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Cristofari(10) **Pub. No.: US 2009/0194094 A1**(43) **Pub. Date: Aug. 6, 2009**(54) **DEVICE FOR COLLECTING RAIN WATER
AND CALORIES FROM SOLAR RADIATION****Publication Classification**(76) Inventor: **Christian Cristofari, Ajaccio (FR)**Correspondence Address:
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(57)

ABSTRACT

A device for collecting rainwater and calories originating from solar radiation in order at the same time to drain the rainwater and generate domestic hot water or heating, capable of being mounted at the base of a roof or on the edge of a balcony, includes an open channel (2) having longitudinal walls and lateral walls (7, 8). The open channel (2) has in cross section a stepped profile including first and second steps. A translucent or transparent cover plate (3) is mounted inside the open channel (2) at the second step while being held by the lateral walls (7, 8) and partly delimits a sealed chamber (2b). A heat exchanger device (12) inside which a coolant can flow is mounted inside the sealed chamber (2b), and the first step defines at least partly a section for the flow of the rainwater.

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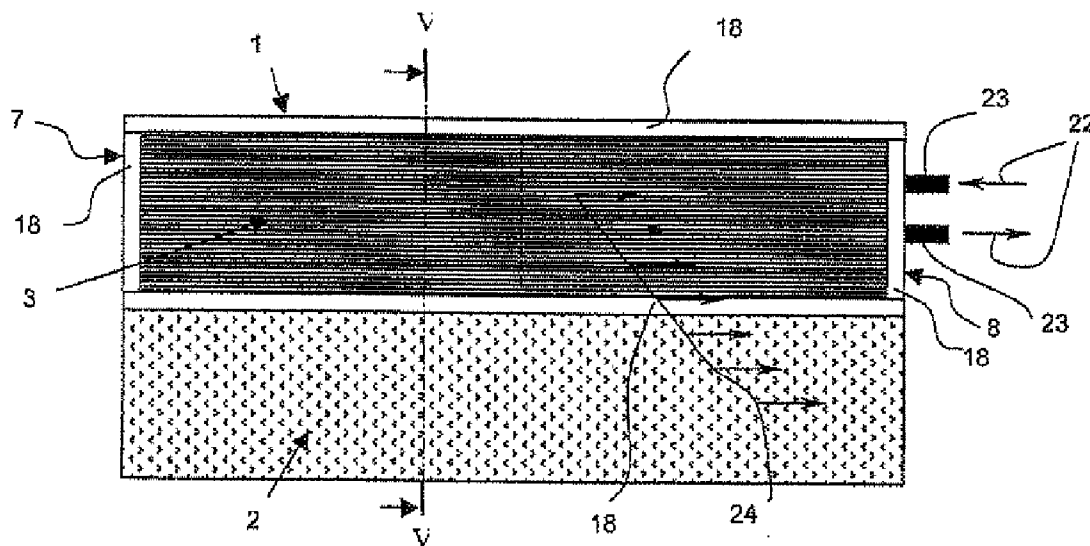


