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(54) ELEVATOR SAFETY GEAR ASSEMBLY

(57) A safety gear assembly (20) for an elevator system (2) comprising a first engagement member (26) and a second engagement member (28). The first and second engagement members (26, 28) are arranged opposite to each other defining a gap (30) which is configured for accommodating a guide member (14, 15) extending in a longitudinal direction. At least one of the engagement members (26, 28) is movable between a released position, in which the at least one of the engagement member (26, 28) does not contact the guide member (14, 15) and an activated position, in which the at least one of the engagement member (26, 28) contacts the guide member (14, 15). At least one of the engagement members (26, 28) is an elastic engagement member (50) which is elastic at least in a direction which is transverse to the longitudinal direction.

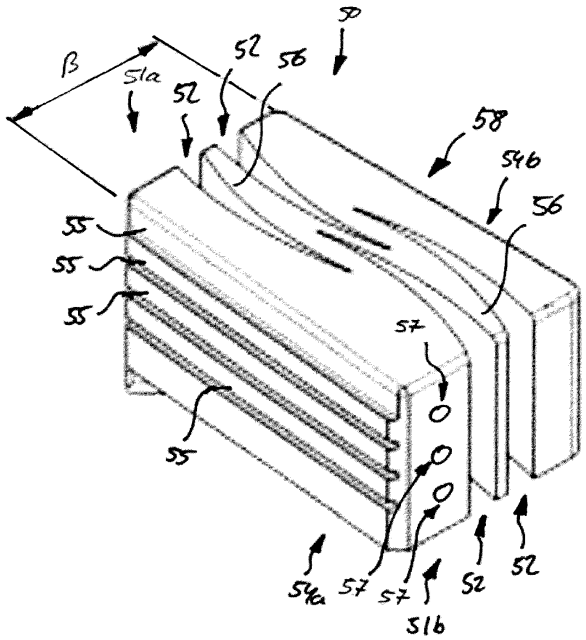

Fig. 7B

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Description

[0001] The invention relates to a safety gear assembly for an elevator system ("elevator safety gear assembly") and to an elevator system comprising such an elevator safety gear assembly.

[0002] An elevator system typically comprises at least one elevator car moving along a hoistway between a plurality of landings, and a driving member, which is configured for driving the elevator car. The elevator system may further include a counterweight moving concurrently and in opposite direction with respect to the elevator car. In order to ensure a safe operation, an elevator system usually comprises at least one safety gear assembly. The safety gear assembly is configured for braking the movement of the elevator car and/or of the counterweight relative to a guide member, such as a guide rail, in the event the movement of the elevator car and/or the counterweight exceeds a predetermined velocity or acceleration. The safety gear assembly usually includes at least one movable engagement member configured for engaging with the guide member when the safety gear assembly is activated. The safety gear assembly usually further comprises at least one elastic member configured for elastically urging the at least one engagement member against the guide member when the safety gear assembly has been activated.

[0003] It would be beneficial to reduce the dimensions, the weight and the costs of an elevator safety gear assembly.

[0004] According to an exemplary embodiment of the invention, a safety gear assembly for an elevator system comprises a first engagement member and a second engagement member. The first and second engagement members are arranged opposite to each other defining a gap configured for accommodating a guide member extending in a longitudinal direction. At least one of the engagement members is movable between a released position, in which it does not contact the guide member, and an activated position, in which it contacts the guide member. The at least one movable engagement member in particular is movable in a direction transverse to the longitudinal direction. The at least one movable engagement member may be movable orthogonally to the longitudinal direction or in a direction which is inclined with respect to the longitudinal direction.

[0005] At least one of the engagement members is an elastic engagement member which is elastic at least in a direction transverse to the longitudinal direction. The at least one elastic engagement member in particular may be the at least one movable engagement member. Alternatively or additionally, the elastic engagement member may be a stationary engagement member arranged opposite to a movable engagement member on the other side of the guide member.

[0006] Since at least one of the engagement members is an elastic engagement member, there is no need for providing an additional elastic member for elastically urging the at least one engagement member against the guide member when the safety gear assembly is activated. Instead, the desired elastic urging force is provided by the elastic engagement member itself.

[0007] As there is no need to provide an additional elastic member, i.e. an elastic member in addition to the engagement member(s), the weight and the dimensions of the safety gear assembly may be reduced. Further, the safety gear assembly may be produced at lower costs.

[0008] Exemplary embodiments of the invention further include an elevator car and a counterweight respectively comprising at least one safety gear assembly according to an exemplary embodiment of the invention.

[0009] Exemplary embodiments of the invention include an elevator system comprising at least one guide member and at least one elevator car and/or at least one counterweight traveling along at least one guide member, respectively, wherein said at least one elevator car and/or at least one counterweight comprise at least one safety gear assembly according to an exemplary embodiment of the invention.

[0010] Exemplary embodiments of the invention also comprise a method of producing an elastic engagement member configured to be employed as an engagement member in a safety gear assembly, wherein the method includes forming the elastic engagement member by using an additive manufacturing method, such as 3D-printing.

[0011] A number of optional features are set out in the following. These features may be realized in particular embodiments, alone or in combination with any of the other features.

[0012] For providing the desired flexibility, at least one recess, in particular at least one slot, and/or at least one cavity, in particular at least one tunnel, may be formed within the at least elastic engagement member.

[0013] Alternatively or additionally, at least one flexible leg may be formed at the at least one elastic engagement member.

[0014] For providing the desired properties with respect to flexibility, the width of the at least one recess, the at least one cavity, and/or the at least one flexible leg may vary along its respective longitudinal extension.

[0015] Alternatively or additionally, the at least one recess, the at least one cavity, and/or the at least one flexible leg may have an arcuate shape.

[0016] For enhancing the flexibility, the at least one elastic engagement member may comprise a plurality of recesses, cavities and/or flexible legs, respectively extending basically in the same direction, i.e. parallel to each other.

[0017] The recesses or cavities may extend from opposing sides towards a central portion of the at least one elastic engagement member. The flexible legs may extend from the central portion towards opposing sides of the at least one elastic engagement member.

[0018] The at least one elastic engagement member may be made of a metal, in particular steel. Alternatively,

the at least one elastic engagement member may be made of a suitable synthetic material having the necessary strength and durability.

[0019] The at least one elastic engagement member may be manufactured by machining or drilling. Alternatively, the at least one elastic engagement member may be manufactured by an additive manufacturing method, such as 3D-printing. An additive method, such as 3D-printing, provides a wide range of freedom for the design of the elastic engagement member, in particular with respect to the shape of the cavities, recesses and/or flexible legs of the elastic engagement member.

[0020] The first engagement member may be movable along a first path having a first end and a second end. The second engagement member may be movable along a second path having a first end and a second end, too. The safety gear assembly may further comprise a connector mechanically connecting the first and second engagement members with each other. The connector may be a single rigid component, in particular a component which is rigid in a plane extending between the two engagement members. The connector may be pivotably connected, e.g. by means of first and second joints, to the first and second engagement members, respectively.

[0021] At least one of the engagement members may be movable along a path which is inclined with respect to the longitudinal direction. Said path in particular may be inclined at an angle of more than 0° and less than 90°, in particular at an angle between 0° and 45°, more particularly at an angle between 0° and 10°, with respect to the longitudinal direction. The first engagement member may be pivotably coupled to the connector by means of a first joint, and the second engagement member is pivotably coupled to the connector by means of a second joint. At least one of the joints is movable along the connector for changing the distance between the first and second joints and modifying the width of the gap between the two engagement members.

[0022] The first joint may comprise a first opening formed within the connector and a first pin extending through the first opening. The second joint may comprise a second opening formed within the connector and a second pin extending through the second opening. At least one of the openings may be an elongated opening. A pin, which is rotatably accommodated in an opening, provides a reliable joint. A joint comprising an elongated opening allows the accommodated pin to move along the connector changing its distance with respect to the other opening.

