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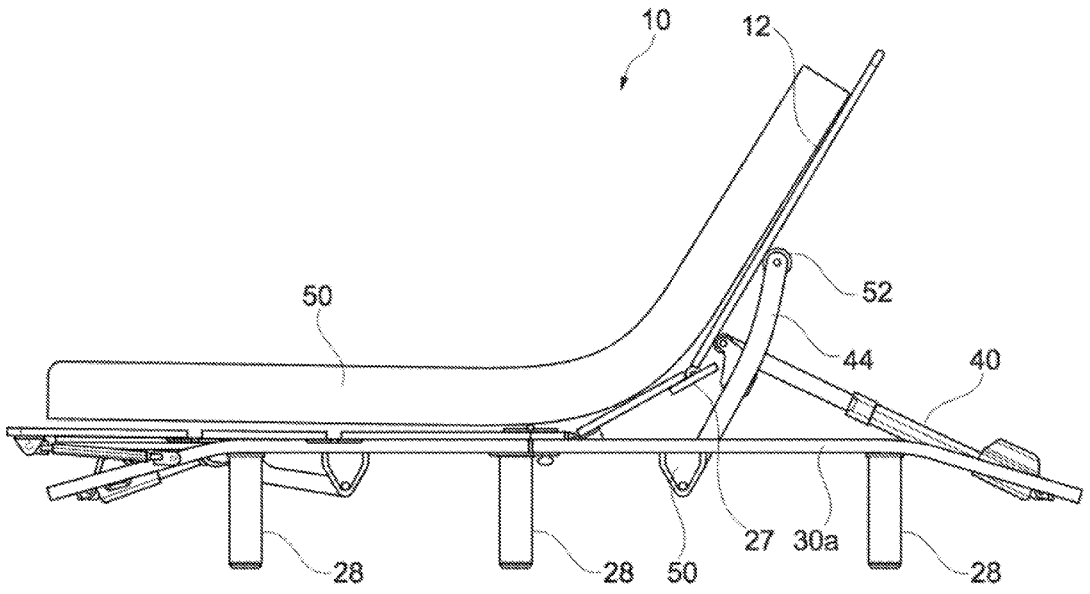

Fig. 6a

(57) Abstract: An article of adjustable furniture (10) comprising at least one support section (12) and a drive mechanism (40) operable to effect pivotal movement of the at least one support section (12), the drive mechanism (40) including at least a first and a second component pivotally joined by a bearing assembly (52), such that operation of the drive mechanism causes pivotal movement between the first and second components so as to effect pivotal movement of the at least one support section.

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ADJUSTABLE FURNITURE

The present invention relates to an article of adjustable furniture such as a chair or a bed, and in particular concerns adjustable furniture having one or more adjustable support sections which can be moved to adjust the configuration of the furniture.

Known articles of adjustable furniture comprise complex mechanisms driven by one or more actuators between different configurations. US2002/0174487 discloses a hospital bed having adjustable back and thigh sections for supporting the occupant in various positions, for example in a flat horizontal position, in a recumbent or semi-recumbent position or simply with the backrest raised. The hospital bed of US2002/0174487 comprises a frame having a pair of parallel and spaced apart first and second side frame members; a mattress support deck including an adjustable back; a fixed seat section located adjacent to the back section; and, an adjustable thigh section located adjacent to the seat section. The thigh section is movable longitudinally relative to the seat section, to increase the length of the thigh section as it is raised relative to the frame. First and second curved tubes are coupled to respective first and second sides of the back section. A plurality of rollers are coupled to the first and second side frame members, with the rollers being configured to support the first and second curved tubes to permit movement of the curved tubes and the backrest section relative to the frame. A linear actuator is disposed beneath the back rest section and coupled to the first and second tubes to move the back rest section from a horizontal position to an elevated position relative to the frame. Two concentric arcuate tubes are provided on each side of the bed which have a radius of curvature centred on a location which emulates the natural hip pivot of a person lying on the mattress of the bed. The tubes are secured between three rollers on each side of the bed. Two rollers are located on a bottom side of the radially outer tube, that is to say radially outwards thereof, and the third roller is located on a top side of the radially inner tube. Cross-members extend between the tubes. The arrangement provides a so called shear-less pivot mechanism in which the adjustable back section pivots about 30 the natural hip point of the person on the bed.

The arrangement disclosed in US2002/0174487 may be considered heavy, robust and mechanically complex.

In a modern domestic setting, where mattress thicknesses of 12 to 18 inches are common, and more typically 14 to18 inches in the United States, the overall weight, stiffness and rigidity of the mattress can place an unacceptable load on the operating mechanism of the bed, for example thicker, heavier mattresses can cause the motor (actuator) to struggle and reduce the longevity of the motor and mechanism. This is becoming increasingly relevant as the

market place is driven by customer demand for thicker mattresses. Motorised adjustable beds have been known to fail after a short number of cycles using mattresses of the afore-mentioned thickness. One way to overcome this has been to use special, more flexible, "ribbed" mattress. However, this is not a practical solution for most applications.

A further problem associated with known designs is the requirement for the operating mechanism to be as compact as possible to free up space underneath the bed. In domestic beds, this space is often used to house drawers for storage, and therefore the more compact, or thinner the mechanism, the greater the storage capability.

There is therefore a requirement for an adjustable article of furniture which addresses the aforementioned problems associated with known designs, which is at least as easy to manufacture, store, transport, deliver and assemble as non-adjustable furniture of known designs.

Thus according to one aspect of the present invention, there is provided an article of adjustable furniture comprising at least one support section and a drive mechanism operable to effect pivotal movement of the at least one support section, the drive mechanism including at least a first and a second component pivotally joined by a bearing assembly, such that operation of the drive mechanism causes pivotal movement between the first and second components so as to effect pivotal movement of the at least one support section.

The provision of a bearing assembly for pivotal components of a drive mechanism enables more efficient use of the actuator. A result of more efficient actuator use is the ability of the actuator to drive the support sections from a shallower angle, which enables more compact mechanisms to be used, freeing up space within the furniture.

The present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a perspective view from above of a frame and operating mechanism of an adjustable bed according to one embodiment of the present invention, with the bed in a semi-upright configuration for supporting an occupant in a seated position,

Figure 2 is a perspective view from above and the rear, left hand side rear quarter, of the frame and operating mechanism of the adjustable bed of Figure 1,

Figure 3 is a perspective view of the bed of Figure 1 with the bed viewed from below,

Figure 4 a side elevation view of the bed of Figure 1, with the bed in the semi-upright adjusted position of Figure 1,

Figure 5 is a perspective view similar to Figure 2 with the bed in a fully upright adjusted position,

Figure 6 a side elevation view of the bed similar to Figure 4, with the bed in the fully upright adjusted position of Figure 5,

Figure 6a is a side elevation view of the bed of Figure 6 with a mattress supported thereon,

Figure 7 is a perspective view similar to Figure 2 with the bed in a fully lowered position, with part of the mattress support deck shown in ghost outline,

Figure 8 a side elevation view of the bed, with the bed in the fully lowered position of Figure 7,

Figure 9 is a perspective view of the bed of Figure 1 with the bed viewed from below in plan,

Figure 10 is a side elevation view of the bed of Figure 1 in a semi-upright configuration,

Figure 11 is perspective view of the bed of Figure 1 in a fully upright adjusted position,

Figures 12 to 16 are enlarged perspective views of components of the bed of Figure 1,

Figure 17 is a side elevation view of an alternative bed with the foot support in a fully raised position,

Figure 18 is a perspective view of the bed of Figure 17 with the foot support in a fully raised position,

Figure 19 is a perspective view of the bed of Figure 17with the support panels removed,

Figures 20 to 25 are enlarged perspective views of components of the bed of Figure 17, and

Figure 26 is a side elevation view of an alternative bed with the back support in a semi-upright configuration.

With reference to Figures 1 to 16, an article of adjustable furniture in the form of a bed 10 comprises a mattress support platform or deck 11 having a plurality of adjacent planar mattress support panels, including an adjustable back, neck and head (upper body) support section panel 12, a lumbar support section panel 13, a non- adjustable intermediate support

section panel 14, a non-adjustable lower body support section panel 16, an adjustable thigh section panel 17 and a lower limb and foot support section panel 18. Throughout the drawings of Figures 2, 5, and 7 the panels 12-18 are shown in ghost outline in order to reveal the detailed construction of the adjustable bed 10. Figure 6a shows a bed assembly including the adjustable bed 10 in the position of Figure 6 with a mattress 50 supported on the deck 11. The mattress 50 is shown slightly elevated above the deck 11 for clarity, although it will be appreciated that the mattress 50 is in direct physical contact with the deck 11 in use. It will be appreciated that references to a mattress include both a separate mattress and a mattress integrated with the support sections or panels.

The panels 12-18 are mounted on a support frame 20. The upper body support panel 12 and lumbar support panel 13 are adjustably mounted on the support frame 20. The intermediate support panel 14 and lower body support section panel 16 are fixed in relation to the frame 20. The thigh support panel 17 and lower limb / foot support panel 18 are adjustably mounted on the support frame 20. The lumbar support section 13 has an upper surface 19, and the backrest support section 14 has an upper surface 21. An interior angle B, is defined between upper surfaces 19,21, the interior angle B always being less then 180 degrees when the bed moves towards the fully raised configuration such that the backrest section 14 is always tilted towards (anti-clockwise when viewing Figure 4 such that a head of the occupant (not shown) is supported by the backrest support section.

The frame 20 comprises two half sections 20a, 20b hinged together at their respective adjacent ends. The two half sections include a head end sub-assembly 20a and a toe end sub-assembly 20b. The two half sections 20a, 20b are hinged together at their respective adjacent ends by hinges 24 fixed to the upward facing surface of the panels14 and 16 at their respective adjacent edges, as can best be seen in Figures 1 and 10. The hinge arrangement is such that the two half sub-assemblies provide a full length structural support frame when hinged apart and locked into position, as shown in the drawings of Figures 1 to 8. The hinged sub–assemblies 20a, 20b allow the upper and lower halves of bed to be folded onto one another, as will be described in greater details below, for transportation, storage, distribution and delivery purposes.

The upper body support panel 12 and the lumbar support section panel 13 are adjustably mounted on the head end support frame sub-assembly 20a. The intermediate support panel 14 is fixedly mounted on the head end support frame subassembly 20a, adjacent to the lumbar support panel 13. The lower body panel 16 is fixed in relation to the toe end support frame sub-assembly 20b adjacent to the intermediate panel 14. The thigh support panel 17 and

lower limb / foot support panel 18 are adjustably mounted on the toe end support frame sub-assembly 20b adjacent to the fixed lower body support section panel 16.

The lumbar support panel 13 is pivotally connected to the fixed intermediate support by means of a hinged joint 22 extending along the respective adjacent edges of the panels. As can best be seen in Figure 9, the hinged joint 22 comprises a plurality of hinges 22' spaced along the edges of the adjacent edges of panels 13 and 14 within the region of the frame 20. The adjacent edges of the panels 13 and 14 are provided with respective elongate hinge mounting brackets 23a, 23b, preferably of metal construction, which extend on the underside of the panels 13 and 14 between the sides of the frame 20a, as can best be seen in Figure 8. Three hinges 22' are provided, including a centrally located hinge and a pair at the respective ends of the elongate mounting brackets 23a, 23b. In the illustrated embodiment, the hinges 22' are conventional design and construction and are fixedly secured to the respective mounting brackets to pivotally mount the lumbar support panel to the fixed intermediate support panel about the pivot axis of the hinge 22.

The upper body support panel 12 is similarly pivotally connected to the lumbar support panel by means of a hinged joint 25 extending along the respective adjacent edges of the panels. The hinged joint 25 comprises a plurality of hinges 25' spaced along the edges of the adjacent edges of panels 12 and 13 within the region of the frame 20. The adjacent edges of the panels 12 and 13 are provided with respective elongate hinge mounting brackets 26a, 26b, preferably of metal construction, which extend on the underside of the panels 12 and 13 between the sides of the frame 20a, as can best be seen in Figure 8. Three hinges 25' are provided, including a centrally located hinge and a pair at the respective ends of the elongate mounting brackets 26a, 26b. In the illustrated embodiment, the hinges 25' are conventional design and construction and are fixedly secured to the respective mounting brackets to pivotally mount the upper body support panel 12 to the lumbar support panel about the pivot axis of the hinge 25.

Hinges 22' and 25' may be conventional pin bracket type hinges or, in other embodiments, constructed of a fatigue resistant plastics material, for example as a so called "living hinge". Other types of hinge are also contemplated including extruded metal tubes, for example extruded aluminium or aluminium alloy, having a d or p shape cross-section, including a longitudinal mounting flange as an integral part of the extrusion, where a hinge pin passes through the extruded tube in a known manner and optionally mounted on bearings (ball bearing type) located at the respective ends of the tube to support the hinge pin in a low friction manner. In preferred embodiments, at least hinges 25' are provided with limited angular adjustment so that the adjustable panel 12 has a limited downward angular adjustment with

respect to the lumbar support panel 13. In the illustrated embodiment, the hinge 25 is provided with an abutment stop in the form of a rectangular, preferably metal, plates 27 that are fixedly secured or connected to the hinge mounting bracket 26a in the region of the hinges 25'. The plates 27 are positioned on the underside of the hinge 25 and prevent panel 12 being lowered beyond the plane of panel 13 by mutual abutment of the plates 27 and the underside of the mounting brackets 26b. Thus, when the panels 12 and 13 are lowered flat they remain 180 degrees apart.

Hinges 22' and 25' are also limited upwards so each platform section 12. 13 cannot go beyond this angle relative to the previous panel section it is hinged to (typically 30 degrees, or the total combined angel of angular adjustment divided by the number of intermediary platform sections). Hinges 22' and 25' are also limited downwards so each platform section cannot fall below parallel to the previous section it is hinged to.

As will be described in greater detail below, panels 12 and 13 may be raised by a predetermined maximum amount about their respective pivot axis during adjustment of the bed, for example 65 degrees, combined, from the horizontal plane as defined by the flat orientation of fixed intermediate support panels 14 and 16 of the bed. Hinges 22 and 25 are provided with stop means to limit the degree of relative angular adjustment of the panels 12 and 13. Typically the maximum combined angular adjustment of the panels is 65 degrees with respect to the plane of the fixed non-adjustable panel 14. The hinges 22 and 25 may thus be adapted so that they contribute to the maximum angular adjustment of the panels 12 and 13 by equal amounts or substantially equal amounts, for example, 50/50 or 40/60 depending on the particular application and maximum angel of adjustment required.

As previously described, in embodiments of the present invention, the maximum combined angle of adjustment of the backrest and lumbar support sections is typically 50-65 degrees. In the illustrated embodiment, the angle of adjustment is shared between hinges 22 and 25 connecting each side of the lumbar support platform. The hinge axes are preferably 200 – 300mm apart in the longitudinal direction of the bed, as best seen from the view of Figure 9. In the illustrated embodiment, a single lumbar support platform having a length dimension of 250mm is preferred.

In Figures 5 and 6 the bed 10 is shown in a fully articulated configuration, adjusted for supporting an occupant in a raised upright seated position. In this position, the upper body support section panel 12 and the lumbar support section panel 13 are raised, and inclined with respect to, the fixed intermediate support section panel 14. The upper body support section

panel 12 is raised about its pivot axis defined by hinge 25 and the lumbar support panel 13 is raised about its pivot axis defined by hinge 22.

