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

(11) EP 3 511 479 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.07.2019 Bulletin 2019/29

(51) Int Cl.:
E04B 1/98 *(2006.01)* ***E04H 9/02*** *(2006.01)*

(21) Application number: **19151058.5**

(22) Date of filing: **09.01.2019**

(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
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **11.01.2018 IT 201800000750**

(71) Applicants:
- **Fratelli E' Possibile - F.E' P. Societa' Cooperativa Sociale**
  47822 Santarcangelo Di Romagna (RN) (IT)
- **Savoia, Marco**
  42123 Reggio Emilia (IT)
- **Pozza, Luca**
  36021 Villaga (VI) (IT)
- **Manfroni, Odine**
  47922 Rimini (IT)
- **Toni, Marco**
  47030 San Mauro Pascoli (FO) (IT)
- **Arlotti, Marco**
  47923 Rimini (IT)
- **Valzania, Ettore**
  47030 Borghi (FO) (IT)

(72) Inventors:
- **SAVOIA, Marco**
  42123 Reggio Emilia (IT)
- **POZZA, Luca**
  36021 Villaga (VI) (IT)
- **MANFRONI, Odine**
  47922 Rimini (IT)
- **TONI, Marco**
  47030 San Mauro Pascoli (FC) (IT)

(74) Representative: **Villanova, Massimo et al**
Luppi Intellectual Property Srl
Viale Corassori, 54
41124 Modena (IT)

(54) FRICTION DAMPING ASSEMBLY

(57) A friction damping assembly is disclosed that is installable in a structure between two elements that are able to move in relation to one another, with a first element extending along a first longitudinal axis, a second element extending along a second longitudinal axis and coupled with the first element around a first rotation axis, first friction means interposed between the first element and the second element and first prestressing means configured to prestress the first friction means between the first element and the second element.

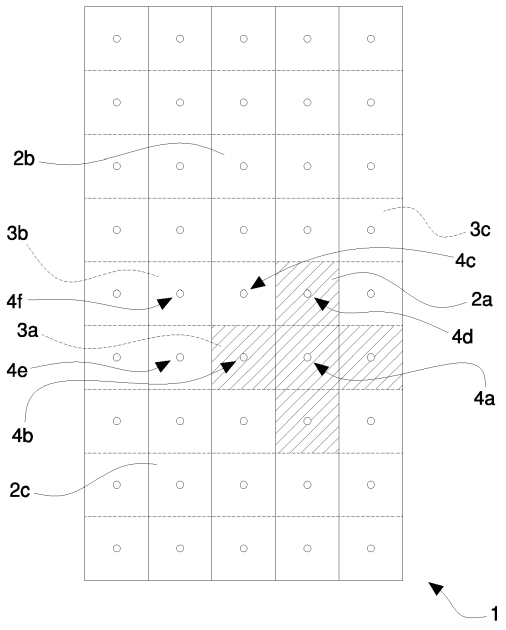

Fig. 3

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Description

Background of the invention

[0001] The invention relates to a friction damping assembly, in particular an assembly that is installable between at least two elements of a structure in which such elements are susceptible of performing reciprocal movements.

[0002] The assembly in question can be associated with a structure or construction in order to increase the dissipation properties thereof, for example to improve the capacity of the structure or construction to withstand seismic events or other potentially disastrous phenomena, strong winds, violent air movements, vibrations (for example caused by machinery), etc.

[0003] Specifically, but not exclusively, the damping assembly in question can be installed in a multi-storey building.

Summary of the invention

[0004] One object of the invention is to make available a damping assembly that is able to ensure a high level of energy dissipation between two structural elements that can move reciprocally.

[0005] The damping assembly in question can be installed in a building (for example in a multi-storey building), in particular, merely by way of non-limiting example, in order to achieve one or more of the following objects and/or advantages:

a) limiting horizontal movements and accelerations in the event of a seismic event;
b) providing additional resistance to the bracing system in the event of a sizable seismic event;
c) reducing the seismic actions acting on the bracing system in the event of a minor seismic event.

[0006] One advantage is reducing movements, accelerations and forces associated with the action that induces a corresponding movement between the structural elements to which the damping assembly in question is connected.

[0007] One advantage is the possibility of modulating the damping effect induced by the present assembly on the structure in which it is installed.

[0008] One advantage is reducing the undesirable effect of potentially destructive actions, in particular horizontal actions, on various types of structure, owing to the dissipation contribution provided by the damping assembly.

[0009] One advantage is the ease and speed of installation of the damping assembly, both on existing buildings and on buildings being built.

[0010] The assembly in question can be advantageously used both in newly constructed structures (for example buildings), in particular for making building systems with zero damage, and in existing structures, in particular for mitigating or eliminating the seismic vulnerability thereof.

[0011] Such objects and advantages and still others are achieved by an assembly according to one or more of the claims set out below.

[0012] In one or more embodiments, the damping assembly comprises at least one first element extending longitudinally, at least one second element extending longitudinally and coupled rotatably with the first element around a first rotation axis, first friction means interposed between the first element and the second element and first prestressing means configured to prestress the first friction means between the first element and the second element.

[0013] In one or more embodiments, the damping assembly may be made in the form of a panel that is insertable into a building structure as a facade curtain wall element, or as an internal compartmentalization element, or a bracing and dissipation element in the floor plane.

Brief description of the drawings

[0014] The invention can be understood better and implemented with reference to the enclosed drawings that illustrate embodiments thereof by way of non-limiting examples:

Figure 1 is a vertical raised frontal view of a first embodiment of a damping assembly;
Figure 2 is a right side view of Figure 1;
Figure 3 is a vertical raised frontal view of a second embodiment of a damping assembly;
Figure 4 is a vertical raised frontal view of a third embodiment of a damping assembly applied to a building structure;
Figure 5 is section V-V of Figure 4;
Figure 6 is an enlarged detail of Figure 5;
Figure 7 is a vertical raised frontal view of a fourth embodiment of a damping assembly applied to a building structure;
Figure 8 is a section on a vertical plane of the assembly of Figure 6;
Figure 9 is an exploded view of a fifth embodiment of a damping assembly.

Detailed description

[0015] With reference to the aforesaid figures, analogous elements of difference embodiments have been indicated, for the sake of simplicity of exposition, by the same numbering. With 1, overall, a friction damping assembly has been indicated that is intended for being installed in a structure between at least two structural elements that can be subjected to moving reciprocally if stressed by external actions, for example actions caused by seismic events, strong winds, violent air movements, vibrations (for example induced by machinery), etc. The

damping assembly 1 may be associated with the structure to increase the dissipation properties thereof and thus improve the capacity thereof to withstand the aforesaid external actions.

[0016] The damping assembly 1 may comprise, in particular, at least one first element 2a extending along a first longitudinal axis k1.

[0017] The damping assembly 1 may comprise, in particular, at least one second element 3a extending along a second longitudinal axis k2.

