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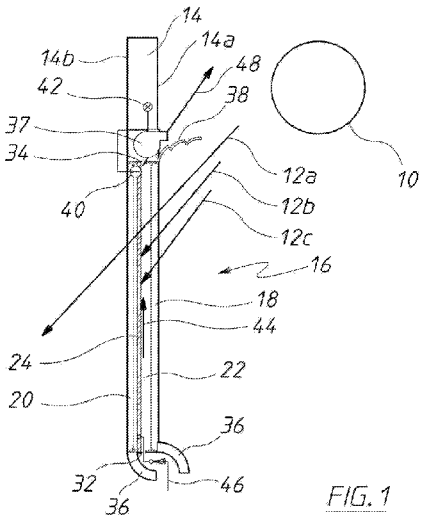

FIG. 1

(57) **Abstract**: A power generating window assembly (16) including a first pane of glass (18), a second pane of glass (20), a surface coating (24) on the on the first pane of glass (18) or the second pane of glass (20), an inlet (32), an outlet (34) and an air current driven generator (37), The first pane of glass (24) has top and bottom edges. The second pane of glass (20) has top and bottom edges and is mounted relative to the first pane of glass (18) such that a space (22) is formed therebetween. The surface coating (24) is ad - apted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light. The inlet (32) is in fluid communication with the space (22) at or near the bottom edges of the first and second panes of glass. The outlet (34) is in fluid communication with the space (22) at or near the top edges of the first and second panes of glass. The air current driven generator (37) is in fluid communication with and, in use, drivable by a flow of air leaving the outlet (34).

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A POWER GENERATING WINDOW ASSEMBLY

Field

[0001] The present invention relates to a power generating window assembly.

[0002] The present invention finds application in power generating window assemblies for new buildings (including residential, commercial and industrial) and also in retrofittable improvements to such existing buildings.

Background

[0003] The world's energy requirements are increasing at rapid rates, especially in developing countries. To date, the world has relied primarily on burning fossil fuels to meet this requirement. However, climate change, due to a build-up of greenhouse gases in the atmosphere, and energy security are now critical issues for governments. One fossil fuel alternative is nuclear energy. However, nuclear energy is expensive, politically sensitive and is not a renewable resource. Further, the cleaning up of emissions from fossil fuel and nuclear power stations is expensive. As a result, energy costs are expected to rise substantially.

[0004] The global population is also increasing at rapid rates, with the majority living and working in large cities. This in turn has led to more densely populated cities and increased building heights.

[0005] As buildings increase in size, so do their energy requirements (for internal lighting, air conditioning and heating requirements).

[0006] Two fossil fuel/nuclear energy alternatives that are renewable are wind and solar. The average maximum amount of solar energy striking the earth per square meter on a sunny day is typically 520W of infrared radiation (heat), 440W of visible light and about 30W of ultraviolet light. Wind at heights of 50m (being the height of many urban environment buildings), typically produces kinetic energy of more than 500W per square meter.

[0007] A building can be made more energy efficient by maximising the visible light entering the building with the use of large windows. However, this also means that large amounts of

infrared radiation (i.e. heat) enter and escape from the building, adding a large load to air conditioning and heating systems respectively.

[0008] It is known to apply tinting films to windows to reduce the thermal effects of sunlight entering a building. However, this typically also reduces visible light, rather than infrared heat, and adds to lighting requirements without substantially reducing air conditioning or heating requirements.

[0009] It is also known to apply thin-film photovoltaic cells, or photovoltaic cell coatings, to windows. However, whilst this generates small amounts of electricity they also, like window tinting, reduce the amount of visible light entering the building while doing very little to reduce the infrared heat. For example, current photovoltaic solar cells struggle to beat 8% efficiency and, because windows are usually vertical, the scattering of sunlight hitting the photovoltaic solar cells mean that they struggle to generate more than 8W per square meter.

Object of the Invention

[0010] It is an object of the present invention to substantially overcome or at least ameliorate one or more of the above disadvantages and/or provide window assemblies which reduce a building's energy consumption.

Summary of Invention

[0011] Accordingly, in a first aspect, the present invention provides a power generating window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a space is formed therebetween;

a surface coating on the first pane of glass or the second pane of glass, the coating adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light;

an inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass;

an outlet in fluid communication with the space at or near the top edges of the first and second panes of glass; and

an air current driven generator in fluid communication with and, in use, drivable by a flow of air leaving the outlet.

[0012] In one form, the window assembly is adapted for installation with the pane of glass having the coating nearest to the Sun. Preferably, the window assembly is adapted for installation with the pane of glass having the coating on the outside of a building. In this form, the coating is preferably on the surface of the pane of glass that faces into the space.

[0013] In another form, the window assembly is adapted for installation with the pane of glass having the coating furthest from the Sun. Preferably, the window assembly is adapted for installation with the pane of glass having the coating on the inside of a building. In this form, the coating is preferably on the surface of the pane of glass that faces into the building.

[0014] Preferably, the first and the second panes of glass have opposed peripheral edges that are substantially sealed with respect to each other, thereby enclosing the space.

[0015] Preferably, the first and the second panes of glass have respective opposed side edges between their said top and bottom edges, wherein the adjacent side edges of the first and the second panes of glass are substantially sealed with respect to each other, thereby enclosing the space in a channel with an open upper end and an open lower end.

[0016] The assembly preferably includes at least one scoop or duct adapted to direct air updrafts and/or cross drafts towards and/or into the inlet.

[0017] The air current driven generator is preferably also adapted for powered use as a suction device. The assembly preferably includes a controller adapted to energise the air current driven generator as a suction device responsive to the second pane of glass reaching and/or exceeding a predetermined temperature.

[0018] The air current driven generator is preferably a tangential blower, most preferably having a width that is approximately the same as the width of the window assembly. Alternatively, the air current driven generator is an axial fan or a centrifugal fan.

[0019] The assembly preferably includes at least one ejector, downstream of the air current driven generator. The ejector(s) is/are preferably slotted.

[0020] The assembly preferably includes at least one heat exchanger between the outlet and the air current driven generator. The assembly preferably includes at least one wall collector in a heat exchanging relationship with the heat exchanger. The assembly preferably includes at least one reverse configured Peltier thermoelectric cooler module between the outlet and the air current driven generator.

[0021] The at least one heat exchanger and/or the at least one wall collector and/or at least one reverse configured Peltier thermoelectric cooler are preferably connected to a heat engine generator. The heat engine generator is preferably an organic Rankine cycle type, a steam turbine Rankine cycle type, a reverse Peltier thermoelectric module, a low vapour expansion engine type or a Stirling engine type.

[0022] In a second aspect, the present invention provides a power generating window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a space is formed therebetween;

an inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass;

at least one scoop or duct adapted to direct air updrafts and/or cross drafts towards and/or into the inlet;

an outlet in fluid communication with the space at or near the top edges of the first and second panes of glass; and

an air current driven generator in fluid communication with and, in use, drivable by a flow of air leaving the outlet.

[0023] The air current driven generator is preferably a tangential blower, most preferably having a width that is approximately the same as the width of the window assembly. Alternatively, the air current driven generator is an axial fan or a centrifugal fan.

[0024] The assembly preferably includes at least one ejector, downstream of the air current driven generator. The ejector(s) is/are preferably slotted.

[0025] In a third aspect, the present invention provides a power generating window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a substantially fluid tight space is formed therebetween;

a surface coating on the first pane of glass or the second pane of glass, the coating adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light;

a fluid inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass;

a fluid outlet in fluid communication with the space at or near the top edges of the first and second panes of glass,

wherein the fluid outlet is in fluid communication with a heat engine generator.

[0026] The window assembly preferably includes a heat exchanger in fluid communication between the fluid outlet and the heat engine generator. The heat exchanger is preferably at least one wall collector.

[0027] The window assembly preferably includes an air current driven generator in fluid communication with and, in use, drivable by air updrafts and/or cross drafts towards. The air current driven generator preferably includes at least one ejector downstream thereof. The ejector(s) is/are preferably slotted.

[0028] In one form, the window assembly is adapted for installation with the pane of glass having the coating nearest to the Sun. Preferably, the window assembly is adapted for installation with the pane of glass having the coating on the outside of a building. In this form, the coating is preferably on the surface of the pane of glass that faces into the space.

[0029] In another form, the window assembly is adapted for installation with the pane of glass having the coating furthest from the Sun. Preferably, the window assembly is adapted for installation with the pane of glass having the coating on the inside of a building. In this form, the coating is preferably on the surface of the pane of glass that faces into the building.

[0030] Preferably, the first and the second panes of glass have opposed peripheral edges that are substantially sealed with respect to each other, thereby enclosing the space.

