



- (51) **International Patent Classification:**
F24F 5/00 (2006.01) *E04B 1/74* (2006.01)
F24F 12/00 (2006.01)
- (21) **International Application Number:**
PCT/GB2009/050195
- (22) **International Filing Date:**
26 February 2009 (26.02.2009)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
0803545.3 26 February 2008 (26.02.2008) GB
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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

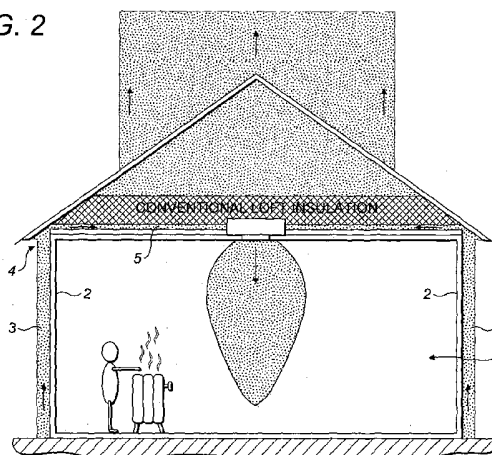
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- with international search report (Art. 21(3))

(54) **Title:** BOUNDARY LAYER ENERGY RECOVERY APPARATUS

FIG. 2



(57) **Abstract:** Apparatus for recovering thermal energy escaping through a wall structure. The apparatus comprising a wall structure (2) provided with a thermal energy recovery layer, the thermal energy recovery layer having an arrangement of one or more air breathable sections provided adjacent one or more non-air breathable sections. Rising or falling air (3) at an outer surface of the wall structure (2) passes over the one or more non-air breathable sections to collect escaping hot or cold thermal energy before passing through the one or more breathable sections to thereby be recovered. Further provided is an air collection means (4) for collecting warmed air rising up or cold air flowing down an external wall of said building. The air collection means comprising a tapering converging guide member extending outwardly from the building's wall (2) for collecting and directing rising or falling air into the building.



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BOUNDARY LAYER ENERGY RECOVERY APPARATUS

The present invention relates to an apparatus for reclaiming thermal energy escaping from a body, in particular a building.

Heating, Ventilation and Air Conditioning (HVAC) systems are generally necessary to maintain a comfortable living environment for occupants within enclosed spaces such as homes and public buildings. In temperate climates such as the UK this is, of course, particularly important during the winter months. However, the production and distribution of heat requires the expenditure of energy, which is often obtained by the burning of fossil fuels. The burning of fossil fuels is well known to produce various pollutants including carbon dioxide, which is a greenhouse gas linked with the dangers of global warming.

The construction and operation of buildings are together responsible for more than 40% of all primary energy consumption in developed countries such as the UK. The emissions from buildings generate more than 50% of the UK's annual carbon emissions, commonly known as a "carbon footprint". Reducing carbon emissions is widely accepted as critical in the fight against climate change. It is therefore of importance to minimize the expenditure of energy for maintaining a suitable temperature within buildings. This would reduce energy costs, lower carbon emissions and create a more healthy living environment.

30

Heating systems are commonly used in homes and public buildings. Some heating systems can utilize several local heating units such as gas or electric fires. Other heating systems can contain a single heating unit which is often situated centrally within the building. In these central

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heating systems a single boiler, furnace, heat pump or other heat generating device acts to heat a fluid medium such as water, steam or air, which is then distributed around the building to various points, for example to a series of
5 radiators. Primarily, radiators act to heat a wide body of air within a building through both conduction and also convection, whereby in the latter case a circulation of air is created by the action of less dense warm air rising through its more dense cooler surrounding air. Thus a single
10 radiator can act to heat a wide volume of air as the air circulates around a room.

It is furthermore commonplace for new buildings to contain a form of insulation, but there are also many old buildings
15 that contain no insulation whatsoever. Heat flow through material making up the walls of a building is determined by the material's resistance to heat flow and the temperature difference across the material. Thus a heated building in winter will conduct heat outwards through the walls, roof and
20 floor to a greater or lesser degree depending upon the temperature difference and the quality and quantity of insulation.

Traditional insulation is designed primarily to prevent heat
25 loss from inside the building to the outside of the building. Any loss of heat to the outside of the building is traditionally wasted energy. More energy is expended in order to replace this wasted energy, which leads to increased carbon emissions or a larger "carbon footprint". However, no
30 traditional insulation systems of reasonable cost can be 100% effective at preventing heat loss from a building to its surrounding environment.

Furthermore, traditional insulation is often combined with
35 measures designed to prevent heat loss that are centred on

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cutting down infiltration and ventilation rates - i.e.,
effectively retaining inside the building as much air as
possible. This can lead to increased humidity which can lead
to condensation, damp, black spotting, an increased sensation
5 of stuffiness, and lower general health of the occupants
through "sick building syndrome". Thus a totally sealed
environment is generally to be avoided.

The present invention seeks to alleviate the problems
10 associated with the above.

According to the present invention there is provided
apparatus for recovering thermal energy escaping through a
wall structure, said apparatus comprising: a wall structure
15 provided with a thermal energy recovery layer, the thermal
energy recovery layer having an arrangement of one or more
air breathable sections provided adjacent one or more non-air
breathable sections, whereby air at an outer surface of the
wall structure passes over the one or more non-air breathable
20 sections to collect escaping thermal energy before passing
through the one or more breathable sections to thereby be
recovered.

The present invention therefore seeks to compensate for non-
25 existing or imperfect insulation of a building or other body
by reclaiming thermal energy escaping from the exterior of
the building or other body and delivering the reclaimed
thermal energy back into the interior of the building or
other body. In this respect, the term "thermal energy"
30 includes both hot and cold thermal energy. The present
invention therefore aims to reduce the extent of
traditionally wasted thermal energy escaping from a building
or other body. Thereby the amount of energy required to
maintain the interior temperature of the building or other
35 body by heating or cooling is minimized and its "carbon

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footprint" reduced.

The present invention further mitigates heat loss or gain whilst still allowing a circulation of air between the interior and exterior of a building or other body. It therefore allows an effective system of insulation which also permits circulation of fresh air into the building, thereby seeking to provide an optimum temperature, humidity and air purity of the interior of a building. Thus the living environment of the interior of the building is maintained a sustainable, energy efficient and healthy environment for the occupants of the building. The breathable sections may take the form of air-permeable modules which help to cycle warm air into the building during winter or conversely cold air into the building during summer. Moreover, the air-permeable modules may have filtering characteristics for filtering out airborne pollutants from external atmospheric air, thereby, for example, helping to alleviate symptoms of asthma for occupants.

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Preferably, in the case of recovering escaping heat energy, the one or more air breathable sections are generally vertically elevated with respect to the one or more non air-breathable sections. In this regard, as the air rises it will naturally pass over the one or more non air breathable sections and over the one or more air breathable sections.

Conveniently, the wall structure has an outer layer, an outer cavity being formed between the outer layer and the heat recovery layer. Preferably, the outer layer has one or more vents for introducing air into the outer cavity. Such vents are ideally provided at or adjacent the base of the non air-breathable sections in the wall structure.

35 Conveniently, the wall structure further comprises an inner

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layer, an inner cavity being formed between the heat recovery layer and the inner layer.

Preferably, air drawn in across the recovery layer is
5 collected in the inner cavity and channeled into a structure bounded by the wall structure.

Conveniently, the apparatus further comprises a converging collection member provided at or adjacent the vertical extent
10 of the wall structure. The converging collection member may take the form of an upturned scoop in cross-section. The collection member may furthermore be provided as an elongated channel running along the length of the top of the wall structure, for example at the roof line thereof. As such, the
15 collection member is preferably configured to collect air up to 25 cm away from the external surface of the outer layer of the wall structure. The scoop seeks to collect any residual rising air, before it is otherwise lost to the atmosphere over the roof of the building.

20

Preferably, pressure differential means are provided for establishing a pressure differential between opposite sides of the heat recovery layer such that air is drawn through the breathable sections. Such pressure differential means may
25 comprise a Mechanical Ventilation with Heat Recovery unit. Circulation of air from the interior to the exterior of a building is beneficial for the well-being of the occupants for replenishment of oxygen and for preventing excessive humidity within the living environment.

30

Conveniently, the air breathable and non-air breathable sections are provided as modular panels. Preferably, the panels are removable for repair/replacement. As such, they are versatile and can be used within different construction
35 methods.

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Conveniently, the breathable sections have graduated filtering profiles, for progressively filtering air passing therethrough.

5 According to a further aspect of the present invention there is provided apparatus for recovering heat escaping from a building through a wall structure, said apparatus comprising:- air collection means for collecting rising warmed air from an external surface, or boundary layer, of
10 said wall structure; a main cavity for collecting said rising warmed air; said main cavity comprising one or more inlets to a breathable insulating filter section, through which said warmed air can pass before being channeled for introduction into said building.

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Preferably, the air collection means comprises a converging guide member provided at or adjacent the vertical extent of the wall structure. Such a guide member may be provided at the roof line of a building.

