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(54) **SYSTEMS AND METHODS FOR AIR COOLING OF VARIOUS ENCLOSURES**

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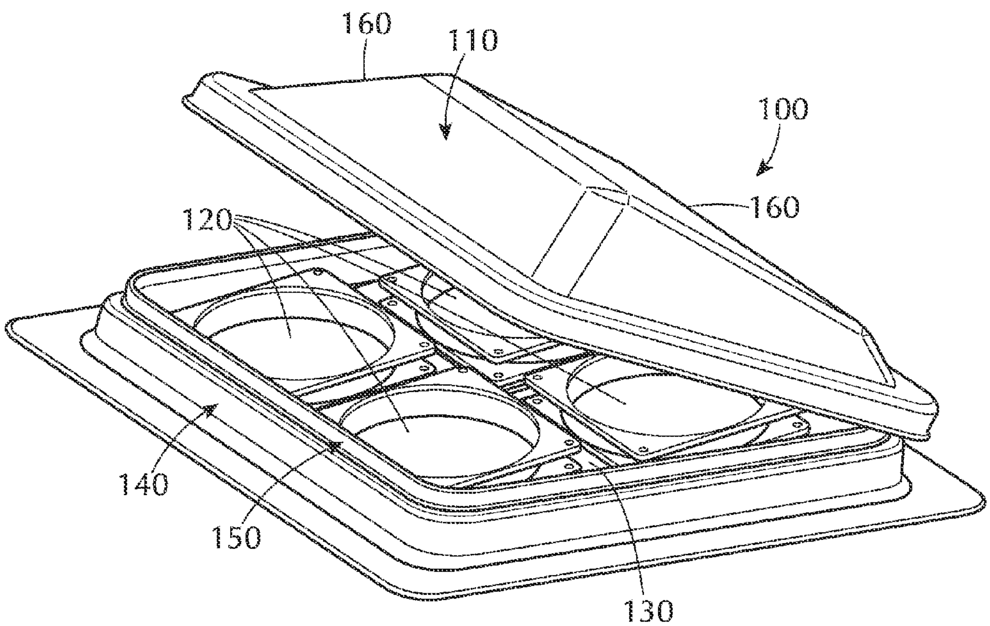
(57) **ABSTRACT**

A system for extracting air from a vehicle includes a mounting body and a plurality of fans mounted in the mounting body. The system further includes a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body. The plurality of fans is in communication with an airflow passage when the panel is in the second position. The system further includes a solar power source in communication with the plurality of fans and providing power to the plurality of fans.



