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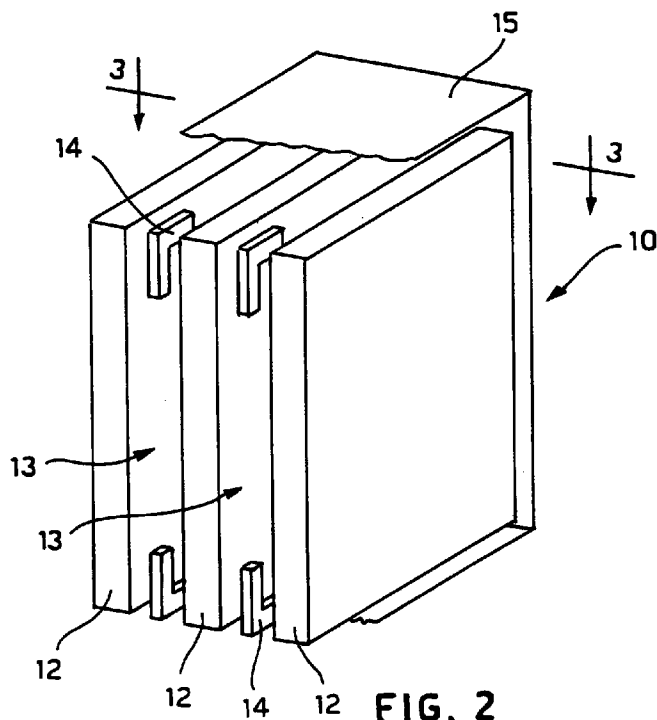
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(54) **Fire-resistant glass barrier**

(57) The fire-resistant glass barrier comprises one or more panels (10), each formed by a set of transparent sheets (12) of vitreous material and arranged parallel in positions spaced apart from one another so as to define sealed chambers (13) free from phase-change material, containing a gas having a thermal conductivity equal to

or less than that of air; the assembly consisting of the sheets (12) and the peripheral sealing means (15) define a modular unit of limited dimensions which can be assembled in a metal frame (11) and in which at least one of the sheets (12) is provided with an infrared-reflecting coating.



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Description

The present invention relates to a transparent, fire and heat resistant barrier, comprising a plurality of transparent sheets or panes of vitreous material, which are parallelly arranged and spaced apart from one another so as to define thermally insulating interspaces, between adjacent glass panes, in a modular unit which can be assembled in a metal support frame.

The expression "transparent sheets of vitreous material" used herein includes any sheet formed of float glass, wired glass, bevelled glass, toughened glass, borosilicate glass, glass-ceramic or a combination thereof, provided that they are suitable for performing fire and heat resistant barriers and/or glazings in civil and industrial buildings or for any other application.

One of the most important aspects when reducing the effects of a fire consists in the possibility of identifying and easily delimiting the areas at risk, so as to be able to contain a possible firing within them, avoiding or delaying spreading of the fire towards surrounding environments.

In the construction of civil, commercial and industrial buildings, containment of a fire is generally achieved by adopting suitable fire resistant barriers, also known as fire-stops, i.e. able to prevent both direct spreading of the flames and overheating of the adjacent environments, avoiding, in this latter case, spreading of the fire as a result of spontaneous ignition caused by the heat irradiated through the barrier itself.

Usually, fire resistant barriers are not transparent and consist of metal panels containing special insulating materials, such as glass wool, ceramic fibers and the like.

Recently, a number of transparent fire-resistant barriers have been developed and marketed, mainly for use in civil and commercial buildings.

Specific safety norms require also that the fire-stop barriers and glazings should generally have a certain degree of fire-resistance, which is determined by suitable experimental tests complying with international standards (ISO 834 and ISO 3009) and/or national standards (UNI 7678, UNI 9723); by these tests it is possible to determine the fire-resistance of a glass element or glazing, in terms of the duration for which the glass element or glazing is able to retain a good mechanical stability and smoke-tightness, normally indicated by RE, or mechanical stability, smoke tightness and good heat insulation, normally indicated by the abbreviation REI. Presently are studying also new norms to take into consideration the following features: mechanical stability, smoke tightness and thermal insulation, the latter for that part relating to radiation heat transmission only; to identify this class of performance, REW is usually used. High values of RE, REW and REI are generally an indication of good performance and good quality of the fire-stop barriers.

