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(71) Applicant: **Transol Corporation**
Morgantown. PA 19543 (US)

(72) Inventors:
- **Galpin, Arnold Timothy**
Morgantown, PA Pennsylvania 19543 (US)
- **Pisotti, David Antony**
Mohnton, PA Pennsylvania 19540 (US)

(74) Representative: **Franzolin, Luigi et al**
Studio Torta S.p.A.
Via Viotti, 9
10121 Torino (IT)

(54) **Anchor trolley and fall arrest system and method implementing the same**

(57) A fall arrest anchor trolley for arresting the fall of a user. In one embodiment, the invention can be a fall arrest trolley comprising: a body, a brake sub-system, and a plurality of wheels rotatably coupled to the body, wherein bottoms of the plurality of wheels collectively define a rolling plane; the brake sub-system comprising a brake rod, a brake pad connected to the brake rod, a lanyard connector connected to the brake rod, and a resilient element; the brake rod slidably coupled to the body so that the brake sub-system is alterable between: (1) a free state in which the brake pad is spaced a distance above the rolling plane; and (2) an arrest state in which at least a portion of the brake pad is located within the rolling plane; the resilient element biasing the brake sub-system into the free state.

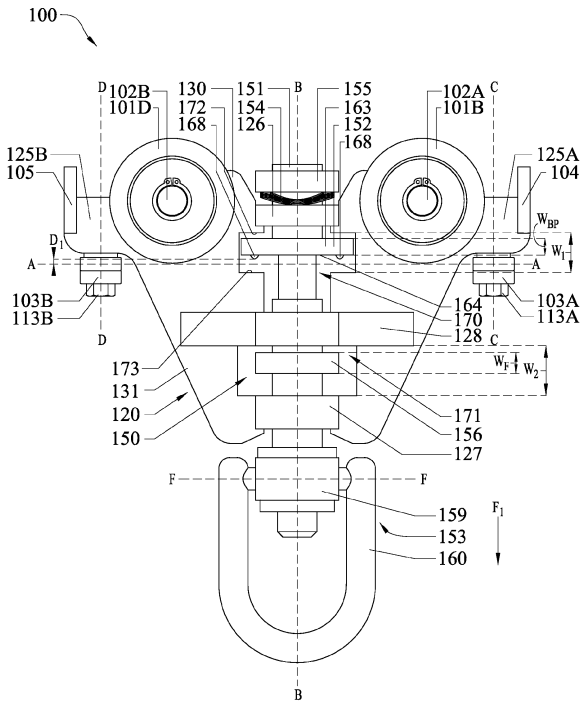

FIG. 3

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to a fall protection apparatus, and more specifically to a fall protection apparatus that arrests longitudinal movement of a trolley along a rail upon a user falling from a work surface.

BACKGROUND OF THE INVENTION

[0002] Many work situations require workers to be positioned on top of platforms or vehicles that cannot be practically protected by a guardrail system enclosing the work surface. To prevent the workers from falling from such elevated positions and thereby sustaining serious or fatal injuries, various fall protection systems can be used. In general, fall arrest or fall protection systems are designed to prevent the worker from reaching an unprotected edge or to quickly stop a fall before the worker impacts a lower level. Such systems typically include a trolley secured to a structure overhead the work surface, a safety harness worn by the worker, and a lanyard interconnecting the trolley to the harness.

[0003] In using conventional fall arrest or fall protection systems, workers who fall from the work surface are carried by momentum a distance from the work surface. As a result, workers are left hanging from the trolley and lanyard until a third party or rescue team arrives at the scene to assist the worker. This can be extremely undesirable because if a worker is left hanging for an extended period of time, the worker may suffer from orthostatic intolerance or suspension trauma.

[0004] Thus, a need exists for a fall arrest apparatus, system and/or method that prevents a worker who falls from a work surface from suffering orthostatic intolerance and negates the need for third party assistance to rescue the worker.

BRIEF SUMMARY OF THE INVENTION

[0005] These and other needs are met by the present invention, which is directed to a fall arrest apparatus, system and method. In one aspect, the invention can be a fall arrest system comprising: a rail extending along a longitudinal axis, the rail comprising a floor and a longitudinal slot separating the floor into a first longitudinal section and a second longitudinal section; a trolley comprising a body, a brake sub-system, and a plurality of wheels rotatably coupled to the body, the plurality of wheels in rolling contact with upper surfaces of the first and second longitudinal sections; the brake sub-system comprising a brake rod, a brake pad connected to the brake rod, a lanyard connector connected to the brake rod, and a resilient element, the brake pad positioned above the first and second longitudinal sections; the brake rod slidably coupled to the body so that the brake sub-system is alterable between: (1) an arrest state in which the brake pad frictionally engages the upper surfaces of the of the first and second longitudinal sections of the rail to prohibit rolling movement of the trolley along the rail; and (2) a free state in which the brake pad is spaced a distance above the upper surfaces of the first and second longitudinal sections of the rail to allow rolling movement of the trolley along the rail; and the resilient element biasing the brake sub-system into the free state.

[0006] In another aspect, the invention can be a fall arrest trolley comprising: a body, a brake sub-system, and a plurality of wheels rotatably coupled to the body, wherein bottoms of the plurality of wheels collectively define a rolling plane; the brake sub-system comprising a brake rod, a brake pad connected to the brake rod, a lanyard connector connected to the brake rod, and a resilient element; the brake rod slidably coupled to the body so that the brake sub-system is alterable between: (1) a free state in which the brake pad is spaced a distance above the rolling plane; and (2) an arrest state in which at least a portion of the brake pad is located within the rolling plane; the resilient element biasing the brake sub-system into the free state.

[0007] In yet another aspect, the invention can be a method of arresting a user from falling off an edge of a work surface comprising: a) coupling a first end of a lanyard to a lanyard connector of a fall arrest trolley, the fall arrest trolley comprising a plurality of wheels in rolling contact with an upper surface of a rail extending along a longitudinal axis; b) upon a user moving on the work surface, the fall arrest trolley rolling along the upper surface of the rail, the trolley comprising a brake sub-system comprising, a brake rod, a brake pad connected to the brake rod and located above the upper surface of the rail, the lanyard connector connected to the brake rod, and a resilient element, wherein the resilient element biases the brake sub-system into a free state in which the brake pad is spaced a distance above the upper surface of the rail to allow the rolling of the trolley along the rail while the user moves on the work surface; and c) upon the user moving off the edge of the work surface, the user's weight exerting a downward vertical force on the lanyard connector that overcomes a spring force of the resilient member and alters the brake sub-system into an arrest state in which the brake pad frictionally engages the upper surface of the rail to prohibit further rolling of the trolley along the rail.

[0008] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will become more fully

understood from the detailed description and the accompanying drawings, wherein:

[0010] Figure 1 is a perspective view of a fall arrest anchor trolley in accordance with another embodiment of the present invention;

[0011] Figure 2 is an exploded view of the fall arrest anchor trolley of FIG. 1;

[0012] Figure 3 is a side view of the fall arrest anchor trolley of FIG. 1;

[0013] Figure 4 is side view of the fall arrest anchor trolley of FIG. 1 disposed within a rail;

[0014] Figure 5 is a cross-sectional view taken along line IXX-IXX of FIG. 4;

[0015] Figure 6 is a cross-sectional view taken along line XX-XX of FIG. 4;

[0016] Figure 7 is a cross-sectional view taken along line XXI-XXI of FIG. 4 with a brake sub-system in a free state;

[0017] Figure 8 is a cross-sectional view taken along line XXII-XXII of FIG. 1 with the brake sub-system in the free state;

[0018] Figure 9 is the cross-sectional view of FIG. 5 with the brake sub-system in an arrest state;

[0019] Figure 10 is the cross-sectional view of FIG. 4 with the brake sub-system in the arrest state;

[0020] Figure 11 is the fall arrest anchor trolley disposed within the rail of FIG. 4 with a user standing on a work surface and attached to the fall arrest anchor trolley by a lanyard;

[0021] Figure 12 is a perspective view of a fall arrest anchor trolley in accordance with yet another embodiment of the present invention;

[0022] Figure 13 is a side view of the fall arrest anchor trolley of FIG. 12;

[0023] Figure 14 is a front view of the fall arrest anchor trolley of FIG. 12;

[0024] Figure 15 is a cross-sectional view taken along line XXIX-XXIX of FIG. 13;

[0025] Figure 16 is a close-up view of area XXX of FIG. 13; and

[0026] Figure 17 is a perspective view of the brake pad of the fall arrest anchor trolley of FIG. 12 removed therefrom.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0028] The description of illustrative embodiments according to principles of the present invention is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description of embodiments of the invention disclosed herein, any reference to direction or orientation is merely intended for convenience of description and is not intended in any way to limit the scope of the present invention. Relative terms such as "lower," "upper," "horizontal," "vertical," "above," "below," "up," "down," "top" and "bottom" as well as derivatives thereof (e.g., "horizontally," "downwardly," "upwardly," etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description only and do not require that the apparatus be constructed or operated in a particular orientation unless explicitly indicated as such. Terms such as "attached," "affixed," "connected," "coupled," "interconnected," and similar refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise. Moreover, the features and benefits of the invention are illustrated by reference to the exemplified embodiments. Accordingly, the invention expressly should not be limited to such exemplary embodiments illustrating some possible non-limiting combination of features that may exist alone or in other combinations of features; the scope of the invention being defined by the claims appended hereto.

[0029] Two structural embodiments of fall arrest systems are disclosed herein that are directed to eliminating a situation where a worker becomes stranded while hanging from a trolley and/or rail system after falling from a work surface. Specifically, the first structural embodiment is a fall arrest self-rescue trolley system and the second structural embodiment is a fall arrest anchor trolley system. Each of these structural embodiments will be discussed in detail below, wherein Figures 1-14 and the accompanying description disclose the fall arrest self-rescue trolley system and Figures 15-25 and the accompanying description disclose the fall arrest anchor trolley system.

[0030] Referring to FIGS. 1-11, a fall arrest anchor trolley 100 within a fall arrest system 500 is illustrated. The description of the fall arrest anchor trolley 100 and system below will be made with reference to FIGS. 1-11.

[0031] Referring to FIGS. 1-3 concurrently, the fall arrest trolley 100 will be described in accordance with an embodiment of the present invention. The trolley 100 generally comprises a body 120, a brake-sub system 150 and a plurality of wheels 101A-D rotatably coupled to the body 120. The body 120 comprises a primary plate 121 having a first side surface 122 and an opposing second side surface 123. In the exemplified embodiment, the first and second side surfaces 122, 123 of the primary plate 121 are substantially flat surfaces. However, the invention is not to be so limited in all embodiments and in certain other embodiments the first and second side surfaces 122, 123 of the primary plate 121 can have ridges, recesses and other contours as desired. In certain embodiments, the primary plate 121 of the body 120 is formed of a rigid metallic material, such as steel, iron, brass, aluminum alloys or the like. Of course, the invention is not to be so limited in all embodiments and mate-

rials other than metal can be used in other embodiments.

[0032] In the exemplified embodiment, the primary plate 121 is generally in the shape of a trapezoid or truncated triangle with a first flange 125A at a first end thereof and a second flange 125B at a second opposite end thereof. The primary plate 121 has various openings and/or slots throughout its central portion for attachment to collars of the body 120 and for slidably receiving therein flanges of the brake sub-system 150 as will be described in more detail below. It should be appreciated that the exact shape of the primary plate 121 is not to be limiting of the present invention in all embodiments and the primary plate 121 may take on any other shapes that enable the trolley 100 to function as described herein.

[0033] The body 120 comprises a first collar 126, a second collar 127 and a third collar 128. Each of the first, second and third collars 126, 127, 128 can be integrally formed with the body 120, or can be formed separately from the body 120 and connected to the body 120 at a later stage in the manufacturing process such as by welding, adhesion, interference fit, snap fit or the like. The first collar 126 has a first central opening 126A, the second collar 127 has a second central opening 127A and the third collar 128 has a third central opening 128A. In the exemplified embodiment, each of the first, second and third central openings 126A, 127A, 128A are axially aligned along a brake axis B-B. However, the invention is not to be so limited in all embodiments and in certain other embodiments the first, second and third central openings 126A, 127A, 128A may be axially offset. The body 120 is bilaterally symmetric about the brake axis B-B in the exemplified embodiment, although the invention is not to be so limited in all embodiments of the invention.

[0034] Moreover, in the exemplified embodiment each of the first, second and third central openings 126A, 127A, 128A have transverse cross-sectional areas (transverse to the brake axis B-B) that are circular or cylindrical in shape. However, the invention is not to be so limited in all embodiments and in certain other embodiments the openings 126A-128A may take on other transverse cross-sectional shapes to correspond to the shape of the brake sub-system 150 (and more specifically to a brake rod 151 of the brake sub-system) as described herein below. Furthermore, in still other embodiments the transverse cross-sectional shapes of the first, second and third central openings 126A, 127A, 128A may merely be able to slidably receive the brake sub-system 150 without actually having a shape that corresponds to the shape of the brake sub-system 150. For example without limitation, in certain embodiments the transverse cross-sectional shapes of the first, second and third central openings 126A, 127A, 128A may be rectangular while the brake sub-system 150 is cylindrical. Thus, in certain other embodiments the transverse cross-sectional shapes of the first, second and third openings 126A, 127A, 128A are merely sized, shaped and configured to slidably receive the brake sub-system 150 therein.

[0035] Moreover, in the exemplified embodiment, the first and second collars 126, 127 are cylindrical in shape and the third collar 128 is octagonal in shape. However, it should be appreciated that the general shapes of the first, second and third collars 126, 127, 128 are not to be limiting of the present invention in all embodiments unless so specified in the claims.

[0036] Referring briefly to FIGS. 1-3 and 6, the wheels 101A-D are rotatably coupled to the body 120 by a first axle 102A and a second axle 102B. The first and second axles 102A, 102B are longitudinally spaced from one another. In certain embodiments, the wheels 101A-D can be held in place on their associated axles 102A, 102B by snap-rings, although the invention is not to be so limited in all embodiments and other structures or mechanisms may be used to maintain the wheels 101A-D in place on the axles 102A, 102B. In certain embodiments, the axles 102A, 102B are fixedly mounted on the body 120 of the trolley 100. However, the invention is not to be so limited and in certain other embodiments the axles 102A, 102B may be separate components that are welded or otherwise coupled to the body 120 of the trolley 100 such as by an interference or snap-fit arrangement.

