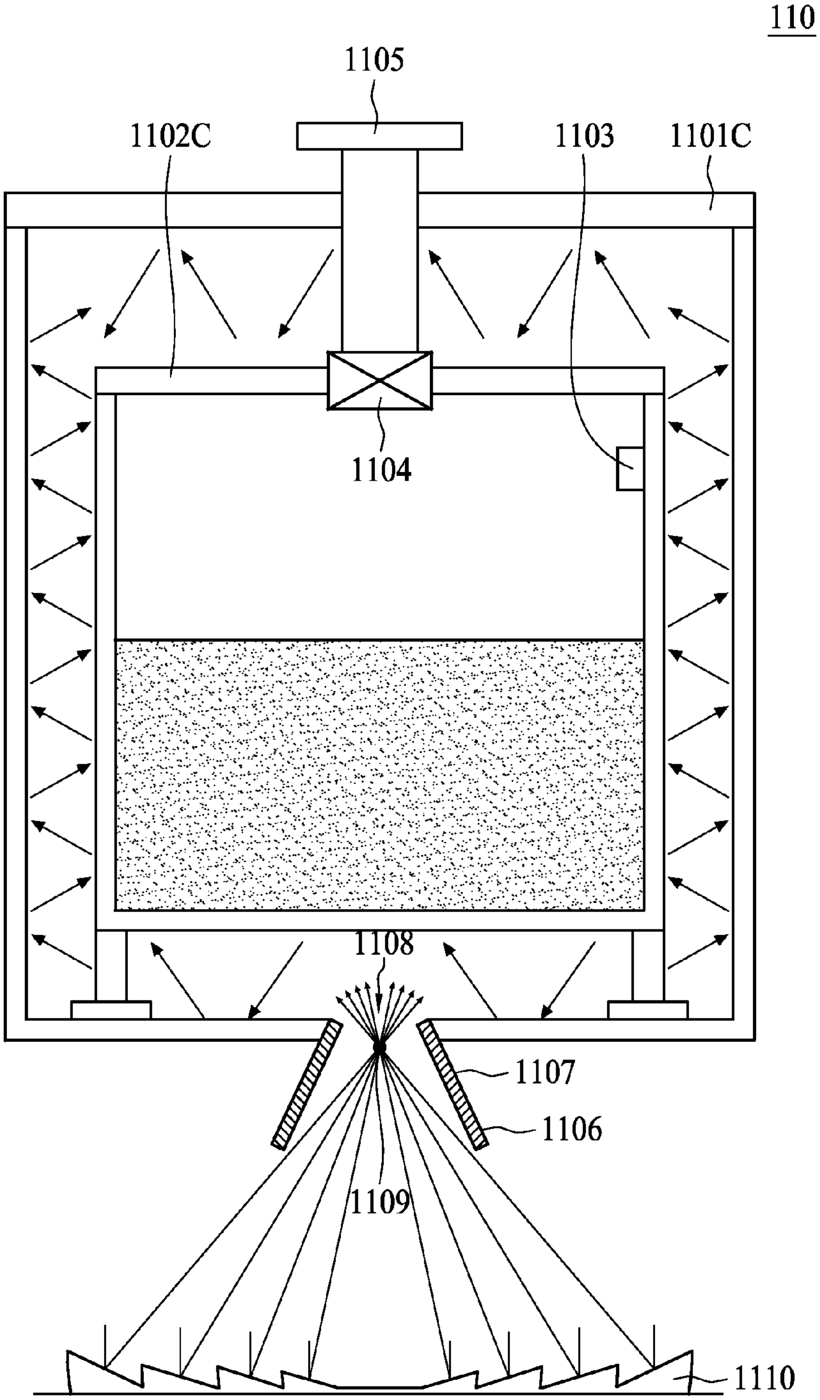


FIG. 11

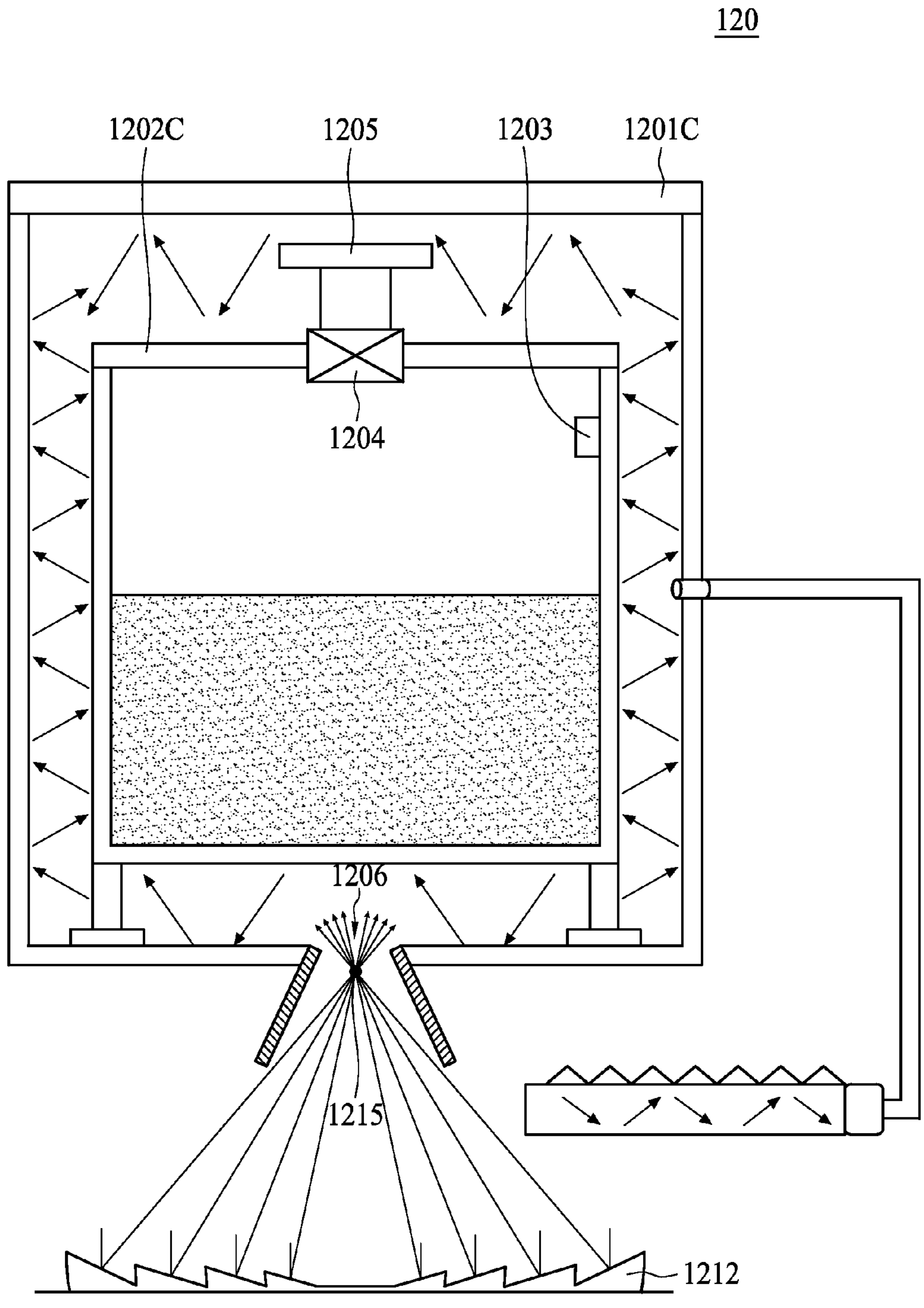


FIG. 12

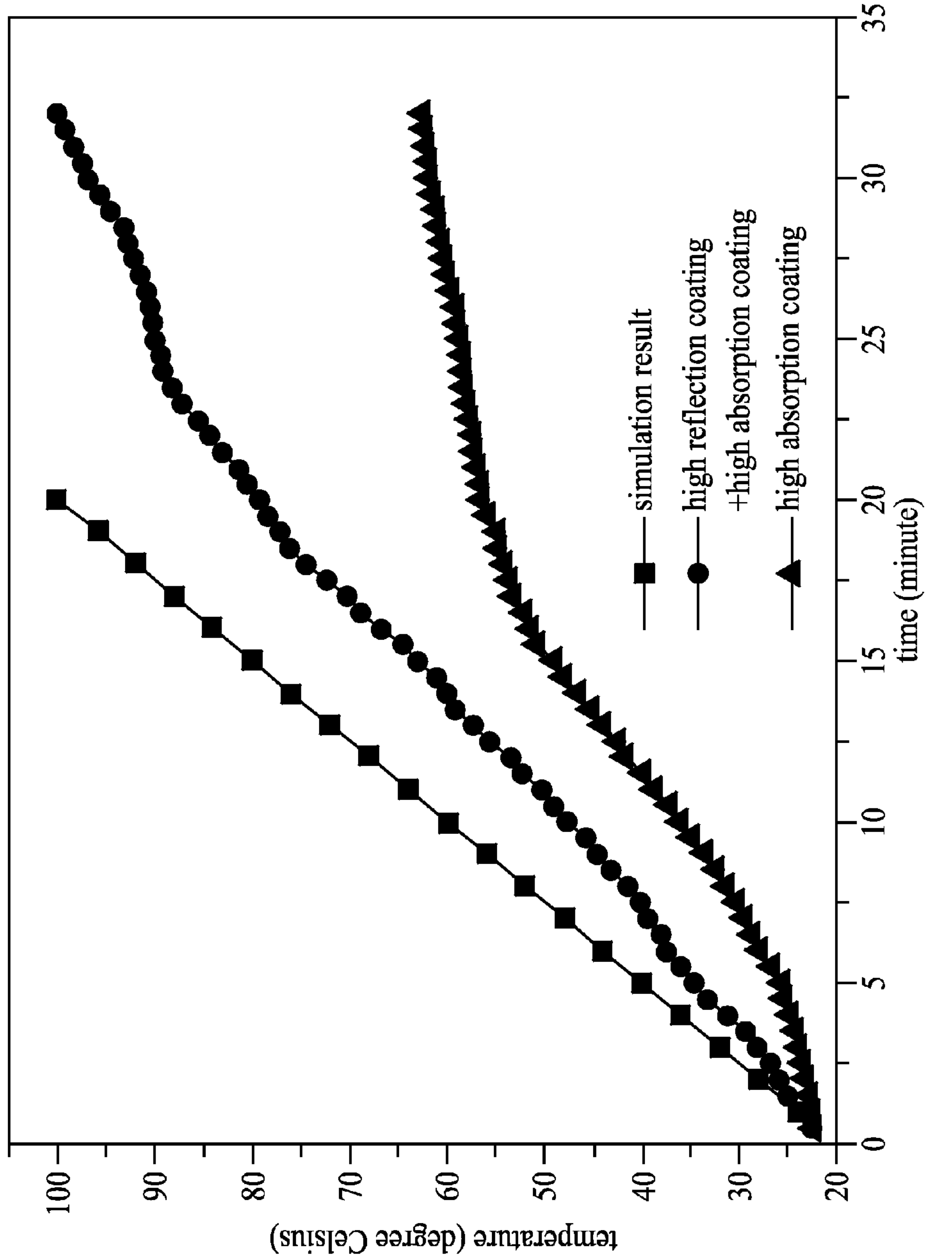

temperature (degree Celsius)
100
90
80
70
60
50
40
30
20
time (minute)
0
5
10
15
20
25
30
35
simulation result
high reflection coating
+high absorption coating
high absorption coating

FIG. 13

APPARATUS FOR SOLAR THERMAL COLLECTION AND SYSTEM OF THE SAME

1. FIELD

[0001] The present invention relates to a solar thermal collection apparatus and the system of the same, and more particularly, to a solar thermal collection apparatus and the system of the same including a thermal resistance body with a high-reflection inner wall and at least one opening, and a solar-thermal converter with a high-absorption outer wall.

2. BACKGROUND

[0002] Due to global warming and industrialization in developing countries, climate change and over-exploitation of natural resources are causing increasing amounts of natural and man-made disasters. In addition, the utilization of renewable energy sources is promoted and many nations have signed international agreements on reducing carbon dioxide output. The two aforementioned reasons are driving increased research and development in renewable energy technologies. The present disclosure provides an apparatus which can be used during emergencies or outdoor recreation activities for heating using solar power. The disclosed apparatus includes new features that are different from conventional solar-thermal converters such as to increase the liquid temperature inside the converter within a short timeframe and are portable and easy to operate.

SUMMARY

