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(54) **Shuttering panel made of a composite and process for manufacturing it by moulding**

(57) The invention relates to a shuttering panel (10) made of a composite, characterized in that it comprises an internal core (28) comprising a plurality of structural elements (46,48,32a,32b), each of which is bounded by at least one fibrous cover (27) which is impregnated with a cured resin, thanks to which said core (28) forms a

skeleton for stiffening the shuttering panel (10) and in that the core (28) is bounded by at least one external fibrous cover (27a) which is impregnated with said cured resin.

The invention also relates to a process for manufacturing the shuttering panel (10) by injection moulding, in which the resin is injected into the fibrous cover (27).

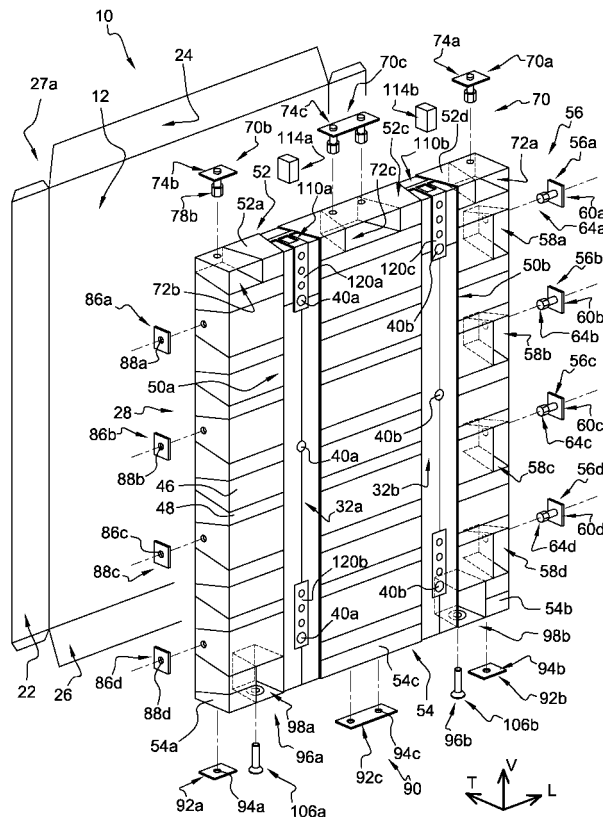


Fig. 2

Description

[0001] The invention relates to a shuttering panel, or a wall form, made of a composite, for example for producing a concrete structure.

[0002] The invention also relates to a process for manufacturing the shuttering panel.

[0003] Many types of shuttering panels are known that are made of a composite for the purpose in particular of addressing the problem of the metal shuttering panels according to the prior art being too heavy.

[0004] In particular, a shuttering panel is known that comprises a sandwich structure made of composites, such as that described in document FR 2.679.582.

[0005] According to the above document, the sandwich-type shuttering panel comprises a cellular plane core which is made of a rigid plastic and is surrounded by a laminated layer.

[0006] The plane core is surrounded by a wooden peripheral frame in order to stiffen the shuttering panel.

[0007] The laminated layer is formed by a plurality of glass fabric plies, each of which is impregnated with a thermosetting resin, here an epoxy resin.

[0008] Such a sandwich panel has a smooth, plane shuttering face and thermal insulation characteristics.

[0009] However, the structure of the sandwich panel lacks rigidity, so that the panel risks being deformed by the concrete thrusting against the shuttering face when shuttering a wall.

[0010] Also known is a type of shuttering panel made of a composite produced by a pultrusion process.

[0011] The pultrusion process consists in pulling fibres impregnated with thermosetting resin through a die mould, in the manner of a lamination process.

[0012] The die mould enables the fibres to undergo a forming operation and the resin impregnated in the fibres to be crosslinked.

[0013] Thus, the objects obtained by the pultrusion process are straight or curved composite sections of constant cross-section.

[0014] Document EP-A1-1.362.966 discloses a shuttering panel produced according to such a pultrusion process.

[0015] According to that document, the panel comprises a front shuttering plate, a rear plate that extends parallel to the front shuttering plate, a first vertical side plate and a second vertical side plate, each of which extends from the rear plate to the front plate.

[0016] In addition, the panel includes a plurality of braces, or reinforcements, each of which extends from the rear plate to the front plate, so as to stiffen the shuttering panel.

[0017] Such a pultruded panel has several drawbacks, these being in particular due to the constant cross-section of the panel, which is inherent in the pultrusion process for manufacturing it.

[0018] Thus, the braces of the panel extend exclusively in a vertical direction or exclusively in a horizontal direc-

tion, in a vertical shuttering plane.

[0019] Now, it is preferable to combine horizontal and vertical braces, or reinforcements, so as to obtain a shuttering panel which, for equivalent volume, benefits from greater structural rigidity.

[0020] In addition, inherently in the pultrusion process, the shuttering panel has a first end and an opposed second end that are each sectioned, and therefore emergent, in such a way that it is difficult to fasten thereto an item of equipment such as a means for attaching it to another shuttering panel.

[0021] Likewise, the sectioned and emergent ends of the shuttering panel are not conducive to good thermal insulation of said shuttering panel, thermal insulation enabling a wall to be protected, during drying, from frost and from high temperatures.

[0022] Thus, the pultrusion process is a manufacturing process that is expensive, difficult to implement and reserved for long production runs.

[0023] The invention proposes a novel concept of shuttering panel, enabling in particular the drawbacks of the prior art to be remedied.

[0024] The invention provides a shuttering panel produced as a one-piece component, the structure of which promotes uniform rigidity of the shuttering panel.

[0025] For this purpose, the invention provides a shuttering panel made of a composite, characterized in that it comprises an internal core comprising a plurality of structural elements, each of which is bounded by at least one fibrous cover which is impregnated with a cured resin, thanks to which said core forms a skeleton for stiffening the shuttering panel.

[0026] According to other features of the shuttering panel:

- structural elements of the core are mutually imbricated so as to form a generally parallelepipedal block, in such a way that said structural elements are connected together by said resin;
- the core is bounded by at least one external fibrous cover which is impregnated with said cured resin, so that said external fibrous cover impregnated with the resin constitutes:

- a vertical front plate, a front shuttering face of which defines the front of the shuttering panel ;
- a vertical rear plate, a rear face of which defines the rear of the shuttering panel; and
- a peripheral frame, which comprises a first vertical side plate, an opposed second vertical side plate, a horizontal top plate and an opposed horizontal bottom plate, each of said plates of the peripheral frame extending from the front shuttering plate to the rear plate of the shuttering panel, so that the shuttering panel constitutes a single component as one entity;

- the core comprises:

-- at least one vertical structural element which extends upwards from the bottom plate to the top plate of the peripheral frame of the shuttering panel, which extends rearwards from the front shuttering plate to the rear plate and which has a trapezoidal horizontal cross-section decreasing towards the front shuttering plate;

-- a first series of horizontal structural elements which each extend horizontally from the first vertical side plate to the second vertical side plate of the shuttering panel, which each extend rearwards from the front shuttering plate to the rear plate and which each have a trapezoidal vertical cross-section decreasing towards the front shuttering plate; and

-- a second series of horizontal structural elements which each extend horizontally from the first vertical side plate to the second vertical side plate of the shuttering panel, which each extend rearwards from the front shuttering plate to the rear plate and which each have a trapezoidal vertical cross-section increasing towards the front shuttering face,

and the horizontal structural elements of said first series and the horizontal structural elements of said second series are fastened together and arranged alternately in a head-to-tail configuration;

- each fibrous cover that bounds the associated structural element has at least one flat extending from the front plate to the rear plate of the shuttering panel, forming a stiffening brace;
- the horizontal structural elements of said first series and the horizontal structural elements of said second series are each intersected by the vertical structural element, in such a way that said horizontal structural elements are each divided into three portions;
- the panel has a parallelepipedal shape and the front shuttering face and the rear face of the shuttering panel are plane and parallel;
- the panel comprises:

-- first male assembly means for joining it onto a neighbouring panel, comprising at least one first (lateral) insert which is embedded in the panel and is pressed against the back of said first side plate, the first (lateral) insert defining a hole for receiving a first (lateral) assembly bolt;

-- second male assembly means for joining it onto a superposed panel, comprising at least one second (top) insert which is embedded in the panel and is pressed against the back of said top plate, the second (top) insert defining a hole for receiving a second (top) assembly bolt ;

-- first female assembly means for joining it onto a neighbouring panel, comprising at least one third (lateral) insert which is embedded in the

panel and is pressed against the back of said second side plate, the third (lateral) insert defining a tapped hole for passage of a complementary assembly bolt; and

-- second female assembly means for joining it onto a lower panel, comprising at least one fourth (bottom) insert which is embedded in the panel and is pressed against the back of said bottom plate, the fourth (bottom) insert defining a tapped hole for passage of a complementary assembly bolt;

- the panel comprises means for adjusting the level of the shuttering panel, comprising at least one fifth (bottom) insert which is embedded in the panel and is pressed against the back of said bottom plate, the fifth (bottom) insert defining a hole for receiving a vertical third (bottom) assembly bolt forming an adjustment foot;
- the panel comprises:

-- at least one first (lateral) recess which is formed in the rear plate and extends towards the front plate, said first (lateral) recess being interposed between the core and the first (lateral) insert so as to allow the first (lateral) bolt associated with the first male assembly means to be manipulated;

-- at least one second (top) recess which is formed in the rear plate and extends towards the front plate, said second (top) recess being interposed between the core and the second (top) insert so as to allow the second (lateral) bolt associated with the second male assembly means to be manipulated; and

-- at least one third (bottom) recess which is formed in the rear plate and extends towards the front plate, said third (bottom) recess being interposed between the core and the fifth (bottom) insert so as to allow the third (bottom) bolt associated with the means for adjusting the level of the shuttering panel to be manipulated;

- the panel comprises means for gripping the shuttering panel, which means comprise:

-- at least one fourth (top) recess which is formed in the top plate of the shuttering panel and extends downwards; and

-- a gripping ring that extends around said gripping bar;

- the panel includes at least one sixth (rear) insert for connecting safety/stabilizing accessories, the sixth (rear) insert being embedded in the panel and pressed against the back of said rear plate, and the sixth (rear) insert defines at least one tapped hole for fastening said accessories;

- each structural element is made of polyurethane foam;
- the resin is a polyester thermosetting or thermoplastic resin.

[0027] The invention also relates to a process for manufacturing the shuttering panel, characterized in that the process is implemented by means of a mould comprising:

- a die, an internal wall of which defines an open internal cavity that has an overall shape complementary to that of the internal core of the shuttering panel; and
- a punch which can occupy a position for closing off the mould, in which the die and the punch together define an internal moulding gap,

and in that the process comprises, in succession:

- a step of preparing the core, a bounding phase of which consists in bounding each of said structural elements of the core with a fibrous cover;
- a step of depositing the core in the gap of the mould;
- a step of closing the mould;
- a step of injecting the resin into the mould in such a way that the resin impregnates said fibrous covers;
- a step of solidifying the impregnated resin in said fibrous covers so as to obtain the shuttering panel; and
- a step of demoulding the shuttering panel.

