(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 265 378 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
08.04.2020 Bulletin 2020/15

(21) Application number: **16758394.7**

(22) Date of filing: **23.02.2016**

(51) Int Cl.:
***B63B 39/00** (2006.01)* ***B63B 17/00** (2006.01)*

(86) International application number:
PCT/CA2016/050181

(87) International publication number:
WO 2016/138578 (09.09.2016 Gazette 2016/36)

(54) SUSPENDED MARINE PLATFORM

HÄNGENDE MEERESPLATTFORM

PLATE-FORME MARINE SUSPENDUE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **04.03.2015 US 201514639091**

(43) Date of publication of application:
10.01.2018 Bulletin 2018/02

(73) Proprietor: **Professional Components Ltd.**
Sidney, BC V8L 5Y1 (CA)

(72) Inventors:
- **SMITH, David A.**
  Sidney, British Columbia V8L 3S6 (CA)
- **ADAMS, Lee M.**
  Parksville, British Columbia V9P 2C7 (CA)

(74) Representative: **Mewburn Ellis LLP**
City Tower
40 Basinghall Street
London EC2V 5DE (GB)

(56) References cited:
WO-A1-2005/025980
WO-A1-2012/129665
WO-A1-2012/129665
US-A- 3 237 906
US-A- 5 542 371
US-B1- 6 237 889
US-B1- 6 786 172

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Printed by Jouve, 75001 PARIS (FR)

Description

Related Application

[0001] This application claims the benefit of US Application No. 14/639,091, filed 4 March 2015.

Field of the Invention

[0002] The present invention relates to a suspended marine platform. More particularly, the present invention relates to a suspended marine passenger platform for use in high-speed watercraft.

Background of the Invention

[0003] High-speed small boats are used in a variety of applications and are particularly useful in military operations, and search and rescue operations. When fast-moving small watercraft encounter even moderately disturbed water, the passengers are subjected to significant forces. At high-speed, in waves of any appreciable size, small watercraft tend to be subjected to rapid and simultaneous vertical and horizontal acceleration and deceleration.

[0004] When a boat moving at high speed impacts the crest of a wave, the boat tends to simultaneously pitch upwards and decelerate, and when it passes over or through the crest and encounters the trough, the boat tends to pitch downwards and accelerate. At high speed, each pitching and acceleration/deceleration cycle may be measured in seconds, such that passengers are subjected to rapid and extreme acceleration and deceleration and the associated shock, which is commonly quantified in terms of multiples of g, a "g" being a unit of acceleration equivalent to that exerted by the earth's gravitational field at the surface of the earth. The term g-force is also often used, but it is commonly understood to mean a relatively long-term acceleration. A short-term acceleration is usually called a shock and is also quantified in terms of g.

[0005] Human tolerances for shock and g-force depend on the magnitude of the acceleration, the length of time it is applied, the direction in which it acts, the location of application, and the posture of the body. When vibration is experienced, relatively low peak g levels can be severely damaging if they are at the resonance frequency of organs and connective tissues. In high-speed watercraft, with the passengers sitting in a conventional generally upright position, which is typically required, particularly with respect to the helmsperson and any others charged with watchkeeping, upward acceleration of the watercraft is experienced as a compressive force to an individual's spine and rapid deceleration tends to throw an individual forward.

[0006] Shock absorbing systems for high-speed boats are known. For example, US Patent No. 6,786,172 (Loffler - Shock absorbing boat) discloses a horizontal base for supporting a steering station that that is hingedly connected to the transom to pivot about a horizontal axis. The base is supported by spring bias means connected to the hull. Another example, WO 2012/129665 (Smith - Suspended marine platform), discloses a shock absorbing assembly for resiliently suspending a marine platform relative to a vessel, having two spar assemblies, one of the spar assemblies forward of the other spar assembly, and each spar assembly comprising a first spar and a second spar, each spar pivotally attached at a proximal end to the vessel and pivotally attached at a distal end to the marine platform with the proximal ends aft of the distal ends and the proximal ends of the spars are spaced athwart one from the other a greater distance than the distal ends of the spars are spaced athwart one from the other.

[0007] Impact attenuation systems for aircraft seats are also known, as disclosed in: US Patent No. 4,349,167 (Reilly - Crash load attenuating passenger seat); US Patent No. 4,523,730 (Martin - Energy-absorbing seat arrangement); US Patent No. 4,911,381 (Cannon et al. - Energy absorbing leg assembly for aircraft passenger seats); US Patent No. 5,125,598 (Fox - Pivoting energy attenuating seat); and US Patent No.5,152,578 - Kiguchi - Leg structure of seat for absorbing impact energy.