[0003] One embodiment of the present disclosure provides a solar-thermal collection apparatus, the apparatus including: a thermal resistance body; a solar-thermal converter positioned in the thermal resistance body, wherein the volume of the solar-thermal converter is less than the volume of the thermal resistance body, and therefore a space exists between the inner wall of the thermal resistance body and the outer wall of the solar-thermal converter; and at least one opening situated on the thermal resistance body, wherein the opening penetrates only the thermal resistance body.

[0004] Another embodiment of the present disclosure provides a solar-thermal collection system, the system including a solar-thermal collection apparatus and a light collection system. The solar-thermal collection apparatus includes a thermal resistance body; a solar-thermal converter positioned in the thermal resistance body, wherein the volume of the solar-thermal converter is less than the volume of the thermal resistance body, and therefore a space exists between the inner wall of the thermal resistance body and the outer wall of the solar-thermal converter; and at least one opening situated on the thermal resistance body, wherein the opening penetrates only the thermal resistance body. The light collection system is positioned outside the at least one opening of the thermal resistance body and is configured to focus the light at the focal point of the light collection system.

[0005] The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter, and form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures or processes for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The objectives and advantages of the present invention are illustrated with the following description and upon reference to the accompanying drawings in which:

[0007] FIG. **1** is a cross-sectional diagram of a solar-thermal collection apparatus according to one embodiment of the present disclosure;

[0008] FIG. **2** is a schematic diagram of the cross section of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0009] FIG. **3** is a schematic diagram of the stereoscopic structure on the outer wall of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0010] FIG. **4** is a cross-sectional view of the stereoscopic structure on the outer wall of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0011] FIG. **5** is a cross-sectional view of the stereoscopic structure on the outer wall of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0012] FIG. **6** is a cross-sectional diagram of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0013] FIG. **7** is a cross-sectional diagram of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0014] FIG. **8** is a cross-sectional diagram of the solar-thermal collection apparatus according to another embodiment of the present disclosure;

[0015] FIG. **9** is a cross-sectional diagram of the solar-thermal collection system according to another embodiment of the present disclosure;

[0016] FIG. **10** is a cross-sectional diagram of the solar-thermal collection system according to another embodiment of the present disclosure;

[0017] FIG. **11** is a cross-sectional diagram of the solar-thermal collection system according to another embodiment of the present disclosure;

[0018] FIG. **12** is a cross-sectional diagram of the solar-thermal collection system according to another embodiment of the present disclosure; and

