(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 808 163 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
03.12.2014 Bulletin 2014/49

(21) Application number: **12874187.3**

(22) Date of filing: **11.04.2012**

(51) Int Cl.:
B32B 17/06 *(2006.01)* ***E06B 5/16*** *(2006.01)*

(86) International application number:
PCT/CN2012/073810

(87) International publication number:
WO 2013/152484 (17.10.2013 Gazette 2013/42)

(84) Designated Contracting States:
AL 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 RS SE SI SK SM TR

(71) Applicants:
- **Qiu, Li**
  Jilin 132021 (CN)
- **Li, Yanhua**
  Beijing 102615 (CN)

(72) Inventors:
- **Qiu, Li**
  Jilin 132021 (CN)
- **Li, Yanhua**
  Beijing 102615 (CN)

(74) Representative: **Elzaburu Marquez, Alberto**
Elzaburu S.L.P.
Miguel Angel, 21
28010 Madrid (ES)

(54) **COMPOSITE FIREPROOF GLASS, MANUFACTURING METHOD THEREOF AND CURTAIN**

(57) The invention provides a compound fireproof glass, a method for manufacturing a compound fireproof glass, and a curtain. The compound fireproof glass of the invention comprises: a first glass substrate; a second glass substrate provided in parallel with the first glass substrate; a connecting portion connected with the first glass substrate and the second glass substrate; a cavity provided between the first glass substrate and the second glass substrate; wherein the compound fireproof glass further comprises: a thermal expansion portion which is an approximately uniformly distributed structure made from a thermal expansion material, and partially fills the cavity. The compound fireproof glass according to the invention has superior fireproof performance, light weight and high transmittance.

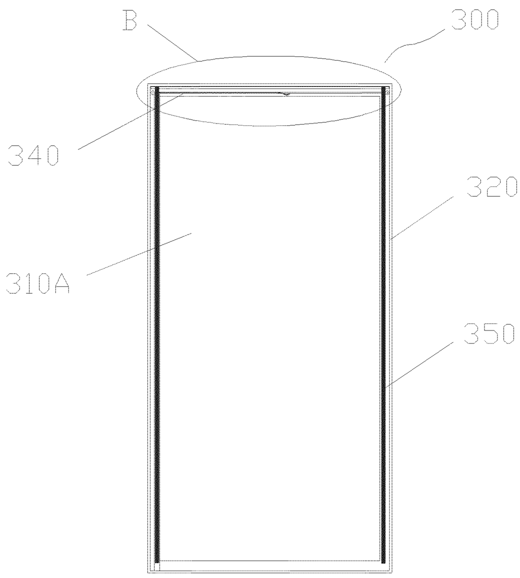

Fig. 4

EP 2 808 163 A1

Description

Field of the Invention

[0001] The invention relates to the field of fireproof glass, and in particular to a compound fireproof glass, a manufacturing method for compound fireproof glass, and a curtain.

Background of the Invention

[0002] In the prior art, the compound fireproof glass is made from two or more layers of glass chips compounded with water-solubility inorganic sandwich fireproof glue. The compound fireproof glass meets the requirements of both fire integrity and fire insulation. The fireproof principle of the compound fireproof glass is: when the fire broke out, the special transparent chemicals in the middle of the compound insulated fireproof glass absorb a great amount of heat from the flame to foam and expand, and become opaque white at the same time, which efficiently prevents the heat generated by burning from transferring from the heated surface to the unexposed surface, and also prevents thermal radiation of the flame on the heated surface of the glass from conducting to the unexposed surface. In this process, the entire glass remains intact, and forms an effective barrier for blocking diffusion and spread of flame, smoke, and high-temperature toxic gas generated by burning. The function of thermal insulation and anti-heat radiation of the compound fireproof glass enables the escape personnels or rescuers within the unexposed area of the glass to be protected from being hurt by the high-temperature heat and the thermal radiation, when the fire broke out, and also prevents the combustible materials and items within the area, such as wood products and carpet, from being ignited by the high temperature and the thermal radiation within a certain period.

[0003] Due to the impacts of stability of raw materials and manufacturing process, the compound fireproof glass in the prior art has the following main problems in use:

1. In daily use, due to temperature change in four seasons and sunlight irradiation, the phenomenon that the fireproof glue becomes white and emulsified usually occurs, which affects the transparence of the glass. Another typical problem is that fine bubbles appeared in the glue layer of the glass, often develop into big bubbles and affect the transparence of the glass.
2. The thickness of the compound insulated fireproof glass in the art is at least tens of millimetres, even up to or more than 100 millimetres. Thus, the compound fireproof glass is very heavy. According to the thickness, the weight per square meter of the common compound fireproof glass in market is 60kg to 90kg, even more. Thus, high load-bearing requirements are imposed upon the fireproof framework and the corresponding building structure for installing the glass, and also, much adverse effects will be brought to the logistics operations.
3. Due to the complicated and demanding manufacturing process, the relatively long manufacturing cycle and the high cost of logistics resulted from the great dead weight, the compound insulated fireproof glass in the art is very expensive. Taking the European market for example, the price of the compound insulated fireproof glass is about 400-800 euroes per square meter.
4. Since the compound insulated fireproof glass itself does not have a central cavity being similar to the hollow glass, the thermal conductivity thereof is higher, close to twice that of the ordinary hollow glass.
5. Thickness tolerance of the compound fireproof glass in the art is very difficult to be controlled because of compound process and raw materials, and is controlled at about ± 3mm by the common manufacturers in the market. Therefore, the requirement on frame installation structure is higher, the installation man-hour is wasted, and the installation cost rises.
6. Due to the particularity of structure, transmittance of the compound fireproof glass in the art is only up to 70%-85%, and even that of some domestic products is only 60%.

Summary of the Invention

[0004] The purpose of the invention is to provide a compound fireproof glass, a method for manufacturing a compound fireproof glass, and a curtain, which have good fireproof performance, light weight and high transmittance,.

[0005] The invention provides a compound fireproof glass comprising: a first glass substrate; a second glass substrate provided in parallel with the first glass substrate; a connecting portion connected with the first glass substrate and the second glass substrate; a cavity provided between the first glass substrate and the second glass substrate; wherein the compound fireproof glass further comprises: a thermal expansion portion which is an approximately uniformly distributed structure made from a thermal expansion material, and partially fills the cavity.

[0006] Further, the thermal expansion portion is made from expandable graphite or a product containing expandable graphite.

[0007] Further, the first glass substrate is a monolayer or multilayer fireproof glass substrate; the second glass substrate is a monolithic tempered glass substrate, a monolayer or multilayer fireproof glass substrate, a monolayer filmed glass substrate, a coated glass substrate, or a compound glass substrate with at least two layers.

[0008] Further, the compound fireproof glass further comprises a sealing portion provided in the edge of the cavity for sealing the cavity.

[0009] Further, the thermal expansion portion is directly and fixedly arranged in the cavity.

[0010] Further, the thermal expansion portion is located at the edge and/or in the center of the cavity.

[0011] Further, the thermal expansion portion forms an approximately uniform pattern in the cavity, preferably, forms a grid-like, dot-like or petal-like pattern.

[0012] Further, the thermal expansion portion is movably arranged in the cavity.

[0013] Further, the thermal expansion portion is curtain-like, which is folded and accommodated at the edge and/or in the center of the cavity at normal temperature.

[0014] Further, the compound fireproof glass further comprises a driving device which changes the thermal expansion portion from a storage state to an expanded state when the compound fireproof glass contacts with fire.

[0015] Further, the thermal expansion portion is provided in the left side and/or the right side of the cavity, and the driving device comprises: a supporting rod provided in the upper portion of the cavity; rollers for winding traction line, wherein two parallel rollers for winding traction line are provided in the left end and the right end of the cavity respectively and below the supporting rod; a traction line annularly wound on the two rollers for winding traction line; a plurality of connecting rings, the upper portions of which are slidably provided on the supporting rod, lower portions of which are uniformly distributed and in connection with the upper portion of the thermal expansion portion, and central portions of which are uniformly distributed and fixedly connected with the traction line; and a driving member connected with the traction line for pulling the traction line.

[0016] Further, the driving member is a memory alloy wire, comprising a first end and a second end opposite to each other, the first end is fixedly connected with the first glass substrate or the second glass substrate, and the second end is fixedly connected with the traction line.

[0017] Further, the memory alloy wire is located in the intermediate position of the upper portion of the cavity; the traction line comprises a first traction portion and a second traction portion on two sides of a plane formed by the axises of the two rollers for winding traction line; and the thermal expansion portion and the plurality of connecting rings connected with the thermal expansion portion are respectively provided on the left side and the right side of the memory alloy wire, the plurality of connecting rings on the left side are fixedly connected with the first traction portion, and the plurality of connecting rings on the right side are fixedly connected with the second traction portion.

[0018] Further, the memory alloy wire has a straight line at normal temperature and becomes a spring shape under 80°C to 120°C.

[0019] Further, the compound fireproof glass further comprises an accommodating case provided in a corresponding side of the cavity where the thermal expansion portion is folded and accommodated, the accommodating case is closed at normal temperature to accommodate the folded thermal expansion portion, and opened in case of fire to expand the folded thermal expansion portion.

