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(72) Inventor; and
(71) Applicant: **OETLINGER, Frank** [US/US]; 1058 Overland Court, Grafton, WI 53024 (US).

(74) Agent: **STOMMA, Peter C.**; 840 North Plankinton Avenue, Milwaukee, WI 53203 (US).

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(54) **Title:** GUIDE ROD SUPPORT ASSEMBLY

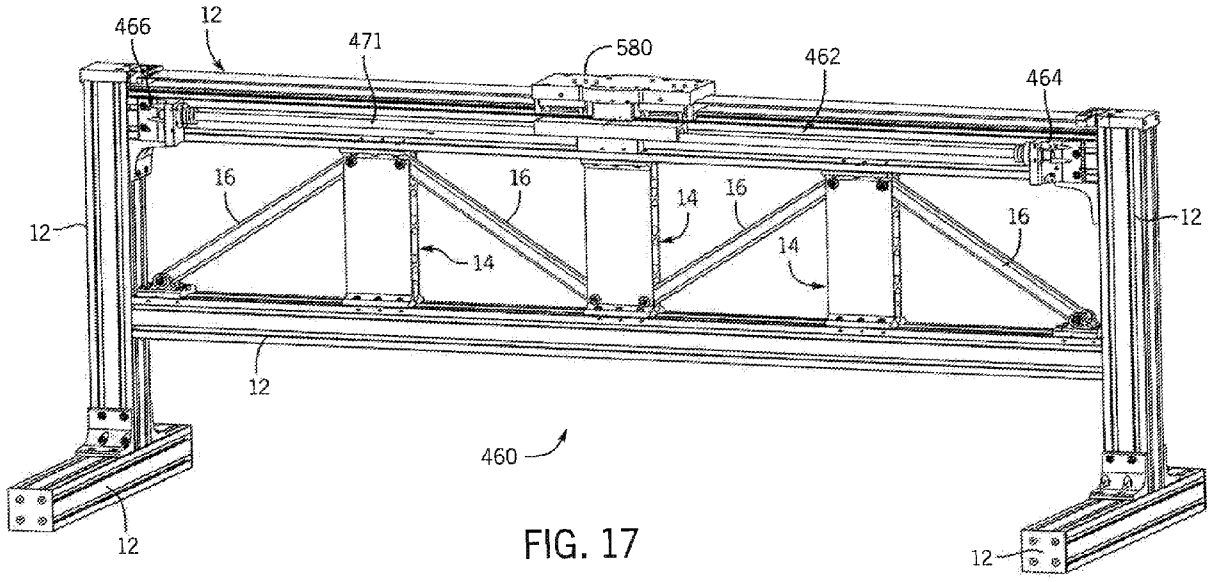

FIG. 17

(57) **Abstract:** A guide rod support assembly is provided for mechanically interlocking to a frame member having a face. The guide rod support assembly including a rod. First and second mounts include support walls having aperture therethrough. Collets are adapted for receiving corresponding ends of the rod and frictionally connecting the corresponding ends of the rod to corresponding support walls. Bases extend from the support walls of each mount. The bases include bolt-receiving bores therethough which extend along axes at acute angles to the inner faces of the bases to facilitate connection of first and second mounts to the face of the frame member.

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GUIDE ROD SUPPORT ASSEMBLY

FIELD OF THE INVENTION

[0001] This invention relates generally to structural frame assemblies for automation equipment and the like, and in particular, to a guide rod support assembly for mechanically interlocking and supporting a guide rod on a frame member of a structural frame.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] As is known, structural frames are used in the construction of a wide variety of products, including everything from automation equipment and furniture to buildings and the like. Structural frames typically incorporate horizontal and vertical frame members tied together by corner pieces, joints or bonding. Coverings, such as panels, may be secured to the frame members to isolate the interior of the structural frames and/or to provide an aesthetically pleasing appearance. In addition, various components may be interconnected to the structural frame to allow the structural frame to be used for its intended purpose. By way of example, hinges may be interconnected to the structural frame to facilitate the mounting of a door thereto. Alternatively, sliders may be interconnected to the sides of a structural frame so as to allow the structural frame to function as a drawer. It can be appreciated that other types of components may be interconnected to the structural frame to facilitate the intended purpose thereof.

[0003] Typically, the components of a structural frame are held together by means of friction. For example, nut and bolt combinations are often used to secure horizontal and vertical frame members together. However, the nut and bolt combinations holding the structural frames together often come loose over time when subjected to vibration and/or the environment. As the nut and bolt combinations loosen, the integrity of the structural frame may be compromised. Further, as the nut and bolt combinations loosen, the frame

members and the components therefore rotate with respect to one another, thereby compromising the alignment of the structural frame.

[0004] Further, these structural frame members are often fabricated from steel. While functional for their intended purpose, steel is very heavy and susceptible to corrosion, thereby requiring significant maintenance and protection measures. Hence, alternate materials, such as aluminum, are often substituted for steel. By way of example, aluminum is a lightweight material known for its combination of strength, corrosion resistance, and thermal conductivity. However, one of the limiting factors of aluminum over steel when used in connection with structural frame members is aluminum's modulus of elasticity which is approximately one third that of steel. Consequently, the effects of lateral loads on structure frame members fabricated from aluminum often limits their applications. In view of the foregoing, it is highly desirable to fabricate structural frame members from lightweight materials, such as aluminum, which may endure working loads far greater than the current structures allow.

[0005] Therefore, it is a primary object and feature of the present invention to provide a guide rod support assembly for mechanically interlocking and supporting a guide rod on a frame member of a structural frame.

[0006] It is a further object and feature of the present invention to provide a guide rod support assembly for mechanically interlocking and supporting a guide rod on a frame member of a structural frame may endure working loads far greater than the current structures allow.

[0007] It is a still further object and feature of the present invention to provide a guide rod support assembly for mechanically interlocking and supporting a guide rod on a frame member of a structural frame that is simple to utilize and inexpensive to manufacture.

[0008] In accordance with the present invention, a guide rod support assembly is provided for mechanically interlocking to a frame member having a face. The guide rod support assembly including a rod having first and second ends. A first mount supports

the first end of the rod. The first mount includes a base having an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face. The bolt-receiving bore extends along an axis at an acute angle to the inner face. A second mount supports the second end of the rod. The second mount including a base having an inner face engageable with the face of the frame member at a location axially spaced from the first mount, an outer face and a bolt-receiving bore extending between the outer face of the base of the second mount and the inner face of the base of the second mount. The bolt-receiving bore of the base of the second mount extends along an axis at an acute angle to the inner face of the base of the second mount.

[0009] The inner face of the base of the first mount includes a rail. The rail defines an opening in communication with the bolt-receiving bore through the base of the first mount. The rail is configured to be received into a corresponding slot in the face of the frame member. The inner face of the base of the second mount includes a rail. The rail of the base of the second mount defines an opening in communication with the bolt-receiving bore through the base of the second mount.

[0010] The first mount includes a support wall extending from base of the first mount at an angle generally perpendicular thereto. The support wall includes an inner face, an outer face directed at the second mount, and an aperture extending between the inner and outer faces of the support wall along an axis generally parallel to the inner surface of the base. The first mount includes a collet adapted for receiving the first end of the rod. The collet is extendable through the aperture in the support wall and is connectable to the support wall. Connection of the collet to the support wall frictionally connects the first end of the rod to the support wall.

[0011] The second mount includes a support wall extending from the base of the second mount at an angle generally perpendicular thereto. The support wall of the second mount includes an inner face, an outer face directed at the first mount, and an aperture extending between the inner and outer faces of the support wall of the second mount along the axis of the aperture through the support wall of the first mount. The second mount includes a

collet adapted for receiving the second end of the rod. The collet of the second mount is extendable through the aperture in the support wall of the second mount and is connectable to the support wall of the second mount. Connection of the collet of the second mount to the support wall of the second mount frictionally connects the second end of the rod to the support wall of the second mount.

[0012] In accordance with a further aspect of the present invention, a guide rod support assembly is provided for mechanically interlocking to a frame member having a face. The guide rod support assembly includes a rod having first and second ends. A mount includes a support wall having an inner face, an outer face, and an aperture extending between the inner and outer faces of the support wall along an axis. A collet is adapted for receiving the first end of the rod. The collet is insertable into the aperture in the support wall and is connectable to the support wall. Connection of the collet to the support wall frictionally connects the first end of the rod to the support wall.

[0013] The mount includes a base extending from the support wall and has an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face, the bolt-receiving bore extending along an axis at an acute angle to the inner face. The inner face of the base of the mount includes a rail. The rail defines an opening in communication with the bolt-receiving bore through the base of the mount. The rail is configured to be received into a corresponding slot in the face of the frame member.

[0014] The mount may be a first mount and the collet may be a first collet. The guide rod support assembly further includes a second mount including a support wall having an inner face, an outer face, and an aperture extending between the inner and outer faces of the support wall of the second mount along an axis. A second collet is adapted for receiving the second end of the rod. The second collet is insertable into the aperture in the support wall of the second mount and is connectable to the support wall of the second mount. Connection of the second collet to the support wall of the second mount frictionally connects the second end of the rod to the support wall of the second mount.

[0015] The first mount may include a base extending from the support wall of the first mount and has an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face of the base. The bolt-receiving bore extends along an axis at an acute angle to the inner face of the base. The second mount includes a base extending from the support wall of the second mount and has an inner face engageable with the face of the frame member at a location axially spaced from the first mount, an outer face and a bolt-receiving bore extending between the outer face of the base of the second mount and the inner face of the base of the second mount. The bolt-receiving bore of the base of the second mount extends along an axis at an acute angle to the inner face of the base of the second mount.

[0016] In accordance with a still further aspect of the present invention, a mount for a guide rod support assembly is provided for supporting a guide rod on a frame member having a face. The mount includes a support wall having an inner face, an outer face, and an aperture extending between the inner and outer faces of the support wall along an axis. A base extends from the support wall and has an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face. The bolt-receiving bore extends along an axis at an acute angle to the inner face. A collet is adapted for receiving a first end of the rod. The collet is insertable into the aperture in the support wall.

[0017] Thc collet is connectable to the support wall and connection of the collet to the support wall frictionally connects the first end of the guide rod to the support wall. The inner face of the base of the mount includes a rail. The rail defines an opening in communication with the bolt-receiving bore through the base of the mount. The rail is configured to be received into a corresponding slot in the face of the frame member.

[0018] These and other features and advantages of the invention will become apparent to those skilled in the art from the following detailed description and the accompanying drawings. It should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the present invention, are given by

way of illustration and not of limitation. Many changes and modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Preferred exemplary embodiments of the invention are illustrated in the accompanying drawings in which like reference numerals represent like parts throughout, and in which:

[0020] FIG. 1 is an isometric view of a structural frame assembly constructed from various structural framing components in accordance with the present invention;

[0021] FIG. 2 is an end view showing a frame member used to construct the structural frame assembly of FIG. 1;

[0022] FIG. 3 is an isometric view of a structural framing component in accordance with the present invention;

[0023] FIG. 4 is a side elevational view showing the structural framing component of FIG. 3 being interconnected to the frame member of FIG. 2;

[0024] FIG. 5 a top plan view of the structural framing component of FIG. 3;

[0025] FIG. 6 is an isometric view a nut used to construct the structural frame assembly of FIG. 1;

[0026] FIG. 7 is an isometric view of a structural frame assembly including a structural framing component, a diagonal web assembly and first and second frame members;

[0027] FIG. 8 is an end view of the structural frame assembly of FIG. 7;

[0028] FIG. 9 is a cross-sectional view showing a first end of the diagonal web assembly of FIG. 7 interconnected to a frame member;

[0029] FIG. 10 an enlarged, cross sectional view of FIG. 9 showing the diagonal web assembly interconnected to the frame member;

[0030] FIG. 11 is a bottom plan view of a mount for the diagonal web assembly of FIG. 7;

[0031] FIG. 12 is a cross-sectional view showing a second end of the diagonal web assembly interconnected to the structural framing component, as depicted in FIG. 7;

[0032] FIG. 13 is a top plan view of a cross brace assembly for interconnecting first and second frame members;

[0033] FIG. 14 is an exploded view of a first side of the cross brace assembly of FIG. 13;

[0034] FIG. 15 is an exploded view of a second side of the cross brace assembly of FIG. 13;

[0035] FIG. 16 is a cross sectional view of a first end of a cross brace assembly interconnected to a frame member;

[0036] FIG. 17 is an isometric view of an alternate construction of a structural frame assembly constructed from various structural framing components in accordance with the present invention;

[0037] and

[0038] FIG. 18 is an isometric view of a mount for a guide rod support assembly interconnected to a frame member as depicted in FIG. 17;

[0039] FIG. 19 is a bottom plan view of the mount of FIG. 18;

[0040] FIG. 20 is front elevational view of the mount of FIG. 18;

[0041] FIG. 21 is a cross-sectional view showing the mount of FIG. 17 interconnected to a frame member;

[0042] FIG. 22 is a cross sectional view of the guide rod support assembly of FIG. 18 wherein a first end of a guide rod supported in the mount interconnected to a frame member;

[0043] FIG. 23 is a cross sectional view of the guide rod support assembly taken along line 23-23 of FIG. 22; and

[0044] FIG. 24 is a cross sectional view of the guide rod support assembly taken along line 24-24 of FIG. 22

DETAILED DESCRIPTION OF THE DRAWINGS

[0045] Referring to FIG. 1, a frame assembly constructed from components in accordance with the present invention is generally designated by the numeral 10. As hereinafter described, the components of the present invention may be used to construct frame assemblies of various configurations. As such, frame assembly 10 is merely exemplary of the type of frame assembly that may be constructed utilizing the components of the present invention. Other configurations of frame assembly 10 and multiple interconnected frame assemblies 10 that are usable as structural supports or fixture components for automation equipment, as well as for furniture and building components, are contemplated as being within the scope of the present invention.

[0046] As hereinafter described, frame assembly 10 includes a plurality of frame members 12 interconnected by a plurality of structural framing components, generally designated by the reference numeral 14; a plurality of diagonal web assemblies, generally designated by the reference numeral 16; and/or a plurality of cross brace assemblies, generally designated by the reference numeral 18. Referring to FIGS. 1 and 2, each frame member 12 has a generally square configuration or cross-sectional profile shape and extends along a longitudinal axis. In alternate embodiments, the frame members 12 may have different cross-sectional profile shapes, for example, round, rectangular, triangular, or some other polygonal shape (not illustrated), depending on the desired end-use configuration. In the depicted embodiment, frame member 12 has an outer surface that is defined by four faces 20a-20d. Each face 20a-20d is identical in structure and, as such, the description hereinafter of face 20a is understood to describe faces 20b-20d, as if fully described herein.

[0047] Referring to FIG. 2, each face 20a of frame member 12 is generally flat and includes first and second slots 22, respectively, therein that extend along the entire length thereof along and that open into a longitudinally extending cavity 24. First and second slots, respectively, are identical in structure. Slot 22 and cavity 24 are substantially symmetrical, whereby description of structures at one side of the slot 22 and/or cavity 24 are equally applicable to the corresponding structures on the other side of the slot 22 and/or cavity 24, only being mirror images thereof.

[0048] Slot 22 is defined between first and second sidewalls 26 and 28, respectively, extending from face 20a at an angle 30 thereto. It is contemplated that angle 30 falls within the range of 1° and 89°, but is preferably between about 30° to about 80° and is most preferably about 70°. Correspondingly, in such a most preferred embodiment, each of the first and second sidewalls 26 and 28 defines an angle of about 20° with respect to an imaginary line that extends through the centerline of the slot 22, whereby the first and second sidewalls 24 and 26, respectively, define an angle of about 40° between each other. Slot 22 is further defined between first and second outer abutment walls 32 and 34, respectively, which diverge from corresponding terminal edges 26a and 28a, respectively, of first and second sidewalls 26 and 28, respectively.

[0049] First outer abutment wall 32 angularly intersects first sidewall 26 to define an angle that is greater than 90° therebetween and second outer abutment wall 34 angularly intersects sidewall 28 to define an angle that is greater than 90° therebetween. Preferably an angle defined between the first outer abutment wall 32 and the first sidewall 26 is between about 110° to about 160° and is most preferably about 130°. From respective outermost portions, first and second inner abutment walls 36 and 38, respectively, define lines that extend angularly down and away from the face 20a, toward a middle portion of the cavity 24. Stated another way, from the inner lands 32a and 34a that connect the outer and inner abutment walls 32, 36 and 34, 38 to each other, respectively, first and second inner abutment walls 32 and 34, respectively, extend in opposing directions that diverge from each other and toward the face 20a. Each of the lands 32a and 34a defines a

flat surface that extends between and connects the respective outer and inner abutment walls 32, 36 and 34, 38 to each other, defining an edge at each intersection of the lands 32a, 32a and outer and inner abutment walls 32, 36 and 34, 38. First and second outer abutment walls 32 and 34, respectively, are at steeper angles or relatively closer to orthogonal with respect to the face 20a than are the inner abutment walls 36 and 38 which are relatively closer to parallel with respect to the face 30a. The first and second outer abutment walls 32 and 34, respectively, in one preferred embodiment, define angles of about 60° with respect to the face 30a, whereas the inner abutment walls 36 and 38 define angles of about 20° or 19° with respect to the face 20a. Concave terminal wall 40 extends between terminal edges 36a and 38a, respectively, of first and second inner abutment walls 36 and 38, respectively, and the cavity 24 is defined between the inner abutment walls 36 and 38 and concave terminal wall 40.

[0050] Referring to FIGS. 3-5, each component 14 includes wall 56 lying in a plane and being defined by parallel, first and second panels 58 and 60, respectively. First panel 58 includes inner face 62, outer face 64, first and second sides 66 and 68, respectively, and first and second ends 70 and 72, respectively. Apertures 74 and 76 extend through first panel 58 between inner and outer faces 62 and 64, respectively, at a location adjacent to first side 66 thereof, for reasons hereinafter described. It is noted that additional apertures (not shown) may extend through first panel 58 between inner and outer faces 62 and 64, respectively, at a location adjacent to second side 68 thereof.