[0018] The second element 3a may be coupled with the first element 2a with the possibility of performing a rotation with respect to the first element 2a around a first rotation axis x1. In particular, the first element 2a and the second element 3a may be coupled with one another by a first hinge zone 4a (where hinge is defined as a constraint that suppresses two degrees of freedom and does not react to the mechanical torque, i.e. a constraint that permits the constrained object only rotations, eliminating translation), for example a first rotation pin, which defines the first rotation axis x1. The first rotation axis x1 may be, as in these embodiments, transverse to the first longitudinal axis k1 and/or to the second longitudinal axis k2.

[0019] The damping assembly 1 may comprise, in particular, first friction means 5a interposed between the first element 2a and the second element 3a. The first friction means 5a may be arranged, in particular, near the first rotation axis x1 and/or around the first rotation axis x1. The first friction means 5a may comprise, in particular, at least one pair of abrasive surfaces in mutual contact. A first abrasive surface may be arranged on one side of the first element 2a. A second abrasive surface may be arranged on one side of the second element 3a.

[0020] The damping assembly 1 may comprise, in particular, first prestressing means 6a configured to prestress with a compression force N the first friction means 5a between the first element 2a and the second element 3a. The first prestressing means 6a may comprise, in particular, screw means provided with a thread coupled with the first element 2a and pretensioned so as to prestress at least the first friction means 5a between the first element 2a and the second element 3a. The first screw means may comprise, for example, at least one bolt (for example a screw coupled with a nut or a counter-rivet) and/or at least one device against spontaneous loosening (for example a washer, a lock nut, a split pin, a Belleville washer, etc). The first prestressing means 6a may comprise, in particular, fastening means of another type, alternatively or in addition to the screw means, for example rivet and/or nail means.

[0021] The damping assembly 1 may comprise, in particular, a further first element 7a extending along a further first longitudinal axis j1. The further first element 7a may be coupled, as in these embodiments, with the second element 3a with the possibility of performing a rotation with respect to the second element 3a around the aforesaid first rotation axis x1. In particular, the further first element 7a and the second element 3a may be coupled with one another by the first hinge zone 4a.

[0022] The second element 3a may be, as in these embodiments, interposed between the first element 2a and the further first element 7a.

[0023] The damping assembly 1 may comprise, in particular, further first friction means 8a interposed between the further first element 7a and the second element 3a. The further first friction means 8a may be arranged, in particular, near the first rotation axis x1 and/or around the first rotation axis x1. The further first friction means 8a may comprise, in particular, at least one pair of abrasive surfaces in mutual contact, one first abrasive surface of which may be arranged on one side of the further first element 7a and a second abrasive surface may be arranged on one side of the second element 3a.

[0024] The first prestressing means 6a may be configured, in particular, to prestress the further first friction means 8a between the further first element 7a and the second element 3a.

[0025] With reference to the embodiments of figures 3, 4 and 6, the damping assembly 1 may comprise, in particular, a third element 2b extending along a third longitudinal axis k3 and coupled with the second element 3a with the possibility of performing a rotation with respect to the second element 3a around a second rotation axis x2. In particular, the second element 3a and the third element 2b may be coupled with one another by a second hinge zone 4b (for example a second rotation pin) that defines the second rotation axis x2. The second rotation axis x2 may be, in particular, transverse to the second longitudinal axis k2 and to the third longitudinal axis k3. The first rotation axis x1 and the second rotation axis x2 may be, as in these embodiments, parallel to and spaced apart from one another.

[0026] The damping assembly 1 may comprise, in particular, second friction means 5b interposed between the second element 3a and the third element 2b. The second friction means 5b may be arranged, in particular, near the second rotation axis x2 and/or around the second rotation axis x2.

[0027] The second friction means 5b may comprise, in particular, at least one pair of abrasive surfaces in mutual contact, one first abrasive surface of which may be arranged on one side of the second element 3a and a second abrasive surface may be arranged on one side of the third element 2b.

[0028] The damping assembly 1 may comprise, in particular, second prestressing means 6b configured to prestress the second friction means 5b between the second element 3a and the third element 2b.

[0029] The damping assembly 1 may comprise, in particular, a fourth element 3b extending along a fourth longitudinal axis k4 and coupled with the third element 2b with the possibility of performing a rotation with respect to the third element 2b around a third rotation axis x3 that is transverse to the third longitudinal axis k3 and to the fourth longitudinal axis k4. In particular, the fourth element 3b and the third element 2b may be coupled togeth-

er by a third hinge zone 4c (for example a third rotation pin) that defines the third rotation axis x3.

[0030] The fourth element 3b may be coupled with the first element 2a with the possibility of performing a rotation with respect to the first element 2a around a fourth rotation axis x4 that is transverse to the first longitudinal axis k1 and to the fourth longitudinal axis k4. In particular, the fourth element 3b and the first element 2a may be coupled with one another by a fourth hinge zone 4d (for example a fourth rotation pin) that defines the fourth rotation axis x4.

[0031] The first element 2a and the third element 2b may be installed, as in these embodiments, so as to be transverse (for example orthogonal) to the second element 3a and to the fourth element 3b.

[0032] The damping assembly 1 may comprise, in particular, third friction means 5c interposed between the third element 2b and the fourth element 3b. The third friction means 5c may be arranged, in particular, near the third rotation axis x3 and/or around the third rotation axis x3.

[0033] The third friction means 5c may comprise, in particular, at least one pair of abrasive surfaces in mutual contact, one abrasive surface of which may be arranged on one side of the third element 2b and the other abrasive surface may be arranged on one side of the fourth element 3b.

[0034] The damping assembly 1 may comprise, in particular, fourth friction means 5d interposed between the fourth element 3b and the first element 2a. The fourth friction means 5d may be arranged, in particular, near the fourth rotation axis x4 and/or around the fourth rotation axis x4. The fourth friction means 5d may comprise, in particular, at least one pair of abrasive surfaces in mutual contact, one of which may be arranged on one side of the fourth element 3b and the other may be arranged on one side of the first element 2a.

[0035] The damping assembly 1 may comprise, in particular, third prestressing means 6c configured to prestress the third friction means 5c between the third element 2b and the fourth element 3b.

[0036] The damping assembly 1 may comprise, in particular, fourth prestressing means 6d configured to prestress the fourth friction means 5d between the first element 2a and the fourth element 3b.

[0037] The damping assembly 1 may comprise, in particular, a further third element 7b extending along a further third longitudinal axis j3. The further third element 7b may be coupled, as in these embodiments, with the second element 3a with the possibility of performing a rotation with respect to the second element 3a around the aforesaid second rotation axis x2. In particular, the further third element 7b and the second element 3a may be coupled with one another by the second hinge rotation zone 4b. The second element 3a may be, as in these embodiments, interposed between the third element 2b and the further third element 7b.

