Device for utilisation of solar energy

Technical field

The invention relates to a device for utilisation of solar energy, especially for its conversion into heat or electric energy, comprising an absorber of solar energy and before it arranged optical means for concentration of solar energy, which comprises a system of side by side arranged optical converging lenses.

Background art

There exists a number of methods how to utilise the solar energy through its conversion into heat or electric energy. The economy of these devices depends on efficiency of this energetic transformation, whose increasing enables to reduce relatively large surfaces absorbing the solar radiation. This positively results in a smaller dimension of built-up areas, reduction of purchase costs, thus also reduction in costs for such obtained energy.

Very frequent way how to eliminate losses arising between the entry surface of energetic device, to which the sun beams fall, and the space of absorber of solar energy, is utilisation of optical means concentrating and directing the parallel sun beams behind the entry surface of the device.

Patent CZ 250255 B1 discloses a solar concentration device comprising a quantity of systems of one after another in concentric manner positioned converging lenses whose curve radius and diameter are reducing in direction of incident solar radiation. In each system, the lenses are mutually controllably rotating and shifting, whereas the systems are controllably moving also towards the frame and in it positioned absorber. Complication and from it resulting unreliability is not obviously balanced with the profit arising from increasing of the device efficiency.

CZ 250882 B1 utilises a large-surface linear raster lens, whose entry surface is a planar one and the exit surface is provided with a raster of the Fresnel type. Geometric arrangement of raster elements requires a high

accuracy to shape and an optimum fixed directing of the whole device towards the north-south direction.

Solar jalousie window according to the utility design CZ 2924 U and according to the patent CZ 284185 B6 consists of fixed positioned raster lenses and of an inner moving frame, in which there are installed a tube absorbers laying in foci of the lenses. By change in position of the frame the tubular absorbers move outside the foci of the lenses and the main portion of incident solar energy shifts into the space behind the absorber, thus it serves also to a direct heating of this space. A common disadvantage of the two last solutions is a complicated space arrangement securing an exact position of optical system with respect to the absorber.

The solar panel according to CZ 19748 U1 comprises a body made of thermal insulating material, in the body there are inserted the transmission bodies with stepped shank of highly heat conductive material. The shanks of transmission bodies are directed to a carrier of optical system formed of a system of convex optical lenses. The foci of lenses are to be found in area of the shanks. Relatively small entry surfaces of shanks of transmission bodies are demanding as to exact positioning, directing and fixing of optical lenses.

Transparent plate for solar collector according to DE 9401964 U1 is made of glass or plastic. Surface of the plate directed to the sun is provided with one or more lenticular massive bodies preferably in the shape of hemisphere. The lower planar surface of the plate abuts without a gap to the collector heat exchanger.

DE 29518303 U1 describes arrangement of a system for directing of the optical lenses from a section of a different focal distance in combination with mirrors positioned in different distances from the central absorber. Entry surface of collector is composed of individual regular modular hexagons, out of which each comprises several lenses.

DE 102007035384 A1 proposes also similar solution comprising system of lenses, thermal absorption system and thermal reservoir with accessories. System of lenses is arranged in a fixed manner in a wall of a box, and further parts of the device are arranged in vacuum inside the thermally insulating box.

Focal distances of lenses are chosen so that all foci are laying in the area of graphite insertion absorbing the radiation in this thermal absorption system.

In a fixed manner positioned lenses arranged in relatively spacious tabular bodies predetermine these means to be used in stabile single-purpose solar collectors.

The goal of this invention is to remedy disadvantages of the background art and to create means concentrating the solar energy, which can be temporary or permanently positioned, as the need may be, for example into a vicinity of glass walls of dwelling spaces and/or before the entry surfaces of solar collectors. The purpose is to activate and de-activate this means in a simple and comfortable manner according to actual level of solar radiation and/or according to actual utilisation of the space with which this means is neighbouring functionally.

Principle of the invention

The goal of the invention has been achieved through the device for utilisation of solar energy, whose principle consists in that the optical means for concentration of solar energy is arranged reversibly adjustably between the position in front of absorber of solar energy and outside absorber of solar energy, whereas the optical means for concentration of solar energy is in the advantage embodiment formed of system of lamellas, in which there are mounted the optical converging lenses, or of a surface bending-deformable carrying means, on which or in which there are mounted the optical converging lenses in systems arranged in transverse rows.. Such device is able by means of optical converging lenses to concentrate the solar energy into places of lenses' foci, it is structurally simple, cheap and it could be easily relocated. The surface bending-deformable carrying means is usually manipulated as a whole and the lenses are at this embodiment positioned on a large surface.

