



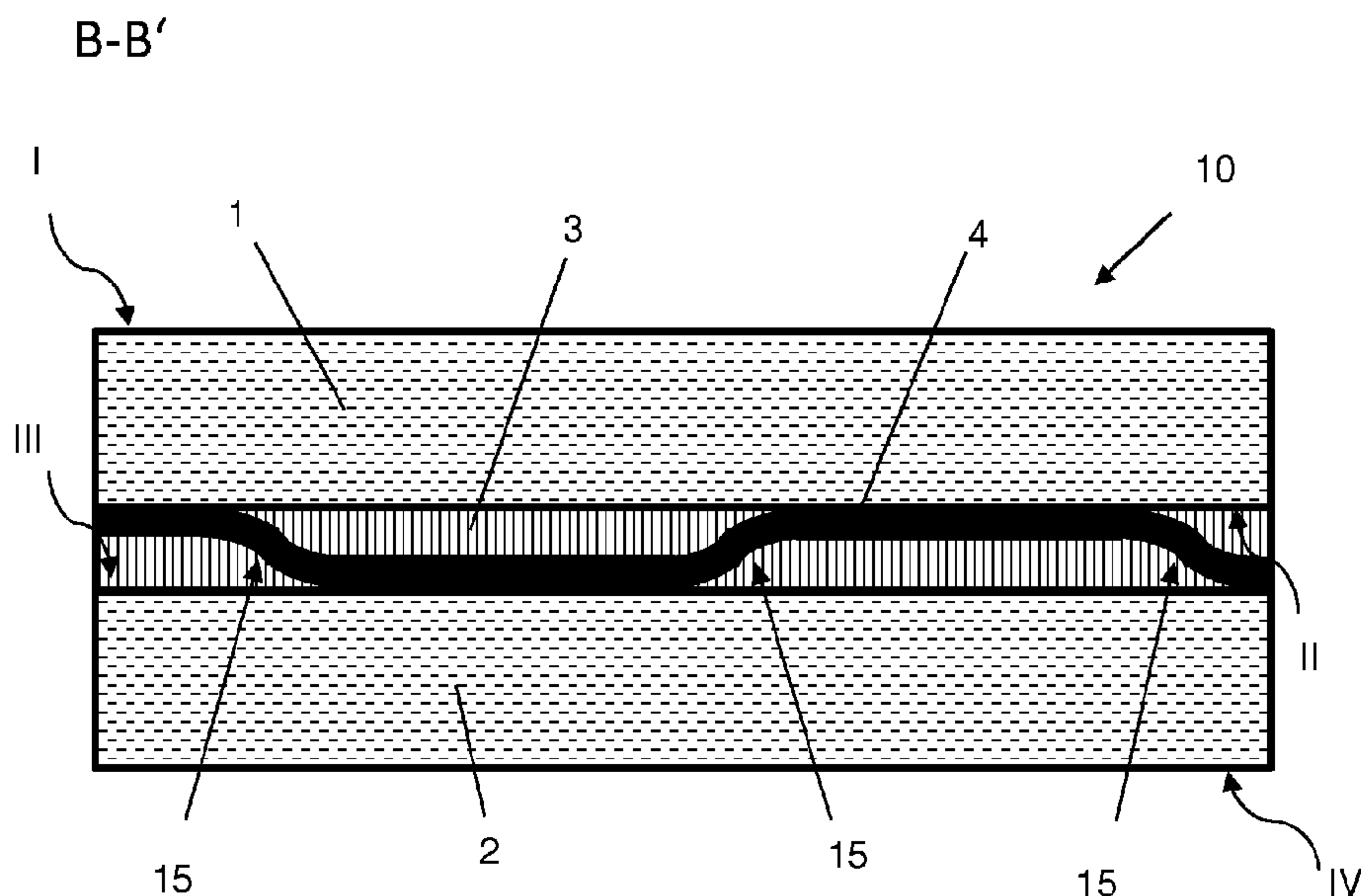
(12) **DEMANDE DE BREVET CANADIEN  
CANADIAN PATENT APPLICATION**

(13) **A1**

(86) Date de dépôt PCT/PCT Filing Date: 2017/03/06  
 (87) Date publication PCT/PCT Publication Date: 2017/09/14  
 (85) Entrée phase nationale/National Entry: 2018/07/13  
 (86) N° demande PCT/PCT Application No.: EP 2017/055181  
 (87) N° publication PCT/PCT Publication No.: 2017/153331  
 (30) Priorités/Priorities: 2016/03/09 (EP16159456.9);  
 2016/03/09 (EP16159469.2)

(51) Cl.Int./Int.Cl. *B32B 17/06* (2006.01),  
*B32B 17/10* (2006.01), *B60Q 3/10* (2017.01),  
*F21V 33/00* (2006.01), *F21V 8/00* (2006.01),  
*G02B 6/00* (2006.01)  
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 (54) Title: ILLUMINABLE COMPOSITE PANE



Figur 1F

(57) **Abrégé/Abstract:**

The present invention relates to a composite pane (10), at least comprising: - an outer pane (1) and an inner pane (2), which are connected to one another by means of an intermediate layer (3); and - at least one light-diffusing glass fibre (4) suitable for emitting light by diffusion along its extent via its lateral wall, some sections of the glass fibre (4) being arranged between the intermediate layer (3) and the outer pane (1) and between the intermediate layer (3) and the inner pane (2) and said glass fibre being conducted through at least one opening (15) in the intermediate layer (3).

### **Abstract**

The present invention relates to a composite pane (10), at least comprising:

- 5       - an outer pane (1) and an inner pane (2) that are bonded to one another via an intermediate layer (3), and
- at least one light-diffusing glass fiber (4) that is suitable for emitting light by diffusion via its side wall along its extension length,

10       wherein the glass fiber (4) is arranged, in sections, between the intermediate layer (3) and the outer pane (1) and between the intermediate layer (3) and the inner pane (2) and is routed through at least one opening (15) of the intermediate layer (3).

Fig. 1F

## illuminable Composite Pane

The invention relates to an illuminable composite pane, in particular a windshield, a rear window, a side pane, or a roof panel of a vehicle, as well as a method for production thereof and use thereof.

Composite panes comprise at least one outer pane, one inner pane, and one adherable intermediate layer that areally bonds the outer pane to the inner pane. Typical intermediate layers are polyvinyl butyral films, which have, in addition to their adhesive properties, high toughness and high acoustic damping. The intermediate layer prevents the disintegration of the composite glass pane in the event of damage. The composite pane merely cracks, but remains dimensionally stable.

Composite panes have clear advantages compared to single-pane safety glass: High acoustic insulation can be obtained by means of a composite pane, which is, for example, particularly advantageous for the separation of motor vehicle interiors from their external environment. Consequently, in addition to windshields, side panes of motor vehicles are also increasingly made of composite glass. At the same time, a composite pane has greater penetration inhibition than a single-pane safety glass and is thus more stable against penetration of foreign bodies or break-in attempts.

DE 10 2005 036869 A1, WO 2008/061789 A1, WO 2007/077099 A1, US 2015/253486 A1, and US 2013/299856 A1 disclose composite structures that are areally illuminable by means of woven glass fiber fabric or glass fiber fleece.

The object of the present invention is to provide an improved composite pane that is illuminable, at least in sections. Integration of the illumination into the composite pane should be simple and cost-effective.

The object of the present invention is accomplished according to the invention by a composite pane according to claim 1. Preferred embodiments are apparent from the subclaims.

The composite pane according to the invention comprises at least:

- one outer pane and one inner pane that are bonded to one another via an intermediate layer, and
- at least one light-diffusing glass fiber that is suitable for emitting light by diffusion

5 via its side wall along its extension length,  
 wherein the glass fiber is arranged, in sections, between the intermediate layer and the outer pane and between the intermediate layer and the inner pane and the glass fiber is routed through at least one opening of the intermediate layer.

10 By means of the arrangement of the glass fiber in at least one opening of the intermediate layer, the position of the glass fiber relative to the intermediate layer is fixed such that slippage of the glass fiber during the production and lamination of the composite pane can be avoided.

15 In an advantageous embodiment, the composite pane according to the invention is a glazing for means of transportation for travel on land, in the air, or on water, in particular in trains, watercraft, and motor vehicles, for example, as a windshield, rear window, side pane, and/or roof panel, in buildings, in particular in the access area, window area, roof area, or façade area, as a built-in component in furniture and appliances.

20 In a particularly advantageous embodiment, the composite pane according to the invention is a laminated side pane, which is provided for a, preferably openable, side window of a vehicle. The term "an openable side window" means a side window that can be opened and closed again by substantially vertical displacement of the side pane

25 in the vehicle door.

The terms "outer pane" and "inner pane" serve merely to distinguish a first pane and a second pane. In the case of use of the composite pane as a vehicle pane or as a building pane, the outer pane is preferably but not necessarily turned toward the

30 exterior of the composite pane; and the inner pane, the interior.

The glass fiber according to the invention is a light-diffusing glass fiber that emits light by diffusion via its side wall along its extension length. Such glass fibers are usually made of at least a glass fiber core that is surrounded by one or a plurality of sheath-

shaped layers arranged around the glass fiber core. The sheath layers usually have a large number of diffusion centers, for example, nanopores or nanoparticles. Suitable light-diffusing glass fibers are well known to the person skilled in the art. Merely by way of example, reference is made here to the glass fibers mentioned in  
 5 US 2011/0122646 A1 or US 2015/0131955 A1. The thickness of the glass fiber is typically from 5  $\mu\text{m}$  to 300  $\mu\text{m}$ , preferably from 100  $\mu\text{m}$  to 250  $\mu\text{m}$ . Of course, as a result of suitable production or processing, the glass fiber can also have light-diffusing regions only in sections.

10 In an advantageous embodiment of the glass fiber according to the invention, the extension length via which the glass fiber emits uninterrupted light via its side wall is at least 5 cm, preferably at least 10 cm, and particularly preferably at least 30 cm.

In the context of the present invention, the term "light-diffusing glass fiber" also means  
 15 a bundle or braid of a plurality of individual glass fibers. In an advantageous embodiment, the composite pane according to the invention has less than or equal to 50 individual glass fibers, preferably exactly one glass fiber, exactly two glass fibers, exactly three glass fibers, exactly four glass fibers, exactly five glass fibers, exactly six glass fibers, exactly seven glass fibers, exactly eight glass fibers, exactly nine glass  
 20 fibers, or exactly 10 glass fibers. In particular, the composite pane according to the invention has no glass fiber fleece. The one to 50 glass fibers are preferably controllable independently from one another, in other words, illuminable independently from one another. The one to 50 glass fibers are preferably arranged near one another. Alternatively, the glass fibers can intersect, preferably a maximum of ten times per glass  
 25 fiber. In an advantageous embodiment of the composite pane according to the invention, the glass fiber is embedded in one surface of the intermediate layer. This can be done automatically during the lamination of the outer pane, intermediate layer, and inner pane since the outer pane and the inner pane are substantially rigid at the temperatures and pressures of lamination and the intermediate layer is soft and flexible.

30

In the context of the present invention, "opening" preferably means an open point in the intermediate layer that is completely bordered by the intermediate layer. Of course, in a finished laminated composite pane according to the invention, the intermediate layer can close the free region of the opening such that the intermediate layer directly

touches the glass fiber routed through the intermediate layer. The opening in the intermediate layer is then filled by the glass fiber.

5 In an advantageous embodiment of the composite pane according to the invention, the opening is a recess, preferably a circular, elliptical, rectangular, or triangular recess, a punched hole, or a slot, preferably a slot along the extension direction of the glass fiber (in short: longitudinal slot) or a slot perpendicular to the extension direction of the glass fiber (in short: transverse slot).

10 In an advantageous embodiment of the composite pane according to the invention, the width  $b$  of the opening perpendicular to the extension direction of the glass fiber ranges from a single diameter  $d$  of the glass fiber up to 40 times the diameter  $d$ .

15 In an advantageous embodiment of the composite pane according to the invention, the width  $b$  of the opening perpendicular to the extension direction of the glass fiber is from 0.5 mm to 10 mm, preferably from 1 mm to 5 mm.