[0051] Second panel 60 includes inner face 82, outer face 84, first and second sides 86 and 88, respectively, and first and second ends 90 and 92, respectively. Apertures 94 and 96 extend through second panel 60 between inner and outer faces 82 and 84, respectively, at a location adjacent to first side 86 thereof, for reasons hereinafter described. Apertures 94 and 96 through second panel 60 are axially aligned with apertures 74 and 76, respectively, through first panel 58, for reasons hereinafter described. It is noted that additional apertures (not shown) may extend through second panel 60 between inner and outer faces 82 and 84, respectively, at a location adjacent to second side 88 thereof. The

apertures though second panel 60 adjacent to second side 88 thereof may be axially aligned with the apertures though first panel 58 adjacent to second side 68 thereof.

[0052] As described, first sides 66 and 86 of first and second panels 58 and 60, respectively, define a first side of wall 56; second sides 68 and 88 of first and second panels 58 and 60, respectively, define a second side of wall 56; first ends 70 and 90 of first and second panels 58 and 60, respectively, define a first end of wall 56; and second ends 72 and 92 of first and second panels 58 and 60, respectively, define a second end of wall 56.

[0053] Inner faces 62 and 82 of first and second panels 58 and 60, respectively, are interconnected by a plurality of connectors 100. The plurality of connectors 100 extend along corresponding parallel axes which are spaced between first and second sides of wall 56. As such, adjacent connectors 100 define corresponding voids 102 in wall 56. In the depicted embodiment, each connector 100 extends from the first end of wall 56 to the second end of wall 56 such that voids 102 therebetween also extend from the first end of wall 56 to the second end of wall 56.

[0054] Each component 14 further includes base members 110 and 110a operatively connected to the first and second sides, respectively, of wall 56. It is noted that base members 110 and 110a are identical in structure and, as such, the description hereinafter of base member 110 is understood to describe base member 110a, as if fully described herein. Base member 110 includes first mounting portion 112 operatively connected to first side 66 of first panel 58. First mounting portion 112 extends between first and second end surfaces 120 and 122, respectively, which are generally co-planar with first and second ends 70 and 72, respectively, of first panel 58. First surface 114 extending laterally from outer face 64 and terminates at terminal edge 124. Second surface 116 extends laterally from inner face 62 at terminates at terminal edge 126. Engagement surface 128 extends from terminal edge 124 and terminates at terminal edge 130. Terminal edges 126 and 130 are interconnected by face 132 which is generally perpendicular to engagement surface 128 and parallel to the plane of wall 56.

Engagement surface 128 includes rail 134 extends along between first and second end surfaces 120 and 122, respectively. Rail 134 has a perimeter shape that corresponds to the perimeter shape of the portion of slot 22 that is defined between first and second sidewalls 24 and 26, respectively. The configuration of rail 134 allows for rail 134 to nest into slot 22, between first and second sidewalls 24 and 26, respectively.

[0055] First mounting portion 112 of base member 110 includes a pair of bolt-receiving bores 136 and 138 that extend angularly between first surface 114 and outer surface 140 of rail 134. Bores 136 and 138 extend along corresponding axes which are generally parallel to each other and at acute angles to the plane of wall 56. More specifically, bores 136 and 138 define lower openings at outer surface 140 of rail 134 and upper openings in first surface 114 of first mounting portion 112 of base member 110. Bores 136 and 138 have enlarged portions adjacent to first surface 114 to accommodate corresponding bolt heads of bolts received bores 136 and 138, as hereinafter described.

[0056] Base member 110 further includes second mounting portion 142 operatively connected to first side 68 of second panel 60. Second mounting portion 142 extends between first and second end surfaces 150 and 152, respectively, which are generally co-planar with first and second ends 90 and 92, respectively, of second panel 60. First surface 144 extending laterally from outer face 84 and terminates at terminal edge 145. Second surface 146 extends laterally from inner face 82 at terminates at terminal edge 147. Engagement surface 148 extends from terminal edge 145 and terminates at terminal edge 150. Terminal edges 147 and 149 are interconnected by face 152 which is generally spaced from and parallel to face 132 of first mounting portion 112 of base member 110. The spacing between faces 132 and 152 allow for first and second mounting portions 112 and 142, respectively, to compensate for irregularities, distortions, and/or imperfections in the configuration of frame member 14 which may occur during the extrusion/fabrication process thereof.

[0057] Engagement surface 148 includes rail 154 extending along between first and second end surfaces 150 and 152, respectively. Rail 154 has a perimeter shape that

corresponds to the perimeter shape of the portion of slot 22 that is defined between first and second sidewalls 24 and 26, respectively. The configuration of rail 154 allows for rail 154 to nest into a corresponding slot 22, between first and second sidewalls 24 and 26, respectively.

[0058] Second mounting portion 142 of base member 110 includes a pair of bolt-receiving bores 156 and 158 that extend angularly between first surface 144 and outer surface 160 of rail 154. Bores 156 and 158 extend along corresponding axes which are generally parallel to each other and at acute angles to the plane of wall 56. More specifically, bores 156 and 158 define lower openings at outer surface 160 of rail 154 and upper openings in first surface 144 of second mounting portion 142 of base member 110. Bores 156 and 158 have enlarged portions adjacent to first surface 144 to accommodate corresponding bolt heads of bolts received bores 156 and 158, as hereinafter described.

[0059] It is intended for rails 134 and 154 of first and second mounting portions 112 and 114, respectively, of base member 110 to provide mechanical interfaces that resist transverse sliding between interconnected components of the joints and which properly align frame member 12, first and second mounting portions 112 and 114, respectively, and nuts 160, hereinafter described, such that bolts 161 can extend through the bores 136 and 138 of first mounting portion 112 and bores 156 and 158 of second mounting portion 142 and engage corresponding nuts 160. Nuts 160 are provided within terminal ends of the cavities 24 so that the nuts 160 are accessible through the slots 22 in first face 20a of frame member 12 by bolts 161 so as to rigidly connect component 14 to frame member 12. Nuts 160 are sized to slide longitudinally through cavities 24 and are captured within cavities 24 so that the nuts 160 do not rotate in unison with rotation of the bolts 161.

[0060] Referring now to FIG. 6, each nut 160 has a substantially planar upper wall 163 and a pair of outwardly tapering sidewalls 162 and 164. Tapering sidewalls 162 and 164 extend angularly from the upper wall 163 at angles that correspond to the angles of outer abutment walls 42 and 44 between which the lower portion of slot 22 is defined in frame member 12. A distance between the tapering sidewalls 162 and 164 is smaller than a

distance between outer abutment walls 42 and 44 so that, during use, a clearance is defined between the tapering sidewall 162 and outer abutment wall 42 in a manner that is described in more detail elsewhere herein.

[0061] A pair of shoulders 166 and 168 extends outwardly from lower portions of the tapering sidewalls 162 and 164 and upwardly in a direction of the upper wall 163. Shoulders 166 and 168 of nut 160 extend at angles that generally correspond to the angles defined between inner abutment walls 46 and 48 and outer abutments walls 42 and 44 of defining slot 20 of frame member 12. It is preferred that the angles are obtuse angles, falling in the range of 91° and 179°, but preferably between about 95° and 105°, and is more preferably about 100°. Angles (not labeled) between shoulder 166 and a longitudinal axis of bore 180, and between shoulder 168 and a longitudinal axis of bore 180 are different. By way of example, the angle between shoulder 166 and the longitudinal axis of bore 180 is about 90°, and the angle between shoulder 168 and the longitudinal axis of bore 180 is about 55°. A lower curved wall 170 extends along an arcuate path between and connects outer ends of the shoulders 166 and 168. The profile shape and radius of curvature of the lower curved wall 170 of nut 160 correspond to those characteristics of the concave terminal wall 40 that define the lower periphery of the cavity 22 of each slot 20 of frame member 12

[0062] Nut 160 includes a pair of bores 180 that are spaced from each other along the length of the nut 160. Bores 180 extend orthogonally through nut 160 in a longitudinal direction of nut 160 and angularly in a transverse direction of nut 160. Bores 180 extend at the same angles that bores 136 and 138 through first mounting portion 112 and bores 156 and 158 through second mounting portion 142, namely, transversely at acute angles. Each of such acute angles of bores 180 falls in the range of 1° and 89°, but is preferably between about 30° and about 80°, and is most preferably about 65° with respect to the upper wall 163 of the nut 160. In this configuration, each bore 180 has an upper opening that is substantially at a centerline of nut 160 and a lower opening that is offset from the centerline of the nut, being positioned below the outwardly tapered sidewall 162.

[0063] Referring back to FIGS. 2-5 and 7, in order to interconnect a pair of frame members 12 to each other, component 14 may be used. By way of example, nuts 160 are slid longitudinally into corresponding cavities 22 of slots 20 in face 20a of a first frame member 12. Rail 134 of first mounting portion 112 of base member 110 and rail 154 of second mounting portion 142 of base member 110 of first frame member 12 are slid into corresponding slots 22 of the face 30a of first frame member 12 until component 14 is in the desired position and bores 136 and 138 through first mounting portion 112 and bores 156 and 158 through second mounting portion 142 align with corresponding pair of bores 180 of nuts 160. As noted above, the spacing between faces 132 and 152 allow for first and second mounting portions 112 and 142, respectively, to compensate for irregularities, distortions, and/or imperfections in the configuration of frame member 14 which may occur during the extrusion/fabrication process thereof such that rail 134 of first mounting portion 112 of base member 110 and rail 154 of second mounting portion 142 of base member 110 of first frame member 12 may be slid into corresponding slots 22 of the face 20a of first frame member 12. Bolts 161 are inserted through the unthreaded bores 136 and 138 through first mounting portion 112 and threaded into threads of bores 180 in a corresponding nut 160. Similarly, bolts 161 are inserted through the unthreaded bores 156 and 158 through second mounting portion 142 and threaded into threads of bores 180 in a corresponding nut 160.

[0064] Tightening bolts 161 into nuts 160 provides multi-axial tightening that clamps the stack of nut 150, first frame member 12, and first mounting portion 112 of base member 110 of component 14 together and transversely compresses first frame member 12 and clamps the stack of nut 150, first frame member 12, and second mounting portion 142 of base member 110 of component 14 together, thereby transversely compressing frame frame member 12. Tightening bolts 161 draws nuts 160 by advancing the nuts 160 along the threads of corresponding bolts 161. Nuts 160 is drawn angularly up and across corresponding cavities 22 so as to provide clamping forces that squeeze first frame

member 12 between first and second mounting portions 112 and 142, respectively, and nuts 160 while tensioning bolts 161.

[0065] As best seen in FIG. 7, in order to interconnect base member 110a of component 14 to a second frame member 12, nuts 160 are slid longitudinally into corresponding cavities 22 of slots 20 in face 20a of second frame member 12. Rail 134 of first mounting portion 112 of base member 110a and rail 154 of second mounting portion 142 of base member 110a of component 14 are slid into corresponding slots 22 of the face 30a of second frame member 12 until component 14 is in the desired position and bores 136 and 138 through first mounting portion 112 of base member 110a and bores 156 and 158 through second mounting portion 142 of base member 110a align with corresponding pair of bores 180 of nuts 160. Bolts 161 are inserted through the unthreaded bores 136 and 138 through first mounting portion 112 of base member 110a and threaded into threads of bores 180 in a corresponding nut 160. Similarly, bolts 161 are inserted through the unthreaded bores 156 and 158 through second mounting portion 142 of base member 110a and threaded into threads of bores 180 in a corresponding nut 160.

[0066] As heretofore described, tightening bolts 161 into nuts 160 provides multi-axial tightening that clamps the stack of nut 150, second frame member 12, and first mounting portion 112 of base member 110a of component 14 together and transversely compresses second frame member 12 and clamps the stack of nut 150, second frame member 12, and second mounting portion 142 of base member 110 of component 14 together, thereby transversely compressing second frame member 12. Tightening bolts 161 draws nuts 160 by advancing the nuts 160 along the threads of corresponding bolts 161. Nuts 160 is drawn angularly up and across corresponding cavities 22 so as to provide clamping forces that squeeze second frame member 12 between first and second mounting portions 112 and 142, respectively, and nuts 160 while tensioning bolts 161.

[0067] Referring to FIGS. 7-11, in order to support each component 14, diagonal web assembly 16 may be provided between component 14 and frame member 12. Web assembly 14 includes rod 170 having opposite first and second ends 172 and 174,

respectively. First end 172 of rod 170 is pivotably connected to mount 176. Mount 176 includes first and second walls 178 and 180, respectively, interconnected by base 182. First wall 178 includes inner surface 184, outer surface 186 and aperture 188 extending therethrough between inner and outer surfaces 184 and 186, respectively. Similarly, second wall 180 includes inner surface 190 spaced from and parallel to inner surface 184 of first wall 178 so as to define cavity 192 therebetween, outer surface 194 and aperture 196 extending therethrough between inner and outer surfaces 190 and 194. respectively.

[0068] Base 182 of mount 176 interconnects the lower ends of first and second walls 178 and 180, respectively. Base 182 includes first and second sides 202 and 204, respectively, and first and second ends 218 and 220, respectively. First and second sides 202 and 204, respectively, are generally parallel to each other and perpendicular to first and second ends 218 and 220, respectively. First surface 198 extending laterally from outer surface 186 of first wall 178 and intersects first side 202 of base 182 at edge 200. Second surface 206 extends laterally from outer surface 194 of second wall 180 and intersects second side 204 of base 182 at edge 208. Engagement surface 210 extends between and interests first and second sides 202 and 204, respectively, at corresponding edges 212 and 214, respectively. Engagement surface 210 is generally planar and perpendicular to first and second sides 202 and 204, respectively.

[0069] First and second rails 214 and 216, respectively, extend along engagement surface 210 between first and second ends 218 and 220, respectively. First and second rails 214 and 216, respectively, extend along axes which are generally parallel to each other and have perimeter shapes that correspond to the perimeter shapes of slots 22 in face 20a of frame member 12. The configurations of first and second rails 214 and 216, respectively, allow for first and second rails 214 and 216, respectively, to nest into corresponding slots 22 in face 20a of frame member 12.

[0070] Base 182 of mount 176 includes a pair of bolt-receiving bores 226 and 228 that extend angularly between first surface 198 and outer surface 230 of first rail 214. Bores 226 and 228 extend along corresponding axes which are generally parallel to each other

and at acute angles to the plane of engagement surface 210. More specifically, bores 226 and 228 define lower openings at outer surface 230 of first rail 214 and upper openings in first surface 198 of base 182 of mount 176. Bores 226 and 228 have enlarged portions adjacent to first surface 198 to accommodate corresponding bolt heads of bolts received bores 226 and 228, as hereinafter described.

[0071] Base 182 of mount 176 further includes a pair of bolt-receiving bores 232 and 234 that extend angularly between second surface 206 and outer surface 236 of second rail 216. Bores 232 and 234 extend along corresponding axes which are generally parallel to each other and at acute angles to the plane of engagement surface 210. More specifically, bores 232 and 234 define lower openings at outer surface 236 of second rail 216 and upper openings in second surface 206 of base 182 of mount 176. Bores 232 and 234 have enlarged portions adjacent to second surface 206 to accommodate corresponding bolt heads of bolts received bores 232 and 234, as hereinafter described.

[0072] It is intended for first and second rails 214 and 216, respectively, of mount 176 to provide mechanical interfaces that resist transverse sliding between interconnected components of the joints and which properly align mount 176, frame member 12, and nuts 160, hereinafter described, such that bolts 161 can extend through the bores 226, 228, 232 and 234 and engage corresponding nuts 160. Nuts 160 are provided within terminal ends of the cavities 24 so that the nuts 160 are accessible through slots 22 in first face 20a of frame member 12 by bolts 161 so as to rigidly connect web assembly 16 to frame member 12. Nuts 160 are sized to slide longitudinally through cavities 24 and are captured within cavities 24 so that the nuts 160 do not rotate in unison with rotation of the bolts 161.

[0073] Pivot pin assembly 240 is provided to pivotably connect first end 172 of rod 170 to mount 176. Pivot pin assembly 240 includes pin 242 having a shaft 244 extending along an axis. Enlarged head 246 is interconnected to first end 248 of shaft 244. Second end 250 of shaft 244 is generally flat and includes a threaded bore 252 extending axially into shaft 244. Pivot pin assembly 240 further includes a cup-shaped end cap 254 defined by

a disc-shaped base 266 and a ring-shaped wall 268 projecting from an outer periphery of base 266. Inner surface 270 of wall 268 and inner surface 272 of base 266 define cavity 274 having a diameter sufficient accommodate second end 250 of shaft 244. Bore 276 extends between outer surface 278 and inner surface 272 of base 266 and is dimensioned to receive shaft 280 of screw 282 therethough.

[0074] In order to pivotably connect first end 172 of rod 170 to mount 176, shaft 244 of pin 240 is inserted through aperture 196 in second wall 180 of mount 176, passage 284 in first end 172 of rod 170, and aperture 188 in first wall 178 of mount 176 such that second end 250 of shaft 244 extends outwardly of outer surface 186 of first wall 178. End cap 254 is positioned over second end 250 of shaft 244 such that second end 250 of shaft 244 is receiving in cavity 274 in end cap 254 and such that bore 276 in end cap 254 is axially aligned with bore 252 in second end 250 of shaft 244. Shaft 280 of screw 282 is inserted through bore 276 in end cap 254 and threaded into bore 252 in second end 250 of shaft 244 so as to interconnect end cap 254 to pin 240, thereby capturing shaft 244 of pin 240 between head 246 and wall 268 of end cap 254 and maintaining first end 172 of rod 170 between first and second walls 178 and 180, respectively.

