

Flexible fluid-flow apparatus as sunshade

TECHNICAL FIELD

This invention relates to a low cost flexible apparatus having a fluid-flow configuration for use, inter alia, both as a water-cooled sunshade or sunblind and as a solar water heater.

BACKGROUND ART

Sunlight and the solar heat are undesired in summer and tropic regions. Many buildings in the tropical area have double layer ventilation roofs to reduce the amount of solar heat entering the top rooms. While the roof of a building receives the most intense solar energy, the external walls, particularly those west or east oriented, also receives vast amount of solar energy, especially in the tropics. For a high-rise building, the total area of the sidewall can be many times of that of the roof. When solar energy received by the roof only heats up top rooms, that received by the sidewall heats up all the rooms on that side of the building. It will be ideal if we could block the sunlight from entering the building through windows or even sidewalls to reduce the electricity consumption for air-conditioning.

It has been a long history for human to use sunshade, sunblind or even curtain to block sun light where and when sunlight is not desired. Above many west oriented windows on the HDB flats in Singapore, fixed structures made of concrete or metal sheet are built outside wall to reduce the sunlight entering the windows. Because these structures are fixed, they are small and can only block small part of the sunlight. Still, such fixed structures more or less block the natural light and wind from entering the windows permanently.

In the prior art for sunshades, inventions are mainly on the control of lift and tilt, and rolling or folding of the sunshade assembly in shading the window or part of the building from direct sunlight. The sunshades are cooled through natural ventilation, and reflection of sunlight and emission of infrared waves back to the surroundings. Thus the solar energy is not recovered but goes back to the environment. When sunblind and curtain is installed inside the windows, such heat is kept in the room and consumes electricity for air-conditioning in hot weather.

Systematic use of water flow has been known to be used since ancient times for cooling purposes. For example, it has been recorded that the palaces of the Tang Dynasty in China used water wheel to draw water up to the roof to allow it to flow down to cool the building. A similar technique is still effectively used today. For instance, Singapore Zoological Garden has a roof cooling system for its public toilets whereby water is pumped onto the roof to flow downwardly.

As the water used for such cooling purposes is generally clean so as not to dirty the building roof or clog the water flow system, the running water is usually collected for recycling by a closed water flow system so as not to waste water. The running water, whether recycled or discharged is not suitable for valuable usage because it contains the dirt from the open roof. Though the cooling effect is obvious, such luxury technique has limited application due to wastage of water and special requirement for the roof structure, particularly the requirement of recycling or drainage system. Furthermore, the heat energy from the sun is not claimed.

Hence, improvement to running water methods generally include providing means for better or more evaporation as the main cooling effect since there is a limit to cooling by surface contact and conduction. One such improvement is to spray water onto the roof so that more evaporation may be achieved with the spray compares to normal evaporation

of a running flow of water. With spraying, less amount of water is used. Examples of such systems may be found in U.S. Patents Nos. 1,831,880, 4,175,703 and 4,372,493. In these patents, water is dispersed by spraying onto the roof to cooling it through evaporation.

In a hot but water-scarce environment, even the spraying of water for cooling purposes may not be acceptable as the evaporation rate may be too high such as in an arid or desert climate and the water loss rate would then be significant. In a tropical environment, the application of spray-cooling methods simultaneously by many buildings may lead to undesirable increase in local humidity.

In the second aspect of the cooling art is the solar energy, particularly solar heat, is merely absorbed by the cooling water flow or sprays to aid evaporation and is not reclaimed at all.

In the aspect of solar energy reclamation, the laminar solar collector has been one of the efforts. Relevant inventions can be found in UK patent Nos. GB2147407 and 2045423, US patent Nos. US20040255932, US2002023740, US4898153, US4455999 and US4286583, and other patent Nos. WO1999/055984, FR2787868, DE19519175 and WO2006/031108. There are three patterns of flow in these patents. UK patent Nos. GB2147407 and 2045423, US patent Nos. US20040255932, US4455999 and US4286583, and patent Nos. WO1999/055984 represent the parallel flow pattern that the fluid introduced through the inlet conduit is distributed to a plurality of parallel passages and merged to the outlet conduit. FR2787868 and WO2006/031108 represent the serpentine flow pattern that the fluid flow in and out through a continuous passage formed between the first and second layers of plates. US2002023740 and US4898153 represent the mixed flow patterns of the above two. However, the solar panels or collectors in these patents are typically rigid or semi-rigid that they cannot be bent to rolled-up or folded. They are mainly suitable for roof installation.

