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(71) Applicant(s):
**Building Product Design Limited**
**(Incorporated in the United Kingdom)**
**2 Brooklands Road, SALE, Cheshire, M33 3SS, United Kingdom**

(72) Inventor(s):
**Wayne Aston**

(74) Agent and/or Address for Service:
**Wilson Gunn**
**5th Floor, Blackfriars House, The Parsonage, MANCHESTER, M3 2JA, United Kingdom**

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**JP 100176851 A** **JP 2004293863 A**
**JP 2004019966 A**

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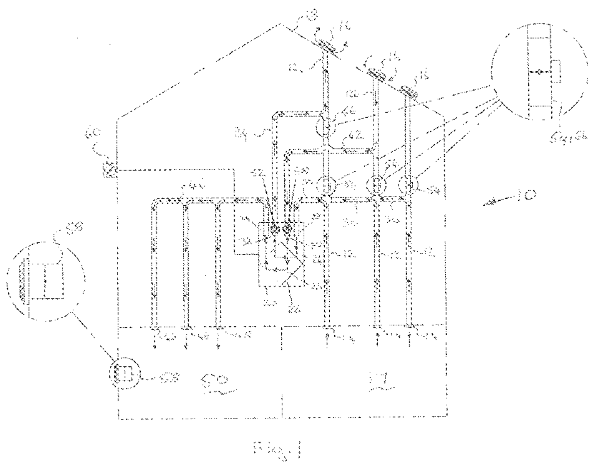
Other: **EPODOC, WPI**

(54) Title of the Invention: **Building ventilation system**
Abstract Title: **Combined mechanical and passive building ventilation system including heat recovery**

(57) The building ventilation system comprises a mechanical ventilation heat recovery (MVHR) ventilation arrangement 20, at least one passive stack ventilation (PSV) stack duct 12, and a controller. The MVHR arrangement includes a heat exchanger 22, an extract air circuit 12, 30, 24, 34, 12a through which extract air can be drawn from one or more rooms 17 by extract vents 14 and passed through the heat exchanger to at least one outlet 16, a fresh air supply circuit 12b, 42, 26, 46 through which ambient air can be drawn into the building and passed to one or more rooms 50 via the heat exchanger and one or more supply terminals 48. The MVHR arrangement further includes an extract fan 52 and a supply fan 38 for moving air along their respective circuits. The PSV stack duct connects at least one of the extract vents with one of the at least one outlets, wherein the one of the at least one outlets is located in a position higher than the extract vent. The controller switches the ventilation system between a forced ventilation mode in which the extract and supply fans are operational and a natural ventilation mode in which the extract and supply fans are deactivated. The controller may switch the mode of ventilation based on ambient temperature measurements or dependence on operation of a heating system in the building. A method of operating the ventilation system is also claimed.



