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(54) **SEISMIC ISOLATOR**

(57) A seismic isolator (1) for a building (10) is provided; the building (10) comprises a substructure (11) and a superstructure (12); the seismic isolator (1) is between the substructure (11) and the superstructure (12) and comprises a first anchor body (2) to the superstructure (12) defining a first base surface (2a) and a lateral surface (2b); a second anchor body (3) to the substructure (11) defining a second base surface (3a) and a second lateral surface (3b); a vertical discharge unit (4) in contact with the base surfaces (2a, 3a) so as to allow the weight of the superstructure (12) to be discharged onto the substructure (11); and an anti-vibration device (5) in contact with the lateral surfaces (2b, 3b) and suitable to absorb horizontal movements between the substructure (11) and superstructure (12).

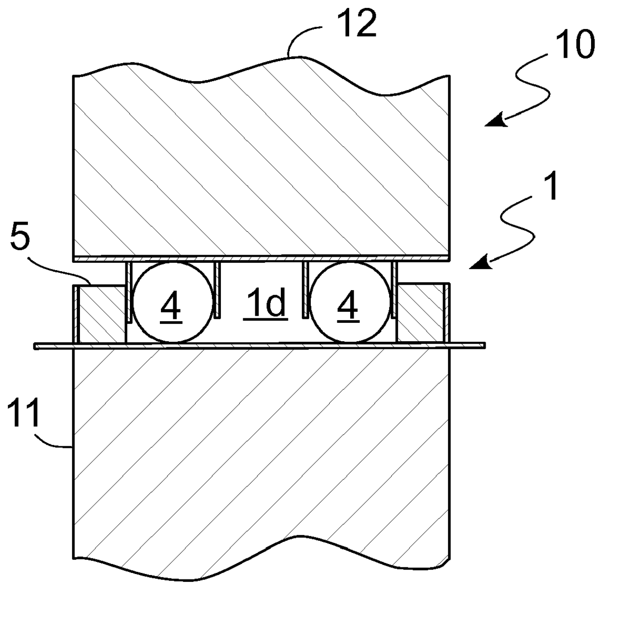

Fig. 1

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Description

[0001] The present invention relates to a seismic isolator, a device used to isolate at least a portion of the load-bearing structure of buildings from the effects of an earthquake, of the type specified in the preamble to the first claim.

[0002] Seismic isolators are suitable for separating the load-bearing structure of a building into two distinct parts avoiding or at least reducing the passage of vibration produced by an earthquake between said two parts of the building. In particular seismic isolators divide a building identifying, with respect to said seismic isolator, a substructure comprising the foundations, and optionally, part of the load-bearing walls; and a superstructure comprising the remainder of the load-bearing structure. Seismic isolators decouple the superstructure from the substructure preventing the seismic waves from being transmitted to the superstructure varying the period thereof and avoiding resonance phenomena in the superstructure.

[0003] To this end, the isolator imposes a greater period on the superstructure (in detail at least triple) compared to the substructure so that it acts like a rigid body with respect to the substructure and is stationary with respect to the vibrations generated by the earthquake.

[0004] A prime example of seismic isolators are deformation isolators.

[0005] These seismic isolators rely on the elastic properties of natural and synthetic elastomers. They consist of a sandwich of horizontal layers of elastomer of a thickness not exceeding 210 mm alternated with horizontal sheets of steel a few millimetres thick and used to increase the bearing capacity to vertical loads of the seismic isolator without affecting the shear deformability.

[0006] In the case of an earthquake deformation seismic isolators dissipate energy by hysteresis exploiting an elastic deformation of the horizontal layers of elastomer. Another example is represented by sliding seismic isolators, also called pendulum isolators.

[0007] Sliding isolators are composed of three overlapping steel elements i.e. a base element associated with the substructure and provided with a concave surface; a central element, called slider, with suitably shaped convex surfaces to couple to the concave surfaces of the base element; and an upper element associating the slider to the superstructure.

[0008] In the case of an earthquake, sliding seismic isolators dissipate energy by friction exploiting a reciprocal sliding of the concave and convex surface and hence a shift between slider and base element.

[0009] The prior art describes has several significant drawbacks.

[0010] In particular, a first drawback, as may be easily inferred from the description above, is the high cost of construction and installation of the seismic isolators known to date.

[0011] This aspect is increased by the difficulty of movement and positioning on the construction site which characterises the prior seismic isolators.

[0012] Significant drawbacks are the limited capacity to dampen the vibrations of the earthquake and, therefore, the reduced isolation between substructure and superstructure given by the prior seismic isolators. As a result they may allow the passage from the substructure to the superstructure of accelerations inducing dangerous oscillations in the building.