The flow pattern in the collector affects the efficiency in energy collection, temperature distribution and the temperature of the outlet fluid. The serpentine flow pattern has the possible highest energy-collecting efficiency and highest heat energy output with the same flow rate/collection area due to its most uniform flow distribution. The parallel flow pattern, on the other hand, creates the least back pressure as the larger total sectional area of the parallel passages reduces the flow velocity in individual passages provided with the same inlet/outlet flow rate. However, due to the inertia of the flowing fluid and the existence of angle between the inlet/outlet conduit and the parallel passages, the flow rates among the parallel passages are normally different. The uneven flow distribution may get worse when pulse flow is formed during switching on and off of the flow when temperature controller is used. Mixed flow pattern recited in US 4898153 and US 2002/0023740 provide a balanced solution between the flow uniformity and the back pressure. However, in the mixed flow pattern designs, the total flow rate in the passages at both ends can be times greater than that in the individual parallel passage. To keep a constant flow velocity among the end and parallel passages, the sectional area for the end passages must be larger than that of the parallel passages. This will mean a greater total circumferential tensile exerted on the wall of the end passages due to pressure from the fluid that contains. All the finished solar collectors in the above mentioned prior inventions will be rigid, even though semi-rigid materials may be used.

It would be a significant advance in energy saving approach to have a water-cooled sunshade to reclaim solar energy while shading the undesired sunlight in summer or tropical area. Such device must be strong and light as there may be no roof structure to support it. It must be flexible so that it can be rolled or folded up, or slid aside as a curtain.

When flexible material is used for such water-cooled sunshade, the water pressure (static and dynamic) will force the water passages to take a possible maximum sectional area, which is the circle shape (neglecting the water weight). If the water passages are defined by two flat sheets, the change of the shape under the pressure will contract the

sunshade in the direction perpendicular to the passages. Such contraction will crease the sunshade at both side edges where the passage direction hence the contracting direction changes.

SUMMARY OF DISCLOSURE

Our invention endeavours to provide a flexible water-cooled sunshade/sunblind that is light but durable enough to be installed onto outer walls of a building or window, or installed in place of roof so that it may be used to absorb the solar energy and hence to cool the surroundings in addition to shading the sunlight and thus reduce energy consumption on air-conditioning. The flexible water-cooled sunshade/sunblind can be folded up or slid aside or laid down easily for light or wind to enter the room.

Another aspect of our invention is to provide our sunshade with water flow means that enables the cooling water heated by the sunlight be channeled away from the sunshade and replaced with fresh cool water so that the absorbed solar heat is less released or reflected back to the environment. The hot water is collected and stored and may then be used for hot bath or shower, cloth washing or further heated for beneficial usage to save electricity.

In one general embodiment of our invention, the sunshade (1) is made of a integral flexible plastic sheet comprising a plurality of fluid passages formed between a first flat flexible plastic layer (6) and a second flexible plastic layer (7) with protruding channels. Preferably still, the said first and second plastic layers are heat-sealed along sunken lines (3) and (8) and edges to form an integral sheet. An inlet (4) provided at the lower portion of said sunshade and an outlet (5) provided at the upper portion of said sunshade are connected to said passages.

Preferably, the said first layer is glass-fiber-reinforced flexible plastic sheet not less than 0.5 mm thick. The said second layer can be either or not glass-fiber-reinforced wherein said plurality of protrusive channels (2) are preformed. The said second layer is preferably to face the sunlight while the said first layer is at the back side.

Preferably, said inlet (4 or 20) and outlet (5 or 21) are integral parts of said sunshade that the inlet is formed by sealing the extension of said first and second plastic layers at the lower portion of said sunshade wherein the said extension of the second layer is preformed to connect to the lower ends of said set of parallel fluid passages; and the outlet is formed by sealing the extension of said first and second plastic layers at the upper portion of said sunshade wherein the said extension of the second layer is preformed to connect to the upper ends of said set of parallel fluid passages.

Preferably, the said first layer (6) is in white or light color and the said second layer (7) is in black or dark color. Preferably still, a third layer of plastic sheet is co-sealed with said first and said second layers to the back side of the said first layer such that a plurality of parallel hollow tubes being opposite to the passages on the second layer side are formed between said first and said third layers.

