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(54) **A METHOD AND SYSTEM FOR REDUCING HEAT TRANSFER THROUGH BUILDING ELEMENTS**

(57) It is described a method and system for reducing heat transfer through a building element, the building element (4, 5) comprised in an outer wall, roof, or floor of a building. The building element (4, 5) comprises two layers (8a, 8b; 9a, 9b) of an insulating material which have surfaces facing a passage (2) between the layers, the layers having like heat transfer numbers (U-values). An air stream is conducted through the passage (2).

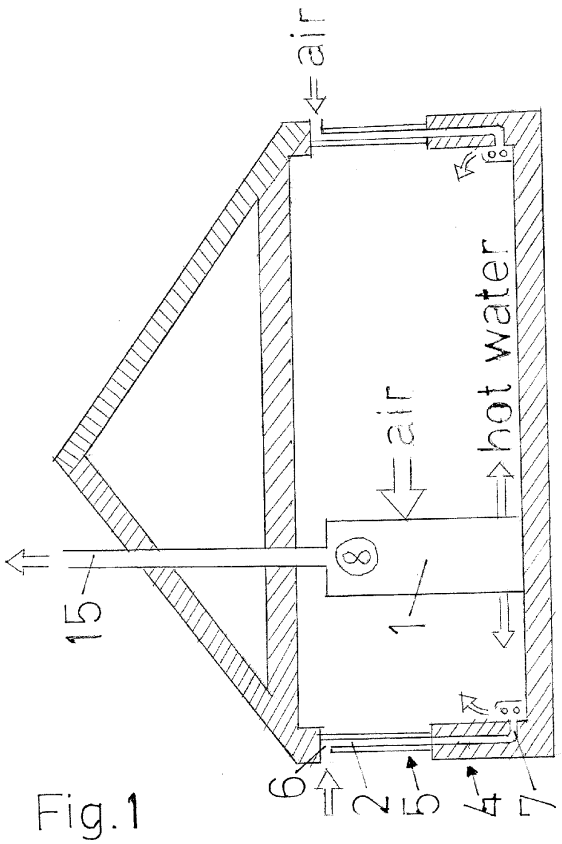

Fig.1

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Description

Field of the invention

[0001] The present invention relates to a system for reducing heat transfer through building elements in a building, in particular the outer walls thereof. The system is applicable both to heated buildings in cool climates and buildings in hot climates needed to be cooled.

Background

[0002] Current building regulations in Norway (TEK 17) states that in e.g. a bedroom with two beds, the air should be exchanged at a rate of 52 m^3 per hour, while a single bed bedroom needs an air exchange of 26 m^3 per hour.

[0003] The regulations also state that the walls should have a heat transmission coefficient (U-value, in $W/(m^2K)$) of less than 0.18, while the windows should have a U-value of less than 0.8. This last value is difficult to achieve, as a normal two-layer window has a U-value of 2.4. To obtain a U-value that satisfies the regulations, one must resort to windows with more than two layers of glass and fill the windows with inert gases such as argon, crypton or xenon.

[0004] Besides loss by ventilation and consumption of hot water, the major energy loss in buildings is by conduction through walls, windows, ceilings, and floors. Each 10th year the authorities present more stringent building regulations to reduce energy consumption in buildings. The walls become thicker, as well as floor, ceiling, and windows. The result of this is a restriction of the usable area of buildings and increased height. It appears that one has reached a limit for increasing dimensions, as it is hardly functionally and economically justifiable to follow this path further in order to reduce the energy footprint of buildings.

[0005] German patent document DE 3326498 describes a building which is heated by a heat pump and furnace. In one embodiment a cold air stream is conducted from outside and into a passage in a window, wherein the passage is formed by an internal single glass pane and an external doble pane. The air stream receives heat from the inside of the building by the heat transmission through the single pane, which is comparatively high due to the low insulation properties of the single pane. A drawback of this solution is that the single layered pane is cooled by the cold outside air stream, whereupon persons being close to the window will experience cold draft, a strong downward chilly air stream. Another drawback is that the air from inside the building has a high absolute humidity which will condense as dew on the internal glass surface and will form ice when the external temperature is extra low.

[0006] The document also describes another embodiment with an internal insulating double glassing and a single pane on the outside. Then, the internal double glassing will prevent the condensation of humidity on the inner glass surface, but the transfer of heat out through the inner double glassing is small, and the air flowing into the building remains cold. The outer single glass pane has little insulation ability, and a lot of the limited heat flow through the inner double glassing to the air stream will be transmitted to the outside environment. Thus, this solution will not provide any significant additional heat to the cold air flowing through the passage.

[0007] In both embodiments particles from polluted air, among others pollen, will settle on the glass surfaces in the passage.

Summary of the Invention

[0008] It is an object of the present invention to provide a method and system for obtaining very low values for the heat transfer through the elements of the building, i.e. such as walls, windows, floors and ceilings. The invention concerns the heat transfer from the building, while the control of the temperature inside the building is another matter. The invention relates to a system for lowering the heat loss from a heated building in a cold climate but may as well find application as a system for reducing the influx of heat into a building located in a hot climate.

[0009] The scope of protection appears from the appended claims.

[0010] The present invention is in opposition to the current trend of steadily increasing dimensions of the insulation in buildings. In case of a heated building in a cold climate, a solution is to let ventilation air from the outside enter slots in the external building elements and let the incoming air collect the energy loss from the inner insulated part. The external insulated part ensures that energy loss from the heated air stream is marginal. Thus, the energy loss becomes almost eliminated and the dimensions and consumption of materials is lowered. The incoming and subsequently heated air is ventilation for the building. This air is always new and fresh from the outside air. When this air has ventilated the building, the energy may be collected by an air-to-water heat pump with an effect of 1:3 - 1:5 COP providing heated water to under floor heating or radiators. Surplus energy may be used to provide hot water for consumption and storage in a magazine for winter use.

[0011] The benefits obtained by this invention includes:

1. Close to no loss of energy compared to existing constructions.
2. The consumption of building materials is reduced as well as harmful effluents by the production of these materials.
3. Thinner constructions means more effective area use and lower buildings.
4. Moisture and water damages from possible defects in the exterior are substantially reduced because the air stream inside the constructions will remove moisture.
5. Air leaks in the climatic screen have minor con-

sequences as the sub-pressure inside the building creates inward going air streams.

6. Moisture from vapor diffusion from warm inside to cold outside will not be harmful because the vapor will be absorbed by the air stream inside the passage and returned to the air inside of the building.

[0012] A corresponding solution may be used in cooled building located in a zone with a hot climate.