[0023] One of the openings may be a circular opening which does not allow the accommodated pin to move linearly with respect to the connector. In an alternative embodiment, both openings may be elongated openings.

[0024] The connector may be rigid, in particular against deformation in a plane extending between the two engagement members. In consequence, the possible movements of the engagement members are defined by the shape of the connector and the elongated opening, and there is no additional degree of freedom provided by flexing the connector. The connector, however, may be flexible in a dimension which is perpendicular to the direction of movement of the engagement members.

[0025] The connector in particular may be made of a rigid material, such as metal, in particular steel, which may be machined conveniently in order to form the necessary openings. The connector in particular may be made of sheet-metal.

[0026] The connector may be arranged in an inclined orientation with respect to the longitudinal direction. The connector in particular may be oriented at an angle α of 20° to 40° with respect to the longitudinal direction. The angle α may change in the course of the movement of the engagement members between the disengaged and engaged positions. The angle α may be in the range of 32° to 40°, in particular in the range of 34° to 38° when the engagement members are located in their disengaged positions.

[0027] The gap between the engagement members has a first width when the engagement members are positioned at the first ends of their respective paths, and wherein the gap between the engagement members has a second width when the engagement members are positioned at the second ends of their respective paths. The second width in particular may differ from the first width.

[0028] The path of each engagement member may extend along a straight line, respectively. The paths in particular may be inclined with respect to each other so that the distance between the paths differs at both ends of the paths.

[0029] An inclined orientation of the paths results in a change of the distance between the two engagement members when moving along said paths.

[0030] It in particular causes the engagement members to engage with a guide member extending through the gap between the two engagement members, said engagement braking the movement of the elevator car and/or counterweight with respect to the guide member.

[0031] The first and second paths may be mirror-symmetrical with respect to a mirror-plane extending in the longitudinal direction. A symmetrical movement of the engagement members causes a symmetric braking of the elevator car or counterweight. A symmetric braking avoids that the braking causes a horizontal displacement of the elevator car or counterweight, respectively. Such a horizontal displacement could damage the elevator system, in particular guiding elements such as sliding guides or roller guides (not shown), which may be used for guiding the elevator car or counterweight along its corresponding guide member.

[0032] The first path may be defined by a first slot extending on a first side of the gap and the second path may be defined by a second slot extending on a second side of the gap. The first and second slots may be formed in a portion of a housing of the safety gear assembly, in particular a cover plate of the housing. The first and second slots in particular may be formed mirror-symmetri-

cally with respect to the mirror-plane. Each of the first and second engagement members may comprise at least one protrusion extending into the first or second slot, respectively.

[0033] In such a configuration the engagement members are reliably guided along their respective path by interaction of the protrusion(s) provided at each engagement member with the corresponding slot. A guidance provided by a combination of a slot and corresponding protrusions may be produced with the necessary accuracy and strength in order to accommodate the forces acting on the guide members when the safety gear assembly is activated for braking the elevator car and/or counterweight.

[0034] In the following, exemplary embodiments of the invention are described in more detail with respect to the enclosed figures:

Figure 1 schematically depicts an elevator system according to an exemplary embodiment of the invention.

Figure 2 shows a perspective view of an elevator car according to an exemplary embodiment of the invention.

Figure 3 shows a perspective view of a safety gear assembly according to an exemplary embodiment of the invention.

Figure 4A shows a plan view of the safety gear assembly shown in Figure 3.

Figure 4B shows a plan view of a cover plate as it is employed in the safety gear assembly shown in Figures 3 and 4A.

Figure 5 shows a plan view of the safety gear assembly shown in Figures 3, 4A, and 4 with the engagement members being positioned in the disengaged position; and

Figure 6 shows a plan view of the safety gear assembly shown in Figures 3, 4A, and 4 with the engagement members being positioned in the engaged position.

Figure 7A is a plane view of an elastic engagement member according to an exemplary embodiment of the invention.

Figure 7B is a perspective view of the elastic engagement member depicted in Figure 7A.

Figure 1 schematically depicts an elevator system 2 according to an exemplary embodiment of the invention.

[0035] The elevator system 2 includes an elevator car 60 which is movably arranged within a hoistway 4 extending between a plurality of landings 8. The elevator car 60 in particular is movable along a plurality of car guide members 14, such as guide rails, extending along the vertical direction of the hoistway 4. Only one of said car guide members 14 is visible in Figure 1. Although only one elevator car 60 is depicted in Figure 1, the skilled person will understand that exemplary embodiments of the invention may include elevator systems 2 having a plurality of elevator cars 60 moving in one or more hoistways 4.

[0036] The elevator car 60 is movably suspended by means of a tension member 3. The tension member 3, for example a rope or belt, is connected to a drive unit 5, which is configured for driving the tension member 3 in order to move the elevator car 60 along the height of the hoistway 4 between the plurality of landings 8, which are located on different floors.

[0037] Each landing 8 is provided with a landing door 11, and the elevator car 60 is provided with a corresponding elevator car door 12 for allowing passengers to transfer between a landing 8 and the interior of the elevator car 60 when the elevator car 60 is positioned at the respective landing 8.

[0038] The exemplary embodiment shown in Figure 1 uses a 1:1 roping for suspending the elevator car 60. The skilled person, however, easily understands that the type of the roping is not essential for the invention and that different kinds of roping, e.g. a 2:1 roping or a 4:1 roping may be used as well.

[0039] The elevator system 2 includes further a counterweight 21 attached to the tension member 3 opposite to the elevator car 60 and moving concurrently and in opposite direction with respect to the elevator car 6 along at least one counterweight guide member 15. The skilled person will understand that the invention may be applied to elevator systems 2 which do not comprise a counterweight 21 as well.

[0040] The tension member 3 may be a rope, e.g. a steel core, or a belt. The tension member 3 may be uncoated or may have a coating, e.g. in the form of a polymer jacket. In a particular embodiment, the tension member 3 may be a belt comprising a plurality of polymer coated steel cords (not shown). The elevator system 2 may have a traction drive including a traction sheave for driving the tension member 3. In an alternative configuration, which is not shown in the figures, the elevator system 2 may be an elevator system 2 without a tension member 3, comprising e.g. a hydraulic drive or a linear drive. The elevator system 2 may have a machine room (not shown) or may be a machine room-less elevator system.

[0041] The drive unit 5 is controlled by an elevator control unit (not shown) for moving the elevator car 60 along the hoistway 4 between the different landings 8.

[0042] Input to the control unit may be provided via landing control panels 7a, which are provided on each

landing 8 close to the landing doors 11, and/or via an elevator car control panel 7b, which is provided inside the elevator car 60.

[0043] The landing control panels 7a and the elevator car control panel 7b may be connected to the elevator control unit by means of electrical wiring, which are not shown in Figure 1, in particular by an electric bus, or by means of wireless data connections.

[0044] The elevator car 60 is equipped with at least one safety gear assembly 20, which is schematically illustrated at the elevator car 60. Alternatively or additionally, the counterweight 21 may be equipped with at least one safety gear assembly 20, which, however, is not shown in Figure 1.

[0045] The safety gear assembly 20 is operable to brake or at least assist in braking (i.e. slowing or stopping the movement) of the elevator car 60 relative to a car guide member 14 by engaging with the car guide member 14. In the following, the structure and the operating principle of a safety gear assembly 20 according to an exemplary embodiment of the invention will be described.

[0046] Figure 2 is an enlarged perspective view of an elevator car 60 according to an exemplary embodiment of the invention. The elevator car 60 comprises a structural frame comprising vertically extending uprights 61 and crossbars 63 extending horizontally between the uprights 61.

[0047] The elevator car 60 further includes a car roof 62, a car floor 64 and a plurality of car side walls 66. In combination, the car roof 62, the car floor 64 and the plurality of side walls 66 define an interior space 68 for accommodating and carrying passengers 70 and/or cargo (not shown).

[0048] An elevator safety gear 20 is attached to an upright 61 of the elevator car 60.