In one preferred embodiment, the said water passages are a set of independent and continuous serpentine water passages (2) extending horizontally in parallel and “U” turn at each end, wherein said fluid flows in via an inlet (4) and flows out via an outlet (5). This embodiment is suitable for single-piece or multiple-piece application to cover a large area.

In a second embodiment of our invention, said sunshade is a vertically elongated flexible sunshade slat (16) wherein said plurality of parallel fluid passages are disposed vertically and share common inlet (20) provided at the lower portion of said sunshade slat and common outlet (21) provided at the upper portion of said sunshade slat.

In a preferred embodiment, a water-cooled sunblind illustrated in Fig 5 comprises a plurality of said sunshade slats wherein each said slat is connected to a flexible common fluid supply conduit (17) with its said common inlet (20) and connected to a flexible common fluid discharge conduit (18) with its said common outlet (21). Preferably, the said sunblind is hooked onto a horizontally slidable mechanism in the manner of vertical blinds wherein its sunshade slats will fold zigzag along the respective vertical axes when said sunblind is slid aside.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood with reference to the accompanying drawings or figures, and the detailed description that follows hereinafter wherein specific embodiments are described as non-limiting examples or illustrations, in which:

FIGURE 1 is a schematic front view of the water-cooled sunshade of this invention.

FIGURE 2 is a schematic sectional view of the water-cooled sunshade;

FIGURE 3 illustrates the side elevation view of FIGURE 2 when folded with pulling-up mechanism;

FIGURE 4 illustrates the side elevation view of a lay-down folding mechanism;

FIGURE 5 is a schematic front view of a water-cooled vertical sunblind of this invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In a general embodiment of our invention, the water-cooled sunshade comprises a integral rectangular sheet in the shape of a window pane, or as large as a piece of roofing sheet, or as small as a slat of a vertical blind. A plurality of fluid passages is formed between the first and the second flexible plastic layers by heat sealing along sunken lines. A fluid inlet is generally provided at the lower portion of the sunshade and a fluid outlet is provided at the upper portion.

In an exemplary embodiment as shown in Fig 1 and Fig 2, the first flexible layer (6) is a 0.5 mm thick white glass-fiber-reinforced polyvinyl chloride (PVC) sheet. The second layer (7) is a 0.5 mm thick dark blue PVC sheet that preformed with protrusive set of serpentine fluid channels (2) and (7). A protrusive inlet (4) extended from the lower ends of the said set of serpentine fluid channels at the lower portion and a protrusive outlet (5) extended from the upper ends of the said set of serpentine fluid channels at the upper portion are also preformed on the second layer. The first and the second layers are RF-sealed along sunken lines (3) and (8), as well as sunken edges. One tube (9) along the upper edge and another tube (12) along the lower edge of the sunshade are formed by folding and RF-sealing the extensions of the first layer (6).

When the flexible sunshade is hung over a fixed supporting rod inserted in the upper tube (9) and water is introduced into the passages (2) through the inlet (4), the first layer (6) taking the full weight of the sunshade with water is nearly flat, and the water passages protruding at the second layer side are in nearly circular sectional shape throughout the whole profile of the sunshade. The flexible sunshade can be propped up at

an inclined angle through fixing the second supporting rod inserted in the lower tube (12) in a desired position.

The inlet is located at the lowest position so that when fluid is introduced, air is easily and uniformly expelled upwardly, and the warmer water of lower density is discharged through the outlet located at the highest position to achieve a more thorough replacement of the warm fluid by fresh one.

The diameter of each passage is uniform and preferably between 6 mm and 10 mm. The smaller the diameter, the lighter the sunshade is, the higher the pressure it can stand, but a higher back pressure it creates. The number of parallel passages, which determines the total flow rate, is dependent on the total effective area of the sunshade, the volume of the hot water storage tank and the diameter of each passage.

In one preferred embodiment, a third layer of plastic sheet is co-sealed with the first and second layers to the back side of the first layer such that a plurality of parallel hollow tubes being opposite to the passages on the second layer side are formed between the first and third layers. These hollow tubes are sealed at the side edges of the sunshade to provide better heat insulation.