FIG.1

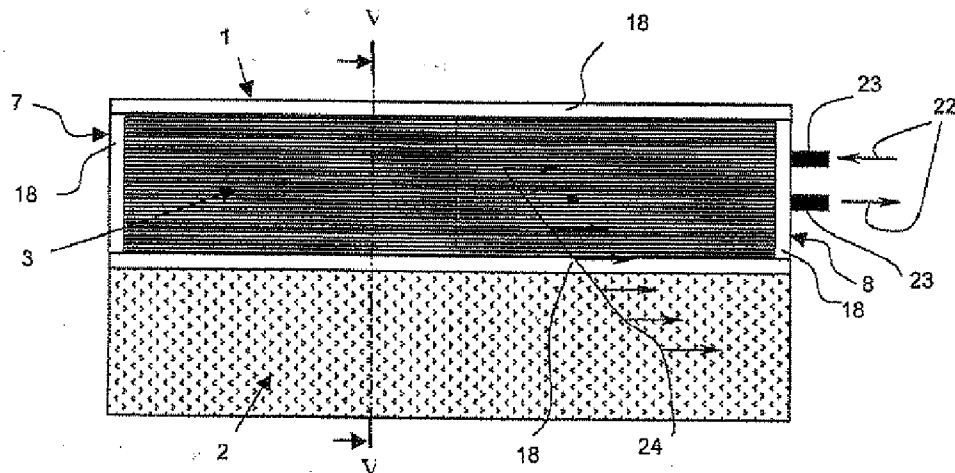


FIG.2

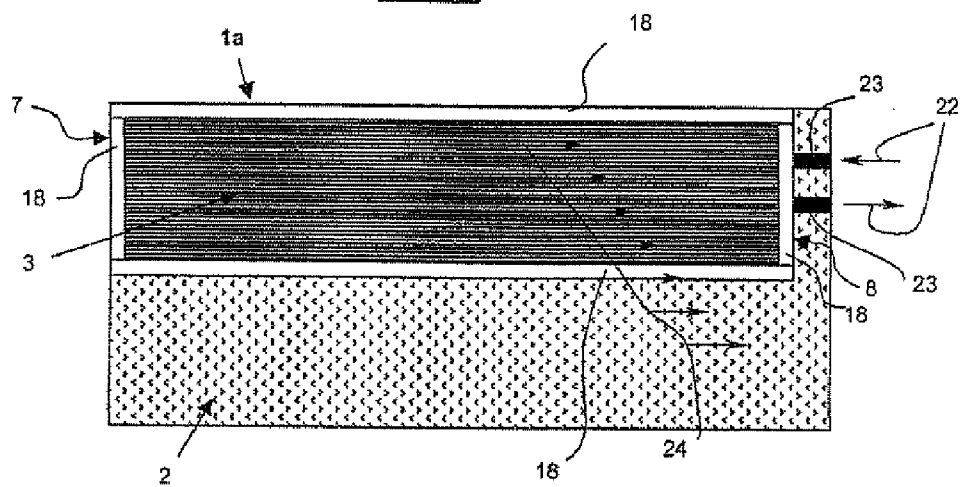


FIG. 3

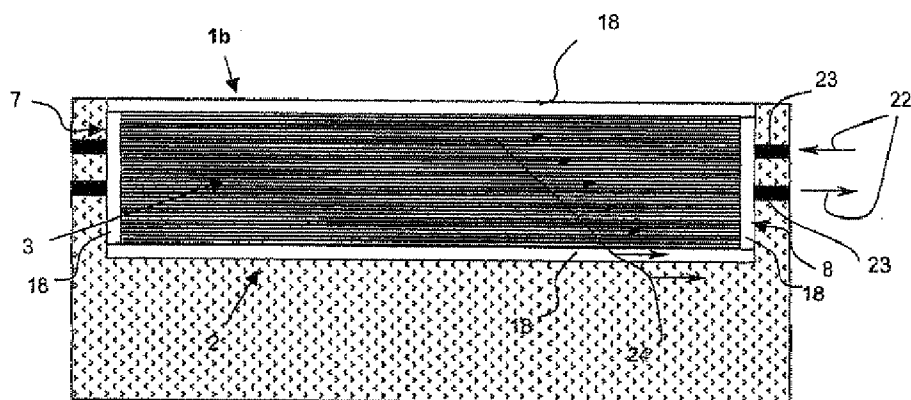
