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(71) Applicant: **FIBERLINE A/S**
6000 Kolding (DK)

(72) Inventor: **Thorning, Henrik**
6000 Kolding (DK)

(74) Representative: **Nielsen, Henrik Sten et al**
Budde, Schou & Ostenfeld A/S
Vester Sögade 10
1601 Copenhagen V (DK)

(54) A window and a window frame

(57) A window comprising a circumferential window frame and one or more window elements mounted in the window frame. The window frame including a first air inlet aperture at the bottom of the frame communicating with the exterior, and a first air outlet aperture communicating with the interior and further communicating with the first air inlet aperture through one or more air channels extending through substantially the entire length of the hollow frame.

EP 1 640 552 A1

Description

[0001] The present invention relates to a novel window structure and further a technique of improving the air within a room of a building or housing.

[0002] The general shortage of energy and environmental concerns have through the last decades caused buildings, in which individuals or persons are staying or working, to be increasingly insulated in order to prevent the waste of energy and heat from the heated buildings to the environments during the cold seasons such as dependent on the location of the building or house in question, the autumn, the winter and the spring.

[0003] The increased insulation of buildings, however, have caused certain health problems, in particular relating to the lack of supply of fresh air from the environment or from the exterior, as most buildings or housings, unless ventilation systems be provided, only allow the air of the room or rooms of the building or the housing in question to be shifted by fresh air by opening one or more windows and introducing fresh cold air from the outside and in doing so, wasting the energy of the hot air which is allowed to escape to the environment.

[0004] Certain attempts have been made to provide vented window structures such as the structures known from US 5,475,957, US 4,572,282 and WO 92/14023. Reference is made to the above publications and the above US patents are further hereby incorporated in the present specification by reference.

[0005] An object of the present invention is to provide a simple and reliable window structure which allows venting of the room of a building, in which building a window is positioned delimiting the room from the surroundings and in doing so, allow a pre-heating of the air, which is introduced into the room in order to save energy rather than allowing cold fresh air to be freely introduced into the room in question.

[0006] It is a feature of the present invention that the pre-heating of air by employing the novel technique according to the present invention allows a saving of up to 50-60% of the energy of the air which is substituted from a room or a house by fresh air from the outside as compared to the situation in which the air from the room is simply allowed to escape and is substituted by fresh unheated air which is introduced into the room.

[0007] It is a particular feature of the present invention that the novel technique of allowing pre-heated air to be introduced into the building, in particular a room of a building, may be established by a window structure, which, as compared to a conventional window has the same appearance and therefore, from an architectural point of view, does not ruin the appearance of the building or house in question and may be produced from high insulating pultruded profiled elements allowing the manufacture of a window and a window frame having the same overall dimensions as a conventional window used in the same building or house and made from conventional materials such as would, plastics, metal or combinations thereof.

[0008] The above object and the above advantage together with numerous other objects, advantages and features which will be evident from the below detailed description of the present invention is according to a first aspect of the present invention obtained by a window comprising a circumferential window frame and one or more window elements mounted in said window frame, said window frame including a first air inlet aperture at the bottom of said frame communicating with the exterior, and a first air outlet aperture communicating with the interior and further communicating with said first air inlet aperture through one or more air channels extending through substantially the entire length of said hollow frame.

[0009] As will be discussed below in a technical description of a first embodiment of the window according to the present invention, a hollow frame is provided in which one or more air channels are provided extending from a bottom air inlet aperture through an air outlet aperture preferably positioned at the top of the window frame for drawing the air through the one or more air channels in which the air is pre-heated by heat from the wall or from the interior of the room. The hollow frame is preferably made from high strength and high insulating polymer materials in particular pultruded polymer material allowing the frame to be made in a shallow structure rather than in a large bulky structure, thereby allowing the overall window to be produced in accordance with existing architectural requirements and without ruining the architectural appearance of the building in which the window is mounted.

[0010] Conventionally, windows of most buildings have a rectangular or square configuration and according to the presently preferred embodiment of the window according to the present invention, the window frame is of an overall rectangular or square configuration and comprises a bottom frame part, two opposite side frame parts and a top frame part. It is to be understood that the window element or window elements which are mounted in the window frame may be of any type well known in the art per se such as a single window element fixed to the window frame, a raisable or lowable, a tiltable or rotatably mounted window element, alternatively a plurality of window elements such as four or six window elements conventionally used in a window of the kind commonly known in Denmark as "Dannebrog"-window (named from the Danish red and white flag Danneborg) or any other structure per se. It is further to be understood that the window pane may be single layer glass, multi layer or glazed window panes and further that the window frame may be made from one material, preferably pultruded profiles, whereas the window elements may have casements made from the same material as the window frame or from a different material or different materials, such as wood, metal, plastics, metal and including insulating materials, e.g. mineral wool or glass wool or polymer materials or combinations

thereof. In this context, it is further to be understood that the term window frame is to be understood as the outer supporting structure of the window, which structure is to fixated directly or through supporting elements to the wall of the house or building in question. Similarly, the term a window element is to be understood as a term defining the element comprising a transparent element made from glass or a multiplicity of layers of glass and included within a circumferential casing or casement.

[0011] For allowing the air channels included in the hollow window frame of the window according to the present invention to function as a chimney for allowing the air to move freely from the inlet aperture to the outlet aperture and in doing so, be pre-heated, the first air inlet aperture is preferably positioned in the bottom frame part, and the at least one air channel extends along the bottom frame part, the side frame parts and the top frame part.

[0012] Dependent on the climatic conditions, in particular the difference in temperature between the exterior and the interior and also the humidity of the air and possibly also the overall structure of the building in question, the transfer of heat from the wall of the building or alternatively from the interior of the building to the pre-heating air channel or air channels included in the hollow window frame of the window according to the present invention, may be limited to a heat transmission for mainly the surrounding wall or alternatively from the room in question. Consequently, according to two alternative embodiments of the window according to the present invention, the hollow frame is insulated on its surface facing the interior for establishing heat transfer to the one or more air channels from the surrounding wall or alternatively, the hollow frame is insulated on its outer surface facing the surrounding wall.

[0013] For guiding and controlling the air flow through the one or more air channels, the air channels or the air channel may be configurated in a specific geometrical configuration and in this context, the hollow frame may have a substantially constant cross section from the air inlet aperture to the air outlet aperture or may have a decreasing cross section or alternatively an increasing cross section for decelerating or accelerating the flow of air through the air channel or the air channels. Further, the surface of the hollow frame defining the air channel or air channels may be provided with a specific coating improving the heat transfer or, as discussed above, serving as an insulating layer or alternatively serving as an air flow accelerating on air flow decelerating surface coating.