20 In an advantageous embodiment of the composite pane according to the invention, the intermediate layer has at least 2, preferably 3 to 100, openings through which the glass fiber is routed. By means of a large number of openings, the glass fiber is reliably fixed and complex line routing of the glass fiber can be achieved.

25 In an advantageous embodiment of the composite pane according to the invention, the distance between adjacent openings is from 0.5 cm to 50 cm, preferably from 0.5 cm to 20 cm, particularly preferably from 0.5 cm to 5 cm, and in particular from 1 cm to 3 cm. By means of such a distance between adjacent openings, the glass fiber is reliably fixed and complex line routing of the glass fiber can be achieved.

30 For the further simplified production of the composite pane, the glass fiber can be fixed in one surface of the intermediate layer before lamination under the action of pressure and temperature. This has the particular advantage that the glass fiber is additionally fixed in its position relative to the intermediate layer during the production of the composite pane and slippage is avoided. The action of pressure and temperature can preferably be produced by a heating element, preferably a soldering iron, a heated

pressure roller, a heating plate, in particular a flat iron, or a stream of hot air in combination with a pressing means.

In another advantageous embodiment of a composite pane according to the invention,  
5 the glass fiber is connected by at least one fastening means to the intermediate layer, the outer pane, and/or the inner pane. This has the particular advantage that the glass fiber is additionally fixed in its position relative to the intermediate layer during the production of the composite pane and slippage is avoided. The fastening means are preferably transparent such that vision through the composite pane is not or not  
10 substantially impaired.

In another particularly advantageous embodiment of a composite pane according to the invention, the fastening means is an adhesive means, preferably an adhesive that is liquid at the time of application, an adhesive tape adhesive on one side (for short:  
15 single-sided adhesive tape) or an adhesive tape adhesive on both sides (for short: double-sided adhesive tape). The single-sided adhesive tape or the double-sided adhesive tape consist of a carrier film, preferably a carrier film made of plastic, which has an adhesive on one side or on both sides.

20 Particularly advantageous adhesives are acrylate adhesives, methacrylate adhesives, cyanoacrylate adhesives, polyepoxides, silicone adhesives, and/or silane cross-linking polymeric adhesives, mixtures, and/or copolymers thereof.

In an alternative advantageous embodiment, the fastening means is a monofilament  
25 cord or a braided cord, preferably a transparent cord, particularly preferably a plastic cord, and in particular a cord made of polyamide (for example, nylon), polyethylene (for example, Dyneema or Spectra), or polyaramide (for example, Kevlar). Such cords have typical diameters from 0.01 mm to 2 mm, preferably from 0.02 mm to 0.1 mm.

30 The outer pane and/or the inner pane preferably contain glass, in particular soda lime glass, or plastics, preferably rigid plastics, in particular polycarbonate or polymethylmethacrylate. The thickness of the pane can vary greatly and thus be ideally adapted to the requirements in the individual case. Preferably, the thicknesses of the

outer pane and of the inner pane are from 0.5 mm to 10 mm and preferably from 1 mm to 5 mm, most particularly preferably from 1.4 mm to 3 mm.

5 The outer pane, the inner pane, or the intermediate layer can be clear and colorless, but also tinted, frosted, or colored. The outer pane and the inner pane can be made of non-prestressed, partially prestressed, or prestressed glass. The outer pane and/or the inner pane can have a masking print, preferably a black print, on one side, which blocks the view of gluing of the pane in a housing or vehicle body or other elements arranged in or on the pane. The masking print can be implemented opaque and full-surface.  
10 Alternatively, the masking print can also be implemented semitransparent, for example, as a dot grid, strip grid, or checkered grid. Alternatively, the masking print can even have a gradient, for example, from an opaque covering to a semitransparent covering.

In an advantageous embodiment, the composite pane according to the invention has,  
15 at least in sections, a masking print on the outer pane or on the inner pane and, in particular, a black print, with the glass fiber arranged, at least in sections, in the region of the masking print. In the case of an opaque masking print, this has the particular advantage that the glass fiber and any fastening means are not discernible when looking through, and, at the same time, the illumination from the glass fiber is  
20 discernible only on one surface of the panes, i.e., on the exterior-side surface of the outer pane or the interior-side surface of the inner pane.

The intermediate layer is formed by at least one thermoplastic bonding film. The thermoplastic bonding film contains at least one thermoplastic polymer, preferably  
25 ethylene vinyl acetate (EVA), polyvinyl butyral (PVB), or polyurethane (PU) or mixtures or copolymers or derivatives thereof. The thickness of the intermediate layer and, in particular, of the thermoplastic bonding film is preferably from 0.2 mm to 2 mm, particularly preferably from 0.3 mm to 1 mm, for example, 0.38 mm or 0.76 mm.

30 In another advantageous embodiment, the composite pane according to the invention has heating means for electrical heating of the composite pane. Preferred heating means are electrically conductive wires and/or one or a plurality of electrically heatable, transparent, electrically conductive layers.

The composite pane according to the invention can have other functionalities besides the heating function effected by the heating means. In an advantageous embodiment, the composite pane has a reflecting coating for the infrared range. Such a coating can be applied on a surface of the outer pane or on a surface of the inner pane, preferably on a surface facing the intermediate layer, in order to protect the coating against corrosion and mechanical action. Alternatively, the coating can be introduced into the composite, in the form of a coated thermoplastic film, for example, made of polyethylene terephthalate (PET). In this case, the coated film is preferably arranged between a first and a second thermoplastic bonding film. IR-reflecting coatings typically have at least one electrically conductive layer. Additionally, the coating can have dielectric layers that serve, for example, to regulate the sheet resistance, to protect against corrosion, or to reduce reflection. The conductive layer preferably contains silver or an electrically conductive oxide (transparent conductive oxide, TCO) such as indium tin oxide (ITO). The conductive layer preferably has a thickness of 10 nm to 200 nm. To improve the conductivity with simultaneously high transparency, the coating can have a plurality of electrically conductive layers that are separated from one another by at least one dielectric layer. The conductive coating can include, for example, two, three, or four electrically conductive layers. Typical dielectric layers contain oxides or nitrides, for example, silicon nitride, silicon oxide, aluminum nitride, aluminum oxide, zinc oxide, or titanium oxide. Of course, these electrically conductive, transparent coatings can also serve for the electrical heating of the pane. The coating preferably has a smaller surface area than the composite pane such that a peripheral edge region with a width of preferably 0.5 mm to 15 mm is not provided with the coating. The conductive coating is thus protected inside the intermediate layer against contact with the surrounding atmosphere, which is advantageous in terms of the prevention of corrosion. The composite pane can also have other uncoated regions, for example, data transmission windows or communication windows.

Another aspect of the invention is a composite pane arrangement, at least comprising:

- a composite pane according to the invention, and
- a lighting means for coupling light into the glass fiber.

The lighting means is preferably arranged on one side edge of the composite pane. In the case of a movable composite pane, such as a side pane that can be opened, the

lighting means is preferably connected to the composite pane and likewise arranged movably. Of course, the lighting means can also be installed independent of the composite pane and can be connected to the light-diffusing glass fiber according to the invention via a preferably non-light-diffusing glass fiber.

5

Advantageous lighting means are, for example, laser diodes, light-emitting diodes (LEDs), or incandescent bulbs, with the invention including any type of light source that is suitable for a respective use. The lighting means according to the invention also include lens systems, mirror systems, reflector systems, or other light guides that can  
10 serve for the coupling of the light into the glass fiber according to the invention.

The lighting means can be colored or white. The lighting means can also give off light in the ultraviolet range, so long as the glass fiber or its surroundings can convert the ultraviolet light into visible light. Preferred light colors are red (due to the pronounced  
15 signaling effect), green (due to the high sensitivity of the human eye for the green color spectrum), and blue (due to its particularly aesthetic and less dazzling effect).

Of course, a composite pane can have one or a plurality of glass fibers. Thereby are all glass fiber preferable jointly or each glass fiber individually, which coupled to a  
20 lighting means. The glass fiber or the glass fibers can be arranged in the composite pane in any technically possible form, for example, in the edge region, in the center, rectilinearly, curved, or as lettering or as a symbol.

Another aspect of the invention is a method for producing a composite pane according  
25 to the invention, at least comprising:

- (a) Preparing a glass fiber, an intermediate layer, an outer pane with an interior-side surface II, and an inner pane with an exterior-side surface III,
- (b) Introducing at least one opening in the intermediate layer and routing the glass fiber through the opening,
- 30 (c) Arranging the intermediate layer between the outer pane and the inner pane,
- (d) Bonding the interior-side surface II of the outer pane to the exterior-side surface III of the inner pane via the intermediate layer by lamination.

The lamination is done with customary methods known per se to the person skilled in the art, for example, autoclave methods, vacuum bag methods, vacuum ring methods, calender methods, vacuum laminators, or combinations thereof. The bonding of the outer pane and the inner pane is customarily done under the action of heat, vacuum, and/or pressure.

In an advantageous improvement of the method according to the invention, in the step (b), the opening is stamped or punched, preferably using a needle, a punch, or a suitably shaped punching tool.

In an advantageous improvement of the method according to the invention, in the step (b), the opening is produced by cutting the intermediate layer, preferably with a scalpel, a blade, a knife, or a laser.

A further aspect of the invention includes the use of the composite pane according to the invention in means of transportation for travel on land, in the air, or on water, in particular in trains, watercraft, and motor vehicles, for example, as a windshield, rear window, side pane, and/or roof panel, in buildings, in particular in the access area, window area, roof area, or façade area, as a built-in component in furniture and appliances.

The composite pane according to the invention is particularly preferably a glazing that is frameless in sections, wherein the light-diffusing glass fiber according to the invention is arranged near the frameless side edges. The light-diffusing glass fiber can also be arranged on an inner side edge, for example, in the region of a cutout made in the glazing such as a skylight in a roof panel.

The composite pane according to the invention is preferably implemented as a stationary glazing, in other words, the glazing is arranged stationary relative to its surroundings and fixed, for example, by section-wise fastening, for example, as a windshield in a vehicle or as a glass partition in a building or in a piece of furniture.

The composite pane according to the invention is alternatively implemented as a movable glazing, in other words, the glazing is arranged movable relative to its

surroundings, for example, as glazing arranged movably in a door, such as a side pane in a vehicle door.

Another aspect of the invention includes the use of a lighting means according to the invention in a composite pane arrangement for the identification of an electrical function, preferably a heating function, a movement of the composite pane according to the invention, preferably of an opening or closing side window and/or as a warning function, preferably in the case of a frameless side pane in an opened vehicle door. A preferred use includes the use of the composite pane arrangement for a coming-home function and/or a leaving-home function. Of course, the electrical function which the lighting means identifies is not merely the operation of the lighting means but rather a different function.

Commonly referred to as a "coming-home function" is a function, in which, after leaving a vehicle, the vehicle lighting remains lighted for a certain time and then switches off automatically. This has the purpose of lighting the way from the parking place to the house door, thus making coming home easier as well as keeping the vehicle better visible while getting out.

Commonly referred to as a "leaving-home function" is a function in which, for example, after opening of the vehicle by remote control, the vehicle lighting is turned on to illuminate the way from the house door to the vehicle.

In the following, the invention is explained in detail with reference to drawings and exemplary embodiments. The drawings are schematic depictions and not true to scale. The drawings in no way restrict the invention.

They depict:

- Fig. 1A a plan view of an embodiment of the composite pane arrangement according to the invention,
- Fig. 1B a cross-sectional view along the section line A-A' through the composite pane of Fig. 1A,
- Fig. 1C an enlarged representation of the intermediate layer with glass fiber of the detail Z of Fig. 1A,

- Fig. 1D a cross-section along the section line B-B' of the detail Z of Fig. 1C,  
 Fig. 1E a cross-section along the section line B-B' of the detail Z of Fig. 1C,  
 Fig. 1F a cross-section along the section line B-B' of the detail Z of Fig. 1C after  
 lamination,  
 5 Fig. 2A a plan view of an alternative embodiment of the composite pane  
 arrangement according to the invention,  
 Fig. 2B a cross-sectional view along the section line A-A' through the composite  
 pane of Fig. 2A,  
 Fig. 3A a plan view of an alternative embodiment of the composite pane  
 10 arrangement according to the invention,  
 Fig. 3B a cross-sectional view along the section line A-A' through the composite  
 pane of Fig. 3A,  
 Fig. 3C an enlarged representation of the intermediate layer with glass fiber of  
 the detail Z of Fig. 3A,  
 15 Fig. 4 a flowchart of an embodiment of the method according to the invention.

