(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 785 800 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.05.2007 Bulletin 2007/20

(51) Int Cl.:
G05F 1/67 *(2006.01)* ***F24F 11/00*** *(2006.01)*

(21) Application number: **06255778.0**

(22) Date of filing: **10.11.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **11.11.2005 GB 0523033**
02.12.2005 GB 0524628

(71) Applicant: **Monodraught Limited**
Buckinghamshire HP12 3SE (GB)

(72) Inventors:
- **Eastmond, Simon Patrick**
  High Wycombe
  Buckinghamshire HP12 3SE (GB)
- **Payne, Terence Michael**
  High Wycombe
  Buckinghamshire HP12 3SE (GB)
- **Hopper, Nicholas**
  High Wycombe
  Buckinghamshire HP12 3SE (GB)

(74) Representative: **Parnham, Kevin**
Swindell & Pearson
48 Friar Gate
Derby DE1 1GY (GB)

(54) **Ventilation control**

(57) A method and a controller for a ventilation arrangement, including a sensor associated with a photovoltaic arrangement to determine an optimum I-V value as an indicator of available electrical power at the photovoltaic arrangement due to current irridescent level presented to the photovoltaic arrangement, the sensor device providing a signal indicative of optimum I-V value to an adjustor for a fan, the adjustor coupled to the fan to enable adjustment of the fan normally in terms of electrical load to limit demand to no more than the optimum I-V value of the photovoltaic arrangement determined by the sensor.

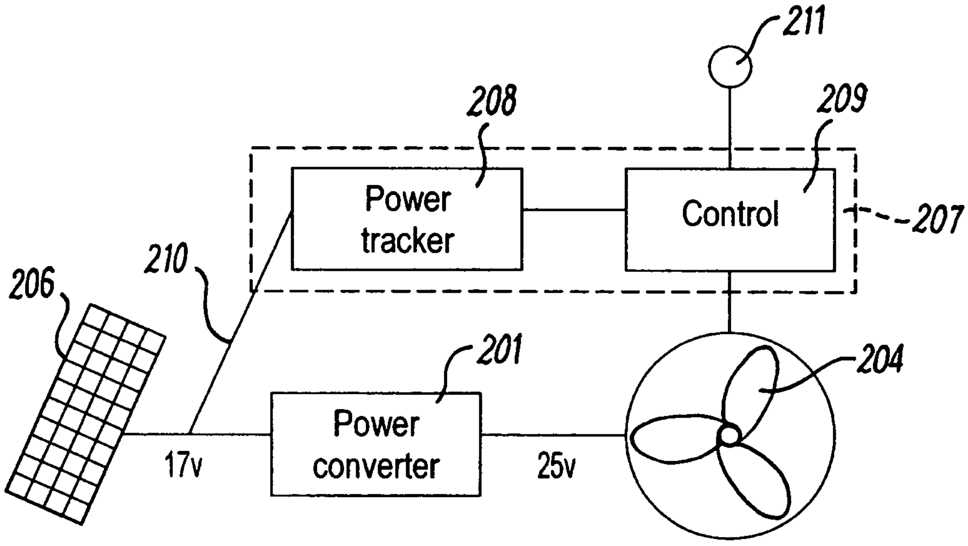

FIG. 3

EP 1 785 800 A1

Description

[0001] The present invention relates to ventilation control and more particularly to ventilation control where a fan is utilised to provide forced air within a ventilation system and the fan is driven by a power source of variable optimised capacity.

[0002] Ventilation within buildings is important not only for occupant comfort but also to ensure a safe environment is maintained. Ventilation can be generally passive in which appropriate ducts are provided with external grilles and internal vents to allow natural ingress and egress of air flows dependent upon temperature differentials and natural air stimulation through incident wind external to a building, occupant movements or natural stratification within a building.

[0003] Such passive ventilation systems have advantages with respect to energy conservation and carbon emission environmental considerations. However, passive ventilation systems are limited in terms of their adjustability and capacity so more recently wind-catcher roof mounted ventilation turrets have been utilised in order to make best use of external wind flows to stimulate air movements through the ventilation system and, therefore, improve ventilation within a building. Nevertheless, such enhanced passive ventilation systems are still dependent upon unpredictable natural wind movements to enhance the ventilation capacity.

[0004] It is known to incorporate electric motor driven fans to create forced air movements within a ventilation system. It is proposed to combine such electric motor powered fans with a photovoltaic arrangement in order to provide electrical power to drive a fan within a ventilation system which, in accordance with the desired approach, will be substantially effective in enhancing passive or wind-catcher ventilation mode. The fan will most advantageously be used as a means of supplementing forced air flow through the ventilation system to increase the range of operability for different building sizes, temperature differentials and other variables.

[0005] The electrical characteristics of photovoltaic arrangements generally vary in terms of the current and voltage available (I and V) dependent upon irradiance and the applied load. Therefore, the potential electrical energy to be utilised by an electric motor in order to drive a fan will also vary. This arrangement is considered to be non-optimised. An I-V curve can be drawn for a photovoltaic arrangement at a given level of irradiance, on which a value point can be found which gives the highest product of amperage and voltage. This is the optimum point of operation for the photovoltaic arrangement at that given irradiance level, from which any deviation will result in non-optimised operation.

[0006] It will be understood that operating ventilation systems in optimised conditions is desirable in order to maximise the level of energy conservation as well as environmental impact considerations.

[0007] Additionally it may be desirable to operate a fan at a different voltage level than that produced by the photovoltaic arrangement. In this case a power converter can be used to boost the voltage. A power converter usually requires a threshold of power to be available before it is activated. If the fan is already running this will create a sudden increase in voltage which will cause more current to be drawn and an excess of current will be drawn from the photovoltaic array, causing the voltage to drop. This will cause the optimum power point to be lost, reducing the available power and possibly causing damage to equipment.