Referring to Figure 6, it can be seen that the combined angle ASB is defined between a plane PS defined by the seat section 16 and a plane PB defined by the backrest support section 12, the combined angle ASB being shared between a first angle ASM defined between the seat section plane PS and a plane PM defined by the lumbar support section 13, and a second angle AMB defined between the plane PM defined by the mattress support section 13 and the plane PB defined by the backrest support section 12.

In the lowered position (Figures 7 and 8) the adjustable support panels 12, 13 combine with the fixed panel 14 and fixed panel or seat section 16 and adjustable panels 17 and 18 to define a substantially flat planar horizontal mattress support platform or deck. The various support panels 12-18 may each have a mattress support cushion (not shown) of pre-determined thickness, which combine to provide a mattress foundation for supporting a suitable mattress. Alternatively, a mattress may be positioned directly on top of the panels 12-16. The panels 12-16 may be upholstered, with or without support cushions. The present invention also contemplates arrangements where the frame 20 is configured to be placed within the internal space of a bed surround, for example of the type common in North America, or integrated in a divan type bed foundation structure, more typically found in the United Kingdom. In the illustrated embodiment, the bed frame 20 is provided with floor standing legs 28 and is thus self-supporting. Thus, the present invention also contemplates arrangements where the frame 20 is arranged to be positioned within a separate surrounding structure, for example a decorative wood or upholstered surround including head and toe boards and lateral side panels between the head and toe boards. The dimensions of the bed are such that the bed has the size of a double bed, but the present invention contemplates beds of many different widths including standard single size beds to much larger doubles.

The half frame sub-assemblies 20a and 20b each comprises a generally rectangular structural support frame, preferably constructed of metal but other materials may be used for various component parts, in addition to or instead of metal, including board type material, for example engineering plastic, MDF, timber or other fibre type board for example.

The two half sections 20a and 20b each comprise a pair of elongate parallel lateral side frame members in the form of respective side rails 30a, 30b. The side frame members extend longitudinally along the length of the bed on both sides thereof and are joined together at their respective ends by metal, preferably steel, cross-members 31a, 31b, 32a, 32b to form rectangular box type structural support frames 20a, 20b.

The side frame members 30a, 30b are constructed of suitably dimensioned box section metal tube, preferably steel, and the cross-members 31a and 32b of similar rectangular box section metal tube. The frame 20 is provided with legs 28 towards each of the corners of the rectangular frame structure and at an intermediate position at the end of the toe end sub-assembly 20b. The side members 30a, 30b and respective cross members 31a, 31b and 32a, 32b are joined together by welding or alternatively by fixing means such as screws, bolts, fasteners or the like. In preferred embodiments, the legs are attachably/detachably fixed to the frame by suitable reversible fixing means as are well known in the art, for example screw thread fittings.

The two half sub-assemblies 20a and 20b are provided with locking means for locking the frame members 30a, 30b together when the frame 20 is unfolded. The locking means comprises a metal plate 33 secured on the underside of the respective side frame members 30b in the region of the hinged connection 24. The metal plate 33 extends over the underside of the adjacent side frame member 30a and is attachably/detachably fixed thereto by suitable reversible fixing means, as are well known in the art, for example screw thread fittings, such as a butterfly or winged 5 nut/bolt connection 35 as in the illustrated embodiment.

The unfolded and locked support frame 20 constitutes a floor standing base of the bed 10. The frame 20 may stand directly on legs 28 or alternatively be provided with castors, feet or the like at the end of the legs, as is well known in the art. Alternatively, the legs may be removed and the frame adapted to be mounted within a bed surround, for example with the side frame members sitting on a suitable mounting on the inside of a suitably adapted bed surround. As previously indicated, the frame 20 can be manually folded and unfolded about the traverse hinge axis defined by the hinge elements 24. Either the head end or toe end frame is moved so that the two half sections of the frame are brought together by 10 relative movement about the hinge axis as shown in Figures 9 and 10 where the panels 12 and 14 lie flat on top of the panel 16. As can be seen in Figures 9 and 10 when the legs 28 are unattached the adjustable bed 10 has a very small space envelope, with half the length dimension of the unfolded bed in exchange for a modest increase in depth, approximately the additional depth of the toe end half frame.

Movement of the adjustable panels 12 and 13 is effected by means of a powered actuation mechanism comprising a linear actuator 40 and a first connecting means in the form of a pivotal “H-frame” 42. The H-frame 42 comprises a pair of arms 44 and a cross-member 46 extending between and connecting the arms 44 approximately midway along their length. The arms 44 have a first distal end 65 and a second distal end 67 with an aperture 69 positioned towards the second distal end 67. Each arm 44 has a feature in the form of a raised portion

71 co-axial with the aperture 69. The arms 44 are generally straight but curve upwards at their first distal end 65 where a roller in the form of a bearing 52 is rotatably mounted. The bearings 52 contact the underside of the panel 12 along wear resistant strips 54 which may be of metal, nylon or the like, along which the bearings 52 run when the panel 12 is lowered and raised.

The H-frame is pivotally mounted at the second distal end of arms 44 on a second component in the form of a bracket 50 which is fixed to the underside of the head end sub-assembly frame 20a at pivot points 48. The brackets 50 depend from the underside of the frame 20a in the region of hinges 25. The bracket 50 includes an integral bearing housing 51 which is configured as described below to house and retain a bearing assembly 53.

In Figures 12 to 16, the bearing assembly 53 comprises an inner race 55 having an inner race internal diameter DIR, and an outer race 57 having an outer race external diameter DOR. The inner 55 and outer 57 races are rotationally moveable relative to each other. The bearing housing 51 has an external wall 57 which includes a part-circular section 59 and a crimped section 61 extending from the part-circular section 59. The crimped section 59 is formed after the bearing assembly 53 is located within the bearing housing 51 such that the bearing assembly 53 is both retained in, and is rotationally fixed with respect to the bearing housing 51. The arms 44 are pivotally attached to the bracket 50 by engagement of the raised portion 71 with an outer face 73 of the inner race 55, and are secured to the bracket 50 using a nut, bolt and washer arrangement 75 such that the arms 44 rotate with the inner race 55 relative to the outer race 57 which is rotationally fast with the bracket 50 which is fixed to the frame 20.

The actuator 40 is a linear actuator of the Delta-drive type as produced by Dewert-Okin GmbH, having a first end (motor and gear box end) pivotally mounted to the cross member 32b and a second end (rod) pivotally connected to a bracket 56 secured to the cross-member 46. The bracket 56 is configured such that the connection between the output rod of the actuator and the bracket 56 is in the plane of the panel 12. This is achieved by means of a cut-out slot 58 in the panel 12 through which the bracket 56 and end of the output rod of the actuator extend. The gearbox and motor end of the actuator 40 is connected to the cross-member 32b at a position midway along its length. The cross-member 32b is located in a plane lower than the general or notional plane of the frame 20 due to the downwardly canted end of the frame 20a. The side members 30a are inclined downwards along the final third of their length from a position immediately rearward of the legs 28 attached to the frame 20a. The side members are inclined downwards approximately 20 degrees or so, so that the connection point between the actuator 40 and the frame 20a is below and offset from the notional plane of the frame 20. This arrangement ensures the actuator is also inclined with respect to the notional plane of

the frame and the plane of the panel 12 when the panel 12 is in its lowered position (Figures 7 and 8). In combination with the other end of the actuator being in the plane of the panel 12, by means of the bracket 56 and cut out 58, the actuator is able to apply a significant initial force to the panel 12 when the panel is to be raised from is lowered position of Figures 7 and 8. It is to be understood that the force component acting on the panel 12 when movement is initiated from its lowered position is dependent on the angular orientation of the actuator force vector with respect to the panel 12.

Rotational movement of the panel 12 is thus effected by activation of linear electrical actuator 40 positioned on the underside of the bed within the space envelope of the frame. Thus, panel 12 is raised and lowered by respective extension and retraction of actuator 40. In operation, in the fully lowered configuration of the bed, the adjustable panels 12 and 13 lie flat on the side rails 30a, with the output rod of actuator 40 fully retracted towards the respective gearbox end of the actuator. This position is shown in Figures 7 and 8. In order to raise the panels 12 and 13, the output rod of the actuator 40 is extended away from the gearbox end of the actuator. Rotational movement of lumbar support panel 13 is thus simultaneously effected by activation of linear electrical actuator 40. Panels 12 and 13 are this raised and lowered by extension and retraction of actuator 40.

The provision of a bearing assembly and housing at the pivotal connection of the arm 44 and the bracket 50 results in a significantly lower initial actuator force being required to move the panel when compared to using a conventional nut, bolt and washer arrangement. In alternative embodiments, a bearing assembly and housing arrangement can be provided at other pivotal connections to further reduce the initial actuator force requirement. For example, the bearing assembly and housing arrangement can be provided between the cross-member 46 of the H-bar 42 and the actuator 40 to provide a pivotal connection. An identical bracket to the bracket 50 of the embodiment of Figures 1 to 16 can replace the bracket 56 used to pivotally connect the cross-member 46 of the H-bar 42 and the actuator 40.

In preferred embodiments, the maximum combined angular adjustment of the panels 12 and 13 is 65 degrees, that is to say the maximum raised inclined angle of the backrest panel 12 with respect to the notional flat horizontal plane of the bed is limited to 65 degrees. This angle of adjustment includes the combined angle of adjustment of the lumbar support panel 13 with respect to the fixed panel 14 and the angle of adjustment of the backrest panel 12 with respect to the lumbar support panel 13. The combined angular adjustment may be less, for example, a maximum of 60, 55, 50 degrees or less, and may be contributed by equal amounts of angular adjustment by the panels 13 and 14. The maximum angular adjustment is determined by the geometry of the actuation mechanism including the mounting arrangement and the operation

stroke of the actuator as well as the relative length dimensions of the respective adjustable panels.

It is to be understood that a mattress of appropriate thickness, say in the range of 25 to 50cm (10 to 20 inches), is to be positioned on the mattress support platform of the bed 10.

Movement of the adjustable panels 17 and 18 is effected by means of a powered actuation mechanism comprising a linear actuator 40a identical to the actuator 40 driving panel 12, and a first connecting means in the form of a pivotal frame 42a. The frame 42a comprises a pair of arms 44a and a cross-member 46a extending between and connecting the arms 44a. The arms have a first distal end 65a which is connected to the underside of the panel 17, and a second distal end 67a which is pivotally mounted on a second component in the form of a bracket 50a which is fixed to the frame 20 at pivot points 48a. The brackets 50a depend from the underside of the frame 20 in the region of hinges 41'. In contrast to the pivotal connection between arms 44 and bracket 50 via a bearing assembly and housing arrangement, the arms 44a are pivotally attached to the bracket 50a using a simple nut, bolt and washer arrangement 75a such that the arms 44a rotate relative to the bracket 50a which is fixed to the frame 20. In an alternative embodiment, the bearing assembly 53 and bearing housing 51 described in relation to the movement of the panel 13 can be used to provide a pivotal connection between the arms 44a and the bracket 50 instead of the nut, bolt and washer arrangement. Similarly, the pivotal connection between the actuator 40a and the cross-member 46a can be provided by a bearing assembly and housing arrangement as described in relation to the pivotal connection between actuator 40 and cross-member 46.

The actuator 40a has a first end (motor and gear box end) pivotally mounted to the cross member 31a and a second end (rod) pivotally connected to a bracket 56a secured to the cross-member 46a. Rotational movement of the panel 17 is thus effected by activation of linear electrical actuator 40a which causes the cross-member 46a and arms 44a to rotate. Thus, panel 17 is raised and lowered by respective extension and retraction of actuator 40a. Panel 18, by virtue of being connected to panel 17 via hinge 43' is also raised and lowered as panel 17 is raised and lowered. A brace 81 is fixed to the underside of panel 18 and the frame 20 to provide additional rigidity and support when panel 18 is under load (Figure 3).

In the above described embodiments, panels 12 and 13 are rotated by an actuator 40 acting on panel 12 via arms 44, and panels 17 and 18 are rotated by actuator 40a acting on panel 17, that is to say, a first connecting means 44,44a acts on and engages with the respective panels 12,17. It is the fact that panels 17 and 18, and panels 12 and 13 are connected by

respective hinges 43' and 25' which causes panel 18 to rotate as panel 17 is rotated, and panel 13 to rotate as panel 12 is rotated.

With reference to Figures 17 to 25, an alternative bed 110 is identical to the bed described in Figures 1 to 16 except that instead of a single connecting means acting on panel 17, a first connecting means or component in the form of a pair of arms 144a acts and engages with panel 118 and a second connecting means or component in the form of a pair of arms 190 which act on and engage with panel 117 such that an actuator 140a, which is identical to actuator 40a, simultaneously drives both panels 117,118.

Actuator 140a is connected to the frame 120 and to the cross-member 146a in the same way as actuator 40 is connected to the frame 20 and to the cross-member 46 of the embodiment of Figures 1 to 16.

Arms 144 extend from cross-member 146 and have a roller bearing 152 at one end which is identical to bearing 52, and is pivotally connected to the frame 120 at the other end at pivot point 148 by an integral bearing housing 151 identical to the bearing housing 51, and a raised portion 171 located on bracket 150, the raised portion 171 being identical to the raised portion 71 (Figure 20). A corner brace 199 is provided between the arms 144 and cross-member 46 to provide rigidity. The bracket 150 is fixed to and depends from the frame 120. The bearing housing 151 retains a bearing assembly (not shown) in the same way as described in relation to bearing housing 51 and bearing assembly 53. The pivotal connection between the bracket 150 and arm 144 is provided in the same was as described in relation to the bracket 50 and arm 44.

The bearing housing 151 and the bearing assembly is located on the arms 144a (first component) and the raised portion 171 is located on bracket 150 (second component) which is in contrast to the pivotal connection between bracket 50 and arm 44 where the raised portion 71 is provided on the arm 44 and the bearing housing 51 and bearing assembly 53 is provided on the bracket 50. It will be appreciated therefore that the bearing housing and assembly can be provided on one of the first or second components, and the feature, such as the bracket with the raised portion can be provided on the other of the first and second components to provide the pivotal connection.

Arms 190 are pivotally connected to the arms 144 at pivot point 191, which is positioned approximately mid-way along the length of arms 144, via a raised portion 171a which engages with a bearing assembly (not shown) identical to bearing assembly 53, housed within an integral bearing housing 151a on one end of the arm 190. Raised portion 171a (Figure 21) is

identical to raised portion 171, and the integral bearing housing 151a is identical to the integral bearing housing 151. The pivotal connection between the raised portion 171a of arm 144 and arm 190 is provided in the same was as described in relation to the bracket 50 and arm 44.

Arms 190 have another integral bearing housing 151b identical to integral bearing housing 151a, at their other end which is pivotally connected to a bracket 195 which is fixed to the underside of the thigh support panel 117 using fixing means such as screws 196. The bracket 195 includes a raised portion 171b (Figure 24) which is identical to raised portions 71,171a. The integral bearing housing 151 retains a bearing assembly (not shown) identical to bearing assembly 53. The pivotal connection between the raised portion 171b of arm 190 and bracket 195 is provided in the same was as described in relation to the bracket 50 and arm 44. The bracket 195 is positioned on the thigh support panel 117 such that the pivotal connection is about an axis which is close to the hinge point 143 between panels 117 and 118. It will be appreciated that the bracket 195 can be positioned anywhere on the length of the panel 117 providing that position enables pivotal movement of panels 117 and 118 between the lowered and the raised positions.