[0075] As best seen in FIG. 12, pivot pin assembly 290 is provided to pivotably connect second end 174 of rod 170 to component 14. Pivot pin assembly 290 includes pin 292 having a shaft 294 extending along an axis. Enlarged head 296 is interconnected to first end 298 of shaft 294. Second end 300 of shaft 294 is generally flat and includes a threaded bore 302 extending axially into shaft 294. Pivot pin assembly 290 further includes a cup-shaped end cap 304 defined by a disc-shaped base 316 and a ring-shaped wall 318 projecting from an outer periphery of base 316. Inner surface 320 of wall 318 and inner surface 322 of base 316 define cavity 324 having a diameter sufficient accommodate second end 300 of shaft 294. Bore 326 extends between outer surface 328 and inner surface 322 of base 266 and is dimensioned to receive shaft 330 of screw 332 therethough.

[0076] To pivotably connect second end 172 of rod 170 to component 14, second end 172 if rod 170 is positioned between inner faces 62 and 82 of first and second panels 58 and 60, respectively, of wall 56 of component 14 such that passage 334 through second end 172 of rod 170 is axially aligned with aperture 74 in first panel 58 and aperture 94 in second panel 60. Shaft 294 of pin 290 is inserted through aperture 94 in second panel 60, passage 334 in second end 174 of rod 170, and aperture 74 in first panel 58 such that second end 300 of shaft 294 extends outwardly of outer face 64 of first panel 58. End cap 304 is positioned over second end 300 of shaft 294 such that second end 300 of shaft 294 is receiving in cavity 324 in end cap 304 and such that bore 326 in end cap 304 is axially aligned with bore 302 in second end 300 of shaft 294. Shaft 330 of screw 332 is inserted through bore 326 in end cap 304 and threaded into bore 302 in second end 300 of shaft 294 so as to interconnect end cap 304 to pin 290, thereby capturing shaft 294 of pin 290 between head 296 and wall 318 of end cap 304 and maintaining second end 174 of rod 170 between first and second panels 58 and 60, respectively, of wall 56.

[0077] In order to provide even further structural support between frame members 12, cross-brace assembly 18 is provided. Cross-brace assembly 18 includes first and second mounts 342 and 344, respectively, interconnected by brace 346. Each mount 342 and 344 are identical in structure, and as such, the description hereinafter of mount 342 is understood to describe mount 344, as if fully described herein. Mount 342 is defined by support portion 348 having first and second faces 350 and 352, respectively, first and second sides 354 and 356, respectively, inner end 358 and outer end 360. Rail 362 extends along second face 352 between first and second sides 354 and 356, respectively. Rail 362 has a perimeter shape that corresponds in shape to grooves 364 and 366 in brace 346, hereinafter described, so as to allow rail 362 to nest in one of grooves 364 and 366. Support portion 348 further includes bolt-receiving bore 368 and 369 that extend angularly between first face 350 and outer surface 370 of rail 362. Bores 367 and 369 extend along axes that are generally parallel and at acute angles to second face 352.

[0078] First and second legs 368 and 370, respectively, extend from inner end 358 of support portion 348 along axes that diverge from each other at an angle of 90 degrees. First leg 368 includes first and second faces 380 and 382, respectively, first and second sides 384 and 386, respectively, inner end 388 and outer end 390. Rail 392 extends along second face 382 between first and second sides 384 and 386, respectively. Rail 392 has a perimeter shape that corresponds in shape to the perimeter shapes of slots 22 in faces 20a-20d of frame member 12. The configuration of rail 392 allows rail 392 to nest into corresponding slot 22 in face 20a -20d of frame member 12, as hereinafter described.

[0079] First leg 368 of mount 342 further includes a pair of bolt-receiving bores 394 and 396 that extend angularly between first face 380 and outer surface 398 of rail 392. Bores 394 and 396 extend along corresponding axes which are generally parallel to each other and at acute angles to the plane of second face 382. More specifically, bores 394 and 396 define lower openings at outer surface 398 of rail 392 and upper openings in first face 380 of first leg 368. Bores 394 and 396 have enlarged portions adjacent to first face 380 to accommodate corresponding bolt heads of bolts received in bores 394 and 396, as hereinafter described.

[0080] Second leg 370 includes first and second faces 400 and 402, respectively, first and second sides 404 and 406, respectively, inner end 408 and outer end 410. Rail 412 extends along second face 402 between first and second sides 404 and 406, respectively. Rail 412 has a perimeter shape that corresponds in shape to the perimeter shapes of slots 22 in faces 20a-20d of frame member 12. The configuration of rail 412 allows rail 412 to nest into corresponding slot 22 in face 20a-20d of frame member 12, as hereinafter described.

[0081] Second leg 370 of mount 342 further includes a pair of bolt-receiving bores 414 and 416 that extend angularly between first face 400 and outer surface 418 of rail 412. Bores 414 and 416 extend along corresponding axes which are generally parallel to each other and at acute angles to the plane of second face 402. More specifically, bores 414 and 416 define lower openings at outer surface 418 of rail 412 and upper openings in first

face 400 of second leg 378. Bores 414 and 416 have enlarged portions adjacent to first face 400 to accommodate corresponding bolt heads of bolts received in bores 414 and 416, as hereinafter described.

[0082] In order to interconnect mount 342, first and second legs 368 and 370, respectively, are positioned against frame member 12 such that second face 382 of first leg 368 abuts face 20a of frame member 12 and rail 392 is seated in a corresponding slot 22 in face 20a of frame member 12 and such that second face 402 of second leg 370 abuts face 20d of frame member 12 and rail 412 is seated in a corresponding slot 22 in face 20d of frame member 12. Nuts 160 are provided within terminal ends of the cavities 24 in frame member 12 so that a first nut 160 is accessible through slot 22 in face 20a of frame member 12 by bolts 420 extending through bores 394 and 396 so as to rigidly connect first leg 368 of mount 342 to frame member 12 and so that a second nut 160 is accessible through slot 22 in face 20d of frame member 12 by bolts 420 extending through bores 414 and 416 so as to rigidly connect second leg 370 of mount 342 to frame member 12. Nuts 160 are sized to slide longitudinally through cavities 24 and are captured within cavities 24 so that the nuts 160 do not rotate in unison with rotation of the bolts 420. It can be appreciated that in the same manner, second mount 344 may be mechanically interlocked to a second frame member, generally designated by the reference number 12a in FIG. 13.

[0083] Brace 346 interconnects first and second mounts 342 and 344, respectively, More specifically, brace 346 extends along an axis and includes first and second sides 422 and 424, first and second ends 426 and 428, and first and second faces 430 and 432, respectively. Brace 346 further includes grooves 364 and 366 in second face 432 thereof. Groove 364 is located adjacent to first end 426 of brace 346 and extends axially in second face 432 between first and second sides 422 and 424 of brace 346. Groove 366 is located adjacent to second end 428 of brace 346 and extends axially in second face 432 between first and second sides 422 and 424 of brace 346. Groove 364 is defined by first and second converging sidewalls 434 and 436, respectively, interconnected by recessed

surface 440 so that groove 364 has an interior shape that corresponds to the perimeter shape of rail 362 extending along second face 352 of first mount 342. Groove 366 is defined by first and second converging sidewalls 442 and 444, respectively, interconnected by recessed surface 446 having an interior shape that corresponds to the perimeter shape of rail 362 extending along second faces 352 of second mount 344. The configurations of grooves 364 and 368 allow for rails 362 to nest into grooves 364 and 366, respectively.

[0084] Brace 346 further includes a first pair of bolt-receiving bores 450 and 451 that extend angularly between first face 430 and recessed surface 440 partially defining groove 364 and a second pair of bolt-receiving bores 452 and 453 that extend angularly between first face 430 and recessed surface 446 partially defining groove 366. Bolts 450 and 451 extend along corresponding axes which are parallel and are at acute angles to the plane of first face 430. More specifically, bores 450 and 451 define openings at recessed surfaces 442 and openings in first face 430 of brace 346. Bores 450 and 452 have enlarged portions adjacent to first face 430 to accommodate corresponding bolt heads of bolts 454 received in bores 450 and 451. Similarly, bolts 452 and 453 extend along corresponding axes which are parallel and are at acute angles to the plane of first face 430. More specifically, bores 452 and 453 define openings at recessed surface 446 and openings at first face 430 of brace 346. Bores 452 and 453 have enlarged portions adjacent to first face 430 to accommodate corresponding bolt heads of bolts 454 received in bores 452 and 453. In the depicted embodiment, bores 450 and 451 lie in a common plane which diverges from the plane of bores 452 and 453, bores 450 and 451 and bores 452 and 453 extend away from second face 432.

[0085] To interconnect brace 346 to first and second mount 342 and 344, brace 346 is positioned such that rails 362 are nested into grooves 364 and 366, respectively. Bolts 454 are interested through bores 450 and 451 and threaded into corresponding bores 367 and 369 in support portion 348 of mount 342. Similarly, bolts 454 are interested through bores 452 and 453 and threaded into corresponding bores 367 and 369 in support portion

348 of mount 344. Tightening bolts 454 draws rails 362 of support portions 348 of first and second mounts 342 and 344, into grooves 364 and 366, respectively, so as to provide clamping forces that squeeze first and second ends 426 and 428, respectively, to first and second mounts 342 and 344, respectively, together.

[0086] Referring to FIG. 17, an alternate frame assembly constructed from components in accordance with the present invention, namely, components 14, web assemblies 16, and cross braces 18, is generally designated by the reference numeral 460. As noted above, the components of the present invention may be used to construct frame assemblies of various configurations, and as such, frame assembly 460 is merely exemplary of the type of frame assembly that may be constructed utilizing the components of the present invention. Other configurations of frame assemblies constructed from the various components described herein are contemplated as being within the scope of the present invention.

[0087] Frame assembly 460 depicts a guide rod support assembly, generally designated by the reference numeral 462, interconnected to a corresponding frame member 12. More specifically, guide rod support assembly 462 includes first and second mounts 464 and 466, respectively, supporting opposite ends 468 and 470, respectively, of guide rod 471. Each mount 464 and 466 are identical in structure, and as such, the description hereinafter of mount 464 is understood to describe mount 466, as if fully described herein.

[0088] Mount 464 includes support wall 472 interconnected to and extending from base 474. Support wall 472 lies in a plane generally perpendicular to base 474 and includes inner surface 476, outer surface 478 and conical-shaped aperture 481 extending therethrough between inner and outer surfaces 476 and 478, respectively, along an axis generally perpendicular to the plane of support wall 472 and generally parallel to base 474. A plurality of threaded, bolt-receiving bores 480 are circumferentially spaces about aperture 481 and extend through support wall 472 between inner and outer surfaces 476

and 478, respectively, along corresponding axes which are parallel to the axis of aperture 481.

[0089] Base 474 includes first and second sides 482 and 484, respectively, and first and second ends 486 and 488, respectively. First and second sides 482 and 484, are generally parallel to each other and perpendicular to first and second ends 486 and 488, respectively. Outer surface 490 extends between and interests first and second sides 482 and 484, respectively, at corresponding edges 492 and 494, respectively. Engagement surface 496 extends between and interests first and second sides 482 and 484, respectively, at corresponding edges 498 and 500, respectively. Engagement surface 496 is generally planar and perpendicular to first and second sides 482 and 484, respectively.

[0090] First and second rails 502 and 504, respectively, extend along engagement surface 496 between first and second ends 486 and 488, respectively. First and second rails 502 and 504, respectively, extend along axes which are generally parallel to each other and have perimeter shapes that correspond to the perimeter shapes of slots 22 in face 20a of frame member 12. The configurations of first and second rails 502 and 504, respectively, allow for first and second rails 502 and 504, respectively, to nest into corresponding slots 22 in face 20a of frame member 12.

[0091] Base 474 of mount 464 includes a pair of bolt-receiving bores 506 and 508 that extend angularly between outer surface 490 and outer surfaces 510 and 512 of first and second rails 502 and 504, respectively. Bores 506 and 508 extend along corresponding axes which are generally parallel to each other and at acute angles to the plane of engagement surface 496. More specifically, bore 506 defines a lower opening at outer surface 510 of first rail 504 and an upper opening in outer surface 490 of base 474 of mount 464. Bore 506 has enlarged portions adjacent to outer surface 490 to accommodate a corresponding bolt head of a bolt received in bore 506, as hereinafter described. Similarly, bore 508 defines a lower opening at outer surface 512 of second rail 504 and an upper opening in outer surface 490 of base 474 of mount 464. Bore 508 has

an enlarged portion adjacent to outer surface 490 to accommodate a corresponding bolt head of a bolt received in bore 508, as hereinafter described.

[0092] It is intended for first and second rails 502 and 504, respectively, of mount 464 to provide mechanical interfaces that resist transverse sliding between interconnected components of the joints and which properly align mount 464, frame member 12, and nuts 160, such that bolts 514 can extend through bores 506 and 508 and engage corresponding nuts 160. Nuts 160 are provided within terminal ends of the cavities 24 so that the nuts 160 are accessible through slots 22 in first face 20a of frame member 12 by bolts 514 so as to rigidly connect mount 464 to frame member 12. Nuts 160 are sized to slide longitudinally through cavities 24 and are captured within cavities 24 so that the nuts 160 do not rotate in unison with rotation of the bolts 514.

[0093] To interconnect mount 464 to frame member 12, nuts 160 are slid longitudinally into corresponding cavities 24 of slots 22 in face 20a of frame member 12 and mount 464 is positioned adjacent a first end of frame member 12 such that first and second rails 502 and 504, respectively, are nested into corresponding slots 22 in face 20a of frame member 12 and such that inner face 476 of support wall 472 of mount 464 is directs at a second opposite end of first member 12. Bolts 514 are inserted through bores 506 and 508 in base 474 of mount 464 and threaded into threads of bores 180 in corresponding nuts 160. Tightening bolts 514 into nuts 160 provides multi-axial tightening that clamps the stack of nut 160, frame member 12, and base 474 of mount 464 together and transversely compresses frame member 12. More specifically, tightening bolts 514 draws nuts 160 by advancing the nuts 160 along the threads of corresponding bolts 514. Nuts 160 is drawn angularly up and across corresponding cavities 22 so as to provide clamping forces that squeeze frame member 12 between base 474 of mount 464 and nuts 160 while tensioning bolts 514. In the same manner, second mount 466 interconnected to frame member 12 at a location adjacent the second end of frame member 12 such that inner face 476 of support wall 472 of mount 464 is directed at the opposite end of frame member 12 and

such that apertures 480 through support walls 472 of first and second mounts 464 and 466, respectively, are co-axial.

[0094] In order to connect guide rod 471 to first and second mounts 464 and 466, respectively, first end 520 of guide rod 471 is inserted through a corresponding tubular bearing sleeve 522, a corresponding collet 524 and aperture 481 in support wall 472 of first mount 464 and second end 526 of guide rod 471 is inserted through a corresponding tubular bearing sleeve 522, a corresponding collet 524 and aperture 481 in support wall 472 of second mount 466. As is conventional, each collet 524 includes a generally conical body 532 extending along an axis. Body 532 includes inner surface 534 defining passage 536 through body 532 and a generally conical-shaped outer surface 538. Body 532 includes a first end 540 defining opening 542 communicating with passage 536 and a second end 544 defining an opening 546 communicating with passage 536.

[0095] Slot 548 in body 532 extends from first end 540 to second end 544. Slot 548 is defined by first and second spaced sidewalls 550 and 552, respectively, which interconnect inner and outer surfaces 534 and 538, respectively, of body 532. Enlarged head 560 projects radially from outer surface 538 of body 532 at a location adjacent second end 540 of body 532. Enlarged head 560 is defined by an inner surface 562, an outer surface 564 and radially outer edge 566 interconnecting inner and outer surfaces 562 and 564, respectively. Bolt-receiving bores 570 are circumferentially spaces about opening 542 in first end 540 of body 532 and extend through senlarged head 560 between inner and outer surfaces 562 and 564, respectively, thereof along corresponding axes which are parallel to the axis of passage 536. It is intended for each bolt-receiving bore 570 to axially align with a corresponding threaded, bolt-receiving bores 480 extending through support wall 472. As described, it can be understood that the diameter of second end 544 of body 532 adjacent enlarged head 560 is greater than the diameter of first end 544 of body 532.

[0096] With first end 520 of guide rod 471 is inserted through a corresponding tubular bearing sleeve 522, passage 536 through a corresponding collet 524 and aperture 481 in

support wall 472 of first mount 464 and second end 526 of guide rod 471 is inserted through a corresponding tubular bearing sleeve 522, passage 536 of a corresponding collet 524 and aperture 481 in support wall 472 of second mount 466, bolts 572 are inserted through corresponding bolt-receiving bores 570 through enlarged head 560 of collet 524 and into corresponding threaded, bolt-receiving bores 480 extending through support wall 472 of first mount 464. Tightening bolts 572 into corresponding threaded, bolt-receiving bores 480 extending through support wall 472 of first mount 464 causes body 532 of collet 524 to be urged into aperture 481 in support wall 472 of first mount 464. As body 532 of collet 524 to be urged into aperture 481 in support wall 472 of first mount 464, the spacing between first and second spaced sidewalls 550 and 552, respectively, is reduced, thereby narrowing slot 548 in body 532 and reduced the diameter of body 532. As the diameter of body 532 is reduced, inner surface 534 is compress against outer surface 580 of guide rod 471 so as to frictional retain first end 520 of guide rod 471 within first mount 464. In a similar manner, it can be understood that second end 526 of guide rod 471 may be frictionally retained within first mount 464. With first and second ends 520 and 526 of guide rod 471 frictionally retained within first and second mounts 464 and 466, respectively, of guide rod support assembly 462, it can be appreciated that guide rod 471 may be utilized to support and to guide linear movement, such as by linear actuator 580, FIG. 17, or the like, along one or more faces 20a-20d of frame member 12.

[0097] As described, the structural framing components described herein, namely, components 14, web assemblies 16, cross braces 18, and guide rod support assembly 462 provide an arrangement wherein the structural framing components, when placed under compression and/or extension, significantly reducing the influence of lateral loads thereon. By placing the structural framing components under compression and/or extension, structures assembled utilized the structural framing components can endure significantly greater working loads than current framing components.