[0008] In accordance with certain aspects of the present invention, there is provided a method of controlling a ventilation arrangement having a fan and a photovoltaic arrangement, the method comprising

(a) determining an optimum I-V value as an indicator of available electrical power at the photovoltaic arrangement with a present level of irradiance to the photovoltaic arrangement; and

(b) adjusting the fan to limit the optimum I-V value which is represented as an electrical load determined for the photovoltaic arrangement, normally in terms of electrical load characteristics of the fan.

[0009] Also in accordance with certain aspects of the present invention there is provided a controller for a ventilation arrangement, the controller including a sensor associated with a photovoltaic arrangement to determine an optimum I-V value as an indicator of available electrical power at the photovoltaic arrangement due to current irridescent level presented to the photovoltaic arrangement, the sensor device providing a signal indicative of optimum I-V value to an adjustor for a fan, the adjustor coupled to the fan to enable adjustment of the fan normally in terms of electrical load to limit demand to no more than the optimum I-V value of the photovoltaic arrangement determined by the sensor.

[0010] Generally, there is a power conversion or converter to convert the electrical voltage of the electrical power from the photovoltaic arrangement.

[0011] Typically, the optimum I-V value of the fan is matched with the optimum I-V value of the photovoltaic arrangement.

[0012] Typically, the optimum I-V value is determined using a maximum power point tracking (MPPT) device.

[0013] Typically, the controller or the method will alter the electrical load characteristics of the fan by causing a commutation pattern of a motor to drive the fan to be changed.

[0014] Generally, the controller or the method is arranged to define an operational threshold and a power conversion threshold for the available electrical power at the photovoltaic arrangement.

[0015] Typically, when the available electrical power at the photovoltaic arrangement is above the operational threshold defined by the controller but below the power conversion threshold, the fan is connected directly to the photovoltaic arrangement without adjusting the fan to match the optimum I-V value.

[0016] Optionally, the controller or the method may also adjust the electrical characteristics of the fan using the methods described below in order to prevent the photovoltaic arrangement from deviating from its optimum I-V value.

[0017] Typically, when the available electrical power increases to above the power conversion threshold, the power converter is engaged to adjust the voltage presented to the fan. Advantageously, to prevent the fan from suddenly drawing excess electrical current which may cause the photovoltaic array to deviate from its optimum I-V point, the controller causes the electrical load of the fan to be adjusted using the methods described below. This adjustment of the electrical load is continued for as long as the power conversion threshold is exceeded.

[0018] Typically, the power converter is only active when the power conversion threshold is above the operational threshold.

[0019] If the available electrical power Is below the operational threshold then the fan is rendered non-operative and the controller or the method continues to monitor the available electrical power in term of the I-V value at the photovoltaic arrangement.

[0020] Typically, the controller or the method is arranged to periodically determine of the optimum I-V point at the photovoltaic arrangement.

[0021] Typically, the method or the controller operates whereby the fan is adjusted in terms of electrical load. Power transmitted to the fan is determined prior to fan adjustment and after fan adjustment so that if a higher value of transmitted electrical power is determined after the fan is adjusted then the fan's electrical load is adjusted again in the same direction whilst if a lower value of transmitted electrical power is determined after the fan is adjusted then the fan's electrical load is adjusted in the opposite direction. Typically the method involves incremental adjustments in the electrical load which will iteratively arrive at the optimum point on the I-V curve, and hence enable the fan to rotate at a higher speed than in a non-optimised condition.

[0022] Alternatively, the controller or the method operates by periodically open-circuiting the photovoltaic arrangement to allow the tracker device to determine open circuit voltage at the photovoltaic arrangement. Normally, the controller or the method assumes a proportional quotient of open circuit voltage is the voltage of the photovoltaic arrangement at which the maximum available electrical power will be available to the fan (the optimised I-V value). Generally, the proportional quotient is in the range of 50-100%, more specifically in the range 60-90%, even more specifically in the range 70-80% and most advantageously about 75% of the open maximum available electrical power.

[0023] Possibly, the controller is also associated with a temperature sensor or air quality sensor to adjust the fan dependent upon temperature or air pollutants.

[0024] In accordance with further aspects of the present invention, there is provided a ventilation arrangement comprising a ventilation controller as described above and a ventilation arrangement, the ventilation arrangement comprising:

a first air duct arrangement and second air duct arrangement which extend in use from roof level into an interior of a building to be ventilated to convey air between the exterior and the interior of the building; and ventilation openings which are arranged to direct moving air caused by wind movement through the first air duct arrangement into the building.

[0025] Also, in accordance with some aspects of the present invention, there is provided a ventilation arrangement comprising a ventilation conduit and a ventilation control as described above.

[0026] In accordance with certain aspects of the present invention there is provided an arrangement which includes a fan and a photovoltaic arrangement to provide electrical power to the fan.

[0027] The fan may be operable to convey air from an exterior of a building to an interior of a building. Alternatively, the fan may be operable to convey air from an interior of a building to an exterior of a building.

[0028] The ventilation arrangement may include an outer wall and ventilation openings may extend continuously around the outer wall.

[0029] The ventilation arrangement may include upper and lower ends. The first air duct arrangement may include a plurality of duct sections which may extend in a direction between the upper and lower ends of the ventilation arrangement. The first air duct arrangement possibly comprises four duct sections.

[0030] The second air duct arrangement may extend through the first air duct arrangement and may extend in a direction between the upper and lower ends of the ventilation arrangement. The second air duct arrangement may communicate with the ventilation openings to enable the fan to convey air between an exterior and an interior of a building.

[0031] The photovoltaic arrangement may include a photovoltaic panel, and the ventilation arrangement may include a photovoltaic panel mounting arrangement which may be arranged to mount the photovoltaic panel at an angle to the horizontal.