[0049] Although only one elevator safety gear 20 is depicted in Figures 1 and 2, respectively, the skilled person will understand that a plurality of safety gear assemblies 20 may be mounted to a single elevator car 60. In particular, in a configuration in which the elevator system 2 comprises a plurality of car guide members 14, an elevator safety gear 20 may be associated with each car guide member 14.

[0050] Alternatively or additionally, two or more elevator safety gears 20 may be provided on top of each other at the same upright 61 of the elevator car 60 in order to engage with the same car guide member 14.

[0051] An example of an elevator safety gear 20 is depicted in more detail in Figures 3 to 5.

[0052] Figure 3 depicts a perspective view of a safety gear assembly 20 according to an exemplary embodiment of the invention, and Figure 4A shows a plan view thereof.

[0053] The safety gear assembly 20 comprises a housing 22, which is covered by a cover plate 24. In order to allow viewing into the safety gear assembly 20, the cover plate 24 is not shown in Figure 3. In Figure 4A, the components of the safety gear assembly 20 including the cover plate 24 are depicted transparently, i.e. only the outlines of the components are shown, in order to illustrate the internal structure of the safety gear assembly 20. The safety gear assembly 20 comprises a first engagement member 26 and a second engagement member 28.

[0054] A plan view of the cover plate 24 with the engagement members 26, 28 being positioned behind the cover plate 24 is shown in Figure 4B.

[0055] The first and second engagement members 26, 28 are arranged opposite to each other defining a gap 30 in between. The gap 30 is configured for accommodating a guide member 14, 15 of the elevator system 2 (cf. Figures 1, 5 and 6) extending in a longitudinal direction, which is the vertical direction in the figures.

[0056] The first and second engagement members 26, 28 are supported within the housing 22 by a support structure including the cover plate 24.

[0057] First and second slots 37, 39 are formed in the cover plate 24. Each of the engagement members 26, 28 is provided with two protrusions 32 extending into the corresponding slot 37, 39 (cf. Figure 4B). Thus, the first engagement member 26 is guided by its protrusions 32 along the first slot 37 defining a first path 36, and the second engagement member 28 is guided by its protrusions 32 along the second slot 39 defining a second path 38. The first and second paths 36, 38 are depicted as broken lines in Figure 4B.

[0058] The slots 37, 39 and in consequence the paths 36, 38 extend along basically straight lines, respectively. The slots 37, 39 and the paths 36, 38 are inclined with respect to the longitudinal direction. As a result, the gap 30 has a smaller width when the engagement members 26, 28 are positioned at second (upper) ends 36b, 38b of the paths 36, 38 compared to a configuration in which the engagement members 26, 28 are positioned at first (lower) ends 36a, 38a of the paths 36, 38 (cf. Figure 4B).

[0059] The slots 37, 39 in particular are provided in a configuration which results in paths 36, 38 of the engagement members 26, 28 which are basically mirror-symmetrical with respect to a mirror-plane M extending in the longitudinal direction along the center of the gap 30.

[0060] Each engagement member 26, 28 is provided with a pin 42, 46 extending from a side facing away from the cover plate 24. In the orientation of the safety gear assembly 20 shown in Figure 3, the pins 42, 46 are not visible as they extend to the rear side of the figure and are covered by the engagement members 26, 28.

[0061] Figure 4A shows that a first pin 42 is provided at a lower portion of the first engagement member 26 and a second pin 46 is provided at an upper portion of the second engagement member 28. This, however, is only an exemplary configuration, and the first and second pins 42, 46 may be provided at any position on the engagement members 26, 28 which is suitable in the specific configuration.

[0062] A connector 34 extending between the pins 42, 46 mechanically connects the two engagement members

26, 28 with each other. The connector 34 is a single component or element made of a rigid material, such as metal. The connector 34 is provided with a first opening 41 accommodating the first pin 42 and a second opening 45 accommodating the second pin 46. Each pin 42, 46 is rotatably accommodated within the corresponding opening 41, 45. As a result, the combination of the first pin 42 and the first opening 41 provides a first joint 40, and the combination of the second pin 46 and the second opening 45 provides a second joint 44 allowing the connector 34 to pivot with respect to the engagement members 26, 28, respectively.

[0063] At least one of the openings 41, 45, in the configuration shown in Figures 3 and 4A the first opening 41, is an elongated opening 41. The elongated opening 41 allows the first pin 42, which is accommodated in said first opening 41, not only to rotate with respect to the connector 34, but additionally to move linearly along the length of the connector 34. Said linear movement allows changing the distance between the first and second pins 42, 46 and in consequence changing the distance between the engagement members 26, 28 when moving along their respective paths 36, 38.

[0064] The connector 34 is arranged in an inclined orientation with respect to the longitudinal direction, which is represented by the mirror-plane M in Figure 4A. The connector 34 in particular may be oriented at an angle α of 20° to 40° with respect to the longitudinal direction. The angle α may change in the course of the movement of the engagement members 26, 28 between the disengaged and engaged positions. The angle α may be in the range of 32° to 40°, in particular in the range of 34° to 38° when the engagement members 26, 28 are located in their disengaged positions depicted in Figure 4A.

[0065] The safety gear assembly 20 further comprises two elastic members 48. The elastic members 48 are configured to elastically support the first engagement member 26 when it is positioned in the engaged position at the second end 36b of its path 36.

[0066] In the embodiment shown in Figures 4A and 4B, the upper portion of the slot 37 next to the elastic members 48, i.e. the first (right) slot 37 shown in Figures 4A and 4B, is slightly wider than the respective upper portion of the other slot 39, i.e. the second (left) slot 39 shown in Figures 4A and 4B, which is more distant from the elastic members 48 than the first slot 37. Such a configuration allows for a small lateral movement of the first engagement member 26 when it is located at the second (upper) end 36b of the first path 36 and interacts with the elastic members 48. Despite this small difference between the first and second slots 37, 39, the configuration depicted in Figures 4A and 4B is still considered as a "symmetrical configuration".

[0067] The operating principle of the safety gear assembly 20 shown in Figures 3 and 4 is illustrated in Figures 5 and 6:

Figure 5 basically corresponds to Figure 4A. Figure 5 additionally depicts a car guide member 14 extending through the gap 30 formed between the two engagement members 26, 28.

[0068] As in Figure 3, the cover plate 24 is omitted in Figures 5 and 6 in order to illustrate the internal structure of the safety gear assembly 20. A car guide member 14 is shown in Figures 5 and 6, but the skilled person will understand that the guide member could also be a counterweight guide member 15 in case the safety gear assembly 20 is attached to a counterweight 21.

[0069] Figure 5 in particular illustrates a disengaged state of the safety gear assembly 20. In the disengaged state, the first and second engagement members 26, 28 are positioned at the first ends 36a, 38a of their respective paths 36, 38, respectively. In consequence, the gap 30 between the first and second engagement members 26, 28 is relatively wide, i.e. the distance between the engagement members 26, 28 is relatively large, so that the engagement members 26, 28 do not contact the guide member 14. As a result, the elevator car 60 may move freely along the guide member 14.

[0070] In order to activate the safety gear assembly 20, a safety actuator (not shown) pulls or pushes at least one of the engagement members 26, 28 out of its disengaged position at the first end 36a, 38a of its path 36, 38 towards the second end 36b, 38b of the respective path 36, 38 (cf. Figure 4B). The safety actuator may be an electric/electronic actuator, a mechanic actuator including a pneumatic or hydraulic actuator, or a combination thereof.

[0071] Since the first and second engagement members 26, 28 are mechanically coupled by the connector 34, the movement of one of the engagement members 26, 28 causes the other engagement member 28, 26 to move out of its disengaged position at the first end 38a, 36a of its path 38, 36 towards the second end 38b, 36b of the path 38, 36 as well.

[0072] In consequence, the gap 30 between the first and second engagement members 26, 28 narrows, i.e. the distance between the engagement members 26, 28 decreases, and the first and second engagement members 26, 28 engage with the guide member 14, which is sandwiched between them. The engagement of the engagement members 26, 28 with the guide member 14 generates a frictional force braking the movement of the elevator car 60 along the guide member 14.