[0098] In order to endure significantly greater working loads, extrusions of the framing components are designed such that, during the extruding process, the desired profile geometry precision of the framing components must be maintained, thereby resulting in desirable load bearing and minimum deflection for the assembled structure. It is contemplated for the connections between the structural framing components to exemplify "bonded connections." When experiencing lateral loads, these "bonded connectons" act as fused unions. It can be understood that frame assemblies constructed utilizing the structural framing component heretofore described define a precision assembly, with superior load bearing characteristics, minimum lateral load deflection and inherent stability when interconnected, thereby allowing a user to produce a cost-effective structure that will perform as well as a welded structure. Further, the modular design allows a user to modify or even repurpose the structural framing components for other uses. Further, it is noted the structural framing components of the present invention are self-aligning and create a bonded connection, thereby giving the assembled structural frame assemblies stability and strength, even when subjected to high loads and dynamics.

[0099] Although the best mode contemplated by the inventors of carrying out the present invention is disclosed above, practice of the above invention is not limited thereto. It will be manifest that various additions, modifications and rearrangements of the features of the present invention may be made without deviating from the spirit and the scope of the underlying inventive concept.

[0100] It should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure. Nothing in this application is considered critical or essential to the present invention unless explicitly indicated as being "critical" or "essential."

CLAIMS

I claim:

1. A guide rod support assembly for mechanically interlocking to a frame member having a face, comprising:

a rod having first and second ends; and

a first mount supporting the first end of the rod, the first mount including a base having an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face, the bolt-receiving bore extending along an axis at an acute angle to the inner face; and

a second mount supporting the second end of the rod, the second mount including a base having an inner face engageable with the face of the frame member at a location axially spaced from the first mount, an outer face and a bolt-receiving bore extending between the outer face of the base of the second mount and the inner face of the base of the second mount, the bolt-receiving bore of the base of the second mount extending along an axis at an acute angle to the inner face of the base of the second mount.

2. The guide rod support assembly of claim 1 wherein the inner face of the base of the first mount includes a rail, the rail defining an opening in communication with the bolt-receiving bore through the base of the first mount.

3. The guide rod support assembly of claim 2 wherein the rail is configured to be received into a corresponding slot in the face of the frame member.

4. The guide rod support assembly of claim 2 wherein the inner face of the base of the second mount includes a rail, the rail of the base of the second mount defining an opening in communication with the bolt-receiving bore through the base of the second mount.

5. The guide rod support assembly of claim 1 wherein the first mount includes a support wall extending from base of the first mount at an angle generally perpendicular thereto, the support wall including an inner face, an outer face directed at the second mount, and an aperture extending between the inner and outer faces of the support wall along an axis generally parallel to the inner surface of the base.

6. The guide rod support assembly of claim 5 wherein the first mount includes a collet adapted for receiving the first end of the rod, the collet extendable through the aperture in the support wall and being connectable to the support wall, wherein connection of the collet to the support wall frictionally connects the first end of the rod to the support wall.

7. The guide rod support assembly of claim 6 wherein the second mount includes a support wall extending from the base of the second mount at an angle generally perpendicular thereto, the support wall of the second mount including an inner face, an outer face directed at the first mount, and an aperture extending between the inner and outer faces of the support wall of the second mount along the axis of the aperture through the support wall of the first mount.

8. The guide rod support assembly of claim 7 wherein the second mount includes a collet adapted for receiving the second end of the rod, the collet of the second mount extendable through the aperture in the support wall of the second mount and being connectable to the support wall of the second mount, wherein connection of the collet of the second mount to the support wall of the second mount frictionally connects the second end of the rod to the support wall of the second mount.

9. A guide rod support assembly for mechanically interlocking to a frame member having a face, comprising:

a rod having first and second ends;

a mount including a support wall having an inner face, an outer face, and an aperture extending between the inner and outer faces of the support wall along an axis; and

a collet adapted for receiving the first end of the rod, the collet insertable into the aperture in the support wall and being connectable to the support wall, wherein connection of the collet to the support wall frictionally connects the first end of the rod to the support wall.

10. The guide rod support assembly of claim 9 wherein the mount includes a base extending from the support wall and has an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face, the bolt-receiving bore extending along an axis at an acute angle to the inner face.

11. The guide rod support assembly of claim 9 wherein the inner face of the base of the mount includes a rail, the rail defining an opening in communication with the bolt-receiving bore through the base of the mount.

12. The guide rod support assembly of claim 11 wherein the rail is configured to be received into a corresponding slot in the face of the frame member.

13. The guide rod support assembly of claim 9 wherein the mount is a first mount and the collet is a first collet and further comprising:

a second mount including a support wall having an inner face, an outer face, and an aperture extending between the inner and outer faces of the support wall of the second mount along an axis; and

a second collet adapted for receiving the second end of the rod, the second collet insertable into the aperture in the support wall of the second mount and being connectable to the support wall of the second mount, wherein connection of the second collet to the support wall of the second mount frictionally connects the second end of the rod to the support wall of the second mount.

14. The guide rod support assembly of claim 9 wherein:

the first mount includes a base extending from the support wall of the first mount and having an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face of the base, the bolt-receiving bore extending along an axis at an acute angle to the inner face of the base; and

the second mount includes a base extending from the support wall of the second mount and having an inner face engageable with the face of the frame member at a location axially spaced from the first mount, an outer face and a bolt-receiving bore extending between the outer face of the base of the second mount and the inner face of the base of the second mount, the bolt-receiving bore of the base of the second mount extending along an axis at an acute angle to the inner face of the base of the second mount.

15. A mount for a guide rod support assembly for supporting a guide rod on a frame member having a face, comprising:

a support wall having an inner face, an outer face, and an aperture extending between the inner and outer faces of the support wall along an axis;

a base extending from the support wall and having an inner face engageable with the face of the frame member, an outer face and a bolt-receiving bore extending between the outer face and the inner face, the bolt-receiving bore extending along an axis at an acute angle to the inner face; and

a collet adapted for receiving a first end of the rod, the collet insertable into the aperture in the support wall.

16. The mount of claim 15 wherein:

thc collet is connectable to the support wall; and

connection of the collet to the support wall frictionally connects the first end of the guide rod to the support wall

17. The guide rod support assembly of claim 15 wherein the inner face of the base of the mount includes a rail, the rail defining an opening in communication with the bolt-receiving bore through the base of the mount.

18. The guide rod support assembly of claim 17 wherein the rail is configured to be received into a corresponding slot in the face of the frame member.

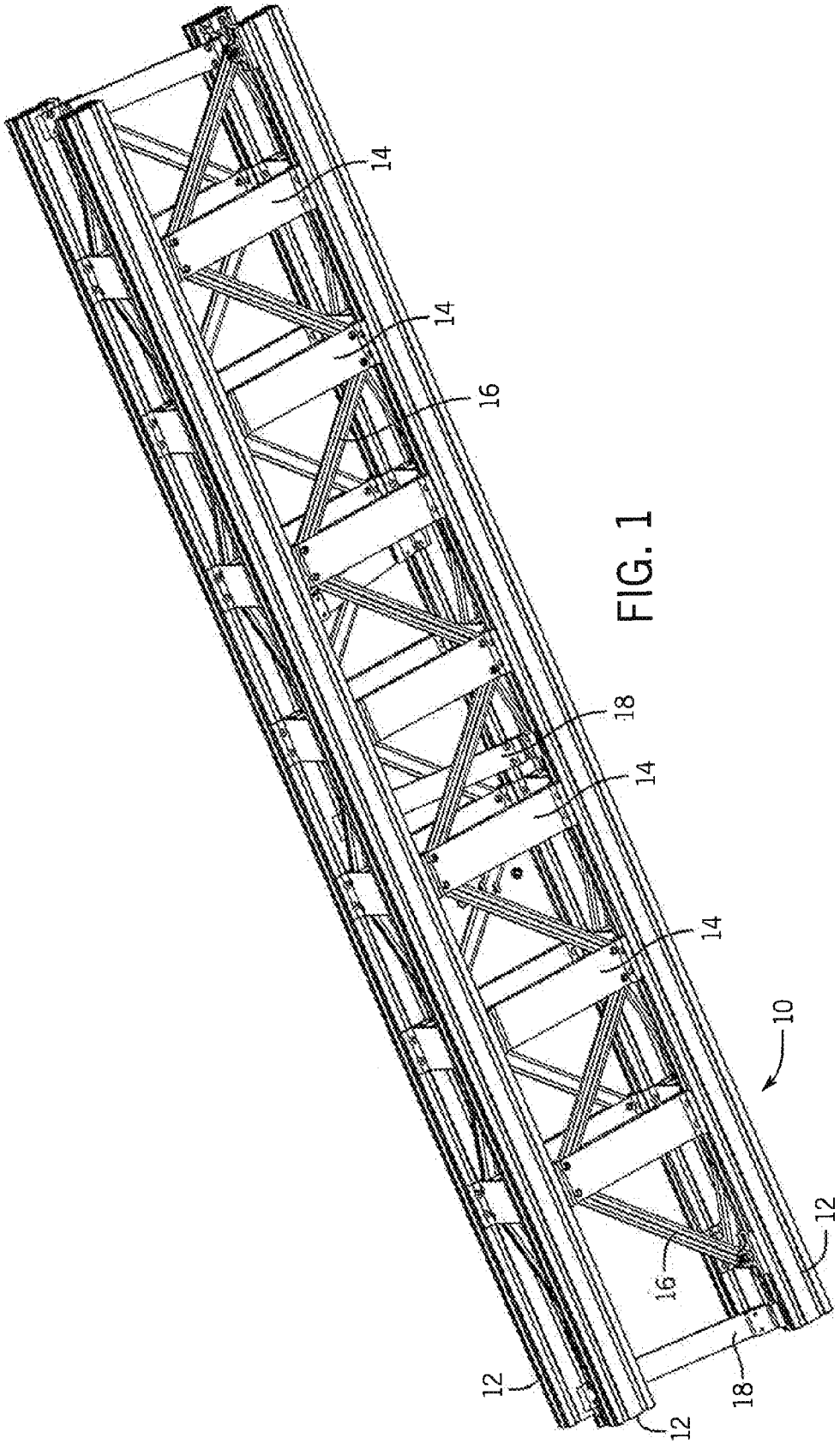

FIG. 1

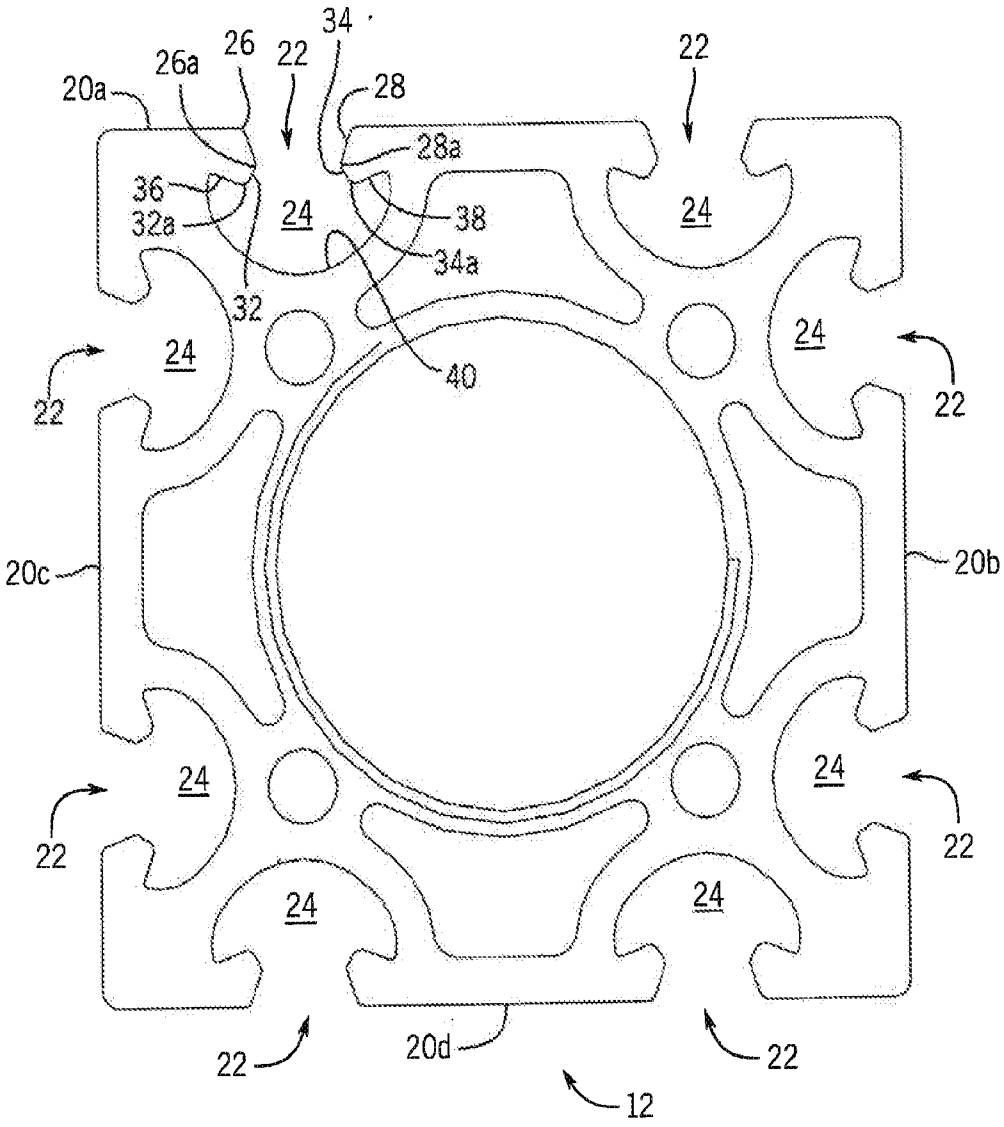
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FIG. 2

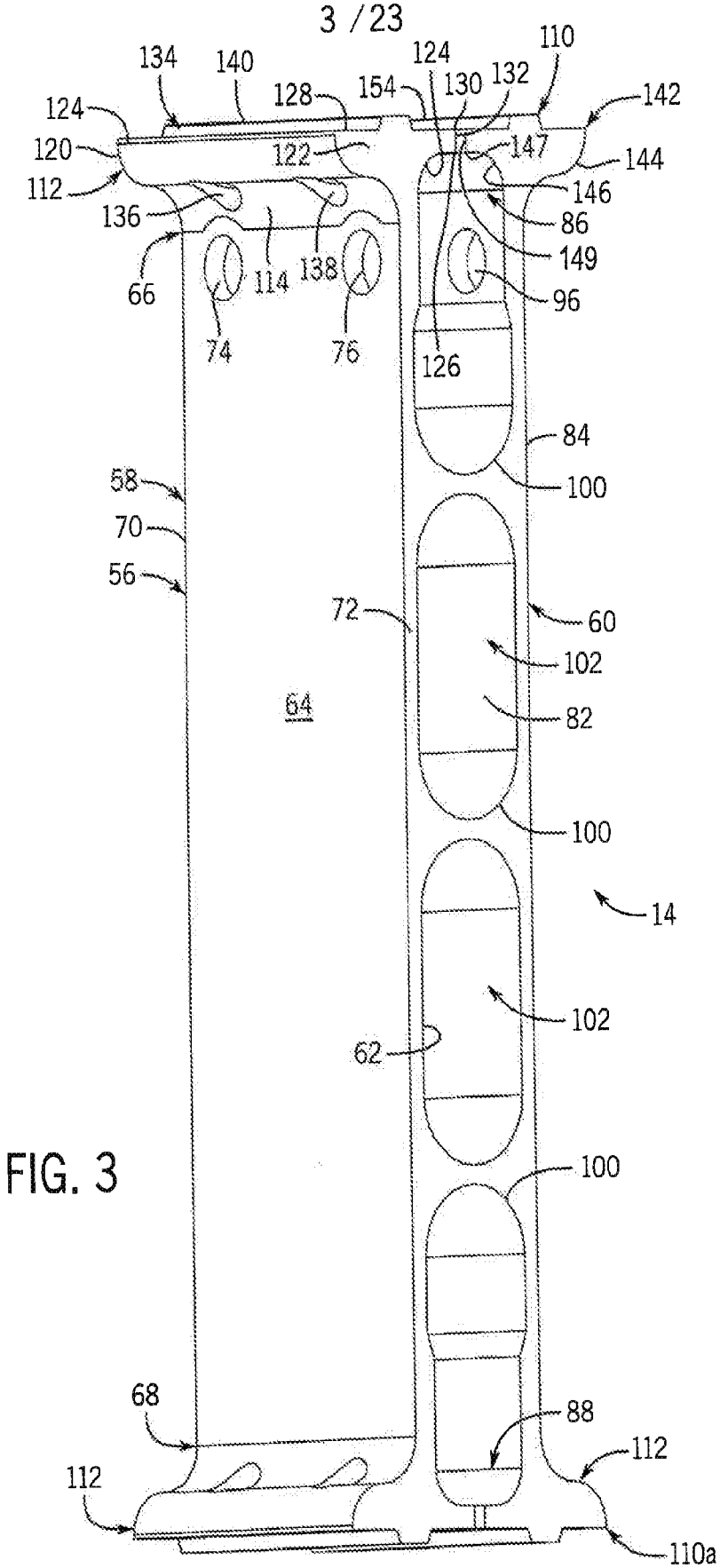
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FIG. 3