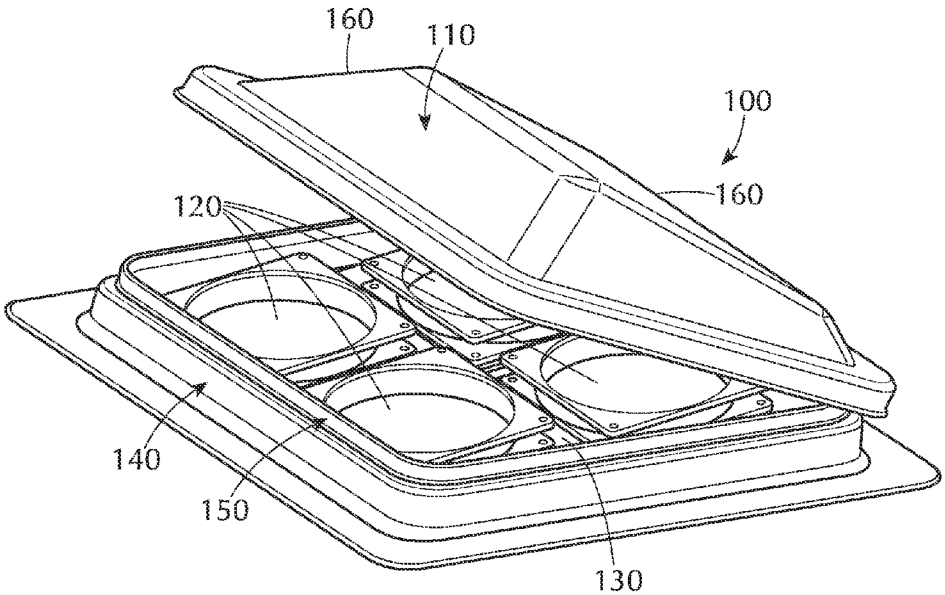


FIG. 1

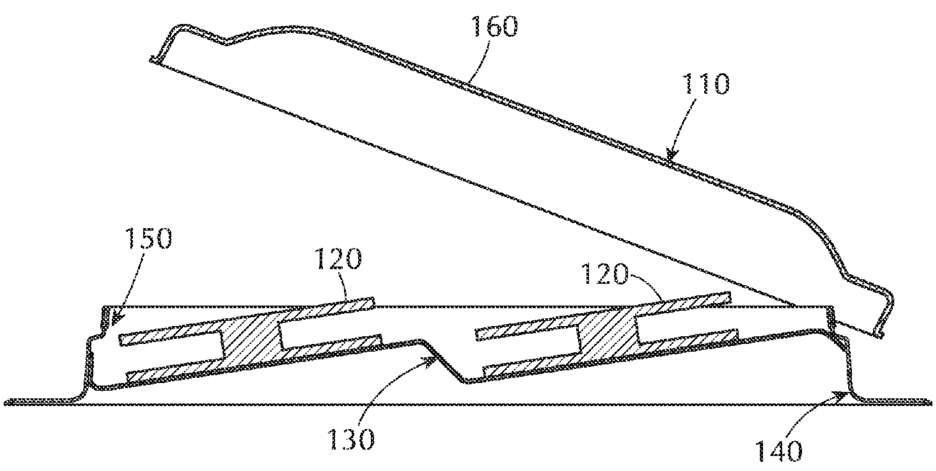


FIG. 2

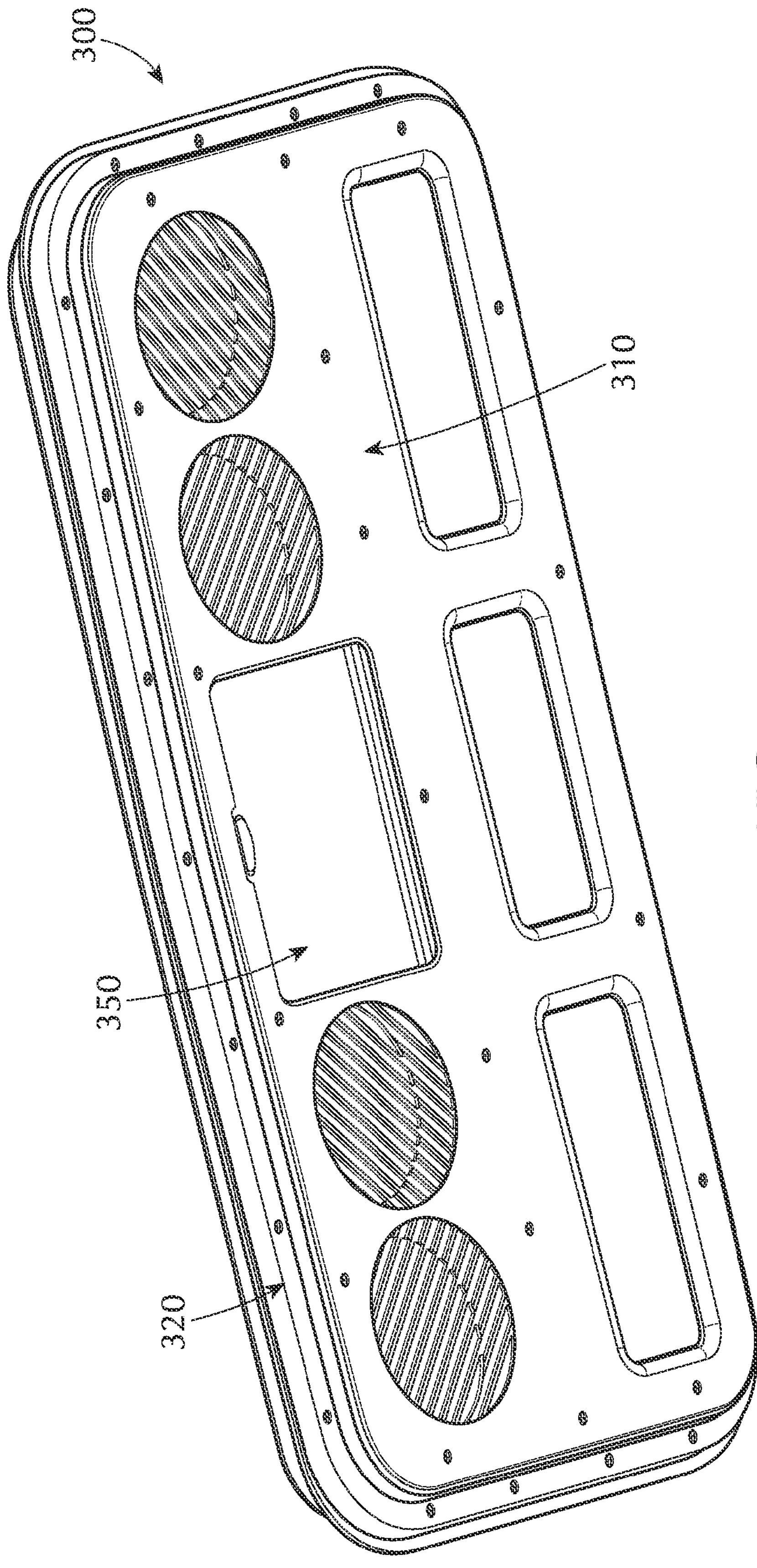


FIG. 3

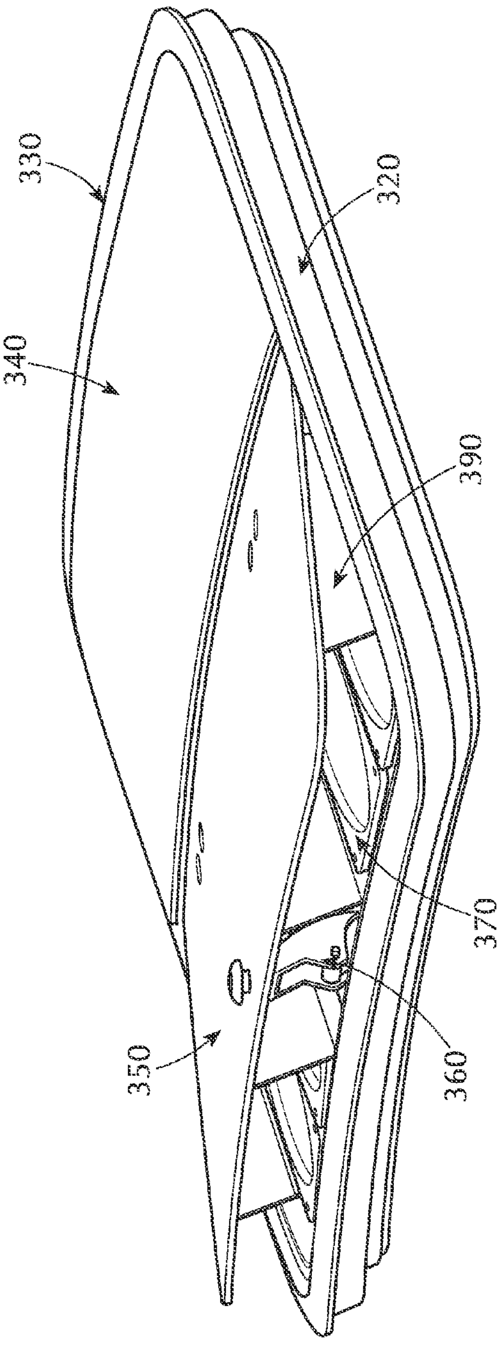


FIG. 4

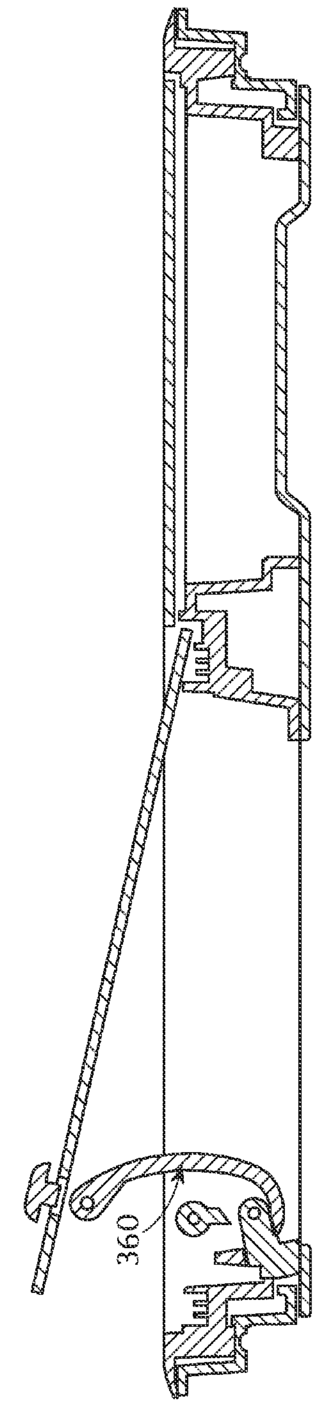


FIG. 7

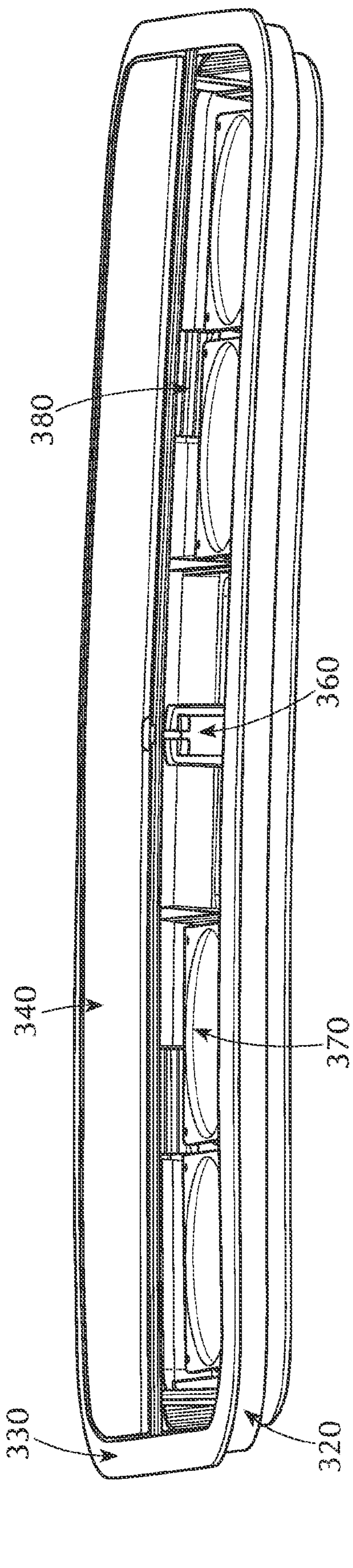


FIG. 5

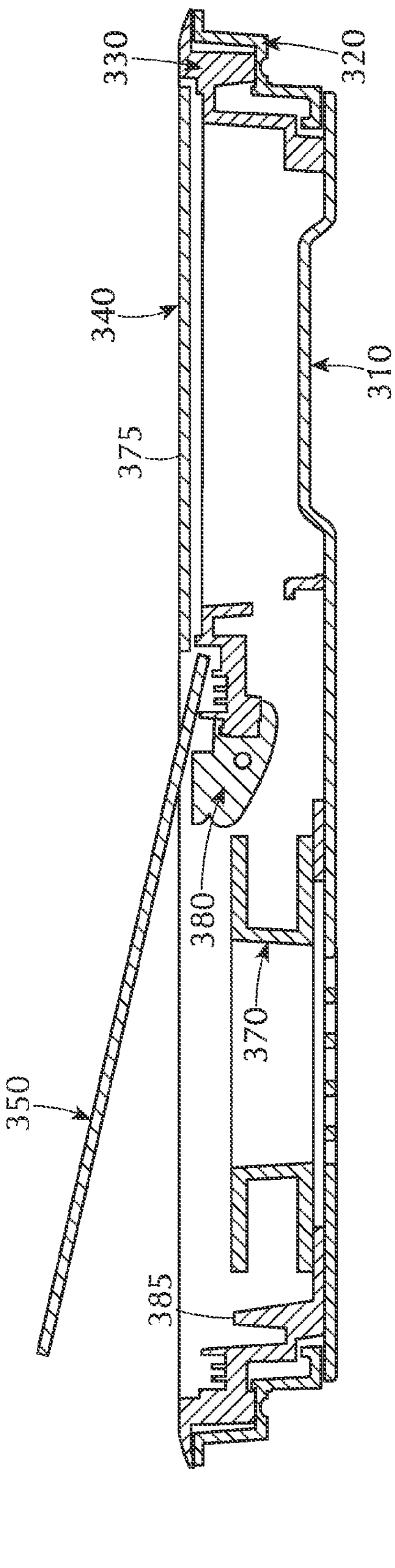


FIG. 6

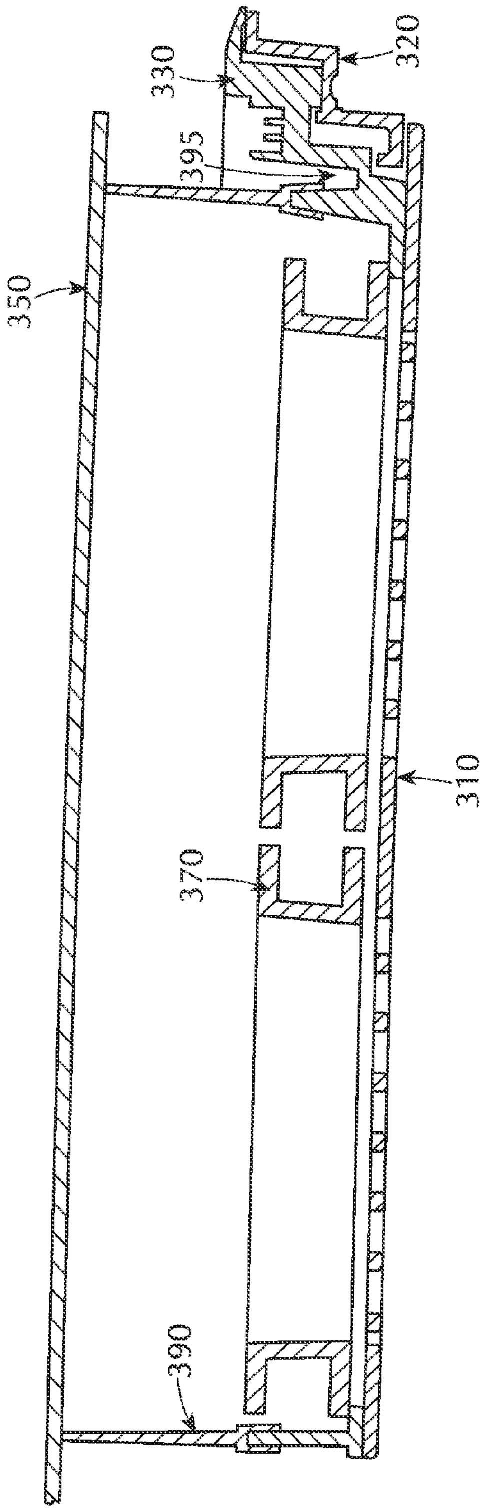


FIG. 8

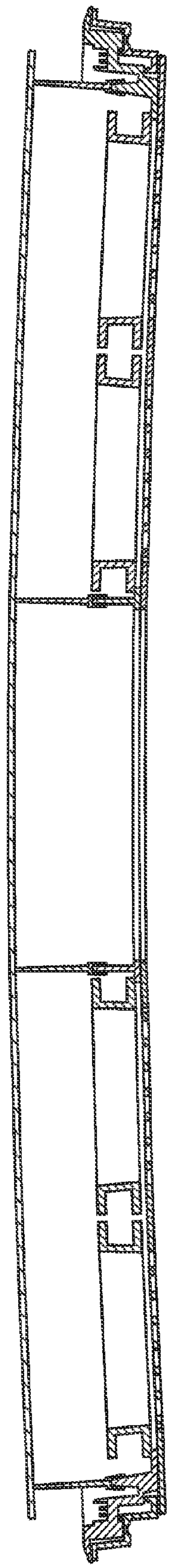


FIG. 9

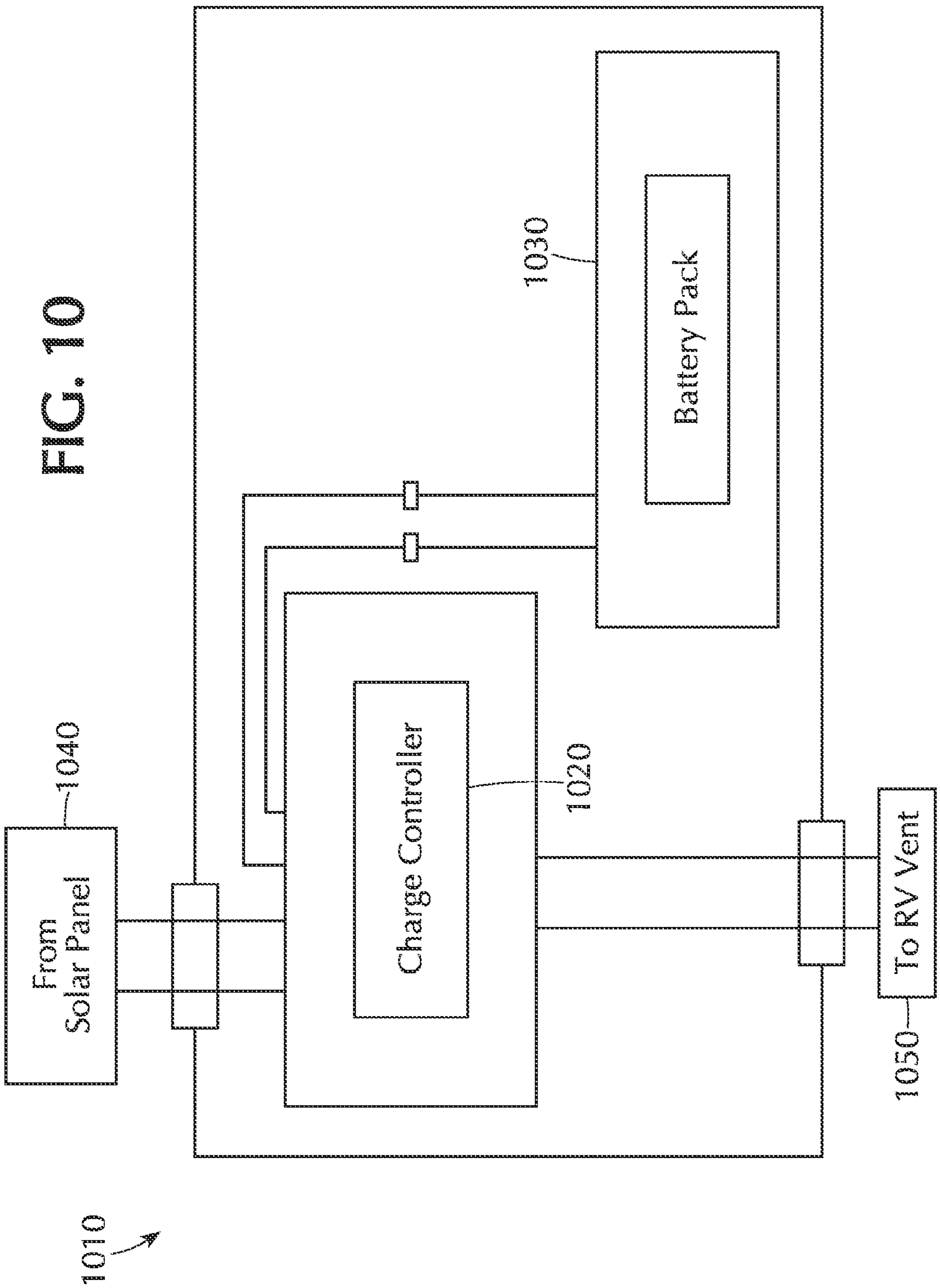

From
Solar Panel
1040
Charge Controller
1020
Battery Pack
1030
To RV Vent
1050
1010

FIG. 10

SYSTEMS AND METHODS FOR AIR COOLING OF VARIOUS ENCLOSURES

TECHNICAL FIELD

[0001] Embodiments described herein generally relate to systems and methods for cooling vehicles and other structures and enclosures that in many cases include the usage of solar energy.

BACKGROUND

[0002] Vehicles and other structures may sit for periods of time exposed to heat and sunlight. At times, these vehicles and other structures do not have a reliable source of power that may provide for the cooling of the vehicle or structure.

SUMMARY

[0003] In one embodiment, a system for extracting air from a vehicle includes a mounting body and a plurality of fans mounted in the mounting body. The system further includes a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body. The plurality of fans is in communication with an airflow passage when the panel is in the second position. The system further includes a solar power source in communication with the plurality of fans and providing power