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(54) **AIR FLOW IN ENCLOSED SPACES**

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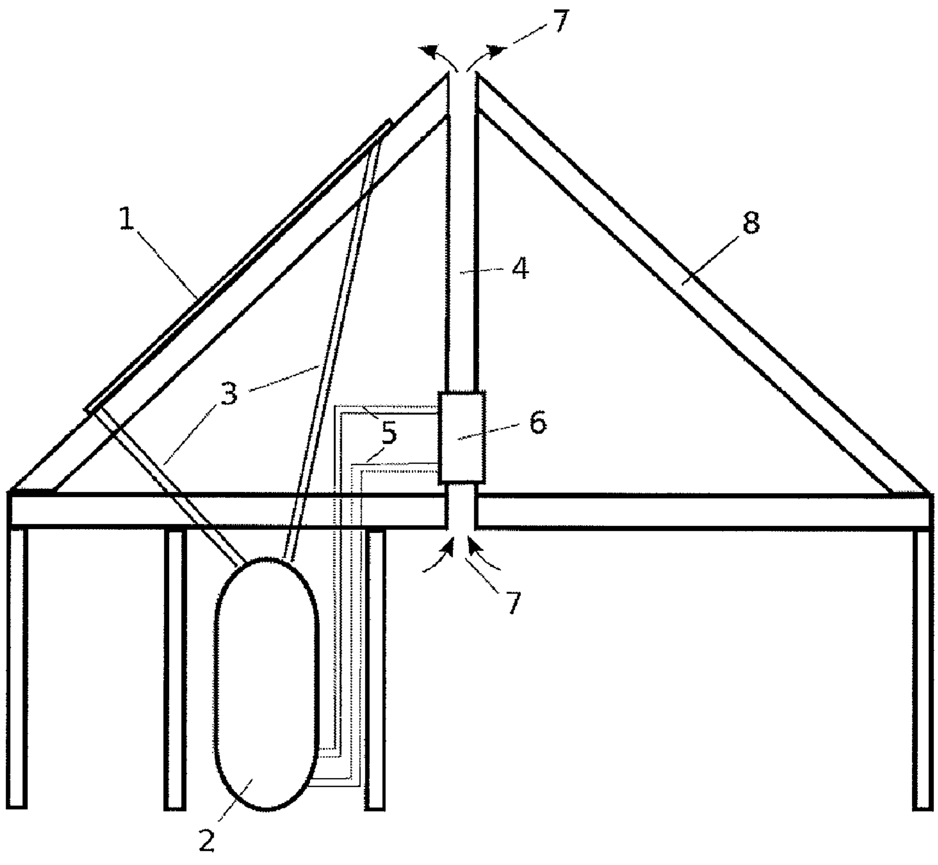
(57) **ABSTRACT**

A method of, and a system for promoting the flow of air from a lower location to an upper location, the method comprising: using heat from a heat source to provide a first heat store; and making a secondary use of heat from said heat source to power a heating device for heating an air conduit connecting said lower and upper locations; wherein said secondary use of heat from said heat source is controlled on the basis of an indicator of whether or not there is an excess of heat in the heat store.