Brief Description of the Drawings

[0013] The invention will now be described in detail with reference to the appended drawings, in which:

Fig. 1 is a schematic section of a building equipped with a system according to the present invention, the building being heated by a heat pump,

Fig. 2 is a section through a wall in said building,

Fig. 3 is a vertical section through a window which may be used in such a building,

Fig. 4 is a horizontal section through a window as shown in Fig. 3, and that is possible to open,

Fig.5 is a horizontal section through a corresponding fixed window,

Fig. 6 is an illustration showing the heat flow in a building element,

Fig. 7 is a diagram illustrating the effect of the invention,

Fig. 8 is a section through a corresponding building which may be in an area with a hot climate, and

Fig. 9 is a section through a wall for use in a cooled building.

Detailed Description

[0014] Fig. 1 is a cross section through a building which is air conditioned with a suction air pump 1. This air pump takes care of both the ventilation and the heating of the building. Air is conducted from outside the building through a passage 2 in at least one building element included in or forming a wall and into the building. Here, the building comprises wall segments 4 and windows 5. The air is entering the passage by an external inlet slot 6 at the upper part of the passage and leaving the passage by a corresponding internal outlet or evacuation slot 7 at the bottom of the passage. The slots should stretch along most of the width of the passage to obtain an even distribution of the air flow. The walls and windows include insulating layers on each side of the passage. An air-to-water type air pump 1 provides hot consumption water as well as heating the building. The air pump also acts as a means for ventilating the building by creating a sub-pressure causing the formation of a cold air stream from the inlet slot to the passage. The air stream will to a large part absorb the outgoing flux of energy through the inner insulation. The air stream, which thus receives additional energy and becomes somewhat warmer, is conducted via the outlet slot into the room inside the building elements. In this case, hot water is lead to radiators mounted near the outlet slot. All ventilation air should pass through building elements according to the invention, thus avoiding additional air/vent valves.

[0015] Fig. 2 shows a possible design of a building element in further detail. The building element includes a layer of an insulating material 8a, 8b on each side of the passage 2. The material in question may be any material suited for the purpose, as will be well known to the skilled person.

[0016] Fig. 3 shows a vertical cross section through a window comprised in a building element according to the invention. Here, the insulating layers are formed by multi-layer panes 9a, 9b on each side of the passage 2. Air is entering the passage 2 through inlet slot 6 and exits through exit slot 7. The external air includes particle pollution which is captured by a filter 10 at the air inlet slot 6. This filter 10 must be replaced at intervals, either from the inside or outside by the arrangements shown in the figure. To prevent particles from adhering to the glass surfaces facing the passage, the surfaces are coated with nanoparticles filling the micro pores in the glass surfaces.

[0017] Fig. 4 is a horizontal cross section through the window shown in Fig. 3. The inner glass pane 9a with frame may be hinged, allowing it to be pivoted outward for giving access to the surfaces between the insulating glass panes for maintenance and cleaning. This embodiment uses two hinges 16, 17 to allow the window to be opened.

[0018] Fig. 5 shows an embodiment of the window including only one hinge 17 connecting the inner pane 9a to be opened for cleaning while the outer pane 9b is fixed.

[0019] The building element may, together with an elongate radiator 11 (Fig. 2) or other heating element, form a complete heating system when the air stream is conducted from the air outlet in proximity with said heating element, thus providing an air stream of a comfortable temperature.

[0020] Vertical slats or lamellas (not shown) may be mounted inside the passage between the insulating glass panes to prevent undesirable solar influx. The lamellas may be turned and pulled aside when not needed.

[0021] Fig. 6 illustrates a setup used to confirm the efficiency of the invention. The setup includes a building element of 1 m x 1 m. Initially, a single layer of insulation of 15 cm mineral wool was used, i.e. with no ventilation passage in the wall. The outside temperature was - 10

degrees centigrade, while the temperature inside the building were 20 degrees. The heat loss with this setup was 10.5 W/m^2. Then, the insulation was split into two separate layers 8a, 8b forming an inner and outer wall segment separated by a passage 2. The distribution of the insulation between the inner and outer wall segments were varied. The air stream in the passage was held at a constant rate of 4.8 m^3/h. The results showed that the heat loss through the building element was at the lowest when the insulation was symmetrically distributed around the air passage. This means that the inner and outer layers of insulation should have similar U-values. Fig. 6 illustrates the final setup with an inner insulation layer of 10 cm mineral wool and an outer insulating layer of 5 cm. This outer layer consists of a product supplied by the present applicant, a product with the same U-value as the inner layer of mineral wool. The stippled double-arrows show the stream of heat from inside the building (at + 20 degrees centigrade) to the passage 2 which receives a stream of air from outside the building, at - 10 degrees. This air stream is heated by the heat stream through the inner insulation layer and exits the passage at a temperature of - 8 degrees. The stippled single-arrows show the much weaker stream of heat passing through the outer insulation layer to the outside of the building. By this setup it was obtained a heat loss through the building element of 1.25 W/m^2, which is substantially less than the original value of 10.5 W/m^2.

[0022] Further investigations have shown that the heat loss through a building element according to the invention is substantially dependent on the flow rate of the air stream conducted through the passage. Fig. 7 shows the result of a case using a window as the building element. The graphs show the U-value as a function of the air stream in the passage between the inner and outer glass panes. Graph A shows the result for a setup with a single inner layer and double outer glass pane as in DE 3326498, and graph B shows the corresponding result for a setup wherein both the inner and outer glassing are double. The double glass panes have U-values of 1 W/m^2, while the single pane is assumed to have a U-value of 5 W/m^2. The graphs show that it is highly beneficial to use a window with double glassing in both the outer and inner panes. Furthermore, it is of particular interest that by using a symmetrical setup of insulation and passing enough air through the passage, the heat loss through the window may be practically eliminated.

[0023] As already mentioned, the building regulation requires a ventilation rate of 26 m^3 per hour in a one-bed bedroom. In order to check if this requirement is satisfied, a common method is to use a suitable meter to measure air flow withdrawn by the heat through an opening in an inner wall of the room. This opening may be provided with a valve for adjusting the flow. If the room has a window according to the invention, this measurement may be used to check that the flow rate through the window is satisfactory.

[0024] The above and further findings are based on/-verified by an adaption of the energy equations below:

$$U_{IN}*A*\Delta t_1 - U_{OUT}*A*\Delta t_2 = 0.35*V*\Delta t_3$$

Wherein:

U = U-value
A = area of building element (wall and/or window)
Δt_1 = temperature difference over inner wall or windowpane
Δt_2 = temperature difference over outer wall or pane
Δt_3 = difference between the temperature in the outside air and the temperature at the evacuation slot 7
V = amount of air in m^3/h

[0025] From an analysis we find that the effect of the invention is best when the insulation properties of the layers forming the passage are substantially symmetrical, i.e. both layers having like U-values. The total heat loss may then be controlled by regulating the flow rate of the air stream conducted through the passage. The conditions are rather different when the building element is a wall or window. In both cases, insulation materials of a lower cost may be selected, and the air stream increased to maintain an acceptable low heat loss through the building element. A building may then be constructed with thinner walls and still satisfy current building regulations, while a window element may comprise cheaper double glass panes, thus avoiding use of more expensive three-layer panes filled with inert gases.