[0038] The damping assembly 1 may comprise, in particular, further second friction means 8b interposed between the further third element 7b and the second element 3a. The further second friction means 8b may be arranged, in particular, near the second rotation axis x2 and/or around the second rotation axis x2.

[0039] The second prestressing means 6b may be configured, in particular, to prestress the further second friction means 8b between the further third element 7b and the second element 3a.

[0040] The first, the second, the third and the fourth rotation axis x4 may be parallel to and spaced apart from one another. In particular, the first, the second, the third and the fourth rotation axis x4 may be arranged, as in these embodiments, so as to define overall a right prism with a square or rhombic base.

[0041] The damping assembly 1 may comprise, in particular, a fifth element 2c that is longitudinal, side by side, parallel to and coplanar with the third element 2b. The fifth element 2c may be coupled with the second element 3a and with the fourth element 3b so as to define, on the whole together with the other elements, six rotation axes (defined by six hinge zones 4a, 4b, 4c, 4d, 4e, 4f) arranged in a lattice with square or rhombic links, at each of which the same number of friction means is arranged, respectively 5a, 5b, 5c, 5d, ..., etc, and the same number of prestressing means respectively 6a, 6b, 6c, 6d, ..., etc. It is possible to arrange further friction means 8a, 8b, 8c, 8d, ..., etc, in addition to the friction means 5a, 5b, 5c, 5d, ..., etc.

[0042] The damping assembly 1 may comprise, in particular, a sixth element 3c that is longitudinal, side by side, parallel to and coplanar with the fourth element 3b. The sixth element 3c may be coupled with the first element 2a, with the third element 2b and with the fifth element 2c so as to define another three rotation axes (defined by three hinge zones) arranged in a lattice with square or rhombic links together with the other hinge zones, at each of which the same number of friction means is arranged and the same number of prestressing means. It is possible to arrange further friction means in addition to each of the aforesaid friction means.

[0043] It is possible to arrange a further fifth element that is longitudinal, side by side, parallel to and coplanar with the further third element 7b. The second element 3a and/or the fourth element 3b and/or the sixth element 3c may be, as in these embodiments, interposed between the fifth element 2c and the further fifth element.

[0044] Each longitudinal element 2a, 2b, 2c, ..., 3a, 3b, 3c, ..., 7a, 7b, ..., can comprise, in particular, a plate-like body (lamella, foil, lath, strip, shingle, stave, slab, etc), for example made of solid wood or of a material based on wood (laminate), or of other materials (metal, plastic, cement, composite, etc).

[0045] The various longitudinal elements may be arranged so as to form a panel in which the various elements 2a, 2b, 2c, ..., may be side by side, parallel to and coplanar with one another and/or in which the various elements 3a, 3, b, 3c, ..., may be side by side, parallel to

and coplanar with one another and/or in which the various further elements 7a, 7b, ..., may be side by side, parallel to and coplanar with one another. The panel may comprise a layer with a desired number (one, two, three or more than three) parallel longitudinal elements in one (for example vertical) direction and a layer with a desired number (one, two, three or more than three) of parallel longitudinal elements in another (for example horizontal) direction. The panel may comprise a further layer with a desired number (one, two, three or more than three) of further longitudinal elements. The panel may comprise a number of longitudinal elements greater than three.

[0046] Each of the friction means and possible further friction means may comprise a pair of contact abrasive surfaces arranged on two respective reciprocally facing longitudinal elements.

[0047] The aforesaid abrasive surfaces of the various friction means and/or of the further friction means may be, as in these embodiments, parallel to or coplanar with one another. Each abrasive surface may comprise, for example, at least one layer of abrasive material, for example of powder and/or granules, and/or at least one high roughness surface layer produced by surface processing. The various friction means may comprise, as in the illustrated embodiments, sheets of paper or abrasive cloth.

[0048] It is possible to provide, as in the embodiment of figure 7, for the first prestressing means to comprise at least one crosspiece 9a coupled with the first element 2a (and/or with the third element 2b and/or with the fifth element 2c, etc) by fastening means, for example of the screw or rivet type, that is pretensioned so as to prestress the various friction means. The first prestressing means may comprise at least one counter-crosspiece 9b opposed to the crosspiece 9a.

[0049] In particular, it is possible to provide a plurality of crosspieces 9a, for example arranged parallel to one another and/or a plurality of counter-crosspieces 9b each opposed to a respective crosspiece 9a. Each crosspiece 9a may extend in length in a direction that is transverse to the first element 2a. Each crosspiece 9a and/or each counter-crosspiece 9b may comprise, in particular, a beam (for example with a square or rectangular section) made of wood or of a material based on wood.

[0050] The damping assembly may be used, for example, to improve the capacity of a structure to withstand external stress. In one embodiment it is possible to install the first element 2a and/or the third element 2b and/or the fifth element 2c, etc, in a vertical position to connect together two floors of a structure, or horizontally to connect the exterior walls of a structure. In another embodiment it is possible to install the second element 3a and/or the fourth element 3b and/or the sixth element 3c, etc, in a vertical position to connect together two floors of a structure, or horizontally to connect the exterior walls of a structure.

[0051] The damping assembly 1 may be made, as has been seen, in the shape of a panel comprising two or more layers of longitudinal elements (in particular of flat shape, for example lamellas, laths, slabs, shingles, boards, etc) arranged transversely and coupled together by several hinge zones with rotation axes that are parallel to one another arranged in a lattice with square or rhombic links.

[0052] The high energy dissipation capacity is assured by the friction means that is set up between the various pairs of reciprocally facing longitudinal elements that are prestressed in an adjustable manner.

[0053] The friction means comprises contact surfaces that have surface roughness that is relatively high in the interfaces between the various layers of the panel. These contact surfaces may be surfaces of the various longitudinal elements (lamellas, laths, slabs, shingles, boards, etc) that are processed, for example, in one or more of the following modes: 1) gluing one or more sheets of abrasive paper; 2) application of one or more layers of abrasive powder (for example silicon glass) on a predistributed adhesive layer; 3) surface treatment for increasing the roughness of the surface.

[0054] The friction means may be pre-stressed, in particular, by a series of screw coupling means arranged in a lattice (with square or rhombic links) for assembling the layers of the panel. The screw means may be arranged at the hinge zones (rotation pins) that in this case may be an integral part of the screw means.

[0055] The panel may have, as has been seen, an arrangement of the hinge zones in the form of a lattice with square or rhombic links, so that the coupling means between the various layers of the resulting structure does not constitute a constraint that is such as to prevent the shearing deformation of the panel. In this case, the shearing deformation of the panel is conditioned mainly, or almost solely, by the friction generated by the friction means (surfaces with great roughness) arranged on the various (longitudinal) elements that form the layers of the panel.