In operation, activation of the linear electrical actuator 140a causes the cross-member 146a and arms 44a to rotate about pivot point 148. As arms 144a rotate, the bearing 152 acts on the underside of panel 118 causing it to be raised relative to the frame 120. Simultaneously, rotation of arms 144 causes the pivotally connected arms 190 to rotate and act against the underside of panel 117 causing panel 17 to rotate relative to the frame 120 about hinge 122' (Figure 17). Thus, operation of the actuator 140a drives both panels 117 and 118 at the same time by virtue of the first (arm 144) and second (arm 190) connecting means.

With reference to Figure 26, an alternative bed 210 is identical to the bed described in Figures 1 to 16 except that instead of a single connecting means in the form of arm 44 acting on panel 12, a first and second connecting means is used to drive panels 212 and 213 in the same way as actuator 40a drives panels 117 and 118 in the embodiment of Figures 17 to 25. The first connecting means in the form of arm 244 is identical to arm 44 except it further includes and additional raised portion 263 which is identical to the raised portion 63 on arm 44. The raised portion 263 enables a pivotal connection to be made with a second connecting means in the form of arm 290 which is identical to arm 190. Bracket 250 is identical to bracket 50 and is pivotally connected to arm 244 in the same way as bracket 50 is connected to arm 44. The raised portion 263 is positioned approximately three-quarters of the way along the length of the arm 244 towards the bracket 250. The raised portion 263 is positioned along the length of arm 244 to provide the required relative rotation between panels 213 and 212 as they are moved between lowered and raised configurations relative to the frame 220.

Operation is similar to the way actuator 40a drives panels 117 and 118 in the embodiment of Figures 17 to 25 Activation of the linear electrical actuator (not shown but identical to actuator 40) causes the arms 244 to rotate about pivot point 248. As arms 244 rotate, the bearing 252 acts on the underside of panel 212 causing it rotate relative to the frame 220. Simultaneously, rotation of arms 244 causes the pivotally connected arms 290 to rotate and act against the underside of panel 213 causing panel 213 to rotate relative to the frame 220 about hinge 222'. Thus, operation of the actuator drives both panels 212 and 213 at the same time by virtue of the first (arm 244) and second (arm 290) connecting means.

It will be understood that in the embodiments of Figures 1 to 26, at least two concepts have been described. One concept relates to the provision of first and second connecting means which act on panels of an adjustable bed to enable coordinated pivotal movement of the panels. A second concept relates to providing a bearing assembly to allow pivotal movement between components of an adjustable bed. Furthermore, the two concepts have been described in relation to pivotal movement between lumbar and back support panels and to pivotal movement between foot and thigh support panels. It will be appreciated that the two concepts can be used independently of each other, and that each of the concepts can be used to provide pivotal movement between lumbar and back support panels and/or to pivotal movement between foot and thigh support panels.

It will also be understood that whilst the above embodiments have been described in relation to an adjustable bed, the concepts also can be applied to an adjustable chair. For example, a bearing assembly and housing can be used to provide a pivotal connection between moving components of the chair such as an actuator supported on a fixed based section and a moveable seat section which is pivotally connected to the actuator. Similarly, first and second connecting means can be used to simultaneously move support panels on a chair.

CLAIMS

1. An article of adjustable furniture comprising at least one support section and a drive mechanism operable to effect pivotal movement of the at least one support section, the drive mechanism including at least a first and a second component pivotally joined by a bearing assembly, such that operation of the drive mechanism causes pivotal movement between the first and second components so as to effect pivotal movement of the at least one support section.

2. An article of adjustable furniture according to claim 1 in which the bearing assembly comprises a bearing with an inner and outer race rotationally moveable relative to each other, in which the outer race is rotationally fixed relative to one of the first or second components, and the inner race is rotationally fixed relative to the other of the first or second components such that operation of the drive mechanism causes relative movement between the inner and outer race to cause pivotal movement between the first and second components so as to effect pivotal movement of the at least one support section.

3. An article of adjustable furniture according to claim 2 in which one of the first or second components includes an integral bearing housing arranged to form an interference fit with the outer race such that the outer race is rotationally fixed relative to one of the first or second components.

4. An article of adjustable furniture according to claim 3 in which the other of the first or second components includes a fixing feature arranged to form an interference fit with the inner race such that the inner race is rotationally fixed relative to the other of the first or second components.

5. An article of adjustable furniture according to claim 3 or 4 in which the interference fit is a crimped fit.

6. An article of adjustable furniture according to any preceding claim in which the first component is a fixed frame of the furniture and the second component is a first connecting means which is fixed to the at least one support section.

7. An article of adjustable furniture according to any one of claims 1 to 5, the first component is a first connecting means and the second component is a second

connecting means, in which the first connecting means is operable to act directly on a first support section, and the second connecting means operable to act directly on a second support section such that the drive mechanism simultaneously acts on both support sections

8. An article of adjustable furniture according to any one of claims 1 to 5, the first component is a second connecting means and the second component is a bracket fixed on the at least one support section.

9. An article of adjustable furniture according to any one of claims 1 to 5 in which the first component is an actuator and the second component is a first connecting means.

10. An article of adjustable furniture according to any preceding claim in which the at least one support section is a plurality of articulated support sections, said support sections including at least one adjustable first support section and at least one adjustable second support section, and the drive mechanism includes an actuator mechanism for effecting co-ordinated pivotal movement to angularly adjust the at least one adjustable first support section relative to the at least one adjustable second support section, in which the actuator mechanism is operable to drive a first connecting means to act directly on the first support section, and a second connecting means to act directly on the second support section or a pivotal point connecting the first and second support sections such that the actuator mechanism simultaneously drives both support sections.

11. An article of adjustable furniture according to claim 10 in which the second connecting means is driven by the actuator mechanism via the first connecting means.

12. An article of adjustable furniture according to claim 10 or 11 in which one of the first and second support sections is free to pivot relative to the other of the first and second support sections independently of the actuator mechanism.

13. An article of adjustable furniture according to any one of claims 10 to 12 in which the second connecting means is pivotally attached to the first connecting means.

14. An article of adjustable furniture according to claim 13 in which the second connecting means has a first end and a second end, the first end is pivotally attached to the first connecting means, the second end is pivotally attached to the second support section.

15. An article of adjustable furniture according to any one of claims 10 to 14 in which the first connecting means has a first end pivotally attached to a frame of the furniture, and a second end free to move translationally relative to the first support section.

16. An article of adjustable furniture according to any one of claims 10 to 15 in which the first connecting means comprises a bar and a pair of spaced apart stays projecting substantially perpendicularly from the bar, the actuator mechanism is pivotally attached to the bar.

17. An article of adjustable furniture according to any one of claims 10 to 16 in which the second connecting means is pivotally positioned on the first connecting means to limit the angular movement between the first and second support sections.

18. An article of adjustable furniture according to any one of claims 10 to 17 in which the first support section is a foot support section and the second support section is a thigh support section.

19. An article of adjustable furniture according to any one of claims 10 to 17 in which the first support section is a back support section and the second support section is a neck support section.

20. An article of adjustable furniture according to any one of claims 10 to 17 in which the first support section is a lumbar support section and the second support section is a back support section.

21. An article of adjustable furniture according to any one of claims 10 to 20 in which the actuator mechanism includes an actuator with a first end pivotally attached to a frame of the furniture, and second end pivotally attached to the first connecting means.

22. An article of adjustable furniture according to any one of claims 1 to 5 in which the furniture is a chair comprising a floor standing base section, the at least one support section is a seat support section pivotally movable relative to the base section, the first component is an actuator fixed to the base section and the second component is a bracket fixed on the seat support section, such that the bearing assembly provides a pivotal connection between the actuator and the bracket to cause pivotal movement between the base section and the seat support section.

23. An article of adjustable furniture according to any preceding claim in which the drive mechanism includes an actuator mechanism.

