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

(11) **EP 3 420 160 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
27.10.2021 Bulletin 2021/43

(21) Application number: **17714890.5**

(22) Date of filing: **16.02.2017**

(51) Int Cl.:
E04H 9/02 *(2006.01)* ***E04B 2/02*** *(2006.01)*
E04C 2/04 *(2006.01)*

(86) International application number:
PCT/IB2017/050878

(87) International publication number:
WO 2017/145025 (31.08.2017 Gazette 2017/35)

(54) **SEISMIC-RESISTANT WALL**

ERDBEBENBESTÄNDIGE WAND

MUR RÉSISTANT AUX SÉISMES

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

(30) Priority: **26.02.2016 IT UB20161114**

(43) Date of publication of application:
02.01.2019 Bulletin 2019/01

(73) Proprietor: **Universita' degli studi di Brescia**
25121 Brescia (IT)

(72) Inventors:
- **PRETI, Marco**
  25121 Brescia (IT)
- **BOLIS, Valentino**
  25121 Brescia (IT)
- **GIURIANI, Ezio**
  25121 Brescia (IT)

(74) Representative: **Gualeni, Nadia**
Jacobacci & Partners S.p.A.
Piazza della Vittoria, 11
25122 Brescia (IT)

(56) References cited:
EP-A1- 3 040 497
EP-A2- 1 043 454
WO-A1-2015/033161
CN-A- 101 476 360
CN-A- 102 268 900

EP 3 420 160 B1

Description

[0001] The present invention relates to a seismic-compatible wall in brickwork and in particular a wall (curtain or partition wall) with sliding joints.

[0002] The curtain wall is the perimetral closure wall of a building constructed with a three-dimensional framework structure (generally in steel or reinforced concrete). Consequently the bearing function is ensured by the structural frame, while the separation function between the inner space and outer space is realized by the curtain wall which fills the squares of the external frames. In the building sector, the curtain wall differs from the partition wall, which is also non-load bearing, but is used separate two interior spaces. The partition wall is in fact a building element consisting of a vertical wall which has the function of dividing into rooms the interior spaces of a building.

[0003] In buildings with a reinforced concrete frame traditional construction methods provide that the curtain and partition walls are made of continuous brickwork, often joined to the structural elements of the building (beams, columns, slabs, etc.). Curtain walls thus constructed are characterised by extreme rigidity and often by brittle behaviour. Moreover, their interaction with the structural frame often negatively affects the behaviour of the latter. During the seismic events which occurred in recent decades such structures have suffered extensive damage related to the interaction of the frame-curtain wall. In fact, the presence of rigid curtain and partition walls appreciably changes the dynamic response of the building during the earthquake, giving rise to collapse mechanisms (global or local) that affect the safety of the building and result in significant post-earthquake damage. In fact, recent earthquakes have shown that the repair of the damage to curtain and partition walls, or traceable to their interaction with the structural frame, represents one of the major cost items of post-earthquake repair. Examples of known walls in brickwork suitable to resist seismic deformation of a bearing structure are disclosed in documents CN 102 268 900 A, CN 101 476 360 A, WO 2015/033161 A1 and EP 1 043 454 A2.

[0004] The need is felt in the anti-seismic construction industry to provide a seismic-compatible wall (curtain or partition wall) that is able to ensure good seismic behaviour both with respect to agents acting on the plane and out of plane or transversal.

[0005] The purpose of the present invention is to resolve the problems of the prior art taking into account the needs of the sector.

[0006] Such object is achieved by a seismic-compatible wall in brickwork divided into sub-portions thanks to the insertion of sliding joints (in the horizontal direction or in the vertical direction) which reduce its rigidity in the plane and ensure the generation of ductile behaviour in the plane which accommodates the deformations of the structural frame during the seismic event.

[0007] Furthermore, such object is achieved by a seismic-compatible wall provided with special construction details for the connection to the adjacent structural elements (such as beams, pillars, slabs, etc.) which enables the deformable behaviour in the plane to be combined with an effective resistance to actions out of plane. Such construction parts must be properly sized for the actions involved, according to the known principles of science and construction methods.

[0008] Such object is achieved by a seismic-compatible wall made according to claims 1. The dependent claims describe preferred or advantageous embodiments of the wall.

[0009] The characteristics and advantages of the wall according to the present invention are evident from the description given below, by way of a non-limiting example, according to the appended drawings, wherein

- Figure 1 shows a seismic-compatible wall according to the present invention, in particular a newly constructed wall 100 divided into vertical bands 101 interconnected by vertical sliding joints 102;
- figures 2A and 2B respectively show a front view and a side view of the connection system between the joint and the bearing structure, applicable to both horizontal joints and vertical joints;
- figures 3A and 3B show a view from above (final and exploded, respectively) of a detail of the wall in figure 1, in an embodiment in which the brickwork blocks are tapped;
- figures 4A and 4B show a view from above (final and exploded, respectively) of a detail of the wall in figure 1, in a further embodiment in the case of blocks of a parallelepiped shape;
- Figure 5 shows a seismic-compatible wall according to the present invention, in particular an existing wall 100 divided into vertical bands 101 interconnected by vertical sliding joints 102;
- Figure 6 shows a view from above (final) of a detail of the wall in Figure 5, in an embodiment example;
- Figure 7 shows a side view (exploded) of the connection system between the joint and the bearing structure, applicable to both horizontal joints and vertical joints;
- Figure 8 shows a seismic-compatible wall according to the present invention, in particular a wall 100 divided into vertical bands 101 interconnected by vertical sliding joints 102, in which there is an aperture 300;
- Figure 9 shows a seismic-compatible wall according to the present invention, in particular a newly constructed wall 200 divided into horizontal bands 202 interconnected by horizontal sliding joints 102;
- Figure 10 shows the wall 200 in Figure 9 in an embodiment variant;
- Figures 11A and 11B show a side view (exploded and final, respectively) of a detail of the wall in figure 9, in an embodiment for brickwork blocks with tapping along the horizontal joints;
- Figures 12A and 12B show a side view (exploded

and final, respectively) of a detail of the wall in figure 9, in a further embodiment for brickwork blocks of a parallelepiped shape;

- Figure 13 shows a seismic-compatible wall according to the present invention, in particular a wall 200 divided into horizontal bands 202 interconnected by horizontal sliding joints 102, in which there is an aperture 300;
- Figures 14A and 14B, that are not part of the present invention, show a view from above (final and exploded, respectively) of a detail of the wall in figure 9 or 12, in a further embodiment;
- Figure 15 shows a seismic-compatible wall that is not part of the present invention, in particular a wall 200 divided into horizontal bands 201 fitted with joints at mid-height.

[0010] With reference to the appended drawings, and in particular to figures 1, 5, 8, 9, 10, 13 and 15, reference numerals 100, 200 denote a seismic-compatible wall.

[0011] The seismic-compatible wall 100,200 is a curtain or a partition wall, which is part of a building with a weight bearing seismic-resistant framework structure 3 (wall systems, frame, etc.). Consequently, the wall 100,200 does not have a supporting function but a space separation function.

[0012] The supporting structure 3 is defined by pillars 301 and beams 302, 302', and in particular by an upper beam 302 and a lower beam 302' (for example constrained to the ground) or by an upper slab and a lower slab in the case of partition walls .

[0013] The wall 100, 200 is divided into bands 101,201 linked together by sliding joints 102,202.

[0014] Preferably, the sliding joints 102, 202 are joints shaped to form "shear lugs", aimed at ensuring stability out of plane.

[0015] The inclusion of sliding joints 102, 202 gives the wall 100,200 the deformability needed to accommodate deformations in the plane of said wall, deformations imposed by seismic activity.

[0016] Preferably, the sliding joints 102,202 are constrained at least partially to the bearing structure 3. As a result, the sliding joints 102,202 also act as connecting joints. In fact, the sliding joints 102,202 form a constraint out of plane, while still allowing a sliding movement in the plane of the wall 200.

[0017] In an alternative embodiment, the sliding joints 102,202 are shear joints.

[0018] In a further embodiment variant, the sliding joints 102,202 are shear joints and tensile joints.

[0019] The connection between the sliding joint 102, 202 and the bearing structure 3 is made by means of a connection element 10. The connection of the joint must ensure the transfer of the shear allowing a certain degree of rotation in the plane and out of plane.

[0020] Preferably, the connection element 10 is deformable, in order to allow the rotation also in a transverse direction to the wall 100. Preferably, the connection element 10 is fixed to the beam by a pin so as to allow the rotation also in a transverse direction to the wall 100.

[0021] To realize a shear connection of the sliding joint 102, 202 to the bearing structure 3, the pin 12 is a pin suitable to ensure a connection to the beam 302 with shear strength, but not tensile strength.

[0022] To provide a tensile connection of the sliding joint 102,202 to the bearing structure 3, the pin 12 is a coach screw not removable from the beam 302.

[0023] The connection element 10 is constrained to the sliding joint 102, 202 by attachment means 11, or is in one piece with the joint itself.

[0024] The sliding joints 102,202 are made of wood, or steel or plastic material or synthetic, or combinations of said materials.

[0025] In order to prevent the triggering of a diagonal strut effect in the bands 101,201 forming the wall 100,200, at least between the wall 100,200 and the upper beam 302 a free space 17 (for example approximately equal to 1 cm) must be left. This free space 17 can be filled with yielding material (for example polyurethane foam).

[0026] The wall 100,200 is then coated with plaster (for example of 1-2 cm). To avoid cracking the plaster in correspondence with the sliding joints 102,202, to cover said joints a mesh-plaster holder band is provided or another material is used suitable to restore the surface continuity.

[0027] In an alternative embodiment, shown in Figures 1 to 8, the wall 100 is divided into vertical bands 101 interconnected by vertical sliding joints 102 constrained at least partially to the bearing structure 3.

[0028] In an alternative variant, shown in Figures 9 to 13, the wall 200 is divided into horizontal bands 201 connected to each other by horizontal sliding joints 202 constrained at least partially to the bearing structure 3.

[0029] The present invention therefore relates to a seismic -compatible wall in two different configurations of the sliding joints system: horizontal joints 202 and vertical joints 102. Such variations lead to similar results from the seismic point of view, albeit through different behaviour mechanisms, which require different constructional details.

Vertical joints: newly built wall

[0030] As shown in Figure 1, the wall 100 is made up of vertical strips 101 of variable width (for example comprised between 50cm - 70cm), connected by vertical sliding joints 102.

[0031] The vertical joints 102 are constrained to the bearing structure 3, and in particular to the beams or upper 302 and lower 302' slab. Therefore, the vertical joints 102 are sliding joints which also serve as connecting joints, in particular shear joints.

[0032] Preferably, the vertical joints 102 are shear and tensile joints.

[0033] The vertical joints 102, during stresses in the plane, have the dual function of inducing the sliding and

relative rotation between the vertical bands 101 of brickwork. At the same time the vertical joints 102, being shaped joints, give the wall 100 the necessary resistance to tilting out of plane.

[0034] The connection of the vertical joint 102 to the bearing structure 3 (upper beam 302 and lower beam 302') is realized via a connection element 10.