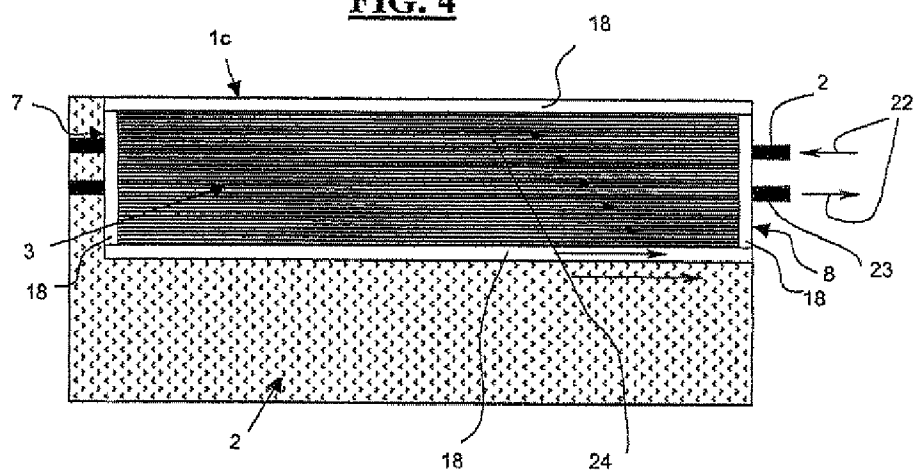
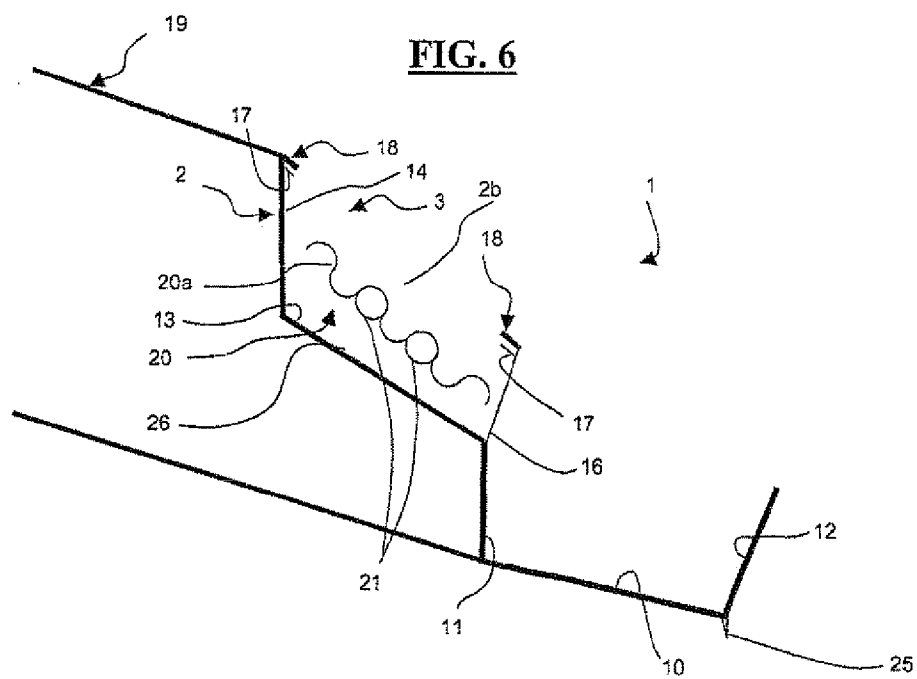
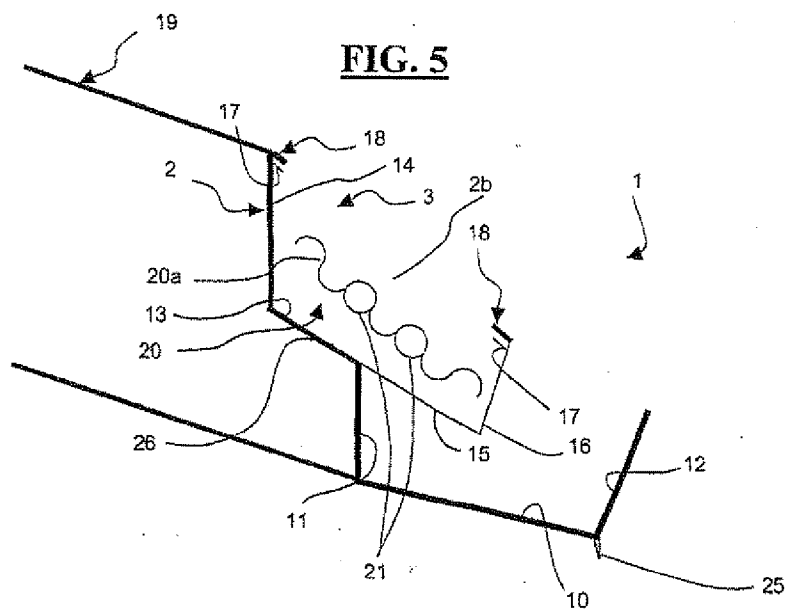