[0031] In a fourth aspect, the present invention provides a method of power generation in a window assembly,

the window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a space is formed therebetween; and

a surface coating on the first pane of glass or the second pane of glass, the coating adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light,

the method including the following steps:

admitting air to the space at or near the bottom edges of the first and second panes of glass;

heating and expanding the air in the space with energy absorbed in the coating from the infrared light and the ultraviolet light thereby causing the air to travel upwardly through the space towards the top edges of the first and second panes of glass; and

directing the heated air leaving the top edges of the first and second panes of glass past an air current driven generator.

[0032] The method preferably includes directing air updrafts and/or cross drafts towards and/or into the inlet, most preferably with at least one scoop or duct

[0033] In one form, the method preferably includes installing the window assembly with the pane of glass having the coating nearest to the Sun. Preferably, the method preferably includes installing the window assembly with the pane of glass having the coating on the outside of a building. In this form, the coating is preferably on the surface of the pane of glass that faces into the space.

[0034] In another form, the method preferably includes installing the window assembly with the pane of glass having the coating furthest from the Sun. Preferably, the method preferably includes installing the window assembly with the pane of glass having the coating on the inside of a building. In this form, the coating is preferably on the surface of the pane of glass that faces into the building.

[0035] Preferably, the method preferably includes sealing opposed peripheral edges of the first pane of glass and the second pane of glass with respect to each other to thereby enclose the space.

[0036] In a fifth aspect, the present invention provides a retrofittable power generating window assembly including:

a first pane of glass having a surface coating thereon which is adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light; and

a mounting arrangement adapted for fixing the pane of glass to the exterior of second pane of glass forming part of an existing building window with a space between the outer face of the second pane of glass and the inner face of the first pane of glass.

[0037] The coating is preferably on the surface of the first pane of glass that faces into the space.

[0038] Preferably, the first and the second panes of glass have opposed peripheral edges that are substantially sealed with respect to each other, thereby enclosing the space.

[0039] Preferably, the first and the second panes of glass have respective opposed side edges between their said top and bottom edges, wherein the adjacent side edges of the first and the second panes of glass are substantially sealed with respect to each other, thereby enclosing the space in a channel with an open upper end an open lower end.

[0040] The retrofittable power generating window assembly preferably further includes an inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass, an outlet in fluid communication with the space at or near the top edges of the first and second panes of glass, and an air current driven generator in fluid communication with and, in use, drivable by a flow of air leaving the outlet.

[0041] The assembly preferably includes at least one scoop or duct adapted to direct air updrafts and/or cross drafts towards and/or into the inlet.

[0042] The air current driven generator is preferably also adapted for powered use as a suction device.

[0043] The assembly preferably includes a controller adapted to energise the air current driven generator as a suction device responsive to the second pane of glass reaching and/or exceeding a predetermined temperature.

[0044] The air current driven generator is preferably a tangential blower, most preferably having a width that is approximately the same as the width of the window assembly. Alternatively, the air current driven generator is an axial fan or a centrifugal fan.

[0045] The assembly preferably includes at least one ejector, downstream of the air current driven generator. The ejector(s) is/are preferably slotted.

[0046] The assembly preferably includes at least one heat exchanger between the outlet and the air current driven generator. The assembly preferably includes at least one wall collector in a heat exchanging relationship with the heat exchanger. The assembly preferably includes at least one reverse configured Peltier thermoelectric cooler module between the outlet and the air current driven generator.

[0047] The at least one heat exchanger and/or the at least one wall collector and/or at least one reverse configured Peltier thermoelectric cooler are preferably connected to a heat engine generator. The heat engine generator is preferably an organic Rankine cycle type, a steam turbine Rankine cycle type, a reverse Peltier thermoelectric module, a low vapour expansion engine type or a Stirling engine type.

Brief Description of Drawings

[0048] Preferred embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings in which:

[0049] Fig. 1 is a schematic cross sectional side view of a first embodiment of a window assembly;

[0050] Figs. 2a and 2b are a schematic cross sectional side view of a second embodiment of a power generating window assembly, pre- and post-installation respectively;

[0051] Fig. 3 is a schematic cross sectional side views of a third embodiment of a power generating window assembly

[0052] Fig. 4 is a schematic cross sectional side view of a fourth embodiment of power generating window assembly;

[0053] Fig. 5 is a schematic cross sectional side view of a fifth embodiment of a power generating window assembly;

[0054] Fig. 6 is a schematic cross sectional side view of a sixth embodiment of a power generating window assembly;

[0055] Fig. 7 is a schematic cross sectional side view of a seventh embodiment of a power generating window assembly;

[0056] Fig. 8 is a schematic cross sectional side view of an eighth embodiment of a power generating window assembly; and

[0057] Fig. 9 is a schematic cross sectional side view of a ninth embodiment of a power generating window assembly.

Detailed Description of the Preferred Embodiments

[0058] Fig. 1 shows the Sun 10 emitting sunlight in the form of visible light 12a, infrared light/radiation (i.e. heat) 12b and ultraviolet light 12c. The sunlight is incident on a wall 14 of a building that has an exterior surface 14a and an interior surface 14b. A first embodiment of a power generating window assembly, indicated generally by the reference numeral 16, is positioned within an opening in the wall 14.

[0059] The window assembly 16 includes a first pane of glass 18 and a second pane of glass 20, which are installed with a space 22 therebetween. A typical size of the first and second panes of glass 18 and 20 are 0.6 m wide, 1.2 m high and 0.04 m deep, with a space 22 therebetween which is 0.02m deep.

[0060] A coating 24 is applied to the surface of the second pane of glass 20 that faces into the space 22. The coating 24 substantially permits the passage of visible light 12a therethrough, whilst substantially absorbing the infrared radiation 12b and the ultraviolet light 12c. A preferred example of the coating 24 is product called Zerocoat and is distributed by 21st Global Pty Ltd of Salamander Bay, New South Wales, Australia. This product is applied with a bonding polymer that is self-leveling. This product hardens to the same hardness as glass. It is a single formula using an absorber of nano-particles ink developed by Sumitomo Metal and Mining. The formulation of the coating can be adjusted to balance the relative amounts of infrared radiation absorption and visible light admittance.

[0061] Other examples of suitable products for the coating 24 are as follows: 3M Solar Control Films, distributed by 3M Australia of North Ryde, Australia; Thin Film Coatings – Custom, distributed by Reynard Corporation of San Clemente, California, USA; and Heat-reflective Coated Glass, distributed by Xinyi Glass of Phase 2, Hong Kong.

[0062] The first and second panes of glass 18 and 20 are sealed with respect to each other along their side edges such that the space 22 is in the form of a vertical channel or passage, having a lower inlet 32 and an upper outlet 34. The assembly 16 includes scoops or ducts 36 adjacent the inlet 32, to assist in directing air updrafts and/or cross-drafts towards and/or into the inlet 32. The assembly 16 also includes an air current driven electrical generator, in the form of a tangential blower 37 mounted downstream of the outlet 34. The blower 37 is about the same width as the first and second panes of glass 18 and 20. An ejector 38 is mounted downstream of the outlet of the blower 34. The ejector 38 is preferably slotted and is similar to that described in Australian provisional patent application no. 2013901993. The assembly 16 also includes a temperature gauge 40 associated with the second pane of glass 20 and a magnetic inductor 42 associated with the blower 37.

[0063] In operation, most of the Sun's visible light 12a passes through the window assembly 16 into the building. Most of the ultraviolet light 12c is blocked by the coating 24. Most of the Sun's infrared radiation 12b does not pass through and instead heats the coating 24 on the second pane of glass 20. This in turn heats the air within the space 22 causing it to expand and rise upwards, as indicated by arrow 44. The upward passage of the heated air 44 is also aided by any air updrafts and/or cross-drafts, as indicated by arrow 46, that are directed into the inlet 32 by the scoops 36. The rising air leaving the outlet 34 is directed through the blower 37, as

indicated by arrow 48, causing it to rotate and thereby generate electricity. The electricity generated is communicated to other parts of the building via the magnetic inductor 42 or by a simple wired connection (not shown). Alternative wireless electricity transmission mechanisms such as laser or microwave (not shown) could also be used instead of the magnetic inductor 42.

[0064] A typical installation of multiple units of the window assemblies 16 in a high rise building can generate up to 500 watts per square metre of solar thermal energy plus more than a further 250 watts per square metre of wind mechanical energy (at 50 metres high). The 500 watts of thermal energy equates to more than 300 watts per square metre of thermal energy blocked from entering the building which can be harnessed and converted to more than 100 watts of electricity. The 250 watts of mechanical wind energy can also be converted to more than 100 watts of electricity. In combination, more than 200 watts of electricity is provided, whilst the 300 watts of blocked thermal energy reduces the air conditioning system electricity requirements by about 100 watts. Overall, the assembly 16 provides up to 300 watts per square metre of nett electricity generated and saved. This figure can be higher in hot and windy climates. In Winter, the thermal radiation from internal heating is smaller than from the Sun. However, a combination of some Winter sunlight combined with significant energy from thermal losses through the window combined with the mechanical wind energy amounts to similar amount of energy saved and generated as in Summer.