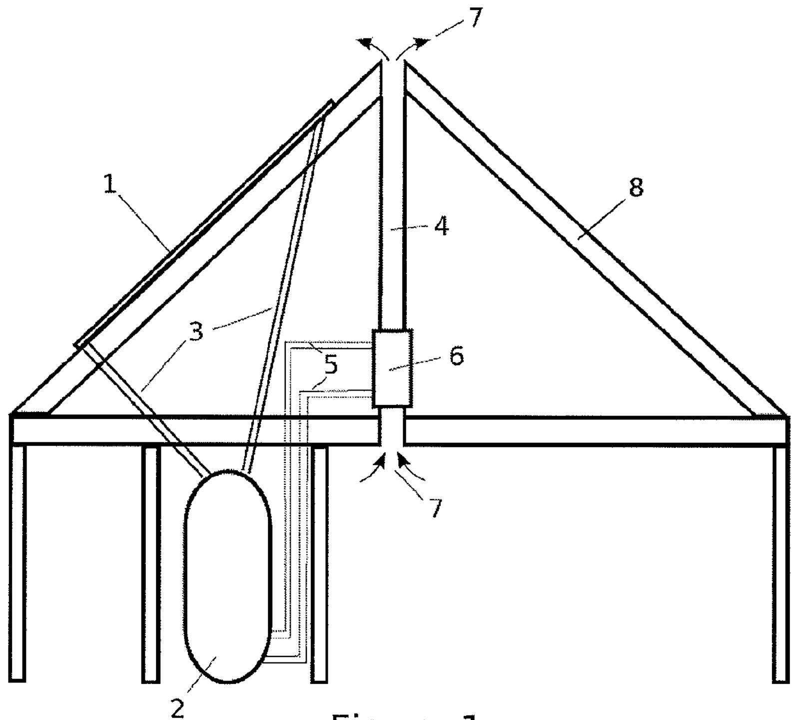


Figure 1

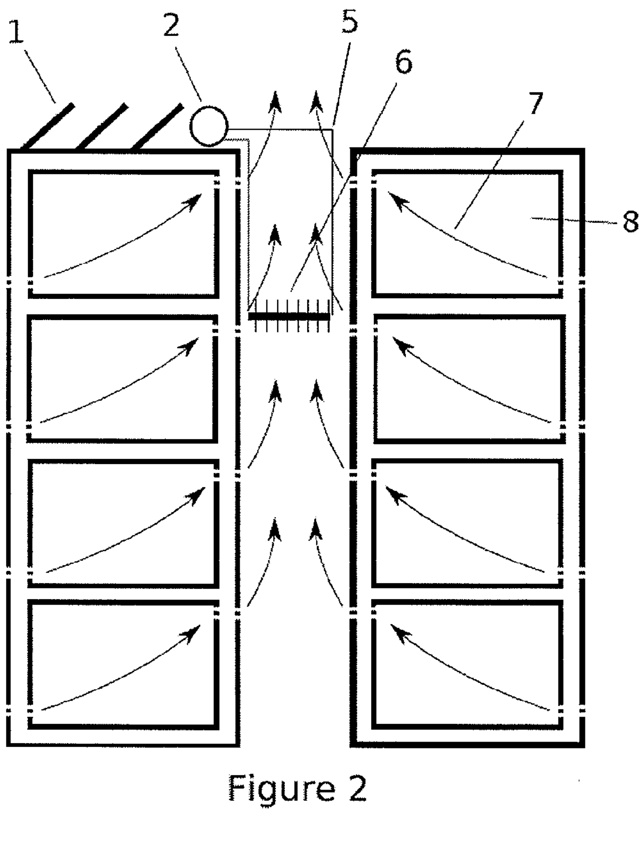


Figure 2

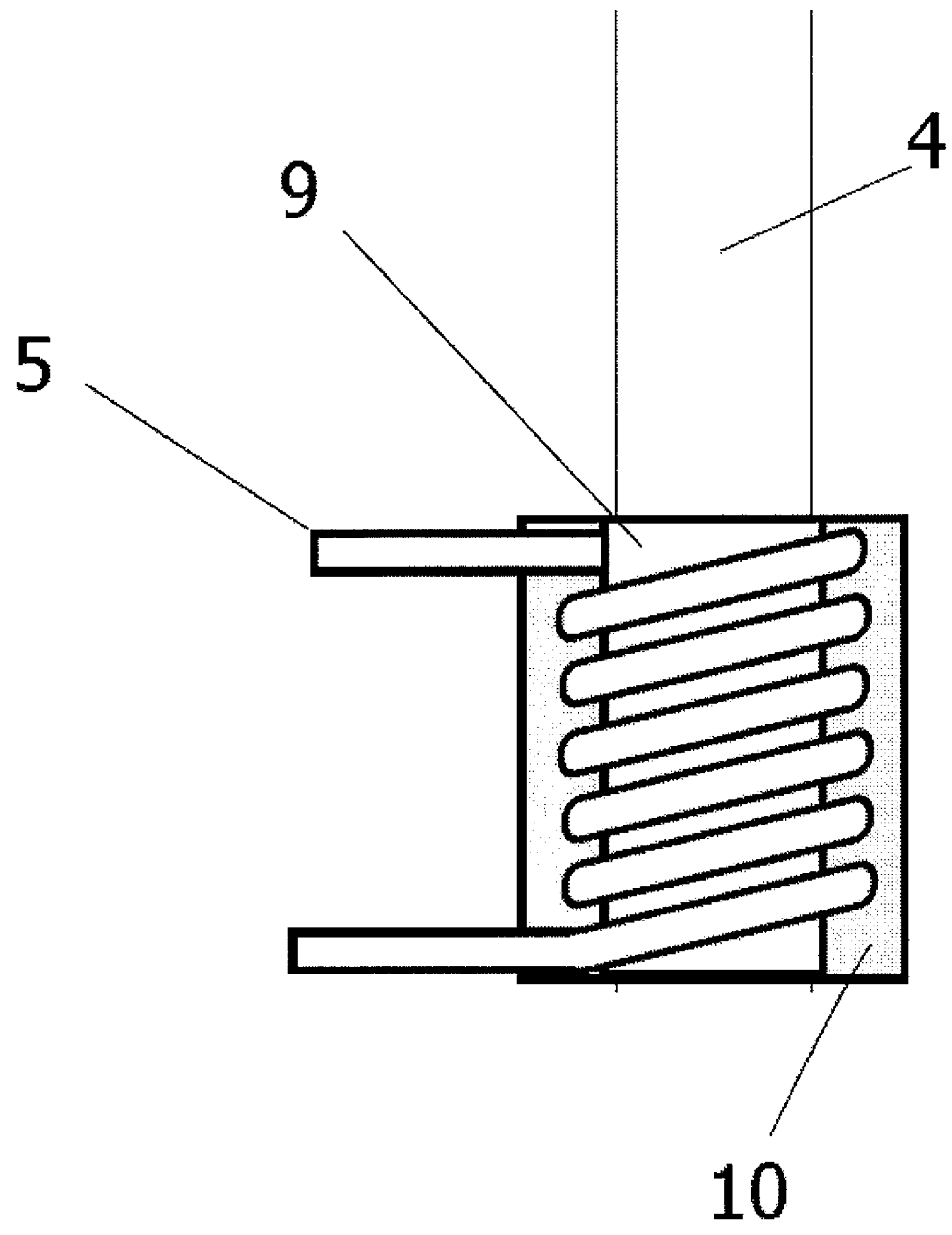


Figure 3

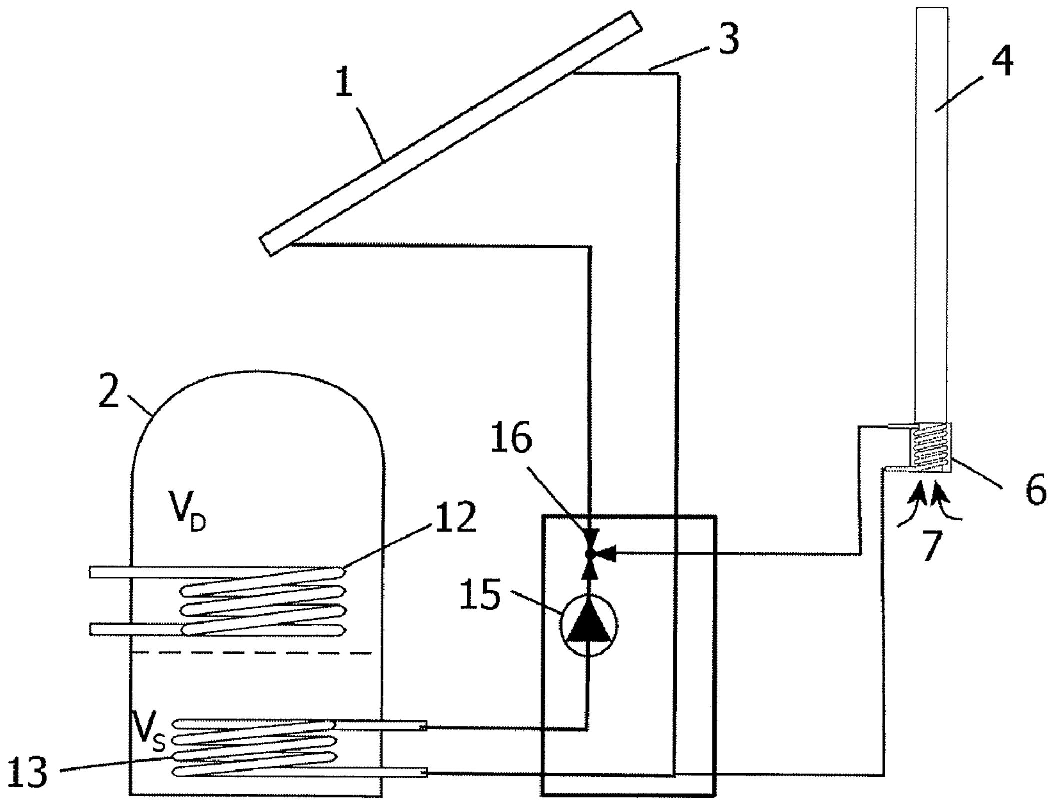


Figure 4