[0019] FIG. **13** shows a testing result according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0020] FIG. **1** shows a cross section of the solar-thermal collection apparatus **10** according to one embodiment of the present disclosure. The solar-thermal collection apparatus **10** includes a thermal resistance body **101** and a solar-thermal converter **102**. The thermal resistance body **101** can be, but is not limited to, a metal container with a high-reflection coating on its inner wall **101**A. The outer wall **102**B of the solar-thermal converter **102** has a high-absorption coating and the inner space of the solar-thermal converter **102** is configured to accommodate food or liquid **105** to be heated. According to one embodiment, the solar-thermal converter **102** is placed inside the thermal resistance body **101** but does not have any direct physical contact with the resistance body **101** due to the support of a stand **104**. An opening **103** penetrating through the wall of the thermal resistance body **101** can be positioned in an arbitrary position on the body **101**; as shown in FIG. **1**, the opening **103** can be disposed at the bottom of the body **101**. A space exists between the thermal resistance body **101** and the solar-thermal converter **102** so as to form a body with high thermal resistance in order to prevent heat from dissipating to the exterior of the solar-thermal converter **102**. As shown in FIG. **1**, a cover **101**C is disposed on the thermal resistance body **101**, and another cover **102**C is disposed on the solar-thermal converter **102**. The implementation of the covers is optional. In the present embodiment, the cover serves to facilitate the displacement and the removal of the food or liquid to be heated.

[0021] The opening **103** positioned at the bottom of the thermal resistance body **101** is configured to receive the solar rays gathered by the light collector (not shown). After passing through the opening **103** and entering the thermal resistance body **101**, a portion of the solar rays are directly absorbed by the high-absorption coating on the outer surface **102**B of the solar-thermal converter **102** and converted into heat. The portion of solar rays which are not absorbed are consecutively and repeatedly reflected by the high-reflection coating on the inner wall of the thermal resistance body **101**. The reflected rays are partially absorbed by the high-absorption coating of the solar-thermal converter **102**, and the portion which are not absorbed are reflected by the high-reflection coating again. A multiple absorption-reflection routine facilitates the efficiency of solar-thermal conversion, and in one embodiment, the metallic solar-thermal converter evenly conducts and transfers the heat to the food or liquid **102** to be heated.

[0022] In the present embodiment, the high-reflection coating is made of aluminum, and the solar-thermal converter **102** is made of high thermal conductivity materials, for example, copper. However, the high-reflection coating and the high thermal conductivity materials are not limited to the materials mentioned above. In other embodiments, the high-reflection coating includes main group metals or transition metals, for example, silver, gold, aluminum, or the combination thereof; materials with high thermal conductivity includes main group metal, transition metal, graphite, carbon fiber, carbonaceous materials, or the like, such as copper, gold, silver, aluminum, or the alloy thereof. The high-absorption coating includes a main body and dopants. In the present embodiment, the main body includes a mixture of carbon black and graphite, and the dopants are gold nanoparticles. However, the main body used in this disclosure is not limited to that of the present embodiment, and other dark color metal oxide, metal sulfide, metal carbide, and metal nitride such as CuO, Hg_2O, V_2O_3, FeO, Ni_2O_3, Co_2O_3, Fe_3O_4, MnO_2, Ag_2S, Cu_2O, CdO, V_2O_5, Fe_2O_3, and Ag_2O can also be used. Moreover, the high-absorption coating can be dark color metalorganic materials as well. The dopants used in the present disclosure are not limited to those of the present embodiment, and other main group metal or transition metal nanoparticles, for example, aluminum nanoparticles or silver nanoparticles, can also be used as dopants. The high-absorption material is composed of main body and dopants mixed with an arbitrary ratio.

[0023] In one embodiment, the high-absorption coating has an absorption rate greater than 30%, and the diameter of the metal nanoparticles is within a range of from 1 nm to 100 nm. The metal nanoparticles applied in the high-absorption coating produces surface plasma effect; in other words, the coating can absorb light and produce instantaneous high temperature, passing the thermal energy to the food or liquid to be heated via the conduction of the solar-thermal converter.

[0024] FIG. **2** is a schematic diagram of the cross section of the solar-thermal collection apparatus **20** according to another embodiment of the present disclosure. The solar-thermal collection apparatus **20** has a thermal resistance body **201** and a solar-thermal converter **202**. The thermal resistance body **201** can be, but is not limited to, a metal container with a high-reflection coating on the inner wall **201**A. The solar-thermal converter **202** possesses an outer wall **202**B with high-absorption coating. The food or liquid to be heated **205** is disposed inside the solar-thermal converter **202**. According to one embodiment, the solar-thermal converter **202** is placed inside the thermal resistance body **201** but does not have any direct physical contact with the resistance body **201** due to the support of a stand **204**. A rectangular opening **203** is disposed at the bottom of the body **201**. A space exists between the thermal resistance body **201** and the solar-thermal converter **202** so as to form a body with high thermal resistance in order to prevent the heat inside the converter from dissipating to the exterior of the solar-thermal converter **202**. As shown in FIG. **2**, a cover **201**C is disposed on the thermal resistance body **201**, and another cover **202**C is disposed on the solar-thermal converter **202**. The implementation of the covers is optional. In the present embodiment; the cover serves to facilitate the displacement and the removal of the food or liquid to be heated.