20

Conveniently, the collection means comprises a wall structure configuration having:- an outer layer; a heat recovery layer, and an inner layer, wherein external air is provided to an outer cavity between the outer layer and the heat recovery
25 layer, the heat recovery layer being permeable to allow air to pass therethrough to an inner cavity which collects and directs air to said main cavity.

In this way, a blanket of tempered outdoor air forms over
30 the heat recovery layer which has been pre-heated by waste heat through the heat recovery layer. This tempered air can be then allowed to pass into the inner cavity before being directed to the main cavity.

35 Preferably, said main cavity is provided in the roof

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structure of a building.

Conveniently, the main cavity is formed between the roof wall and the breathable insulating filter section.

5

According to a further aspect of the present invention, there is provided apparatus for recovering heat escaping from a building, said apparatus comprising:-

an air collection means for collecting warmed air
10 rising up an external wall of said building, said air collection means comprising a converging guide member for coupling at or adjacent the building's roof line, the guide member in use extending outwardly from the building's wall for collecting and directing rising air into the building.

15

Embodiments of the present invention will now be described in detail by way of example, with reference to the accompanying drawings, in which:

20 Figure 1 is a schematic view of a conventional house and the heat escaping therefrom;

Figure 2 is a schematic view of a house fitted with a heat recovery apparatus according to a first embodiment of the present invention;

25 Figure 3 is a schematic view of a house with a dynamic roof and heat recovery scoop system according to a second embodiment of the present invention;

Figure 4 is a cross sectional view of a wall section according to the first embodiment of the present invention;

30 Figure 5 is a partially cut away perspective view of the wall section of Figure 4;

Figure 6 is an enlarged diagram of the roof system of Figure 3;

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Figure 7 shows the measurement points for the heat scoop effect used in the experimental test of a third embodiment of the present invention;

Figure 8 shows the experimental result of the tests 5 conducted on the third embodiment shown in Figure 7 for the week commencing 14th Jan 2008, with plots of (a) indoor and outdoor temperatures, (b) front and rear heat scoop temperature rises, and (c) median wind speeds; and

Figure 9 shows the experimental result of the tests 10 conducted on the third embodiment shown in Figure 7 for the week commencing 7th July 2008, with plots of (a) indoor and outdoor temperatures, (b) front and rear heat scoop temperature rises, and (c) median wind speeds,

15 The embodiments of the present invention described below are for use with a house, although the present invention can also be applied to any building, such as a school, hospital, residential tower block, office block, industrial building, municipal building, etc.

20

In this respect, Figure 1 shows a conventional house 1 whose insulation is less than 100% efficient. As such, in winter heat is conducted through external walls 2 to heat the air 3 surrounding the exterior of the building. The warmed air 25 expands, becomes less dense than the surrounding atmosphere and consequently rises away from the house. Colder air from the surrounding atmosphere moves in to replace the space around the house, is itself warmed by conduction of heat through the walls of the house and also rises away from the 30 house. Thus a cycle of heating exterior air is created and the energy to drive this cycle is continually expelled into the atmosphere and wasted. In summer, as outdoor temperatures soar, the cycle is reversed and the exterior walls of the house become relatively cool through conduction with its 35 interior to thereby cool the air layer that blankets the

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house. The cool air falls away from the house, to be replaced by warm outdoor air and so the cycle of coolth loss continues.

5 Figure 2 shows a conventional house installed with apparatus of a first embodiment of the present invention. The air blanket surrounding the exterior of the house is again heated by conduction through the external walls of the house as in Figure 1. The warmed air, which can be up to 7°C higher in
10 temperature than its surroundings, rises and is collected by a collection means (heat scoop) 4 which delivers the warm air via suitable channeling 5 into the interior of the building. Thus, the energy previously used to heat the air surrounding the external walls, which would have been lost to the
15 atmosphere from a traditional house, is reclaimed back into maintaining the temperature of the interior of the house. As less energy is wasted, less energy is required to maintain the temperature of the house and its carbon footprint is reduced substantially. Moreover, abundant fresh air is
20 circulated into the house from the outside without cost penalty.

Figure 4, shows how the wall structure of the house of Figure 2 has been enhanced for recovering heat loss. As
25 shown, the wall structure comprises an outer layer 7 and a heat recovery layer 8. The outer layer 7 and heat recovery layer 8 enclose an outer cavity 9, and a vent 10 at the base of the wall structure allows air to enter into the outer cavity. As shown in Figure 5, air in this cavity flows over
30 non-breathable or static panels 11 and is warmed by heat loss through conduction from the interior of the building through the non-breathable panels. The air, thus suitably warmed, will rise through the cavity and pass over the breathable or dynamic panels 12. The warmed air is drawn through the
35 breathable or dynamic panels 12 and into an inner cavity 13

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is returned to the recovery layer of the building. The heat recovery layer is formed to incorporate breathable and non breathable sections. The breathable sections are breathable in the sense of dynamically insulated breathable wall technology, namely that they allow air to pass through them at a rate compatible with the provision of fresh air ventilation to indoor spaces.

Figures 3 and 6 shows a second embodiment of the present invention, comprising the boundary layer recovery heat scoop of the present invention together with a dynamic roof apparatus for the purpose of Heating, Ventilation and Air Conditioning (HVAC). The boundary layer recovery scoop, and recovery layer in the wall structure again act to collect the rising warm air surrounding the external walls of the building and channel the warm collected air into a main cavity in the roof of the house. The cavity is formed between an external boundary layer such as the roof tiles and a series of air permeable or breathable dynamic "Energyflo™" cells. The Energyflo™ cells are connected to a Mechanical Ventilation with Heat Recovery unit (MVHR) as can be seen in Figure 6, which draws the warm external air into the interior of the house. The MVHR can also act to extract stale (hot or cold) air from the interior of the house and expel it to the atmosphere. The average temperature in the recovery layer of the dynamic roof arrangement is on average up to 7°C higher than the outdoor ambient temperature.

30 Experimental Example

A third embodiment of the present invention is described below in relation to Figures 7 to 9. This third embodiment is a full-scale confidential building trial conducted in the City of Edinburgh, Scotland. The observed experimental performance of the the heat scoop effect of this third

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embodiment is summarised below.

The test house featured a dynamically insulated roof, used to supply fresh, pre-heated, filtered ventilation air to the house via a MVHR unit as shown in Figure 7. The air intakes were along front and rear eaves of the roof, directly above the warm blanket of air (the heat recovery layer) that develops as a result of heat loss through the conventionally insulated walls of the house. The incoming air temperatures at the intakes 19,20, outdoor ambient temperature 21, indoor temperature 22 and external wind 23,24 (front and sideways components) were continuously monitored and recorded over an extended period of 1 year.

The results shown in Figures 8 and 9 are for one representative week in winter (starting 14th January 2008) and one week in summer (starting 7th July 2008), respectively. The measure of scoop heat recovery is temperature rises above ambient. The effect of external wind was considered.

20

During the winter week the average temperature rise was 3°C (1.4°C min to 6.4°C max) from the rear-facing scoop and 5°C (2.9°C min to 7.3°C max) from the front-facing scoop. The average energy recovered was around 20% (12% min to 33% max) of the total heat loss through the front and back walls. The rear scoop appears to be sensitive to the normal wind component - see link between (b) and (c) during the second half of 15th of January. Also, the evening dip on 18th January confirms the relationship between heat loss and indoor to outdoor temperature difference - see the link between (a) and (b).

30

During the summer week the average temperature rise was 4.7°C (1.2°C min to 10.9°C max) from the rear-facing scoop and 5.9°C (4°C min to 10.9°C max) from the front-facing scoop. The average energy recovered was comparable to that observed for

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the winter week when the large temperature swings attributed to solar gain have been factored out. The front and rear scoop gains are almost identical and both are sensitive mid-day solar gains - see the multiple links between (a) and 5 (b) throughout the week. The only significant wind during a relatively calm week, over the 9th and 10th of July, does not appear to have any effect.

During the winter week the house was unoccupied, whereas 10 during the summer week it was occupied. This is evident from a comparison of the indoor temperature plots in Figures 8(a) and 9(a). The variability of indoor temperatures in the latter is attributed to occupancy.

15 The above results relate to an non-optimised experimental evaluation of the heat scoop effect for a building featuring an exposed heat recovery layer. From this experimental third embodiment it is expected that, once optimised, embodiments of the present will be able to deliver greater levels of 20 heat recovery.

The present invention is able to form the basis for a new approach and new products and applications in both the new and retrofit / refurbishment building markets and beyond. In 25 this respect, heat scoop of the present invention can dramatically improve efficiency in buildings, and particularly in currently energy inefficient homes and buildings, including the millions of hard to insulate solid wall dwellings in existence.

30

It will be understood that the embodiments illustrated above describe the invention in particular forms only for the purposes of illustration. In practice, the invention may be applied to many different configurations, including, but not 35 limited to, building heating and cooling applications,

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Heating, Ventilation and Air Conditioning (HVAC), fresh air ventilation or any heat recovery application involving boundary layer heat transfer. The detailed embodiments of which would be straightforward for those skilled in the art
5 to implement.

