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(72) Inventor: **Messana, Roberto**
33170 Pordenone (IT)

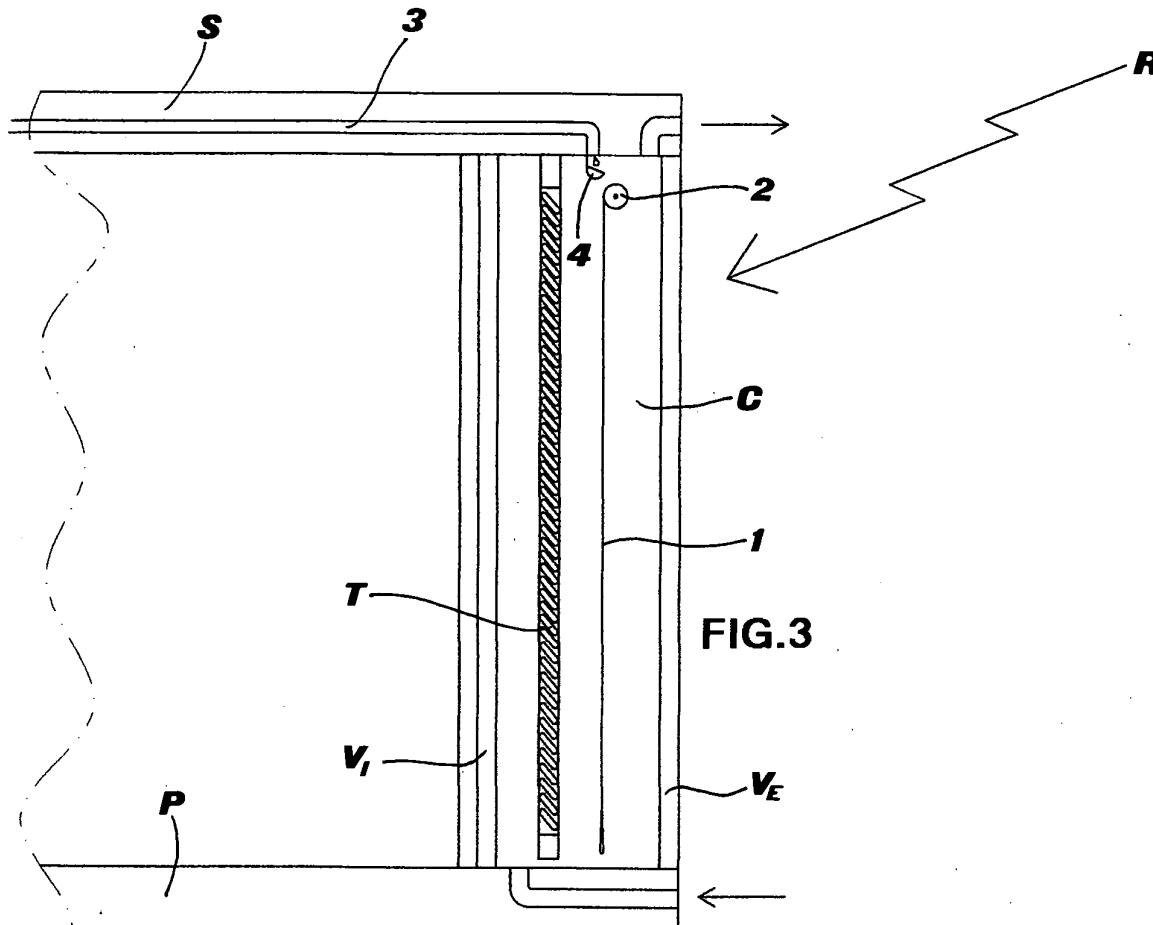
(74) Representative: **Faggioni, Marco, Dr. Ing. et al**
Fumero Studio Consulenza Brevetti,
Pettenkoferstrasse 20-22
80336 München (DE)

(71) Applicant: **Messana, Roberto**
33170 Pordenone (IT)

(54) **Transparent exterior wall for reducing solar radiation**

(57) Transparent external wall for buildings, of the type consisting of at least two glass elements (V_I, V_T) defining an inner cavity (C) of the wall in which a ventilation air flow is created. Inside said cavity is fed an

evaporable fluid to cool the cavity itself thanks to the latent heat necessary for causing the evaporation thereof. Preferably, the evaporable fluid is distributed on at least one surface inside the cavity, such as a cloth (1) hanging on a plane parallel to said glass elements.