FIG. 4





DEVICE FOR COLLECTING RAIN WATER AND CALORIES FROM SOLAR RADIATION

[0001] The subject of the present invention is a device for collecting rainwater and calories originating from solar radiation. This collection device is designed for buildings and is capable of being mounted at the base of a roof or on the edge of a balcony.

[0002] The importance that is to be attached to energy-saving is known, particularly in the building industry, for developing solar devices capable of reducing the energy bill.

[0003] It is known how to collect solar energy by using solar sensors usually placed on building roofs. Inside these sensors a coolant is set in motion which can then be used for transmitting the calories to the inside of residential premises, for example by means of individual solar water heaters (sometimes called ISWH) or floors fitted with passageways for the coolant (sometimes called "direct solar floors").

[0004] Water-based or coolant-based solar converters are known, usually made of metal or composite materials, comprising a lower portion consisting of a box, an insulator, an absorber and a collector and an upper portion consisting of a translucent or transparent panel thereby producing a greenhouse effect. Also known are coolant-based solar converters made of metal materials and of glass that can be used while operating in a vacuum, or else hybrid solar converters generating heat through both a coolant and electricity.

[0005] Usually, these solar sensors or converter devices used in buildings have a flat geometry (assemblies of modules or of tubes in a vacuum for a surface area of 2 m² for example) and have only one function, the collection of solar energy.

[0006] The object of the present invention is to increase the efficiency of solar energy collection relative to the devices usually used, to thereby improve the calorific yield of these solar devices, and to propose a solar product fully integrated into the building and having a dual function of recovering rainwater and collecting energy from solar radiation.

[0007] Accordingly, the present invention proposes to use the physical phenomena associated with the conversion of solar radiation such as absorption and the greenhouse effect by using as a structure a collection device mounted at the base of a building roof or on the rim of a building balcony.

[0008] The calories are recovered through a heat exchanger that uses the greenhouse effect and that is fitted to a device for producing domestic hot water or heating. The collection device therefore has a dual function, being capable at the same time of recovering rainwater and recovering solar energy in order to transmit it to a coolant which may be water or another fluid. In addition, depending on the coating of the exchanger absorber, it is also possible to generate electricity.

[0009] In one embodiment, the device for collecting rainwater and calories originating from solar radiation, that makes it possible at the same time to drain the rainwater and generate domestic hot water or heating, or else electricity, is capable of being mounted at the base of a roof or on the edge of a balcony and comprises an open channel having longitudinal walls and lateral walls.

[0010] The open channel has in cross section a stepped profile comprising first and second steps. A translucent or transparent cover plate is mounted inside the open channel at the second step while being held by the lateral walls, and partly delimits a sealed chamber.

[0011] A heat exchanger device inside which a coolant can flow is mounted inside said sealed chamber.

[0012] The first step defines at least partly a section for the flow of the rainwater.

[0013] In one embodiment, the translucent or transparent cover plate defines the sealed chamber with at least one longitudinal wall of the second step.

[0014] Preferably, the lower portion of the second step of the open channel may at least partly define the sealed chamber. The sealed chamber, jointly with the first step of the open channel, may define the section for the flow of the rainwater.

[0015] In a preferred embodiment, the device also comprises a lower longitudinal wall extending a bottom wall of the second step of the open channel, said lower wall partly forming the bottom of the sealed chamber and partly delimiting the section for the flow of the rainwater.

[0016] Advantageously, the lower longitudinal wall extends up to the vicinity of an outer longitudinal wall of the first step of the open channel.

[0017] In another embodiment, the lower portion of the second step of the open channel entirely defines the bottom of the sealed chamber.

[0018] In another embodiment, the sealed chamber is fitted against a bottom wall and a longitudinal wall of the second step of the open channel.

