



(51) International Patent Classification:
F24J 2/28 (2006.01) *F24J 2/38* (2006.01)

(21) International Application Number:
PCT/TR2009/000115

(22) International Filing Date:
14 September 2009 (14.09.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2009/00196 12 January 2009 (12.01.2009) TR

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,
KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,
NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD,
SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT,
TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ,
TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished
upon receipt of that report (Rule 48.2(g))

(54) Title: TEXTILE BASED AIR HEATER SOLAR COLLECTOR

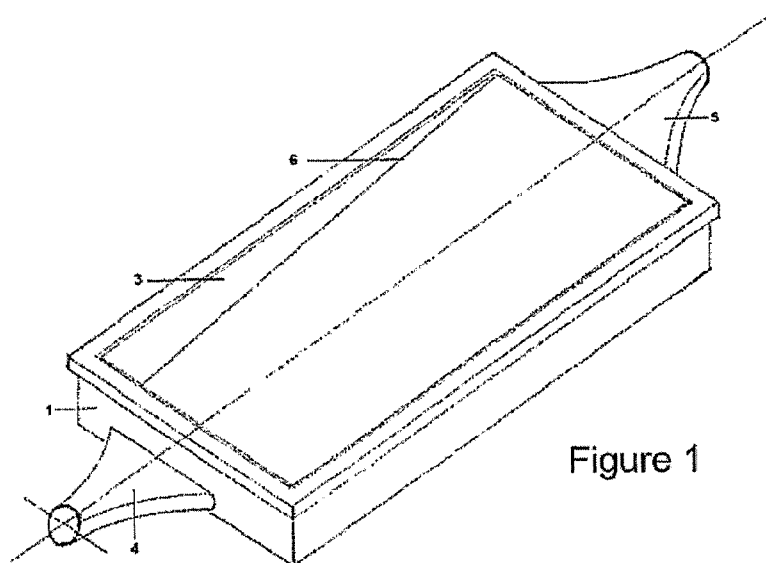


Figure 1

(57) Abstract: In the invented active type textile based air heater solar collector, a black textile surface (fabric) has been used instead of black metallic, ceramic, plastic or composite plates, and passing of the air to be heated through this textile surface has been succeeded. The movement of the air in the collector and the transportation to the space to be heated or drying medium is provided by a fan which is connected to output or input side of the collector. It is also possible to connect 2 fans both input and output sides of the collector. In order to enhance the airflow through the hot fabric, the fabric is placed on a fabric support (7) with a high air permeability, in the rectangular-prism shaped collector box, in which the fabric is placed to the base (2) at the inlet side (4) and is diagonally ascended to the outlet side (5), where it is in contact with the transparent surface (3) while the cold air inlet (4) is situated above the fabric and the hot air outlet (5) situated under it.

TEXTILE BASED AIR HEATER SOLAR COLLECTOR

This invention relates to textile based solar collector that ensures hot air production for heating or drying operations.

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Background of the invention:

Fossil-based fuels are not renewable resources and therefore they will run out after a certain period of time. On the other hand, the global warming occurring by the greenhouse effect due to carbon dioxide emissions generated by the combustion of fossil-fuels has increased the importance of the alternative energy resources.

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Solar energy has the easiest and most common available use in the renewable and clean energy sources such as hydroelectric, solar, wind, geothermal, etc.

Even the solar collectors that enable water heating already have a common use, the solar air heating for space heating and drying purposes are not widespread because of the lower efficiency of these types of solar collectors.

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Air heater solar energy collectors are based on a black-colored metallic, plastic, ceramic or composite plate; placed inside a box in the form of a rectangular prism made of metallic, plastic or composite material. The back and side surfaces of the rectangular box are insulated and the upper surface (sun seeing surface) is covered with a normal or special glass, polycarbonate or other transparent layer.

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The black plate heated by the absorption of high-IR radiation of sun rays, heats the air to a limited extent in the box, in which a green house effect occurs. On the other hand, especially in case of moving air, this is the case in the air heater collectors; the actual heat transfer takes place by convection.

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In the heating through convection, the amount of heat transfer rate is proportional to the surface area of heat transfer. Thus, the majority of the development works and granted patents regarding air heater solar collectors are intended to increase the contact surface area between the air and hot black plate. The heat transfer efficiency is aimed to be increased by several constructions by providing the contact of the air with the both sides of the black plate, using finned plates of one or both sides, perforated plates or special black plates with rough surface structures, creating a meander type passing route for the air to extend the contact path with the hot plate, placing of metallic networks between the transparent layer and the black plate, etc.

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The purpose of the invention:

The purpose of the invention is to increase the heat transfer rate from the black absorber plate to the air to be heated.

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The heat transfer equation is:

$$\dot{Q} = A \cdot \alpha \cdot (T_p - T_A) \quad (1a)$$

$$\alpha = \frac{\lambda}{h} \quad (1b)$$

where,

$\dot{Q}$ is the heat transfer rate,

5 A the surface area participating to the heat transfer (m^2),

α the heat transfer coefficient (W/m^2K),

T_p the temperature of the black plate (K),

T_A the temperature of the air to be heated (K),

λ the thermal conductivity at the boundary layer (W/mK) and

10 h the thickness of the boundary layer.