For example, in the above illustrative embodiments, the various features of the present invention have been described within the context of air being heated by the building and
10 rising up the exterior of the building. In such cases, the interior building temperature is higher than the external air temperature, as is the case in winter or in colder climates. Nevertheless, it will also be understood that the present invention is equally applicable where the interior building
15 temperature is lower than the external air temperature, such as in hotter climates or during the summer. In such cases, with the present invention, the walls of the building are relatively cool compared to the external air temperature. This causes the air over the outer surface of the wall to be
20 cooled, causing it to fall/flow downwardly. The coolth in this relatively cool air can then be collected by the present invention and returned to the interior of the building in order to retain the cooler air temperature indoors. In this way, the present invention is able to recover the coolth or
25 cold flows escaping from the building. This is important as significant amounts of energy are often used in order to keep a building cool, for example by air conditioning units. As such, as well as the recovery of hot thermal energy described in the above embodiments, the present invention is also able
30 to recover cold thermal energy. The present invention is recovering "thermal energy" in the sense that it is retaining the energy used to cool the interior of the building, or retaining energy which would have otherwise been used to keep the building cool. As such, the cold thermal energy is
35 embodied in the coolth or cold flows escaping from the

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building which are subsequently recovered by the present invention.

In this connection, in the embodiments of the present
5 invention where the wall structure is provided with a heat
recovery layer having an arrangement of air breathable
sections and adjacent non-air breathable sections, the air
at an outer surface of the wall structure passes over the
one or more non-air breathable sections. Here, the air is
10 cooled by the escaping coolth, which causes it to fall. That
is, the relatively cool outer wall surface acts to cool the
warmer exterior air. The descending cooled air then passes
through the one or more breathable sections into the
building's interior to thereby recover the coolth.

15

In other embodiments, an air collection means may be provided
having a guide member which extends outwardly from the
building's wall and upwardly so as to collect falling cooled
air and direct it back into the building. In some
20 embodiments, the air collection means may also enable
collection of both cool and warm air from the outer boundary
of the exterior wall. For example, the air collection means
may be provided with two guide members or channels which,
respectively, face upwardly and downwardly so that, depending
25 on conditions, falling cool air or rising hot air can be
collected and returned into the building.

Accordingly, it will be understood that embodiments of the
present invention are therefore able to recover both hot and
30 cold thermal energy.

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CLAIMS

1. Apparatus for recovering thermal energy escaping through a wall structure, said apparatus comprising:-

5 a wall structure provided with a thermal energy recovery layer, the thermal energy recovery layer having an arrangement of one or more air breathable sections provided adjacent one or more non-air breathable sections,

whereby air at an outer surface of the wall structure
10 passes over the one or more non-air breathable sections to collect escaping thermal energy before passing through the one or more breathable sections to thereby be recovered.

2. Apparatus according to claim 1, wherein the thermal
15 energy is heat and the one or more breathable sections are generally vertically elevated with respect to the one or more non-breathable sections.

3. Apparatus according to claim 1 or 2, wherein the wall
20 structure comprises an outer layer, an outer cavity being formed between the outer layer and the recovery layer.

4. Apparatus according to claim 3, wherein the outer
25 layer has one or more vents for introducing air into the outer cavity.

5. Apparatus according to any preceding claim, wherein
the wall structure further comprises an inner layer, an inner
30 cavity being formed between the recovery layer and the inner layer.

6. Apparatus according to claim 5, wherein air recovered
through the recovery layer is collected in the inner cavity
and channeled into a structure bounded by the wall structure.

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7. Apparatus according to any preceding claim, further comprising a converging collection member provided at or adjacent the vertical extent of the wall structure.

5 8. Apparatus according to claim 7, wherein the converging collection member takes the form of an upturned scoop in cross-section.

9. Apparatus according to claim 7 or 8, wherein air is
10 collected up to 25 cm from the external surface of the outer layer.

10. Apparatus according to any preceding claim, wherein air is drawn through the breathable sections by means of a
15 Mechanical Ventilation with Heat Recovery unit.

11. Apparatus according to any preceding claim, wherein the breathable and non-breathable sections are provided as panels.

20

12. Apparatus according to claim 11, wherein the panels are removable for repair/replacement.

13. Apparatus according to any preceding claim, wherein
25 the breathable sections have graduated filtering profiles, for progressively filtering air passing therethrough.

14. Apparatus for recovering heat escaping from a building through a wall structure, said apparatus
30 comprising:-

air collection means for collecting rising warmed air from an external surface of said wall structure;

a main cavity for collecting said rising warmed air, said main cavity comprising one or more inlets to a
35 breathable insulating filter section through which said

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warmed air can pass, before being channeled for introduction into said building.

15. Apparatus according to claim 14, wherein the air collection means comprises a converging guide member provided at or adjacent the vertical extent of the wall structure.

16. Apparatus according to claim 14 or 15, wherein the collection means comprises a wall structure configuration 10 having:-

an outer layer;
a heat recovery layer, and
an inner layer,

wherein external air is provided to an outer cavity 15 between the outer layer and the heat recovery layer, the heat recovery layer being permeable to allow air to pass therethrough to an inner cavity which collects and directs air to said main cavity.

20 17. Apparatus according to any of claims 14 to 16, wherein said main cavity is provided in the roof structure of a building.

18. Apparatus according to claim 17, wherein the main 25 cavity is formed between the roof wall and the breathable insulating filter section.

19. Apparatus for recovering heat escaping from a building, said apparatus comprising:-

30 an air collection means for collecting warmed air rising up an external wall of said building, said air collection means comprising a converging guide member for coupling at or adjacent the building's roof line,

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wherein the guide member, in use, extending outwardly from the building's wall for collecting and directing rising warmed air into the building.

5 20. Apparatus for cooling the temperature of air entering a building, said apparatus comprising:-

an air collection means for collecting air flowing down and cooled by an external wall of said building, said air collection means comprising a tapering converging guide
10 member for coupling at or adjacent said external wall,

the guide member, in use, extending outwardly from the building's wall for collecting and directing falling cooled air into the building.

15 21. Apparatus for recovering a hot or cold air flow resulting from escaping thermal energy at an outer surface of a building, said apparatus comprising:-

an air collection means for collecting warmed air rising up, or cooled air flowing down an external wall of
20 said building, said air collection means comprising a tapering converging guide member for coupling at or adjacent the building's external wall,

the guide member, in use, extending outwardly from the building's wall for collecting and directing rising or
25 falling air into the building.

22. Apparatus for recovering thermal energy through a wall structure, said apparatus comprising:-

a wall structure provided with a energy recovery
30 layer, the energy recovery layer having an arrangement of one or more air breathable sections provided adjacent one or more non-air breathable sections,

whereby air at an outer surface of the wall structure passing over the one or more non-air breathable sections is

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heated or cooled thereby, and then rises or falls before passing through the one or more breathable sections.

23. Apparatus for recovering thermal energy escaping from
5 a building through a wall structure, said apparatus comprising:-

air collection means for collecting rising warmed air or falling cooled air from an external surface of said wall structure;

10 a main cavity for receiving said rising warmed air or falling cooled air from the air collection means, said main cavity comprising one or more inlets to a breathable insulating filter section through which said warmed or cooled air can pass, before being channeled for introduction into
15 said building.