[0025] The rectangular opening **203** positioned at the bottom of the thermal resistance body **201** is configured to receive the solar rays gathered by the light collector (not shown). After passing through the opening **103** and entering the thermal resistance body **201**, a portion of the solar rays are directly absorbed by the high-absorption coating on the outer surface **202**B of the solar-thermal converter **202** and converted into heat. The portion of the solar rays which are not absorbed are consecutively and repeatedly reflected by the high-reflection coating on the inner wall of the thermal resistance body **201**. The reflected rays are partially absorbed by the high-absorption coating of the solar-thermal converter **202** and the portion which are not absorbed are reflected by the high-reflection coating again. A multiple absorption-reflection routine facilitates the efficiency of solar-thermal conversion, and in one embodiment, the metallic solar-thermal converter evenly conducts and transfers the heat to the food or liquid **205** to be heated. The design of the rectangular opening **203** serves to take into account the relative position of the sun with respect to the solar-thermal converter **20**. The path of the focal point of the collector changes as the relative position of the sun changes. Typically, the path is a straight line, and therefore the rectangular opening **203** can direct most of the light into the apparatus over a long timeframe. However, the shape of the opening **203** is not limited by the present embodiment, and other shapes such as circle, square, triangle, and polygons are all applicable to the present apparatus.

[0026] In the present embodiment, the high-reflection coating is made of silver, and the solar-thermal converter **202** is made of high thermal conductivity materials, for example, graphite. The high-absorption coating includes a main body and dopants. In the present embodiment, the main body includes dark color metal oxide such as CuO, Ni_2O_3, Co_2O_3, Fe_3O_4, MnO_2, Fe_2O_3, and Ag_2O, and the dopants are gold nanoparticles.

[0027] In one embodiment, the high-absorption coating has an absorption rate greater than 30%, and the diameter of the metal nanoparticles is within a range of from 1 nm to 100 nm. The metal nanoparticles applied in the high-absorption coating produces surface plasma effect; in other words, the coating can absorb light and produce instantaneous high temperature, passing the thermal energy to the food or liquid to be heated via the conduction of the solar-thermal converter **202**.

[0028] FIG. **3** is a schematic diagram of the stereoscopic structure on the outer wall **202**B of the solar-thermal collection apparatus according to another embodiment of the present disclosure. A special treatment to form micro-features on the high-absorption material of the solar-thermal converter increases the absorption rate of the high-absorption material. The micro-features in the embodiment shown in FIG. **4** are a plurality of tetrahedrons **2021**. The total number of the light impingement on the stereoscopic microstructure surface is greater than that on the untreated planar surface. Because the absorption rate is proportionally related to the number of light impingement, the absorption rate is increased on the surface with stereoscopic microstructures.

[0029] FIG. **4** is a cross-sectional view of the stereoscopic structure on the outer wall **202**B of the solar-thermal collection apparatus according to another embodiment of the present disclosure. A microstructural high-absorption coating **2021**A is positioned on the outer surface of the solar-thermal converter **202**. The process to prepare the structure includes forming a high-absorption coating on the outer surface of the solar-thermal converter **202** by electroplating or anodic treatment, followed by the shaping of the microstructure. However, the method for forming a high-absorption coating on the outer surface is not limited to the present embodiment; other physical vapor deposition methods such as e-gun evaporation, thermal evaporation, or sputtering can be adopted to form the coating. General chemical vapor deposition, chemical oxidation treatment, or spin coating can also be used to form the high-absorption coating.

[0030] FIG. **5** is a cross-sectional view of the stereoscopic structure on the outer wall of the solar-thermal collection apparatus according to another embodiment of the present disclosure. A microstructural high-absorption coating **2021**B is positioned on the outer surface of the solar-thermal converter **202**. The process to prepare the structure includes forming a high-absorption coating on the outer surface of the solar-thermal converter **202** by electroplating or anodic treatment, followed by a surface-roughing procedure. Another layer of the high-absorption coating is subsequently applied on the roughened surface to thicken the microstructure through a manner corresponding to the morphology of the underlying roughened surface.

[0031] FIG. **6** is a cross-sectional diagram of the solar-thermal collection apparatus **60** according to another embodiment of the present disclosure. The overall structure of the apparatus **60** is similar to that of the embodiment shown in FIG. **1**. As shown in FIG. **6**, the opening **603** of the solar-thermal collection apparatus **60** is connected to a light collection apparatus. The light collection apparatus includes a cone-shaped collector **607** and a condenser **606**. The light collection apparatus can enhance the collection of the solar light and guide the light into the space between the thermal resistance body and the solar-thermal converter. However, the number and the position of the opening **603** are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body and be connected to the light collection apparatus. The solar-thermal collection apparatus **60** further includes a cover **601**C shared by the thermal resistance body and the solar-thermal converter.