[0065] The temperature gauge 40 is connected to a simple temperature controller (not shown) which sensors the temperature of the glass pane 20 to ensure that it does not exceed at pre-determined set point at which it could crack. If the set point is reached, the blower 37 is energised for a period of time, turning it into a suction fan, to draw air though the space to cool the glass pane 20 down to a safe temperature.

[0066] The economics of a power generation device are a major concern and the window assembly 16 can be constructed from relatively simple and inexpensive components, and can generate relatively large amounts of electricity for relatively long amounts of time. This equates to a much more attractive and cost-effective device. The window assembly 16 addresses two major issues for power generation and consumption. That is, it significantly reduces the amount of energy required by a building, whilst also generating meaningful amounts of power (typically more than 300W per square meter). Additionally, most power is consumed on a hot sunny day

and this is when most power is generated, thereby importantly matching the power supply to meet the demand.

[0067] The assembly 16 is most suited for replacement of existing windows in an existing building or in the provision of new windows for a new building. Figs. 2a and 2b show a second embodiment of a power generating window assembly 60. The assembly 60 is similar to the assembly 16 described with reference to Fig. 1 and like features have been indicated with like reference numerals. The assembly 60 is best suited to converting an existing window into a power generating window assembly similar to that previously described. In the assembly 60, the coating 24 is applied to the inside facing surface of a third window pane 62. The third window pane 62 forms a sub-assembly with the scoops 36, the blower 37, the magnetic inductor 42 and the temperature gauge 40. This sub-assembly is then mounted to the outside of the existing window panes 18/20 with a space 64 therebetween. Once installed, the operation of the assembly 60 is identical to that described with reference to the assembly 30 with the magnetic inductor 42 supplying energy to further magnetic inductors 66 for powering lighting 68 and other components (not shown) and/or supply excess energy back to the building switchboard 70, which can then be fed into the electricity grid to produce income.

[0068] Fig. 3 shows a third embodiment of a power generating window assembly 80. The assembly 80 is similar to the assembly 16 described with reference to Fig. 1 and like features has been indicated with like reference numerals. However, the system 80 includes a heat exchanger 82 positioned between the outlet 34 and the blower 37 in a heat exchanging relationship with the heated air 44 moving upwardly through the space 22. The heat exchanger 82 is connected to a heat engine generator (not shown) by inlet line 84 and outlet line 86 for generation of additional electricity to that previously described. The operation of the assembly 80 is similar to that described with reference to the assembly 16 except for the additional electricity generation from the heat exchanger 82 and the heat engine generator (not shown). There are numerous different types of heat engine generators suitable for this application including an organic Rankine cycle type, a steam turbine Rankine cycle type, a reverse Peltier thermoelectric module, a low vapour expansion engine type or a Stirling engine type.

[0069] Fig. 4 shows a fourth embodiment of a power generating window assembly 100 which is similar to the system 80 previously described. Once again, like features are indicated with like reference numerals. However, in the system 100, a Peltier thermoelectric cooler 102 working in

reverse that is in a heat exchanging in relationship with the heated air 44 traveling upwardly through the gap 22. The passage of the heated air 44 past the cooler 102 generates an additional amount of electrical energy that is typically twice the efficiency and double the amount generated compared to just heating and expanding the air as described in the assembly 16 with reference to Fig. 1.

[0070] Fig. 5 shows a fifth embodiment of a power generating window assembly 120. The assembly 120 is similar to the assembly 16 described with reference to Fig. 1 and like features have been indicated with like reference numerals. However, the assembly 120 includes a closed circuit heat engine generator, indicated generally by the reference numeral 122. The generator 122 includes a fluid pump 124 which pressurises a fluid such that it is at a medium pressure and low temperature at a junction measured by a pressure sensor 126 and a temperature sensor 128. At that junction, the fluid enters a concentrated solar collector, in the form a flat plate 130 with fluid circuits inside and coated with a heat absorbent coating such as the Zerocoat previously mentioned or a carbon nanotube coating. Alternatively a traditional concave reflector mirror (not shown) can be used to heat a small collector or a flat plate heat exchanger. In either case, the collector 130 tracks the Sun 10 for maximum heat absorption and the fluid is heated to a very high temperature, typically of several hundred degrees Celsius. This also causes the pressure of the fluid to increase to a very high level, typically to several bars. The fluid at this relatively high temperature and pressure is measured by a pressure sensor 130 and a temperature sensor 132. The fluid is then supplied to an expander turbine 134 causing it to rotate and drive a generator (not shown) which generates electricity. The fluid exiting the expander turbine 134 is at a low pressure and a medium temperature, as measured by a pressure sensor 136 and a temperature sensor 138. The fluid then enters a condenser 140 where it is cooled to a low temperature gas (for a reverse refrigeration cycle-not shown) or to a low temperature liquid (for an organic Rankine-cycle as shown). The condenser 140 has an associated temperature sensor 141. The condenser 140 has a fan 142 which is electrically or mechanically coupled to the pump 124. A clutch or electronic controller (not shown) is configured such that when the pump 124 operates, the condenser fan 142 operates to provide the required cooling.

[0071] At the junction adjacent to the sensors 126 and 128, the fluid is at medium pressure and low temperature and the fluid can optionally branch off to a valve 143 and integrate with an ice maker plus cold thermal energy storage tank 144 and/or integrate or retrofit to a new or existing air conditioning (or refrigeration) system 146. In either case, the infrastructure and refrigerant

fluid of the ice maker system 144 or the air conditioning system 146 is utilised to reduce capital costs, particularly if such components already exist in a building. Two non-return valves 148 and 150 are used to stop fluid entering the ice maker or air conditioning system from the wrong direction. Integration with an existing air conditioning system advantageously reduces the capital costs overall and significantly reduces operational costs, particularly in Winter or colder seasons where in any heat generated from the collectors can be utilised for off-loading the air conditioning system working as a reverse cycle heat pump.

[0072] Fig. 6 shows a sixth embodiment of a window generating assembly160. The assembly 160 is similar to the assembly 120 described with reference to Fig. 5 and like features have been indicated with like reference numerals. However, the assembly 160 also includes wall mounted solar collector 162 and a roof mounted solar collector 164 which are also connected to, and provide heated fluid to, the closed circuit heat engine generator 122, thereby increasing its power output. Additionally a heat exchanger (not shown) can be used to capture the waste heat from an air conditioning or refrigeration system condenser or from other waste heat from industrial processes thereby further increasing the power output of the heat engine generator 122.

[0073] Fig. 7 shows a seventh embodiment of a window generating assembly 180. The system 180 is similar to the assembly 16 described with reference to Fig. 1 and like features have been indicated with like reference numerals. However, in the assembly 180, the coating 24 is not utilised and, as result, the Sun's infrared radiation 12b can also pass into the building. The air 44 within the space 22 is thus heated to a lesser extent than would be the case with the window assembly 16. The upward passage of the heated air 44 is also aided by an air updrafts and/or cross drafts 46. The assembly 180 therefore typically produces less energy per square meter than the assembly 16. The assembly 180 finds particular application in very cold climates where there is little solar radiation 12b.

[0074] Fig. 8 shows an eighth embodiment of a power generating window assembly 200. The assembly 200 is similar to the assembly 16 described with reference to Fig. 1 and like features have been indicated with like reference numerals. However, in the assembly 200, fluid (not air) is heated during its passage through the space 22 for electricity generation via a closed circuit heat engine generator, such as the generator 122 described with references to Fig. 5. In this embodiment, an air updrafts and/or cross drafts are directly into the inlet of the blower 37.

[0075] Fig. 9 shows a ninth embodiment of power generating window assembly 220. The assembly 220 is similar to the assembly 16 described with reference to Fig. 1 and like features have been indicated with like reference numerals. However, in the assembly 220, about the lower third of the side edges between the first and second glass panes 18 and 20 are also open and provide extra side inlets 222 and 224, in addition to the lower edge inlet 32. The scoop/ducts 36 also include side extensions 226 and 228 to assist in directing air updrafts and/or cross drafts 46 into the side inlets 222 and 224. The side extensions 226 and 228 are will capture more cross drafts to provide significantly more power to drive the blower 37, particularly in densely packed cities, where winds flow around buildings creating a "wind tunnel" effect.

[0076] Although the invention has been described with reference to preferred embodiments, it will be appreciated by persons skilled in the art that the invention may be embodied in many other forms.

CLAIMS:

1. A power generating window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a space is formed therebetween;

a surface coating on the first pane of glass or the second pane of glass, the coating adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light;

an inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass;

an outlet in fluid communication with the space at or near the top edges of the first and second panes of glass; and

an air current driven generator in fluid communication with and, in use, drivable by a flow of air leaving the outlet.

2. The power generating window assembly as claimed in claim 1, wherein the window assembly is adapted for installation with the pane of glass having the coating nearest to the Sun.