[0026] According to the TEK-17 building regulations, the walls of a building should have a U-value of 0.18 W/(m^{2}K) or less. A building element according to the present invention may comprise insulating layers with a higher U-value and still reach the required U-value of 0.18 by streaming air through the passage at a rate of at least 4 m^3/h per m^2 of the area of the passage, the flow rate being adjusted according to the chosen U-value.

[0027] A window is required to have a U-value below 0.8 W/(m^{2}K). In a window designed according to the invention, even when using glass panes with a U-value higher than 0.8, e.g. in a range less than 2.5 W/(m^{2}K), the regulations may be fulfilled by using a higher air flow rate in the passage, of say at least 4 m^3/h per m^2 of the area of the passage. In both cases the distance between the insulating layers defining the passage should be sufficient to allow the air steam to pass without creating undue friction. This distance may then be between 5 and 60 mm.

[0028] Fig. 8 is a section through a building equipped with a corresponding solution for preventing heat influx. This system is of particular interest for use in buildings in hot climates and in temperate climates where the day temperatures may be higher. As in the previous embodiments, this building includes walls with double walled building parts 4. Separate means are used to provide ventilation and reduce the temperature inside the building. A ventilation unit 12 provides air under pressure to

the interior of the building. A heat pump 1 takes air from the interior of the building and emits cooled air out of the building, the heat produced in the process being used to provide hot consumption water. A part of the cool air from the air pump outlet is supplied to the ventilation unit 12 to take advantage of the work made by the heat pump. The pressurized air from the ventilation unit will create an air stream through the passages 2 in the walls or building elements and reduce any influx of heat energy from outside, in the figure illustrated by the sun heating the building. The operation of the ventilation unit 12 must be balanced against the operation of the heat pump 1. While the ventilation unit 12 will elevate the pressure inside the building, the heat pump 1 will extract air from the building and lower the pressure. Thus, the ventilation unit 12 must work harder to overcome the pressure reducing effect of the heat pump 1 and establish the necessary over-pressure. The system may be dimensioned according to the principles covered above.

[0029] Fig. 9 is a section through a building element according to the invention, for use in a building wall in a hot climate. Although no windows are shown, the same principles apply here, too. Air is entered in an air inlet 13 near the floor, conducted through the passage 2 between the outer and inner parts of the building element and released from an air outlet 14 at the top of the passage.

[0030] An embodiment of the invention comprises a method for reducing heat transfer through a building element, the building element (4, 5) comprised in an outer wall, roof, or floor of a building, the method comprising conducting a stream of air from inside the building, through a passage (2) between an inner insulating layer (8a; 9a) and an outer insulating layer (8b; 9b) of the building element (4, 5), and to the outside of the building, the air stream being conducted at a flow rate of more than 4 m^3/h per m^2 of the area of the passage (2).

[0031] A further embodiment comprises a system for reducing heat transfer through a building element, the building element (4, 5) comprised in an outer wall, roof or floor of a building and wherein the system is adapted to transfer heat from inside the building to the outside of the building, the outer wall including a building element (4, 5) with two layers of an insulating material (8a, 8b; 9a, 9b) forming a passage (2) between the layers, the system further including a ventilation unit (12) creating an air stream from inside the building, through the passage (2), and out of the building.

[0032] The invention may also comprise a method and system for air conditioning a building, the building comprising at least one outer wall and wherein the invention is adapted to transfer heat from inside the building to the outside of the building, the outer wall comprising a building element (4, 5) with two layers of an insulating material (8, 9a, 9b) forming a passage (2) between the layers, the building further comprising ventilation means creating an air stream through the passage (2) and out of the building.

[0033] In all embodiments described above, the inlet slot may be located close to the lower part of the building element with the outlet slot located close to the upper part, or in the opposite way with the inlet slot close to the upper part and the outlet slot close to the lower part. This means that the air flow will be reversed inside the passage from the directions shown in the illustrations.

Claims

1. A method for reducing heat transfer through a building element (4, 5) forming part of an outer wall, roof, or floor of a building, the method comprising conducting a flow of air through a passage (2) between an inner insulating layer (8a; 9a) and an outer insulating layer (8b; 9b) of the building element (4, 5), the inner insulating layer having a first U-value and the outer insulating layer having a second U-value, **characterized in** selecting materials for the inner and outer insulating layers both having U-values less than 2.5 W/(m^2K), the ratio between the first and second U-values being set to 0.5 - 1.0, and wherein the air is conducted at a rate of at least 4 m^3/h per m^2 of the area of the passage (2).

2. The method according to claim 1, wherein the ratio between the U-values of the insulating layers is set to 0.9 - 1.0.

3. A system for reducing heat transfer through a building element (4, 5) forming part of an outer wall, roof, or floor of a building, wherein the building element (4, 5) comprises two layers (8a, 8b; 9a, 9b) of an insulating material and a passage (2) between the layers, the system further including means (1, 12) for creating an air stream through the passage (2), **characterized in** the insulating layers having U-values less than 2.5 W/(m^2K), and wherein the ratio between the U-values of the two layers of insulating material is 0.5 - 1.0, and wherein said means (1, 12) are adapted to provide an air stream through the passage in the range of at least 4 m^3/h per m^2 of the area of the passage (2).

4. The system according to claim 3, wherein the ratio between the U-values of the insulating layers is 0.9 - 1.0.

5. The system according to claim 3 or 4, wherein the distance between the layers forming the passage is between 5 mm and 60 mm.

6. The system according to claim 3, 4 or 5, wherein the means creating the air stream comprises a heat pump (1) evacuating air from the building, said air stream passing from outside the building, through the passage and to the inside of the building.

7. The system according to claim 3, 4 or 5, wherein the

means creating the air stream comprises a ventilation unit (12) forming an overpressure inside the building, the overpressure creating the air stream passing from inside the building, through the passage and to the outside of the building.

8. The system according to claim 7, the means further comprising a heat pump (1), wherein cold exhaust air from the heat pump (1) is supplied to an inlet of the ventilation unit (12) for reducing the temperature inside the building.

9. The system according to claim 8, wherein heat from the heat pump (1) not used for hot consumption water, is used for heating a storage magazine for winter use.

10. The system according to any of the claims 4 to 9, wherein said building element (4, 5) is a wall element, the insulating layers having a U-values less than 2.5 $W/(m^2K)$.