[0035] In an embodiment example (shown in figures 2A and 2B) the connection element 10 is shaped (e.g. L-shaped) and constrained to the vertical joint 102 by attachment means 11 (for example bolted).

[0036] In an embodiment (not shown) the connection element 10 is in one piece with the vertical joint 102: the connection element 10 is the end (upper or lower) of the vertical joint 102.

[0037] The connection of the vertical joint 102 must overall guarantee the transfer of the shear allowing a certain degree of rotation in the plane and out of plane.

[0038] The connection element 10 is fixed to the beam by a pin 12, so as to allow the rotation also in a transverse direction to the wall 100.

[0039] Preferably, between the beam 302, 302' and the element 10 a washer is inserted fitted on the pin 12.

[0040] Preferably, the connection element 10 is made of metal (for example steel) and has a limited flexural rigidity in the plane of the wall.

[0041] In the absence of the washer, the connection element 10 is deformable (given a limited flexural rigidity in the plane of the wall).

[0042] The vertical joints 102 are shaped joints. The shaped profile can be made with different methods and materials, depending on the type of brickwork used. For example (figures 3A and 3B), in the presence of bands 101 in shaped blocks (tapped blocks), the vertical joint 102 has a profile of the same shape. The vertical joint 102 is inserted dry along the vertical tapping between two adjacent vertical bands 101.

[0043] For example (figures 4A and 4B), in the presence of vertical bands 101 without shaping (smooth blocks), the vertical joint 102 has as "Ω" or "H" profile for example. The vertical joint 102 is embedded in a bed 13 of bonding agent (e.g. mortar) made between two adjacent vertical bands 101. Preferably, the vertical joint 102 is coated on both sides with a film 14, for example polyethylene, designed to prevent the adhesion of the bonding agent to the joint itself. This solution facilitates sliding between the two sub-portions 13' of the bed 13 and the vertical joint 102.

[0044] In the example of Figures 3 and 4, the vertical joint 102 is shaped with a "Ω" profile, thus with a protruding central portion 120, compared to the joint plane, fitted with two lateral portions 121.

[0045] Preferably a free space 17 must be guaranteed between the vertical bands 101 and the upper beam 302, to avoid a strut effect of the vertical bands 101.

[0046] In another example, the vertical joint 102 is inserted in the connection element 10 shaped to create a seat suitable to prevent the horizontal displacement with respect to the beam 302, 302' without being mechanically clamped to it.

Vertical joints: existing wall

[0047] The technical solution of the vertical bands 101 connected by sliding vertical joints 102 according to the present invention can also be applied in the case of seismic reinforcement of existing walls.

[0048] As shown in Figure 5, vertical grooves 15 are made in the pre-existing wall, for example using a circular saw, so as to divide the wall itself in vertical bands 101. The vertical joints 102 are inserted in the grooves 15 and attached to the bearing structure 3, and in particular to the upper 302 and lower 302' beams. In order to restore the continuity of the wall, ensuring contact between the vertical bands 101 and the vertical joints 102, an injection of bonding agent (e.g. mortar) is made on both sides of the vertical joint 102. Lastly, a horizontal cut is made to ensure a free space 17 between the vertical bands 101 and the upper beam 302.

[0049] In an embodiment example, shown in figure 6, the vertical joint 102 is a table 122 (e.g. in wood) fitted with L-shaped profiles 123 (e.g. in steel). This way a chamber 124 is made between the table 122 and the vertical band 101 for housing the injection of bonding agent (e.g. mortar).

[0050] In order to inhibit the adhesion between the table 122 and the bonding agent, the vertical joint 102 is coated on both sides with a film 14, for example in polyethylene.

[0051] Given the fluid consistency of the mortar injected and the standard construction method which provides for existing curtain walls the use of blocks with horizontal holes, the injection of mortar is made inside a stocking in stretch fabric.

[0052] In this embodiment too, the connection of the vertical joint 102 to the bearing structure 3 (upper beam 302 and lower beam 302') is realized via a connection element 10.

[0053] In an embodiment example, shown in figure 7, the connection element 10 is shaped (e.g. U-shaped) and constrained to the vertical joint 102 by attachment means 11 (for example self-tapping screws) or in one piece with the vertical joint 102.

[0054] The connection element 10 is fixed to the beam by means of a pin 12 and preferably between the beam 302, 302' and the element 10 a washer is inserted, fitted on the pin 12.

[0055] A method of seismic reinforcement of an existing wall, that is not part of the invention, comprising the steps of:

- making in the existing wall at least one vertical groove 15 so as to divide said wall into vertical bands 101;
- inserting in the groove 15 a vertical joint 102 and attaching it to the upper 302 and lower 302' beams;

- injecting into the groove 15 a bonding agent on both sides of the vertical joint 102.

[0056] Specifically, the method of seismic reinforcement provides, prior to insertion into the groove 15, for covering the vertical joint 102 with a film 14, for example in polyethylene.

[0057] In addition, the method of seismic reinforcement provides for making an injection of mortar into the groove, and in particular to inject the mortar inside a stocking in stretch fabric.

[0058] The seismic reinforcement method, that is not part of the invention, further provides for the steps of:

- making a horizontal cut to ensure a space 17 between the vertical bands 101 and the upper beam 302;
- filling the space 17 with a yielding material.

Vertical joints: wall with aperture

[0059] In the presence of an aperture 300 in the wall 100 for example to make a door as shown in figure 8, at the sides of the aperture 300 two vertical joints 102 are inserted which act as vertical uprights, constrained above and below to the beams 302, 302' of the bearing structure 3. In this case, the vertical joints 102, with upright function, are made with appropriately sized profiles.

[0060] The upper portion of the aperture 300 is defined by an architrave 307 connected with a simple support constraint to the vertical joints 102 acting as uprights.

Horizontal joints: newly built wall

[0061] In the case of a newly constructed curtain wall it may be easier to divide the wall into horizontal bands free to slide relatively in the plane of said curtain wall. This result can be obtained with the technique described in the case of vertical bands 101 connected by vertical sliding joints 102, placing the same elements as above in horizontal and constraining them to the pillars 301 of the bearing structure 3 to ensure resistance out of plane. Unlike the production variant with vertical joints 102, in the case of horizontal joints 202 the connection must also ensure the transfer of an axial action in the joint.

[0062] As shown in Figure 9, the wall 200 is made up of horizontal bands 201 of variable width connected by horizontal sliding joints 202.

[0063] The horizontal joints 202 are shaped joints. This solution creates an indentation between the horizontal bands 201 that allows sliding in the plane, but inhibits the relative displacement out of plane.

[0064] For example (figures 11A and 11B), in the presence of bands 201 in shaped blocks (tapped blocks), the horizontal joint 202 has a profile of the same shape. The horizontal joint 202 is positioned between two adjacent horizontal bands 201 and matches the shaping thereof.

[0065] For example (figures 12A and 12B), in the presence of horizontal bands 201 without shaping (smooth blocks), the horizontal joint 202 has as "Ω" or "H" profile for example. The horizontal joint 202 is embedded in a bed 13 of bonding agent (e.g. mortar) made between two adjacent horizontal bands 201. Preferably, the horizontal joint 202 is coated on both sides with a film 14, for example polyethylene, designed to prevent the adhesion of the bonding agent to the joint itself. This solution facilitates sliding between the two sub-portions 13' of the bed 13 and the horizontal joint 202.

[0066] The horizontal joints 202 are constrained to the bearing structure 3, particularly to the pillars 301. Therefore, the 202 horizontal joints are sliding joints which also serve as connecting joints, in particular at least shear joints.

[0067] Preferably, the horizontal joints 202 are shear and tensile joints.

[0068] In order to avoid triggering a strut effect in the horizontal bands 201, between the wall 200 and the pillars 301 and also between the wall 200 and the upper beam 302 a free space 17 must be left.

Horizontal joints: partition wall with aperture

[0069] Even in the case of a wall 200 with horizontal bands 201 connected by horizontal sliding joints 202, the presence of an aperture 300 in the wall requires the predisposition of vertical uprights.

[0070] The wall 200, in this case the curtain wall, is built with the same technique as the solid curtain wall (Figure 9) .

[0071] In the presence of an aperture 300 in the wall 200 for example to make a door as shown in figure 13, at the sides of the aperture 300 two vertical joints 102 (suitably sized to guarantee the necessary resistance to concentrated actions transferred by the horizontal joints) are inserted which act as vertical uprights, constrained above and below to the beams 302, 302' of the bearing structure 3.

[0072] The upper portion of the aperture 300 is defined by an architrave 307 connected with a simple support constraint to the vertical joints 102 acting as uprights.

[0073] The above-door or the above-window of the aperture 300 reproduces the horizontal bands 201 of the adjacent brickwork.

Workaround for horizontal joints

[0074] In an embodiment variant that is not part of the invention (figures 10 and 15), the wall 200 consists of horizontal bands 201 connected to the bearing structure 3 by means of an intermediate joint 204.

[0075] In the variant in figure 10, the horizontal bands 201 are connected to each other by horizontal shear connecting joints 202. Preferably, the horizontal joints 202 are tensile connection joints.

[0076] Preferably, the intermediate joint 204, that is not part of the invention, is located at mid-height of the hor-

izontal band 201. This allows minimizing of the stress transferred, in the plane of the wall, from the wall 200 to the pillar 301 or to the uprights, safeguarding them from an over excessive stress due to the interaction between the bearing structure 3 and the wall 200 (curtain wall) .

[0077] In the example in figures 14A and 14B, that is not part of the invention, the intermediate joint 204 is made between a connection element 10 constrained to the pillar 301 and suitable to house a shaped profile 11 of the horizontal band 201. The intermediate joint 204 thus realizes a constraint out of plane and a monolateral contact constraint in the plane, between the band 201 and the pillar allowing in any case the detachment and vertical sliding of the elements 201 from the pillar 301.

[0078] The connection element 10 is shaped (e.g. C-shaped) and constrained to the pillar 301 by attachment means 18 (for example plugs).

[0079] The horizontal band 201 has a tapping or, preferably, a contoured profile 11, for example, "Ω"-shaped, in order to fit into the connection element 10.

[0080] The contoured profile 11 is constrained to the horizontal band 201 by means of an adhesive layer 9 (such as mortar or boding agent).

[0081] Preferably, the contoured profile 11 extends for the full height of the horizontal band 201, in order to redistribute the load concentrated on said band.

[0082] In an embodiment variant in figure 10, the horizontal joints 202 are shear joints. In this variant the element 204, that is not part of the invention, is a simple dowel (e.g. of wood) located in the middle of the brickwork, which makes the tensile connection for the element 10 superfluous, which at this point needs only to support the cut transversely to the wall.

[0083] It has been noted that the variant of wall 200, with horizontal bands 201 connected by sliding 202 and connecting 204 horizontal joints made according to the example in Figures 14A and 14B, that is not part of the invention, lends itself to a different resistant mechanism out of plane, which provides for the activation of an arc mechanism between the pillars 301, in the thickness of the wall or a bending mechanism between the pillars in the presence of a reinforced plaster of the brickwork This makes it possible, in some cases, to avoid connecting the horizontal joints 202 to the pillars 301. This simplification is however balanced by the need to ensure the connection out of plane between the horizontal bands 201 in brickwork and the pillars 301 or vertical uprights (in the form of vertical joints 102) of the aperture 300, for example, in the manner described in Figures 14A and 14B that is not part of the invention.