[0032] The ventilation arrangement may include an airflow control arrangement for controlling the flow of air in use between an exterior and an interior of a building. The airflow control arrangement may-be situated at the lower end of the ventilation arrangement. The airflow control arrangement may comprise a plurality of louvered members which may be rotatable between a closed position and an open position. In the closed position, the louvered members may prevent the flow of air between an exterior and an interior of the building through the first and second air duct arrangements, and in the open position, the slats may permit the flow of air between an exterior and an interior of the building through the first and second air duct arrangements.

[0033] The airflow control arrangement may include an electric motor for rotating the louvered members between the closed and open positions and the ventilation arrangement may include a rechargeable battery for providing power to the electric motor. The rechargeable battery may be arranged to receive electrical energy from the photovoltaic arrangement to effect recharging. The control may be arranged to control the supply of electrical energy from the photovoltaic arrangement to the rechargeable battery and may be arranged to permit the supply of electrical energy from the photovoltaic arrangement to the rechargeable battery only when the fan is inoperative or when the amount of electrical energy produced by the photovoltaic arrangement is greater than the amount of electrical energy to operate the fan.

[0034] The ventilation arrangement may include a manual control arrangement which may permit the operation of the fan and/or the airflow control means to be controlled by a user.

[0035] Embodiments in accordance with certain aspects of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic cross-sectional side view of a ventilation arrangement;

Fig. 2 is a more schematic illustration of a ventilation arrangement in which a ventilation control in accordance with the present invention may be incorporated;

Fig. 3 is a schematic illustration of a ventilation control arrangement in accordance with the present invention; and,

Fig. 4 is a flow diagram illustrating a ventilation control method in accordance with certain aspects of the present invention.

[0036] Fig. 1 shows a ventilation arrangement 10 for ventilating an interior 12 of a building (not shown). The ventilation arrangement 10 is mounted on a roof 14 of the building and extends through the roof space 15 into the building interior 12.

[0037] The ventilation arrangement 10 comprises a first air duct arrangement 16 which extends from roof level through the roof space 15 into the building interior 12. The ventilation arrangement 10 comprises an outer wall 17 which is of generally square cross-section in the illustrated example and includes upper and lower ends 18, 20.

[0038] The first air duct arrangement 16 is divided into four duct sections which are arranged to convey air between the exterior and interior 12 of the building. The outer wall 17 includes ventilation openings 22 which extend continuously around the outer wall 17. Each of the duct sections, which is closed at its respective upper end, is in communication with a ventilation opening 22 so that air can pass along the duct sections between the exterior and the interior 12 of the building. The ventilation openings 22 define a portion of the side wall of each duct section. Air can flow in either direction, into or out of the building, through the ventilation openings 22 and along the duct sections, as will now be described.

[0039] The ventilation openings 22 capture moving air caused by the prevailing wind and direct the moving air into the duct sections. The direction of the prevailing wind will determine into which of the duct sections the moving air is directed. As will be clearly understood, the duct sections which are on the windward side of the ventilation arrangement will receive air from the ventilation openings 22.

[0040] The ventilation arrangement 10 includes a fan 30 which is driven by an electric motor. A photovoltaic panel 32, converts solar energy into electrical energy, supplying electrical energy to the fan 30 to operate it.

[0041] In the example illustrated in Fig. 1, the fan 30 is operable to convey air from the exterior of the building through the ventilation openings 22 and into the second air duct arrangement 24, as shown by the arrows F. Fresh air is thus conveyed into the building interior 12 along the second air duct arrangement 24 by the fan 30.

[0042] On days of the year when it is sufficiently windy, there will be a sufficient natural flow of cooling air into the building along the duct sections which are on the windward side of the ventilation arrangement 10 and of warm air from the building along the duct sections which are on the leeward side of the ventilation arrangement 10, and the ventilation arrangement 10 will thus be capable of adequately cooling the building interior 12 without the operation of the fan 30.

[0043] During summer months when there is strong sunlight and the external temperature may be high, the temperature of the building interior 12 will also be greater than during cooler months of the year. During these periods, there may also be very little or no wind movement and hence little or no airflow along the duct sections. The fan 30 can therefore be operated during such periods to provide additional, boosted, forced air ventilation to the building interior 12. As the fan 30 will only be required to operate during hot periods when there is strong sunlight, the photovoltaic panel 32 will be able to provide the fan 30 with sufficient electrical energy to operate it.

[0044] The ventilation arrangement 10 includes a photovoltaic panel mounting arrangement 34 having a sloping mounting surface 36. When the photovoltaic panel 32 is mounted on the sloping mounting surface 36, it thus defines an angle with the horizontal plane enabling it to maximise the capture of solar energy. The ventilation arrangement 10 is mounted such that the sloping surface 36 faces in a direction due south or in a direction within a range between south east and south west.

[0045] In order to control the operation of the fan 30, the ventilation arrangement 10 includes an automatic control arrangement 38 in the form of an electronic controller. In embodiments of the invention, the automatic control arrangement 38 is operable to vary the rotational speed of the fan 30, dependent upon the intensity of light incident upon the photovoltaic panel 32, by adjusting the electrical load characteristics of the fan. '

[0046] When the air temperature in the building is greater than a predetermined temperature, for example approximately 20°C, the automatic control arrangement 38 is desirably operable to vary the rotational speed of the fan 30 up to its maximum rotational speed according to the intensity of light incident upon the photovoltaic panel 32. However, when the air temperature in the building is in a range below the predetermined temperature, for example a range between approximately 17°C and 20°C, the automatic control arrangement 38 is desirably operable to limit the rotational speed of the fan 30, for example by removing the fan from within the power conversion threshold to operational threshold.