Lamellas may be formed of a solid transparent material or are formed of a frame in which the lenses are mounted by their edges. Lamellas may also comprise a frame, in which the lenses are mounted by means of at

least one auxiliary carrying means. In another possible embodiment the lamellas are formed of a textile or a foil and are at least by their upper end mounted in a travel track.

In advantage embodiment the lamellas are coupled with means for their turning towards the radiation source.

To better secure the mutual position of lamellas it is advantageous if the lamellas are mutually rotatably connected on their longitudinal edges or on their ends, and due to this they can be adjusted towards the radiation source and gathered at least to one edge of the system of lamellas.

Lamellas in which the optical lenses are positioned represent one of possible embodiments of optical means for concentration of solar energy. Their advantage is that they can be easily handled and stored, while their disadvantage is relative complication arrangement of lamellas into a system, and in some embodiments also complication in controlling such system of lamellas. On the contrary, they enable turning of lamellas according to angle of incident radiation.

The lenses may be connected by their edges with the surface bending-deformable carrying means. At this embodiment it is not necessary that the surface bending-deformable carrying means is transparent, because the light may pass at least through the lenses.

Transparency of the surface bending-deformable formation is necessary in embodiments of invention, when the optical converging lenses are with the surface bending-defermable carrying means connected by their optical surface or are mounted between two transparent foils, while the last embodiment can be easily produced for example by simple welding a couple of foils in a space between the lenses.

For an easy transfer of the device according to the invention from the working position, in which the solar energy is concentrated, into the standby or rest position it is advantageous, if the surface bending-deformable carrying means can be wound. Such carrying means can easily be wound on a rotating cylindrical carrier or it can be moved to the ceiling, under the floor of the room or

to side walls, whereas the surface bending-deformable carrying means bends by approximately 90 ° and copies the shape of the room.

For some applications it is advantageous, if the system of optical converging lenses comprises the lenses of at least two different focal distances.

At the same time the optical converging lenses may be made of glass or plastic.

To strengthen the surface bending-deformable carrying means there are arranged reinforcing means in gaps between the optical converging lenses in direction of width or length of the surface bending-deformable carrying means , whereas the reinforcing means may be formed of reinforcing slats.

At embodiments of the device, which do not require bending of the surface bending-deformable carrying means on a small radius, it is advantageous especially for fixation of lenses in rows, if the reinforcing slats have a profile of „X“ shape, and the lenses are leaning on the bottom of supporting grooves in the „X“ profile.

In advantage, the reinforcing slats are flexible.

Description of the drawing

Exemplary embodiments of the invention are schematically represented in the drawing, where Fig. 1a, 1b show an optical means formed of the surface bending-deformable carrying means with identical lenses in various arrangements, Fig. 2 a view to optical means with the surface bending-deformable carrying means with lenses of various diameter and various focal distances and with transverse reinforcing slats, Fig. 3 cross-section A-A of the embodiment according to Fig. 1b with one transparent surface bending-deformable carrying means, Fig. 4 cross-section A-A of the embodiment according to Fig. 1b with two transparent surface bending-deformable carrying means, Fig. 5 cross-section B-B of embodiment according to Fig. 2 comprising reinforcing slats, Fig. 6 cross-section of embodiment with reinforcing slats with profile of „X“ shape, Fig. 7 detail of mutual arrangement of lenses and the reinforcing slat with profile of „X“ shape from Fig. 6, Fig. 8a vertical arrangement

of device in the form of vertical lamellas in working position, Fig. 8b vertical arrangement of device according to Fig. 8a in standby shifted off and folded position, the Fig. 8c embodiment of lamella comprising a frame, in which the lenses are mounted, Fig. 8d embodiment of lamella comprising a frame, in which the lenses are mounted by means of auxiliary carrying means, Fig. 8e embodiment of lamella formed of transparent plastic foil, Fig. 9 examples of application of device in embodiment according to Fig. 1b in dwelling space, and Fig. 10 shows a cross-section C-C from Fig. 9.