Fig. 1A depicts a plan view of a composite pane arrangement 100 according to the  
 invention, which comprises a composite pane 10 according to the invention and a  
 lighting means 20. Fig. 1B depicts a cross-sectional view along the section line A-A'  
 20 through the composite pane 10 of Fig. 1A. The composite pane 10 is configured as a  
 roof panel of a passenger car in this example.

The composite pane 10 according to the invention includes an outer pane 1 with an  
 interior-side surface II, an inner pane 2 with an exterior-side surface III, and a  
 25 thermoplastic intermediate layer 3 that bonds the interior-side surface II of the outer  
 pane 1 to the exterior-side surface III of the inner pane 2 via the pane surface. The  
 outer pane 1 and the inner pane 2 are made, for example, of soda lime glass and have,  
 for example, a thickness of 1.5 mm in each case. The thermoplastic intermediate layer  
 3 is, for example, a three-ply film made of polyvinyl butyral (PVB) with a total thickness  
 30 of 0.86 mm. Of course, other glass panes or polymeric panes can also be used as the  
 outer pane and the inner pane. Furthermore, the thickness of the outer pane 1 and the  
 inner pane 2 can be adapted to the respective use.

The glass fiber 4 is, according to the invention, arranged, in sections, between the interior-side surface II of the outer pane 1 and the intermediate layer 3 and, in sections, between the intermediate layer 3 and the exterior-side surface III of the inner pane 2. In the cross-section depicted in Fig. 1B, the glass fiber 4 is arranged between the interior-side surface II of the outer pane 1 and the intermediate layer 3.

The glass fiber 4 has a diameter  $d$  of, for example, 200  $\mu\text{m}$  and is suitable for emitting light via its side wall along its extension length. The light is coupled into the glass fiber 4 via one end face of the glass fiber 4. For this, a lighting means 20 is arranged on one end of the glass fiber 4. The lighting means 20 consists, for example, of a laser diode, which can, for example, couple light into the glass fiber 4 via a reflector. Upon application of a voltage to the laser diode, light is then coupled into the glass fiber 4. The glass fiber 4 then diffuses the light on its surface along its entire extension length such that the glass fiber 4 lights up over its entire extension length.

Fig. 1C depicts an enlarged representation of the intermediate layer 3 with glass fiber 4 of the detail Z of Fig. 1A in a plan view of the side of the intermediate layer 3 facing the interior-side surface II of the outer pane 1. In this exemplary embodiment, the intermediate layer 3 has, in the detail Z, three circular openings 15 that were introduced into the intermediate layer 3, for example, by punching. The glass fiber 4 is alternately routed over to under and under to over through the openings 15 of the intermediate layer 3. Of course, the intermediate layer 3 also has further openings 15 outside of the detail Z shown here, through which the glass fiber 4 is routed. Such an arrangement according to the invention has the particular advantage that the glass fiber 4 is fixedly connected to the intermediate layer 3 and in the production of the composite pane 10 according to the invention cannot slip in its position relative to the intermediate layer 3.

Fig. 1D depicts the detail Z with the elements of the composite pane 10 before lamination. These include the outer pane 1 with an interior-side surface II and the inner pane 2 with an exterior-side surface III as well as a glass fiber 4 and a thermoplastic intermediate layer 3. For production, first, for example, a plurality of openings 15 are introduced into the intermediate layer 3. For example, in the detail Z depicted, three openings 15 are introduced into the intermediate layer 3. For example, for the entire composite pane 10 of Fig. 1A, 20 openings 15 are introduced into the intermediate

layer. Of course, the number of openings 15 can be freely adapted depending on the respective technical conditions, such as, for instance, stiffness of the glass fiber 4, curvature the desired course of the glass fiber 4 in the composite pane 10, etc.

5 Here, the openings 15 are, for example, circular and are cut out of the intermediate layer 3, for example, by a punch. Of course, the openings 15 can also be slot-shaped, for example, in the shape of longitudinal cuts along the extension direction of the glass fiber 4 or in the shape of transverse cuts perpendicular to the extension direction of the glass fiber 4. Of course, the type of opening 15 can also vary and different types of  
10 openings can be combined.

In another process step, the glass fiber 4 is routed through the openings 15 of the intermediate layer 3. The glass fiber 4 is arranged in sections on one side of the intermediate layer 3 and on the other side of the intermediate layer 3 after routing  
15 through one of the openings 15.

Of course, the introduction of the openings 15 and the passage of the glass fiber 4 through the intermediate layer 3 can also be done alternatingly. In other words, first, an opening 15 is introduced into the intermediate layer 3, and subsequently, the glass fiber  
20 4 is routed through the opening 15. After that, another opening 15 is introduced into the intermediate layer 3, and the glass fiber 4 is routed through this other opening 15, and so on.

In another process step, the intermediate layer 3 together with the threaded glass fiber  
25 4 is arranged between the outer pane 1 and the inner pane 2. For example, in that the intermediate layer 3 with the glass fiber 4 is arranged on the exterior-side surface III of the inner pane 2 (arrow P1) and, then, the outer pane 1 is arranged with its interior-side surface II on the intermediate layer 3 (arrow P2). Of course, the stack order can also be reversed.

30

Fig. 1E depicts a cross-section along the section line B-B' of the detail Z of the stack sequence thus produced, before lamination. Since the polymeric intermediate layer 3 is flexible and the glass inner pane 2 and the glass outer pane 1 are largely rigid, the

glass fiber 4 penetrates into a region of the respective adjacent surface of the intermediate layer 3.

In another process step, the outer pane 1, the intermediate layer 3, and the inner pane  
5 2 are bonded by lamination under the action of pressure and temperature.

Fig. 1F depicts a cross-section along the section line B-B' of the detail Z of the composite pane 10 according to the invention, after lamination. By means of the action of pressure and temperature during lamination, the thermoplastic intermediate layer 3  
10 is softened such that the glass fiber 4 is embedded in the surface of the intermediate layer 3. At the same time, the openings 15 are filled with the material of the intermediate layer 3 such that the openings 15 are no longer visible or are not substantially visible when looking through the composite pane 10 according to the invention. The opening  
15 15 is consequently reduced in the optimum case to the space occupied by the glass fiber 4 when routed from one side of the intermediate layer 3 to the opposite side of the intermediate layer 3.

Fig. 2A depicts a plan view of a composite pane arrangement 100 according to the invention that includes a composite pane 10 according to the invention and a lighting  
20 means 20. Fig. 2B depicts a cross-sectional view along the section line A-A' through the composite pane 10 of Fig. 2A. The composite pane 10 is configured in this example as a side pane for a side window of a passenger car.

The composite pane 10 according to the invention includes an outer pane 1 with an  
25 interior-side surface II, an inner pane 2 with an exterior-side surface III, and a thermoplastic intermediate layer 3 that bonds the interior-side surface II of the outer pane 1 to the exterior-side surface III of the inner pane 2 to one another via the pane surface. The outer pane 1 and the inner pane 2 are made, for example, of soda lime glass and have, for example, a thickness of 2.1 mm in each case. The thermoplastic  
30 intermediate layer 3 is, for example, a film made of polyvinyl butyral (PVB) with a thickness of 0.76 mm. Of course, other glass panes or polymeric panes can also be used as the outer pane and inner pane. Furthermore, the thickness of the outer pane 1 and inner pane 2 can be adapted to the respective use.

Here again, the glass fiber 4 is routed through openings 15 of the intermediate layer. An exemplary detailed representation of the detail Z and of the production method is presented in Fig. 1C through 1F and the associated description.

5 The light-defusing glass fiber 4 has a diameter  $d$  of, for example, 200  $\mu\text{m}$  and is suitable for emitting light via its side wall along its extension length. The light is coupled into the glass fiber 4 via one end face of the glass fiber 4. For this, a lighting means 20 is arranged on one end of the glass fiber 4. The lighting means 20 consists, for example, of a laser diode, which can, for example, couple light into the glass fiber 4 via a reflector.

10 Upon application of a voltage to the laser diode, light is coupled into the glass fiber 4. The glass fiber 4 diffuses the light on its surface along its entire extension length such that the glass fiber 4 lights up over its entire extension length.

Here, the composite pane 10 is, for example, a side pane of a vehicle door of a passenger car, and the glass fiber 4 is arranged near the front and top side edge 6 of the composite pane 10. The border of the side pane in the vehicle door is, for example, frameless such that the side pane is guided and inserted into the vehicle door only at its lower side. Here, the lighting means 20 is, for example, a high-performance light-emitting diode.

20 The composite pane arrangement 100 produced with this composite pane 10 is, for example, configured such that, upon opening of the vehicle door, the lighting means 20 is activated and the glass fiber 4 is illuminated. This has the particular advantage that the vehicle door is illuminated in the opened state and is particularly well discernible by other road users. The visibility of the composite pane 10 thus illuminated is particularly increased in the darkness — in particular since the composite pane 10 in this example is frameless and is fastened in the vehicle door only at its lower side edge. The side edge of the composite pane 10 illuminated by the glass fiber 4 is thus freely visible without obstruction.

30 The lighting means 20 can be monochromatic or can identify different states by different colors. Thus, the warning function is particularly high for a red lighting means, since a red color is commonly associated with danger. Green lighting means are readily

discerned in the dark since the human eye has a particularly high sensitivity for the green color spectrum.

5 In another exemplary embodiment, the lighting means 20 has, for example, a red light-emitting diode and a blue light-emitting diode. In that case, the composite pane arrangement 100 is connected, for example, to the vehicle electronic system such that when the composite pane 10 is opened by an electrical window lifter, the glass fiber 4 is illuminated with blue light; and when the composite pane 10 is closed, the glass fiber 4 is illuminated with red light. This has the particular advantage that the direction of  
10 movement of the composite pane 10 relative to the doorframe is thus visible and individuals can quickly recognize the danger of entrapment of body parts or objects in the closing window. Of course, other colors or white light can also be used for the illumination of the glass fiber 4. Furthermore, other functions can also be indicated by the illumination of the composite pane 10 or particularly aesthetic lighting can be  
15 realized.

Composite panes 10 according to the invention can optionally have an additional electrical function and, for example, an electrical heating function. For example, heating means (not shown here), such as heating wires or heating layers can be arranged in  
20 the region between the outer pane 1 and the inner pane 2. Such heating wires are made, for example, of copper or tungsten and have a thickness of, for example, 30  $\mu\text{m}$ . Transparent, electrically conductive coatings, as described above are, for example, known as heating layers. Heating wires and heating layers can be formed, for example, by busbars, for example, strips of a copper foil with a thickness of, for example, 100  
25  $\mu\text{m}$  and a width of, for example, 7 mm. When a voltage is applied to the busbars, a current flows through the heating wires or heating layer, by which means the heating effect is produced. The voltage can be the usual automobile on-board voltage of 14 V, or even a voltage of, for example, 42 V or 48 V. Of course, the voltage can also be a customary supply voltage of, for example, 110 V or 220 V, in particular with the use of  
30 a composite pane according to the invention 10 in building technology, such as a transparent heater. The corresponding level of heating of the composite pane 10 can, again, be indicated by the illumination of the glass fiber 4 by the lighting means 20.

Fig. 3A depicts a plan view of an alternative composite pane arrangement 100 according to the invention, which includes an alternative composite pane 10 according to the invention, and a lighting means 20. Fig. 3B depicts a cross-sectional view along the section line A-A' through the composite pane 10 of Fig. 3A. In this example, the  
 5 composite pane 10 is configured as a windshield of a passenger car.