[0084] In such embodiment variant shown in figure 15, that is not part of the invention, the wall 200 is composed of horizontal bands 201 connected to the bearing structure 3 by means of an intermediate joint 204 suitable to ensure stability of the wall (200) both in the plane and out of plane.

[0085] In this case the horizontal joints 202 are pure connection joints between the bands 201 and serve only to introduce sliding surfaces between the sub-portions of brickwork. The horizontal bands 201 are thus connected to each other by purely sliding horizontal joints 202 (i.e. not constrained to the bearing structure 3).

[0086] The resistance out of plane is guaranteed by the arc effect inside the brickwork that is activated via special connections of the brickwork (intermediate joints 204, that is not part of the invention) at the lateral pillars.

[0087] Preferably, said sliding joints 202 are shaped joints designed to ensure further stability of the wall (200) out of plane,

[0088] All the wall solutions proposed 100, 200 according to the present invention and appropriately sized for the actions involved, provide curtain and partition walls in brickwork with good seismic behaviour both as regards actions acting in the plane and transverse thereto. In fact, thanks to the division of the wall into sub-portions by inserting sliding joints (horizontal or vertical) it is possible to reduce the rigidity of the wall in the plane, as well as to ensure ductile behaviour in the plane which accommodates the deformation of the structural frame during the earthquake. Moreover, the introduction of special construction details for the connection of the wall to the adjacent structural elements makes it possible to combine the deformable behaviour in the plane with an effective resistance out of plane.

[0089] The solution proposed according to the present invention represents a significant development in terms of construction details, which on the one hand optimises the seismic-compatible behaviour of the wall and on the other makes its industrialization possible through a simplification of the components.

[0090] The solution proposed according to the present invention applies to the construction industry both in the construction of new buildings and in the seismic reinforcement and/or improvement of existing buildings. In detail, the horizontal joints can be used in the construction of new curtain walls, while the adoption of vertical joints can be used both for newly constructed and existing curtain walls. In fact, the variant with vertical joints is applicable to existing curtain walls by making special cuts in the existing brickwork to house the sliding joint. In the case of internal partitions, only the vertical configuration of the joints is proposed.

[0091] The solution proposed according to the present invention is independent of the material used for the construction of the wall, and is therefore compatible with the different construction methods used today to make brick walls, including prefabricated panels.

[0092] Innovatively, a seismic-compatible wall according to the present invention ensures good seismic behaviour both with respect to agents acting on the plane and out of plane or transversal.

[0093] Advantageously a seismic-compatible wall in brickwork divided into sub-portions thanks to the insertion of sliding joints (in the horizontal direction or in the vertical direction) ensures the generation of ductile behaviour in the plane which accommodates the deformations of the

structural frame during the seismic event.

[0094] Advantageously, a seismic-compatible wall provided with special construction details for the connection to the adjacent structural elements (such as beams, columns, slabs, etc.) allows the deformable behaviour in the plane to be matched with an effective resistance to actions out of plane.

[0095] It is clear that a person skilled in the art may make modifications to the wall described above, all contained within the scope of protection as defined by the following claims.

Claims

1. Wall suitable to resist seismic deformation comprising:

   - a bearing structure (3) defined by two pillars (301) and at least one upper beam (302);
   - a wall (100,200) in brickwork, said wall (100, 200) being divided into bands (101,201) linked together by sliding joints (102,202),

   characterised in that
   said sliding joints (102,202) being tapped joints shaped to ensure stability of the wall (100,200) out of plane, and wherein said sliding joints (102, 202) are constrained to the bearing structure (3) so as to act as shear joints by means of a connection element (10) suitable to allow a certain degree of rotation in plane and out of plane.

2. Wall according to claim 1, wherein the sliding joints (102, 202) are shear and traction joints.

3. Wall according to claim 1 or 2, wherein the connection element (10) is fastened to the beam by means of a pin (12) .

4. Wall according to claim 3, wherein to make a shear connection of the sliding joint (102, 202), the pin (12) is a plug.

5. Wall according to claim 3, wherein to make a traction connection of the sliding joint (102, 202), the pin (12) is a coach screw.

6. Wall according to any of the preceding claims, wherein between wall (100,200) and an upper beam (302) of the bearing structure (3) there is a space (17) filled with yielding material.

7. Wall according to any of the preceding claims, wherein the bands (101, 201) are composed of tapped blocks, and wherein the sliding joint (102, 202) has a profile corresponding to the tapping of the tapped blocks and is inserted between two adjacent bands.

8. Wall according to any of the claims from 1 to 6, wherein the bands (101, 201) are composed of non-tapped blocks, and wherein the sliding joint (102, 202) is embedded in a bed of a bonding agent made between two adjacent bands.

9. Wall according to any of the preceding claims, wherein the sliding joint (102, 202) is covered with a film, for example of polyethylene (14).

10. Wall according to any of the preceding claims, wherein the wall (100, 200) comprises an aperture (300) defined:

    at the sides, by two vertical joints (102) which act as uprights and constrained to the beams (302, 302');
    at least on the upper side, by an architrave (307) connected to the vertical joints (102) which act as uprights.

11. Wall according to any of the preceding claims, wherein the wall (100) is divided into vertical bands (101) connected by vertical sliding joints (102) constrained to an upper beam (302) and a lower beam (302') of the bearing structure (3).

12. Wall according to any of the claims from 1 to 10, wherein the wall (200) is divided into horizontal bands (201) connected by horizontal sliding joints (202) constrained to the two pillars (301) of the bearing structure.

13. Wall according to claim 12, wherein each horizontal band (201) is connected to the pillars (301) of the bearing structure (3) with an intermediate joint (204) located at mid-height of the horizontal band (201).

14. Wall according to claim 13, wherein the intermediate joint (204) is a connection element (10) constrained to the pillar (301) and suitable to house a shaped profile (111) of the horizontal band (201).

15. Wall according to claim 14, wherein the shaped profile (111) extends for the entire height of the horizontal band (201) .

Patentansprüche

1. Wand, die geeignet ist, seismischer Verformung zu widerstehen, umfassend:

   - eine Tragstruktur (3), die durch zwei Säulen (301) und mindestens einen oberen Balken (302) definiert ist;

- eine Wand (100, 200) in Mauerwerk, wobei die Wand (100, 200) in Bänder (101, 201) unterteilt ist, die mittels Gleitfugen (102, 202) miteinander verbunden sind,
dadurch gekennzeichnet, dass
die Gleitfugen (102, 202) gestufte Fugen sind, die so geformt sind, dass sie die Stabilität der Wand (100, 200) außerhalb der Ebene sicherstellen,
und wobei die Gleitfugen (102, 202) so an die Tragstruktur (3) eingespannt sind, dass sie mittels eines Verbindungselements (10), das geeignet ist, einen gewissen Grad an Drehung in der Ebene und außerhalb der Ebene zuzulassen, als Scherfugen wirken.

2. Wand nach Anspruch 1, wobei die Gleitfugen (102, 202) Scher- und Zugfugen sind.

3. Wand nach Anspruch 1 oder 2, wobei das Verbindungselement (10) mittels eines Stifts (12) an dem Balken befestigt ist.

4. Wand nach Anspruch 3, wobei der Stift (12) zum Herstellen einer Scherverbindung der Gleitfuge (102, 202) ein Bolzen ist.

5. Wand nach Anspruch 3, wobei der Stift (12) zum Herstellen einer Zugverbindung der Gleitfuge (102, 202) eine Schwellenschraube ist.

6. Wand nach einem der vorhergehenden Ansprüche, wobei sich zwischen der Wand (100, 200) und einem oberen Balken (302) der Tragstruktur (3) ein mit nachgiebigem Material gefüllter Raum (17) befindet.

7. Wand nach einem der vorhergehenden Ansprüche, wobei die Bänder (101, 201) aus gestuften Blöcken bestehen und wobei die Gleitfuge (102, 202) ein Profil aufweist, das der Stufung der gestuften Blöcke entspricht und zwischen zwei benachbarten Bändern eingefügt ist.

8. Wand nach einem der Ansprüche 1 bis 6, wobei die Bänder (101, 201) aus nicht gestuften Blöcken bestehen und wobei die Gleitfuge (102, 202) in einem Bett eines Bindungsmittels eingebettet ist, das zwischen zwei benachbarten Bändern hergestellt ist.

9. Wand nach einem der vorhergehenden Ansprüche, wobei die Gleitfuge (102, 202) mit einem Film, zum Beispiel aus Polyethylen (14), bedeckt ist.

10. Wand nach einem der vorhergehenden Ansprüche, wobei die Wand (100, 200) eine Öffnung (300) umfasst, die definiert ist:

an den Seiten, durch zwei vertikale Fugen (102), die als Pfosten wirken und an die Balken (302, 302') eingespannt sind;
mindestens an der oberen Seite, durch einen Architrav (307), der mit den vertikalen Fugen (102) verbunden ist, die als Pfosten wirken.

11. Wand nach einem der vorhergehenden Ansprüche, wobei die Wand (100) in vertikale Bänder (101) unterteilt ist, die durch vertikale Gleitfugen (102) verbunden sind, die an einem oberen Balken (302) und einem unteren Balken (302') der Tragstruktur (3) eingespannt sind.

12. Wand nach einem der Ansprüche 1 bis 10, wobei die Wand (200) in horizontale Bänder (201) unterteilt ist, die durch horizontale Gleitfugen (202) verbunden sind, die an den zwei Säulen (301) der Tragstruktur eingespannt sind.

13. Wand nach Anspruch 12, wobei jedes horizontale Band (201) mit den Säulen (301) der Tragstruktur (3) mit einer Zwischenfuge (204) verbunden ist, die sich auf mittlerer Höhe des horizontalen Bandes (201) befindet.

14. Wand nach Anspruch 13, wobei die Zwischenfuge (204) ein Verbindungselement (10) ist, das an der Säule (301) eingespannt ist und geeignet ist, ein geformtes Profil (111) des horizontalen Bandes (201) aufzunehmen.

15. Wand nach Anspruch 14, wobei das geformte Profil (111) sich über die gesamte Höhe des horizontalen Bandes (201) erstreckt.

Revendications

1. Mur adapté pour résister à des déformations sismiques, comprenant :

- une structure porteuse (3) définie par deux piliers (301) et au moins une poutre supérieure (302),
- un mur (100, 200) en briques, le mur (100, 200) étant divisé en bandes (101, 201) rattachées les unes aux autres par des joints coulissants (102, 202), **caractérisé en ce que**

les joints coulissants (102, 202) sont des joints de forme ayant une forme pour assurer une stabilité du mur (100, 200) en dehors du plan et **en ce que** les joints de forme (102, 202) sont fixés à la structure porteuse (3) de façon à agir comme des joints de séparation à l'aide d'un élément de connexion (10) adapté pour permettre un certain degré de rotation dans le plan et en dehors du plan.