Description

[0001] The present invention relates to a transparent external wall for buildings which causes a marked abatement of the thermal energy transferred inside the building by solar radiation incident onto the wall itself.

[0002] In the building sector, transparent external walls for buildings that replace the traditional masonry with windows are well-known, especially in skyscrapers and other large buildings mainly intended for office use. The transparent wall may extend along the whole height of each storey of the building, or only along the upper part of the same; in any case the ratio between transparent portion and opaque portion of the wall is extremely high and completely opposite to that of traditional buildings, where serious problems arise when trying to realise adequate air-conditioning of inner spaces.

[0003] The problem of most arduous solution is the one arising in summer in rooms having walls directly exposed to solar radiation. The thermal energy contained in such radiation can in fact increase the temperature of inner spaces beyond the comfort level, therefore requiring adequate temperature control through an air-conditioning system, and consequently causing a proportional increase in energy consumption.

[0004] In order to reduce the negative impact of this phenomenon, the possibility has been known for some time to build said walls with an inner cavity large enough to accommodate movable shading means, preferably of the venetian blind type, which allow to obtain and adjust the shading of inner rooms when solar radiation is most intense. Such shading means are preferably controlled by automatic devices which control their activation and position according to the presence and intensity of incident solar radiation, and possibly according to outer and inner temperature.

[0005] Since in this case the infrared radiation component is of course entirely discharged onto the shading means, it is essential to provide for a cooling of the same to avoid the means themselves and the cavity in which they are housed being subject to an excessive temperature increase, which would later cause - albeit with some delay - a corresponding overheating of the inner spaces, due to the radiative and convective effect.

[0006] The solutions provided in the prior art to overcome this problem are substantially twofold and both provide to create an air current for ventilation inside the cavity of the transparent wall where the shading means are housed, releasing the overheated air into the open atmosphere.

[0007] In the first solution to be launched on the market, the incoming air to the cavity is drawn from inside the building: the steady state temperature in the cavity will therefore tend to approximate the temperature existing in the inner spaces of the building, which in summer are conditioned to reach an average temperature of about 25°C. According to this first solution, the temperature of the cavity in the transparent wall is therefore

maintained at such a level that a minimal quantity of heat, if any, is transferred to the inner environment. The whole heat flow of the solar radiation incident onto the wall, however, is burdened onto the inner air-conditioning system by drawing such a flow of internal ventilation air which, to achieve the set aim, must be sufficiently large and in any case definitely larger than the flow of primary exchange air actually necessary for correct room ventilation.

[0008] In a second solution, introduced more recently, incoming air to the cavity is drawn instead from outside the building and is therefore at a temperature which, again in the hot season, is much higher than the previous one, averaging for example 35°C. Through such air flow, the transparent wall is thus maintained at a steady temperature higher than the internal temperature of the building, so determining an incoming heat flow towards the inner rooms which must be indirectly compensated by the air-conditioning system. The energy balance of this second solution, however, is more advantageous than that of the previous solution, since the load on the air-conditioning system is equal only to the fraction of the incoming solar heat flow to the cavity which was not removed by the ventilation air flow.

[0009] Both the prior art solutions briefly illustrated above, however, have the disadvantage of completely or partially transferring to the air-conditioning system of the inner spaces of the building the heat flow of the solar radiation incident on the transparent portion of the building wall. This can occur directly, i.e. by drawing already-conditioned indoor air to perform cavity ventilation (first solution), or indirectly, by only partially cooling the cavity when the ventilation thereof is performed with outdoor air (second solution).

[0010] Another drawback is to be attributed to the fact that the minimum theoretical steady temperature up to which the outer wall cavity can be brought is that of the ventilation air employed; in no case, hence, not even with extremely large flows of ventilation air, is it possible - with known systems - to obtain a steady temperature of said cavity that is lower than that of the ventilation air used. In practical applications then, considering that the ventilation air flow is subject to clear limitations due to obvious reasons, both economical and in terms of plant performance, the steady temperature inside the cavity is normally even 20-30°C higher than the temperature of the ventilation air employed.