[0028] According to other features of the process:

- the step of preparing the core includes a first covering phase, which consists in covering the internal cavity of the die of the mould with an external fibrous cover, so as to constitute the peripheral frame and the front plate of the shuttering panel;
- the step of preparing the core includes a first reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould for the formation of the first (lateral) recess associated with the first male assembly means, by means of at least one removable first (lateral) implant that defines an internal blind hold, said first reserving phase consisting in:

- placing the head of the first (lateral) bolt in said blind hole of the first (lateral) implant in such a way that a threaded portion of the first (lateral) bolt projects axially from a first side face of said implant;
- covering at least said first lateral face of the first (lateral) implant with a fibrous cover;
- inserting the associated first (lateral) insert around said threaded portion projecting from the first (lateral) bolt through the through-hole of said first (lateral) insert; and

- placing the assembly formed by the first (lateral) implant, the first (lateral) bolt and the first (lateral) insert into the gap of the mould in such a way that the threaded portion of the first (lateral) bolt is placed in a through-hole in the wall of the die of the mould, and in such a way that the first (lateral) insert is interposed axially between two fibrous covers;

- the step of preparing the core includes a second reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould for the formation of the second (top) recess associated with the second male assembly means, by means of at least one removable second implant;
- the step of preparing the core includes a third reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould for the formation of the third (bottom) recess associated with the means for adjusting the level of the shuttering panel, by means of at least one removable third implant;
- each of said implants is made of an elastically deformable silicone;
- each implant has a shape complementary to the shape of the associated recess and each implant is placed so as to be extractable from the shuttering panel after the step of solidifying the shuttering panel;
- the step of preparing the core includes a placing phase, the placing phase being carried out after said first covering phase and consisting in placing, in the gap of the mould:

- the third (lateral) insert of the first female assembly means in such a way that the third (lateral) insert is interposed between at least two fibrous covers; and
- the fourth (bottom) insert of the second female assembly means in such a way that the fourth (bottom) insert is interposed between at least two fibrous covers;

- the step of depositing the core in the gap of the mould comprises, in succession:

- a first depositing phase, for depositing the structural elements in the gap of the mould so as to form the core into a parallelepipedal block;
- a second depositing phase, which consists in depositing the sixth (rear) insert for connecting safety and stabilizing accessories onto a visible rear face of the core and entirely covering said sixth insert with a fibrous cover;
- a second covering phase, which consists in covering the visible rear face of the core with a fibrous cover so as to constitute the rear plate

of the shuttering panel; and
 -- a phase of cutting the fibrous cover deposited beforehand, said cover covering the rear face of the core, so as to uncover each removable implant so as to allow each implant to be extracted after the step of solidifying the shuttering panel;

- the mould includes:

-- at least one injection duct for injecting the resin into the gap of the mould; and
 -- at least one suction duct, which opens into the gap of the mould,

and the step of injecting the resin consists in injecting the resin into the gap of the mould via the injection duct and simultaneously in sucking out the air contained in the gap via the suction duct so as to create a vacuum in the gap and make the resin flow into said fibrous covers of the shuttering panel; and

- the demoulding step includes a phase of extracting said removable implants.

[0029] Other features and advantages of the invention will become apparent on reading the following detailed description, to understand which the reader should refer to the appended drawings given as non-limiting examples, in which:

- Figure 1 is a perspective overall view illustrating a parallelepipedal shuttering panel made of a composite, which is bounded by a plurality of plates, each of which is made of fibres impregnated with a cured resin, or matrix;
- Figure 2 is a perspective exploded overall view illustrating an internal core of the panel of Figure 1, which comprises a plurality of horizontal and vertical stiffening structural elements;
- Figure 3 is a transverse sectional view on the line 3 - 3 of Figure 1, illustrating the horizontal structural elements of the core of Figure 2 and means for adjusting the level of the shuttering panel;
- Figure 4 is a longitudinal sectional view on the line 4 - 4 of Figure 1, illustrating the vertical structural elements of the core of Figure 2 and means for gripping the shuttering panel;
- Figure 5 is a longitudinal sectional detail on the line 5 - 5 of Figure 1, illustrating a first (lateral) male assembly device which is placed in a first (lateral) recess of the rear plate of the shuttering panel;
- Figure 6 is a longitudinal sectional detail on the line 6 - 6 of Figure 1, illustrating a first (top) male assembly device which is placed in a first (top) recess of the rear plate of the shuttering panel;
- Figure 7 is a longitudinal sectional detail on the line 7 - 7 of Figure 1, illustrating a second (top) male

assembly device which is placed in a second (top) recess of the rear plate of the shuttering panel;

- Figure 8 is a longitudinal sectional detail along the line 8 - 8 of Figure 1, illustrating a first insert of the first (lateral) female assembly means;
- Figure 9 is a longitudinal sectional detail on the line 9 - 9 of Figure 1, illustrating a first insert of the second (bottom) female assembly means;
- Figure 10 is a longitudinal sectional detail on the line 10 - 10 of Figure 1, illustrating a second insert of the second (bottom) female assembly means;
- Figure 11 is a longitudinal sectional detail on the line 11 - 11 of Figure 1, illustrating the means for adjusting the level of the shuttering panel of Figure 3;
- Figure 12 is a transverse sectional detail on the line 12 - 12 of Figure 1, illustrating means for gripping the shuttering panel;
- Figure 13 is a longitudinal sectional schematic view illustrating a mould in an open position, for the manufacture of the shuttering panel of Figure 1 by a manufacturing process according to the invention;
- Figure 14 is a longitudinal sectional schematic view illustrating the mould of Figure 13 in a closed moulding position;
- Figure 15 is a longitudinal sectional view similar to Figure 5, illustrating a removable lateral implant which is placed in the mould for moulding the first (lateral) recess of Figure 5; and
- Figure 16 is a longitudinal sectional view similar to Figure 11, illustrating a removable bottom implant which is placed in the mould for moulding the first (bottom) recess of Figure 11.

[0030] The description and the claims will use, without being limited, the "longitudinal", "vertical" and "transverse" orientations to denote, respectively, elements according to the definitions given in the description and relative to the three coordinates (L, V, T) shown in the figures.

[0031] Likewise, the terms "top" and "bottom" will be used to refer to the vertical orientation and without reference to the Earth's gravity.

[0032] In addition, the terms "left" and "right" will be used with reference to the left-hand part and right-hand part of Figure 1.

[0033] Furthermore, identical, similar or analogous elements of the invention will be denoted by the same reference numerals.

[0034] Figure 1 shows a shuttering panel 10 or wall form, which is made of a composite.

[0035] The shuttering panel 10 has a parallelepipedal general shape and lies here in a longitudinal vertical plane.

[0036] As may be seen in the exploded view in Figure 2, the shuttering panel 10 is formed mainly by an internal core 28 and by an external fibrous cover 27a (only part of which is shown in Figure 2), the core 28 being bounded by the external fibrous cover 27a.

[0037] In the description, the expression "bounded by a fibrous cover" means totally covered by at least one layer of a fibrous reinforcement.

[0038] The fibrous cover 27, 27a is understood to mean a cover comprising, for example, synthetic fibres, such as glass fibres or carbon fibres or aramid fibres, or a cover comprising natural fibres, such as flax fibres or hemp fibres or sisal fibres.

[0039] However, according to the example described here, the expression "fibrous cover" denotes a cover comprising polypropylene fibres and glass fibres.

[0040] In addition, the expression "fibrous cover" denotes a cover impregnated with a resin.

[0041] The term "resin" denotes here, for example, a thermoplastic resin, or matrix, or a thermosetting resin.

[0042] However, according to the example described here, the term "resin" denotes a polyester resin.

[0043] The external fibrous cover 27a, which bounds the internal core 28 of the shuttering panel 10, comprises a first portion, which constitutes a vertical front plate 12 and a peripheral frame, and a second portion constituting a vertical rear plate 16 parallel to the front plate 12.

[0044] For the sake of clarity, that portion of the external fibrous cover 27a constituting the rear plate 16 has not been shown in Figure 2.

[0045] The front plate 12 has a front shuttering face 14 that lies in a vertical longitudinal plane and is shown in Figure 3.

[0046] The vertical front shuttering face 14 is plane and smooth, so that the front shuttering face 14 is capable of forming a structure, such as a concrete wall, with a smooth surface finish.

[0047] Likewise, the rear plate 16 of the shuttering panel 10 has a rear face 18 that lies in a longitudinal vertical plane.

[0048] The rear face 18 is plane, thanks to which it is easy to press thereon an additional reinforcement (not shown) in order to increase the stiffness of the shuttering panel 10.

[0049] The peripheral frame comprises a first (right-hand) vertical side plate 20, a second (left-hand) vertical side plate 22, a horizontal top plate 24 and a horizontal bottom plate 26, each of which extends rearwards from the front shuttering plate 12 to the rear plate 16 of the shuttering panel 10, so as to delimit the shuttering panel 10 laterally.

[0050] The internal core 28 of the shuttering panel 10, shown in Figure 2, is overall parallelepipedal and comprises a plurality of structural elements.

[0051] The core 28 comprises a first (left-hand) vertical structural element 32a and a second (right-hand) vertical structural element 32b, each of which extends upwards from the bottom plate 26 to the top plate 24 of the peripheral frame of the shuttering panel 10.

[0052] As may be seen in Figure 4, the first vertical structural element 32a and the second vertical structural element 32b each extend rearwards from the front shuttering plate 12 to the rear plate 16.

[0053] Each vertical structural element 32a, 32b has here a trapezoidal horizontal cross-section decreasing towards the front shuttering plate 12.

[0054] The first vertical structural element 32a is formed by three vertical uprights fastened together, a first upright 34a of which bears towards the front on the front plate 12, and a second upright 36a and a third upright 38a each bear on the rear plate 16.

[0055] Each vertical upright 34a, 36a, 38a of the first vertical structural element 32a is here a long block of foam, which is bounded by a resin-impregnated fibrous cover 27.

[0056] In the description, the term "foam" denotes a polyurethane foam.

[0057] In addition, the first vertical structural element 32a, formed by the three vertical uprights 34a, 36a, 38a, is bounded by an additional fibrous cover 27 impregnated with the resin 29.

[0058] As may be seen in Figure 2, the first vertical structural element 32a defines three through-holes 40a that pass through the shuttering panel 10, each through-hole 40a extending transversely rearwards from the front plate 12 to the rear plate 16, for passage of a shuttering rod (not shown) for fastening the shuttering panel 10 to another shuttering panel (not shown) juxtaposed thereto.

[0059] The fibrous cover 27 which bounds the first vertical structural element 32a includes in particular a first lateral flat 42a and a second lateral flat 44a, each of which extends from the front plate 12 to the rear plate 16 of the shuttering panel 10, forming a stiffening brace, shown in Figure 4.

[0060] The second vertical structural element 32b defines three through-holes 40b that pass through the shuttering panel 10, each through-hole 40b extending transversely rearwards from the front plate 12 to the rear plate 16, for passage of a shuttering rod (not shown), for fastening the shuttering panel 10 to another shuttering panel (not shown) juxtaposed thereto.

[0061] The second vertical structural element 32b here is identical to the first vertical structural element 32a and is placed symmetrically in a transverse vertical mid-plane of symmetry.

[0062] Consequently, the second structural element 32b has not been described in detail for the sake of clarity.

[0063] Complementarily, the core 28 comprises a first series of horizontal structural elements 46 and a second series of horizontal structural elements 48.

[0064] The horizontal structural elements 46, 48 each extend rearwards from the front shuttering plate 12 to the rear plate 16.

[0065] Likewise, the horizontal structural elements 46, 48 each extend horizontally from the first (right-hand) vertical side plate 20 to the second (left-hand) vertical side plate 22 of the shuttering panel 10, except for four horizontal structural elements that are placed set back towards the left relative to the first (right-hand) side plate so as to reserve four spaces for assembly means described in the rest of the description.

[0066] Each horizontal structural element 46 of the first series has here a trapezoidal vertical cross-section decreasing towards the front shuttering plate 12, as may be seen in Figure 3.

[0067] Conversely, each horizontal structural element 48 of the second series has here a trapezoidal vertical cross-section increasing towards the front shuttering plate 12.

[0068] The horizontal structural elements 46 of the first series and the horizontal structural elements 48 of the second series are fastened together and mutually imbricated so as to form an overall parallelepipedal block and arranged alternately in a head-to-tail fashion.

[0069] As may be seen in Figure 2, the horizontal structural elements 46, 48 are each divided into three portions in such a way that between them they define a first housing 50a of trapezoidal cross-section, in which the first vertical structural element 32a is placed, and a second housing 50b of trapezoidal cross-section, in which the second vertical structural element 32b is placed.

[0070] The portions of the horizontal structural elements 46, 48 are each formed by a long block of foam which is bounded by a resin-impregnated fibrous cover 27.

[0071] To give the core 28 its overall parallelepipedal shape, the core 28 includes an additional first (top) horizontal structural element of non-trapezoidal cross-section, which is placed vertically beneath the top plate 24 of the shuttering panel 10.

[0072] The first additional horizontal structural element 52 is divided into four portions, a first portion 52a and a second portion 52b of which are placed on either side of the first vertical structural element 32a, and a third portion 52c and a fourth portion 52d of which are placed on either side of the second vertical structural element 32b, so as to reserve spaces in the core 28 for placing male assembly means described in the rest of the description.