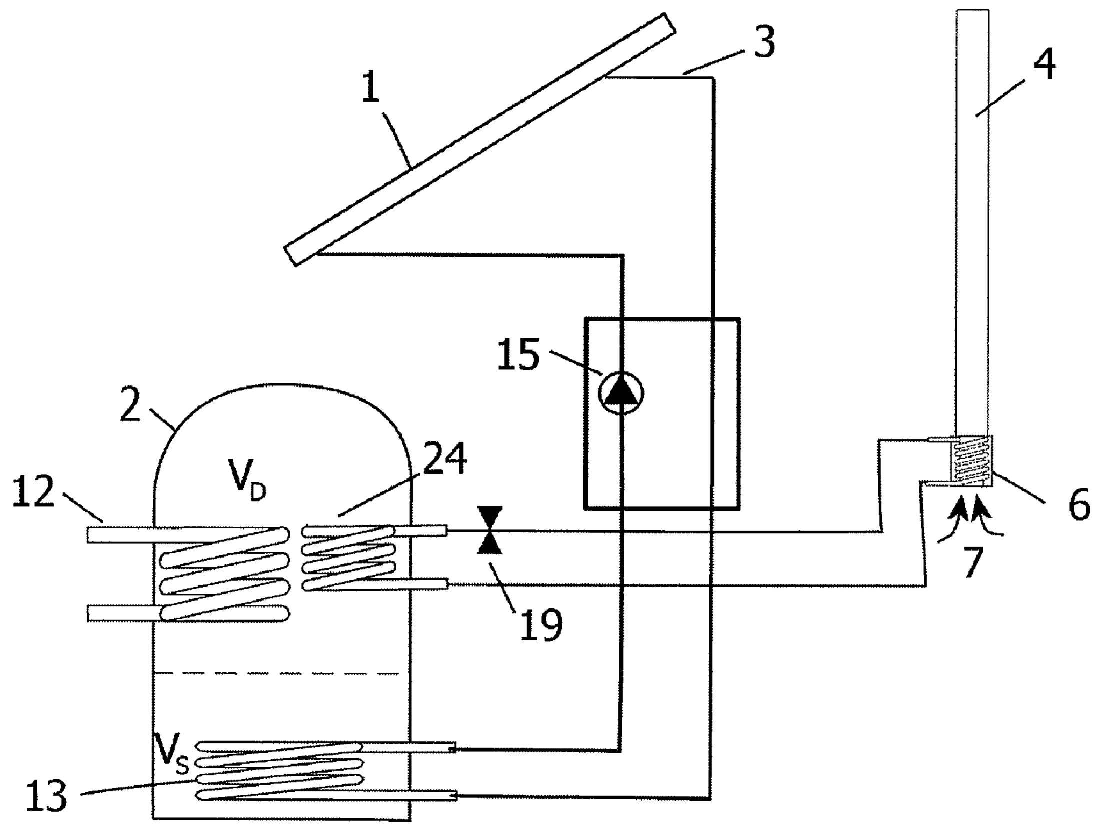


Figure 5

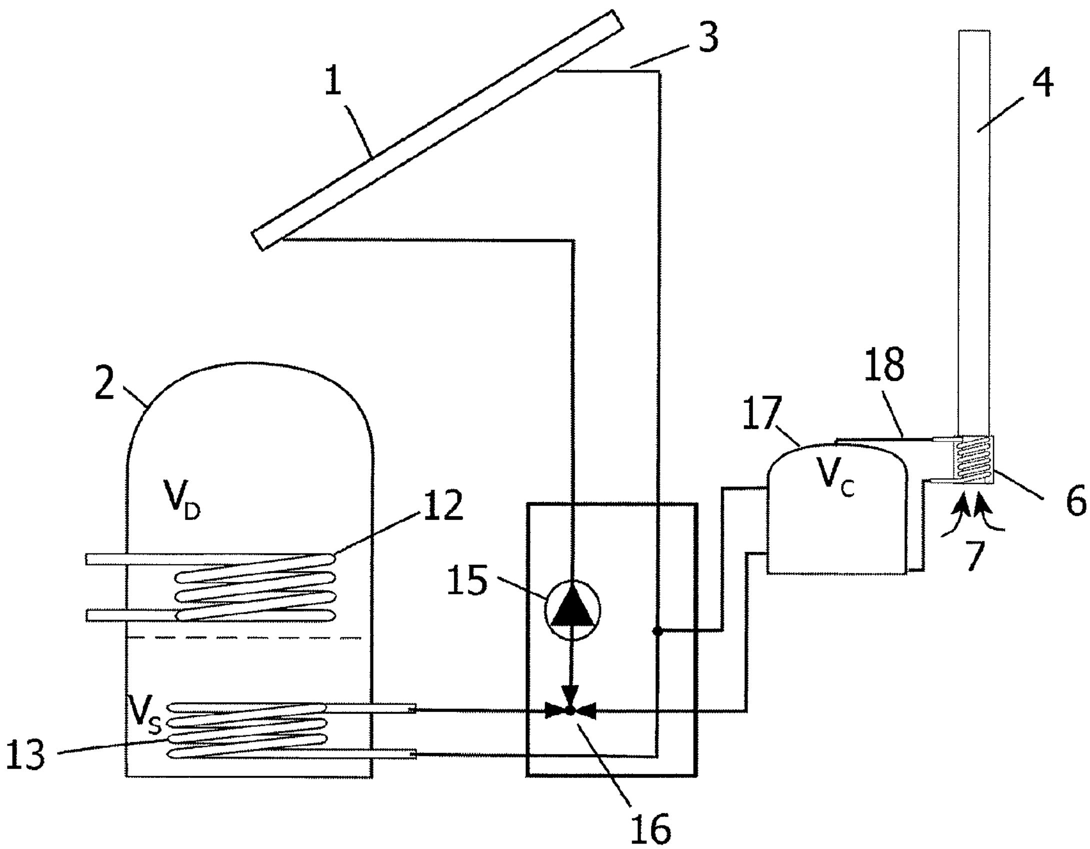


Figure 6

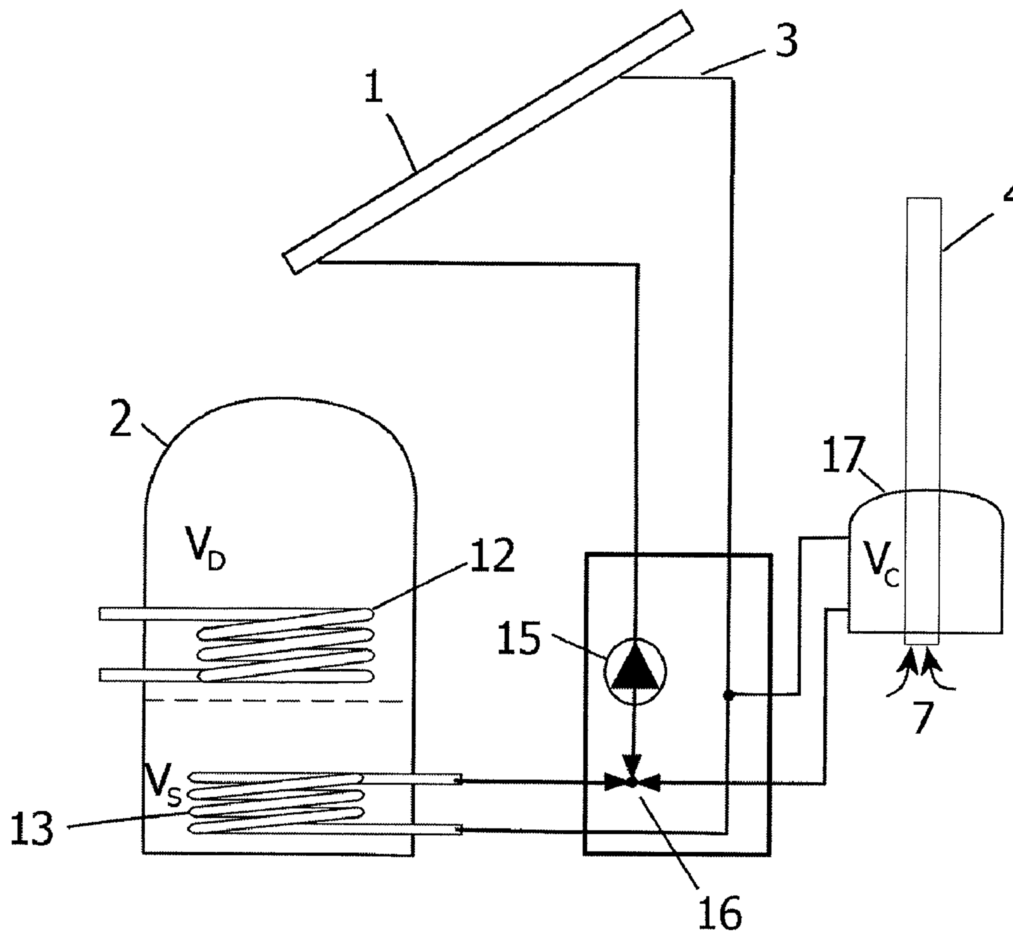


Figure 7

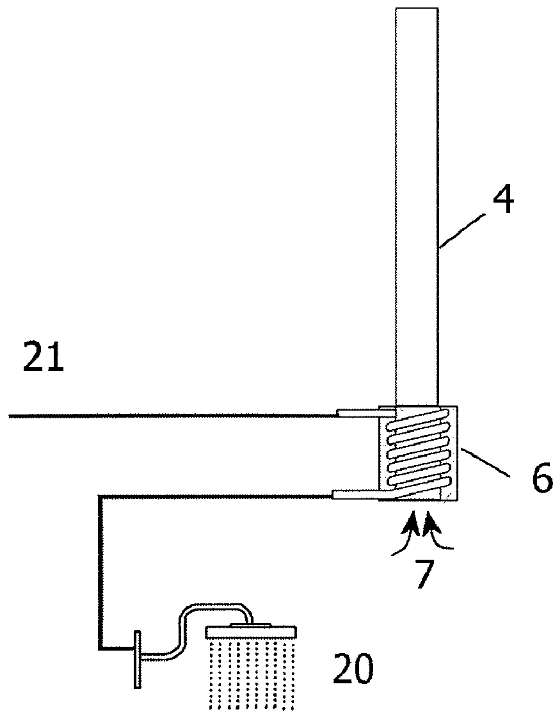


Figure 8

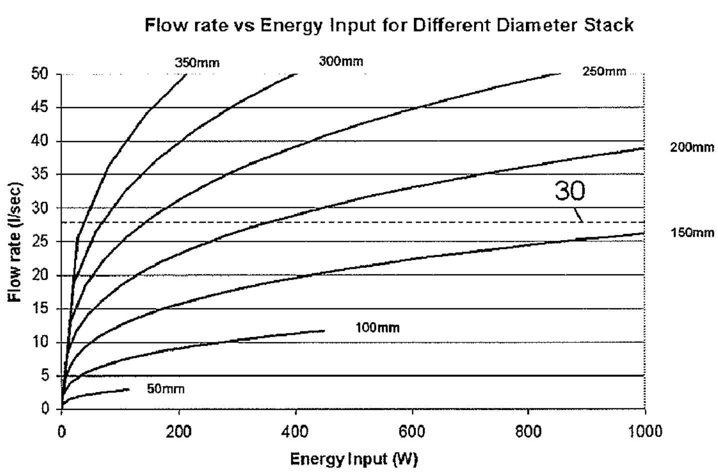