11. A window for use as a building element in a system according to any of the claims 4 to 9, **characterized in that** the window includes two multi-layer glasses (9a, 9b) forming said passage (2), the multi-layer glasses having at least two glass panes each.

12. The window according to claim 11, wherein the passage (2) is dimensioned to permit an air flow rate of at least 4 m^3/h per m^2 of the area of the passage.

13. The window according to claim 11 or 12, wherein the multi-layer glasses (9a, 9b) are set in separate frames in a parallel relationship, the frames being hinged together for access to their interspace.

14. The window according to claim 11, 12 or 13, wherein the glasses (9a, 9b) are provided with a coating on surfaces facing the passage (2), the coating preventing pollution from settling on the glass surfaces.

15. The window according to any of the claims 11 to 14, wherein a filter (10) is arranged on an inlet (6) to the passage (2).

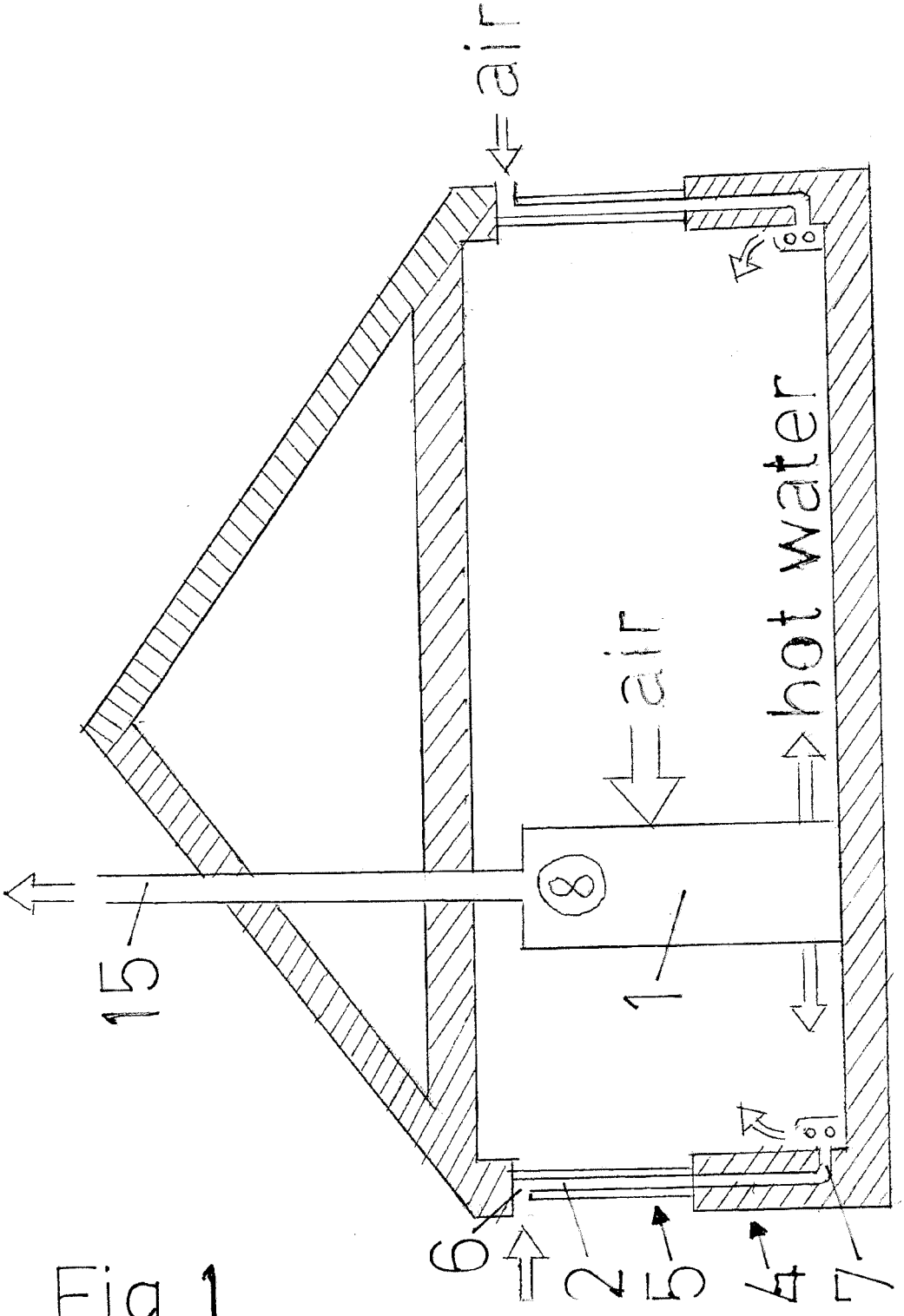

Fig.1

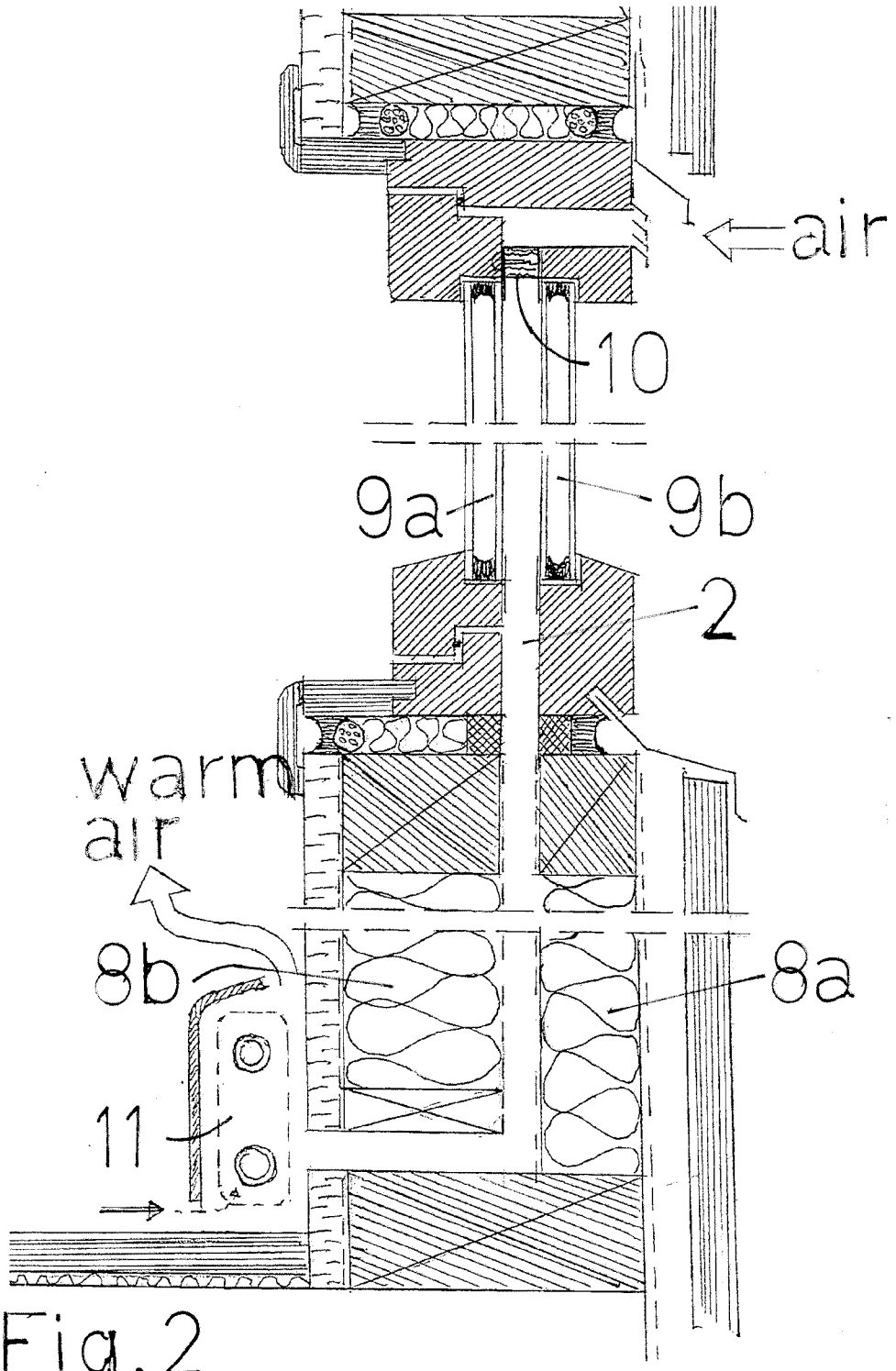