3. The power generating window assembly as claimed in claim 2, wherein the window assembly is adapted for installation with the pane of glass having the coating on the outside of a building.

4. The power generating window assembly as claimed in claim 3, wherein the coating is on the surface of the pane of glass that faces into the space.

5. The power generating window assembly as claimed in claim 1, wherein the window assembly is adapted for installation with the pane of glass having the coating furthest from the Sun.

6. The power generating window assembly as claimed in claim 5, wherein the window assembly is adapted for installation with the pane of glass having the coating on the inside of a building.

7. The power generating window assembly as claimed in claim 6, wherein the coating is on the surface of the pane of glass that faces into the building.

8. The power generating window assembly as claimed in any one of claims 1 to 7, wherein the first and the second panes of glass have opposed peripheral edges that are substantially sealed with respect to each other, thereby enclosing the space.

9. The power generating window assembly as claimed in any one of claims 1 to 7, wherein the first and the second panes of glass have respective opposed side edges between their said top and bottom edges, wherein the adjacent side edges of the first and the second panes of glass are substantially sealed with respect to each other, thereby enclosing the space in a channel with an open upper end and an open lower end.

10. The power generating window assembly as claimed in any one of claims 1 to 9, wherein the assembly includes at least one scoop or duct adapted to direct air updrafts and/or cross drafts towards and/or into the inlet.

11. The power generating window assembly as claimed in any one of claims 1 to 10, wherein the air current driven generator is also adapted for powered use as a suction device.

12. The power generating window assembly as claimed in claim 11, wherein the assembly includes a controller adapted to energise the air current driven generator as a suction device responsive to the second pane of glass reaching and/or exceeding a predetermined temperature.

13. The power generating window assembly as claimed in any one of claims 1 to 12, wherein the air current driven generator is a tangential blower

14. The power generating window assembly as claimed in claim 13, wherein the tangential blower has a width that is approximately the same as the width of the window assembly.

15. The power generating window assembly as claimed in any one of claims 1 to 13, wherein the air current driven generator is an axial fan or a centrifugal fan.

16. The power generating window assembly as claimed in any one of claims 1 to 15, wherein the assembly includes at least one ejector, downstream of the air current driven generator.

17. The power generating window assembly as claimed in claim 16, wherein the ejector(s) is/are slotted.

18. The power generating window assembly as claimed in any one of claims 1 to 17, wherein the assembly includes at least one heat exchanger between the outlet and the air current driven generator.

19. The power generating window assembly as claimed in claim 18, wherein the assembly includes at least one wall collector in a heat exchanging relationship with the heat exchanger.

20. The power generating window assembly as claimed in any one of claims 1 to 17, wherein the assembly includes at least one reverse configured Peltier thermoelectric cooler module between the outlet and the air current driven generator.

21. The power generating window assembly as claimed in claims 18, 19 or 20, wherein the at least one heat exchanger and/or the at least one wall collector and/or at least one reverse configured Peltier thermoelectric cooler are connected to a heat engine generator.

22. The power generating window assembly as claimed in claim 21, wherein the heat engine generator is an organic Rankine cycle type, a steam turbine Rankine cycle type, a reverse Peltier thermoelectric module, a low vapour expansion engine type or a Stirling engine type.

23. A power generating window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a space is formed therebetween;

an inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass;

at least one scoop or duct adapted to direct air updrafts and/or cross drafts towards and/or into the inlet;

an outlet in fluid communication with the space at or near the top edges of the first and second panes of glass; and

an air current driven generator in fluid communication with and, in use, drivable by a flow of air leaving the outlet.

24. The power generating window assembly as claimed in claim 23, wherein the air current driven generator is a tangential blower

25. The power generating window assembly as claimed in claim 24, wherein the tangential blower has a width that is approximately the same as the width of the window assembly.

26. The power generating window assembly as claimed in claim 23, wherein the air current driven generator is an axial fan or a centrifugal fan.

27. The power generating window assembly as claimed in any one of claims 23 to 26, wherein the assembly includes at least one ejector, downstream of the air current driven generator.

28. The power generating window assembly as claimed in claim 27, wherein the ejector(s) is/are slotted.

29. A power generating window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a substantially fluid tight space is formed therebetween;

a surface coating on the first pane of glass or the second pane of glass, the coating adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light;

a fluid inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass;

a fluid outlet in fluid communication with the space at or near the top edges of the first and second panes of glass,

wherein the fluid outlet is in fluid communication with a heat engine generator.

30. The power generating window assembly as claimed in claim 29, wherein the window assembly includes a heat exchanger in fluid communication between the fluid outlet and the heat engine generator.

31. The power generating window assembly as claimed in claim 30, wherein the heat exchanger is at least one wall collector.

32. The power generating window assembly as claimed in claim 29, 30 or 31, wherein the window assembly includes an air current driven generator in fluid communication with and, in use, drivable by air updrafts and/or cross drafts towards.

33. The power generating window assembly as claimed in claim 32, wherein the air current driven generator includes at least one ejector downstream thereof.

34. The power generating window assembly as claimed in claim 33, wherein the ejector(s) is/are slotted.

35. The power generating window assembly as claimed in any one of claims 29 to 34, wherein the window assembly is adapted for installation with the pane of glass having the coating nearest to the Sun.

36. The power generating window assembly as claimed in claim 35, wherein the window assembly is adapted for installation with the pane of glass having the coating on the outside of a building.

37. The power generating window assembly as claimed in claim 36, wherein the coating is on the surface of the pane of glass that faces into the space.

38. The power generating window assembly as claimed in any one of claims 29 to 34, wherein the window assembly is adapted for installation with the pane of glass having the coating furthest from the Sun.

39. The power generating window assembly as claimed in claim 38, wherein the window assembly is adapted for installation with the pane of glass having the coating on the inside of a building.

40. The power generating window assembly as claimed in claim 39, wherein the coating is preferably on the surface of the pane of glass that faces into the building.

41. The power generating window assembly as claimed in any one of claims 29 to 40, wherein the first and the second panes of glass have opposed peripheral edges that are substantially sealed with respect to each other, thereby enclosing the space.

42. A method of power generation in a window assembly,

the window assembly including:

a first pane of glass having top and bottom edges;

a second pane of glass having top and bottom edges and mounted relative to the first pane of glass such that a space is formed therebetween; and

a surface coating on the first pane of glass or the second pane of glass, the coating adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light,

the method including the following steps:

admitting air to the space at or near the bottom edges of the first and second panes of glass;

heating and expanding the air in the space with energy absorbed in the coating from the infrared light and the ultraviolet light thereby causing the air to travel upwardly through the space towards the top edges of the first and second panes of glass; and

directing the heated air leaving the top edges of the first and second panes of glass past an air current driven generator.

43. The method as claimed in claim 42, wherein the method includes directing air updrafts and/or cross drafts towards and/or into the inlet.

44. The method as claimed in claim 43, wherein the air is directed with at least one scoop or duct.

45. The method as claimed in claim 42, 43 or 44, wherein the method includes installing the window assembly with the pane of glass having the coating nearest to the Sun.

46. The method as claimed in claim 45, wherein the method includes installing the window assembly with the pane of glass having the coating on the outside of a building.

47. The method as claimed in claim 46, wherein the coating is on the surface of the pane of glass that faces into the space.

48. The method as claimed in claim 42, 43 or 44, wherein the method includes installing the window assembly with the pane of glass having the coating furthest from the Sun.

49. The method as claimed in claim 48, wherein the method includes installing the window assembly with the pane of glass having the coating on the inside of a building.

50. The method as claimed in claim 49, wherein the coating is on the surface of the pane of glass that faces into the building.

51. The method as claimed in any one of claims 42 to 50, wherein the method includes sealing opposed peripheral edges of the first pane of glass and the second pane of glass with respect to each other to thereby enclose the space.

52. A retrofittable power generating window assembly including:

a first pane of glass having a surface coating thereon which is adapted to substantially permit the passage of visible light therethrough whilst substantially absorbing infrared light and ultraviolet light; and

a mounting arrangement adapted for fixing the pane of glass to the exterior of second pane of glass forming part of an existing building window with a space between the outer face of the second pane of glass and the inner face of the first pane of glass.

53. The retrofittable power generating window assembly as claimed in claim 52, wherein the coating is on the surface of the first pane of glass that faces into the space.

54. The retrofittable power generating window assembly as claimed in claim 52 or 53, wherein the first and the second panes of glass have opposed peripheral edges that are substantially sealed with respect to each other, thereby enclosing the space.

55. The retrofittable power generating window assembly as claimed in claim 52 or 53, wherein the first and the second panes of glass have respective opposed side edges between their said top and bottom edges, wherein the adjacent side edges of the first and the second panes of

glass are substantially sealed with respect to each other, thereby enclosing the space in a channel with an open upper end an open lower end.