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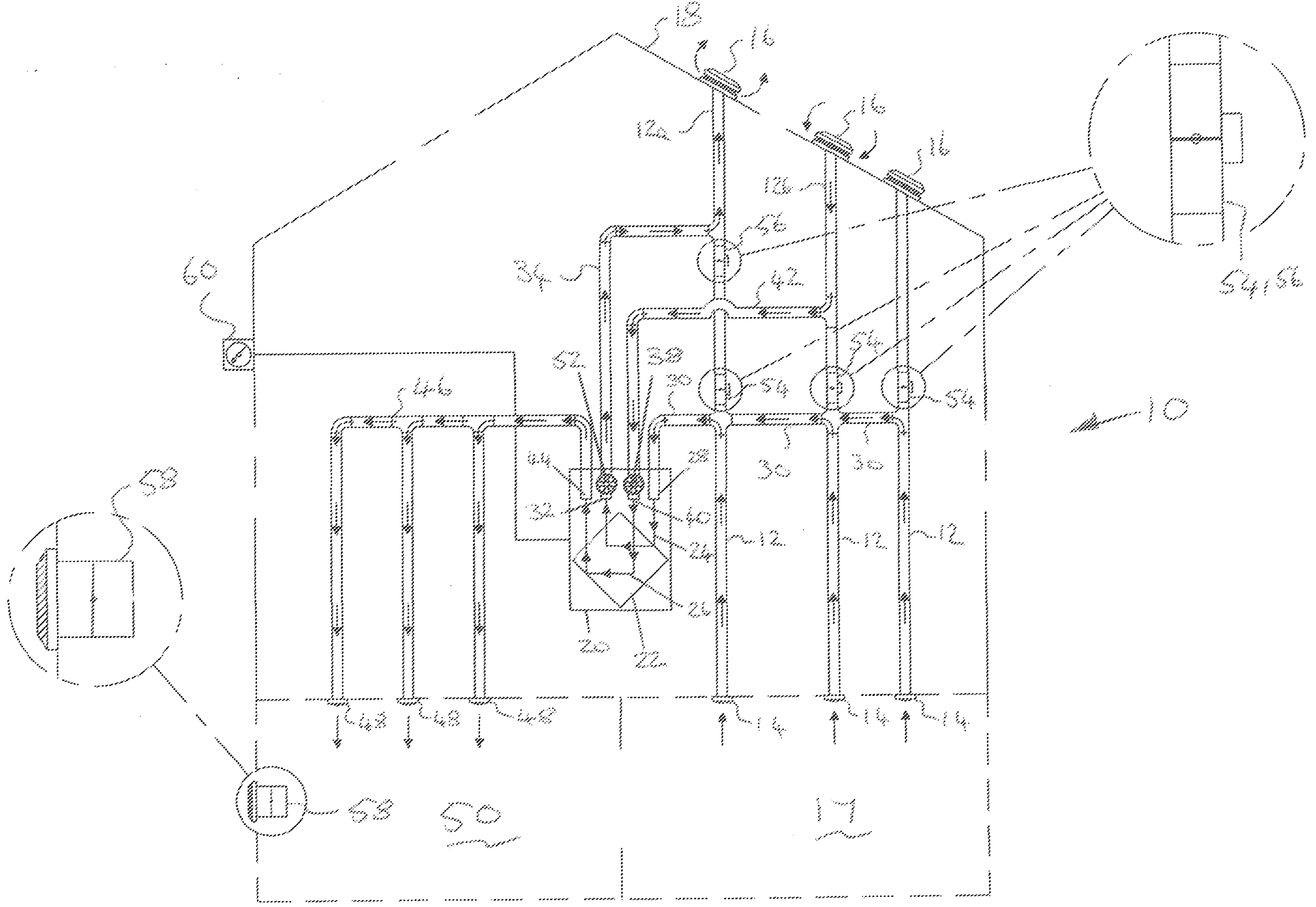