[0037] In the exemplified embodiment, four wheels 101A-D are illustrated. However, the invention is not to be so limited and more or less than four wheels can be used in other embodiments of the invention. The wheels 101A-D are rotatable about an axis E-E. Specifically, the trolley 100 has two sets of wheels wherein the first set of wheels 101a, 101B are coupled to the body 120 and to each other by the first axle 102A and the second set of wheels 101C, 101D are coupled to the body 120 and to each other by the second axle 102B. In certain embodiments, the wheels 101A-D are formed of a tough, wear resistant material, such as polyamide. However, the invention is not to be so limited in all embodiments and in certain other embodiments the wheels 101A-D can be formed of any other material known to be used with trolley assemblies, such as for example without limitation plastic materials, rubber, elastomeric materials, thermoplastic elastomers, wood or metal.

[0038] Referring again to FIGS. 1-3, bottoms of the plurality of wheels 101A-D collectively define a rolling plane A-A. In the exemplified embodiment, the rolling plane A-A is illustrated with a dotted line. However, it should be understood that the dotted line showing the rolling plane A-A is a plane that is perpendicular to the page on which the figures are illustrated and that the rolling plane A-A is collectively formed by all four of the plurality of wheels 101A-D. The body 120 comprises a first portion 130 that is located above the rolling plane A-A and a second portion 131 that is located below the rolling plane A-A. Thus, the body 120 extends through the rolling plane A-A. Furthermore, the primary plate 121 of the body 120 is oriented substantially perpendicular to the rolling plane A-A.

[0039] The trolley 100 comprises a first stop member 104 located at a first longitudinal end of the body 120 and a second stop member 105 located at a second longitu-

dinal end of the body 120. Specifically, the first stop member 104 is connected to the first flange 125A of the primary plate 121 of the body 120 and the second stop member 105 is connected to the second flange 125B of the primary plate 121 of the body 120. The plurality of wheels 101A-D are each located between the first and second stop members 104, 105. In the exemplified embodiment, the first and second stop members 104, 105 are rectangular shaped plates that form the ends of the body 120. Of course, the first and second stop members 104, 105 can take on other shapes in certain other embodiments. The first and second stop members 104, 105 provide a flat surface of the trolley 100 to contact an end of a rail when the trolley 100 is positioned within a rail as will be described in more detail below with reference to FIG. 4. Thus, the first and second stop members 104, 105 make a worker aware that the trolley 100 has reached the end of the rail and can move no further in that particular longitudinal direction.

[0040] The trolley 100 also comprises one or more rollers 103A, 103B connected to the body 120. In the exemplified embodiment, there are two rollers including a first roller 103A and a second roller 103B connected to the body 120. More specifically, the first and second rollers 103A, 103B are mounted on vertically extending bolts 113A, 113B, respectively, that are secured to the body 120 of the trolley 100. The first roller 103A extends downwardly from a bottom of the first flange 125A of the primary plate 121 and the second roller 103B extends downwardly from a bottom of the second flange 125B of the primary plate 121.

[0041] In the exemplified embodiment, the first and second rollers 103A, 103B are cam rollers. It should be understood that the invention is not to be so limited in all embodiments and in certain other embodiments the first and second rollers 103A-B can take on other forms, such as including without limitation ball bearings, roller bearings, ball thrust bearings, roller thrust bearings, tapered roller bearings, plain bearings, flexure bearings, magnetic bearings or the like. In the exemplified embodiment, the first roller 103A is connected to the body 120 at a position between the first stop member 104 and the wheels 101a, 101B and the second roller 103B is connected to the body 120 at a position between the second stop member 105 and the wheels 101C, 101D. The first and second rollers 103A, 103B are connected to the body 120 adjacent to and below the rolling plane A-A. Furthermore, the first roller 103A is rotatable about an axis of rotation C-C and the second roller 103B is rotatable about an axis of rotation D-D. Each of the axes of rotation C-C, D-D are oriented substantially perpendicular to the rolling plane A-A.

[0042] As noted above, the trolley 100 also comprises the brake sub-system 150. The brake sub-system 150 both permits and prohibits longitudinal movement of the trolley 100 when the trolley is positioned within a rail or otherwise located such that vertical movement of the trolley 100 is prohibited as will be described in detail below. The brake sub-system 150 generally comprises a brake rod 151, a brake pad 152, a lanyard connector 153 and a resilient element 154. When the trolley 100 is fully assembled, the brake rod 151 is slidably coupled to the body 120 so that the brake sub-system 150 is alterable between a free state and an arrest state, which will be described in more detail below. Thus, when the trolley 100 is fully assembled, the brake rod 151 slides within the central openings 126A-128A of the collars 126-128 of the body 120.

[0043] The brake rod 151 extends along the brake axis B-B, which is oriented substantially perpendicular to the rolling plane A-A and substantially parallel to the axes of rotation C-C, D-D of the rollers 103A, 103B. In the exemplified embodiment, the brake rod 151 is generally cylindrical in shape. However, as described herein above, the invention is not to be limited by the shape of the brake rod 151 in all embodiments and the brake rod 151 can take on other shapes so long as it can be slidably received within the central openings 126A-128A of the first, second and third collars 126, 127, 128 of the body 120.

[0044] The brake rod 151 comprises a sleeve 157 on its lower portion. The sleeve 157 is essentially a larger diameter portion of the brake rod 151. The sleeve 157 comprises a threaded inner surface 158 (FIG. 7) for connecting the lanyard connector 153 to the brake rod 151 as will be described below. The brake rod 151 is coupled to a first flange 155, a second flange 156, the brake pad 152 and the lanyard connector 153. Specifically, in certain embodiments the brake rod 151 is integrally formed with the first flange 155, the second flange 156 and the brake pad 152. However, the invention is not to be so limited in all embodiments and in certain other embodiments the brake rod 151 may be separately formed from and later connected to the first flange 155, the second flange 156 and the brake pad 152 such as by welding or any other connection techniques described herein or known in the art. The first flange 155 is connected to a top end of the brake rod 151 and the lanyard connector 153 is connected to a bottom end of the brake rod 151.

[0045] The brake pad 152 generally comprises a brake plate 163 having a bottom surface 164 and a top surface 165. In the exemplified embodiment, the brake plate 163 is a flat plate and each of the bottom and top surfaces 164, 165 are flat, planar surfaces. However, the invention is not to be so limited in all embodiments and in certain other embodiments the brake plate 163 can have a contoured or other shape. Furthermore, the brake plate 163 is oriented substantially parallel to the rolling plane A-A. The brake plate 163 comprises at least one opening 166 therethrough. In the exemplified embodiment, the brake plate 163 includes four of the openings 166. Each one of the openings 166 is a threaded hole through which a set screw 167 can extend. In the exemplified embodiment, there are four set screws 167, each of which extends through one of the openings 166 in the assembled state. Of course, the invention is not to be so limited in all embodiments and in certain other embodiments more

or less than four set screws 167 can be used. The set screws 167 extend through the openings 166 such that tip portions 168 of the set screws 167 form a plurality of protrusions that extend from the bottom surface 164 of the brake plate 163 of the brake pad 152. When the trolley 100 is positioned within a rail, the tip portions 168 of the set screws 167 frictionally engage upper surfaces of the rail to prevent or stop the trolley 100 from longitudinal movement when the brake sub-system 150 is in the arrest state as will be described in more detail below.

[0046] Although the exemplified embodiment illustrates the tip portions 168 of the set screws 167 forming the plurality of protrusions that extend from the bottom surface 164 of the brake plate 163, in certain other embodiments the set screws 167 may be omitted. In such embodiments, the bottom surface 164 of the brake plate 163 may engage upper surfaces of the rail when the brake sub-system 150 is in the arrest state to stop longitudinal movement of the trolley 100. In still other embodiments, protuberances formed of rubber, metal or any other desired material may be affixed, such as by welding, adhesion or the like, to the bottom surface 164 of the brake plate 163 to form the component that frictionally engages the upper surfaces of the rail to prevent longitudinal movement of the trolley 100 when the brake subsystem 150 is in the arrest state.

[0047] The lanyard connector 153 comprises a hub portion 159, an eye 160 pivotably connected to the hub portion 159 by a pivot pin 161 and a threaded engagement portion 162. In the exemplified embodiment, the eye 160 is a U-shaped component extending downwardly from the hub portion 159. However, the invention is not to be so limited in all embodiments and in certain other embodiments the eye 160 can take on other shapes. The eye 160 is pivotable relative to the hub portion 159 about an axis of rotation F-F that is substantially parallel to the rolling plane A-A. The eye 160 is the portion of the lanyard connector 153 to which a lanyard is attached as will be described in more detail below with reference to FIG. 11. The threaded engagement portion 162 of the lanyard connector 153 operates like a threaded screw and can be connected to the sleeve 157 of the brake sub-assembly 150. More specifically, referring briefly to FIG. 7, the inner surface 158 of the sleeve 157 of the brake rod 151 is a threaded surface that engages the threaded engagement portion 162 of the lanyard connector 153 to couple the lanyard connector 153 to the brake rod 151 of the brake sub-assembly 150.

[0048] When the trolley 100 is fully assembled and the brake sub-assembly 150 is coupled to the body 120 as illustrated in FIGS. 1 and 3, the brake rod 151 extends through the first, second and third central openings 126A, 127A, 128A of the first, second and third collars 126, 127, 128 of the body 120. Furthermore, the first flange 155 of the brake sub-assembly 150 is located above the first collar 126 of the body 120 and the resilient element 154 is positioned between the first flange 155 of the brake sub-assembly 150 and the first collar 126 of the body 120. Further still, the second collar 127 of the body 120 is located below the second flange 156 of the brake sub-assembly 150 and the second flange 156 of the brake sub-assembly 150 is located below the first collar 126 of the body 120. Moreover, the third collar 128 of the body 120 is located between the first and second collars 126, 127 of the body 120 and between the first and second flanges 155, 156 of the brake sub-assembly 150. The brake pad 152 is located between the first collar 126 and the third collar 128 of the body 120. Thus, when fully assembled, the flanges 155, 156 and collars 126-128 are positioned from a top of the trolley 100 to a bottom of the trolley 100 as follows: first flange 155, first collar 126, brake pad 152, third collar 128, second flange 156, second collar 127.

[0049] The brake pad 152 is positioned within a first slot 170 in the primary plate 121 that is located between the first collar 126 and the third collar 128. The second flange 156 of the brake sub-system 150 is positioned within a second slot 171 in the primary plate 121 that is located between the second collar 127 and the third collar 128. Furthermore, the first slot 170 has a width W_1 that is larger than a width W_{BP} of the brake pad 152 and the second slot 171 has a width W_2 that is larger than a width W_F of the second flange 156. In certain embodiments the width W_1 of the first slot 170 is between ½ inch and ¾ inch, and most preferably approximately ⅝ inch. In certain embodiments the width W_{BP} of the brake pad 152 is between ⅛ inch and ⅜ inch, and more preferably approximately ¼ inch. In certain embodiments the width W_2 of the second slot 171 is between ⅝ inch and ⅞ inch, and more preferably approximately ¾ inch. In certain embodiments the width W_F of the second flange 156 is between $\frac{3}{16}$ inch and $\frac{7}{16}$ inch, and more preferably approximately $\frac{5}{16}$ inch. It should be appreciated that the widths described above are not limited to the recited ranges in all embodiments and can have measurements outside of the recited ranges in certain other embodiments so long as W_1 is larger than W_{BP} and W_2 is larger than W_F.

[0050] As a result of the relative widths described above, when the brake sub-assembly 150 is slidably received by the body 120, there is ample space within the first slot 170 for upward and downward movement of the brake pad 152 therein and ample space within the second slot 171 for upward and downward movement of the second flange 156 therein. As will be described in more detail below with reference to FIGS. 7-10, the brake pad 152 moves axially (along the brake axis B-B) within the first slot 170 and the second flange 156 moves axially (along the brake axis B-B) within the second slot 171 when the brake sub-system transitions between the free state and the arrest state.

[0051] In the exemplified embodiment, the resilient el-

ement 154 comprises a plurality of spring discs 169. It should be appreciated that the invention is not to be limited to the use of spring discs 169 as the resilient element 154 in all embodiments and other components can be used as the resilient element 154 in other embodiments such as, for example without limitation, compression springs, torsion springs, extension springs, barrel springs, spring pins, cantilever springs, leaf springs, die springs, rubber springs, wave springs, washer springs and the like. In the exemplified embodiment, the resilient element 154 comprises four spring discs 169. Of course, more or less than four spring discs 169 can be used to create a greater or lesser spring force.

[0052] In the fully assembled state described above, the spring discs 169 of the resilient element 154 exert an upward force on the first flange 155 of the brake sub-system 150 to bias or urge the brake sub-system 150 into the free state, whereby the brake pad 152, and more specifically the tip portions 168 of the set screws 167, are spaced a distance D_1 above the rolling plane A-A. Thus, in the free state, the resilient element 154 urges the second flange 156 axially upward within the second slot 171 and urges the brake pad 152 axially upward within the first slot 170. In certain embodiments, D_1 results in a clearance in a range of $\frac{1}{16}$ inch to $\frac{3}{16}$ inch, and more specifically approximately ⅛ inch between the brake pad 152 and the rolling plane A-A. The distance D_1 is measured between the tip portions 168 of the set screws 167 and the rolling plane A-A (in embodiments that use the set screws 167) when the brake sub-system 150 is in the free state. It should be appreciated that the distance D_1 is not limited to the above recited range in all embodiments and can be a distance outside of the recited range in certain other embodiments. Specifically, the distance D_1 is adjustable by screwing the set screws 167 further into or further out of the brake pad 152.