[0073] In order to enhance the braking performance, engagement sides 54a of the engagement members 26, 28 facing and configured for engaging the guide member 14 may be provided with frictional coatings enhancing the friction between the engagement members 26, 28 and the guide member 14.

[0074] The engaged position of the engagement members 26, 28 is illustrated in Figure 6.

[0075] When the first engagement member 26 is positioned in or close to the second end 36b of its path 36, the elastic members 48, such as springs, control the normal force pressing the first engagement member 26 against the guide member 14.

[0076] In the illustrated embodiment, the engagement members 26, 28 are wedge members, but it is to be appreciated that alternative elements, which are suitable for frictional engagement with the guide member 14, may be used as well. For example, the engagement members 26, 28 may be provided as or include roller members, which are configured for engaging with the guide member 14.

[0077] The arrangement of the first and second engagement members 26, 28 of the exemplary embodiment disclosed in the figures is referred to as a "symmetric arrangement", based on the symmetric positioning of the engagement members 26, 28 on opposing sides of the guide member 14. In such a symmetric arrangement, it is important to synchronize the movement of the engagement members 26, 28 subsequent to the actuation of at least one of the engagement members 26, 28 by means of the safety actuator.

[0078] In the disclosed exemplary embodiment, the elastic members 48 directly interact with only one of the two engagement members 26, 28. In the illustrated embodiment, the elastic members 48 directly interact only with the first engagement member 26, which is shown on the right side of Figures 3 to 6. Said direct actuation of the first engagement member 26 needs to be transferred indirectly to the second engagement member 28, but in a manner that facilitates the desired symmetric movement of the engagement members 26, 28, as described above.

[0079] It is to be appreciated that completely symmetric operation of the engagement members 26, 28 is not required. It in particular is not necessary that the first and second engagement members 26, 28 move completely symmetrically from the disengaged position shown in Figure 5 to the engaged position shown in Figure 6. The speeds and positions of the two engagement members 26, 28 along their paths 36, 38 may change, and they in particular differ from each other throughout their movement. However, at the end, the movement of the engagement members 26, 28 usually results in a symmetric configuration of the engagement members 26, 28 as it is illustrated in Figure 6.

[0080] There further may be small asymmetrical displacements of the engagement members 26, 28 due to the fact that elastic members 48 are located only on one side of the safety gear assembly 20, and their small compression may result in small asymmetry in the movement of the engagement members 26, 28.

[0081] The arrangement illustrated in the figures is still referred to as a "symmetric arrangement" based on the symmetric configuration of the paths 36, 38 and slots 37, 39 and the fact that the extent of asymmetry is considered negligible.

[0082] According to an exemplary embodiment of the invention, at least one of the engagement members 26, 28 and the elastic members 48 are replaced by an elastic engagement member 50 (see Figures 7A and 7B) which is elastically compressible and/or deformable at least in a direction transverse to the longitudinal direction.

[0083] Figure 7A is a plan view of an elastic engagement member 50 according to an exemplary embodiment of the invention, and Figure 7B is a perspective view thereof.

[0084] The elastic engagement member 50 depicted in Figures 7A and 7B comprises an engagement side 54a, which is configured for facing and contacting the guide member 14, 15, and an opposing rear side 54b. The engagement side 54a and the rear side 54b are oriented non-parallel with respect to each other at an angle β which basically corresponds to the angle of the slots 37, 39 formed in the cover plate 24 defining the paths 36, 38 of the engagement members 26, 28 with respect to the longitudinal direction (cf. Figs. 4A and 4B).

[0085] The elastic engagement member 50 further comprises a plurality of recesses 52a, 52b formed as slots extending from opposing sides 51a, 51b, in particular from an upper side 51a and from a lower side 51b of the elastic engagement member 50, towards a central portion 58 of the elastic engagement member 50. The recesses 52a, 52b extend through the whole elastic engagement member 50 in one dimension (in a direction which is perpendicular to the plane of Figure 7A), but they do not extend completely through the elastic engagement member 50 in the dimension extending between the upper and lower sides 51a, 51b. Flexible legs 56 extending parallel to the recesses 52a, 52b are formed between two adjacent recesses 52a, 52b.

[0086] For enhancing flexibility and/or stability of the elastic engagement member 50, the recesses 52a, 52b and the flexible legs 56 may have an arcuate shape and a varying width along their longitudinal direction, respectively.

[0087] The recesses 52a, 52b extending from opposing sides 51a, 51b of the elastic engagement member 50 overlap in the central portion 58 of the engagement member; i.e. the tip ends 53a of the recesses 52a extending from the upper side 51a extend beyond the tip ends 53b of the recesses 52b extending from the opposing lower side 51b.

[0088] Instead of or additionally to the recesses 52a, 52b, cavities 57, which may be tunnels, may be formed within the elastic engagement member 50. The cavities 57 may basically correspond to the recesses 52a, 52b depicted in Figures 7A and 7B, but their extension may be limited in the direction extending perpendicular to the plane of Figure 7A. A plurality of cavities 57 may be formed next to each other in order to increase the flexibility of the elastic engagement member 50.

[0089] The cavities 57 may extend over the whole distance between the upper and lower sides 51a, 51b of the elastic engagement member 50. Alternatively, the cavities 57 may be blind holes extending from one of the sides 51a, 51b but not over the whole length of the elastic engagement member 50. According to another alternative, the cavities 57 may be completely enclosed by the material of the engagement member 50 without being

connected with the environment of the elastic engagement member 50.

[0090] The recesses 52a, 52b and/or cavities 57 may be manufactured by machining or drilling. Alternatively, elastic engagement members 50 comprising recesses 52a, 52b, cavities 57 and/or flexible legs 56 may be formed by an additive manufacturing method, such as 3D-printing. Employing an additive manufacturing method results in a lot of freedom when designing the elastic engagement member 50, in particular for forming the recesses 52a, 52b and/or cavities 57 extending through the elastic engagement member 50.

[0091] In order to provide the necessary strength and workability, the elastic engagement member 50 may be made of a suitable metal, such as steel. Alternatively, a suitable synthetic material providing the required strength may be used.

[0092] In order to avoid overheating the elastic engagement member 50 and/or the guide member 14, 15, a plurality of cooling ribs 55 extending between the upper and lower sides 51a, 51b of the elastic engagement member 50 are formed on the engagement side 54a of the elastic engagement member 50 facing the guide rail 14, 15.

[0093] Although the elastic engagement member 50 depicted in Figures 7A and 7B has the same shape as the first engagement member 26 depicted in Figures 1 to 6, the skilled person understands that the second engagement member 28 depicted in Figures 1 to 6 may be provided as an elastic engagement member 50 as well.

[0094] Thus, in a safety gear assembly 20 according to an exemplary embodiment of the invention, either one of the first and second engagement members 26, 28 or both engagement members 26, 28 may be provided as an elastic engagement member 50.

[0095] When an elastic engagement member 50 as depicted in Figures 7A and 7B is employed as at least one of the engagement members 26, 28 of a safety gear device 20 depicted in Figures 1 to 6, the elastic members 48 shown in Figures 1 to 6 may be omitted since the desired elasticity and urging force is provided by the elastic engagement member 50 itself.

[0096] As a result, the weight and the dimensions of the safety gear assembly 20 may be reduced. Further, the safety gear assembly 20 may be produced at lower costs.

[0097] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adopt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention shall not be limited to the particular embodiment disclosed, but that the invention includes all embodiments falling within the scope of the dependent claims.