[0020] Further, the accommodating case comprises: a case body with a rectangular section; a spring hinge; and a cover towards the inner side of the cavity and pivotally provided on a side surface of the case body which is on the side of the second glass substrate via one or more spring hinges, the cover is connected with a side surface of the case body which is on the side of the first glass substrate via one or more hot melt adhesive seal points at normal temperature.

[0021] The invention further provides a manufacturing method of compound fireproof glass comprising the following steps: a. providing a first glass substrate and a second glass substrate, and forming a cavity between the first glass substrate and the second glass substrate; b. providing a thermal expansion portion in the cavity and making the cavity partially filled with the thermal expansion portion, making the thermal expansion portion from a thermal expansion material with an approximately uniformly distributed structure; and c. connecting the first glass substrate and the second glass substrate as an integral structure.

[0022] Further, the step b comprises: directly and fixedly arranging the thermal expansion portion in the cavity.

[0023] Further, the step b comprises: movably arranging the thermal expansion portion (330) in the cavity.

[0024] The invention further provides a curtain, wherein the curtain is made from a thermal expansion material.

[0025] The compound fireproof glass according to the invention has good fireproof performance because the thermal expansion portion, formed by the thermal expansion material and partially filled between the substrates of the double layers glass, can rapidly expand in case of high temperature and form a fire resistance layer. Moreover, as the cavity between the double layers of glass is not completely filled at normal temperature, the compound fireproof glass has lighter weight and good transmittance.

[0026] The invention preferably employs a thermal expansion portion made from expandable graphite or something containing expandable graphite. The expandable graphite has the characteristic of rapid expansion when heated, can rapidly expand by several to tens of times in case of fire, and can rapidly expand to fill the entire cavity of the compound fireproof glass to form a fire resistance layer and prevent the spread of flame and smoke. The expandable graphite has a very small thermal conductivity and has good thermal stability, and can effectively block the transfer of heat. As the expandable graphite has small density, expands rapidly when heated and has a great expansion capacity, the compound fireproof glass just needs a small volume of expandable graphite, compared with other materials, it is more advantageous to reduce the weight of the compound fireproof glass and increase the transmittance of the compound fireproof glass.

Brief Description of the Drawings

[0027] The accompanying drawings constituting a part of the application are used to provide a further understanding of the invention. The exemplary embodiments and the description thereof are used to explain the invention without unduly limiting the scope of the invention. In the accompanying drawings:

Fig. 1 shows a structural view of the compound fireproof glass according to the first embodiment of the invention;
Fig. 2 shows an A-A structural view of Fig. 1;
Fig. 3 shows a structural view of the compound fireproof glass according to the second embodiment of the invention;
Fig. 4 shows a structural view of the compound fireproof glass according to the third embodiment of the invention, in which the thermal expansion portion is in a storage state;
Fig. 5 shows a partial enlarged structural view of part B in Fig. 4;
Fig. 6 shows a partial enlarged structural view of part C in Fig. 5;
Fig. 7 shows a 3D structural view of the accommodating case in the compound fireproof glass according to the third embodiment of the invention;
Fig. 8 shows a side structural view of the compound fireproof glass in Fig. 4;
Fig. 9 shows a structural view of the compound fireproof glass according to the third embodiment of the invention, in which the thermal expansion portion is in an expanded state;
Fig. 10 shows a partial enlarged structural view of part D in Fig. 9;
Fig. 11 shows a partial enlarged structural view of part E in Fig. 10;
Fig. 12 shows a partial structural view of a driving device of the compound fireproof glass according to the third embodiment of the invention; and
Fig. 13 shows a structural side view of the compound fireproof glass in Fig. 9.

Detailed Description of the Embodiments

[0028] The invention will be described hereinafter in detail with reference to the drawings and embodiments. It shall be understood that the embodiments of the application and the features of the embodiments can be combined with each other if there is no conflict.

[0029] The invention provides a compound fireproof glass, comprising: a first glass substrate; a second glass substrate provided in parallel with the first glass substrate; a connecting portion connected with the first glass substrate and the second glass substrate; a cavity provided between the first glass substrate and the second glass substrate. The compound fireproof glass further comprises a thermal expansion portion which is an approximately uniformly distributed structure made from a thermal expansion material, and partially fills the cavity.

Glass Substrate

[0030] At least one of the first glass substrate and the second glass substrate is a heated surface glass substrate, which should be fire-resistant and should not be deformed or damaged at high temperatures, and could be a monolayer or multilayer (more than two layers) fireproof glass substrate. Generally, one of the two glass substrates is a heated surface glass substrate, and the other is an unexposed surface glass substrate, and according to the requirements, both of the two glass substrates could be heated surface glass substrates. The unexposed surface glass substrate could be selected from a monolithic tempered glass substrate, a monolayer or multilayer fireproof glass substrate, a monolayer filmed glass substrate, a coated glass substrate, or a compound glass substrate with at least two layers.

Connection Portion

[0031] In the invention, the connecting portion connects the first glass substrate with the second glass substrate, and the connecting portion could select any suitable connection member to make the two substrates connected. In one embodiment, the connecting portion is a spacer sandwiched and sticked between edge positions of the two glass substrates, for example, the spacer could be a glass plate or metal framework, and so on, or could be a clip clipping at the outer edge of the two glass substrates. The connecting portion can seal the cavity between the two glass substrates while making the two glass substrates connected. The connecting portion could only have the connection function but the sealing function, in the case, the cavity could be non-hermetic.

Sealing Portion

[0032] The compound fireproof glass could further comprise a sealing portion, which is provided in the edge of the cavity for sealing the cavity. In one embodiment, the connecting portion could also serve as the sealing portion.

Thermal Expansion Portion

[0033] The thermal expansion portion contains a thermal expansion material, preferably volume of which can at least expand 1.5 times than its original volume at 100-200°C, and volume of which, at a temperature of above 200°C, can rapidly expand several, dozen, or even tens or hundreds of times than its original volume with the rise of the temperature.

[0034] The thermal expansion portion has a very small volume before heated, and is in the partial location of the cavity of the double-layer glass, for example, within an area 20mm far away from the edge. After the heated surface glass substrate of the compound fireproof glass contacts with fire and the temperature rises, the volume of thermal expansion portion rapidly expands and fills the entire cavity of the double-layer glass to form a fire resistance layer. As the fire resistance layer formed by the thermal expansion portion has a very small thermal conductivity and is opaque, it can effectively insulate thermal radiation, thermal convection and thermal conduction.

[0035] The thermal expansion material for forming the thermal expansion portion could be hydrated alkali metal silicate, such as sodium silicate, or organic thermal expansion material, such as polyurethane polyfoams, and so on. However, more preferably, the thermal expansion material could be expandable graphite. The expandable graphite has the characteristic of rapid expansion when heated, can rapidly expand by several to tens of times in case of fire, and can rapidly expand to fill the entire cavity of the compound fireproof glass and form a fire resistance layer, to prevent the spread of flame and smoke. Compared with the common glass interlayer materials in the prior art, the expandable graphite has a small density, expands rapidly when heated and has a great expansion volume. Therefore, only a small volume of expandable graphite is needed, compared with other materials, which is more advantageous to reduce the weight of the compound fireproof glass and increase the transmittance of the compound fireproof glass.

[0036] By means of experiments, the inventor of the invention unexpectedly found that the effect of using expandable graphite is superior to that of using hydrated alkali metal silicate or polyurethane polyfoams to a great extend, which will be proved by the experimental results provided in the first embodiment. When used, the expandable graphite can be directly fixed between the two glass substrates. It should be noted that, the thermal expansion portion could also be made from a product containing expandable graphite, for example, expansion strips formed by expandable graphite as the main raw material in combination with fireproof glue.

[0037] In one embodiment, the thermal expansion portion is located at the edge and/or in the center of the cavity.

[0038] In another embodiment, the thermal expansion portion forms a pattern which is substantially uniformly distributed in the cavity, preferably, forms a grid-like pattern in the cavity, or forms the patterns, such as a dot-like, petal-like or snowflake-like, and so on.

[0039] In still another embodiment, the thermal expansion portion is movably arranged in the cavity. Wherein the thermal expansion portion is curtain-like, and forms a curtain of the thermal expansion material, which is folded and accommodated at the edge and/or in the center of the cavity at normal temperature.

[0040] The compound fireproof glass preferably further comprises a driving device, which changes the curtain of the thermal expansion material from a storage state to an expanded state when the compound fireproof glass contacts with fire.

[0041] The thermal expansion portion in the form of a curtain may be only provided in the upper portion of the cavity. Taking a curtain in the form of shutter for example, a plurality of parallel curtain strips is connected together via a connecting thread. One end of the connecting thread is fixed in the upper portion of the cavity, and the plurality of curtain strips are stacked and accommodated in the upper portion of the cavity through a fixed release member. When the fixed release member is opened, the plurality of curtain strips falls down under the effect of their own gravity, and forms an expanded curtain. The fixed release member, for example, a thin wire or a memory alloy wire, ties the plurality of stacked curtain strips together, and in case of fire, the thin wire or memory alloy wire can automatically release the curtain strips under the effect of temperature variation. Specifically, the fixed point of the thin wire can be broken automatically to release the curtain strips when the temperature rises to a certain temperature, and the memory alloy wire can change from an expanded state to a contracted state under the effect of temperature. The fixed release member may also adopt a buckle structure, for example, the left side and the right side of the upper portion of the cavity are respectively provided with a buckle. Under normal conditions, the buckles block the plurality of stacked curtain strips, and in case of fire, the buckles are disengaged to release the plurality of stacked curtain strips, thus the curtain strips fall down and become expanded. In another example, an accommodating case to be described in detail in the third embodiment can also serve as a fixed release member. Under normal conditions, the curtain strips are folded and accommodated in the accommodating case, and in case of fire, a cover of the accommodating case is automatically opened, and the curtain strips fall down and are expanded. According to the above description, in the case where the thermal expansion portion is only provided in the upper portion of the cavity, the driving device may not be provided.