[0053] The spring discs 169 collectively exert a spring force K that is a sufficient amount of force to maintain the distance D_1 between the tip portions 168 of the set screws 167 and the rolling plane A-A when the brake sub-system 150 is in the free state. In certain embodiments, the spring force K is between 40 lbs. and 60 lbs., more preferably between 45 lbs. and 55 lbs., and more preferably between 46 lbs. and 50 lbs. It should be appreciated that the spring force K is not limited to being within the recited ranges in all embodiments, and the spring force K can take on other numerical values by adding more of the spring discs 169, reducing the number of spring discs 169 or changing the tension of the spring discs 169. As noted above and as will be described in more detail below with reference to FIG. 25, a lanyard may be connected to the lanyard connector 153. Thus, the spring force K is greater than the weight of the lanyard that is to be attached to the lanyard connector 153, and more preferably at least two to three times the weight of the lanyard attached to the lanyard connector 153, to avoid any accidental locking or arresting of the trolley 100. Thus, the spring force K of the spring discs 169 of the resilient element 154 is sufficient to maintain a distance, such as the distance D_1, between the brake pad 152 and the rolling plane A-A taking into account any components, such as a lanyard, that are normally connected to the trolley 100.

[0054] Regardless of the specific numerical value of the spring force K of the spring discs 169 of the resilient element 154, the fully assembled trolley 100 will remain fully assembled during use of the trolley 100. Specifically, the spring discs 169 will urge the brake sub-system 150 upwardly relative to the body 120 of the trolley 100. However, the brake sub-system 150 is prevented from excessive upward movement because at a certain point the top surface 165 of the brake pad 152 will contact an upper shoulder 172 of the first slot 170 of the body 120 and the second flange 156 of the brake sub-system 150 will contact the third collar 128 of the body 120. Thus, the brake pad 152 can only move between the upper shoulder 172 and a lower shoulder 173 of the first slot 170 and the second flange 156 can only move between the second collar 127 and the third collar 128. Thus, all of the components of the trolley 100 maintain their general relative positioning when the brake sub-system 150 is slidably coupled to the body 120.

[0055] As noted above, the brake sub-system 150 is alterable between a free state and an arrest state. In the free state, the brake pad 152 is spaced the distance D_1 above the rolling plane A-A. In the arrest state, at least a portion of the brake pad 152 is located within the rolling plane A-A. In certain embodiments, the portion of the brake pad 152 that is located within the rolling plane A-A in the arrest state is the tip portions 168 of the set screws 167. The brake sub-system 150 is biased in the free state by the resilient element 154 urging the first flange 155 upwardly and is altered from the free state to the arrest state upon a downward vertical force F_1 being applied to the lanyard connector 153 while vertical movement of the trolley 100 is prohibited. Of course, it should be appreciated that the downward vertical force F_1 required to transition the brake sub-system 150 from the free state to the arrest state is greater than any force exerted on the brake sub-system 150 by a lanyard attached to the lanyard connector 153. Transitioning of the brake sub-system 150 from the free state to the arrest state will be discussed in more detail below with particular reference to FIGS. 7-11.

[0056] Referring to FIGS. 4-11, a fall arrest system 500 that comprises the anchor trolley 100 will be described. The fall arrest system 500 comprises the trolley 100 described above and a rail 200. Common components of the trolley 100 that have been described above with reference to FIGS. 15-17 are provided with the same reference numerals in FIGS. 18-25 to indicate relative positioning of the components, but are not described in detail with particular reference to FIGS. 18-25 to avoid redun-

dancy in the description. It should be understood that the description of construction, arrangement and operation of the components of the trolley 100 from FIGS. 1-3 is equally applicable to FIGS. 4-11 even when such description is not repeated.

[0057] Referring first to FIGS. 4-6, in the exemplified embodiment the rail 200 is a rigid structure that extends along a longitudinal axis G-G. The rail 200 may be formed of any strong material, such as stainless or carbon steel or other metallic materials. The rail 200 is formed of a material with sufficient strength to support the weight of a worker. The rail 200 comprises a floor 201, a pair of angularly oriented sidewalls 210, 211 extending upwardly from the floor 201, a pair of vertical sidewalls 212, 213 extending upwardly from the pair of angularly oriented sidewalls 210, 211 and a roof 214 positioned opposite the floor 201 and extending between the pair of vertical sidewalls 212, 213.

[0058] The rail 200 further comprises a longitudinal slot 202 that separates the floor 201 into a first longitudinal section 203 and a second longitudinal section 204. The roof 214, opposing vertical and angularly oriented sidewalls 210-213 and the first and second longitudinal sections 203, 204 of the floor 201 define a cavity 205. When the trolley 100 is positioned within the rail 200, the wheels 101A-D of the trolley 100 are located within the cavity 205, and specifically in contact with the first and second longitudinal sections 203, 204 of the floor 201.

[0059] It should be understood that the rail 200 having the enclosed configuration illustrated in the exemplified embodiment is not limiting of the invention in all embodiments. Thus, in certain other embodiments the first and second longitudinal sections 203, 204 of the floor 201 can be formed by separate I-beams or L-beams that collectively define the floor 201. Thus, each of the I-or L-beams may contain one of the wheels of each pair of wheels. Moreover, in still other embodiments the rail 200 may merely omit the roof 214 or sidewalls 210-213 so that the rail 200 is not enclosed. Thus, the invention is not to be limited by the particular structural illustration of the rail provided herein in all embodiments and the rail may take on other shapes, structures or configurations in certain other embodiments.

[0060] The first and second longitudinal sections 203, 204 of the floor 201 comprise an upper surface 206 upon which the bottoms of the plurality of wheels 101A-D are in rolling contact. Thus, the upper surface 206 of the first and second longitudinal sections 203, 204 of the floor 201 of the rail 200 lies substantially along the rolling plane A-A formed by the bottoms of the wheels 101A-D. In the exemplified embodiment, the upper surface 206 of the first and second longitudinal sections 203, 204 of the floor 201 is a substantially flat surface. However, the invention is not to be so limited in all embodiments and the upper surface 206 of the first and second longitudinal sections 203, 204 of the floor 201 can be oriented at any of various angles with the wheels 101A-D similarly angled for smooth rolling contact therewith.

[0061] When the trolley 100 is positioned within the rail 200, the first portion 130 of the body 120 of the trolley 100 is positioned above the first and second longitudinal sections 203, 204 of the floor 201 and within the cavity 205 and the second portion 131 of the body 120 of the trolley 100 is located below the first and second longitudinal sections 203, 204 of the floor 201. Furthermore, the body 120 and the brake rod 151 extend through the longitudinal slot 202 in the floor 201 and the rollers 103A, 103B are located within the longitudinal slot 202. The brake pad 152 and first flange 155 of the brake sub-system 150 are positioned above the first and second longitudinal sections 203, 204 while the second flange 156 of the brake sub-system 150 and the second and third collars 127, 128 of the body 120 are positioned below the first and second longitudinal sections 203, 204. The lanyard connector 153 is connected to a bottom end of the brake rod 151 and is also positioned below the first and second longitudinal sections 203, 204.

[0062] The rollers 103A, 103B have a diameter that is slightly smaller than the width of the longitudinal slot 202 so that the rollers 103A, 103B can be centered within the longitudinal slot 202 without contacting edges 207 of the longitudinal slot 202 during normal movement of the trolley 100 along the rail 200. Thus, the rollers 103A, 103B maintain alignment of the trolley 100 on the rail 200 and roll against the edges 207 of the longitudinal slot 202 as necessary to maintain said alignment. Furthermore, the rollers 103A, 103B ensure that portions of the body 120 that extend through the longitudinal slot 202 do not engage or bind on the edges 207 of the longitudinal slot 202 when the trolley 100 moves along the rail 200.

[0063] Referring now to FIGS. 4, 7 and 8 concurrently, the fall arrest system 500 will be described with the trolley 100 positioned within the rail 200 in the free state. When the trolley 100 is positioned in the rail 200 such that the wheels 101A-D are in rolling engagement with the upper surfaces 206 of the first and second longitudinal sections 203, 204 of the floor 201 and there is no downward vertical force F_1 being applied to the lanyard connector 153, the resilient element 154 biases the brake sub-system 150 into the free state such that the brake pad 152 is spaced above the upper surfaces 206 of the first and second longitudinal sections 203, 204 of the rail 200. More specifically, in the free state the tip portions 168 of the set screws 167 that protrude from the bottom surface 164 of the brake pad 152 are spaced a distance D_2 from the upper surface 206 of the first and second longitudinal sections 203, 204 of the floor 201. This relative positioning of the components of the brake sub-system 150 relative to the rail 200 enables rolling movement of the trolley 100 along the rail 200. Because the upper surface 206 of the first and second longitudinal sections 203, 204 of the floor 201 is positioned along the same plane as the rolling plane A-A described herein above, the distance D_2 is substantially similar to the distance D_1.

[0064] When the trolley 100 is positioned within the rail 200 such that the brake sub-system 150 is in the free

state, the resilient element 154 is biased so that a gap G_1 exists between the first flange 155 of the brake sub-system 150 and the first collar 126 of the body 120 of the trolley 100. As will be discussed below, the size of the gap between the first flange 155 of the brake sub-system 150 and the first collar 126 of the body 120 of the trolley 100 is greater when the brake sub-system 150 is in the free state than when the brake sub-system 150 is in the arrest state.

[0065] As described above, the brake sub-system 150 is received within the body 120 of the trolley 100 such that the brake sub-system 150 is able to slide upwardly and downwardly along the direction of the brake axis B-B. In order to facilitate such sliding movement, a first annular gap 181 exists between the brake sub-system 150 and the first collar 126, a second annular gap 182 exists between the brake sub-system 150 and the second collar 127, and a third annular gap 183 exists between the brake sub-system 150 and the third collar 128. The first, second and third annular gaps 181-183 create an annular space between the brake sub-system 150 and the components that are integrally formed with or welded to the body 120 of the trolley 100 to facilitate the transition of the brake sub-system 150 from the free state to the arrest state.

[0066] Referring now to FIGS. 9 and 10 concurrently, the fall arrest system 500 will be described with the trolley 100 positioned within the rail 200 in the arrest state. Figures 23 and 24 illustrate the trolley 100, and more particularly the brake sub-system 150 of the trolley 100, when a downward vertical force F_1 is being applied to the lanyard connector 153. As described above, the downward vertical force F_1 is a force that has sufficient strength to overcome the bias of the resilient element 154. In certain embodiments, the downward vertical force F_1 is achieved when the trolley 100, and more specifically the brake sub-system 150 of the trolley 100, supports the weight of a worker who has fallen from a work surface.

[0067] When the downward vertical force F_1 is applied to the brake sub-system 150 indirectly via the lanyard connector 153, a gap G_2 exists between the first flange 155 of the brake sub-system 150 and the first collar 126 of the body 120 of the trolley. The gap G_2 is substantially equal to the width of the resilient element 154 (i.e., the combined width of the spring discs 169 in embodiments that use the plurality of spring discs 169 as the resilient element 154). The gap G_2 is smaller than the gap G_1 because when a downward vertical force F_1 is applied to the lanyard connector 153, the entire brake sub-system 150, including the brake rod 151, the brake pad 152, the first flange 155 and the second flange 156, shift downwardly relative to the body 120 of the trolley 100 in the axial direction of the brake axis B-B.

[0068] When the brake pad 152 shifts downwardly, the tip portions 168 of the set screws 167 that protrude downwardly from the bottom surface 164 of the brake plate 163 frictionally engage the upper surfaces 206 of the first and second longitudinal sections 203, 204 of the rail 200 to prohibit rolling movement of the trolley 100 along the direction of the longitudinal axis G-G of the rail 200. It should be understood that in certain embodiments the set screws 167 form a part of the brake pad 152 such that it is the brake pad 152 that frictionally engages the upper surfaces 206 of the first and second longitudinal sections 203, 204 of the rail 200 to prohibit rolling movement of the trolley 100 along the rail 200. Furthermore, in still other embodiments the set screws 167 may be altogether omitted such that the bottom surface 164 of the brake pad 152 or some other component protruding from the bottom surface 164 of the brake pad 152 frictionally engages the upper surfaces 206 of the first and second longitudinal sections 203, 204 of the rail 200 to prohibit rolling movement of the trolley 100 along the rail 200.

[0069] Due to the relatively small nature of the distance D_2 between the brake pad 152 (or the tip portions 168 of the set screws 168 that protrude from the bottom surface 164 of the brake plate 163 of the brake pad 152) and the upper surfaces 206 of the first and second longitudinal sections 203, 204 of the rail 200, transitioning from the free state to the arrest state occurs essentially immediately upon the downward vertical force F_1 acting on the lanyard connector 153. Thus, in use, when a worker falls from a work surface, the brake sub-system 150 essentially immediately transitions from the free state to the arrest state to prohibit rolling longitudinal movement (along the longitudinal axis G-G of the rail 200) of the trolley 100. As a result, a worker who falls from a work surface will remain in near enough proximity to the work surface to be able to pull him or herself back onto the work surface after a fall. This quick arrest action of the brake sub-assembly 150 negates the need for a third party to rescue a fallen worker and removes any likelihood that the worker will suffer orthostatic intolerance due to hanging from the rail 200 and trolley 100 for an extended period of time.

[0070] Turning now to FIG. 11, the fall arrest system 500 is illustrated with a worker 301 standing on a work surface 304 and connected to the lanyard connector 153 of the trolley 100 by a lanyard 302. The worker 301 has a harness 303 secured onto his body to support his body should he fall from the work surface 304. The lanyard 302 is connected to (or integrally formed with) and extends from the harness 303 to its connection point with the lanyard connector 153.

[0071] The lanyard 303 can be coupled to the lanyard connector 153 by any desired method, such as by tying the lanyard 303 directly to the eye 160 of the lanyard connector 153 or attaching the lanyard 303 to the lanyard connector 153 indirectly via another component. In the exemplified embodiment, the lanyard 303 is connected directly to the lanyard connector 153 and the lanyard 303 can not be extended in length, but rather remains taut, or nearly taut with a small amount of slack, while the worker 301 is positioned on the work surface 304. Maintaining the lanyard 303 in this manner ensures that upon a fall, the brake sub-system 150 will expeditiously tran-

sition from the free state into the arrest state so that momentum will not carry the worker 301 a distance from the work surface 304. Rather, the fast action of the brake sub-system 150 will lock the trolley 100 in place on the rail 200 while the worker 301 is close enough to the work surface 304 to pull himself back onto the work surface 304 after a fall. Of course, the invention is not limited to the lanyard 303 being taut and non-extendable in all embodiments and in certain embodiments, the lanyard 303 is connected to the lanyard connector 153 by a retractor such that the lanyard 303 can be extended or shortened as needed. The retractor may be self-retracting or otherwise.