[0047] The ventilation arrangement 10 also includes an airflow control arrangement 40 for controlling the flow of air between the exterior and the interior 12 of the building, along the duct sections and along the second air duct arrangement 24. The airflow control arrangement 40 comprises a plurality of slats 42 which are rotatable between an open position, shown in Fig. 1, and a closed position. In the open position, the slats 42 permit the flow of air from the duct sections 16a-d into or out of the building interior 12, and permit the flow of air from the second air duct arrangement 24 into the building interior 12 during operation of the fan 30. When the slats 42 are in the closed position (rotated through 90 degrees from the position shown in Fig. 1), they co-operate to prevent the flow of air into or out of the building interior 12.

[0048] In some embodiments of the invention, a rechargeable battery 46 provides power to the electric motor 46 and receives electrical energy from the photovoltaic panel 32 to maintain its charge. In order to ensure that maximum electrical energy is provided to the fan 30 during its operation, the automatic control arrangement 38 is configured such that it permits the supply of electrical energy from the photovoltaic panel 32 to the rechargeable battery 46 only when the fan 30 is inoperative.

[0049] The ventilation arrangement 10 can also be provided with a manual control arrangement (not shown) to enable a user to directly control the operation of the fan 30 and/or the airflow control arrangement 40. Where the fan 30 is a variable speed fan, the fan speed may be controlled using the manual control arrangement.

[0050] It will be appreciated from above that fans with associated electrical motors act within ventilation systems in order to force air flow. As illustrated with regard to Fig. 1 by appropriate configuration of a ventilation arrangement advantage can be taken of external wind stimulated air flows in order to create adequate ventilation and, where necessary, cooling effects within a building. Ventilation control in accordance with certain aspects of the present invention may be applied to more generic ventilation arrangements which are not particularly configured to take advantage of external wind or other ventilation flow stimulating processes. It will be understood that within buildings it is possible to provide simple ducting which has an external grill and an internal grill connected by a duct conduit. These ventilation arrangements will generally simply pass through a wall in order to allow some air exchange when windows and other closures are closed. It is possible that an electric fan may be located within the ducting, particularly where there is a long duct path in order to force air flow.

[0051] Fig. 2 provides a generic schematic illustration of a vent arrangement 100 in which a conduit duct 101 connects an external vent or grill 102 mounted on an external wall with an internal vent or grill 103 secured to an internal wall. A fan 104 is located within the conduit duct 101 and this fan 104 is driven by an electrical motor 105. Electrical power for the motor 105 is derived from a photovoltaic arrangement 106 which generates electrical power from incident sunlight/radiation. A ventilation control 107 is provided in order to condition and appropriately present electrical power to the motor 105 for rotation of the fan 104. Electrical power is delivered through cabling 108 and it will be understood that generally the photovoltaic arrangement 106 will take the form of a solar panel mounted externally and probably upon a roof of a building incorporating the ventilation arrangement 100.

[0052] It will be understood that the arrangements depicted in Figs. 1 and 2 are generally stand-alone and do not utilise mains electricity. In such circumstances the energy requirements of the arrangements depicted in Figs. 1 and 2 are self-contained and, therefore, generally environmentally friendly and energy efficient. Certain aspects of the present invention are directed towards ventilation controls such as control 107 depicted in Fig. 2 in order to best condition and present the electrical power provided by a photovoltaic arrangement to achieve more efficient operation of ventilation arrangements.

[0053] Fig. 3 provides a schematic illustration of a ventilation control in accordance with certain aspects of the present invention. In such circumstances, as can be seen, a photovoltaic arrangement 206 is associated with a fan 204 so that electrical power generated by the arrangement 206 is utilised in order to drive rotation of the fan 204. It will be understood that the fan 204 is driven by an electrical motor (not shown) and this electrical motor presents an electrical load to the arrangement 206. In such circumstances, matching of the maximum available electrical power at the arrangement 206 with the electrical load of the fan 204 and, in particular, its electrical motor is important with respect to achieving efficient operation. Unfortunately, the available power at the arrangement 206 is dependent upon a number of factors, including incident sunlight/radiation, component temperature along with general component aging and degradation through adhered dirt, friction, etc. It will also be understood that the electrical load requirements for the fan 204 can be varied electively at a user's discretion and also based upon the availability of electrical power from the photovoltaic arrangement 206. It will be understood that the need for forced air movement generated by the fan 204 will be dependent upon prevailing conditions in terms of building temperature and in situations as described with regard to Fig. 1 the availability of other air flow stimulated mechanisms such as wind-catching, that is to say where there is already adequate air flow the need for air-forcing provided by the fan 204 will not be necessary. In such circumstances it will be understood it is desirable to know the constraints upon the ventilation arrangement as indicated. This will principally be dependent upon the available electrical power from the arrangement 206.

[0054] In terms of operation of a ventilation control, it will be understood the methodology will typically require an initial determination of available electrical power and optimum I-V point from the panel 206 along with setting an operational threshold and a power conversion threshold such that if there is insufficient electrical power, i.e. below the operational threshold, the fan 204 is rendered inoperative but above the operational threshold the fan 204 is operated in an efficient manner. This operation is simply open-loop to act proportionately to the available electrical power. However, more normally, and generally as a necessity, within the power conversion threshold, a power converter 201 will be provided in order to adjust the electrical voltage of the electrical power generated by the photovoltaic arrangement 206 to a voltage acceptable by an electric motor (not shown) to turn the fan 204. Generally present photovoltaic arrangements 206 will provide a notional operational voltage under load of 17 volts whilst electric motors for a fan 204 will be specified at 25 volts and, therefore, the converter 201 will make this step up. The power converter is effectively an electronic power transformer.