2. Mur selon la revendication 1, **caractérisé en ce que** les joints de forme (102, 202) sont des joints de séparation et de traction.

3. Mur selon la revendication 1 ou 2, **caractérisé en ce que** l'élément de connexion (10) est fixé à la poutre par une broche (12).

4. Mur selon la revendication 3, **caractérisé en ce que**, pour former une connexion de séparation du joint de forme (102, 202), la broche (12) est une virole.

5. Mur selon la revendication 3, **caractérisé en ce que**, pour former une connexion de traction du joint de forme (102, 202), la broche (12) est un tire-fond.

6. Mur selon l'une des revendications précédentes, **caractérisé en ce que**, entre le mur (100, 200) et une poutre supérieure (302) de la structure porteuse (3), il y a un espace (17) rempli de matériau flexible.

7. Mur selon l'une des revendications précédentes, **caractérisé en ce que** les bandes (101, 201) sont constituées de blocs de forme et **en ce que** le joint coulissant (102, 202) a un profile correspondant à la forme des blocs de forme et est inséré entre deux bandes adjacentes.

8. Mur selon l'une des revendications 1 à 6, **caractérisé en ce que** les bandes sont constituées de blocs autres que de blocs de forme et **en ce que** le joint coulissant (102, 202) est logé dans un lit d'un agent de liaison réalisé entre deux bandes adjacentes.

9. Mur selon l'une des revendications précédentes, **caractérisé en ce que** le joint coulissant (102, 202) est recouvert d'un film, par exemple en polyéthylène (14).

10. Mur selon l'une des revendications précédentes, **caractérisé en ce que** le mur (100, 200) comprend une ouverture (300) défini :

    sur les côtés par deux joints verticaux (102) qui agissent comme des montants et sont fixés aux poutres (302, 302'),
    au moins sur le côté supérieur par une architrave (307) attachée aux joints verticaux (102) qui agissent comme des montants.

11. Mur selon l'une des revendications précédentes, **caractérisé en ce que** le mur (100) est divisé en bandes verticales (101) reliées par des joints coulissants verticaux (102) fixés à une poutre supérieure (302) et une poutre inférieure (302') de la structure porteuse (3).

12. Mur selon l'une des revendications 1 à 10, **caractérisé en ce que** le mur (200) est divisé en bandes horizontales (201) reliées par des joints coulissants horizontaux (202) fixés aux deux piliers (301) de la structure porteuse.

13. Mur selon la revendication 12, **caractérisé en ce que** chaque bande horizontale (201) est reliée aux piliers (301) de la structure porteuse (3) avec un joint intermédiaire (204) situé à mi-hauteur de la bande horizontale (201).

14. Mur selon la revendication 13, **caractérisé en ce que** le joint intermédiaire (204) est un élément de connexion (10) fixé au pilier (301) et adapté pour loger un profilé formé (111) de la bande horizontale (201).

15. Mur selon la revendication 14, **caractérisé en ce que** le profilé formé (111) s'étend sur la hauteur complète de la bande horizontale (201).