[0011] It is therefore the object of the present invention to provide a ventilated external wall of the above mentioned type in which it is possible to achieve a steady temperature in the wall inner cavity that is significantly lower than the temperatures achievable in known-type walls and, in particular, a temperature even lower than that of the ventilation air used.

[0012] Another object of the present invention is to provide a ventilated external wall of the type described above in which the temperature can be controlled, in the presence of incident solar radiation, with a reduced load

on the air-conditioning system as compared to systems of the known type.

[0013] It is a further object of the present invention to provide a wall of the type described above with substantially negligible power consumption rates.

[0014] Such objects are achieved, according to the present invention, by means of a transparent external wall for buildings, of the type consisting of at least two flat glass elements defining an inner cavity of the wall in which a ventilation air flow is created, characterised in that an evaporable fluid is further introduced into said cavity.

[0015] Further features and advantages of the present invention will in any case be apparent from the following detailed description of a preferred embodiment of the same, taken in conjunction with the accompanying drawings, wherein:

fig. 1 is a diagrammatic cross-section view of a first version of a ventilated transparent external wall according to the prior art;

fig. 2 is a diagrammatic cross-section view of a second version of a ventilated transparent external wall according to the prior art;

fig. 3 is a diagrammatic cross-section view of a ventilated transparent wall according to the present invention; and

fig. 4 is an enlarged-scale front view of a portion of the upper area of the transparent wall shown in fig. 3.

[0016] Figg. 1 and 2 show diagrammatically the solutions used so far in the prior art. Only a functional diagram of such solutions is of course detailed in the drawings, i.e. their specific installation and structural features are not highlighted, being well-known to skilled people in the field.

[0017] Figg. 1-3 hence show diagrammatically an inner space A of a generic building E whose external walls are entirely or mainly formed of transparent glass surfaces. The inner space A is internally delimited by a ceiling S and by a floor P, and delimited to the outside by said transparent glass wall. Said external wall consists of an inner element V_I , normally a double glass panel with a sealed inner chamber, and by an outer element V_E , between which a cavity C is so formed. Inside the cavity C there is provided a shading device T of the venetian blind type, which may be activated and adjusted manually or automatically, for the purpose of shielding against the incoming solar radiation R.

[0018] In a first ventilation system, shown in fig. 1, inside the cavity C a ventilation air flow is formed drawing air from the environment A through the inner input vent I_I and releasing said air to the outside through the output vent O, after the air flow has passed through the cavity C cooling the cavity itself and - most importantly - the shading device T therein housed, which is continuously heated by the incoming solar radiation against which it

shields. The ventilation air flow inside the cavity C is always of the forced type and can therefore have either of two directions: descending, as shown in the drawing, or ascending.

[0019] The solution adopted most recently for the ventilation system of the cavity C is instead illustrated in fig. 2, where it can be appreciated that ventilation air is drawn from outside at the outer input vent I_E and released into the same outdoor air through the output vent O, after having cooled the cavity C and the shading device T therein housed. In this second solution the ventilation air flow can be either forced or natural, and an ascending flow as shown in the drawing is therefore preferred, which exploits the chimney effect occurring inside the cavity C.

[0020] In order to overcome the limitations of the known conventional systems described above, according to the essential idea informing the present invention, it is proposed to cool the cavity C not only by increasing the sensible heat of the air flow passing through the cavity itself, but, mainly, by using the latent heat necessary to evaporate an evaporable fluid adequately distributed, in the necessary amount, inside the cavity C.

[0021] The evaporable fluid is preferably water, and is fed into the cavity C by letting it flow onto as large a surface as possible, so as to maximise the quantity of evaporated fluid per time unit and, consequently, the amount of dissipated heat. In a preferred embodiment, shown in figg. 3 and 4, such surface consists of a cloth 1 wound around a motorised roller 2 fixed to the ceiling S at the cavity C, and more precisely in the area between the outer element V_E and the shading device T. At the roller 2 a water distribution system is also provided, which draws the water supplied by a pipe 3 and distributes it, as evenly as possible, over the cloth 1. The special type of water distribution system employed is not critical, as such system need only be capable of distributing water as evenly as possible, so as to avoid preferential water distribution channels and to ensure that the cloth 1 is evenly moist at all times.