[0008] Other seat suspension systems are also known, as disclosed in: US Patent No. 5,657,950 (Han et al. - Backward-leaning-movement seat leg structure); US Patent Application No. 10/907,931 (App.) (Barackman et al. - Adjustable attenuation system for a space re-entry vehicle seat); US Patent No. 3,572,828 (Lehner - Seat for vehicle preferably agricultural vehicle); US Patent No. 3,994,469 (Swenson et al. - Seat suspension including improved damping means); and US Patent No. 4,047,759 (Koscinski - Compact seat suspension for lift truck).

Summary of the Invention

[0009] In one aspect, the present invention provides a suspension system for a suspended marine platform on a high-speed water vessel having a usual direction of travel, the suspension system including: a shock absorbing assembly for resiliently suspending a marine platform relative to a vessel, wherein the shock absorbing assembly tends to cause the marine platform to remain in an upper at-rest position and to return to the at-rest position on cessation of a force causing the marine platform to move generally vertically towards a bottom position; two spar assemblies, one of the spar assemblies forward of the other spar assembly, and each spar assembly including a first spar and a second spar, each spar pivotally attached at a proximal end to the vessel and pivotally attached at a distal end to the marine platform, wherein: the proximal ends are aft of the distal ends; and the proximal ends of the spars are spaced athwart one from the other a greater distance than the distal ends of the spars are spaced athwart one from the other; wherein: the attachment of one of the spar assemblies to the vessel permits relative fore and aft movement between the vessel and the proximal ends of the spars of that one of the spar assemblies; or the attachment of one of the spar assemblies to the marine platform permits relative fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies.

[0010] The attachment of the one of the spar assemblies to the marine platform permits relative fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies. The relative fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies, may be linear. The relative fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies, may be provided by a track and car assembly.

[0011] The relative fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies, may be arcuate. The relative fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies, may be provided by a pivot assembly.

[0012] The suspension system may include a roll-attenuation assembly interconnected between the marine platform and the vessel. The roll-attenuation assembly may include a torsion bar mounted so as to extend athwart, the torsion bar comprising a torsion spring having at each end an arm extending laterally from the torsion spring, wherein the torsion spring is mounted to one of the marine platform and the vessel, and the arms are each interconnected to the other of the marine platform and the vessel.

[0013] In one of the spar assemblies, the first spar and second spar may be fixed one to the other in the vicinity of their distal ends and the pivotal attachment of their distal ends to the marine platform may be by way of a shared pivotal attachment. The shock absorbing assembly may include four shock-absorbing struts, each interconnected between the marine platform and the vessel.

[0014] In another aspect, the present invention provides a suspension system for a suspended marine platform on a high-speed water vessel having a usual direction of travel, the suspension system including: a shock absorbing assembly for resiliently suspending a marine platform relative to a vessel, wherein the shock absorbing assembly tends to cause the marine platform to remain in an upper at-rest position and to return to the at-rest position on cessation of a force causing the marine platform to move generally vertically towards a bottom position; two spar assemblies, one of the spar assemblies forward of the other spar assembly, and each spar assembly including a first spar and a second spar, each spar pivotally attached at a proximal end to the vessel and pivotally attached at a distal end to the marine platform, wherein: the proximal ends are aft of the distal ends; and the proximal ends of the spars are spaced athwart one from the other a greater distance than the distal ends of the spars are spaced athwart one from the other; wherein the attachment of one of the spar assemblies to the marine platform permits relative linear fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies; and further including a roll-attenuation assembly interconnected between the marine platform and the vessel.

[0015] The roll-attenuation assembly may include a torsion bar mounted so as to extend athwart, the torsion bar comprising a torsion spring having at each end an arm extending laterally from the torsion spring, wherein the torsion spring is mounted to one of the marine platform and the vessel, and the arms are each interconnected to the other of the marine platform and the vessel. The shock absorbing assembly may include four shock-absorbing struts, each interconnected between the marine platform and the vessel.

[0016] In another aspect, the present invention provides a suspension system for a suspended marine platform on a high-speed water vessel having a usual direction of travel, the suspension system including: a shock absorbing assembly for resiliently suspending a marine platform relative to a vessel, wherein the shock absorbing assembly tends to cause the marine platform to remain in an upper at-rest position and to return to the at-rest position on cessation of a force causing the marine platform to move generally vertically towards a bottom position; two spar assemblies, one of the spar assemblies forward of the other spar assembly, and each spar assembly including a first spar and a second spar, each spar pivotally attached at a proximal end to the vessel and pivotally attached at a distal end to the marine platform, wherein: the proximal ends are aft of the distal ends; and the proximal ends of the spars are spaced athwart one from the other a greater distance than the distal ends of the spars are spaced athwart one from the other; wherein the attachment of one of the spar assemblies to the marine platform includes a pivot assembly so as to permit relative arcuate fore and aft movement between the marine platform and the distal ends of the spars of that one of the spar assemblies; and further including a roll-attenuation assembly interconnected between the marine platform and the vessel.