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Fig. 1

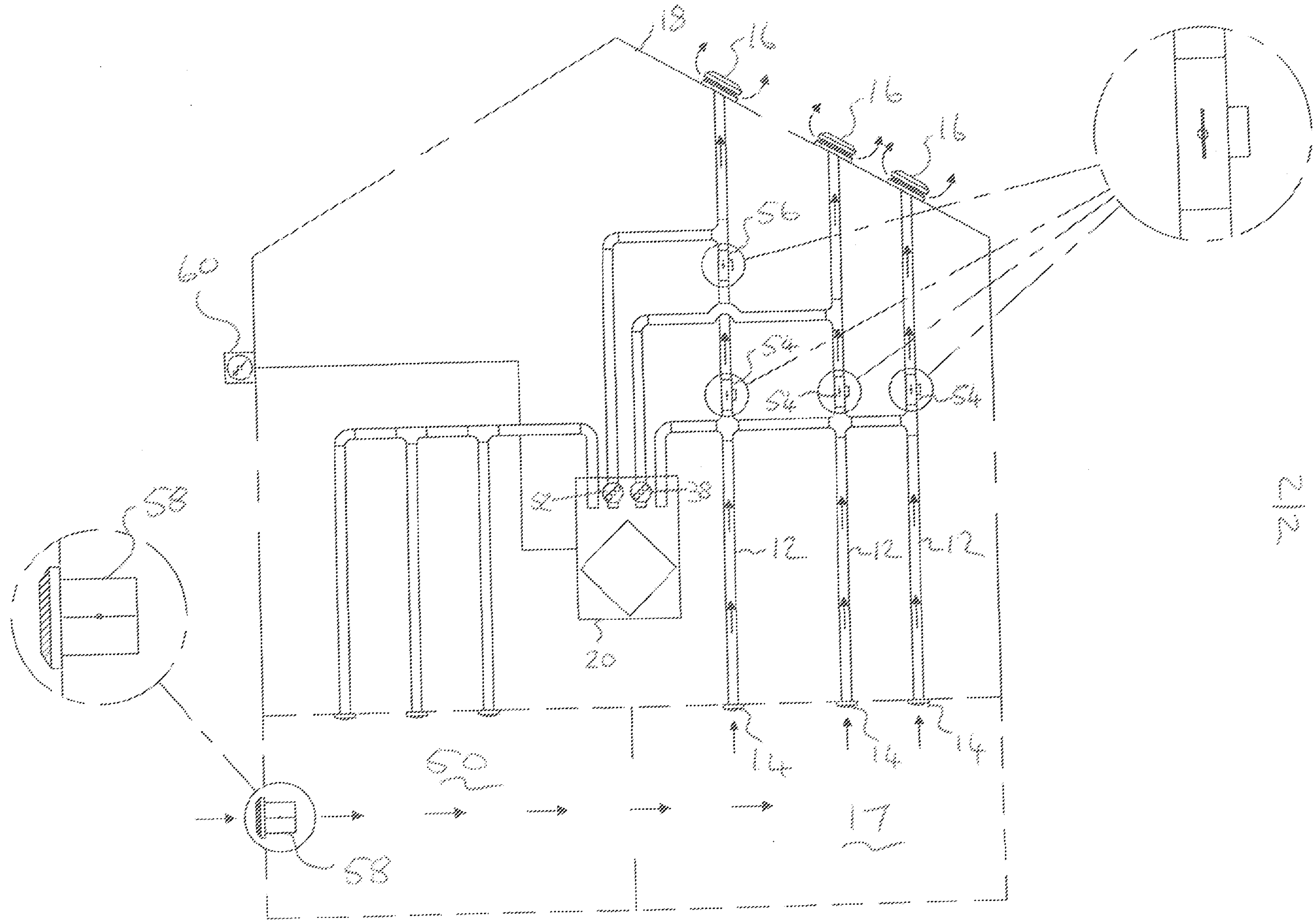


Fig. 2

# Building Ventilation System

The present invention relates to a building ventilation system and in particular, but not exclusively, to a whole building ventilation system.

The need to provide adequate ventilation is dealt with under various building regulations and in its simplest form is concerned with limiting the accumulation of moisture and pollutants in a building by removing stale indoor air and replacing with fresh outside air.

In order to maintain indoor air quality whilst minimising energy wastage, it is important that ventilation is purpose provided in a controlled manner and not reliant on the uncontrolled infiltration through various leakage paths of a building structure. Various methods can be employed to provide ventilation which range from purely naturally driven systems to intermittently running local extract fans and continuously running central extract systems.

Passive or natural ventilation systems are known which use natural forces to drive both the extraction of the stale air and the supply of fresh air. Such passive systems are advantageous in that no additional input energy is required to drive the system. However, the heat energy in the extracted air is lost. Known Passive Stack Ventilation (PSV) systems comprise ducts which connect extract grilles 14, usually located in the wet rooms of the building (e.g. kitchens, bathrooms etc.), with outlet roof terminals. When the air inside the building is warmer than that outside, it rises up the ducts by natural convection, carrying moisture with it. Wind blowing across the roof provides additional suction to draw out the moisture laden air via the venturi effect. As the warm stale air rises, replacement fresh air is normally drawn into the building through either wall or window background ventilators which are usually sited in the habitable (dry) rooms. As a naturally driven system it does not require additional input energy.

Mechanical extract systems are known which use one or more fans to extract the stale air (extract air) from inside a building and which usually draw in replacement fresh air (supply air) via background vent openings in the building fabric. These mechanical extract systems are less energy efficient than the passive systems as they require additional energy input to run the fans and, as with the passive systems, heat energy is normally lost in the extracted air. To reduce the loss of heat energy in the extracted air, Mechanical Heat Recovery Ventilation (MVHR) systems have been developed in which the extract air and supply air are passed through a heat exchanger in order to recover some of the heat energy from the extract air into the supply air. MVHR systems require the use of two fans, one to extract the stale air and one to draw in fresh supply air through the heat exchanger and into the habitable (dry) rooms of the house through supply terminals. Although such MVHR systems require electrical energy to power the fans and control system, depending on the efficiency of the heat exchanger, a net reduction in overall energy use can be obtained by virtue of the recovery of the normally expelled heat energy. However, known MVHR systems are less efficient when the temperature of the supply air being drawn into the building is close to or above that of the extract air.