The composite pane according to the invention 10 includes an outer pane 1 with an interior-side surface II, an inner pane 2 with an exterior-side surface III, and a thermoplastic intermediate layer 3 that bonds the interior-side surface II of the outer  
 10 pane 1 to the exterior-side surface III of the inner pane 2 to one another via the pane surface. The outer pane 1 and the inner pane 2 are made, for example, of soda lime glass and have, for example, a thickness of 2.1 mm in each case. The thermoplastic intermediate layer 3 is, for example, a film made of polyvinyl butyral (PVB) with a thickness of 0.76 mm. Of course, other glass panes or polymeric panes can also be  
 15 used as the outer pane 1 and inner pane 2. Furthermore, the thickness of the outer pane 1 and the inner pane 2 can be adapted to the respective use.

In this exemplary embodiment, two light-diffusing glass fibers 4 are arranged between the outer pane 1 and the inner pane 2. Here again, the glass fibers 4 are routed through  
 20 openings 15 of the intermediate layer 3.

Fig. 3C depicts an exemplary detailed representation of the detail Z of the intermediate layer 3 with glass fiber 4 of the detail Z of Fig. 3A. Here, the openings 15 are implemented, by way of example, as slots perpendicular to the extension direction of  
 25 the glass fiber 4. The width  $b$  of the slots is, for example, 5 mm. The further production method is presented, for example, in Fig. 1D through 1F and the associated description.

The light-defusing glass fibers 4 have a diameter  $d$  of 150  $\mu\text{m}$  in each case and are suitable for emitting light via their side wall along their extension length. The light is  
 30 coupled into the glass fiber 4 via one end face of the glass fiber 4. For this, a lighting means 20 is arranged on one end of each glass fiber 4. The lighting means 20 consists, for example, of a laser diode, which can, for example, couple light into the glass fiber 4 via a reflector. Upon application of a voltage to the laser diode, light is coupled into the

glass fiber 4. The glass fiber 4 then diffuses the light on its surface along its entire extension length such that the glass fiber 4 lights up over its entire extension length.

5 The composite pane 10 has, in this example, on a peripheral edge region of the exterior-side surface III of the inner pane 2, an opaque masking print 7, for example, a black print made of a ceramic ink, which forms a permanent bond with the glass surface III of the inner pane 2, by firing. The masking print 7 has the purpose of blocking the view of the gluing points with which the composite pane 10 is glued into a vehicle body. At the same time, the gluing point is protected against light irradiation and, in particular,  
10 against irradiation by UV light, which would cause accelerated aging of the gluing point.

The glass fibers 4 are arranged, in this example, in the form of a frame in the edge region of the composite pane 10. The distance from the side edge 6 is, for example, 1 cm to 20 cm.

15

Here, the glass fibers 4 are, for example, arranged in a region that is covered from the interior-side surface IV of the inner pane 2 by the masking print 7. This means that the glass fibers 4 cannot be seen from the vehicle interior. In particular, light emitted on the sidewalls of the glass fibers 4 also does not enter the vehicle interior such that  
20 occupants cannot be dazzled or disturbed thereby.

Here, the lighting means 20 is, for example, a high-performance laser diode. The composite pane arrangement 100 produced with this composite pane 10 is, for example, configured such that the lighting means 20, upon locking or unlocking the  
25 vehicle doors, lights the glass fiber 4 for a certain period of time, for example, 1 min. This can occur independent of or simultaneously with the rest of the vehicle lighting. Such illumination can serve as an unambiguous signal to the individual the locking and unlocking, for example, using a radio receiver, that the vehicle is securely locked or unlocked. At the same time, a coming-home or leaving-home function can be realized  
30 therewith.

The lighting means 20 can be monochromatic or can identify different states by different colors. Different colors permit readily distinguishing visually between locking and unlocking the vehicle. If the illumination of the glass fiber 4 is used as a warning

function, a red or orange light can, for example, be used since a red or orange color is commonly associated with danger. Green lighting means are, in particular, readily discerned in the dark since the human eye has particularly sensitivity for the green color spectrum.

5

Of course, the glass fiber 4 need not be arranged along one side edge of a pane or only along one side edge, but can be arranged in any manner desired. In particular, one or a plurality of glass fibers 4 can be arranged in the shape of a symbol, for example, a hazard triangle, or can form lettering.

10

Of course, the glass fiber 4 can also have regions in which light can exit the glass fiber 4 via the sidewalls such that symbols not connected to one another can be illuminated.

Furthermore, of course, in all exemplary embodiments according to the invention, other intermediate layers (not shown here) can be arranged between the intermediate layer 3 and one of the panes 1,2. This is particularly advantageous when the intermediate layer 3 has no adhesive properties, for example, a PET film, which are adhesively bonded to the panes 1, 2 via additional intermediate layers, made, for example, of PVB films. The glass fiber 4 is then routed, for example, through openings of the intermediate layer 3 or other intermediate layers.

20

Fig. 4 depicts a flowchart of an exemplary embodiment of the method according to the invention for producing a composite pane 10 according to the invention. The method according to the invention includes, for example, the following steps:

- 25 (a) Preparing a glass fiber 4, a thermoplastic intermediate layer 3, an outer pane 1 with an interior-side surface II, and an inner pane 2 with an exterior-side surface III;
- (b) Introducing at least one opening 15 in the intermediate layer 3 and routing the glass fiber 4 through the opening 15,
- 30 (c) Arranging the intermediate layer 3 between the outer pane 1 and the inner pane 2;
- (d) Bonding the interior-side surface II of the outer pane 1 to the exterior-side surface III of the inner pane 2 via the intermediate layer 3 by lamination.

## List of Reference Characters:

	1	outer pane
	2	inner pane
5	3	intermediate layer, thermoplastic intermediate layer
	4	glass fiber
	6	side edge
	7	masking print
	10	composite pane
10	15	opening
	20	lighting means
	100	composite pane arrangement
	b	width of the opening 15
15	d	diameter of the light-diffusing glass fiber 4
	A-A'	section line
	B-B'	section line
	P1, P2	arrow
	Z	detail
20	I	exterior-side surface of the outer pane 1
	II	interior-side surface of the outer pane 1
	III	exterior-side surface of the inner pane 2
	IV	interior-side surface of the inner pane 2

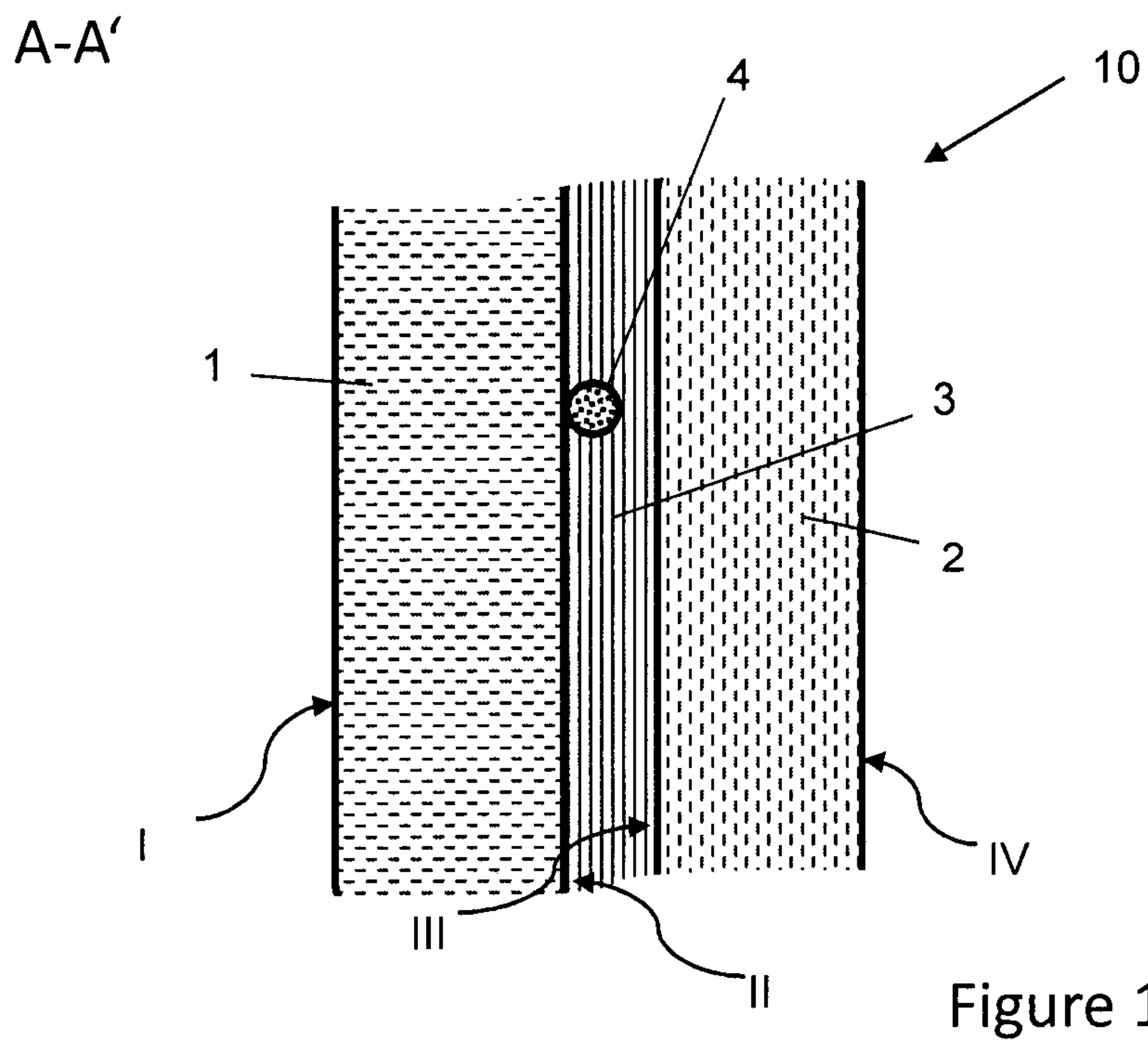
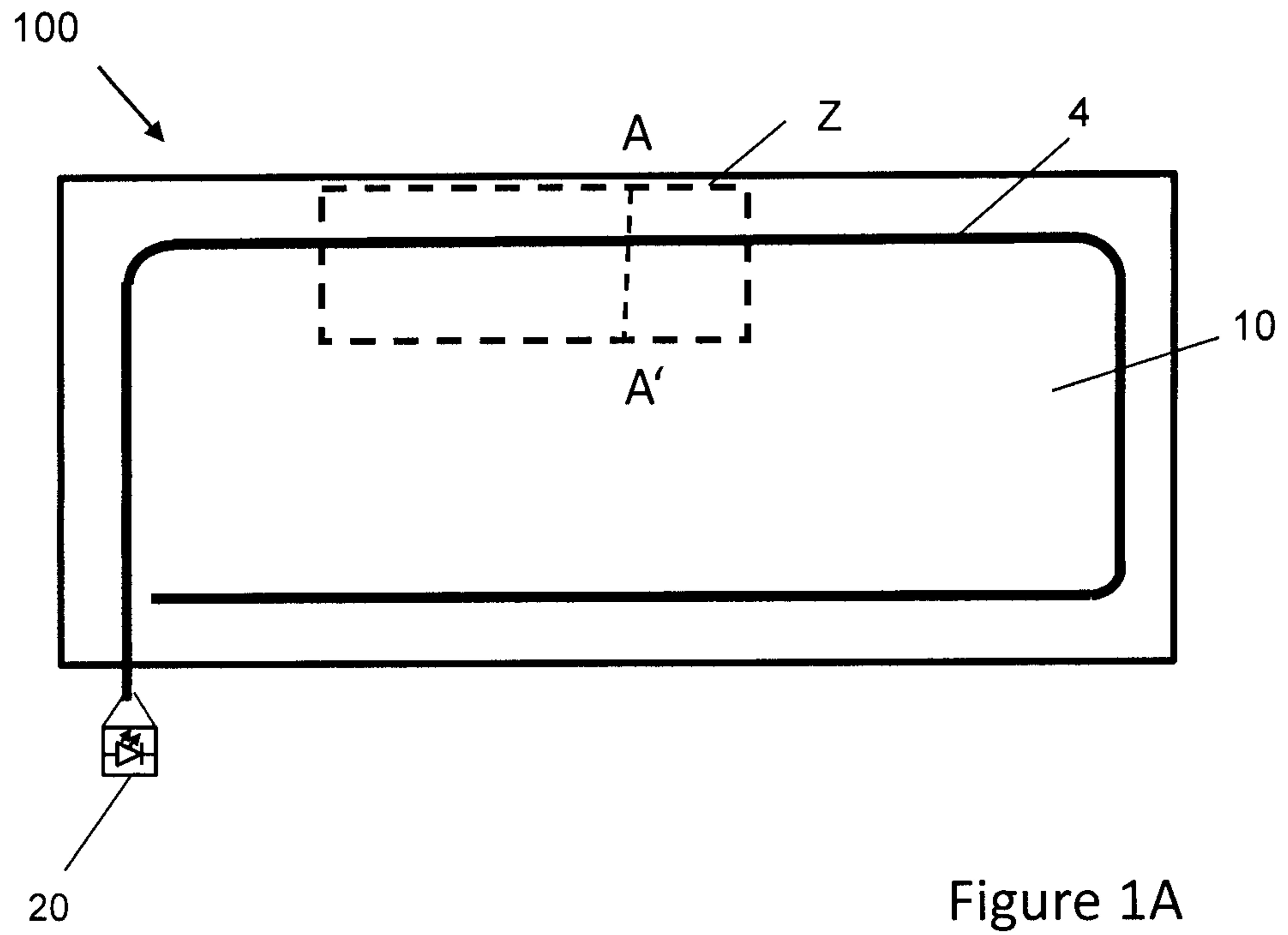
## Claims