[0017] The roll-attenuation assembly may include a torsion bar mounted so as to extend athwart, the torsion bar including a torsion spring having at each end an arm extending laterally from the torsion spring, wherein the torsion spring is mounted to one of the marine platform and the vessel, and the arms are each interconnected to the other of the marine platform and the vessel. The shock absorbing assembly may include four shock-absorbing struts, each interconnected between the marine platform and the vessel.

Summary of the Drawings

[0018]

Figure 1 is a forward-port-side isometric partially transparent view of a double-wishbone anti-sway embodiment of the present invention, shown in the at-rest position.

Figure 2 is a starboard-side elevation view of the embodiment illustrated in Figure 1, shown in the at-rest position.

Figure 3 is a forward elevation view of the embodiment illustrated in Figure 1, shown in the at-rest position.

Figure 4 is a bottom plan view of the embodiment illustrated in Figure 1, shown in the at-rest position.

Figure 5 is a starboard-side elevation view of the embodiment illustrated in Figure 1, shown in a compressed position.

Figure 6 is a forward elevation view of the embodiment illustrated in Figure 1, shown in a compressed position.

Figure 7 is a starboard-side elevation view of the embodiment illustrated in Figure 1, shown in a rolled-to-starboard position.

Figure 8 is a forward elevation view of the embodiment illustrated in Figure 1, shown in a rolled-to-starboard position.

Figure 9 is a forward-port-side isometric partially transparent view of a single-wishbone panhard anti-sway embodiment of the present invention, shown in the at-rest position.

Figure 10 is a starboard-side elevation view of the embodiment illustrated in Figure 9, shown in the at-rest position.

Figure 11 is a forward elevation view of the embodiment illustrated in Figure 9, shown in the at-rest position.

Figure 12 is a bottom plan view of the embodiment illustrated in Figure 9, shown in the at-rest position.

Figure 13 is a starboard-side elevation view of the embodiment illustrated in Figure 9, shown in a compressed position.

Figure 14 is a rear-port-side isometric view of a control-module double-wishbone embodiment of the present invention, shown in the at-rest position.

Figure 15 is a forward-port-side isometric partially transparent view of a single-wishbone Watt's linkage anti-sway embodiment of the present invention, shown in the at-rest position.

Figure 16 is a forward-port-side isometric partially transparent view of a double two-spar roll-attenuation embodiment of the present invention, shown in the at-rest position.

Figure 17 is an isometric isolation view of a portion of an anti-sway assembly embodiment of the present invention.

Figure 18 is an isometric isolation view of an in-line clevis mount embodiment of the present invention.

Figure 19 is a bottom plan view of a laterally displaced clevis mount embodiment of the present invention.

Figure 20 is a perspective from-below isolation view of a sliding spar bracket embodiment.

Figure 21 is a perspective from-below isolation view of the sliding spar bracket embodiment of Figure 20, shown with spars.

Figure 22 is a perspective from-below isolation view of a sliding spar bracket with track mount embodiment.

Figure 23 is a perspective from-below isolation view of the sliding spar bracket with track mount embodiment of Figure 22, shown with spars.

Figure 24 is a perspective exploded view of a pivot block and pivot pin assembly embodiment.

Figure 25 is a cutaway perspective view of a pivoting spar bracket embodiment, shown with spars.

Figure 26 is a perspective from-below view of a double two-spar roll-attenuation embodiment of the present invention with movement-accommodating spar brackets wherein the forward spars are interconnected to the marine platform via a sliding spar bracket and the torsion spring is attached to the marine platform roughly in the middle of the fore and aft extent of the marine platform and with the adjustable torsion arms extending aft from the torsion spring.

Figure 27 is a side elevation view of embodiment shown in Figure 26.

Figure 28 is a perspective from-below view of a double two-spar roll-attenuation embodiment of the present invention with movement-accommodating spar brackets wherein the aft spars are interconnected to the marine platform via a sliding spar bracket and the torsion spring is attached to the marine platform toward the forward end of the marine platform and with the adjustable torsion arms extending forward from the torsion spring.

