



(11) **EP 2 221 442 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.08.2010 Bulletin 2010/34

(51) Int Cl.:
E06B 9/24 (2006.01)

(21) Application number: **09002408.4**

(22) Date of filing: **20.02.2009**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL
PT RO SE SI SK TR**
Designated Extension States:
AL BA RS

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(54) **Sun shield**

(57) The invention relates to a sun shield (1) for controlling the light transmission from the outside to the inside of a building or the like, where the sun shield (1) comprises a plurality of light transmission channels or cells (2) thereby forming a three-dimensional structure with an external surface (26) and an internal surface (27), the inner surface (27) facing the inside of said building or the like, said channels or cells (2) being defined by one or more inner surface(s) (3, 4, 5, 6, 7, 8) and by a longitudinal axis (X), said axis (X) extending at an angle

(α) relative to horizontal. According to a specific embodiment of the sun shield according to the invention, the light transmission channels or cells (2) are of a hexagonal cross-section and one or more of said inner surfaces (3, 4, 5, 6, 7, 8) of the light transmission channels or cells (2), or portions of one or more of these surfaces, are provided with light reflective means (9, 18, 24). According to a specific embodiment, the light reflective means are in the form of a plurality of circular islands (9) provided on the three lower inner surfaces (6, 7, 8) of the individual cells (2).

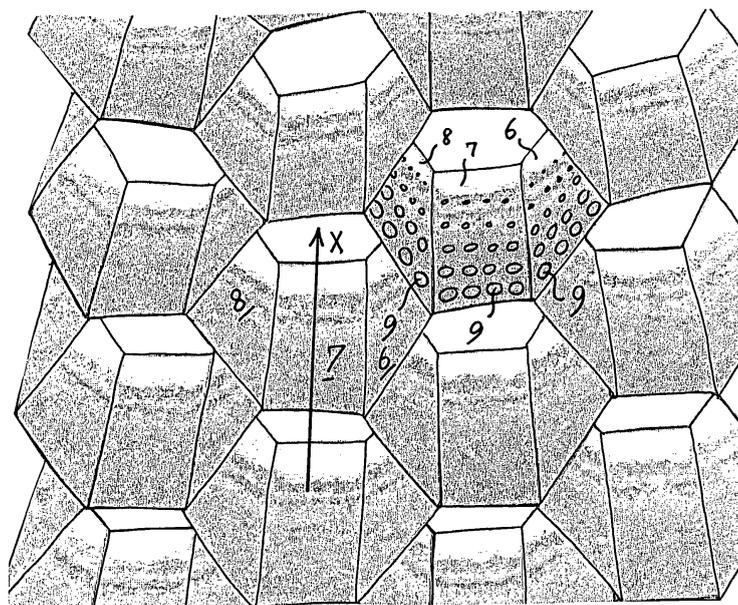


Fig. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates generally to sun shields for instance to be provided over a window opening and more specifically to a sun shield allowing direct passage of sun rays from a limited region in space, whereas direct passage of sun rays is blocked from other directions of incidence and where the direct passage of light from these other directions is at least to some extent converted to diffuse light reaching the area behind the sun shield.

BACKGROUND OF THE INVENTION

[0002] Various kinds of sun shields are known within the art, a typical example of a sun shield being a Venetian blind. There is at least one drawback with Venetian blinds, however, in that they do not provide shielding against laterally incident sun rays without reducing the view through for instance a window provided with a Venetian blind. Sun rays of substantially lateral and horizontal incidence are often a serious problem in connection with windows facing either east or west.

[0003] It would in many architectural applications be advantageous to have access to sun shields that do not prevent an unobstructed view substantially perpendicular to the plane of the window and that yet would provide an effective shielding against sun rays of horizontal and lateral incidence relative to the window.

[0004] A further important property of an effective sun shield would be that it should provide an effective shield not only against direct sunlight but also against undesirable heating of the room behind the sun shield, especially during the summer season. During the winter season, a certain amount of direct sunlight through the sun shield might be acceptable, the overall light intensity being generally low during the winter season. Furthermore, heat transmission through the sun shield may provide a desirable additional supply of thermal energy to the room behind the sun shield during the winter season.

SUMMARY OF THE INVENTION

[0005] The above advantageous effects are attained with a sun shield according to the present invention as defined by the independent claim. Specific - non-limiting - embodiments of the sun shield according to the invention are described in the detailed description of the invention.

[0006] The present invention is related to novel kinds of daylight shielding - in the following referred to as "sun shields", especially for use in offices, hospitals and various public locations. However, it is to be understood that the sun shields according to the invention may also find application at other locations, for instance in domestic surroundings.

[0007] Basically, the sun shield according to the invention is conceived as a disposable product that does not require maintenance and which can either be re-cycled after application or disposed of in a refuse disposal plant with minimal environmental problems. Also, the final product must comply with local fire regulations.

[0008] Preferably the choice of geometrical parameters of the sun shields according to the invention will be based on the actual path of movement of the sun over the sky at the specific geographical location at which the sun shield is to be applied. In the specific embodiments of the invention described in the following detailed description of the invention, these parameters have been optimized to conditions in Denmark, but these specific parameters can easily be adapted to other geographical locations without departing from the scope of the invention.

[0009] The above objects are according to the invention attained by a sun shield for controlling the light transmission from the outside to the inside of a building or the like, said sun shield comprising a plurality of light transmission channels or cells that form a three-dimensional structure with an external surface facing the outside of the building or the like and an internal surface-facing the inside of said building or the like, said channels being defined by one or more inner surface(s) and by a longitudinal axis X, said axis X extending at an angle α relative to the horizontal.

[0010] According to a presently preferred embodiment of the invention, the light transmission channels (or "cells" as they are alternatively referred to in the detailed description of the invention) are of a hexagonal cross-section, but other cross-sectional shapes of the light transmission channels may also be used without departing from the scope of the invention.