[0072] As was described above, the spring force K of the resilient element 154 (not illustrated in FIG. 11) is sufficiently strong to maintain the brake sub-system 150 of the trolley 100 in the free state even when the lanyard 302 is connected to the lanyard connector 153. Thus, the spring force K of the resilient element 154 is greater than the weight of the lanyard 302 (and the sall amount of weight exerted by the brake system). As a result, while the worker 301 is positioned on the work surface 304 and connected to the fall arrest trolley 100 of the fall arrest system 500 by the lanyard 302, the trolley 100 will move longitudinally along the rail 200 in a corresponding manner with the movement of the worker 301 along the work surface 304. However, immediately upon the worker 301 falling from the work surface 304 or otherwise initiating a downward vertical force on the lanyard connector 153, the brake sub-system 150 of the trolley 100 will transition from the free state to the arrest state as has been described in detail herein. Specifically, upon the worker 301 falling from an edge of the work surface 304, the worker's weight exerts a downward vertical force F_1 on the lanyard connector 153. The downward vertical force F_1 overcomes the spring force K of the resilient member and alters the brake sub-system 150 into the arrest state in which the brake pad 154 frictionally engages the upper surface 206 of the first and second longitudinal sections 203, 204 of the rail 200 to prohibit further rolling of the trolley 100 along the rail 200 as has been described in detail herein above.

[0073] In certain embodiments, the worker 301 need not even pull himself back onto the work surface 304 after a fall therefrom. Rather, in certain embodiments, upon the worker 301 falling from an edge of the work surface 304, the fall arrest trolley 100 acts as an anchor point that returns the user back to the work surface 304 via a pendulum motion of the lanyard 302. Thus, the worker 301 may fall from the work surface 304, and the trolley 100 immediately locks into the arrest state against the rail 200. As the trolley 100 locks into the arrest state, the momentum of the worker 301 will create a pendulum motion on the lanyard 302, which will swing away from and then back towards the work surface 304, thereby returning the worker 301 to the work surface 304.

[0074] FIGS. 12-17 illustrate alternative embodiment of a fall arrest anchor trolley 100i. The anchor trolley 100i is similar to anchor trolley 100 described above and depicted in FIGS. 15-25 having substantially many of the same components. Thus, for brevity, only the structural or other components of anchor trolley 100i that are different than the anchor trolley 100 will be discussed herein below with the understanding that the description above with regard to FIGS. 1-11 applies to all other structural components identified in FIGS. 12-17. Furthermore, the components of the anchor trolley 100i have been assigned the same reference numerals as similar components from anchor trolley 100 except that the suffix "i" will be added to connote that the components are part of anchor trolley 100i shown in FIGS. 26-31. It will be understood that features that are not described below are the same as its similarly numbered feature described above.

[0075] Referring to FIGS. 12-15, anchor trolley 100i includes a cap 300 which is added to protect the first flange 155i and particularly resilient spring discs 169i from the ingress of elements, dirt, and debris that might adversely effect full deformation of the spring discs and proper operation of the brake system. Cap 300 defines a socket 301 configured for receiving first flange 155i and spring discs 169i therein as best shown in FIG. 13. Cap 300 may be made of any suitable metallic or non-metallic material.

[0076] Anchor trolley 100i is configured to provide a more compact design which facilitates use in situations where available physical space may be more restricted. First and second stop members 104, 105 are eliminated from first and second flanges 125Ai and 125Bi, respectively, as shown. In addition, the body 120i including primary plate 121i is generally more compact in design and shortened longitudinally between first and second flanges 125Ai and 125Bi. To help facilitate this, rollers 103Ai and 103Bi are moved at least partially inboard of the wheels 101Ai-Di, as best shown in FIG. 27. In one embodiment, the outermost extremities of rollers 103Ai and 103Bi fall on approximately the same vertical plane defined parallel to brake axis B-B as the outermost extremities of wheels 101Ai-Di. Anchor trolley 100i further eliminates second flange 156 from sleeve 157 shown in FIG. 2 of the previous embodiment such that new sleeve 157i no longer includes a second flange. This further contributes to the compact design of anchor trolley 100i and reduces weight and component costs.

[0077] Referring to FIGS. 12-15 and 16-17, a new brake plate 302 is provided in anchor trolley 100i which advantageously increases the applied braking force when the brake sub-system 150 is activated to the arrest state as previously described herein. In one preferred embodiment, brake plate 302 includes eight (8) set screws 167i to double the braking force in contrast to the embodiment shown in FIGS. 15 and 16. To produce this benefit, brake plate 302 has a generally H-shaped body 304 as best shown in FIG. 31. Brake plate 302 includes a top surface 314, bottom surface 316, first end 308, opposing end 310, and opposing lateral sides 312 extend-

ing longitudinally between the ends. In one embodiment, lateral sides 312 may be arranged in substantially parallel relationship. A central aperture 306 is provided which slidably receives brake rod 151i through the aperture as shown in FIG. 13.

[0078] With continuing reference to FIGS. 12-13 and 16-17, brake plate 302 includes a plurality of set screws 167i which are threadly engaged through mating threaded holes in the brake plate. In one preferred embodiment, eight set screws 167i are provided which are comprised of four pairs of screws disposed near each corner of the brake plate 302. It will be appreciated that any suitable arrangement or number of set screws 167i may be used. As shown in the figures, the tip portions 168i extend below brake plate 302 as best shown in FIG. 30 to frictionally engage upper surfaces of the rail to prevent or stop the trolley 100i from longitudinal movement when the brake sub-system 150 is in the arrest state similar to the arrangement of set screws 167 shown in FIGS. 1-11.

[0079] In order to provide an H-shaped body 304, a cutout 320A, 320B is provided at each end 308 and 310 respectively. The cutouts 320A, 320B slidably receive a portion of first and second flanges 125Ai, 125Bi adjacent each lateral side of first slot 170i (see, e.g. FIGS. 12-13), thereby allowing the brake plate 302 to have a longer longitudinal length for adding extra set screws 167i without sacrificing structural strength for withstanding braking forces. When the brake sub-system 150 transitions from the free state to the arrest state as described herein, the lateral portions of first and second flanges 125Ai, 125Bi adjacent each lateral side of first slot 170i will move vertically up/down within each cutouts 320A, 320B.

[0080] As used throughout, ranges are used as shorthand for describing each and every value that is within the range. Any value within the range can be selected as the terminus of the range. In addition, all references cited herein are hereby incorporated by referenced in their entireties. In the event of a conflict in a definition in the present disclosure and that of a cited reference, the present disclosure controls.

[0081] While the invention has been described with respect to specific examples including presently preferred modes of carrying out the invention, those skilled in the art will appreciate that there are numerous variations and permutations of the above described systems and techniques. It is to be understood that other embodiments may be utilized and structural and functional modifications may be made without departing from the scope of the present invention. Thus, the spirit and scope of the invention should be construed broadly as set forth in the appended claims.

Claims

1. A fall arrest trolley comprising:

a body, a brake sub-system, and a plurality of wheels rotatably coupled to the body, wherein bottoms of the plurality of wheels collectively define a rolling plane;

the brake sub-system comprising a brake rod, a brake pad connected to the brake rod, a lanyard connector connected to the brake rod, and a resilient element;

the brake rod slidably coupled to the body so that the brake sub-system is alterable between: (1) a free state in which the brake pad is spaced a distance above the rolling plane; and (2) an arrest state in which at least a portion of the brake pad is located within the rolling plane;

the resilient element biasing the brake sub-system into the free state.

2. The fall arrest trolley of claim 1 wherein the brake sub-system is altered from the free state to the arrest state upon a downward vertical force being applied to the lanyard connector while vertical movement of the fall arrest trolley is prohibited.

3. The fall arrest trolley of claim 2 further comprising a lanyard coupled to the lanyard connector, the lanyard having a weight, and wherein the resilient element has a spring force that is greater than the weight of the lanyard.

4. The fall arrest trolley of claim 2 or 3 wherein the brake rod extends along a brake axis, wherein the brake axis is oriented substantially perpendicular to the rolling plane.

5. The fall arrest trolley of claim any of claims 2-4 further comprising one or more rollers connected to the body, the one or more rollers located adjacent to and below the rolling plane, each of the one or more rollers rotatable about an axis of rotation that is oriented substantially perpendicular to the rolling plane.

6. The fall arrest trolley of any of the preceding claims wherein the brake sub-system comprises a first flange connected to the brake rod, and the body comprises a first collar through which the brake rod extends, the first collar of the body located below the first flange of the brake sub-system, the resilient element positioned between the first flange of the brake sub-system and the first collar of the body to urge the brake sub-system into the free state.

7. The fall arrest trolley of claim 6 wherein the resilient element comprises a plurality of spring discs.

8. The fall arrest trolley of claim 6 or 7 wherein the brake sub-system comprises a second flange connected to the brake rod, and the body comprises a second collar through which the brake rod extends, the second collar of the body located below the second

flange of the brake sub-system, and the second flange of the brake sub-system located below the first collar of the body.

9. The fall arrest trolley of any of the preceding claims wherein the body comprises a primary plate oriented substantially perpendicular to the rolling plane and the brake pad comprises a brake plate oriented substantially parallel to the rolling plane, the primary plate extending above and below the rolling plane.

10. The fall arrest trolley of any of the preceding claims wherein the body comprises a first stop member located at a first longitudinal end of the body and a second stop member located at a second longitudinal end of the body, and wherein the plurality of wheels are located between the first and second stop members.

11. The fall arrest trolley of any of the preceding claims wherein the lanyard connector is connected to a bottom end of the brake rod and a first flange is connected to a top end of the brake rod, the resilient element exerting an upward force on the first flange to bias the brake sub-system into the free state.

12. A fall arrest system comprising:

a rail extending along a longitudinal axis, the rail comprising a floor and a longitudinal slot separating the floor into a first longitudinal section and a second longitudinal section; and
a fall arrest trolley according to any of the preceding claims,
wherein the brake pad is positioned above the first and second longitudinal sections; and

(1) in the arrest state the brake pad frictionally engages the upper surfaces of the first and second longitudinal sections of the rail to prohibit rolling movement of the trolley along the rail; and (2)in the free state the brake pad is spaced a distance above the upper surfaces of the first and second longitudinal sections of the rail to allow rolling movement of the trolley along the rail.

13. The fall arrest system of claim 12 wherein the rail is an enclosed rail comprising a roof, two opposing sidewalls and the first and second longitudinal sections of the floor that define a cavity, the plurality of wheels located within the cavity.

14. The fall arrest system of claim 12 or 13 wherein the brake rod extends through the longitudinal slot.

15. A method of arresting a user from falling off an edge of a work surface comprising:

a) coupling a first end of a lanyard to a lanyard connector of a fall arrest trolley, the fall arrest trolley comprising a plurality of wheels in rolling contact with an upper surface of a rail extending along a longitudinal axis;
b) upon a user moving on the work surface, the fall arrest trolley rolling along the upper surface of the rail, the trolley comprising a brake sub-system comprising a brake rod, a brake pad connected to the brake rod and located above the upper surface of the rail, the lanyard connector connected to the brake rod, and a resilient element, wherein the resilient element biases the brake sub-system into a free state in which the brake pad is spaced a distance above the upper surface of the rail to allow the rolling of the trolley along the rail while the user moves on the work surface; and
c) upon the user moving off the edge of the work surface, the user's weight exerting a downward vertical force on the lanyard connector that overcomes a spring force of the resilient member and alters the brake sub-system into an arrest state in which the brake pad frictionally engages the upper surface of the rail to prohibit further rolling of the trolley along the rail.

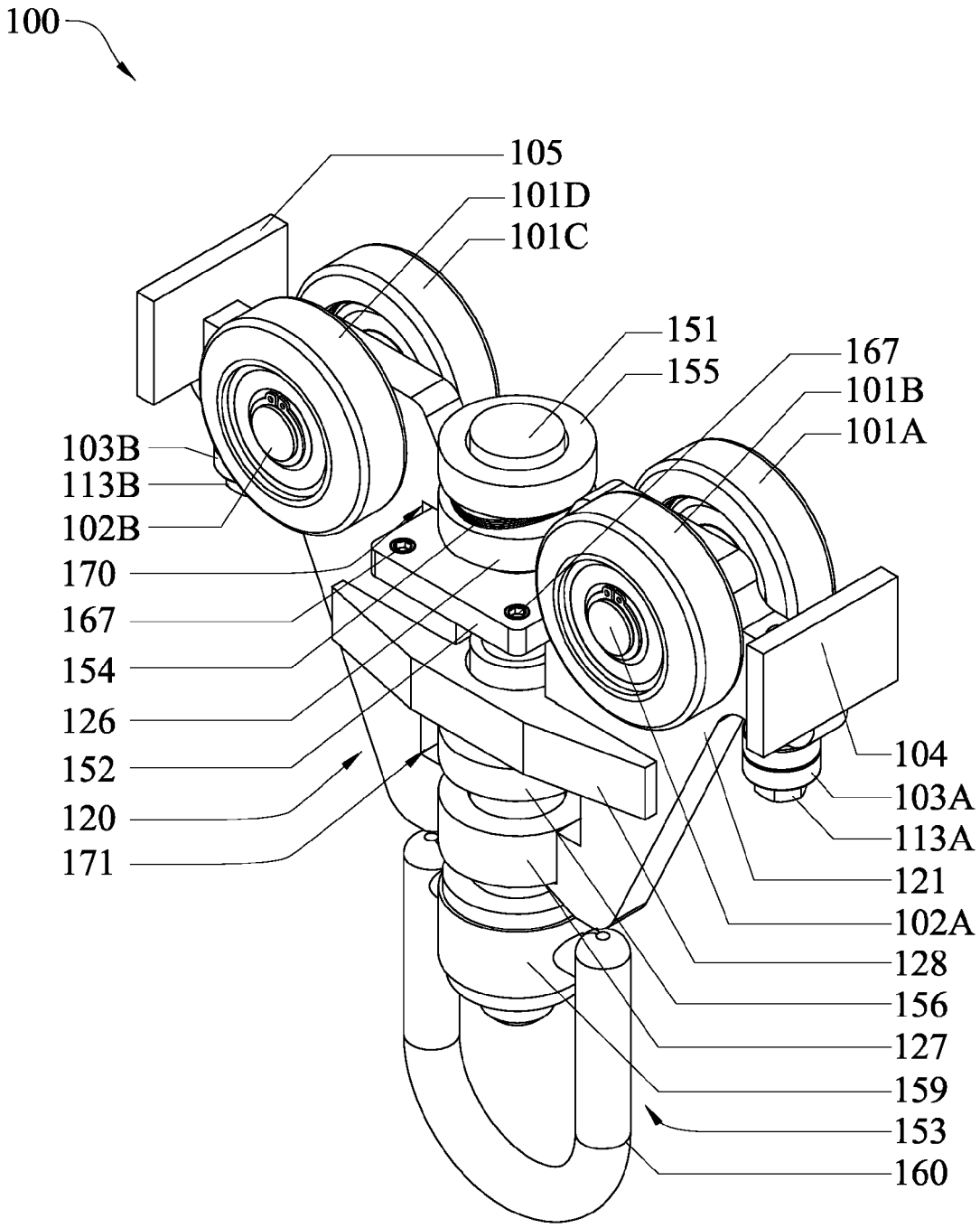
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FIG. 1