Figure 29 is a side elevation view of embodiment shown in Figure 28.

Figure 30 is a perspective from-below view of a double two-spar roll-attenuation embodiment of the present invention with movement-accommodating spar brackets wherein the aft spars are interconnected to the marine platform via a pivoting spar bracket and the torsion spring is attached to the marine platform toward the forward end of the marine platform and with the adjustable torsion arms extending forward from the torsion spring.

Figure 31 is a side elevation view of the embodiment shown in Figure 30.

Detailed Description with Reference to the Drawings

[0019] In this specification, including the claims, terms conveying an absolute direction (forexample, up, down etc.) or absolute relative positions (for example, top, bottom etc.) are used for clarity of description and it is understood that such absolute directions and relative positions may not always pertain. As well, in this specification, including the claims, terms relating to directions and relative orientations on a watercraft, for example, port, starboard, forward, aft, fore and aft (which when used herein means a generally horizontal direction generally parallel to the direction of travel of the vessel), bow, stern, athwart (which when used herein means a generally horizontal direction generally perpendicular to the direction of travel of the vessel) etc. are used for clarity of description and it is understood that such terms may not always pertain.

[0020] As well, in this specification, including the claims, the terms "roll and "pitch" are used to refer to movement relative to an imaginary line parallel to the nominal direction of travel of the vessel or object, and passing through the center of mass of the vessel or object, with "roll" being quasi-pivotal or quasi-rotational lateral movement with respect to the imaginary line, and "pitch" being a generally vertical angle of displacement (e.g. bow up or bow down) caused by a vertical force applied at a distance from the center of mass.

[0021] In most of the figures, a marine platform 200 is represented in a simplified stylized manner, however it will be appreciated that in an actual installation, marine platform 200 may comprise several other features, including: contoured seats, windscreens, covers, vessel controls etc. As well, marine platform 200 may be a passenger module comprising a plurality of individual seats. Marine platform 200 may be configured for use with a variety of items, including a stretcher or stretchers, cargo, a cockpit, a pallet of seats, and may configured for interchangeable use with many different types of such items.

[0022] In the figures, a deck 204 is indicated as being below, and providing support for, the marine platform 200. In an actual installation, the marine platform 200 and the associated suspension system are typically mounted to the vessel, such as to an integral deck. However, in some installations, it may be preferable to mount the marine platform 200 and suspension system to a carriage (such as a suitable plate or framework) and to attach the carriage to the vessel.

[0023] The embodiments shown in the figures all have four shock absorbing struts 206, which serve to suspend marine platform 200 above deck 204, with each strut 206 shown as positioned in the general vicinity of an associated corner of the marine platform 200 and extending generally vertically. In the figures, each strut 206 is secured to deck 204 with a strut deck bracket 207 and to marine platform 200 with a strut module bracket 208. The struts 206 may be any suitable type of shock absorber such as air shocks, MacPherson struts etc. Further, there need not be exactly four struts 206; more or fewer struts 206 may be suitable in some applications.

[0024] Some of the embodiments shown in the drawings include a roll-attenuation assembly 220 and/or a pitch-attenuation assembly 230. The roll-attenuation assembly 220 and the pitch-attenuation assembly 230 share functionally analogous components and for convenience and simplicity herein such functionally analogous components are given the same descriptive terms and reference numbers, though it will be understood that such components may differ in many respects, including size, as between the roll-attenuation assembly 220 and the pitch-attenuation assembly 230.

[0025] Each of the roll-attenuation assembly 220 and the pitch-attenuation assembly 230 includes a torsion bar 240, comprising: a longitudinally extending torsion spring 242 having at each end a torsion arm 244 or an adjustable torsion arm 246, extending laterally from the torsion spring 242. The torsion arm 244 has a torsion arm mounting hole 247 in the vicinity of the end of the torsion arm 244 opposite the torsion spring 242. The adjustable torsion arm 246 has a plurality of torsion arm mounting holes 247 in the vicinity of the end of the adjustable torsion arm 246 opposite the torsion spring 242.

[0026] A torsion arm link 248 or adjustable torsion arm link 250 is pivotally connected to each of the torsion arm 244 and adjustable torsion arm 246 at a respective torsion arm mounting hole 247. At the end of each torsion arm link 248 or adjustable torsion arm link 250 opposite the connection to the torsion arm 244 or adjustable torsion arm 246, as the case may be, there is a link bracket 252, that in use is mounted to the marine platform 200 or deck 204 or other appropriate component.