Figure 9

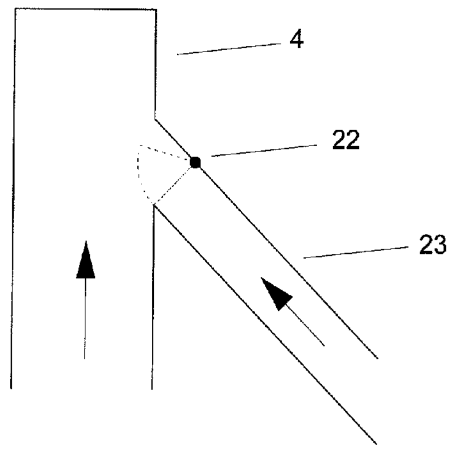


Figure 10

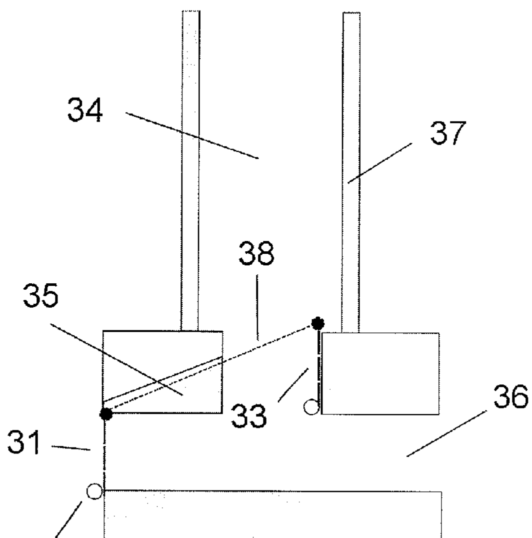


Figure 11

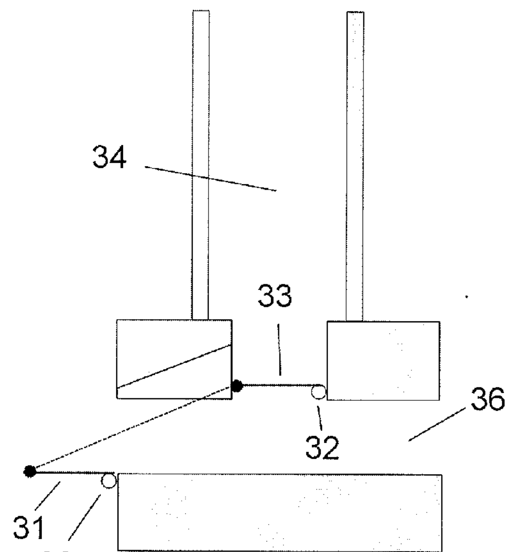
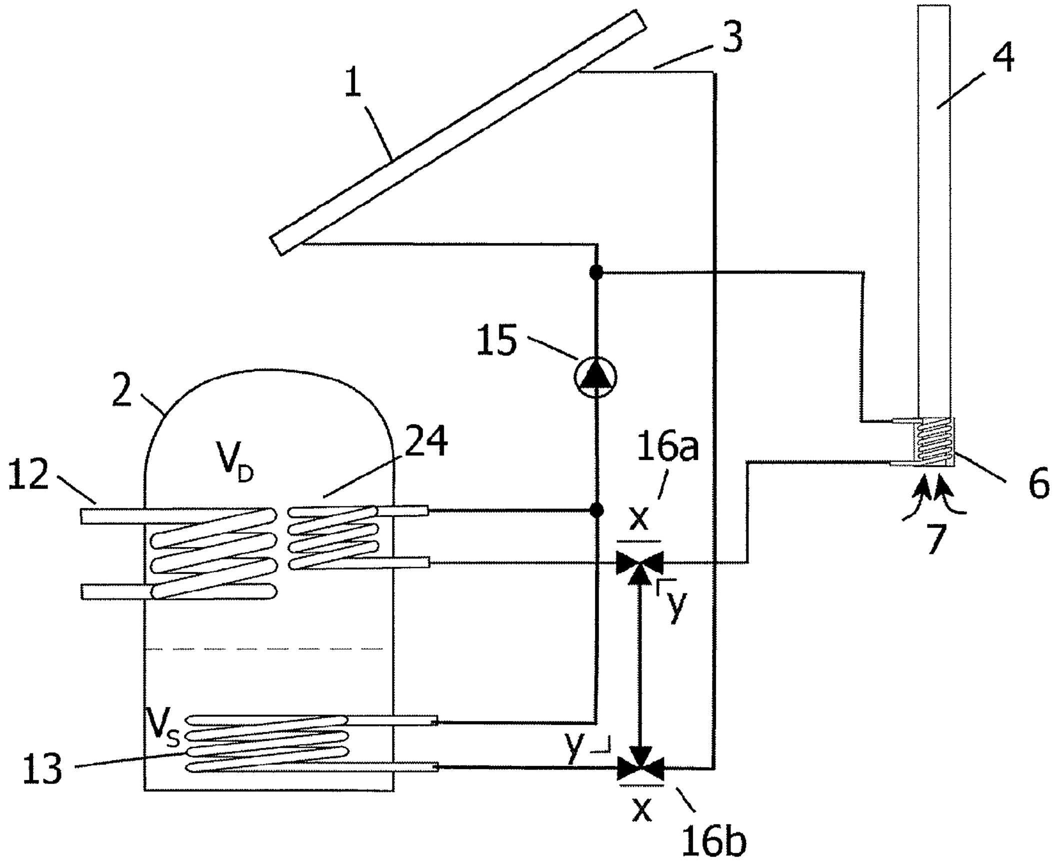