[0014] The hollow frame including the at least one air channel characteristic of the present invention may be separated into a plurality of air channels constituting a set of parallel air channels or a continuous air channel and consequently, the hollow window frame may, according to a further embodiment of the window according to the present invention, including an interior separation wall dividing the hollow frame into two separate channels.

[0015] The separate channels defined by the separation wall may constitute two channels, the one being a continuation of the first channel, thereby providing an air flow channel twice the length of a single air flow channel occupying the inner space defined within the hollow window frame. In order to improve the heat transmission between the air input to the room and the air allowed to escape from the room, the window according to the present invention, may advantageously be configurated so that a first channel delimited by the separation wall establishes communication from the first air inlet to the first air outlet and the hollow frame further includes a second air inlet aperture communicating with the interior and a second air outlet aperture communicating with the exterior, a second channel of said hollow window frame establishing communication from the second air inlet aperture to the second air outlet.

[0016] In order to ensure that the heat transfer from the air to be vented from the room in question is used for pre-heating the air to be introduced into the room, the first channel is preferably positioned closest to the exterior and the second channel is preferably positioned behind the first channel closest to the interior.

[0017] The air flow through the second channel may be established dependent on the actual position of the second air inlet aperture and the second air outlet aperture in parallel with and in the same direction and alternatively and preferable, in the opposite direction as compared to the air flow through the first channel.

[0018] In order to allow the individual or individuals located in the room to which the window according to the present invention allows the access of pre-heated air to close off the entry of pre-heated air provided e.g. the temperature outside reaches an extremely low level, the inlet/outlet aperture or apertures of the window according to the present invention are preferably provided with closure means for allowing the window to be sealed off.

[0019] In the window according to the present invention, however, cold, fresh outdoor air is introduced through the hollow frame, thus reducing the difference of temperature between the cavity and the cold surroundings, and correspondingly the heat loss that way. On the other hand the heat loss from the warm indoor climate directly to the inside surface of the frame rises. However, the major part of the heat loss is used for increasing the temperature of the cold, fresh air.

[0020] The interesting size of the temperature efficiency, i.e. the amount of air being pre-heated in relation to the indoor and outdoor temperatures. Said temperature efficiency is just called the efficiency, abbreviated "e" and is calculated as follows:

$$e = \frac{T_{indblæsning} - T_{ude}}{T_{inde} - T_{ude}}$$

[0021] The above calculation indicates that the efficiency would be 100% is it were possible to heat up the air current to the same temperature as the indoor air temperature. When heating up the air from 0° to 10°C when the outdoor temperature is 0°C and the indoor temperature is 20°C, the e=50%.

Theory against empiricism

[0022] The results of the measurements turned out to be a little further more positive than the estimates - applying the same geometry, amounts of air, etc. the measurements resulted in a slightly higher efficiency: The air was simply pre-heated more than expected.

[0023] The most significant single-parameter as to the efficiency is the relationship between the heat-transmitting are (between the indoor air and the cavity, i.e. the inside of the frame) and the current by volume through the cavity: The bigger heat-transmitting area and the smaller current by volume, the bigger efficiency.

[0024] Therefore, the efficiency is also illustrated by the very factor in Figure 9 which compare results of measurements to estimates.

[0025] In the estimates a somewhat bigger area per current by volume than in the tests was anticipated, and, consequently, the calculated efficiencies of the estimates were also the highest.

[0026] A simple, linear extrapolation (which is considered to be reasonable within the present field) shows, however, that at least just as high efficiencies would have been *measured* if a corresponding area had been available for the test.

[0027] Based on the above-mentioned calculations and tests it must be presumed that a pre-heating of the outdoor air with a temperature efficiency of 50 - 60% can be achieved.

[0028] The results have been reached without including any solar contribution. A considerable incident solar radiation would of course contribute to a further pre-heating of the air.

OPTIMIZATION OF THE WINDOW

[0029] The development of the window has not yet been terminated. The construction is to be further optimised, including:

- Minimisation of the heat transmission from the air current to the outer side of the frame: Theory and tests have proved that a slight roughness on the surface of the cavity reduces the friction between the surface and the air current. Thus the "contact" between the surface and the air current becomes less convex, and the heat transmission is reduced. The result is shown in the Figure of the results of measurements.

- The thermal bridge cutting off/cold-conductor interruption in the brickwork is to be optimised: The depth of the slot and the amount needed before reducing the effect.

- Development of a thermal bridge/cold-conductor secured closing device for the air current.

- Development of constant volume current regulator.

- For future use in new residences the window is to be further developed resulting in a halving of the heat transmission coefficient. The aim is 0,8 $W/m^2/k$.

[0030] On the other hand, a maximisation of heat transmission from the inside of the frame to the air current is not interesting, since it is necessary to insulate the inside of the frame in order to keep a sufficiently high surface temperature on the surface towards the room.

[0031] In Fig. 1, a first and presently preferred embodiment of a window according to the present invention is shown designated the reference numeral 10 in its entirety. The window 10 is generally of a design which is extremely common in older buildings in Denmark and conventionally called a "Dannebrog" window (named after the Danish red and white flag). The window 10 includes a circumferential hollow frame 12 composed of two parallel and vertical frame parts 14, a horizontal top frame part 16 and an opposite horizontal bottom frame part 18. The individual frame parts of the frame 12 are integrally joint together and provided an interior hollow space to which access is obtained from the exterior through a bottom aperture 20 provided centrally in the horizontal frame part 18.

[0032] The window 10 further comprises a vertical post 22 and a horizontal post 24 providing the overall geometrical structure of the "Dannebrog". In each of the four openings provided between the frame 12 and the crossing vertical and horizontal post 22 and 24, a total of four individual window elements are mounted, preferably journalled on individual hinges for allowing the windows to be opened and closed. The hinges, which may be concealed behind the frame, are not shown in the drawings. In Fig. 1, a single window, the left hand lower window, is designated the reference numeral 26 and comprises a window casement 28 and a glazed window 30.

[0033] In Fig. 2, the window 10 is shown in a vertical, sectional view. Fig. 2 illustrates that the top and bottom frame parts 16 and 18, respectively, are constituted by hollow, structural elements, in which a hollow inner space is provided. In the top frame part 16, a hollow inner space is provided designated the reference numeral 17. Similarly, the bottom frame part 18 is provided with an inner space 19.