[0022] A first possible embodiment of the water distribution system consists for example of a simple gutter 4 - shown in fig. 4 - fed by pipe 3 and running above the roller 2 along the whole length of the same. The gutter 4 runs in such a way as to have one of its edges slightly depressed and perfectly horizontal, so as to form a continuous water film falling down onto the roller 2 and rapidly and evenly flowing from there to the cloth 1 wetting it entirely.

[0023] In a second embodiment, not shown, it is pipe 3 which runs directly, with its end portion, above the roller 2, where such pipe is equipped with a series of jets facing the roller 2, so as to allow an even water distribution over the same.

[0024] In a third possible embodiment, again not shown, the end portion of the pipe 3 is evenly bored and represents itself the axial support onto which the roller 2 is mounted, which is thus evenly wetted from inside

rather than from outside as in the previous embodiments.

[0025] Operation of the transparent wall according to the present invention is extremely simple and can be immediately guessed from the previous description. In fact, when solar radiation irradiates upon the wall, an automatic mechanism similar to the one which in traditional walls determines the lowering and/or the closure of the shading device T, controls the rotation of the motorised roller 2, so as to unwind the cloth 1. When it is fully unwound, the cloth 1 finds itself fully or partly between the shading device T and the outer element V_E , and is therefore capable of intercepting, in the desired measure, the infrared component of the incident solar radiation R.

[0026] The material and the structure of the cloth 1 are chosen so as to ensure instead a high degree of transparency of the cloth itself to light radiation, which is thus not subject to any appreciable attenuation. The presence of the cloth 1 allows instead to obtain a diffusion effect of the incoming light radiation, improving the distribution efficiency thereof.

[0027] While the cloth 1 is unwound, suitable water flow control means in pipe 3 are simultaneously activated, which are adjusted - by sensors and devices known per se - so that the incoming water flow is at least sufficient to keep the cloth 1 constantly moist across its whole surface. The structure of the cloth 1 must be such as to guarantee a swift diffusion of the water across the cloth and a quantity of withheld water, per cloth surface unit, sufficient to achieve the object of the invention.

[0028] A preferred cloth type, which meets the above described requirements of transparency to light radiation and of even distribution and good water retention properties, is a synthetic transparent fibre fabric, normally used in serigraphy. The invention of course is not limited to this type of cloth, any other material capable of performing as described above being acceptable.

[0029] Air circulation inside the cavity C is then accomplished in a fully conventional way, according to one of the two solutions provided by the prior art; fig. 3 shows the most recent solution, according to which air circulation is performed with external air introduced into the cavity C through the input vent I_E and released outside through the vent O.

[0030] When the radiation R begins to heat the cloth 1, the water therein contained begins to evaporate. Thanks to the constant air circulation maintained inside the cavity C, the water vapour so formed is immediately removed, allowing evaporation to continue. Given that evaporation is an endothermic phenomenon, the equilibrium limit temperature of the system is no more, as in the prior art, the dry-bulb temperature (T_S) of the ventilation air, but rather the wet-bulb temperature (T_U) of the same ventilation air. This temperature, as is well-known to field experts, is significantly lower than the previous one, depending on the relative humidity value (UR) of the ventilation air (for example, for $T_S = 25^\circ\text{C}$ and UR =

55%, $T_U = 19^\circ\text{C}$, or for $T_S = 35^\circ\text{C}$ and UR = 40%, $T_U = 24^\circ\text{C}$), and it is therefore possible to reach an equilibrium temperature of the cavity C lower than the temperature of the cooling air employed, so achieving the first object of the invention.

[0031] Consequently, the residual flow of thermal energy, which from the wall so cooled transfers to the inner environment A, is also significantly reduced, or even eliminated - depending on the temperature and relative humidity values of the ventilation air -, so achieving also the second object of the invention.