[0013] A further drawback is the fact that an earthquake significantly deteriorates seismic isolators preventing their subsequent proper functioning and thus forcing their replacement.

[0014] In fact, in the case of sliding seismic isolators, for example, an earthquake may cause the deformation of the arched surfaces which subsequently may no longer match each other perfectly and/or may be unable to reciprocally slide in case of a further earthquake.

[0015] Such operation requires the destruction of the superstructure in order to make the broken seismic isolator accessible and therefore replaceable.

[0016] Another drawback of no less importance is the impossibility of use in ordinary masonry buildings.

[0017] In this situation the technical purpose of the present invention is to devise a seismic isolator able to substantially overcome at least some of the drawbacks mentioned. Within the sphere of said technical task one purpose of the invention is to obtain a seismic isolator which is simple and cheap to construct and install.

[0018] Another important purpose of the invention is to make a highly effective seismic isolator and therefore able to prevent the passage of accelerations between the substructure and the superstructure in the case of intense earthquakes.

[0019] A further purpose of the invention is to have a seismic isolator able to withstand multiple earthquakes of high intensity.

[0020] The technical purpose and specified aims are achieved by a seismic isolator as claimed in the appended claim 1.

[0021] Preferred embodiments are described in the dependent claims.

[0022] The characteristics and advantages of the invention are clearly evident from the following detailed description of preferred embodiments thereof, with reference to the accompanying drawings, in which:

Fig. 1 shows a seismic isolator according to the invention in cross-section;

Fig. 2 shows an exploded view of Fig. 1;

Fig. 3 shows the seismic isolator assembly in Fig. 1;

Fig. 4 is a seismic isolator according to the invention; and

Fig. 5 shows a second view of seismic isolator in Fig. 2.

[0023] Herein, the measures, values, shapes and geometric references (such as perpendicularity and parallelism), when used with words like "about" or other similar terms such as "approximately" or "substantially", are to be understood as except for measurement errors or inaccuracies due to production and/or manufacturing errors and, above all, except for a slight divergence from the value, measure, shape or geometric reference which it is associated with. For example, said terms, if associated with a value, preferably indicate a divergence of not more than 10% of said value.

[0024] In addition, where used terms such as "first", "second", "upper", "lower", "main" and "secondary" do not necessarily refer to an order, a priority relationship or relative position, but may simply be used to more clearly distinguish different components from each other.

[0025] The measurements and data presented herein are to be considered, unless otherwise indicated, as made in Standard International Atmospheres ICAO (ISO 21322222).

[0026] With reference to the Drawings, reference numeral **1** globally denotes the seismic isolator according to the invention.

[0027] The seismic isolator 1 is suitable to isolate at least partially, appropriately entirely, a building **10** (figs. 1 and 21) preventing an earthquake or other similar event from damaging the load-bearing structure of said building - i.e. the load-bearing walls of the building meant to absorb the loads and external actions which the building 10 is subject to throughout its life.

[0028] The building 10 comprises a substructure **11**; a superstructure **12** above the substructure 11; and at least one seismic isolator 1 interposed between the superstructure 12 and the substructure 11.

[0029] The substructure 11 comprises at least the building's foundations 10 i.e. the part of the building 10 transmitting the loads from the structures protruding from the ground (which the load-bearing structure is part of) to the ground. Optionally, the substructure 11 may comprise the foundations and a portion of the load-bearing structure.

[0030] The superstructure 12 comprises at least part and, in some cases, all of the load-bearing structure of the building 10.

[0031] The seismic isolator 1 is suitable to allow a passage, advantageously exclusive, of vertical loads from the superstructure 12 to the substructure 11. It is suitable to prevent any horizontal accelerations, such as those caused by an earthquake, from passing from the substructure 11 to the superstructure 12.

[0032] The term vertical identifies a direction parallel to the lying plane of the load-bearing walls of the load-bearing structure and, in particular, to the gravitational gradient. In contrast, the term horizontal identifies a direction perpendicular to the lying plane of the load-bearing walls of the load-bearing structure and, in particular, to the gravitational gradient.

[0033] The seismic isolator 1 defines and, in particular, delimits a housing volume **1a** suitable to be interposed between substructure 11 and superstructure 12.

[0034] The seismic isolator 1 may comprise a first anchor body **2** suitable to be integrally connected to the superstructure 12; and a second anchor body **3** suitable to be integrally connected to the substructure 11.

[0035] The first anchor body 2 is integral with the superstructure 12.