Examples of embodiment

In connection with expansion of utilisation of alternative sources of energy, at present the development focuses especially on utilisation of wind and solar energy. Opponents against solar energy among others argument with a large area of land, which is required for installation of devices at higher performance. This regards not only the lots for photovoltaic power stations, but also larger roof or wall devices for heating the water, possibly for exchanger heating systems. Therefore the prerequisite is to achieve the highest efficiency of the device. This endeavour leads to production of a device for utilisation of solar energy, which comprises an absorber **A** of solar energy, in front of which there is arranged an optical means **OM** for concentration of the solar energy, which comprises a system of optical converging lenses **1**. According to the invention, the optical means **OM** for concentration of solar energy is arranged reversibly adjustably between the position in front of the absorber **A** of solar energy, i.e. so called working position, and the position outside the absorber **A** of solar energy, in i.e. so called standby position, in which it is wound or shifted off outside an entry surface of the absorber **A**, as it is represented in Fig. 9. Optical means **OM** for concentration of solar energy may be installed between the source of solar radiation, this is the Sun, and the absorber **A** of solar radiation. It is apparent that the absorber **A** may be formed of a liquid exchanger of heating or of the entry surface of photovoltaic cells. The absorber may also be formed of inner space of a room, as it is represented in Fig. 9, where behind one window there is installed the absorber **A** formed of liquid

exchanger or photovoltaic cell and further three windows are provided with optical means **OM**.

As represented in Fig. 10, the optical means **OM** is mounted between the window **W** and the absorber **A** of solar energy. In the most advantageous embodiment the active surface of the absorber **A** lies in focal distance **f** of lenses **1** of the optical means **OM** or close to this value. The foci **F** of individual lenses **1** of optical means **OM** in case of usage of the lenses **1** with the same focal distance lie on active surface of the absorber **A** and utilisation of solar energy is maximum.

Optical means **OM** for concentration of solar energy may be formed of system of lamellas **2**, in which there are positioned optical converging lenses **1** or the surface bending-deformable carrying means **3**, on which or in which the optical converging lenses **1** are mounted.

System of lamellas **2** with optical converging lenses **1** is represented in Fig. 8a in unwound status, which corresponds to the working position, and in Fig. 8b in wound up status, which corresponds to the standby position. At this embodiment the lamellas **2** may be formed of a solid non-transparent or transparent material, for example of a plastic plate, and the lenses **1** are mounted in lamellas **2** by their circumference in some of the known methods. In the represented embodiment the lamellas **2** are mutually rotatably connected on their longitudinal edges by means of some of the known methods and on their ends are provided with conductors **20** for mounting into a known not represented guidance, similarly like the folding door, so that they can be folded outside the absorber into the standby position represented in the Fig. 8b. Another system of mutual connection of lamellas **2** is the jalousie-like, when there are mutually connected at least the edges of upper ends of neighbouring lamellas **2**, which enables their turning with respect to the source of radiation as well as their shifting into the standby position.

Lamellas **2** may also be formed of the frame **21**, as it is represented in Fig. 8c and 8d. In embodiment according to Fig. 8c the lenses **1** are mounted in the frame **21** by their edges and in places of contact are by these edges also mutually connected. In embodiment according to Fig. 8d the lenses **1** are

connected with the frame **21** and mutually by means of auxiliary carrying means **22**. In the not represented embodiment these auxiliary carrying means **22** are formed of a foil or textile fixed in the frame **21**, with which the lenses **1** are connected by their edges, or by one or both optical surfaces. In one of the advantageous embodiments the auxiliary carrying means **22** is formed of two transparent plastic foils, which are at least in gaps between the lenses **1** mutually connected, whereas they may be mutually connected also on their edges.

In example of embodiment according to Fig. 8e the lamellas **2** are formed of at least one transparent plastic foil **23**, in which and/or on which the lenses **1** are mounted. Such lamella **2** is at least on its upper end provided with conductor **20** for mounting on a known not represented travel track. In advantageous embodiment the lamellas **2** are formed of two transparent plastic foils **23**, which are on their edges and in gaps between the lenses **1** mutually connected,. The above described jalousie-like system is an optimal one to control the system of lamellas **2** according to Fig. 8e.

Fig. 1 to 7 represent embodiment of the optical means **OM** for concentration of solar energy formed of the surface bending-deformable carrying means **3**, on which or in which the lenses **1** are mounted.

In example of embodiment according to Fig. 1a, 1b and 3 the surface bending-deformable carrying means **3** is formed of one transparent plastic foil **31**, for example made of PVC, PET or PP material, on which are by its one optical surface fixed the optical converging lenses **1**. Between individual rows of optical converging lenses **1** arranged crosswise with respect to the carrying means **3** there are gaps enabling folding of optical means **OM**. Optical converging lenses **1** are produced by any known method from glass or plastic and in case of need they may be also hollow and filled with liquid. In embodiment according to Fig. 1a the lenses **1** are arranged in rows in transverse direction of the carrying means **3**, whereas the neighbouring rows are offset by a half of pitch between the lenses **1**. This embodiment reduces the distance between the rows of lenses **1**, which results in worse ability of the whole optical means **OM** to fold . In embodiment according to Fig. 1b the lenses

1 are arranged in transverse rows and longitudinal columns. Distances between the transverse rows of lenses **1** are greater than in previous embodiment and the optical means **OM** is better foldable.