[0032] FIG. **7** is a cross-sectional diagram of the solar-thermal collection apparatus **70** according to another embodiment of the present disclosure. The overall structure of the apparatus **70** is similar to that of the embodiment shown in FIG. **1**. As shown in FIG. **7**, the opening **703** of the solar-thermal collection apparatus **70** is connected to a light collection apparatus. The light collection apparatus includes a wave geode **707**, a microstructure layer **706**, a condenser **708**, and an optical fiber **709**. The light collection apparatus can enhance the collection of the solar light and guide the light into the space between the thermal resistance body and the solar-thermal converter. However, the number and the position of the light collection apparatus are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body and be connected to the light collection apparatus. The solar-thermal collection apparatus **70** further includes two covers. One of the covers **701**C is coupled with the thermal resistance body, and the other cover **702**C is coupled with the solar-thermal converter.

[0033] FIG. **8** is a cross-sectional diagram of the solar-thermal collection apparatus **80** according to another embodiment of the present disclosure. The overall structure of the apparatus **80** is similar to that of the embodiment shown in FIG. **1**. As shown in FIG. **8**, the opening **803** of the solar-thermal collection apparatus **80** is connected to a light collection apparatus. The light collection apparatus includes a cone-shaped light collector **806** and a reflective mirror **807** positioned on the inner wall of the light collector **806**. The light collection apparatus can enhance the collection of the solar light and guide the light into the space between the thermal resistance body and the solar-thermal converter. However, the number and the position of the light collection apparatus are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body and be connected to the light collection apparatus. The solar-thermal collection apparatus **80** further includes a cover **801**C shared by the thermal resistance body and the solar-thermal converter.

[0034] FIG. **9** is a cross-sectional diagram of the solar-thermal collection system **90** according to another embodiment of the present disclosure. The solar-thermal collection system **90** includes a thermal resistance body **901** and a solar-thermal converter **902**. The thermal resistance body **901** can be, but is not limited to, a metal container with an inner wall **901**A coated with a high-reflection coating. The solar-thermal converter **902** has an outer wall **902**B with a high-absorption coating, and food or liquid **905** to be heated is contained in the solar-thermal converter **902**. The solar-thermal converter is placed inside the thermal resistance body **901** but does not make any physical contact with the resistance body **901** due to the support of a stand **904**. An opening **903** penetrating through the wall of the thermal resistance body **901** can be positioned in an arbitrary position on the body **90**. As shown in FIG. **9**, the opening **903** is disposed at the bottom of the body **901**. A space exists between the thermal resistance body **901** and the solar-thermal converter **902** so as to form a body with high thermal resistance in order to prevent heat from dissipating to the exterior of the solar-thermal converter **902**. A cover **901**C is further included in the apparatus, wherein the cover **901**C is shared by the thermal resistance body **901** and the solar-thermal resistance body **902** to facilitate the placement and the removal of the food or liquid to be heated.

[0035] As shown in FIG. **9**, the solar-thermal collection apparatus **90** includes the aforesaid solar-thermal converter and a light collection system. The light collection system includes a light collection apparatus connected to the solar-thermal collection apparatus **90** as shown in FIG. **6** and a Fresnel lens **910** not connected with the solar-thermal collection apparatus **90**. Opposite to the planar side of the Fresnel lens **910**, a series of concentric circles defines the surface morphology of the other side of the Fresnel lens **910**. The angle and the thickness of every concentric circle are different, but effectively the Fresnel lens **910** used herein is like a plano-convex lens. In the present embodiment, the side with concentric circles is coated with high-reflective metal and is configured to focus the light beam into a focal point in space. The incident solar rays have a focal point **909** generated by the light collection system, and after passing thorough the focal point **909**, the rays are guided to the space between the solar-thermal converter and the thermal resistance body. However, the number and the position of the opening **903** are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body and be connected to the light collection apparatus. At the outside of the thermal resistance body can be positioned a light collection apparatus with a greater light collecting area, and the combination of such light collection apparatus is called a light collection system. In another embodiment of the present disclosure, if the opening is positioned at the side wall of the solar-thermal collection apparatus, the light collection apparatus with a greater light collecting area can be a set of reflective mirrors or a set of Fresnel lenses coated with high-reflection metal. In yet another embodiment of the present disclosure, if the opening is positioned at the top of the solar-thermal collection apparatus, the light collection apparatus with a greater light-collecting area can be a set of condensers or a set of Fresnel lenses. The light collection system includes Fresnel lenses, condensers, reflective mirror, waveguide, optical fibers, cone-shaped light collector, or the combination thereof.

[0036] FIG. **10** is a cross-sectional diagram of the solar-thermal collection system **100** according to another embodiment of the present disclosure. The overall structure of the apparatus **100** is similar to that of the embodiment shown in FIG. **1**. The light collection system includes a light collection apparatus as shown in FIG. **7** and a Fresnel lens **1010**. In the present embodiment, the Fresnel lens **1010** is not connected with the solar-thermal collection apparatus. The Fresnel lens **1010** passes the focused light into the space between the solar-thermal converter and the thermal resistance body via the light collection apparatus. As shown in FIG. **10**, the conjunction of the light collection apparatus and the thermal resistance body is positioned at the bottom of the body. However, the number and the position of the conjunction are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body as a port for conjunction and can be connected to the light collection apparatus. At the outside of the thermal resistance body can be positioned a light collection apparatus with a greater light collecting area, and the combination of such light collection apparatuses is called a light collection system. In another embodiment of the present disclosure, if the opening is positioned at the side wall of the solar-thermal collection apparatus, the light collection apparatus with a greater light colleting area can be a set of reflective mirrors or a set of Fresnel lenses coated with high-reflection metal. In yet another embodiment of the present disclosure, if the opening is positioned at the top of the solar-thermal collection apparatus, the light collection apparatus with a greater light-collecting area can be a set of condensers or a set of Fresnel lenses.