to the plurality of fans. Optionally, the system further includes a pressure switch; the pressure switch proximate to the panel, such that when the panel is in the second position, the switch is activated and the plurality of fans are activated. Optionally, the system further includes a battery pack interconnected with the plurality of fans and the solar power source. In one alternative, the system further includes a power management circuit, the power management circuit configured to charge the battery pack with power from the solar power source. In another alternative, the system further includes a water management system, the water management system proximate to the panel and configured to prevent entry of water through the plurality of fans and the airflow passage from precipitation. Optionally, the water management system includes a groove portion that allows for the collection of water. Alternatively, the plurality of fans is set at an angle to the mounting body. Optionally, the angle to the mounting body and the second position of the panel is configured such that, in combination with the water management system, water is prevented from passing through the airflow passage and the plurality of fans. Alternatively, the mounting body is configured to mount in a sunroof of a vehicle. In one configuration, the system functions independently of an electrical system of the vehicle. Alternatively, the opening created in the second position includes the panel at an acute angle to the mounting body. Optionally, an exhaustion rate provided by the system is at least equal to a rate of an entire volume of the enclosure each minute.

[0004] In another embodiment, a vehicle including a system for extracting air includes a sunroof aperture in the vehicle. The vehicle further includes a mounting body positioned in the sunroof aperture and a plurality of fans mounted in the mounting body. The vehicle further includes a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body. The plurality of fans is in communication with an airflow passage when the panel is in the second position. The vehicle further includes a solar power source in communication with the plurality of fans and providing power to the plurality of fans. In one alternative, the vehicle includes a battery pack interconnected with the plurality of fans and the solar power source; and a power management circuit, the power management circuit configured to charge the battery pack with power from the solar power source. Alternatively, the vehicle includes a water management system, the water management system proximate to the panel and configured to prevent entry of water through the plurality of fans and the airflow passage from precipitation, wherein the water management system includes a groove portion that allows for the collection of water, and the plurality of fans are set at an angle to the mounting body. Optionally, the angle to the mounting body and the second position of the panel is configured such that, in combination with the water management system, water is prevented from passing through the airflow passage and the plurality of fans.