1. Composite pane (10), at least comprising:
  - an outer pane (1) and an inner pane (2) that are bonded to one another via an intermediate layer (3), and
  - at least one light-diffusing glass fiber (4) that is suitable for emitting light by diffusion via its side wall along its extension length,
 wherein the glass fiber (4) is arranged, in sections, between the intermediate layer (3) and the outer pane (1) and between the intermediate layer (3) and the inner pane (2) and is routed through at least one opening (15) of the intermediate layer (3).
  
2. Composite pane (10) according to claim 1, wherein the glass fiber (4) is embedded in one surface of the intermediate layer (3).
  
3. Composite pane (10) according to claim 1 and 2, wherein the opening (15) is a circular, elliptical, rectangular, or triangular recess, a punched hole, or a slot, preferably a longitudinal slot or a transverse slot.
  
4. Composite pane (10) according to one of claims 1 through 3, wherein the width  $b$  of the opening (15) perpendicular to the extension direction of the glass fiber (4) is one times the diameter  $d$  of the glass fiber (4) up to 40 times the diameter  $d$ .
  
5. Composite pane (10) according to one of claims 1 through 3, wherein the width  $b$  of the opening (15) perpendicular to the extension direction of the glass fiber (4) is from 0.5 mm to 10 mm, preferably from 1 mm to 5 mm.
  
6. Composite pane (10) according to one of claims 1 through 5, wherein the glass fiber (4) is routed through at least 2, preferably through 3 to 100 openings (15).
  
7. Composite pane (100) according to one of claims 1 through 6, wherein the distance between adjacent openings (15) is from 0.5 cm to 50 cm, preferably from

0.5 cm to 20 cm, particularly preferably from 0.5 cm to 5 cm, and, in particular, from 1 cm to 3 cm.

8. Composite pane arrangement (100), comprising:
- 5       - a composite pane (10) according to one of claims 1 through 7, and  
        - a lighting means (20) for coupling light into the glass fiber (4).
9. Composite pane arrangement (10) according to claim 8, wherein the lighting means (20) contains at least one laser diode or at least one light-emitting diode.
- 10
10. Method for producing a composite pane (10) according to one of claims 1 through 7, at least comprising:
- (a) Preparing a glass fiber (4), a thermoplastic intermediate layer (3), an outer pane (1) with an interior-side surface (II), and an inner pane (2) with an exterior-side surface (III),
- 15       (b) Introducing at least one opening (15) in the intermediate layer (3) and routing the glass fiber (4) through the opening (15),
- (c) Arranging the intermediate layer (3) between the outer pane (1) and the inner pane (2),
- 20       (d) Bonding the interior-side surface (II) of the outer pane (1) to the exterior-side surface (III) of the inner pane (2) via the intermediate layer (3) by lamination.
11. Method according to claim 10, wherein in step (b), the opening (15) is punched out, preferably using a needle or a hole punch.
- 25
12. Method according to claim 10, wherein in step (b), the opening (15) is produced by cutting the intermediate layer (3), preferably with a scalpel, a blade, a knife, or a laser.
- 30   13. Method one of claims 10 through 12, wherein in step (b) an opening (15) with a width  $b$  perpendicular to the extension direction of the glass fiber (4) of 0.5 mm to 10 mm, preferably of 1 mm to 5 mm, is introduced.

14. Use of the composite pane (10) according to one of claims 1 through 7 or the composite pane arrangement (100) according to claim 8 or 9 in means of transportation for travel on land, in the air, or on water, in particular in trains, watercraft, and motor vehicles, for example, as a windshield, rear window, side pane, and/or roof panel, in buildings, in particular in the access area, window area, roof area, or façade area, as a built-in component in furniture and appliances.
- 5
15. Use of a lighting means (20) in a composite pane arrangement (100) according to claim 8 or 9 for the identification of an electrical function, wherein the electrical function is not the operation of the lighting means itself, preferably a heating function and/or a movement of the composite pane (10), preferably an opening or closing side window, for the identification of a position, as a warning function, or for other signaling, in particular for indicating the locking or unlocking of a door and/or of a window of a building or of a vehicle, or as a coming-home function and/or a leaving-home function.
- 10
- 15