56. The retrofittable power generating window assembly as claimed in any one of claims 52 to 55, further including an inlet in fluid communication with the space at or near the bottom edges of the first and second panes of glass, an outlet in fluid communication with the space at or near the top edges of the first and second panes of glass, and an air current driven generator in fluid communication with and, in use, drivable by a flow of air leaving the outlet.

57. The retrofittable power generating window assembly as claimed in claim 56, wherein the assembly includes at least one scoop or duct adapted to direct air updrafts and/or cross drafts towards and/or into the inlet.

58. The retrofittable power generating window assembly as claimed in claim 56, wherein the air current driven generator is also adapted for powered use as a suction device.

59. The retrofittable power generating window assembly as claimed in claim 58, wherein the assembly includes a controller adapted to energise the air current driven generator as a suction device responsive to the second pane of glass reaching and/or exceeding a predetermined temperature.

60. The retrofittable power generating window assembly as claimed in claim 57, 58 or 59, wherein the air current driven generator is a tangential blower

61. The retrofittable power generating window assembly as claimed in claim 60, wherein the tangential blower has a width that is approximately the same as the width of the window assembly.

62. The retrofittable power generating window assembly as claimed in claim 57, 58 or 59, wherein the air current driven generator is an axial fan or a centrifugal fan.

63. The retrofittable power generating window assembly as claimed in any one of claims 57 to 62, wherein the assembly includes at least one ejector, downstream of the air current driven generator.

64. The retrofittable power generating window assembly as claimed in claim 63, wherein the ejector(s) is/are preferably slotted.

65. The retrofittable power generating window assembly as claimed in any one of claims 57 to 64, wherein the assembly includes at least one heat exchanger between the outlet and the air current driven generator.

66. The retrofittable power generating window assembly as claimed in claim 65, wherein the assembly includes at least one wall collector in a heat exchanging relationship with the heat exchanger.

67. The retrofittable power generating window assembly as claimed in any one of claims 57 to 64, wherein the assembly includes at least one reverse configured Peltier thermoelectric cooler module between the outlet and the air current driven generator.

68. The retrofittable power generating window assembly as claimed in claim 64, 66 or 67, wherein the at least one heat exchanger and/or the at least one wall collector and/or at least one reverse configured Peltier thermoelectric cooler are connected to a heat engine generator.

69. The retrofittable power generating window assembly as claimed in claim 68, wherein the heat engine generator is an organic Rankine cycle type, a steam turbine Rankine cycle type, a reverse Peltier thermoelectric module, a low vapour expansion engine type or a Stirling engine type.

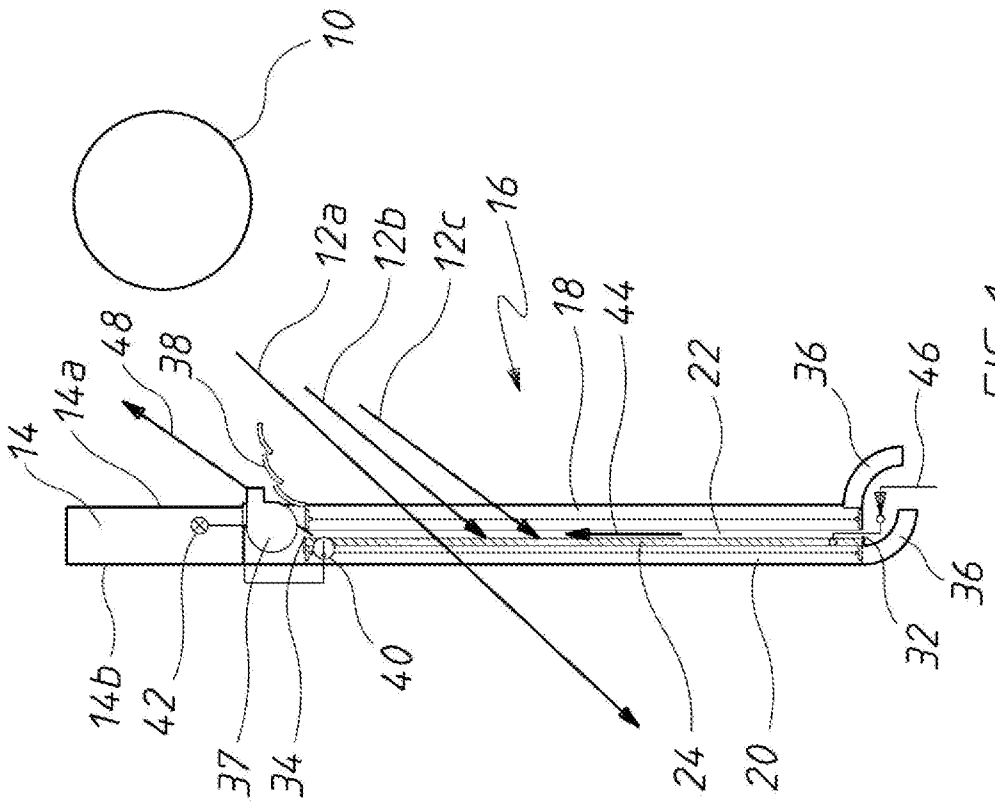
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FIG. 1

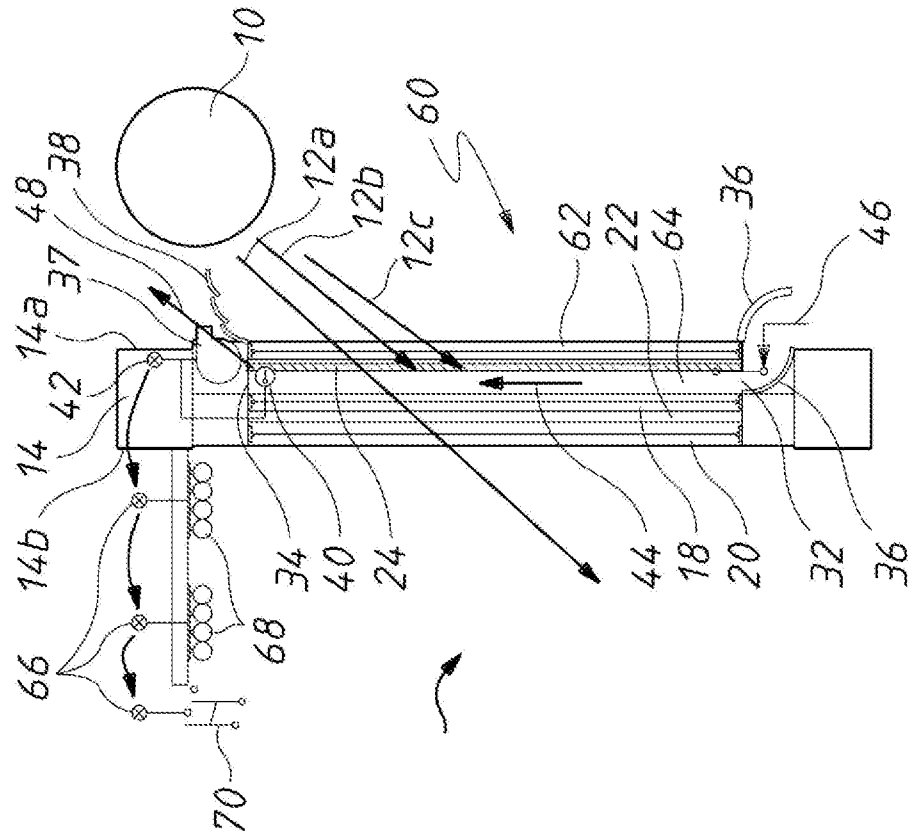
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FIG.2b

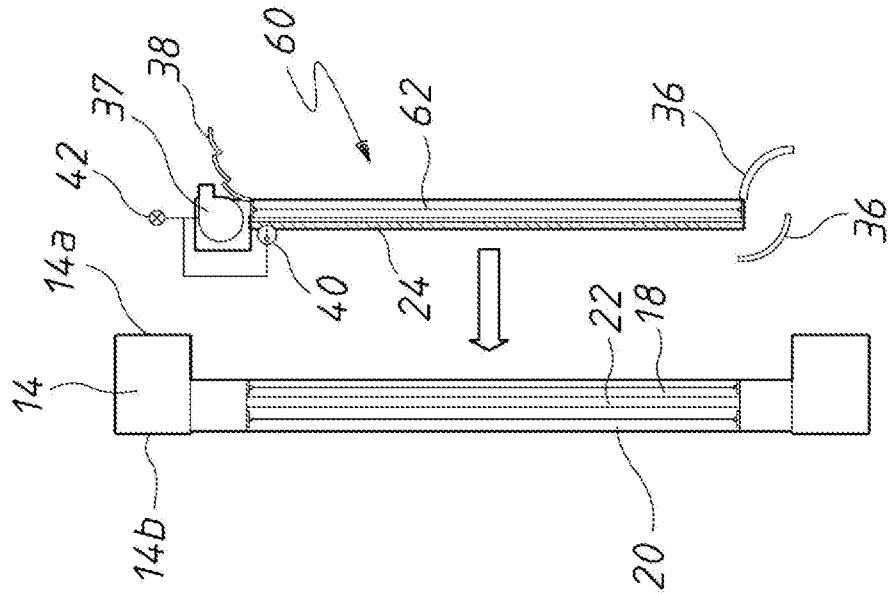
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FIG.2a

