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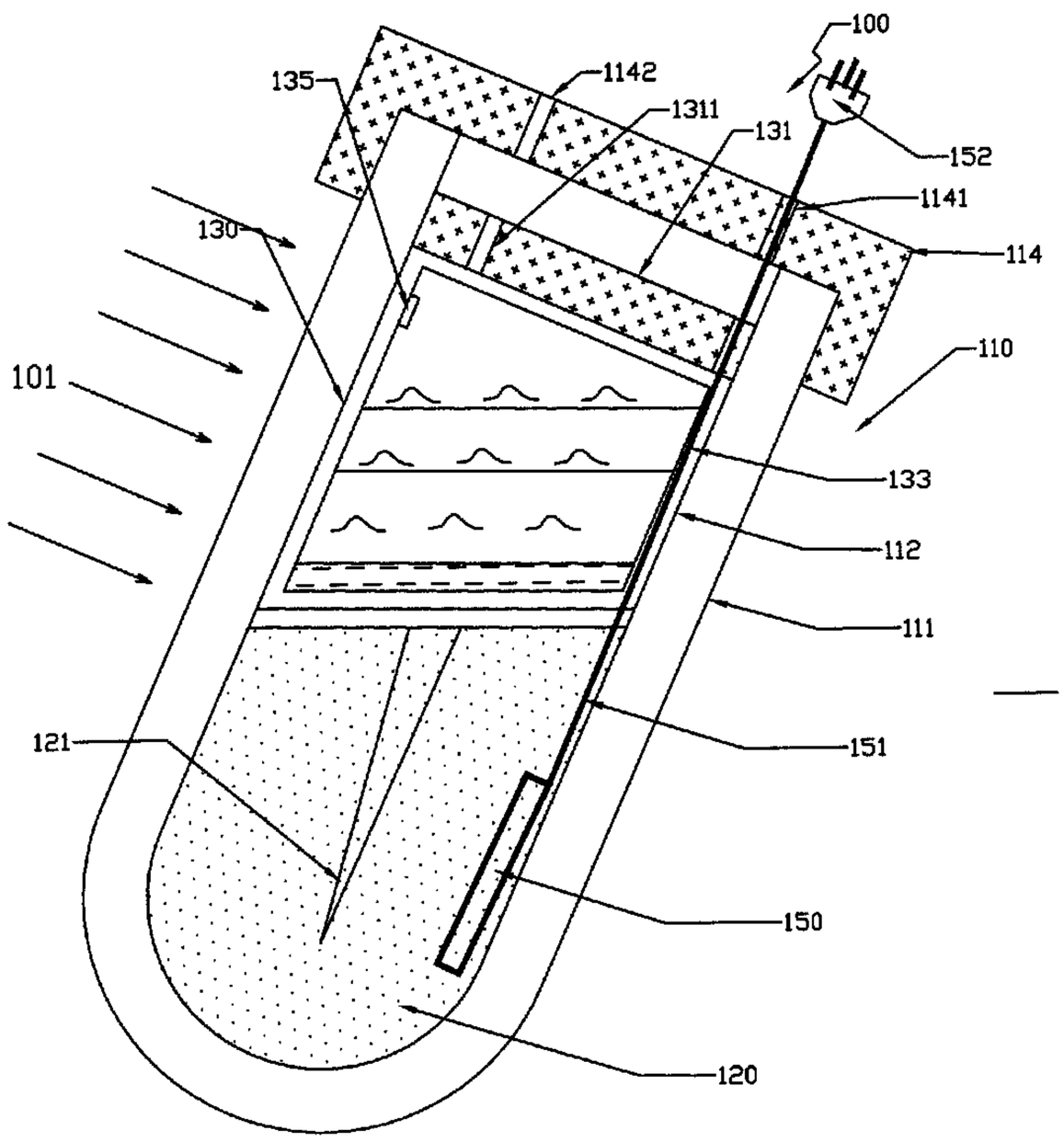
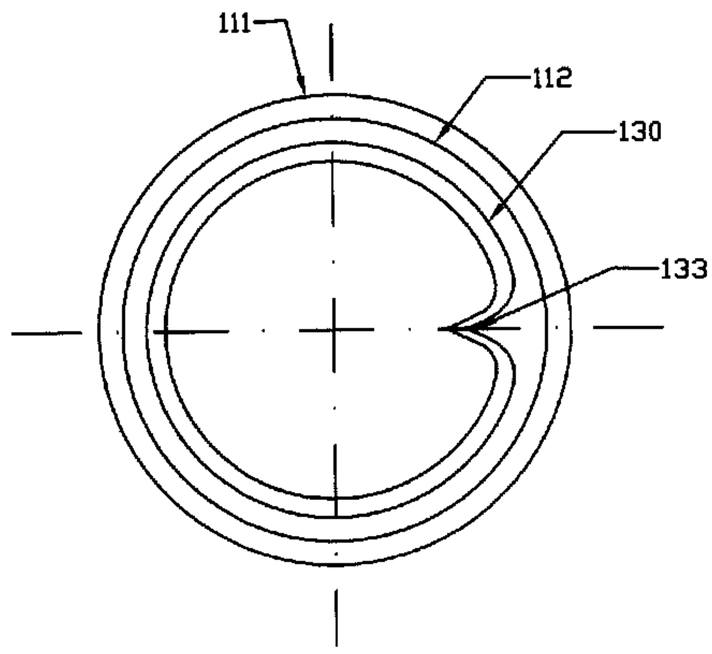
(54) Title: SOLAR COOKING APPLIANCES