There is a need for an improved building ventilation system which overcomes, or at least mitigates, the drawbacks of the known ventilation systems.

In accordance with a first aspect of the invention there is provided a building ventilation system comprising an MVHR ventilation arrangement including a heat exchanger, an extract air circuit through which extract air can be drawn from one or more rooms in the building through the heat exchanger to an outlet, a supply air circuit through which supply air can be drawn into the building from an inlet and passed through the heat exchanger and into one or more rooms in the building through supply terminals, the MVHR arrangement further comprising an extract fan for moving extract air along the extract circuit and an supply fan for moving supply air along the supply circuit, the ventilation system also comprising at least one PSV stack duct connecting at least one extract vent in a room in the house with an outlet located at a position higher than the extract vent, the ventilation system having a control system operative to switch the ventilation system between an MVHR mode of operation in which the extract and supply fans are operative and a passive mode of operation in which the extract and supply fans are not operative.

In a building ventilation system in accordance with the invention, the advantages of an MVHR ventilation system and a PSV system are combined in a single ventilation system with an effective control system to automatically switch between the two for increased energy efficiency.

The, or each, supply terminal may be located in a dry or habitable room of the building.

The, or each, extract vent may be located in a wet room of the building.

The control system may be arranged to switch the ventilation system between the MVHR and passive modes of operation in response to a control signal. The control system may include a temperature sensor for sensing the temperature of the air outside the building, the control system being operative to switch the system to run in an MVHR mode when the temperature of the air outside the building is at or below pre-determined threshold value and to switch the ventilation system to operate in the passive mode when the temperature of the air outside the building is above the threshold value. A suitable threshold temperature may be in the range of 7 to 11 $^{o}$C and in particular may be about 9 $^{o}$C. Alternatively, the ventilation system control may be connected with a control system for a heating system in the building, the ventilation control system being operative to run the ventilation system in the MVHR mode when the heating is on and to switch the ventilation system to operate in the passive mode when the heating is off. The control system may include a manual override to allow a user to switch the ventilation system between MVHR and passive modes of operation.

The ventilation system may comprise an arrangement for closing each PSV stack duct when operating in the MVHR mode. The ventilation system may comprise a valve in each PSV stack duct, the valve being switchable between a closed condition in which the flow of air through the valve is prevented and an open condition in which air can flow through the valve, the control system being operative to close each valve when the ventilation system is in the MVHR mode and to open each valve when the ventilation system is in the passive mode. Each valve may be a motorised valve.

The ventilation system may comprise at least one background ventilator through which supply air can enter the building when the ventilation system is operative in the passive mode and means for closing each background ventilator when the ventilation system is operative in the MVHR mode. Where the control system is operative to switch the ventilation system to the MVHR mode of operation when the external temperature is at or below a pre-determined threshold value, each background ventilator may be thermostatically controlled to close when the external temperature is at or below the same pre-determined threshold value. Alternatively, the control system may be operative to close each background ventilator when the ventilation system is being run in the MVHR mode.

Each PSV stack duct may be fluidly connected with an extract air inlet of the heat exchanger to form part of the MVHR extract air circuit, such that when the ventilation system is being run in the MVHR mode, extract air can be drawn through each extract vent and part of each PSV stack duct into the heat exchanger. Where the control system includes a switchable valve in each PSV stack duct, each PSV stack duct may be fluidly connected with the extract air inlet of the heat exchanger at a position upstream from (below) the valve.

An exhaust air outlet of the heat exchanger may be fluidly connected with a PSV stack duct, the arrangement being such that when the ventilation system is being run in the MVHR mode, exhaust air can be directed from the heat exchanger into said PSV stack duct to pass out through its respective outlet. Where the control system includes a switchable valve in each PSV stack duct, the exhaust air outlet of the heat exchanger may be connected with said PSV stack duct at a position downstream from (above) the switchable valve. The control system may comprise a further switchable valve in said PSV stack duct at a position immediately upstream of (below) the fluid connection between the heat exchanger extract air outlet and the duct, the control system being operative to close the further switchable valve when the ventilation system is being run in the MVHR mode. The further switchable valve may be a motorised valve.