[0034] In Fig. 3, the frame 12 is shown together with a cutaway part of the window 26. Fig. 3 illustrates in greater detail the inner passage defined within the hollow frame 12 as the aperture 20 of the bottom frame part 18 communicates with the inner space 19 defined within the frame part 18 and further communicates with inner spaces 15 defined within the vertical side frame parts 14 from which communication is further provided to the hollow top frame part 16, which is provided with an aperture 32, through which the air input into the hollow frame 12 at the bottom as indicated by the arrow 34 is allowed to pass from the outside into the frame 12 and further by heating the air when in contact with the wall and the frame to be transported through the vertical hollow side frame part 14 and be input to the room in which the window is mounted through the top aperture 32. Below, a more detailed technical analysis of the properties and features of the first and presently preferred embodiment of the window shown in Figs. 1-3 is presented.

[0035] The technique of providing a hollow air passage from a bottom inlet aperture facing the environment to an inlet aperture through which the fresh outer air after heating of the air through passage in the hollow window frame is allowed to be introduced into the interior of the housing or building in which the window is mounted, may be modified in numerous ways by e.g. providing additional channels within the hollow frame 12, by providing insulating coverings within the hollow frame or by including heat transfer elements such as passive heaters constituted by metallic panels or heat sink like elements or active heaters.

In the below descriptions of alternative embodiments, components or elements identical to components or elements described above with reference to Figs. 1-3 are designated the reference numeral or reference numerals identifying the element or component in question in Figs. 1-3. Components or elements included in the below alternative embodiments and described below having the same function as the elements or components described above, however, differing geometrically from the above-described element or component is designated the same reference numeral as the previously described element or component, however added a marking for identifying the geometrical difference.

[0036] In Fig. 4a, 5a and 6a, three alternative variants of the window frame 12 is illustrated. In Fig. 4a, a double passage is provided within the frame 12 as the air input to the hollow frame 12 through the aperture 20 as indicated by the arrow 34 is allowed to pass through an outer passage delimited from an inner passage by a separation wall 36, which is shown in greater details in Fig. 4b allowing the input air to pass a first or outer passage 15a, vide also Fig. 4c, and to descend through an inner passage 15b before the air is input to the interior of the building or house through the aperture 32', which is provided in the bottom frame part 18 as distinct from the above described first and presently preferred embodiment in which the aperture 32 allowing the preheated air to be input through the aperture 32 provided in the top frame part 16.

[0037] In Fig. 5a, the frame 12" includes the same separation wall 36 as described above with reference to Figs. 4a-4c, however, whereas the separation wall 36 described above separates a single channel into two parts, the separation wall 36 provides two separate channels, the one channel being established as an inlet channel from the inlet aperture 20 to the aperture 32, which channel is designated the reference numeral 15a and serves the same function as the inlet channel 15 described above with reference to Fig. 3.

[0038] A further channel constituting an outlet channel is provided behind the inlet channel, which outlet channel is divided into two parts establishing communication from two apertures 38 in the top frame part 18 and communicating with two bottom outlet apertures 40 in the bottom frame part 16 through the channels 15b, which are positioned behind the inlet channel 15a. The channels 15b constitute pre-heating channels in which the outlet air, which is guided from the interior of the house or building is used for pre-heating the inlet air. In the apertures 38, closures may preferably be provided for allowing the user to shut off the outlet air provided an excessive air outlet stream is established and similarly in Figs. 3, 4a and 5a, a closure may be provided in the air inlet aperture 20 or alternatively in the aperture 32.

[0039] In Fig. 5b, the two channels 15a and 15b of Fig. 5a are shown in greater details illustrating the opposite directions of the two air streams from the interior of the house or building to the exterior and vice versa.

[0040] In Fig. 6a, the fourth embodiment 12" of the window frame is shown as the window frame 12" shown in Fig. 51 is modified by a simple reversal of the direction of flow through the air outlet channel 15b. In Fig. 6a, a single aperture 38' is provided as an inlet of the air outlet channel 15b from which inlet in the bottom frame part 18, communication is established through the air outlet channel 15b to two outlets 40' in the top frame part 16. In Fig. 6b, the directions of the air flowing through the channels 15a and 15b are illustrated.

[0041] In Fig. 7, a window 10 implemented in accordance with the presently preferred embodiment of the window according to the present invention is mounted in a brick wall. In Fig. 7, the frame 12 is divided into two parts by a through-going partition wall 36' primarily serving the purpose of reinforcing the inner wall of the frame 12. In the channel 15, an insulating covering 13 is provided, which is applied to the outwardly facing panel of the frame 12 and serving to improve the insulating property of the outwardly facing panel of the hollow frame 12.

[0042] It is to be understood that the window 10 may be modified from the so-called "Dannebrog" type into any conventionally single glazed window pane or multi-sectional glazed window structure and further, it is also to be realised that the individual window including the casement may be made in accordance with any architectural or functional criteria.

[0043] The window 10 including the window frame 12 may be made from any appropriate material such as wood, plastics materials, metal in combination with insulating materials, e.g. wood, mineral wool or glass wool plastics materials etc. In particular plastics material including PVC, PE, PP, ABS or any other UV resistant or UV resistivity improved polymer material may be used including fibre reinforced or non-fibre reinforced materials. Provided polymer materials, such as vinyl ester, phenols and epoxy resin are chosen, extrusion and in particular pultrusion processes are relevant for providing the frame 12 as a composite profiled element, preferably made from pultruded elements exhibiting the advantageous characteristics of high strength, low weight and high thermal resistance.

[0044] In Fig. 8, the air flow through the window frame of the window according to the present invention is shown in greater detail.

[0045] In Annex 1, a detailed discussion of advantages inhered in the technique of providing a controlled airflow through a hollow window frame is discussed in a report including a diagram illustrating the correspondence between transmission area of the air flow and the temperature efficiency and also including the corresponding text.

[0046] Although the above description includes a detailed discussion of a single presently preferred embodiment and various modifications and alternatives, it is to be understood that the present invention is by no means limited to the above discussed embodiments, as numerous modifications will be evident to a person having ordinary skill in the art and such modifications are therefore to be considered part of the present invention as defined in the appending claims.

ANNEX 1

Characteristics of the window:

[0047]

- It allows the light to enter
- It renders a lookout to the user
- It keeps the heat indoor. Two or more layers of transparent material (glass) keeps a gas (atmospheric air or argon) at rest whereby it to a great extent resists the heat transport by convection. Certain coatings on one layer of glass against the cavity reduces the heat transport by radiation. Glass in itself has a bigger transmittance for short-waved electromagnetic radiation (including visible light) than for long-waved electromagnetic radiation (including heat radiation at indoor and ambient temperatures)
- The pane is secured in a window casement
- The window can normally be opened
- The window is provided with a rescue aperture
- The airing renders certain possibilities to the user, but it also requires an active operation in order to obtain a good quality of air without allowing too much heat to leave the room and in order to minimise draught from the fresh air
- It keeps down the noise from the traffic.