References

[0098]

2	elevator system
3	tension member
4	hoistway
5	drive unit
7a	landing control panel
7b	elevator car control panel
8	landing
11	landing door
12	elevator car door
14	car guide member
15	counterweight guide member
20	safety gear assembly
21	counterweight
22	housing
24	cover plate
26	first engagement member
28	second engagement member
30	gap
32	protrusion
34	connector
36	first path
36a	first end of the first path
36b	second end of the first path
37	first slot
38	second path
38a	first end of the second path
38b	first end of the second path
39	second slot
40	first joint
41	first opening
42	first pin
44	second joint
45	second opening
46	second pin
48	elastic element
50	elastic engagement member
51a	upper side of the engagement member
51b	lower side of the engagement member
52a, 52b	recesses
53	tip end of the recess
54a	engagement side
54b	rear side
55	cooling rib
57	cavity
58	central portion
60	elevator car
62	car roof
64	car floor
66	car side wall
68	interior space of the elevator car
70	passenger
M	mirror-plane

Claims

1. A safety gear assembly (20) for an elevator system (2) comprising:

   a first engagement member (26); and
   a second engagement member (28);
   wherein the first and second engagement members (26, 28) are arranged opposite to each other defining a gap (30) which is configured for accommodating a guide member (14, 15) extending in a longitudinal direction;
   wherein at least one of the engagement members (26, 28) is movable between a released position, in which it does not contact the guide member (14, 15) and an activated position, in which it contacts the guide member (14, 15); and
   wherein at least one of the engagement members (26, 28) is an elastic engagement member (50) which is elastic at least in a direction transverse to the longitudinal direction.

2. The safety gear assembly (20) according to claim 1, wherein at least one recess (52) and/or at least one cavity (57) is formed within the at least elastic engagement member (50).

3. The safety gear assembly (20) according to claim 1 or 2, wherein the at least one elastic engagement member (50) comprises at least one flexible leg (56).

4. The safety gear assembly (20) according to claim 2 or 3, wherein the at least one recess (52), the at least one cavity (57) and/or the at least one flexible leg (56) has a longitudinal extension and a varying width along said longitudinal extension, and/or wherein the at least one recess (52), the at least one cavity (57) and/or the at least one flexible leg (56) has an arcuate shape.

5. The safety gear assembly (20) according to any of claims 2 to 4, wherein the at least one elastic engagement member (50) comprises a plurality of recesses (52), cavities (57) and/or flexible legs (56) extending basically parallel to each other.

6. The safety gear assembly (20) according to claim 5, wherein the plurality of recesses (52), cavities (57) and/or flexible legs (56) extend from opposing sides (51a, 51b) of the at least one elastic engagement member (50).

7. The safety gear assembly (20) according to any of the preceding claims, wherein the at least one elastic engagement member (50) is made of a metal, in particular steel.

8. The safety gear assembly (20) according to any of the preceding claims, wherein the at least one elastic engagement member (50) is a machined element or an additively manufactured element.

9. The safety gear assembly (20) according to any of the preceding claims, wherein both engagement members (26, 28) are elastic engagement members (50).

10. The safety gear assembly (20) according to any of the preceding claims further comprising:

    a connector (34) mechanically connecting the first and second engagement members (26, 28) with each other,
    wherein the first engagement member (26) is pivotably coupled to the connector (34) by means of a first joint (40);
    wherein the second engagement member (28) is pivotably coupled to the connector (34) by means of a second joint (42); and
    wherein at least one of the joints (40, 42) is movable along the connector (34) for changing the distance between the first and second joints (40, 42).

11. The safety gear assembly (20) according to claim 10, wherein the first joint (40) comprises a first opening (41) formed within the connector (34) and a first pin (42) extending through the first opening (41);
    wherein the second joint (44) comprises a second opening (45) formed within the connector (34) and a second pin (46) extending through the second opening (45); and
    wherein at least one of the openings (41, 45) is an elongated opening (41) allowing the accommodated pin (42, 46) to change its distance with respect to the other opening (45).

12. A counterweight (21) for an elevator system (2), the counterweight (21) comprising at least one safety gear assembly (20) according to any of claims 1 to 11.

13. An elevator car (60) comprising at least one safety gear assembly (20) according to any of claims 1 to 11.

14. An elevator system (2) comprising at least one counterweight guide member (15) and a counterweight (21) according to claim 12 traveling along said at least one counterweight guide member (15), and/or at least one car guide member (14) and at least one elevator car (60) according to claim 13 traveling along said at least one car guide member (14).

15. Method of producing an elastic engagement member (50) configured to be employed as an engage-

ment member (26, 28) in a safety gear assembly (20) according to any of claims 1 to 11, the method comprising using an additive manufacturing method, in particular 3D-printing.