[0019] The open channel and the lateral walls may be made of synthetic materials (of the polymer or composite type), of glass, of metal or of alloy.

[0020] On its portion involved in the recovery of solar calories, the open channel has a translucent or transparent cover providing the greenhouse effect. It may also have, in its lower portion, an insulating strip placed over at least a portion of the inner face of the longitudinal walls of the lower portion of the second step of the open channel inside the closed chamber.

[0021] On its portion involved in the draining of rainwater, the open channel may be coated on the inside with a reflective covering or coating so as to increase the effect of solar concentration. The reflective coating may be affixed to the inner face of the portion open to the air of a longitudinal wall of the first step of the open channel.

[0022] In a preferred embodiment, the heat exchanger device consists of a metal plate, preferably corrugated, which serves as the absorber, and at least one metal tube making it possible for the coolant to flow. The absorber, which may be differently inclined depending on the latitude of the installation site, and the geometry of the device make it possible to provide an optimum effect of concentrating the solar radiation with a high efficiency.

[0023] Preferably, the corrugated metal plate is coated on its upper face with a selective black paint, a black coating produced by anodization, or a mineral coating of the mono- or polycrystalline silicon type, absorbing the heat optimally and radiating in long wavelengths, thereby maximizing the greenhouse effect.

[0024] The metal tube or tubes may be welded to the lower face of the corrugated metal plate and attached to the lateral walls of the open channel. The corrugated profile makes it possible to obtain greater calorific efficiency by concentration effect. Advantageously there is a space between the corrugated metal plate and the translucent or transparent cover, thereby promoting the temperature rise inside the solar sensor portion.

[0025] In another embodiment, the heat exchanger device consists of at least one pipe made of metal or of a welded

composite synthetic material, of rectangular section, attached to the lateral walls and allowing the coolant to flow. Preferably, the metal pipe(s) is/are covered with a selective black paint, a black coating made by anodization, or a mineral coating of the mono- or polycrystalline silicon type. The pipes made of composite synthetic material incorporate black monochromatic polymers, thereby absorbing the heat optimally and radiating in long wavelengths, thereby maximizing the greenhouse effect.

[0026] There is a space between the metal or composite synthetic pipes and the translucent or transparent cover, thus promoting the rise in temperature inside the solar sensor portion.

[0027] In an advantageous embodiment, the lateral walls may be connected together by a simple join, interlocked, bonded or welded, which may be furnished, for the phenomena of expansion, with a polymer seal.

[0028] The sealed closed chamber may form a controlled-atmosphere enclosure.

[0029] Advantageously, the metal plate is coated with at least one mineral in order to convert radiation into electricity. The mineral coating may for example be silicon.

[0030] The invention will be better understood on studying the particular embodiments described as nonlimiting examples and illustrated by the appended drawings, in which:

[0031] FIG. 1 is a top view of a first embodiment of a device according to the invention;

[0032] FIGS. 2, 3 and 4 are top views of individual modules designed to be assembled to form a second embodiment of a device according to the invention;

[0033] FIG. 5 is a section along V-V of FIG. 1 showing the internal structure of the device; and

[0034] FIG. 6 is a section corresponding to the section of FIG. 5 showing the internal structure of a third embodiment of a device according to the invention.

[0035] A first embodiment of the device for collecting rainwater and calories originating from solar radiation is referenced 1 in its entirety in FIGS. 1 and 5.

[0036] The device 1 comprises an open channel 2, and a translucent or transparent cover plate 3 of generally rectangular shape. The device 1 is in this instance shown mounted on the edge of a building roof 19, like a conventional gutter.

[0037] Naturally, the arrangement of the device 1 on the edge of a roof 19 is in no way limiting. It could equally be envisaged to mount the device on the edge of a balcony.

[0038] The open channel 2 comprises, on one of its two smallest sides, a flat lateral wall 7 of reduced section relative to the section of the open channel 2. The open channel 2 also comprises on its opposite side a flat lateral wall 8 with a section delimited in part by the section of the open channel 2. The open channel 2 may comprise in various sections one or more transverse flat plates (not shown) with a section delimited in part by the section of the open channel 2, in order to heighten the mechanical strength of the device 1, and thereby to provide good rigidity.