[0048] The air is let in through a slot in the outer side of the bottom of the window frame, is led up through the sides of the window frame and enters through an aperture at the inner side of the top of the window frame, thereby achieving

- Natural pre-heating of the outside air by 50-60% and thereby less draught for the user
- Reduction in the total heat loss to ventilation and through the window
- Airing without noise
- Less dust

[0049] As to the thermal aspect of the invention the construction of the window has been based on the following three characteristics:

1. The air current through the window frame in one window is 30 m^3/h corresponding to one person's need of fresh air
2. The inside surface temperature of the window frame may be adapted so that the conditions of hyphomycete and

condensation are not present 95% of the year
3. The total heat transmission coefficient of the window when the air in the window frame is stationary is supposed to live up to the general requirements in the recommendations to new energy-saving provisions in the building regulations. Consequently, the heat transmission coefficient may not exceed 1,5 W/m^{2}K.

[0050] The window and the window frame is constructed in consideration of acoustic environments.
[0051] The three heat technical requirements on which the construction of the window are based are as follows:

1. The air current through the window frame in one window is 30 m^3/h corresponding to one person's need of fresh air
2. The inside surface temperature of the window frame may not become so low that hyphomycete and condensation arise
3. The total heat transmission coefficient of the window when the air in the window frame is stationary is supposed to live up to the general requirements in the recommendations to new energy-saving provisions in the building regulations. Consequently, the heat transmission coefficient may not exceed 1,5 W/m^{2}K.

[0052] Furthermore when mounting the window it is possible to build a thermal bridge cutting off/cold-conductor interruption in the brickwork defining the hole of the window.

Air current

[0053] Presumably, most residences include at least one window of a certain size, 1-2 m^2 in area or 4-6 m in circumference of the window frame per habitant.
[0054] The supply of outside air necessary in order to obtain a good quality of the air corresponds to 25-30 m^3/h per habitant.
[0055] In order to minimise the loss of pressure in the window frame in order for the window also to work under unfavourable conditions, the speed of the air through the window frame is limited to 0,5 m/s resulting in the cross section of the single profile of the window frame being 333x25 mm.

Hyphomycete and condensation

[0056] For the removal of hyphomycete and condensation clothes with chlorine may be used. Another possibility is to remove the conditions for the formation of hyphomycete and condensation.
[0057] The presence of condensation is not necessary for the formation of hyphomycete, the presence of a high atmospheric humidity is sufficient. Based on the below assumptions:

- A "common household"
- An air current of 120 m^3/h in the whole residence

[0058] it is quite simple to calculate:
[0059] If the conditions for the formation of hyphomycete are to be removed during 95% of the heating season, the construction of the window should correspond to the inside surface temperature at the coldest place of the window frame not being below 14,2°C when the indoor temperature is 20°C and the outdoor temperature is 0°C. When the outdoor temperature is higher, the lowest indoor surface temperature must correspondingly be higher since there is then more humidity in the outdoor air with which the residence is ventilated. Vice versa when the outdoor temperature is lower.
[0060] In order to describe the above in general terms a factor which may be translated as "the dimensionless, indoor surface temperature, r_{fsi} is used, which factor may be defined as follows:

$$r_{fsi} = \frac{T_{indvendig} - T_{ude}}{T_{inde} - T_{ude}}$$

[0061] Said factor r_{fsi} must be more than 0,71 If the conditions for the formation of hyphomycete are to be removed during 95% of the heating season.
[0062] In the window the requirement to r_{fsi} that the inside of window frame must be very well insulated at the bottom where the cold air is entering while it can be a little less insulated at the top where the air has become somewhat warmer.

The heat transmission coefficient of the window

[0063] An object of the heat transmission coefficient of the window is defined corresponding to the general requirements in the recommendations to new energy-saving provisions in the building regulations: Maximum 1,5 W/m^2K which makes it necessary to insulate the window frame against the surroundings with what corresponds to 20 mm common insulation. This also results in a minimising of the heat loss from the air current further out through the frame of the window when the ventilation is working.

[0064] The good central heat transmission coefficient of the pane and the insulation of the window frame are thermally connected via an overlapping of at least 30 mm which overlapping ends in weatherstrips at both sides. At the edge of the pane an insulating TPS distance section is used for keeping the panes together.

[0065] The geometry of the window frame makes it obviously possible to improve the heat transmission coefficient further just as the heat transmission coefficient of the pane may also be considerably improved if a three-layer pane is chosen, possibly by using a thinner, possibly iron-free glass so that the weight remains the same, the solar energy transmittance is improved and the staining is reduced.

Built-in thermal bridge/cold-conductor

[0066] When the hole of the window is laid open, a slot may be cut around the periphery of the hole of the brickwork. Said slot may be used for mounting a thermal bridge cutting off/cold-conductor interruption in the brickwork whereby the heat current around the well-insulated window frame is reduced.

[0067] In order to obtain a good quality of the air, residences must be provided with an air exhauster or an ordinary outlet in the bathroom as well as in the kitchen. The air current through the window frame is moved by the differences of pressure originating from the exhauster or outlet.

Loss of pressure and regulation

[0068] An ordinary outlet naturally depends on wind and weather, but in most circumstances a sufficient forward pressure will be present. When the weather is calm, when the outdoor and the indoor temperatures are more or less the same, it might very well (like always) happen that the forward pressure is too low. In these situations, however, there is no need of pre-heating the ventilating air, and the users can just open the windows as they normally do.

Energy-saving exhaustion

[0069] The power consumption when ventilating is described in the building regulations as "the specific power consumption", SEL. In the recommendations to new energy-saving provisions the requirement to air exhausters is that they do not exceed 1000 J/m^3.

[0070] It is, however, possible to create a balanced mechanical ventilation through heat recurculation (and thus a high loss of pressure) where SEL is less than 1500 J/m^3. It is therefore expected that air exhausters, which are supposed to yield a far smaller pressure, may be produced with a SEL which is far below the requirement of 1000 J/m^3.

PRE-HEATING OF THE WINDOW FRAME

[0071] In the solid frame of an ordinary window the amount of hot air flowing into the frame (from the warm indoor climate) is the same as the amount of hot air flowing out of the frame (to the colder surroundings).

[0072] This is also the case in a hollow frame with stagnant air.

[0073] In the window according to the present invention, however, cold, fresh outdoor air is introduced through the hollow frame, thus reducing the difference of temperature between the cavity and the cold surroundings, and correspondingly the heat loss that way. On the other hand the heat loss from the warm indoor climate directly to the inside surface of the frame rises. However, the major part of the heat loss is used for increasing the temperature of the cold, fresh air.