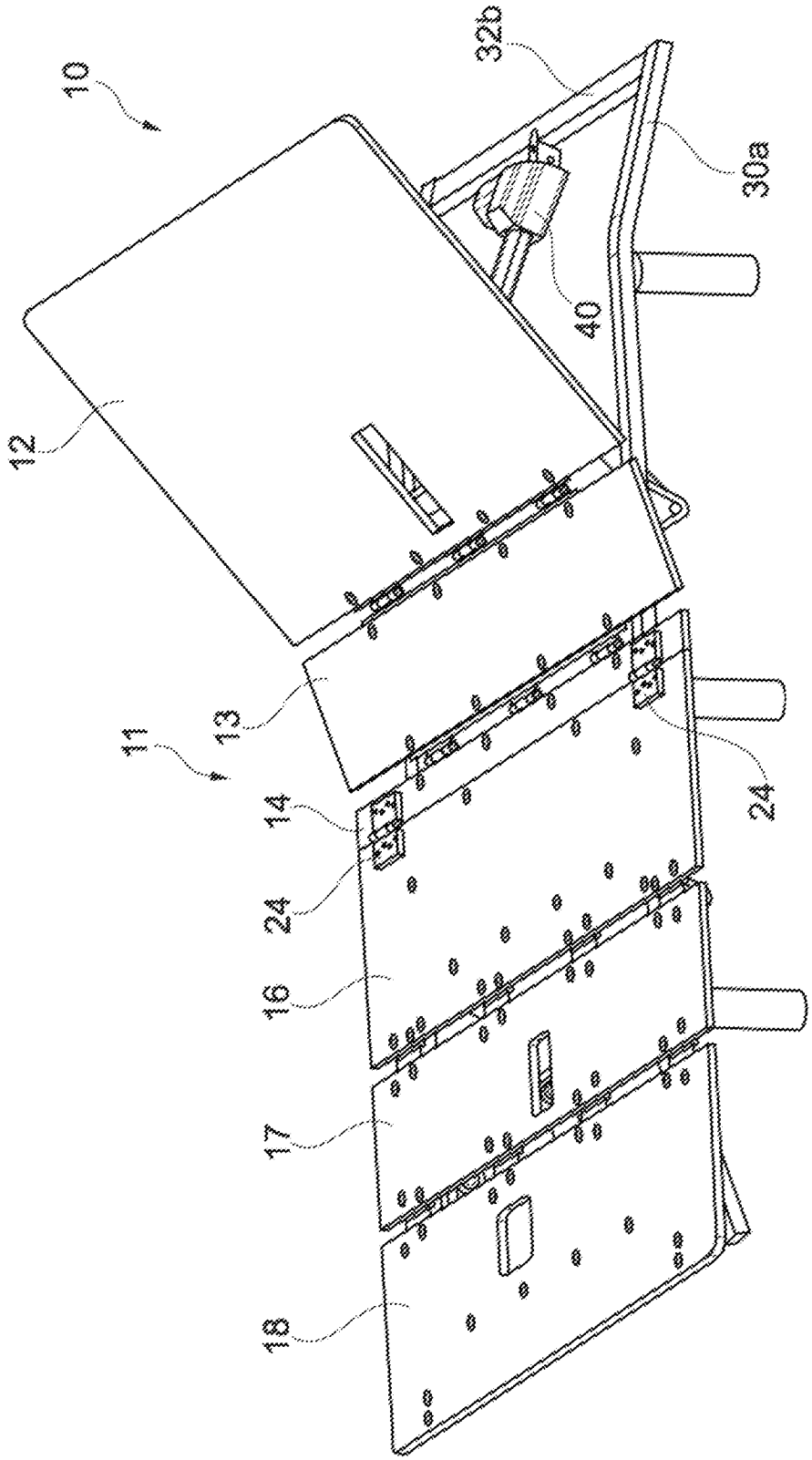

Fig. 1

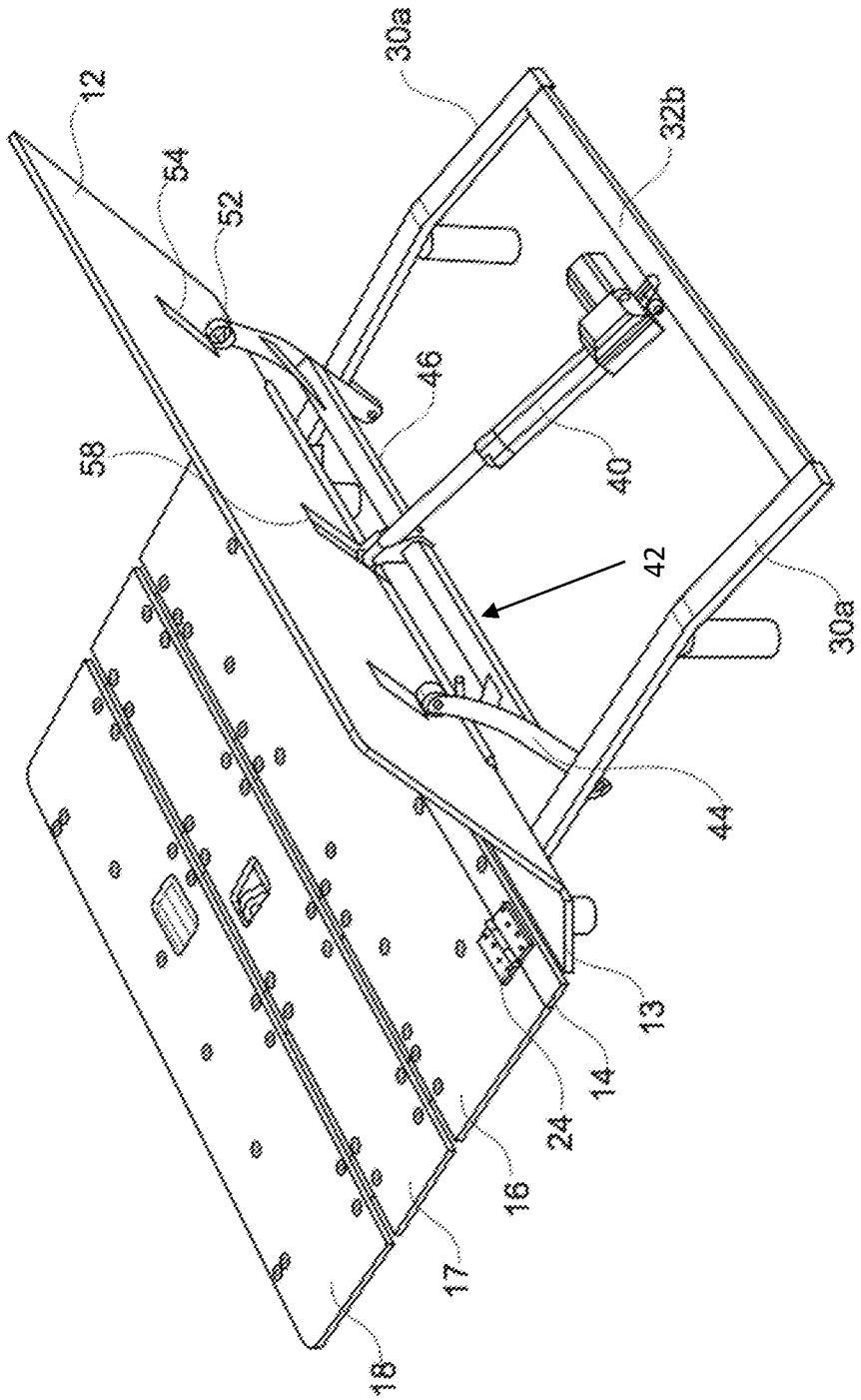

Fig. 2

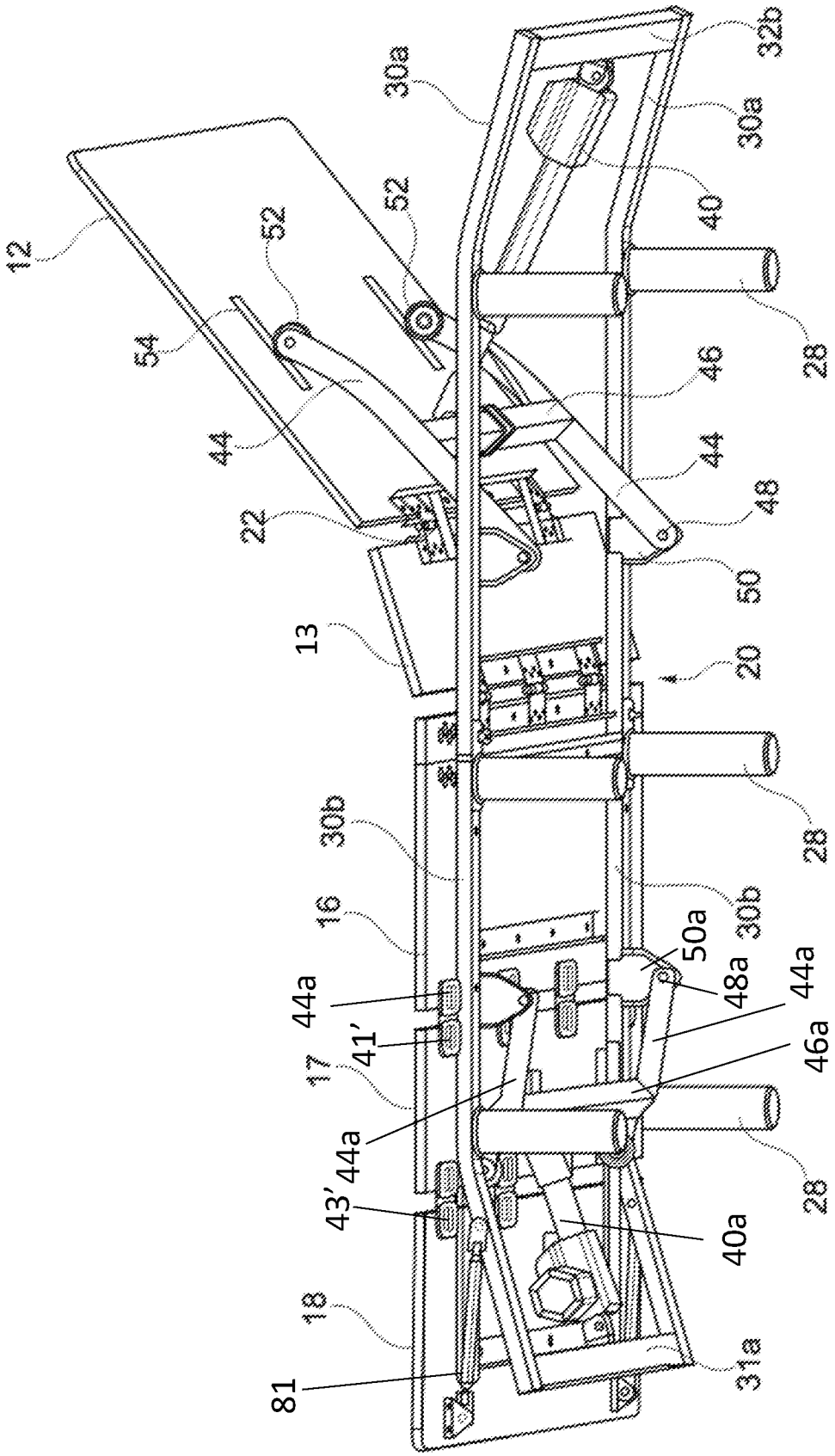
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Fig. 3

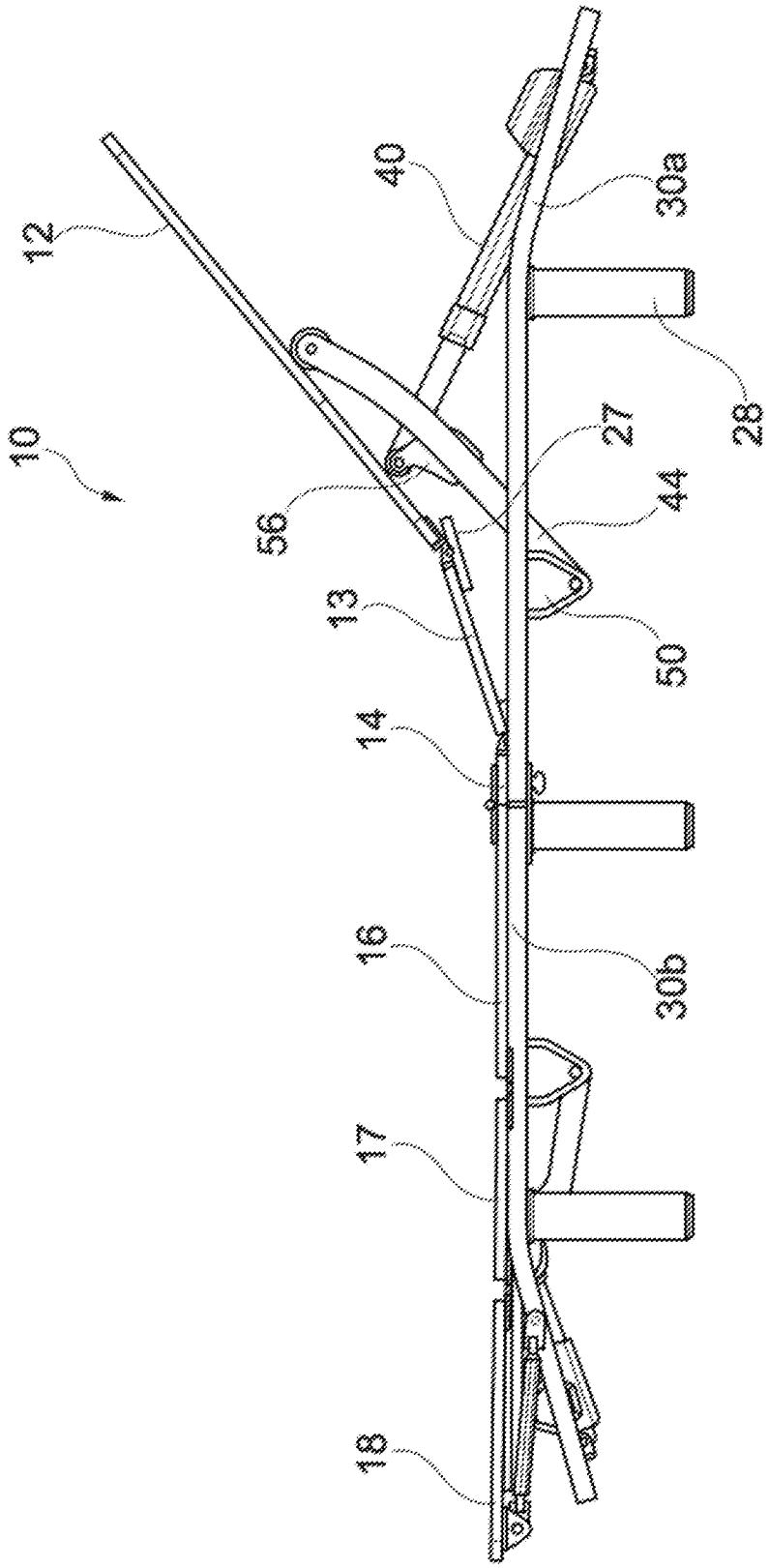

Fig. 4

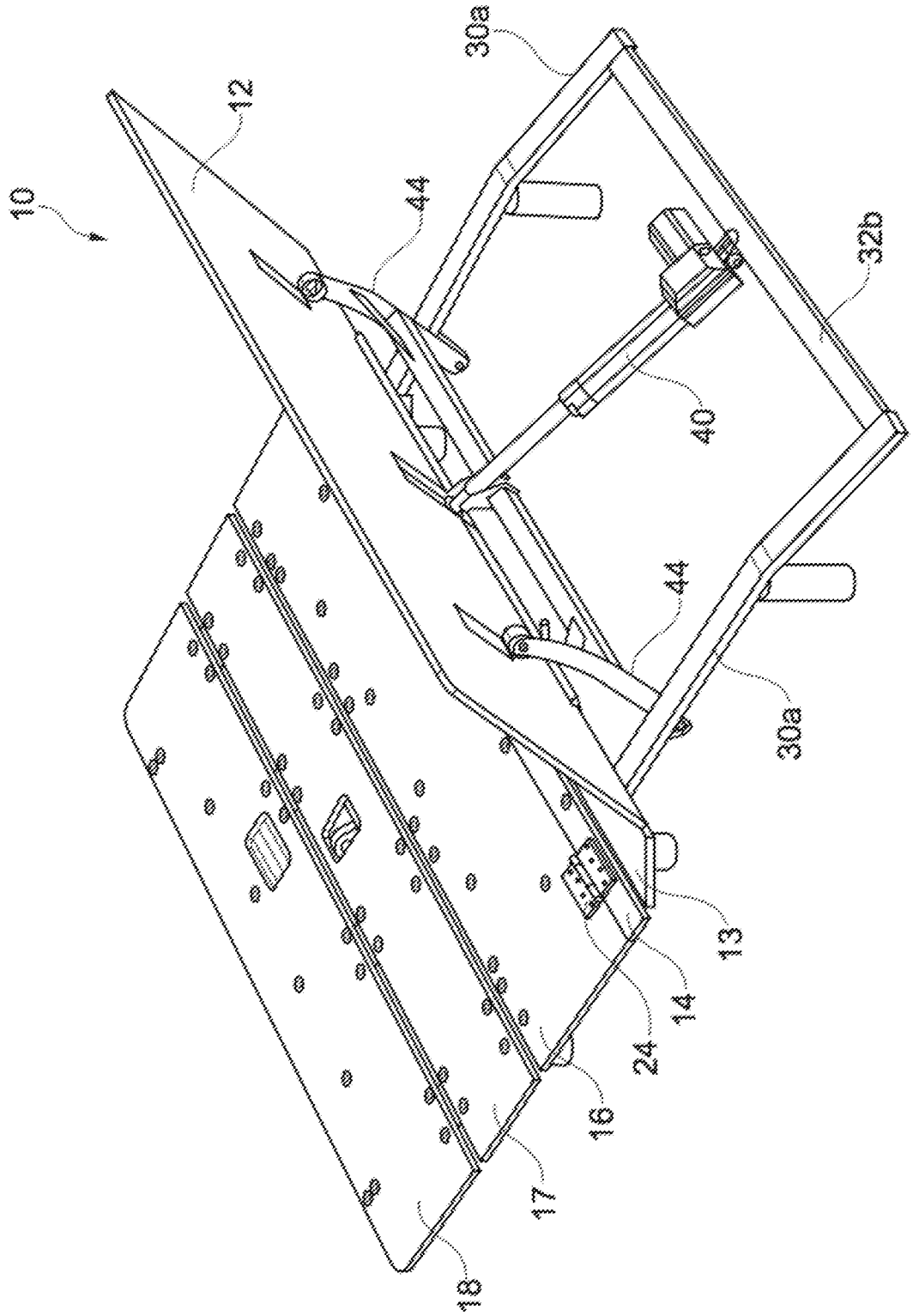

Fig. 5

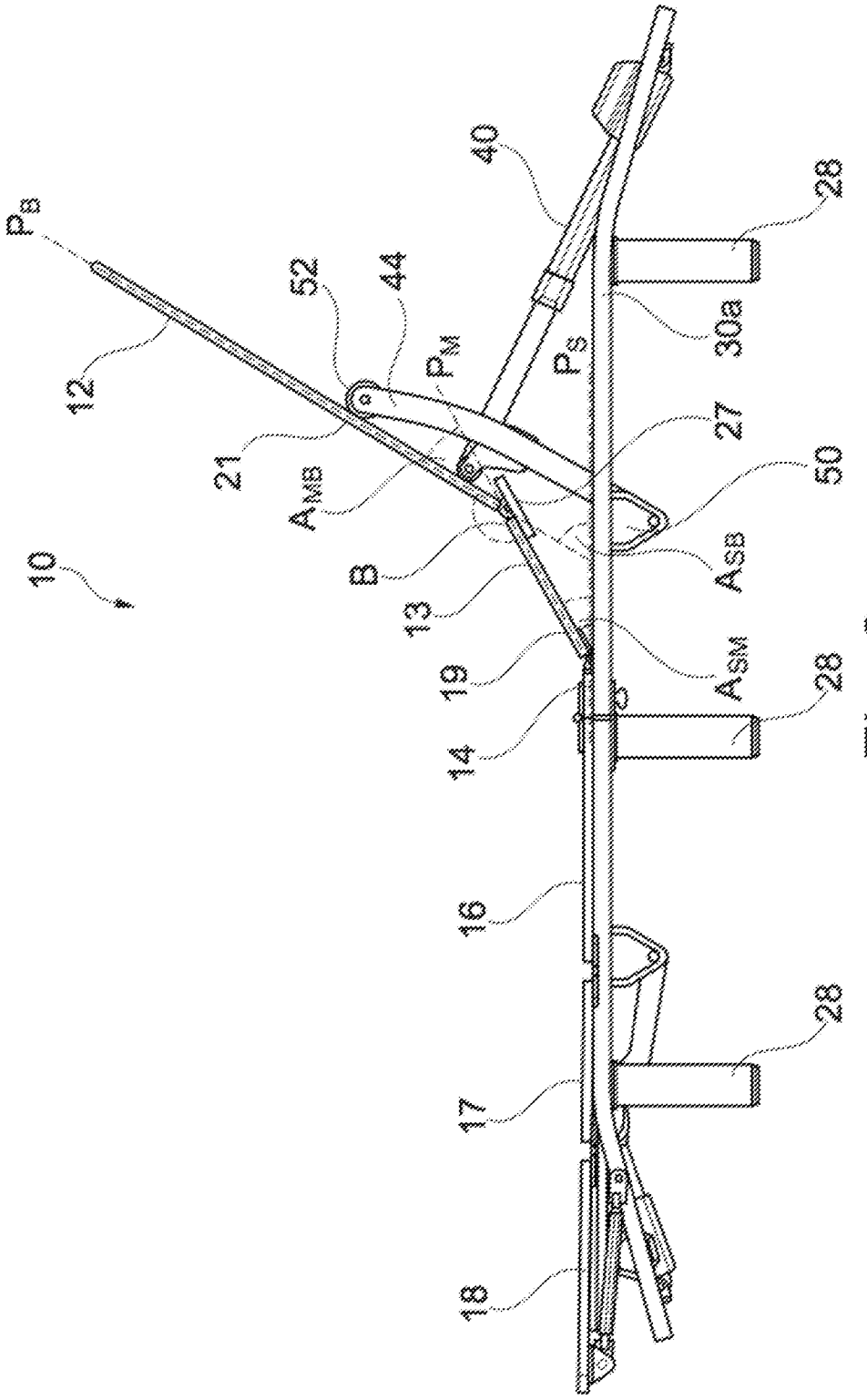
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Fig. 6