[0039] As illustrated in FIG. 5 representing the internal structure of the device 1, the open channel 2 has in cross section a stepped profile that is open upward.

[0040] The open channel 2 comprises a bottom wall 10, an inner longitudinal wall 11 situated on the side of the building roof 19 and extending substantially vertically upward one end of the bottom wall 10, and an outer longitudinal wall 12 extending substantially vertically upward the bottom wall 10, on the side opposite to the inner wall 11.

[0041] The bottom wall 10 and the inner and outer longitudinal walls 11 and 12 therefore constitute a first step of the open channel 2 which is, in cross section, generally "U"-shaped and is open upward.

[0042] The open channel 2 also comprises an intermediate wall 13, extending substantially horizontally inward in the direction of the building roof 19 the top free end of the inner longitudinal wall 11, which is itself extended vertically upward by a top inner longitudinal wall 14, being connected at its free end to the roof 19. The intermediate wall 13 and the inner wall 14 form the second step of the open channel 2. This second step has, in cross section, a generally "L"-shaped profile.

[0043] In order to delimit a closed sealed chamber inside the open channel 2, the latter also comprises a lower longitudinal wall 15 attached to the lateral walls 7 and 8 of the open channel 2, in order to extend the intermediate wall 13 in the direction of the outer longitudinal wall 12, and a wall 16 extending vertically upward said lower wall 15 while being substantially parallel to the outer wall 12.

[0044] The lower wall 15 therefore extends up to the vicinity of the outer wall 12 so as to extend the intermediate wall 13 of the second step continuously. In other words, the intermediate wall 13 and the lower wall 15 are coplanar.

[0045] The lower wall 15 is situated at the level of the first step of the open channel 2, while being placed at a distance from the bottom wall 10 of said channel. For example, the wall 15 may be mounted so that its lower end is situated half-way up the first step of the open channel 2.

[0046] In order to delimit a closed sealed chamber inside the open channel 2, the translucent cover plate 3 is attached at its edges 17 to the ends of the longitudinal walls 14 and of the wall 16, and to the lateral walls 7 and 8. Fixing rods 18 hold the cover plate 3. In these conditions, the walls 13 to 16 and the cover plate 3 delimit a sealed closed chamber 2b.

[0047] The intermediate wall 13 and the wall 15 form the bottom of the sealed chamber 2b. An insulation strip 26 is attached inside the channel, in order to carpet the bottom and the longitudinal walls 14 and 16 of the chamber 2b.

[0048] As mentioned above, the lower longitudinal wall 15 leaves a space between the bottom wall 10 of the channel and said wall 15. Similarly, the wall 16 leaves a space between it and the outer longitudinal wall 12 of the open channel 2 situated on the side opposite to the building roof 19.

[0049] In other words, the sealed chamber 2b extends from the wall 14 of the second step of the open channel 2 up to an upper portion of the first step of the open channel 2, while being offset relative to the bottom wall 10 and relative to the outer longitudinal wall 12.

[0050] Therefore, the rainwater travels mainly between the wall 16 and the outer wall 12 of the open channel, and between the wall 15 and the bottom wall 10 of the channel.

[0051] The section for the flow of rainwater is therefore delimited by the walls 15 and 16 of the sealed chamber 2b and by the walls 10 to 12 of the first step of the open channel 2.

[0052] In this embodiment, the rainwater can flow on the side and underneath the chamber 2b on the first step of the open channel 2, the translucent cover plate 3 directing the rainwater toward the first step of the channel. The section of flow for the rainwater is therefore relatively large.

[0053] A heat exchanger 20 is mounted in the chamber 2b and comprises a corrugated metal plate 20a on the lower face

of which are attached, for example by welding, two metal tubes **21**. As a variant, it is also envisageable to provide a single metal tube.

[0054] The two metal tubes **21** allow the flow of a coolant in the direction of the arrows **14** (FIG. 1) from one of the faces of the wall **8** to the wall **7** and returning to the wall **8**, for example via a 180° return bend that is not visible in the figures.