[0074] The interesting size of the temperature efficiency, i.e. the amount of air being pre-heated in relation to the indoor and outdoor temperatures. Said temperature efficiency is just called the efficiency, abbreviated "e" and is calculated as follows:

$$e = \frac{T_{indblæsning} - T_{ude}}{T_{inde} - T_{ude}}$$

[0075] The above calculation indicates that the efficiency would be 100% is it were possible to heat up the air current to the same temperature as the indoor air temperature. When heating up the air from 0° to 10°C when the outdoor temperature is 0°C and the indoor temperature is 20°C, the e=50%.

Theory against empiricism

[0076] The results of the measurements turned out to be a little further more positive than the estimates - applying the same geometry, amounts of air, etc. the measurements resulted in a slightly higher efficiency: The air was simply pre-heated more than expected.

[0077] The most significant single-parameter as to the efficiency is the relationship between the heat-transmitting are (between the indoor air and the cavity, i.e. the inside of the frame) and the current by volume through the cavity: The bigger heat-transmitting area and the smaller current by volume, the bigger efficiency.

[0078] Therefore, the efficiency is also illustrated by the very factor in the below Figure which compare results of measurements to estimates:

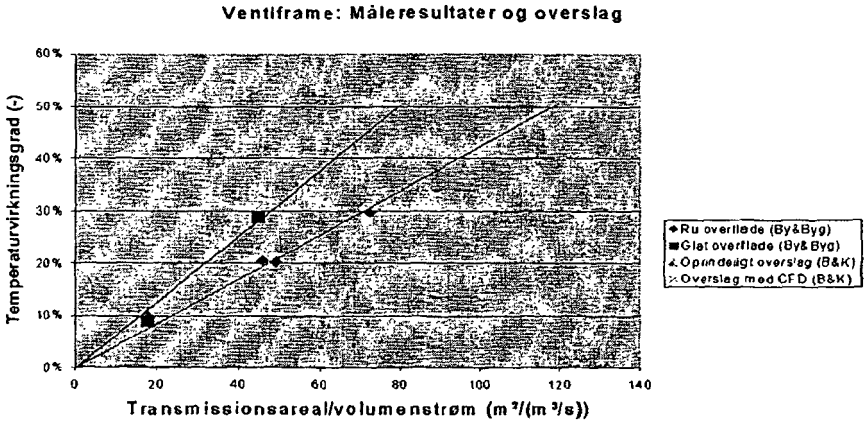


Fig. 9

[0079] In the estimates a somewhat bigger area per current by volume than in the tests was anticipated, and, consequently, the calculated efficiencies of the estimates were also the highest.

[0080] A simple, linear extrapolation (which is considered to be reasonable within the present field) shows, however, that at least just as high efficiencies would have been measured if a corresponding area had been available for the test.

[0081] Based on the above-mentioned calculations and tests it must be presumed that a pre-heating of the outdoor air with a temperature efficiency of 50 - 60% can be achieved.

[0082] The results have been reached without including any solar contribution. A considerable incident solar radiation would of course contribute to a further pre-heating of the air.

OPTIMIZATION OF THE WINDOW

[0083] The development of the window has not yet been terminated. The construction is to be further optimised, including:

- Minimisation of the heat transmission from the air current to the outer side of the frame: Theory and tests have proved that a slight roughness on the surface of the cavity reduces the friction between the surface and the air current. Thus the "contact" between the surface and the air current becomes less convex, and the heat transmission is reduced. The result is shown in the Figure of the results of measurements.

- The thermal bridge cutting off/cold-conductor interruption in the brickwork is to be optimised: The depth of the slot and the amount needed before reducing the effect.
- Development of a thermal bridge/cold-conductor secured closing device for the air current.
- Development of constant volume current regulator.
- For future use in new residences the window is to be further developed resulting in a halving of the heat transmission coefficient. The aim is 0,8 $W/m^2/k$.

[0084] On the other hand, a maximisation of heat transmission from the inside of the frame to the air current is not interesting, since it is necessary to insulate the inside of the frame in order to keep a sufficiently high surface temperature on the surface towards the room.

Claims

1. A window comprising a circumferential window frame and one or more window elements mounted in said window frame, said window frame including a first air inlet aperture at the bottom of said frame communicating with the exterior, and a first air outlet aperture communicating with the interior and further communicating with said first air inlet aperture through one or more air channels extending through substantially the entire length of said hollow frame.

2. The window according to claim 1, said window frame being of an overall rectangular or square configuration and comprising a bottom frame part, two opposite side frame parts and a top frame part.

3. The window according to claim 2, said first air inlet aperture being provided in said bottom frame part, said first air outlet aperture being provided in said top frame part and said at least one air channel extending along said bottom frame part, said side frame parts and first top frame part.

4. The window according to any of the claims 1-3, said hollow frame being insulated on its surface facing the interior for establishing heat transfer to said one or more air channels from the surrounding wall.

5. The window according to any of the claims 1-3, said hollow frame being insulated on its outer surface facing the surrounding wall.

6. The window according to any of the claims 1-5, said hollow frame having a substantially constant cross section from said first air inlet aperture to said first air outlet aperture, having a decreasing cross section from said first air inlet aperture to said first air outlet aperture or an increasing cross section from said first air inlet aperture to said air first outlet aperture.

7. The window according to any of the claims 1-6, said hollow window frame including an interior separation wall dividing said hollow frame into two separate channels.

8. The window according to claim 7, a first channel delimited by said separation wall establishing communication from said first air inlet to said first air outlet and said hollow frame further including a second air inlet aperture communicating with the interior and a second air outlet aperture communicating with the exterior, a second channel of said hollow window frame establishing communication from said second air inlet aperture to said second air outlet.

9. The window according to claim 8 said first channel being positioned closest to the exterior and said second channel being positioned behind said first channel closest to the interior.

10. The window according to any of the claims 8 or 9, said second channel establishing an air flow in the same direction as said first channel or alternatively and preferably, said second channel establishing an air flow opposite to said first channel.

11. The window according to any of the claims 1-10, said air inlet and/or air outlet aperture or apertures having closure means for closing off said aperture or apertures.

12. A circumferential window frame of a window or to be used in a window, said window including one or more windows mounted in or to be mounted in said window frame, said window frame including a first air inlet aperture communicating with the exterior and a first air outlet aperture communicating with the interior and further communicating with said

first air inlet aperture through one or more air channels extending through substantially the entire length of said hollow frame.

13. The window according to claim 12, further comprising any of the features of the window according to any of the claims 2-9.