(57) Abrégé/Abstract:
The solar cooking appliance comprises a solar heat collector to collect and store solar heat. A heat storage and conducting material partially filling said solar heat collector. A set of solar cooking utensils and each utensil is sized to fit a shape and size of the internal shape and size of the solar heat collector. The utensil has a wall, which is thermally connected to the heat storage and conducting material and an internal wall of the solar heat collector to receive solar heat for cooking food. The utensil further comprises a removable part for opening and closing said utensils during cooking. A second heat conducting/transferring material located within said solar heat collector for faster transferring the solar heat to said cooking utensil

ABSTRACT

The solar cooking appliance comprises a solar heat collector to collect and store solar heat. A heat storage and conducting material partially filling said solar heat collector. A set of solar cooking utensils and each utensil is sized to fit a shape and size of the internal shape and size of the solar heat collector. The utensil has a wall, which is thermally connected to the heat storage and conducting material and an internal wall of the solar heat collector to receive solar heat for cooking food. The utensil further comprises a removable part for opening and closing said utensils during cooking. A second heat conducting/transferring material located within said solar heat collector for faster transferring the solar heat to said cooking utensil

SOLAR COOKING APPLIANCES

FIELD OF TECHNOLOGY

[0001] The present disclosure relates to solar heat application field, especially related to solar cooking appliances to cook the food in the solar heat collector.

BACKGROUND

[0002] For all kinds of existing energy sources in the earth, solar energy is the most widespread, the richest and the most uniformly distributed energy source. Solar energy can be used very easily. It is available every day, everywhere and for every body.

[0003] For all kinds of human energy consuming activities, cooking food and beverage is the most often activity and has the longest history. Every body in anywhere needs to cook the foods every day.

[0004] It is very interesting and valuable topic to use solar energy for food cooking. There are many efforts in this field. (Please refer to the existing patents).

[0005] The solar power on a unit earth area is not very large. The solar radiation intensity is varied from North to South and from morning to afternoon. It depends on the weather and is also different in four seasons, so that to develop an economic solar cooking appliance is always a challenge and need continue efforts.

[0005] In view of these difficulties, some solar cooking appliances tried to make the sunlight receiving area as large as possible. But the heat insulation for the received heat is difficult. Some solar cooking appliances follow and focus the sunlight using expensive automation system and need additional power to run the system. Some solar cooking appliances also use the heat storage materials. The materials may be expensive and not easy to get.

[0006] The present disclosure absorbs the historic experience and combines the new solar water heating technologies and developed a set of economic and practicable solar cooking appliances.

SUMMERY

[0007] The object of this disclosure is to improve the existing technologies and provide a set of solar cooking appliances that is economy, easy to manufacture and use and high efficient. The invention takes following steps to overcome the difficulties of applying solar energy for food cooking:

[0008] To use the evacuated solar heat collector for optimum heat collecting;

[0009] To filled heat storage and conducting material in the evacuated solar heat collector for storing and saving heat to provide a continue and stable cooking heat;

[0010] A light reflector focuses the surrounding light to the cooking appliances;

[0011] A sundial indicates the light direction, an adjustable and rotatable fixing and supporting trestle allows to receiving the highest solar power;

[0012] A electric power supply provides a backup power source when the solar power is not enough. Further more, the solar cooking appliances also provide backup or energy storage equipment at low electricity price period for cooking at electric power outage.

[0013] Following are the detailed summary of present disclosure.

[0014] In accordance with one aspect of the present disclosure there is provided a set of solar cooking appliances, comprising: a solar heat collector wherein the solar heat is collected and stored, further more food is cooked or heated inside, said solar heat collector having a removable part for covering during cooking; the heat storage and conducting material that partially filled in said solar heat collector; a set of solar cooking utensils, each said utensil having the size and shape to fit the internal size and shape of the solar heat collector for a closed heat connection with the inner wall of said solar heat collector and also with said heat storage and conducting material within said solar heat collector; each said utensil having a removable part for closing said utensil during cooking; an utensil is located in said solar heat collector during cooking; and the necessary accessories that including a fixing and supporting trestle with a rotatable base and adjustable incidence angle that arrange and support the each part of the solar cooking appliances at a proper situation; the light reflecting object and a cone bar attached to the solar heat collector perpendicularly to show the angle of sun light;

[0015] The said solar heat collector is a evacuated-tube solar heat collector; or a group of modular evacuated-tube solar heat collectors that mounted in a certain shape, e.g. in parallel row, in full or partial cone-shaped column, etc; the said heat storage and conducting material can be a solid material, or a liquid material or a chemical or change head storage materials, or the combination of two or more materials mentioned above. The said heat conducting material can be a heat tube, or a heat conductor. For safety reason, transparent cover or evacuated toughened-glass tube solar heat collector are suggested.

[0016] In accordance with another aspect of the present disclosure there is provided a set of solar cooking utensils, each of said utensil is a cylinder container made of stainless steel, that is located in an evacuated-tube solar heat collector, having a removable and detachable handle at the inner wall; said container having a diameter near but not bigger than the inner diameter of said evacuated-tube solar heat collector; a pleated structure on the wall of said container from the top to the bottom to provide a gap and patch for air exchange and allow a minor adjustable diameter for said container. These utensils can be

a solar coffee/tea maker, a steamer, a solar cooking fryer; a cooking wok or pot, a boiler, a cooking pan etc.