24. An apparatus substantially as hereinbefore described with reference to the accompanying drawings.

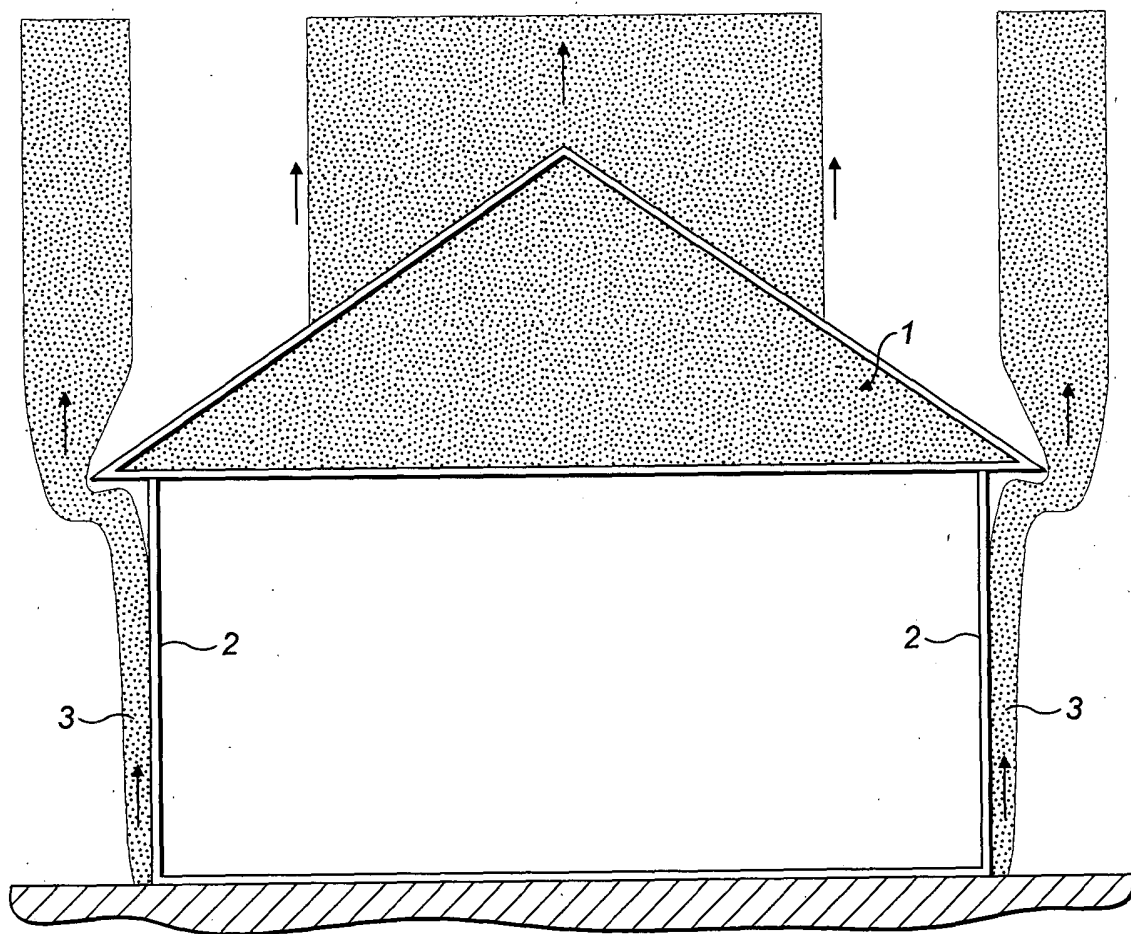


FIG. 1

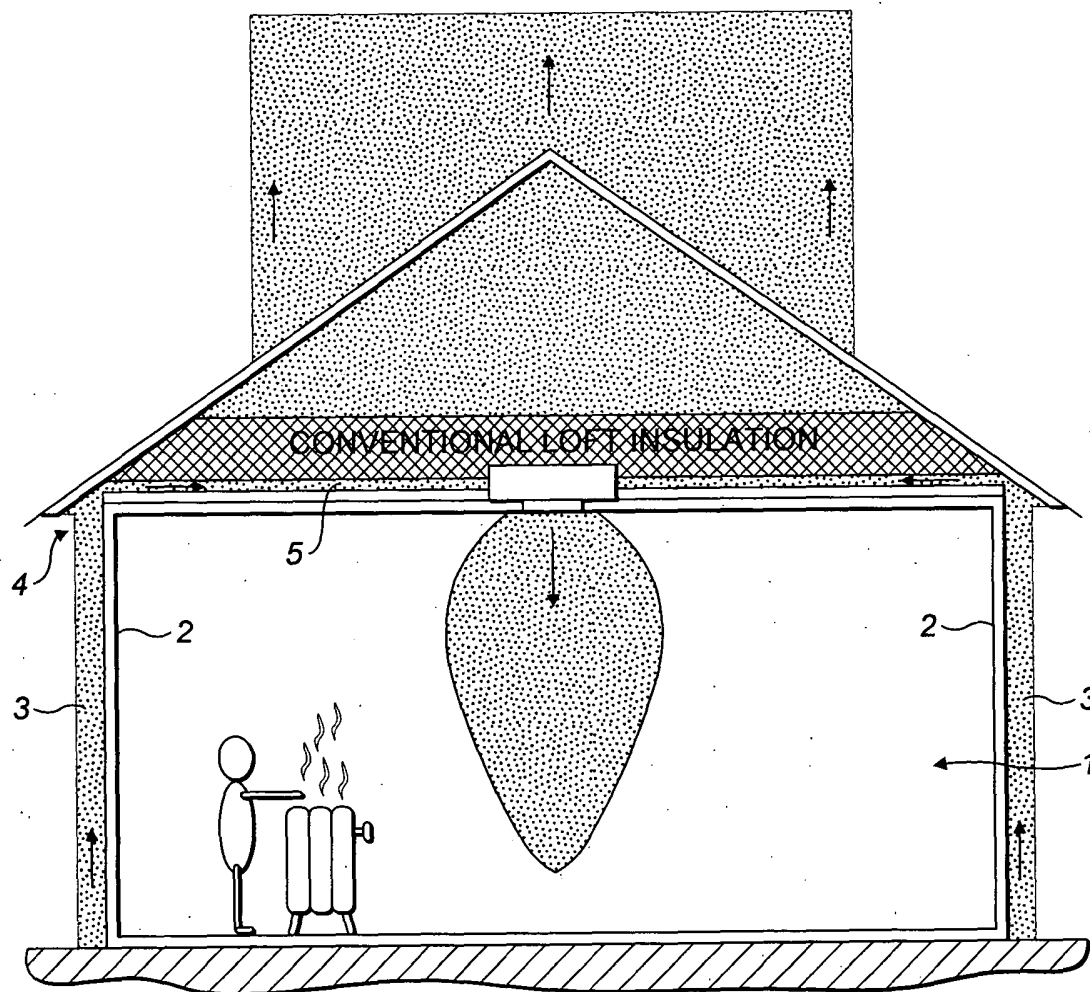