[0055] As indicated above, a ventilation control as depicted by box 207 in Fig. 3 is provided in order to make the initial threshold determination as to the acceptability for operation of the fan 204. This control 207 will generally comprise an optimum I-V point tracker device and appropriate processor control methods to control and determine efficient ventilation control operation. These devices are commonly referred to as MPPT devices and are described in a number of text books including Practical Handbook of Photovoltaics (Fundamentals and Application) - Tom Markvart et al, page 578. These maximum power point tracker devices act to determine by an appropriate sampling regime the available electrical power and are utilised with regard to a number of applications.

[0056] Maximum power tracker devices can implement a number of interrogation strategies including so-called "perturb and observe" regimes in which in the present case the electrical load presented by the fan 204 will be increased and then the tracker device 208 utilised in order to determine the available power through a sampling coupling 210 connected to the output from the photovoltaic arrangement 206. In such circumstances, if the available electrical power from the arrangement 206 after increase in the electrical load at the fan 204 is reduced then that electrical load presented by the fan 204 through its electric motor may be reduced or, if the available electrical power at the arrangement 206 is increased then a further increase in the electrical load presented by the fan 204 may be provided until balance is achieved, that is to say all available electrical power at the arrangement 206 is at a peak and the fan 204 is operating at required to provide forced air flow through a ventilation arrangement. It will be understood that the tracker 208 as indicated will also make the initial assessment as to whether the operation threshold has been achieved with respect to the minimum necessary electrical power supply requirements to operate the fan 204 and above that operational threshold will perform the tracking procedures as described above.

[0057] An alternative approach to determining the optimum I-V point at the arrangement 206 is to periodically open-circuit the photovoltaic arrangement 206 such that there is no electrical load. In such circumstances, the tracker 208 will then determine the voltage at the photovoltaic arrangement 206 that will deliver maximum power for the arrangement 2. In such circumstances, either theoretically or by electrical load testing, a projected proportionality quotient may be applied to this open circuit voltage value from the arrangement 206 in order to then tailor the fan 204 and its electrical motor in terms of electrical load requirements to this determined situation. Typically, the proportional quotient will be in the range 50-100% but could be in the range 60-80% or more specifically 70-80% or generally about 75% of the open circuit voltage from the arrangement 206.

[0058] In view of the above it will be appreciated that a control processor 209 is associated with a ventilation arrangement and generally coupled between the tracker device 208 and the fan 204 /motor in order to match the maximum available electrical power with the electrical load presented by the fan 204 /motor. The control device 209 may operate purely upon optimum I-V value determined by the tracker 208 in order to set the electrical load requirements of the electrical motor for the fan 204 in order to generate forced air flow through a ventilation arrangement. However, more typically, an external sensor or user-determined control 211 will be used in order to set the desired operational performance parameters for the ventilation arrangement. The external sensor or user-determined parameter

211 may take the form of a temperature sensor internally located within a building or manual on-off switch.

[0059] It will be understood that the available electrical power from the photovoltaic arrangement 206 may vary during the course of a day as the availability of electrical power will be dependent upon incident sunlight etc. In such circumstances, the tracker 208, control 209 and other aspects of the present control will be arranged to periodically re-set in order to determine the available electrical power and other requirements within a ventilation arrangement to optimise or achieve specific desired performance objectives.

[0060] Fig. 4 is a schematic flow diagram illustrating one potential way for operation of a control processor in accordance with certain aspects of the present invention. Thus, an activator 300 which, as indicated above, may be in the form of a simple on-off switch or sensor for temperature. The available voltage will be compared with an operational threshold in an comparison step 302 in order that if the available electrical power is too low then the fan is turned off at step 303 for a period of time whilst, if acceptable, that is to say the operational threshold is reached then the fan operated. Typically, in an initial mode the fan speed will be limited in order to limit the electrical load requirements. It will be understood that normally the power conversion threshold will be the threshold at which operation of a boost electrical power converter (201 in Fig. 3) becomes operational in order to adjust the electrical voltage received from a photovoltaic arrangement and maximise the acceptable voltage for an electrical motor to drive a fan. This power conversion threshold is above the operational threshold.

[0061] In view of the above it will be appreciated that the ventilation control avoids tying the operation of the fan to a single rotational speed which may adversely affect the capability of the photovoltaic arrangement to provide sufficient electrical power to drive the fan at that rotational speed resulting in the fan stalling with inadequate torque generated by the electrical power supply from the power converter.

[0062] As indicated above, the maximum power point (or optimum I-V point) from the photovoltaic arrangement is important in determining the capability of the fan in terms of its being able to force air through a ventilation arrangement. The present ventilation control, as indicated, can adjust the electrical load requirements of the fan by altering the electronic commutation pattern in order to match those requirements to effectively make use of all available electrical power. It will also be understood that the present control could be associated with means for adjusting the photovoltaic arrangement in terms of its orientation to sun position during the day in order to maximise the capabilities of the photovoltaic arrangement. Electrical power to drive this adjustment may be provided by the photovoltaic arrangement itself and adjustment achieved through interactive or iterative movements until the maximum available electrical power reaches a peak.

[0063] As indicated above, a further advantage of particular aspects of the present invention are that the ventilation control can be associated with wind-catcher type ventilation arrangements where air flow may be stimulated by means other than an electric motor-driven fan. In such circumstances, depending upon environmental conditions, forced air flow by the fan may not be required but the photovoltaic arrangement will generate electrical power. In such circumstances as indicated above, this electrical power may be stored in an appropriate battery or other mechanism for use subsequently when electrical power is not available through darkness or otherwise.

[0064] It will be understood by those skilled in this technology that modifications and alterations to this present invention may be performed. Thus, where desirable, a single photovoltaic arrangement may drive two or more electric motors and associated fans in differing ventilation conduits either individually or in combination.