[0017] In accordance with another aspect of the present disclosure there is provided a set of solar cooking appliances that mainly use the solar heat, but use electricity as a backup, comprising, a solar heat collector wherein the solar heat is collected and stored, further more food is cooked or heated inside, said solar heat collector having a removable part for covering during cooking; the heat storage and conducting material that partially filled in said solar heat collector; a set of solar cooking utensils, each said utensil having the size and shape to fit the internal size and shape of the solar heat collector for a closed heat connection with the inner wall of said solar heat collector and also with said heat storage and conducting material within said solar heat collector; each said utensil having a removable part for closing said utensil during cooking; an utensil is located in said solar heat collector during cooking; and the necessary accessories that including a fixing and supporting trestle with a rotatable base and adjustable incidence angle that arrange and support the each part of the solar cooking appliances at a proper situation; the light reflecting object and a cone bar attached to the solar heat collector perpendicularly to show the angle of sun light; a electric heat element with power supply and a measuring, indication and controlling systems for the solar cooking appliance's operating characteristic parameter, e.g. timing, temperature, pressure, moisture etc.

[0018] Other aspects and features of the present disclosure will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DISCRIPTION OF THE DRAWINGS

[0019] In the figures which illustrate exemplary embodiments of this invention:

[0020] Fig. 1 is a schematic diagram illustrating a evacuated-tube solar cooking appliances in vertical section and cross section view;

[0021] Fig. 2 is a set of solar cooking appliances is illustrated schematically in a perspective view;

[0022] Fig. 3 illustrates schematically a set of exemplary solar heat collectors in vertical section view;

DETAILED DESCRIPTION

[0023] Referring to Fig.1, an evacuated-tube solar cooking appliances are illustrated in vertical section and cross section view during use.

[0024] A set of solar cooking appliances 100 includes a solar heat collector 110, the heat storage and conducting material 120, a heat conducting medium 121, a solar cooking

utensil 130, a removable part 114 of 110 and a removable part 131 for 130, and a electric heat element 150 with power supply.

[0025] Solar heat collector may be any kind of solar heat collector that can heat the heat storage and conducting material 120 to the temperature higher than the water boiling temperature. In this case, the solar heat collector 110 is an evacuated-tube solar heat collector. It may also is a group of modular evacuated-tube solar heat collectors that mounted in a certain shape, e.g. in parallel row, in full or partial cone-shaped column as its one of the examples shown in Fig 2. The solar heat collector 110 has a removable part 114 with two holes 1141 and 1142. The hole 1141 is a path of power cable and air. The hole1142 is to continue the hole 1311 for releasing of cooking steam.

[0026] The evacuated-tube solar heat collectors110 has transparent outer layer 111 and inner layer 112. It is evacuated in between. The inner layer 112 has a heat absorbing coating that does not show in the Fig 1. The evacuated-tube solar heat collector 110 has the same material and manufacture processing as the evacuated-tube solar heat collector that used for solar water heating. But the evacuated-tube solar heat collector used in solar cooking has a larger diameter and a shorter length comparing to the regular evacuated-tube.

[0027] The evacuated-tube solar heat collector 110 is made of glass. In case the glass tube is broken, the glass piece is dangers for the user. So the solar heat collector has a transparent plastic cover for safety reason. (not shown in Fig. 1). The transparent plastic cover can be either the mantles for each tube or a protective cover for an entire collector panel. But the plastic protective mantles may reduce the efficiency of the solar heat collector. So an evacuated toughened-glass tube solar heat collector is a better solution.

[0028] The heat and conducting material 120 in this case is salt or quartz sand for storing the solar heat and transferring heat to the cooking utensil 130. In fact, many kinds of the materials can be used as the solar heat storage and conducting material. For example, they are solid materials such as salt and sand, liquid material, such as water and oil including cooking oil and petroleum products; phase change material, such as paraffin and metals. The cook takes place in the tube wherein utensil is located, so the food safety needs to put special attention. In this invention, we prefer the salt, quartz or basalt sand, cooking oil and large piece of metal. For the heat conducting materials, except the materials mentioned above, metal or alloy conductors and heat tube are suggested.

[0029] In Fig.1 there is another heat conducting material 121. In this case, this is a copper conductor in T shape inserted in the heat storage and conducting material 120 for faster transferring the solar heat to the cooking utensil 130. The conductor 121 can be any other heat conductivity conductor or a heat tube. The heat conducting material 121 is not a necessary component. In many cases, without the heat conducting material 121, the solar cooking appliances work well.

[0030] The cooking utensil 130 is a cylinder container located inside of solar heat collector 110 upper the salt or sand 120. It made of stainless steel. The cooking utensil

130 has a removable part 131 with a hole 1311, it is a stopper inserted in the cooking utensil 130. The utensil has a diameter near but not bigger than the inner diameter of the evacuated-tube solar heat collector 110. A pleated structure 133 is on the wall of the container from the top to the bottom to provide a gap and patch for air exchange and power cable 151. Furthermore it allows a minor adjustable diameter for the container 130. The cooking utensil 130 further includes a removable and detachable handle 135 at the inner wall for removing the utensil 130 from the solar heat collector 110.