The surface area of the heat transfer is equal to the surface area of the plate, in case of an air flow parallel to one face of the hot plate. On the other hand, when the air flows by contacting both faces of the plate the heat transfer area doubles.

15 In case of laminar flow parallel to the surface of the black plate, none of the air flow elements are perpendicular to the surface of the plate, and therefore, the air boundary layer (h) to be overcome by convection reaches the maximum thickness and the heat transfer coefficient (α) is less than $50 W/m^2K$. Hence, as aforementioned in the "background of the invention" section, a number of constructions were developed and patented to increase the heat transfer surface area (A) and to reduce the thickness of boundary layer (h), but none of them could provide the optimum heat transfer rate.

Description of the invention:

To reach the objective of the invention, textile based air heater solar collector have been schematized in the attached figures, and these figures present the following:

Figure 1-The front view of the textile based air heater solar collector

Figure 2-The side view of the textile based air heater solar collector

The units in the figures have been numbered and shown below:

- 30 1) Collector outer body
 2) Surface of the collector insulation
 3) Transparent surface
 4) Cold air inlet
 5) Hot air outlet
 35 6) Fabric

7) Fabric support

8) Collector insulation

In this invention, a black textile surface (fabric) (6) has been used on an active type air heater solar collector instead of black metallic, ceramic, plastic or composite plates, and passing of the air to be heated through this textile surface has been maintained. The movement of the air in the collector and the transportation to the space to be heated or drying medium is provided by a fan which is connected to output or input side of the collector. It is also possible to connect 2 fans both input and output of the collector.

In case of passing of the air through the black textile fabric, the air passes through the capillary pores between the fibers, thus the surface area participating to the heat transfer is equal to the total area of the fiber surfaces, namely, much higher compared to the plates with no air permeability. As the air passes through the capillary pores between the fibers instead of a parallel flow to the fabric surface, the thickness of the air boundary layer (h) on the fibers decreases to a minimum, and the heat transfer coefficient (α) exceeds the value of 400 W/m²K.

Warm-up time of the fabrics is a good proof of the increase in the heat transfer rate due to the air flow through the fabrics. The time required to heat a dry fabric up to 200 °C by a hot air of 200 °C is 35 s to 60 s for air flow parallel to the surface of the fabric, and 1 s to 3 s for the airflow through the fabric. During the hot air flow through the fabric, the heat transfer rate ($\dot{Q}$) depends on the temperature and velocity of the air flow and the structure and the temperature of the fabric.

Black or dark colored woven, knitted or non-woven fabrics made by natural, regenerated or synthetic fibers and their blends can be used as textile surface. The heat transfer rate is lower in loose woven and knitted fabrics, because air tends to flow through the pores between the yarns, instead of the capillary pores between the fibers within the yarns. On the other hand the fabrics with very tight structures require higher fan power for air flow through the textile structures. In order to extend the flow path of the air through the fabric, increasing of fabric thickness is useful. However, airflow through a tight and thick woven fabric without piles requires very high fan power. Thus, the optimum results can be provided with piled woven or knitted fabrics or not tight bulky non-woven structures.

The fabric is placed diagonally into the rectangular prism-shaped box (1). At the entry side of the collector fabric is placed to the base (2) and is diagonally ascended through the output side, where the fabric contacts with the transparent surface (3) in order to enhance the airflow through the hot fabric (6) in the collector box.

The collectors are mounted on the roofs facing to the south or placed on the south-facing walls. The cold air inlet (4) to the collector is above the fabric (6), and the hot air outlet (5) stays under

the fabric (6). The air enters at the bottom side of the collector, where the distance (volume) between the fabric (6) and the transparent surface (3) is at maximum. By the blowing (if the fan is located to the air inlet) or suction (if the fan placed to the air outlet) effect of the fan, the air tends to flow to the exit, and due to the decrease of the distance between the fabric (6) and the transparent surface (3) during the movement of the air, the pressure and therefore the flow rate of the air through the fabric increases according to the law of Boyle-Marriott. On this account, by the diagonal placement of the fabric, the air heated by the greenhouse effect between the transparent surface (3) and fabric (6) passes through the hot fabric and enters the exit section between the base (2) and fabric (6). This permeation is higher at the upper side of the collector (close to the air outlet), where the air and the fabric have maximum temperature.

Utilization and applicability of the invention:

Textile based air heater solar collectors can be used anywhere and in the same way for space heating and drying operations, in which the currently available active type solar collectors are used.

CLAIMS

1. A textile based air heater solar collector characterized in that the black or dark colored
woven, knitted or non-woven fabrics made by natural, regenerated or synthetic fibers and
5 their blends instead of black metallic, ceramic, plastic or composite plates is used and the
air flows through this fabric (textile surface).
2. According to Claim 1, a textile based air heater solar collector characterized in that the fabric
(6) on a fabric support (7) with a high air permeability is diagonally placed in the rectangular-
10 prism shaped collector box, in which the fabric is placed to the base (2) at the inlet side (4)
and is diagonally ascended to the outlet side (5), where it is in contact with the transparent
surface (3) while the cold air inlet (4) is situated above the fabric and the hot air outlet (5)
situated under the fabric.