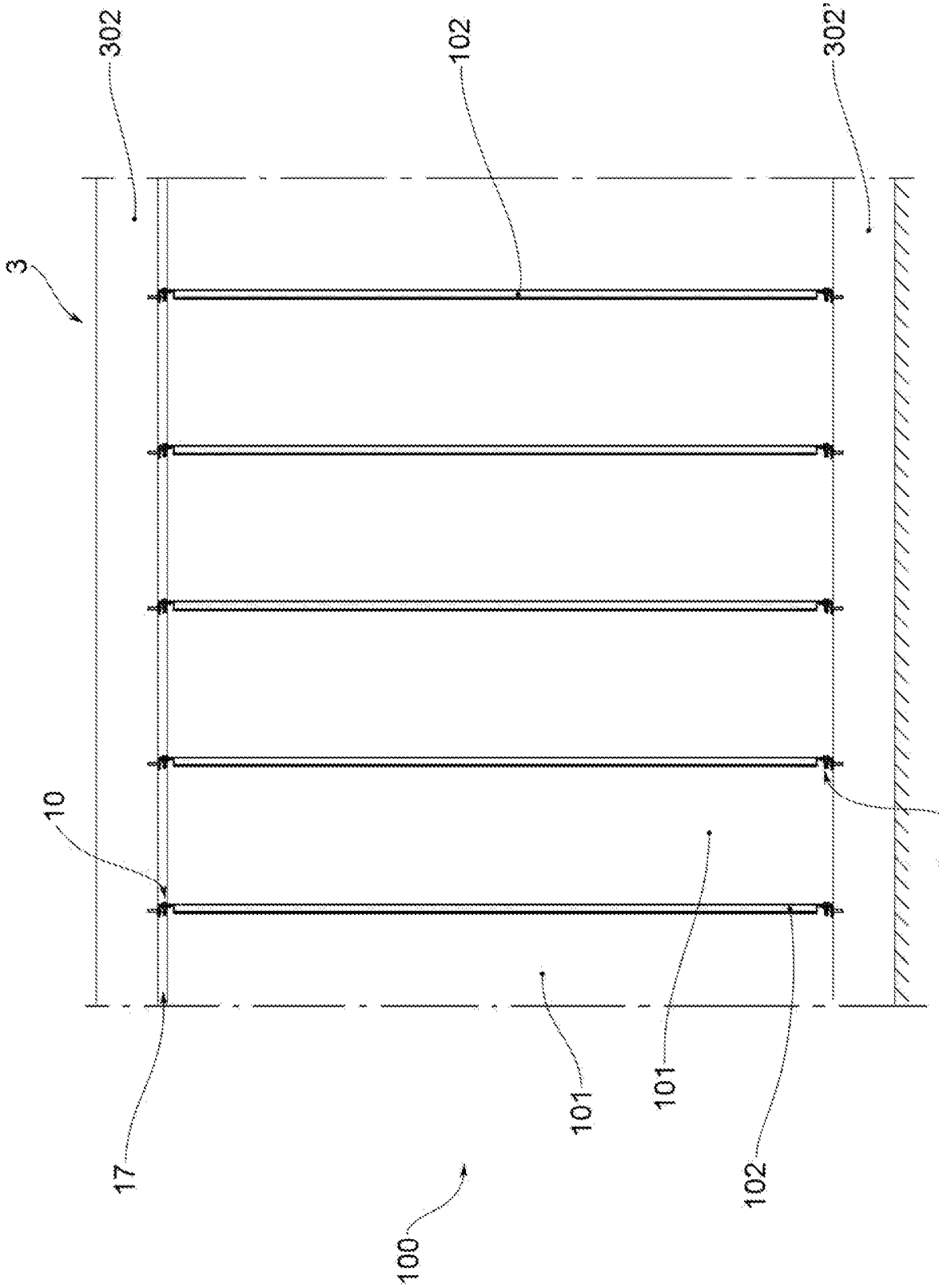

FIG.1

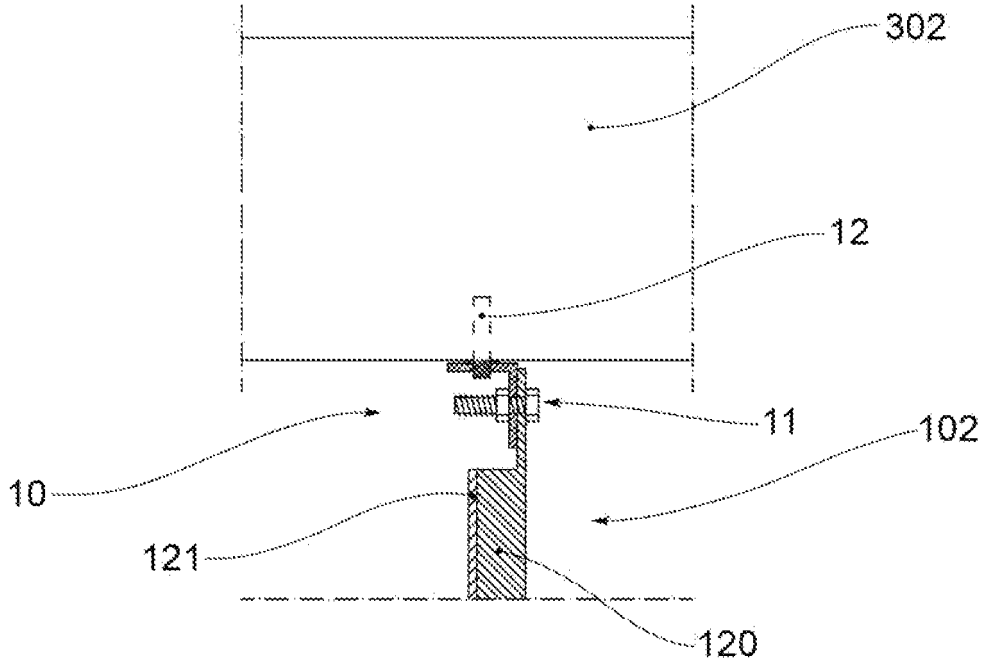

FIG.2a

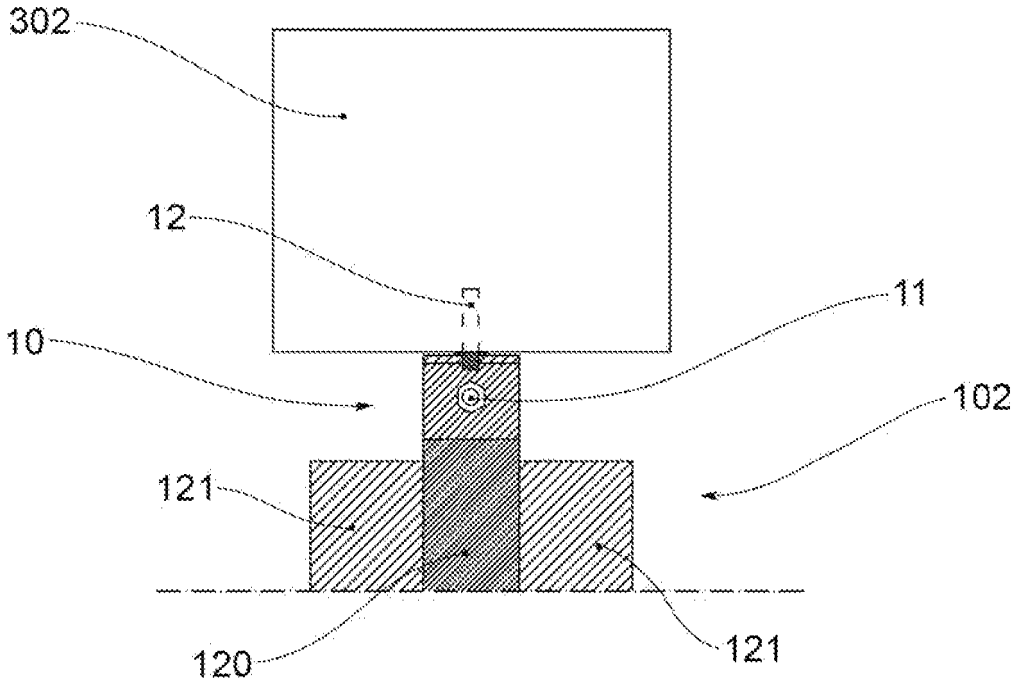

FIG.2b

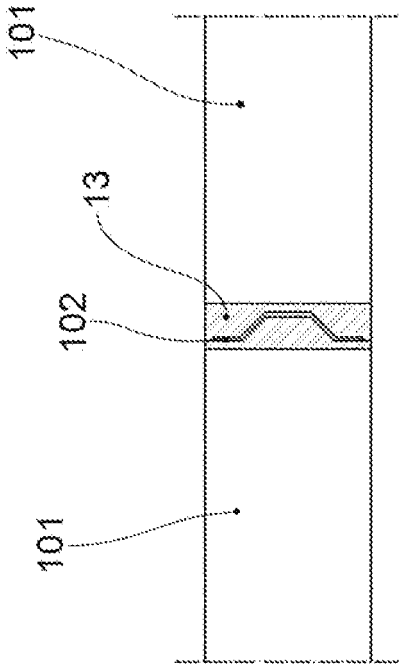

FIG.4a

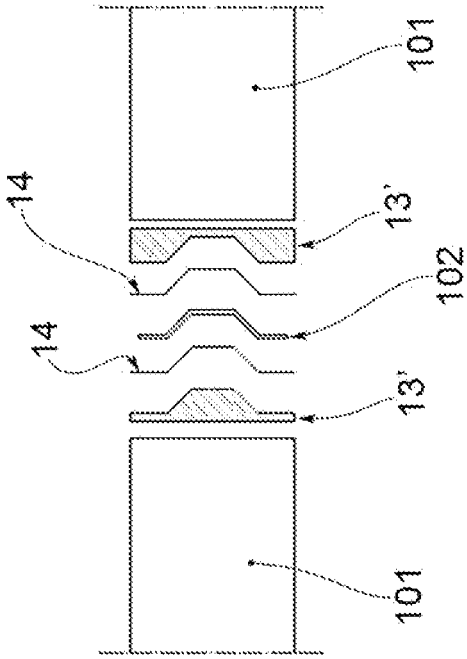

FIG.4b

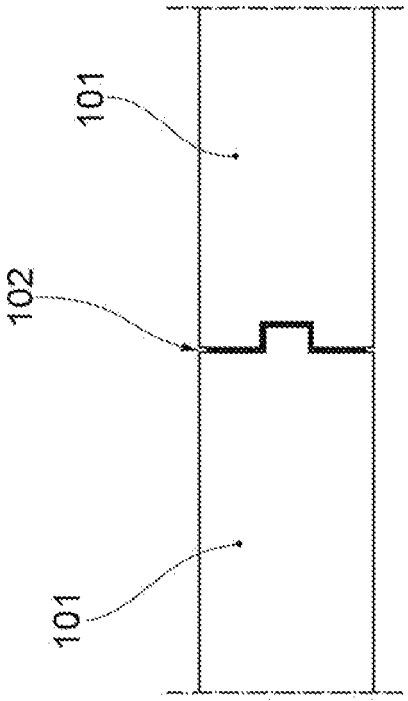

FIG.3a

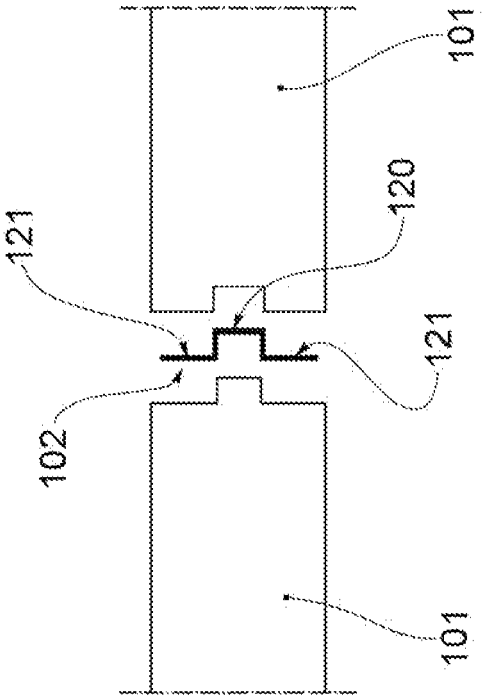

