A line-focus type solar collector unit (10, 110) comprising one or more trough-like concentrator or reflector (12, 112, 142, 144) and a longitudinal radiation receiver (14, 114, 146, 148) fixed at the focus of each of the one or more concentrator or reflector. The solar collector unit is received within a casing (16, 116, 140) having a transparent sealing panel (18, 118, 150) provided over the aperture of the concentrator or reflector.
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SOLAR COLLECTOR SYSTEM

FIELD OF THE INVENTION

The present invention is generally in the field of solar collectors and more specifically it is concerned with a line-focus type solar collector.

BACKGROUND OF THE INVENTION

The ever growing search for alternative energy sources, in particular so-called "green" energy, i.e. environmental friendly, has yielded a large variety of solar collectors whereby, the sun's radiation is absorbed by collectors and is converted into heat in a fluid heat-transfer medium (liquid or gases).

Solar energy can be converted for useful work or heat by using a collector to absorb solar radiation, allowing much of the sun's radiant energy to be converted into heat, which can then be used directly in residential, industrial and agricultural operations or, converted to mechanical electric power or applied to chemical reactions for production of fuels and chemicals.

A solar collecting system typically comprises a concentrator and a receiver. The concentrator redirects and focuses sunlight on the receiver by using mirrors or lenses, and the receiver absorbs solar radiation and converts it to heat. Solar collectors are of two basic designs, namely, non-focusing and focusing.

Collectors are generally divided into two categories, namely concentrating and non-concentrating, the former being the greater class of collectors. Line-focus collectors are commonly considered for remote community-power systems, military applications, individual factory or commercial building systems or agricultural applications. These collectors must always point towards the sun and don't make use of diffuse and reflected light.
In line-focus collectors, radiation is reflected by a concentrating, mirrored reflector surface onto a radiation absorbing tube.

The most common collector is the line-focus collector with a parabolic trough-like reflective surface. However, this type has some drawbacks. First, the parabolic design is such that the radiation collecting tube extends above the aperture line of the collector, resulting in large dimensions and essentially heavy weight. This design, apart from consuming large space, also renders the solar unit poor wind-load resistant and relatively low durability. Where the radiation collector extends bellow the aperture line of the collector/reflector than the collector is significantly large.

Even more so, the reflector and the radiation receiver are vulnerable and a solar efficiency is highly effected by dirt (dust, sand and other particulate matter) which then require frequent periodic attendance.

It is an object of the present invention to provide an improved line-focus type solar collector wherein the above disadvantages are significantly reduced or overcome.

**SUMMARY OF THE INVENTION**

According to the present invention there is provided a line-focus type solar collector unit comprising one or more trough-like concentrator or reflector and a longitudinal radiation receiver fixed at the focus of each of the one or more concentrator or reflector, the solar collector unit characterized in that it is received within a casing, said casing having a transparent sealing panel provided over the aperture of the concentrator or reflector. The term “aperture” as used herein in the specification may alternatively be used to denote the “opening” or “span” of the concentrator or reflector.

By its preferred embodiment, the reflector is parabolic and the radiation receiver is a longitudinal tube through which a heat absorbing fluid flows.

Still preferably, although not restricted thereto, the solar collector unit is mounted on a sun-tracking mechanism, and wherein there is further provided a sun-
tracking system associated with said sun-tracking mechanism. Where there is provided a sun-tracking mechanism, then the solar collector unit is displaceable at tracking increments of about 2°.

By a preferred design of the present invention, the concentration ratio is defined as:

\[ \frac{X}{P} = 1:4 - 1:15 \]

Where \( X = \) aperture of the collector; and \( P = \) perimeter of radiation receiver.

However, a preferred concentration ratio is between 1:8 to 1:10.