FIG. 2

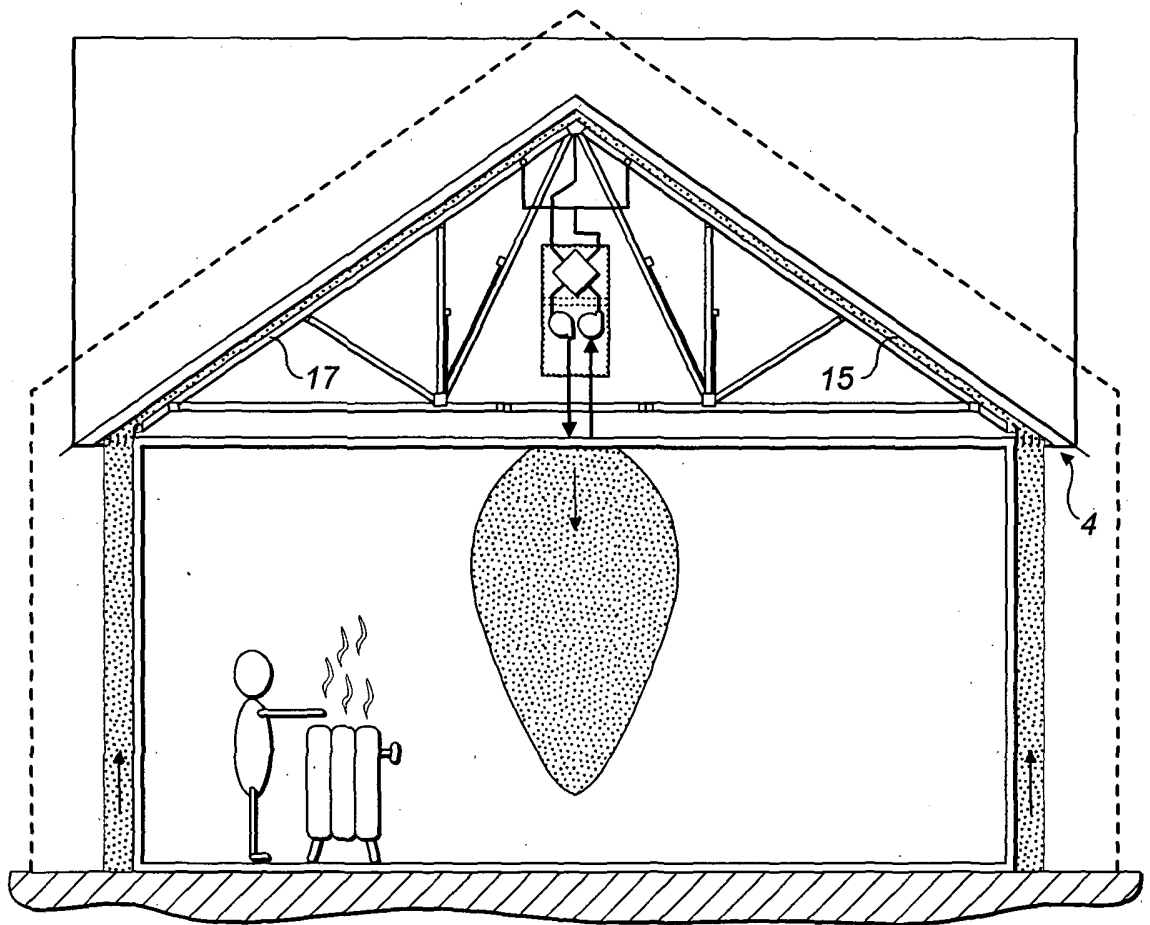


FIG. 3

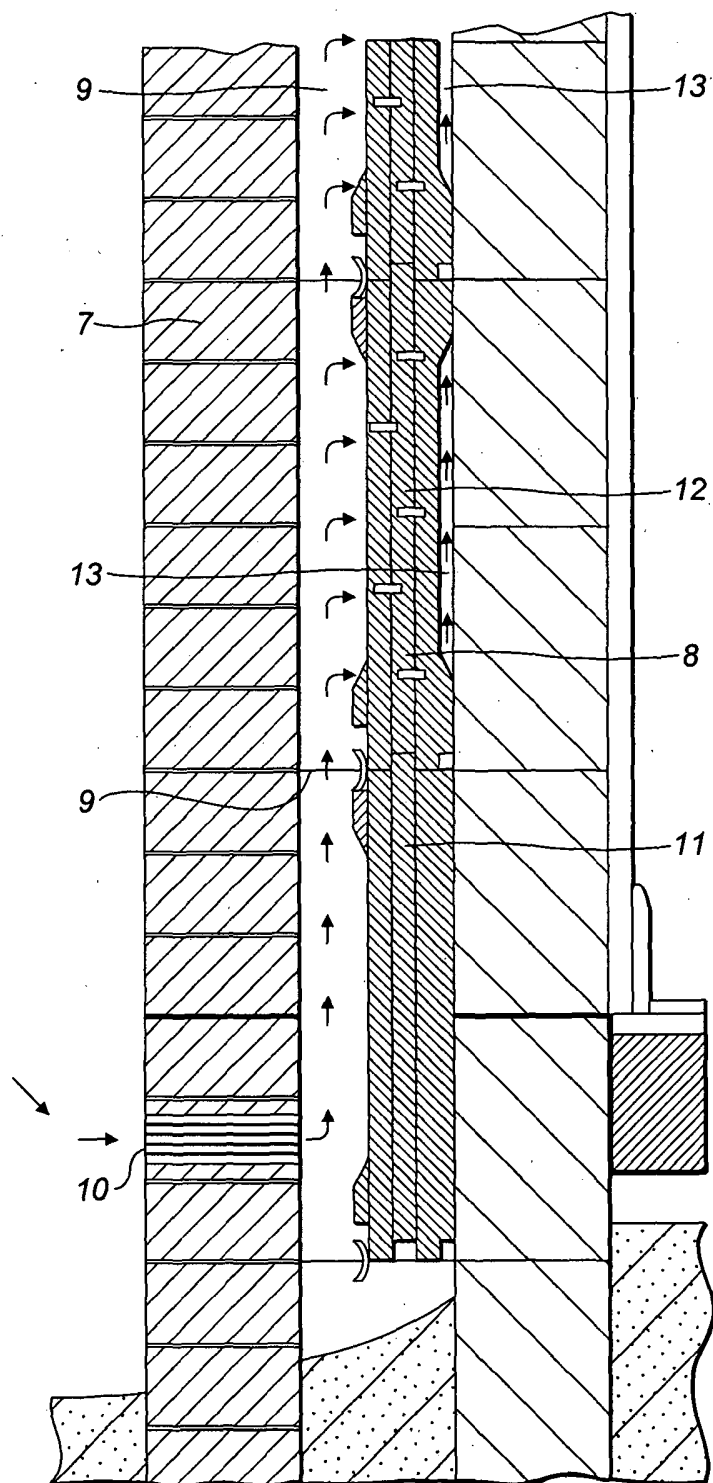


FIG. 4

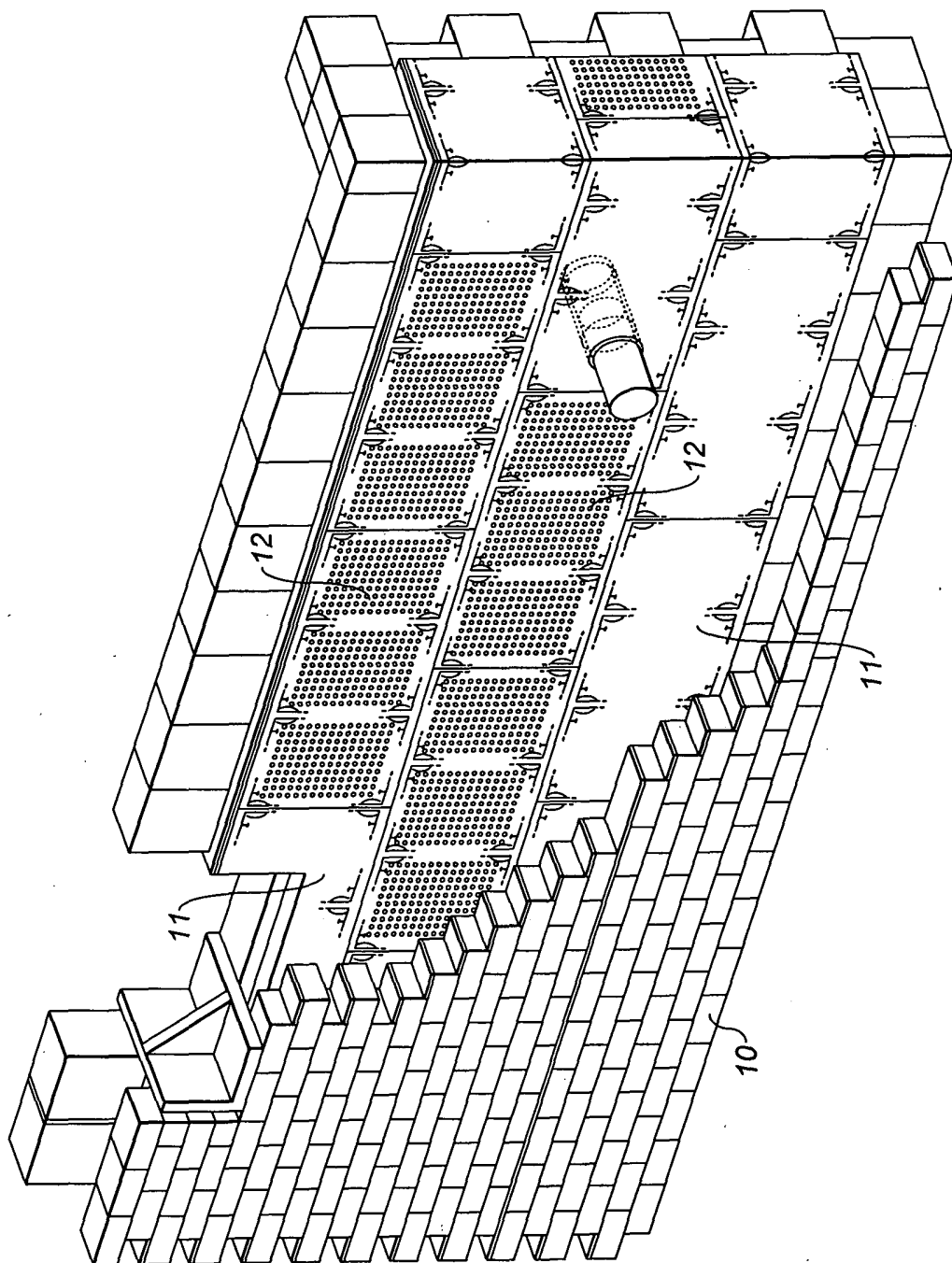


FIG. 5