In example of embodiment according to Fig. 1a, 1b and 4 the surface bending-deformable carrying means **3** is formed of two transparent plastic foils **31**, **32**, between which the lenses **1** are mounted, whereas the foils **31**, **32** are at least in gaps between the transverse rows of lenses **1** mutually connected. More stabile position of lenses **1** in optical means **OM** is achieved by mutual connecting of foils **31**, **32** also between the lenses **1** in transverse rows.

Fig. 2 and 5 represent further exemplary embodiment of optical means **OM**, whose surface bending-deformable carrying means **3** is formed of two transparent plastic foils **31**, **32**. Between the foils **31**, **32** there are mounted three various sizes of optical converging lenses **1**, which differ by their diameter as well as focal distance. The foils **31**, **32** are connected in the gaps between the lenses **1**, for example by bonding or heat seal. Moreover in the continuous transverse gaps between the rows of configurations of optical converging lenses **1** are in the same manner are fixed the reinforcing means **33**, which prevent undesired lateral deformation of the carrying means **3** upon its winding on a cylindrical or other suitable carrier and upon its unfolding. Diameter and focal distance of the used optical converging lenses **1** is selected according to the purpose and technological parameters of the space where they are to be used. There may be used one size of lenses **1** with the same focal distance or one size of lenses **1** with various focal distance, or various size of lenses **1** with identical or various focal distances. Number of types of lenses **1** in one optical means **OM** is not restricted in any way.

In the not represented example of embodiment the optical converging lenses are arranged in the same manner as in Fig. 1 and 2, but they are at their peripheral sections mutually connected by means of known connecting means, or they are by their edges connected with the carrying means and so they create the surface bending-deformable carrying means. At this embodiment the carrying means may be a non-transparent one.

The reinforcing means **33** may also be of other cross-section, for example an oval, rectangular or triangular.

At example of embodiment according to Fig. 6 the carrying means **3** is formed of two foils **31**, **32** and it comprises reinforcing means **33** formed of reinforcing slats **330** with profile in „X“ shape. This is advantageous from the point of view of securing a permanent space between optical converging lenses **1** of identical diameter in each transverse row. The lenses **1** are in contact with bottoms of supporting grooves of reinforcing slats **330**. By this arrangement between the lenses **1** and reinforcing slats **330** there are created articulated joints enabling their mutual swinging motion at manipulation with optical means **OM**. Angle of possible mutual swinging of lenses **1** and the reinforcing slats **330** is given by the angle **331** of opening of supporting grooves of the reinforcing slat **330** and the angle **11**, which form the tangential planes to the convex surfaces of optical converging lens **1** in place of circumference of this lens **1**, as represented in detail in Fig. 7. In represented embodiment the angle **331** of opening of supporting grooves of reinforcing slat **330** equals to 75^{o} and angle **11**, which form the tangential planes to convex surfaces of the optical converging lens **1** in place of circumference of this lens **1** equals to 30^{o}. The arms creating a supporting groove of the reinforcing slat **330** may be flexible.

Embodiment according to Fig. 6 and 7 is advantageous for usage in places, where the carrying means **5** is not wound on a carrier, but the carrying means **3** with lenses **1** is only shifted off outside the working position similarly like e.g. at lamella garage doors.

Optical converging lenses **1** may be produced of glass or plastic, while simultaneously they may be filled or hollow, possibly hollow being filled with liquid, in advantage with oil. Individual lenses **1** or a group of lenses, in a case of need, may be exchanged or replaced by others.

Optical means **OM** of the device for production of solar energy according to the invention, at the time when it is not used, is folded or shifted off into the non working standby position outside the window or outside the entry surface of the absorber **A** of solar energy, for example of solar heat or photovoltaic collector. In working position the optical means **OM** overlays the surface of

absorber **A** , whereas in this position concentrates the sun beams into foci **F** of optical converging lenses **1**. The foci **F** are situated either in inner space of the room to be heated or in the place of active surface of the absorber **A** of solar energy.

Difference of focal distances of various lenses contributes to improvement in efficiency of energetic conversion by means of the described device comprising the proposed optical means, which substantially reduces losses caused by change in direction of sun beams incident on surface of the optical means due to motion of the Sun on the sky. Moreover, the structure of optical means is relatively cheap, when not in service it is storable and it enables less expensive mass production, storage, transport, as well as installation of the final device. Through this it is also suitable for already existing facilities and their sections.