[0065] Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

Claims

1. A method of controlling a ventilation arrangement having a fan and a photovoltaic arrangement, the method comprising

   (a) determining an optimum I-V value as an indicator of available electrical power at the photovoltaic arrangement with a present level of irradiance to the photovoltaic arrangement; and
   (b) adjusting the fan to limit the optimum I-V value which is represented as an electrical load determined for the photovoltaic arrangement, normally in terms of electrical load characteristics of the fan.

2. A method as claimed in claim 1 wherein the optimum I-V value of the fan is matched with the optimum I-V value of the photovoltaic arrangement.

3. A method as claimed in claim 1, or claim 2 wherein the optimum I-V value is determined using a maximum power point tracking (MPPT) device.

4. A method as claimed in any of claims 1 to 3 wherein the method alters the electrical load characteristics of the fan by causing a commutation pattern of a motor to drive the fan to be changed.

5. A method as claimed in any preceding claim wherein the method is arranged to define an operational threshold and a power conversion threshold for the available electrical power at the photovoltaic arrangement.

6. A method as claimed in claim 5 wherein when the available electrical power at the photovoltaic arrangement is above the operational threshold defined by the controller but below the power conversion threshold, the fan is connected directly to the

photovoltaic arrangement without adjusting the fan to match the optimum I-V value.

7. A method as claimed in any preceding claim wherein there is adjustment of the electrical load continued for as long as a power conversion threshold is exceeded.

8. A method as claimed in any preceding claim wherein the method is arranged to periodically determine the optimum I-V point at the photovoltaic arrangement.

9. A method as claimed in any preceding claim wherein power transmitted to the fan is determined prior to fan adjustment and after fan adjustment so that if a higher value of transmitted electrical power is determined after the fan is adjusted then the fan's electrical load is adjusted again in the same direction whilst if a lower value of transmitted electrical power is determined after the fan is adjusted then the fan's electrical load is adjusted in the opposite direction.

10. A method as claimed in claim 8 and any claim dependent thereon wherein the method operates by periodically open-circuiting the photovoltaic arrangement to allow a tracker device to determine open circuit voltage at the photovoltaic arrangement.

11. A method as claimed in claim 10 wherein the method assumes a proportional quotient of open circuit voltage is the voltage of the photovoltaic arrangement at which the maximum available electrical power will be available to the fan (the optimised I-V value).

12. A controller for a ventilation arrangement, the controller including a sensor associated with a photovoltaic arrangement to determine an optimum I-V value as an indicator of available electrical power at the photovoltaic arrangement due to current irridescent level presented to the photovoltaic arrangement, the sensor device providing a signal indicative of optimum I-V value to an adjustor for a fan, the adjustor coupled to the fan to enable adjustment of the fan normally in terms of electrical load to limit demand to no more than the optimum I-V value of the photovoltaic arrangement determined by the sensor.

13. A controller as claimed in claim 12 wherein the optimum I-V value is determined using a maximum power point tracking (MPPT) device.

14. A controller as claimed in claim 12 or claim 13 wherein the controller alters the electrical load characteristics of the fan by causing a commutation pattern of a motor to drive the fan to be changed.

15. A controller as claimed in any of claims 12 to 14 wherein when the available electrical power at the photovoltaic arrangement is above the operational threshold defined by the controller but below the power conversion threshold, the fan is connected directly to the photovoltaic arrangement without adjusting the fan to match the optimum I-V value.

16. A controller as claimed in any of claims 21 to 15 wherein the controller is associated with a temperature sensor or air quality sensor to adjust the fan dependent upon temperature or air pollutants.

17. A ventilation arrangement comprising a ventilation controller as claimed in any of claims 12 to 16 and a ventilation arrangement, the ventilation arrangement comprising:

a first air duct arrangement and second air duct arrangement which extend in use from roof level into an interior of a building to be ventilated to convey air between the exterior and the interior of the building;
and ventilation openings which are arranged to direct moving air caused by wind movement through the first air duct arrangement into the building.

18. An arrangement as claimed in claim 17 wherein the photovoltaic arrangement includes a photovoltaic panel, and the ventilation arrangement includes a photovoltaic panel mounting arrangement which may be arranged to mount the photovoltaic panel at an angle to the horizontal.

19. An arrangement as claimed in claim 17 1 or claim 18 wherein the controller is arranged to control the supply of electrical energy from the photovoltaic arrangement to the rechargeable battery and is arranged to permit the supply of electrical energy from the photovoltaic arrangement to the rechargeable battery only when the fan is inoperative or when the amount of electrical energy produced by the photovoltaic arrangement is greater than the amount of electrical energy to operate the fan.