[0027] Along the torsion spring 242, there are two torsion-bar mounts 254 for mounting the torsion bar 240 to the marine platform 200 or deck 204 or other appropriate component. The torsion-bar mounts 254 tend to impede longitudinal movement of the torsion spring 242 while permitting rotational movement of the torsion spring 242.

[0028] In use, the roll-attenuation assembly 220 is mounted with the relevant torsion spring 242 extending athwart. In use, the pitch-attenuation assembly 230 is mounted with the relevant torsion spring 242 extending fore and aft.

[0029] The roll-attenuation assembly 220 and pitch-attenuation assembly 230 function along the lines of a conventional anti-sway bar in that the roll-attenuation assembly 220 and pitch-attenuation assembly 230 impede differential relative vertical movement between the two sets of components between which the two ends of the roll-attenuation assembly 220 and pitch-attenuation assembly 230 are interconnected. The degree to which the roll-attenuation assembly 220 and pitch-attenuation assembly 230 impede such relative vertical movement (i.e., the "stiffness" of the roll-attenuation assembly 220 and pitch-attenuation assembly 230) depends on the size and characteristics of the torsion spring 242; and the distance between the axis of rotation of the torsion spring 242 and the connection between the torsion arm 244 or adjustable torsion arm 246 and the torsion arm link 248 or adjustable torsion arm link 250 (as the case may be). Therefore, the "stiffness" of the roll-attenuation assembly 220 and pitch-attenuation assembly 230 may be adjusted by changing the torsion spring 242, and by moving the location of the connection between the adjustable torsion arm 246 and the torsion arm link 248 or adjustable torsion arm link 250 (as the case may be) by moving the connection to a different one of the plurality of torsion arm mounting holes

247 provided in the adjustable torsion arm 246.

[0030] The adjustable torsion arm 246 includes a bottlescrew 260 so as to permit adjustment of the length of the adjustable torsion arm 246.

[0031] Some of the embodiments shown in the drawings include spars 270, pivotally connected between the marine platform 200 and deck 204, by way of spar brackets 272, spar clevis brackets 274 or spar clevis lateral brackets 276.

[0032] In this specification, the term wishbone (e.g., forward wishbone 302 and aft wishbone 304) is used to refer to an assembly of two spars in which the two spars are fixed one to the other in the vicinity of the marine platform 200 and share a common pivotal attachment to the marine platform 200, being a wishbone platform bracket 312.

[0033] The spars 270 preferably have heim joints 314 (also referred to as rod end bearings and rose joints) at each end. The forward wishbone 302 and aft wishbone 304 preferably have heim joints 314 for the connection to the wishbone platform bracket 312. The heim joints 314 are preferably high-strength stainless steel heim joints.

[0034] Referring to Figures 1 through 8, there is illustrated an embodiment of the present invention comprising a marine platform 200 and an associated double-wishbone roll-attenuation suspension system, generally referenced by numeral 300, mounted to a deck 204. In Figures 1 through 4, the embodiment is shown with the marine platform 200 in a no-load at-rest position. In Figures 5 and 6, the embodiment is shown with the marine platform 200 in a compressed bottom position In Figures 7 and 8, the embodiment is shown with the marine platform 200 rolled to starboard relative to the deck 204.

[0035] In the embodiment shown in Figures 1 through 8, the double-wishbone roll-attenuation suspension system 300, includes four struts 206, a forward wishbone 302, an aft wishbone 304, and a roll-attenuation assembly 220.

[0036] As shown in the figures, each of the forward wishbone 302 and aft wishbone 304 is pivotally attached to the deck 204 with two wishbone deck brackets 310 and is pivotally attached to the marine platform 200 with a wishbone platform bracket 312. The heim joint 314 at the connection between each wishbone platform bracket 312 and the respective forward wishbone 302 and aft wishbone 304 permits some lateral pivotal movement so as to accommodate rolling of the marine platform 200 relative to the deck 204 when in use.

[0037] In use, fast-moving relatively small watercraft are subject to complicated forces that cause the vessels to pitch, yaw, roll, rise, fall, decelerate and accelerate. The response of the double-wishbone anti-sway suspension system 210 embodiment to such forces is indicated in Figures 5 through 8.

[0038] Referring to Figures 9 through 13, there is illustrated an embodiment of the present invention comprising a marine platform 200 and an associated single-wishbone panhard roll-attenuation suspension system, generally referenced by numeral 350, mounted to a deck 204. In Figures 9 through 12, the embodiment is shown with the marine platform 200 in a no-load at-rest position. In Figure 13, the embodiment is shown with the marine platform 200 in a compressed bottom position.