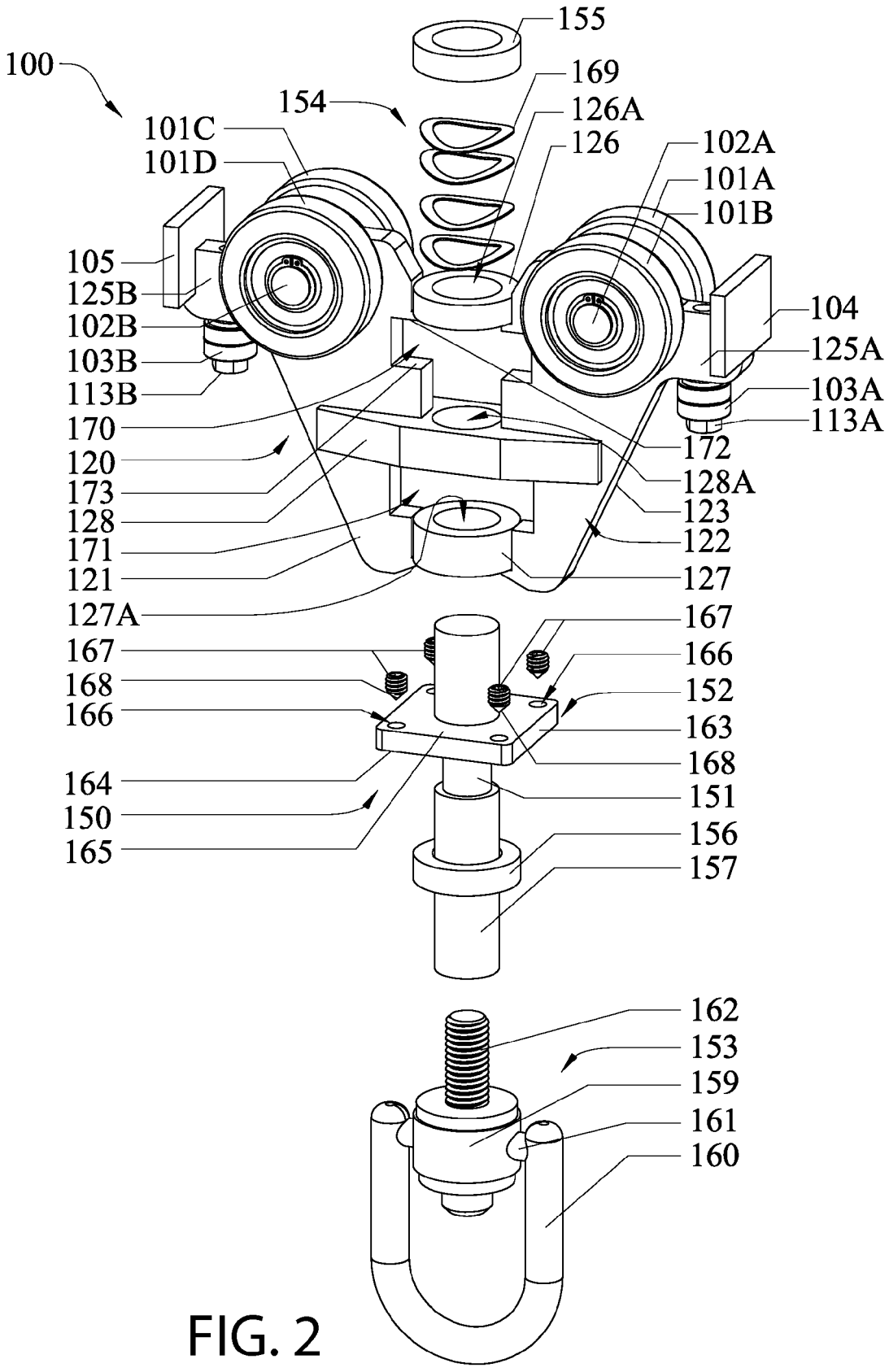
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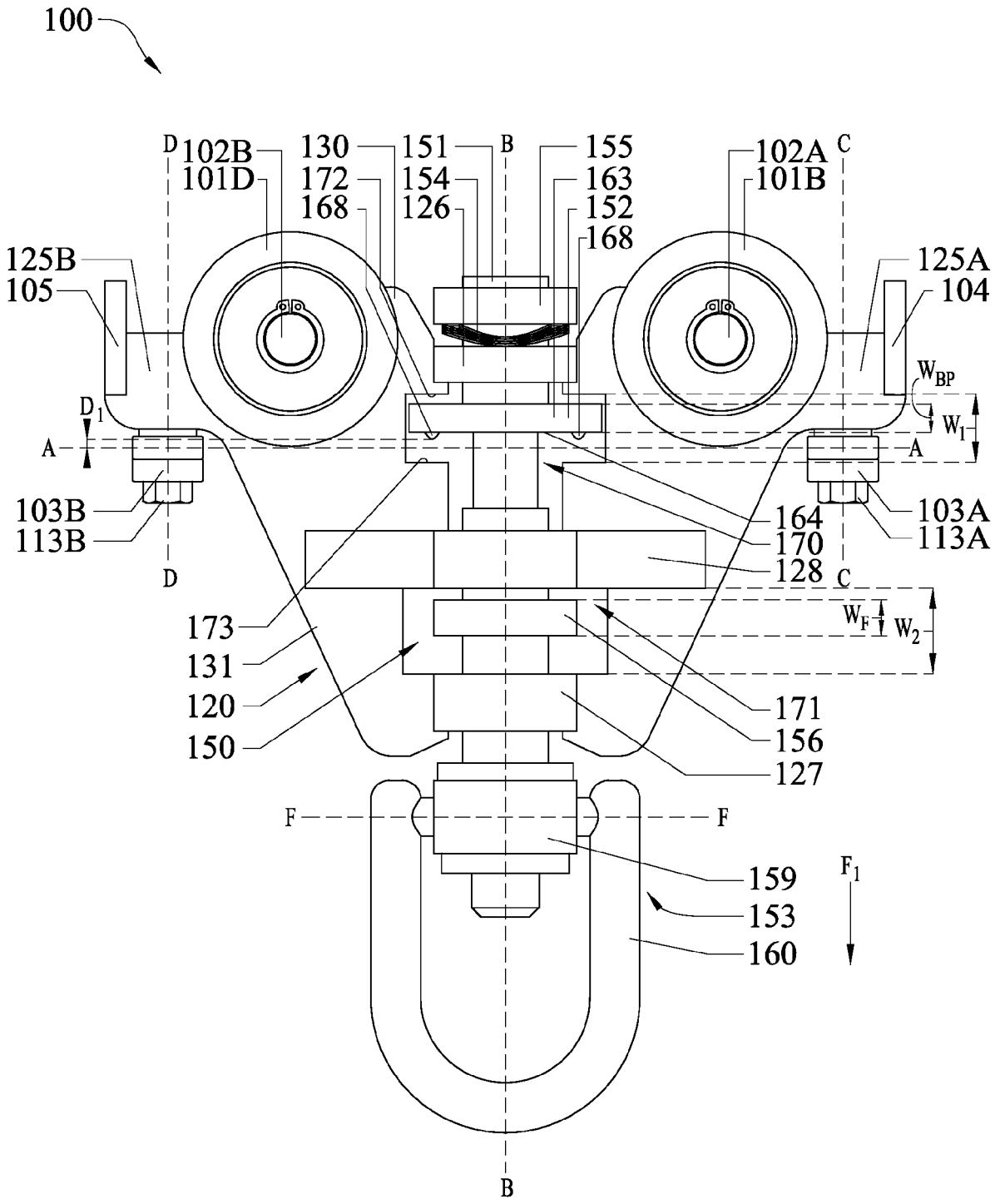
FIG. 2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125A
104
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W_1
D_1
A
A
103B
113B
164
170
128
103A
113A
D
C
173
131
120
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W_F
W_2
171
156
127
F
F
159
153
160
F_1
B

FIG. 3

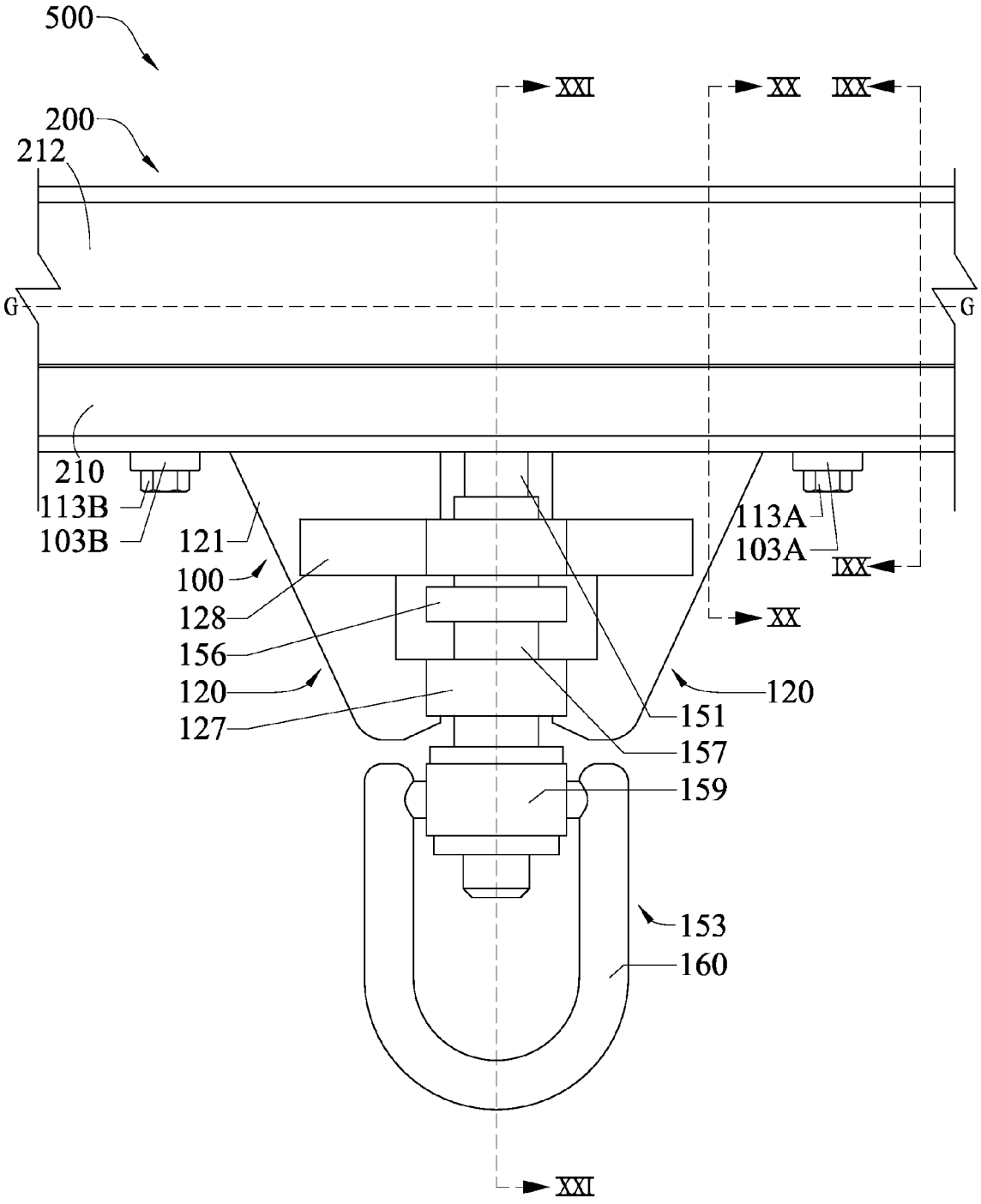
500
200
212
XXI
XX
XX
G
G
210
113B
103B
121
100
128
156
120
127
113A
103A
XX
120
151
157
159
153
160
XXI