Figure 12



Valve Setting

Heat Flow	16a	16b	
1 - 13	y	x	Solar heating
24 - 6	x	y	Ventilation boost
6 - 13	y	y	Heat recovery

Figure 13

AIR FLOW IN ENCLOSED SPACES

[0001] The present invention relates to promoting the flow or air through an enclosed space, and to recovering heat from air rising from out of an enclosed space.

[0002] In one embodiment, the present invention relates to a method of improving passive summertime ventilation rates in buildings and increasing the comfort of buildings in hot weather without using active air conditioning.

[0003] In many buildings passive ventilation, driven by differences in temperature and wind pressure, is used to provide fresh air and remove pollutants for occupant health, and to distribute heat or cool buildings. In addition solar hot water heaters are often used to provide hot water to buildings from the heat of the sun.

[0004] However, during hot, still days in summer, the airflow rates provided by passive ventilation systems in buildings are often at their lowest although these are the times when higher ventilation rates are usually required for the cooling of occupants and the building fabric. The reason for this is the weakness of the two driving factors at this time i.e. small temperature differences between inside and outside the building and low wind speeds. This inability of passive systems to respond to hot still conditions makes them unsuitable for the cooling of occupants and buildings in summer.

[0005] Thermal solar panels absorb light and trap the energy as heat in the solar panel. Fluid circulated through the panel transfers the heat to a store for later use. Due to the seasonality of solar energy in temperate climates, sizing a solar panel to provide more than 50% of the hot water load for a building becomes less economically efficient as you push to higher fractions of solar energy. Over-sized solar panel areas increases the energy captured in winter, but the solar panels are idle for large parts of the summer, spring and autumn, when they have already satisfied the water demand for the building.

[0006] U.S. Pat. No. 4,706,471 describes the use of heat energy from thermal solar collectors to boost ventilation through increased buoyancy of the exhaust ventilation air. A number of drawbacks and/or deficiencies have been identified for the system described in U.S. Pat. No. 4,706,471.

[0007] It is an aim of the present invention to provide an effective technique for promoting the flow or air through an enclosed space.

[0008] It is another aim of the present invention to provide an effective technique for recovering heat from heated air rising out of an enclosed space.

[0009] According to one aspect of the present invention, there is provided a method of promoting the flow of air from a lower location to an upper location, the method comprising: using heat from a heat source to provide a first heat store; and making a secondary use of heat from said heat source to power a heating device for heating an air conduit connecting said lower and upper locations; wherein said secondary use of heat from said heat source is controlled on the basis of an indicator of whether or not there is an excess of heat in the heat store.

[0010] According to another aspect of the present invention, there is provided a system for promoting the flow of air from a lower location to an upper location, the system comprising: a heat source; a first heat store for storing heat from said heat source; and a heating device powered by a secondary use of heat from said heat source and for heating an air conduit connecting said lower and upper locations; wherein said secondary use of heat from said heat source is controlled on the basis of an indicator of whether or not there is an excess of heat in the heat store.

[0011] In one embodiment, the secondary use of heat involves transferring heat from said heat source to said heating device via said heat store, and in another embodiment, the secondary use of heat involves transferring heat from said heat source to said heating device other than via said heat store.

[0012] According to another aspect of the present invention, there is provided a method of promoting the flow of air through a lower location into which a heated fluid is introduced via a heated fluid outlet, the method including: directing said heated fluid to said heated fluid outlet via a device for heating an air conduit connecting said lower location to an upper location and using a portion of the heat from said heated fluid to power said device.

[0013] According to another aspect of the present invention, there is provided a system for promoting the flow of air through a lower location into which a heated fluid is introduced via a heated fluid outlet, wherein the system includes a device for heating an air conduit connecting said lower location to an upper location, and wherein the system is configured such that said heated fluid is directed to said heated fluid outlet via said device and a portion of the heat from said heated fluid is used to power said device.

[0014] According to another aspect of the present invention, there is provided a method of promoting the flow of air between a first lower location and an upper location including: heating at least a portion of an air conduit connecting the first lower location and the upper location to promote the flow of air up from the first lower location, wherein said air conduit also connects said upper location to a second lower location, and including providing a valve between said upper location and said second lower location so as to impede the flow of air from said first lower location to said second lower location via said air conduit whilst allowing the flow of air from said second lower location to said upper location.

[0015] According to another aspect of the present invention, there is provided a system for promoting the flow of air between a first lower location and an upper location including: an air conduit connecting the first lower location and the upper location; a device for heating at least a portion of said ari conduit to promote the flow of air up from the first lower location, wherein said air conduit also connects said upper location to a second lower location, and wherein said system further includes a valve between said upper location and said second lower location so as to impede the flow of air from said first lower location to said second lower location via said air conduit whilst allowing the flow of air from said second lower location to said upper location.

[0016] According to another aspect of the present invention, there is provided a method of ventilating an enclosed space containing a volume V m**3** of air, including promoting the flow of air through the enclosed space by heating an air conduit connected to an upper portion of said enclosed space, wherein the air conduit has a cross-sectional area A m**2**, and wherein $V>0.00015\times A$.

[0017] According to another aspect of the present invention, there is provided a system for ventilating an enclosed space containing a volume V m**3** of air, said system including an air conduit connected to an upper portion of said enclosed space, and a heating device for heat the air conduit to promote the flow of air through the enclosed space, wherein the air conduit has a cross-sectional area A m**2**, and wherein V>0.00015×A.

[0018] According to another aspect of the present invention, there is provided a device for controlling the intake of air into an enclosed space, the device including a first path for the intake of air into said enclosed space via between the panes of a multi-glazed window, and a second path for the intake of air into said enclosed space other than via between said panes of said multi-glazed window, wherein the device is configured such that the opening of either of the first and second paths automatically closes the other of the first and second paths.

[0019] According to another aspect of the present invention, there is provided a method of recovering heat from air rising out of an enclosed space via an air conduit, including transferring heat away from said air, wherein the transfer of heat away from said air is actively controlled on the basis of an indicator of the flow rate of air through said air conduit.

[0020] According to another aspect of the present invention, there is provided a system for recovering heat from air rising out of an enclosed space via an air conduit, including a device for actively controlling the transfer of heat away from said air on the basis of an indicator of the flow rate of air through said air conduit.

[0021] According to another aspect of the present invention, there is provided a method of promoting the flow of air from a lower location to an upper location, the method comprising: using one or more fluid circuits to transfer heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations, wherein the heat reservoir includes a tank of fluid having a cross-sectional area larger than that of one or more fluid conduits constituting said one or more fluid circuits.