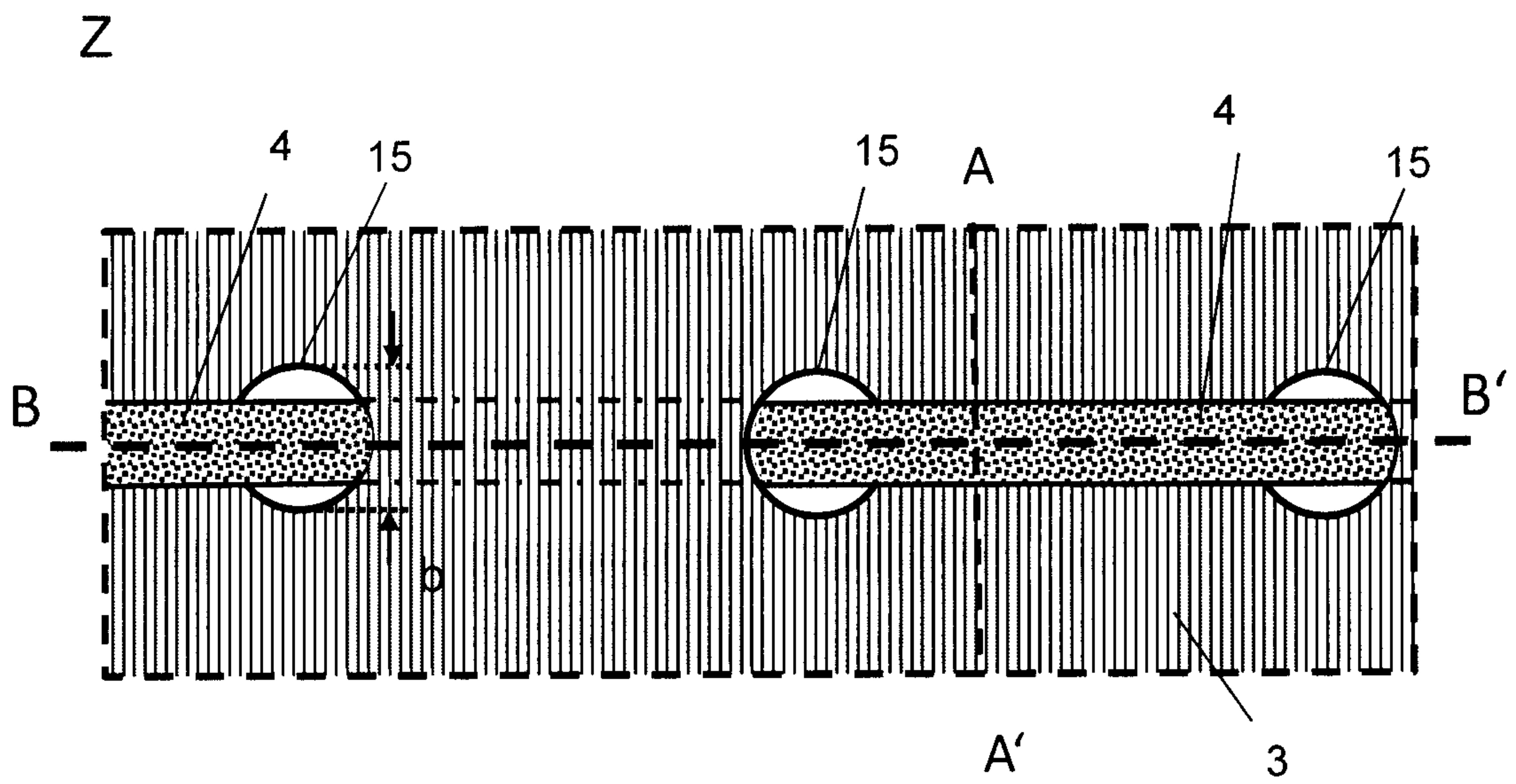


Figure 1C

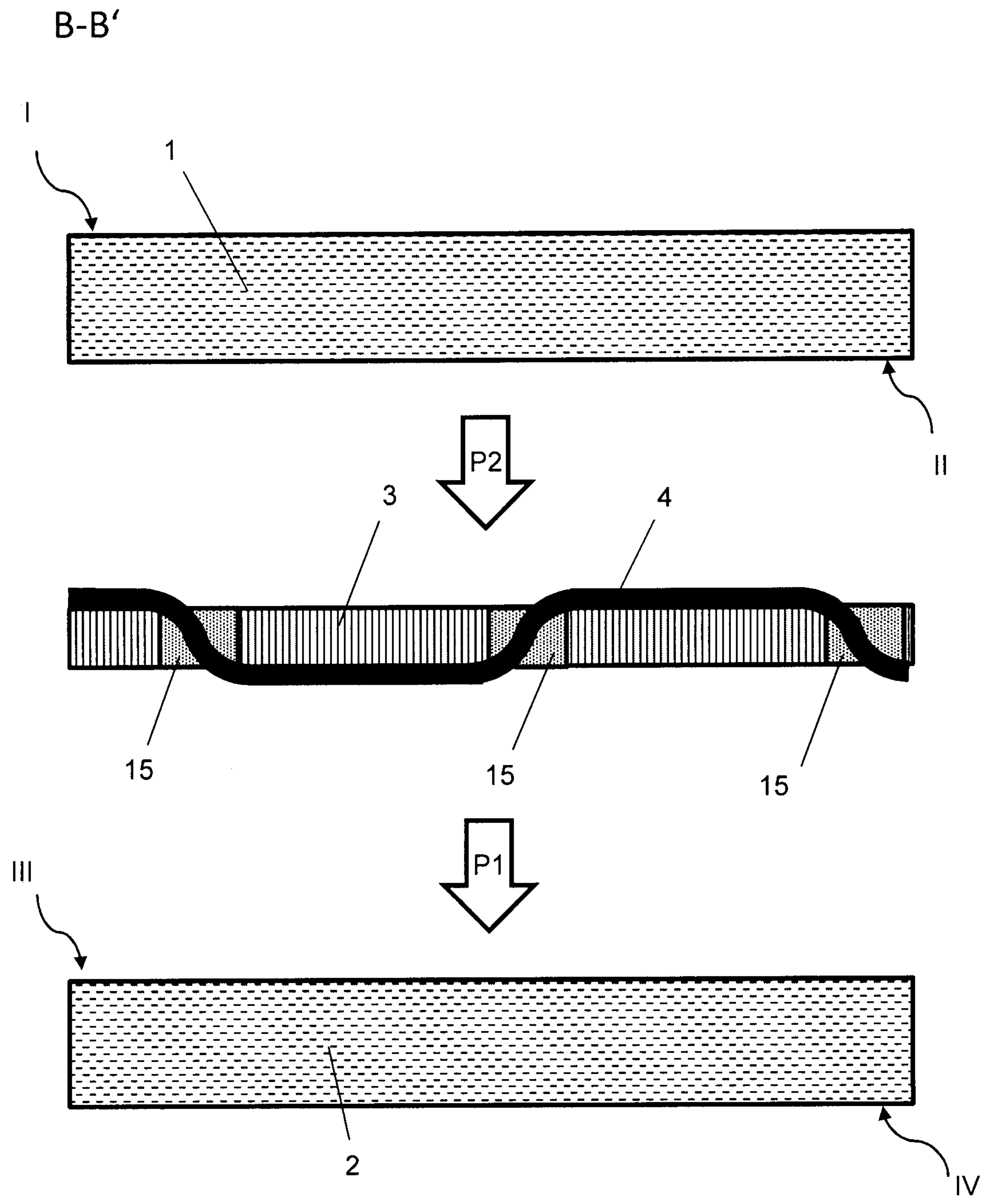


Figure 1D

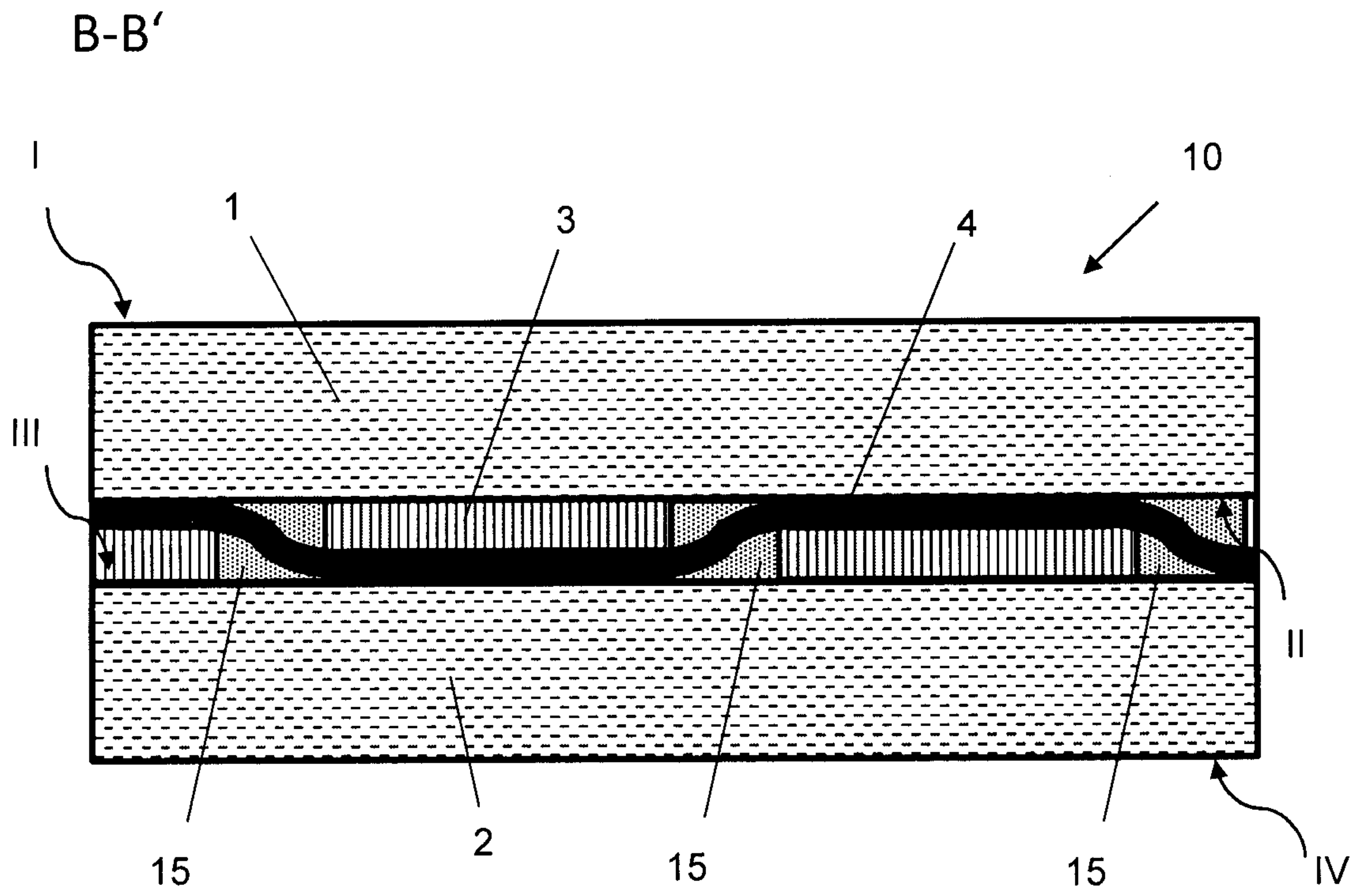


Figure 1E

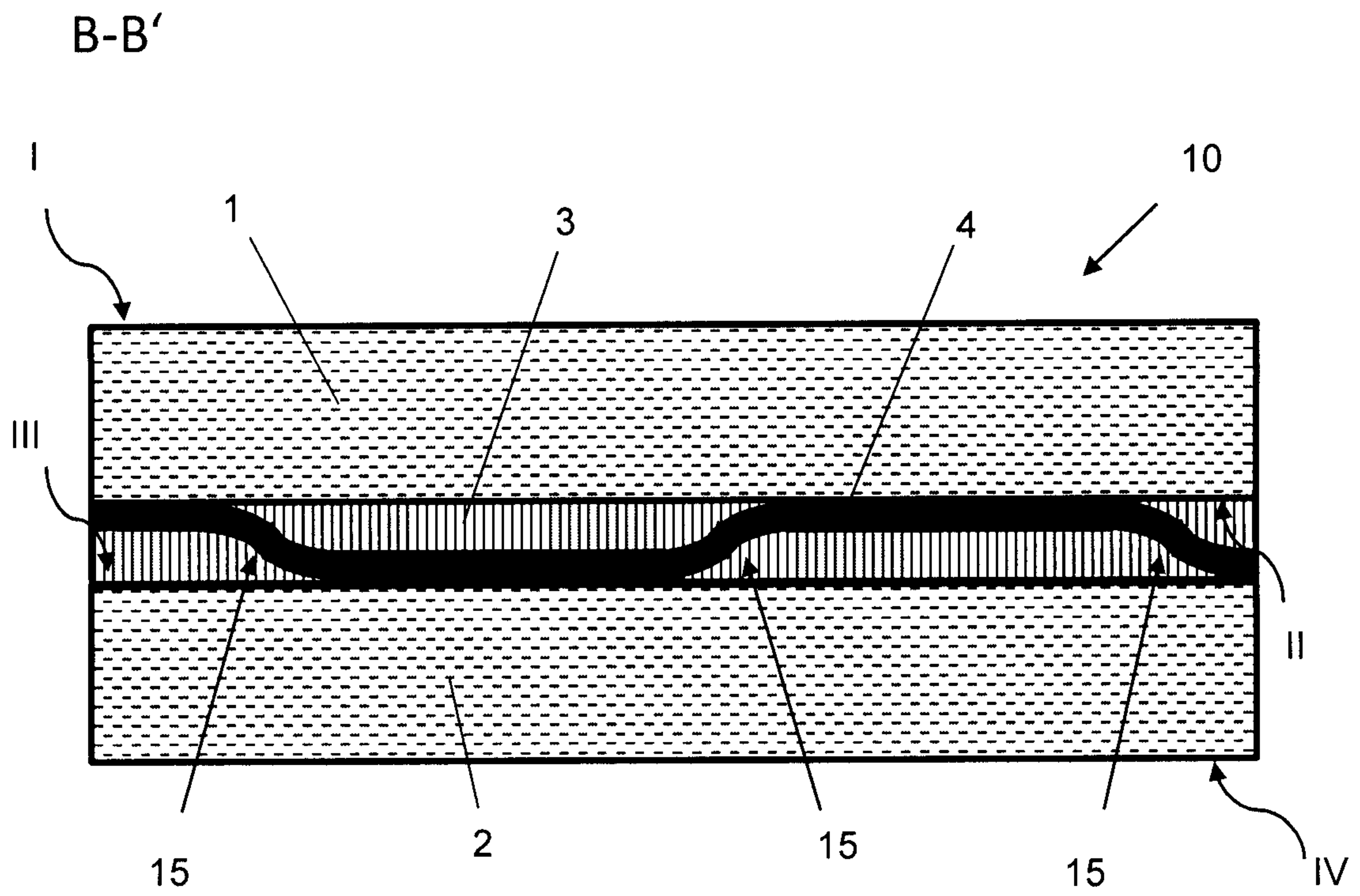


