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(54) **DEVICE FOR THE UTILIZATION OF SOLAR ENERGY**

(71) Applicant: **Jan Sehnoutek**, Praha 1 (CZ)

(72) Inventor: **Jan Sehnoutek**, Praha 1 (CZ)

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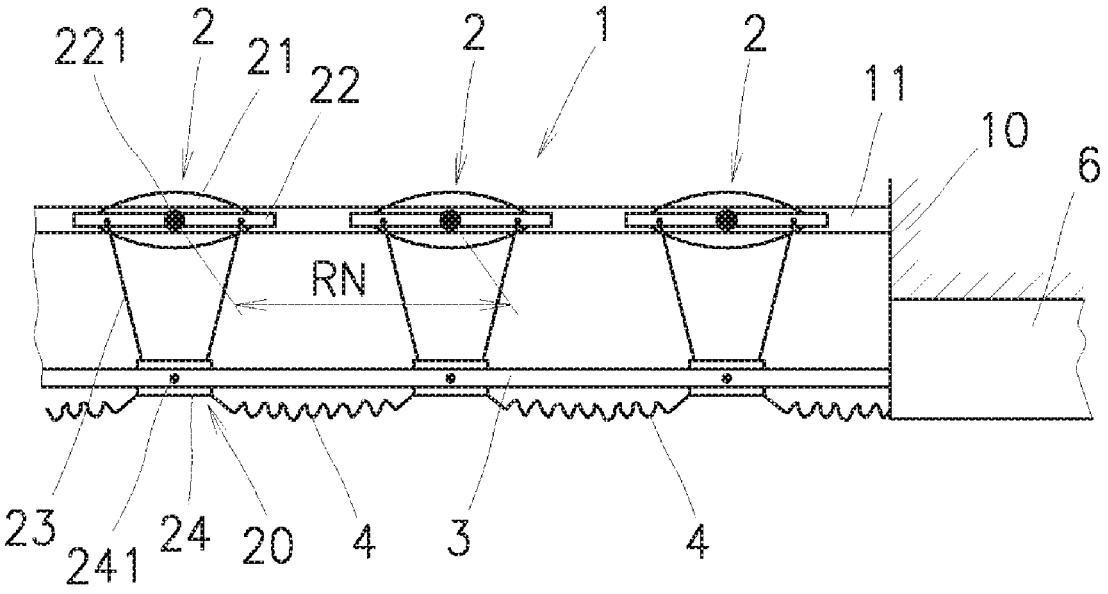
(57) **ABSTRACT**

The invention relates to a device for the utilization of solar energy which contains a row of absorbing members (**2**) arranged in a rigid lamella (**1**), each of the absorbing members containing an optical lens (**21**) and an absorbing means (**20**) coupled to it in an optical axis. The absorbing members (**2**) are oscillatingly mounted in a support bar (**11**) of the rigid lamella (**1**) which is fixedly mounted in a longitudinal frame (**10**). The absorbing members (**2**) are jointly deflectable in relation to the rigid lamella (**1**) by means of a movable guide bar (**3**) located below the support bar (**11**) of the rigid lamella (**1**) and are coupled with the absorbing means (**20**).