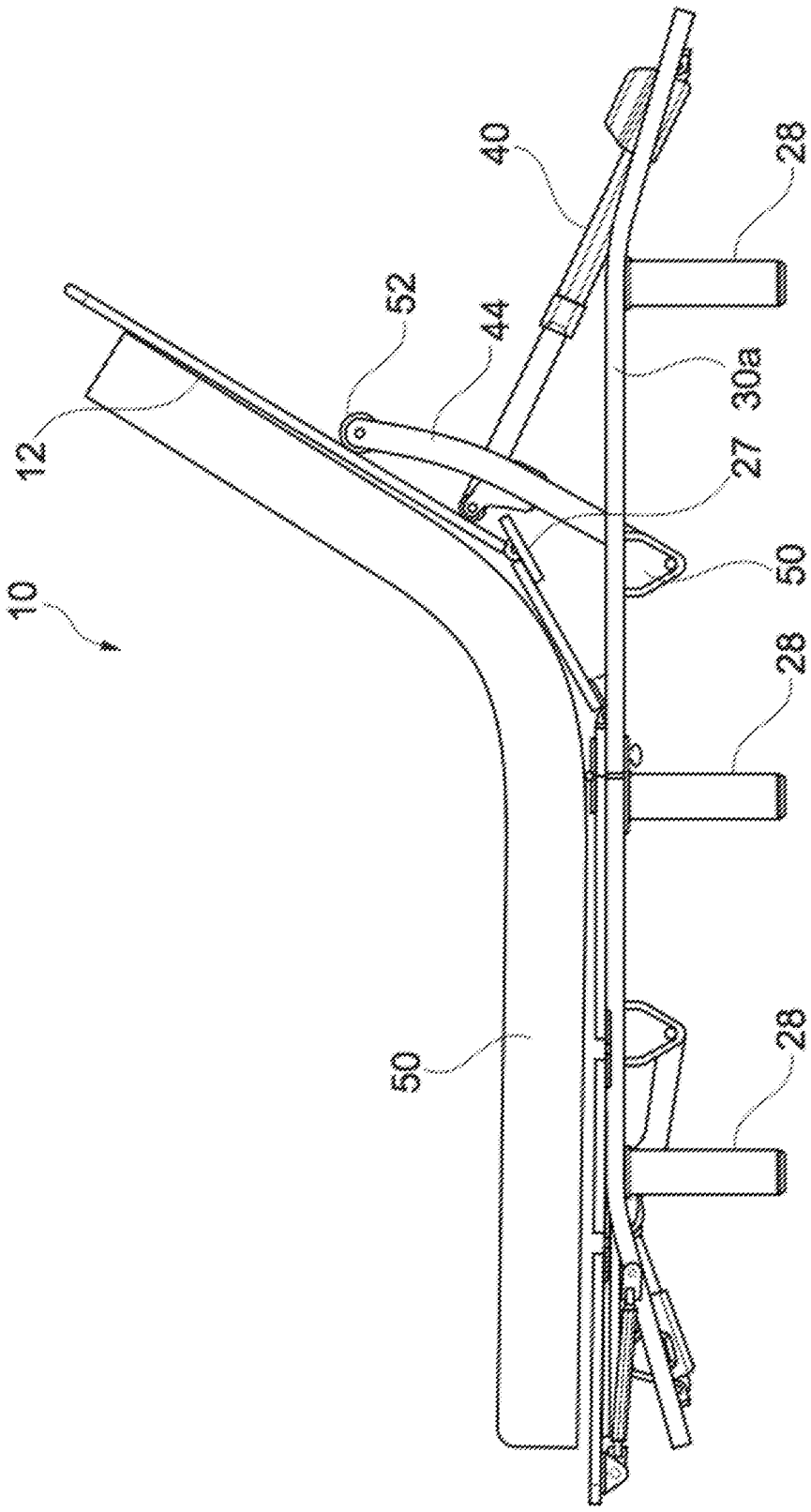


Fig. 6a

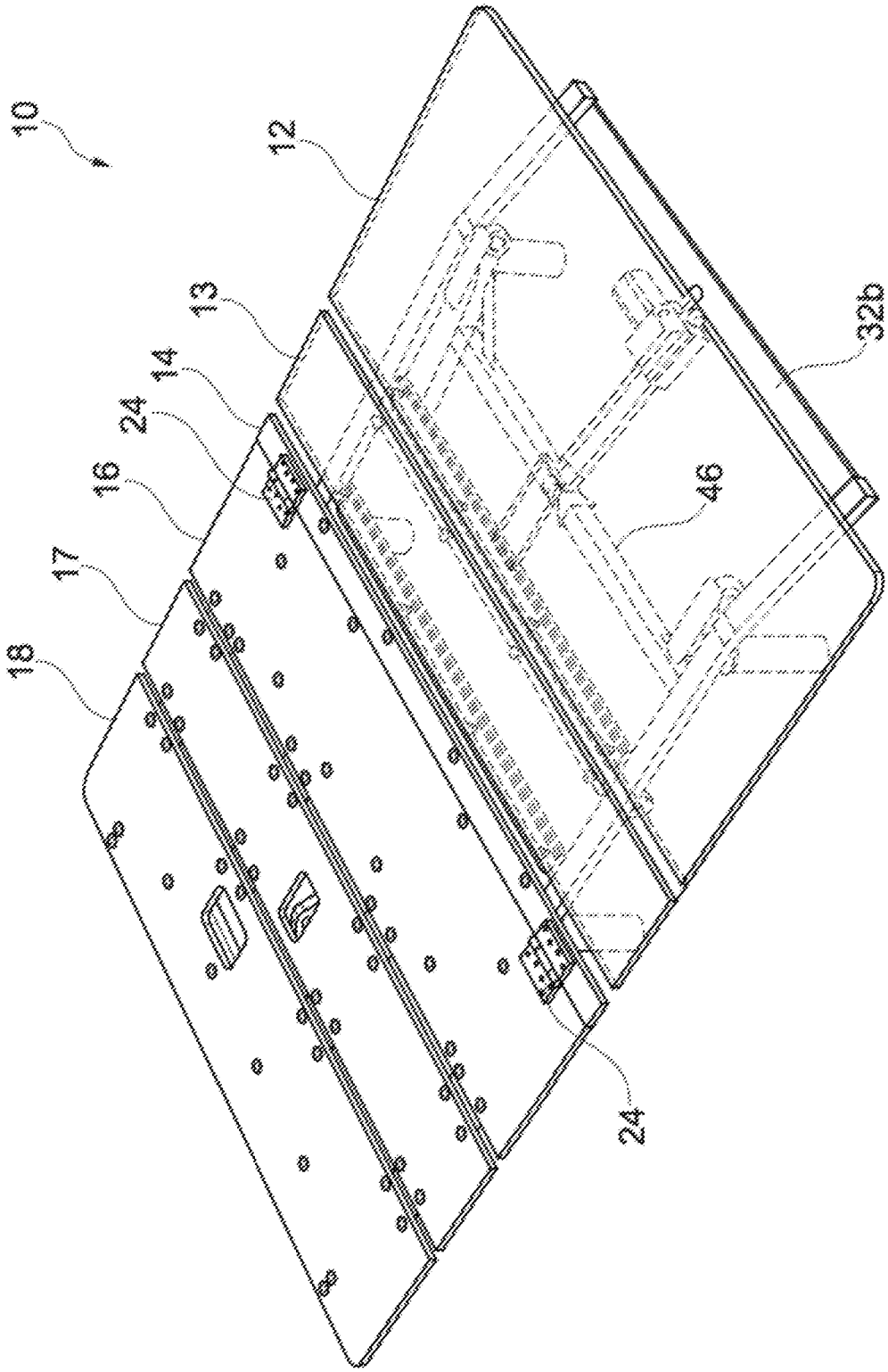


Fig. 7

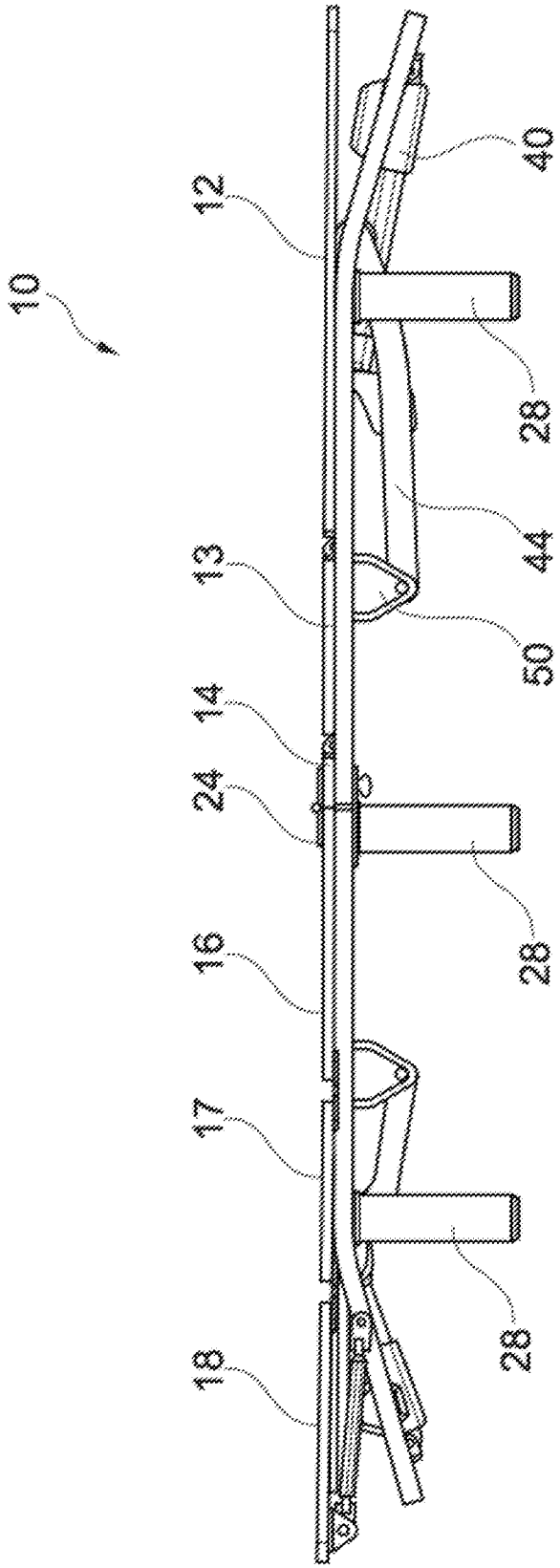
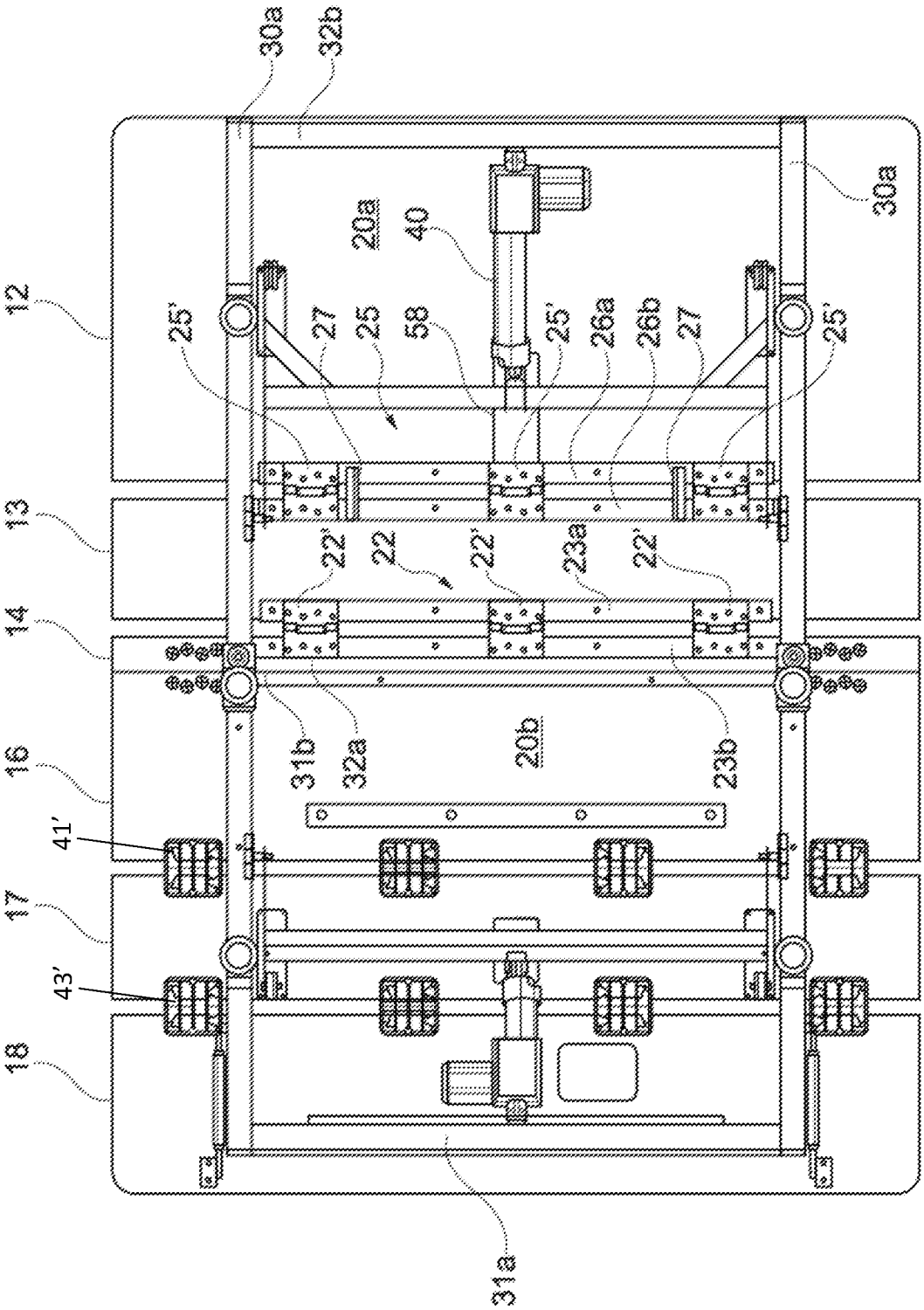


Fig. 8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18
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Fig. 9