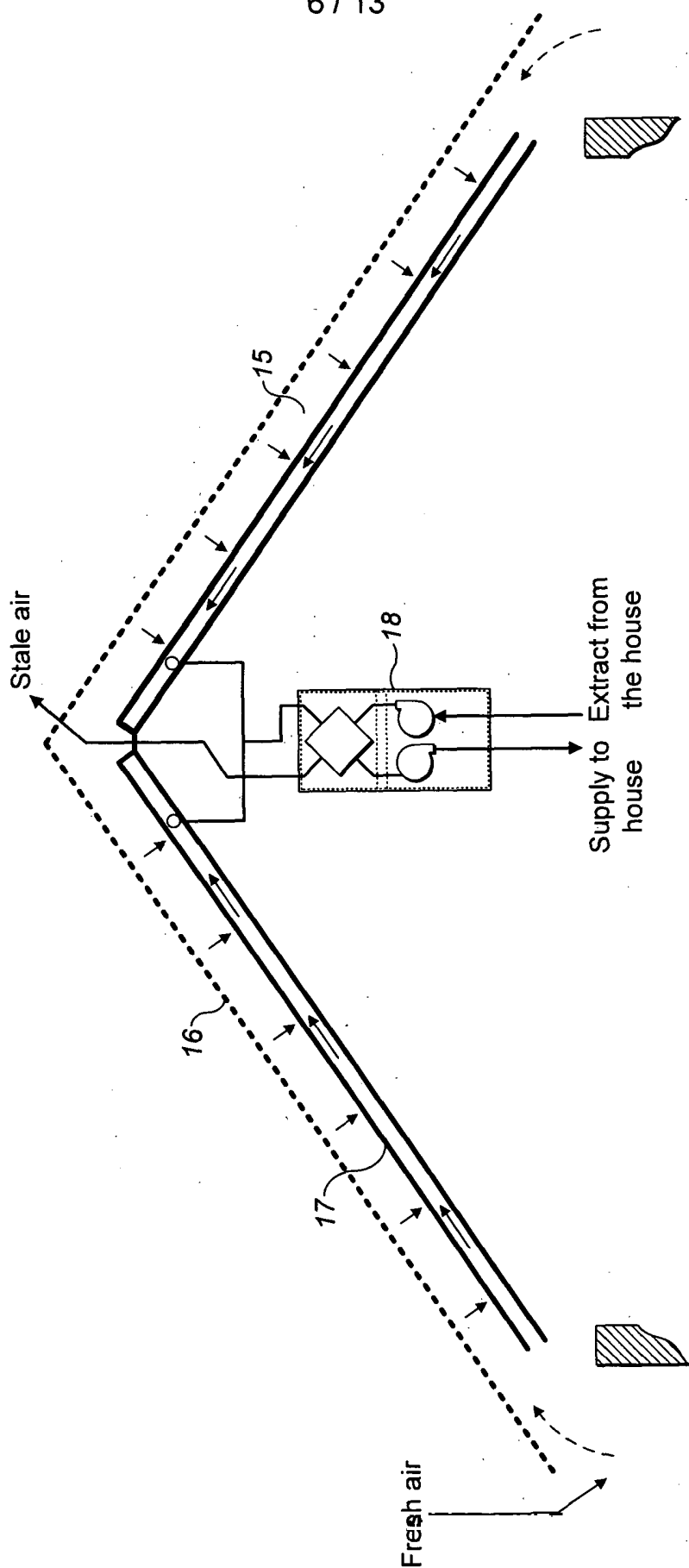


FIG. 6

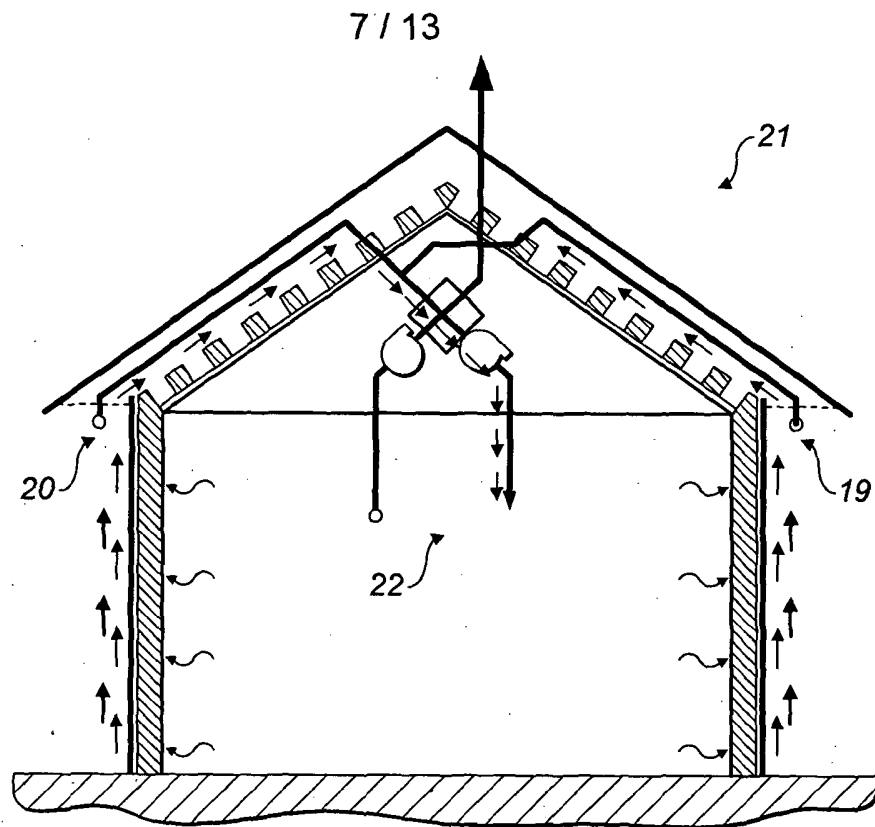


FIG. 7a

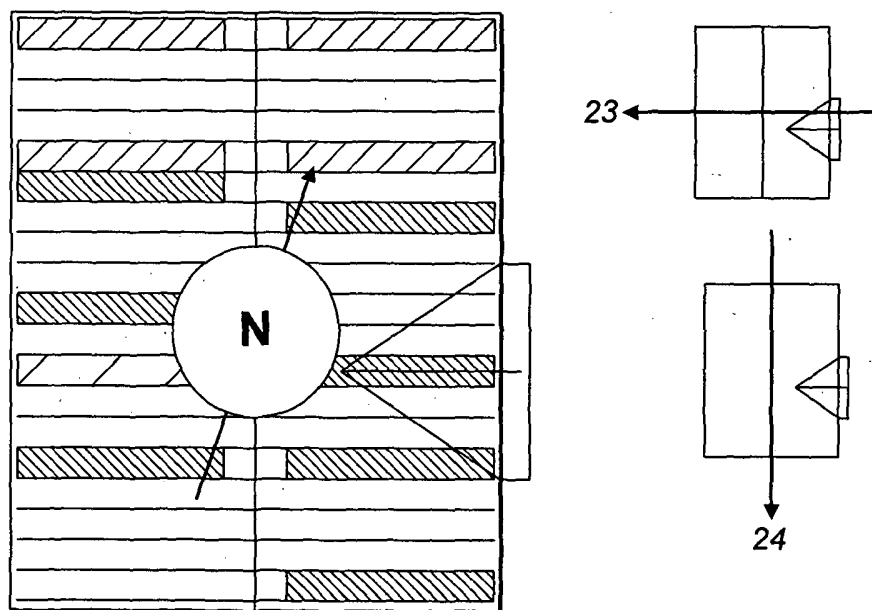
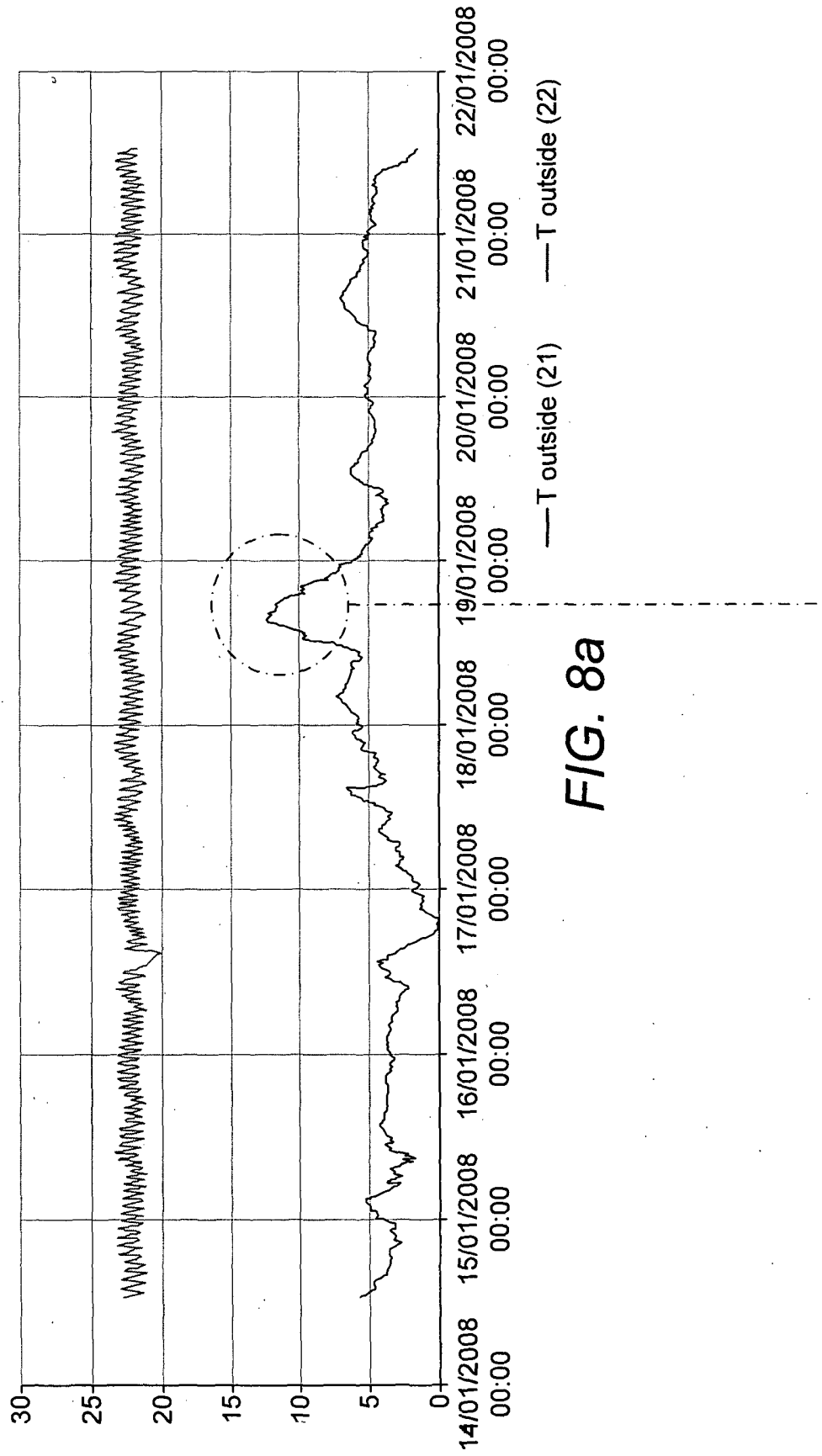