In a preferred embodiment as shown in Fig 2 and Fig 3, a flexible plastic tube (10) made of the same material as the first layer is sealed to the first layer at the middle height of the back of the sunshade. A third supporting rod is inserted into the tube (10). Two pairs of pulleys (11) evenly distributed across the width of the sunshade are mounted on the third rod (10) and the first rod (9) respectively. Two strings (13) threaded through the two pairs of pulleys are tied with one ends to the second rod inserted in the lower tube (12). When the two strings (13) are pulled from the other ends, the second rod is lifted first and the lower part of the sunshade below the third rod is folded up. After the second rod touches the third rod (pulleys), further pulling of the strings lifts the third rod together

with the second rod and the upper part of the sunshade above the third rod is folded up until the third rod touches the first rod.

In another preferred embodiment of our invention as shown in Fig 4, two strings threaded through two pulleys (15) mounted on the wall above the window frame are tied to the first rod in the tube (9). A level shelf (14) with at least two “U” shape fenders is mounted to the wall below the window frame. When the strings (13) are fully released slowly, the flexible sunshade is folded zigzag within the “U” shapes and laid down on the flat bottom of the shelf. When the strings (13) are pulled, the sunshade is hung up.

In a second embodiment of our invention as shown in Fig 5, a plurality of said flexible sunshade slats elongated vertically (15) are arranged to assemble a vertical sunblind, wherein each slat comprises a plurality of parallel protrusive fluid passages, a fluid inlet (20) at a lower portion connected to a flexible common fluid supply conduit (17) and a fluid outlet (21) at an upper portion connected to a flexible common fluid discharge conduit (18), and a hook (19) at the top. Preferably, each sunshade slat is provided with one or more short horizontal bars fixed in the middle position at the slat back to prevent the slat from curving when water is fed. Preferably, the said sunblind is hooked onto a horizontally slidable mechanism wherein its sunshade slats will fold zigzag along the respective vertical axes when the sunblind is slid aside.

It will be apparent for a skilled person that, with the above-described sunshade and sunblind configurations, they may be used on a building structure such as an outer wall, roof, window, door, building frame and the like.

As the fluid passages are narrow and long, and the flow resistance is high in this thin water-cooled sunshade or sunblind, forced circulation by a low pressure pump is preferred. Preferably, the pump is controlled by the temperature difference provided by temperature sensors installed at the outlets of the sunshade and storage tank, so that

forced circulation of water between the sunshade and the water tank only occurs when the temperature of out-flowing water from the sunshade is higher than that of the water near the bottom of the water tank for a preset surplus to prevent the water in the tank from cooling. Preferably still, a check valve is installed between the outlet of the storage tank and the inlet of the sunshade or sunblind to prevent reversed water flowing from the sunshade or sunblind inlet to the tank outlet.

The preset surplus feature may be explained as follows. The water temperature at the bottom of the tank is the lowest. If the temperature at the outlet of the sunshade is equal to that of the tank bottom, circulation will no longer further heat the water. However, introducing the cooler water to the top of the tank will result in undesirable mixing in the tank. When the temperatures at the outlet of the sunshade is only slightly higher, it indicates that the energy obtainable from circulation is limited and the temperatures will be equalized very soon after circulation, which will lead to too frequent switching on-and-off of the pump. It is also a waste of power. A preset surplus can solve this problem to reduce undesired mixing, prolong the life of the pump and save power. The check valve will prevent the reversed gravitational circulation when the average temperature of the water in the sunshade is lower than that in the storage tank so as to prevent the water in the tank from cooling.

It is important to employ strong and weathering-resistant material and fittings in installation of the sunshade or sunblind outdoors.

It will be appreciated that a number of the above-described features of our invention may be adopted according to the required heat exchange efficiency or demands by users which are still based on the same general concept, features and working principles of the present invention. It is important to employ strong and weathering-resistant material and fittings in installation of the sunshade or sunblind outdoors.

Variations and alternative embodiments may be used in substitution of the aforesaid parts, components, materials, steps or processes as alternative configurations or embodiments not specifically described herein but which may still be used to effectively work the concept and working principles of this invention. Accordingly, they are not to be considered as departures from the present invention but shall be considered as falling within the letter and scope of the following claims.