[0056] The screw means, in addition to permitting the assembly between the various longitudinal elements and/or the various layers of the panel (and to providing the hinge zones), may also ensure the desired degree of axial preload between the various longitudinal elements and/or the various layers of the panel, so as to control the friction force that can be exerted between the various suitably prestressed (reciprocal rubbing surfaces).

[0057] The preload may be obtained, as has been seen, by one or more threads of the screw means, in which each thread may couple with a sole longitudinal element (for example an element arranged on one side of the assembly). The preload may be maintained almost constant over time by using a split washer (installed on the side of the assembly opposite the side coupled with the thread) capable of compensating for possible shrinkage and transverse swelling phenomena of the longitudinal element (for example made of wood or of a material based on wood).

[0058] It is possible, as in the embodiment of Figure 7, to use "sandwich" closing means for closing the damping assembly, in which the "sandwich" closing means comprises a series of longitudinal bodies (beams or squared timber) that are parallel to one another that close the two sides of the damping or dissipating assembly (panel) (with crosspiece elements) and are tightened by tightening (screw) means.

[0059] It is possible to adjust the resistance to shearing of the damping or dissipating assembly in various manners: for example, by modifying the number of layers of longitudinal elements (lamellas, slabs, foils, laths, shingles, boards, etc) that are coupled and/or crossed with one another, varying the dimension of the longitudinal elements, adjusting the preloading level of the prestressing means (tightening screws), adopting friction means with different friction coefficients, etc.

[0060] The damping assembly in question, that may comprise, in particular, a panel with two or more layers of longitudinal elements coupled together by hinge zones arranged in a lattice with square or rhombic links, is capable of ensuring a high level of energy dissipation of friction type and thus significantly increasing the damping capacity of the structure (for example of the building system) in which it is installed, for example as a curtain wall element and/or facade cladding, internal dividing wall or screed above the horizontal planes.

[0061] The assembly in question thus enables the damping capacity of (new or existing) constructions to be increased significantly, improving the ability thereof to withstand seismic events, even of considerable intensity.

Legend:

[0062]

1	damping assembly
2a, 2b, 2c	first element, third element, fifth element
3a, 3b, 3c	second element, fourth element, sixth element
4a, 4b, 4c	first hinge zone, second hinge zone, third hinge zone
4d, 4e, 4f	fourth hinge zone, fifth hinge zone, sixth hinge zone
5a, 5b	first friction means, second friction means
5c, 5d	third friction means, fourth friction means
6a, 6b	first prestressing means, second prestressing means
6c, 6d	third prestressing means, fourth prestressing means
7a, 7b	further first element, further third element
8a, 8b	further first friction means, further second friction means
8c, 8d	further third friction means, further fourth friction means
9a, 9b	crosspiece, counter-crosspiece
x1, x2	first rotation axis, second rotation axis
x3, x4	third rotation axis, fourth rotation axis
k1, k2	first longitudinal axis, second longitudinal axis
k3, k4	third longitudinal axis, fourth longitudinal axis
j 1, j3	further first longitudinal axis, further third longitudinal axis

Claims

1. Friction damping assembly, comprising:

- a first element (2a) extending along a first longitudinal axis (k1);
- a second element (3a) extending along a second longitudinal axis (k2) and coupled with the first element (2a) with the possibility of performing a rotation with respect to the first element (2a) around a first rotation axis (x1) that is transverse to the first longitudinal axis (k1) and to the second longitudinal axis (k2);
- first friction means (5a) interposed between said first element (2a) and said second element (3a) around said first rotation axis (x1);
- first prestressing means (6a) configured to prestress said first friction means (5a) between said first element (2a) and said second element (3a);
- a third element (2b) extending along a third longitudinal axis (k3) and coupled with the second element (3a) with the possibility of performing a rotation with respect to the second element (3a) around a second rotation axis (x2) that is transverse to the second longitudinal axis (k2) and to the third longitudinal axis (k3), said first and second rotation axis (x1; x2) being parallel to and spaced apart from one another;
- second friction means (5b) interposed between said second element (3a) and said third element (2b) around said second rotation axis (x2);
- second prestressing means (6b) configured to prestress said second friction means (5b) between said second element (3a) and said third element (2b);
- a fourth element (3b) extending along a fourth longitudinal axis (k4) and coupled with the third element (2b) with the possibility of performing a rotation with respect to the third element (2b) around a third rotation axis (x3) that is transverse to the third longitudinal axis (k3) and to the fourth longitudinal axis (k4), said first, second and third rotation axis (x1; x2; x3) being parallel to and spaced apart from one another, said fourth element (3b) being coupled with the first element (2a) with the possibility of performing a rotation with respect to the first element (2a) around a fourth rotation axis (x4) that is transverse to the first longitudinal axis (k1) and to the fourth lon-

gitudinal axis (k4), said first, second, third and fourth rotation axis (x1; x2; x3; x4) being parallel to and spaced apart from one another, in which said elements (2a; 3a; 2b; 3b) are arranged so as to form a panel in which said first element (2a) and third element (2b) are side by side, parallel to and coplanar with one another and said second element (3a) and fourth element (3b) are side by side, parallel to and coplanar with one another, said first element (2a) and third element (2b) being transverse to said second element (3a) and fourth element (3b);
- third friction means (5c) interposed between said third element (2b) and said fourth element (3b) around said third rotation axis (x3);
- fourth friction means (5d) interposed between said fourth element (3b) and said first element (2a) around said fourth rotation axis (x4);
- third prestressing means (6c) configured to prestress said third friction means (5c) between said third element (2b) and said fourth element (3b);
- fourth prestressing means (6d) configured to prestress said fourth friction means (5d) between said first element (2a) and said fourth element (3b);
- a fifth element (2c) side by side, parallel to and coplanar with said third element (2b), said fifth element (2c) being coupled with said second and fourth element (3a and 3b) so as to define, on the whole, six rotation axes with friction and prestressing means arranged in a lattice with square or rhombic links;
- a sixth element (3c) side by side, parallel to and coplanar with said fourth element (3b), said sixth element (3c) being coupled with said first, third e fifth element (2a, 2b and 2c) so as to define, on the whole, nine rotation axes with friction and prestressing means arranged in a lattice with square or rhombic links;

wherein each element (2a, 2b, 2c, 3a, 3b, 3c, 7a, 7b) comprises a plate-like body made of solid wood or of a material based on wood.

2. Assembly according to claim 1, wherein said first, second, third and fourth rotation axis (x1, x2, x3, x4) are arranged so as to define a right prism with a square or rhombic base.

3. Assembly according to claim 1 or 2, wherein:

- said first friction means (5a) comprises at least one pair of abrasive surfaces in mutual contact, one arranged on one side of the first element (2a) and the other arranged on one side of the second element (3a);
- said second friction means (5b) comprises at least one pair of abrasive surfaces in mutual contact, one arranged on one side of the second element (3a) and the other arranged on one side of the third element (2b);
- said third friction means (5c) comprises at least one pair of abrasive surfaces in mutual contact, one arranged on one side of the third element (2b) and the other arranged on one side of the fourth element (3b);
- said fourth friction means (5d) comprises at least one pair of abrasive surfaces in mutual contact, one arranged on one side of the fourth element (3b) and the other arranged on one side of the first element (2a).