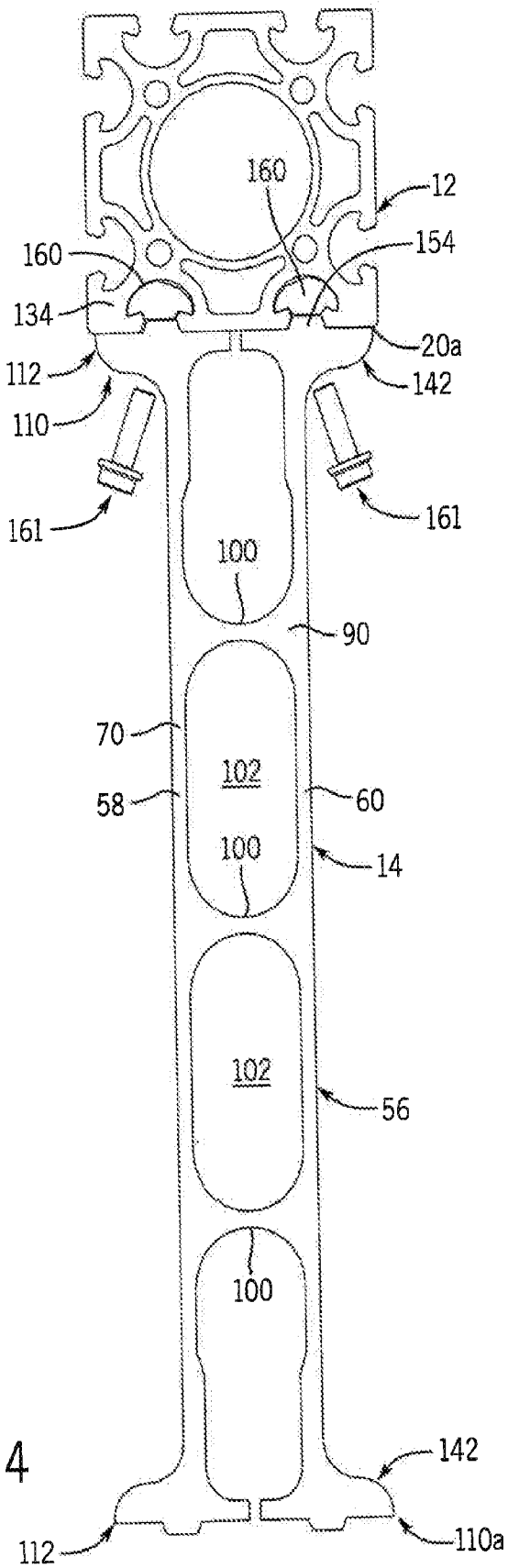
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FIG. 4

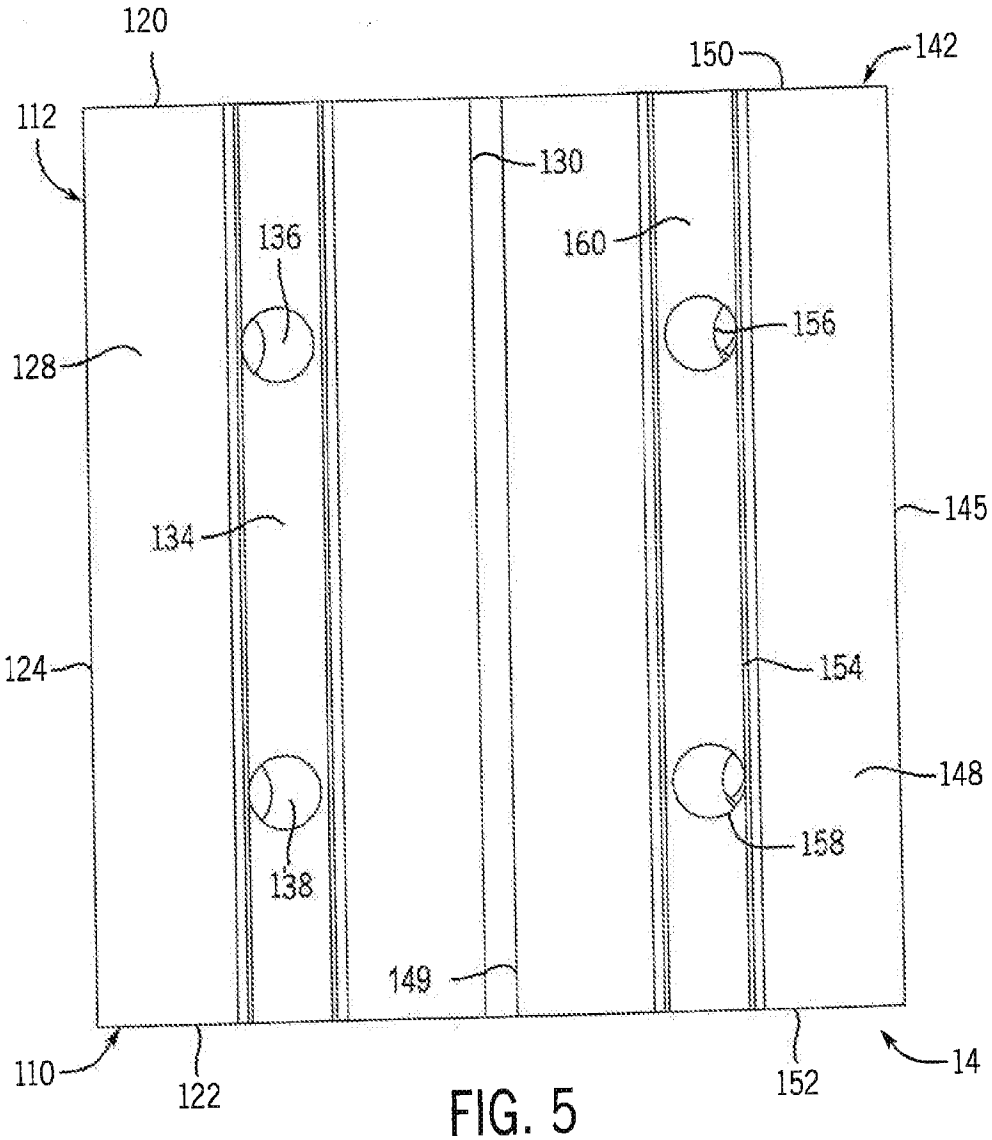
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FIG. 5

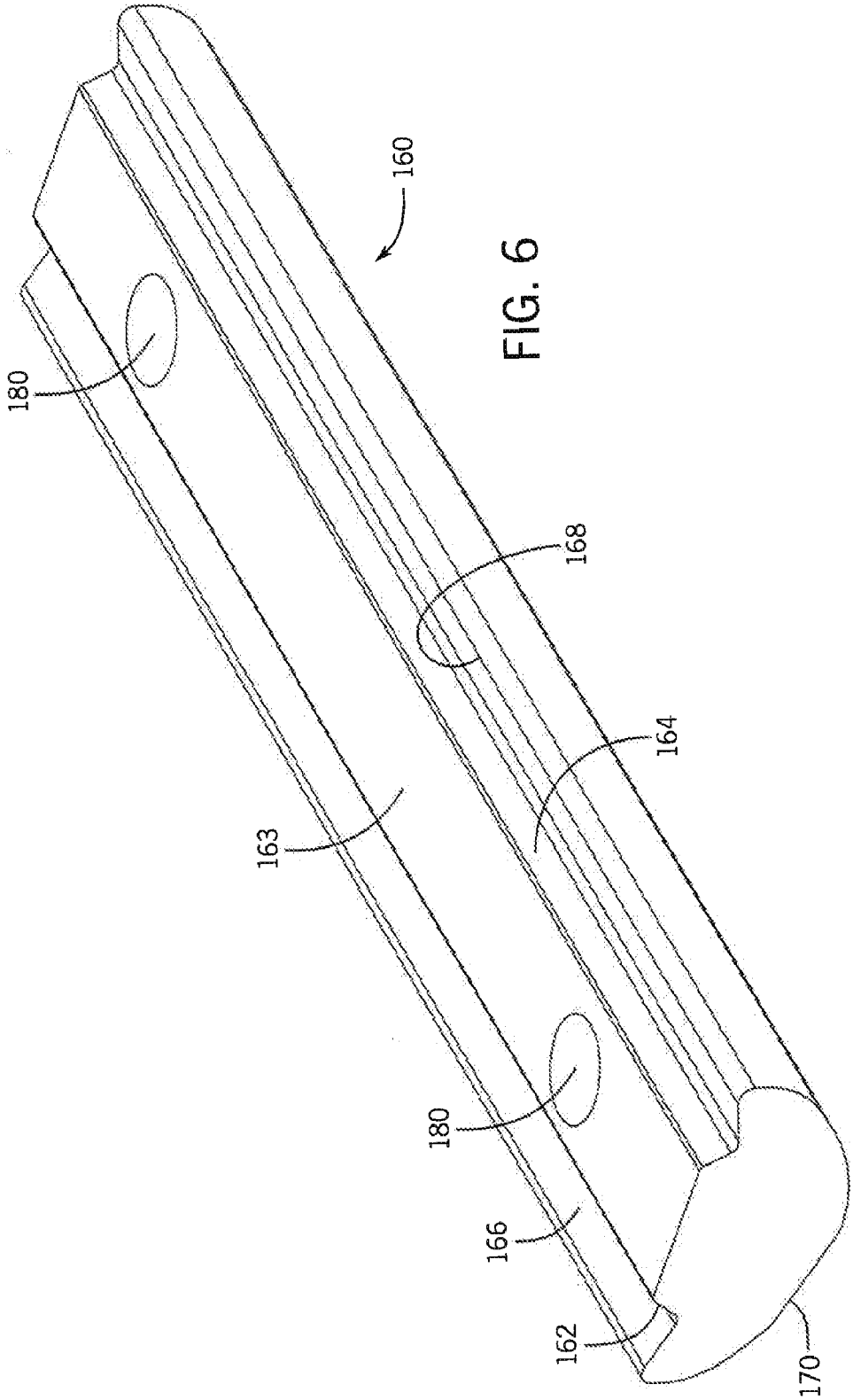

FIG. 6

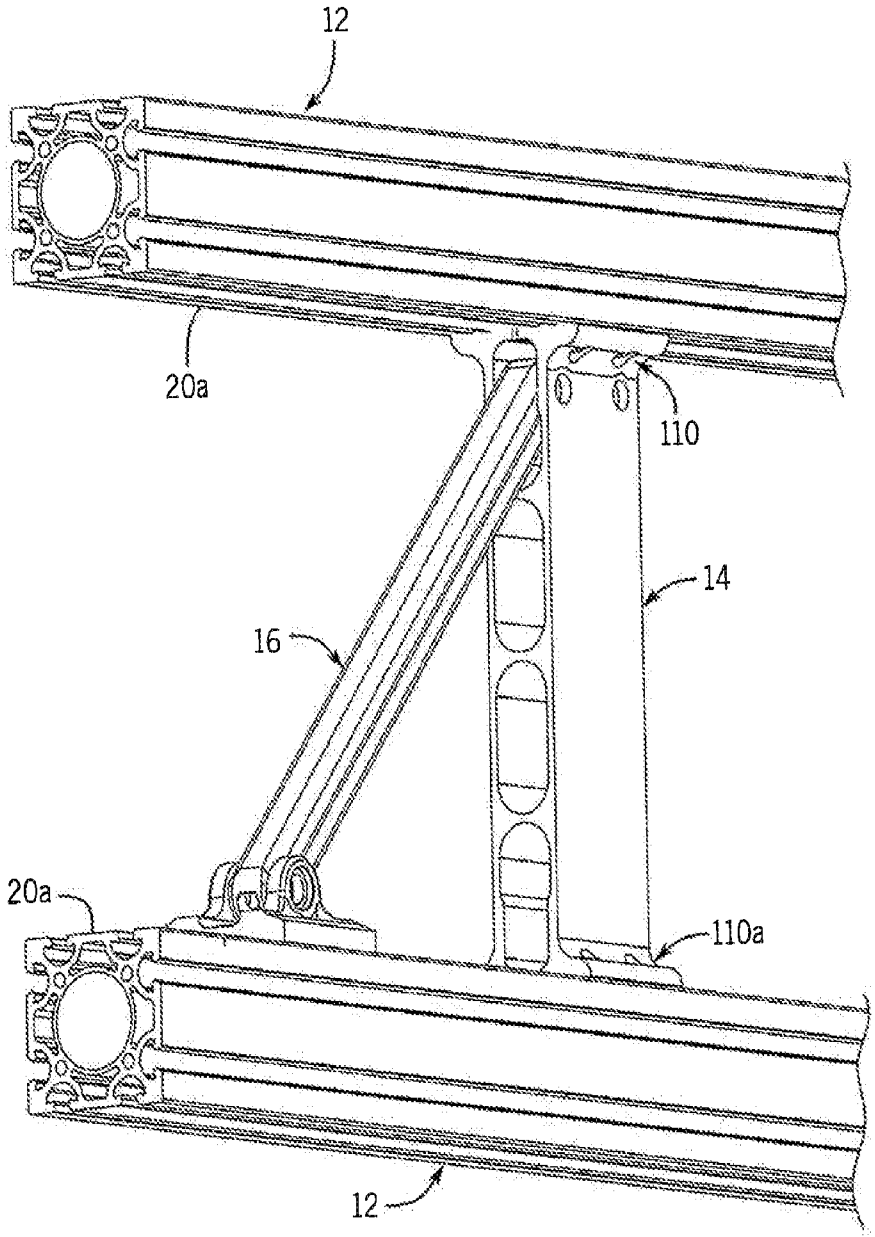

FIG. 7

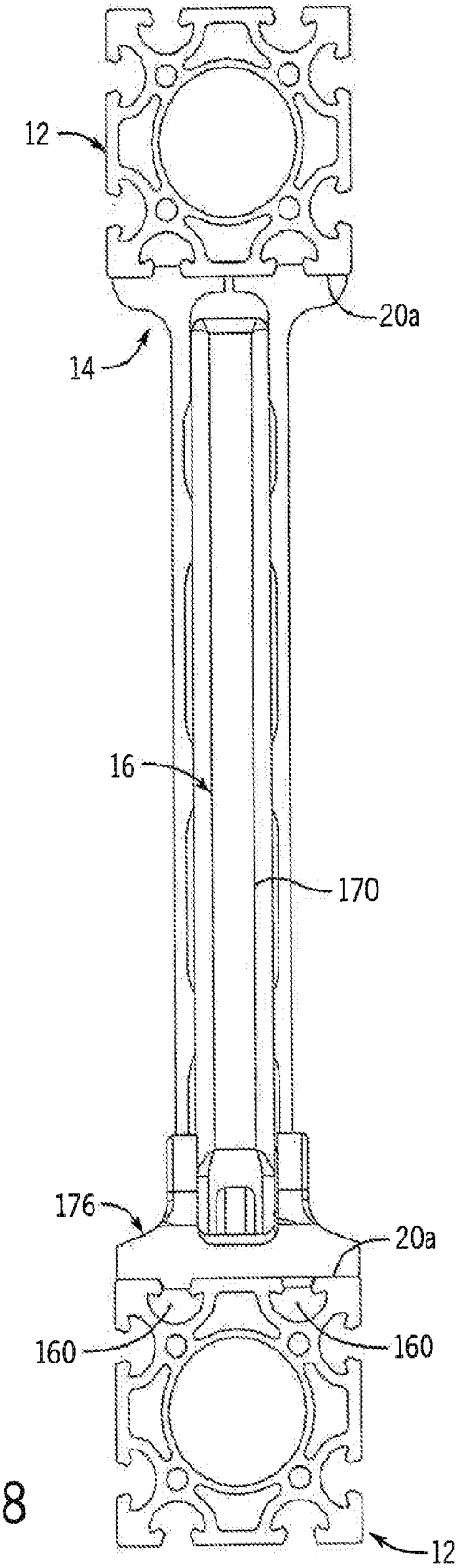

FIG. 8

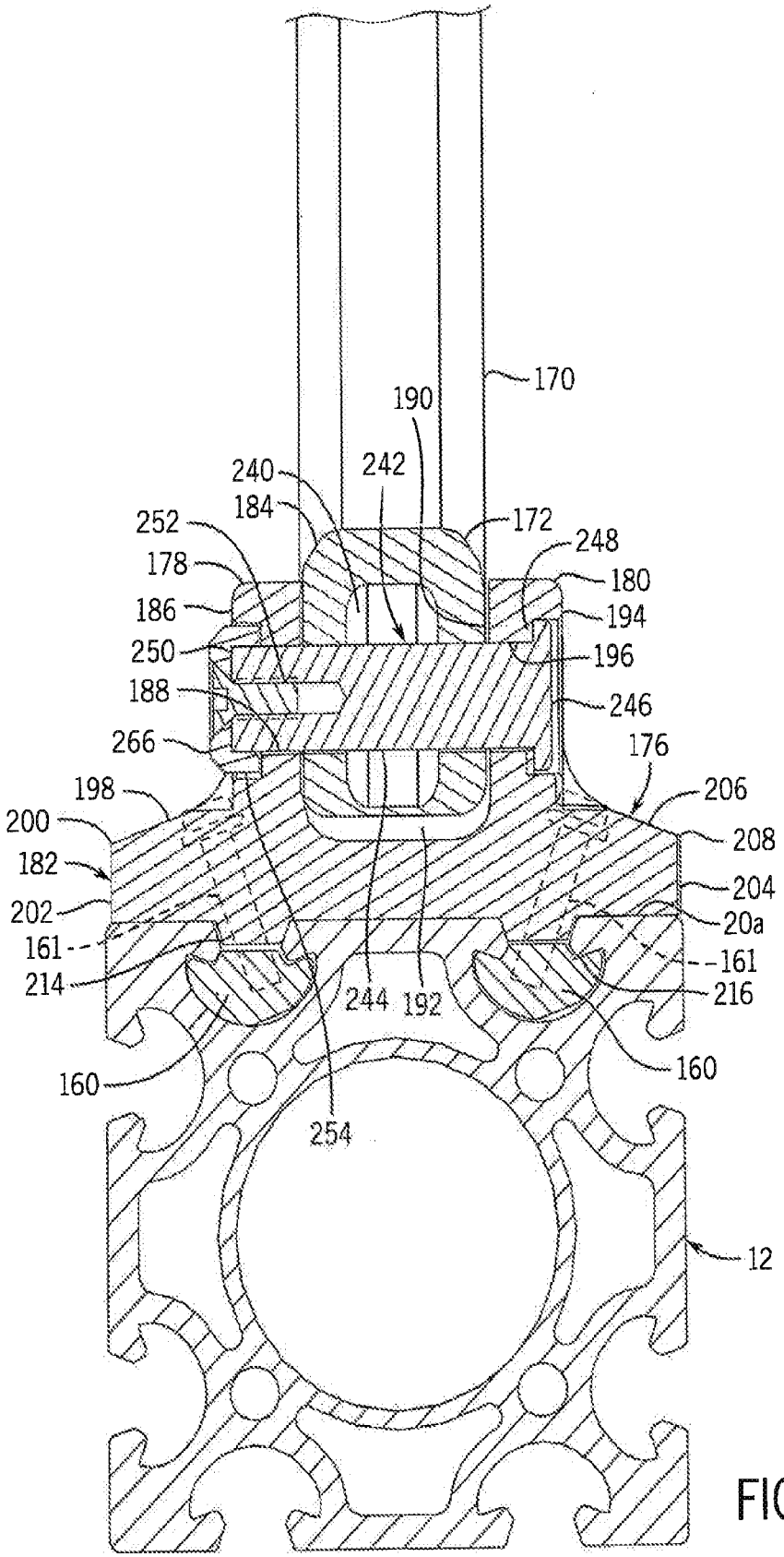
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FIG. 9