A supply air inlet of the heat exchanger may be fluidly connected with a PSV stack duct, the arrangement being such that when the ventilation system is being run in the MVHR mode, supply air can be drawn into the heat exchanger through part of said PSV stack duct and its respective outlet. Where the control system includes a switchable valve in each PSV stack duct, the supply air inlet of the heat exchanger may be connected with said PSV stack duct at a position downstream from (above) the switchable valve. The control system may comprise a further switchable valve in said PSV stack duct at a position immediately upstream of (below) the fluid connection between the heat exchanger supply air inlet and the duct, the control system being operative to close the further switchable valve when the ventilation system is being run in the MVHR mode. The further switchable valve may be a motorised valve.

Where the ventilation system has at least two PSV stack ducts, each PSV stack duct connecting a respective extract vent with a respective outlet, the heat exchanger exhaust air outlet may be fluidly connected with at least one of the

PSV stack ducts and the supply air inlet of the heat exchanger fluidly connected with at least one other of the PSV stack ducts.

The outlet of each PSV stack duct may be located on the roof of the building.

The heat exchanger and the extract and supply fans may be provided as part of an integrated MVHR unit.

In accordance with a second aspect of the invention, there is provided a method of operating a building ventilation system in accordance with the first aspect of the invention, the method comprising using the control system to operate the ventilation system in the MVHR mode when the external air temperature is at or below a pre-determined threshold value and to operate the ventilation system in the passive mode when the external air temperature is above the pre-determined threshold value.

The threshold temperature may be in the range of 7 to 11°C and may be about 9°C.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of a building ventilation system in accordance with the invention, illustrating the system when operating in a MVHR mode; and

Figure 2 is similar to Figure 1 but illustrates the system when operating in a passive mode.

A whole building ventilation system which can be run in a MVHR mode of operation or a passive mode of operation in accordance with the invention is indicated generally at 10. The ventilation system 10 includes one or more PSV stack ducts 12, which each fluidly connect an extract vent 14 with an outlet 16. The, or each, extract vent 14 will usually be located in a so called wet room 17 of the building and the PSV stack duct outlets 16 will usually be located in the roof 18 of the building in the form of a roof terminal.

The term “wet room” generally refers to rooms in which a higher than usual build up of moisture in the air can be expected. These would typically include rooms such bathrooms, shower rooms, kitchens, utility rooms, toilets and the like. Other habitable rooms in the house, such as bedrooms, dining rooms, lounges and the like in which a higher than usual build up of moisture in the air is less likely are generally referred to as “dry rooms”. Often wet rooms will have a water supply or will be designed to house washing machines or tumble driers and the like.

The ventilation system 10 also includes an MVHR unit 20 which incorporates a heat exchanger 22 having a first flow path 24 through which extract air flows and a second flow path 26 through which supply air flows. Each of the PSV stack ducts 12 is fluidly connected with an inlet 28 to the extract air flow path 24 through the heat exchanger by means of further ducting 30, which can be referred to as extract air inlet ducting.

The terms “downstream” and “upstream” when used in connection with the PSV stack ducts 12, refers to the direction of flow of the extract air from the extract vents 14 to the outlets 16 when the ventilation system is operating in a passive mode as illustrated in Figure 2.

An outlet 32 from the extract air flow path 24 through the heat exchanger 22 is fluidly connected by means of further ducting 34, which can be referred to as extract air outlet ducting, with at least one of the PSV stack ducts 12a at a position which is above and downstream from the fluid connection with the exhaust air inlet ducting 30.

An MVHR extract air circuit through which extract air can flow from the wet rooms 17 to atmosphere is provided by means of the extract vents 14, a lower portion of the PSV stack ducts 12, the extract air inlet ducting 30, the extract air flow path 24 through the heat exchanger, the extract air outlet ducting 34, an upper part of the PSV stack duct 12a and the outlet 16 of the PSV stack duct 12a. The MVHR unit has a fan 38 for moving extract air along the extract circuit when it is operative.

An inlet 40 to the supply air flow path 26 through the heat exchanger 22 is connected by ducting 42, which can be referred to as supply air inlet ducting, with at least one of the other PSV stack ducts 12b at a position which is above and downstream from the fluid connection between the further PSV stack duct 12b and the extract air inlet ducting 30.

An outlet 44 of the supply air flow path 26 through the heat exchanger 22 is connected by air supply outlet ducting 46 with supply terminals or vents 48 in one or more of the dry rooms 50 in the building.