FIG. 4

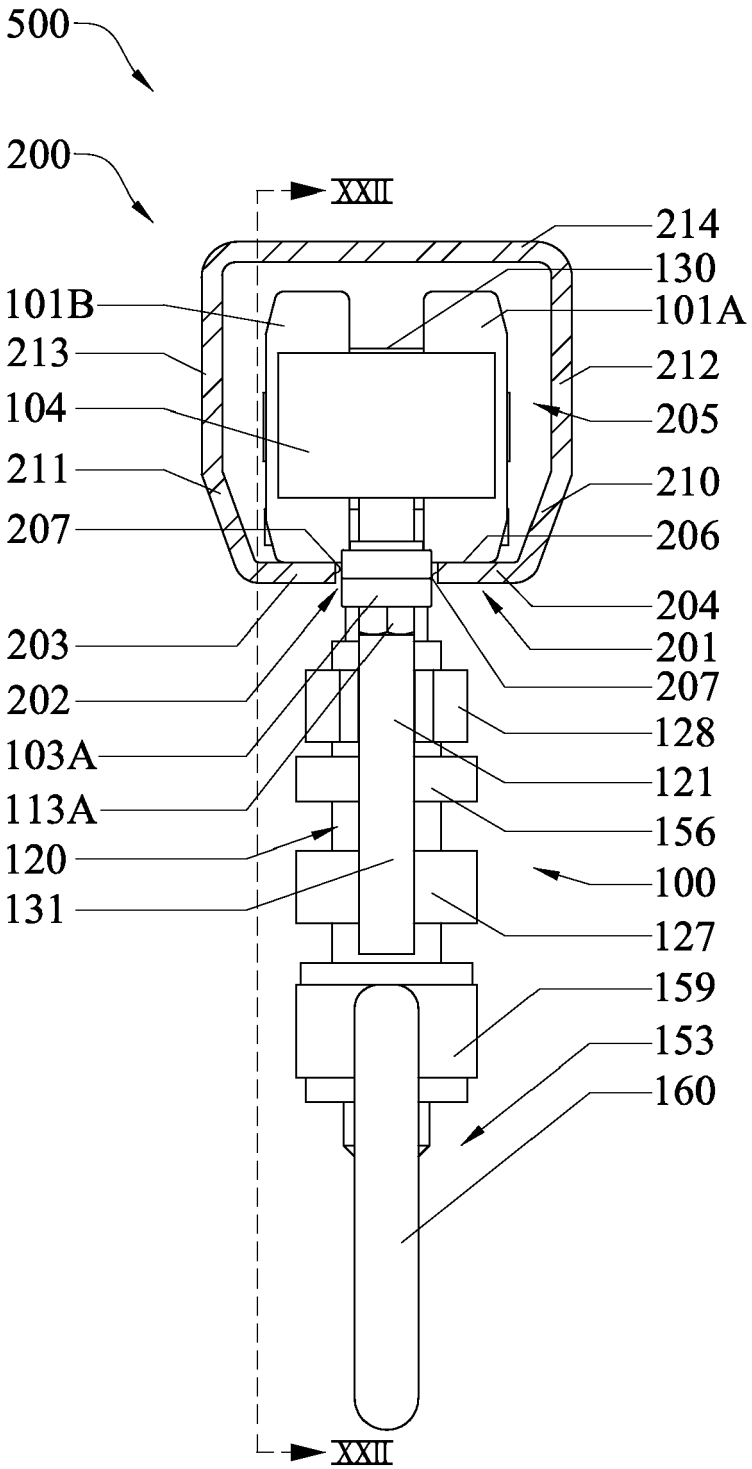
500
200
XXII
214
130
101B
101A
213
212
104
205
211
210
207
206
204
203
201
202
207
128
103A
121
113A
156
120
100
131
127
159
153
160
XXII

FIG. 5

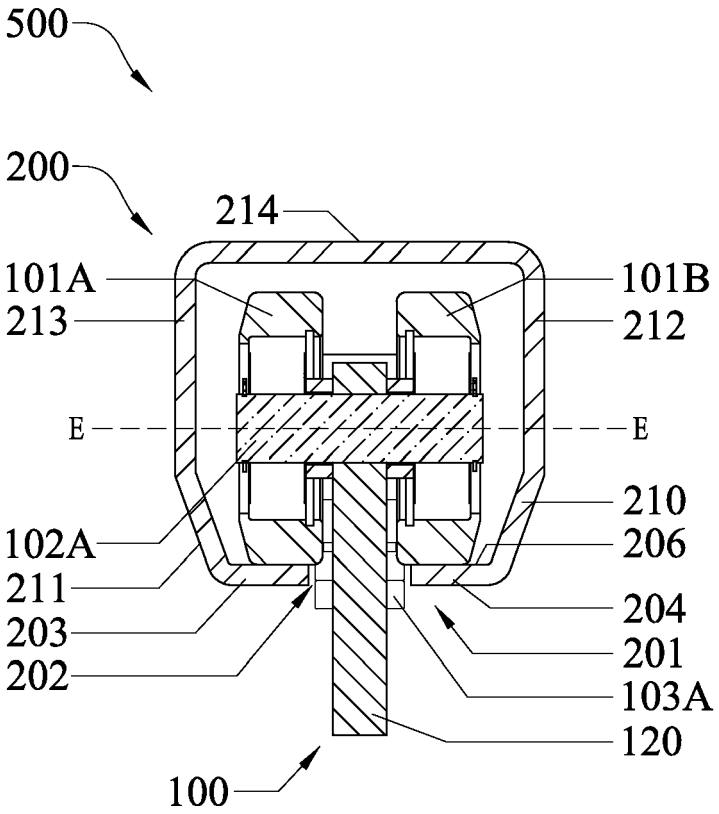
500
200
214
101A
213
101B
212
E
E
210
102A
206
211
204
203
201
202
103A
120
100

FIG. 6

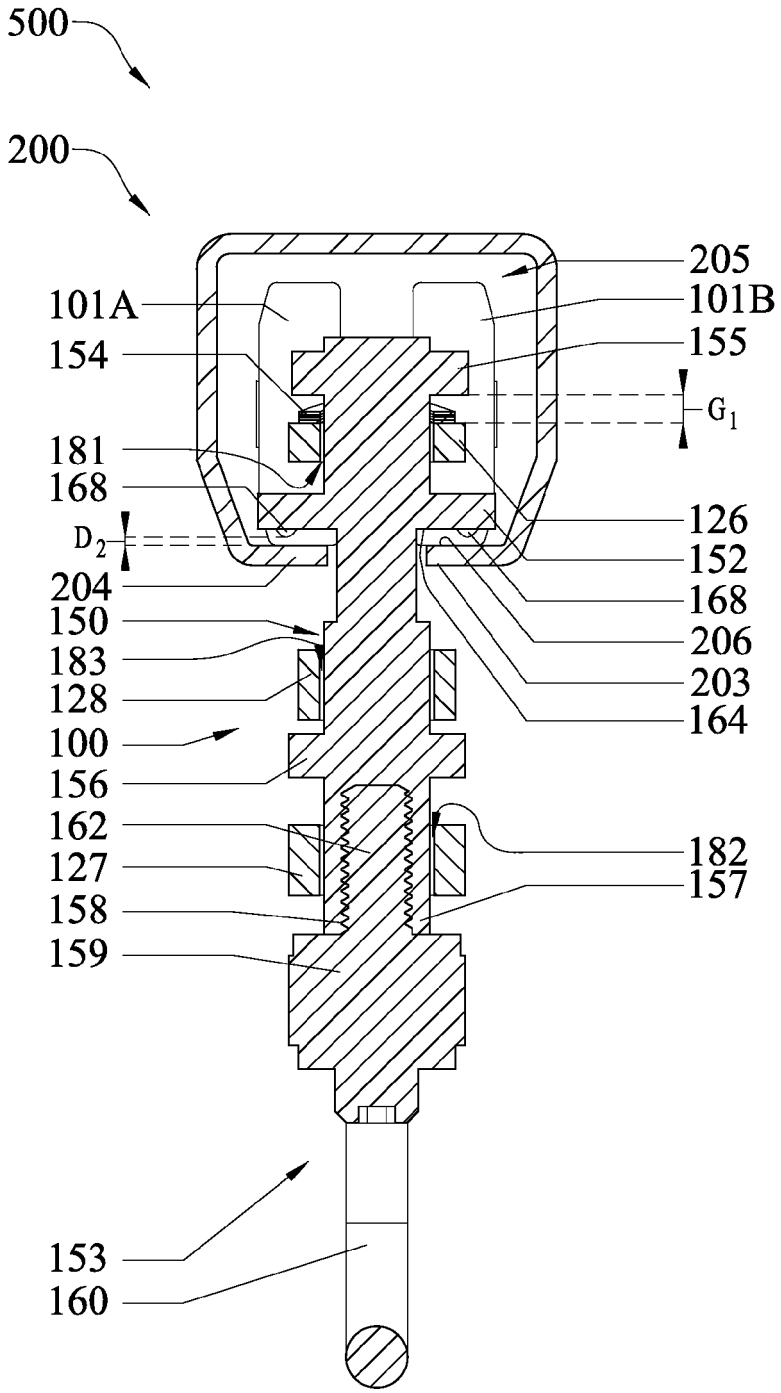
500
200
205
101A
101B
154
155
G_1
181
168
126
D_2
152
204
168
150
206
183
203
128
164
100
156
162
182
127
157
158
159
153
160

FIG. 7

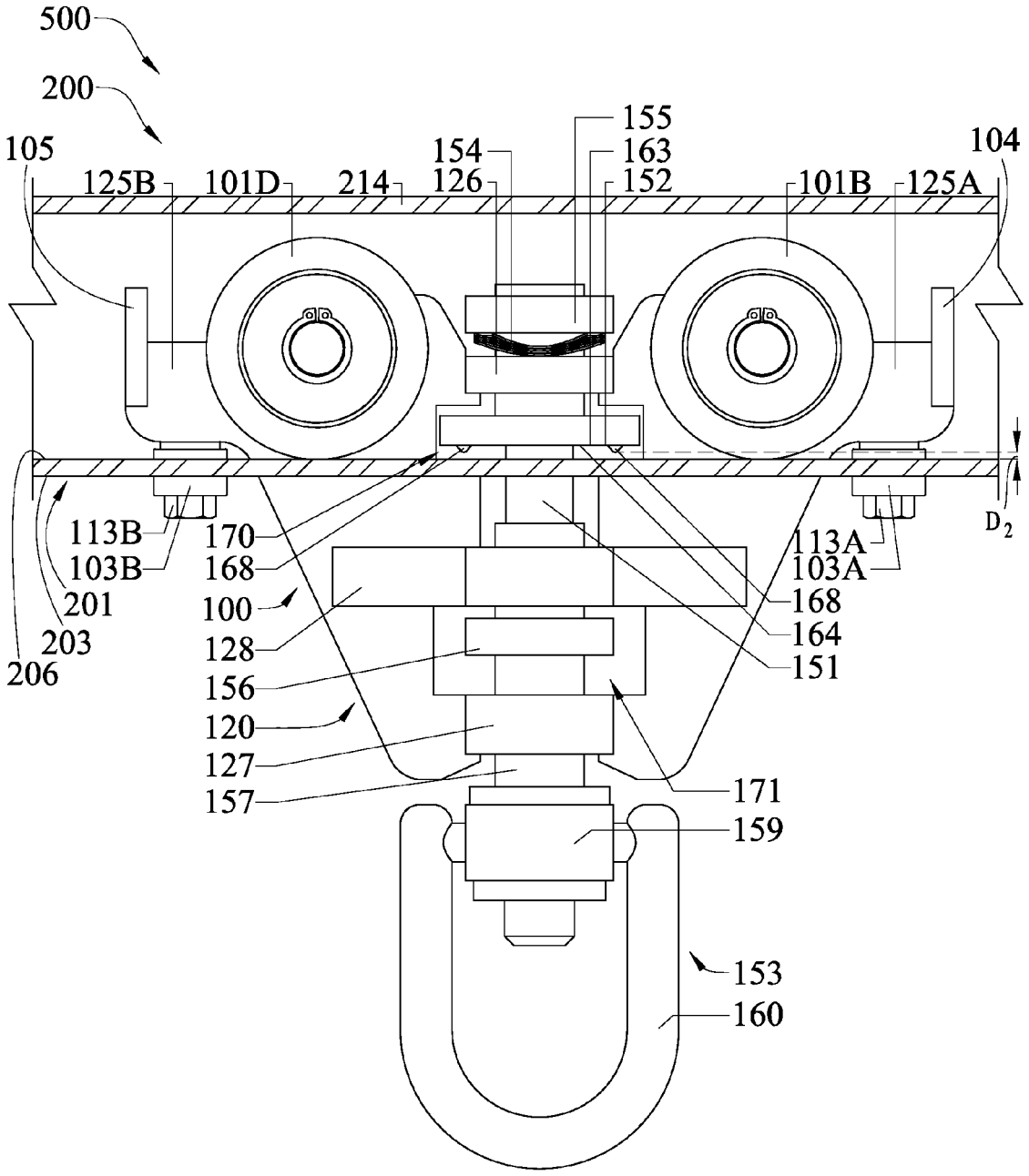
500
200
105
125B
101D
214
154
126
155
163
152
101B
125A
104
113B
103B
201
203
206
170
168
100
128
156
120
127
157
113A
103A
168
164
151
171
159
153
160
D2