[0042] The curtain of the invention contains the thermal expansion material or is made from the thermal expansion material. Besides the form of shutter as described above, the curtain can also be in the form of a full curtain or a hollow curtain. It is required that the curtains with above forms can be foldablely provided.

[0043] The driving device of the invention changes the thermal expansion portion from the storage state to the expanded state, when the compound fireproof glass contacts with fire. Unrestricted by the embodiments, the driving device could also adopt other structures or manners besides the embodiments, its power could be provided in the manner of power in the prior art, such as a spring, a rubber band, a gravity structure, and a motor. It is only necessary to provide a trigger mechanism, such as a memory alloy or a sensor, which provides power for the driving device in case of fire so as to change the curtain-like thermal expansion portion from the storage state to the expanded state. In addition, the driving device can also use a temperature sensor, an optical sensor or the like as a drive signal, and a battery as the driving power to drive the movable thermal expansion portion. It is also feasible to provide the power part of the driving device outside the cavity, and only provide a curtain, a necessary traction device, and so on in the cavity.

[0044] The thermal expansion portion can be provided in the left side and/or the right side of the cavity, or in the center of the cavity. When the thermal expansion portion is provided in the center of the cavity, the curtain can expand towards the left and right directions.

[0045] In one embodiment, the driving device comprises: a supporting rod provided in the upper portion of the cavity; rollers for winding traction line provided on the left and right ends, and/or the right end of the cavity, and located below the supporting rod; a traction line annularly wound on the rollers for winding traction line; a plurality of connecting rings, the upper portions of which are slidably provided on the supporting rod, and the lower portions of which are in connection with the upper portion of the thermal expansion portion. The connecting rings are connected with the traction line fixedly. The traction line is connected with a driving member fixedly, and the driving member can pull the traction line, and further drive the curtain-like thermal expansion portion to change from the storage state to the expanded state. In one embodiment, the driving member is a memory alloy wire, comprising a first end and a second end opposite to each other, the first end is connected with the first glass substrate or the second glass substrate fixedly, and the second end is connected with the traction line fixedly. The memory alloy wire is in a straight line at normal temperature and in a spring shape under 80°C to 120°C.

[0046] The invention further provides a manufacturing method for compound fireproof glass, comprising the following steps: a. providing a first glass substrate and a second glass substrate, and forming a cavity between the first glass substrate and the second glass substrate; b. providing a thermal expansion portion in the cavity and making the cavity partially filled with the thermal expansion portion, making the thermal expansion portion from a thermal expansion material with an approximately uniformly distributed structure; and c. connecting the first glass substrate and the second glass substrate as an integral structure. Preferably, the step b comprises: directly and fixedly arranging the thermal expansion portion in the cavity, or movably arranging the thermal expansion portion in the cavity.

[0047] In addition, the invention and all the embodiments thereof are not limited to a compound fireproof glass with two layers of glass, but are applicable to a compound fireproof glass with at least three layers of glass. Moreover, the shape of the invention and all the embodiments thereof are not limited to a rectangle, but could also be a circular, a parallelogram, or a polygon with at least five sides.

[0048] The invention further provides a curtain made from the thermal expansion material. Preferably, the curtain comprises a plurality of curtain strips that are made from the thermal expansion material.

Embodiments

[0049] The left side and the right side in the invention are the directions viewed from the heated side to the unexposed side.

The first embodiment

[0050] As shown in Figs. 1-2, the compound fireproof glass 100 in the first embodiment is a rectangular compound fireproof glass with substantially parallel double layers of glass substrates, which mainly comprises a heated surface glass substrate 110A, an unexposed surface glass substrate 110B, and a connecting portion 120 for connecting the edge portions of the heated surface glass substrate 110A with the edge portions of the unexposed surface glass substrate 110B. The connecting portion 120 may adopt a glass strip, the glass strip is provided on the outside of the edges of the two layers of glass substrates 110A and 110B, and they are integrated by means of sticking with inorganic fireproof glue. The heated surface glass substrate 110A, the unexposed surface glass substrate 110B and the connecting portion 120 define the cavity. The thermal expansion material partially fills the edges of the cavity, and thereby a thermal expansion portion 130 is formed. As shown in Fig. 1, the thermal expansion portion 130 is a strip-like structure made from the thermal expansion material, and the strip-like structure is located in the left, right upper and lower sides of edges of the compound fireproof glass 100, and is directly fixed between the heated surface glass substrate 110A and the unexposed surface glass substrate 110B.

[0051] Refer to the data in Table 1 and Table 2, it has been demonstrated by experiments that expandable graphite has superior performance. Therefore, in the first embodiment and the following other embodiments, only the thermal expansion portion made form expandable graphite is taken as an example to describe the compound fireproof glass of the invention.

[0052] In the first embodiment, the unexposed surface glass substrate 110B of the double-layer glass adopts the conventional tempered glass with the thickness of 6MM or other. The ordinary tempered glass can withstand the thermal shock of temperature variation of over 200°C, and therefore, the unexposed surface glass substrate 110B adopting a monolayer tempered glass will not be broken under thermal shock. Of course, in order to ensure the strength of the unexposed surface glass substrate 110B in case of fire, a monolithic fireproof glass substrate, a monolayer filmed or coated glass substrate, or a double-layer or multilayer compound glass substrate can also be used as the unexposed surface glass substrate 110B. The heated surface glass substrate 110A preferably uses a fireproof glass substrate which may be ordinary monolayer or multilayer fireproof glass sold in the market. The fireproof glass substrate can ensure maintenance of fire integrity of the compound fireproof glass and insulation of naked flame, and toxic and harmful gas from the heated surface in a certain time, in order to ensure that there is sufficient time for the thermal expansion material layer 130 to fill the entire cavity so as to form a fire resistance layer.

[0053] Refer to Table 1 and Table 2, according to eight fireproof experiments on the compound fireproof glass, the thermal expansion portion of which is made from different thermal expansion materials, when the thermal expansion portion is made from expandable graphite, as long as the manufacturing process and product quality meet the requirements, and the experiment lasts for at least 90 minutes under the condition that the temperature of the heated surface is 1000-1100°C, it can be ensured that the highest temperature rise of the unexposed surface is no more than 180°C and the average temperature rise is no more than 140°C, which can meet or be superior to Chinese national standards or European standards for fireproof glass.

[0054] In the contrast experiments, the glass substrates of the compound fireproof glasses use the same material, the size is 800mm × 1000mm, the distance between the first glass substrate and the second glass substrate is 25mm, all the thermal expansion portions are arranged in the edges of the cavity, and located at the position which is less than 25mm away from the edge of the cavity. The thermal expansion portions are respectively made from sodium silicate, polyurethane polyfoams and expandable graphite. The comprehensive results of the contrast experiments demonstrate that expandable graphite has superior physical properties and fireproof performance to sodium silicate and polyurethane polyfoams.

Table 1: Comparison table of physical properties of compound fireproof glasses with thermal expansion portions made from different materials

Material of thermal expansion portion	Weight per square meter (unit: kg/m^2)	Visible transmittance (unit: %)
sodium silicate	40	78
polyurethane polyfoams	40	76
expandable graphite	35	77

Table 2: Comparison table of fireproof performance of compound fireproof glasses with thermal expansion portions made from different materials

Experiment number	Material	Filling time (unit: minute) and filling degree (unit: percent)	Time of the unexposed surface being overtemperature (the highest temperature rise exceeds 180°C or the average temperature rise exceeds 140 °C) (unit: minute)
1	sodium silicate	25 minutes, percent of filling is 15%	25 minutes
	polyurethane polyfoams	40 minutes, percent of filling is 95%	40 minutes
	expandable graphite	15 minutes, percent of filling is 100%	91 minutes
2	sodium silicate	,20 minutes, percent of filling is 18%	20 minutes
	polyurethane polyfoams	19 minutes, percent of filling is 95%	19 minutes
	expandable graphite	19 minutes, percent of filling is 100%	99 minutes
3	sodium silicate	23 minutes, percent of filling is 25%	23 minutes
	polyurethane polyfoams	31 minutes, percent of filling is 99%	31 minutes
	expandable graphite	11 minutes, percent of filling is 100%	101 minutes
4	sodium silicate	15 minutes, percent of filling is 14%	15 minutes
	polyurethane polyfoams	25 minutes, percent of filling is 95%	25 minutes
	expandable graphite	12 minutes, percent of filling is 100%	122 minutes
5	sodium silicate	10 minutes, percent of filling is 9.5%	10 minutes
	polyurethane polyfoams	38 minutes , percent of filling is 95%	38 minutes
	expandable graphite	18 minutes, percent of filling is 100%	98 minutes
6	sodium silicate	27 minutes, percent of filling is 19%	27 minutes
	polyurethane polyfoams	34 minutes, percent of filling is 75%	34 minutes
	expandable graphite	11 minutes, percent of filling is 100%	96 minutes
7	sodium silicate	21 minutes, percent of filling is 17%	21 minutes
	polyurethane polyfoams	35 minutes, percent of filling is 100%	35 minutes
	expandable graphite	10 minutes, percent of filling is 100%	90 minutes

(continued)

Experiment number	Material	Filling time (unit: minute) and filling degree (unit: percent)	Time of the unexposed surface being overtemperature (the highest temperature rise exceeds 180°C or the average temperature rise exceeds 140 °C) (unit: minute)
8	sodium silicate	8 minutes, percent of filling is 11%	8 minutes
	polyurethane polyfoams	45 minutes, percent of filling is 99%	45 minutes
	expandable graphite	14 minutes, percent of filling is 100%	92 minutes

[0055] In the case that sodium silicate or polyurethane polyfoams is used, since their thermal expansion performance is inferior to the thermal expansion performance of expandable graphite, they are only applicable to the case that the size of the compound fireproof glass is small. For the large size glass, as the cavity is relatively large and is not easy to be filled, only expandable graphite can easily meet the expansion requirement.