FIG. 7b



— T outside (21) — T outside (22)

FIG. 8a

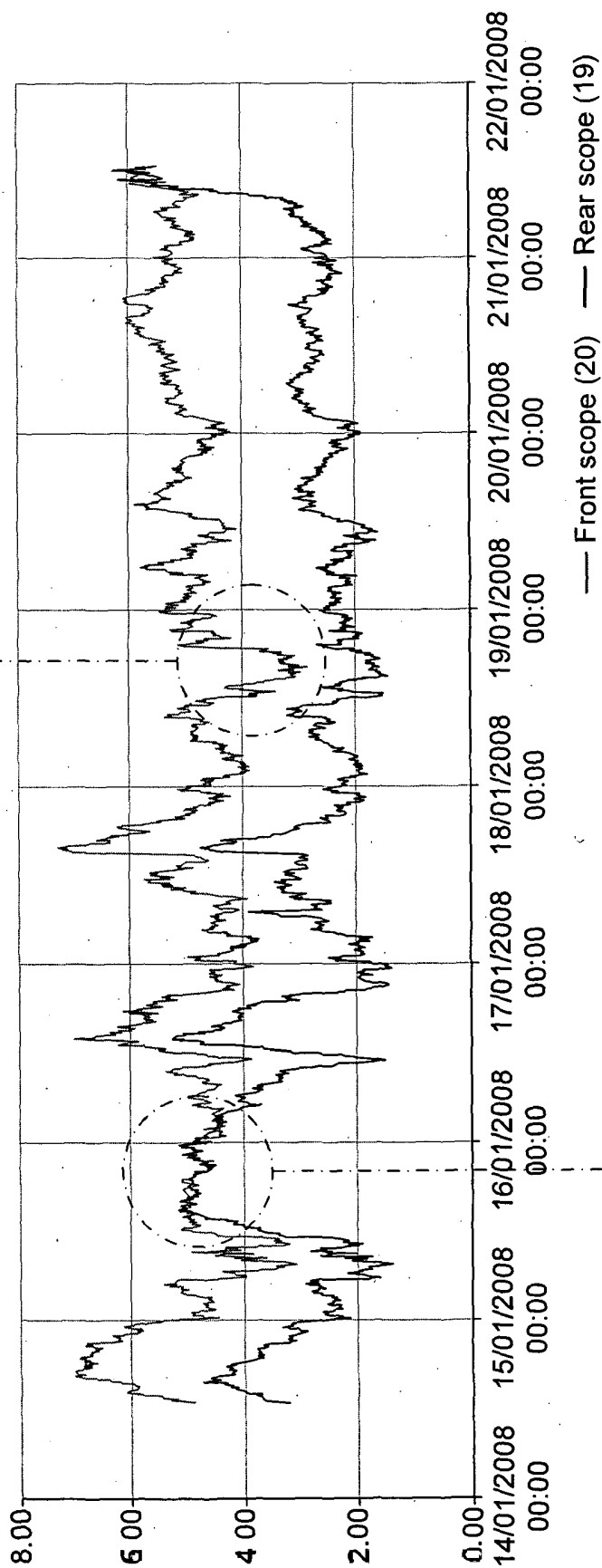
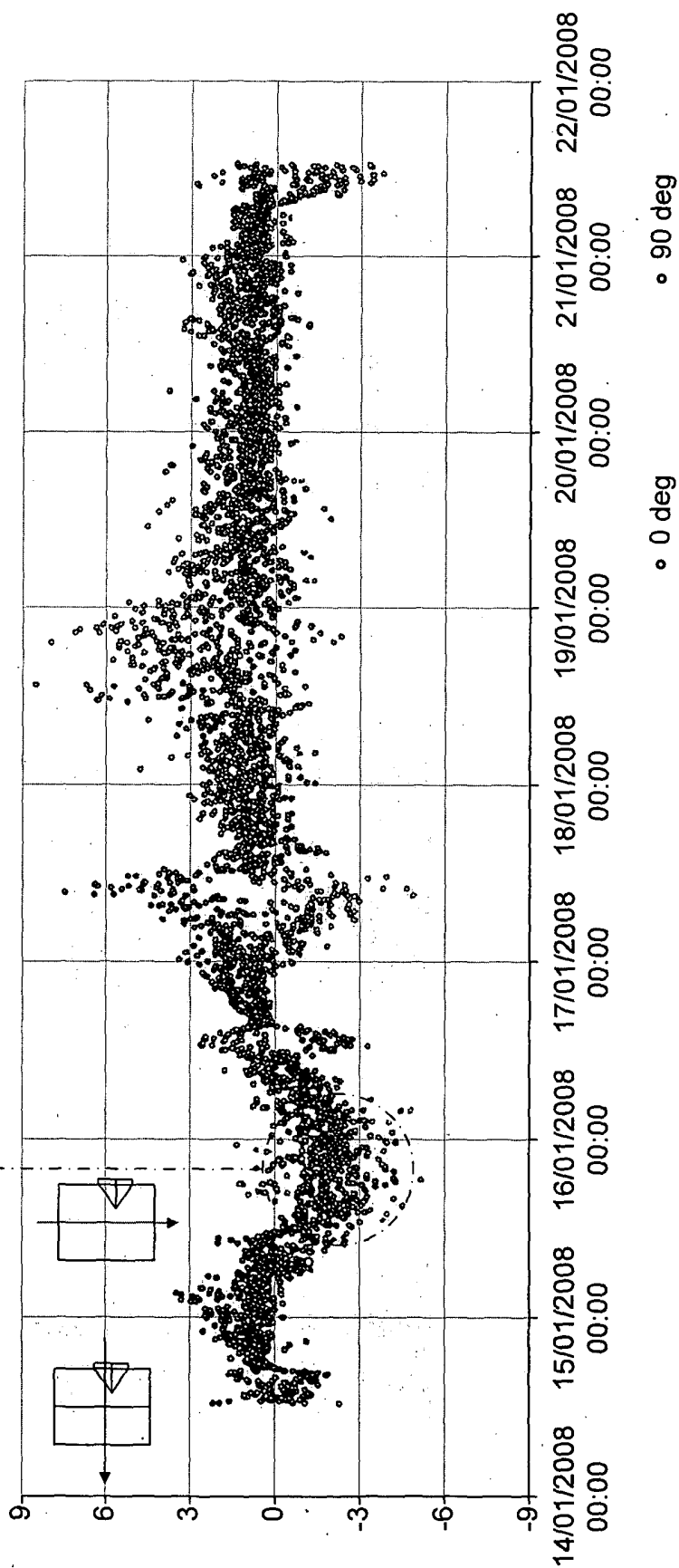