[0073] Each portion 52a, 52b, 52c, 52d of the first additional horizontal structural element 52 is formed by a long block of foam bounded by a resin-impregnated fibrous cover 27.

[0074] Likewise, the core 28 includes a second (bottom) additional horizontal structural element 54 of non-trapezoidal cross-section, which is placed vertically above the bottom plate 26 of the shuttering panel 10.

[0075] The second additional horizontal structural element 54 is divided into three portions, a first portion 54a of which is placed in a first (left-hand) bottom corner of the shuttering panel 10, a second portion 54b of which is placed in a second (right-hand) bottom corner of the shuttering panel 10 and a third, central portion 54c of which is interposed between the first vertical structural element 32a and the second vertical structural element 32b so as to reserve spaces in the core 28 for placing adjustment means described in the rest of the description.

[0076] Each portion 54a, 54b, 54c of the second additional horizontal structural element 54 is formed by a long

block of foam bounded by a resin-impregnated fibrous cover 27.

[0077] According to another aspect, the shuttering panel 10 includes first (right-hand) lateral male assembly means 56 for joining the shuttering panel 10 onto an adjacent shuttering panel (not shown).

[0078] The first lateral male assembly means 56 comprise a first right-hand male assembly device 56a which is placed in a first right-hand lateral recess 58a, as may be seen in detail in Figure 5.

[0079] The first right-hand lateral recess 58a extends transversely forwards, from the rear plate 16 of the shuttering panel 10, in such a way that the first right-hand lateral recess 58a runs rearwards into the rear face 18 of the shuttering panel 10.

[0080] The first right-hand lateral recess 58a is delimited vertically by two horizontal structural elements 48 and longitudinally by a horizontal structural element 46 and a portion for assembling the vertical right-hand side plate 20.

[0081] Finally, the first right-hand lateral recess 58a is delimited at the front by the front plate 12 of the shuttering panel 10.

[0082] In addition, the walls of the first right-hand lateral recess 58a are formed by an additional resin-impregnated fibrous cover 27.

[0083] The first right-hand male assembly device 56a includes a first right-hand lateral metal insert 60a which delimits a hole 62a.

[0084] The first right-hand lateral insert 60a is sandwiched between the right-hand side plate 20 and the additional fibrous cover 27 of the first right-hand lateral recess 58a.

[0085] Finally, the first right-hand male assembly device 56a includes a first lateral bolt 64a that extends longitudinally through the hole 62a in the first right-hand lateral insert 60a and the right-hand side plate 20, in such a way that the first lateral bolt 64a is held captive in the first right-hand lateral recess 58a.

[0086] Thus, a threaded portion 68a of the first lateral bolt 64a can project axially relative to the right-hand side plate 20 so as to be screwed onto an adjacent shuttering panel (not shown).

[0087] The first lateral bolt 64a has a head 66a with a frustoconical bearing surface that cooperates with a complementary bore of the first right-hand lateral insert 60a, forming self-centring means.

[0088] The first male assembly means 56 include here a second right-hand lateral male assembly device 56b which is placed in a second right-hand lateral recess 58b and includes a second right-hand lateral insert 60b cooperating with an associated second lateral bolt 64a.

[0089] Likewise, the first male assembly means 56 include a third right-hand lateral male assembly device 56c which is placed in a third right-hand lateral recess 58c and includes a third right-hand lateral insert 60c cooperating with an associated third lateral bolt 64c.

[0090] Finally, the first male assembly means 56 in-

clude a fourth right-hand lateral male assembly device 56d which is placed in a fourth right-hand lateral recess 58d and includes a fourth right-hand lateral insert 60d cooperating with an associated fourth lateral bolt 64d.

[0091] The second, third and fourth right-hand lateral male assembly devices 56b, 56c, 56d are similar to the first right-hand lateral male assembly device 56a described above and are distributed vertically upwards in a regular manner, as illustrated in Figure 1. Consequently, they will not be described in detail for the sake of clarity.

[0092] Thus, the first right-hand lateral male assembly means 56 can cooperate with complementary female assembly means of an adjacent shuttering panel.

[0093] The shuttering panel 10 includes second (top) male assembly means 70 for joining the shuttering panel 10 onto a superposed panel (not shown).

[0094] The second male assembly means 70 include a first top male assembly device 70a which is placed in a first top recess 72a, in the top right corner of the shuttering panel 10, as may be seen in detail in Figure 6.

[0095] The first top recess 72a extends transversely forwards, from the rear plate 16 of the shuttering panel 10, in such a way that the first top recess 72a runs rearwards into the rear face 18 of the shuttering panel 10.

[0096] The first top recess 72a is delimited vertically by a horizontal structural element 48 and by the top plate 24.

[0097] The first top recess 72a is delimited longitudinally from left to right by the third portion 52c of the first additional horizontal structural element 52 and by the first (right-hand) side plate 20.

[0098] Finally the first top recess 72a is delimited towards the front by the front plate 12 of the shuttering panel 10.

[0099] In addition, the walls of the first top recess 72a are formed by an additional resin-impregnated fibrous cover 27.

[0100] The first top male assembly device 70a includes a first top metal insert 74a that delimits a hole 76a.

[0101] The first top insert 74a is sandwiched between the top plate 24 and the additional fibrous cover 27 of the first top recess 72a.

[0102] Finally, the first top male assembly device 70a includes a first top bolt 78a which extends longitudinally through the hole 76a of the first top insert 74a and the top plate 24, in such a way that the first top bolt 78a is held captive in the first top recess 72a.

[0103] Thus, a threaded portion 80a of the first top bolt 78a can project axially relative to the top plate 24 so as to be screwed into a superposed shuttering panel (not shown).

[0104] The first top bolt 78a has a head 82a with a frustoconical bearing surface that cooperates with a complementary bore of the first top insert 74a, forming self-centring means.

[0105] The second male assembly means 70 comprise a second top male assembly device 70b which is placed in a second top recess 72b, in the top left corner of the

shuttering panel 10, as may be seen in detail in Figure 6.

[0106] The second top male assembly device 70b includes a second top insert 74b that cooperates with an associated second top bolt 78b.

[0107] Likewise, the second male assembly means 70 include a third top male assembly device 70c which is interposed longitudinally between the first vertical structure element 32a and the second vertical structural element 32b, in a third top recess 72c, as may be seen in detail in Figure 6.

[0108] The third top male assembly device 70c includes a third top insert 74c that cooperates with a pair of third associated top bolts 78c, as shown in Figure 7.

[0109] The second and third top male assembly devices 70b, 70c are similar to the first top male assembly device 70a described above. Therefore, they will not be described in detail for the sake of clarity.

[0110] Thus, the second top male assembly means 70 can cooperate with complementary female assembly means of a superposed shuttering panel.

[0111] According to another aspect, the shuttering panel 10 comprises first (left-hand) lateral female assembly means 84 for joining the shuttering panel 10 onto an adjacent shuttering panel (not shown).

[0112] As may be seen in Figures 1, 2 and 8, the first (left-hand) lateral female assembly means 84 comprise a first (left-hand) lateral insert 86a, a second (left-hand) lateral insert 86b and a third (left-hand) lateral insert 86c and a fourth (left-hand) lateral insert 86d, each of which is sandwiched longitudinally between the second (left-hand) side plate 22 of the shuttering panel 10 and a horizontal structural element 46 of the core 28.

[0113] In addition, a fibrous cover 27 is interposed longitudinally between each left-hand lateral insert 86a, 86b, 86c, 86d and the associated horizontal structural element 46.

[0114] The left-hand lateral inserts 86a, 86b, 86c, 86d are arranged vertically downwards in a regular fashion, in such a way that they can cooperate with complementary male assembly means of an adjacent shuttering panel.

[0115] For this purpose, each left-hand lateral insert 86a, 86b, 86c, 86d is a metal plate that lies in a transverse vertical plane and delimits a tapped hole 88a, 88b, 88c, 88d respectively.

[0116] Finally, each left-hand lateral insert 86a, 86b, 86c, 86d is placed in a complementary cavity (not shown) formed in the associated horizontal structural element 46, 48, in such a way that each left-hand lateral insert 86a, 86b, 86c, 86d is flush with the associated horizontal structural element 46, 48.

[0117] Thus, the shuttering panel 10 comprises second (bottom) female assembly means 90 for joining the shuttering panel 10 onto a lower shuttering panel (not shown).

[0118] As may be seen in Figures 1, 2 and 9, the second (bottom) female assembly means 90 comprise a first bottom insert 92a which is sandwiched vertically between

the bottom plate 26 of the shuttering panel 10 and the first portion 54a of the second additional horizontal structural element 54.

[0119] In addition, a fibrous cover 27 is interposed vertically between the first bottom insert 92a and the first portion 54a.

[0120] The first bottom insert 92a is a metal plate that lies in a horizontal plane and delimits a first tapped bottom hole 94a of vertical axis.

[0121] Likewise, the second (bottom) female assembly means 90 include a second bottom insert 92b which is sandwiched vertically between the bottom plate 26 of the shuttering panel 10 and the second portion 54b of the second additional horizontal structural element 54.

[0122] In addition, a fibrous cover 27 is interposed vertically between the second bottom insert 92b and the second portion 54b.

[0123] The second bottom insert 92b is a metal plate that lies in a horizontal plane and delimits a second tapped bottom hole 94b of vertical axis.

[0124] Finally, as may be seen in Figure 10, the second (bottom) female assembly means 90 include a third bottom insert 92c which is sandwiched vertically between the bottom plate 26 of the shuttering panel 10 and the central third portion 54c of the additional second horizontal structural element 54.

[0125] In addition, a fibrous cover 27 is interposed vertically between the third bottom insert 92c and the central third portion 54c.

[0126] The third lower insert 92c is a metal plate that lies in a horizontal plane and delimits a pair of third tapped bottom holes 94c of vertical axis.

[0127] The bottom inserts 92a, 92b, 92c are arranged longitudinally in a regular fashion, in such a way that they can cooperate with complementary male assembly means of a lower shuttering panel.

[0128] Finally, each bottom insert 92a, 92b, 92c is placed in a complementary cavity (not shown) formed in the second additional horizontal structural element 54, in such a way that each bottom insert 92a, 92b, 92c is flush with the associated additional horizontal structural element 54.

[0129] According to another aspect, the shuttering panel 10 includes bottom adjustment means 96 for adjusting the level of the shuttering panel 10, as shown in Figure 2.

[0130] The adjustment means 96 comprise a first (left-hand) adjustment device 96a which is placed in a first bottom recess 98a, this being interposed longitudinally between the first section 54a of the second additional horizontal structural element 54 and the first vertical structural element 32a.

[0131] The first bottom recess 98a extends transversely forwards from the rear face 16 of the shuttering panel 10, in such a way that the first bottom recess 98a runs rearwards into the rear face 18 of the shuttering panel 10.

[0132] The first bottom recess 98a is delimited vertically upwards by a horizontal structural element 46 and

by the bottom plate 26 of the peripheral frame of the shuttering panel 10.

[0133] Finally, the first bottom recess 98a is delimited forwards by the front plate 12 of the shuttering panel 10.

[0134] In addition, the walls of the first bottom recess 98a are formed by an additional resin-impregnated fibrous cover 27.

[0135] As may be seen in Figure 11, the first bottom recess 98a has a first boss 100a that extends vertically upwards in the first bottom recess 98a, from the bottom plate 26.

[0136] The first boss 100a here has a frustoconical shape of upwardly decreasing cross-section and is formed by a portion of the fibrous cover 27 that constitutes the walls of the first bottom recess 98a.

[0137] The first boss 100a is delimited upwards by a circular portion that extends horizontally and delimits a fourth bottom hole 102a of vertical axis.

[0138] Advantageously, the first boss 100a includes a fourth bottom insert 104a in the form of a washer that extends around the fourth bottom hole 102a.

[0139] The fourth bottom insert 104a is sandwiched vertically between two fibrous covers 27.

[0140] The first (left-hand) adjustment device 96a comprises a first bottom bolt 106a with a vertical axis, forming an adjustment foot, which bolt is screwed into the fourth bottom hole 102a and into the fourth bottom insert 104a, in such a way that the first bottom bolt 106a can be adjusted along a vertical axis.