[0055] The two metal tubes **21** of the heat exchanger **12** terminate in two connectors **23** (FIG. 1) which protrude from the outside of the channel **2** and can be connected respectively to a supply pipe and extraction pipe not shown in the figures. These supply and extraction pipes may be incorporated into a rainwater downpipe. This option allows a total incorporation of the device **1** into the structure of the building. As a variant, it could be sufficient to have a single tube with connectors situated on the two sides of the device.

[0056] In order to increase the calorific efficiency, a reflective coating may be affixed to the internal side of the outer wall **12** of the first step of the open channel **2** (FIG. 5).

[0057] The collection device **1** illustrated in FIG. 1 may be the subject of a fractioning over its length then producing several collection modules assembled to one another. Examples of such modules referenced **1a**, **1b** and **1c** are respectively illustrated in FIGS. 2, 3 and 4 in which similar elements bear the same reference numbers. It is therefore possible to produce considerable collection lengths.

[0058] The portion of the open channel **2** designed for carrying the rainwater in the direction of the arrows **24** (FIG. 1) is delimited in this instance by the bottom wall **10**, the inner and outer walls **11** and **12**, and by the lower wall **15** and the wall **16**. The water flows from the wall **7** to the wall **8** and the rainwater is collected over the whole length of the device referenced **1** or of the various modules referenced **1a**, **1b** and **1c**.

[0059] In other words, the section of flow of the rainwater is delimited by the first step of the open channel and by the walls **15** and **16** delimiting the sealed chamber **2b**.

[0060] A water drip device **25** may be bonded, welded or molded onto the lower portion of the first step of the open channel **2** at the junction between the bottom wall **10** and the outer longitudinal wall **12**. Aeration and venting holes (not shown) may be made through the wall **16**, in order to support any pressure variations in the sealed chamber **2b**. These aeration and venting holes are situated above a horizontal plane passing through the top free end of the outer wall **12**, in order to prevent the infiltration of water into the chamber **2b**.

[0061] The material forming the channel **2** may be metallic like that forming the exchanger **12**. As a variant, the material forming the channel **2** may be a synthetic polymer or any other material appropriate to the collection of rainwater. It can also be envisaged to create a vacuum in the chamber **2b**.

[0062] Although the description has been made with reference to an exemplary embodiment in which the heat exchanger comprises two round-trip passageways for a coolant, a variant with a single coolant passageway could be envisaged. It would also be possible to envisage an absorber consisting of a flat metal plate. The geometry of the profile of the open channel **2** is in no way essential and other shapes than those illustrated could perfectly well be used.

[0063] In these situations, the walls of the sealed chamber **2b** are not partly formed by the walls **13** and **14**, but are separate from these walls and match them in shape.

[0064] The third embodiment of the collection device illustrated in FIG. 6 differs from the embodiments of the preceding figures in that the wall **16** extends the inner wall **11** of the first step of the open channel **2** so as to be substantially parallel to the outer wall **12** of said first step.

[0065] Therefore, the sealed chamber **2b** is situated entirely on the second step of the open channel **2**. In other words, the intermediate wall **13** entirely defines the bottom of the sealed chamber **2b**.

[0066] In these situations, the section for the flow of the rainwater is delimited by the inner and outer walls **11** and **12** and by the bottom wall **10**. The device **1** in this instance has no wall extending the wall **13** in the direction of the outer wall **12** and situated on the first step.

[0067] In order to obtain considerable collection lengths, the device illustrated in FIG. 6 may also be the subject of a fractioning over its length, producing several collection modules assembled together.

[0068] Although in all the preceding embodiments the sealed chamber **2b** is partly delimited by the walls of the second step of the open channel **2**, it is easy to conceive that it is also possible, without departing from the context of the invention, to provide a sealed chamber **2b** that is assembled on the outside of the open channel **2**, and then fitted and attached against the intermediate wall **13** and the inner wall **14** of the second step of the open channel **2**.