[0005] In one embodiment, a method of cooling a vehicle includes providing a sunroof-mounted cooling system. The method further includes exhausting air from the sunroof-mounted cooling system and inflowing air from apertures of the vehicle. Optionally, the sunroof-mounted cooling system includes a mounting body positioned in the sunroof aperture; and a plurality of fans mounted in the mounting body. The sunroof-mounted cooling system further includes a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body. The plurality of fans is in communication with an airflow passage when the panel is in the second position. The sunroof-mounted cooling system further includes a solar power source in communication with the plurality of fans and providing power to the plurality of fans. Optionally, the method includes managing the power captured by the solar power source using a battery pack interconnected with the plurality of fans, the solar power source, and a power management circuit, the power management circuit configured to charge the battery pack with power from the solar power source. Alternatively, the sunroof-mounted cooling system includes a water management system, the water management system proximate to the panel and configured to prevent entry of water through the plurality of fans and the airflow passage from precipitation, wherein the water management system includes a groove portion that allows for the collection of water, and the plurality of fans are set at an angle to the mounting body. Optionally, the angle to the mounting body and the second position of the panel is configured such that, in combination with the water management system, water is prevented from passing through the airflow passage and the plurality of fans. Optionally, the method further includes receiving an indication from a user as to when to run the plurality of fans.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** shows an isometric view of one embodiment of a solar-powered air movement system;

[0007] FIG. **2** shows a cross-sectional view of the solar-powered air movement system of FIG. **1**;

[0008] FIG. **3** shows a bottom view of one embodiment of a solar-powered air movement system;

[0009] FIG. **4** shows a top right view of the solar-powered air movement system of FIG. **3**;

[0010] FIG. **5** shows a rear view of the solar-powered air movement system of FIG. **3**;

[0011] FIG. **6** shows a cross-section of the fore/aft section through the fan and glass hinge of FIG. **3**;

[0012] FIG. **7** shows a cross-sectional view of the solar-powered air movement system of FIG. **3** through the fore/aft section and through the latch;

[0013] FIG. **8** shows a cross-sectional view of the solar-powered air movement system of FIG. **3** through a half-car cross-section through the fans;

[0014] FIG. **9** shows a cross-sectional view of the solar-powered air movement system of FIG. **3** through the whole car cross-section through the fans; and

[0015] FIG. **10** shows one embodiment of a functional block diagram **110** for a solar-powered air movement system.

DETAILED DESCRIPTION OF THE DRAWINGS

[0016] Described herein are embodiments of systems and methods for cooling various enclosures. Some embodiments of the system include one or more fans, a solar panel, and a frame portion for fitting the system into the sunroof area of a vehicle. In the description, the system is many times described in terms of specific enclosures, such as a vehicle; however, the various embodiments, alternatives, and configurations may be implemented with any enclosure.

[0017] In some embodiments, the solar-powered air cooling systems described are designed to keep the affected enclosure at or below ambient temperature using a system that includes photovoltaic solar cells arranged into panels, a regulator, power storage batteries, a series of strategically mounted and angled fans, a water management system, and enclosures with sealing materials. Working together as an integrated system, the cooling unit removes a volume of air from an enclosure at a rate faster than that volume of air can be heated by the sun and by heat-soaked materials adjacent to and within the enclosure. By constantly removing the air in the enclosure and having such air being replaced by ambient temperature air from outside of the enclosure, the enclosure will be maintained at or below the ambient temperature. Additionally, through the use of storage batteries to operate the system after the solar panels cease producing power, the system will continue to operate for a period of time depending on the number of and type of batteries used.

[0018] In some embodiments, the flow rate enabled by the system is important in keeping the vehicle temperature low. Various vehicle enclosures have been researched. For example, a Lincoln Navigator has 335 cubic feet (CF) of interior space. A fan system with a 300 CF air extraction capacity has been determined to keep the interior of such a size below ambient temperature. In some embodiments, the optimal air exchange is one that provides for the entire volume of the vehicle to exchange each minute. It is believed that flow rates of at least one-half the volume of the vehicle per minute are sufficient to keep the vehicle at ambient temperature. One unexpected feature of such a flow rate is that it causes air to enter the vehicle through the ventilation system and other apertures of the vehicle, providing a more even flow throughout the vehicle. One important aspect is that the air that flows out cannot flow back in and thereby negate the positive effect of removing cabin air. Also, the tighter the enclosure, the greater pressure differential in the interior versus the exterior; and this differential also contributes to a temperature reduction inside the cabin. Similar air flow rates are believed to hold true for structures.

[0019] Another aspect of the system is that if too large of an aperture for the exhaustion of air is used, air may backflow into the vehicle or other aperture. This combined with the need for environmental controls to prevent the entrance of precipitation or bugs leads to the partially open design shown in the various figures.

[0020] Embodiments of the solar-powered air cooling systems are designed so as to require a minimum of alteration to the enclosure, whether such enclosure is a recreational vehicle, an automobile, a truck, a trailer, house or garage or similar enclosure, a shed, a portable or permanent outhouse, or any enclosure subject to heat build-up. Some embodiments of the solar-powered air cooling system essentially function in the same way; that is, each will remove from the enclosure a volume of air at a rate sufficient to keep the enclosure at or below ambient air temperature. The rate at which air is removed is an important component of the cooling effect. When the heated air resulting from the effects of the sun is removed and replaced by outside cooler air at a rate faster than the heat-soak effects of the sun, the enclosure will remain at a temperature no greater than the outside air being sucked into the enclosure. The rate of air extraction causes a pressure within the enclosure which is lower than outside of the enclosure, thus creating an environment where outside cooler air is drawn into the enclosure from vents, cracks, and other openings in the enclosure. In many configurations, there is a significant economic advantage to retaining the vehicle or enclosure at ambient temperature. Furthermore, embodiments of the system may limit a user's exposure to toxic gases and may reduce the chance for spontaneous combustion of materials under heat.

[0021] Systems included herein overcome the damaging effects of the sun, including the effect of the sun heating not only the air inside the enclosure but also the effects of the heated air heat-soaking materials in the enclosure. Such materials affected by the heat-soaking effects of the sun include seats, dashboards, and carpets in a vehicle, and the construction materials and contents of building structures.

[0022] For automobiles, recreational vehicles, trucks, and trailers parked in the sun, the cabin gets very hot and such heat is soaked into the materials within the vehicle, such as seats, steering wheel, carpets, dashboards, handles and knobs, and all exposed surfaces. This is caused by solar radiation entering the cabin and spreading the heat around the cabin and into the cabin contents and materials. The trapped heat causes real damage to the materials and to persons and other living things within the cabin. Such a heat buildup can cause harm and even death to humans and pets.

[0023] An alternative system might include a solar-powered air movement system, the system merely drawing outside air into the vehicle cabin and mainly through the dash-mounted openings connected to the engine compartment. This system does not provide for a method to extract the heated air from the cabin and as such only delays the heat-soaking which eventually will occur. Embodiments of the solar-powered air movement system provide for rapid air extraction at a rate at which the cabin air is prevented from being heated at a rate causing heat build-up and also creates a pressure differential within the cabin that causes cooler air to be sucked into the cabin, thus keeping the cabin at or below ambient temperature.

[0024] The joint effects of hot air extraction and lowering the cabin pressure thus allowing cooler air to enter causes a cabin temperature at or below ambient temperature. This will in turn cause vehicle owners to use minimal air conditioning initially upon entering the vehicle and to use lower air conditioning settings, if at all, after the vehicle is in operation. The use of air conditioning, especially in a heat-soaked vehicle, is a major factor in fuel consumption. Embodiments of the solar-powered air movement system cause less fuel to be used in temperatures in which drivers engage the vehicle air conditioning system.