14. A method of improving the air of a room of a building or a house by allowing fresh, preheated air from the exterior to be introduced into the room by providing a window according to any of the claims 1-11, mounting the window in said building or housing and allowing air from the exterior to be input through said first air inlet channel and be transmitted through said one or more air channels extending through substantially the entire length of said hollow frame and in doing so, being preheated and allowing preheated air to be introduced into the room through said air outlet aperture.

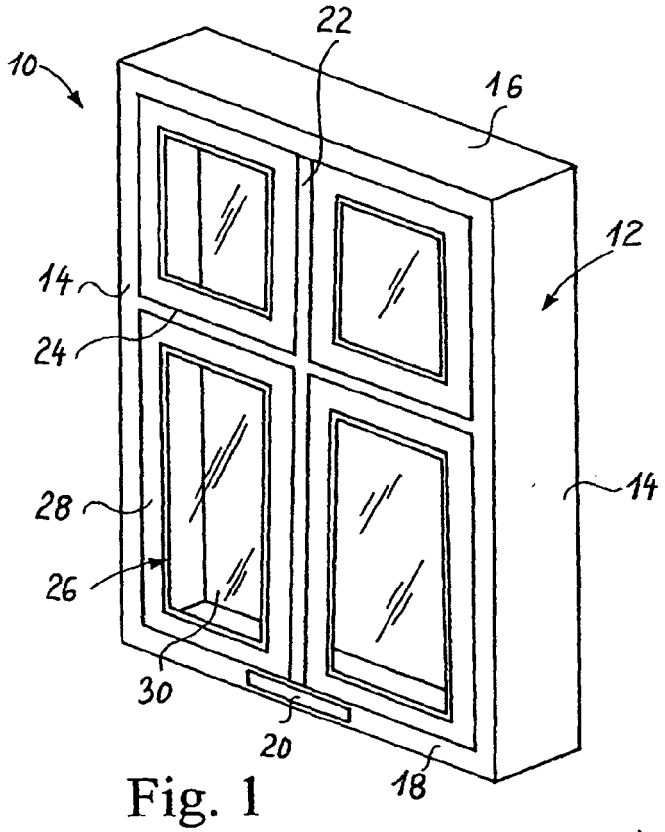


Fig. 1

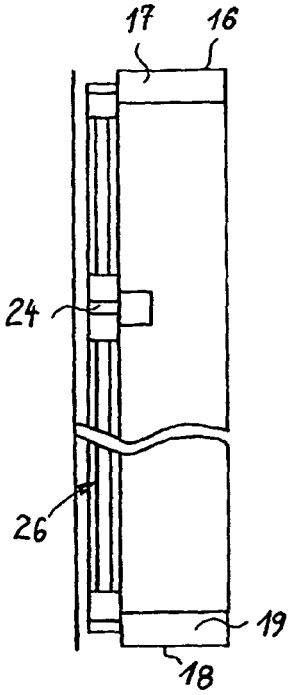


Fig. 2

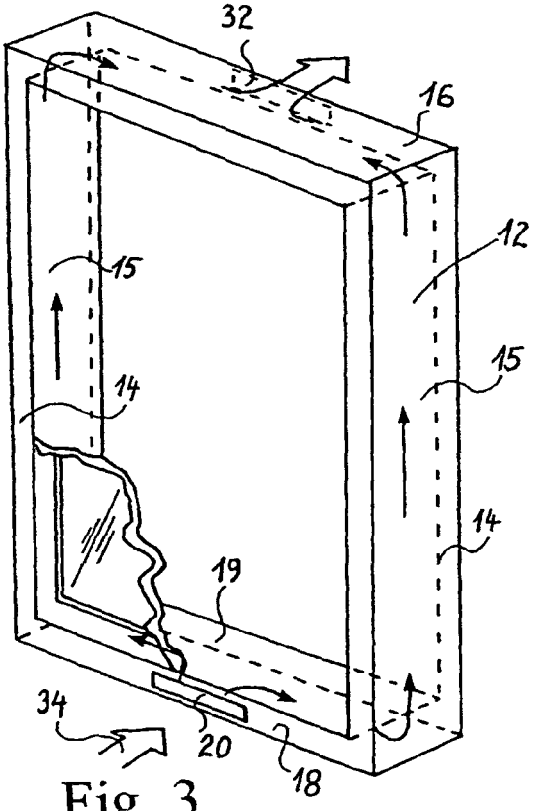


Fig. 3

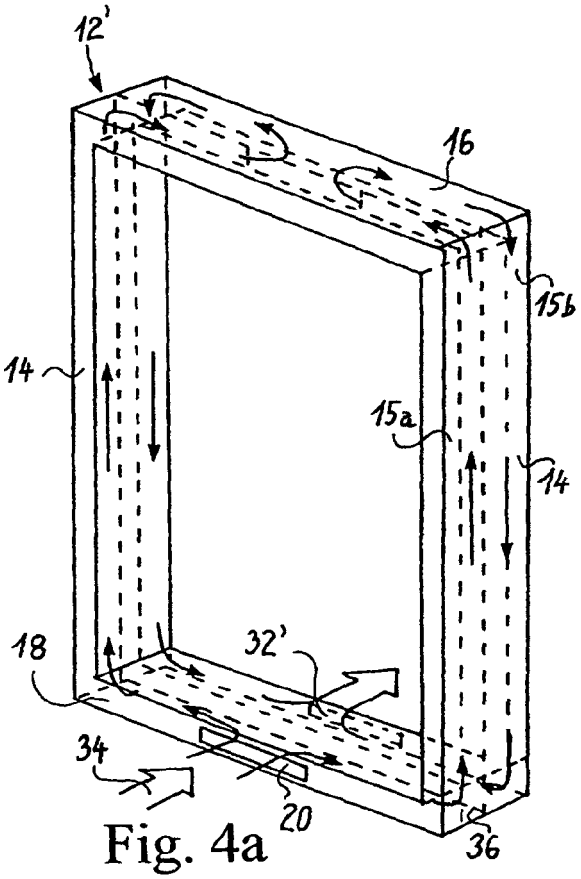


Fig. 4a

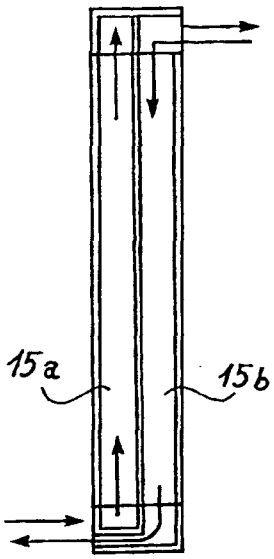


Fig. 5b

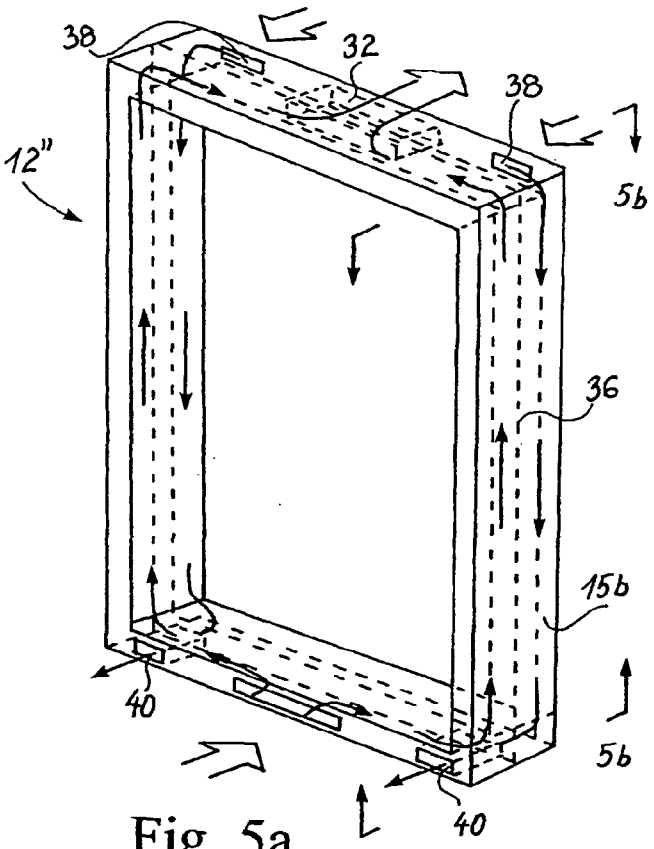


Fig. 5a

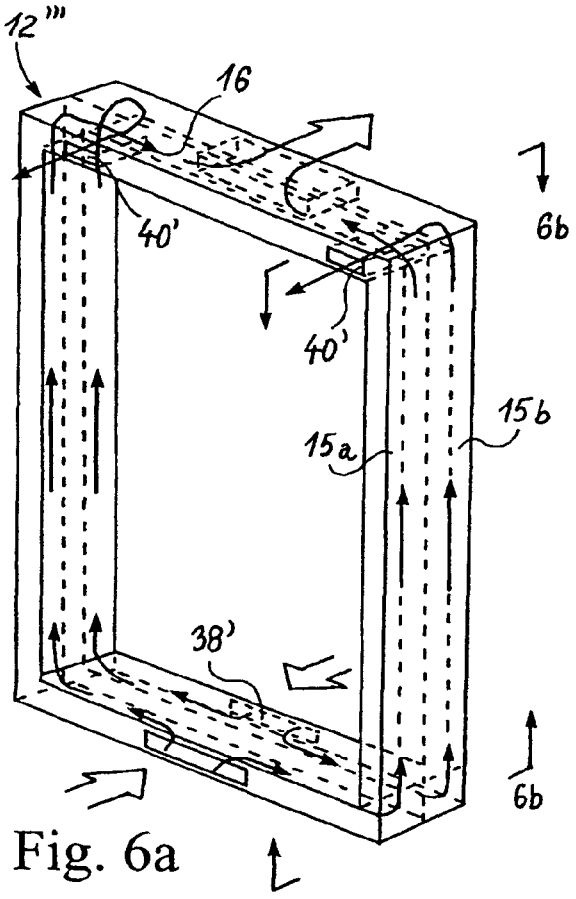


Fig. 6a

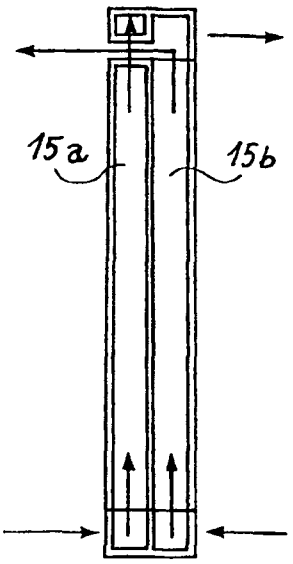


Fig. 6b

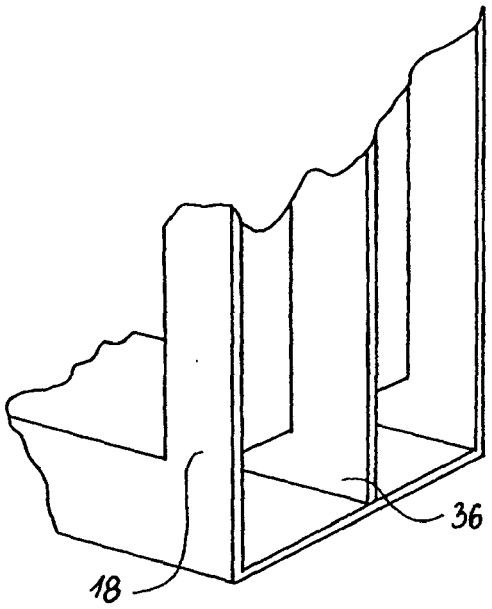


Fig. 4b

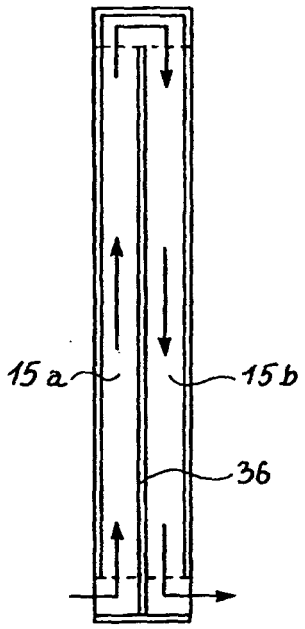


Fig. 4c