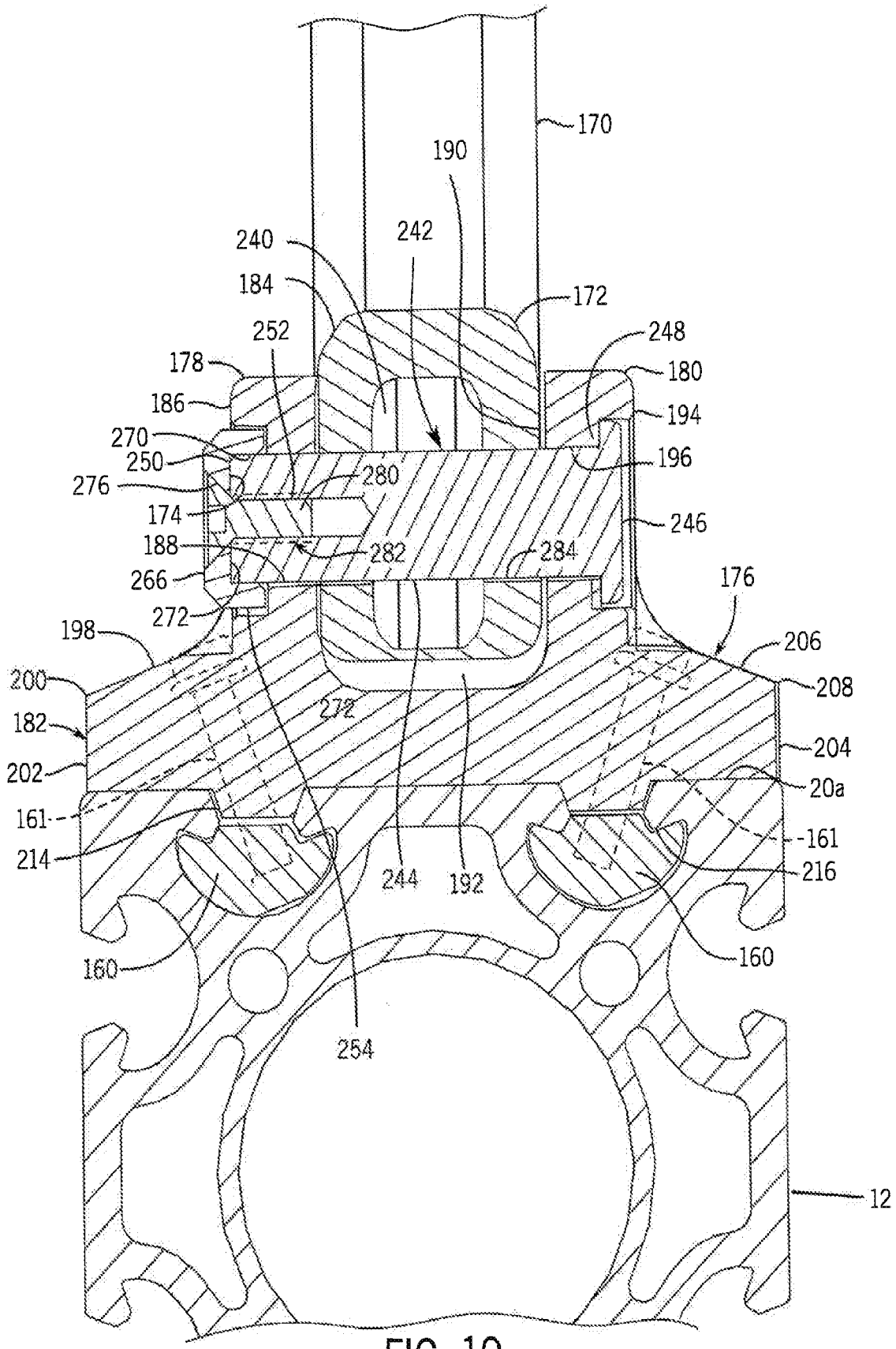
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FIG. 10

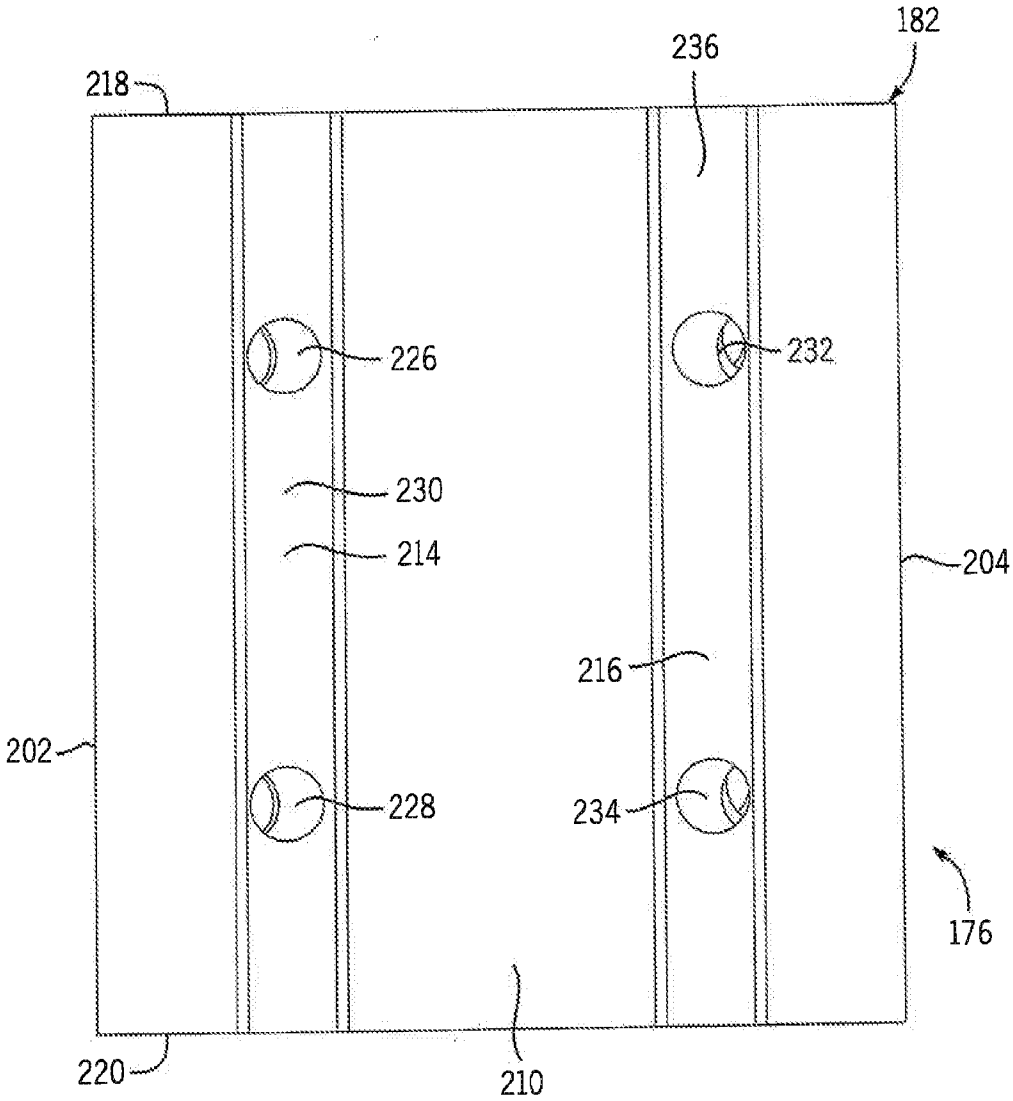

FIG. 11

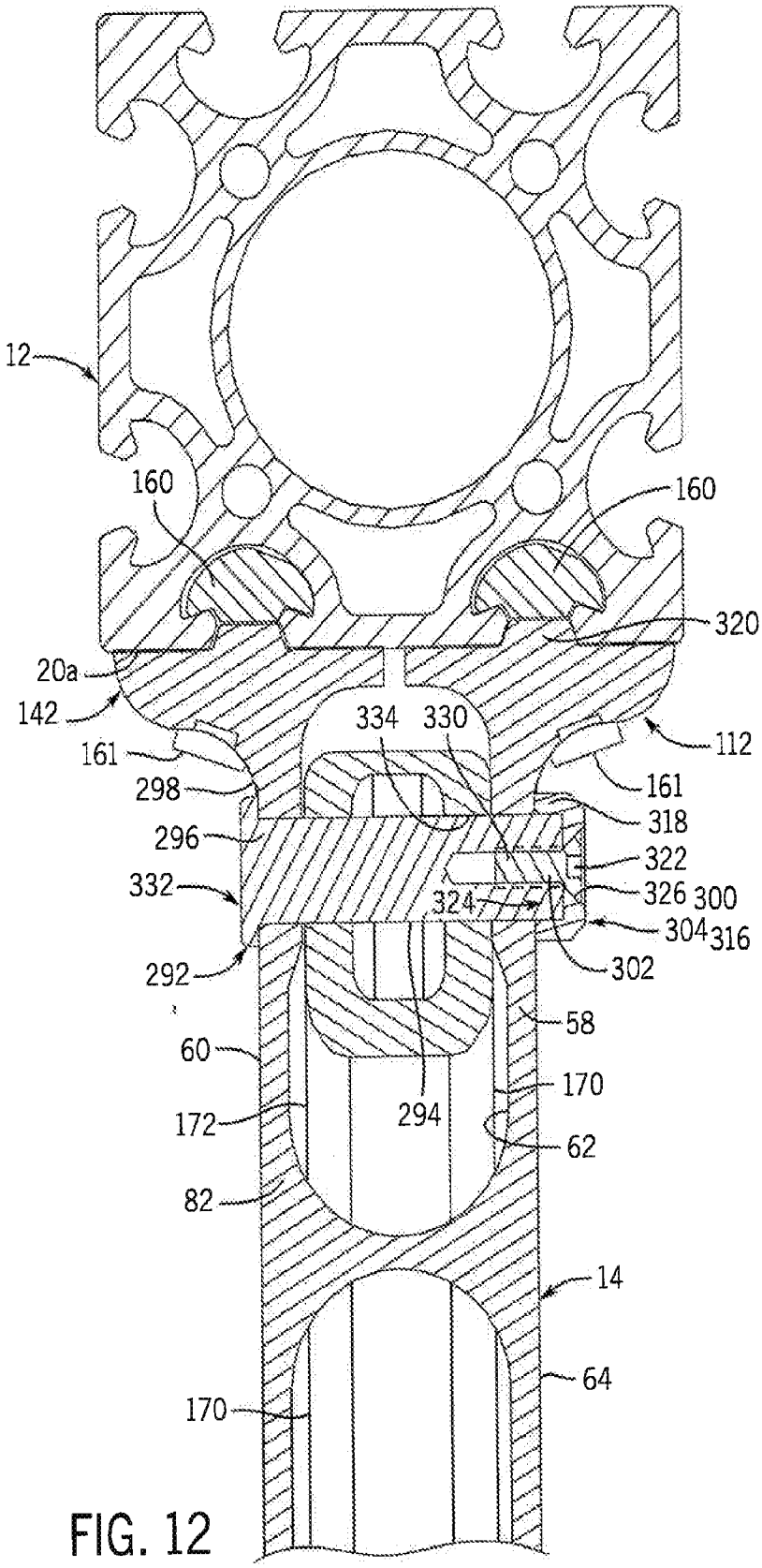
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FIG. 12

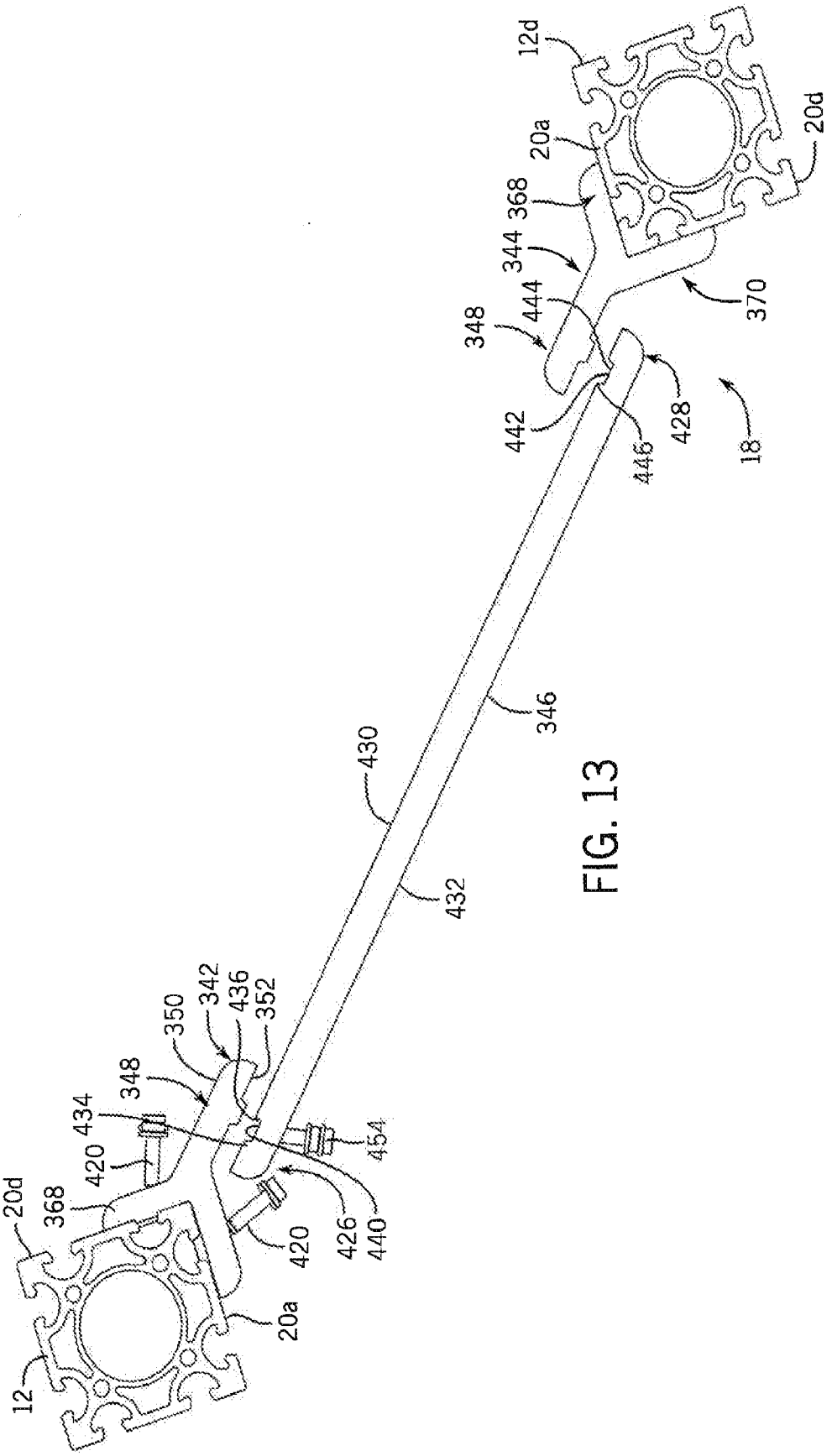
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FIG. 13