[0025] Embodiments of the solar-powered air movement system provide that, upon return to a vehicle parked in the sun, the operator can comfortably use the vehicle immediately. Oftentimes, drivers will return to a heat-soaked vehicle and open the doors and windows and run the vehicle air conditioner at the maximum cool setting for a number of minutes before even getting into the vehicle. This idling activity consumes fuel at a high rate without moving the vehicle, effectively resulting in achieving zero miles per gallon during the whole time the vehicle is idling. When vehicle occupants return to a cool vehicle, the vehicle is ready to be driven immediately.

[0026] When embodiments of the solar-powered air movement system are used in a moving vehicle, the same principles are in effect. Potentially heated air is removed at a rate faster than the sun can heat soak the interior cabin air and contents, and cooler ambient air is drawn into the vehicle. The need for air conditioning will be reduced or even eliminated, thus saving fuel that is diverted from driving the vehicle to simply keeping the occupants cool. Embodiments of the solar-powered air movement system decrease fuel consumption and increase resulting mile-per-gallon results.

[0027] The heat-soaking effect of the sun also releases benzene gasses contained in vehicle plastics. Such gasses are released into the cabin air which is breathed by vehicle occupants. Eliminating the heat-soaking effects through ventilation is effective in reducing contamination. Embodiments of the solar-powered air movement system eliminate occupants from breathing in such harmful benzene gasses.

[0028] The joint effects of hot air extraction and lowering the cabin pressure, thus allowing cooler air to enter, will further translate into an effective method of removing odors and smoke and similar undesirable air pollutants from vehicle cabins.

[0029] Embodiments of the solar-powered air movement system further assist in premature deterioration of the materials used in a vehicle cabin, including upholstery, plastics, cabinets, and other materials in a recreational vehicle, as well as glues and adhesives used in vehicle construction (especially in recreational vehicles). As such, vehicle interiors have a longer life and do not degrade at the same rate as a vehicle exposed to constant heat soaking. Additionally, embodiments of the solar-powered air movement system eliminate the degradation of typical belongings found in vehicles—cosmetics, electronic equipment, compact disks, crayons, and ink pens subject to melting, carbonated beverage containers subject to heat-caused explosion, and grocery items left in the vehicle for an extended period of time.

[0030] The same principles described above for passenger vehicles apply to other enclosed areas, such as trailers, delivery vans, truck cabins, trailers, horse trailers, and vehicles of all types. The enclosed areas are kept cooler, the air is kept fresher, and occupants will not be exposed to the harmful effects of solar heating. For instance, toy haulers are used to transport racing vehicles, recreational vehicles, motorcycles, and all sorts of sporting equipment that include gasoline in their tanks or in gasoline containers. The fumes from the tanks of these vehicles can be harmful and even deadly, so removing the poisoned and heated air and replacing that air with fresh air from outside will prove very beneficial.

[0031] For stationary enclosures, especially for those not equipped with air conditioning or serviced by electricity, embodiments of the solar-powered air movement system allow for the effective removal of heat, odors, and gasses; and will allow fresh outside air to replace such heated or poisoned air. For houses, garages, and sheds, embodiments of the solar-powered air movement system allow the contents in the enclosure to be kept at or below outside air temperatures while also providing a system to extract odors and gasses, such as paint odors from sheds, waste odors from port-a-potties and free standing outhouses used in parks and camping areas, and the heated air in house attics which cause heat build-up in the housing structure. Removing the hot air from an attic is effective in keeping the house cool and reducing or eliminating the need for air conditioning in the home.

[0032] Embodiments of the solar-powered air movement system may include a number of innovative features. Embodiments of the solar-powered air movement system include a multiple fan system designed and angled to prevent virtually all rainwater from entering the enclosure because of the fan placement and revolutions per minute (RPMs) generated by the power source. Embodiments of the solar-powered air movement system include a water management system that captures any rainwater that does enter (in severe and horizontal downpours) and prevents the water from entering the interior of the enclosure. Embodiments of the solar-powered air movement system include a multiple fan system arrangement to operate at a high rate of speed and to extract air in the enclosure at a rate that prevents heat build-up within the enclosure. Embodiments of the solar-powered air movement system include a multiple fan system arrangement positioned to maximize air extraction by providing a more direct path of the air out of the enclosure. Embodiments of the solar-powered air movement system include a wind-funneling channel to maximize air extraction and minimize air backflow, thereby increasing the efficiency at which heated air is forced out of the enclosure. In embodiments designed for vehicle use, a design that closely resembles a sunroof is shown so that traditional sunroof installers need no special training to install the system, and so that consumers have a product that does not look out of place on their vehicle. For embodiments used in vehicles, the solar-powered air movement system's fixed glass panel allows for maximum solar accumulation while the movable panel is hinged to achieve maximum air flow while preventing water intake. Embodiments of the solar-powered air movement system include solar cells arranged and flexed to capture the solar power for a longer period of time than if the solar panels were simply flat.

[0033] Embodiments of the solar-powered air movement system include a flexible design to allow for as few as four and as many as twelve fans depending on the volume of air in the enclosure and the shape of the opening in the enclosure. Embodiments of the solar-powered air movement system include the use of a watertight compartment for battery alignment for power storage once the direct sunlight is reduced to non-power-generating status.

[0034] Embodiments of the solar-powered air movement system include the use of commercially available batteries to keep the initial cost of the unit low and to make battery replacement easy for the consumer. Embodiments of the solar-powered air movement system seal tight when closed and not in use so that outside elements—rain, snow, wind, etc.—may not enter into the enclosure. Embodiments of the solar-powered air movement system include the use of a battery charge controller to manage battery charging, not over-charging the batteries, and charging when the battery power level drops to such that it is needed.

[0035] Embodiments of the solar-powered air movement system are an entirely self-contained unit that does not require any interface with the vehicle, other than the mechanical mounting of the unit to the vehicle. Embodiments of the solar-powered air movement system include a switch integrated into the opening and closing mechanism such that, when the hinged opening is closed, the fans shut off. Embodiments of the solar-powered air movement system include inner valence covers that cover the fans, battery, and controller storage compartment while allowing for latch access.

[0036] Embodiments of the solar-powered air movement system are designed to work with a recreational vehicle. Embodiments of the recreational vehicle unit ("RV unit") may be designed to fit precisely into the pre-existing air vent that exists in all recreational vehicles. Some configurations of the RV unit are self-contained, such that they do not tap into a vehicle's existing electrical system and draw down the batteries or require a generator to be operating. Some configurations of the RV unit can be integrated into a vehicle's existing solar panel, if so equipped, precluding the need for the purchase of a solar panel. In one embodiment, the solar-powered air movement system is designed to fit with an automobile that includes a sunroof ("auto unit"). Some configurations of the auto unit resemble a sunroof and can be installed with common sunroof installation tools by the sunroof installation community of restylers. Embodiments designed for vehicles will cause operators to use less air conditioning, thereby increasing the vehicle's fuel economy. Embodiments designed for vehicles will prevent bugs and other foreign objects and rain from entering the vehicle because of the angle and width of the opening in the movable panel.