Industrial applicability

The device according to this invention may be used for utilisation of solar energy on already existing or new buildings or objects, both designed for dwelling, industrial purposes, production of energy, heating of water, etc.

CLAIMS

1. The device for utilisation of solar energy, especially for its conversion into heat or electric energy, comprising an absorber (A) of solar energy and in front of it arranged optical means (OM) for concentration of solar energy, which comprises a system of side by side arranged optical converging lenses (1), **characterised in that, the** optical means (OM) for concentration of solar energy is arranged reversibly adjustably between the position in front of absorber (A) of solar energy and outside absorber (A) of solar energy, whereas the optical means (OM) for concentration of solar energy is formed of system of lamellas (2), in which there are mounted the optical converging lenses (1), or of a surface bending-deformable carrying means (3), on which or in which there are mounted the optical converging lenses (1) in systems arranged in transverse rows.

2. The device according to the claim 2, **characterised in that, the** lamellas (2) are made of solid transparent material.

3. The device according to the claim 2, **characterised in that, the** lamellas (2) are formed of frame (21), in which the lenses (1) are mounted by their edges.

4. The device according to the claim 2, **characterised in that, the** lamellas (2) comprise the frame (21), in which the lenses (1) are mounted by means of at least one auxiliary carrying means (22).

5. The device according to the claim 5, **characterised in that, the** auxiliary carrying means (22) is formed of two transparent plastic foils, which are at least in gaps between the lenses (1) mutually connected.

6. The device according to the claim 2, **characterised in that, the** lamellas (2) are formed of at least one transparent plastic foil (23), in which and/or on which there are mounted the lenses (1) and they are at least on their upper end provided with conductors (20) for mounting in a travel track.

7. The device according to the claim 7, **characterised in that, the** lamella (2) is formed of two transparent plastic foils (23), which are on their edges and in gaps between the lenses (1) mutually connected.

8. The device according to any of the claims 2 to 8, **characterised in that, the** lamellas (2) are coupled with means for their turning towards the source of radiation.

9. The device according to any of the claims 2 to 9, **characterised in that, the** lamellas (2) are mutually rotatably connected on their longitudinal edges or on ends.

10. The device according to the claim 10, **characterised in that, the** lamellas (2) can be wound to at least one edge of the system of lamellas (2).

11. The device according to the claim 12, **characterised in that, the** optical converging lenses (1) are with the surface bending–deformable carrying means (3) connected by their edges.

12. The device according to the claim 12, **characterised in that, the** surface bending–deformable carrying means (3) is formed of transparent plastic foil (31).

13. The device according to the claim 14, **characterised in that, the** lenses (1) are with the transparent plastic foil (31) connected by their optical surface.

14. The device according to the claim 12, **characterised in that, the** surface bending–deformable carrying means (3) is formed of two transparent plastic foils (31, 32).

15. The device according to the claim 16, **characterised in that, the** transparent plastic foils (31, 32) are mutually connected at least in gaps between the transverse rows of lenses (1).

16. The device according to any of the claims 12 to 17, **characterised in that,** at least in gaps between the transverse rows of optical converging lenses (1) there are arranged the reinforcing means (33).

17. The device according to the claim 18, **characterised in that, the** reinforcing means (33) are formed of reinforcing slats (330), which have profile of „X“ shape, whereas the optical converging lenses (1) in one gap between the reinforcing slats (330) lean on the bottoms of supporting grooves formed of the „X“ profile of the reinforcing slats (330), whereas angle of opening of the supporting grooves of the reinforcing slat (330) is larger than the angle of tangential planes to convex surfaces of the optical converging lenses (1) in the place of their circumference.

18. The device according to the claim 18 or 19, **characterised in that, the** reinforcing means (33) are flexible.

19. The device according to any of the previous claims, **characterised in that, the** optical converging lenses (1) are divided into at least two groups with different focal distance.

20. The device according to any of the previous claims, **characterised in that, the** optical converging lenses (1) are made of glass or plastic.

Abstract

Title of the invention: **Device for utilisation of solar energy**

The invention relates to the device for utilisation of solar energy, especially for its conversion into heat or electric energy, comprising an absorber (A) of solar energy and in front of it arranged optical means (OM) for concentration of solar energy, which comprises a system of side by side arranged optical converging lenses (1), whereas the optical means (OM) for concentration of solar energy is arranged reversibly adjustably between the position in front of absorber (A) of solar energy and outside absorber (A) of solar energy.