[0031] In Fig.1, the utensil 130 is a food steamer. Three layers of steam basket are arranged in the utensil upper the water in the bottom. The food is cooked on the steam basket. In fact, the cylinder container, i.e. the utensil 130, can be many kinds of the utensils. We can have a set of cylinder containers for different cooking purposes. For example, second container can have water and coffee or tea for cooking. It is a solar coffee/tea maker. Third container can have a wire mesh container to hold food when frying and drain them after cooked. It is a solar cooking fryer. Fourth container can have a whisker net made of several curved and intersecting steel wires used to press the food sheets close to the inner wall of container for roasting or baking. Fifth container can back and roast breads and cookies. Of cause, if in the container food and water are arranged for braising or boiling. It is a cooking wok or pot. Based on above descriptions, it is believed that other modifications to the utensils used in this solar heat collector 110 will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.

[0032] A removable part 114 covers the top of solar heat collector 110. It has two holes 1141 and 1142. The first hole 1141 connects to said gap and path for air exchange and power cable 133. The second hole 1142 continues the hole 1311 in the stopper 131 of the container 130. The stopper may be a plant fibril cork with an air gap or a hole.

[0033] The electric heat element 150 with power supply is a very low power electric heat element. It located under the cooking utensil 130 and within heat storage and conducting material 120. A power cable 151 has very high resistive heat temperature that connects the electric heat element 150 to power supply plug 152 outside of the solar heat collector 110, through the path formed by a pleated structure133 on the walls of the utensil 130. The electric heat element 150 may further includes a measuring, indicating and controlling systems for the solar cooking appliance's operating characteristic parameter, e.g. timing, temperature, pressure, moisture etc. These equipments are not shown in Fig. 1. The electric heat element with power supply can be removed from the set of cooking appliance. In this case the set of solar cooking appliances is still a complete cooking appliances that use solar heat as only energy source. Fig. 3 shows the solar heat collectors without electric heat element.

[0034] Some time the evacuated-tubes are mounted in a raw for cooking several foods at the same time.

[0035] Refer to Fig. 2, a set of solar cooking appliances 200 is illustrated schematically in a perspective view. Five evacuated tube solar heat collector 201, 202, 203, 204 and 205 are mounted in a parallel raw.

[0036] A fixing and supporting trestle 206 arranges and supports the five solar heat collectors at the proper locations and situations. The movable support 207 allows the adjustment of the incidence angle of the solar heat collector 210 to the sunlight. Four wheels 241, 242, 243 and 244 are installed in the four bottom corners of the supporting trestle 206 for adjust the direction of the solar heat collector 210. (243 and 244 are not shown in Fig.2). A sundial (not shown in Fig. 2) is a cone bar. It attaches to the solar heat collector 210 perpendicularly for indicating the incidence angle of sunlight;

[0037] A light reflecting object (not shown in Fig. 2) is equipped under the evacuated-tube for focusing the surrounding sun light to the solar heat collector;

[0038] When the solar light shines on the solar heat collector 210, the cooking processing in each utensil is the same as the processing mentioned in Fig. 1. We'll not repeat it again.

[0039] Referring to Fig. 3, a set of exemplary solar heat collectors are illustrated schematically in vertical sections.

[0040] Fig. 3 A is a schematic vertical section view of an evacuated-tube solar heat collector partially filled with liquid heat storage and conduction material, e.g. water or oil. In some cases, water can also be a heat transferring medium for food cooking.

[0041] Fig. 3 B is a schematic vertical section view of an evacuated-tube solar heat collector partially filled with solid heat storage and conduction material, e.g. ore stone or turves.

[0042] Fig. 3 C is a schematic vertical section view of an evacuated-tube solar heat collector partially filled with sand and having a heat tube or a heat conductor as the heat transferring medium.

[0043] Fig. 3 D is a schematic vertical section view of an evacuated-tube solar heat collector partially filled with a combination of solid and liquid heat storage and conducting materials, e.g. quartz sand and cooking oil;

[0044] Fig. 3 E is a schematic partial vertical section view of a group of modular evacuated-tube solar heat collectors that mounted in a vertical parallel raw;

[0045] Fig. 3 F is a schematic partial vertical section view of a group of modular evacuated-tube solar heat collectors that mounted in a horizontal parallel raw;

[0046] When set up a solar cooking appliance, not only these kinds of solar heat collectors but also more kinds of their varieties and combinations can be selected and used.

[0047] Based on the detailed description of the samples, other modifications will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.

I CLAIM

1. A solar cooking appliance, comprising:

a solar heat collector operative to collect and store solar heat,

a first heat medium of a solid heat storage and conducting material placed partially in said solar heat collector, and said solid heat storage and conducting material being heatable to a temperature higher than the water boiling temperature by the radiated solar heat;

a removable solar cooking utensil located within the solar heat collector, and said solar cooking utensil having size and shape to fit internal size and shape of said solar heat collector, and said utensil having a wall located in thermal contact with an internal wall of the solar heat collector and said solid heat storage and conducting material to transfer heat to the utensil; and

said utensil having a removable part for opening and closing said utensil, and having a hole formed therein, and a pleated structure formed on a wall of said utensil to provide a gap and patch.

2. The solar cooking appliance according to Claim 1 further comprising:

an electric heater located in said solar heat collector.

3. The solar cooking appliance according to claim 1, wherein said solar heat collector is selected from a group consisting of: an evacuated-tube solar heat collector and a plurality of modular evacuated-tube solar heat collectors.

4. The solar cooking appliance according to claim 3, wherein said evacuated-tube solar heat collector comprises an element selected from a group consisting of: a transparent cover; an evacuated toughened-glass tube solar heat collector and a transparent plastic protective mantle for safety reason.

5. The solar cooking appliance according to claim 1 or 2, wherein said solid heat storage and conducting material is selected from a group consisting of: salt; sand; quartz sand; a solid chemical material; a solid multi- H_2O chemical material; a basalt sand and a heat conductor made of metal, copper or heat conductive alloy.