FIG.3b

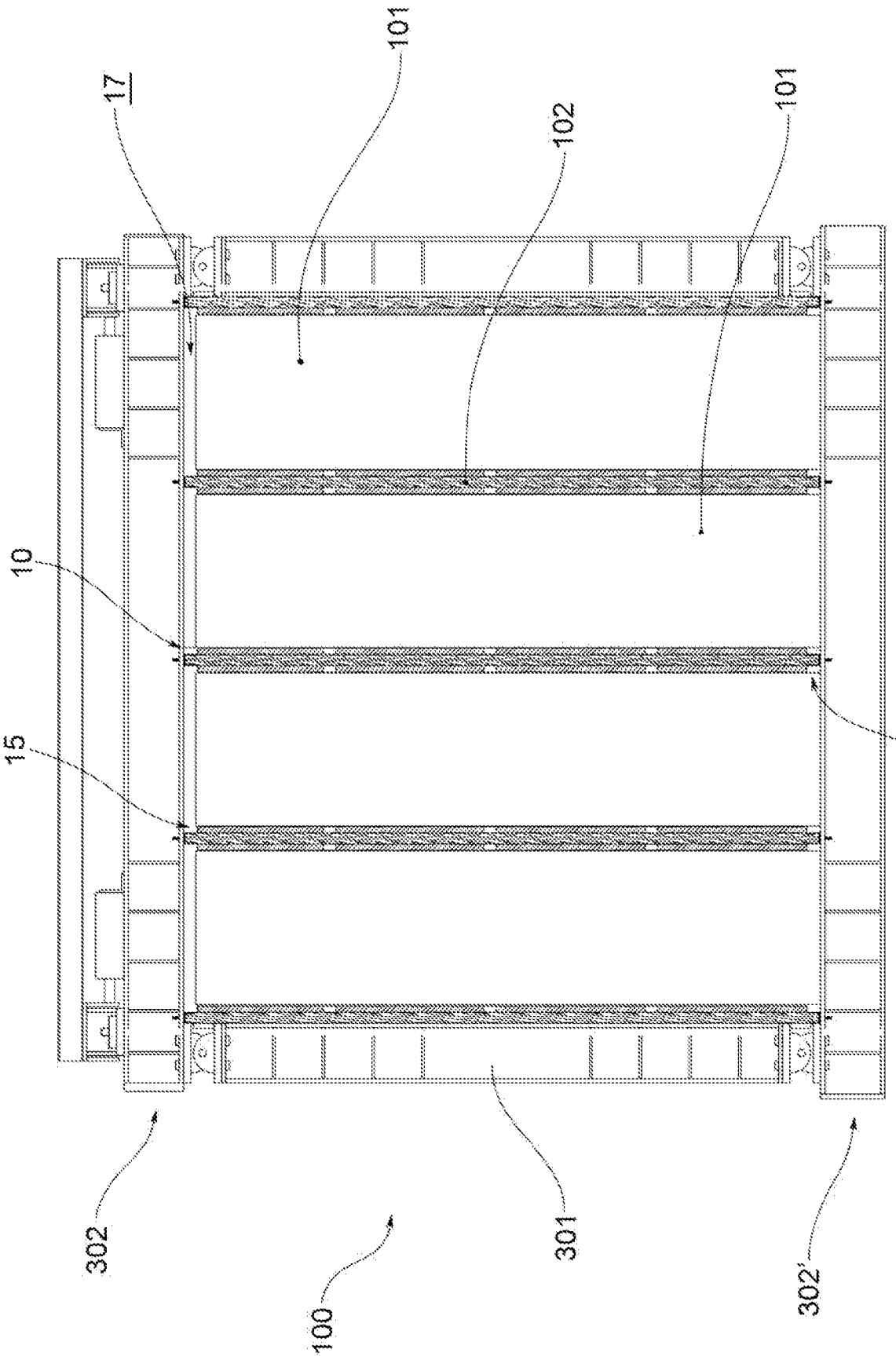

FIG.5

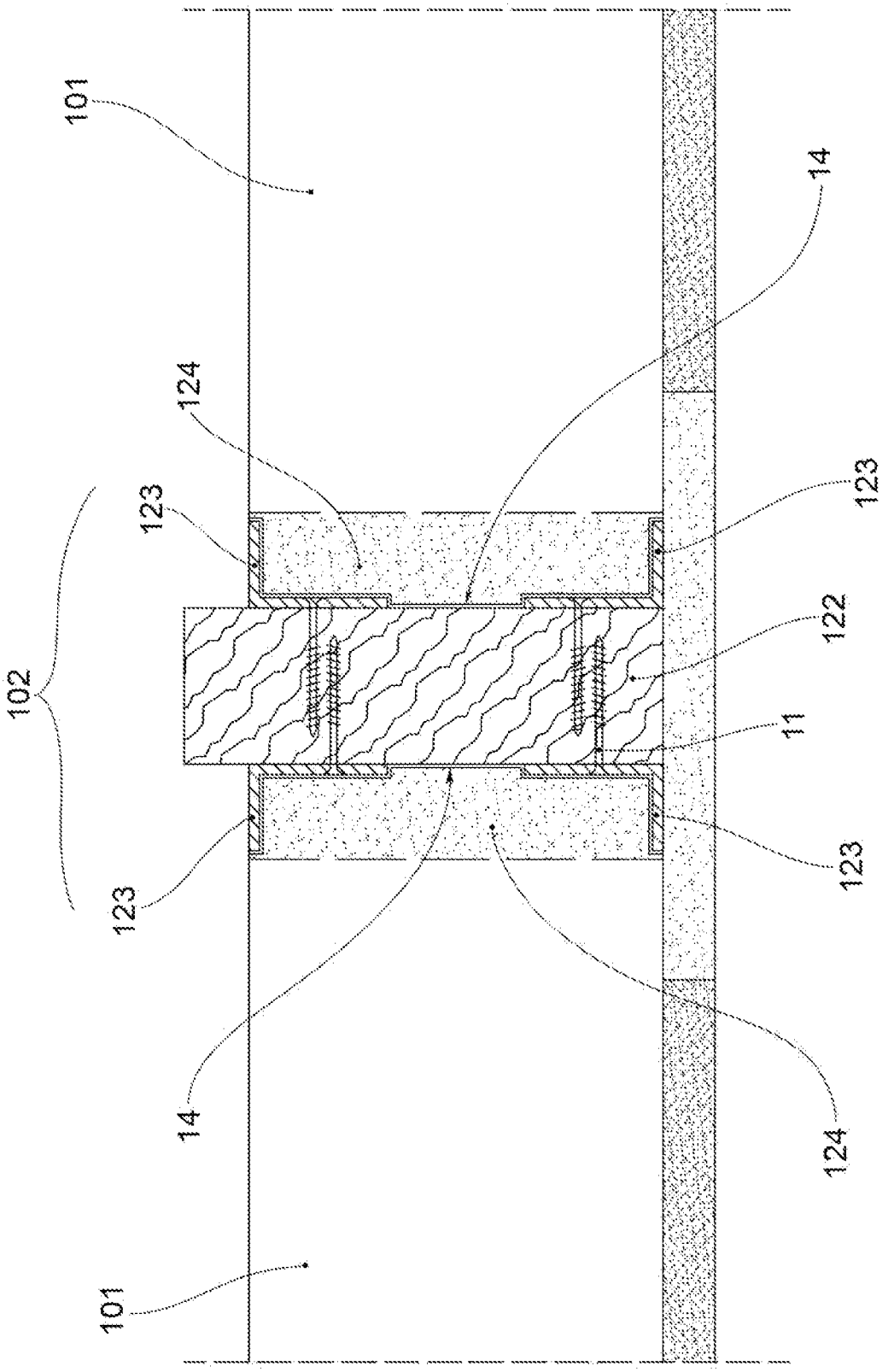

FIG.6

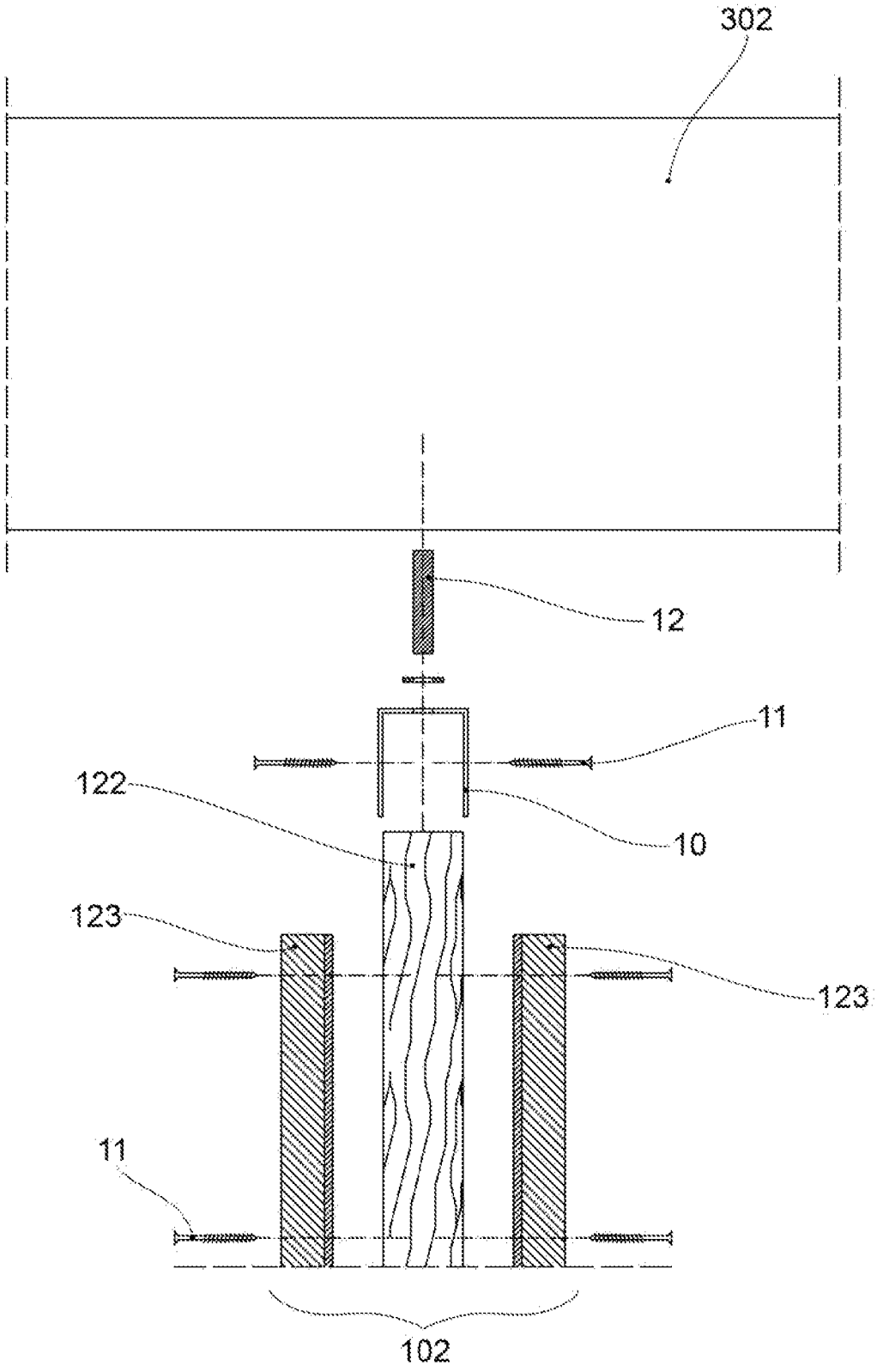

FIG.7

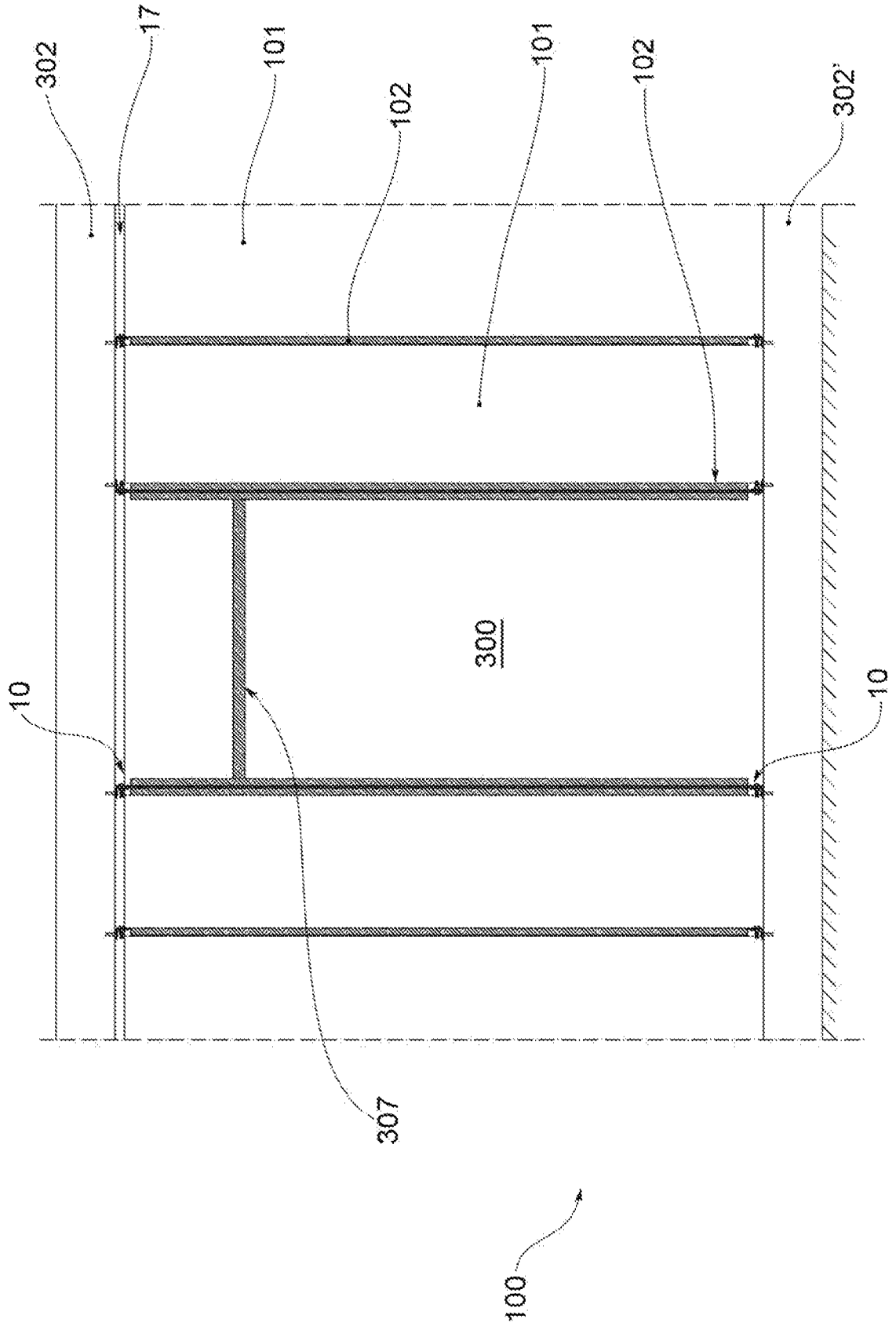

FIG.8

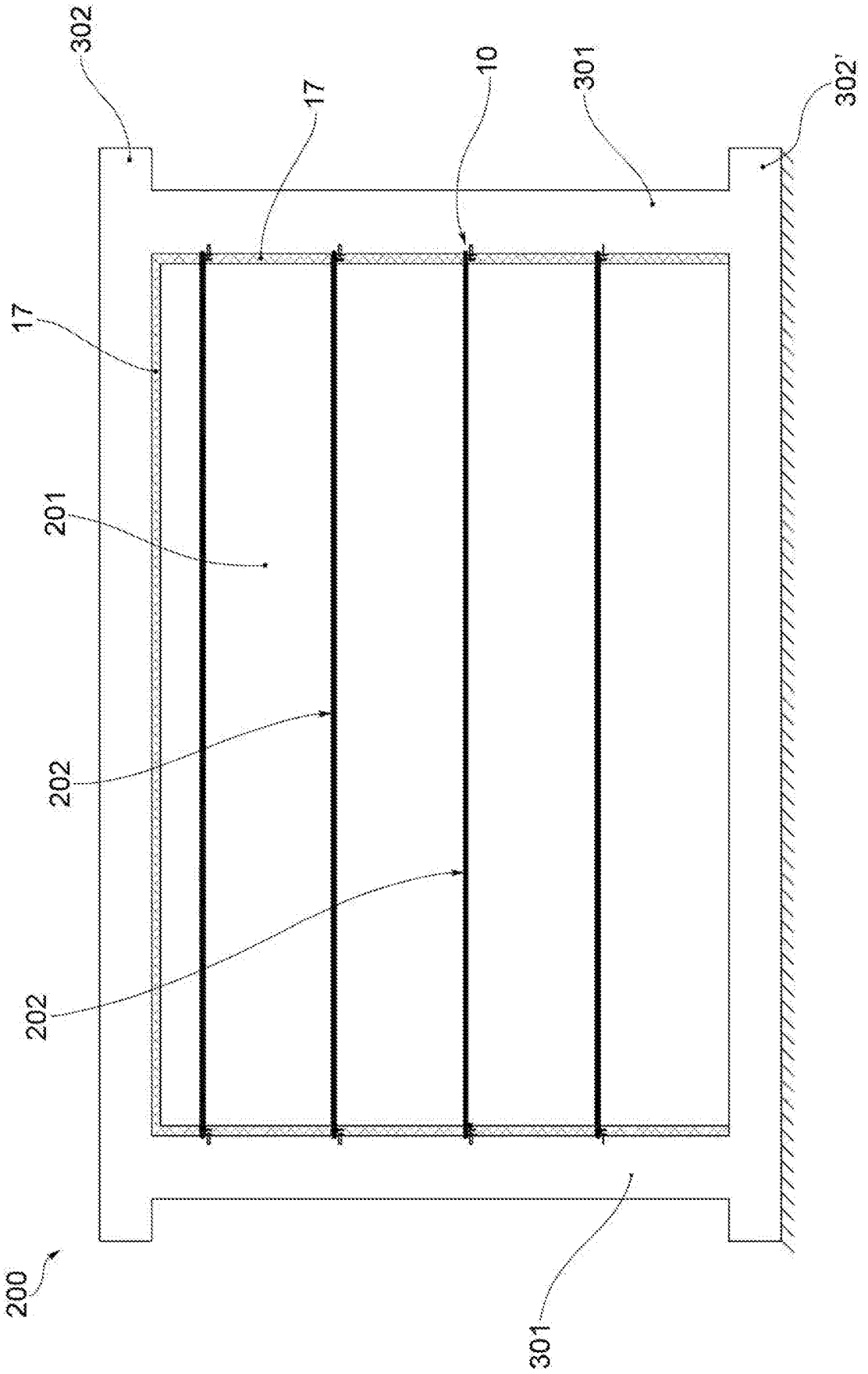

FIG.9

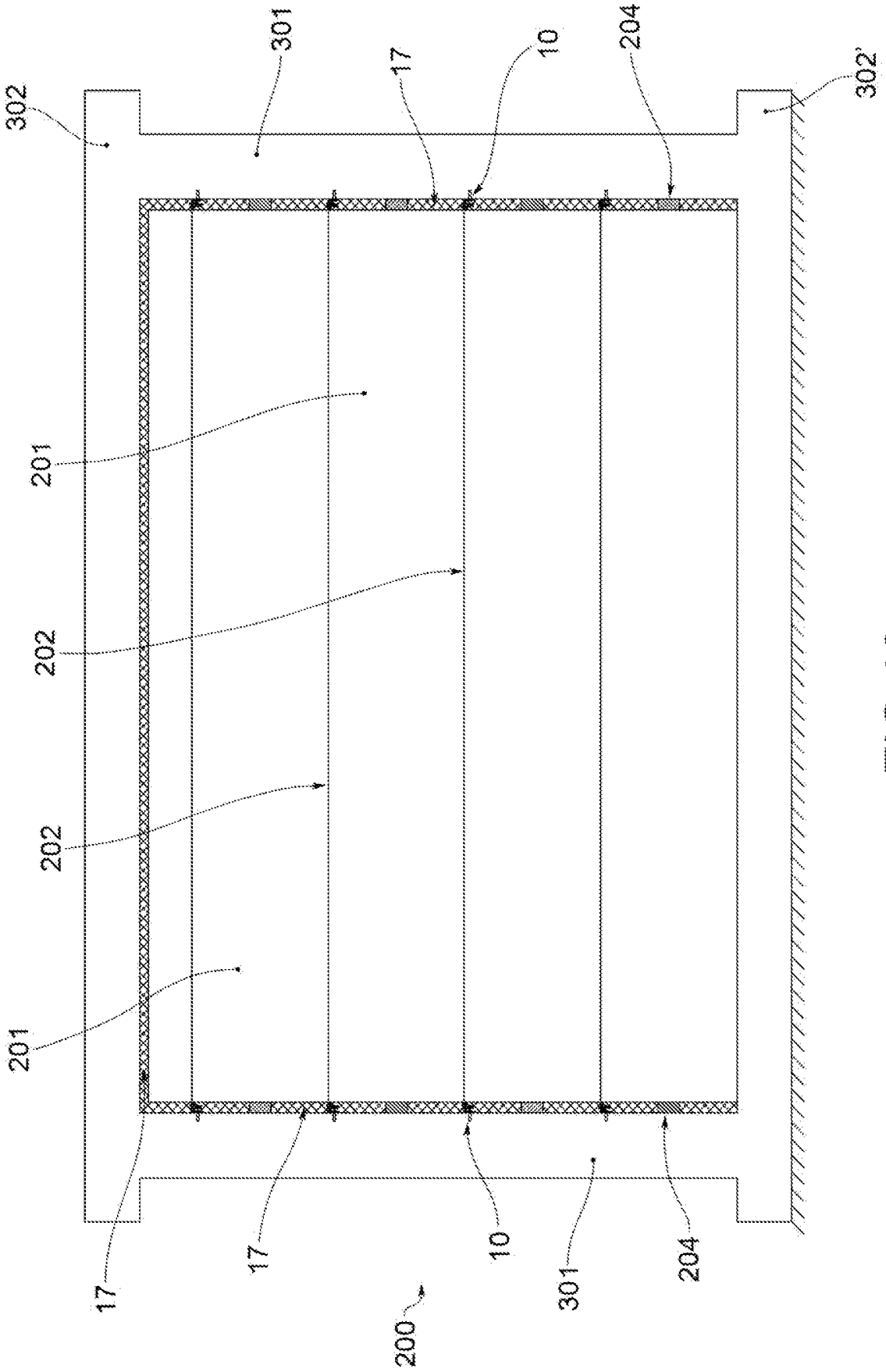

FIG.10