[0039] In the embodiment shown in Figures 9 through 13, the single-wishbone panhard roll-attenuation suspension system 350, includes four struts 206, an aft wishbone 304, a roll-attenuation assembly 220 and a panhard assembly 360. The aft wishbone 214 is configured and mounted as described above.

[0040] The panhard assembly 360 comprises a panhard rod 362, a panhard deck mount 364 and a panhard platform mount 366. The proximal end of the panhard rod 362 is pivotally mounted to the deck 204 with the panhard deck mount 364. The distal end of the panhard rod 362 is pivotally mounted to the marine platform 200 with the panhard platform mount 366.

[0041] In the embodiment shown in Figures 9 through 13, the panhard assembly 360 is positioned in the vicinity of the forward end of marine platform 200. The panhard assembly 360 prevents more than minimal lateral movement of marine platform 200 relative to deck 204. As the distal end of panhard rod 362 moves in an arc as marine platform 200 moves vertically relative to the deck 204, panhard rod 360 induces a slight lateral movement of marine platform 200 during vertical movement of marine platform 200. This slight lateral movement of marine platform 200 relative to deck 204 is accommodated generally by the various connections between the components of embodiment being configured to permit some relative lateral movement.

[0042] Referring to Figure 14, there is illustrated an embodiment of the present invention comprising a control module 400, and a double-wishbone suspension system, generally referenced by numeral 410, mounted to a deck 204.

[0043] The control module 400 comprises two seats 420, a helm/control station 422, two foot rests 424 (one on the port side and the other on the starboard side; only one is visible in the drawing) and two foot openings 426 (again, one on the port side and the other on the starboard side; only one is visible in the drawing). The foot openings 426 permit users to selectively stand on the deck 204 or sit on the seats 420 while controlling the vessel or while being partially sheltered from spray by the control module 400.

[0044] In the embodiment shown in Figure 14, the double-wishbone suspension system 410, includes four struts 206, a forward wishbone 302 and an aft wishbone 304.

[0045] Referring to Figure 15, there is illustrated an embodiment of the present invention comprising a marine platform 200 and an associated single-wishbone Watt's linkage roll-attenuation suspension system, generally referenced by numeral 450, mounted to a deck 204. In Figure 15, the embodiment is shown with the marine platform 200 in a no-load at-rest position.

[0046] In the embodiment shown in Figure 15, the single-wishbone Watt's linkage roll-attenuation suspension system 450, includes four struts 206, an aft wishbone 214, a roll-attenuation assembly 222 and a Watt's linkage 460.

[0047] The Watt's linkage 460 embodiment shown in the drawings comprises a Watt's link 462 rotatably mounted to the marine platform 200; a starboard Watt's rod 464 attached at one end to the Watt's link 462 and attached at the other end to the deck 204 via a starboard Watt's rod deck mount 466; and a port Watt's rod 468 attached at one end to the Watt's link 462 (opposite the location of attachment of the starboard Watt's rod 464) and attached at the other end to the deck 204 via a port Watt's rod deck mount 470.

[0048] The Watt's linkage 460 permits vertical movement of the marine platform 200 relative to the deck 204, with minimal lateral movement of the marine platform 200 relative to the deck 204.

[0049] Referring to Figure 16, there is illustrated an embodiment of the present invention comprising a marine platform 200 and an associated double two-spar roll-attenuation suspension system, generally referenced by numeral 500, mounted to a deck 204. In Figure 16, the embodiment is shown with the marine platform 200 in a no-load at-rest position.

[0050] In the embodiment shown in Figure 16, the double two-spar roll-attenuation suspension system 500, includes four struts 206, a roll-attenuation assembly 220 and four spars 270. The spars 270 are arranged in two pairs, a forward pair and an aft pair, with each pair in the shape of a V, with the base of the V attached to the marine platform 200 and the top of the V attached to the deck 204.

[0051] Referring to Figures 20 to 31 there are shown movement-accommodating spar brackets which permit relative fore and aft movement as between the spars 270 (or forward wishbone 302 or aft wishbone 304) and marine platform 200, or the deck 204, that the movement-accommodating spar bracket is interconnecting. The movement-accommodating spar bracket embodiments illustrated in the drawings are a sliding spar bracket 930 and pivoting spar bracket 950, which are configured for interconnecting two spars 270 to a marine platform 200.

[0052] As indicated in Figures 20 -23, the sliding spar bracket 930 comprises a track assembly 922 and a slide assembly 924.

[0053] The track assembly 922 comprises two spaced-apart parallel tracks 926 having a general "T" configuration. The track assembly 922 may also include a track mount 928, being, in the embodiments shown in the drawings, a plate suitable for maintaining the relative orientation of the tracks 926 during use and for affixing to the marine platform 200. Alternatively, the tracks 926 may be affixed directly to the marine platform 200.