[0069] The dual collection device according to the invention has many advantages relating to its integration into buildings, its space requirement, its positioning, its weight since it can be modular and its improved performance by concentration effect. As a variant, it is also possible to envisage incorporating the device into an existing eaves trough and/or to create a vacuum in the chamber **2b**.

[0070] The dual collection device according to the invention may be associated, like a conventional gutter, with downpipes via down-connectors and, like a conventional solar sensor with a regulation loop and with a storage cylinder or tank for storing the hot water thus generated, and/or with equipment using electricity for its operation.

1. A device for collecting rainwater and calories originating from solar radiation in order at the same time to drain the rainwater and generate domestic hot water or heating, capable of being mounted at the base of a roof or on the edge of a balcony, comprising an open channel (**2**) having longitudinal walls and lateral walls (**7**, **8**), characterized in that the open channel (**2**) has in cross section a stepped profile comprising first and second steps, a translucent or transparent cover plate (**3**) is mounted inside the open channel (**2**) at the second step while being held by the lateral walls (**7**, **8**) and partly delimits a sealed chamber (**2b**), a heat exchanger device (**12**) inside which a coolant can flow is mounted inside said sealed chamber (**2b**), and in that the first step defines at least partly a section for the flow of the rainwater.

2. The device as claimed in claim 1, wherein the translucent or transparent cover plate (**3**) defines the sealed chamber (**2b**) with at least one longitudinal wall (**14**) of the second step.

3. The device as claimed in claim 1, wherein the lower portion of the second step of the open channel (**2**) partly defines the sealed chamber (**2b**).

4. The device as claimed in claim 1, wherein the sealed chamber (**2b**) defines jointly with the first step of the open channel (**2**) the section for the flow of the rainwater.

5. The device as claimed in claim 1, also comprising a lower longitudinal wall (**15**) extending a bottom wall (**13**) of

the second step of the open channel, said lower wall partly forming the bottom of the sealed chamber (2b) and partly delimiting the section for the flow of the rainwater.

6. The device as claimed in claim 5, wherein the lower longitudinal wall (15) extends up to the vicinity of an outer longitudinal wall (12) of the first step of the open channel (2).

7. The device as claimed in claim 1, wherein the lower portion of the second step of the open channel (2) entirely defines the bottom of the sealed chamber (2b).

8. The device as claimed in claim 1, wherein the sealed chamber (2b) is fitted against a bottom wall (13) and a longitudinal wall (14) of the second step of the open channel.

9. The device as claimed in claims claim 1, fractioned over its length and having several modules (1a, 1b and 1c) assembled together.

10. The device as claimed in claim 1, wherein an insulating strip (11) is placed over at least a portion of the inner face of the longitudinal walls of the lower portion of the second step of the open channel (2) inside the sealed chamber (2b).

11. The device as claimed in claim 1, wherein a reflective coating is affixed to the inner face of the portion open to the air (2a) of an outer longitudinal wall (12) of the first step of the open channel (2).

12. The device as claimed in claim 1, wherein the heat exchanger device (12) comprises a corrugated metal plate (12a) on the lower face of which is welded at least one metal tube (5), inside which the coolant flows.

13. The device as claimed in claim 1, wherein the material forming the open channel (2) is different from that of the heat exchanger device (12).

14. The device as claimed in claim 1, associated with a rainwater downpipe via a down-connector into which pipes for the supply and extraction of the coolant may be incorporated.

15. The device as claimed in claim 1, wherein the sealed chamber (2b) forms a controlled-atmosphere enclosure.

16. The device as claimed in claim 12, wherein the metal plate (12a) is coated with at least one mineral in order to convert radiation into electricity.

17. The device as claimed in claim 2, wherein the lower portion of the second step of the open channel (2) partly defines the sealed chamber (2b).

18. The device as claimed in claim 13, wherein the metal plate (12a) is coated with at least one mineral in order to convert radiation into electricity.

19. The device as claimed in claim 14, wherein the metal plate (12a) is coated with at least one mineral in order to convert radiation into electricity.

20. The device as claimed in claim 15, wherein the metal plate (12a) is coated with at least one mineral in order to convert radiation into electricity.

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