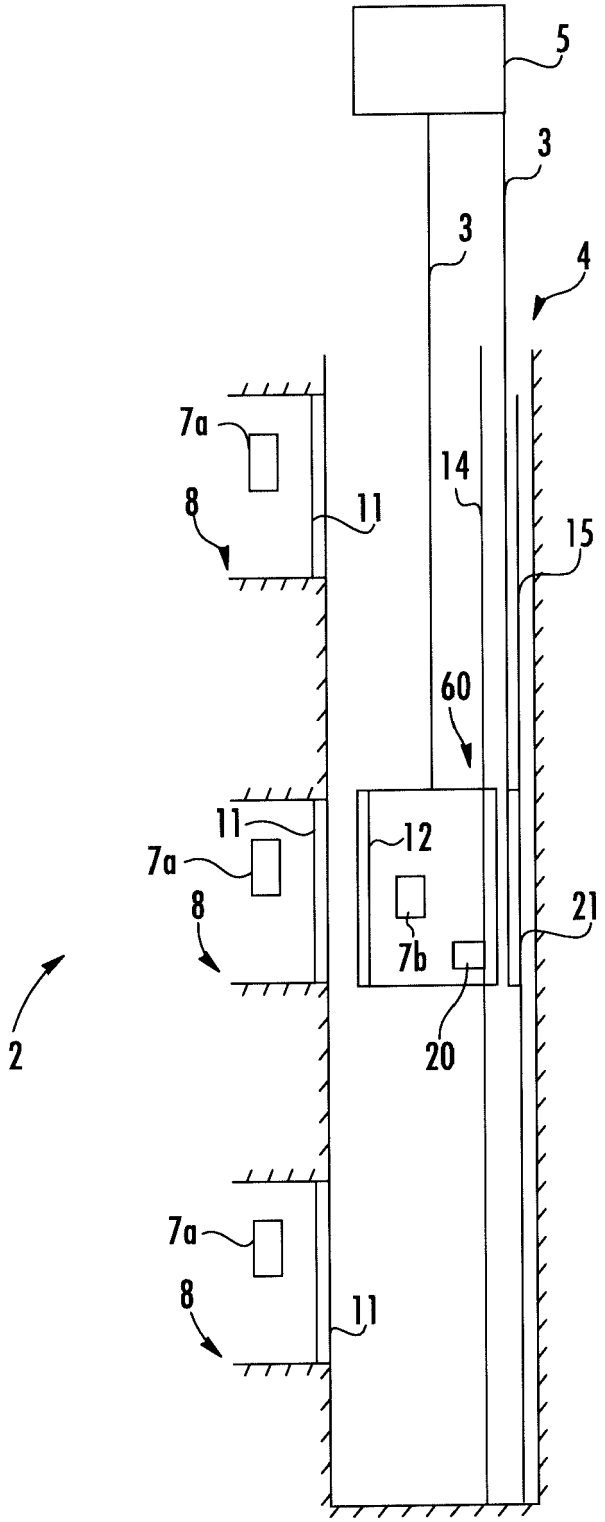

FIG. 1

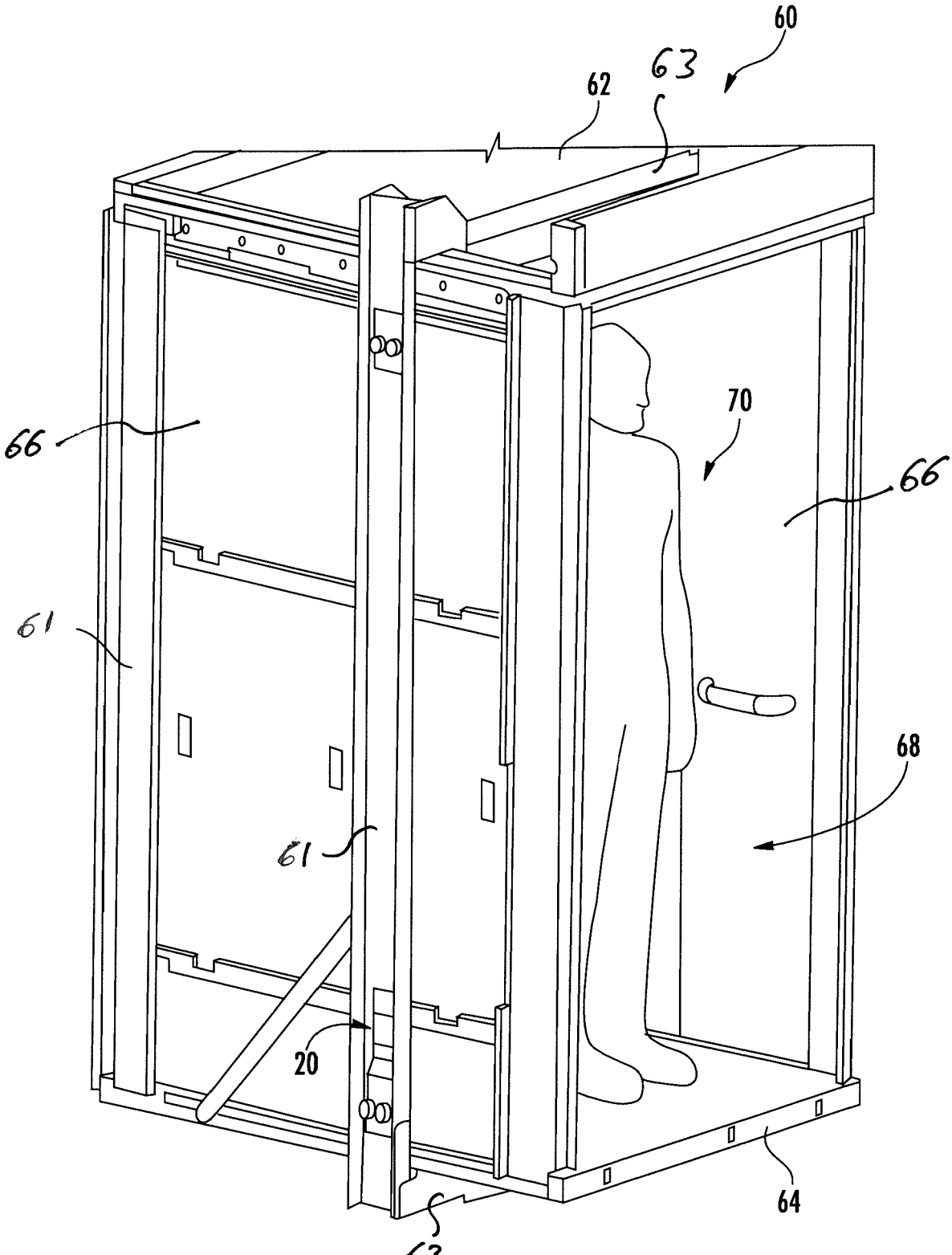

FIG. 2

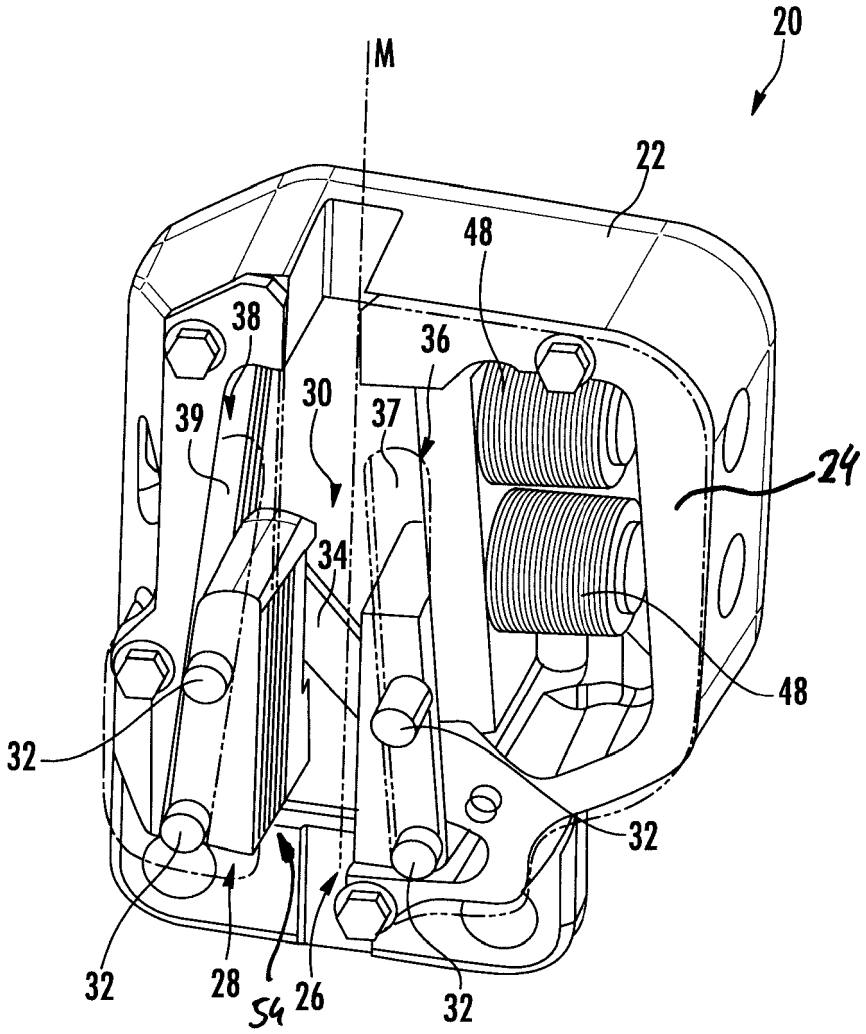

FIG. 3

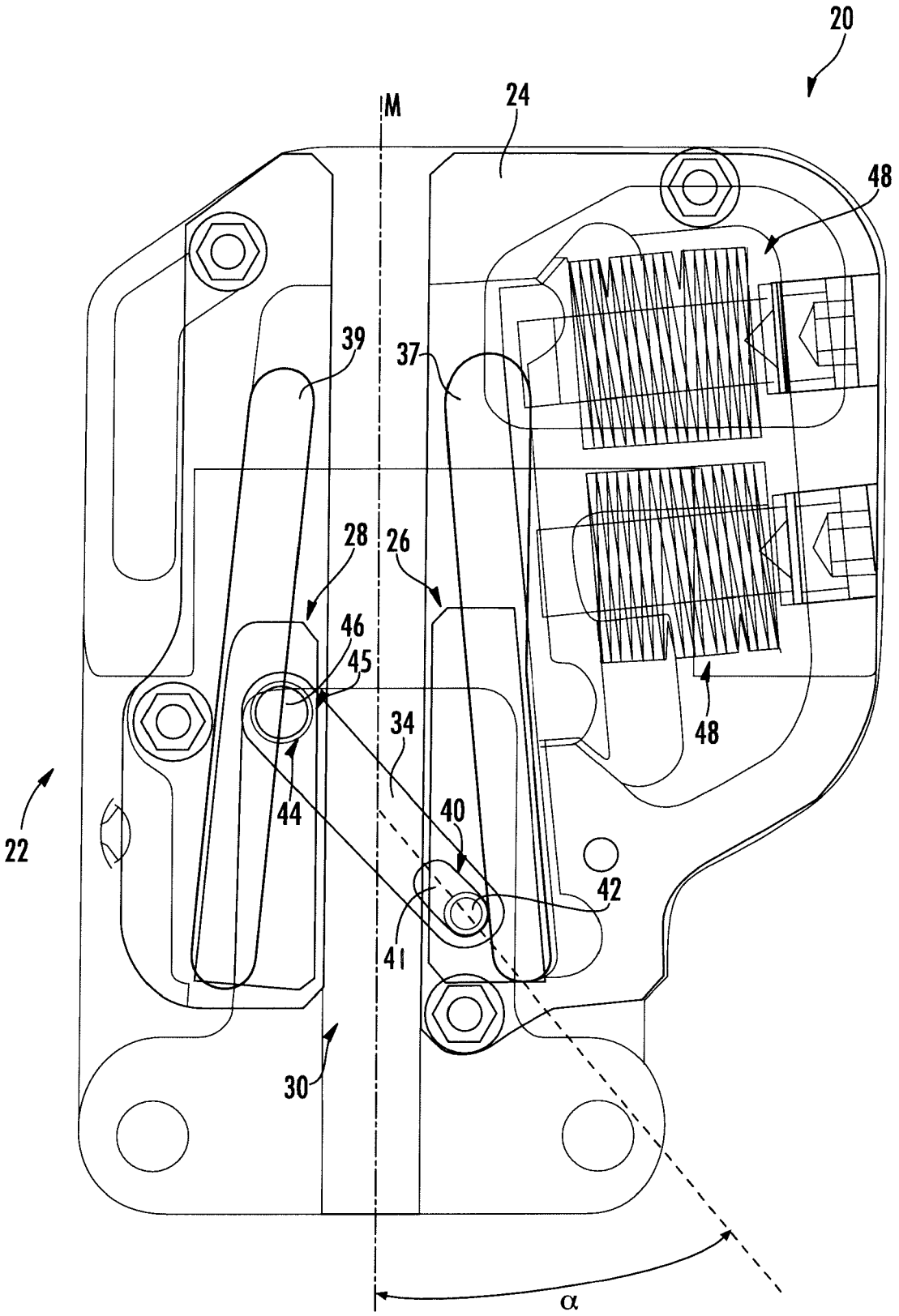