[0056] Besides the superior fireproof performance, the above compound fireproof glass of the first embodiment further has the following advantages: the weight per square meter of the compound fireproof glass is much less than that of the compound fireproof glass in the prior art. Because the compound fireproof glass is partially filled with the thermal expansion material and only a small part of the compound fireproof glass is filled with the thermal expansion material, and the part not filled with the thermal expansion material has the same transmittance as the ordinary hollow glass, the overall transmittance of the compound fireproof glass is improved. Because the compound fireproof glass employs the same technology as the ordinary hollow glass to control the thickness, the thickness could be effectively controlled. As the compound fireproof glass has the cavity similar to the ordinary hollow glass, the thermal conductivity thereof is smaller. In the case that the thermal expansion material in the compound fireproof glass is expandable graphite, there is little change under the common season alternation and sunlight irradiation, which can effectively overcome the defect of poor weatherability of the current compound fireproof glass.

[0057] The other embodiments of the invention will be described in detail as follows, and the similar to the first embodiment will be no longer specifically described.

The second embodiment

[0058] As shown in Fig. 3, the compound fireproof glass 200 in the second embodiment mainly comprises a heated surface glass substrate 210A, an unexposed surface glass substrate 210B, and a connecting portion 220 for connecting the edge portions of the heated surface glass substrate 210A with the edge portions of the unexposed surface glass substrate 210B. The cavity defined by the heated surface glass substrate 210A, the unexposed surface glass substrate 210B and the connecting portion 220 is partially filled with a thermal expansion portion 230. The difference from the thermal expansion portion 130 in the first embodiment is that the thermal expansion portion 230 in the second embodiment forms a uniformly distributed pattern between the two layers of glass substrates. Specifically, the pattern in the second embodiment is a rectangular grid-like pattern. In the second embodiment, the thermal expansion portion 230 forming a uniformly distributed pattern is also formed by directly fixing the thermal expansion material between the heated surface glass substrate 210A and the unexposed surface glass substrate 210B.

[0059] The term "directly fixed/fixing" in the first embodiment or the second embodiment means there is no an enclosed layer outside the thermal expansion material, but the thermal expansion portion 130 or 230 is directly sandwiched between the two layers of glass substrates. The reason is that the enclosed layer will affect the expansion speed of the thermal expansion portion 130 or 230, also affect the uniformity of the expansion, even destroy the integrity of the fire resistance layer, and significantly reduce the fireproof performance of the compound fireproof glass.

[0060] Besides the effects of the first embodiment, the advantages of forming the thermal expansion portion 230 by means of the second embodiment are that: compared with the first embodiment, the thermal expansion portion 230 can expand more rapidly and uniformly to fill the entire cavity when contacting with fire, which can more effectively achieve the object of fire resistance, and also make the compound fireproof glass 230 aesthetic and decorative.

[0061] Compared with the first embodiment, the second embodiment has the effects reflected in the following Table 3.

The third embodiment

[0062] Figs. 4-12 show the compound fireproof glass 300 of the third embodiment of the invention. The compound fireproof glass 300 of the third embodiment mainly comprises a heated surface glass substrate 310A, an unexposed surface glass substrate 310B, and a connecting portion 320 for connecting the edge portions of the heated surface glass substrate 310A with the edge portions of the unexposed surface glass substrate 310B. The difference from the first and second embodiments, the thermal expansion portion 330 is a curtain in the form of shutter formed by a plurality of curtain strips, the distance between the first glass substrate and the second glass substrate is 25mm, and the thickness of the thermal expansion portion 330 is 0.8mm. When the compound fireproof glass 300 is used in a normal environment, as shown in Figs. 4-8, the thermal expansion portion 330 in the form of curtain is folded and accommodated in the left side and the right side of the cavity formed by the heated surface glass substrate 310A, the unexposed surface glass substrate 310B and the connecting portion 320. When contacting with fire and heating up, the thermal expansion portion 330 in the form of curtain can move from the left and right side to the center, and finally fill the entire cavity. Thus, in the third embodiment, the thermal expansion portion 330 is movably provided in the cavity of the compound fireproof glass.

[0063] Preferably, a driving device 340 could be provided in the cavity, and in case of fire, as shown in Figs. 9-12, the thermal expansion material 330 can be rapidly expanded through the driving device 340 to form a curtain for covering the entire surface of the compound fireproof glass 300. With the rise of temperature, the expanded thermal expansion material 330 rapidly expands to fill the entire cavity to form a complete fire resistance layer.

[0064] With reference to Figs. 4-12, the structure and principle of the third embodiment will be specifically described below.

[0065] Fig. 4 is a structural view of the compound fireproof glass 300 of the third embodiment, in which the thermal expansion portion 330 is in a storage state; Fig. 5 is a partial enlarged structural view of part B in Fig. 4; Fig. 6 is a partial enlarged structural view of part C in Fig. 5; and Fig. 8 is a side structural view of the compound fireproof glass in Fig. 4.

[0066] The driving device 340 mainly comprises a supporting rod 341, a glass fiber traction line 342, a plurality of connecting rings 343, a memory alloy wire 344 and two parallel rollers for winding traction line 345. The upper portion of the connecting ring 343 has a through hole, the plurality of connecting rings 343 can be slidably hung on the supporting rod 341 through the through holes in upper portions thereof, and the lower portions of the connecting rings 343 are substantially uniformly distributed and connected to the upper portion of the curtain of the thermal expansion material 330. The two rollers for winding traction line 345 are provided in the left end and the right end of the cavity respectively and below the supporting rod 341. The glass fiber traction line 342 is annularly wound on the two rollers for winding traction line 345. Thus, in the third embodiment, and the two lower traction portions substantially parallel to each other are formed in the upper portion of the cavity. Of course, the glass fiber traction line 342 can also respectively form front and rear traction portions which are parallel to each other.

[0067] A memory alloy spring is straightened to form the memory alloy wire 344, the right end of which is sticked to the heated surface glass substrate 310A or the unexposed surface glass substrate 310B, and the left end of which is connected to the nearest connecting ring 343 on the left side, therefore which is connected to the glass fiber traction line 342 through the nearest connecting ring 343. The left end of the memory alloy wire 344 could also be directly connected with the glass fiber traction line 342.

[0068] The plurality of connecting rings 343 on the left side of the memory alloy wire 344 are respectively fixed, corresponding to the position that the thermal expansion portion 330 is in the expanded state, on the traction portion on the lower side of the glass fiber traction line 342; while the plurality of connecting rings 343 on the right side of the memory alloy wire 344 are respectively fixed, corresponding to the position that the thermal expansion portion 330 is in the expanded state, on the traction portion on the upper side of the glass fiber traction line 342.

[0069] As shown in Figs. 4-5, when the thermal expansion portion 330 is in a storage state, the memory alloy wire 344 is in an expanded state.

[0070] Fig. 7 is a 3D structural view of the accommodating case of the compound fireproof glass according to the third embodiment of the invention. In the third embodiment, both the left side and the right side of the cavity are provided with an accommodating case 350, and the two accommodating cases 350 have the same structure and are arranged to face each other. The main structure of the accommodating case 350 is a case body 351 with a rectangular section, a cover 354 is provided on the inner side of the case body 351 towards the cavity of the compound fireproof glass 300, the cover 354 is pivotally provided, via two or more spring hinges 352, on the side surface of the case body 351 towards the side of the unexposed surface glass substrate, and the cover 354 and the side surface of the case body 351 towards the side of the heated surface glass substrate are connected via a plurality of hot melt adhesive seal points 353. At normal temperature, the thermal expansion portion 330 is folded and accommodated in the accommodating case 350, and in case of fire, the hot melt adhesive seal points 353 are broken by heating, and the cover 354 is automatically opened under the effect of the spring hinges 352, then the thermal expansion portion 330 could be expanded, unimpeded by the cover 354, under the drive of the driving device 340.