[0011] Furthermore, one or more of said inner surfaces of the light transmission channels are according to specific embodiments of the invention provided with light reflective means, these means giving rise to reflection of direct sun light in general and more specifically to thermal energy backwards to the region outside the building etc, in which the sun shield is used. Alternatively, only portions of said one or more inner surfaces may be provided with light reflective means. A specific configuration of a reflective coating for the sun shield according to the invention is described in the detailed description of the invention.

[0012] The sun shield according to the invention could be made from a variety of materials, such as paper or non-woven textile or different types of plastics foil or combinations of such materials. An important characteristic of the material is its ability to diffuse light. The light transmission channels or cells of the sun shield can be formed by welding or by the application of a suitable adhesive material or by any other suitable means dependent among others on the particular material of the sun shield.

[0013] It is desirable that the sun shields according to the invention be able to provide as much diffuse light to

a receptor region (for instance an office) behind the shield. Traditional heat reflective surfaces for instance comprising a coating of a metal such as aluminium will only provide a limited amount of diffuse light and hence according to presently preferred embodiments of the invention, the reflective regions in the light transmission channels or cells comprise a combination of reflective sub-regions and diffusive sub-regions. This can for instance be accomplished by means of the structure described in the detailed description of the invention, wherein the cells are made of a material that has an inner surface (within the cells) that diffuses light and where a certain proportion of the relevant inner surfaces of the cells is provided with the reflective means, thereby creating a pattern of sub-regions on relevant inner surfaces of the cells, where some of these sub-regions are reflective and others will diffuse light.

[0014] Heat reflection is most important on the lower surfaces of the cells that are facing towards the outside, i.e. towards the sun. Hence, according to a specific embodiment of the invention, the proportion of reflective sub-regions to the diffusive sub-regions increases towards the outside of the sun shield as exemplified by an embodiment shown and described in the detailed description of the invention. A gradual change of said proportions can also have a visually advantageous effect, as a sharp limit of the reflective region on a given inner surface of the cells can lead to unpleasant contrasts when seen in backlight.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention will be better understood with reference to the following non-limiting detailed description of embodiments of the invention taken in conjunction with the figures of the drawing, where:

Figure 1 shows a perspective view of a portion of a sun shield according to an embodiment of the present invention comprising a plurality of hexagonal light transmission channels, wherein the three upper, inner surfaces of the individual cells that diffuse light incident on these surfaces are visible in this figure;

Figure 2 shows a perspective view of a portion of a sun shield according to the embodiment of the present invention illustrated in figure 1, showing reflective portions in the form of reflective circular "islands" provided on the three lower inner surfaces of the respective light transmission channels, where the diameter of these islands in the shown embodiment changes along the longitudinal axis X through the channels, such that the diameter is largest in the direction towards the incident sun rays, i.e. towards the outside of a building etc. in which the sun shield is used;

Figure 3 shows an illustration of the effect on light transmission through the channels of one embodiment of the invention, where the channels incline an angle of approximately 43 degrees relative to horizontal and where the maximum elevation of the sun above horizontal is approximately 10.5 degrees, corresponding to mid-winter in Denmark;

Figure 4 shows an illustration of the effect on light transmission through the channels of one embodiment of the invention, where the channels incline an angle of approximately 43 degrees relative to horizontal and where the maximum elevation of the sun above horizontal is approximately 34 degrees, corresponding to equinox in Denmark;

Figure 5 shows an illustration of the effect on light transmission through the channels of one embodiment of the invention, where the channels incline an angle of approximately 43 degrees relative to horizontal and where the maximum elevation of the sun above horizontal is approximately 57.5 degrees, corresponding to mid-summer in Denmark;

Figure 6 shows an illustration of the effect on light transmission through the channels of a second embodiment of the invention, where the channels extend approximately horizontally; and

Figure 7 shows an illustration of the effect on light transmission through the channels of the second embodiment of the invention shown in figure 7 and where the maximum elevation of the sun above horizontal is approximately 34 degrees, corresponding to equinox in Denmark, and wherein a reflective means providing retro-reflection is provided on one or more of the lower inner surfaces of the individual light transmission channels.

DETAILED DESCRIPTION OF THE INVENTION

[0016] There follows a detailed description of a first and second embodiment of the sun shield according to the invention, but it is understood that these embodiments are only illustrative examples that do not limit the scope of the invention as defined by the independent claim. Specifically, the invention is not limited to hexagonal cells or to the application of the specific configuration of reflective regions in the form of circular "islands" that are described in detail in the following.

[0017] Referring to figure 1 there is shown a perspective view of a portion of a sun shield according to an embodiment of the present invention generally indicated by reference numeral 1 comprising a plurality of hexagonal light transmission channels, referred to generally as "cells" in the following. These channels thus have six inner surfaces 3, 4, 5, 6, 7 and 8 (three "upper inner surfaces" 3, 4 and 5 and three "lower inner surfaces" 6, 7

and 8) and the extension and direction of the cells is defined by the longitudinal axis X through the individual cells. The longitudinal axis will in different embodiments of the invention form different angles relative to horizontal, where this angle can be optimized to the specific geographical location, at which the sun shield is to be applied, i.e. to the elevation of the sun above the horizon.

[0018] Referring to figure 2 there is shown a perspective view of a portion of a sun shield 1 according to the same embodiment of the present invention as shown in figure 1 showing reflective portions 9 in the form of reflective circular "islands" provided on the three lower inner surfaces 6, 7 and 8 of the respective cells, where the diameter of these islands in the shown embodiment changes along the longitudinal axis X through the cells. These reflective islands are in figure 2 only shown in one of the cells for clarity, but typically they will be provided in all of the cells, although they could also be provided only in some of the cells.

[0019] It is understood that light reflective means in the form of the circular islands shown in figure 2 is only one example of how light reflective means could be provided. Alternatively, light reflection may be provided by an essentially continuous reflective surface that specifically could have a progressively changing light reflection, for instance such that the largest reflection was provided towards the outside of the sun shield, i.e. towards the sun, and less reflection was provided towards the inside of the building (the "receptor region"). Also, reflective regions may only extend longitudinally over a certain distance within the cells as will be shown and described in the following.