CLAIMS

1. A flexible water-cooled sunshade comprising
 - a first layer of flexible plastic sheet;
 - a second layer of flexible plastic sheet whereon protrusive fluid channels are preformed;
 - a plurality of closed fluid passages (2) disposed between said first layer and said second layer by sealing said first and said second layer along preformed sunken lines (3) on said second layer and edges;
 - a fluid inlet to said fluid passages; and
 - a fluid outlet to said fluid passages.
2. A flexible water-cooled sunshade according to Claim 1 wherein the second layer is oriented to face solar ray incidence.
3. A flexible water-cooled sunshade according to Claim 1 wherein the first and the second layers are resistant to ultra-violet rays.
4. A flexible water-cooled sunshade according to Claim 1 wherein the first layer is glass-fiber reinforced flexible plastics.

5. A flexible water-cooled sunshade according to Claim 1 wherein said fluid inlet (4 or 20) and said outlet (5 or 21) are integral parts of said sunshade that the inlet and outlet are formed by sealing the preformed protrusive joint extensions of said protrusive parallel channels on said second layer with the extensions of said flat first layer at the lower portion and the upper portion of said sunshade respectively.

6. A flexible water-cooled sunshade according to Claim 1 wherein a third layer of plastic sheet may be co-sealed with said first layer and said second layer to the back side of said first layer whereby a plurality of parallel hollow tubes are formed between said first and said third layers being disposed opposite to the passages on said second layer side.

7. A flexible water-cooled sunshade according to Claim 1 wherein the fluid is water which supply is admitted into said passages via the fluid inlet and flows out of said passages via the fluid outlet.

8. A flexible water-cooled sunshade according to Claim 7 wherein the inlet is provided at a lower portion of said sunshade with the water flowing through the passages formed between said first and second layers, therein said water collects heat from said sunshade as it flows therethrough, and wherein said water flows out of the fluid outlet at an upper portion of said sunshade.

9. A flexible water-cooled sunshade according to Claim 1 wherein tubes (9), (12) and (10) are provided for inserting supporting rods for hanging or propping said sunshade to a building structure including any one of an outer wall, a roof, a window, door, building frame and the like, and for lifting and folding.

10. A flexible water-cooled sunshade according to Claim 9 wherein a lifting and folding mechanism is provided comprising two pairs of pulleys (11) mounted on the middle and the top supporting rods inserted in said tube (10) and said tube (9) respectively, two strings (13) threaded through said two pairs of pulleys (11) and tied to the lowest supporting rod inserted in said tube (12).

11. A flexible water-cooled sunshade according to Claim 9 wherein a lifting and folding mechanism is provided comprising a shelf with two or more “U” shape fenders (14) mounted on the lower wall or window frame, a pair of pulleys (15) mounted on the upper wall or window frame, and two strings (13) threaded through said pulleys (15) and tied to the top supporting rod inserted in said tube (9) of said sunshade.

12. A flexible water-cooled sunshade according to Claim 1 wherein the plurality of passages (2) are disposed to extend horizontally in parallel and “U” turn at each end to form a set of continuous serpentine fluid passages, therein said fluid flows in via an inlet provided at a lower portion of the sunshade and flows out via an outlet provided at an upper portion of the sunshade.

13. A flexible water-cooled sunshade slat (16) according to Claim 1 wherein the plurality of passages are disposed to extend vertically in parallel and jointly connected to the preformed protrusive common horizontal passages at both lower portion and upper portion of said sunshade slat.

14. A flexible water-cooled sunshade slat according to Claim 13 whereon a hock rotatable along vertical axis is mounted.

15. A plurality of water-cooled sunshade slats according to Claim 14 wherein said sunshade slats are with their inlets connected to a flexible common supply conduit (17) at

the lower portion of said sunblind and with their outlets connected to a flexible common discharge conduit (18) located at the upper portion of said sunblind.

16. A plurality of water-cooled sunshade slats according to Claim 15 hanging from a horizontally slidable mechanism to form a water-cooled sunblind, which horizontally sliding positions of the blinds are adjustable by a user.

17. A water-cooled sunblind according to Claim 16 wherein said sunshade slats with their inlets and outlets connected to flexible common conduits are zigzag-foldable along each vertical axis when they are slid aside along the sliding mechanism.

18. A plurality of water-cooled sunshade slats according to any one of Claims 13 to 17 used as water-cooled sunblind for a building structure including any one of an outer wall, a roof, a window, door, building frame and the like.