[0036] In use, the bodies 2 and 3 are not in direct contact with each other, i.e. are not in mutual contact and/or provide for a component interposed between them.

[0037] In use, the bodies 2 and 3 do not enclose/delimit the housing volume 1 a.

[0038] They are mutually movable in any horizontal direction. The seismic isolator 1 is free, except for the antivibration device described below, of horizontal connections between the anchor bodies 2 and 3 suitable to prevent a horizontal movement between said bodies 2 and 3.

[0039] In use, between the bodies 2 and 3 there is solely a passage of vertical loads and not of horizontal loads.

[0040] The first anchor body 2 defines a first base surface **2a** of the housing volume 1a. The first base surface 2a is horizontal.

[0041] The first anchor body 2 defines at least a first lateral surface **2b** transversal and in detail, perpendicular to the first base surface 2a.

[0042] Preferably, the first anchor body 2 may comprise several first lateral surfaces 2b, appropriately four, delimiting a first chamber **1b** identifying at least a portion of the volume 1 a. More preferably, the first lateral surfaces 2b define the entire perimeter of the first chamber 1b.

[0043] The first chamber 1b may have a square horizontal cross-section.

[0044] The first lateral surface 2b is vertical.

[0045] The first anchor body 2 comprises a first base **21** defining the first base surface 2a. The first base 21 is integral with the superstructure 12.

[0046] It is horizontal.

[0047] The first anchor body 2 comprises, for each lateral wall 2b, at least a first wall 22 defining a first lateral surface 2b.

[0048] The first wall 22 is integral with the superstructure 12 and transverse to the base 21.

[0049] It is vertical.

[0050] The first base 21 and/or the first 22 wall are made of metal and in detail steel, appropriately stainless.

[0051] The first wall 22 is integral with the first base 21. Appropriately the first anchor body 2 is in one piece.

[0052] The first base 21 and/or the first wall 22 and thus the first body 2 can be defined by the superstructure 12.

[0053] Alternatively, the first base 21 and/or the first wall 22 can be distinct from the superstructure 12 and suitable to be integrally connected to it by means, for example, of gluing or welding. Preferably, the entire first anchor body 2 identifies an element distinct from the superstructure 12.

[0054] The first anchor body 2 may comprise portioning means **23** (such as a grid) suitable to divide the first chamber 1b into first compartments **1d** appropriately having a square horizontal cross-section.

[0055] Each compartment 1d can define at least one, in detail two and precisely four first lateral sides 2b.

[0056] The portioning means 23 are integral with the first walls 22.

[0057] It can be seen how the portioning means 23 can also define one or more first lateral surfaces 2b (as shown in Figs. 21 and 22).

[0058] The second anchor body 3 is integral with the substructure 12.

[0059] The second anchor body 3 defines a second base surface **3a** of the housing volume 1a.

[0060] The second base surface 2a is horizontal.

[0061] The base surfaces 2a and 3a are on opposite sides with respect to the volume 1 a. The base surfaces 2a and 3a are substantially parallel to each other.

[0062] The second anchor body 3 defines at least a second lateral surface **3b** transversal and in detail, perpendicular to the second base surface 3a. Preferably, it comprises several second lateral surfaces 3b, appropriately four, delimiting a first chamber **1c** identifying at least a portion of the housing volume 1 a. More preferably, the second lateral surfaces 2b define the entire perimeter of the second chamber 1 c.

[0063] The second lateral surface 3b is vertical.

[0064] The second anchor body 3 comprises a second base **31** defining the second base surface 3a.

[0065] The second base 31 is horizontal.

[0066] It is integral with the substructure 11.

[0067] The second anchor body 3 comprises, for each second lateral surface 3b, at least a second wall **32** defining the second lateral surface 3b.

[0068] The second wall 32 is integral with the substructure 11 and transverse to the second base 31. It is vertical.

[0069] The second wall 32 is integral with the second base 31. Appropriately the second anchor body 3 is in one piece.

[0070] In some cases the second body 3 may comprise connection means, in detail of the detachable type, suitable to make the second base 31 integral with each second wall 32.

[0071] The second base 31 and/or the second wall 32 are made of metal and in detail steel, appropriately stainless.

[0072] The first wall 22 is integral with the first base 21.

[0073] The second base 31 and/or the second wall 32 may be defined by the substructure 11. Alternatively, the second base 31 and/or the second wall 32 may be distinct elements from the substructure 11 and suitable to be integrally connected to it by means, for example, of gluing. Preferably, the entire second body 3 is distinct from the substructure 11.

[0074] The second chamber 1 c may have a square horizontal cross-section.