FIG. 8b



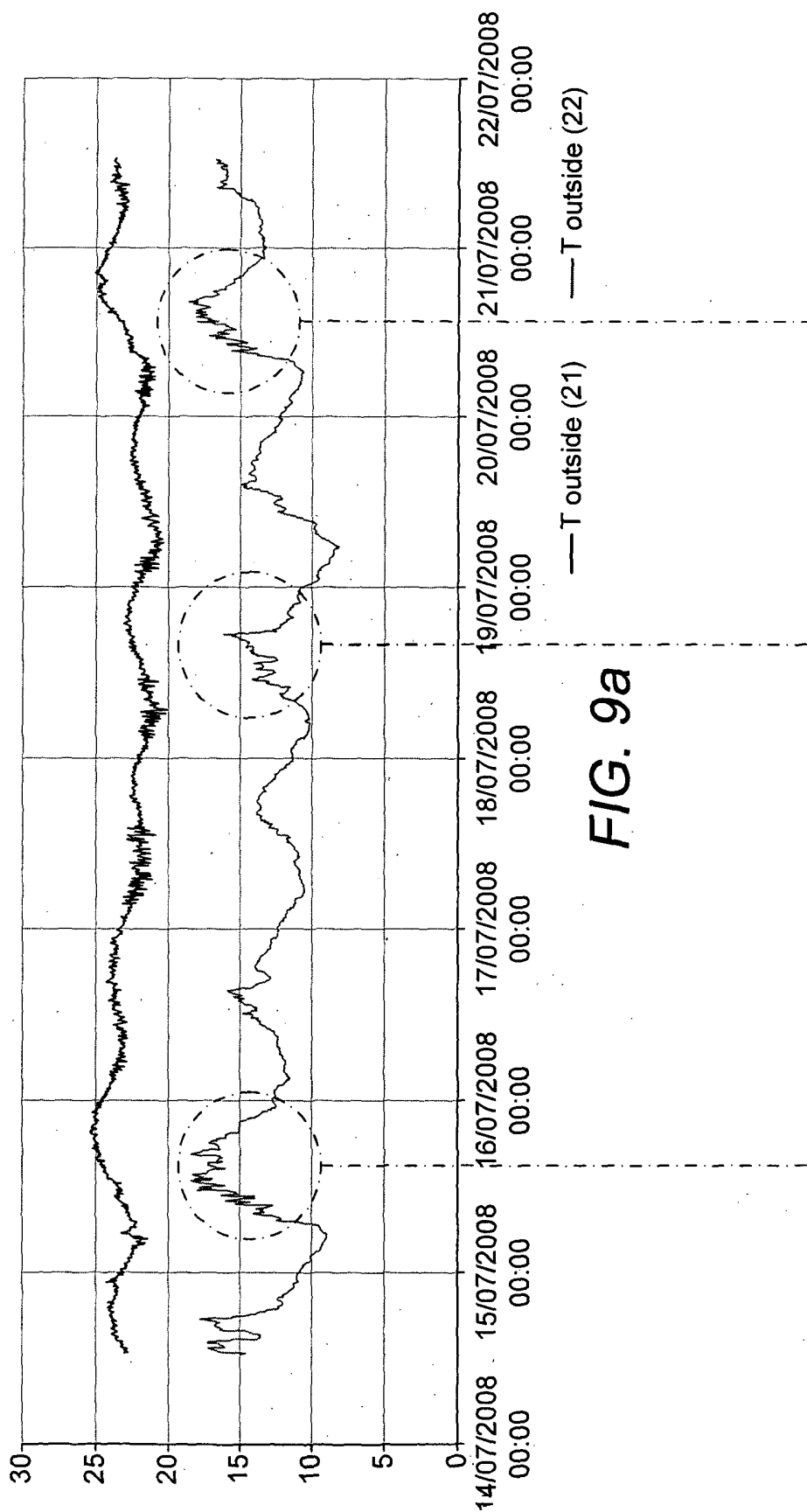


FIG. 9a

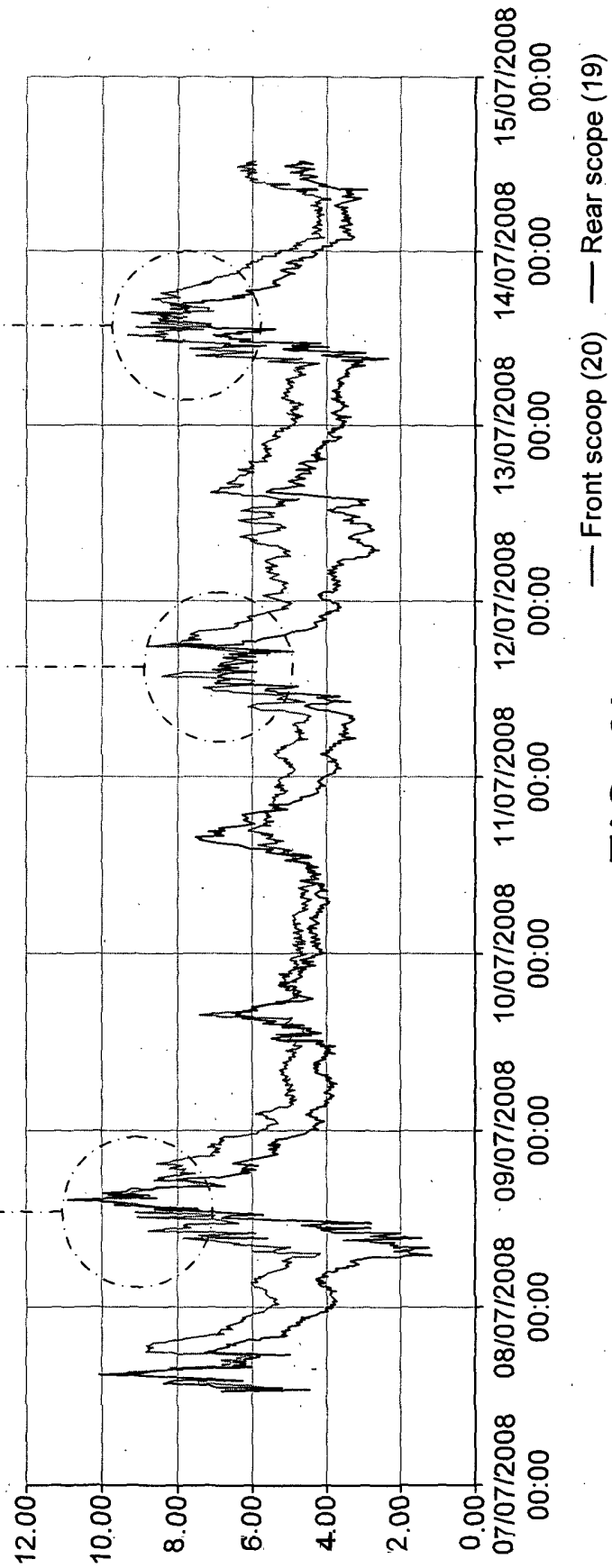


FIG. 9b

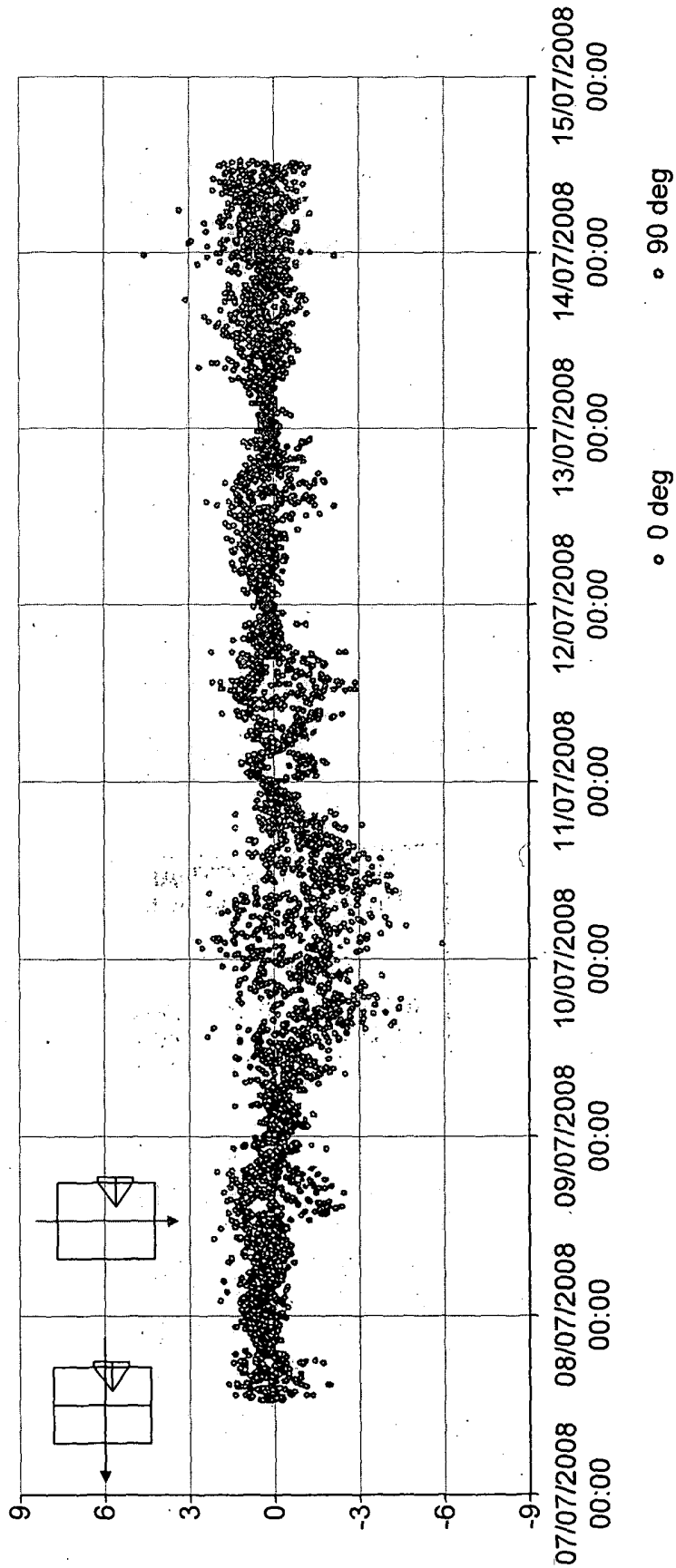


FIG. 9C

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/050195

A. CLASSIFICATION OF SUBJECT MATTER		
INV. F24F5/00 F24F12/00 E04B1/74		
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) F24F F28D E04B		
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 practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 183 398 A (EHRKE RAINER [DE]) 15 January 1980 (1980-01-15) column 2, line 45 - column 3, line 8; figure 1 -----	1-24
X	JP 2001 059284 A (OM KENKYUSHO KK) 6 March 2001 (2001-03-06) paragraph [0018] - paragraph [0025]; figure 1 -----	1-24
A	US 6 319 115 B1 (SHINGAKI MORINOBU [JP]) 20 November 2001 (2001-11-20) the whole document -----	1-24
A	DE 198 49 127 A1 (PRIEBE THOMAS [DE]) 27 April 2000 (2000-04-27) the whole document -----	1-24
	-/--	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 document 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
8 June 2009		17/06/2009
Name and mailing address of the ISA/ European Patent Office, P.B. 5618 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer González-Granda, C

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/050195

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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International application No

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