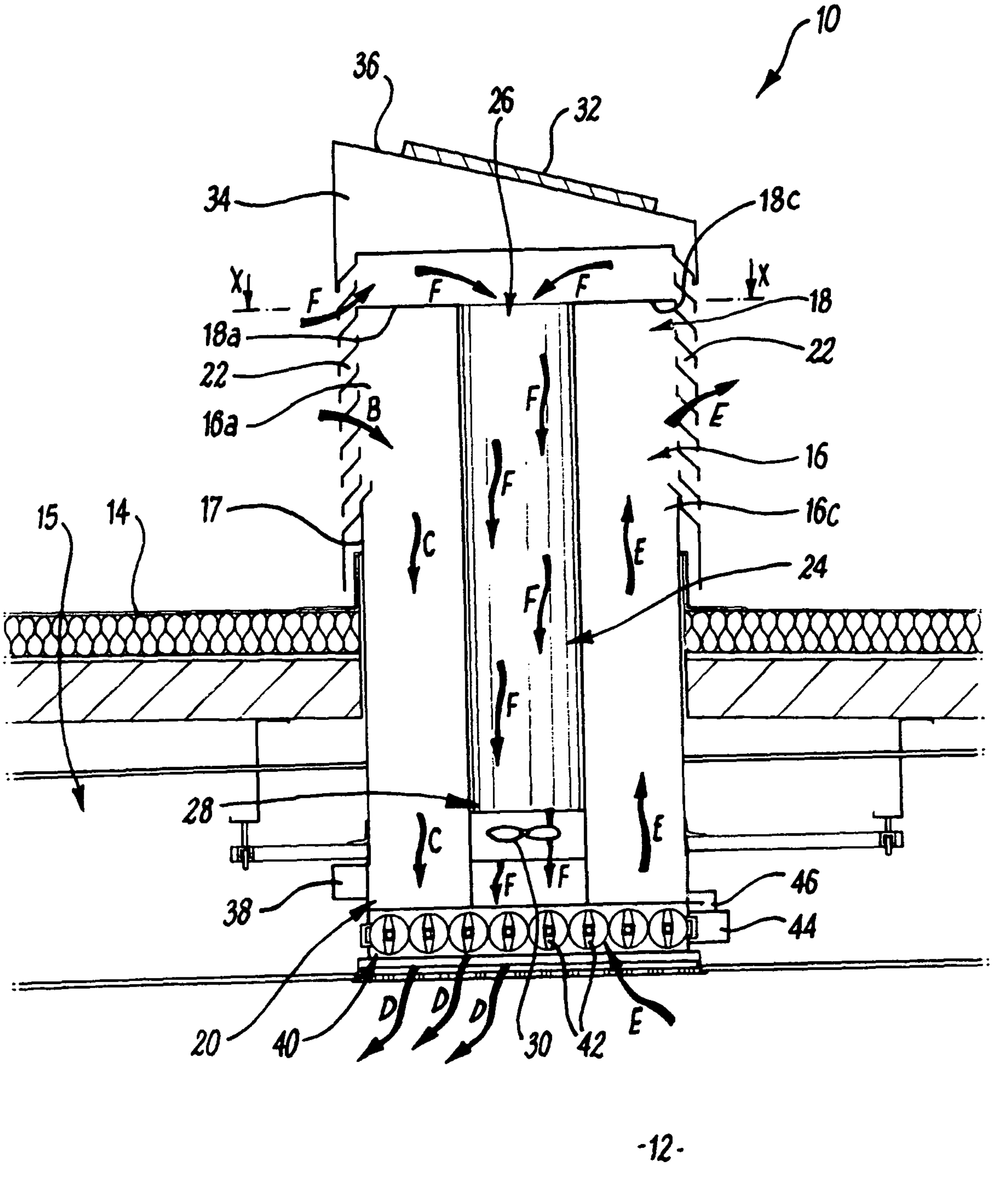
10
36
26
32
34
18c
X
F
18
18a
22
16a
B
E
16
15
14
17
C
16c
24
28
38
46
44
D
20
40
30
42
-12-

FIG. 1

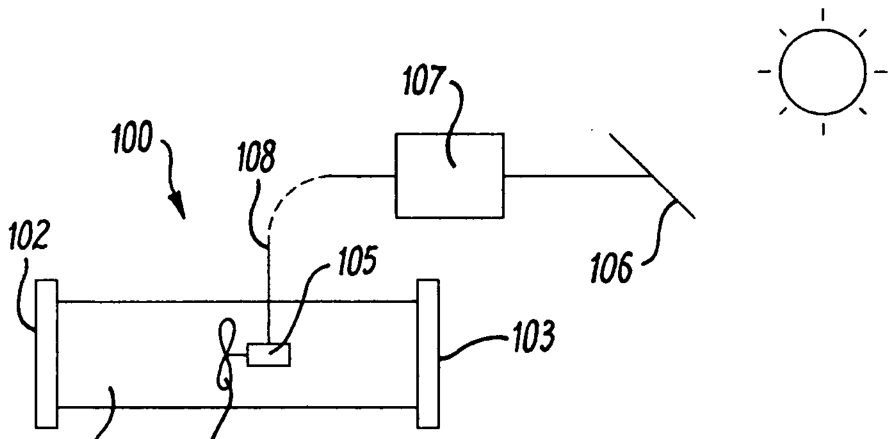
107
100
108
102
105
106
103
101
104

FIG. 2

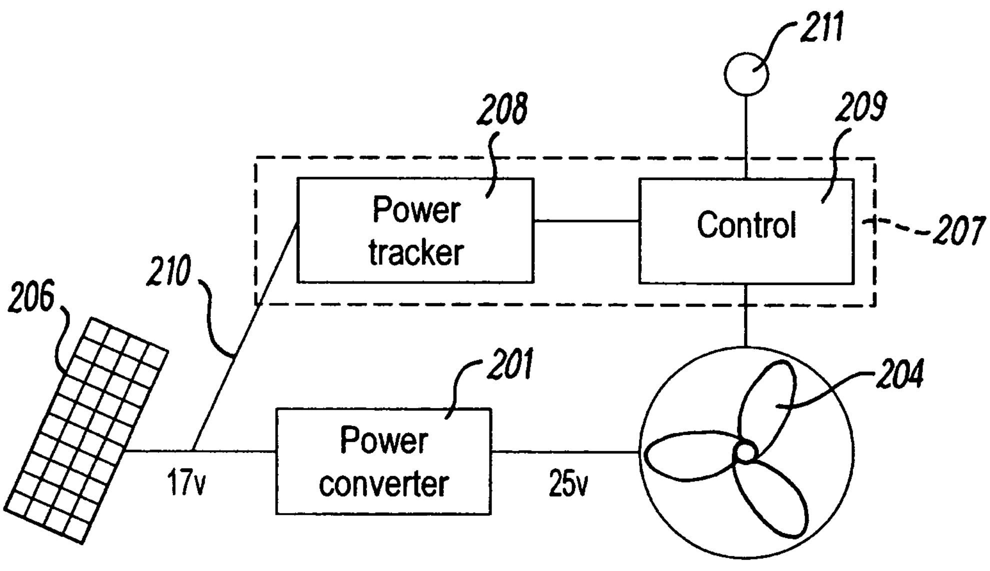
211
208
209
Power
tracker
Control
207
210
206
201
204
Power
converter
17v
25v