[0075] The second chamber 1 c may include inside it the first chamber 1 b and therefore identify the entire housing volume 1 a.

[0076] Preferably, the second chamber 1 c surrounds the entire first chamber 1 b. In use, the first walls 22 are placed between the second walls 32 (figs. 1-22).

[0077] Alternatively, the first chamber 1 b may include inside it the second chamber 1 c and therefore identify the entire housing volume 1 a. Therefore, the second walls 32 are between the first 22 walls.

[0078] To have, in use, a passage of vertical loads between the bodies 2 and 3 the seismic isolator 1 may comprise at least one vertical discharge unit **4** interposed between the bodies 2 and 3 and in simultaneous contact with both base surfaces 2a and 3a (i.e. the base surfaces 21 and 31) allowing the weight of the superstructure 12, or other vertical load to be discharged to the substructure 11.

[0079] The vertical discharge unit 4 is placed between the bases 2a and 3a and is in contact with said bases 2a and 3a. It is in the housing volume 1a and more preferably in the innermost chamber between the chambers 1 b or 1 c.

[0080] It is the only vertical contact element between the anchor bodies 2 and 3, i.e. in contemporary contact with the bases 2a and 3a and therefore with the two bases 21 and 31. The isolator 1 does not include other elements in simultaneous contact with the base surfaces 2a and 3a.

[0081] Optionally the isolator 1 comprises several units 4 in detail at least four and precisely between four and nine vertical discharge units 4. Each unit 4 is placed in a compartment 1d.

[0082] It should be noted that in some cases all the compartments 1d can house a vertical discharge unit 4; in other cases only some compartments 1d house a unit 4 (Figs. 1-2 and 4-5).

[0083] The vertical discharge units 4 can be placed at least perimetrally to the central core of inertia of the superstructure 12 which thus falls inside the outermost perimeter defined by the arrangement of the units 4.

[0084] The unit 4 allows the passage between the superstructure 12 and substructure 11 of vertical loads only such as weight. It does not allow the passage of horizontal forces between the superstructure 12 and substructure 11.

[0085] In order not to have a passage of horizontal loads through the vertical discharge unit 4, it is never simultaneously in contact with both lateral surfaces 2b and 3b. The unit 4 is thus suitable to come into contact horizontally with at most one of the lateral surfaces 2b and 3b.

[0086] If the first chamber 1 b is internal to the second chamber 1 c, the vertical discharge unit 4 can come into contact only with the base surfaces 2a and 3a and only with the first lateral surfaces 2b (Fig. 1). In the case of the second chamber 1 c inside the first chamber 1 b, the unit 4 is suitable to come into exclusive contact with the base surfaces 2a and 3a and second lateral surfaces 3b only.

[0087] The vertical discharge unit 4 may comprise a rolling element, preferably spherical, suitable to be in contact and enclosed between the base surfaces 2a and 3a.

[0088] The vertical discharge unit 4 and base surfaces 2a and 3a have a reciprocal friction coefficient of less than 0.01. The rolling element is thus in a material suitable to define with the base surfaces 2a and 3a a low friction coefficient (similar to that of rolling bearings, i.e. 0.001 ÷ 0.005) so as to minimize the transfer of horizontal loads by friction.

[0089] The bearings may be made of metallic or ceramic material (such as steel, appropriately stainless).

[0090] The vertical length of the vertical discharge unit 4 may be greater than that of the lateral surfaces 2b and 3b and, therefore, of the walls 22 and 32 so that only the vertical discharge unit 4 is in simultaneous contact with both base surfaces 2a and 3a.

[0091] In order not to have, in use, a passage of horizontal loads between the bodies 2 and 3, the seismic isolator 1 may comprise at least one anti-vibration device 5 suitable to absorb vibrations, preferably exclusively horizontal, generated by an earthquake, preventing them from being transferred from the substructure 11 to the superstructure 12.

[0092] In particular, the anti-vibration device 5 is suitable to absorb said vibration deforming itself elastically and/or plastically.

[0093] The anti-vibration device 5 is interposed between and in contact with at least one first lateral surface 2b and at least one second lateral surface 3b.

[0094] It is the only element of horizontal contact between the anchor bodies 2 and 3, i.e. in simultaneous contact with the first lateral surfaces 2b and the second surfaces 3b and thus with both the first walls 22 and the second walls 32 appropriately mutually facing. It is therefore interposed, along a substantially horizontal direction, between the lateral surfaces 2b and 3b preventing the passage between the bodies 2 and 3 of horizontal loads / displacements. The isolator 1 does not include other elements in simultaneous contact with the lateral surfaces 2b and 3b.