FIG. 4A

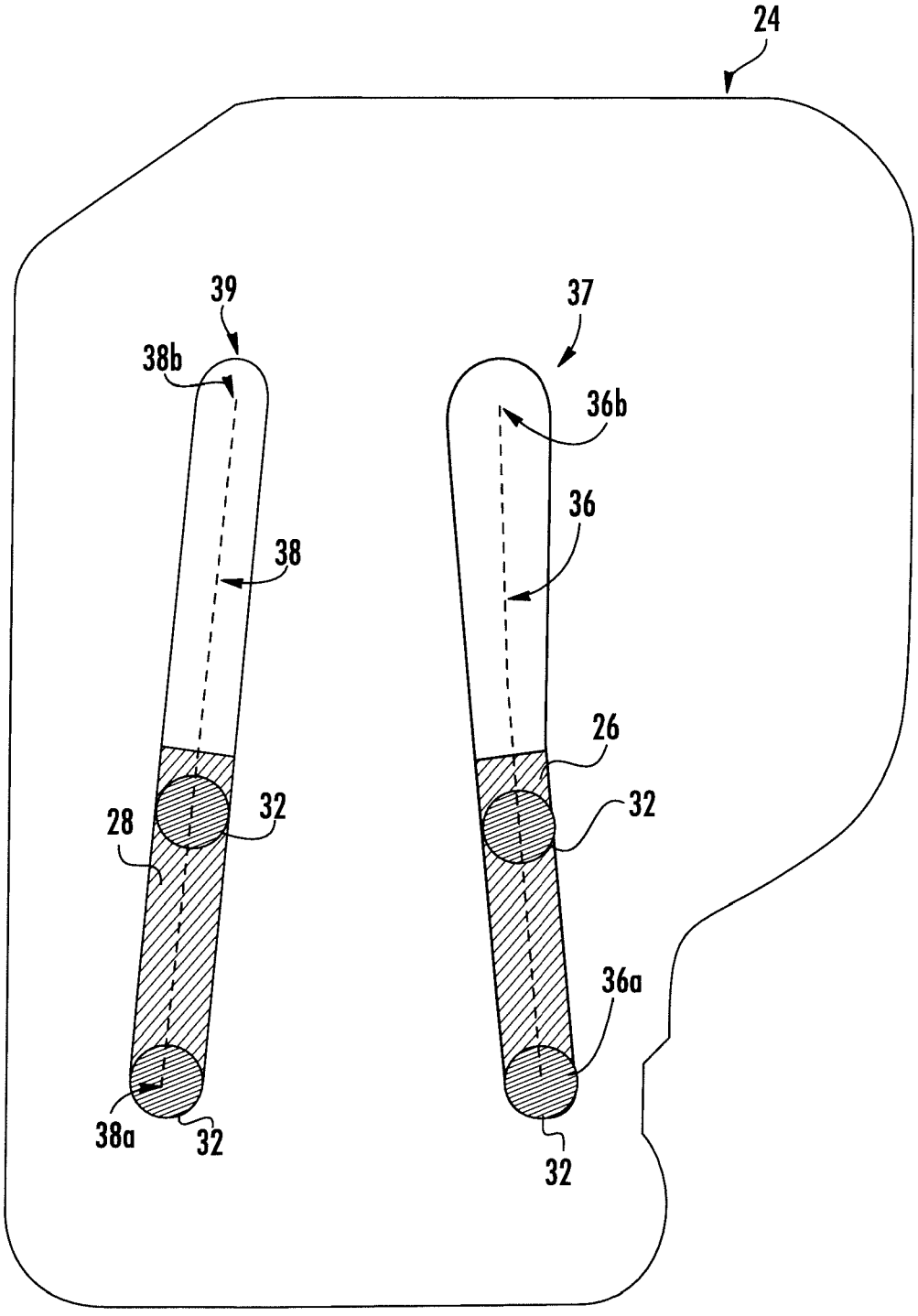

FIG. 4B

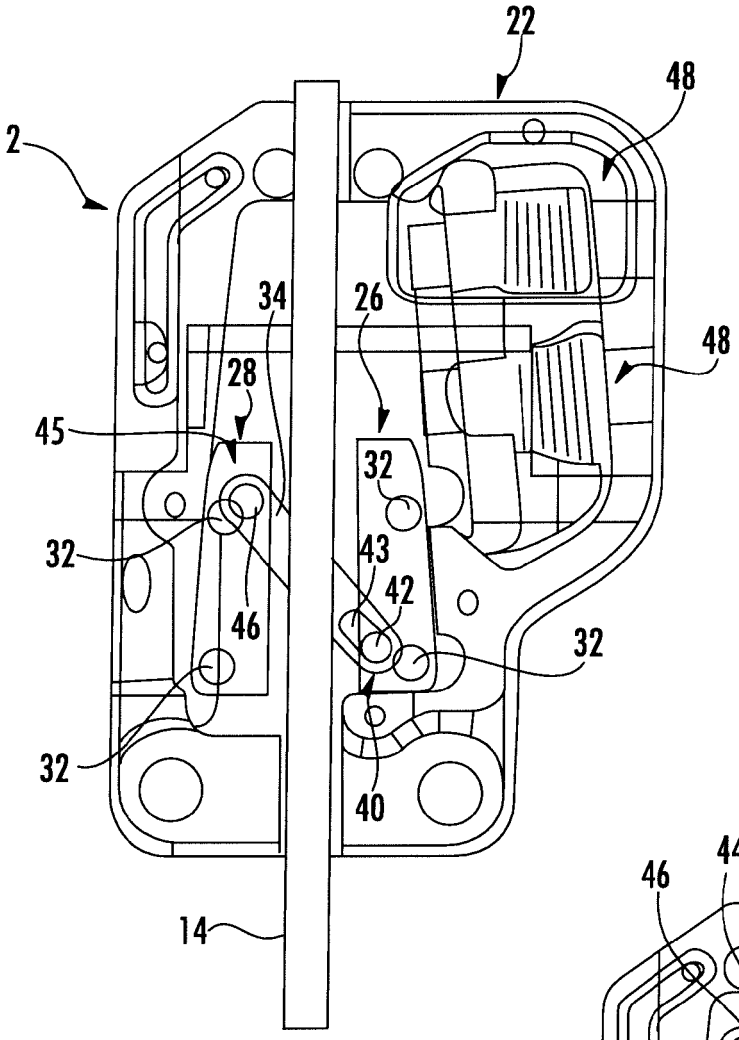
22
48
2
34
26
48
28
45
32
32
43
42
46
32
32
40
14