FIG. 8

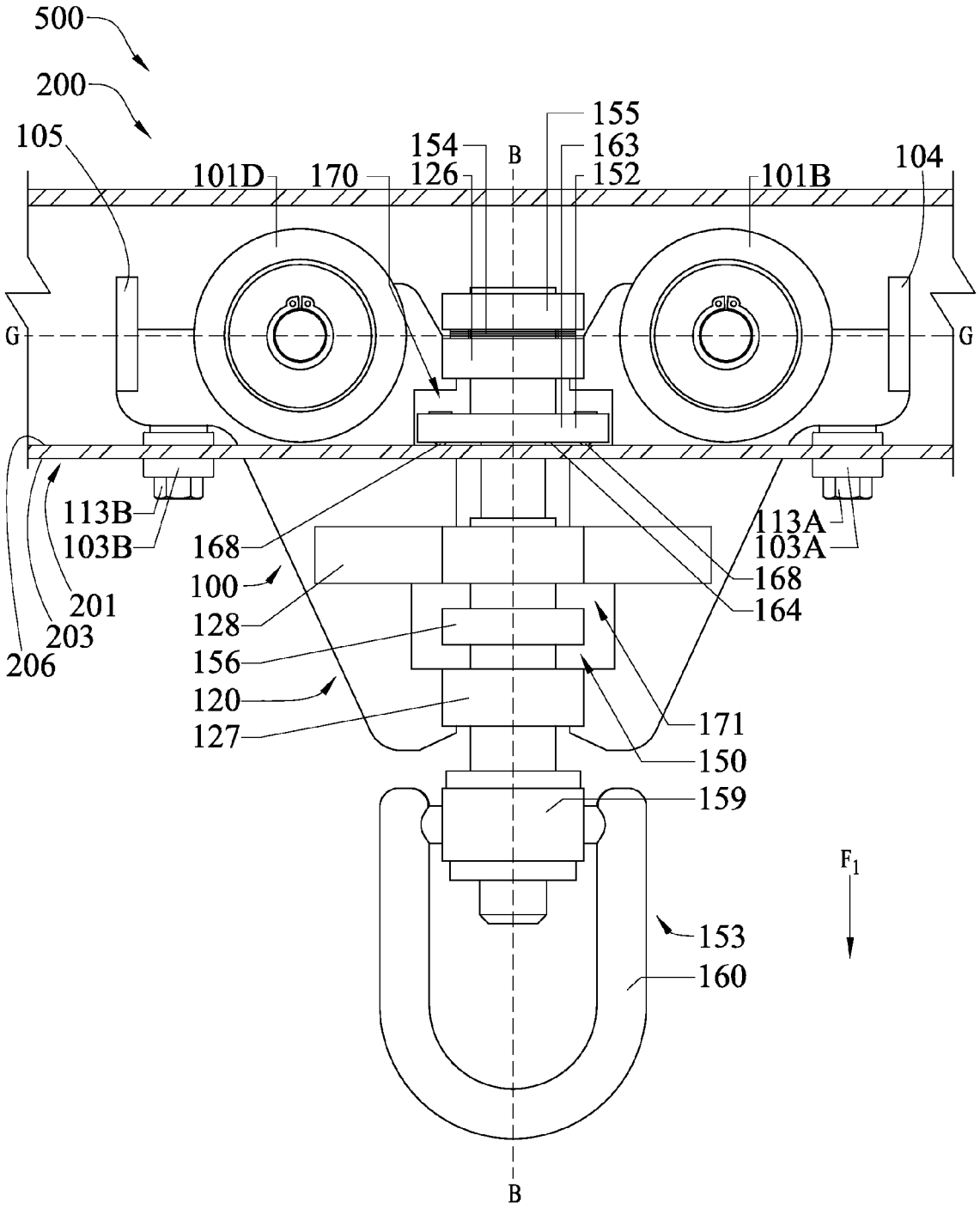
500
200
105
101D
170
154
126
B
155
163
152
101B
104
G
G
113B
103B
168
100
128
156
120
127
201
203
206
113A
103A
168
164
171
150
159
153
160
F1
B

FIG. 9

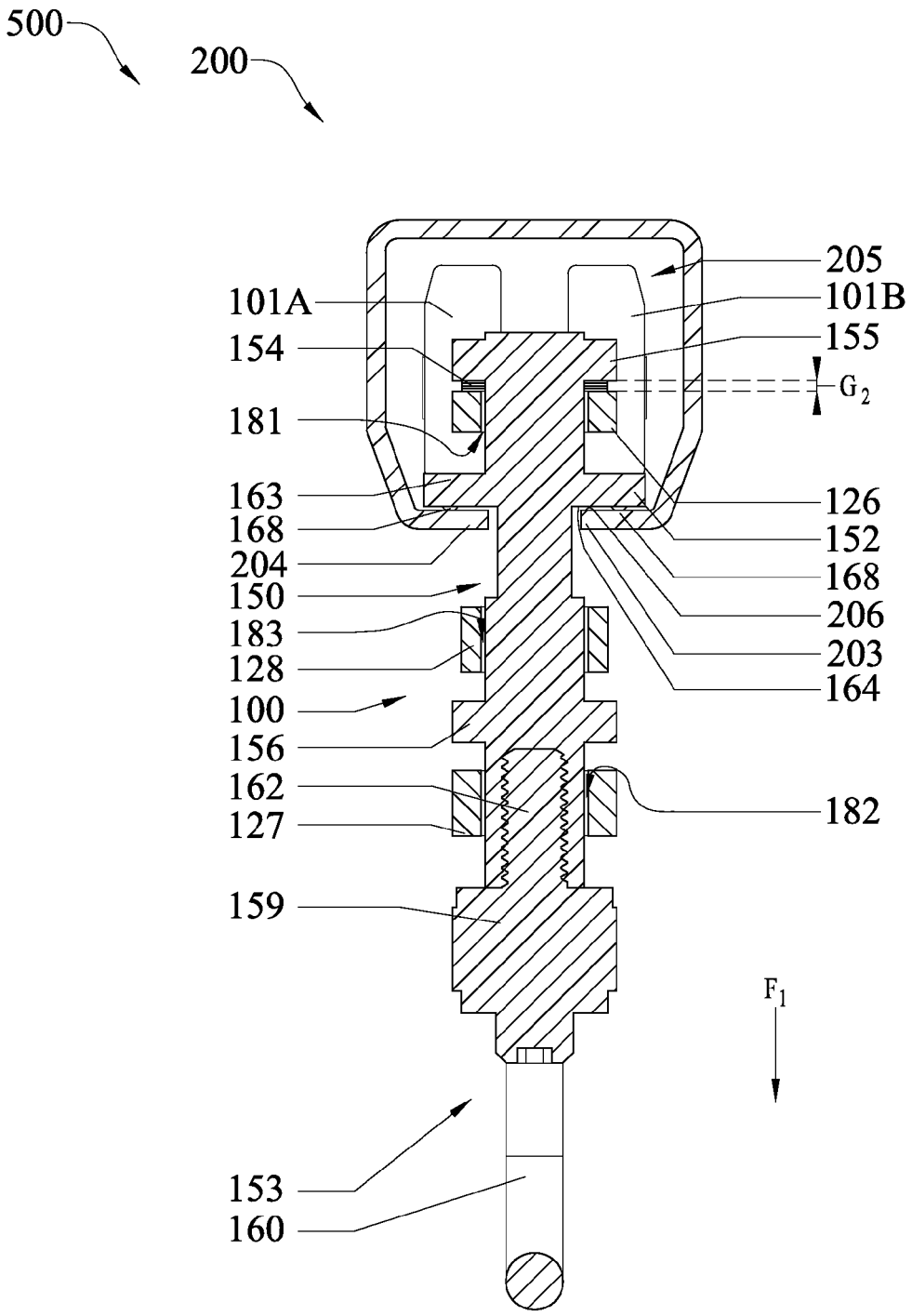
500
200
205
101A
101B
154
155
G_2
181
163
126
168
152
204
168
150
206
183
203
128
164
100
156
162
182
127
159
F_1
153
160

FIG. 10

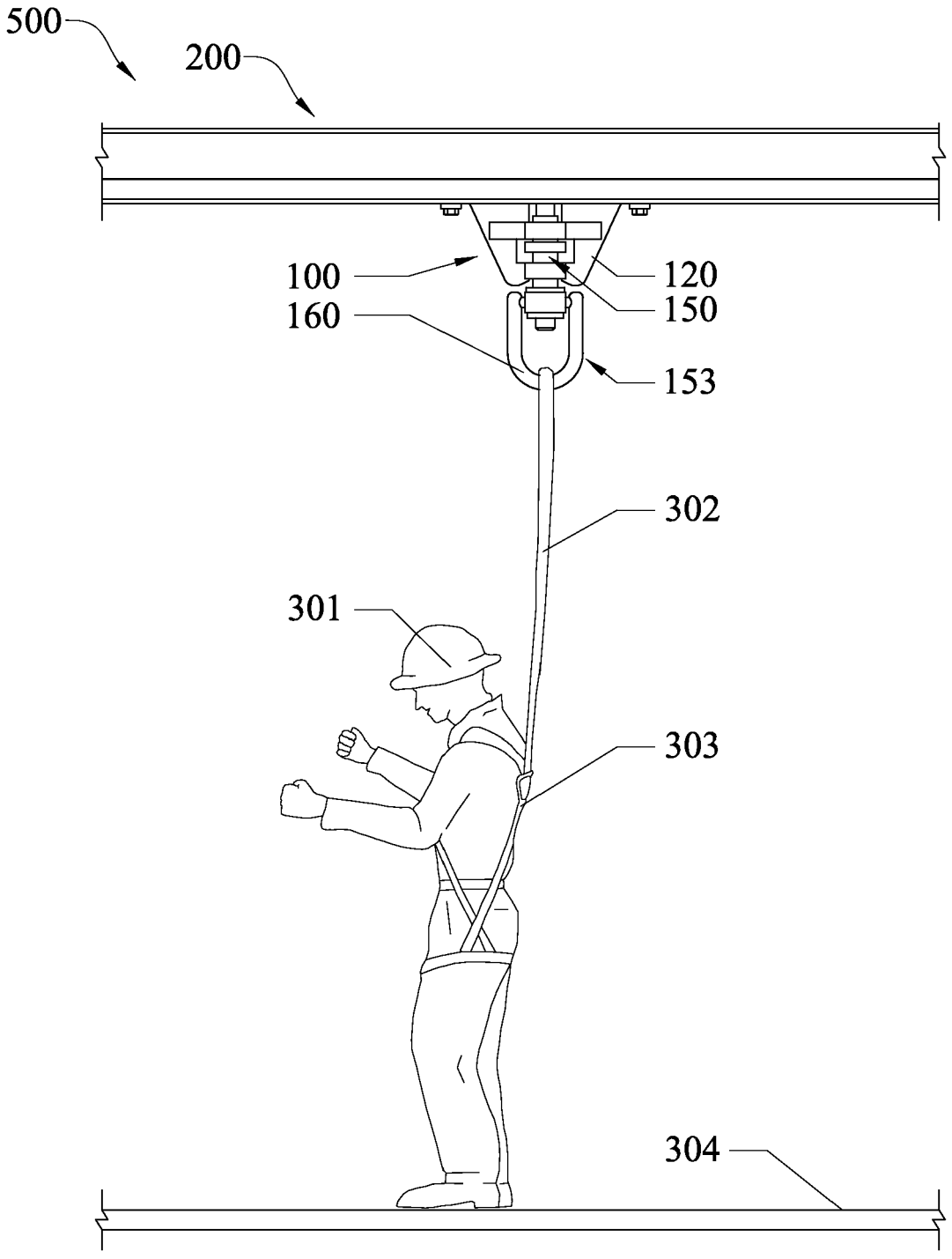

FIG. 11

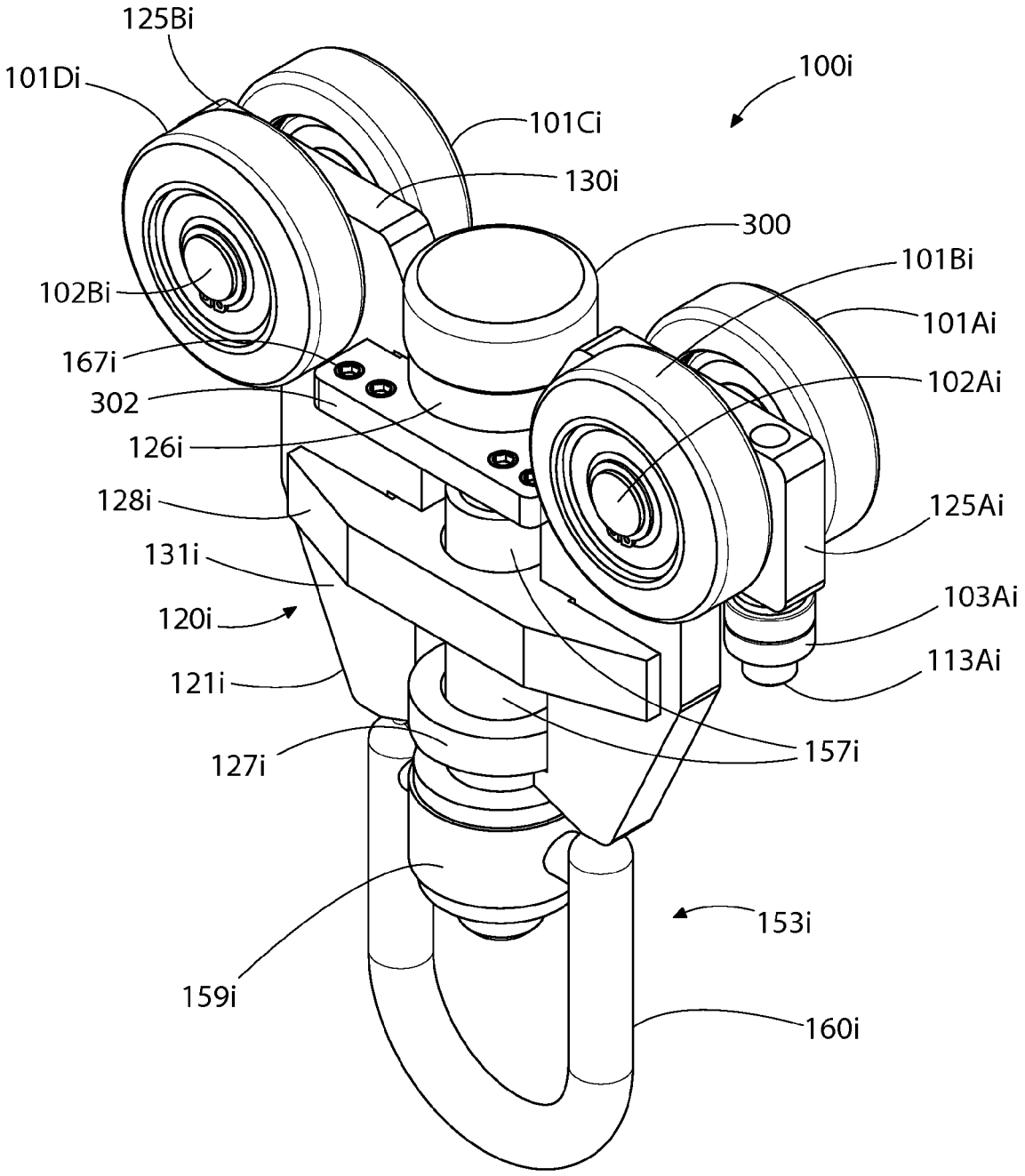
125Bi
101Di
100i
101Ci
130i
300
101Bi
102Bi
101Ai
167i
102Ai
302
126i
125Ai
128i
131i
103Ai
120i
113Ai
121i
157i
127i
153i
159i
160i