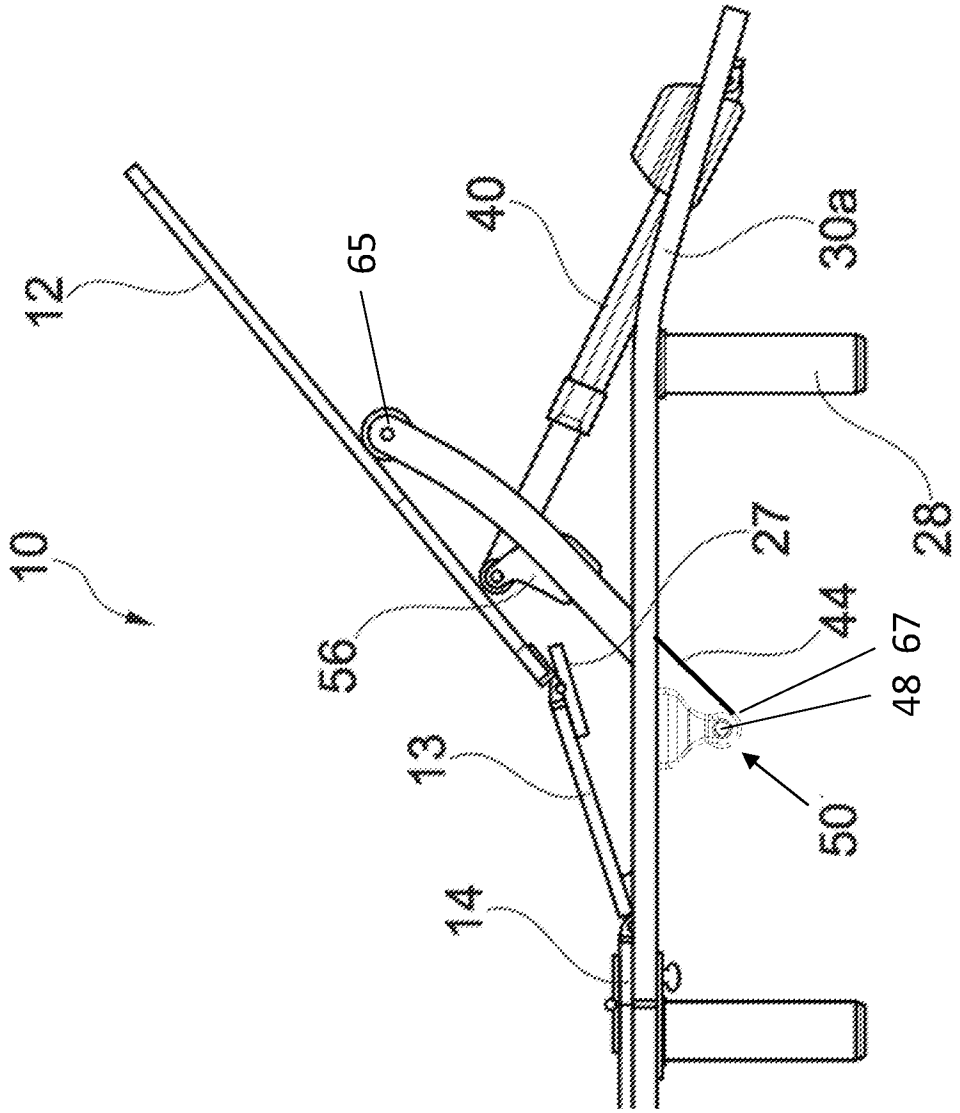

Figure 10

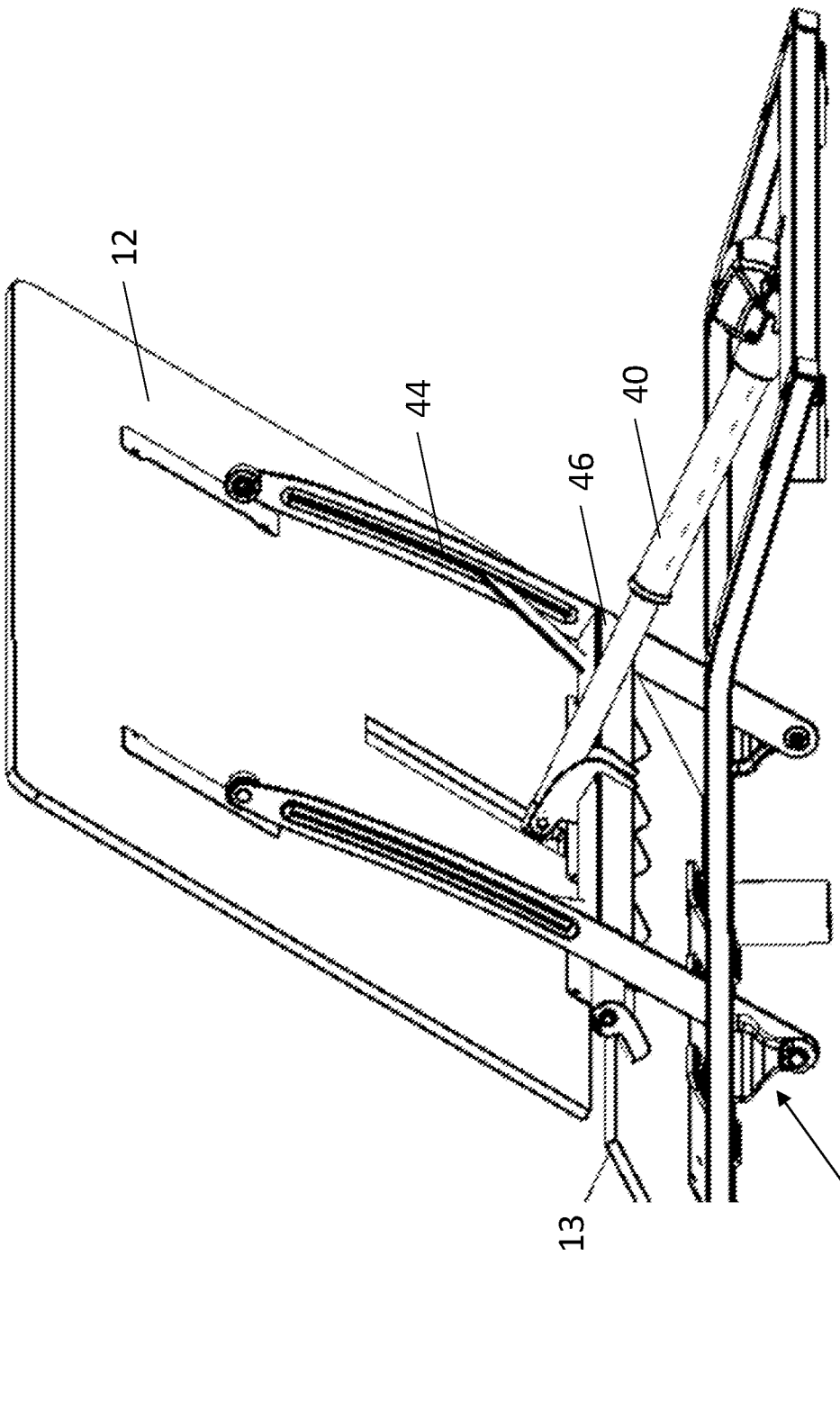

Figure 11

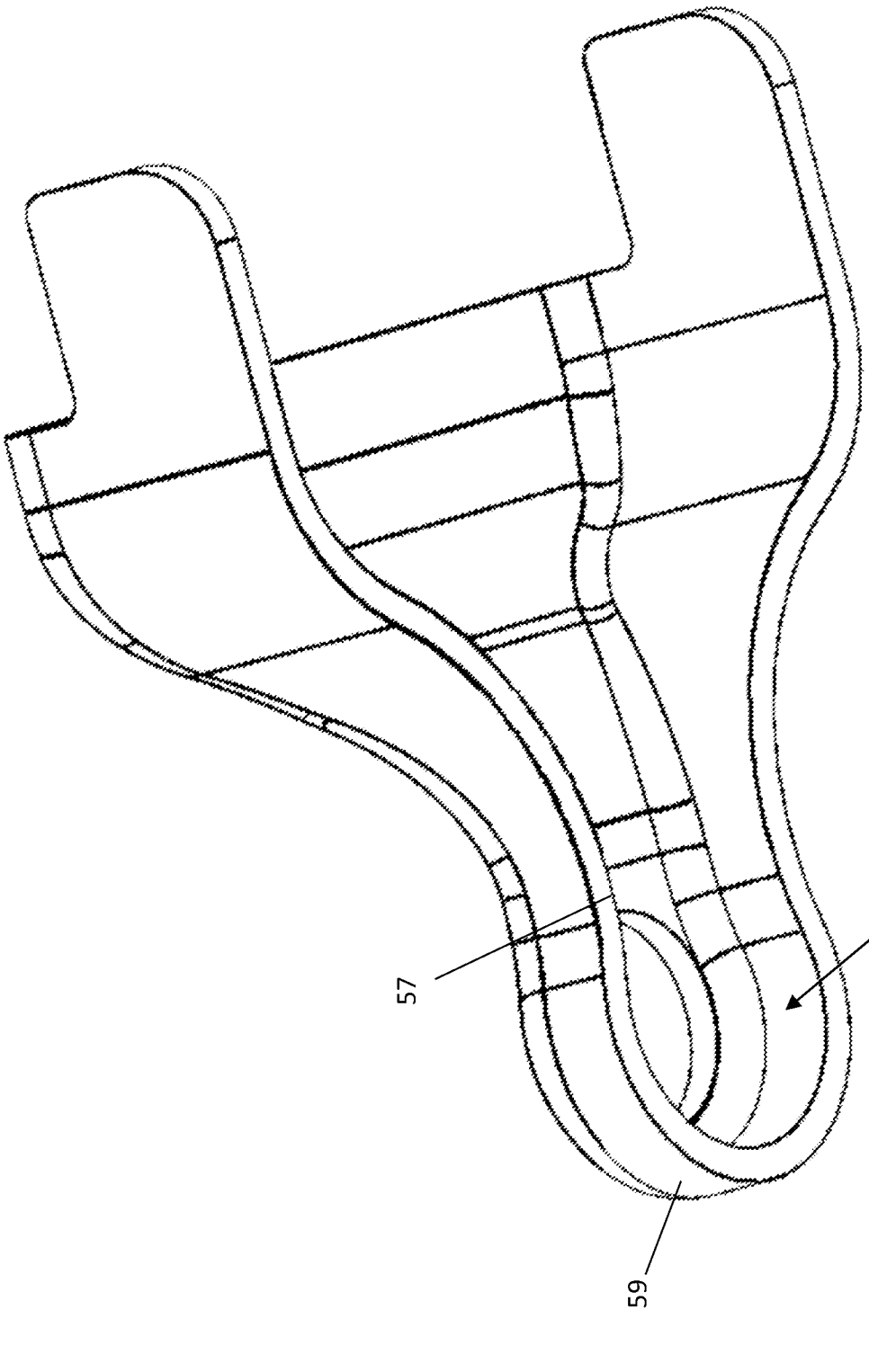

Figure 12

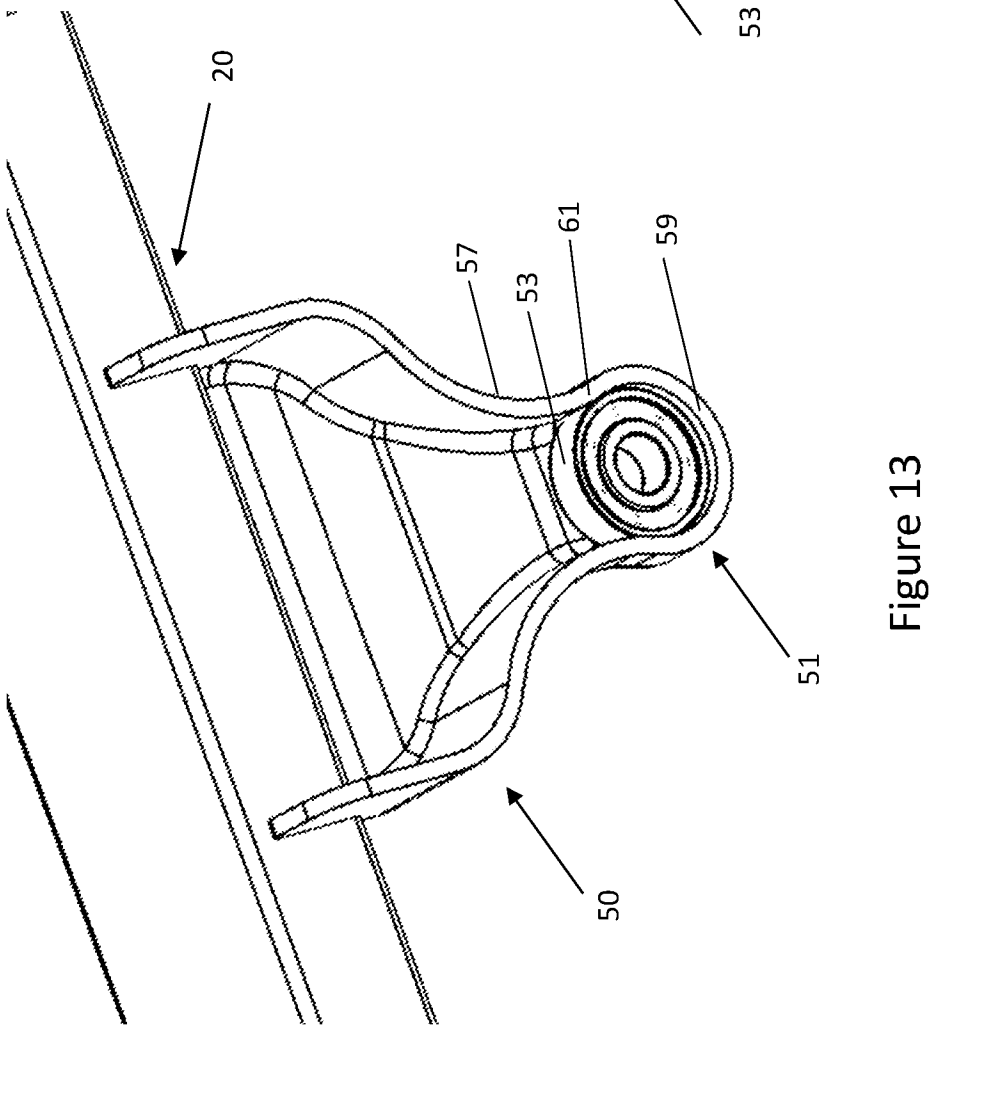

Figure 14

Figure 13

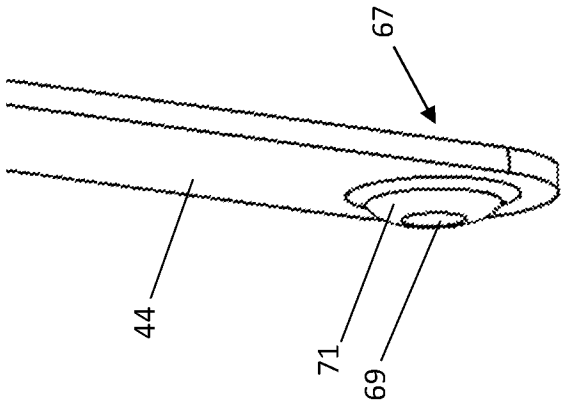

Figure 16

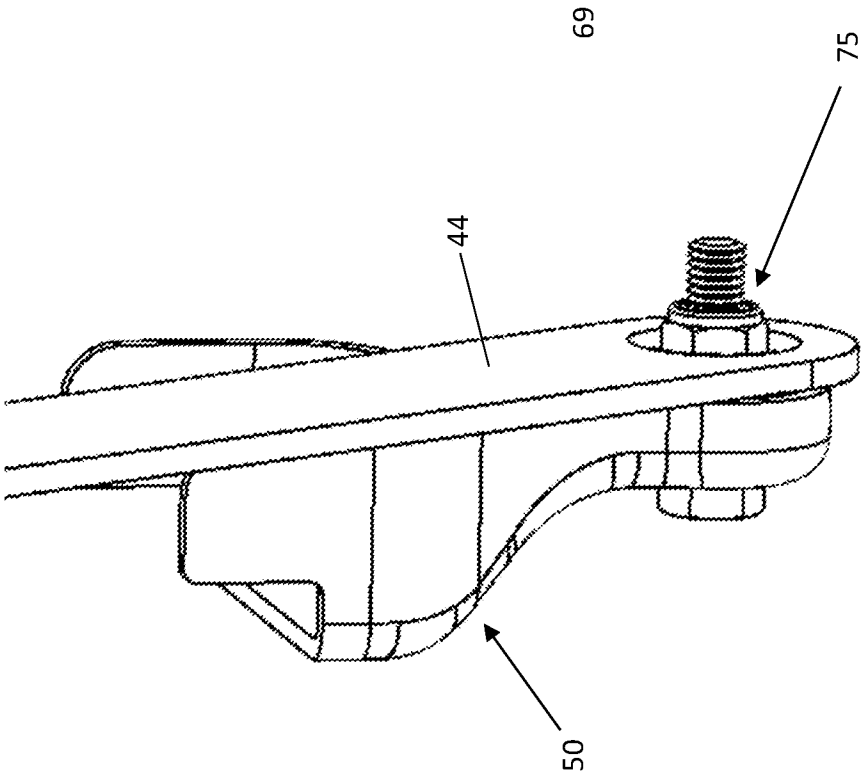

Figure 15

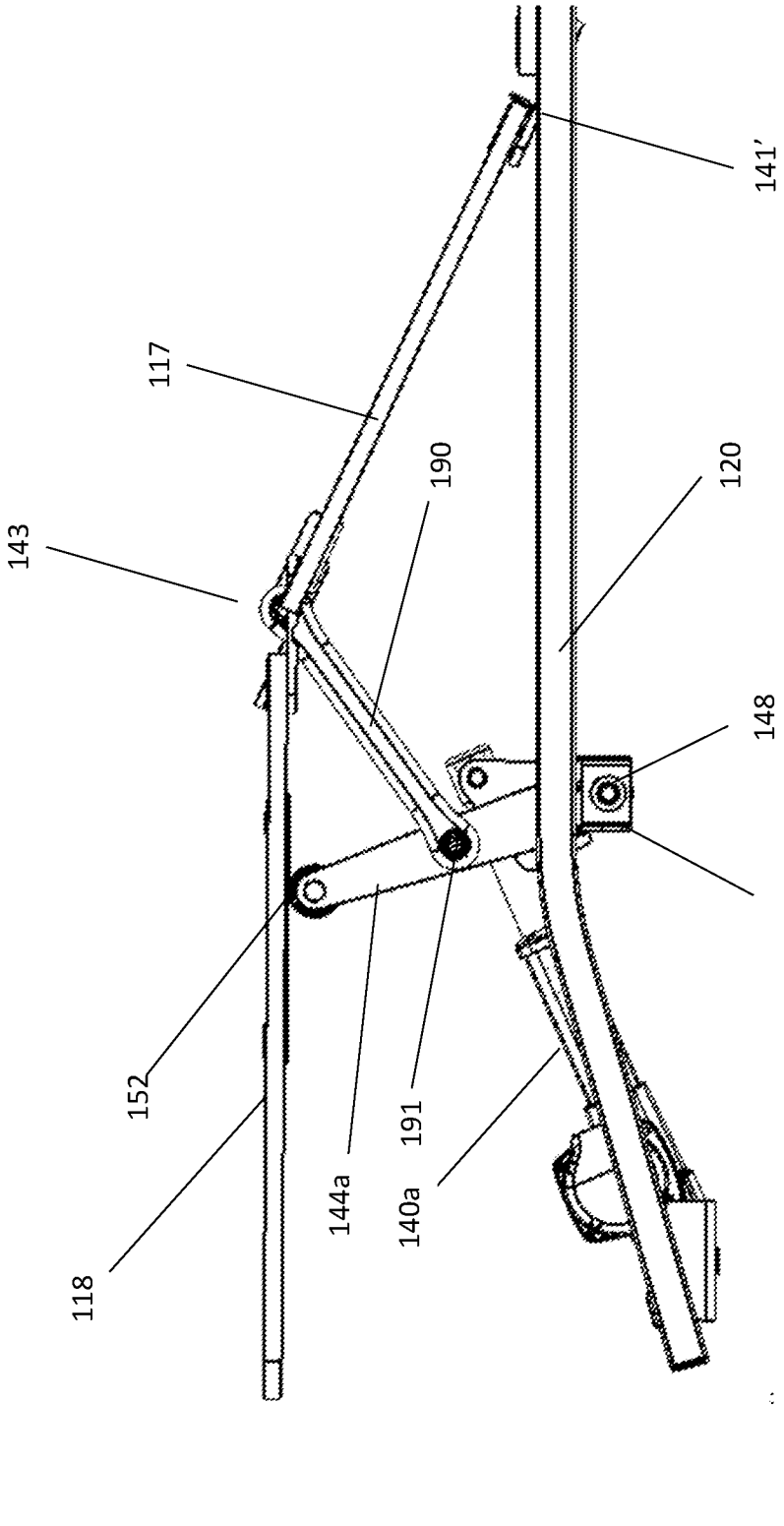

Figure 17

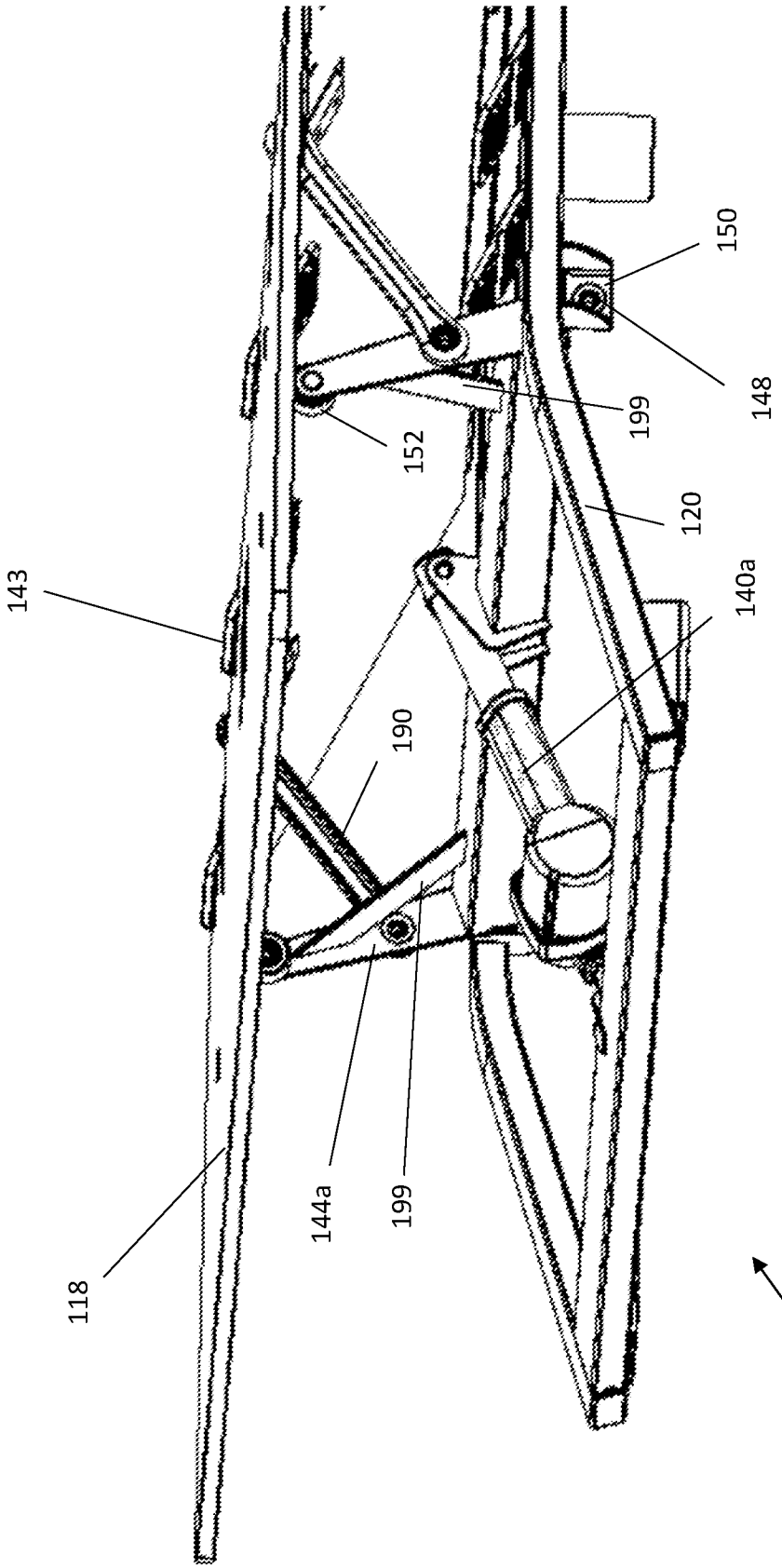

Figure 18

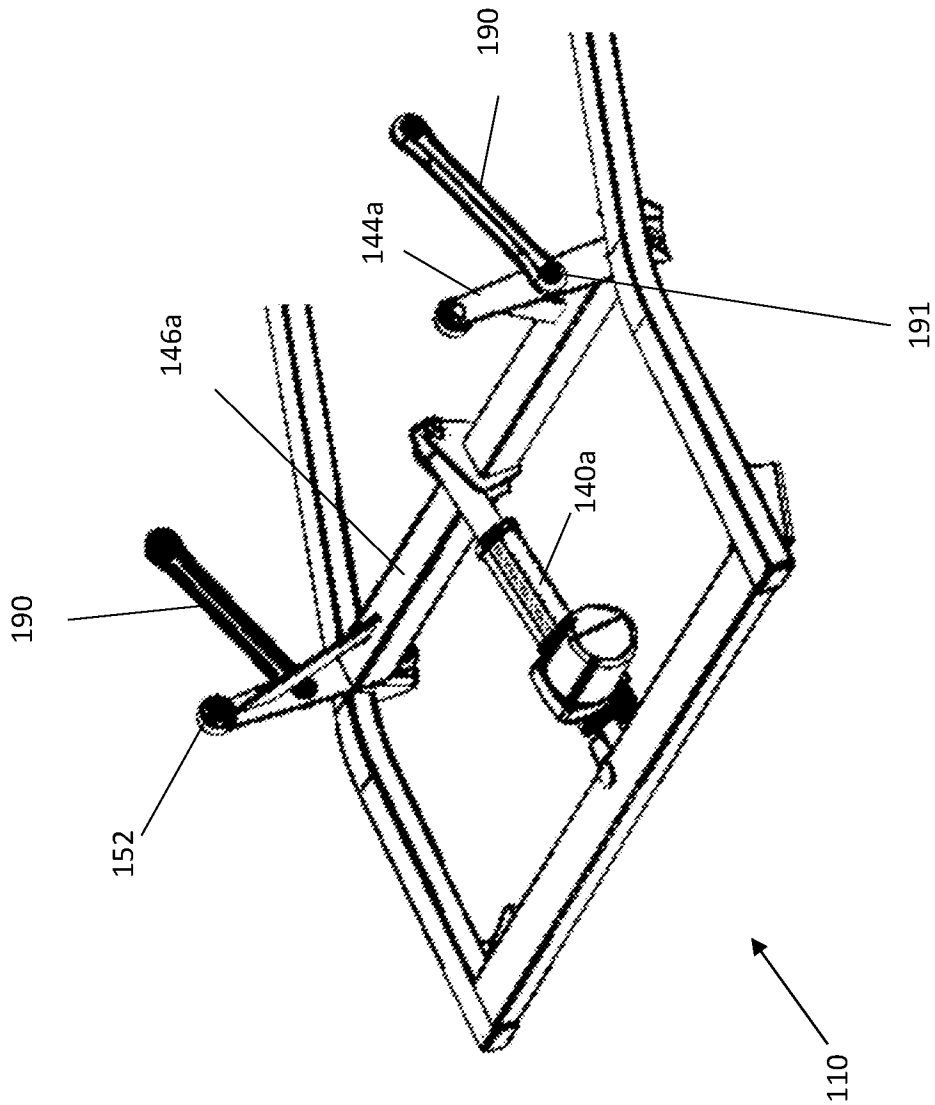

Figure 19

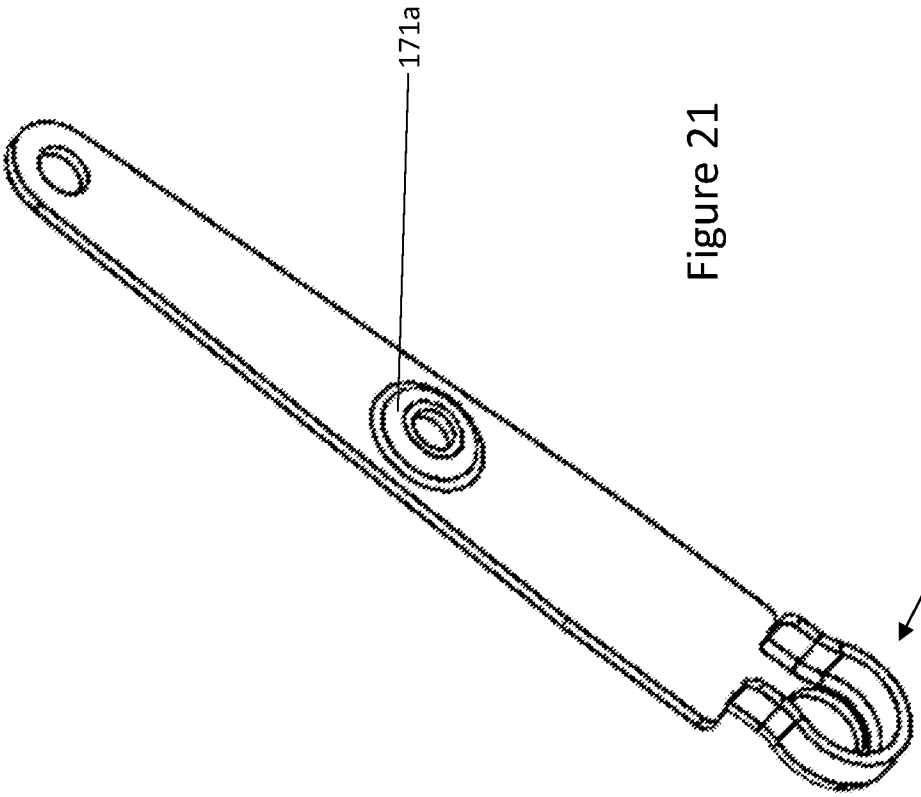

Figure 21

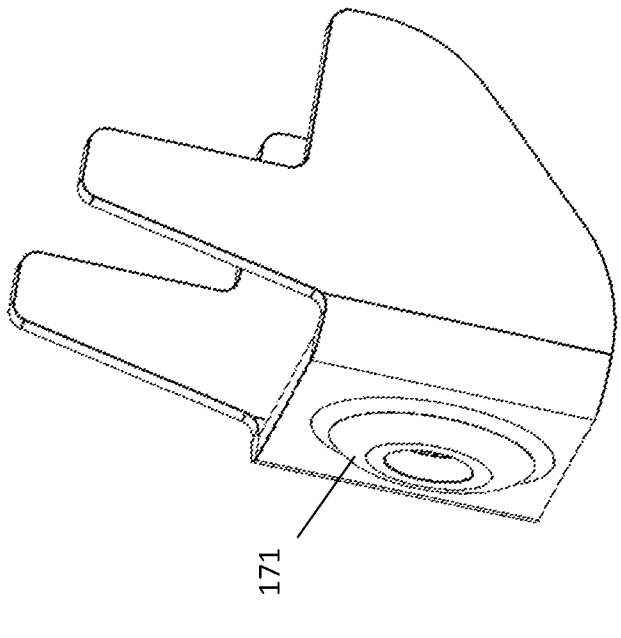

Figure 20

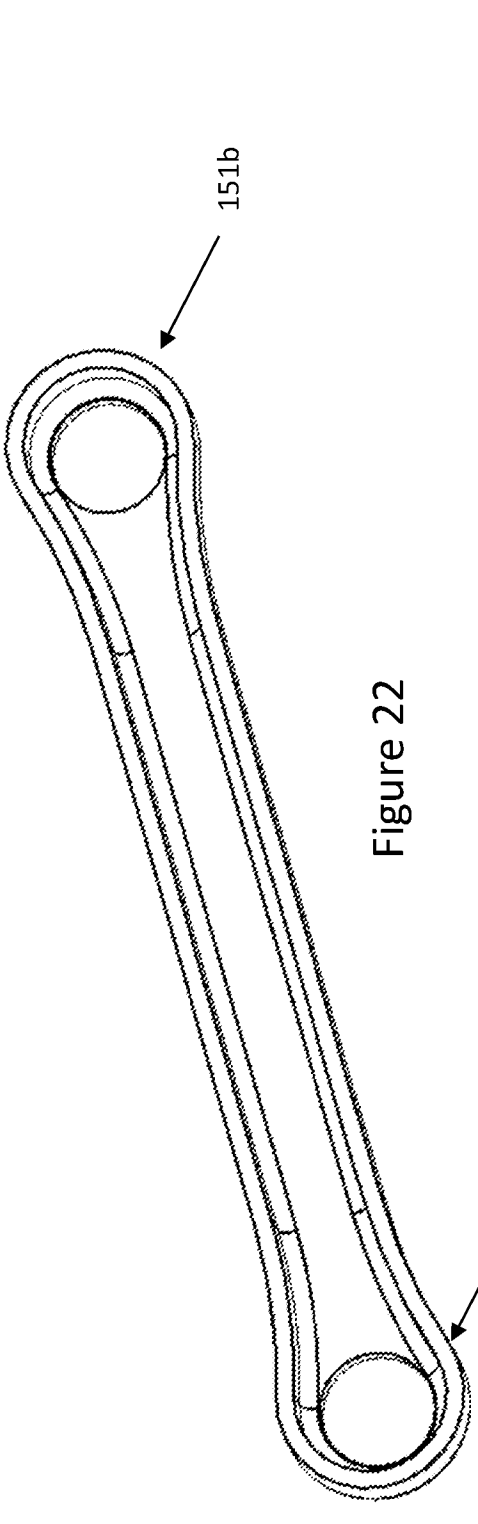

Figure 22

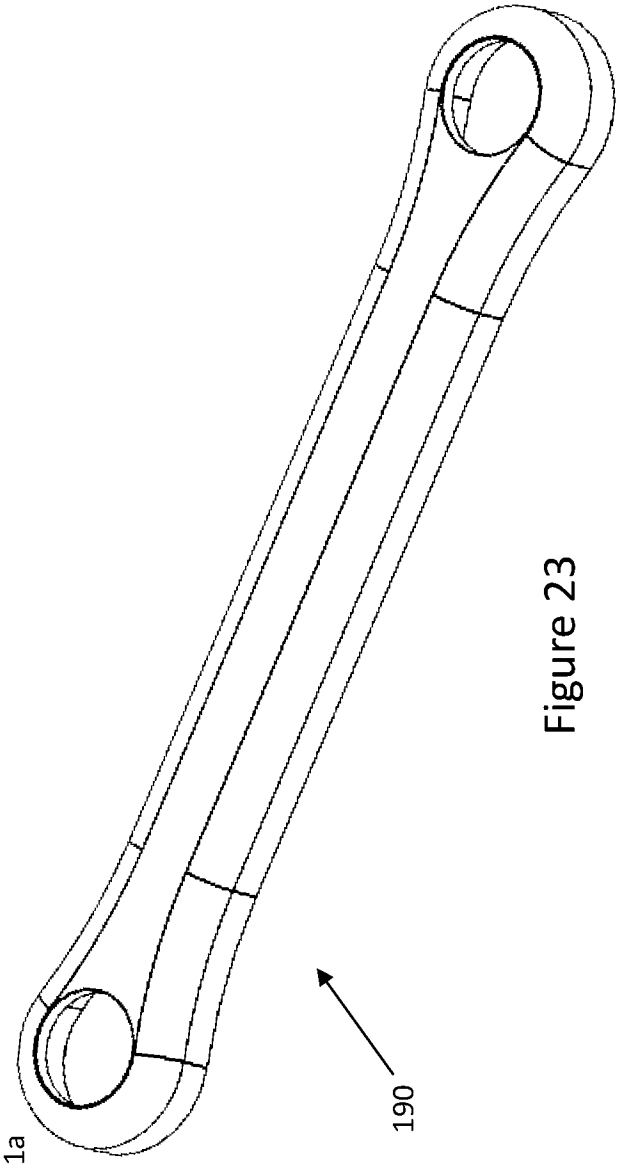

Figure 23

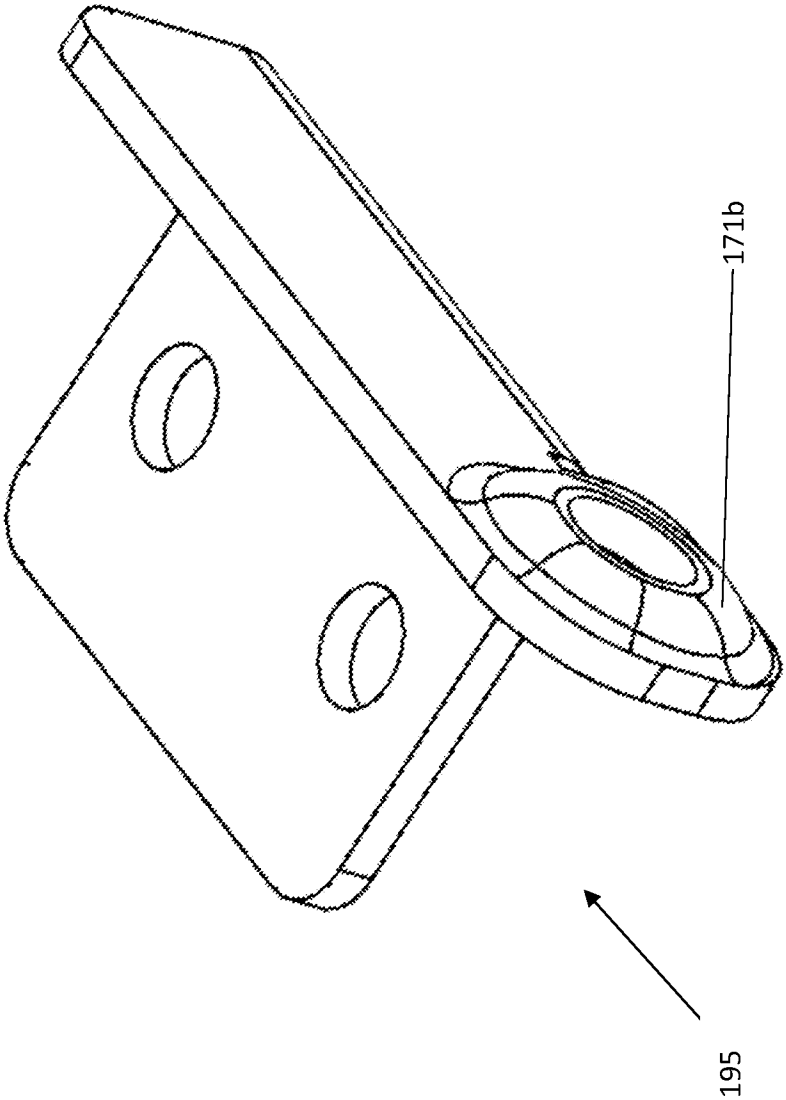

Figure 24

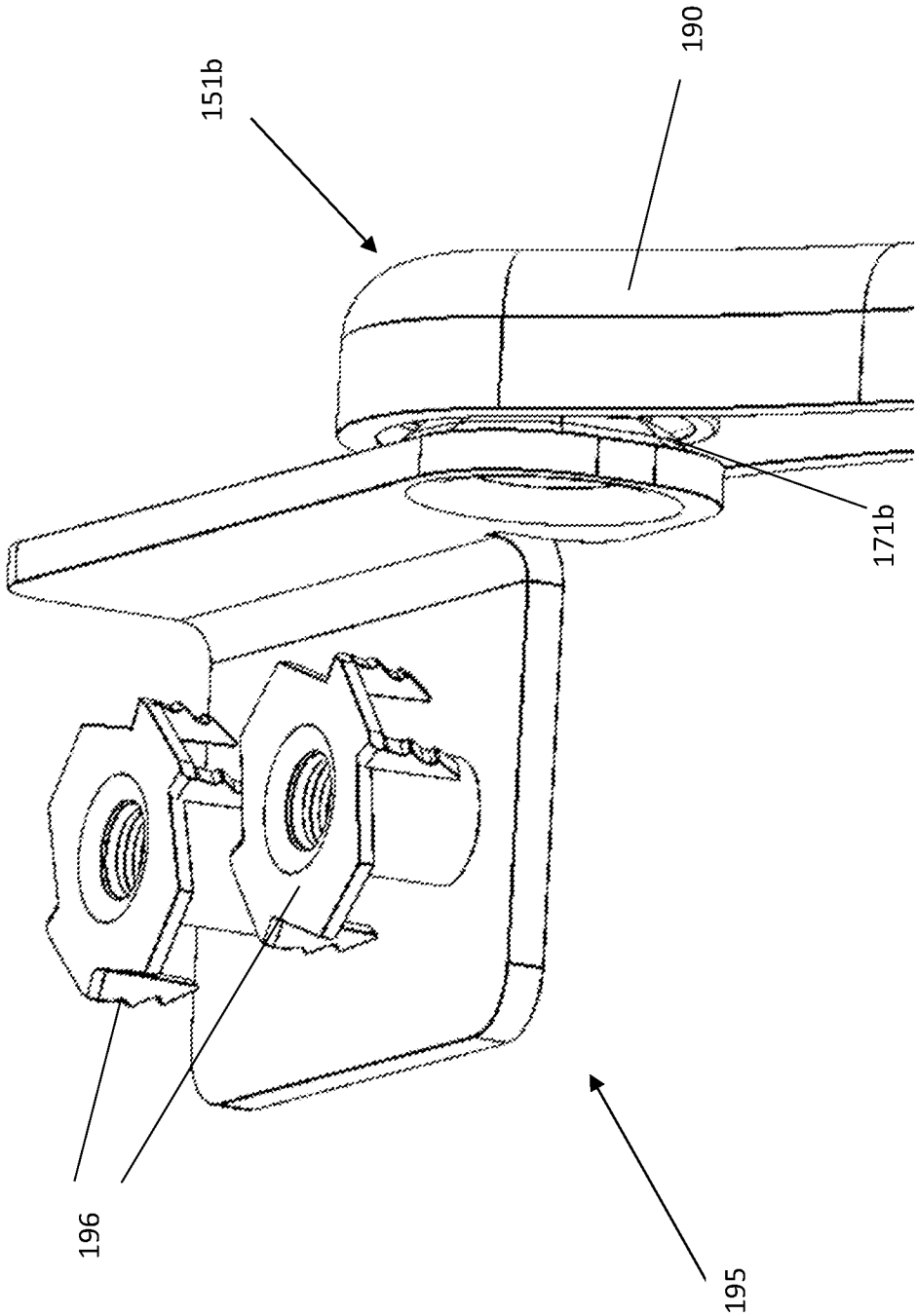