[0054] The slide assembly 924 comprises a slide assembly body 930, two spar connectors 932 on the lower side of the slide assembly body 930 and two spaced apart aligned car assemblies 934 on the upper side of the slide assembly body 930.

[0055] Each spar connector 932 comprises two parallel projecting tangs 936 configured (including each having a hole therethrough) for receiving the heim joint 314 of a respective spar 270 and securing same with a heim joint fastener 938. The spar connectors 932 are angled relative to each other so as to be aligned with a pair of spars 270 oriented in the shape of a V, with the base of the V attached to the spar connectors 932 and the top of the V attached to the deck 204.

[0056] Each car assembly 934 comprises one or more aligned cars 940 configured for slidable engagement with a respective track 926. As will be apparent from the drawings, when engaged one with the other, the slide assembly 924 and track assembly 922 are constrained to undergoing relative reciprocating linear movement.

[0057] To obtain the desired alignment (and thus low friction), as the slide assembly body 930 is preferably metal (preferably stainless steel plate) and the tangs 936 are preferably welded to the slide assembly body 930, the face of the slide assembly body 930 to which the tracks 926 are affixed, is preferably machined after the tangs 936 are attached to remove any distortion caused by the welding.

[0058] Given the marine environment to which they are exposed in use, the tracks 926 and cars 940 are preferably corrosion resistant and low friction without lubrication. The tracks 926 are preferably anodized aluminum T- rail. The cars 940 preferably comprise anodized aluminum bodies with low-friction plastic sliding elements.

[0059] It has been found that products provided by IGUS GmbH and IGUS Inc. are suitable for use as cars 940 and tracks 926, namely DryLin® T - profile rail series, specifically car part no. TW-01-25 and rail part no. TS-01-25 (the car is 6063-T6 Aluminum and clear anodized, and the rail is 6063-T6 Aluminum and hard anodized). The IGUS GmbH and IGUS Inc. cars in include a sliding element made from iglide® J material and the sliding elements are adjustable with stainless steel screws.

[0060] As indicated in Figures 24 and 25, the pivoting spar bracket 950 comprises a pivot block 952, a pivot cavity 954 and pivot pin assembly 956.

[0061] The pivot block 952 includes two spar connectors 932 oriented in the same manner as the spar connectors 932 of the sliding spar bracket 920. The pivot block 952 includes a pivot block bore 958.

[0062] The pivot cavity 954 includes a recess for receiving the pivot block 952 and two pivot cavity holes 960. The pivot cavity 954 may be a separate component affixed to the marine platform 200 or may be integral to the marine platform 200.

[0063] The pivot pin assembly 956 includes a pivot bolt 962, pivot nut 964, pivot washer 966, two pivot sleeves 968 and a pivot bushing 970.

[0064] The pivoting spar bracket 950 is assembled by: inserting a pivot sleeve 968 into each end of the pivot block bore 958; inserting the pivot bushing 970 into the pivot sleeves 968; positioning the pivot block 952 within the pivot cavity 954 so as to bring the pivot block bore 958 into alignment with the pivot cavity holes 960; inserting the pivot bolt 962 therethrough; and securing the pivot bolt 962 with the pivot nut 964 and pivot washer 966.

[0065] It has been found that the iglide® J material provided by IGUS GmbH and IGUS Inc. is suitable for use as pivot bushing 970, for example bushing part no: JFI-2428-24.

[0066] Double two-spar roll-attenuation embodiments of the present invention with movement-accommodating spar brackets are shown in the drawings.

[0067] Figures 26 and 27 show a double two-spar roll-attenuation embodiment of the present invention with movement-accommodating spar brackets wherein the forward spars 270 are interconnected to the marine platform 200 via a sliding spar bracket 920 and the torsion spring 242 is attached to the marine platform 200 roughly in the middle of the fore and aft extent of the marine platform and with the adjustable torsion arms 246 extending aft from the torsion spring 242.

[0068] Figures 28 and 29 show a double two-spar roll-attenuation embodiment of the present invention with movement-accommodating spar brackets wherein the aft spars 270 are interconnected to the marine platform 200 via a sliding spar bracket 920 and the torsion spring 242 is attached to the marine platform 200 toward the forward end of the marine platform and with the adjustable torsion arms 246 extending forward from the torsion spring 242.