6. The solar cooking appliances according to claim 1 or 2, wherein said solid heat storage and conducting material is selected from a group consisting of:

a combination of two or more different solid materials; and

a solid heat storage and conduction material being mixed with a liquid material, wherein said liquid material being capable to be heated to a temperature higher than the water boiling temperature.

7. The solar cooking appliances according to claims 1 or 2, wherein said solid heat storage and conducting material is selected from a group consisting of: quartz sand containing colza oil and basalt sand containing bean oil.

8. The solar cooking appliance according to claim 1 or 2, wherein said solar cooking utensil is a stainless steel container, and said container having a removable and detachable handle at an internal wall and a pleated structure on an external wall from top to bottom, which to provide a gap and path for air exchange and to allow ~~a~~ minor adjustment of the diameter for said container.

9. The solar cooking appliance according to claim 1 or 2, wherein said solar cooking utensil is selected from a group consisting of: a coffee port and a tea maker.

10. The solar cooking appliance according to claim 1 or claim 2, wherein said solar cooking utensil is selected from a group consisting of:

a fryer with a wire mesh for frying and draining a food; a whisker net to press the food to an internal wall of said utensil for food roasting and baking,; a wok and a pot.

11. The solar cooking appliance, according to claim 1, wherein said solar cooking utensil is selected from a group consisting of: a pan; a plurality of fry pans suspended in a parallel manner in said utensil for frying, sautéing or browning food.

12. The solar cooking appliance according to claim 1, further including one or more selected from a group consisting of:

a trestle for arranging and supporting all parts of said solar cooking appliances;

an inclining structure for adjusting angle of said solar heat collector to sunlight;

a directional structure for adjusting direction of said solar heat collector to sunlight;

a light reflector to focus surrounding sunlight to the solar heat collector; and

a sundial attached to the solar heat collector perpendicularly for showing the angle of the sun light relative to said sundial.

13. The solar cooking appliance according to claim 1, further comprising a wrapping material for wrapping a food to be cooked in the solar cooking appliance, said wrapping material being made of a material being chosen from the group of material consisting of: metal; paper and plastic.

14. The solar cooking appliance according to claim 1, further comprising a suitcase for arranging and packaging said solar cooking appliance to form a potable solar cooking appliance.

15. The solar cooking appliance according to Claim 1 or 2, wherein said electric heater is selected from a group consisting of:

an electric heating device;

an electric heater element located under the solar cooking utensil and within the solid heat storage and conducting material;

an electric heating device comprising a power cable, which passing through a path formed by a pleated structure on the walls of the containers;

an electric heating device comprising an operating data measuring and indicating device, and said operating data being selected from a group consisting of: operating duration; temperature; pressure and moisture; and

an electric heater with a controlling system for the solar cooking appliance's operating data, said data is selected from a group consisting of: timing; temperature; pressure; moisture and a hybrid combination of these data.

16. The solar cooking appliance according to Claim 1 or 2, further comprises:

a second heat conducting/transferring medium arranged within said solar heat collector for transferring the solar heat to said cooking utensil, said second heat conducting/transferring medium capable of transferring heat faster than said first medium, and said second heat medium being selected from a group consisting of: a heat tube; a metal conductor; an alloy conductor and a heat conductive conductor capable of transferring heat faster than said first solid heat storage and conducting material.