Figure 25

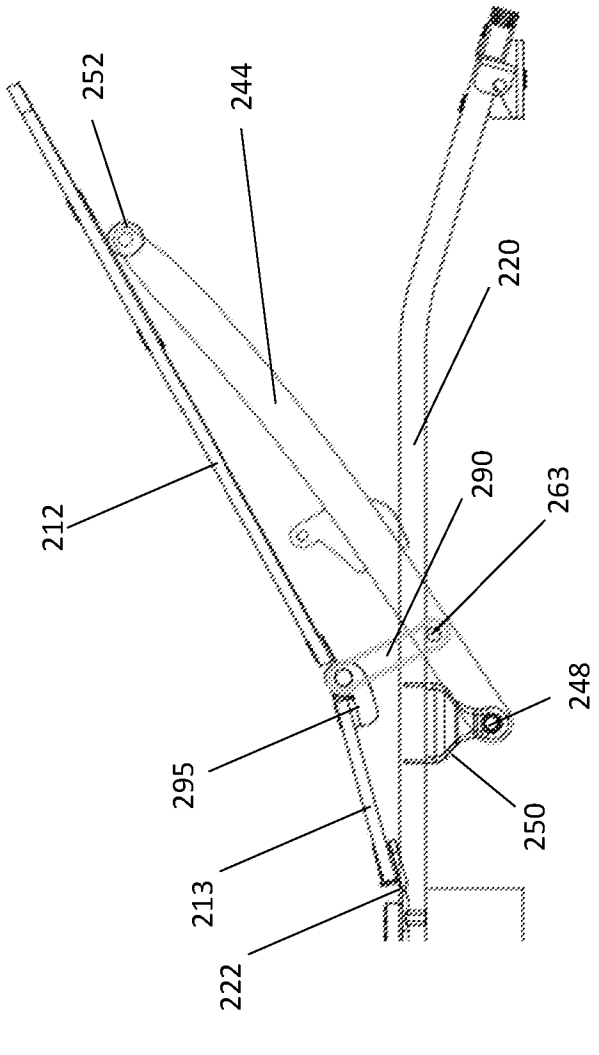

Figure 26

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/052151

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47C20/04 A47C19/12 A61G7/015
ADD.

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)
A47C A61G

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR 2 780 256 A1 (EPEDA SA [FR]) 31 December 1999 (1999-12-31)	1,2,6-23
A	page 8, lines 26-30; claim 1; figures page 7, lines 13-15,26-29	3-5
Y	EP 1 676 505 A1 (INDUSTRIAS HIDRAULICAS PARDO S [ES]) 5 July 2006 (2006-07-05)	1,2,6-23
A	paragraphs [0008], [0019]; figures	3-5
Y	US 5 640 730 A (GODETTE ROBERT G [US]) 24 June 1997 (1997-06-24) claims 1,7; figures 1,2	1,18
Y	DE 201 06 465 U1 (SHIH LONG TIME [TW]) 13 June 2001 (2001-06-13) claims; figures	1,19,21

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[X] Further documents are listed in the continuation of Box C.

[X] 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

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"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
29 August 2018	07/09/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Amghar, Norddin

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/052151

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005 111126 A (AISIN SEIKI) 28 April 2005 (2005-04-28) figures -----	1,20

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2018/052151

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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