[0095] The anti-vibration device 5 is in contact simultaneously with both lateral surfaces 2b and 3b. At most it is in contact with only one of the base surfaces 2a and 3a.

[0096] It is in the housing volume 1a and preferably in the interspace between the chambers 1b and 1c and to be precise partially or preferably entirely fills such interspace. For example, in the case of the first chamber 1b internal to the second 1c, it is in the second chamber 1c and fills at least partially and in detail totally the interspace between the chambers 1b and 1c.

[0097] The anti-vibration device 5 surrounds the unit 4.

[0098] The anti-vibration device 5 is made of a material having a hardness less than that of the vertical discharge unit 4. For example, it may have a hardness of less than 100 sh and in detail 50 sh and, in more detail, substantially comprised between 50 and 320 sh. Preferably, the anti-vibration device 5 is made of elastomeric material such as industrial rubber and, to be precise, bargom ®.

[0099] The anti-vibration device 5 is suitable to come into contact vertically with at most only one of the base surfaces 2a and 3a so as not to have a passage of vertical loads between the superstructure 12 and substructure 11 through the anti-vibration device 5. Therefore, the vertical length of the anti-vibration device 5 is less than that of the vertical discharge unit 4 so that only the vertical discharge unit 4 is in contact simultaneously with both base surfaces 2a and 3a.

[0100] The functioning of the seismic isolator 1 described above in structural terms, is as follows.

[0101] During normal operation the seismic isolator 1 presents the vertical discharge unit 4 in contact with both base surfaces 2a and 3a and, therefore, with both bases 21 and 31 allowing the passage of only the vertical load (weight) from the superstructure 12 to the substructure 11.

[0102] It is to be noted how, in this situation the vertical height of the vertical discharge unit 4 avoids the contact of the first walls 22 with the second base 31, the second walls 32 with the first base 21, and the anti-vibration device 5 with the bases 21 and 31.

[0103] In the event of an earthquake the substructure 11 is subjected to horizontal accelerations that are transmitted to the second base 31 and, therefore, to the second lateral surfaces 3b.

[0104] The second walls 32 discharge the horizontal components of these accelerations onto the anti-vibration device 5 which, by deforming, absorbs such horizontal components avoiding (or at least limiting) their passage to the superstructure 12.

[0105] It should be noted how during the earthquake small displacements of the vertical discharge unit 4 may occur which, thanks to the reduced friction with the base surfaces 2a and 3a, does not determine a passage of horizontal loads to the superstructure 12.

[0106] The seismic isolator 1 according to the invention achieves important advantages. In fact, the seismic isolator 1 withstands an earthquake of high intensity without damage.

[0107] This advantage is determined by the fact that the isolator 1, conversely to the known isolators, discriminates the vertical forces from the horizontal ones thanks to the presence of two distinct elements (the vertical discharge unit 4 and the anti-vibration device 5) each of which is able to interact with the vertical forces only or the horizontal forces only.

[0108] The vertical discharge unit 4 is in contact with horizontal surfaces of both bodies 2 and 3 (i.e. both base surfaces 2a and 3a) and at most only one out of the first lateral surfaces 2b and second lateral surfaces 3b). It is thus capable of transmitting between the superstructure 12 and substructure 11 vertical forces (perpendicular to the base surfaces 2a and 3a) but unable to transmit horizontal forces.

[0109] This aspect is increased by the use of a rolling element as the vertical discharge unit 4 or of construction material of the unit 4 that minimizes the friction force exchanged between the bodies 2 and 3.

[0110] The anti-vibration device 5 is in contact with both the vertical lateral surfaces 2b and 3b i.e. with vertical surfaces of both the bodies 2 and 3 and at most only one of the first base surfaces 2a 3a. It is thus capable of transmitting between the superstructure 12 and substructure 11 the horizontal forces (perpendicular to the base surfaces 2a and 3a) but unable to transmit vertical forces.

[0111] It should be noted that the effectiveness of the isolator 1 is given by the particular vertical discharge unit 4 chosen and in detail by the choice of the rolling element preferably spherical. In fact, seismic waves (like all waves) transport energy without transporting mass, and communicate it to any construction integral with the ground. Consequently, the constructions that receive this energy (not kinetic because it has no moving masses) dispose of it by internal deformation depending on their construction characteristics and elasticity. The choice of this vertical discharge unit 4 and in detail of the preferably spherical rolling element prevents the passage of seismic waves from the substructure 11 to the superstructure 12 and thus prevents the communication of energy from the ground to the building 10. In fact, the seismic waves cannot cross the discharge unit 4, and especially the preferably spherical rolling element and find the only communication route between the substructure 11 and the superstructure 12 through the anti-vibration device 5.