[0032] The water employed to wet the cloth 1 must preferably be demineralised water - so as to avoid formation of limescale deposits on the cloth itself - easily obtained through a suitable water softener. For the purpose of reducing the overall running costs of the wall and at the same time optimising water consumption in the building, the water used to wet the cloth 1, however, is preferably condensation water from the air processing units of the building itself.

[0033] The above described solution to obtain water evaporation inside the cavity C of course is not the only one possible and, although being currently preferred, must not be intended as limiting the scope of the invention. The water to be vaporised might in fact be distributed directly over the inner side of the outer glass panel V_E of the transparent wall, or directly atomised inside the cavity C, in this way also achieving the object of the invention.

[0034] The present invention was hence described with reference to a preferred embodiment of the same, but it is evident that a number of changes may be made to the same, all within the reach of a skilled person in the field, without departing from the scope of the invention, as it is defined in the attached claims.

Claims

1. Transparent external wall for buildings, of the type consisting of at least two glass elements defining an inner cavity of the wall in which a ventilation air flow is created, **characterised in that** an evaporable fluid is further introduced into said cavity.
2. Transparent wall as claimed in claim 1), wherein said evaporable fluid is distributed on at least one wet surface housed inside the cavity.
3. Transparent wall as claimed in claim 2), wherein said wet surface comprises a cloth hanging on a plane parallel to said glass elements.
4. Transparent wall as claimed in claim 3), wherein said cloth may be wound on a motorised roller fixed to the ceiling of said cavity.
5. Transparent wall as claimed in claim 4), wherein

said cloth is wetted by a feeding plant of said evaporable fluid and by a system for the even distribution on the cloth of said fluid.

6. Transparent wall as claimed in any one of the claims 2) to 4), wherein said cloth is formed by a transparent synthetic fibre fabric. 5
7. Transparent wall as claimed in any one of the claims 3) to 6), further comprising inside the cavity a shading device, preferably of the venetian blind type, wherein said cloth hangs between the shading device and the external glass element of the cavity. 10
8. Transparent wall as claimed in claim 7), wherein said shading device is equipped with an automatic control system triggered by the amount of solar radiation incident onto the wall, and the operation of said motorised roller - to unwind the cloth thereon wound - is controlled by said automatic control system. 15 20
9. Transparent wall as claimed in any one of the previous claims, wherein said evaporable fluid is demineralised water. 25
10. Transparent wall as claimed in claim 9), wherein said demineralised water is condensation water coming from the air processing units of the inner spaces of the same building where the wall is installed. 30