4. Assembly according to claim 3, wherein said abrasive surfaces of the first, second, third and fourth friction means are parallel to or coplanar with one another.

5. Assembly according to claim 3 or 4, wherein one or more of said abrasive surfaces comprises at least one layer of abrasive material, for example of powder and/or granules.

6. Assembly according to any one of claims 3 to 5, wherein one or more of said abrasive surfaces comprises at least one high roughness surface layer produced by surface processing.

7. Friction damping assembly, in particular according to any preceding claim, comprising:

- a first element (2a) extending along a first longitudinal axis (k1);
- a second element (3a) extending along a second longitudinal axis (k2) and coupled with the first element (2a) with the possibility of performing a rotation with respect to the first element (2a) around a first rotation axis (x1) that is transverse to the first longitudinal axis (k1) and to the second longitudinal axis (k2);
- first friction means (5a) interposed between said first element (2a) and said second element (3a) around said first rotation axis (x1);
- first prestressing means (6a) configured to prestress said first friction means (5a) between said first element (2a) and said second element (3a).

8. Assembly according to any preceding claim, comprising at least one first hinge zone (4a) around which said first and second element (2a e 3a) can rotate in relation to one another.

9. Assembly according to any preceding claim, wherein said first prestressing means (6a) comprises screw means provided with a thread coupled with said first element (2a) and pretensioned so as to prestress

said first friction means (5a) and/or in which said first prestressing means (6a) comprises rivet means pretensioned so as to prestress said first friction means (5a).

10. Assembly according to any preceding claim, wherein said first prestressing means (6a) comprises at least one crosspiece (9a) coupled with said first element (2a) by fastening means, for example of the screw and/or rivet type, pretensioned so as to prestress said first and second friction means (5a and 5b), said at least one crosspiece (9a) extending in length in a direction that is transverse to said first element (2a).

11. Assembly according to claim 10, wherein said at least one crosspiece (9a) comprises a beam made of wood or of a material based on wood;

12. Assembly according to claim 10 or 11, wherein said first prestressing means (6a) comprises at least one counter-crosspiece (9b) opposed to said at least one crosspiece (9a).

13. Assembly according to any preceding claim, comprising a further first element (7a) extending along a further first longitudinal axis (j1) and coupled with the second element (3a) with the possibility of performing a rotation with respect to the second element (3a) around said first rotation axis (x1), said second element (3a) being interposed between said first element (2a) and said further first element (7a).

14. Assembly according to claim 13, comprising further first friction means (8a) interposed between said further first element (7a) and said second element (3a) around said first rotation axis (x1), said first prestressing means (6a) being configured to prestress said further first friction means (8a) between said further first element (7a) and said second element (3a).

15. Use of an assembly according to any preceding claim to improve the capacity of a structure to withstand external stress, in which one of said first and second element is installed vertically to connect two floors of a structure to each other, or horizontally to connect exterior walls of a structure.