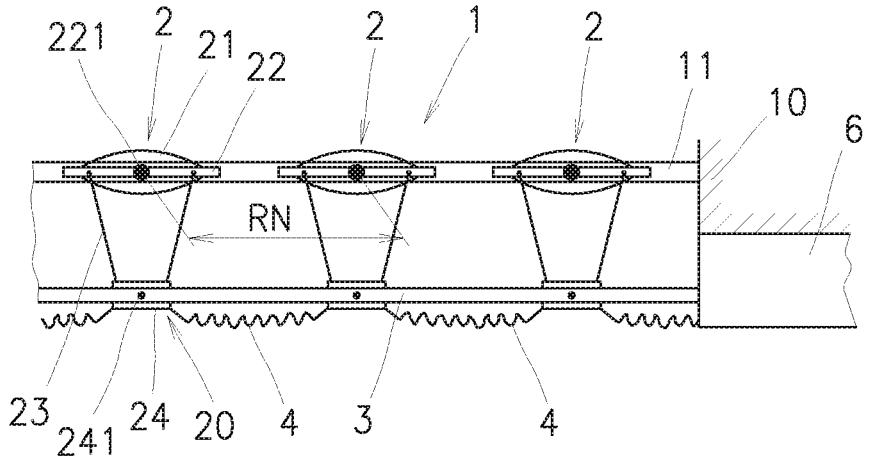

221
2
21
22
2
1
2
11
10
6
RN
23
241
24
20
4
3
4

Fig. 1

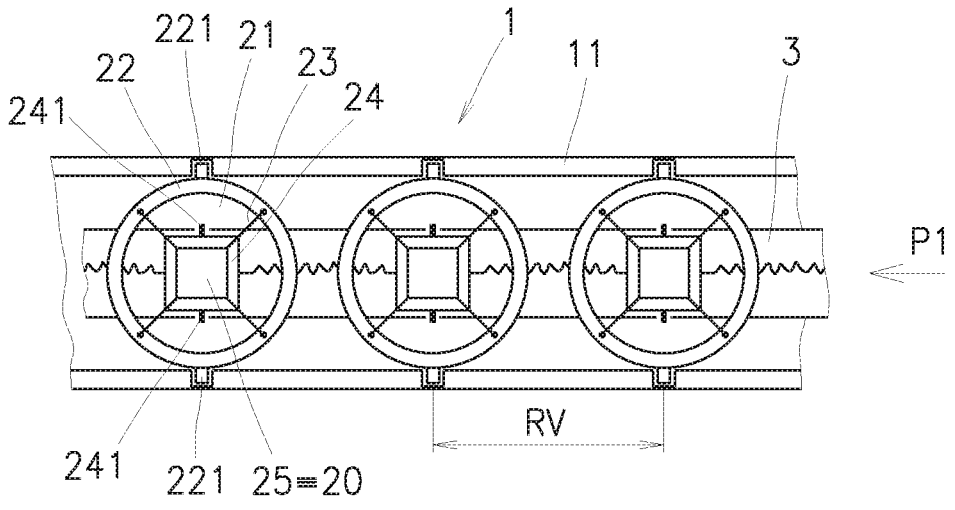

221
21
1
22
23
11
3
241
24
P1
RV
241
221
25=20

Fig. 2

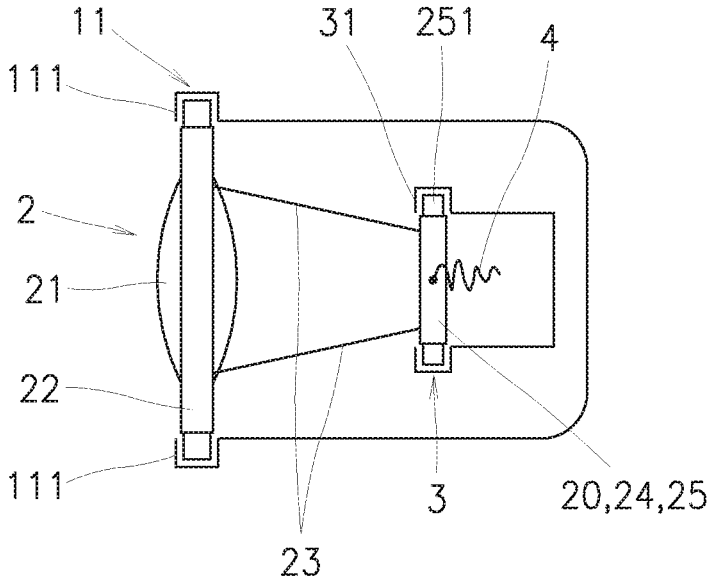

11
31
251
4
111
2
21
22
111
3
20,24,25
23

Fig. 3

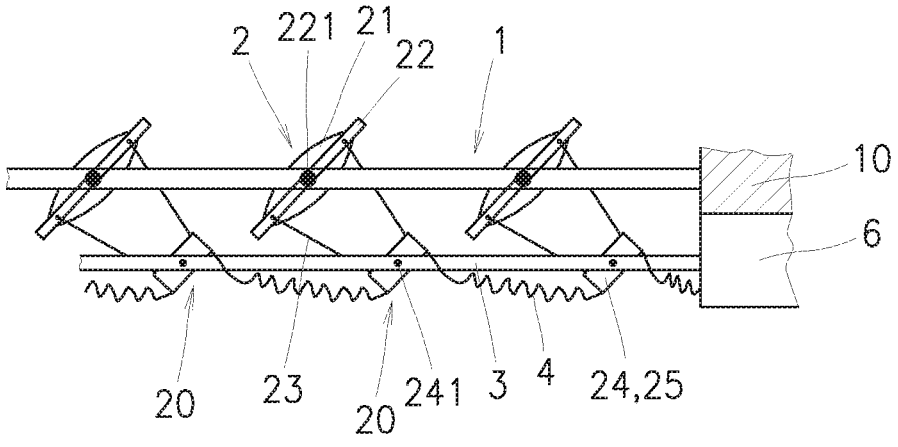

2
221
21
22
1
10
6
20
23
20
241
3
4
24,25

Fig. 4

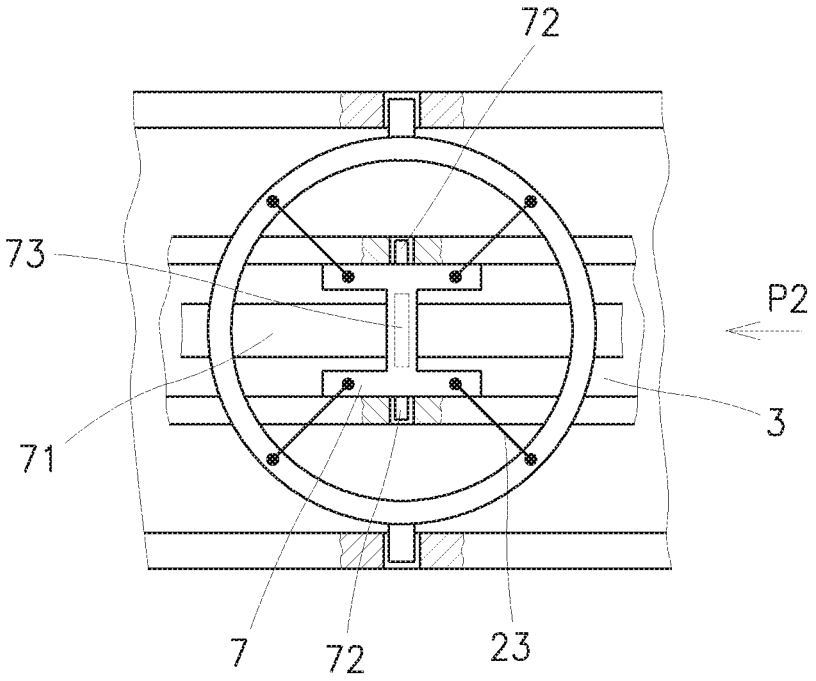


Fig. 5