[0020] Figures 3, 4 and 5 illustrate the function of cells that are inclined relative to horizontal at an angle α of approximately 34 degrees. This inclination angle is chosen such that the angle of incidence of sun rays at midsummer in Denmark is approximately 90 degrees relative to the lowermost inner surface of the cells (cf. figure 5). Figure 3 shows the effect on light transmission through the cells of one embodiment of the invention, where the cells incline an angle of approximately 34 degrees relative to horizontal and where the maximum elevation of the sun above horizontal is approximately 10.5 degrees, corresponding to mid-winter in Denmark. Figures 4 and 5 show light incidence at equinox in Denmark and at midsummer in Denmark, respectively.

[0021] By choosing the inclination angle α of the cells to approximately 34 degrees, the angle of incidence of sun rays at midsummer in Denmark is approximately 90 degrees relative to the lowermost inner surface of the cells, whereby a large proportion of the heat of the sun can be reflected backwards through the glass of the window over which the sun shield is applied, said reflection being for instance brought about by means of a simple metal coating (for instance aluminium) on the lowermost surfaces of the cells, which coating in certain embodiments may not be applied to the entire surface area but as mentioned above could extend over a limited longitu-

dinal extension d of these surfaces. Alternatively, reflection could take place from a pattern of reflective regions, like the "islands" 9 shown in figure 2 or by the application of a heat reflective textile material used for forming the cell structure. The shown inclination of the cells provides an optimal shielding for direct sun ray incidence.

[0022] Other types of coatings with heat reflective effect could also be envisaged and the coating might cover the entire surface if it is not compact but being able to diffuse light. This is for instance the case with textile surfaces, wherein the heat reflective coating is applied to the individual fibres and not as a continuous surface portion.

[0023] One drawback of a sun shield comprising inclined cells might be that the cells cannot be pushed together vertically without increasing the depth or "thickness" of the sun shield. The displacement of the individual layers of cells has the effect that the layers will not lie directly above each other when pushed together, whereby the horizontal extension will be quite large, when the cells are pushed together vertically. Embodiments of the invention with inclined cells are therefore most suited for sun shields that can be displaced horizontally.

[0024] Figures 6 and 7 illustrate a second embodiment of the invention, wherein the cells are extending substantially horizontally. Sun shields with horizontally extending cells open up for the possibility to vary the height of the cells. The sun shield structure (or "grid") will when applied for instance over a window opening be subjected to gravity and if the grid is made of flexible materials, the uppermost cells will be deformed (extended vertically) to a larger extent than cells placed at lower levels of the grid. Light transmission will consequently be larger through the upper layers of the sun shield than through the lower, i.e. the shielding effect will be the largest in the lower portions of the grid.

[0025] It is an advantage that sun shields with horizontally extending cells can be pushed together vertically without thereby increasing the horizontal extent of the grid as the individual layers of cells are placed directly above each other. Thus, the sun shield according to this embodiment takes up lesser space, than the sun shield with inclined cells, when not in use.

[0026] The surfaces of the cells will, when not covered by reflective coatings, provide both diffuse reflection and diffuse light transmission and thereby contribute to the distribution of daylight in the room behind the screen. There will be no shielding effect for horizontal sunray incidence, i.e. for sun ray incidence perpendicularly to the plane of the window opening. However, for other directions of incidence of the sun rays, the shielding effect will be effective and the surface of for instance tables in a room behind the sun shield as well as persons working at such tables will be effectively protected against direct sunlight.

[0027] Typically aluminium or another metal will be used as a coating for reflecting heat radiation. With ref-

erence to figures 6 and 7, the sun rays will be reflected from the inner horizontal surfaces of the cells and be transmitted into the room behind the sun shield. According to the invention it is therefore proposed to apply a coating on these surfaces that can provide retro-reflection, i.e. a reflection backwards substantially in the direction opposite that of the incident sun rays. Although the entire surface area of the surfaces 6, 7 and 8 (see figures 1 and 2) could be covered by the reflective coating, the reflective coating may as mentioned above in practice only extend over a limited longitudinal extension d of the surfaces 6, 7 and 8.

[0028] The provision of reflective material over the entire surface areas of the surfaces 6, 7 and 8 could be advantageous from a manufacturing point of view or the reflective material could be integrated in the constitution of the textile material used for the grid.

[0029] The reflective material may consist of small transparent plastic or glass spheres with a suitable index of refraction. The plastic or glass spheres must preferably be provided in a uniform layer in a suitable binding agent with approximately $1/3$ extending beyond the binding agent. A reflective effect can be attained with or without a pigment of aluminium, i.e. not only as a gray surface, but also as a white surface or a surface of any other colour. Reflective means can be applied to textile surfaces using transfer printing or direct printing.

[0030] Retro-reflection is limited by the angle of incidence of the sun rays and functions best for angles of incidence above approximately 45 degrees.

[0031] Reverting to figure 3 there is shown an illustration of the effect on light transmission through the cells of one embodiment of the invention, where the cells incline an angle of approximately 43 degrees relative to horizontal and where the maximum elevation of the sun above horizontal is approximately 10.5 degrees, corresponding to mid-winter in Denmark. The figure shows a cross sectional view through a single cell of a sun shield with an external surface 26 facing the sun and an internal surface 27 facing the receptor region (for instance a room in a building) behind the sun shield, where the upper portion 3 and the lower portion 7 (corresponding to the reference numerals used in figures 1 and 2) of the cell are shown. Sun rays are generally designated by reference numeral 10 incident on the cell from the outside I and to some extent transmitted to the room II behind the window opening. On the inner surface of the lower portion surface 7, there is over a distance d provided a reflective coating 18, for instance made of aluminium, whereas the remaining inner surface portions 19 of the cell portions 3 and 7 consist of a material that will have a diffusive effect on impinging light. The reflective coating could for instance comprise the pattern of spherical "islands" described in connection with figure 2 although other configurations of reflective coatings or layers could also be used without departing from the scope of the invention.