[0112] In addition, the waves being characterized by frequency and amplitude the energy transported is proportional to the square of the amplitude so if the wave is damped the amplitude tends to zero and the energy transported decreases exponentially. To achieve this, the isolator 1 is equipped with a special anti-vibration device 5 able to dampen the entire range of frequencies characteristic of earthquakes.

[0113] Another advantage is the fact that the isolator 1, being able to withstand a high intensity earthquake without incurring breakage, can absorb the energy of a plurality of earthquakes and does not require replacement after each earthquake.

[0114] Other advantages are the simplicity of construction and installation that reduces costs and allows use of the seismic isolator 1 also in existing buildings 10.

[0115] One advantage is that the connection means, allowing a separation of each second wall 32 from the second base 31, make it possible to easily replace the anti-vibration device 5.

[0116] Such advantage is evident in the case in which the seismic isolator 1 is visible, i.e. not covered by masonry.

[0117] Variations may be made to the invention described herein without departing from the scope of the inventive concept defined in the claims. In said sphere all the details may be replaced with equivalent elements and the materials, shapes and dimensions may be as desired.

Claims

1. Seismic isolator (1) for a building (10);

- said building (10) comprising
    - ◦ a substructure (11) comprising at least the foundations of said building (10) and
    - ◦ a superstructure (12) comprising at least part of the load-bearing structure of the building (10);

said seismic isolator (1) suitable to be placed between said substructure (11) and said superstructure (12) and being **characterized in that** it comprises

- a first anchor body (2) to said superstructure (12) defining a first horizontal base surface (2a) and at least one lateral surface (2b) transverse to said first base surface (2a);
- a second anchor body (3) to said substructure (11) defining a second horizontal base surface (3a) and at least a second lateral surface (3b) transverse to said second base surface (3a);
- at least one vertical discharge unit (4) in contact with both said base surfaces (2a, 3a) so that only vertical loads pass between said superstructure (12) and said substructure (11) through said vertical discharge unit (4); and
- at least one anti-vibration device (5) defining the only element in simultaneous contact with both said lateral surfaces (2b, 3b) and suitable to absorb horizontal movements between said substructure (11) and said superstructure (12).

2. Seismic isolator (1) according to claim 1, in which said vertical discharge unit (4) is suitable to come into contact horizontally with at most one of said first walls (22) and said second walls (32) so as not to have a passage of horizontal loads between said superstructure (12) and said substructure (11) through said vertical discharge unit (4).

3. Seismic isolator (1) according to the preceding claim, wherein said vertical discharge unit (4) is suitable to come into contact only with said first walls (22) and said bases (21, 31).

4. Seismic isolator (1) according to at least one of the preceding claims, wherein the vertical length of said vertical discharge unit (4) is greater than the vertical length of said walls (22, 32).

5. Seismic isolator (1) according to the preceding claim, wherein the vertical discharge unit (4) comprises a rolling element.

6. Seismic isolator (1) according to the preceding claim, wherein said vertical discharge unit (4) comprises a spherical rolling element.

7. Seismic isolator (1) according to the preceding claim, wherein the vertical discharge unit (4) and said bases (21, 31) have a mutual friction coefficient of less than 0.01.

8. Seismic isolator (1) according to at least one of the preceding claims, wherein said lateral surfaces (2b, 3b) are vertical.

9. Seismic isolator (1) according to at least one of the preceding claims, wherein said anti-vibration device (5) is suitable to come into contact vertically with only one out of said first base (21) and said second base (31) so as not to have a passage of vertical loads between said superstructure (12) and said substructure (11) through the anti-vibration device (5).

10. Seismic isolator (1) according to at least one of the preceding claims, wherein the vertical length of said anti-vibration device (5) is less than said vertical length of said vertical discharge unit (4).