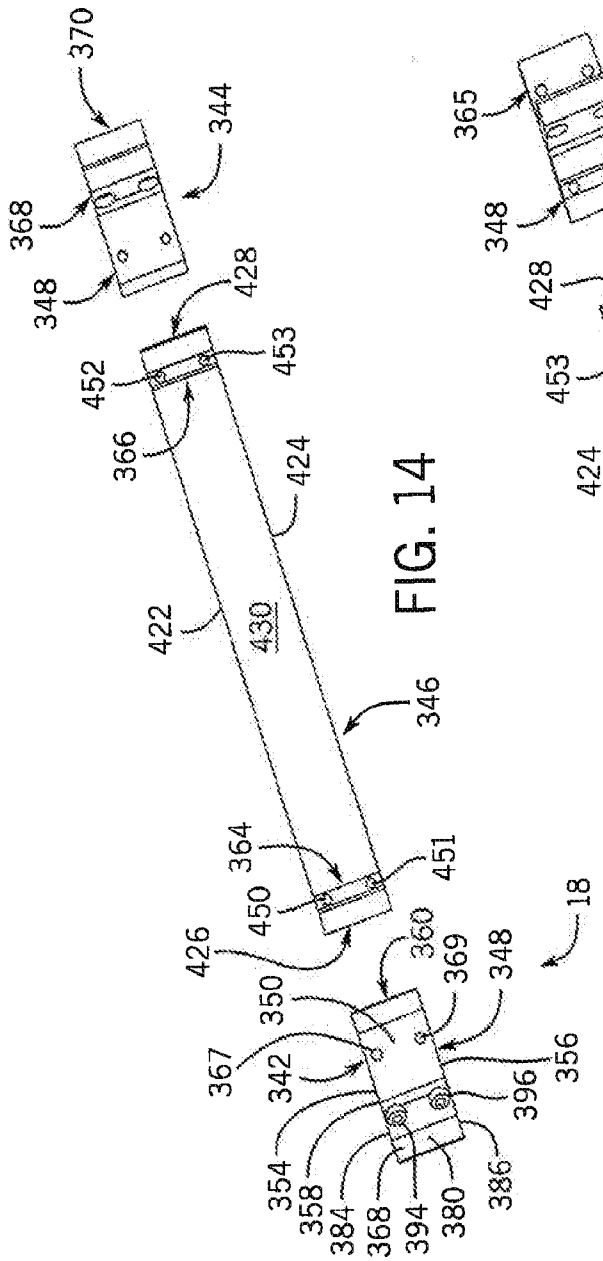
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FIG. 14

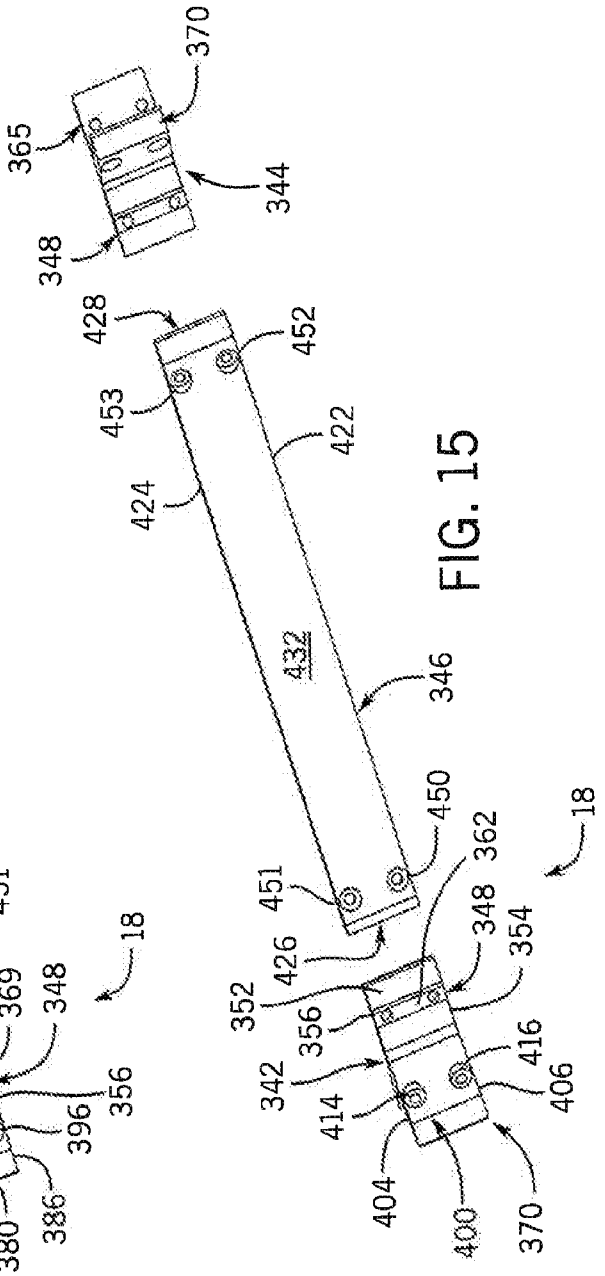
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FIG. 15

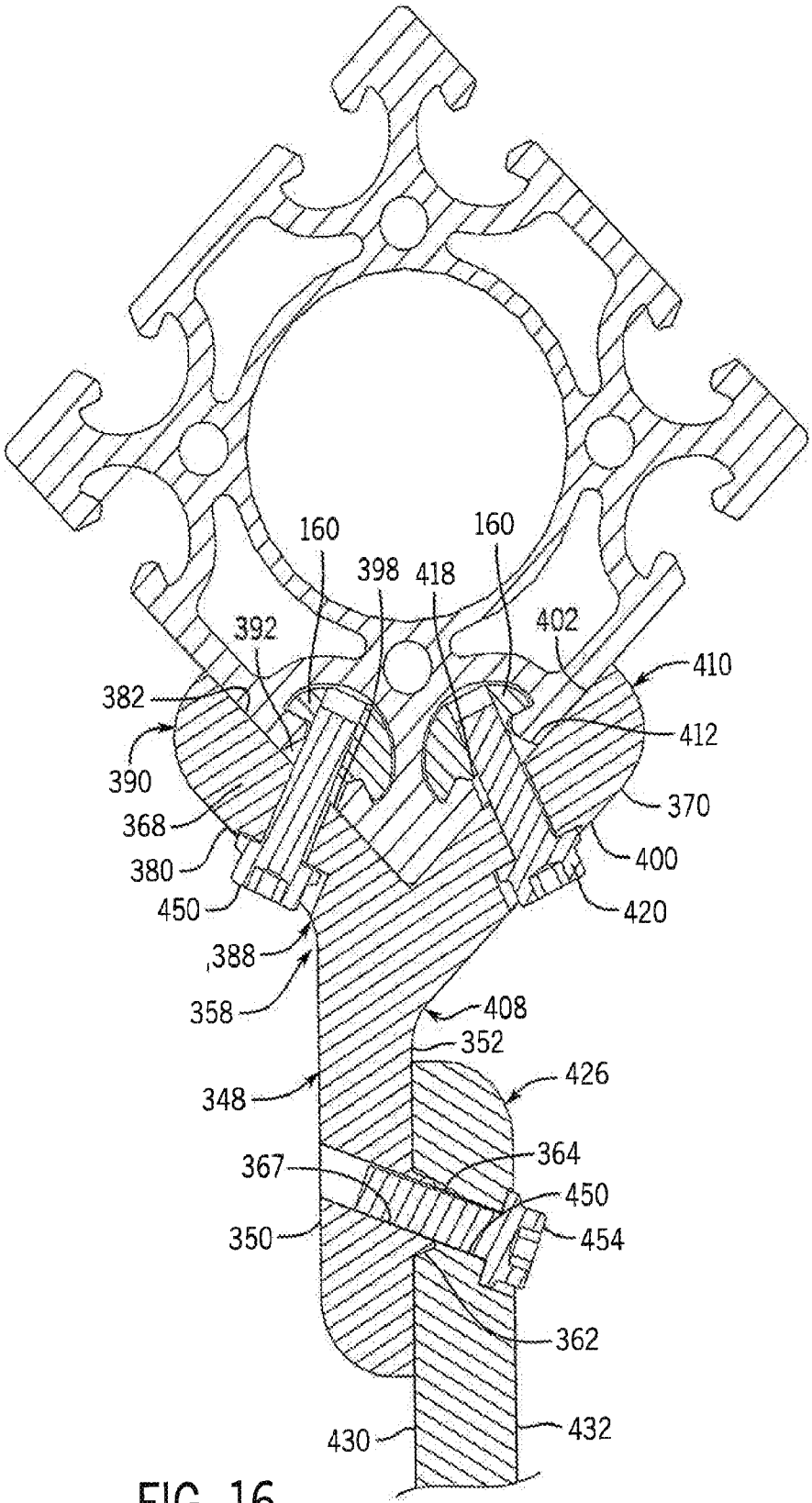
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FIG. 16

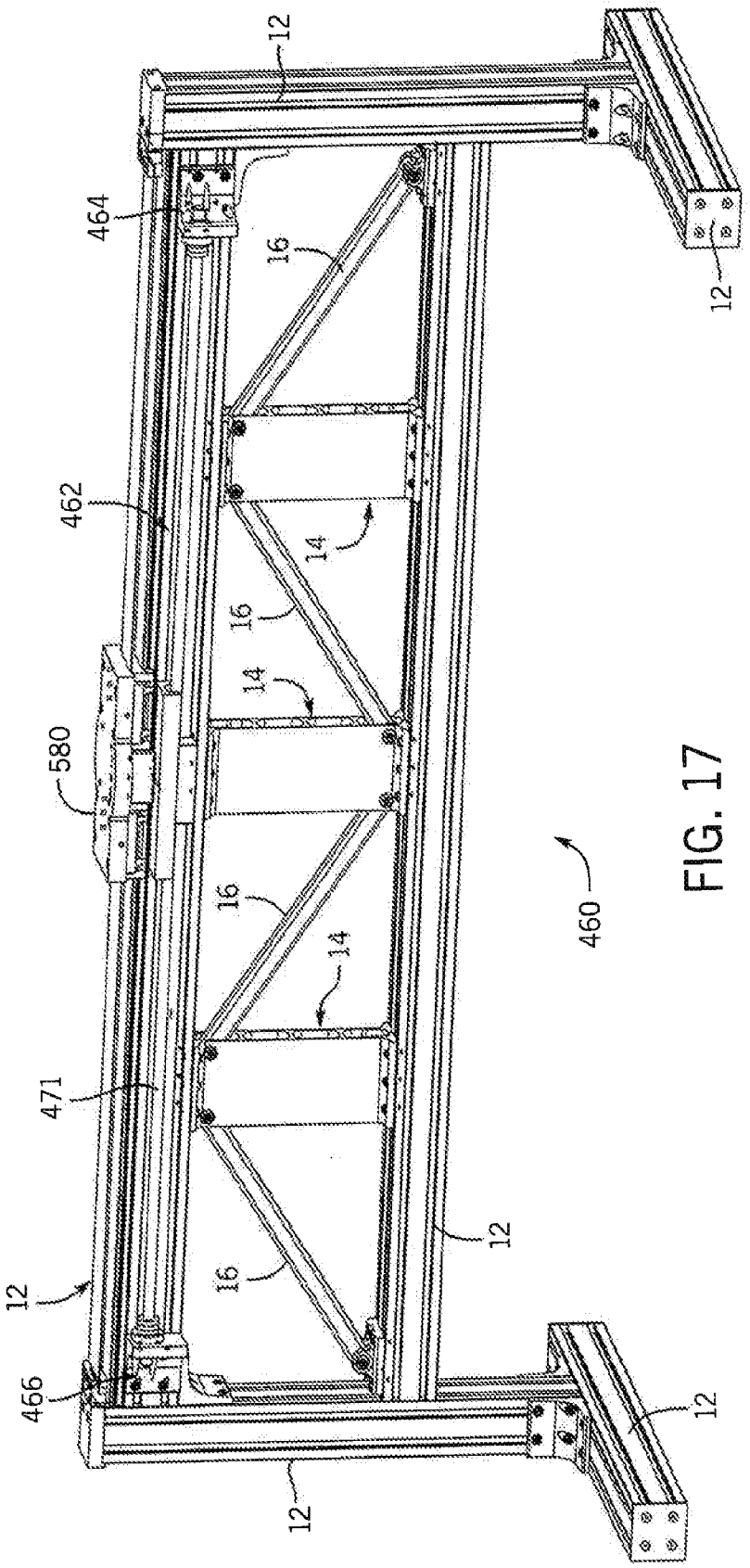

FIG. 17

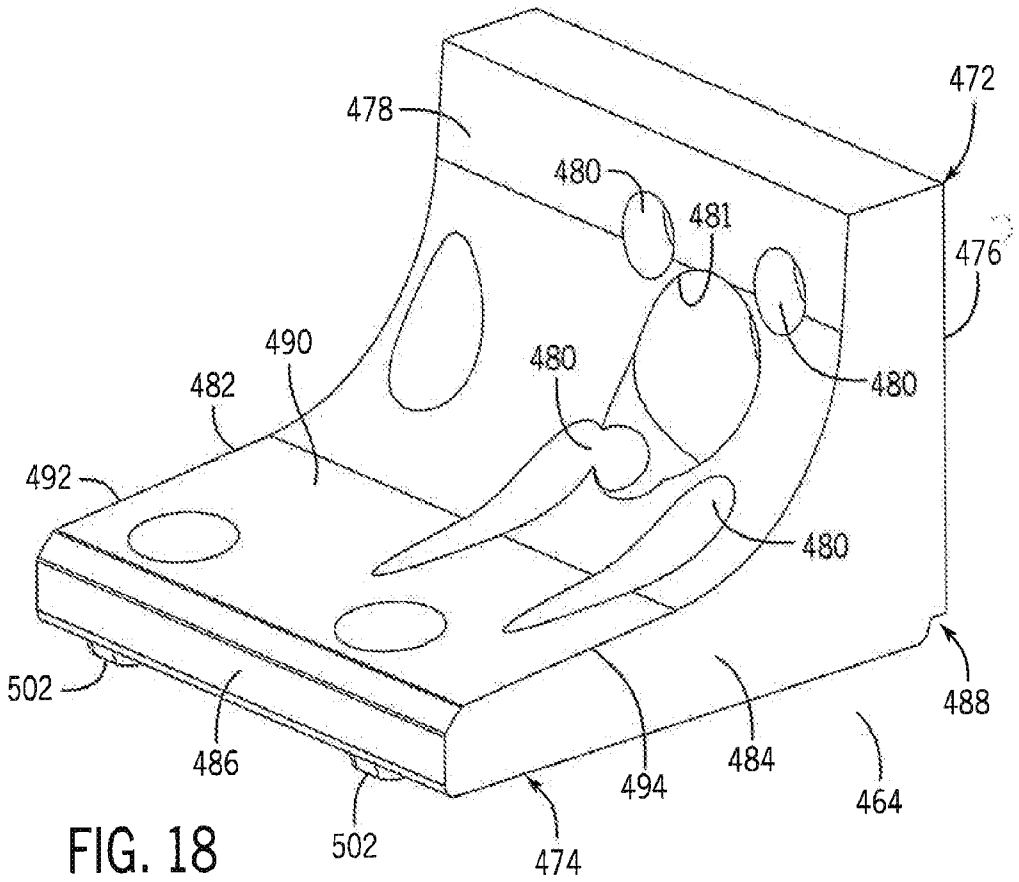
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FIG. 18