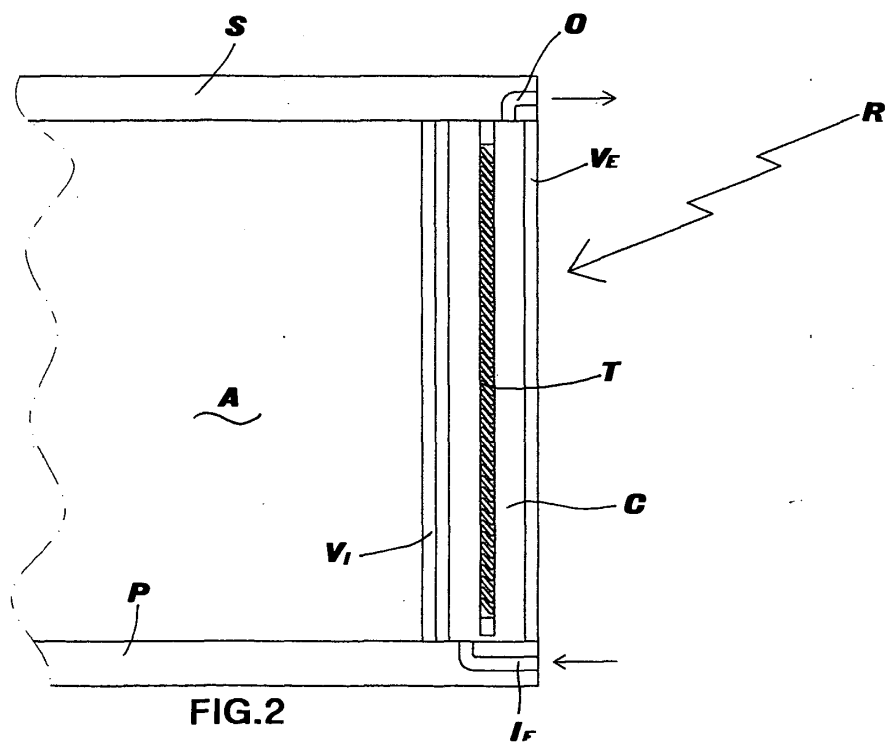
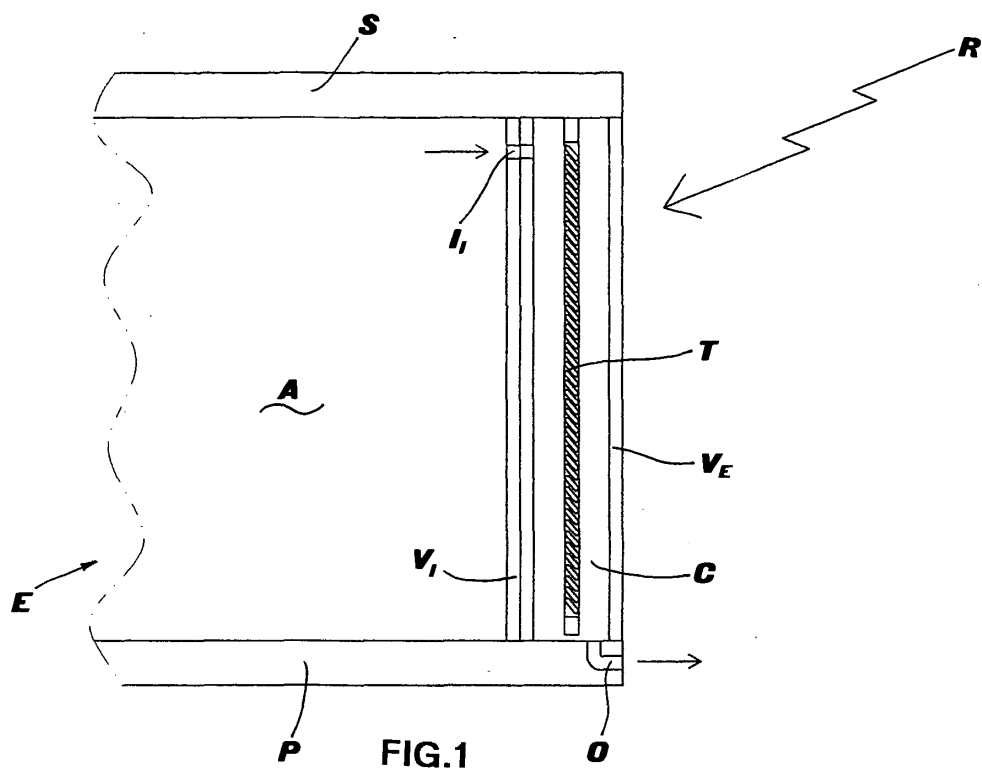
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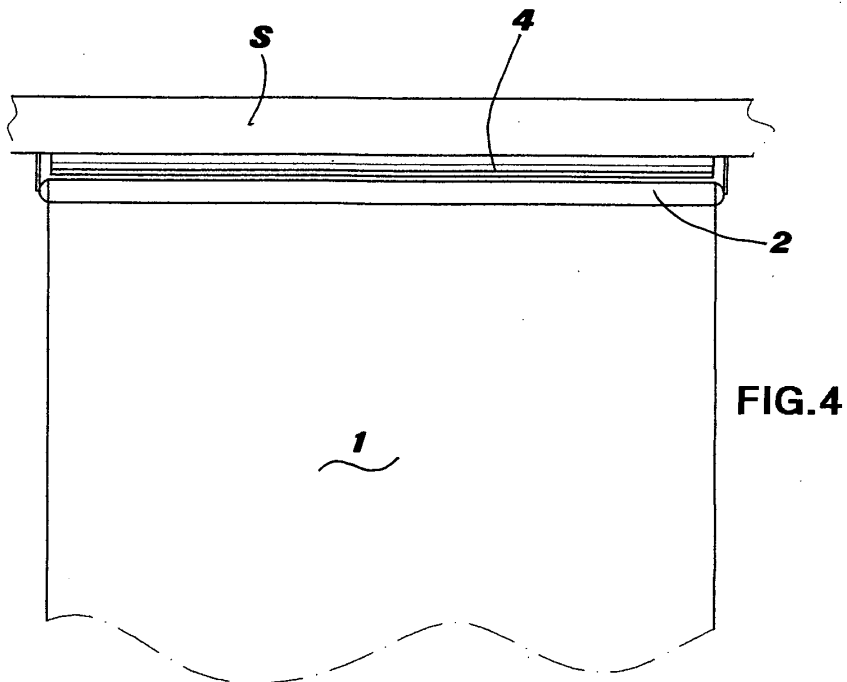
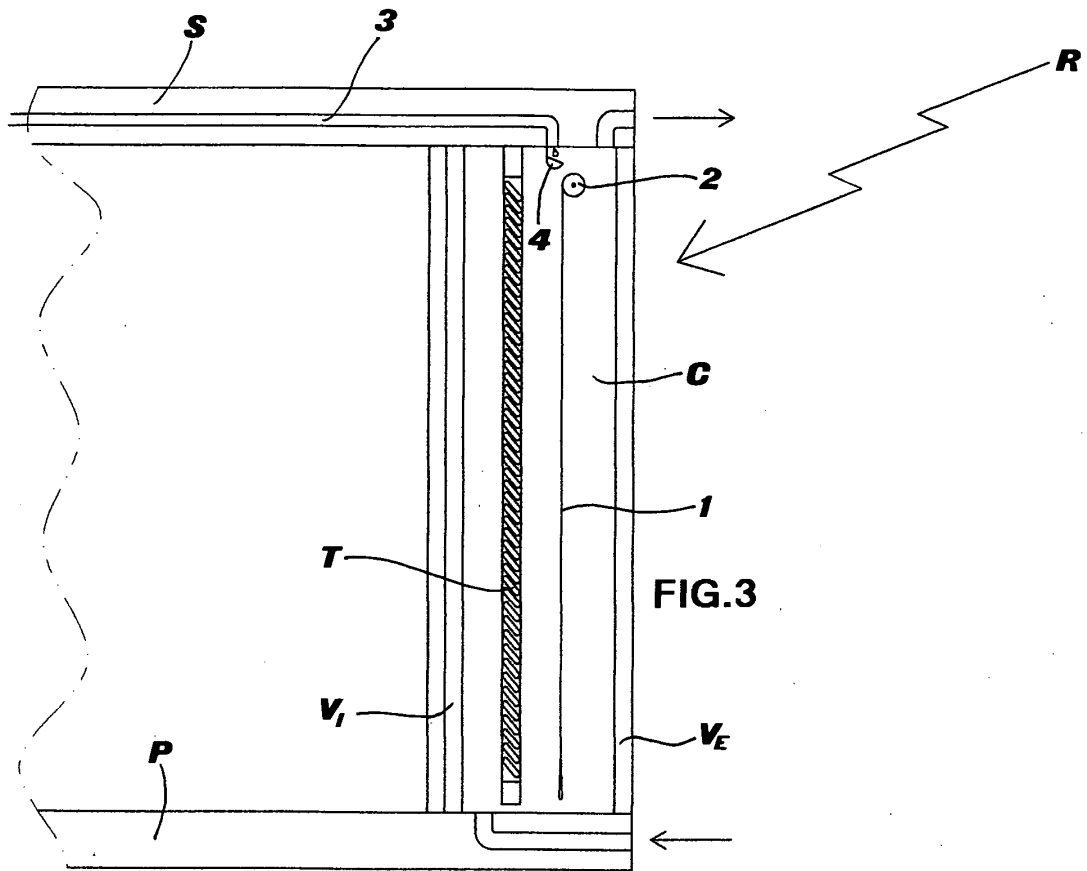
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Application Number
EP 03 42 5694

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 13 April 2004	Examiner Khera, D
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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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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