FIG. 3

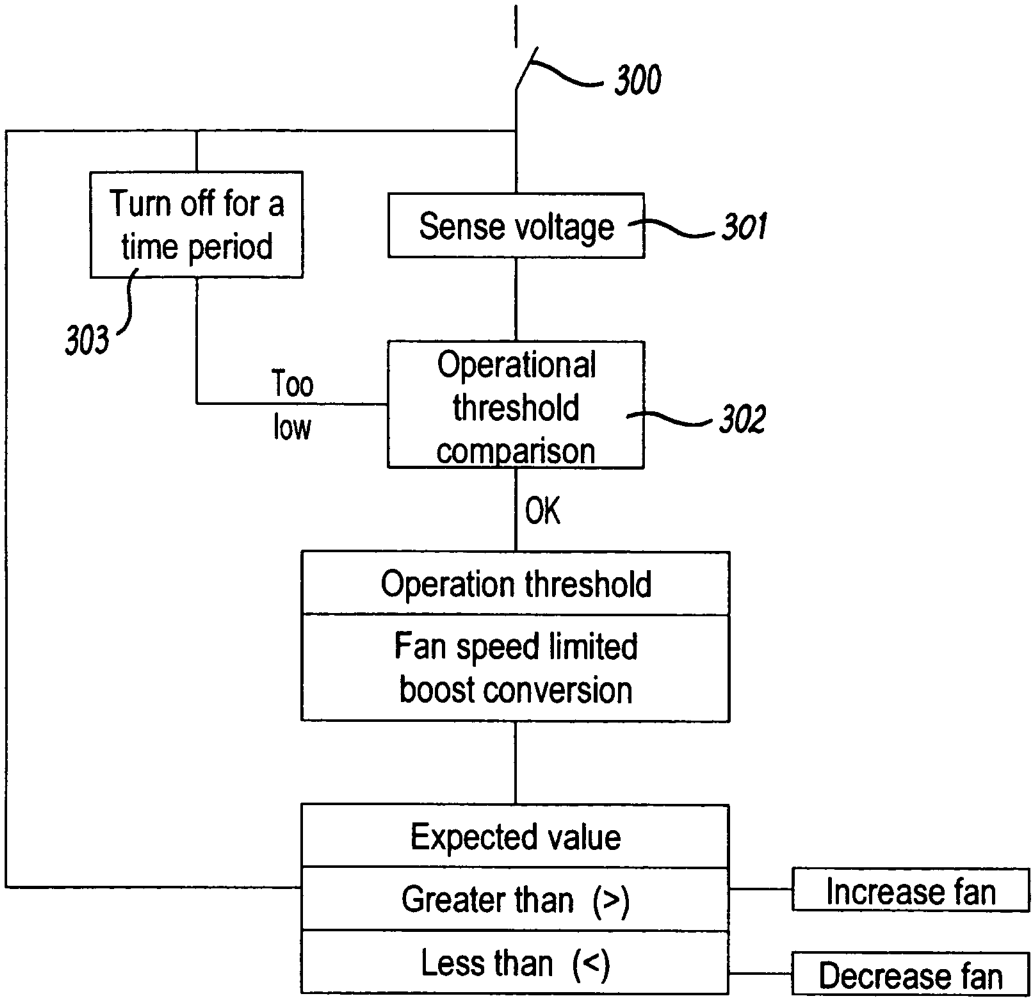
300
Turn off for a time period
Sense voltage
301
303
Too low
Operational threshold comparison
302
OK
Operation threshold
Fan speed limited boost conversion
Expected value
Greater than (>)
Less than (<)
Increase fan
Decrease fan

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 25 5778

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2005/116671 A1 (MINAMI MASAHIRO [JP] ET AL) 2 June 2005 (2005-06-02) * paragraphs [0002] - [0012]; claim 5; figures 7-9 * -----	1-4, 12-14	INV. G05F1/67 F24F11/00
X	DE 196 18 882 A1 (WEBASTO KAROSSERIESYSTEME [DE]) 13 November 1997 (1997-11-13) * column 3, line 1 - column 8, line 20; figures 1,3 * -----	1-5, 12-15	
A	DE 197 55 499 A1 (MARKERT WALTER ING GRAD [DE]) 17 June 1999 (1999-06-17) * the whole document * -----	1,12	
A	JP 2003 009572 A (EBARA CORP) 10 January 2003 (2003-01-10) * the whole document * * abstract * -----	1,12	
A	JP 08 136023 A (SANYO ELECTRIC CO) 31 May 1996 (1996-05-31) * the whole document * * abstract * -----	1,5,12	TECHNICAL FIELDS SEARCHED (IPC) G05F F24F F04D
A	WO 91/12651 A (MCCARTHY PAUL ANTHONY [AU]; JAMES JOHN BARRY [AU]) 22 August 1991 (1991-08-22) * abstract * -----	1,12	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 February 2007	Lienhard, Dominique

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 25 5778

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-02-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005116671 A1	02-06-2005	WO 03065564 A1	07-08-2003
DE 19618882 A1	13-11-1997	NONE	
DE 19755499 A1	17-06-1999	NONE	
JP 2003009572 A	10-01-2003	NONE	
JP 8136023 A	31-05-1996	NONE	
WO 9112651 A	22-08-1991	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82