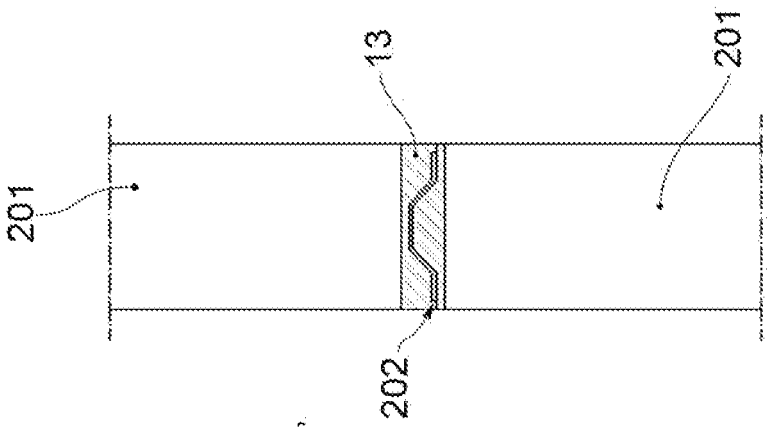

FIG.12b

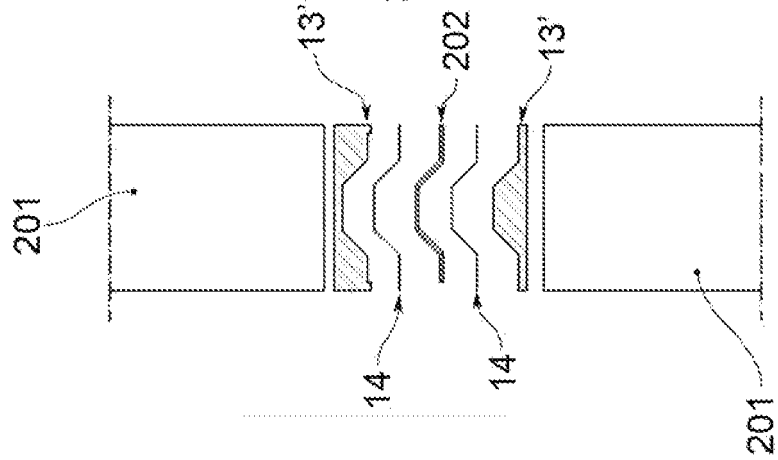

FIG.12a

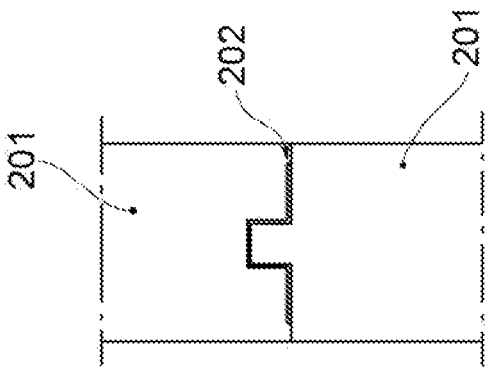

FIG.11b

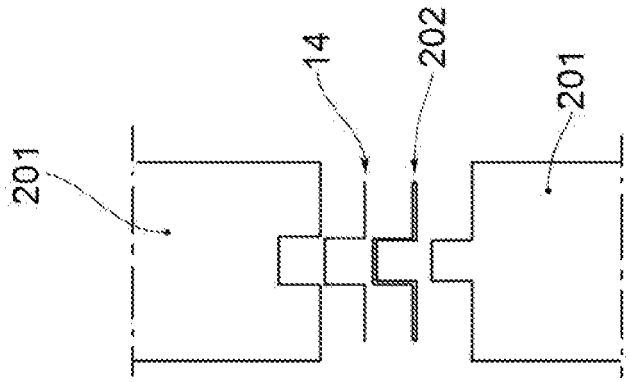

FIG.11a

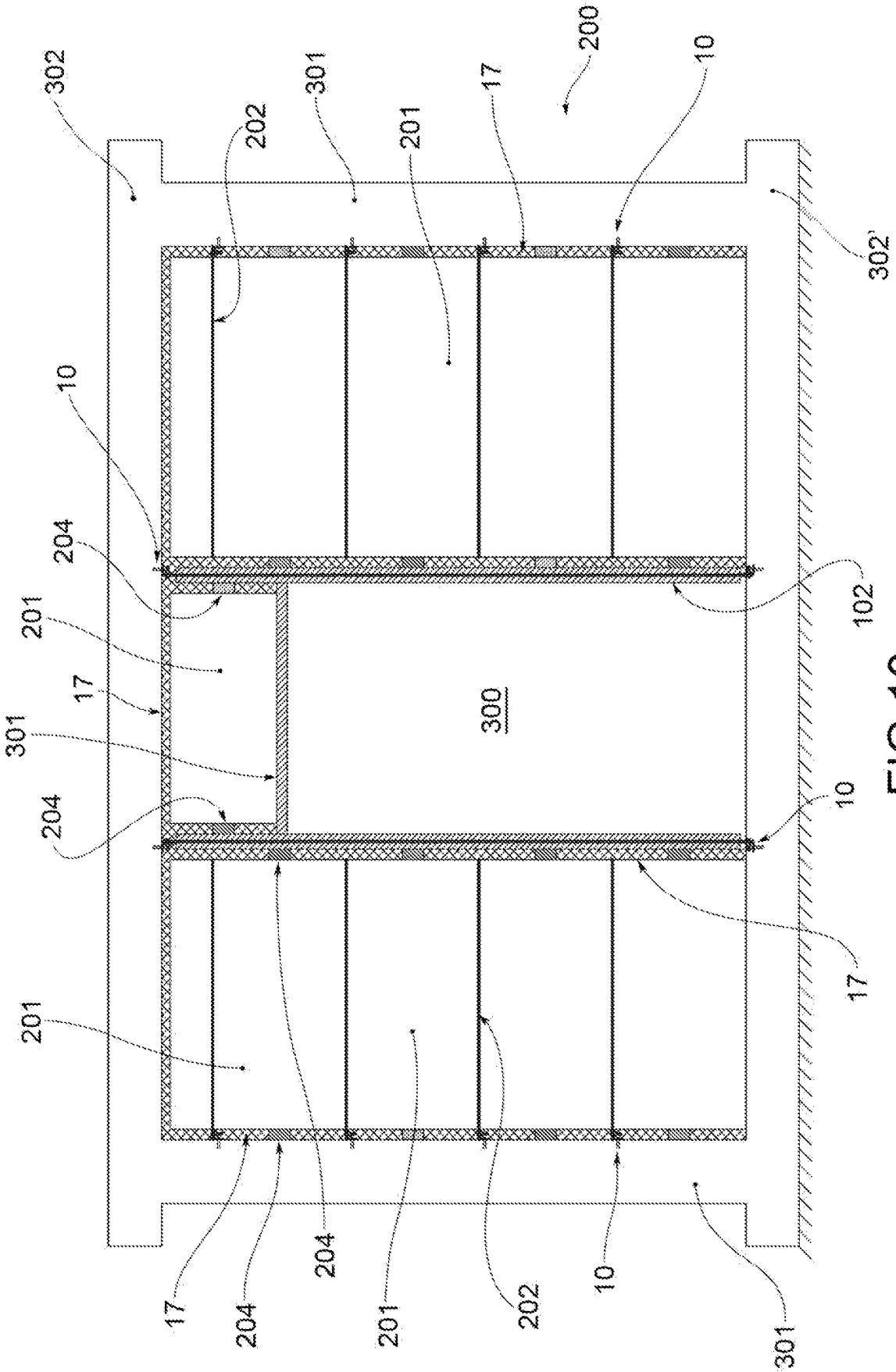
200
302
301
202
201
17
10
302'
10
204
201
17
301
204
300
102
10
17
201
17
204
204
201
202
10
301