In the past wired glass sheets have been widely used to form fire-resistant barriers since wired glass, compared to other types of glass, is able to partly delay

propagation of the smoke and flames. However, glass in general is not effective in preventing heat passing through as a result of irradiation, which alone is able to trigger or propagate a fire beyond the same protection barrier.

In this connection, fire-stop barriers which are able to satisfy to a large extent the requirements of stability, tightness and heat insulation have been devised and marketed, their functioning ability being based on the presence of phase-change materials (PCM), which are for example gel-based and are characterised by the physical phenomenon of transition from one physical state to another one occurring at temperatures of about 90-100°C, in order to maintain these temperatures constant until the phase-change for the entire substance has been completed.

Examples of these fire-resistant glazings or barriers are provided for example in GB-A-2,195,136, EP-A-0,389,291, GB-A-1,604,388 and US-A-3,997,700. In these types of barriers generally use is made of layered glass panels, in which a gel or a layer of phase change material is disposed in close contact between adjacent glass sheets.

These barriers, although they adequately satisfy the fire-resistance requirements nevertheless have the serious drawback that they do not maintain the required transparency during a fire, since the phase change materials tend to become opaque when their critical transition temperature is exceeded. Such a characteristic is therefore extremely negative since it does not allow monitoring of the environment where the fire is developing, resulting in serious danger for the people trapped therein.

In fire-stop barriers of the aforementioned kind it has also been proposed to use an infrared reflecting coating, mainly for the purpose to protect the phase change material between the glass sheets, by reducing the aging effects due to heat sources exposition and solar radiations (see US-A- 4,173,668). Nevertheless, although the use of said infrared reflecting coating allows to improve for a certain amount the fire-withstanding ability this feature is mainly due to the presence of the phase change material between the glass sheets which in the event of a fire prevents the sight through the barrier.

The fact of thus having thermally insulating and fire-resistant barriers which retain their transparency during a fire, therefore satisfies not only factors of an aesthetic nature, but also practical requirements of extreme importance for the safety of human lives at risk during a fire. In fact, the possibility of seeing through the fire-stop barrier for a sufficiently long period of time, even when the barrier itself is directly affected by the flames, allows one to identify any people who are in difficulty and facilitates provision of the necessary assistance.

Therefore, the fire-stop barriers proposed hitherto, and practically in use, do not entirely satisfy the safety standards; furthermore, requirements of an industrial and commercial nature require elimination of the extreme complexity and reduction of the substantially

high costs which are generally associated with such barriers and tend to limit their use.

In fact, the presence of phase-change materials and the said layered structure of the fire-stop barriers which are currently commercially available, impose a series of conditions which must be rigorously observed both during manufacturing and during all the subsequent stages of transportation, storage and installation of the barrier itself. In particular, the fire-stop vitreous glazings previously proposed or commercially available must be made to specification directly at the factory since subsequent processing operations at the installation site are not permitted. They are, moreover, extremely influenced by the thermohygrometric conditions since they tend to become opaque if continuously exposed to solar radiation or other heat sources tending to rise the temperature more than 40-50°C, or deteriorate if placed in damp environments. This attitude is strongly limiting the use in exterior glazings.

Therefore, an object of the present invention is to provide a fire-resistant barrier made of vitreous material which, in addition to satisfying the requirements of classes RE, REW and REI, also retains its transparency in the event of a fire, thus providing a high degree of safety against fires and security for the protected environment.

A further object of the present invention is to provide a fire-resistant barrier as described above which could be used for exterior glazings without any particular limitation in respect to their durability and provided with good values of thermal transmittance.

A further object of the present invention is to provide a fire-resistant barrier as described above which, in addition to having the characteristics of stability, tightness, heat insulation and transparency up to the moment at which its yielding occurs, does not produce smoke with a high optical density or does not produce toxic fumes.