[0037] In some embodiments, the opening of the units designed for powered vehicles is much more restricted than a sunroof opening and will not allow unwelcome intruders any access to the contents of the vehicle. Optionally, configurations of the solar-powered air movement system prevents dangerous and deadly heat soaking known to cause damage to construction materials, enclosure contents, pets, and humans. Optionally, solar-powered air movement system units installed in buildings serve to exhaust dangerous fumes that may accumulate and explode or otherwise cause harm to those inhaling the fumes. In one configuration, solar-powered air movement system units installed in buildings cause a lower temperature than an unaffected area, and cause the building air conditioning system to operate less frequently and cause the building to be cooler for its occupants. In one alternative, solar-powered air movement system units installed in buildings, in any type of vehicle, or structure may be engaged or disengaged with the operation of a switch.

[0038] Embodiments of a solar-powered air movement system will find use in a variety of contexts including, but not limited to, commercial trucks and vans and their drivers/occupants; semi-truck drivers who must comply with anti-idling laws but still require a cooler cabin temperature; delivery vehicles owners/businesses and their drivers/occupants who can eliminate the unsafe driving condition of operating the delivery vehicle with the doors open; mail delivery vehicles seeking driver comfort plus increased fuel economy; governmental fleets seeking driver comfort plus increased fuel economy; military vehicles, especially those in hot climates; canine units of law enforcement agencies; horse trailer owners (and the horses) who want additional comfort for their livestock; toy hauler owners who desire to exhaust dangerous fumes and want a cooler trailer enclosure; garages and storage shed owners; homeowners who desire to keep their attics and entire homes cooler than otherwise; port-a-pottie businesses who desire to eliminate fumes and odors from the portable units; state and federal park systems and their visitors that use park-provided restrooms; private campground owners and their guests using the restrooms; RV/camper owners desiring to not use their noisy/expensive air conditioning units at night, whether by park-provided power or by self-generated power; pet owners with pets left in vehicles—passenger vehicles or RVs; and RV/camper owners desiring to exhaust cooking odors, smoke, and other by-products.

[0039] FIG. **1** shows an isometric view of one embodiment of a solar-powered air movement system. Solar-powered air movement system **100** is designed for use with an RV or similar vehicle. Similar arrangements of solar-powered air movement system **100** may be utilized in buildings, portable restrooms such as port-a-potties, and other buildings or structures. Solar-powered air movement system **100** includes a lid **110**. Lid **110** is designed to open and close based on user input. Lid **110** may be moved manually by the user or may have an electric motor or other movement device. Lid **110** interfaces with a mechanical switch on the body of solar-powered air movement system **100**. The mechanical switch is designed such that the solar-powered air movement system **100** is turned off when the lid **110** is firmly fixed on the body of solar-powered air movement system **100**; and the solar-powered air movement system **100** is turned on when lid **110** is tilted upwards or removed. Solar-powered air movement system **100** includes one or more fans **120**. Fans **120** are operated by batteries to extract air from the enclosure. Fans **120** may be attached using screws or other types of fastening systems to fan tray **130**. Fan tray **130** fits into main frame **140**. Seal **150** provides for sealing of lid **110** to main frame **140** when lid **110** is closed. Solar panels **160** are mounted on lid **110** and provide for power generation which charges the batteries that power the solar-powered air movement system **100**.

[0040] The solar-powered air movement system **100** may include various circuitry and/or microcontrollers that manage the battery charging, usage, and battery life. In many configurations, the batteries and circuitry may be contained in a waterproof container. FIG. **2** shows a cross-sectional view of the solar-powered air movement system **100** of FIG. **1**. As is clear in FIG. **2**, fans **120** are set at an angle to the horizontal on fan tray **130**. This angled arrangement provides for more direct evacuation of air from the vehicle while still providing for a low profile fixture.

[0041] FIG. **3** shows a bottom view of one embodiment of a solar-powered air movement system **300**. The solar-powered air movement system **300** includes an inner valence **310**. Inner valence **310** is visible to the driver/passengers of a vehicle in which the system is mounted. Inner valence **310** covers the fans, covers the battery/charge controller storage area, and allows for latch access at the center rear. Inner valence **310** also covers the leading edge of the vehicle headliner that is glued to the clamp frame. Inner valence **310** attaches to the clamp frame and main frame with screws. The solar-powered air movement system **300** includes clamp frame **320**. Clamp frame **320** attaches to the main frame **330** (see FIG. **4**) with screws and pinches the roof of the car between clamp frame **320** and the main frame **330** outer flange. Clamp frame **320** sits on the underside of the roof. Clamp frame **320** also is where the vehicle headliner will be attached. The solar-powered air movement system **300** includes rear glass panel **350**. Rear glass panel **350** is attached to the main frame **330** via the rear glass hinges **380** (see FIG. **5**) and the rear glass latch **360** (see FIG. **5**). Rear glass panel **350** pivots up approximately 40 mm at the rear to allow for air to be extracted. Rear glass panel **350** interfaces with a mechanical switch which turns the fans on when the rear glass panel **350** is opened and turns the fans off when the rear glass panel **350** is closed.

[0042] FIG. **4** shows a top right view of solar-powered air movement system **300**. The solar-powered air movement system **300** includes main frame **330**. Main frame **330** sits inside the cut opening in the roof skin, with an outer flange that rests outside the cut opening on the top of the vehicle. Main frame **330** attaches to the clamp frame **320** with screws. Main frame **330** holds the fans **370**, side covers **390** (see FIG. **8**), battery holder, charge controller, rear glass latch **360** (see FIG. **5**), rear glass hinges **380** (see FIG. **5**), front glass panel **340**, glass seal, and incorporates the water management area **395** (see FIG. **8**). The solar-powered air movement system **300** includes front glass panel **340**. A solar panel is physically bonded to the underside of front glass panel **340**. The front glass panel **340** is physically bonded to the main frame **330** around the perimeter of the front glass panel **340**. The solar-powered air movement system **300** includes rear glass latch **360**. Rear glass latch **360** is a hand-operated mechanical apparatus that opens the rear glass panel **350** and holds it open when operated as such, and closes the rear glass panel **350** and locks it closed when operated as such. Optionally, automatic motor drive systems may be utilized. The solar-powered air movement system **300** includes fan **370**. One or more fans **370** may be included in the system. Fans **370** are operated by the batteries to extract air from the enclosure. They attach to the main frame **330** via screws.

[0043] The solar-powered air movement system **300** includes rear glass hinge **380** (see FIG. **5**). Rear glass hinge **380** allows the rear glass panel **350** to open and close when the rear glass latch **360** (see FIG. **5**) is operated. They attach to the main frame **330** via screws. The solar-powered air movement system **300** includes side covers **390** (see FIG. **8**). Side covers **390** close off open areas in the rear opening and channel the air out the rear of the opening. They attach to the main frame **330**.