FIG. 12

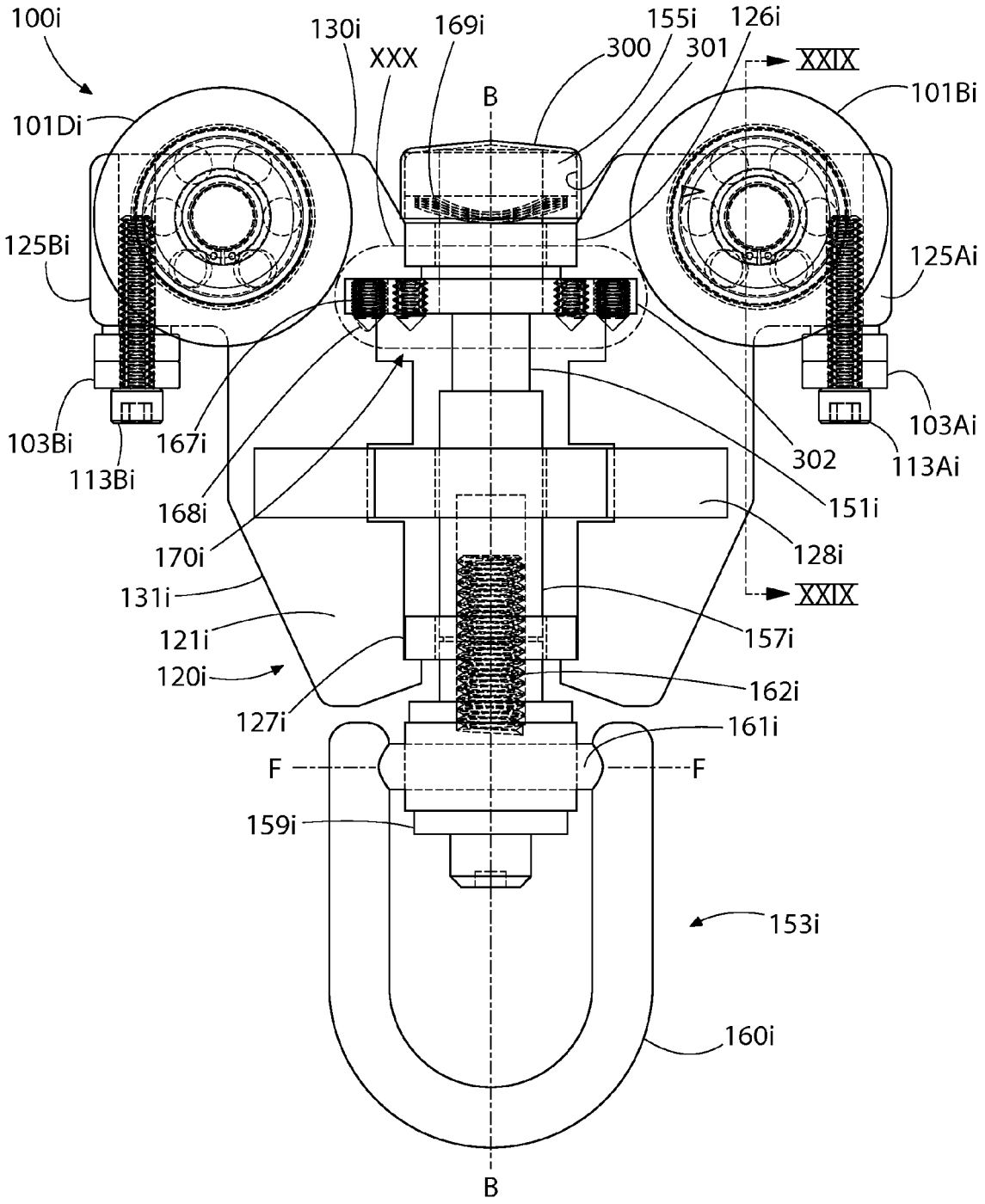
100i
130i
169i
155i
126i
300
301
XXIX
101Bi
XXX
B
101Di
125Bi
125Ai
103Ai
103Bi
167i
113Ai
302
113Bi
151i
168i
128i
170i
131i
XXIX
121i
157i
120i
162i
127i
161i
F
F
159i
153i
160i
B

FIG. 13

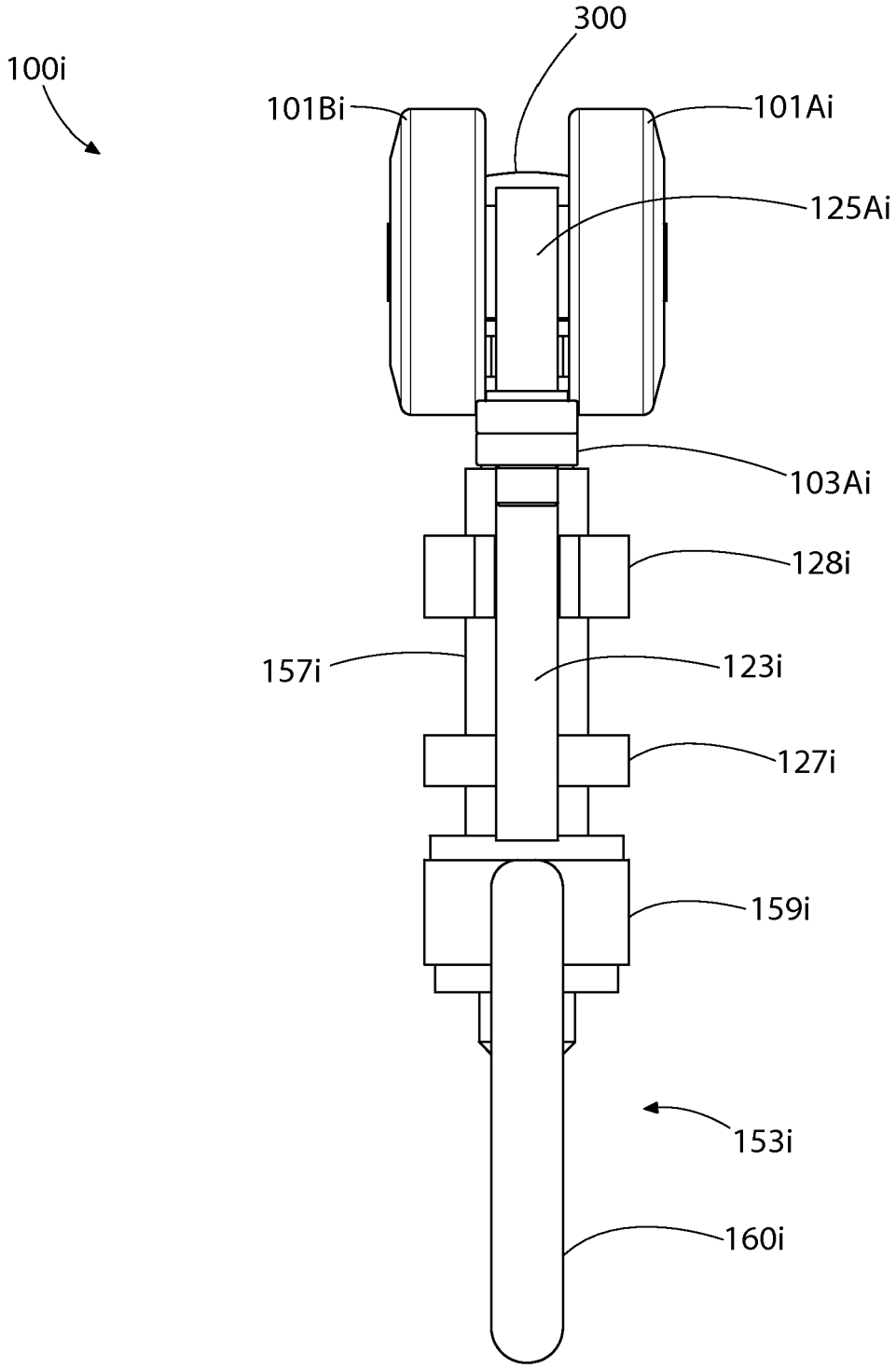
100i
300
101Bi
101Ai
125Ai
103Ai
128i
157i
123i
127i
159i
153i
160i

FIG. 14

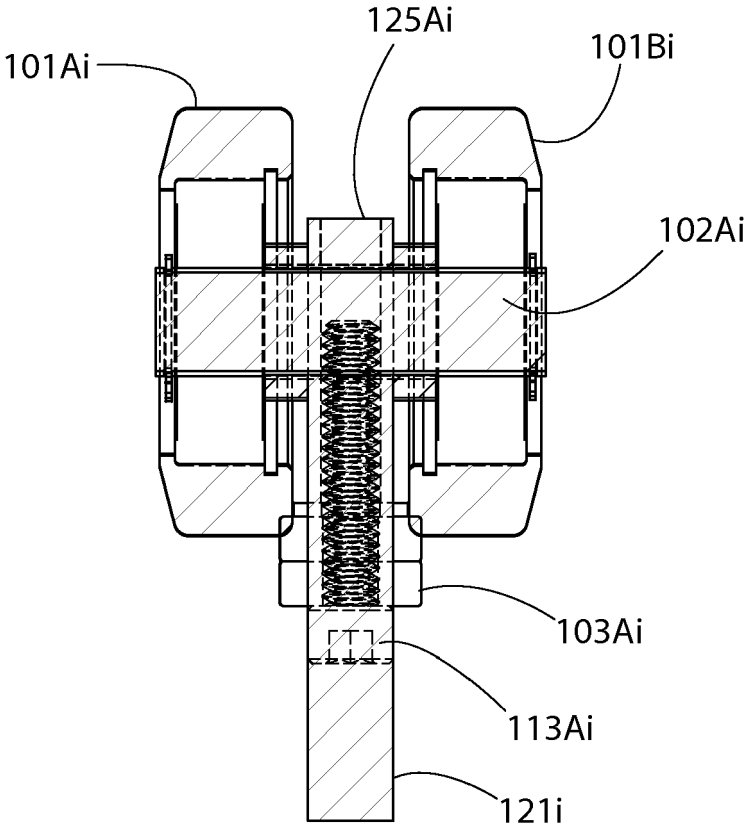

FIG. 15

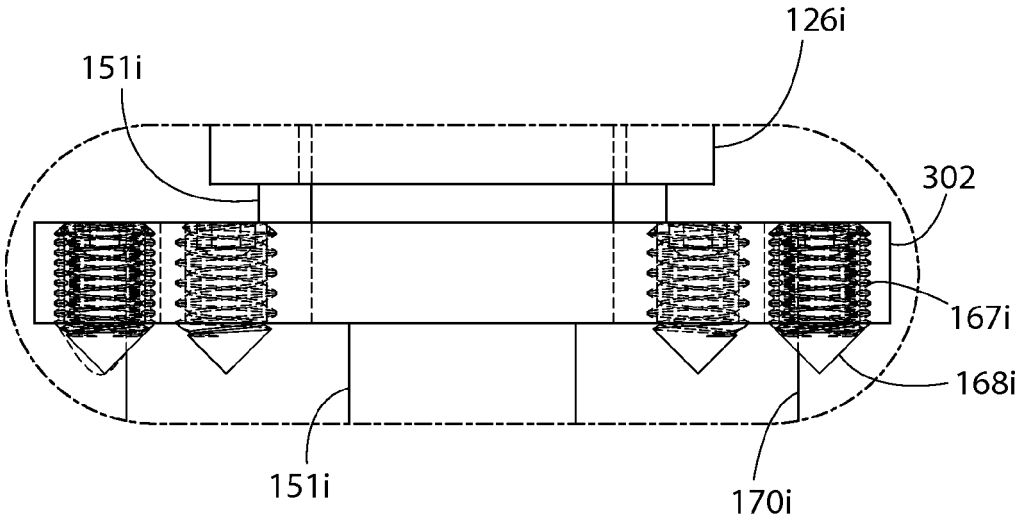

FIG. 16

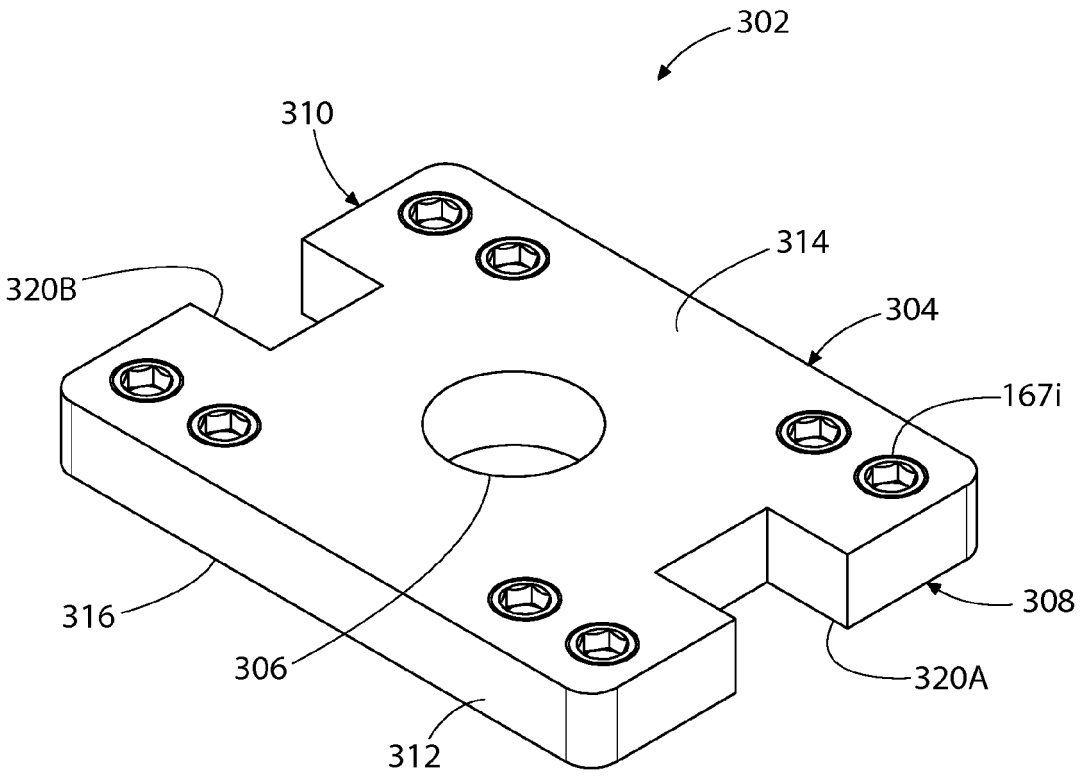

FIG. 17