Figure 1F

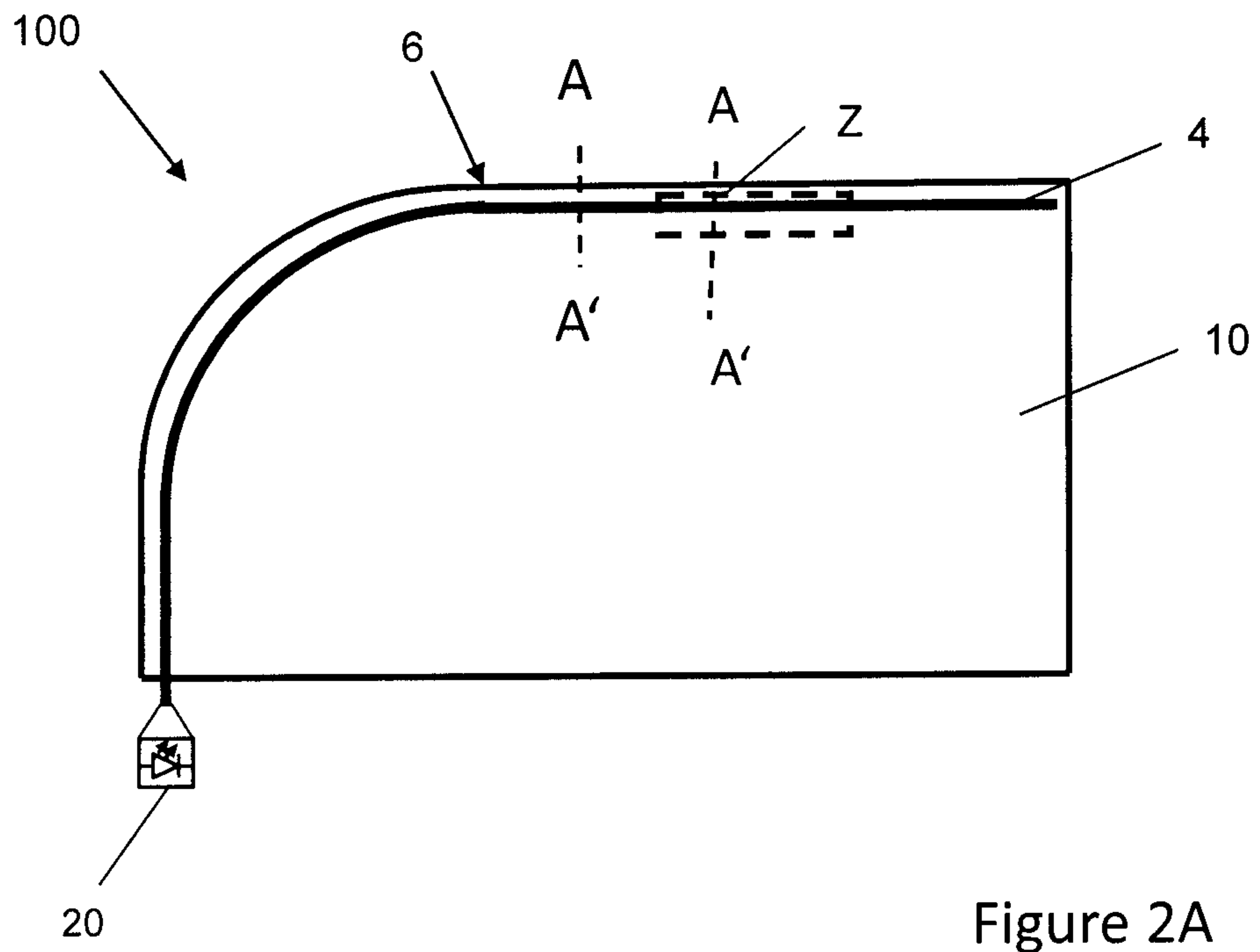


Figure 2A

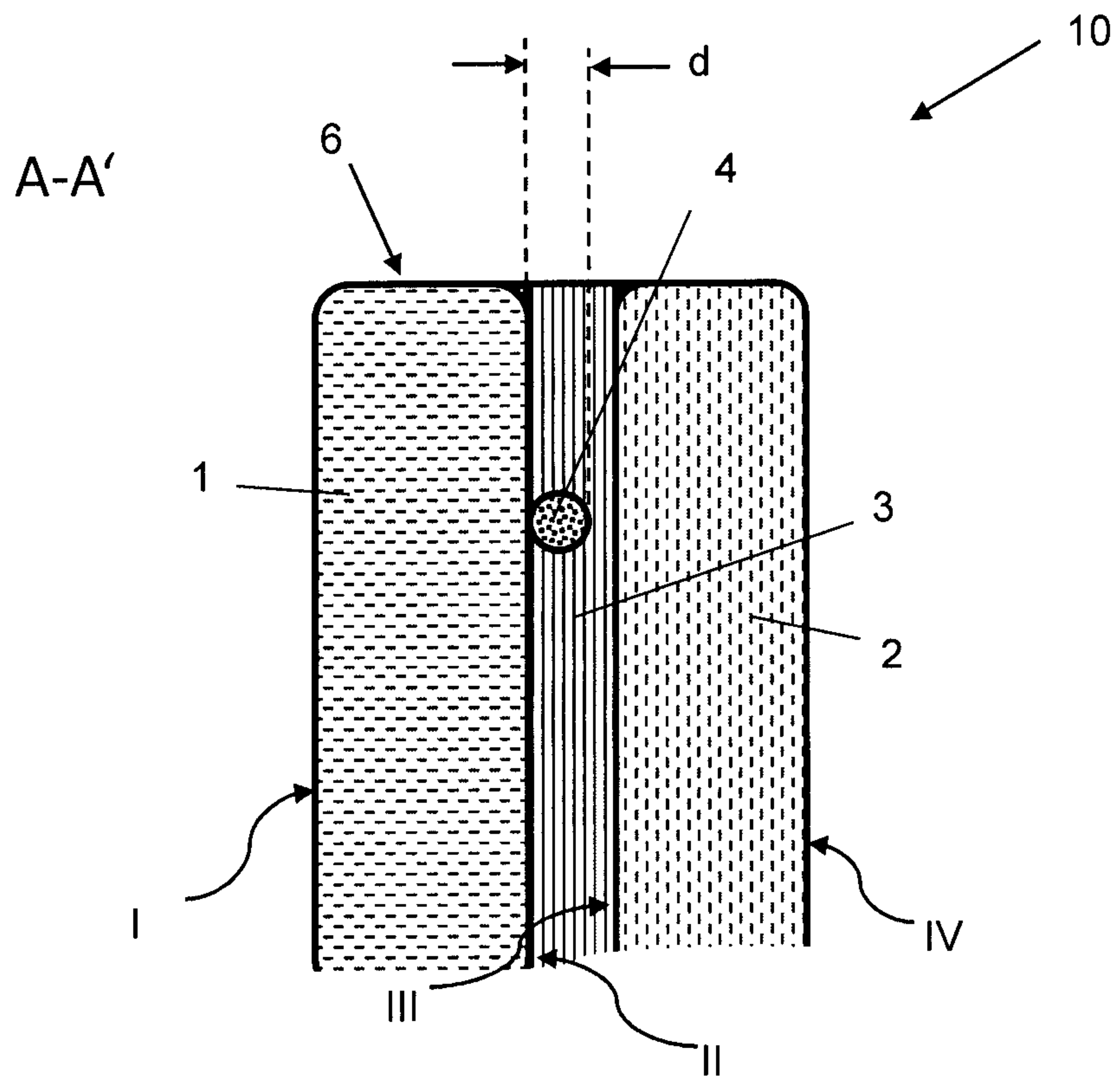


Figure 2B

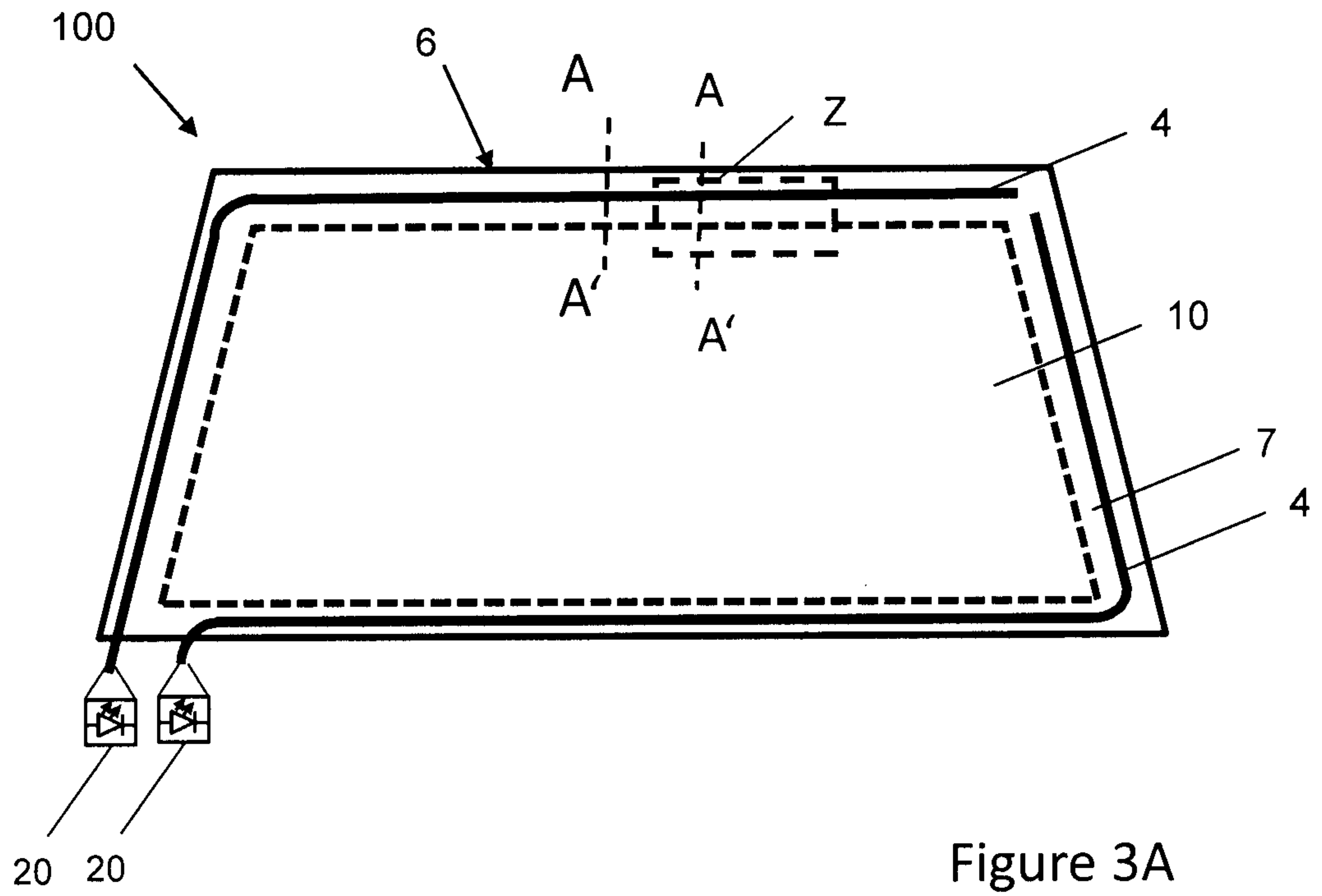


Figure 3A