[0071] Although the accommodating case 350 is not necessary for the compound fireproof glass 300 in the third embodiment to achieve the fireproof function, the accommodating case 350 will prevent the thermal expansion portion 330 from becoming irregular in the transportation and installation process at normal temperature, affecting the appearance of the compound fireproof glass, and the occurrence of the problems such as aging of the thermal expansion portion 330 due to long-term sunshine.

[0072] Fig. 9 is a structural view of the compound fireproof glass according to the third embodiment of the invention, in which the thermal expansion portion 330 is in an expanded state. Fig. 10 is a partial enlarged structural view of part D in Fig. 9; Fig. 11 is a partial enlarged structural view of part E in Fig. 10; Fig. 12 is a partial structural view of the driving device of the compound fireproof glass according to the third embodiment of the invention; and Fig. 13 is a side structural view of the compound fireproof glass in Fig. 9.

[0073] When a fire breaks out, the heated surface glass substrate 310A is heated, the hot melt adhesive seal points 353 are broken by heating, and the cover 354 is automatically opened under the effect of the spring hinges 352. The memory alloy wire 344 gradually reaches the deformation temperature of 80-120°C, under the effect of the deformation temperature, the memory alloy wire 344 automatically contracts to a spring shape. The pulling force generated in the contracting process of the memory alloy wire 344 pulls the connecting ring 343 connected with the left end thereof, and the connecting ring 343 pulls the glass fiber traction line 342. On one hand, the traction portion of the lower portion of the glass fiber traction line 342 expands the curtain of the thermal expansion portion 330 on the left side under the force from left to right, and on the other hand, the traction portion of the upper portion of the glass fiber traction line 342 expands the curtain of the thermal expansion portion 330 on the right side under the force from right to left. Therefore, a complete curtain made from the thermal expansion material is rapidly formed on the entire base surface of the compound fireproof glass. As the complete curtain can be formed rapidly on the entire base surface of the glass substrate, in the third embodiment, although the entire cavity is not full of the thermal expansion material, the better fire resistance effects have already been achieved. With the rise of the temperature continually, the complete curtain begins to expand and eventually fills the entire cavity to form a fire resistance layer, thereby achieving more effective fire resistance effect.

[0074] Identical to the first embodiment, the heated surface glass substrate 310A preferably uses a fireproof glass substrate. When a fire occurs, it can be assured that the fireproof glass substrate will not be broken at the beginning of the fire. Shown by the data obtained by eight experiments, for the compound fireproof glass of the third embodiment, with the rise of temperature, the thermal expansion material for forming the complete curtain can rapidly expand to fill the cavity and form the fire resistance layer, which can effectively block heat from transferring to the unexposed surface glass substrate 310B. In the case that the manufacturing process and product quality meet the requirements, it can be assured that, within 90 minutes, the highest temperature rise of the unexposed surface glass substrate 310B is no more than 180 °C, and the average temperature rise is no more than 140°C.

[0075] The compound fireproof glass of the third embodiment also has the advantages of the compound fireproof glass of the first embodiment. As the thermal expansion portion 330 is accommodated in the side edges of the cavity at normal temperature, the compound fireproof glass has more advantages in transmittance. At the beginning of the fire, the thermal expansion portion 330 can be rapidly and automatically expanded into the curtain to cover the entire base surface of the glass, and then expands. Compared with the first embodiment, it can more uniformly and rapidly fill the entire cavity. Compared with the second embodiment, it has a better fire resistance effect even when it does not fill the entire cavity. Moreover, the fire resistance layer in the third embodiment has higher quality because of very uniform expansion, and therefore it is more advantageous to the achieve fire and smoke resistance functions.

[0076] Table 3 is a comparison table of fireproof performance of the first, second and third embodiments when the thermal expansion portion is made from expandable graphite. In the three embodiments, all the glass substrates have a size of 400mm × 600mm and the same material. However, the thermal expansion portion is arranged in the edges of the cavity according to the first embodiment, in the cavity in a grid-like pattern according to the second embodiment, and in the left side and the right side of the cavity in the form of a complete curtain according to the third embodiment. Besides, the driving device is the one shown in Figs. 4-12.

Table 3: Comparison table of fireproof performance of compound fireproof glass in the first, second and third embodiments.

Experiment number	Embodiment	Filling time (unit: minute) and filling degree (unit: percent)	Highest /average temperature rise of the unexposed surface (unit: °C)
1	The first embodiment	10/100%	151/134
	The second embodiment	5/100%	133/126
	The third embodiment	8/100%	105/101

(continued)

Experiment number	Embodiment	Filling time (unit: minute) and filling degree (unit: percent)	Highest /average temperature rise of the unexposed surface (unit: °C)
2	The first embodiment	12/100%	176/140
	The second embodiment	8/100%	135/131
	The third embodiment	8/100%	122/109
3	The first embodiment	15/100%	145/135
	The second embodiment	6/100%	138/128
	The third embodiment	9/100%	130/121
4	The first embodiment	13/100%	179/135
	The second embodiment	11/100%	141/130
	The third embodiment	9/100%	111/100
5	The first embodiment	12/100%	163/128
	The second embodiment	6/100%	132/127
	The third embodiment	9/100%	109/103
6	The first embodiment	14/100%	155/137
	The second embodiment	4/100%	139/129
	The third embodiment	11/100%	146/121
7	The first embodiment	11/100%	167/133
	The second embodiment	7/100%	136/130
	The third embodiment	10/100%	129/110
8	The first embodiment	11/100%	177/139
	The second embodiment	6/100%	139/120
	The third embodiment	8/100%	128/107

[0077] The compound fireproof glass of the invention could adopt the following manufacturing method:

a. providing a first glass substrate and a second glass substrate, and forming a cavity between the first glass substrate and the second glass substrate;
b. providing a thermal expansion portion in the cavity and making the cavity partially filled with the thermal expansion portion, making the thermal expansion portion from a thermal expansion material with an approximately uniformly distributed structure; and
c. connecting the first glass substrate and the second glass substrate as an integral structure.

[0078] One preferred solution is that the step b comprises: directly and fixedly arranging the thermal expansion portion in the cavity.
[0079] Another preferred solution is that, in the step b, the thermal expansion portion is movably arranged in the cavity.
[0080] In the step b, it is feasible to fold and accommodate the curtain-like thermal expansion portion in the upper side of the cavity, or the left side and/or the right side of the cavity, or in the center of the cavity.

[0081] More preferably, the step b comprises: arranging the driving device in the edge of the cavity.

[0082] Arranging the driving device in the edge of the cavity specifically comprises: providing a supporting rod 341 in the upper portion of the cavity; providing two rollers for winding traction line 345 parallelly in the left end and the right end of the cavity, respectively, and below the supporting rod 341; winding a traction line 342 annularly onto the two rollers for winding traction line 345; slidably providing the upper portions of a plurality of connecting rings 343 on the supporting rod 341, uniformly and distributedly connecting the lower portions thereof with the upper portion of the thermal expansion portion 330, and fixedly connecting the central portions thereof with the traction line 342 uniformly and distributedly; and fixedly connecting a first end of a memory alloy wire 344 with the glass substrates forming the cavity, and fixedly connecting a second end, which is opposite to the first end, of the memory alloy wire 344 with the traction line 342.

[0083] The step b further comprises the steps of arranging an accommodating case 350 in the corresponding side of the cavity where the thermal expansion portion 330 is folded and accommodated, and folding and accommodating the thermal expansion portion 330 in the accommodating case 350.

[0084] According to the above description, the above embodiments of the invention achieve the following technical effects: the compound fireproof glass has superior fireproof performance; the weight per square meter of the compound fireproof glass is much less than that of the compound fireproof glass in the prior art; on the whole, the transmittance of the compound fireproof glass is improved; and the compound fireproof glass employs the same process as the ordinary hollow glass, and the thickness can be well controlled.

[0085] The descriptions above are only preferable embodiments of the invention, which are not used to restrict the invention. For those skilled in the art, the invention may have various changes and variations. Any modifications, equivalent substitutions, improvements etc. within the spirit and principle of the invention shall all be included in the scope of protection of the invention.

Claims

1. A compound fireproof glass comprising:

a first glass substrate (110A, 210A, 31A);
a second glass substrate (110B, 210B, 310B) provided in parallel with the first glass substrate (110A, 210A, 310A);
a connecting portion (120, 220, 320) connected with the first glass substrate (110A, 210A, 310A) and the second glass substrate (110B, 210B, 310B);
a cavity provided between the first glass substrate (110A, 210A, 310A) and the second glass substrate (110B, 210B, 310B);
wherein the compound fireproof glass further comprises:

a thermal expansion portion (130, 230, 330) which is an approximately uniformly distributed structure made from a thermal expansion material, and partially fills the cavity.

2. The compound fireproof glass according to claim 1, wherein the thermal expansion portion (130, 230, 330) is made from expandable graphite or a product containing expandable graphite.

3. The compound fireproof glass according to claim 1, wherein
the first glass substrate (110A, 210A, 310A) is a monolayer or multilayer fireproof glass substrate;
the second glass substrate (110B, 210B, 310B) is a monolithic tempered glass substrate, a monolayer or multilayer fireproof glass substrate, a monolayer filmed glass substrate, a coated glass substrate, or a compound glass substrate with at least two layers.

4. The compound fireproof glass according to claim 1, wherein the compound fireproof glass further comprises a sealing portion provided in the edge of the cavity for sealing the cavity.