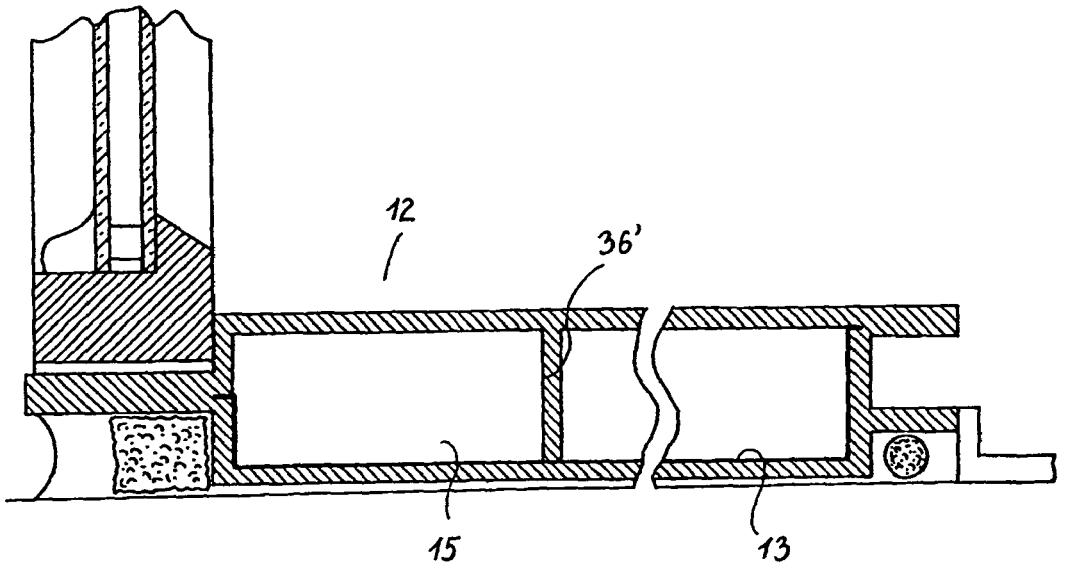


Fig. 7

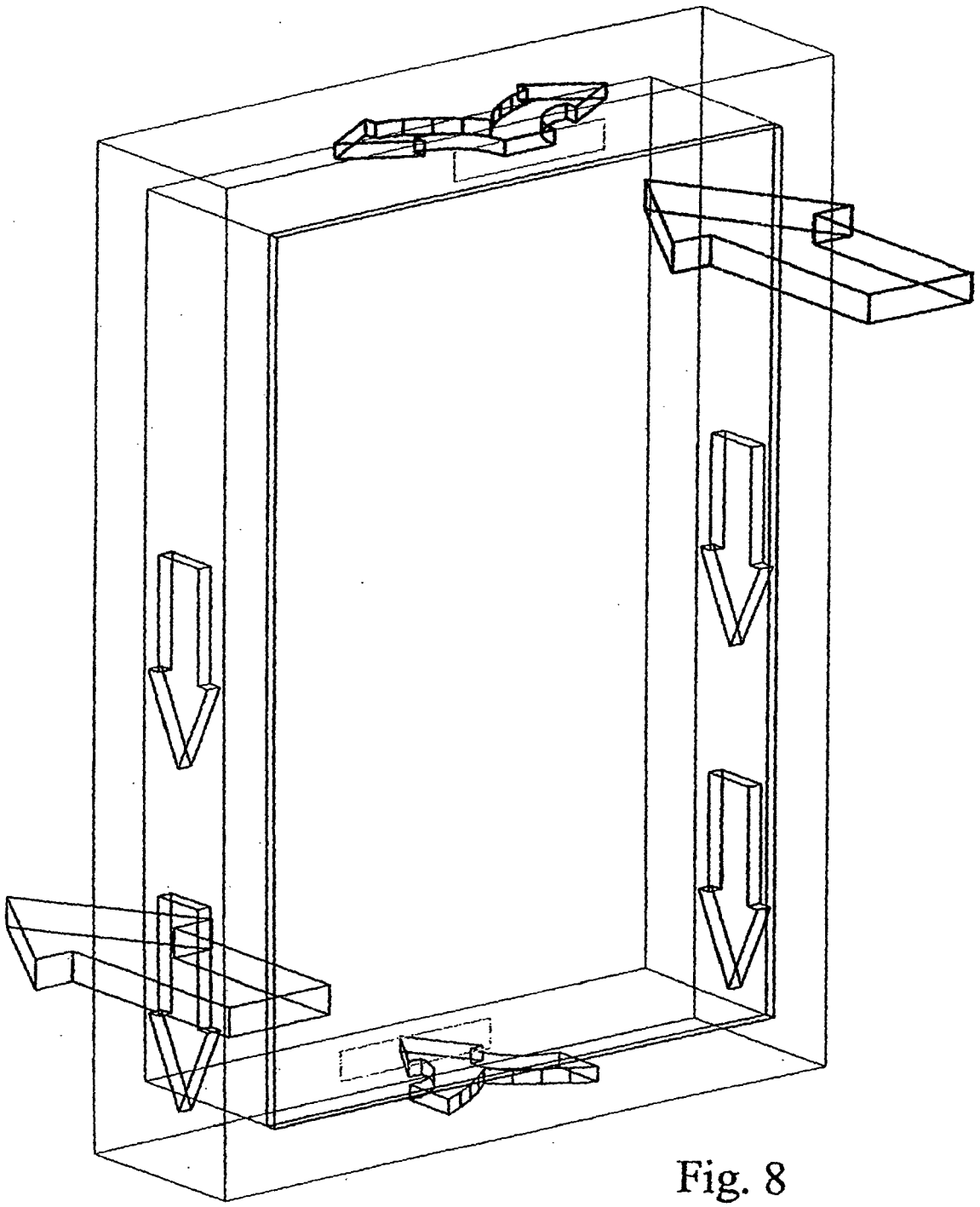
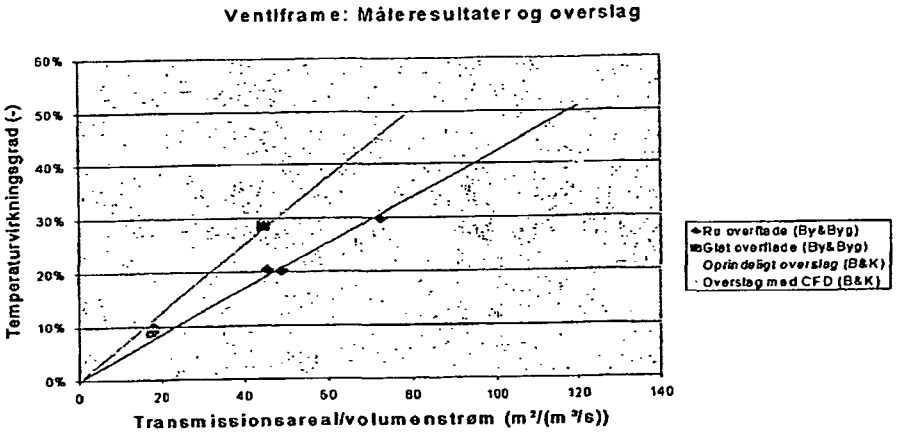


Fig. 8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60
80
100
120
140
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Ru overflade (By&Byg)
Glat overflade (By&Byg)
Oprindeligt overslag (B&K)
Overslag med CFD (B&K)

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 04 38 8061

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 February 2005	Kofoed, P

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