By a preferred embodiment, the radiation receiver is a tube which is preferably received within a glass enveloping tube. Still preferably, a space between the radiation receiver and the glass enveloping tube is evacuated. Preferably, the glass envelope tube is coated with an anti-reflective coating increasing radiation absorption of the radiation receiver and decreasing heat loss from the glass tube.

By one specific and preferred design, the transparent sealing panel is coated with an anti-reflective layer of about 94% to 97% solar radiation transparency, according to solar spectrum air mass 1.5.

In order to increase radiation absorption and to decrease heat loss from the radiation receiver, the latter is coated with a selective solar coating. Preferably, the selective solar coating has emmissivity of about 0.03 to 0.09 at up to 400°C, and solar radiation absorption of about 94% to 99%.

For improving thermal efficiency of the solar collector unit, the casing is preferably thermally isolated.

In accordance with a particular design of the invention, the distance of the collector from the sealing panel is about 8 to 20 mm. A preferred distance was found to be about 10mm.

**BRIEF DESCRIPTION OF THE DRAWINGS**

For better understanding the invention and to show how it may be carried out in practice, some preferred embodiments will now be described, by way of
non-limiting examples only. with reference to the accompanying drawings, in which:

Fig. 1 is an isometric view of a solar collector unit in accordance with an embodiment of the invention, one wall removed for the sake of clarity;

Fig. 2 is a sectional view along line II-II in Fig. 1;

Fig. 3 is a sectional view similar to that of Fig. 2, of a different embodiment of the solar collector unit; and

Fig. 4 is an isometric view of still another embodiment, with one wall of the casing removed for the sake of clarity.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Attention is first directed to Figs. 1 and 2 illustrating a solar collector unit generally designated 10 in accordance with a first embodiment of the invention. The solar collector unit 10 comprises a trough-like reflector 12 and a tubular-longitudinal radiation receiver 14, fixed at a focus of the reflector 12.

The reflector 12 and the radiation receiver 14 are received within a casing 16 fitted with a transparent sealing panel 18 extending over the aperture (designated X in Fig. 2) of the trough-like reflector 12. The panel 18 creates a hot-house effect within the collector unit 10 and thus increases the overall thermal efficiency. Furthermore, the flat panel protects both the reflector 12 and the radiation receiver 14 and is easy to maintain and clean.

Typically, reflector 12 is parabolic and serves also as a concentrator. Furthermore, radiation receiver 14 is a tube through which a heat absorbing fluid flows, as known per se.

Best results have been shown in a solar collector unit wherein the concentration ratio X/P = 1:4 – 1:15.

Where X is the aperture of the reflector, as indicated in Fig. 2, and P is the perimeter of the radiation receiver, namely of the tube 14.

Typical dimensions of the casing 16 seen in the figures are approximately:
Height: 20mm.; Width: 140mm.; Length: as required.
The distance of the collector tube 14 from the sealing panel 18 is about 8 to 20 mm. with a preferred distance was found to be about 10 mm. However, these are dimensions of one preferred embodiment and they may differ depending on a variety of considerations.

The relative compact dimensions of the solar collector unit provide good wind-load resistance, i.e., there is no need to transfer the unit to stow position at windy conditions.

Although not illustrated, the artisan will appreciate that for obtaining best results, it is preferred to mount the solar collector unit 10 on a sun-tracking mechanism, which may be of known design. However, the particular features of the solar collector unit according to the invention are such that tracking increments of about 2° are sufficient to obtain good concentration and thus high thermal efficiency.

Further attention is now directed to Fig. 3 in which a device similar to that of Figs. 1 and 2 is illustrated, in which, for the sake of clarity, like elements were given the same reference numerals shifted by 100.

In order to increase thermal efficiency of the solar collector unit 110, the radiation receiver, namely tube 114 is received within a glass enveloping tube 126. By a preferred design, the intermediate space 128 between radiation receiver tube 114 and enveloping tube 126 is evacuated. Still preferably, the radiation receiver tube 114 is coated with a selective solar coating for increasing radiation absorption and, on the other hand, decreasing heat loss therefrom.