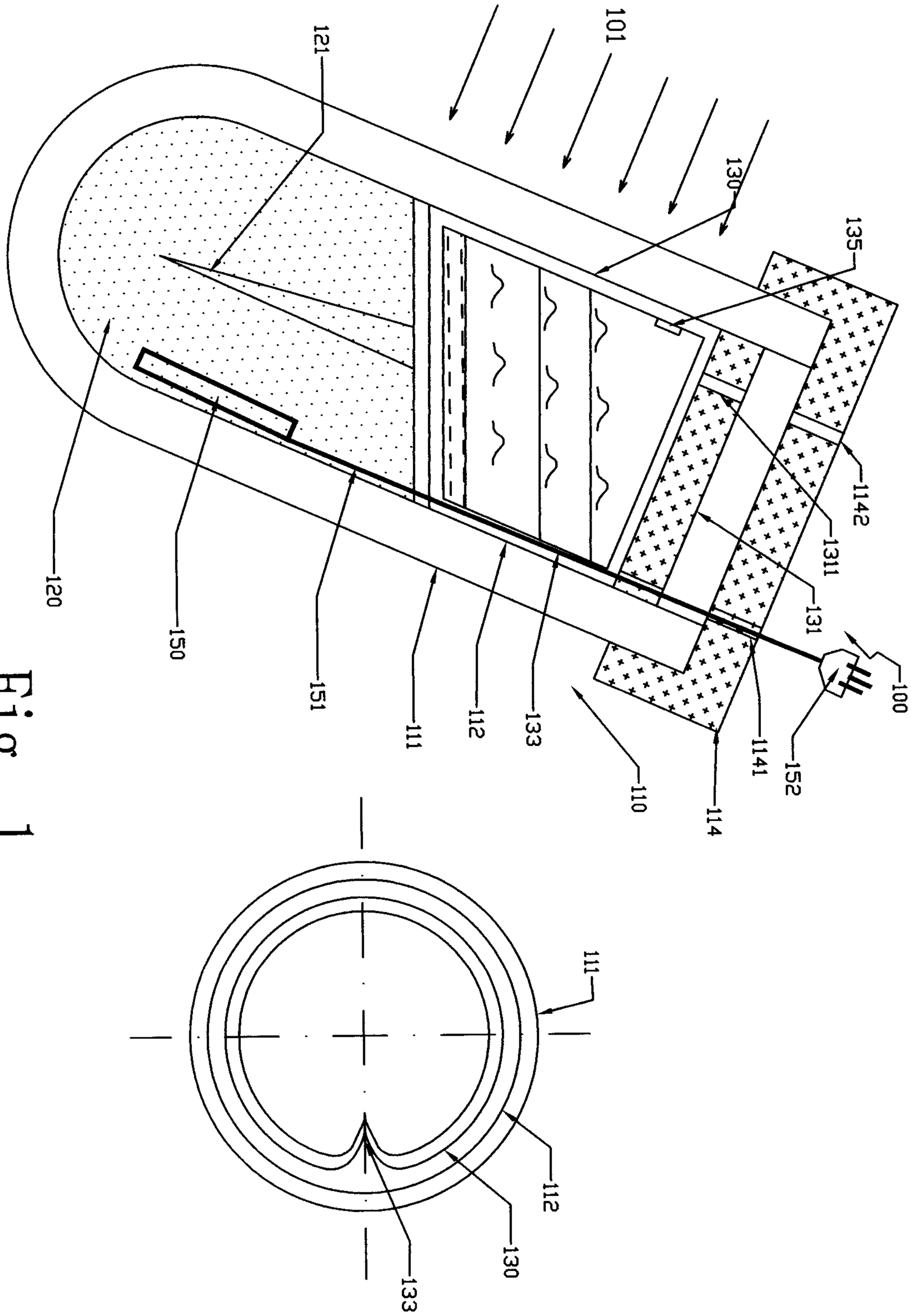

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Fig. 1