5. The compound fireproof glass according to any of claims 1 to 4, wherein the thermal expansion portion (130, 230) is directly and fixedly arranged in the cavity.

6. The compound fireproof glass according to claim 5, wherein the thermal expansion portion (130) is located at the edge and/or in the center of the cavity.

7. The compound fireproof glass according to claim 5, wherein the thermal expansion portion (230) forms an approximately uniform pattern in the cavity, preferably, forms a grid-like, dot-like or petal-like pattern.

8. The compound fireproof glass according to any of claims 1 to 4, wherein the thermal expansion portion (330) is movably arranged in the cavity.

9. The compound fireproof glass according to claim 8, wherein the thermal expansion portion (330) is curtain-like, which is folded and accommodated at the edge and/or in the center of the cavity at normal temperature.

10. The compound fireproof glass according to claim 9, wherein the compound fireproof glass further comprises a driving device (340) which changes the thermal expansion portion (330) from a storage state to an expanded state when the compound fireproof glass contacts with fire.

11. The compound fireproof glass according to claim 10, wherein the thermal expansion portion (330) is provided in the left side and/or the right side of the cavity, and the driving device (340) comprises:

a supporting rod (341) provided in the upper portion of the cavity;
rollers for winding traction line (345), wherein two parallel rollers for winding traction line are provided in the left end and the right end of the cavity respectively and below the supporting rod (341);
a traction line (342) annularly wound on the two rollers for winding traction line (345);
a plurality of connecting rings (343), the upper portions of which are slidably provided on the supporting rod (341), lower portions of which are uniformly distributed and in connection with the upper portion of the thermal expansion portion (330), and central portions of which are uniformly distributed and fixedly connected with the traction line (342); and
a driving member connected with the traction line (342) for pulling the traction line (342).

12. The compound fireproof glass according to claim 11, wherein the driving member is a memory alloy wire (344), comprising a first end and a second end opposite to each other, the first end is fixedly connected with the first glass substrate (310A) or the second glass substrate (310B), and the second end is fixedly connected with the traction line (342).

13. The compound fireproof glass according to claim 12, wherein
the memory alloy wire (344) is located in the intermediate position of the upper portion of the cavity;
the traction line (342) comprises a first traction portion and a second traction portion on two sides of a plane formed by the axises of the two rollers for winding traction line (345); and
the thermal expansion portion (330) and the plurality of connecting rings (343) connected with the thermal expansion portion (330) are respectively provided on the left side and the right side of the memory alloy wire (344), the plurality of connecting rings (343) on the left side are fixedly connected with the first traction portion, and the plurality of connecting rings (343) on the right side are fixedly connected with the second traction portion.

14. The compound fireproof glass according to claim 12, wherein
the memory alloy wire (344) has a straight line at normal temperature and becomes a spring shape under 80°C to 120°C.

15. The compound fireproof glass according to claim 9, wherein the compound fireproof glass further comprises an accommodating case (350) provided in a corresponding side of the cavity where the thermal expansion portion (330) is folded and accommodated, the accommodating case (350) is closed at normal temperature to accommodate the folded thermal expansion portion (330), and opened in case of fire to expand the folded thermal expansion portion (330).

16. The compound fireproof glass according to claim 15, wherein the accommodating case (350) comprises:

a case body (351) with a rectangular section;
a spring hinge (352); and
a cover (354) towards the inner side of the cavity and pivotally provided on a side surface of the case body (351) which is on the side of the second glass substrate (310B) via one or more spring hinges (352), the cover (354) is connected with a side surface of the case body (351) which is on the side of the first glass substrate (310A) via one or more hot melt adhesive seal points (353) at normal temperature.

17. A manufacturing method of compound fireproof glass comprising the following steps:

a. providing a first glass substrate (110A, 210A, 310A) and a second glass substrate (110B, 210B, 310B), and forming a cavity between the first glass substrate (110A, 210A, 310A) and the second glass substrate (110B, 210B, 310B);
b. providing a thermal expansion portion (130, 230, 330) in the cavity and making the cavity partially filled with the thermal expansion portion (130, 230, 330), making the thermal expansion portion (130, 230, 330) from a thermal expansion material with an approximately uniformly distributed structure; and
c. connecting the first glass substrate (110A, 210A, 310A) and the second glass substrate (110B, 210B, 310B) as an integral structure.

18. The method according to claim 17, wherein the step b comprises: directly and fixedly arranging the thermal expansion portion (130, 230) in the cavity.

19. The method according to claim 17, wherein the step b comprises: movably arranging the thermal expansion portion (330) in the cavity.