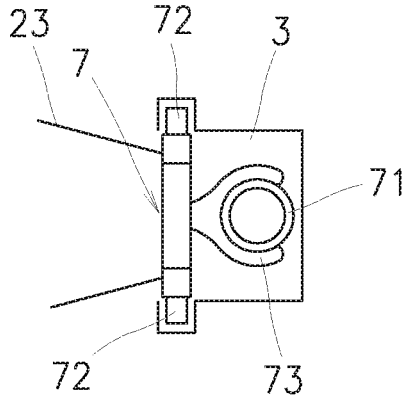


Fig. 6

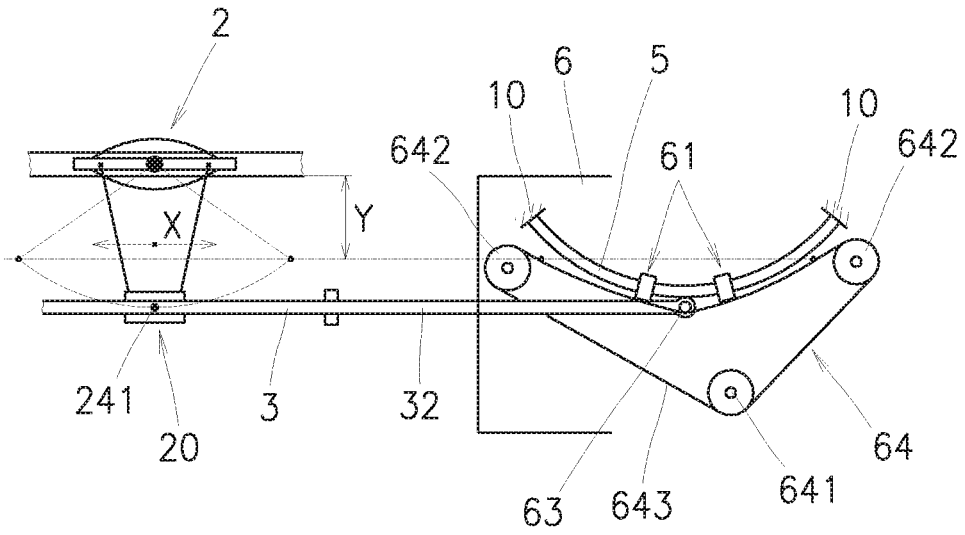

2
6
5
10
10
642
642
61
X
Y
241
20
3
32
63
643
641
64

Fig. 7

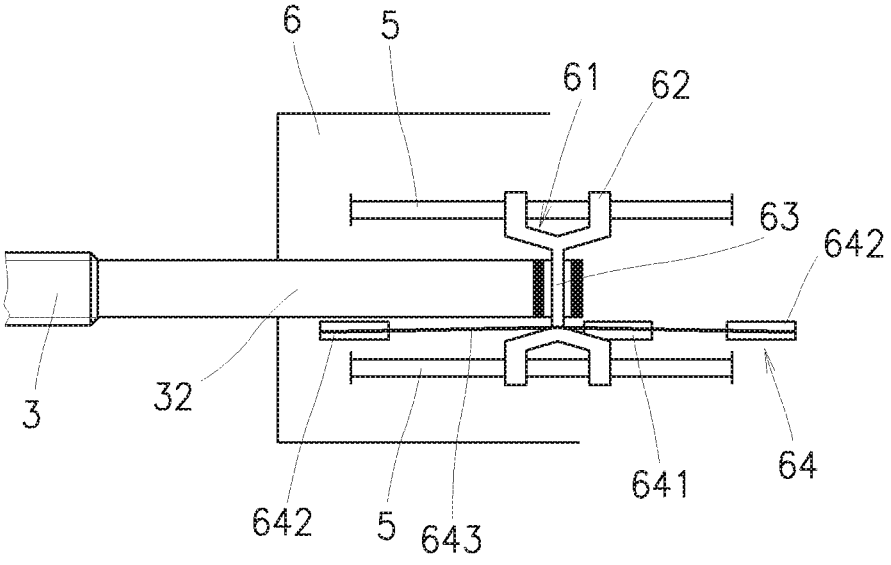

6
5
61
62
63
642
3
32
642
5
643
641
64

Fig. 8

DEVICE FOR THE UTILIZATION OF SOLAR ENERGY

TECHNICAL FIELD

[0001] A device for the utilization of solar energy, which contains a row of absorbing members arranged in a rigid lamella, each of the absorbing members containing an optical lens and an absorbing means coupled to it in an optical axis.

BACKGROUND ART

[0002] Recently in the field of the utilization of solar energy the focus of investors' interest has been moving from large-scale high performance ground-mounted photovoltaic plants to smaller units suitable to be used as a source of electrical energy or a heat source for heating and providing domestic hot water for houses, guest houses, swimming pools and the like.