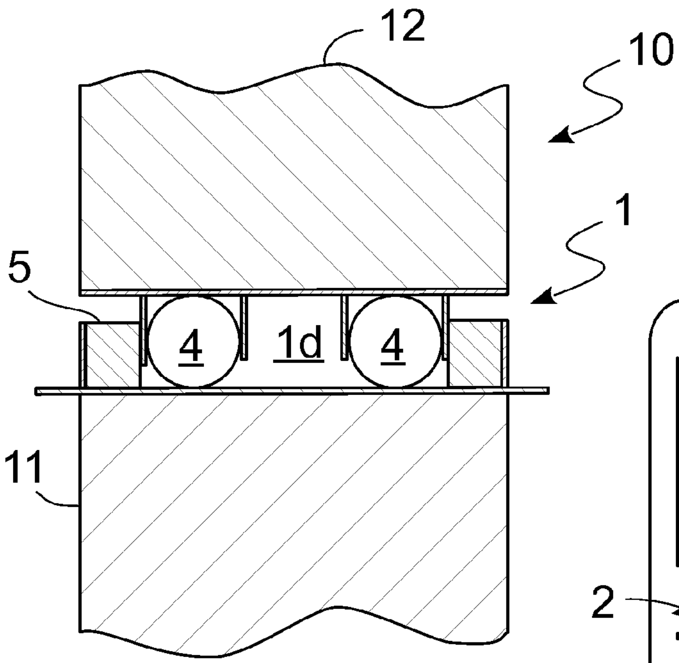


Fig. 1

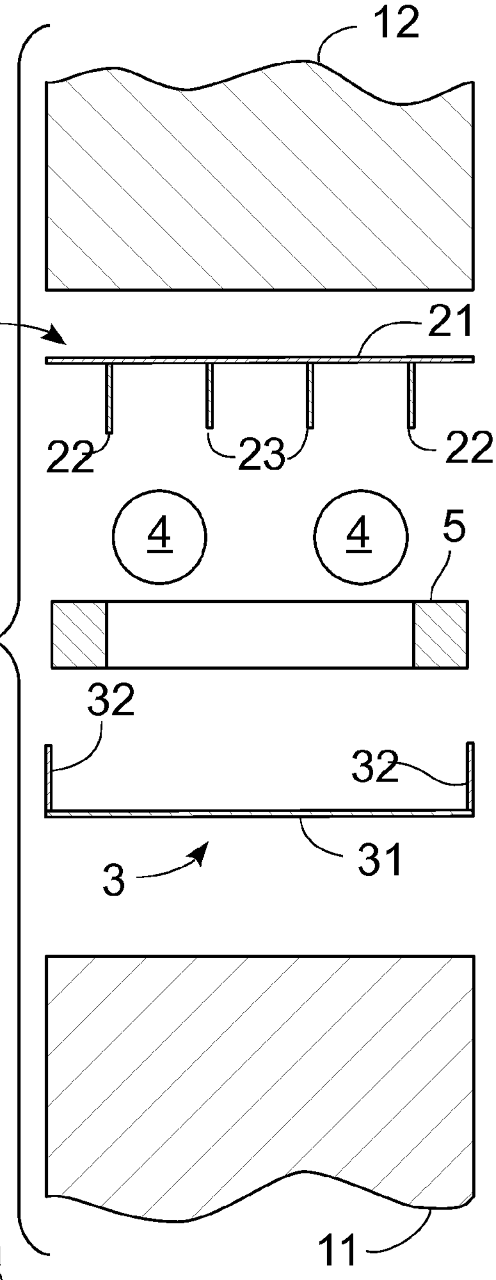
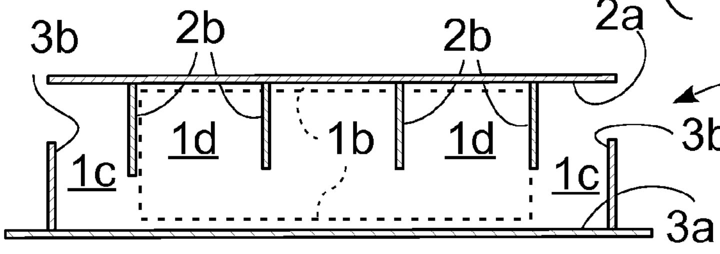