Fig.2

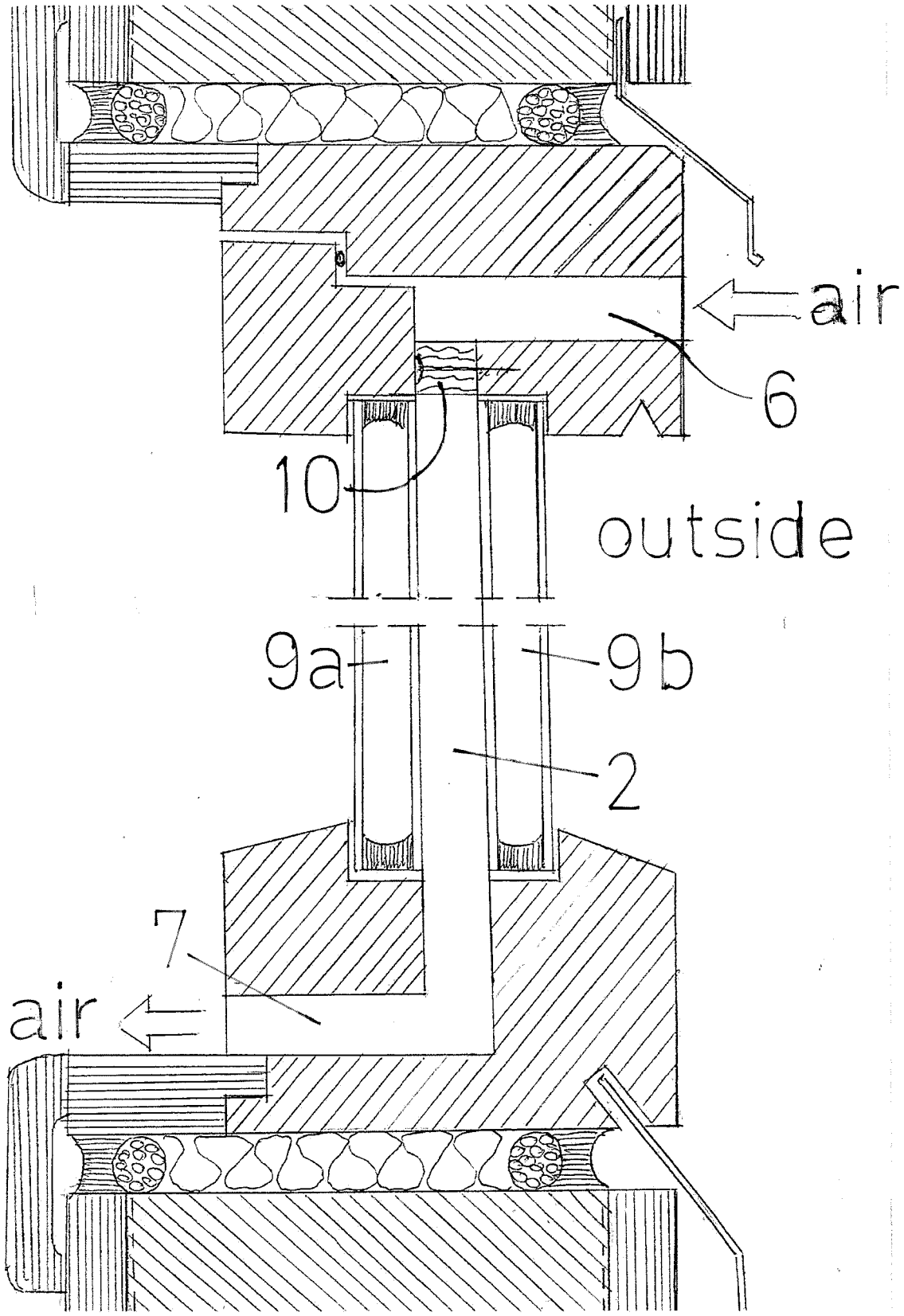

Fig. 3

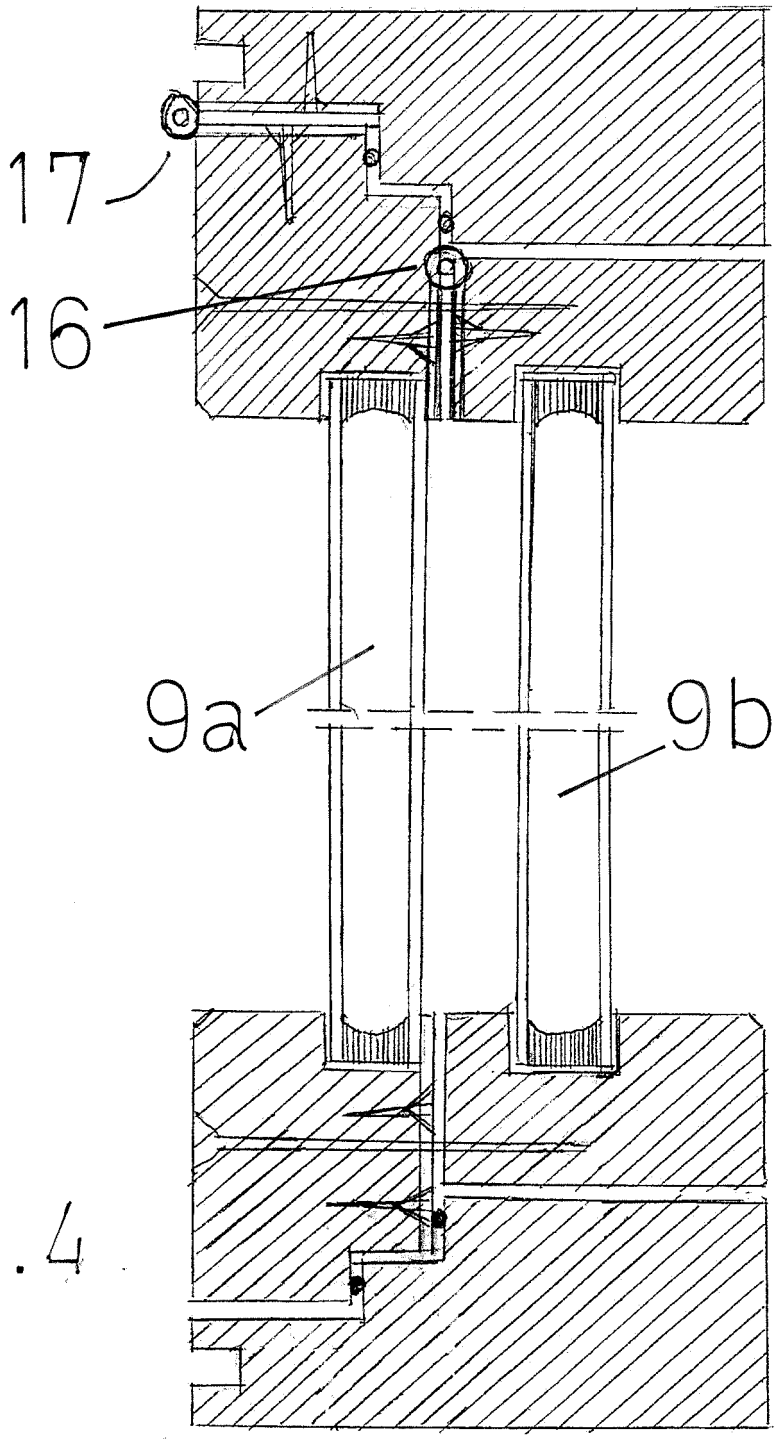

Fig. 4

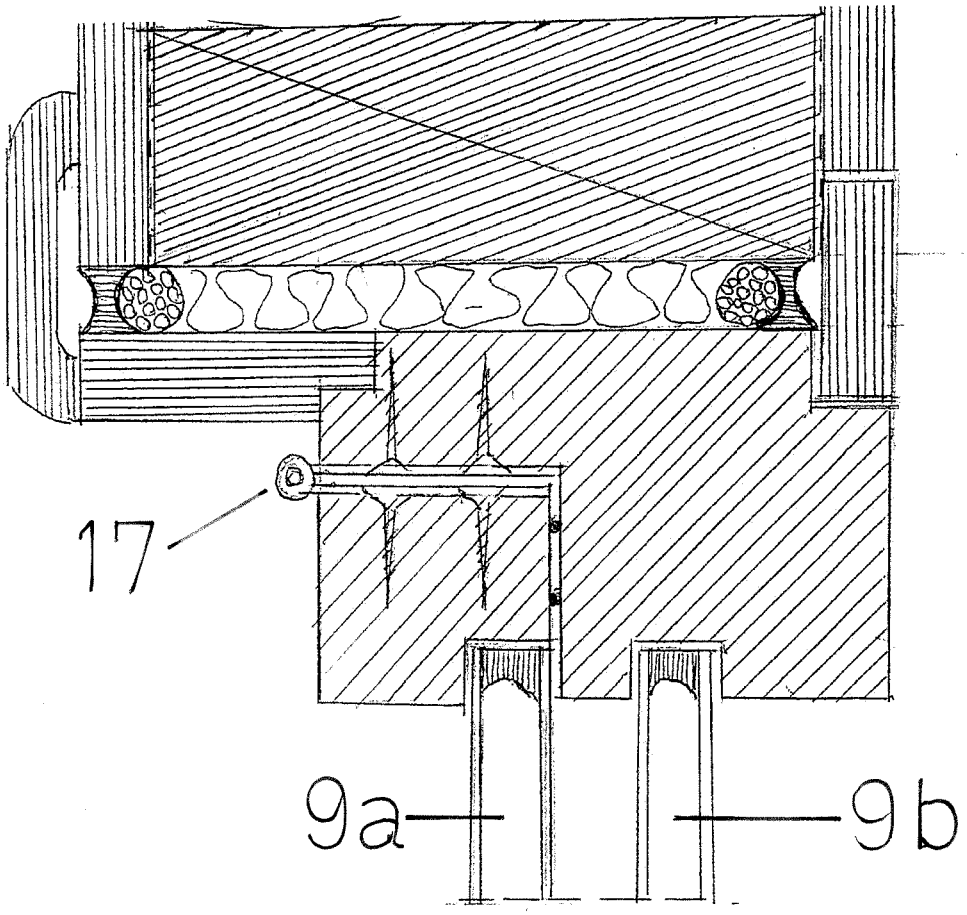

Fig. 5

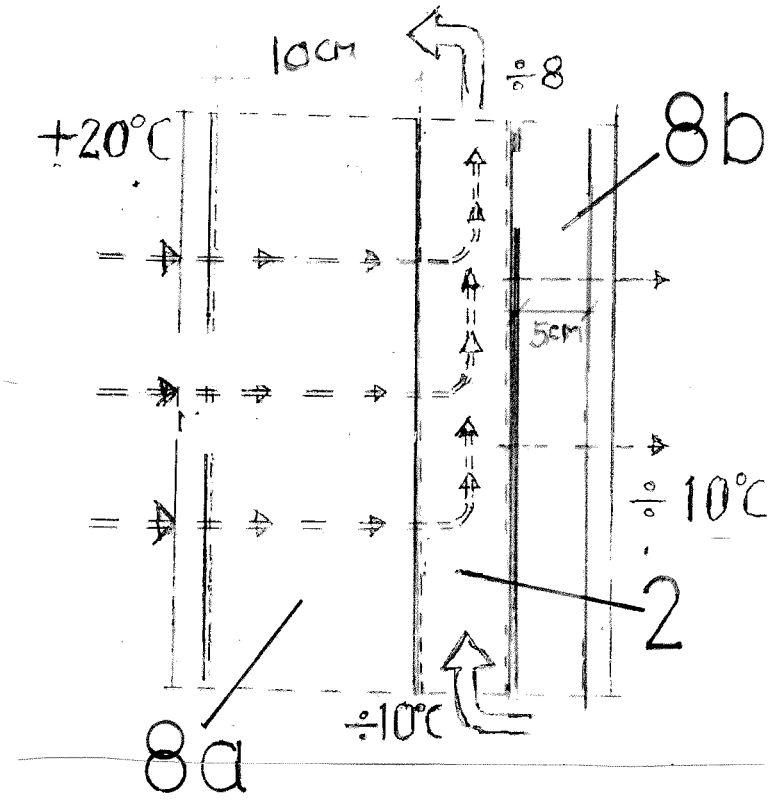

Fig.6

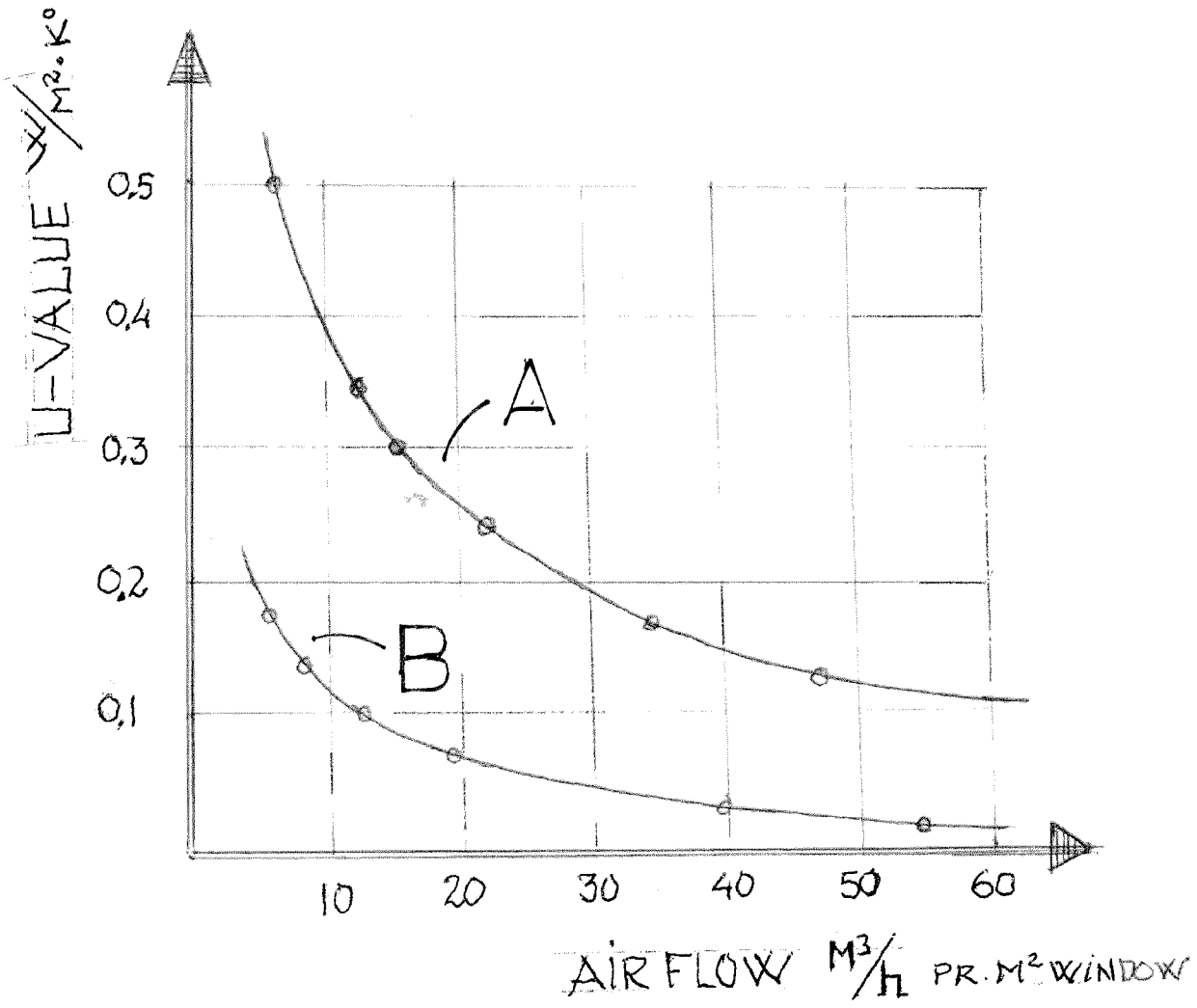
U-VALUE W/M2.K°
0,5
0,4
0,3
0,2
0,1
A
B
10
20
30
40
50
60
AIR FLOW M3/H PR. M2 WINDOW