[0141] The first bottom bolt 106a has an upper portion placed in the first bottom recess 98a and cooperating with a first nut 108a.

[0142] Likewise, the first bottom bolt 106a has a lower portion of flared shape that can bear vertically on the ground, thanks to which it is possible to adjust the level of the shuttering panel 10.

[0143] The adjustment means 96 include a second (right-hand) adjustment device 96b which is placed in a second bottom recess 98b, this being interposed longitudinally between the second portion 54b of the second additional horizontal structural element 54 and the second (right-hand) vertical structural element 32b.

[0144] The second (right-hand) adjustment device 96b comprises in particular a second bottom recess 98b, a second boss (not shown) and a second bottom bolt 100b.

[0145] The second (right-hand) adjustment device 96b is identical to the first (left-hand) adjustment device 96a, and will therefore not be described in detail for the sake of clarity.

[0146] According to another aspect, the shuttering panel 10 includes means for gripping the shuttering panel 10, which allow said shuttering panel 10 to be grasped from above for the purpose of being lifted and moved.

[0147] The gripping means comprise a first gripping device 110a which is placed in a third top recess 112a, as may be seen in Figure 12 and 4.

[0148] The third top recess 112a extends vertically downwards from the top plate 24 of the shuttering panel

10, in such a way that the third top recess 112a opens vertically upwards.

[0149] As may be seen in Figure 4, the third top recess 112a is formed in an upper part of the first vertical structural element 32a.

[0150] The first gripping device 110a comprises a first metal box 114a which is inserted into the third top recess 112a and open at the top.

[0151] The first gripping device 110a comprises a first metal gripping bar 116a that extends longitudinally in the first box 114a and includes first and second free ends, each projecting longitudinally through a hole in the first box 114a.

[0152] The first and second free ends of the first gripping bar 116a are each embedded in the associated first structural element 32a.

[0153] Finally, the first gripping device 110a includes a first metal gripping ring 118a that extends freely around the first gripping bar 116a, in order to grip the shuttering panel 10.

[0154] The gripping means include a second gripping device 110b which is placed in a fourth top recess 112b, this being formed in a top part of the second vertical structural element 32b.

[0155] The second gripping device 110b comprises a second metal box 114b, a second metal gripping bar (not shown) and a second metal gripping ring (not shown).

[0156] The second gripping device 110b is identical to the first gripping device 110a, and will therefore not be described in detail for the sake of clarity.

[0157] Finally, the shuttering panel 10 is equipped with rear connection means, for example for connecting accessories such as stabilizing stays (not shown) and a top passageway (not shown).

[0158] As may be seen in Figure 2, the rear connection means comprise a first (left-hand) rear insert 120a and a second (left-hand) rear insert 120b, each of which is sandwiched transversely between the first vertical structural element 32a and the rear plate 16 of the shuttering panel 10.

[0159] Furthermore, an additional fibrous cover 27 (not shown) is interposed transversely between the rear plate 16 of the shuttering panel 10 and the first (left-hand) rear insert 120a. An additional fibrous cover 27 (not shown) is interposed transversely between the rear plate 16 of the shuttering panel 10 and the second (left-hand) rear insert 120b.

[0160] Likewise, the rear connection means comprise a third (right-hand) rear insert 120c and a fourth (right-hand) rear insert 120d, each of which is sandwiched transversely between the second vertical structural element 32b and the rear plate 16 of the shuttering panel 10.

[0161] Furthermore, an additional fibrous cover 27 (not shown) is interposed transversely between the rear plate 16 of the shuttering panel 10 and the third (right-hand) rear insert 120c. Another additional fibrous cover 27 (not shown) is interposed transversely between the rear plate 16 of the shuttering panel 10 and the fourth (right-hand)

rear insert 120d.

[0162] Each rear insert 120a, 120b, 120c, 120d extends vertically and delimits a series of three tapped holes which can cooperate with an associated bolt for fastening the accessories.

[0163] In addition, each rear insert 120a, 120b, 120c, 120d delimits a smooth hole for passage of a shuttering rod.

[0164] Finally, each rear insert 120a, 120b, 120c, 120d is placed in a cavity (not shown) of the associated vertical structural element 32a, 32b in such a way that each rear insert 120a, 120b, 120c, 120d is flush with the associated vertical structural element 32a, 32b.

[0165] The invention also relates to a process for manufacturing the shuttering panel 10.

[0166] The manufacturing process is carried out by means of a mould 122 which comprises a die 124 and a punch 126, as shown in Figures 13 and 14.

[0167] The bottom die 124 has a parallelepipedal internal cavity 128 of a shape complementary to the shape of the shuttering panel 10.

[0168] The internal cavity 128 is delimited by a horizontal base face 134 which is intended to form, or mould, the front plate 12 of the shuttering panel 10.

[0169] Likewise, the internal cavity 128 is delimited by four vertical peripheral faces, namely a right-hand lateral face 132a and a left-hand lateral face 132b, which are intended to form the first (right-hand) side plate 20 and the second (left-hand) side plate 22 respectively, and a top face and a bottom face (these not being shown) which are intended to form the top plate 24 and the bottom plate 26 of the shuttering panel 10, respectively.

[0170] The internal cavity 128 opens into a rectangular opening 130 for passage of the shuttering panel 10.

[0171] In addition, the die 124 includes a peripheral upper flange 136 which extends horizontally towards the outside of the die 124, starting from the opening 130, forming a first parting line.

[0172] The punch 126 takes the form of a horizontal plate that includes a rectangular central portion 138 projecting towards the die 124 and a rectangular peripheral portion 140 that extends around the central portion 138 so as to form a second parting line.

[0173] As may be seen in Figure 14, the punch 126 is capable of occupying a position for closing off the mould 122, in which position the punch 126 extends horizontally over the die 124 in such a way that the projecting central portion 138 of the punch 126 and the internal cavity 128 of the die 124 together delimit a parallelepipedal gap for moulding the shuttering panel 10.

[0174] Likewise, the die 124 and the punch 126 together delimit a peripheral runner 140 that extends around the opening 130 and communicates with the gap of the mould 122.

[0175] The peripheral runner 140 is connected to two injection ducts 142, each of which extends through the punch 126 in such a way that each injection duct 142 can feed the peripheral runner 140 with resin.

[0176] Complementarily, the punch 126 includes a suction duct 144 that opens into the gap and lies at the centre of the projecting central portion 138 of the punch 126.

[0177] In addition, when the punch 126 occupies its closure position, the first parting line and the second parting line are placed facing each other, and a first (internal) peripheral seal 139a and a second (external) peripheral seal 139b are interposed vertically between the first parting line and the second parting line.

[0178] Thus, the first parting line and the second parting line together delimit a vacuum chamber 146.

[0179] Complementarily, the punch 126 includes a vacuum duct 148 that opens into the vacuum chamber 146 and is capable of creating a vacuum in the vacuum chamber 148 so as to fix, through the vacuum, the punch 126 in its position for closing off the mould 122.

[0180] The manufacturing process comprises, in succession: a step of preparing the core 28; a step of depositing the core 28 in the gap of the mould 122; a step of closing the mould 122; a step of injecting the resin into the mould 122, so as to impregnate the fibrous covers 27 of the shuttering panel 10; a step of solidifying the impregnated resin in all the fibrous covers 27 of the shuttering panel 10; and a step of demoulding the shuttering panel 10.

[0181] The step of preparing the core 28 comprises a bounding phase that consists in bounding each of the structural elements 32a, 32b, 46, 48, 54, 52 of the core 28 in the associated fibrous cover 27.

[0182] In addition, the step of preparing the core 28 includes a first covering phase that consists in covering the five faces of the internal cavity 128 of the die 124 of the mould 122 with a first part of the external fibrous cover 27a, in order to form the peripheral frame and the front plate 12 of the shuttering panel 10.

[0183] The step of preparing the core 28 includes a first reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould 122 for each of the four right-hand lateral recesses 58a, 58b, 58c, 58d associated with the first male assembly means 56.

[0184] So as not to burden the description, only the first phase of reserving the first right-hand lateral recess 58a will be described, the phases for reserving each of the other right-hand lateral recesses 58b, 58c, 58d being identical to the first reserving phase.

[0185] The first reserving phase is carried out by means of a first removable right-hand lateral implant 150, which has a shape complementary to the shape of the first right-hand lateral recess 58a, as may be seen in Figure 15.

[0186] The first right-hand lateral implant 150 is delimited by five clearance faces for the formation of the first right-hand lateral recess 58a, a lateral clearance face 154 of which delimits a hollow 156.

[0187] In addition, the first right-hand lateral implant 150 delimits an internal blind hole 152.

[0188] The first reserving phase consists in placing the head 66a of the first lateral bolt 64a in the blind hole 152 of the first right-hand lateral implant 150, in such a way that the threaded portion 68a of the first lateral bolt 64a projects axially from a clearance face 154 of the first right-hand lateral implant 150.

[0189] For this purpose, the first right-hand lateral implant 150 is slit down to the blind hole 152 so as to make it easier to position the head 66a of the first lateral bolt by elastic deformation of the first right-hand implant 150.

[0190] According to the first reserving phase, the five clearance faces of the first lateral implant 150 are covered with a fibrous cover 27, which constitutes the walls of the first right-hand lateral recess 58a, then the first right-hand lateral insert 62a is inserted around the projecting threaded portion 68a of the first lateral bolt 64a and then the assembly thus formed is placed in the gap of the mould 122 in such a way that the first right-hand lateral insert 62a is pressed against the external fibrous cover 27a placed beforehand on the vertical peripheral faces 132 of the cavity 128 of the mould 122.

[0191] Thus, the first right-hand lateral insert 62a is interposed axially, or sandwiched, between two fibrous covers 27.

[0192] In addition, the projecting threaded portion 68a of the first lateral bolt 64a is placed in a through-hole 156 provided in the right-hand lateral face 132a of the cavity 128 of the mould 122, in such a way that the projecting threaded portion 68a of the first lateral bolt 64a projects axially through the mould 122, thanks to which the first right-hand lateral insert 62a and the associated first lateral bolt 64a are precisely positioned relative to the mould 122.

[0193] Finally, according to the first reserving phase, a nut 158 is screwed onto the projecting threaded portion 68a of the first lateral bolt 64a, on the outside of the mould 122, by virtue of which the first lateral bolt 64a is held in position on the mould 122.

[0194] Advantageously, the mould 122 includes a removable first bell 160 which is fastened against an external face of the mould 122 and delimits an internal housing in which the nut 158 is housed, so as to prevent the resin from flowing through the through-passage 156 of the mould 122.

[0195] The first reserving phase of the step of preparing the core 28 is repeated for each of the three other right-hand lateral recesses 58b, 58c, 58d associated with the first male assembly means 56, by means of three other additional removable lateral implants (not shown).

[0196] Likewise, the step of preparing the core 28 includes a second reserving phase carried out after the first covering phase and consisting in reserving a space in the gap of the mould 122 for each of the three top recesses 72a, 72b, 72c associated with the second top male assembly means 70.

[0197] The second reserving phase is carried out by means of three removable first top implants (not shown) which have a shape complementary to the shape of the

three top recesses 72a, 72b, 72c.

[0198] The second reserving phase is similar to the first reserving phase, and will therefore not be described for the sake of clarity.

[0199] The step of preparing the core 28 includes a third reserving phase carried out after the first covering phase and consisting in reserving a space in the gap of the mould 122 for the formation of the first bottom recess 98a and a space for forming the second bottom recess 98b, these being associated with the bottom adjustment means 96 for adjusting the level of the shuttering panel 10.

[0200] According to Figure 16, the third reserving phase is carried out by means of a removable first bottom implant 162 which has a shape complementary to the shape of the first bottom recess 98a.

[0201] The first bottom implant 162 has a main first part 162a which is delimited by five clearance faces for the formation of the first bottom recess 98a, a lateral clearance face 164 of which delimits a hollow 166 having a frustoconical shape the cross-section of which decreases towards the interior of the first bottom implant 162.

[0202] The first part 162a of the first bottom implant 162 delimits a first hole 170a that opens into the lateral clearance face 164.