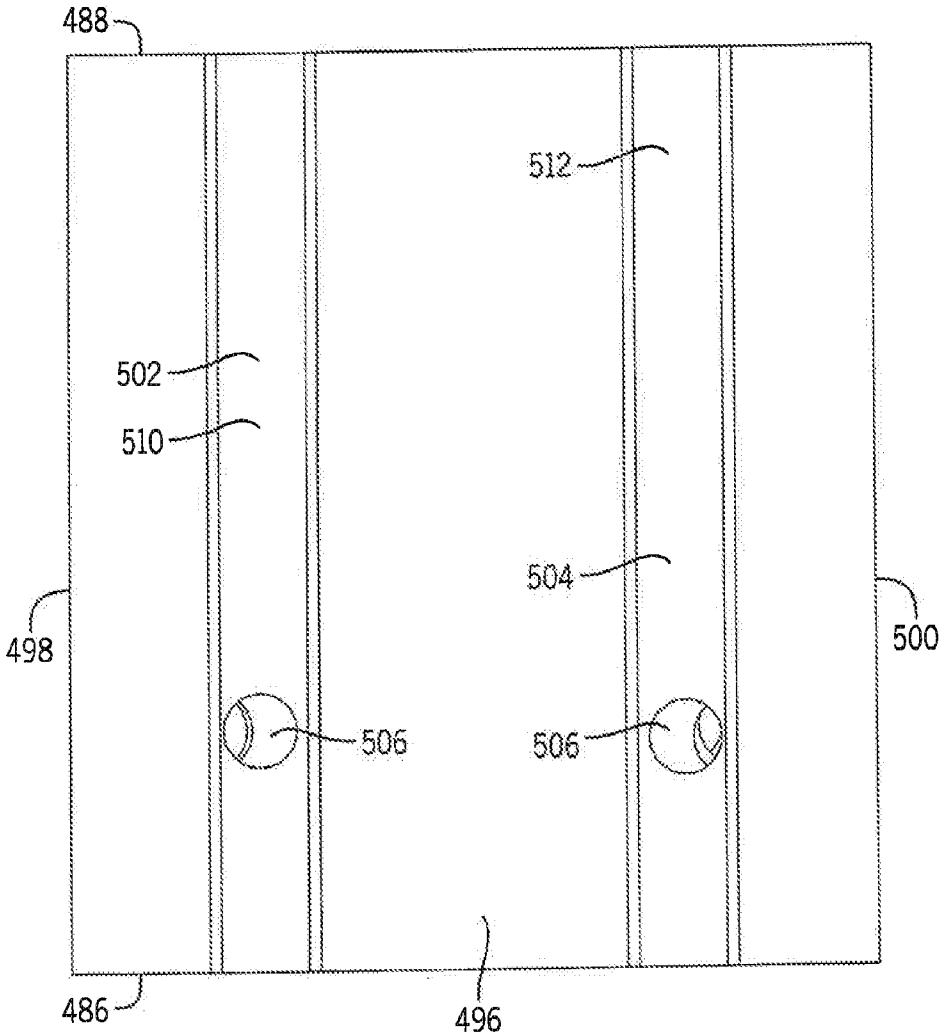

FIG. 19

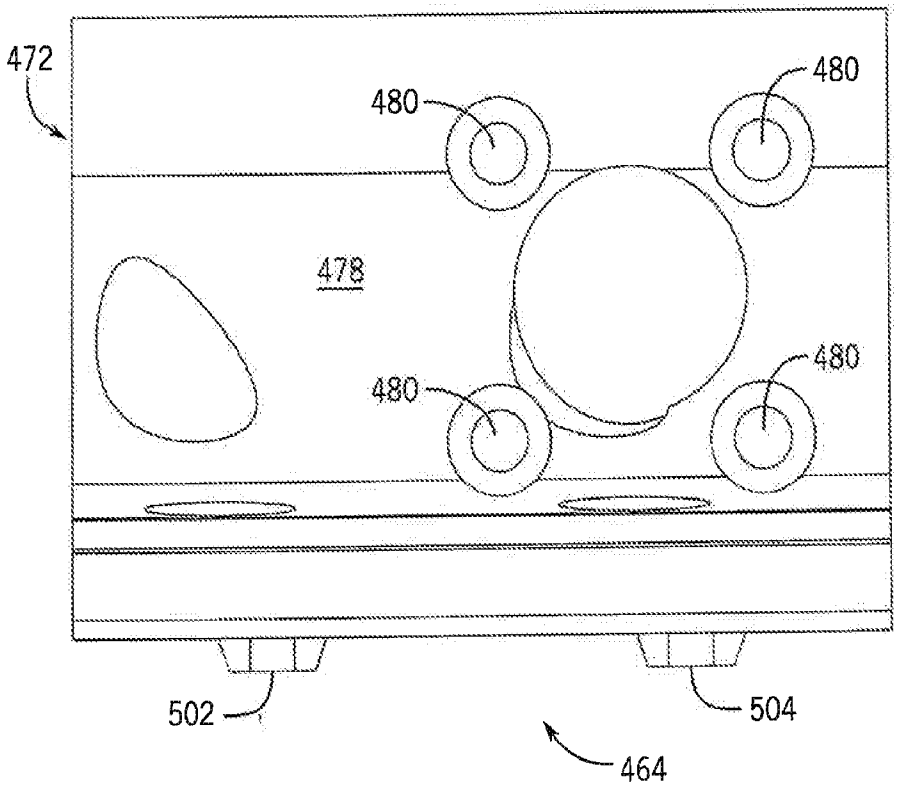

FIG. 20

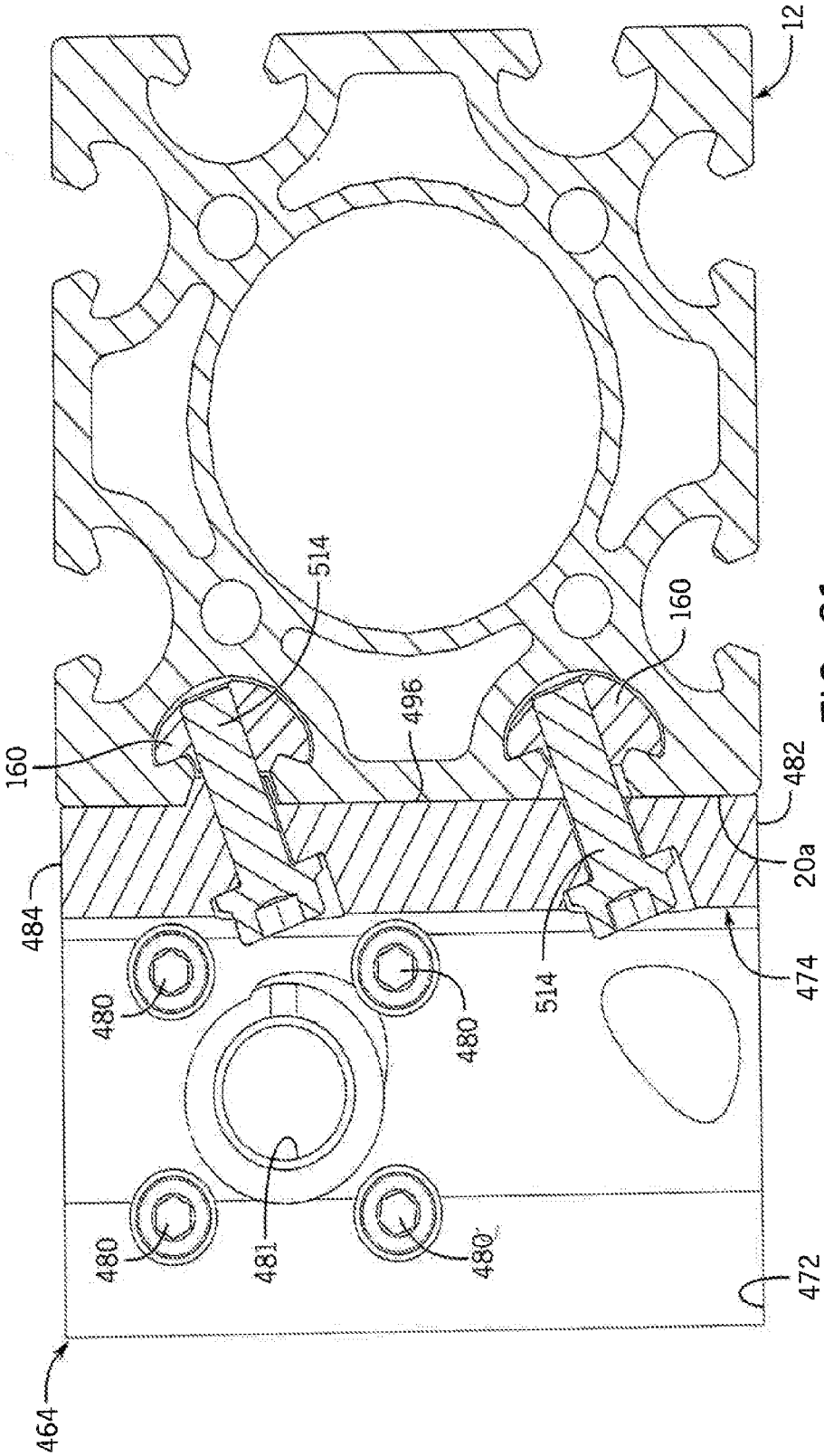
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FIG. 21

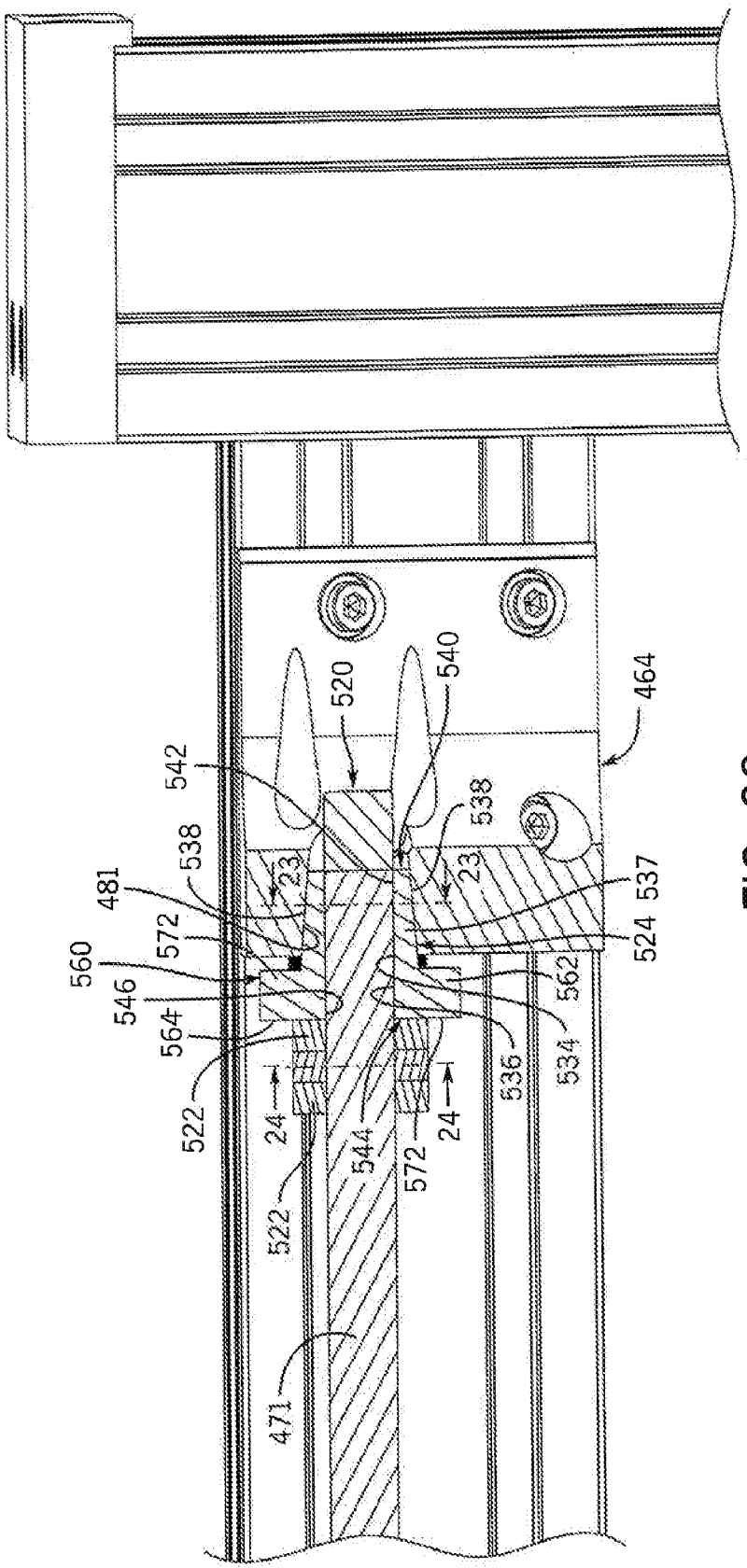
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FIG. 22

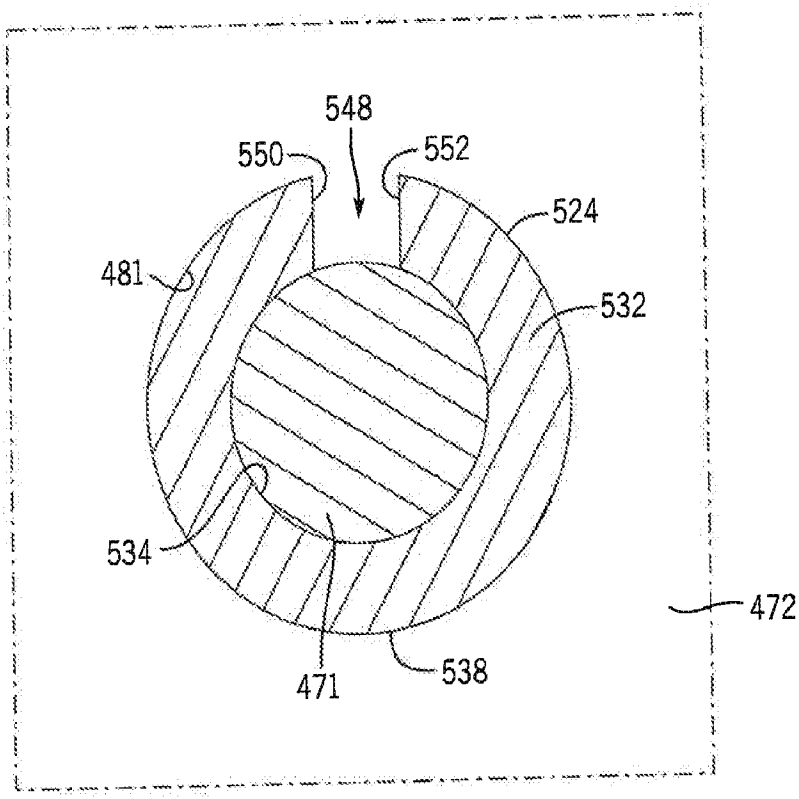

FIG. 23

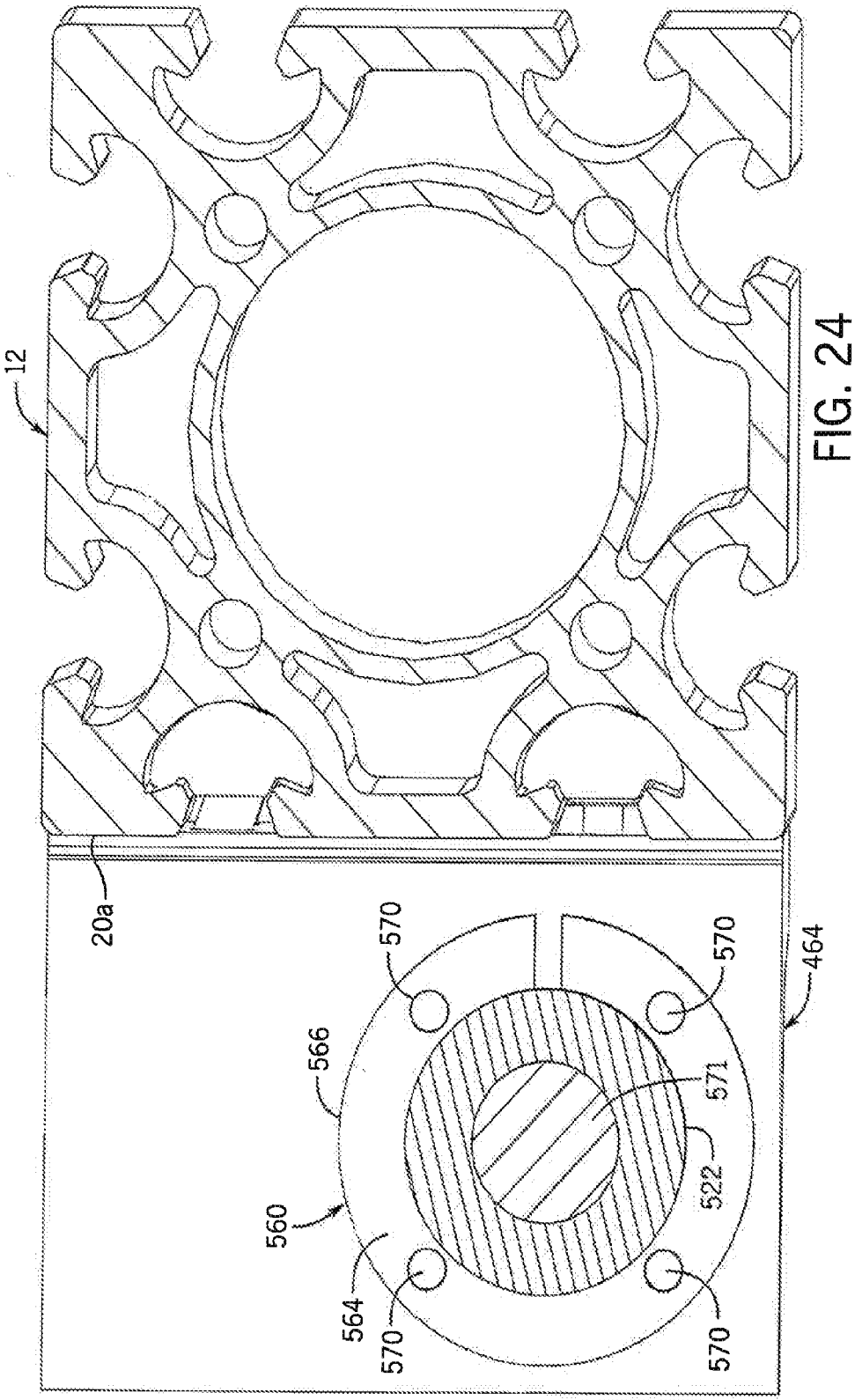

FIG. 24

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/054878

A. CLASSIFICATION OF SUBJECT MATTER

F16B 5/12(2006.01)i; **E04B 1/24**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16B 5/12(2006.01); B31B 1/28(2006.01); B65D 19/06(2006.01); B66C 13/00(2006.01); E04B 1/24(2006.01); E04B 1/58(2006.01); F16B 7/04(2006.01); F16B 7/18(2006.01); F16D 1/10(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: bolt, guide rod, mount, frame, opening, rail, slot, collet, friction, assembly

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 2007-0142195 A1 (OETLINGER, FRANK E.) 21 June 2007 (2007-06-21)	
X	paragraphs [0065]-[0078], claim 1 and figures 1-4	1-4
Y		9,11-12,14-18
A		5-8,10,13
	US 2012-0189381 A1 (FAIRCHILD et al.) 26 July 2012 (2012-07-26)	
Y	claim 1	9,11-12,14-18
	JP 2022-027316 A (HIROHO K.K.) 10 February 2022 (2022-02-10)	
A	paragraph [0035] and figure 1	1-18
	JP 2013-181336 A (JFE STEEL CORP.) 12 September 2013 (2013-09-12)	
A	paragraphs [0017]-[0027]	1-18

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 February 2025	**18 February 2025**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **189 Cheongsa-ro, Seo-gu, Daejeon** **35208, Republic of Korea**	**PARK, Tae Wook**
Facsimile No. **+82-42-481-8578**	Telephone No. **+82-42-481-3405**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/054878

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 208454309 U (HENAN DONGQI MACHINERY CO., LTD.) 01 February 2019 (2019-02-01) claims 1-4 and figure 2	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2024/054878

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2007-0142195 A1	21 June 2007	AT E488339 T1	15 December 2010
		AU 2003-237328 A1	22 December 2003
		CA 2488624 A1	18 December 2003
		CA 2488624 C	22 February 2011
		EP 1509470 A1	02 March 2005
		EP 1509470 B1	17 November 2010
		ES 2358069 T3	05 May 2011
		US 2003-0226869 A1	11 December 2003
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		US 6712254 B2	30 March 2004
		US 6715953 B2	06 April 2004
		US 6796474 B2	28 September 2004
		US 6942132 B2	13 September 2005
		US 7143916 B2	05 December 2006
		US 7182235 B2	27 February 2007
		US 7185797 B2	06 March 2007
		WO 03-104124 A1	18 December 2003
US 2012-0189381 A1	26 July 2012	None	
JP 2022-027316 A	10 February 2022	JP 7213496 B2	27 January 2023
JP 2013-181336 A	12 September 2013	JP 5982879 B2	31 August 2016
CN 208454309 U	01 February 2019	None	