FIG.13

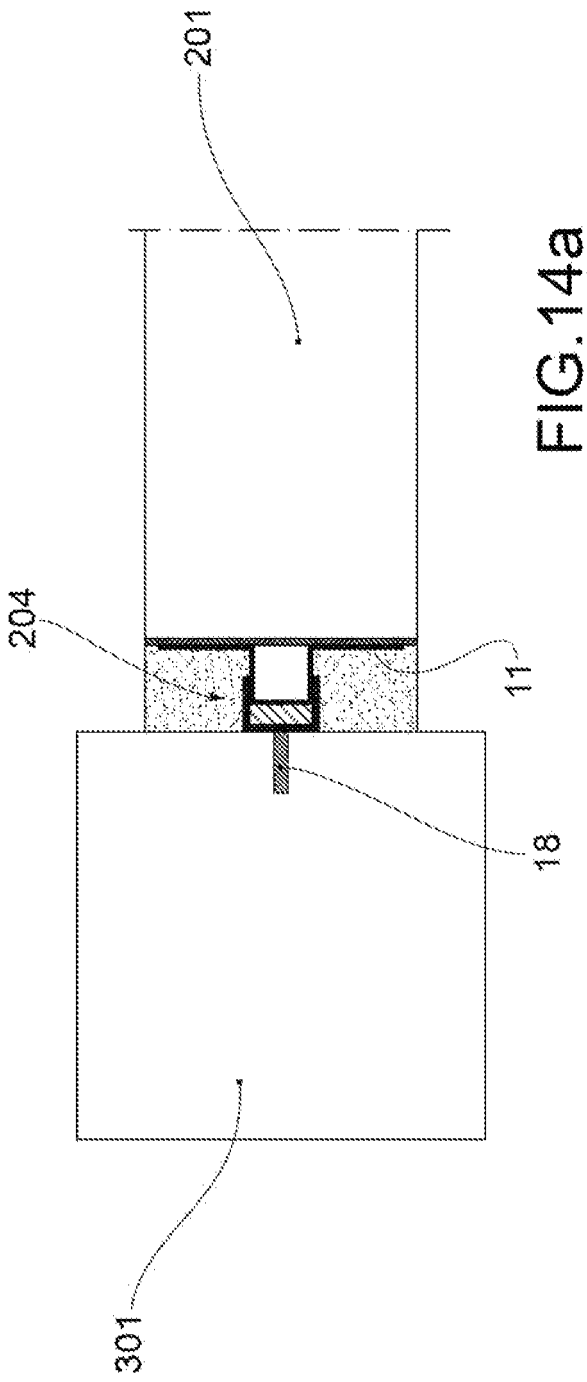

FIG.14a

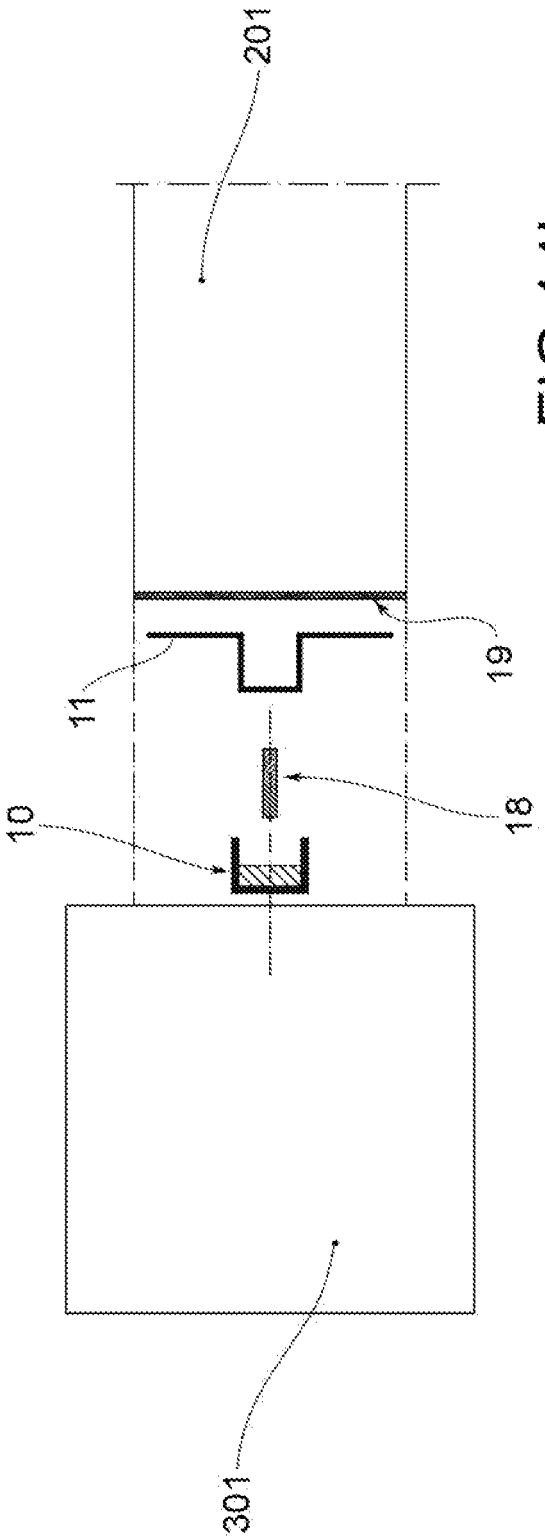

FIG.14b

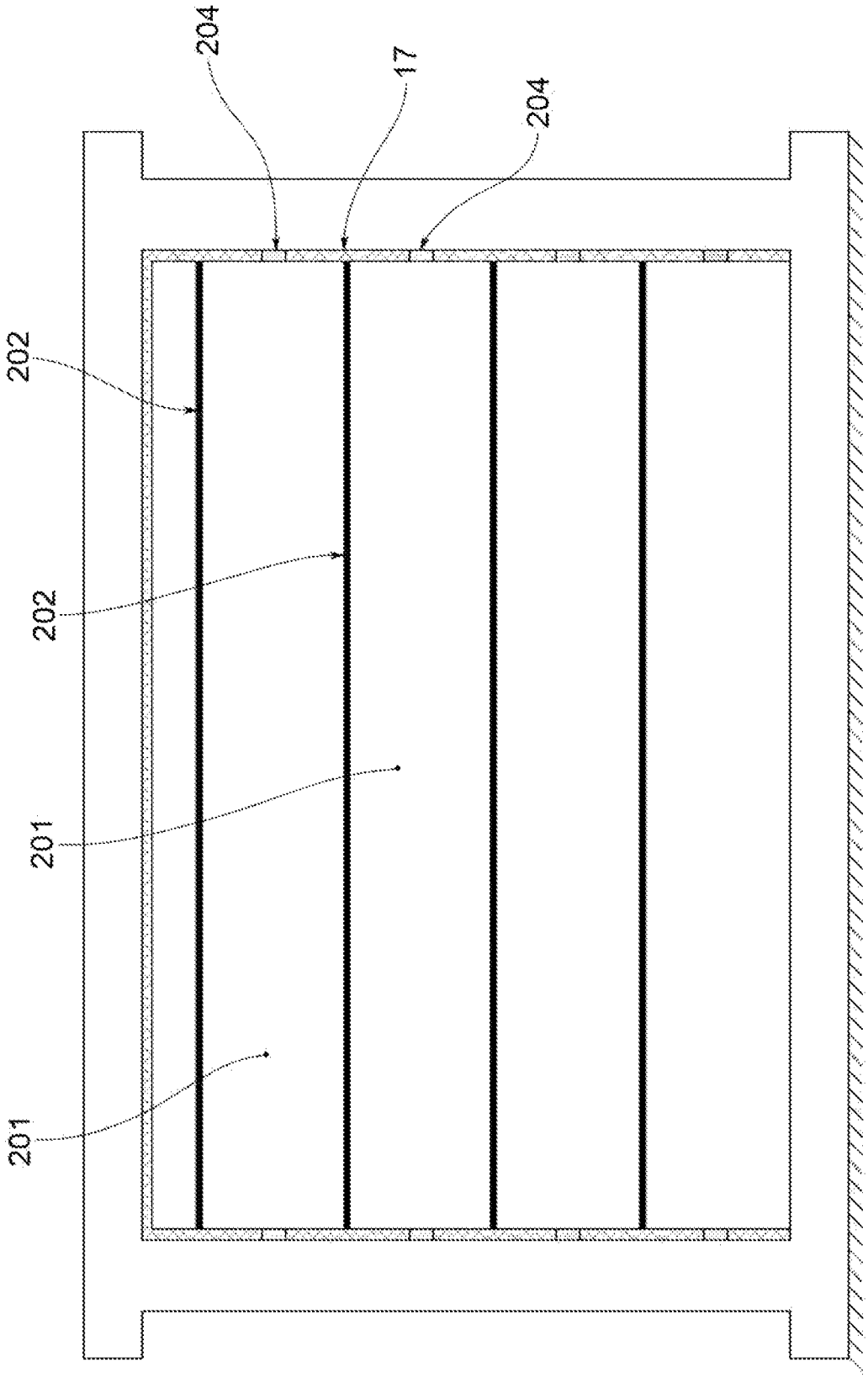

FIG.15

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 102268900 A **[0003]**
- CN 101476360 A **[0003]**
- WO 2015033161 A1 **[0003]**
- EP 1043454 A2 **[0003]**