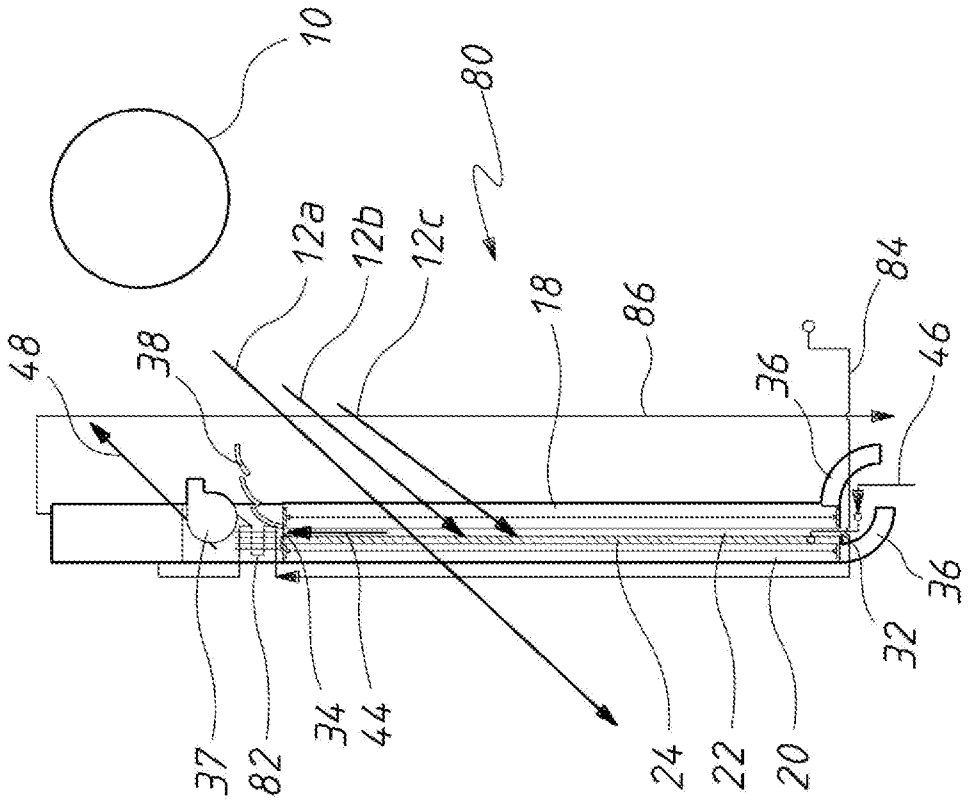

FIG.3

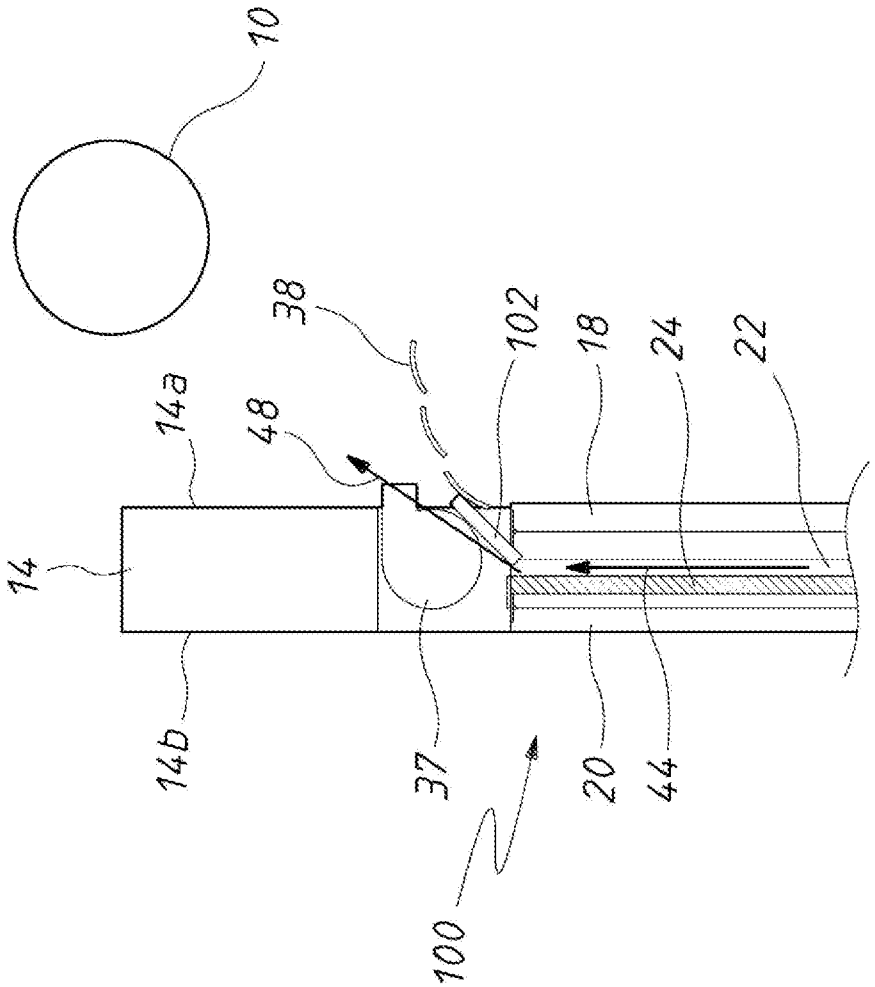

FIG.4

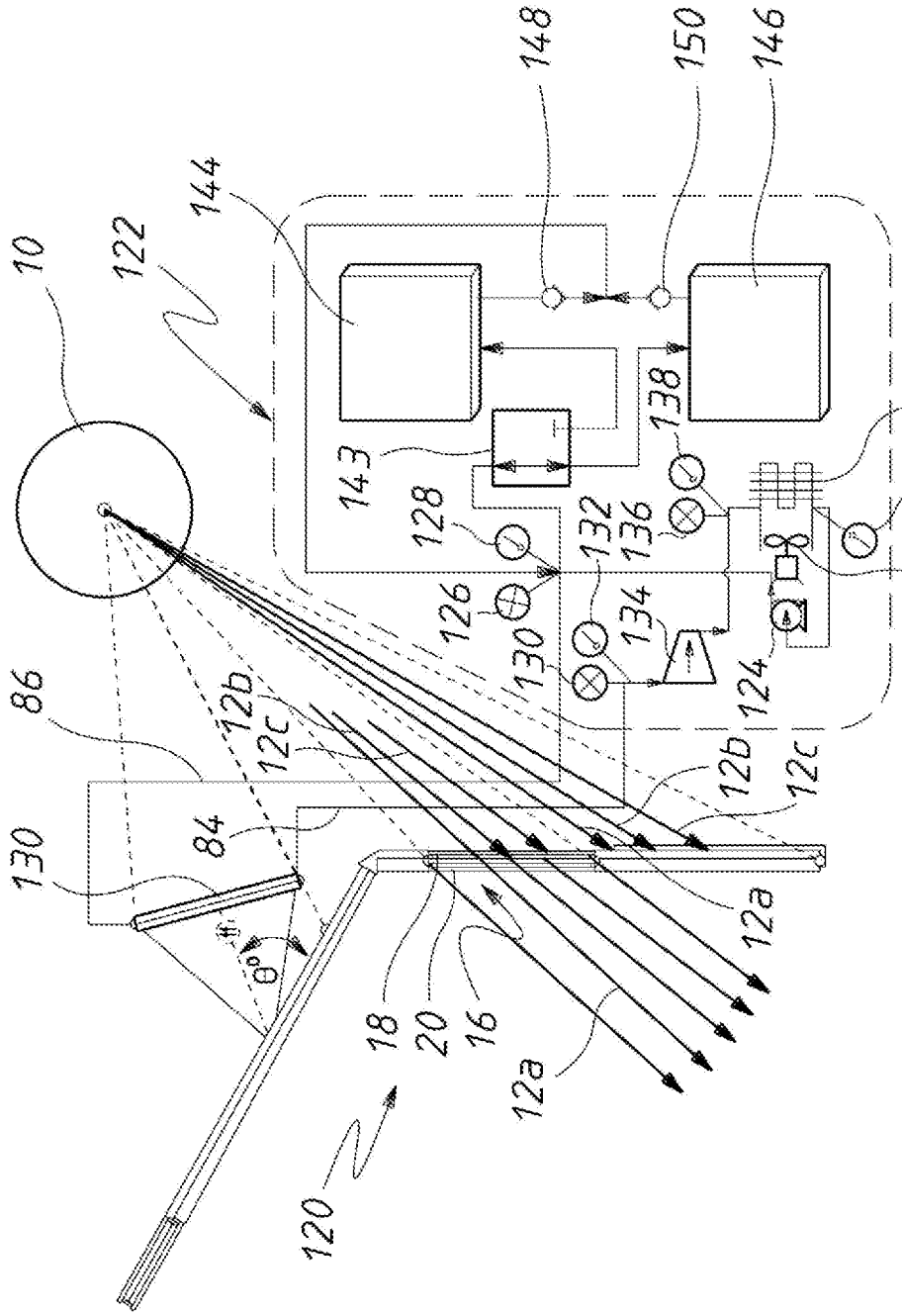
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FIG.5