[0032] With the given elevation of the sun (10.5 degrees relative to horizontal), some of the light rays (ref-

erence numeral 11) will pass directly through the cell to the receptor region II behind the window opening. Other light rays will impinge on the reflective coating 18 and be reflected towards the upper cell portion 3 (indicated by the light rays 12). From the upper portion 3 these rays will be diffused as indicated by 17 and contribute to diffuse lightening of the receptor region II. Finally, some of the incident rays 10 will impinge on the diffusive part 19 of the lower cell portion 7 and be spread from this part of the lower cell portion 7 as diffuse light, a portion of this diffuse light contributing directly to diffuse lightening of the receptor region II and a portion of this diffuse light impinging on the upper cell portion 3 from where it is again diffused at least partly into the receptor region II. Thus, with the shown cell inclination and with the particular angle of incidence of the sun rays 10 relative to the cell, the receptor region II will receive both a certain amount of direct sun light and a certain amount of diffuse light.

[0033] Figure 4 shows light ray propagation through a similar cell for an elevation of the sun of 34 degrees. The same reference numerals as in figure 3 are used to indicate similar items. Contrary to figure 3, however, the receptor region II only receives diffuse light as the incident light rays 10 will either be reflected by the reflective coating 18 backwards and out of the cell or be reflected from 18 towards the upper diffusive surface 19 of the cell, from where an amount of light will be transmitted to the receptor region II as diffuse light. Finally, some of the incident light rays will impinge on the diffusive inner surface portion of the lower cell portion 19 and be spread as diffusive light either impinging on the diffusive upper surface 19 or being radiated into the receptor region II.

[0034] Figure 5 shows light ray propagation through a similar cell for an elevation of the sun of 57.5 degrees. The same reference numerals as in figure 3 are used to indicate similar items. With the shown elevation of the sun, a large proportion on the incident sun rays 10 will be reflected from the reflective coating 18 directly backwards (retro-reflection), whereby a very effective prevention of heating caused by thermal energy of the incident sun light will be provided. Diffuse light from outside will still impinge on both the reflective coating 18 and on the other inner surfaces of the cell giving rise to propagation of a certain amount of diffuse light through the sun shield to the receptor region II.

[0035] Referring now to figures 6 and 7 there is shown an illustration of the effect on light transmission through the channels of a second embodiment of the invention, where the channels extend approximately horizontally in the case where the maximum elevation of the sun above horizontal is approximately 34 degrees, corresponding to equinox in Denmark.

[0036] Application of a sun shield according to the invention with horizontally extending cells that are not provided with reflective portions on the inner surfaces of the cells will provide both diffuse reflection and transmission from the outside region I through the individual cells of

the sun shield to the receptor region II and thereby contribute to the distribution of daylight in the reception region II. There will be no shielding effect for horizontal sun ray incidence from a direction substantially perpendicular to the plane of the sun shield. For other angles of incidence of the sun rays, the shielding will, however, be effective and offer good protection against direct sun light incidence on working tables and people seated at such tables etc. in the reception area II.

[0037] Referring to figure 6, the lower surface portion 7 of the cell is provided with a reflective coating 18 that could typically be aluminium or other metal coating. This coating could extend a certain distance d over the corresponding inner surface portion of the cell although other extensions and indeed configurations of reflective material could also be used. As apparent from figure 6, the sun rays 10 incident on the reflective surface 18 will be reflected off this surface and propagate as sun rays 21 into the reception region II. Diffuse light transmission is indicated by reference numerals 22 and 23. In order to prevent direct sun ray propagation into the receptor region II it is according to one embodiment of the invention shown in figure 7 proposed to use a coating 24 that provides retro-reflection as indicated by reference numeral 25 in figure 7. The coating may be provided over the entire inner surfaces 6, 7, 8 of the cells (or optionally over the entire lower surface 7 of the cells) or over a limited portion of one or more of these surfaces as indicated by d in figure 7. Provision over the entire lower inner surfaces might be advantageous from a manufacturing point of view, or reflective means could be integrated in the structure of the textile material of the cells. Reflection could be provided by small transparent plastics or glass spheres of a suitable index of refraction. These spheres should preferably be provided in a uniform layer in a suitable binding agent with approximately $1/3$ extending above the binder agent. Reflection may be obtained with and without aluminium pigment, i.e. not only as a gray surface, but also as a surface of white or another colour. Such reflective means may be applied to the textile material transfer printing or direct printing, the first mentioned of these techniques giving the best effect.

[0038] Retro-reflection is limited by the direction of incidence and is most effective at directions of incidence above approximately 45 degrees. Taking the angle of incidence into account it can be calculated how far into the cell it would be absolutely necessary to apply reflective means if all heat of the sun should be reflected at noon in summer.

Claims

1. A sun shield for controlling the light transmission from the outside to the inside of a building or the like, said sun shield (1) comprising a plurality of light transmission channels or cells (2) thereby forming a three-dimensional structure with an external surface

(26) and an internal surface (27), said channels or cells (2) being defined by one or more inner surface (s) (3, 4, 5, 6, 7, 8) and by a longitudinal axis (X), said axis (X) extending at an angle (α) relative to horizontal.

2. A sun shield according to claim 1, wherein said light transmission channels or cells (2) are of a hexagonal cross-section.

3. A sun shield according to claims 1 or 2, wherein one or more of said inner surfaces (3, 4, 5, 6, 7, 8) of said light transmission channels or cells (2), or portions of one or more of these surfaces, are provided with light reflective means (9, 18, 24).

4. A sun shield according to claim 3, wherein said light reflective means are formed as circular islands (9) on one or more of said inner surfaces of the light transmission channels or cells, where each of the circular islands (9) is **characterized by** a given diameter that may be different for different islands.

5. A sun shield according to claim 4, wherein said diameters decrease in the direction of the light transmitting channels or cells towards said internal surface (27) of the sun shield (1), i.e. in the direction towards the receptor region (II).