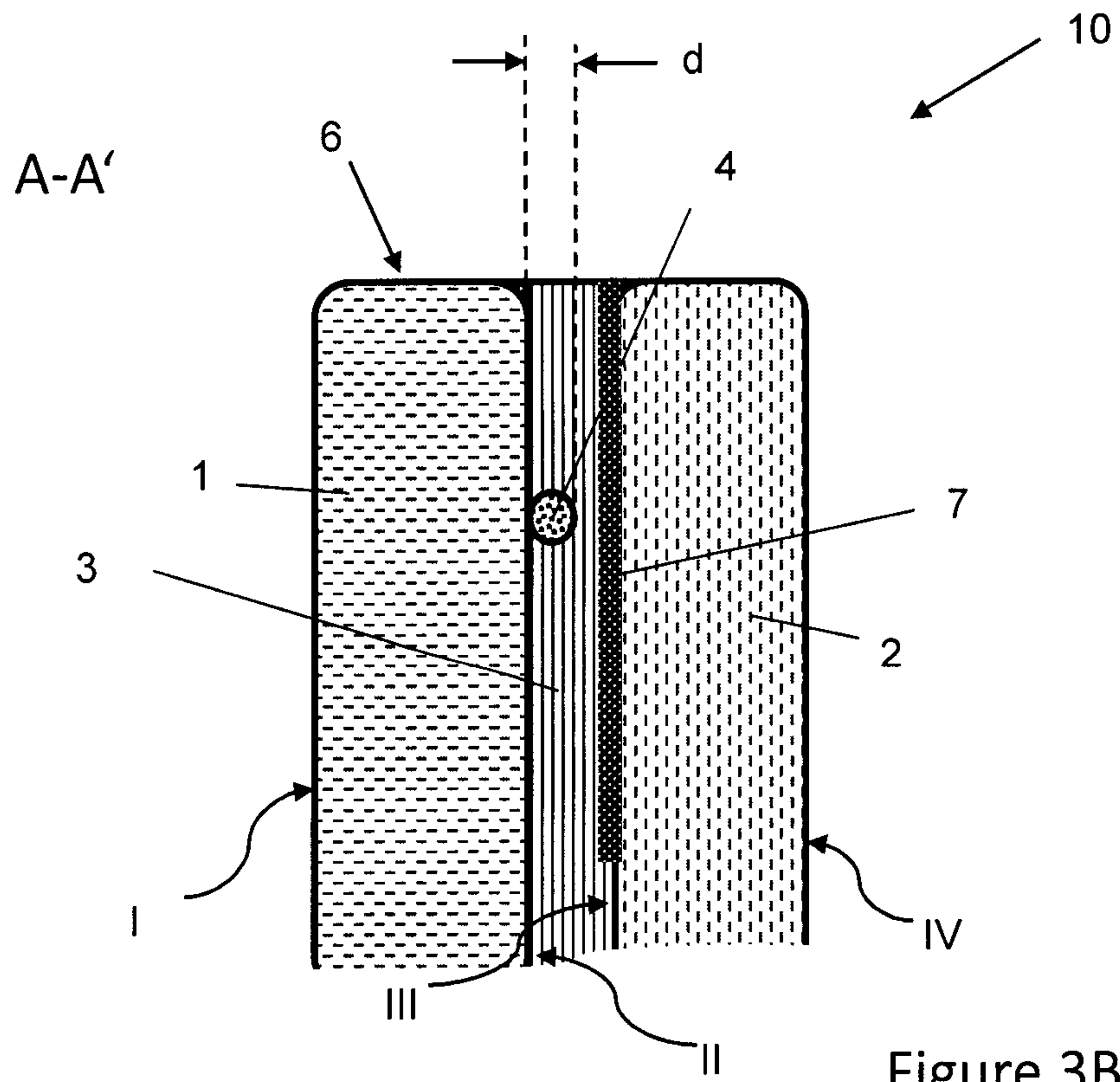


Figure 3B

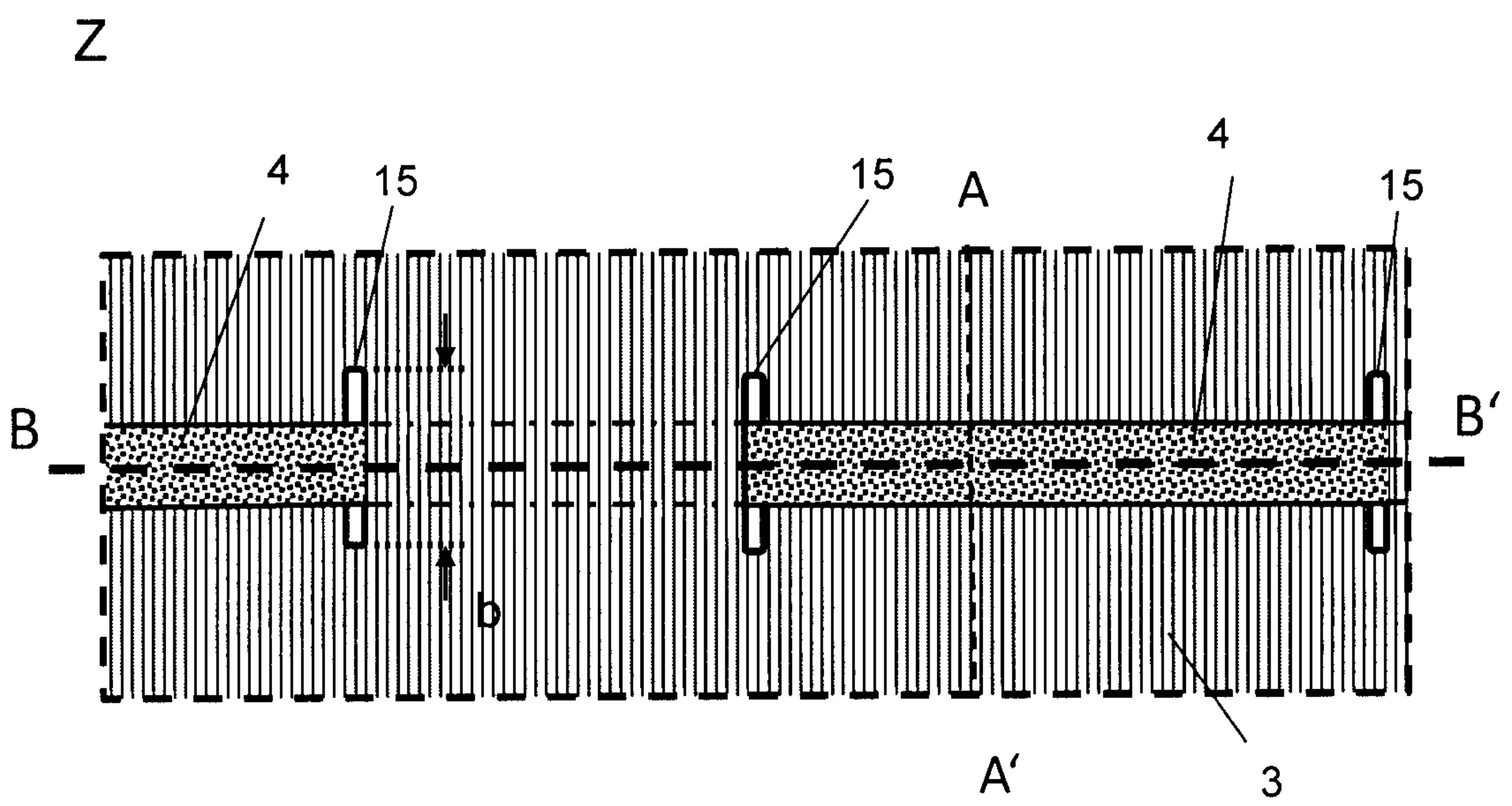


Figure 3C

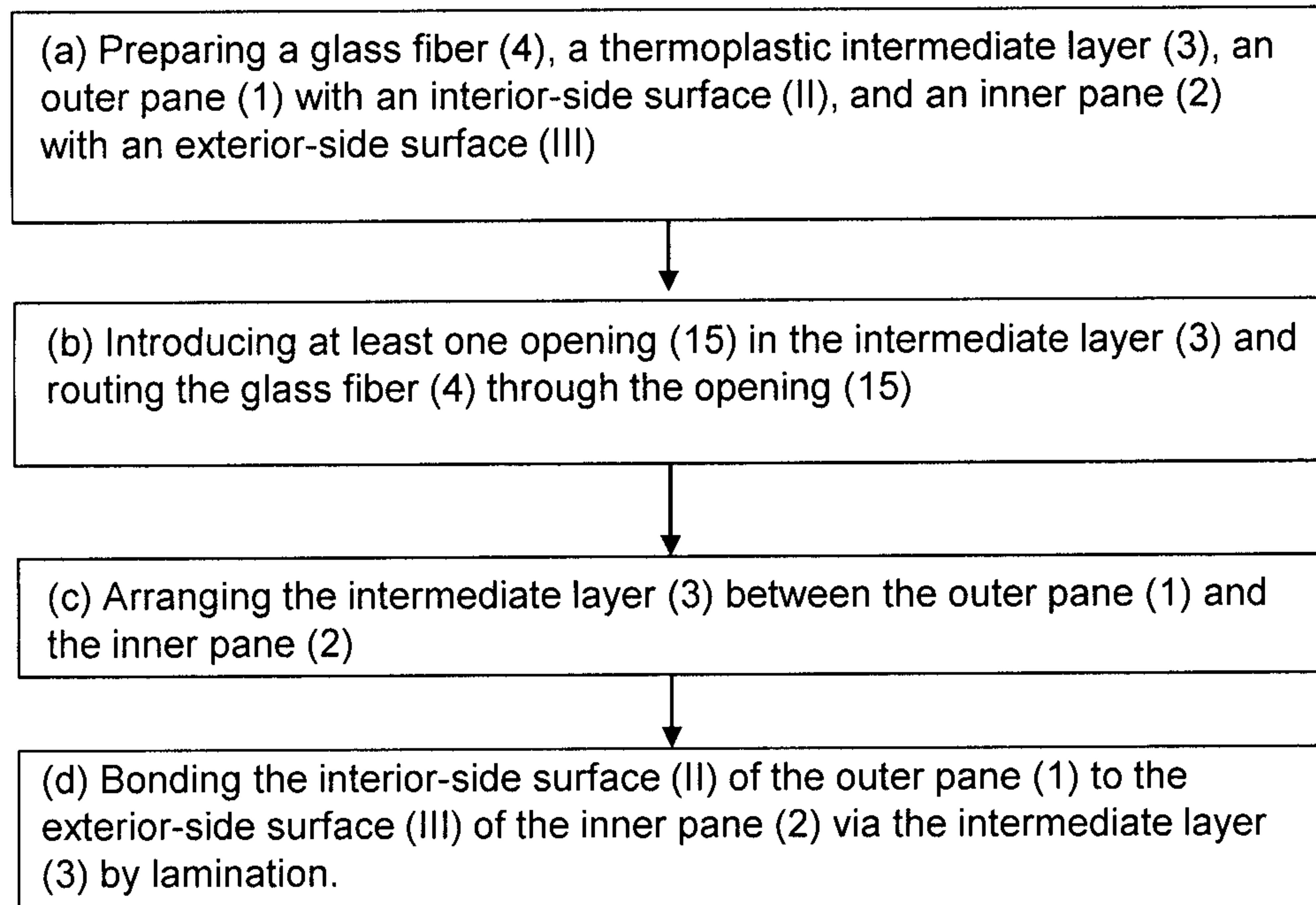
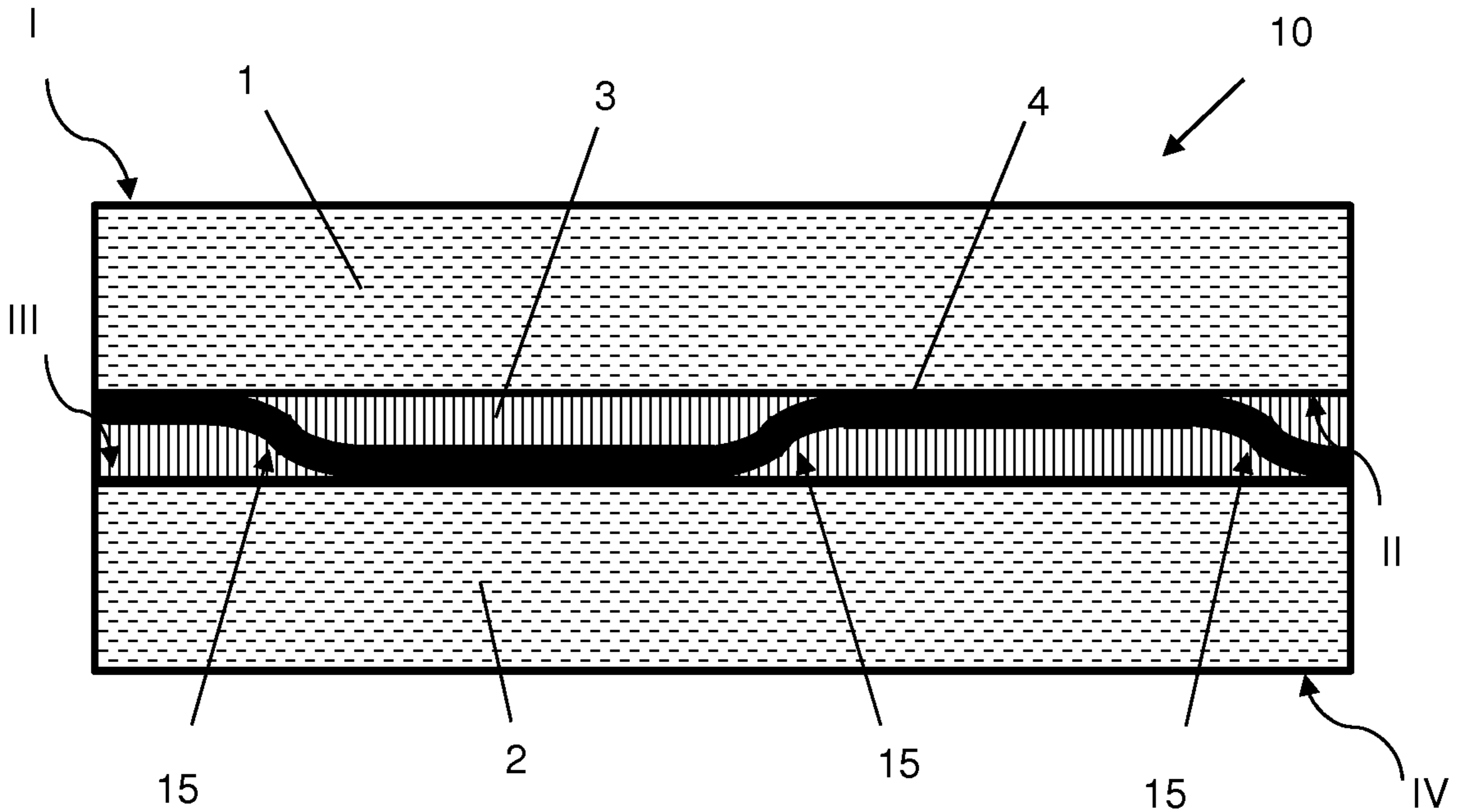


Figure 4

B-B'



Figur 1F