20. A curtain, wherein the curtain is made from a thermal expansion material.

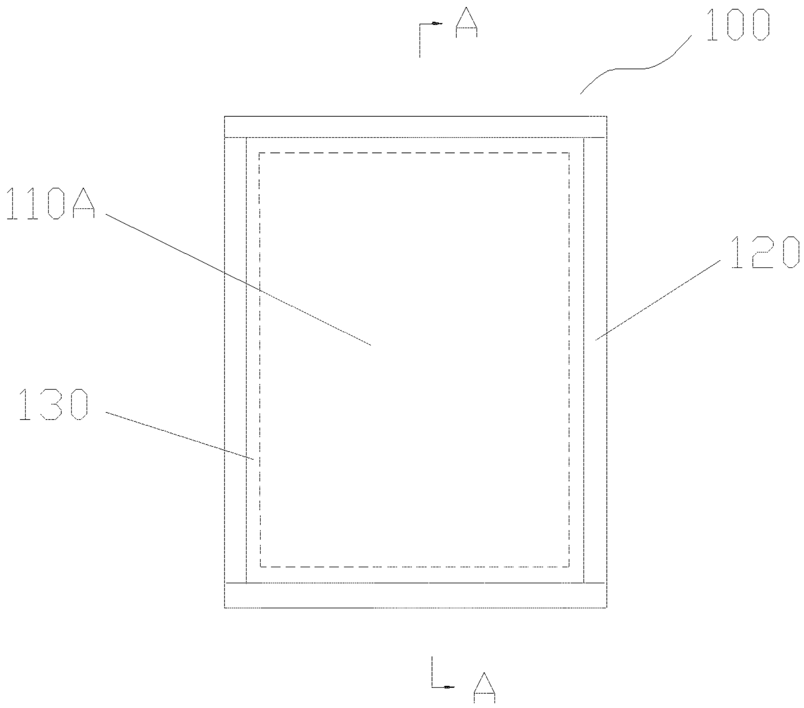

Fig. 1

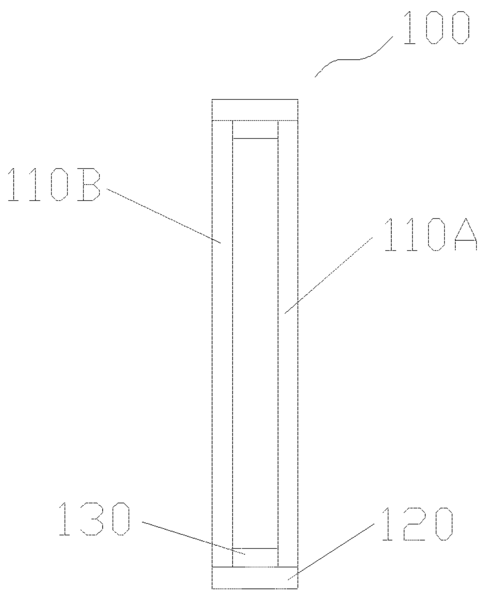

Fig. 2

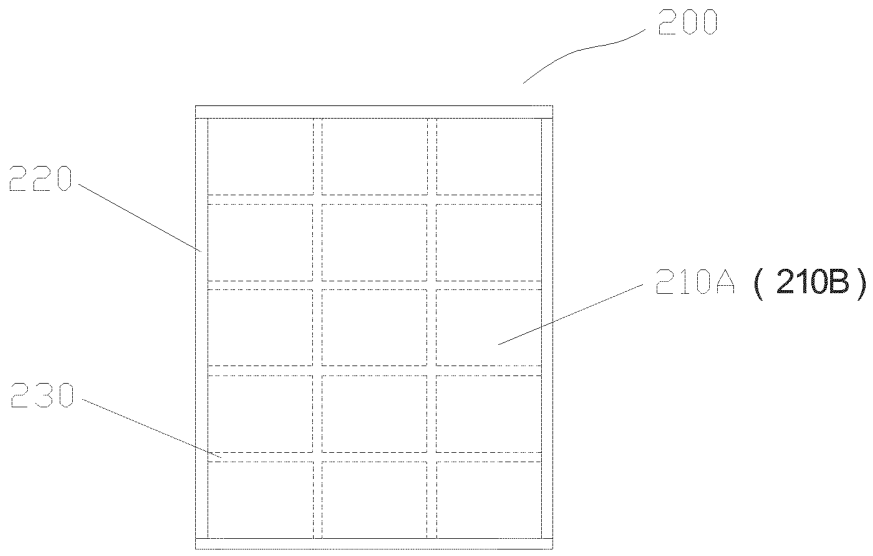

Fig. 3

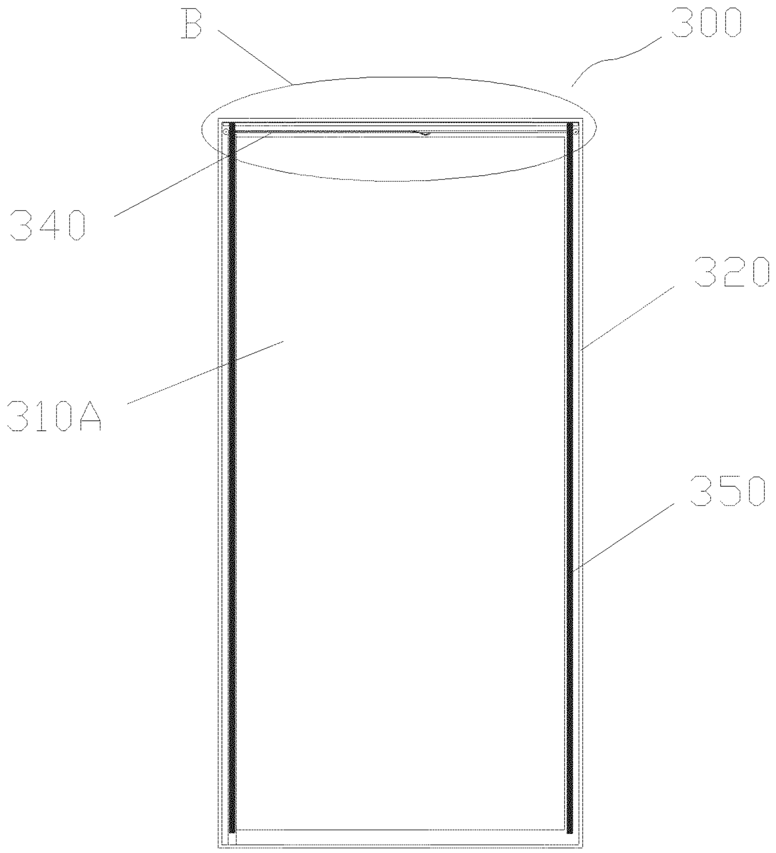

Fig. 4

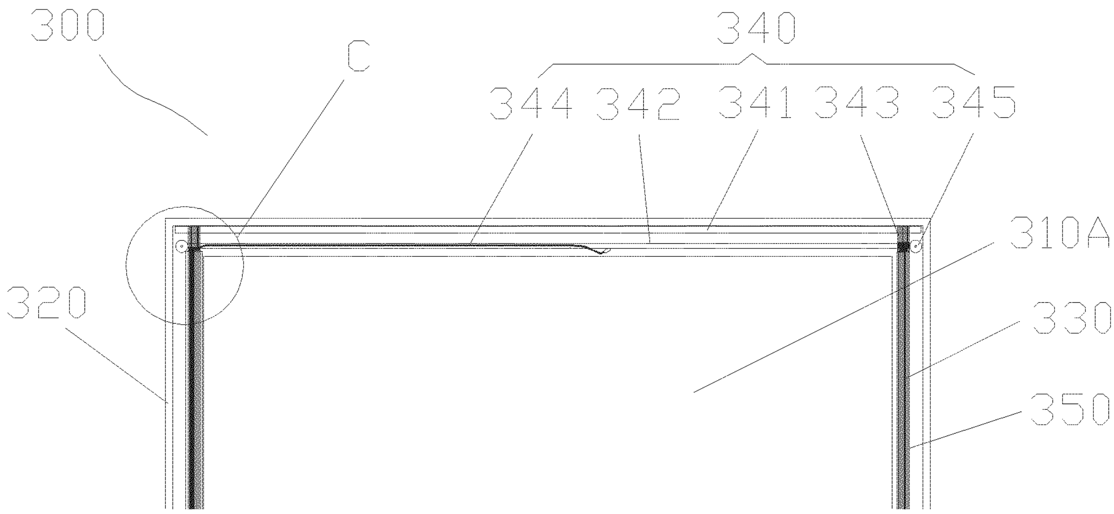
300
C
340
344 342 341 343 345
310A
320
330
350