[0037] FIG. **11** is a cross-sectional diagram of the solar-thermal collection system **110** according to another embodiment of the present disclosure. The overall structure of the apparatus **110** is similar to that of the embodiment shown in FIG. **1**. The solar-thermal collection apparatus of FIG. **11** further includes a pressure sensor **1103**, and a depressurization apparatus, such as a vent valve **1104** positioned on a cover **1102**C, wherein the vent valve **1104** penetrates through another cover **1101**C and connects with a mechanical knob **1105**. When the pressure sensor **1103** senses that the pressure inside the solar-thermal converter is greater than a predetermined safe value, the sensor **1103** will generate a signal, for example, an alarm, to remind the user to manually vent the solar-thermal converter by turning the mechanical knob **1105**. The light collection system includes a light collection apparatus and a Fresnel lens **1110**. In the present embodiment, the Fresnel lens **1110** is not connected with the solar-thermal collection apparatus.

[0038] The incident solar ray has a focal point **1109** generated by the light collection system, and after passing thorough the focal point **1109**, the ray is guided to the space between the solar-thermal converter and the thermal resistance body. However, the number and the position of the opening **1108** are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body and can be connected to the light collection apparatus. At the outside of the thermal resistance body can be positioned a light collection apparatus with a greater light collecting area, and the combination of those light collection apparatus is called a light collection system. In yet another embodiment of the present disclosure, if the opening is positioned at the top of the solar-thermal collection apparatus, the light collection apparatus with a greater light-collecting area can be a set of condensers or a set of Fresnel lenses.

[0039] FIG. **12** is a cross-sectional diagram of the solar-thermal collection system **120** according to another embodiment of the present disclosure. The overall structure of the apparatus **120** is similar to that of the embodiment shown in FIG. **1**. The solar-thermal collection apparatus of FIG. **12** further includes a pressure sensor **1203**, and a depressurization apparatus such as a vent valve **1204** positioned on a cover **1202**C, wherein the vent valve **1204** penetrates only through the cover **1202**C and connects with a mechanical knob **1205**. When the pressure sensor **1203** senses that the pressure inside the solar-thermal converter is greater than a predetermined safe value, the sensor **1203** will generate a signal, for example, an alarm, to remind the user to open the cover **1201**C and to manually vent the solar-thermal converter by turning the mechanical knob **1205**. The light collection system includes two light collection apparatuses as shown in FIGS. **7** and **8**, and a Fresnel lens **1212**. In the present embodiment, the lens **1212** is not connected with the solar-thermal collection apparatus. The light collection apparatus shown in FIG. **7** is devised at the side wall of the thermal resistance body, while the one as shown in FIG. **8** is devised at the bottom of the thermal resistance body. In the present disclosure, the Fresnel lens **1212** is not connected with the solar-thermal collection apparatus.

[0040] The incident solar rays have a focal point **1205** generated by the light collection system, and after passing thorough the focal point **1205**, the rays are guided to the space between the solar-thermal converter and the thermal resistance body. However, the number and the position of the opening **1206** are not limited to those of the present embodiment. One or a plurality of the openings can be positioned on the wall of the thermal resistance body and can be connected to the light collection apparatus. A light collection apparatus with a greater light collecting area is positioned on the outside of the thermal resistance body, and the combination of such light collection apparatuses is called a light collection system. In yet another embodiment of the present disclosure, if the opening is positioned at the top of the solar-thermal collection apparatus, the light collection apparatus with a greater light-collecting area can be a set of condensers or a set of Fresnel lenses.

[0041] FIG. **13** shows a testing result according to an embodiment of the present disclosure. According to the simulation result, water inside the solar-thermal collection apparatus reaches 100 degrees Celsius within 20 minutes under solar radiation. According to the actual test result, the apparatus as shown in FIG. **9** of the present disclosure reaches 100 degrees Celsius within 30 minutes under solar radiation. The apparatus of FIG. **9** possesses high-reflection coating and high-absorption coating. The control group is a solar-thermal collection apparatus with only high-absorption coating. Water inside the apparatus of the control group reached only 63 degrees Celsius after 30 minutes of thermal radiation. Therefore, the solar-thermal collection apparatus having both the high-reflection and the high-absorption coatings can boil the water contained within in a reasonable timeframe, hence, the purpose to make use of the solar energy to survive in emergency or outdoor recreation activity can be achieved in this preferred embodiment.

[0042] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. For example, many of the processes discussed above can be implemented in different methodologies and replaced by other processes, or a combination thereof.

[0043] Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed, that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

What is claimed is:

1. A solar-thermal collection apparatus, comprising:

a thermal resistance body;

a solar-thermal converter positioned in the thermal resistance body, wherein the volume of the solar-thermal converter is less than the volume of the thermal resistance body, and therefore a space exists between the inner wall of the thermal resistance body and the outer wall of the solar-thermal converter; and

at least one opening situated on the thermal resistance body, wherein the opening only penetrates the thermal resistance body.