An MVHR supply air circuit by means of which fresh supply air can be introduced into the dry rooms 50 of the building is formed by means of the outlet 16 of the PSV stack duct 12b, an upper region of the PSV stack duct 12b, the supply air inlet ducting 42, the supply air flow path 26 through the heat exchanger, the supply air outlet ducting 46 and the supply terminals 48. The MVHR unit includes a supply fan 52 for moving the supply air along the supply air circuit when operative.

The ventilation system 10 includes a control system which is operative to run the ventilation system in an MVHR mode of operation or a passive mode of operation. The system includes a first motorised damper valve 54 in each of the PSV stack ducts 12. The first motorised valves 54 are located in each PSV stack duct just above and downstream from the connection between the PSV stack duct 12 and the extract air inlet ducting 30. The motorised valves can be switched between open and closed conditions to control the flow of air through the valves along the PSV stack ducts. In the present embodiment, the system includes a second motorised valve 56 in the first PSV stack duct 12a just below and upstream from the connection with the extract air outlet ducting 34.

However, a second motorised valve 56 may not always be required, depending on the particular installation.

When the ventilation system is to be operated in a MVHR mode, the motorised valves 54, 56 are closed and the extract and supply fans 38, 52 are switched on by the control system. In this configuration, air is extracted from inside the wet rooms 17 through the extract vents 14 and passes along the lower parts of the PSV stack ducts 12 below the valves 54 and through extract air inlet ducting 30 into the extract air flow path 24 through the heat exchanger. From the heat exchanger, the extract air flows along the extract air outlet ducting 34 and the upper part of PSV stack duct 12a above the second motorised valve 56 to vent to atmosphere through the outlet roof terminal 16 of the PSV stack duct 12a. At the same time, fresh supply air is drawn into to the heat exchanger through the outlet roof terminal 16 of the PSV stack 12b, an upper part of the PSV stack 12b and the supply air inlet ducting 42. From the heat exchanger, the supply air is directed by the supply air outlet ducting 46 into one or more of the dry rooms 50 in the building via the supply air terminals 48. As the extract air and the supply air pass through the heat exchanger, heat energy is transferred from the hotter extract air into the cooler supply air in a known manner. The system 10 will then operate in a traditional heat recovery mode with continuously running supply and extract fans providing ventilation and recovery of heat energy from the extract air.

When the ventilation system is to be operated in a passive mode, the motorised valves 54, 56 are opened and the supply and extract fans 38, 52 are switched off by the control system. With the motorised valves 54, 56 open, the PSV stack ducts are fully open and the system operates in natural mode to extract stale air from the wet rooms by the passive stack effect. Thus the warmer air inside the building rises up the ducts 12 by natural convection, carrying moisture with it. Wind blowing across the roof provides additional suction to draw out the moisture laden air via the venturi effect.

To allow replacement air to be drawn in to the building when the ventilation system 10 is being operated in the passive mode, one or more background ventilators 58 are incorporated into the building envelope, typically in the habitable dry room locations 50. The control system includes an arrangement for automatically closing the background ventilators 58 when the ventilation system is being run in the MVHR mode and to open them when the ventilation system is operating in the passive mode.

The control system is configured to switch the ventilation system between MVHR and passive modes automatically in response to a control input. Preferably, the control system is configured so that the ventilation system is run in the MVHR mode when it is efficient to do so from an energy conservation and/or economic perspective and to run the ventilation system in the passive mode at other times. In the present embodiment, the control system includes an external temperature sensor 60 and control system is configured to run the ventilation system in the MVHR mode only when the external temperature is at or below a pre-determined threshold value. The threshold temperature is set at one at which it becomes economically viable and/or energy efficient to use the MVHR unit. A suitable threshold temperature may be in the range of 7 to 11 $^{o}$C and in particular may be about 9 $^{o}$C. When the temperature is above the threshold value, the ventilation system is operated in the passive mode.

Where the control system operates in response to the external temperature, the background ventilators 58 can be thermostatically controlled background vents which will also close at or below the same threshold temperature. This is advantageous as the background ventilators 58 can be provided as entirely separate units that need not be connected to the rest of the control system. However, in other embodiments, the background ventilators 58 can be arranged to open and/or close in response to a signal or other control input from a central control unit.

Whilst use of the external temperature to trigger the ventilation control system is particularly efficient, the control system can be arranged to switch the ventilation system 10 between the MVHR and passive modes of operation in response to other inputs. For example, the ventilation control system can be linked with a central heating control system for the building such that the ventilation system is run in the MVHR mode when the heating is on and in the passive mode when the heating is off. The control system may also have a manual override so that a user can selectively run the ventilation system 10 in either the MVHR mode or the passive mode.