[0022] According to another aspect of the present invention, there is provided a system for promoting the flow of air from a lower location to an upper location, the system comprising one or more fluid circuits for transferring heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations; wherein said heat reservoir includes a tank of fluid of having a cross-sectional area larger than that of one or more fluid conduits constituting said one or more fluid circuits.

[0023] According to another aspect of the present invention, there is provided a method of promoting the flow of air from a lower location to an upper location, the method comprising: actively controlling the rate of transfer of heat from a heat source to air in an air conduit connecting said lower and upper locations.

[0024] According to another aspect of the present invention, there is provided a system for promoting the flow of air from a lower location to an upper location, wherein the system includes a heat source, and the system is configured to actively control the rate of transfer of heat from the heat source to air in an air conduit connecting said lower and upper locations.

[0025] According to another aspect of the present invention, there is provided a method of promoting the flow of air from a lower location to an upper location, the method comprising: using one or more fluid circuits to transfer heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations, wherein the heat reservoir has a heat capacity greater than the combined heat capacity of said one or more fluid circuits.

[0026] According to another aspect of the present invention, there is provided a system for promoting the flow of air from a lower location to an upper location, the system comprising one or more fluid circuits for transferring heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations; wherein said heat reservoir has a heat capacity greater than the combined heat capacity of said one or more fluid circuits.

[0027] In one embodiment, ventilation or comfort is enhanced in buildings in summer by using a stored heat source to boost airflow rates through buoyancy effects.

[0028] In one embodiment, heat from solar processes is used as the heat source.

[0029] In one embodiment, ventilation boost is provided at a time separated from the time of availability of the heat energy.

[0030] In one embodiment, domestic hot water demands as well as ventilation boost are satisfied without additional requirement for auxiliary heat from conventional heat sources.

[0031] In one embodiment, flow is diverted to an energy store for the ventilation boost once domestic hot water needs are satisfied.

[0032] In one embodiment, a solar thermal store for the ventilation boost energy is separated from a store for domestic hot water needs.

[0033] In one embodiment, a heat store for ventilation surrounds the air exhaust path.

[0034] In one embodiment, hot water feed is taken from a tap or shower through a heat exchanger in the passive stack to boost ventilation rates by increasing the buoyancy of the air in a stack.

[0035] In one embodiment, reverse flow within stacks extracting from other locations (e.g. rooms) is prevented by forming a junction incorporating a one-way valve between two stacks, thereby promoting boosted air flow within a subsidiary stack.

[0036] In one embodiment, a supply air window is modified for integration with a solar boosted whole house ventilation system whereby a means is provided for the air inlet to the house provided by the window to enter the house directly, by-passing the heat exchange channel between the window panes.

[0037] Embodiments of the invention will now be described in detail, solely by way of example, and with reference to the accompanying drawings in which:

[0038] FIG. **1** shows an embodiment of the present invention. It shows a domestic set-up with a roof mounted solar hot water panel connecting to a hot water storage tank, which in turn interfaces to the exhaust of a passive stack ventilation system.

[0039] FIG. **2** shows another embodiment of the present invention. It shows a cross-section of a commercial building with a roof mounted solar water heater connecting to a roof mounted hot water storage tank interfacing with the air exhausting through a central atria.

[0040] FIG. **3** shows a heat exchanger for transferring heat into and out of the passive stack.

[0041] FIG. **4** shows another embodiment of the present invention. It shows a detailed arrangement for storing solar derived heat energy, then later using it to boost a passive stack.

[0042] FIG. **5** shows another embodiment of the present invention; it shows a detailed arrangement for storing solar derived heat energy, then later using it to boost a passive stack, where the removal of excess energy is determined by the temperature in the store and does not cause the auxiliary heating to switch on.

[0043] FIG. **6** shows another embodiment of the present invention. It shows a detailed arrangement for storing solar derived heat energy, then later using it to boost a passive stack, with a separated thermal store for excess solar energy.

[0044] FIG. **7** shows another embodiment of the present invention. It shows a detailed arrangement for storing solar derived heat energy, then later using it to boost a passive stack, with a simplified and separated thermal store for excess solar energy.

[0045] FIG. **8** shows another embodiment of the present invention. It shows an alternative buoyancy driven boost to a passive stack for the special case of a bathroom.

[0046] FIG. **9** shows a graph illustrating the relationship between flow rates and buoyancy driven ventilation for different passive stack diameters.

[0047] FIG. **10** shows another embodiment of the present invention. It shows a non-return valve arrangement for the prevention of back-flow from a stack with a solar boost into another ventilation path without such a boost.

[0048] FIGS. **11** and **12** show another embodiment of the present invention. They show cross-sections of the base of a supply air window, modified according to an embodiment of the current invention with a by-pass. FIG. **11** shows the supply air window in the heat recovery mode of operation;

[0049] FIG. **12** shows the window in by-pass mode.

[0050] FIG. **13** shows another embodiment of the present invention. It shows one arrangement that combines three modes of operation—solar heating of the heat store, a ventilation boost when excess energy is present in the store and heat recovery from the exhaust air flow when conditions allow.

[0051] Referring to FIG. **1**, a thermal solar panel **1**, mounted on the roof **8**, heats the hot water storage cylinder **2** via interconnecting pipes **3**. Heat from the hot water cylinder circulates hot water to the heat exchanger **6** in the passive stack **4** via interconnecting pipes **5**. The exchange of heat into the exhausting air increases the air flow **7** through the passive stack system **4**.

[0052] It will be appreciated that this invention is not limited in application to domestic properties, and FIG. **2** shows such a situation. The roof mounted solar water heater **1** interfaces with a hot water storage facility **2**. Pipes **5** connect the storage facility with a heat exchanger **6** situated in the central air exhaust channel or atria. Increased buoyancy of the air in the atria increases air flow **7** through the adjacent habitable spaces **8**.

[0053] The exchange of heat from heated liquid to the air in the passive stack can be achieved for example by a device such as that shown in FIG. **3**. The warm liquid is circulated to and from the hot water store either by active pumping, or through passive thermo-syphon effect in pipe **5**. The pipes **5** are wound in intimate heat-conducting contact with a thermally conductive inner wall **9**. Air inside the wall **9** warms and expands, producing a buoyant force to increase the flow rate in the passive stack. The pipes **5** are preferably insulated on the outside with thermal insulation **10** to undesirable heat loss to the environment. Fins or other features to increase surface area for heat exchange inside the tube can advantageously increase the efficiency of the heat exchanger.

[0054] FIG. **4** shows an arrangement for the collection of solar hot water with a modification to allow thermal boost of passive ventilation. The hot water store **2** consists of two heating zones V_D and V_S. A coil of pipe **12** is heated from a conventional heat source such as a boiler. The position of coil **12** is such that by convection it can heat the volume V_D only. In one example, the volume is selected to be of similar magnitude to the daily demand of the building, so that in low-irradiation days, there is still sufficient hot water.

[0055] Coil **13**, connected to the solar panel **1** via a pump **15** is located at the bottom of the cylinder, and in the right weather conditions can heat the entire cylinder volume V_S plus V_D. If V_D is already hot, then volume V_S is always available to heat, and solar energy can be collected whenever it is available. In one example, the volume V_S is selected to be about 50% of V_D, to take into account draw-offs of hot water from the top of the cylinder during the day, by which the hot zone of the cylinder shrinks, but remains as a layer floating on top of the cooler zone below which the solar coil **13** can heat.