Such a selective solar coating typically has emissivity of about 0.03 to 0.09 at up to 400°C, and solar radiation absorption of about 94% to 99%.

By a preferred embodiment, the transparent sealing panel 118 is coated with an anti-reflective layer of about 94% to about 97% solar radiation transparency, measured at solar spectrum air mass 1.5.

In order to further increase the solar efficiency of the solar collector unit 110, space 132 between a bottom surface of the reflector 112 and the inner
walls of the casing 116 is filled with thermally isolating material such as foam material, rock wool, etc.

In the embodiment of Fig. 4, casing 140 accommodates two reflectors 142 and 144 with two corresponding radiation receiver tubes 146 and 148, respectively. A transparent sealing panel 150 extends over the opening of both reflectors 142 and 144, as seen in the figure.

The other features of this device are essentially similar to those explained in connection with Figs. 1 to 3 with the possible variations as exemplified in Fig. 3.

It will be appreciated by the artisan that the above illustrated embodiments are an example only, and a variety of different configurations, all within the scope of the invention as defined in the appended claims, are possible.

For example, a variety of different shapes of concentrators and reflectors may be provided as well as a variety of radiation receivers and cases. Furthermore, a variety of tracking means may be provided as known in the art. Even more so, different means for increasing the radiation absorption on the one hand and, on the other hand, decreasing heat loss may be provided, as demonstrated hereinabove.
CLAIMS:
1. A line-focus type solar collector unit 10 comprising one or more trough-like concentrator or reflector 12 and a longitudinal radiation receiver 14 fixed at the focus of each of the one or more concentrator or reflector 12, the solar collector unit 10 characterized in that it is received within a casing 16, said casing 16 having a transparent sealing panel 18 provided over the aperture of the concentrator or reflector 12.

2. A solar collector unit according to claim 1, wherein the reflector 12 is parabolic.

3. A solar collector unit according to claim 1, wherein a heat absorbing fluid flows through the longitudinal radiation receiver 14.

4. A solar collector unit according to claim 1, wherein the solar collector unit is mounted on a sun-tracking mechanism, and wherein there is further provided a sun-tracking system associated with said sun-tracking mechanism.

5. A solar collector unit according to claim 4, wherein the solar collector unit is displaceable at tracking increments of about 20.

6. A solar collector unit according to claim 1, wherein the concentration ratio is defined as:

$$\frac{X}{P} = 1:4 - 1:15$$

Where $X =$ aperture of the collector 10; and
$P =$ perimeter of radiation receiver 12.

7. A solar collector unit according to claim 1, wherein the radiation receiver is a tube.

8. A solar collector unit 110 according to claim 7, wherein the radiation receiver is a tube 114 received within a glass enveloping tube 126.

9. A solar collector unit according to claim 8, wherein a space 128 between the radiation receiver 114 and the glass enveloping tube 126 is evacuated.
10. A solar collector unit according to claim 1, wherein the transparent sealing panel 18; 150 is coated with an anti-reflective layer of about 94% to 97% solar radiation transparency, according to solar spectrum air mass 1.5.

11. A solar collector unit according to claim 1, wherein the radiation receiver is coated with selective solar coating increasing radiation absorption and decreasing heat loss therefrom.

12. A solar collector according to claim 11, wherein the selective solar coating has emmisivity of about 0.03 to 0.09 at up to 400°C, and solar radiation absorption of about 94% to 99%.

13. A solar collector unit according to claim 8, wherein the glass envelope tube 126 is coated with an anti-reflective coating increasing radiation absorption of the radiation receiver and decreasing heat loss from the glass tube.

14. A solar collector unit 110 according to claim 1, wherein the casing 116 is thermally isolated.

15. A solar collector unit according to claim 1, wherein the distance of the collector 14; 146; 148 from sealing panel 18; 150 is in the range of about 8 to 20 mm.