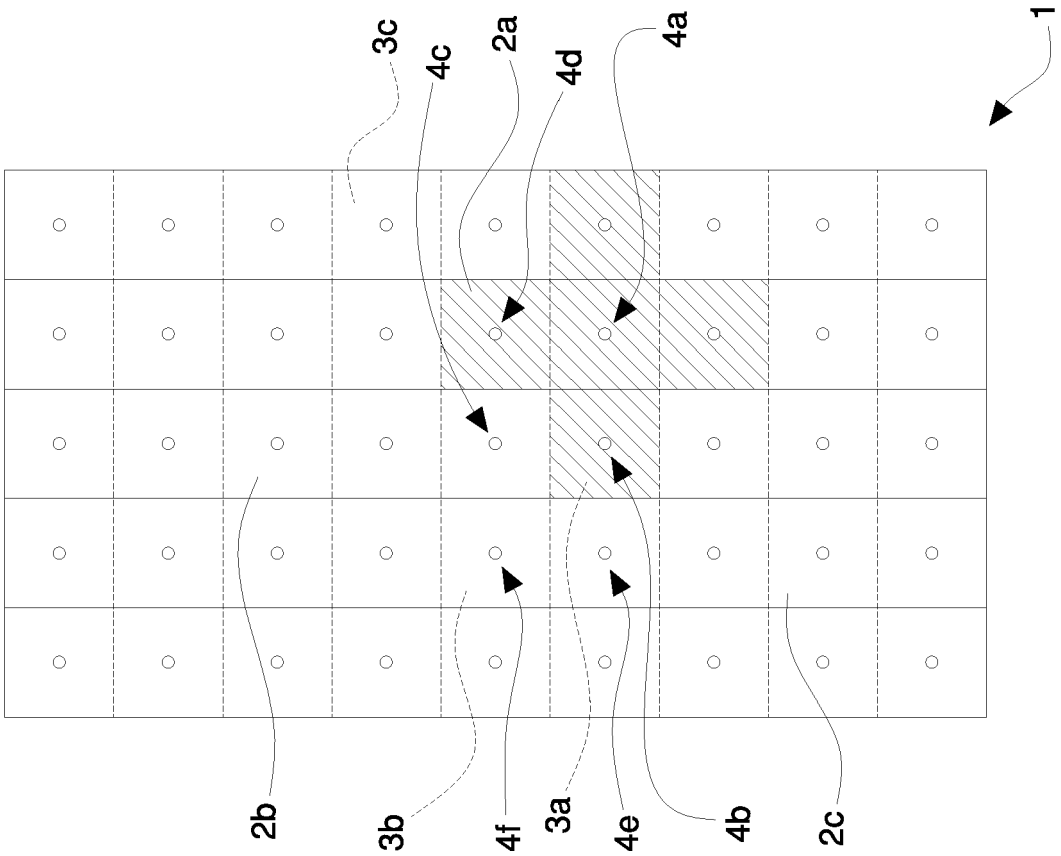

Fig. 3

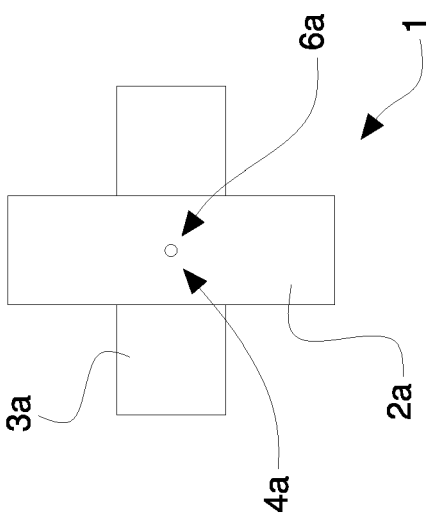

Fig. 1

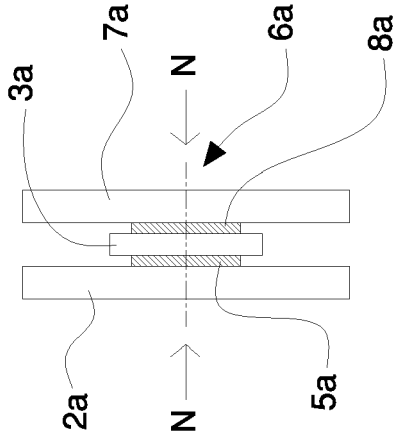

Fig. 2

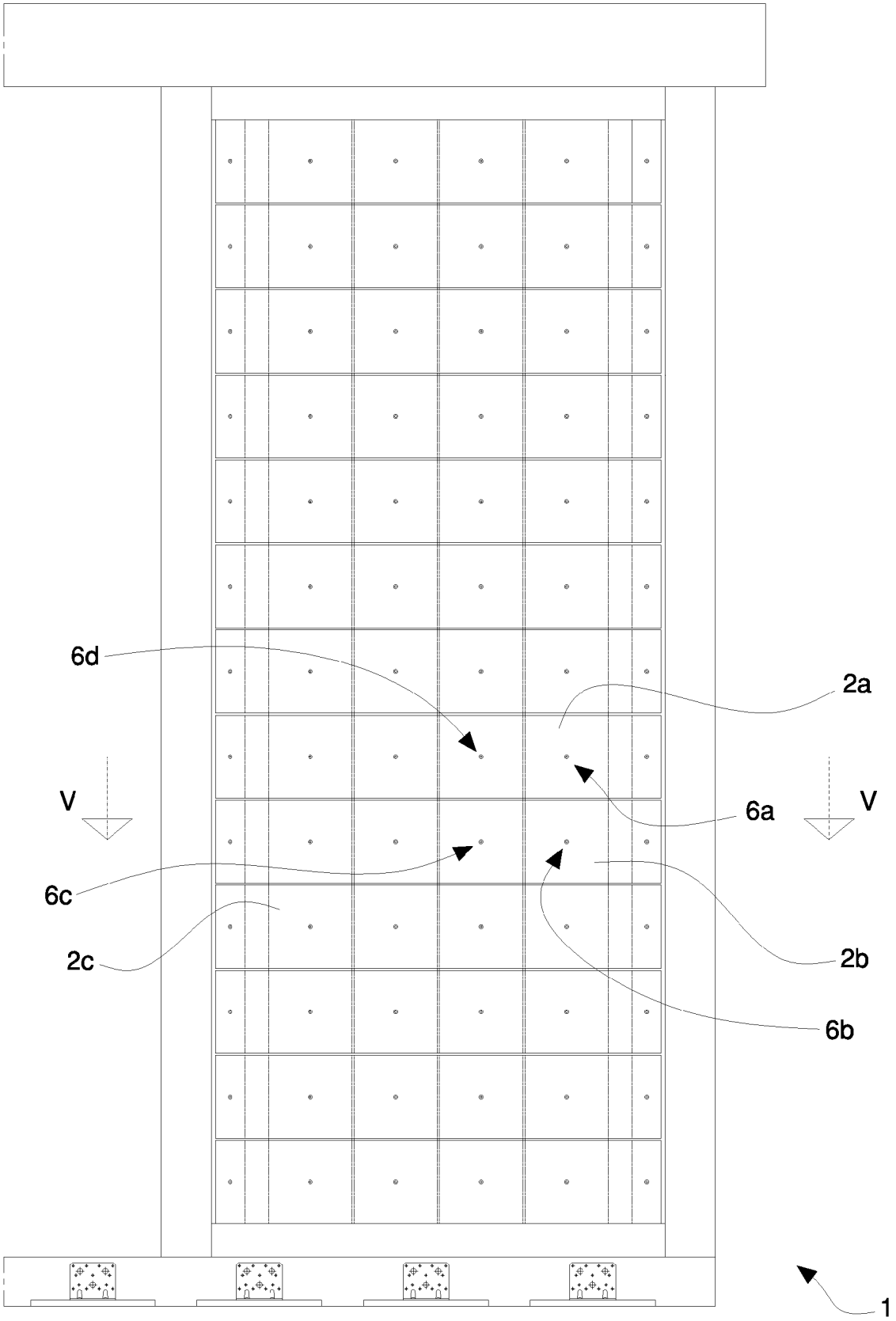

Fig. 4

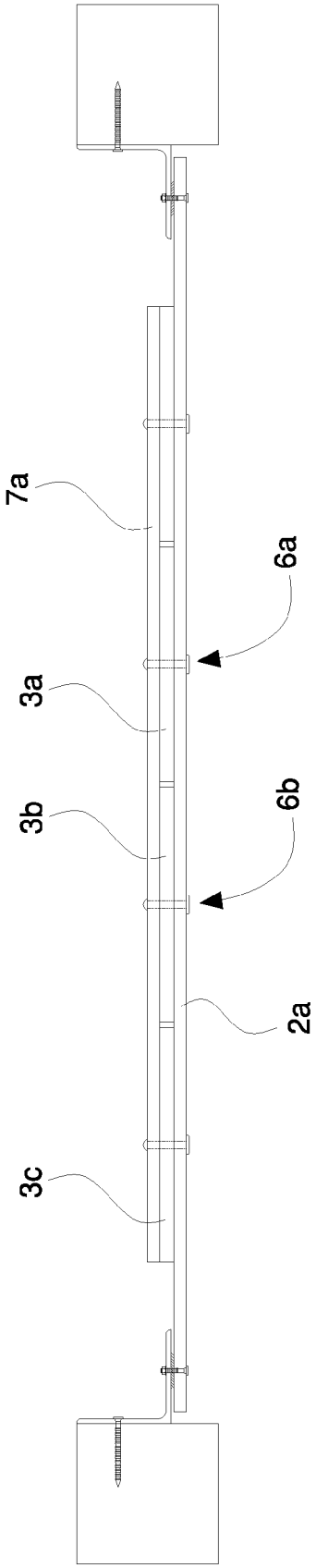

Fig. 5

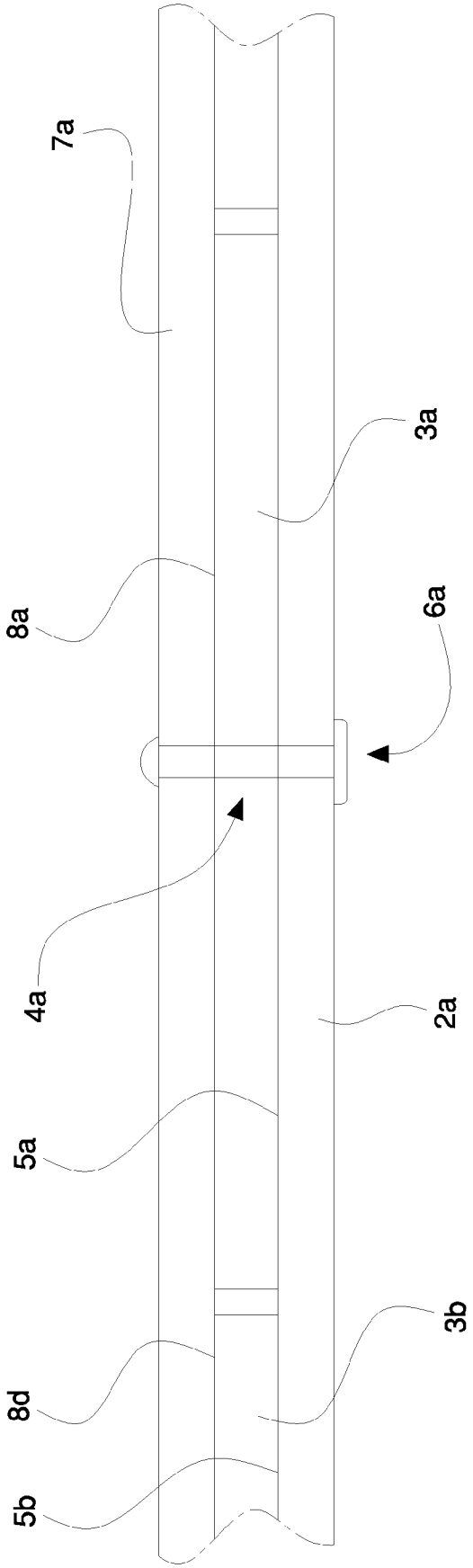

Fig. 6

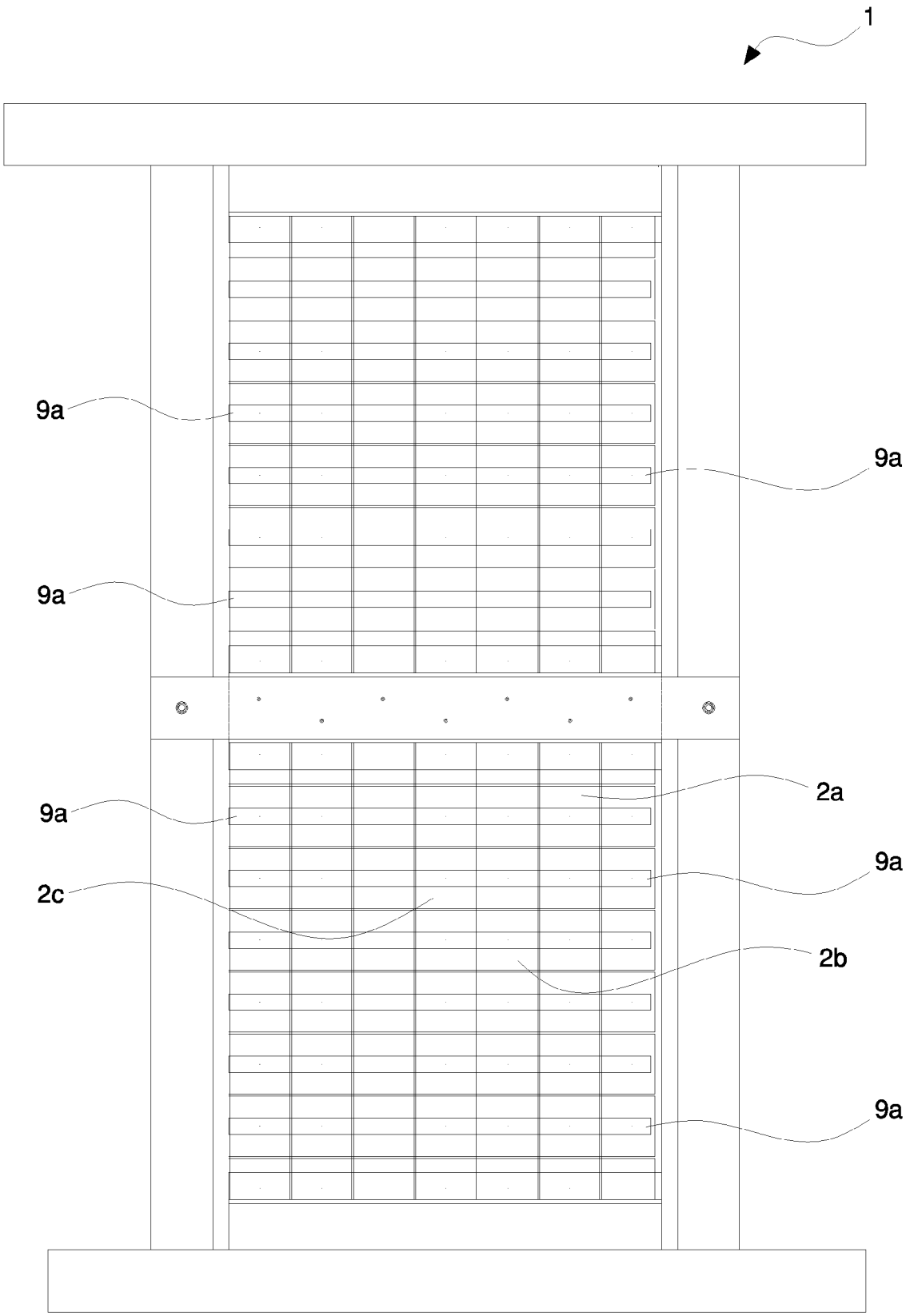

Fig. 7