[0003] Common for such uses are devices illuminated by the sun, whose rays hit directly the surface of the absorbers—that is photovoltaic panels or heat exchangers to heat water. The performance of such a device is determined by the angle of incidence of rays on the surface of the solar panel. If the sun rays fall perpendicularly on the irradiated surface, the reflection of the rays is minimum. With regard to the changing position of the sun in the sky, absorbers are adjustable in relation to the solid ground so that, if possible, the required angle of incidence of the rays will be maintained. In most cases, adjustment of absorbers takes place automatically depending on the position of the sun. This fundamental technical task, which is essential for the utilization of solar energy,—adjustment of absorbers—is solved, for example, by document CZ 297801 B6.The aim of the solution according to document CZ 284185 B6 is to increase the efficiency of the utilization of solar energy by concentrating rays on the surface or surfaces of a "solar window", in whose frame is mounted an absorber tube, whereby between the sun and the frame is arranged a raster planar system of optical converging lenses. Their focal length determines the distance of the system of lenses from the surface of the absorber tube. By shifting the absorber tube its tubes get outside of the focal point of the lenses and the main part of the incident solar energy enters the space behind the absorber, directly heating this space.

[0004] These and similar devices are above all complex, but at the same time they are single-purpose. Document CZ 302600 B6 discloses a substantial simplification of the optical system. The lenses are mounted in mutually transverse rows in a planar bending-deformable carrying means or in vertical or horizontal lamellas. If the carrying means is transparent, the lenses are, for example, glued to its entire surface; if it is not transparent, the lenses are glued by their edges in corresponding cut-out holes. The optical means is simple, therefore also inexpensive and it can be easily moved or transferred, folded, rolled etc. The disadvantage is the fact that the exact adjustment of the position of the optical axes of the lenses according to the direction of the incident sun rays is difficult, which reduces the efficiency of the device. The aim of the invention is to increase the efficiency of the device for converting the energy of concentrated solar radiation into electrical energy and/or thermal energy.

Principle of the Invention

[0005] The goal of the invention has been achieved by a device for the utilization of solar energy, whose principle consists in that absorbing members are mounted oscillatingly in a support bar of a lamella, which is fixedly mounted in a longitudinal frame, whereby in relation to the support bar the absorbing members are jointly deflectable by means of a movable guide bar, which is arranged below the support bar of the rigid lamella and coupled to the absorbing means.

[0006] At the same time, it is advantageous if a guide bar for deflecting the absorber is driven in relation to the longitudinal frame in one direction or the other by at least one drive mechanism. As a result, the absorbing member can observe the position of the sun and adapt to it by adjusting its position according to it.

[0007] The absorbing means contains at least a photovoltaic cell, which is preferably located outside of the focal point of the lens, particularly preferably in front of the focal point of the optical lens. Thus, the photovoltaic cell is protected from undesired overheating which would occur at the focal point of the lens, whereby in the position in front of the focal point of the lens, a large amount of light falls on it regardless of another alternative arrangement of the absorbing means.

[0008] The absorbing means can also contain at least a heat exchanger tube to heat a liquid or gaseous medium, whereby it can at the same time carry also a photovoltaic cell. In that case, it is possible to utilize simultaneously or alternately the conversion of the solar energy into electrical energy or into thermal energy.

[0009] The heat exchanger tube is preferably located at the focal point of the optical lens, where maximum solar energy can be utilized without a danger of overheating the tube or the heat transfer medium.

[0010] The absorbing means can also contain at least the end of fiber optic waveguide for the entry of solar radiation. This extends the possibilities of the utilization of solar energy even after it has been converted into light energy.

[0011] Individual longitudinal frames are arranged in the main frame, in relation to which they are oscillatingly adjustable about the axes which are parallel to the longitudinal axes of the rigid lamellas. Thus the absorbing means can adapt to the sun in two directions.

[0012] Preferably, the longitudinal frames are arranged in a common planar surface, which allows to adjust the position of the absorbing members according to the sun.

[0013] If the space where the device for utilization of solar energy is located does not enable to arrange the longitudinal frames on a common planar surface, it is necessary to adjust their position, for example, to the terrain. The control of the position of the absorbing members in individual longitudinal frames is then adapted to this position of the longitudinal frames.