[0203] In addition, the first bottom implant 162 has a second part 162b forming a frustoconical plug, which has an overall shape complementary to that of the hollow 166.

[0204] Finally, the second part 162b of the first bottom implant 162 delimits a second hole 170b that opens facing the first hole 170a.

[0205] The third reserving phase consists in placing the bottom portion of the first bottom bolt 106a of vertical axis forming the adjustment foot in the second hole 170b of the second part 162b of the first bottom implant 162, and then in covering the frustoconical wall of the second part 162b with a fibrous cover 27, this fibrous cover 27 being intended to form the first boss 100a of the first bottom recess 98a.

[0206] The third reserving phase then consists in placing the fourth bottom insert 104a, or washer, around the upper portion of the first bottom bolt 106a and then in covering the fourth bottom insert 104a with a fibrous cover 27, in such a way that the fourth bottom insert 104a is sandwiched between two fibrous covers 27.

[0207] The third reserving phase then consists in inserting the plug-forming second part 162b into the complementary hollow 166 of the first part 162a of the first bottom implant 162, in such a way that the upper portion of the first bottom bolt 106a is placed in the first hold 170a of the first part 162a of the first bottom implant 162, as may be seen in Figure 16.

[0208] The third reserving phase then consists in covering the five clearance faces of the first part 162a of the first bottom implant 162 with a fibrous cover 27, which constitutes the walls of the first bottom recess 98a.

[0209] Finally, according to the third reserving phase, the first bottom implant 162 is placed in the gap of the

mould 122, in such a way that the plug-forming second part 162b of the first bottom implant 162 bears on the lower face of the internal cavity 128 of the die 122.

[0210] For this purpose, the external fibrous cover 27a, which is placed beforehand on the vertical peripheral faces 132 of the cavity 128, is cut in such a way that the plug-forming second part 162b can be removed from the shuttering panel 10 after demoulding.

[0211] The third reserving phase of the step of preparing the core 28 is repeated a second time in order to produce the second bottom recess 98b, by means of a second bottom implant (not shown).

[0212] The step of preparing the core 28 includes a fourth reserving phase which is carried out after the first covering phase and consists in placing a removable third top implant (not shown) in the first metal box 114a of the first gripping device 110a.

[0213] For this purpose, the third top implant has a shape complementary to the shape of the first metal box 114a, and the third top implant is made in several parts.

[0214] The third top implant imprisons the first metal gripping bar 116a, which extends longitudinally along the first box 114a, and the first metal gripping ring 118a.

[0215] Each implant is made of an elastically deformable silicone.

[0216] Finally, the step of preparing the core 28 includes a first placing phase in which all of the metal inserts of the female assembly means 84, 90 are placed in the gap of the mould 122, which placing phase is carried out after the first covering phase.

[0217] The set of metal inserts of the female assembly means 84, 90 comprises the first left-hand lateral insert 86a, the second left-hand lateral insert 86b, the third left-hand lateral insert 86c and the fourth left-hand lateral insert 86d of the first (left-hand) lateral female assembly means 84 and the first bottom insert 92a, the second bottom insert 92b, and the third bottom insert 92c of the second (bottom) female assembly means 90.

[0218] The first placing phase consists in placing the set of metal inserts of the female assembly means 84, 90 against the external fibrous cover 27a, deposited beforehand in the mould 122, in such a way that these inserts are each placed facing a through-hole passage made in the left-hand lateral face 132b and in the lower face (not shown) of the internal cavity 128 of the mould 122.

[0219] In addition, as shown in Figure 14, each insert of the set of metal inserts of the female assembly means 84, 90 is fastened by means of a fastening screw 172 that extends through the die 124 and is screwed into the associated insert.

[0220] Each head of the fastening screw 172 advantageously cooperates with a second removable bell 174 (one of which is shown in Figure 14) which is fastened against an external face of the mould 122 so as to prevent the resin from flowing out.

[0221] The step of depositing the core 28 in the gap of the mould 122 is carried out after the step described

above of preparing the core.

[0222] The step of depositing the core 28 includes a first phase of depositing the structural elements between them in the gap of the mould, so as to form the core 28 as an overall parallelepipedal block.

[0223] For this purpose, the first depositing phase consists in depositing the horizontal structural elements 46, 48 in the gap of the mould 122 followed by the vertical structural elements 32a, 32b prepared beforehand.

[0224] In addition, the step of depositing the core 28 includes a second depositing phase that consists in depositing the first left-hand rear connection insert 120a and the second left-hand rear connection insert 120b each in the cavity (not shown) associated with the first vertical structural element 32a, in such a way that the first left-hand rear connection insert 120a and the second left-hand rear connection insert 120b are flush.

[0225] Likewise, the second depositing phase consists in depositing the first right-hand rear connection insert 120c and the second right-hand rear connection insert 120d each in the cavity (not shown) associated with the second vertical structural element 32b, in such a way that the first right-hand rear connection insert 120c and the second right-hand rear connection insert 120d are flush.

[0226] The rear inserts 120a, 120b, 120c, 120d are each covered with an additional fibrous cover 27 (not shown), in such a way that each of the rear inserts 120a, 120b, 120c, 120d is sandwiched between at least two fibrous covers 27.

[0227] In addition, each tapped hole of each rear insert 120a, 120b, 120c, 120d receives a bolt (not shown) so as to fasten each rear insert 120a, 120b, 120c, 120d to the associated vertical structural element 32a, 32b and to prevent the resin from penetrating into these tapped holes.

[0228] Likewise, each smooth hole for passage of a shuttering rod receives a complementary rod (not shown).

[0229] In addition, the step of depositing the core 28 includes a second covering phase, carried out after the second depositing phase.

[0230] The second covering phase consists in covering the visible face of the core 28 placed in the die 124 with a second part of the external fibrous cover 27a so as to constitute the rear plate 16 of the shuttering panel 10, in such a way that the second part of the external fibrous cover 27a is interposed between the core 28 and the punch 126 when the mould 122 is closed.

[0231] Finally, the step of depositing the core 28 includes a cutting phase which here is carried out after the second covering phase.

[0232] The cutting phase consists in cutting the second part of the external fibrous cover 27a that covers the visible face of the core 28, so as to uncover each removable implant, in order to allow each implant to be extracted after the step of solidifying the shuttering panel 10.

[0233] Likewise, the second part of the external fibrous cover 27a is cut so as to be able to remove the screws

(not shown) that are housed in the tapped holes of the rear inserts 120a, 120b, 120c, 120d.

[0234] Without being limiting, the cutting phase may be carried out before the step of depositing the core 28.

5 **[0235]** The manufacturing process includes a step of injecting the resin into the gap of the mould 122.

[0236] The injection step consists in placing the punch 126 in its closure position, shown in Figure 14, and in creating a vacuum, by means of the vacuum duct 148, in the vacuum chamber 146 so as to fasten, through the vacuum, the punch 126 in its position for closing off the mould 122.

10 **[0237]** The injection step then consists in injecting the resin into the runner 140 via the injection duct 142, in such a way that the resin flows into the runner 140 around the core 28.

15 **[0238]** Simultaneously, the injection step consists in sucking out the air contained in the gap by means of the suction duct 144 so as to create a vacuum in the gap and make the resin flow throughout the fibrous covers 27 of the shuttering panel 10.

[0239] Advantageously, the resin also spreads out by the capillary effect into the fibrous covers 27.

20 **[0240]** The manufacturing process includes a step of solidifying the impregnated resin in all the fibrous covers 27 of the shuttering panel 10, which step is carried out after the injection step.

25 **[0241]** Finally, the manufacturing process includes a step of demoulding the shuttering panel 10, which is carried out after the resin solidification step.

30 **[0242]** The demoulding step consists in opening the mould 122 and then in extracting the shuttering panel 10 from the mould 122.

35 **[0243]** Once the shuttering panel 10 has been extracted from the mould 122, the demoulding step consists in removing all the removable implants from the shuttering panel 10.

40 **[0244]** In addition, the demoulding step includes a finishing step that consists in deflashing the shuttering panel 10.

[0245] The manufacturing process according to the invention enables the shuttering panel 10 to be manufactured in a single moulding operation.

45 **[0246]** The shuttering panel 10 is ready for use after the demoulding step, the attachment means being incorporated into the shuttering panel 10 during the manufacturing process.

50 **[0247]** The shuttering panel 10 according to the invention exhibits great structural rigidity thanks to the combination of the horizontal structural elements 46, 48 and vertical structural elements 32a, 32b.

55 **[0248]** In addition, these structural elements are made of foam, so that the shuttering panel 10 has a low weight, thereby making it easier to manipulate and transport the shuttering panel 10.

[0249] The shuttering panel 10 meets in particular the NF 93-350 standard relating to worksite equipment and more particularly to industrial wall forms for concrete

structures.

[0250] The invention also relates to shuttering tables, especially for producing horizontal walls.

[0251] This is because shuttering tables have a certain analogy with the shuttering panels.

[0252] Likewise, the invention also relates to what are called "hand-held" shuttering panels, these being the lightweight panels of small dimensions that are capable of being carried by a person.

Claims

1. Shuttering panel (10) made of a composite, which lies in a longitudinal vertical plane, **characterized in that** it comprises an internal core (28) comprising a plurality of structural elements (46, 48, 32a, 32b), each of which is bounded by at least one fibrous cover (27) which is impregnated with a cured resin, thanks to which said core (28) forms a skeleton for stiffening the shuttering panel (10) and **in that** the core (28) is bounded by at least one external fibrous cover (27a) which is impregnated with said cured resin, so that said external fibrous cover (27a) constitutes:

- a vertical front plate (12), a front shuttering face (14) of which defines the front of the shuttering panel (10);

- a vertical rear plate (16), a rear face (18) of which defines the rear of the shuttering panel (10); and

- a peripheral frame, which comprises a first vertical side plate (20), an opposed second vertical side plate (22), a horizontal top plate (24) and an opposed horizontal bottom plate (26), each of said plates of the peripheral frame extending from the front shuttering plate (12) to the rear plate (16) of the shuttering panel (10), so that the shuttering panel (10) constitutes a single component as one entity.

2. Shuttering panel (10) according to Claim 1, **characterized in that** said structural elements (46, 48, 32a, 32b) of the core (28) are mutually imbricated so as to form a generally parallelepipedal block, in such a way that said structural elements (46, 48, 32a, 32b) are connected together by said resin.

3. The shuttering panel (10) as claimed in either of the preceding claims, **characterized in that** the core (28) comprises:

- at least one vertical structural element (32a, 32b) which extends upwards from the bottom plate (26) to the top plate (24) of the peripheral frame of the shuttering panel (10), which extends rearwards from the front shuttering plate

(12) to the rear plate (16) and which has a trapezoidal horizontal cross-section decreasing towards the front shuttering plate (12);

- a first series of horizontal structural elements (46) which each extend horizontally from the first vertical side plate (20) to the second vertical side plate (22) of the shuttering panel (10), which each extend rearwards from the front shuttering plate (12) to the rear plate (16) and which each have a trapezoidal vertical cross-section decreasing towards the front shuttering plate (12); and

- a second series of horizontal structural elements (48) which each extend horizontally from the first vertical side plate (20) to the second vertical side plate (22) of the shuttering panel (10), which each extend rearwards from the front shuttering plate (12) to the rear plate (16) and which each have a trapezoidal vertical cross-section increasing towards the front shuttering face,

and **in that** the horizontal structural elements (46) of said first series and the horizontal structural elements (48) of said second series are fastened together and arranged alternately in a head-to-tail configuration.

4. Shuttering panel (10) as claimed in any one of the preceding claims, **characterized in that** each fibrous cover (27, 27a) that bounds the associated structural element (46, 48, 32a, 32b) has at least one flat (33a, 33b) extending from the front plate (12) to the rear plate (16) of the shuttering panel (10), forming a stiffening brace.

5. Shuttering panel (10) according to Claim 3, **characterized in that** the horizontal structural elements (46) of said first series and the horizontal structural elements (48) of said second series are each intersected by the vertical structural element (32a, 32b), in such a way that said horizontal structural elements (46, 48) are each divided into three portions.

6. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** it has a parallelepipedal shape and **in that** the front shuttering face (14) and the rear face (18) of the shuttering panel (10) are plane and parallel.

7. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** it comprises:

- first male assembly means (56) for joining it onto a neighbouring panel, comprising at least one first (lateral) insert (60a) which is embedded in the panel (10) and is pressed against the back

of said first side plate (20), the first (lateral) insert (60a) defining a hole (62a) for receiving a first (lateral) assembly bolt (64a);

- second male assembly means (70) for joining it onto a superposed panel, comprising at least one second (top) insert (74a) which is embedded in the panel (10) and is pressed against the back of said top plate (24), the second (top) insert (74a) defining a hole for receiving a second (top) assembly bolt (78a);

- first female assembly means for joining it onto a neighbouring panel, comprising at least one third (lateral) insert (86a) which is embedded in the panel (10) and is pressed against the back of said second side plate (22), the third (lateral) insert (86a) defining a tapped hole (88a) for passage of a complementary assembly bolt; and

- second female assembly means for joining it onto a lower panel, comprising at least one fourth (bottom) insert (92a) which is embedded in the panel (10) and is pressed against the back of said bottom plate (26), the fourth (bottom) insert (92a) defining a tapped hole (94a) for passage of a complementary assembly bolt.

8. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** it comprises means for adjusting the level of the shuttering panel (10), comprising at least one fifth (bottom) insert (104a) which is embedded in the panel (10) and is pressed against the back of said bottom plate (26), the fifth (bottom) insert (104a) defining a hole for receiving a vertical third (bottom) assembly bolt (106a) forming an adjustment foot.

9. Shuttering panel (10) according to Claims 7 and 8, **characterized in that** it comprises:

- at least one first (lateral) recess (58a) which is formed in the rear plate (16) and extends towards the front plate (12), said first (lateral) recess (58a) being interposed between the core (28) and the first (lateral) insert (60a) so as to allow the first (lateral) bolt (64a) associated with the first male assembly means (56) to be manipulated;

- at least one second (top) recess (72a) which is formed in the rear plate (16) and extends towards the front plate (12), said second (top) recess (72a) being interposed between the core (28) and the second (top) insert (74a) so as to allow the second (lateral) bolt (78a) associated with the second male assembly means (70) to be manipulated; and

- at least one third (bottom) recess (98a) which is formed in the rear plate (16) and extends towards the front plate (12), said third (bottom) recess (98a) being interposed between the core

(28) and the fifth (bottom) insert (104a) so as to allow the third (bottom) bolt (106a) associated with the means for adjusting the level of the shuttering panel (10) to be manipulated.

10. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** it comprises means for gripping the shuttering panel (10), which means comprise:

- at least one fourth (top) recess (112a) which is formed in the top plate (24) of the shuttering panel (10) and extends downwards; and

- a gripping ring (118a) that extends around said gripping bar (116a).

11. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** it includes at least one sixth (rear) insert (120a) for connecting safety/stabilizing accessories, the sixth (rear) insert (120a) being embedded in the panel (10) and pressed against the back of said rear plate (16), and **in that** the sixth (rear) insert (102a) defines at least one tapped hole for fastening said accessories.

12. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** each structural element (46, 48, 32a, 32b) is made of polyurethane foam.

13. Shuttering panel (10) according to any one of the preceding claims, **characterized in that** the resin is a polyester thermosetting or thermoplastic resin.

14. Process for manufacturing a shuttering panel (10) according to any one of the preceding claims, **characterized in that** the process is implemented by means of a mould (122) comprising:

- a die (124), an internal wall of which defines an open internal cavity (128) that has an overall shape complementary to that of the internal core (28) of the shuttering panel (10); and

- a punch (126) which can occupy a position for closing off the mould (122), in which the die (124) and the punch (126) together define an internal moulding gap, and **in that** the process comprises, in succession:

- a step of preparing the core (28), a bounding phase of which consists in bounding each of said structural elements (46, 48, 32a, 32b) of the core (28) with a fibrous cover (27);

- a step of depositing the core (28) in the gap of the mould (122);

- a step of closing the mould (122);

- a step of injecting the resin into the mould

- (122) in such a way that the resin impregnates said fibrous covers (27, 27a);
 - a step of solidifying the impregnated resin in said fibrous covers (27, 27a) so as to obtain the shuttering panel (10); and
 - a step of demoulding the shuttering panel (10).
15. Process according to Claim 14, **characterized in that** the step of preparing the core (28) includes a first covering phase, which consists in covering the internal cavity (128) of the die (124) of the mould (122) with an external fibrous cover (27a), so as to constitute the peripheral frame (20, 22, 24, 26) and the front plate (12) of the shuttering panel (10).
16. Process according to either of Claims 14 and 15, **characterized in that** the step of preparing the core (28) includes a first reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould (122) for the formation of the first (lateral) recess (58a) associated with the first male assembly means (56), by means of at least one removable first (lateral) implant (150) that defines an internal blind hold (152), said first reserving phase consisting in:
- placing the head (66a) of the first (lateral) bolt (64a) in said blind hole (152) of the first (lateral) implant (150) in such a way that a threaded portion (68a) of the first (lateral) bolt (64a) projects axially from a first side face (154) of said implant (150);
 - covering at least said first lateral face (154) of the first (lateral) implant (150) with a fibrous cover (27);
 - inserting the associated first (lateral) insert (60a) around said threaded portion (68a) projecting from the first (lateral) bolt (64a) through the through-hole (62a) of said first (lateral) insert (60a); and
 - placing the assembly formed by the first (lateral) implant (150), the first (lateral) bolt (64a) and the first (lateral) insert (60a) into the gap of the mould (122) in such a way that the threaded portion (68a) of the first (lateral) bolt (64a) is placed in a through-hole in the wall of the die (124) of the mould (122), and in such a way that the first (lateral) insert (60a) is interposed axially between two fibrous covers (27).
17. Process according to either of Claims 14 and 15, **characterized in that** the step of preparing the core (28) includes a second reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould (122) for the formation of the second (top) recess (72a) associated with the second male assembly means (70), by means of at least one removable second implant.
18. Process according to either of Claims 14 and 15, **characterized in that** the step of preparing the core (28) includes a third reserving phase, which is carried out after the first covering phase and consists in reserving a space in the gap of the mould (122) for the formation of the third (bottom) recess (98a) associated with the means for adjusting the level of the shuttering panel (10), by means of at least one removable third implant (162).
19. Process according to any one of Claims 14 to 18, **characterized in that** each of said implants (150, 162) is made of an elastically deformable silicone.
20. Process according to any one of Claims 14 to 19, **characterized in that** each implant (150, 162) has a shape complementary to the shape of the associated recess (58a, 98a, 72a) and each implant (150, 162) is placed so as to be extractable from the shuttering panel (10) after the step of solidifying the shuttering panel (10).
21. Process according to either of Claims 14 and 15, **characterized in that** the step of preparing the core (28) includes a placing phase carried out after said first covering phase and consisting in placing, in the gap of the mould (122):
- the third (lateral) insert (86a) of the first female assembly means in such a way that the third (lateral) insert (86a) is interposed between at least two fibrous covers (27); and
 - the fourth (bottom) insert (92a) of the second female assembly means in such a way that the fourth (bottom) insert (92a) is interposed between at least two fibrous covers (27).
22. Process according to Claim 14, **characterized in that** the step of depositing the core (28) in the gap of the mould (122) comprises, in succession:
- a first depositing phase, for depositing the structural elements (32a, 32b, 46, 48) in the gap of the mould (122) so as to form the core (28) into a parallelepipedal block;
 - a second depositing phase, which consists in depositing the sixth (rear) insert (120a) for connecting safety and stabilizing accessories onto a visible rear face of the core (28) and entirely covering said sixth insert (120a) with a fibrous cover (27);
 - a second covering phase, which consists in covering the visible rear face of the core (28) with a fibrous cover (27a) so as to constitute the rear plate (16) of the shuttering panel (10); and

- a phase of cutting the fibrous cover (27a) deposited beforehand, said cover covering the rear face of the core (28), so as to uncover each removable implant (150, 162) so as to allow each implant (150, 162) to be extracted after the step of solidifying the shuttering panel (10). 5

23. Process according to Claim 14, **characterized in that** the mould (122) includes: 10

- at least one injection duct (142) for injecting the resin into the gap of the mould (122); and
- at least one suction duct (144), which opens into the gap of the mould (122), 15

and **in that** the step of injecting the resin consists in injecting the resin into the gap of the mould (122) via the injection duct (142) and simultaneously in sucking out the air contained in the gap via the suction duct (144) so as to create a vacuum in the gap and make the resin flow into said fibrous covers (27, 27a) of the shuttering panel (10). 20

24. Process according to Claim 14, **characterized in that** the demoulding step includes a phase of extracting said removable implants (150, 162). 25

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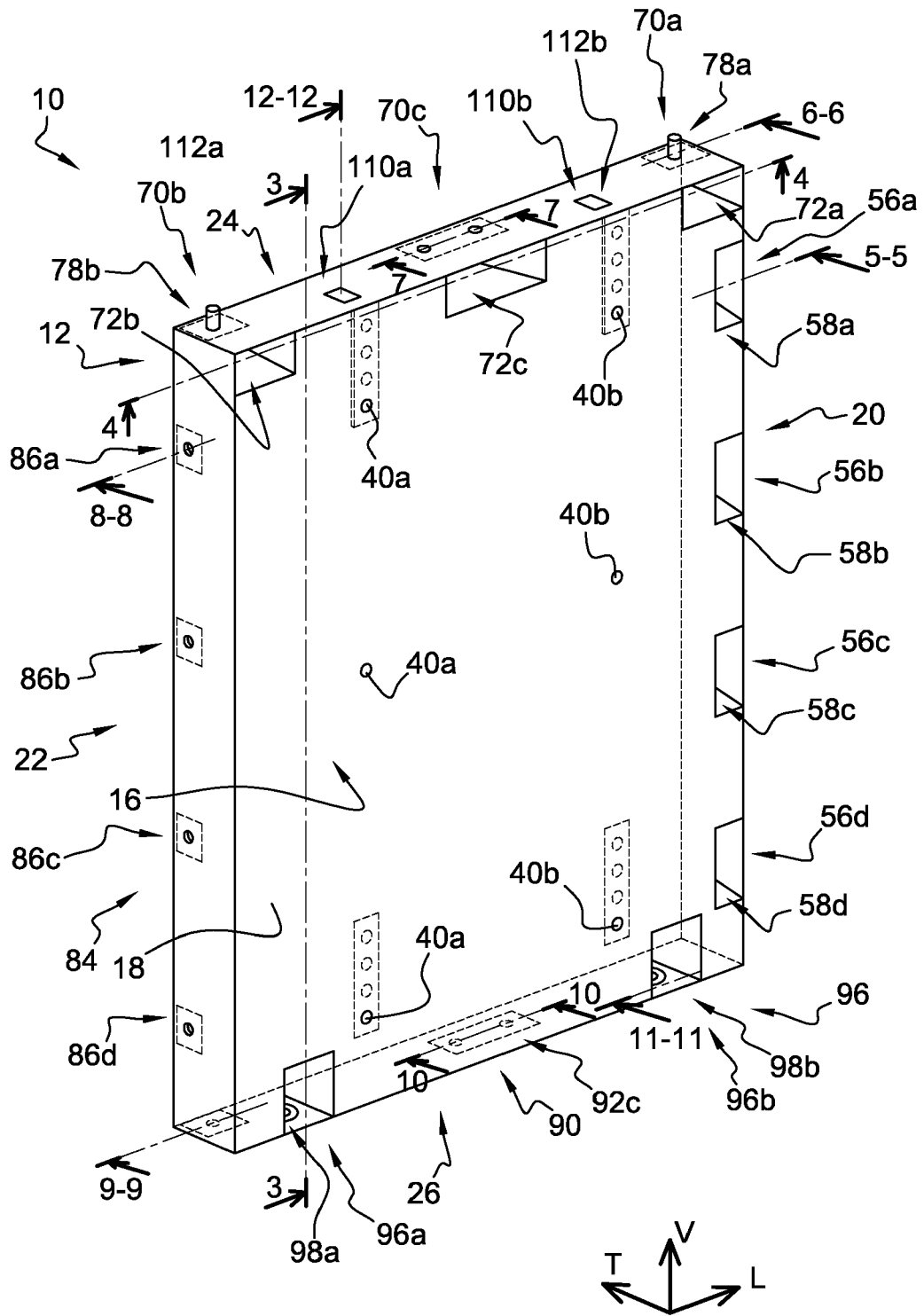