Yet another object of the present invention is to provide a fire-resistant barrier, made of vitreous material, which is constructionally simple, has a relatively low cost and which at the same time enables fire-resistant barriers and glazings of any form and dimensions to be made without the need for subsequent operations, being able to be mounted on a simple metal support structure designed for this purpose.

The above has been made possible by means of a fire-resistant barrier made of vitreous material, having the general features described in the claim 1.

As a result of suitable tests and experiments, it has in fact been established that, by providing a fire-resistant barrier comprising a series of transparent sheets of vitreous material parallelly arranged and spaced apart from one another so as to form tightly closed chambers containing a gas having a thermal conductivity equal to or less than that of the air and by also providing an infrared-reflecting coating on one or both surfaces of at least one of the sheets of the barrier, an effective fire-resistant barrier which is able to satisfy the aforementioned requirements is provided.

The general features of the fire-resistant barrier according to the invention and some preferred embodiments thereof will be described in greater detail hereinbelow with reference to the accompanying drawings, in which:

- Fig. 1 is a front view of a general type glazing formed by a set of modular panels designed to form an anti-fire barrier according to the invention;
- Fig. 2 is a perspective view of a panel according to a first embodiment;
- Fig. 3 is a sectional view along the line 3-3 of Figure 2;
- Fig. 4 is a sectional view along the line 4-4 of Figure 1, for a second embodiment of modular panels suitable for forming a fire-resistant barrier according to the invention.

As shown in Figure 1, according to the invention a fire-resistant barrier is provided, comprising one or more modular panels 10 consisting of transparent vitreous material and assembled in a metal support frame 11 which can be formed in various ways and must satisfy predetermined safety requirements laid down by specific standards.

In particular, according to the example shown in Figures 2 and 3, each modular panel 10 comprises a plurality of glass sheets or panes 12, three in the example shown, parallelly arranged and spaced apart from one another so as to form interspaces or chambers 13 by means of suitable spacers 14 made of unburning material, for example ceramic material.

As initially specified, the sheets 12 can be made with any vitreous material suitable for the purpose and may have any variable thickness from a few millimetres to a few tens of millimetres, for example between 3 and 15 mm depending on the number of sheets which make up the panel, and the application required.

Similarly, the interspaces 13 which are formed between adjacent sheets, in view of the arrangement of the spacers 14 between them, must have a suitable width in relation to the dimensions and thickness of the glass sheets used, as well as in relation to specific heat insulation requirements, as specified below. In general, the thickness and the interspaces 13 between adjacent panes may be of the order of a few millimetres or tens of millimetres, ranging for example between 3 and about 20 mm, or more.

The various glass sheets 12 of each panel 10 which forms a module of the barrier shown in Figure 1 are joined together in a preassembled condition by means suitable for peripherally sealing the interspaces 13 between adjacent sheets, so as to form corresponding tightly closed chambers which can be filled with dehydrated air or with any suitable gas having a thermal conductivity equal to or less than that of the air, so as to improve the fire-withstanding ability and heat insulation characteristics of the barrier, while ensuring the constructional simplicity and low cost of the panel as well as

ease of assembly of the said barrier. Good results were obtained, for example, by making fire-resistant barriers comprising three glass sheets with a thickness of 6 mm, forming two chambers of 6 mm thickness containing air; the panes had dimensions of 50 x 50 cm. Good results were also obtained using argon, krypton, sulphur hexafluoride and mixtures thereof, as the filling gas.

In the example of Figure 2, assembly of the individual glass sheet 12 which make up each panel 10 was obtained by means of an adhesive metal band 15 which was wound peripherally along the entire edge of each panel.

Other systems for assembling the glass sheet in each panel are possible, as for example shown in Figure 4, provided that they are able to provide panels of reduced dimensions having the characteristics of tightness and heat insulation between glass sheets which define sealed chambers 13 containing gas with a low thermal conductivity in accordance with the general features of the present invention.