DESCRIPTION OF DRAWINGS

[0014] An example of embodiment of an improved device for the utilization of solar energy is schematically represented in the drawing, where

[0015] FIG. **1** is a lateral view of a row of photovoltaic elements with optical means in a basic position;

[0016] FIG. **2** shows a plan view to supplement FIG. **1**;

[0017] FIG. **3** is a view of a lamella in the direction P**1** of its longitudinal axis;

[0018] FIG. **4** is a lateral view of a row of photovoltaic elements with optical means in an inclined position,

[0019] FIG. **5** is a plan view of the element for the utilization of solar energy to heat a liquid medium;

[0020] FIG. **6** is a lateral view in the direction P2 of a detail of the mounting of a heat exchanger tube from FIG. **5**;

[0021] FIG. **7** there is a lateral view of the arrangement of the drive of a guide bar; and

[0022] FIG. **8** there is a plan view for FIG. **7**.

SPECIFIC DESCRIPTION

[0023] A device for the utilization of solar energy is in an example of embodiment according to the invention designed in the form of elongated lamellas which can be used separately, or they can be arranged modularly in continuous large assemblies which have a shape of planar surfaces or, according to the possibilities of the space where they are to be installed, a shape of curved surfaces.

[0024] FIGS. **1**, **2** show the length section of the elongated lamella **1** in the basic configuration. For better understanding, only its substantial components are shown, the other segments are apparent from the view in the direction along the length of the lamella **1** in FIG. **3**.

[0025] A firm part of the lamella is a support bar **11**, which is fixedly mounted in an unillustrated longitudinal frame **10** of the device. The support bar **11** is at both longitudinal ends provided with an edge **111**, in which are hung in a mutual spacing RN individual absorbing members **2**. An absorbing member **2** contains an optical lens **21**, which is in the example of embodiment fixed, for example, with glue into the annulus **22**. The annulus **22** is mounted oscillatingly by two rotating pins **221** in the support bar **11**.

[0026] To the annulus **22** is mounted by four rigid draw bars **23** a bed **24**, in which is fixedly mounted an absorbing element of concentrated solar radiation. In the case of a photovoltaic solar means this element is a photovoltaic cell **25**. In the lower portion of the lamella **1** is arranged in its longitudinal direction a movable guide bar **3**, whose longitudinal edges form hems **31**, in which in mutual distances RV identical with distances RN are oscillatingly mounted beds **24** of photovoltaic cells **25** with the aid of of lateral rotating pins **241**.

[0027] The photovoltaic cells **25** of one lamella are mutually electrically interconnected by conductors **4**.

[0028] The guide bar **3** is with both ends connected to oscillating links **5**. Only the oscillating link **5** at the end of the bar **3** on the right-hand side is illustrated, which is at the same time a rigid component of the drive mechanism **6** (FIGS. **7**, **8**).

[0029] In the illustrated example of embodiment, the support bar **11** of the lamella **1** is made with a U-type profile, analogically to the guide bar **3**.

[0030] In an unillustrated embodiment, the lamella may be designed as a substantially planar elongated plate allowing the swinging mounting of the lenses **21**. In this case, the lenses **21** are disposed in the elliptical openings in this planar plate, which do not block the lens in its inclined position with the sun rays falling in an oblique direction. If the lens **21** is made of plastic, it does not have to be inserted in the annulus **22**. The draw bars **23** carrying the bed **24** for mounting the photovoltaic cell **5** and the lateral rotating pins **221** are cast directly in the material of the plastic lens.

[0031] FIGS. **5** and **6** show a modification of the device—a solar collector heat exchanger, which is used, for example, for heating water or air or another liquid.

[0032] The bed **24** for mounting the photovoltaic cell **25** from FIGS. **1** to **4** is replaced by a hinge **7** of the heat exchanger tube **71**, which is, for example, a metal tube or hose made of a suitable heat conducting material. The hinge **7** carried by the draw bars **23** has a shape of the letter "H" in the plan view in FIG. **5**, whereby it is oscillatingly mounted in the guide bar **3** by lateral rotating pins **72** analogically to the bed **24** for mounting the photovoltaic cell **25** by the lateral rotating pins **241**. In the crossbar of the hinge **7** is mounted a flexible partially opened sleeve **73** for simple fixation of the longitudinal straight heat exchanger tube **71**.