[0056] In one variation, the system is modified by the addition of a circuit to the passive stack heat exchanger **6**, activated by a 3-way valve **16**. An electronic controller is programmed to switch the valve **16** at a pre-determined time to circulate from the solar coil **13** to the passive vent heat exchanger **6**, so cooling the water in the cylinder below the top of the coil by convection and heating the air in the passive stack **7** and boosting air flow rates.

[0057] Alternatively, the fluid in the cylinder **2** could directly heat the passive stack heat exchanger **6** via pipes attached to ports directly into the cylinder, where there is no concern about fluid in this circuit entering the wholesome water supply, even where the circuit may be static for long periods in winter time.

[0058] The circulation to the passive stack could be active (by running the pump), or passive (driven by thermosyphon and eliminating energy overhead associated with the pump).

[0059] The water in the cylinder zone V_S would only be cooled in a zone below the top of the coil since the cooling would be by convection, leaving a layer above the coil in V_S that is available to provide hot water for the following day.

[0060] One possible drawback of this arrangement is that if the volume of V_S is increased to enable storage of sufficient energy for both the ventilation boost and the following day's hot water needs, then on certain days in spring and winter time when the ventilation boost is not required, the solar heating might produce a larger volume of tepid water rather than a smaller amount of useful hot water. The boiler would fire unnecessarily, with the concomitant emission of greenhouse gases.

[0061] Another possible drawback with this arrangement is that if the household uses hot water from the cylinder (say in the early evening), then cold water is introduced to the cylinder at the bottom. The hot solar-heated water floats on top. The solar coil is now in cold water and the excess energy in the cylinder is not available for ventilation boost.

[0062] The arrangement in FIG. **5** avoids such drawbacks. The hot water store **2** is allowed to exceed the demand temperature for hot water, when heated by the solar coil **13**. A blending valve at the outlet from the cylinder is provided to avoid dangerously hot water at the tap. A valve **19** is actuated to allow thermo-syphon flow from an indirect coil **24** near the top of the store to the ventilation boost heat exchanger **6**, once the domestic hot water store **2** reaches a temperature greater than the set temperature for hot water. Control for the valve could be most simply provided by a thermostatic switch at the store. In this way, excess solar heat energy is used to boost ventilation rates by raising the temperature of the air in the exhaust path from the building and increasing air flow through the tendency of hot air to rise. The withdrawal of heat energy from the store to boost ventilation rates does not reduce the temperature in the store to a temperature lower than the useful temperature for domestic hot water, which might cause the activation of an auxiliary heat source, such as a carbon fuel based heat source (gas boiler or electric heating), and negate the energy efficiency benefits of the renewable energy based ventilation boost.

[0063] Since the ventilation boost coil **24** is located near the top of the store, it can cool the whole depth of the store by convection. The control is set such that once the store has been cooled to a temperature just above the demand temperature for the store, the valve closes, and the ventilation boost ends. In this way, the take off of energy for ventilation boost does not inadvertently result in carbon fuel consumption to heat the section of the cylinder V_D.

[0064] The circulation could be augmented by an active pump to force the circulation, also controlled by the same thermostatic means.

[0065] The arrangement in FIG. **6** also avoids such drawbacks. A separate ventilation boost store **17** is provided for excess solar energy. This store is dedicated to the storage of energy for ventilation boost. A diverter valve **16** is actuated to divert flow from the solar loop to the ventilation boost store once the domestic hot water store **2** is satisfied. Heat exchange to the ventilation boost store can be direct as shown in the figure, or indirect via a coil.

[0066] The ventilation boost store is connected to the passive stack heat exchanger **6** via pipes **18**. Flow to and from the passive stack heat exchanger can be completely passive (driven by thermosyphon), passive and controlled by a valve or pumped. In the latter two examples, the exact timing of the ventilation boost can be controlled electronically. In the former, the boost would tend to start later on in the day, and continue into the night since the rate of energy removal from the ventilation boost cylinder would normally be much slower than the rate of addition from the solar panel.

[0067] There are benefits to achieving this separation in timing. Night time temperatures are generally cooler than day time temperatures, particularly during the high pressure weather systems that produce the combination of low wind speed and high ambient daytime temperatures that can diminish the effectiveness of passive ventilation systems. Storing the energy collected during the day to boost night-time ventilation rates would decrease the temperature of the fabric of the building, and particularly if coupled to building design incorporating high heat capacity elements, would reduce the maximum daytime temperature the following day.

[0068] A simplified arrangement of this design is illustrated in FIG. **7**. The ventilation boost store **17** is integrated with the passive stack **4**, with a heat conducting and thin walled tube passing through the ventilation boost store, and defining the ventilation exhaust path. Heat is transferred from the store to the air inside the tube by conduction through the wall.

[0069] The above-described techniques can be modified to run in reverse in winter time. FIG. **13** illustrates one such arrangement to achieve this. Stale, warm air **7** leaving the house via the passive stack **4** could have some of its energy reclaimed by the stack heat exchanger **6** and transferred to the hot water store **2** via a system fluid circulated by pump **15** to heat exchange coil **13**.

[0070] The arrangement further comprises two three-way valves **16***a*, **16***b* which can be configured to allow circulation between solar panel **1** and heat exchange coil **13** for collecting solar energy, coil **24** and passive stack heat exchanger **6** for ventilation boost and passive stack heat exchanger **6** and coil **13** for heat recovery from the passive stack—all using the same pump by setting the valves as indicated in the table.

[0071] The heat exchanger in the stack is configured to react dynamically to the air flow in the stack, and only removes heat when the air flow rate is sufficient to accept this e.g. when the wind driven component of the stack flow is sufficient to make the buoyancy driven flow component of less importance. One way to achieve this is to measure the flow rate in the stack, for example with two spaced-apart pressure sensors, and to only allow flow to transfer heat to the water store through the heat exchanger when the pressure difference between the sensors indicates that there is sufficient flow to accept heat removal.

[0072] Another application of buoyant boost for passive stack ventilation according to an embodiment of the present invention is illustrated in FIG. **8**. The hot water feed to a bathroom or kitchen **21** is taken through a passive stack heat exchanger **6** before reaching outlets **20**. In this way a buoyant boost for the passive stack **4** is achieved through increased air flow **7** at the time when the room most requires a higher level of air extraction.

[0073] It has been found that the flow rate achieved by a buoyancy-driven boost follows a non-intuitive relationship with the energy input. The benefit of designs that increase the energy input rapidly follow a curve of diminishing returns.

[0074] FIG. **9** illustrates this by way of a series of curves showing how the volumetric flow rate in the stack varies with changes in the input energy. The series of curves are for stacks with increasing cross-sectional area from 50 mm diameter to 350 mm diameter in steps of 50 mm. The dash line **30** shows a minimum useful flow rate for a night-time cooling strategy for a dwelling of 80 square metres floor area.

[0075] We have discovered an important relationship between the cross-sectional area of the ventilation ducting and the flow rates induced by heating the exhaust gas, which serves to limit the effective area of the stack to a range above a minimum value.

[0076] It has been found that for a solar boosted ventilation stack to achieve measurable improvements in the comfort of an enclosed space, the aggregate cross-sectional area of the heated stack in m^2 should be greater than 0.00015 times the volume of air in the enclosed space in m^3.

[0077] A consequence of boosting passive stack ventilation is that stacks extracting from other rooms without the benefit of solar boost may, according to weather conditions, suffer from reverse flow. This is due to the flow rate in the boosted stack being in excess of the flow that the other stack can achieve due to buoyancy forces alone, if the building has been constructed to be air-tight.