The ventilation system is 10 is arranged to revert to the passive mode of operation as a fail safe option. Accordingly, in the event that the MVHR unit stops working unexpectedly, the motorised damper valves 54, 56 in the PSV stack ducts 12 open automatically so that the system operates in the passive mode. This is accomplished either by means of an appropriate signal from the control system to open the valves and/or by the use of spring return actuators (not shown) which open the valves 54, 56 in the event of power loss.

Furthermore, the ventilation system 10 can incorporate a number of volume control dampers or balancing valves (not shown) on the MVHR extraction side to balance the flow of extraction air through the various extraction vents 14 and their associated ducts 12, 30 in a manner known in the art. Balancing of the extraction air flow is preferable when the system is being operated in the MVHR mode to ensure that a required flow rate of air is extracted from each of the wet rooms having an extraction vent 14.

The ventilation system in accordance with the invention offers considerable energy saving advantages in providing ventilation with the heat recovery benefits in the heating season whilst the external temperatures are low, whilst avoiding wasteful electrical energy used for running continuously ventilation fans in the warmer months.

It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiment, which are described by way of example only.

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**Claims**

1. A building ventilation system comprising an MVHR ventilation arrangement including a heat exchanger, an extract air circuit through which extract air can be drawn from one or more rooms in the building through the heat exchanger to an outlet, a supply air circuit through which supply air can be drawn into the building from an inlet and passed through the heat exchanger and into one or more rooms in the building through supply terminals, the MVHR arrangement further comprising an extract fan for moving extract air along the extract circuit and a supply fan for moving supply air along the supply circuit, the ventilation system also comprising at least one PSV stack duct connecting at least one extract vent in a room in the building with an outlet located at a position higher than the extract vent, the ventilation system having a control system operative to switch the ventilation system between an MVHR mode of operation in which the extract and supply fans are operative and a passive mode of operation in which the extract and supply fans are not operative.

2. A building ventilation system as claimed in claim 1, in which the, or each, supply terminal is located in a dry or habitable room of the building.

3. A building ventilation system as claimed in claim 1or claim 2, in which the, or each, extract vent is located in a wet room of the building.

4. A building ventilation system as claimed in any one of the preceding claims, in which the control system is arranged to switch the ventilation system between the MVHR and passive modes of operation in response to a control signal.

5. A building ventilation system as claimed in claim 4, in which the control system includes a temperature sensor for sensing the temperature of the

air outside the building, the control system being operative to switch the system to run in an MVHR mode when the temperature of the air outside the building is at or below a pre-determined threshold value and to switch the ventilation system to operate in the passive mode when the temperature of the air outside the building is above the threshold value.

6. A building ventilation system as claimed in claim 5, in which the threshold temperature is in the range of 7 to 11 °C.

7. A building ventilation system as claimed in claim 4, in which the ventilation control system is connected with a control system for a heating system in the building, the ventilation control system being operative to run the ventilation system in the MVHR mode when the heating is on and to switch the ventilation system to operate in the passive mode when the heating is off.

8. A building ventilation system as claimed in any one of the preceding claims, in which the control system includes a manual override to allow a user to switch the ventilation system between MVHR and passive modes of operation.

9. A building ventilation system as claimed in any one of the preceding claims, in which the control system comprises a valve in each PSV stack duct, the valve being switchable between a closed condition in which the flow of air along the stack duct beyond the valve is prevented and an open condition in which air can flow through the valve, the control system being operative to close each valve when the ventilation system is in the MVHR mode and to open each valve when the ventilation system is in the passive mode.

10. A building ventilation system as claimed in any one of the preceding claims, in which the ventilation system comprises at least one background ventilator through which supply air can enter the building

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when the ventilation system is operative in the passive mode and means for closing each background ventilator when the ventilation system is operative in the MVHR mode.

11. A building ventilation system as claimed in claim 10 when dependent on claim 5, in which each background ventilator is thermostatically controlled to close when the external temperature is at or below the pre-determined threshold value.

12. A building ventilation system as claimed in claim 10, in which the control system is operative to close each background ventilator when the ventilation system is being run in the MVHR mode.