FIG. 5

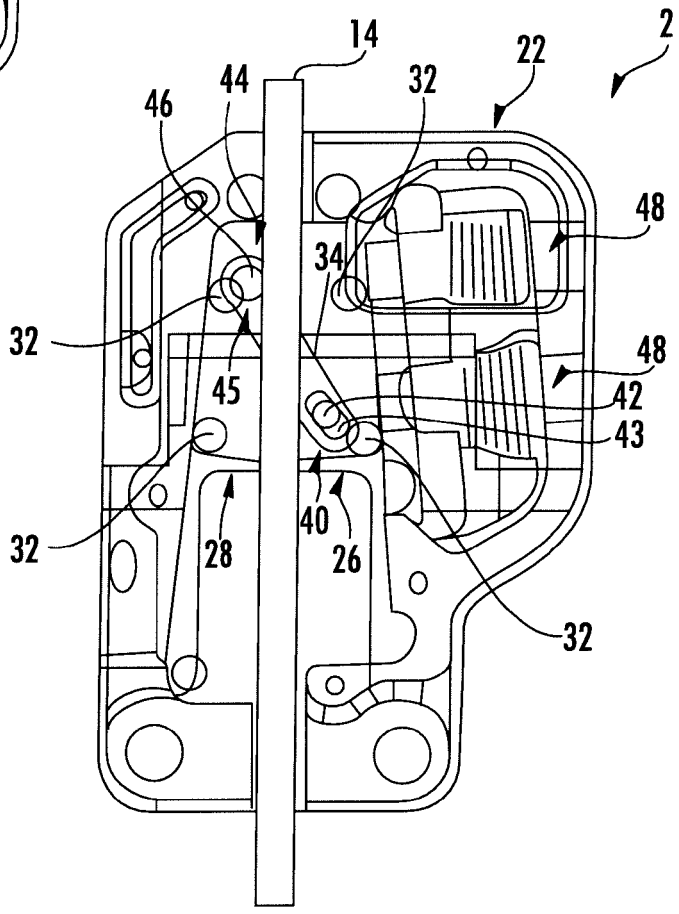
14
22
2
46
44
32
48
34
32
48
45
42
43
40
26
32
28
32

FIG. 6

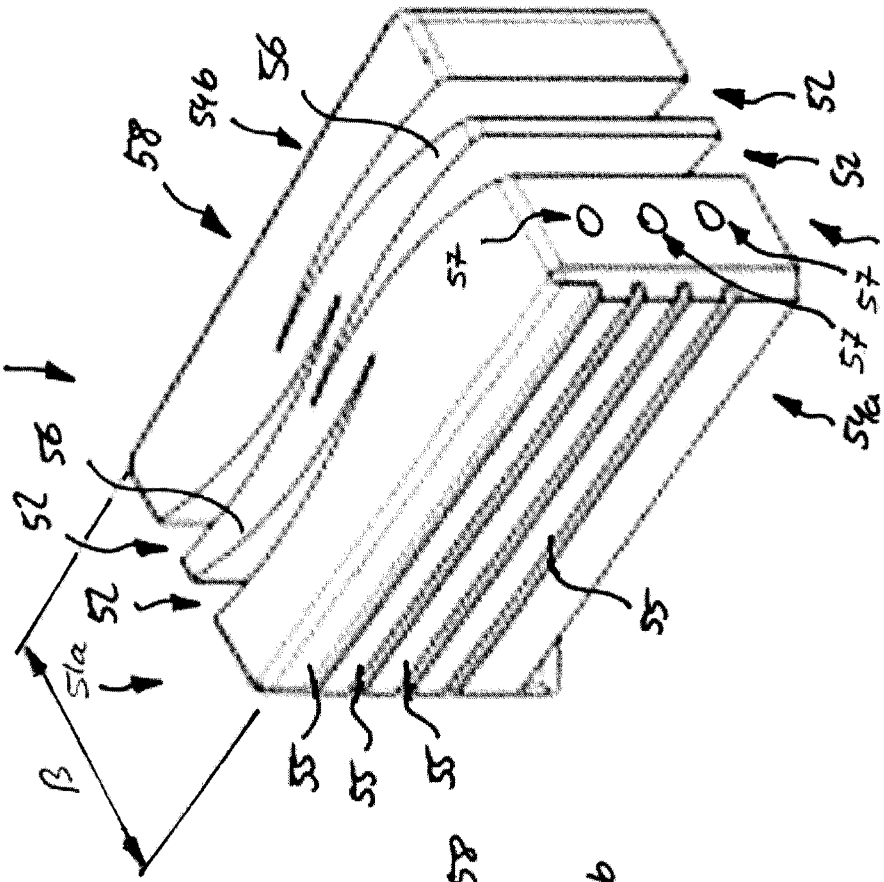
58
54b
56
52
52
51b
57
57
57
57
54a
55
55
55
55
51a
52
52
56
β

Fig. 7B

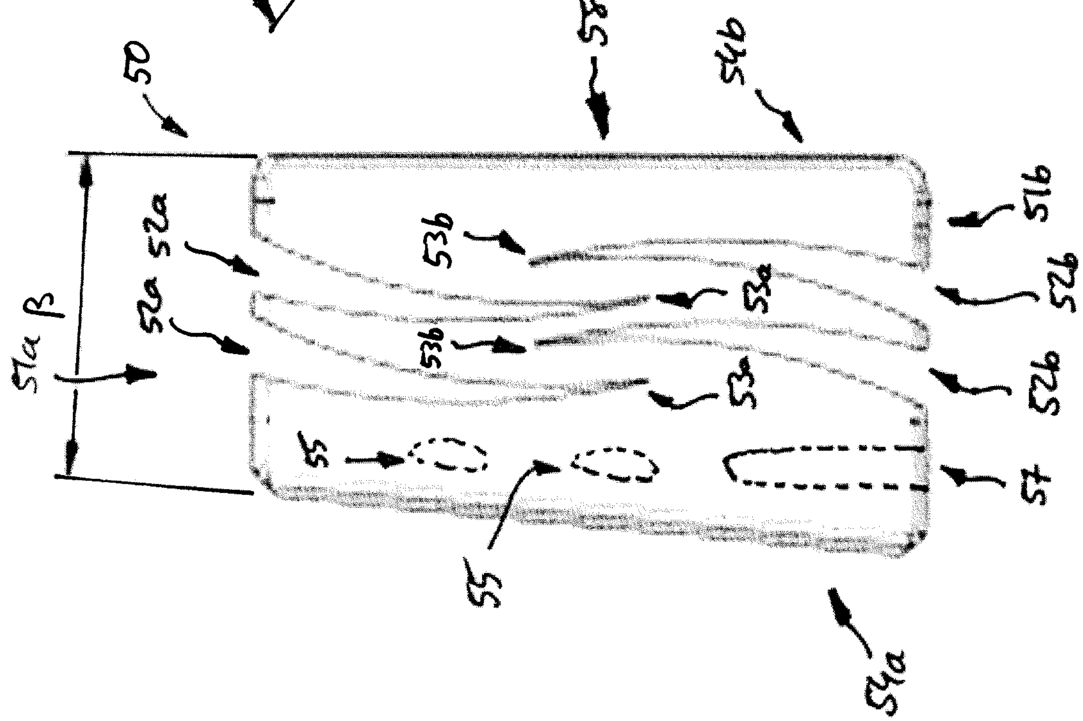
50
58
54b
51a
β
52a
52a
53b
53a
53b
53a
51b
52b
52b
57
55
55
54a

Fig. 7A

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 3252

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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