Fig. 1

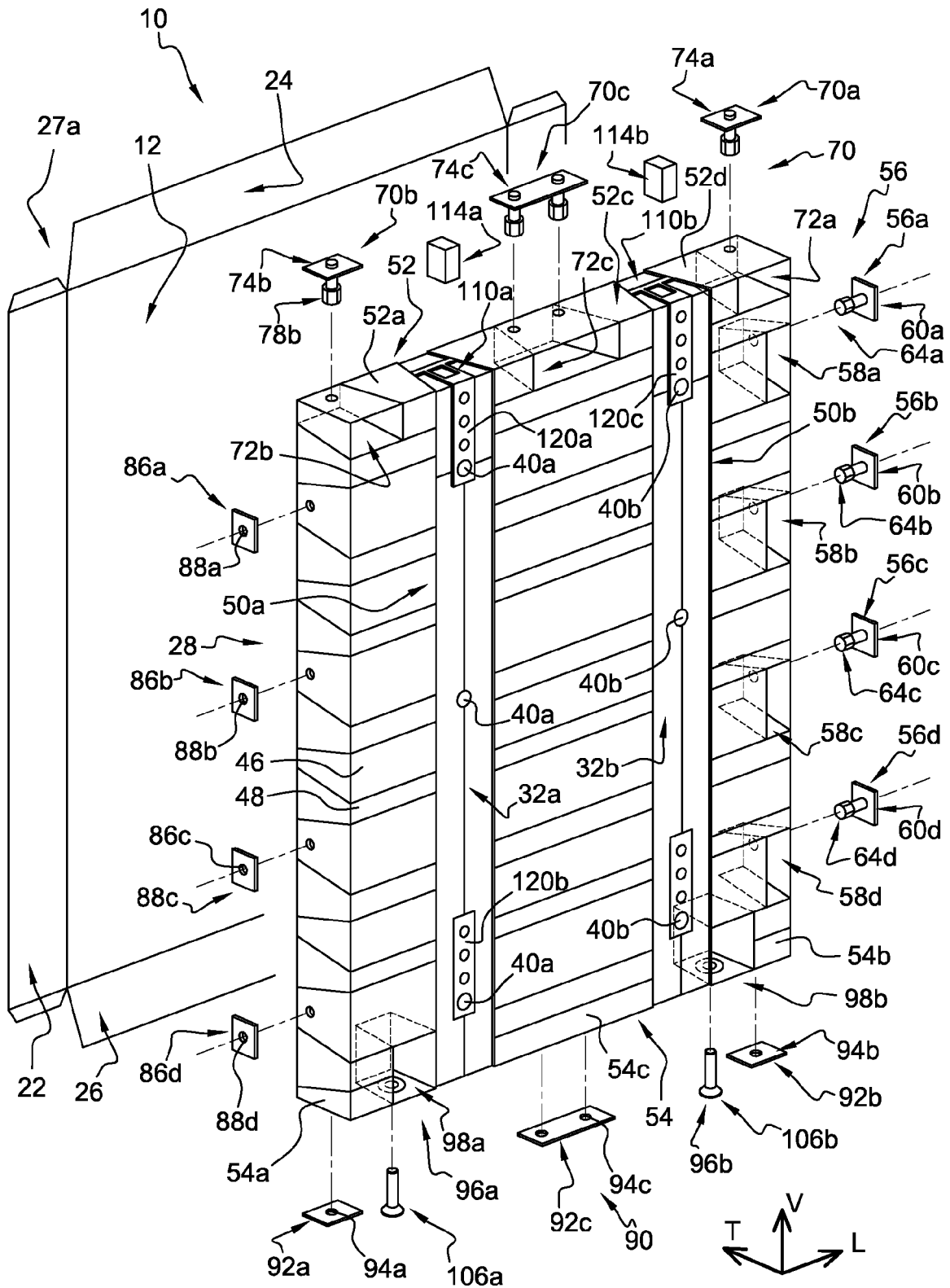


Fig. 2

Fig. 3

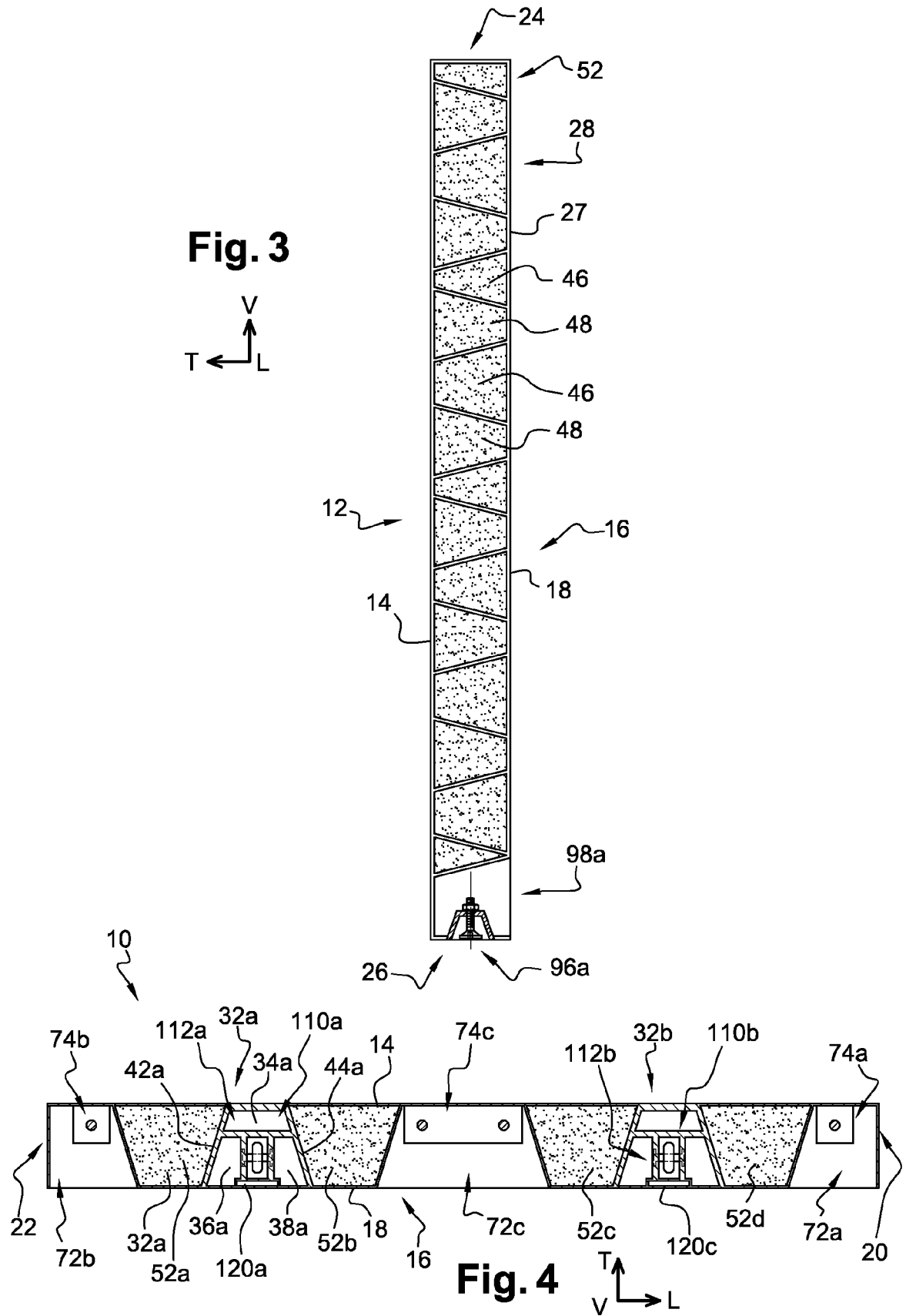
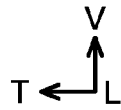
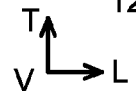