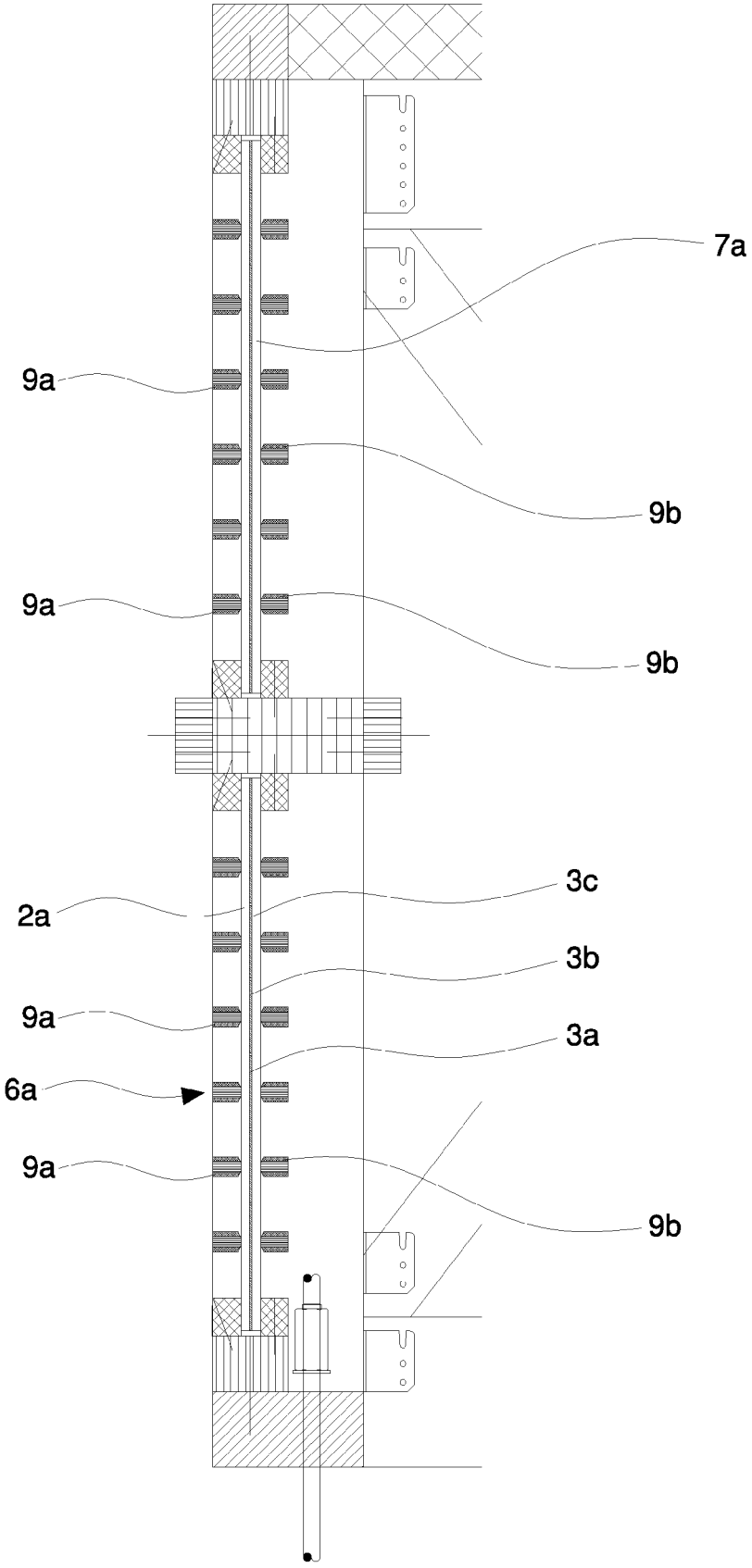

Fig. 8

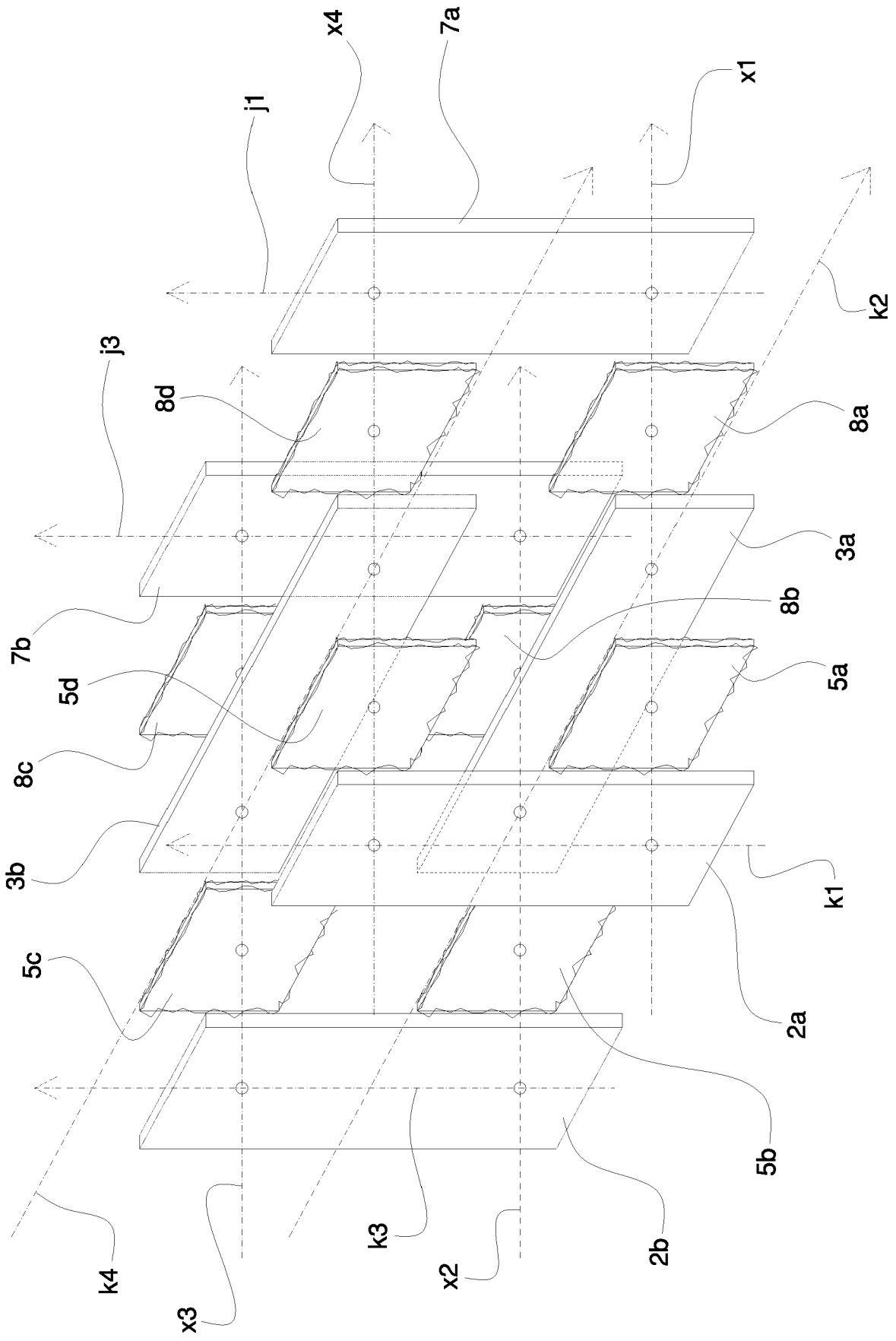

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 1058

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2011/038742 A1 (DAMPTECH APS [DK]; MUALLA IMAD H [DK]) 7 April 2011 (2011-04-07) * page 1, line 4 - line 7 * * page 6, line 11 - page 14, line 7; figures 1-5 * -----	1-15	INV. E04B1/98 E04H9/02

TECHNICAL FIELDS SEARCHED (IPC)

E04B
E04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 February 2019	Melhem, Charbel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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15-02-2019

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