Fig.7

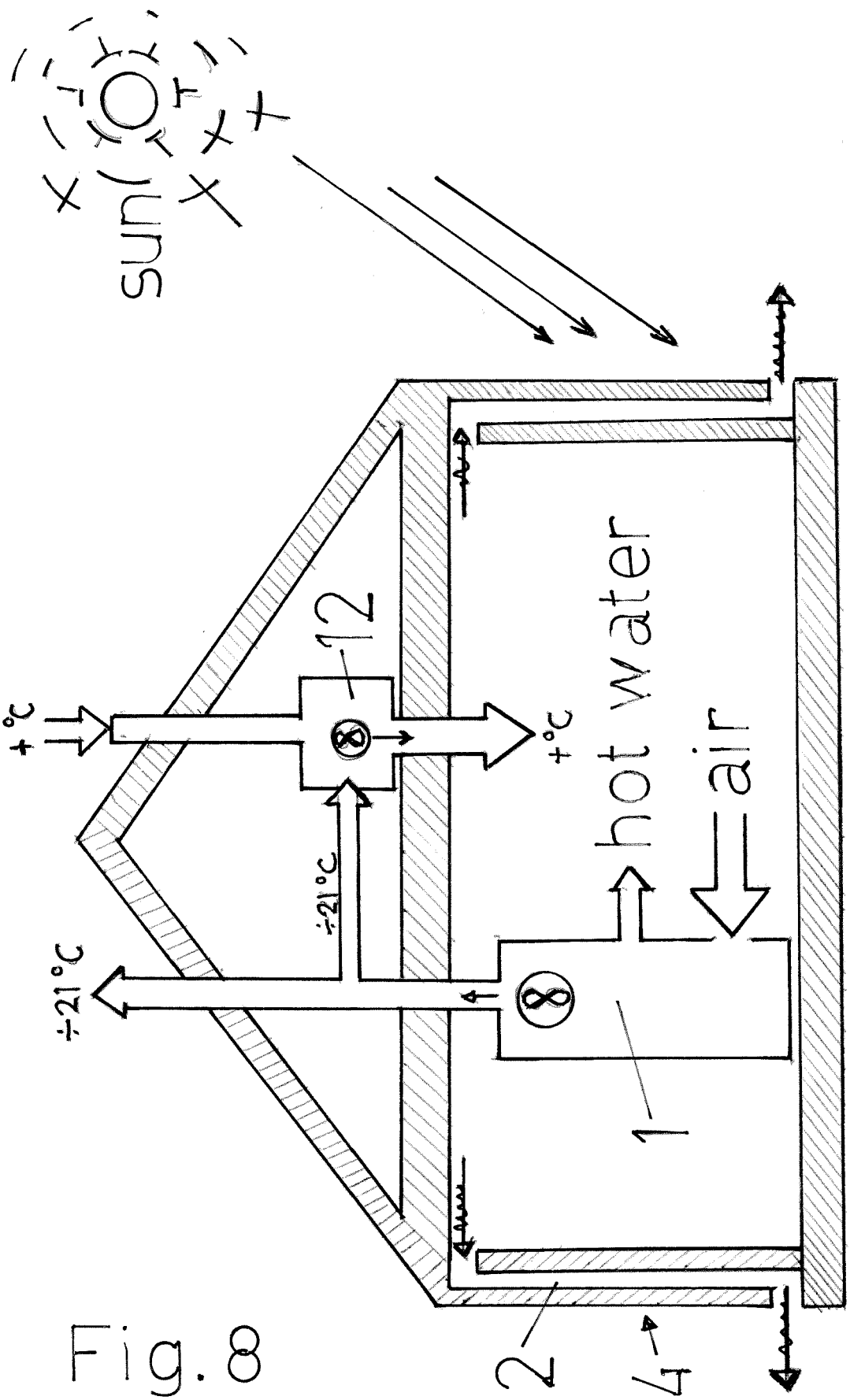

Fig. 8

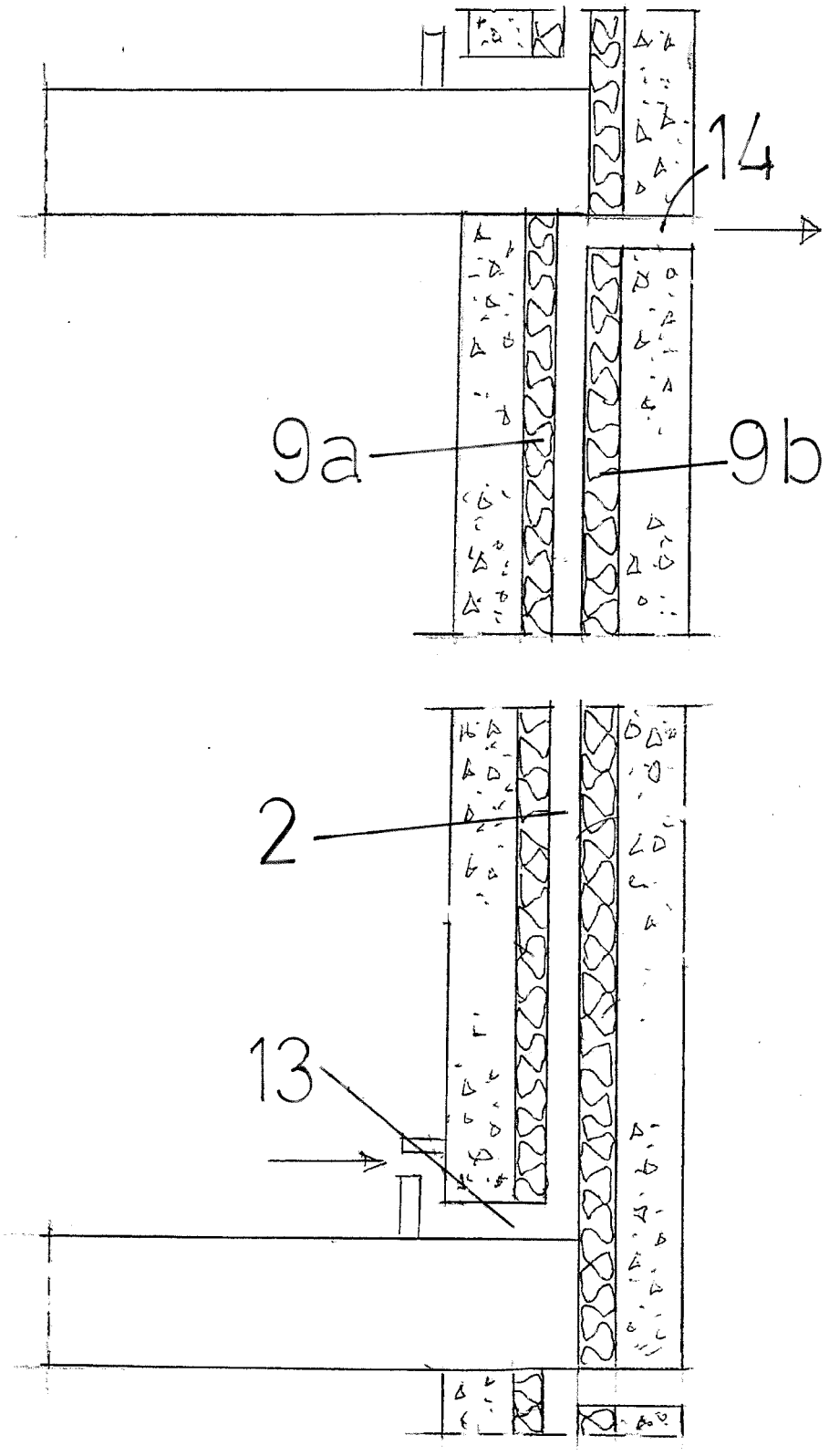

Fig.9

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 9488

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 051 053 A1 (VEKA AG [DE]) 3 August 2016 (2016-08-03) * paragraph [0020] - paragraph [0026]; figures 1-4 *	1-15	INV. E04B1/76 E06B7/02 F24F5/00 F24F7/007
X	DE 20 2014 100066 U1 (LACHER MARTIN [DE]) 13 February 2014 (2014-02-13) * paragraph [0021] - paragraph [0036]; figure *	1-15	ADD. F24D3/12
X	US 2012/108158 A1 (HAMBY AUBREY EUGENE [US]) 3 May 2012 (2012-05-03) * paragraph [0039] - paragraph [0057]; figures 1-5 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E04B
F24H
E06B
F24F
F24D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5 December 2024	Galanti, Flavio

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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05-12-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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