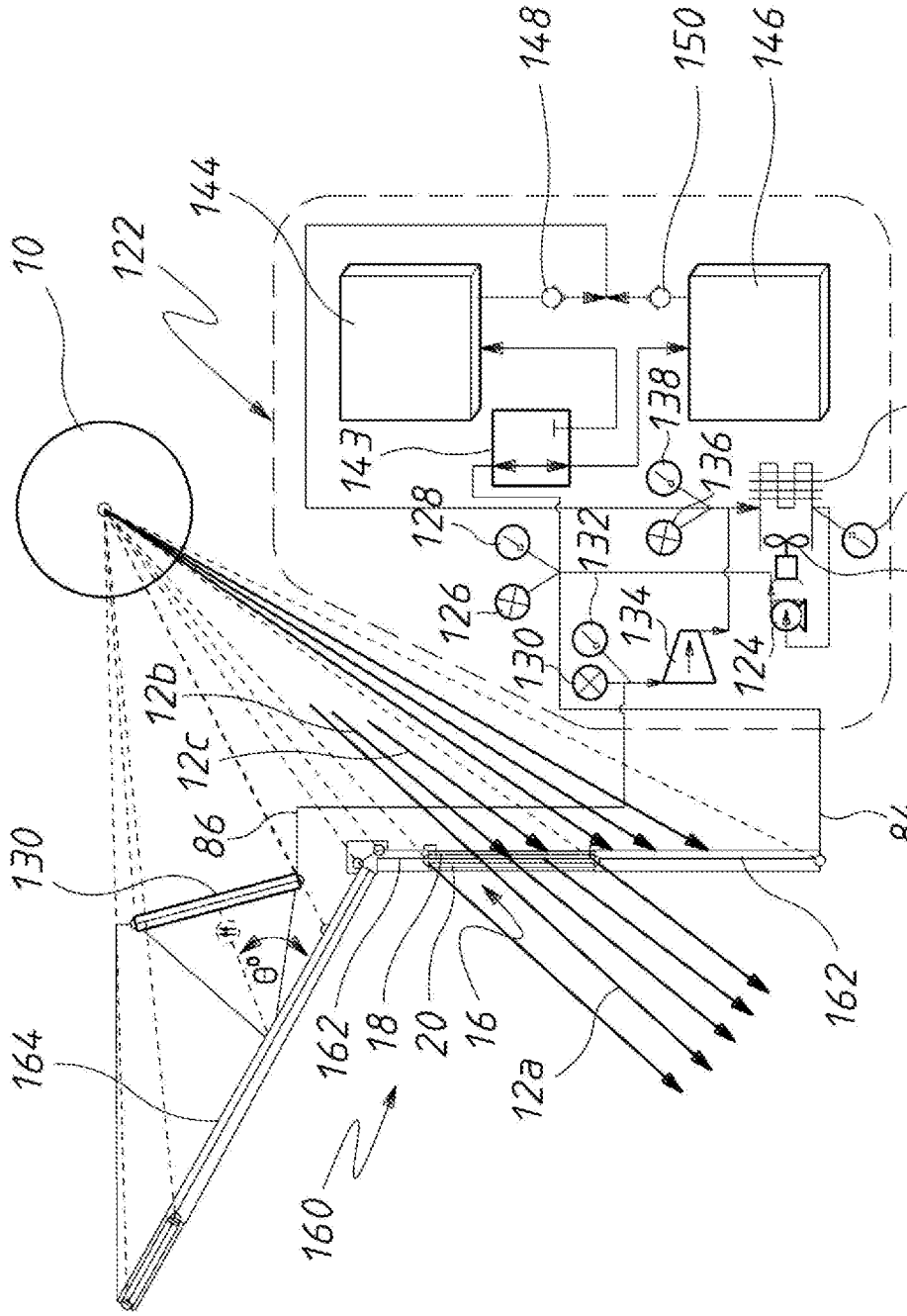
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FIG.6