In the example of Figure 4, each panel 10 consists of two glass sheets 12 separated by a spacer 16 consisting of a metal band which extends on each side along the entire peripheral edge of the panel; dehydrating salts 17 are placed between the spacer 16 and a layer of silicone 18 so as to form a sealed joint along the entire peripheral edge of the chamber 13. The two glass sheets 12 with the spacer 16 are assembled in a metal frame 19, arranging a strip of ceramic paper 20 between the peripheral edge of the sheets 12 and the central contact surfaces of the frame 19, as well as an intumescent felt seal 21 between the edges of the two external faces of each glass sheet 12 and the two hollow lateral sections 22 of the frame 19 of each panel.

As previously mentioned, a sealed chamber 13 is thus formed between two adjacent glass sheets 12, which chamber, according to a feature of the present invention, is filled with any gas or gas mixture having a thermal conductivity equal to or less than that of air, so as to improve the heat insulation and fire-resistance characteristics of the entire panel, depending on the thickness of the chamber 13 the insulating gas contained therein, as well as the reduced overall dimensions and glass mass allowed for a panel according to the invention.

A further feature, in the formation of fire-resistant barriers according to the invention, consists in the provision of a thin layer of a transparent and infrared-reflecting coating, indicated by 23, on one or both surfaces or faces of the glass sheets 12 of the panel, which delimit the chamber or each sealed chamber 13.

Preferably, the infrared-reflecting coating consists of a very thin metal layer, having a thickness of some tens of nanometres, which can be deposited by means of any suitable technique, for example by sputtering, comprising any metal selected from the group consisting of aluminium, copper, gold, silver, platinum, palladium or oxides, in the pure or doped stated of the elements group consisting of: tin, indium, silicon, titanium, zirconium, alu-

minium and tantalum. The choice of the coating metal, of oxide or the doping element will depend on specific requirements and will influence in a more or less decisive manner the reflection characteristics for the infrared radiation depending on the wavelengths of the latter.

In substitution of and/or in combination with a metal coating as indicated above or pure or doped oxides, it is also possible to use nitrides, carbides and/or metal sulphides or similar metal compounds.

It will have been noted that each panel 10 for forming fire-resistant barriers according to the invention is characterised by the presence of several glass panes or sheets arranged at a distance so as to form one or more sealed chambers containing a gas having a thermal conductivity equal to or less than that of air, as well as by the presence of an infrared-reflecting coating on one or both faces of glass sheets which delimit each sealed chamber.

Therefore, the total absence of phase change material between adjacent glass sheets and the absence of any layered structure in the panel enable the latter to maintain perfect visibility and transparency in any condition during the occurrence of a fire, as well as a high structural stability of each panel and the entire barrier, owing to the possibility of forming modular panels even of small dimensions.

Since the metal frame which assembles each panel, or which supports the entire barrier, may constitute a heat transfer point, a phase change material which enables heating of the metal frame itself to be delayed, may be arranged inside the cavities of the tubular sections of the metal frame. Finally, assembly of the sections or of the individual panels which make up the barrier may be performed with any suitable means, for example by means of screws which enable rapid assembly and easy disassembly of the entire structure or part thereof.

The fire-resistant barrier may be formed in a modular manner using glass sheets of any geometrical shape, for example square, rectangular or polygonal, having limited dimensions, for example with sides having a length ranging between 30 and 50 cm, increasing in this manner the structural stability of the glass panes which, the other conditions being equal, result in a further improvement in the fire-withstanding ability of the entire barrier.

From that stated and illustrated in the examples of the accompanying drawings it will therefore have been understood that a fire-resistant barrier has been provided, in which no use is made of phase change material and which, therefore, is not subject to the limitations arising from the use of such materials; furthermore, in view of the modularity of the individual panels, each of which has optimum stability, fire-insulation, heat-insulation and transparency characteristics, the formation of fire-resistant barriers or glazings is extremely simplified in that large-size glazings or barriers may also be obtained from modules which use normal glass formats, performing normal standard-technology operations which are entirely similar to those commonly used in the glass industry. Therefore, during handling, transportation and

storage, as well as installation of the various panels, no special precautionary measures are required, apart from those strictly required for such categories of materials. In all cases the result is a barrier or glazing which, under the same conditions of RE, REW or REI is less costly and more reliable than conventional barriers or glazings.