[0033] The principal difference between the arrangement of the photovoltaic solar collector and a heat exchanger solar collector is the distance of the lens and the absorbing means itself, i.e. the photovoltaic cell **25** or the heat exchanger tube **71**. While the heat exchanger tube **71** is preferably located at the focal point of the optical lens **21**, where the device has the greatest efficiency, the photovoltaic cell **25** is situated outside of the focal point of the optical lens **21**, in an exemplary embodiment in front of the focal point of the optical lens **21**. This is necessary due to the material of the photovoltaic cell **25** itself, which is not able to withstand overheating by the high temperature of the radiation concentrated at the focal point. Moreover, in the position in front of the focal point of the optical lens **21** greater absorption of sun rays is utilized. In addition, the device enables easy replacement of one photovoltaic absorbing means **20** with a heat exchanger tube **71**, whereby it is possible to use in one absorbing means **20** simultaneously a photovoltaic cell **25** as well as a heat exchanger tube **71**.

[0034] The above-mentioned device according to the invention can be further used at least partially for the conversion of solar energy into light energy. In an unillustrated embodiment, the end of a fiber optic waveguide is in this case located at the focal point of the lens or in the vicinity of the focal point of the lens **21** of at least some absorbing members **2**. The fiber optic waveguide can be, for example, provided with an inner reflective layer blocking lateral irradiation of light and it can be used for lighting, for example, dark spaces, in which the light from the fiber optical waveguide is irradiated to facilitate the orientation of moving persons. The fiber optical waveguide with lateral light radiation, at least in a part of its length not provided with an inner reflective layer, can be also used for orientation in corridors and hallways or, for example, for glowing advertising signs and the like.

[0035] The movement of the moving guide bar **3** is carried out by at least one drive mechanism **6** according to FIG. **7**. Both rigid ends **32** of the guide bar **3** are in a longitudinal direction substantially oscillatingly mounted relative to the longitudinal frame **10**. The end of the guide bar **3** is connected to the drive mechanism **6** by means of a slider **61**, which has a shape of the letter "H" in the plan view (FIG. **8**). The slider **61** is by means of its four lifting lugs **62** slidingly mounted on a pair of guide oscillating links **5**, whereby the connecting pin **63** of the slider **61** is connected to the driving means **64** of the drive mechanism **6**. In an example of embodiment, the drive means **64** contains a belt gear with a drive pulley **641** mounted on a shaft of an unillustrated bidirectional rotary motor, with two guide

pulleys **642** and an endless belt **643**, which is oscillatingly connected to the connecting pin **63** of the slider **61**. In an unillustrated embodiment, the driving means contains cable gear or chain gear instead of belt gear, optionally it can be formed by worm gear.

[0036] An unillustrated other end of the movable guide bar **3** (not shown) is mounted without the driving means **64** analogically to the end driven by means of the oscillating links **5** and the slider **61**. In an alternative unillustrated embodiment, the non-driven end of the movable guide bar **3** is suspended in relation to the longitudinal frame **10** by means of a pendulum in such a manner that it moves along a curve corresponding to the curvature of the oscillating links **5** similarly to the piston rod of a double-crank four-joint mechanism (parallelogram). It is apparent that in the case of a great length of the movable guide bar **3** synchronous drive mechanisms **6** may be at both its ends.

[0037] Individual elongated lamellas **1** are in the basic arrangement located next to each other, thus constituting substantially a planar surface. This planar surface may be rigid in an unillustrated common frame, whereby, the absorbing members **2** are arranged movable towards it in the above-described manner by means of rotating pins **221**, the absorbing members **2** swinging about axes perpendicular to the longitudinal axis of the support bar **11**. Individual lamellas **1** may be arranged as blinds, which in relation to the common frame oscillate about longitudinal axes of the lamellas **1** in the same mutual direction according to a method known from the background art, such as from document CZ 302600 B6.