[0044] FIG. **5** shows a rear view of the solar-powered air movement system **300**. FIG. **6** shows a cross-section of the fore/aft section though the fan **370** and glass hinge **380**. The solar-powered air movement system **300** also includes a wire harness that connects the solar panel, charge controller, batteries, switch, and fans. The solar-powered air movement system **300** also includes a switch **385** that controls the operation of the fans, dependent upon the position of the rear glass panel. The solar-powered air movement system **300** also includes batteries that provide power to the fans when the switch allows. The batteries receive energy from the solar panel when directed by the charge controller. The solar-powered air movement system **300** also includes a charge controller that provides power to the batteries from the solar panel when needed. The charge controller stops power from the solar panel to the batteries when fully charged. The charge controller provides power to the fans when the switch allows. The solar-powered air movement system **300** also includes solar panel **375**. Solar panel **375** provides power to the batteries when the charge controller allows. Solar panel **375** is bonded to the underside of the front glass panel **340**. The solar-powered air movement system **300** also includes a glass seal that seals the enclosure from rain, wind, etc., when the rear glass panel is closed and attaches to the main frame. FIG. **7** shows a cross-sectional view of the solar-powered air movement system **300** of the fore/aft section through the latch **360**. FIG. **8** shows a cross-sectional view of the solar-powered air movement system **300** of a half-car cross-section through the fans. The solar-powered air movement system **300** includes water management system **395**. Water management system **395** is integrated into the main frame **330** (see FIG. **4**) and collects any water that may intrude into the opening. Water management system **395** includes a groove portion that allows for the collection of water. FIG. **9** shows a cross-sectional view of the solar-powered air movement system **300** of the whole car cross-section through the fans.

[0045] FIG. **10** shows one embodiment of a functional block diagram **1010** for a solar-powered air movement system. Charge controller **1020** manages the power of the system. Charge controller **1020** receives and transfers power from and to battery pack **1030**. Solar panel **1040** provides power to charge controller **1020** which then manages the charging of battery pack **1030**. Charge controller **1020** also transfers power to the fans in the RV vent **1050**. In many embodiments, the power required to run the fans is less than that of the output of the solar panel, such that the battery pack **1030** may be charged during operation of the fans. Power management circuitry prevents the overcharge of the battery pack **1030**. In some embodiments, the power management circuitry provides the user the opportunity to estimate when their return will be or otherwise program the system to run at certain times. In such a configuration, the power management circuitry may estimate the period of time needed to cool the vehicle or, alternatively, simply save power such that it may run a set period of time before the user's return to ensure maximum coolness for the user, even in the absence of a solar charging source. Therefore, in operation, based on the power output of the solar-powered air movement system, the power management circuitry may either run the fan or not. If it can run the fan and retain a full charge on the battery for later use, it may do so; otherwise, it may conserve power.

[0046] The previous detailed description is of a small number of embodiments for implementing the systems and methods for solar-powered air movement and is not intended to be limiting in scope. The following claims set forth a number of the embodiments of the systems and methods for solar-powered air movement disclosed with greater particularity.

What is claimed:

1. A system for extracting air from an enclosure, the system comprising:

a mounting body;

a plurality of fans mounted in the mounting body;

a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body, wherein the plurality of fans are in communication with an airflow passage when the panel is in the second position; and

a solar power source in communication with the plurality of fans and providing power to the plurality of fans.

2. The system of claim **1**, further comprising a pressure switch, the pressure switch proximate to the panel such that, when the panel is in the second position, the switch is activated and the plurality of fans are activated.

3. The system of claim **1**, further comprising a battery pack interconnected with the plurality of fans and the solar power source.

4. The system of claim **3**, further comprising a power management circuit, the power management circuit configured to charge the battery pack with power from the solar power source.

5. The system of claim **1**, further comprising a water management system, the water management system proximate to the panel and configured to prevent entry of water through the plurality of fans and the airflow passage from precipitation.

6. The system of claim **5**, wherein the water management system includes a groove portion that allows for the collection of water.

7. The system of claim **6**, wherein the plurality of fans are set at an angle to the mounting body.

8. The system of claim **7**, wherein the angle to the mounting body and the second position of the panel are configured such that, in combination with the water management system, water is prevented from passing through the airflow passage and the plurality of fans.

9. The system of claim **1**, wherein the mounting body is configured to mount in a sunroof of a vehicle.

10. The system of claim **9**, wherein the system functions independently of an electrical system of the enclosure.

11. The system of claim **1**, wherein the enclosure is a vehicle.

12. The system of claim **1**, wherein the opening created in the second position includes the panel at an acute angle to the mounting body.

13. The system of claim **1**, wherein an exhaustion rate provided by the system is at least equal to a rate of an entire volume of the enclosure each minute.

14. A vehicle including a system for extracting air comprising:

a sunroof aperture in the vehicle;

a mounting body positioned in the sunroof aperture;

a plurality of fans mounted in the mounting body;

a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body, wherein the plurality of fans are in communication with an airflow passage when the panel is in the second position; and

a solar power source in communication with the plurality of fans and providing power to the plurality of fans.

15. The system of claim **14**, further comprising:

a battery pack interconnected with the plurality of fans and the solar power source; and

a power management circuit, the power management circuit configured to charge the battery pack with power from the solar power source.

16. The vehicle of claim **14**, further comprising a water management system, the water management system proximate to the panel and configured to prevent entry of water through the plurality of fans and the airflow passage from precipitation, wherein the water management system includes a groove portion that allows for the collection of water and the plurality of fans are set at an angle to the mounting body.

17. The vehicle of claim **16**, wherein the angle to the mounting body and the second position of the panel are configured such that, in combination with the water management system, water is prevented from passing through the airflow passage and the plurality of fans.

18. The vehicle of claim **14**, wherein the opening created in the second position includes the panel at an acute angle to the mounting body.

19. The vehicle of claim **14**, wherein an exhaustion rate provided by the plurality of mounted fans is at least equal to a rate of an entire volume of the enclosure each minute.

20. A method of cooling an enclosure, the method comprising:

providing a sunroof-mounted cooling system;

exhausting air from the sunroof-mounted cooling system; and

inflowing air from apertures of the enclosure.

21. The method of claim **20**, wherein the sunroof-mounted cooling system includes a mounting body positioned in the sunroof aperture; a plurality of fans mounted in the mounting body; a panel, interconnected with the mounting body, the panel pivotably attached to the mounting body, the panel having a first position closing the mounting body and a second position opening the mounting body, wherein the plurality of fans are in communication with an airflow passage when the panel is in the second position; and a solar power source in communication with the plurality of fans and providing power to the plurality of fans.

22. The method of claim **21**, further comprising:

managing the power captured by the solar power source using a battery pack interconnected with the plurality of fans and the solar power source and a power management circuit, the power management circuit configured to charge the battery pack with power from the solar power source.

23. The method of claim **22**, wherein the sunroof-mounted cooling system includes a water management system, the water management system proximate to the panel and configured to prevent entry of water through the plurality of fans and the airflow passage from precipitation, wherein the water management system includes a groove portion that allows for the collection of water, and the plurality of fans are set at an angle to the mounting body.

24. The method of claim **22**, wherein the angle to the mounting body and the second position of the panel are configured such that, in combination with the water management system, water is prevented from passing through the airflow passage and the plurality of fans.

25. The method of claim **22**, further comprising:

receiving an indication from a user as to when to run the plurality of fans.

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