Claims

1. Fire-resistant barrier comprising one or more panels (10) each panel having a set of sheets (12) in transparent vitreous material said vitreous sheets being parallelly arranged and spaced apart from one another in a metal support frame (11), characterised in that spacers (14, 16) and sealing means (15, 18) are provided along the peripheral edges between the sheets (12) of the panel, to define a sealed or tightly chamber (13) free-from phase change material between adjacent sheets (12);
 in that said sealed chambers (13) are filled with a gas having a thermal conductivity equal to or less than that of air;
 and in that an infrared-reflecting coating (23) is provided on one or both lateral surfaces of at least one of the sheets (12) of the panel (10).
2. Fire-resistant barrier according to Claim 1, in which the sheets (12) of vitreous material of each panel (10) are assembled by means of a frame (19) consisting of hollow metal sections, characterised in that said cavities (22) of the assembly frame (19) contain a phase-change substance which delays heating of the metal frame for assembly of the said panel.
3. Fire-resistant barrier according to Claim 1, characterised in that a layer (21) of intumescent material is arranged between the edge of each glass sheet (12) and the opposing surface of the metal frame (19) for assembly of the panel (10).
4. Use of a fire-resistant barrier according to any preceding claim to perform exterior and/or interior glazings.
5. Fire-resistant barrier according to Claim 1, characterised in that said infrared-reflecting coating (23) comprises a metal selected from the group consisting of: aluminium, copper, gold, silver, platinum and palladium.
6. Fire-resistant barrier according to Claim 1, characterised in that the infrared-reflecting coating (23) consists of oxides in the pure or doped state of the elements selected from the following group: tin, indium, silicon, titanium, zirconium, aluminium and tantalum.
7. Fire-resistant barrier according to Claim 1, characterised in that said infrared-reflecting coating (23) comprises nitrides, carbides and/or metal sulphides.
8. Fire-resistant barrier according to Claim 1, characterised in that said gases for filling the sealed chambers (13) are chosen from the group comprising air, argon, krypton, sulphur hexafluoride or mixtures thereof.
9. Fire-resistant barrier according to any of the preceding claims, characterised in that the panes (12) of vitreous material of each panel (10) have a thickness ranging between 3 and 15 mm and in that the sealed chambers (13) have a thickness ranging between 3 and 20 mm.
10. Fire-resistant barrier according to any one of the preceding claims, characterised in that each panel (10) of the barrier has modular dimensions equal to or less than those of the normal formats of glass.
11. Fire-resistant barrier according to Claim 10, characterised in that each modular panel (10) is composed of glass sheets (12) having square, rectangular or polygonal geometrical shape, and side dimensions ranging between 30 and 50 cm.