[0038] The operation of the drive mechanism **6** is initiated by an unillustrated per se known sun-tracking device, whose information give signals for turning the drive motor of the driving means **64**. The driving means **64** shifts the slider **61** by means of an endless belt **643** in one or the other direction on the oscillating links **5**, whereby the guide bar **3** shifts in a direction parallel to the rigid support bar **11** by the distance X, whereby it changes its distance Y from the support bar **11**. Thus, around the pins a respective row of absorbing means of one lamella **1** is inclined so that the direction of their optical axes will get to the current direction of the incident rays. If it is a heat exchanger solar collector, also the heat exchanger tube **71** moves with the guide bar **3**, the ends of heat exchanger tube **71** being in the case of using the tube connected to the entire exchanger circuit by a flexible hose.

[0039] In an unillustrated embodiment, the bed **24** of the photovoltaic cell **25** and the hinge **7** of the heat exchanger tube **71** have a common universal shape, which allows to connect to it either the photovoltaic cell **25**, or the heat exchanger tube **71**. This versatility enables the user to relatively easily convert a photovoltaic system into a heat exchange system, e.g., depending on the season or in inaccessible areas, for instance even in space. An advantageous mutual position of the lens **21** and the photovoltaic cell **25** or the heat exchanger tube **71** can be implemented by an inserted sleeve **73** for securing the heat exchanger tube **71** or by setting the length of the draw bars **23**, which can be mounted in the annulus **22** of the lens **21**, or in the plastic lens, or in the bed **24** of the photovoltaic cell **25** by using high frictional forces, which cannot be overcome without intentionally applying external force.

[0040] The advantage of the device according to the invention is concentration of solar energy into the absorbing means **20**, which may be either a photovoltaic cell **25** or a heat exchanger tube **71**, or simultaneously both these types of absorbing means. The device enables continuous adjustment of the position of the absorbing means **20** according to the current position of the sun in the sky. In addition, the device contains relatively simple and inexpensive components, which makes it easy to replace them separately after being damaged, in contrast to, for example, large-scale panels. Also, the costs of the recycling of the device and its parts are considerably lower.

LIST OF REFERENCES

[0041] **1** lamella
10 frame of the device (longitudinal)
11 support bar (of the lamella)
2 absorbing member
20 absorbing means
21 lens (of the absorbing element)
22 annulus (of the lens)
221 pivot (of the annulus)
23 draw bar (joint of the annulus and the bed of the photovoltaic cell or the tube hinge)
24 bed of the photovoltaic cell
241 lateral pins (beds of the photovoltaic cell)
25 photovoltaic cell
3 guide bar (movable)
31 edge of the guide bar
32 end of the guide bar
4 conductors (electric)
5 oscillating link (guide oscillating link for the guide bar)
6 drive mechanism (of the guide bar)
61 slider
62 lifting lug (of the slider)
63 connecting pin (of the slider)
64 drive means
641 drive pulley (of the driving means)
642 guide pulley (of the driving means)
644 endless belt (of the driving means)
7 hinge (of the heat exchanger tube)
71 heat exchanger tube
72 lateral rotating pin (of the hinge of the heat exchanger tube)
73 sleeve (of the heat exchanger tube)
RN mutual distance (of the absorbing members **2** in the support bar)
RV mutual distance (of the absorbing means **20** in the guide bar)
X distance (spacing between adjacent absorbing elements)
Y distance of the guide bar from the support bar of the guide bar from the support bar (when changing the position of the absorbing elements)

1. A device for the utilization of solar energy which contains a row of absorbing members (**2**) arranged in a rigid lamella (**1**), each of which contains an optical lens (**21**), to which is coupled an absorbing means (**20**), characterized in that the absorbing members (**2**) are mounted oscillatingly in a support bar (**11**) of the rigid lamella (**1**) mounted in a longitudinal frame (**10**), the absorbing members (**2**) being jointly deflectable in relation to the rigid lamella (**1**) by means of a movable guide bar (**3**), situated below the support bar (**11**) of the rigid lamella (**1**) and coupled to the absorbing means (**20**).

2-14. (canceled)

* * * * *