[0078] FIG. **10** illustrates an arrangement designed to overcome this problem. Near the top of the boosted stack **4** a junction is made with the extract stack, without solar boost **23**, from the other room. At the junction a one-way valve **22** allows air to be exhausted into the boosted stack and the extract of air is promoted by the connection between the two. The one way valve avoids any exchange of air between the two rooms by shutting across the end of the passive stack **23** to prevent reverse flow.

[0079] Some passively ventilated buildings employ so called "supply air windows", where air drawn into the building is by means of a flow path that brings it between the panes **37** of a double glazed window. This has the beneficial effects of pre-heating the air in winter and minimising the experience of draughts, and lowers the effective U value of the window. According to another embodiment of the present invention, such a window is modified by the addition of a by-pass valve to allow cool night air directly into the house, without the need for opening the window, which many people consider to be an unacceptable security risk.

[0080] FIGS. **11** and **12** illustrate this embodiment. In the normal (heat recovery) mode of operation, air from outside the building enters the window through inlet **36**, and is drawn into the building through the gap **34** between the window panes **37**. In doing so, the air collects heat and enters the building at a higher temperature than the outdoor temperature. Since the heat flow escaping through the window is collected and returned to the building, the effective insulation value of the window is increased.

[0081] When cooling in summertime, it is desirable that the air enters the building directly. A vent cover **31**, is hinged **32** such that it can fold down to open a direct ventilation path to outside. The vent cover **32** is joined to a secondary vent cover **33** by a linkage **38** which passes through a hole **35** in the window frame. The action of pulling the vent cover **31** into the open position pulls the secondary vent cover **33** into a closed position, allowing air to enter the house directly, and closing off air flow in the window gap **34**. The effective insulation provided by the window is decreased, improving the cooling effect on the building.

[0082] The above-described techniques can apply in any situation where the possibility for solar water heating, and passive ventilation exists e.g. domestic, commercial, educational and other types of buildings or fixed or mobile structures.

[0083] Advantages of one or more of the above-described embodiments are:

[0084] Using a renewable source of energy to cool buildings in summer saves the use of carbon dioxide emitting electricity for air conditioning.

[0085] Solar thermal energy collection is significantly more cost effective than solar electric energy (PV)

[0086] The use of excess solar energy in summer to achieve a desirable effect in the building justifies the installation of a larger area of solar panel, boosting the water heating benefits in Spring, Autumn and Winter.

[0087] The separation of the timing of energy collection and effect enables night-time ventilation boost which can cool the fabric of the building more effectively than a daytime boost.

[0088] The applicants draw attention to the fact that the present invention may include any feature or combination of features disclosed herein either implicitly or explicitly or any generalisation thereof, without limitation to the scope of any definitions set out above.

[0089] Furthermore, in view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. For example, each of the techniques illustrated in FIGS. **8**, and **10** to **12** can be used individually or together in combination with any of the techniques illustrated in FIGS. **1**, **2**, **4** to **7** and **13**.

1. A method of promoting the flow of air from a lower location to an upper location, the method comprising: using heat from a heat source to provide a first heat store; and making a secondary use of heat from said heat source to power a heating device for heating an air conduit connecting said lower and upper locations; wherein said secondary use of heat from said heat source is controlled on the basis of an indicator of whether or not there is an excess of heat in the heat store.

2. A method according to claim **1**, wherein said secondary use of heat comprises transferring heat away from said heat store to said heating device.

3. A method according to claim **1**, wherein said heating device includes a second heat store, and from which heat can be controllably transferred to said air conduit.

4. A method according to claim **3**, further including actively controlling the timing of the transfer of heat from said second heat store to said air conduit.

5. A method according to claim **1**, wherein said heating device includes an inlet for receiving hot fluid from said heat store and/or said heat source and an outlet for returning fluid to said heat store and/or said heat source, and wherein the heating device has a part for transferring heat to the air conduit which defines a flow path for fluid having a cross-sectional area greater than that of the inlet and outlet.

6. A method according to claim **1**, including triggering said secondary use of heat from said heat source when an indicator of the temperature of the heat store exceeds a predetermined value, and continuing said secondary use until said indicator no longer exceeds said predetermined value.

7. A method according to claim **1**, wherein the heat source is a solar device for capturing heat from solar energy.

8. A method according to claim **1**, wherein the heat store is a source of hot water in a first storage vessel.

9. A system for promoting the flow of air from a lower location to an upper location, the system comprising: a heat source; a first heat store for storing heat from said heat source; and a heating device powered by a secondary use of heat from said heat source and for heating an air conduit connecting said lower and upper locations; wherein said secondary use of heat from said heat source is controlled on the basis of an indicator of whether or not there is an excess of heat in the heat store.

10. (canceled)

11. (canceled)

12. (canceled)

13. A method according to claim **1**, wherein said air conduit also connects said upper location to a second lower location, and including providing a valve between said upper location and said second lower location so as to impede the flow of air from said first lower location to said second lower location via said air conduit whilst allowing the flow of air from said second lower location to said upper location.

14. A system according to claim **9**, wherein said air conduit also connects said upper location to a second lower location, and wherein said system further includes a valve between said upper location and said second lower location so as to impede the flow of air from said first lower location to said second lower location via said air conduit whilst allowing the flow of air from said second lower location to said upper location.

15. (canceled)

16. A use of a method according to claim **1** for ventilating an enclosed space containing a volume V m**3** of air, wherein the air conduit has a cross-sectional area A m2, and wherein $V>0.00015\times A$.

17. A system according to claim **9**, wherein said lower location defines an enclosed space containing a volume V m**3** of air, wherein the air conduit has a cross-sectional area A m**2**, and wherein V>0.00015×A.

18. (canceled)

19. (canceled)

20. (canceled)

21. (canceled)

22. A method according to claim **1**, further including transferring heat away from air flowing through the air conduit to the heat store when the flow rate of air from the lower location to the upper location is above a predetermined minimum flow rate even without using heat from the heat source, and actively controlling the transfer of heat away from the air to the heat source such that it does not reduce the flow rate of air through said air conduit to below said predetermined minimum flow rate.

23. A system according to claim **9**, further including a device for actively controlling the transfer of heat away from said air on the basis of an indicator of the flow rate of air through said air conduit.

24. A method according to claim **30** comprising: using one or more fluid circuits to transfer heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations, wherein the heat reservoir includes a tank of fluid having a cross-sectional area larger than that of one or more fluid conduits constituting said one or more fluid circuits.

25. (canceled)

26. A method according to claim **30** comprising: actively controlling the rate of transfer of heat from a heat source to air in an air conduit connecting said lower and upper locations.

27. (canceled)

28. A method according to claim **30** comprising: using one or more fluid circuits to transfer heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations, wherein the heat reservoir has a heat capacity greater than the combined heat capacity of said one or more fluid circuits.

29. (canceled)

30. A method of promoting the flow of air from a lower location to an upper location, the method comprising: (a) using one or more fluid circuits to transfer heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations, wherein the heat reservoir includes a tank of fluid having a cross-sectional area larger than that of one or more fluid conduits constituting said one or more fluid circuits; or (b) actively controlling the rate of transfer of heat from a heat source to air in an air conduit connecting said lower and upper locations; or (c) using one or more fluid circuits to transfer heat from a heat source via a heat reservoir to air in an air conduit connecting said lower and upper locations, wherein the heat reservoir has a heat capacity greater than the combined heat capacity of said one or more fluid circuits.

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