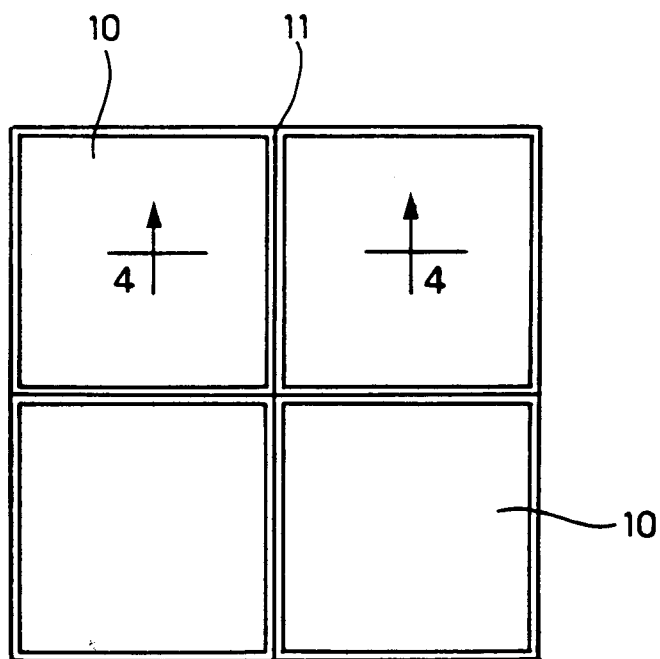


FIG. 1

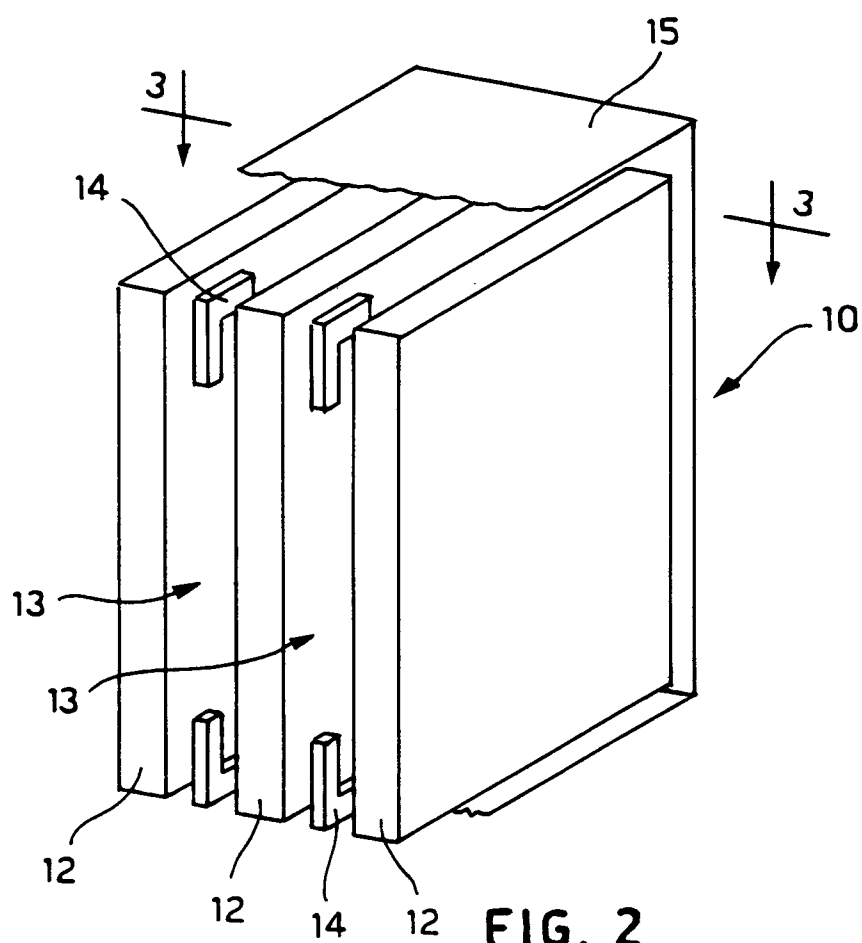


FIG. 2

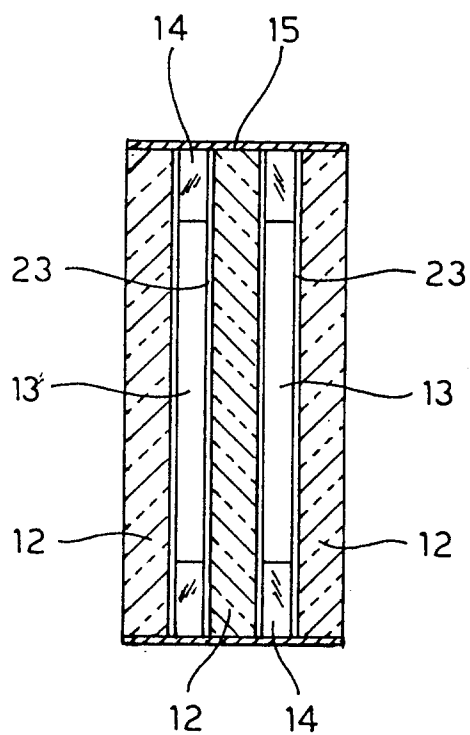


FIG. 3

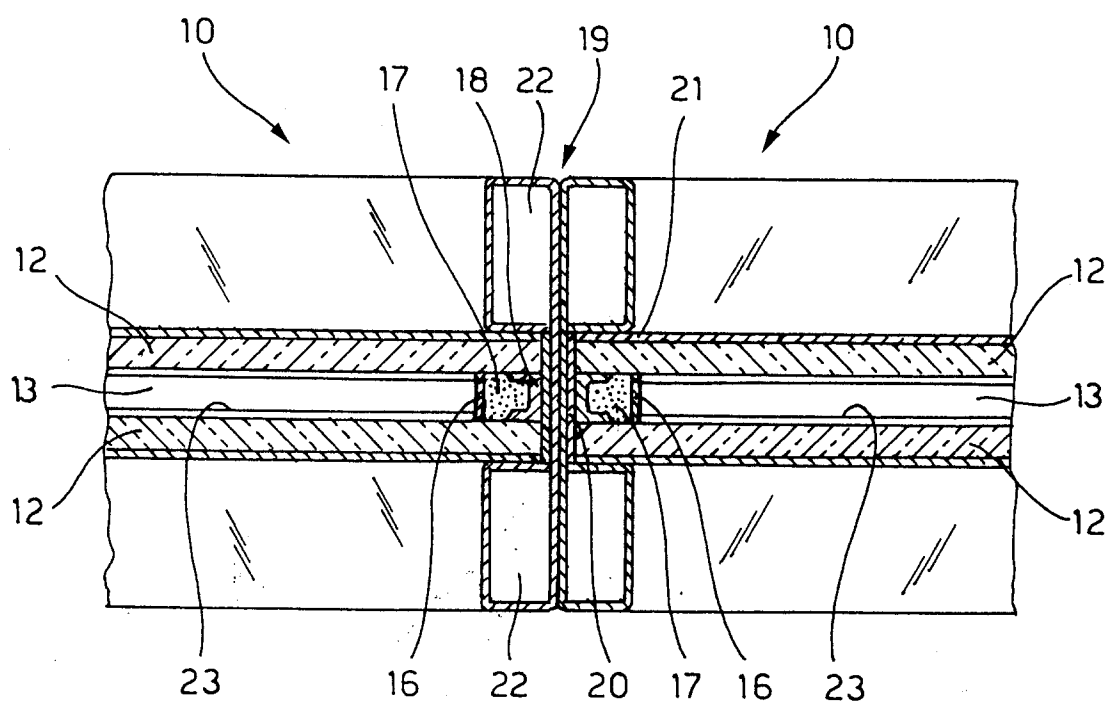


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 95 11 4952

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	EP-A-0 608 457 (SCHOTT GLASWERKE) * column 1, line 1 - column 6, line 11 * ---	1,4-7,10 2,3	E06B5/16 E06B3/67
X	FR-A-2 309 680 (FIRMA JENAER GLASWERK SCHOTT & GEN) * page 3, line 1 - page 8, line 35 * * page 10, line 21 - page 11, line 11 * * figure 1 * ---	1,4-6, 8-11	
X	EP-A-0 499 868 (FLACHGLAS AG) * line 1 - column 54, line 2; figure 8 * * column 3, line 44 - column 7, line 9 * * figures * ---	1,4-8	
X	DE-A-90 14 083 (V. KANN RASMUSSEN INDUSTRI A/S) * page 3, line 3 - page 8, line 21; figure * ---	1,4-6,8	
Y	DE-A-38 40 232 (SOMMER METALLBAU-STAHLBAU) * column 2, line 9 - column 4, line 53; figure * ---	2	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
Y	GB-A-2 212 546 (BRIGGS AMASCO) * page 7, paragraph 4; figure 2 * ---	3	E06B
D,A	US-A-4 173 668 (HENTZELT ET AL) * column 1, line 6 - column 3, line 47 * * column 6, line 20 - column 10, line 2 * * figures * ---	1,4-9	
P,X	DE-A-43 31 263 (BISCHOFF GLASTECHNIK) * page 2, line 3 - page 3, line 63 * * page 4, line 18 - line 53 * * figure * -----	1,4-6, 8-10	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 3 January 1996	Examiner Depoorter, F
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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