13. A building ventilation system as claimed in any one of the preceding claims, in which each PSV stack duct is fluidly connected with an extract air inlet of the heat exchanger to form part of the MVHR extract air circuit, such that when the ventilation system is being run in the MVHR mode, extract air can be drawn through each extract vent and part of each PSV stack duct into the heat exchanger.

14. A building ventilation system as claimed in claim 13 when dependent on claim 9, in which each PSV stack duct is fluidly connected with the extract air inlet of the heat exchanger at a position upstream from (below) the valve.

15. A building ventilation system as claimed in any one of the preceding claims, in which an exhaust air outlet of the heat exchanger is fluidly connected with a PSV stack duct, the arrangement being such that when the ventilation system is being run in the MVHR mode, exhaust air can be directed from the heat exchanger into said PSV stack duct to pass out through its respective outlet.

16. A building ventilation system as claimed in claim 15 when dependent on claim 9, in which the exhaust air outlet of the heat exchanger is

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connected with said PSV stack duct at a position downstream from (above) the switchable valve.

17. A building ventilation system as claimed in claim 16, in which the control system comprises a further switchable valve in said PSV stack duct at a position immediately upstream of (below) the fluid connection between the heat exchanger extract air outlet and the duct, the control system being operative to close the further switchable valve when the ventilation system is being run in the MVHR mode.

18. A building ventilation system as claimed in any one of the preceding claims, in which a supply air inlet of the heat exchanger is fluidly connected with a PSV stack duct, the arrangement being such that when the ventilation system is being run in the MVHR mode, supply air can be drawn into the heat exchanger through part of said PSV stack duct and its respective outlet.

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19. A building ventilation system as claimed in claim 19 when dependent on claim 9, in which the supply air inlet of the heat exchanger is connected with said PSV stack duct at a position downstream from (above) the switchable valve.

20. A building ventilation system as claimed in claim 20, in which the control system comprises a further switchable valve in said PSV stack duct at a position immediately upstream of (below) the fluid connection between the heat exchanger supply air inlet and the duct, the control system being operative to close the further switchable valve when the ventilation system is being run in the MVHR mode.

21. A building ventilation system as claimed in any one of claims 18 to 20 when dependent on claim 15, in which the ventilation system has at least two PSV stack ducts, each PSV stack duct connecting a respective extract vent with a respective outlet, the heat exchanger exhaust air

outlet being fluidly connected with at least one of the PSV stack ducts and the supply air inlet of the heat exchanger being fluidly connected with at least one other of the PSV stack ducts.

22. A building ventilation system as claimed in any one of the preceding claims, in which the outlet of each PSV stack duct is located on the roof of the building.

23. A building ventilation system as claimed in any one of the preceding claims, in which the heat exchanger and the extract and supply fans are provided as part of an integrated MVHR unit.

24. A building ventilation system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

25. A method of operating a building ventilation system in accordance with any one of the preceding claims, the method comprising using the control system to operate the ventilation system in the MVHR mode when the external air temperature is at or below a pre-determined threshold value and to operate the ventilation system in the passive mode when the external air temperature is above the pre-determined threshold value.

26. A method of operating a building ventilation system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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| **Application No:** | GB1002845.4 | **Examiner:** | Colin Whitbread |
| **Claims searched:** | 1-23 and 35 | **Date of search:** | 27 May 2011 |

# Patents Act 1977: Search Report under Section 17

**Documents considered to be relevant:**

| Category | Relevant to claims | Identity of document and passage or figure of particular relevance |
|---|---|---|
| X | 1-2, 4-9, 22-23 and 25 | JP 2004019966 A (TOSHIBA CARRIER KK) See paragraphs 0005-0024 and figures 1 and 2. |
| A | - | JP 10176851 A (MATSUSHITA SEIKO KK) 30.06.98 (See WPI Abstract Accession No. 1998-423121 [36] and all figures). |
| A | - | JP 2004293863 A (MATSUSHITA ELECTRIC IND CO LTD) 21.10.04 (See EPODOC Abstract and all figures). |

Categories:

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
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**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

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Worldwide search of patent documents classified in the following areas of the IPC

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| F24F |

The following online and other databases have been used in the preparation of this search report

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| EPODOC, WPI |

**International Classification:**

| Subclass | Subgroup | Valid From |
|---|---|---|
| F24F | 0012/00 | 01/01/2006 |
| F24F | 0007/007 | 01/01/2006 |
| F24F | 0007/02 | 01/01/2006 |
| F24F | 0011/00 | 01/01/2006 |