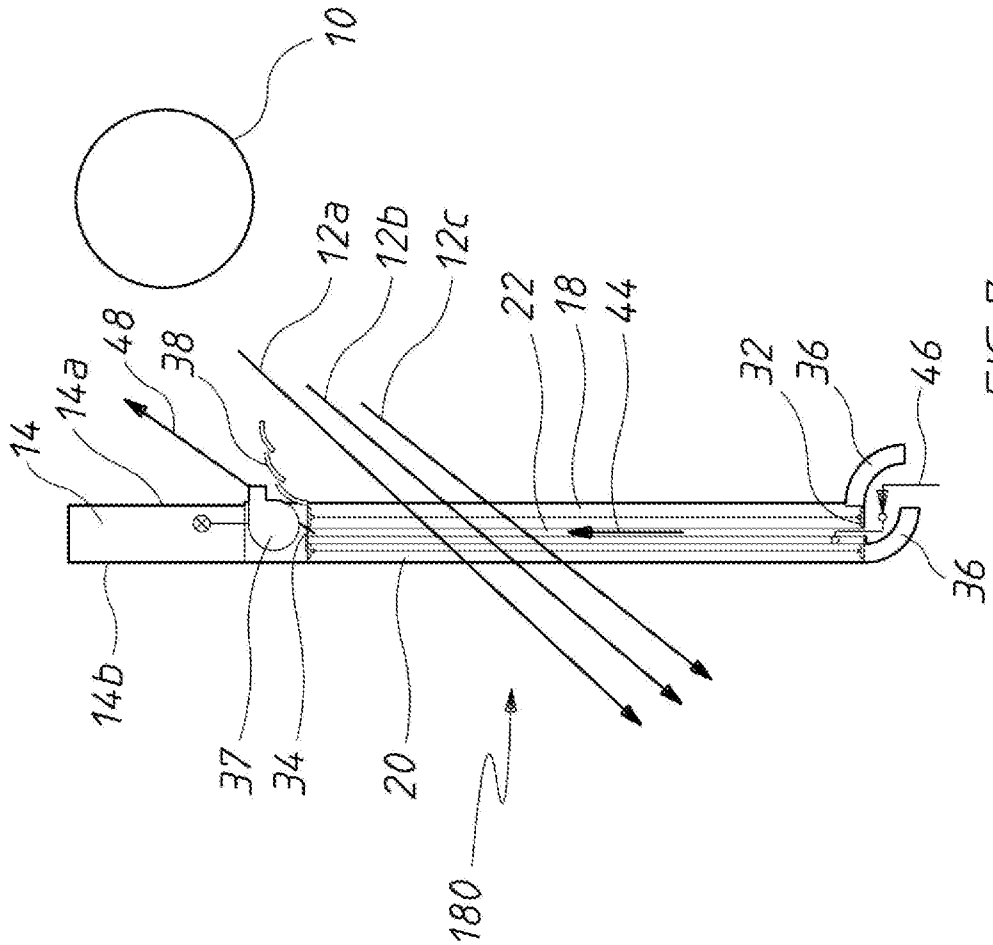

FIG.7

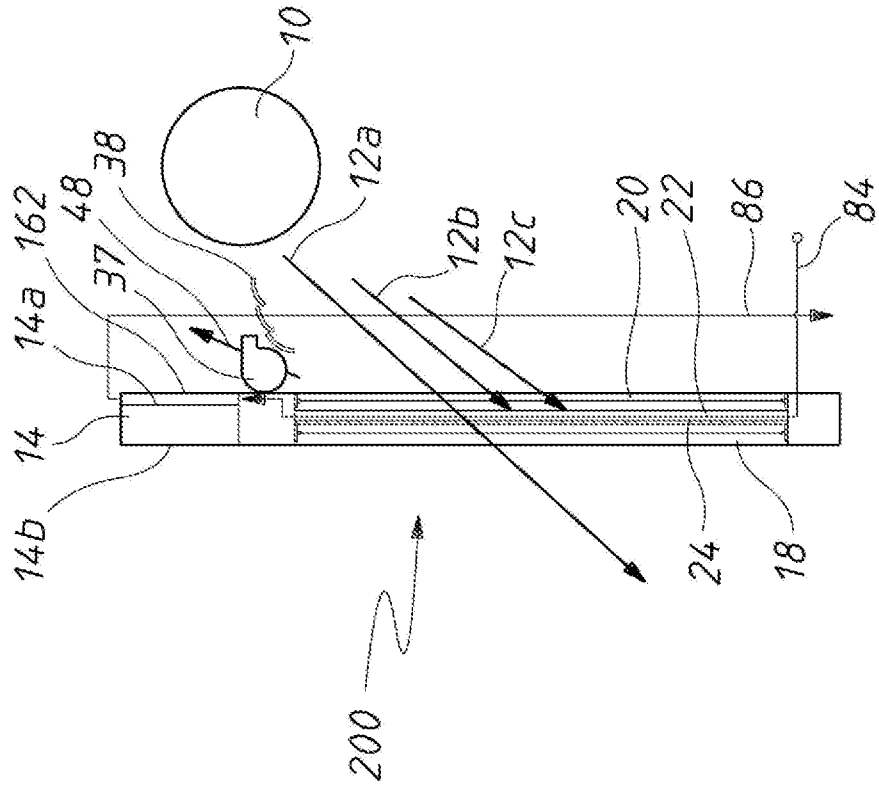

FIG.8

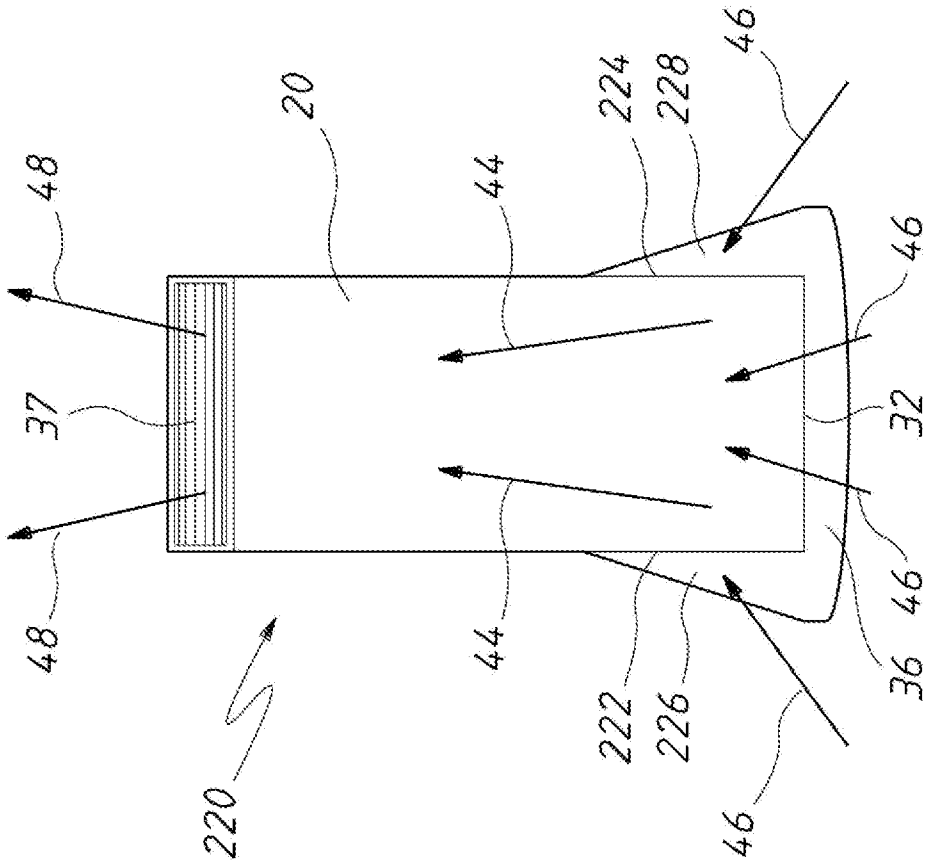

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2014/000752

A. CLASSIFICATION OF SUBJECT MATTER

E06B 3/67 (2006.01) ***E06B 7/02 (2006.01)*** ***F24J 2/05 (2006.01)*** ***F24J 2/20 (2006.01)*** ***F24J 2/48 (2006.01)***
F03D 1/04 (2006.01) ***F03D 9/00 (2006.01)*** ***C03C 17/00 (2006.01)*** ***C09D 5/32 (2006.01)***

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC - IPC, CPC, ICO: E06B3, E06B5, E06B7, E06B2003/6638, E06B2007/023, E06B2007/026, C03C17, C09D5/32, F24J2/04, FF24J2/0433, F24J2/0444, F24J2/0488/LOW, F24J2/05, F24J2/20, F24J2/48, F24J2/485/LOW, F24J2/50, F24J2/505/LOW, F03D1, F03D3, F03D9, F03G7, Y02E10/70/LOW, Y02E10/465/LOW, Y02B10/30 and Keywords (double, glazing, generate, power, space, wind, turbine, fan, water, fluid, retro, kit, film, absorb, UV, IR, building) & like terms.

WPI, EPODOC - Michael Urch as the applicant or inventor.

Google Patents - window building "heat engine" infrared ultraviolet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 November 2014	03 November 2014
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Allan Smailes AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832154

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2014/000752**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 202009015506 U1 (FRANZ HESEDENZ GMBH) 18 March 2010 Abstract; figures 1-6; paragraphs 4, 19-20	1-28, 42-51, 56-69
X Y	WO 1995/004006 A1 (McKEE) 09 February 1995 Abstract; figures 1-5 Abstract; figures 1-5; column 2, lines 23-30; column 3, lines 49-53	52-55 1-28, 42-51, 56-69
X Y	WO 2007/082103 A2 (GURIN) 19 July 2007 Abstract; figure 21; paragraphs 3, 118 Abstract; figure 21; paragraphs 3, 118	29-31, 35-41 32-34
Y	US 4159707 A (MIQUEL) 03 July 1979 Abstract; figures 5-6; column 2, lines 23-30; column 3, lines 49-53	29-41
Y	DE 3333196 A1 (BATTELLE-INSTITUT E.V.) 28 March 1985 Figures 7-8; page 20, line 28	10, 23-28, 43-44, 57
Y	KR 10-0994381 B1 (EUN-GWAN LEE) 18 November 2010 Figure 1; paragraphs 27-28	20-22, 67-69
Y	DE 3433299 A1 (BRAUN, JEAN) 20 March 1986 Figure 7; page 2, lines 31-33	32-34
A	US 4577619 A (HOWE Jr.) 25 March 1986 Abstract; column 2, lines 46-53	52-69

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2014/000752

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2014/000752

Supplemental Box

Continuation of: **Box III**
This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-22, 42-51 are directed to a power generating window with spaced panes having a lower inlet and an upper outlet, one pane having a coating to permit visible light while absorbing UV and IR radiation to heat air between the panes to induce an updraft that drives a generator. Using a coating to heat air and cause an airflow to drive a generator is specific to this group of claims.
- Claims 23-28 are directed to a power generating window with spaced panes having a lower inlet and an upper outlet, and having a scoop to direct updrafts between the panes to drive a generator. Using a scoop to cause an airflow to drive a generator is specific to this group of claims.
- Claims 29-41 are directed to a power generating window with spaced panes having a lower inlet and an upper outlet, one pane having a coating to permit visible light while absorbing UV and IR radiation to heat a fluid between the panes to drive a heat engine generator. Using a coating to heat a fluid to drive a heat engine generator is specific to this group of claims.
- Claims 52-56 are directed to a window pane with a coating to permit visible light while absorbing UV and IR radiation and configured to retrofit adjacent an existing window pane. The feature of a coated retrofit window pane is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions is spaced window panes; however it is considered that this feature is generic in this particular art.

Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied a priori.

Note that the first and second groups of claims also have the common feature that an airflow between window panes is used to generate power; however this feature does not make a contribution over the prior art because it is disclosed in DE 202009015506 U1 (FRANZ HESEDENZ GMBH) 18 March 2010. The first, third and fourth groups of claims also have the common feature of a coating to permit visible light while absorbing UV and IR to generate heat between two window panes, however this this feature does not make a contribution over the prior art because it is disclosed in WO 1995/004006 A1 (McKEE) 9 February 1995. Therefore in the light of these documents any features common to a selection of the above groups of claims cannot be special technical features.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2014/000752**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
DE 202009015506 U1	18 March 2010	None	
WO 1995/004006 A1	09 February 1995	AU 7347394 A	28 Feb 1995
		GB 2280503 A	01 Feb 1995
		GB 2280503 B	19 Nov 1997
WO 2007/082103 A2	19 July 2007	AU 2006259876 A1	28 Dec 2006
		AU 2007204830 A1	19 Jul 2007
		AU 2007230908 A1	04 Oct 2007
		BR PI0611605 A2	21 Sep 2010
		BR PI0707884 A2	10 May 2011
		BR PI0709137 A2	28 Jun 2011
		CA 2611455 A1	28 Dec 2006
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

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