2. The solar-thermal collection apparatus of claim **1**, wherein the inner wall of the thermal resistance body further comprises a high-reflection coating comprising metal, transition metal, or the alloy thereof.

3. The solar-thermal collection apparatus of claim **1**, wherein the outer wall of the solar-thermal converter comprises a high-absorption coating, and the absorption rate of the high-absorption coating is greater than 30 percent.

4. The solar-thermal collection apparatus of claim **3**, wherein the high-absorption coating comprises:

a major body selected from the group consisting of graphite, carbon black, dark color metal compound, dark color metalorganic compound, and the combination thereof; and

dopant selected from the group consisting of metal nanoparticles, transition metal nanoparticles, and the combination thereof;

wherein the major body and the dopant are mixed with any arbitrary ratio.

5. The solar-thermal collection apparatus of claim **4**, wherein the size of the metal nanoparticles and the size of the metalorganic nanoparticles are within a range of from 1 nm to 100 nm.

6. The solar-thermal collection apparatus of claim **3**, wherein the high-absorption coating comprises a planar structure or a stereoscopic microstructure.

7. The solar-thermal collection apparatus of claim **1**, wherein the solar-thermal converter comprises materials with high thermal conductivity, and the materials comprise metal, transition metal, carbonaceous materials, or the alloy thereof.

8. The solar-thermal collection apparatus of claim **1**, wherein the shape of the opening comprises rectangle, circle, square, triangle, or polygons.

9. The solar-thermal collection apparatus of claim **8**, wherein the opening is further connected to a light collection apparatus, and the light collection apparatus comprises condensers, reflective mirrors, cone-shaped light collectors, and the combination thereof.

10. The solar-thermal collection apparatus of claim **8**, wherein the opening is further connected to a light collection apparatus, and the light collection apparatus comprises a waveguide, a microstructure layer, a condenser, and an optical fiber.

11. The solar-thermal collection apparatus of claim **6**, wherein the microstructure of the high-absorption coating is a plurality of tetrahedrons.

12. The solar-thermal collection apparatus of claim **6**, wherein the microstructure surface further comprises a high-absorption coating formed by electrical plating or anodic treatment.

13. The solar-thermal collection apparatus of claim **1**, further comprising at least one cover configured to seal the thermal resistance body and the solar-thermal converter.

14. The solar-thermal collection apparatus of claim **1**, wherein the solar-thermal converter comprises a depressurization apparatus.

15. A solar-thermal collection system, comprising;

a solar-thermal collection apparatus, comprising:

a thermal resistance body;

a solar-thermal converter positioned in the thermal resistance body, wherein the volume of the solar-thermal converter is less than the volume of the thermal resistance body, so that a space exists between the inner wall of the thermal resistance body and the outer wall of the solar-thermal converter; and

at least one opening situated on the thermal resistance body, wherein the opening only penetrates the thermal resistance body; and

a light collection system positioned outside of the opening and configured to collect the light to the focal point of the light collection system.

16. The solar-thermal collection system of claim **15**, wherein the inner wall of the thermal resistance body further comprises a high-reflection coating comprising metal, transition metal, or the alloy thereof.

17. The solar-thermal collection system of claim **16**, wherein the outer wall of the solar-thermal converter comprises a high-absorption coating, and the absorption rate of the high-absorption coating is greater than 30 percent.

18. The solar-thermal collection system of claim **17**, wherein the high-absorption coating comprises:

major body selected from the group consisting of graphite, carbon black, dark color metal compound, dark color metalorganic compound, and the combination thereof; and

dopant selected from the group consisting of metal nanoparticles, transition metal nanoparticles, and the combination thereof;

wherein the major body and the dopant are mixed with any arbitrary ratio.

19. The solar-thermal collection system of claim **18**, wherein the size of the metal nanoparticles and the size of the metalorganic nanoparticles are within a range of from 1 nm to 100 nm.

20. The solar-thermal collection system of claim **17**, wherein the high-absorption coating comprises a planar structure or a stereoscopic microstructure.

21. The solar-thermal collection system of claim **15**, wherein the solar-thermal converter comprises materials with high thermal conductivity, and the materials comprise metal, transition metal, carbonaceous materials, or the alloy thereof.

22. The solar-thermal collection system of claim **15**, wherein the shape of the opening comprises rectangle, circle, square, triangle, or polygons.

23. The solar-thermal collection system of claim **15**, wherein the light collection system comprises condensers, reflective mirrors, cone-shaped light collectors, Fresnel lenses, or the combination thereof.

24. The solar-thermal collection system of claim **15**, wherein the light collection system comprises a waveguide, a microstructure layer, a condenser, a Fresnel lens, or the combination thereof.

25. The solar-thermal collection system of claim **15**, wherein the focal point of the light collection system is positioned at the opening.

26. The solar-thermal collection system of claim **15**, further comprising at least one cover configured to seal the thermal resistance body and the solar-thermal converter.

27. The solar-thermal collection system of claim **15**, wherein the solar-thermal converter comprises a depressurization apparatus.

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