Fig. 4



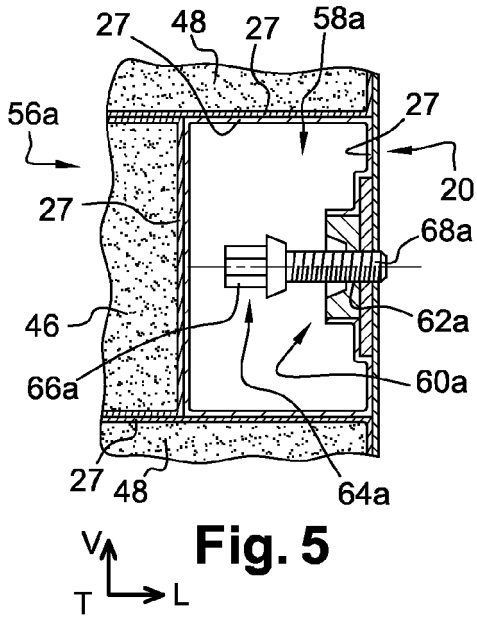


Fig. 5

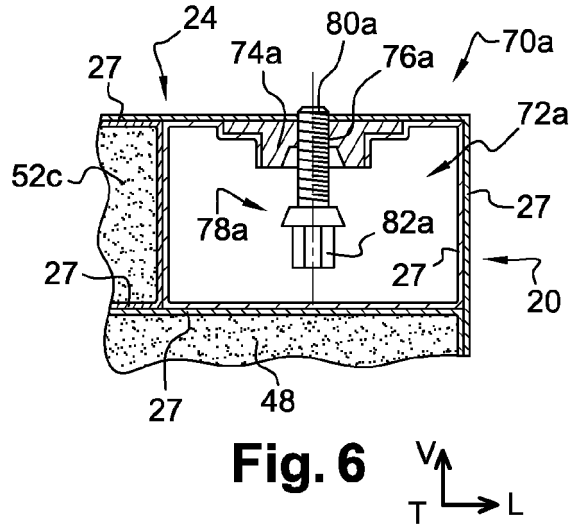


Fig. 6

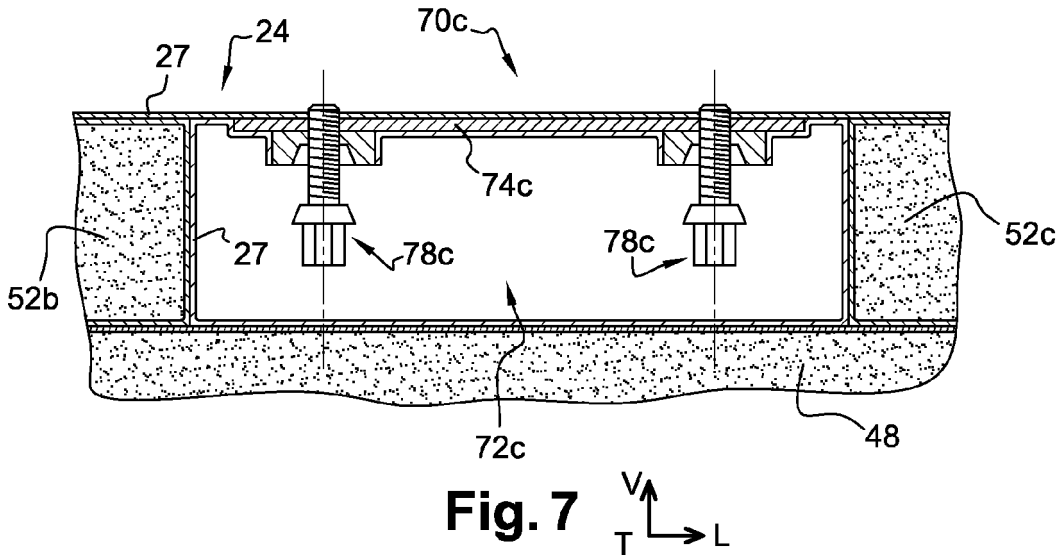


Fig. 7

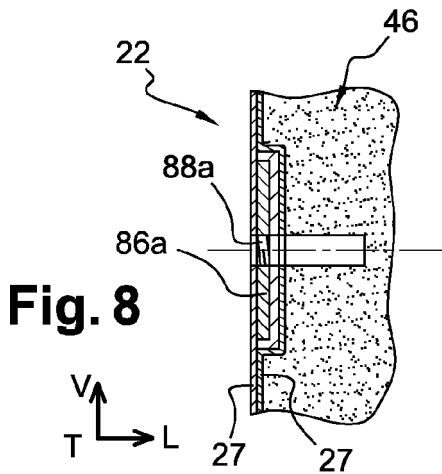


Fig. 8

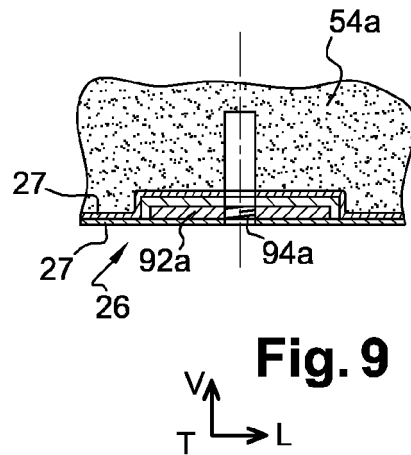


Fig. 9

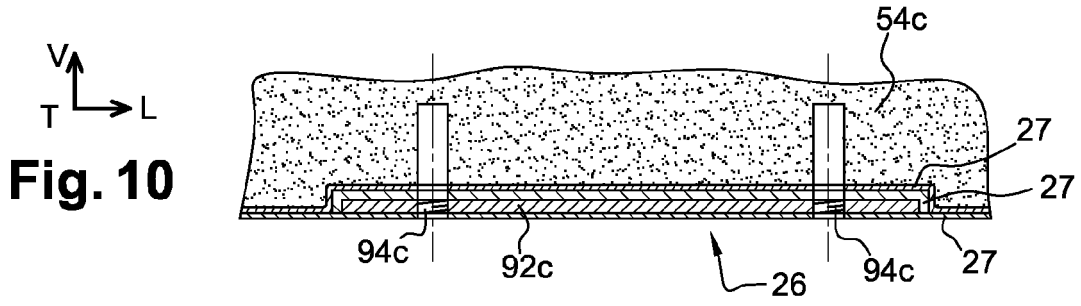


Fig. 10

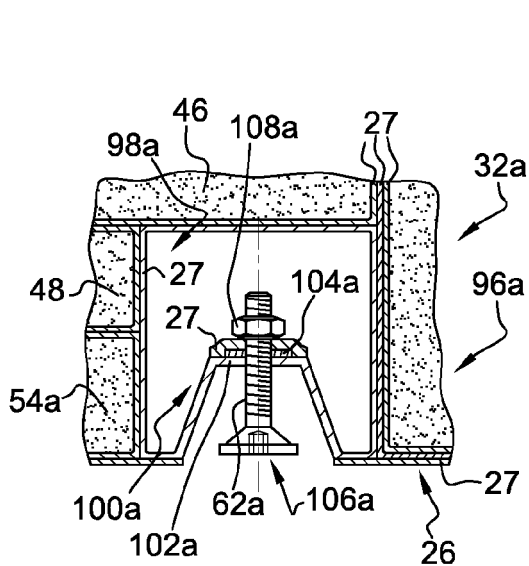


Fig. 11

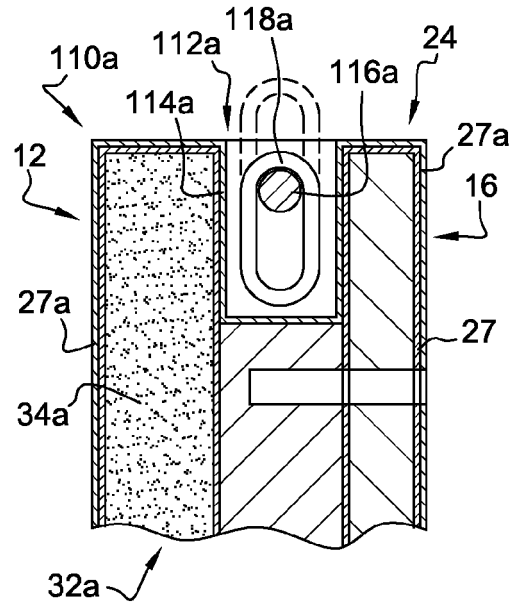


Fig. 12

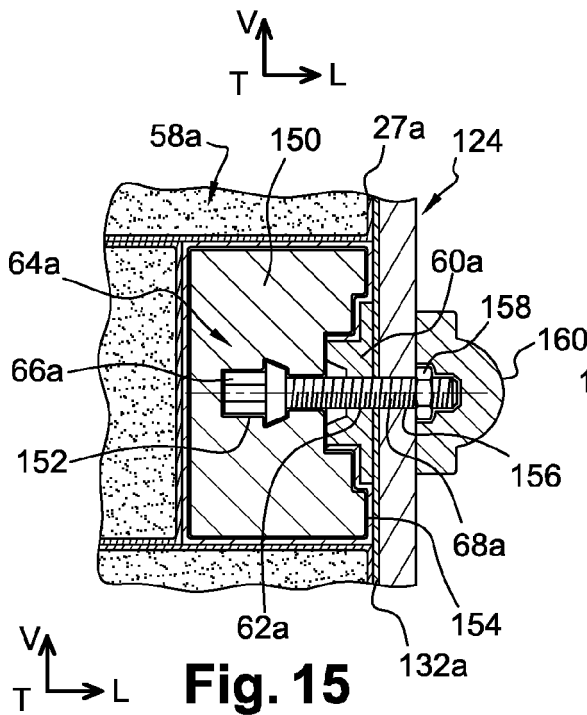


Fig. 15

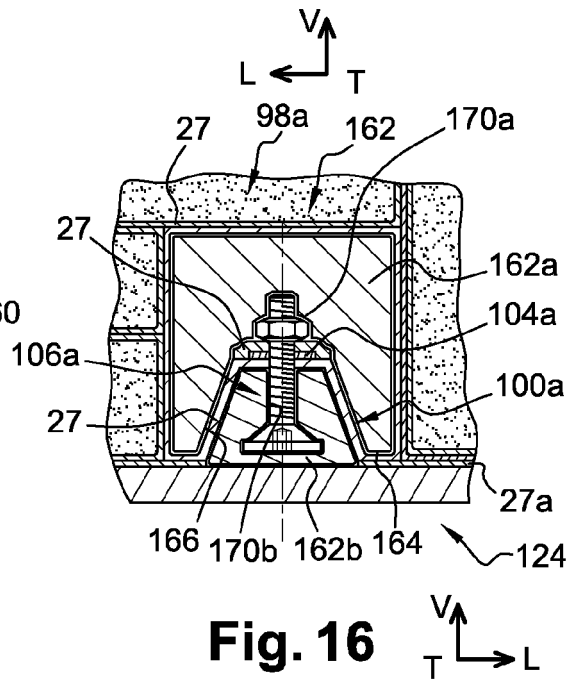
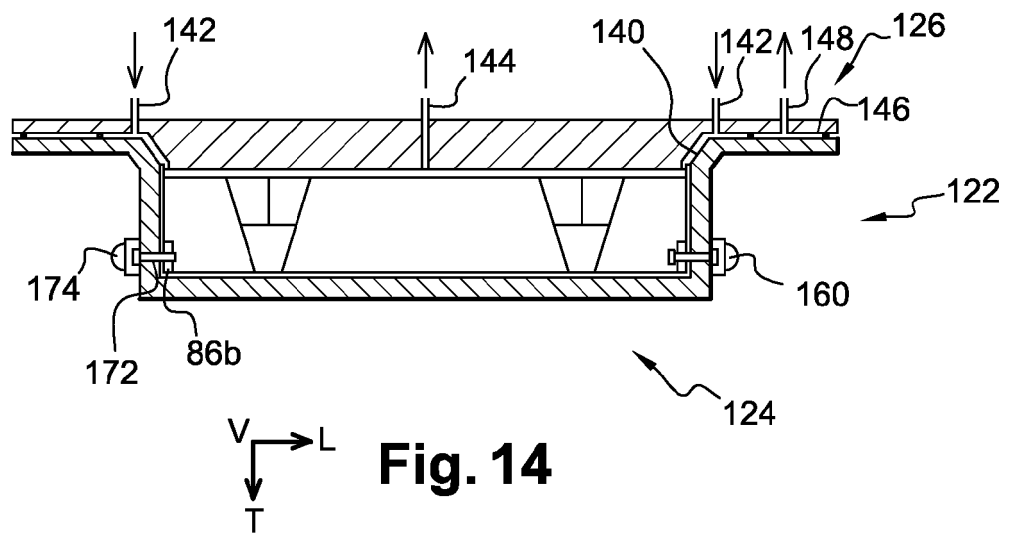
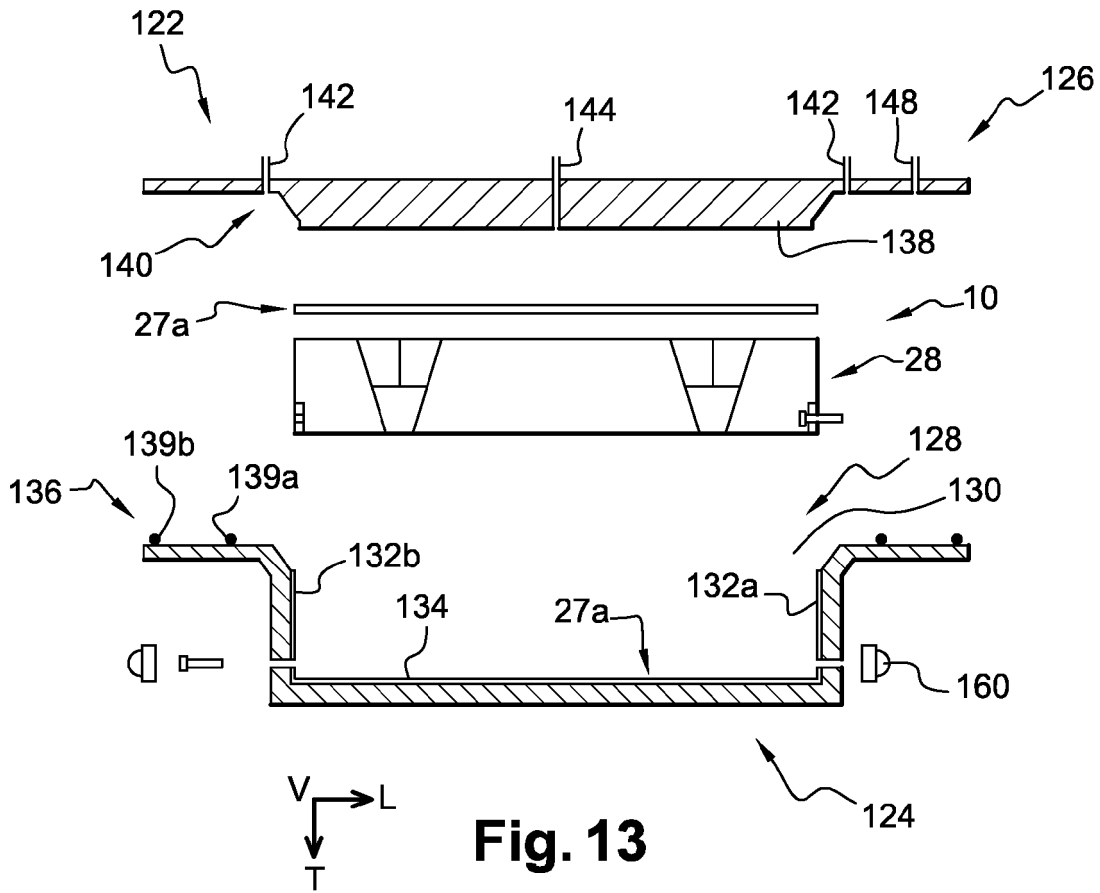


Fig. 16



ANNEX TO THE EUROPEAN SEARCH REPORT
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01-09-2009

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