Fig. 5

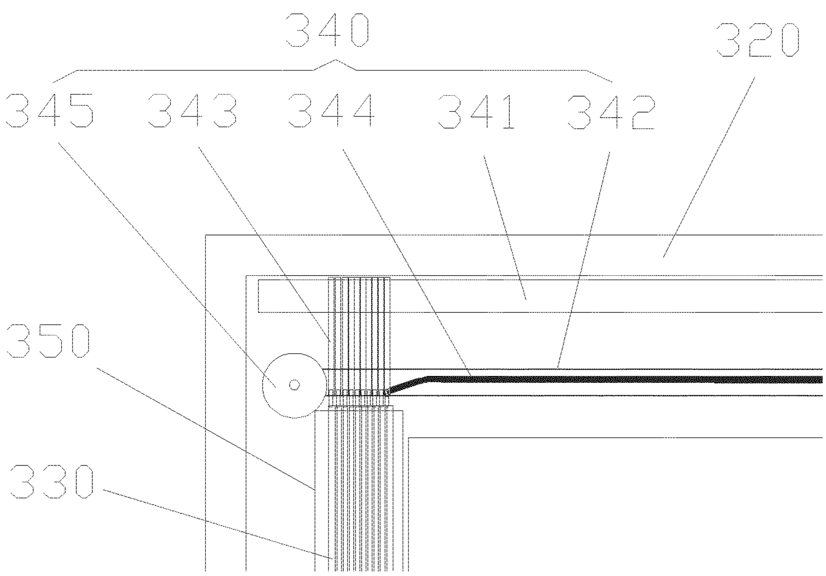
340
345 343 344 341 342
320
350
330

Fig. 6

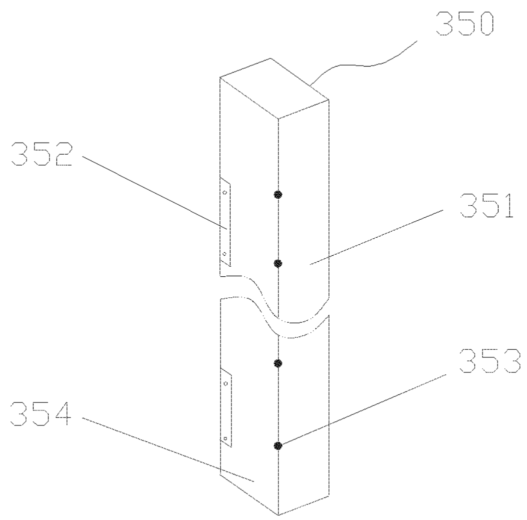

Fig. 7

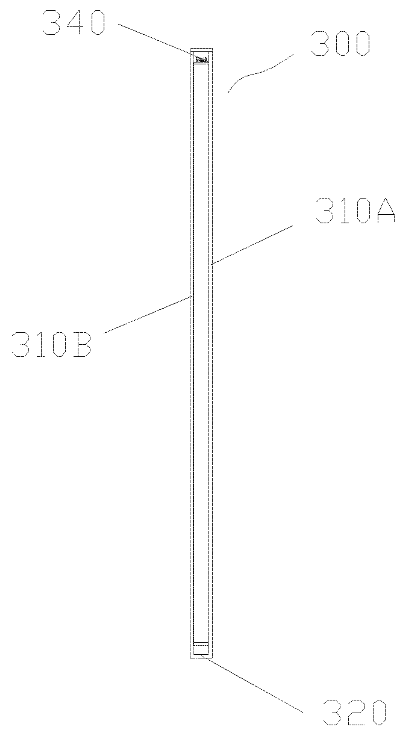

Fig. 8

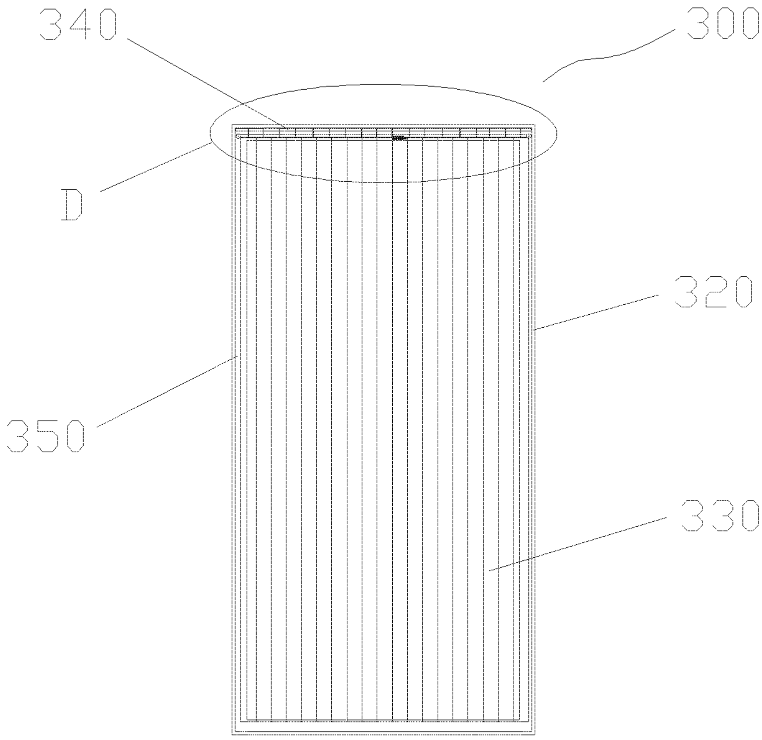

Fig. 9

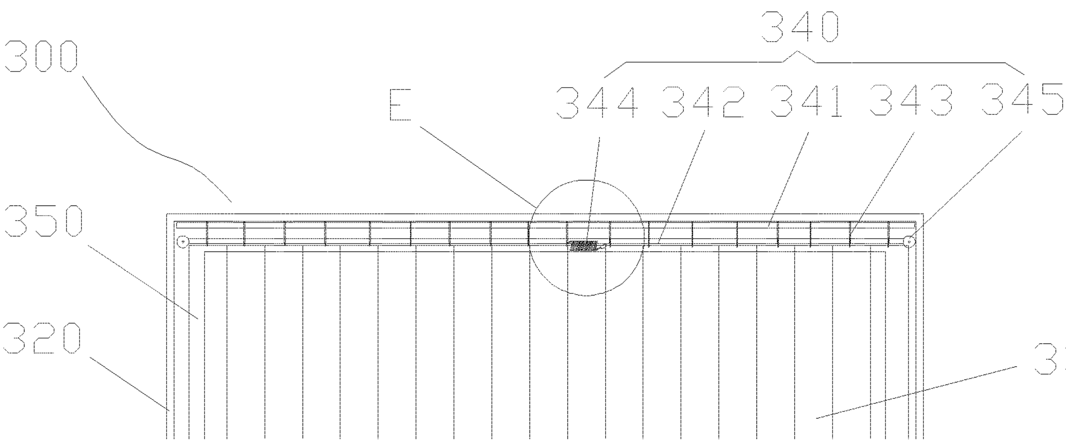

Fig. 10

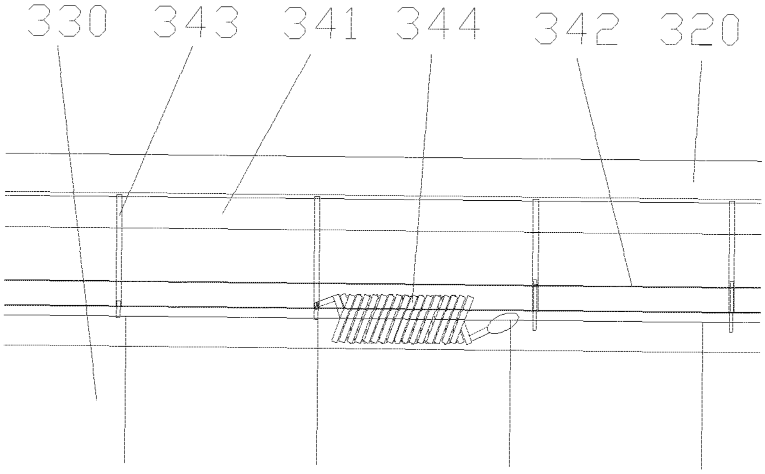

Fig. 11

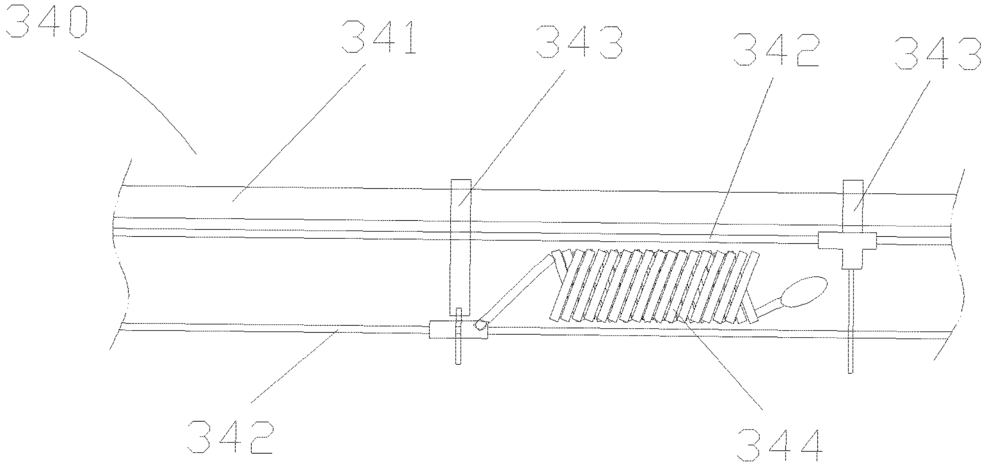

Fig. 12

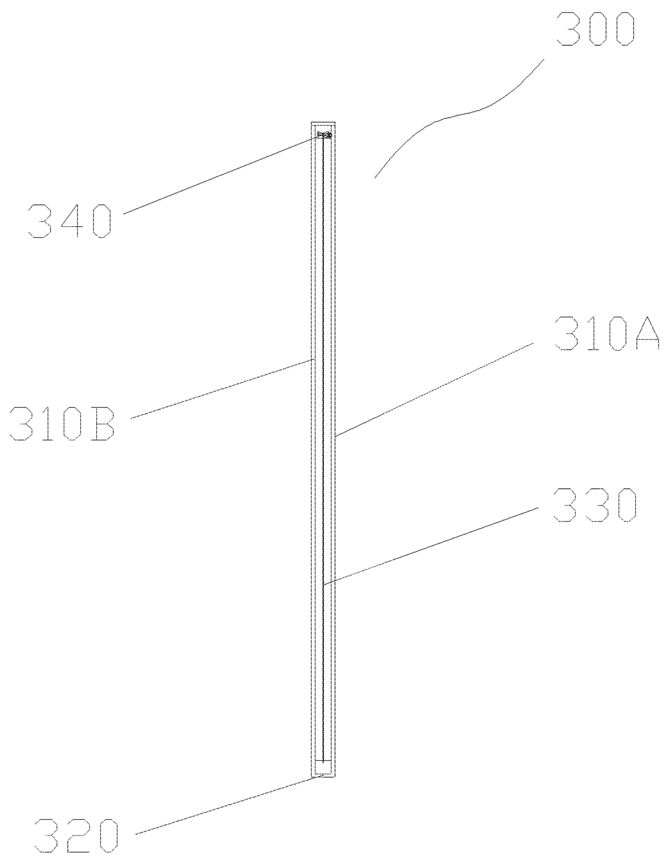

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/073810

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B32B, E06B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

VEN, CNPAT, CNKI: curtain, drape, pardah, purdah, blind, shutter, gill, jalousie, persiennes, shade, louvers, glass, window, expand, expans+, dilat+, fire, fireproof, refractor, heat, thermal, prevent, protect, resistan, proof, retard, insulat, isolate, carbon, graphite, plumbag, black, lead, blacklead

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 201292757 Y (XU, Nengtong) 19 August 2009 (19.08.2009) claims 1 and 2, description, figures 1 and 2	1-19
Y X	JP 2009215721 A (ASHIMORI IND CO LTD) 24 September 2009 (24.09.2009) description, paragraphs [0023]-[0032] and figures 1-3	1-19 20
Y	CN 2293344 Y (QINDAO QINHE INDUSTRY CO) 07 October 1998 (07.10.1998) description, page 2, paragraph [0002]	12-14
A	CN 1360659 A (VETROTECH SAINT-GOBAIN INT AG) 24 July 2002 (24.07.2002) the whole document	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 January 2013 (04.01.2013)	24 January 2013 (24.01.2013)

Name and mailing address of the ISA	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	LIU, Shimin Telephone No. (86-10) 62084850

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/073810

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The application has 3 independent claims:
claim 1 a composite fire-proof glass;
claim 17 a method for manufacturing the composite fire-proof glass;
claim 20 a curtain.
The same or corresponding technical feature between claim 17 and claim 1 is the composite fire-proof glass mentioned in claim 1; the same or corresponding technical feature between claim 20 and claim 1 or 17 is a thermal expansion material. It is found that the same or corresponding technical features mentioned above do not make contribution to the prior art by searching, therefore, the any two among claims 1, 17 and 20 do not have same or corresponding special technical features, that is , the any two among claims 1, 17 and 20 are not so linked as to form a single general inventive concept and do not have unity of invention as required by PCT Rule 13.1.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA /210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/073810

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 201292757 Y	19.08.2009	None	
JP 2009215721 A	24.09.2009	None	
CN 2293344 Y	07.10.1998	None	
CN 1360659 A	24.07.2002	WO 0104449 A1	18.01.2001
		AU 5385100 A	30.01.2001
		NO 20020107 A	08.03.2002
		EP 1194673 A1	10.04.2002
		CZ 20014527 A3	12.06.2002
		ES 2173822 T1	01.11.2002
		JP 2003504542 A	04.02.2003
		EP 1194673 B1	29.10.2003
		DE 50004262 G	04.12.2003
		NZ 515597 A	30.01.2004
		ES 2173822T T3	16.06.2004
		US 6787214 B1	07.09.2004
		CN 1153889 C	16.06.2004
		NO 320919B B1	13.02.2006
		CA 2377460 C	22.04.2008
		CZ 299987 B6	14.01.2009
		JP 4484411 B2	16.06.2010

Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/073810

A. CLASSIFICATION OF SUBJECT MATTER

B32B 17/06 (2006.01) i

E06B 5/16 (2006.01) i

Form PCT/ISA /210 (extra sheet) (July 2009)