Fig. 2

Fig. 3



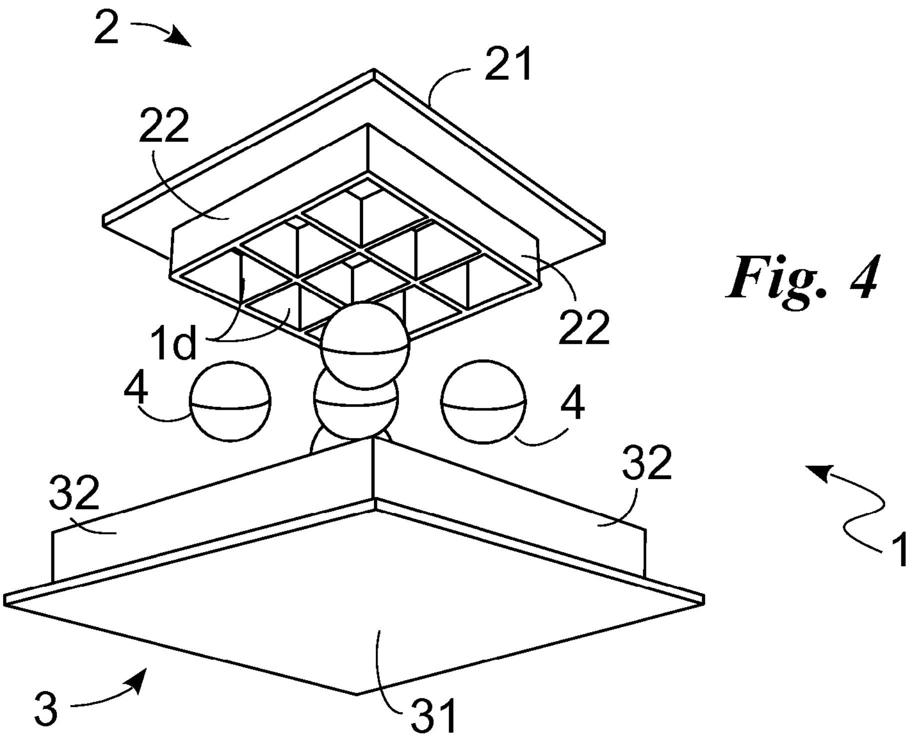
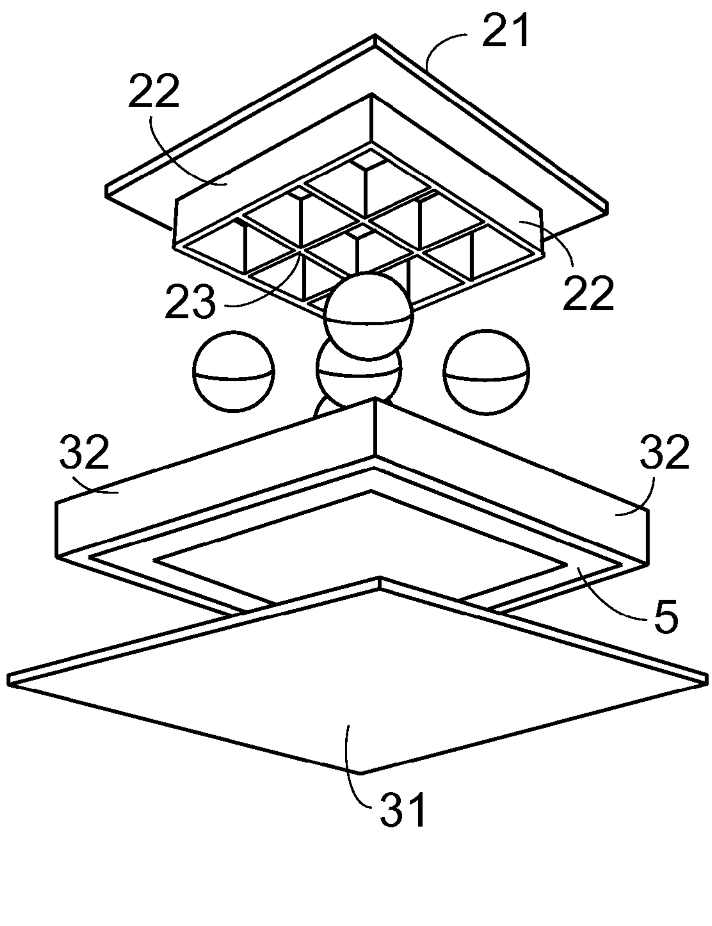


Fig. 4

Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3536

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	US 2004/131287 A1 (LEE GEORGE C [US] ET AL) 8 July 2004 (2004-07-08) * paragraphs [0072], [0077], [0082]; figure 3 * -----	1-10	INV. E04H9/02
X	US 5 689 919 A (YANO KENICHI [JP]) 25 November 1997 (1997-11-25) * the whole document * -----	1-10	
X	DE 34 08 591 A1 (MARKUS ECKART; POCANSCHI ADRIAN DR ING) 24 October 1985 (1985-10-24) * the whole document * -----	1-10	
A	US 2 035 143 A (GIUSEPPE CAVAGLIERI) 24 March 1936 (1936-03-24) * the whole document * -----	1-10	
A	US 2012/260586 A1 (THUBOTA KUNIHIRO [JP]) 18 October 2012 (2012-10-18) * the whole document * -----	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

E04H

The present search report has been drawn up for all claims

4

Place of search	Date of completion of the search	Examiner
Munich	11 April 2018	Valenta, Ivar

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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