6. A sun shield according to claim 1, wherein said angle (α) depends on the maximum elevation of the sun above the horizon at the specific geographical location where the sun shield is to be used.

7. A sun shield according to claim 1, wherein said angle (α) is approximately equal to zero degrees.

8. A sun shield according to claim 1, wherein said angle (α) is approximately equal to 34 degrees.

9. A sun shield according to claim 7, wherein one or more of said inner surfaces (3, 4, 5, 6, 7, 8) of said light transmission channels (2) is provided with a layer or coating (24) extending a distance d into the channels, which layer or coating is retro-reflective, such that light rays incident on the reflective layer or coating (24) is reflected backwards substantially in the direction opposite to the direction of incidence.

10. A sun shield according to claim 9, wherein said retro-reflective layer or coating (24) comprises small transparent plastics or glass spheres of a given index of refraction applied in a binding agent, the spheres being provided in a substantially uniform layer with approximately $1/3$ extending above the binder agent.

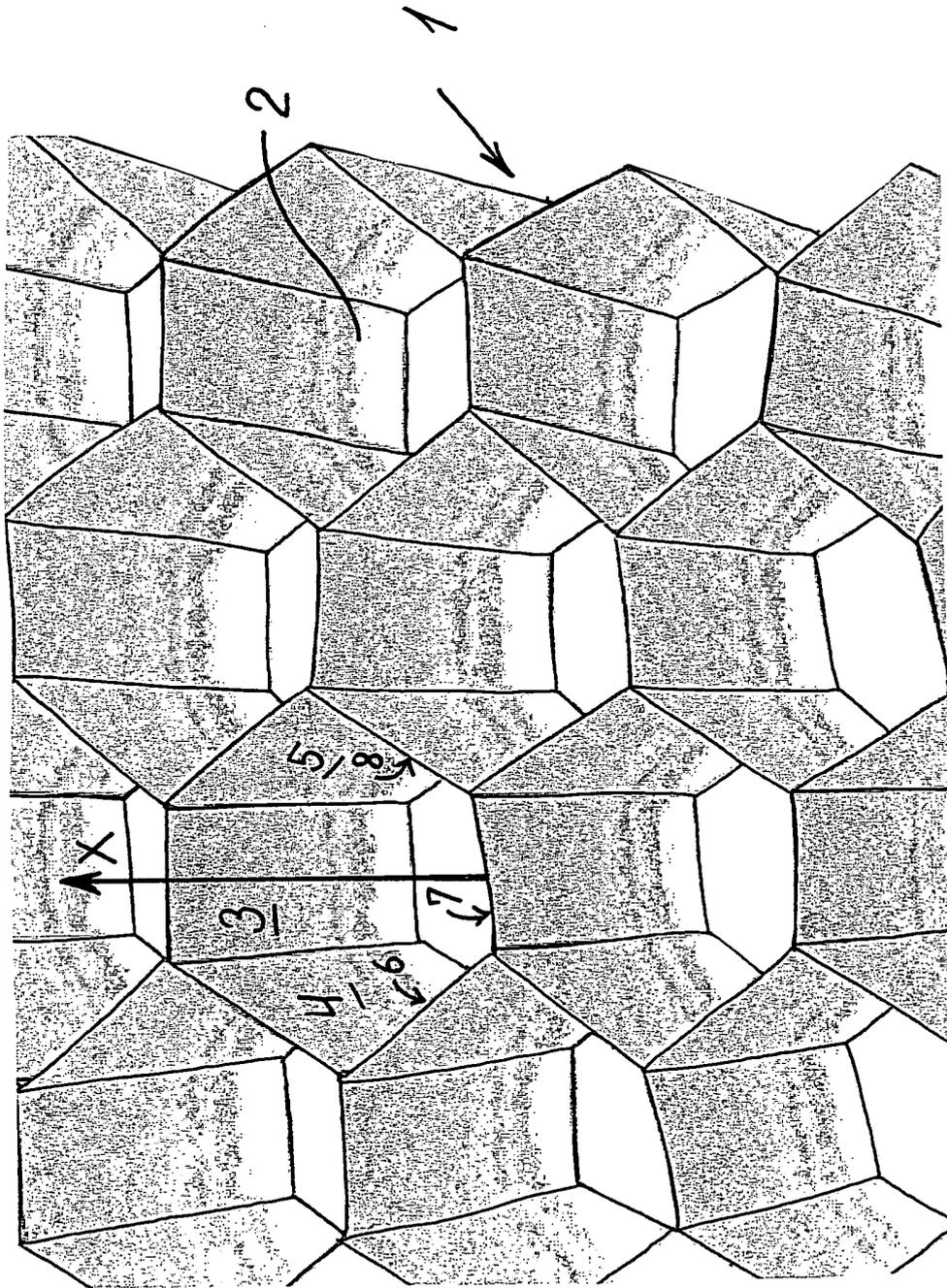


Fig. 1

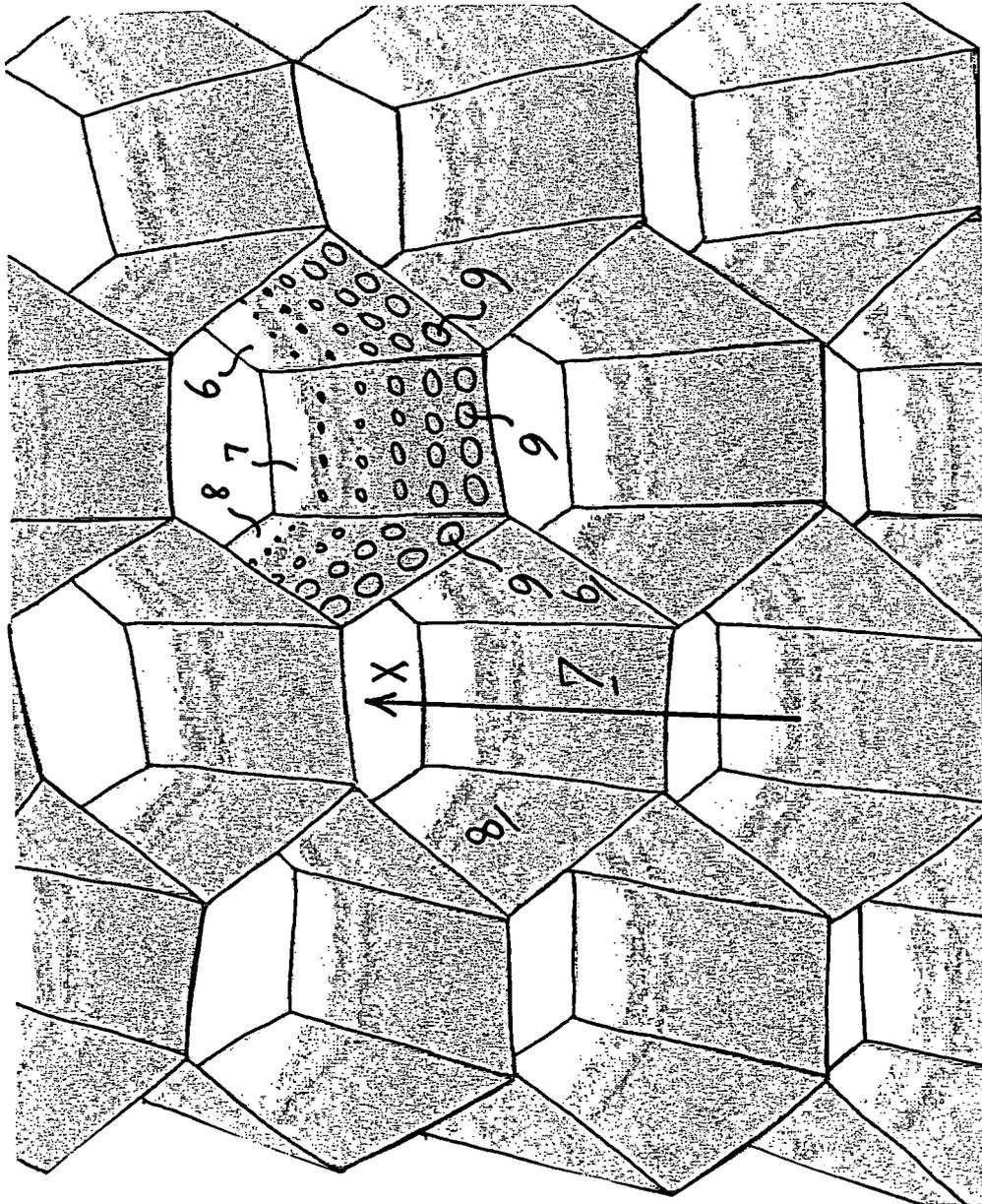


Fig. 2

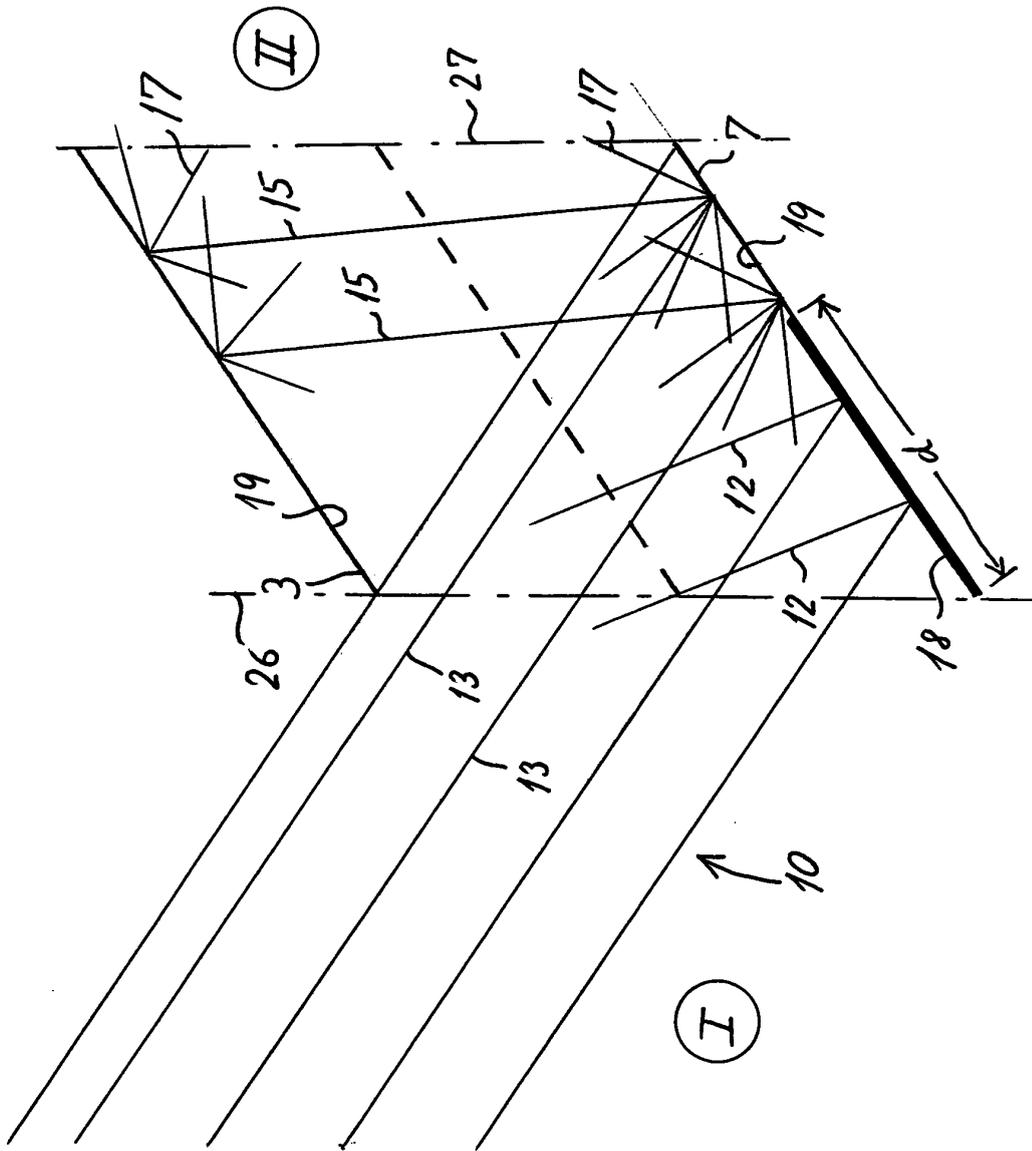


Fig. 4

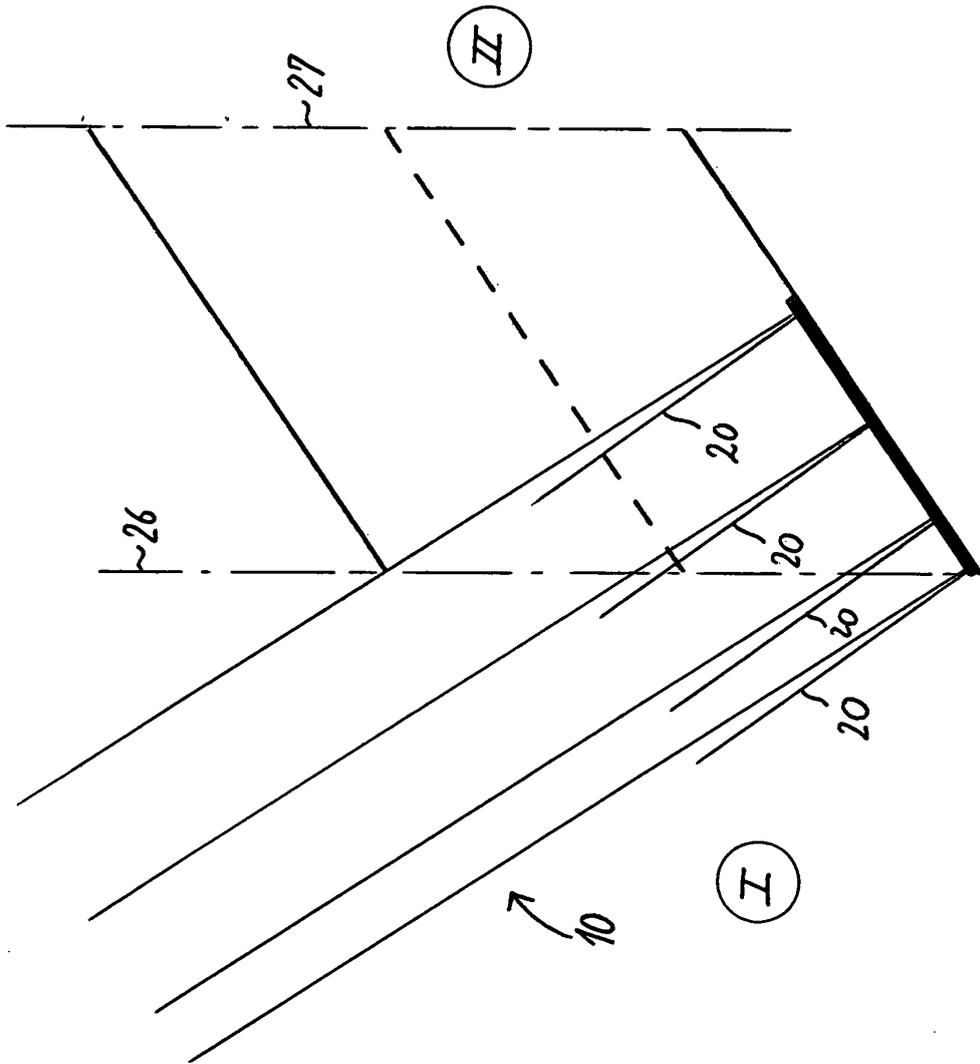


Fig. 5