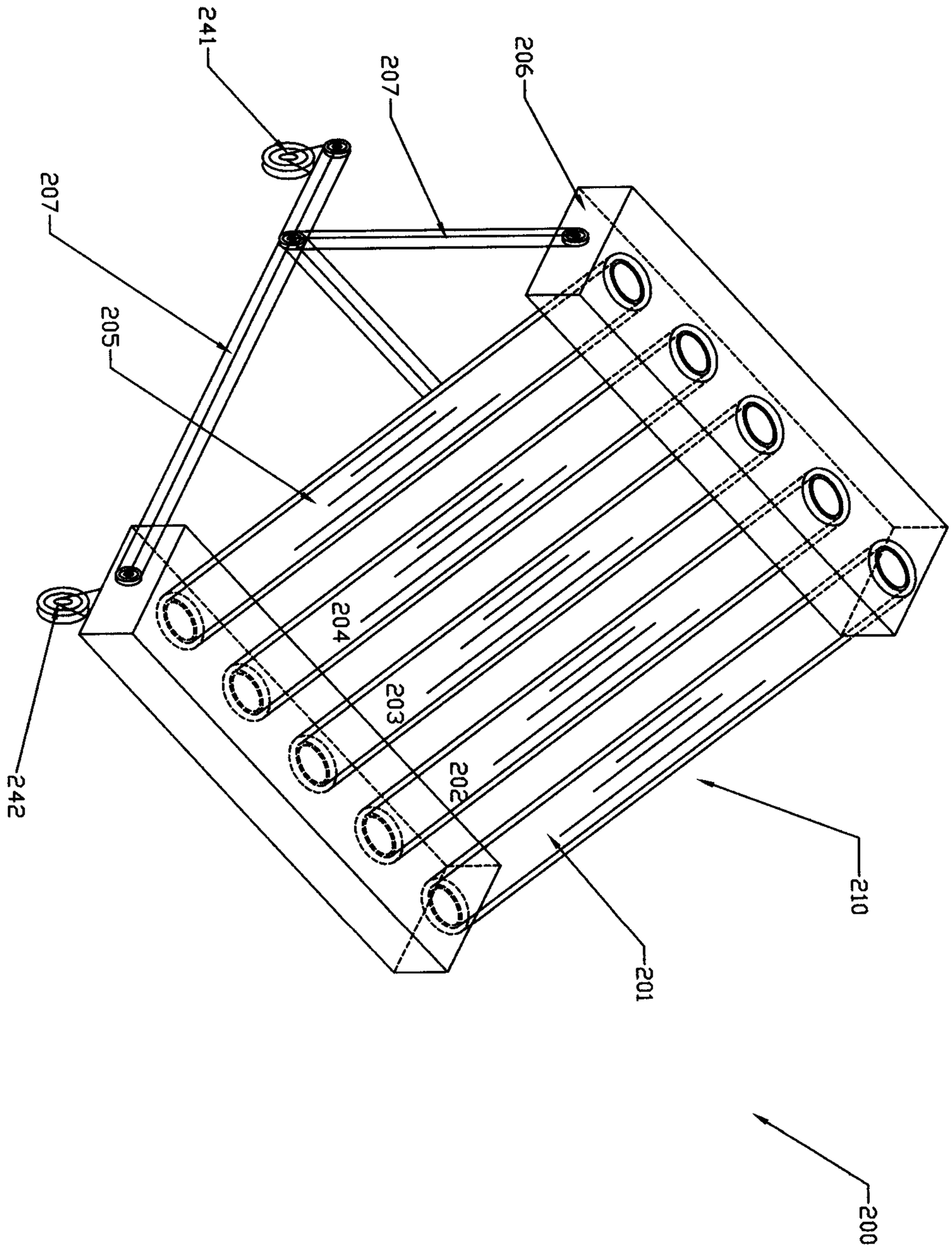


Fig. 2

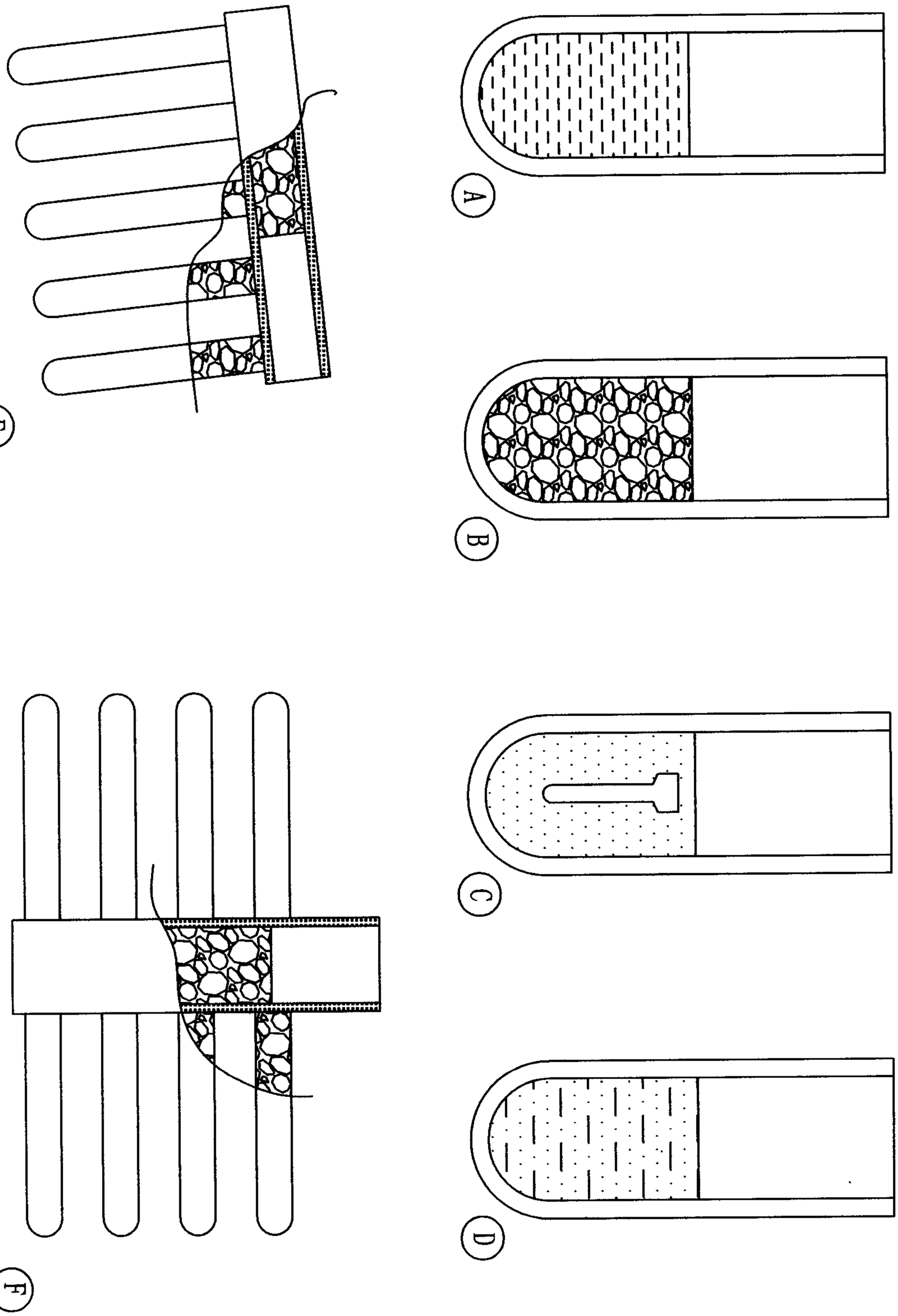
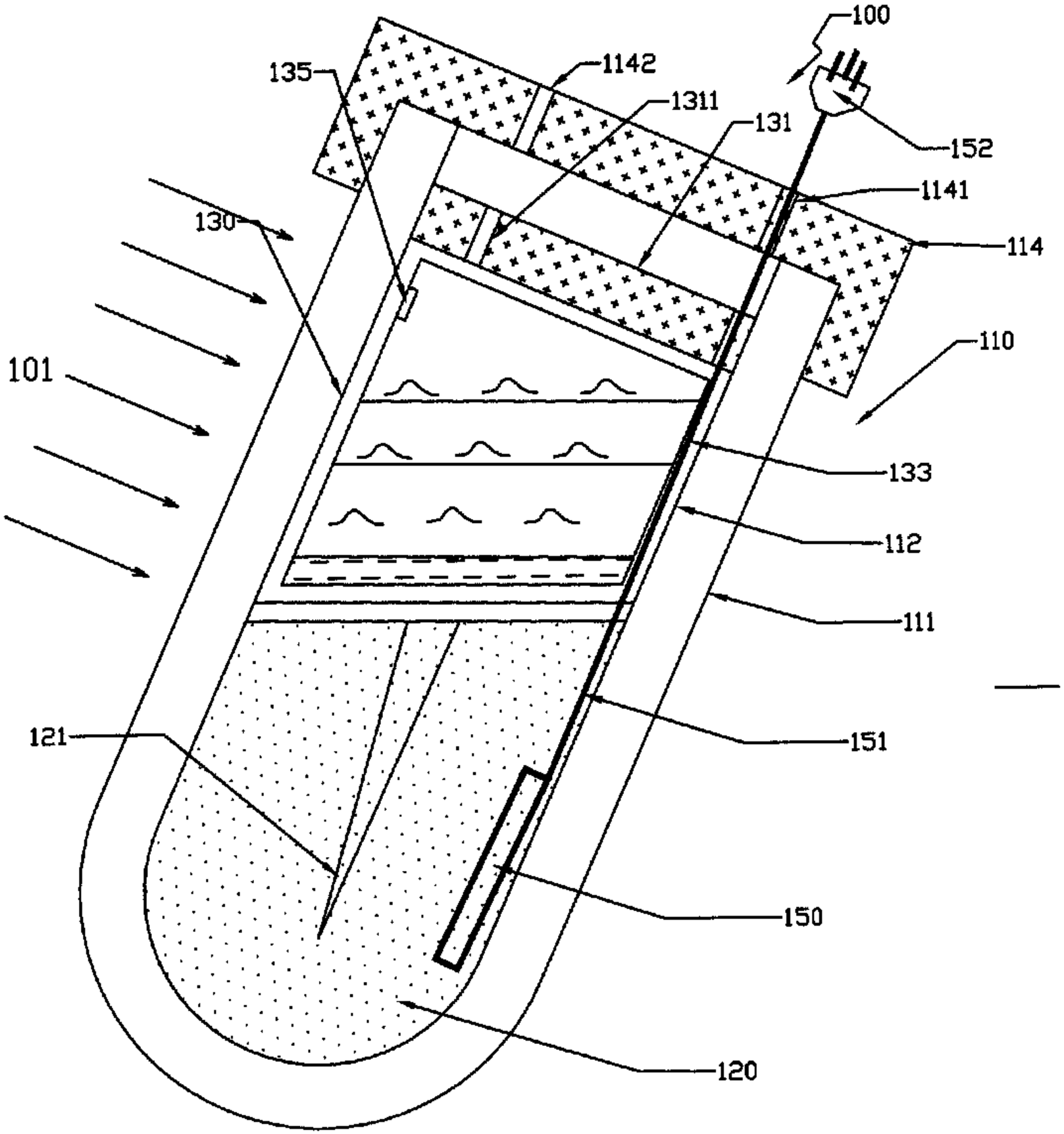