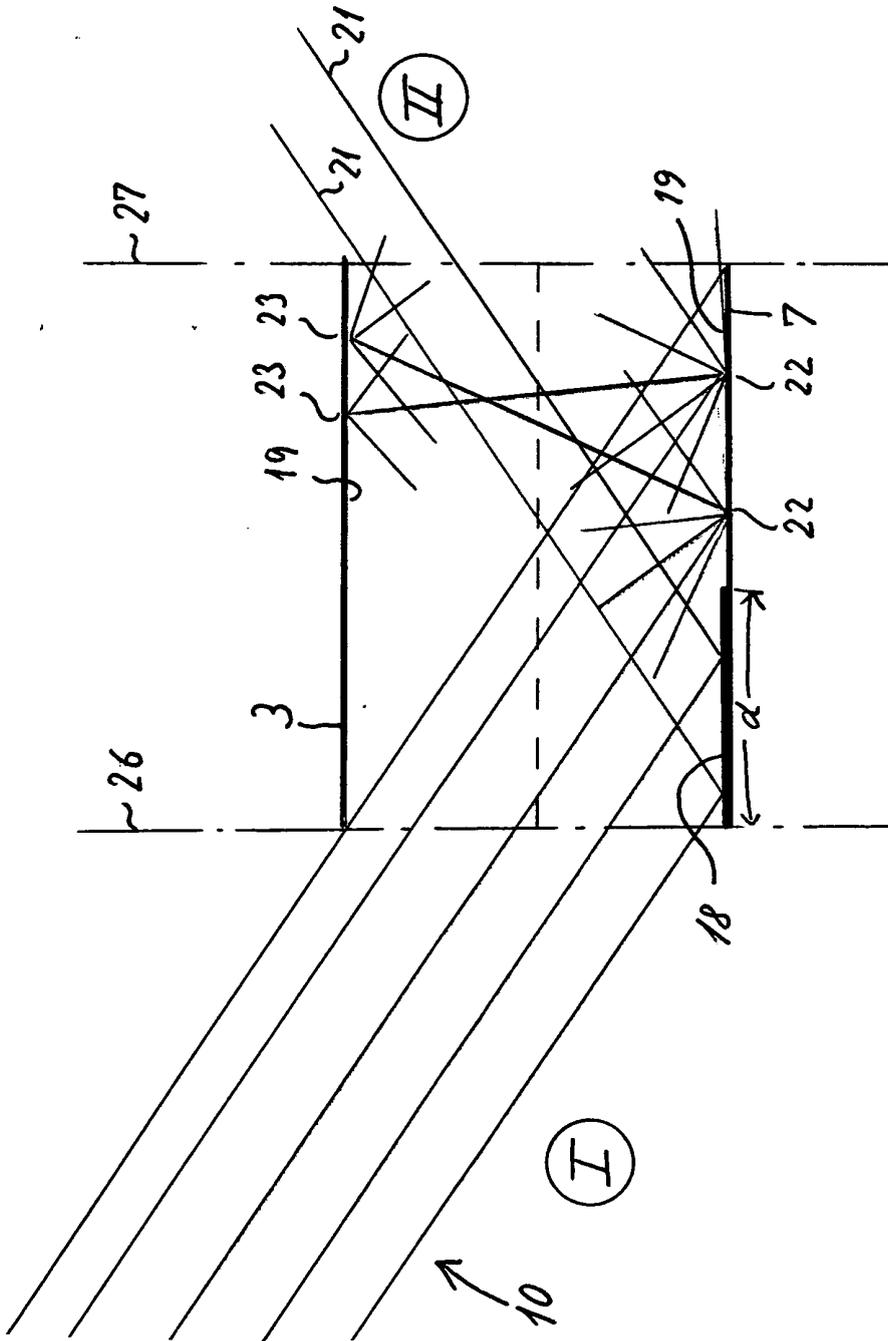


Fig. 6

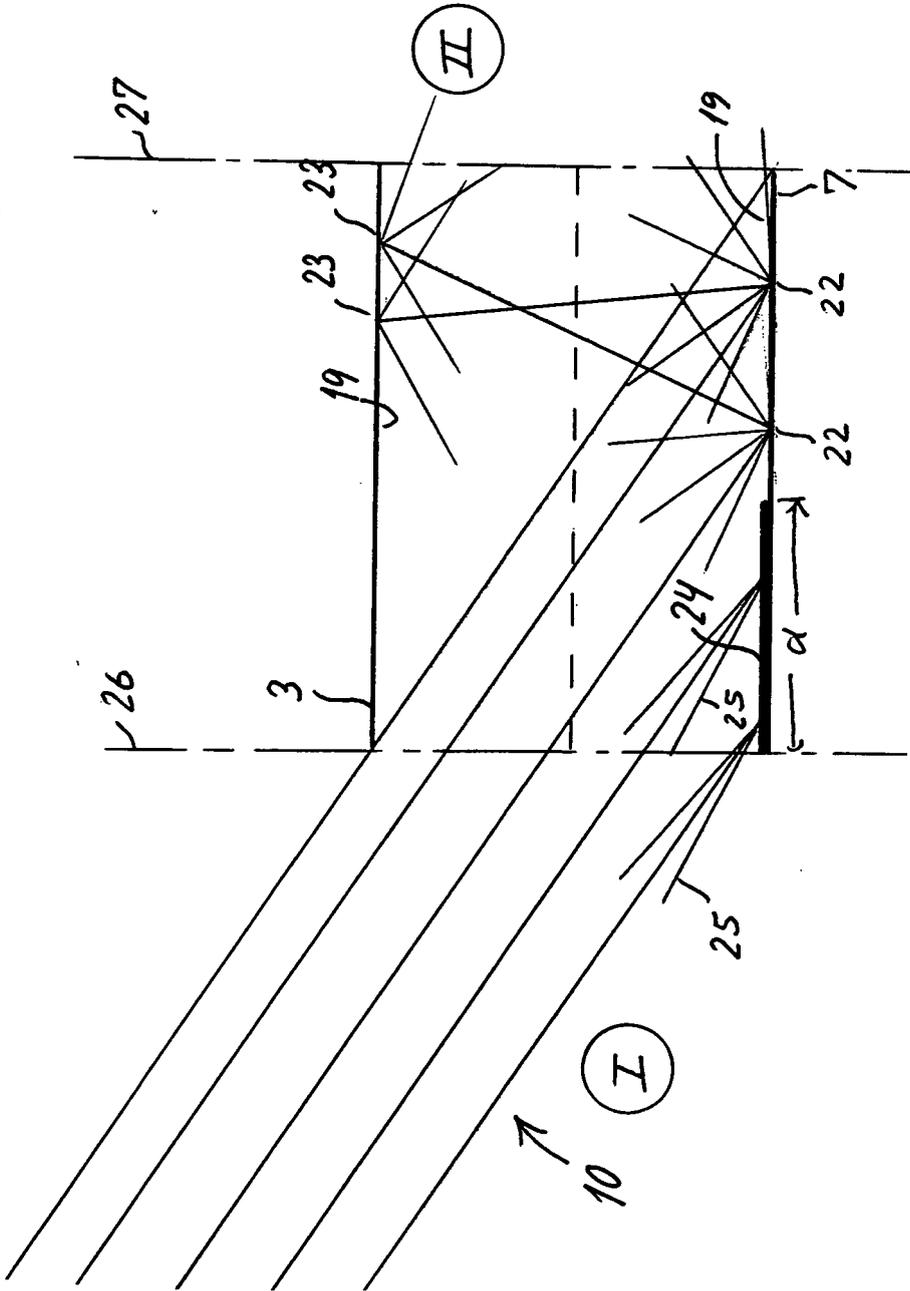


Fig. 7



EUROPEAN SEARCH REPORT

Application Number
EP 09 00 2408

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 July 2009	Examiner Cornu, Olivier
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03/82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 09 00 2408

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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