Fig. 3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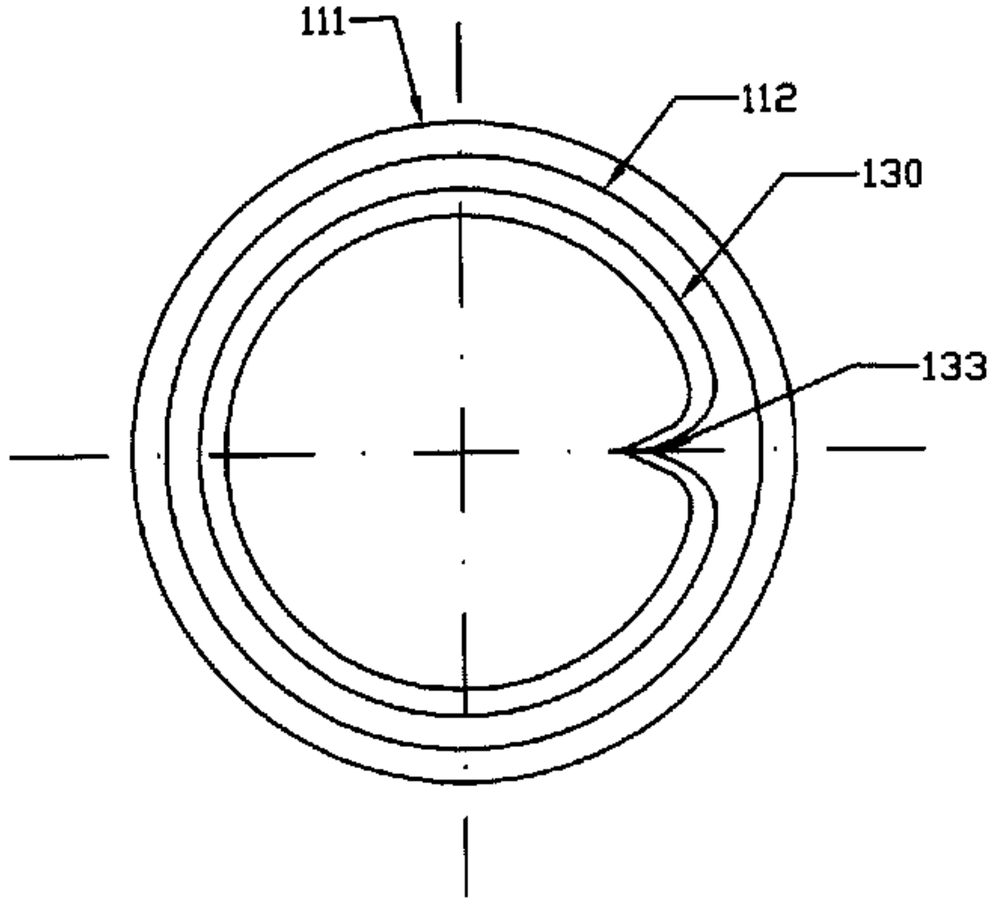
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