[0069] Figures 30 and 31 show a double two-spar roll-attenuation embodiment of the present invention with movement-accommodating spar brackets wherein the aft spars 270 are interconnected to the marine platform 200 via a pivoting spar bracket 950 and the torsion spring 242 is attached to the marine platform 200 toward the forward end of the marine platform and with the adjustable torsion arms 246 extending forward from the torsion spring 242.

[0070] It will be apparent that the movement-accommodating spar brackets permit relative differential vertical movement as between the forward and aft portions of the marine platform 200, which improves suspension performance in terms of response to pitch.

[0071] The sliding spar bracket 920 and pivoting spar bracket 950 are preferably configured to accommodate the maximum permitted differential movement as between the forward and aft portions of the marine platform 200, in terms of the simultaneous maximum compression of the forward struts 206 and maximum extension of the aft struts 206, or the simultaneous maximum extension of the forward struts 206 and maximum compression of the aft struts 206.

[0072] Similar permitted relative differential vertical movement as between the forward and aft portions of the marine platform 200 could be provided by interconnecting the two spars 270 to the deck 204 with a movement accommodating mounting (not shown), although it is understood that it is simpler and thus preferable to have a single movement accommodating component where the spars 270 converge (i.e., as described above).

Claims

1. A suspension system for a suspended marine platform (200) on a high-speed water vessel having a usual direction of travel, the suspension system comprising:

    a shock absorbing assembly for resiliently suspending a marine platform (200) relative to a vessel, wherein the shock absorbing assembly tends to cause the marine platform (200) to remain in an upper at-rest position and to return to the at-rest position on cessation of a force causing the marine platform (200) to move generally vertically towards a bottom position;
    two spar assemblies, one of the spar assemblies forward of the other spar assembly, and each spar assembly comprising a first spar (270) and a second spar (270), each spar pivotally attached at a proximal end to the vessel and pivotally attached at a distal end to the marine platform (200), wherein:

        the proximal ends are aft of the distal ends; and
        the proximal ends of the spars (270) are spaced athwart one from the other a greater distance than the distal ends of the spars (270) are spaced athwart one from the other;

    characterized in that:

        the attachment of one of the spar assemblies to the vessel permits relative fore and aft movement between the vessel and the proximal ends of the spars (270) of that one of the spar assemblies; or
        the attachment of one of the spar assemblies to the marine platform (200) permits relative fore and aft movement between the marine platform (200) and the distal ends of the spars (270) of that one of the spar assemblies.

2. The suspension system of claim 1, wherein the attachment of the one of the spar assemblies to the marine platform (200) permits relative fore and aft movement between the marine platform (200) and the distal ends of the spars (270) of that one of the spar assemblies.

3. The suspension system of claim 2, wherein the rel-

ative fore and aft movement between the marine platform (200) and the distal ends of the spars (270) of that one of the spar assemblies, is linear.

4. The suspension system of claim 3, wherein the relative fore and aft movement between the marine platform (200) and the distal ends of the spars (270) of that one of the spar assemblies, is provided by a track and car assembly (920).

5. The suspension system of claim 2, wherein the relative fore and aft movement between the marine platform (200) and the distal ends of the spars of that one of the spar assemblies, is arcuate.

6. The suspension system of claim 5, wherein the relative fore and aft movement between the marine platform (200) and the distal ends of the spars of that one of the spar assemblies, is provided by a pivot assembly (950).

7. The suspension system of claim 1, further comprising a roll-attenuation (220) assembly interconnected between the marine platform (200) and the vessel.

8. The suspension system of claim 7, wherein the roll-attenuation assembly (220) comprises a torsion bar (240) mounted so as to extend athwart, the torsion bar (240) comprising a torsion spring (242) having at each end an arm (244) extending laterally from the torsion spring (242), wherein the torsion spring (242) is mounted to one of the marine platform (200) and the vessel, and the arms (244) are each interconnected to the other of the marine platform (200) and the vessel.

9. The suspension system of claim 1, wherein, in one of the spar assemblies (302, 304), the first spar and second spar are fixed one to the other in the vicinity of their distal ends and the pivotal attachment of their distal ends to the marine platform (200) is by way of a shared pivotal attachment (312).

10. The suspension system of claim 1, wherein the shock absorbing assembly comprises four shock-absorbing struts (206), each interconnected between the marine platform (200) and the vessel.

Patentansprüche

1. Aufhängungssystem für eine aufgehängte Meeresplattform (200) auf einem Hochgeschwindigkeits-Wasserfahrzeug, das eine übliche Bewegungsrichtung aufweist, wobei das Aufhängungssystem Folgendes umfasst:

eine Stoßdämpfungsanordnung zum elastischen Aufhängen einer Meeresplattform (200) in Bezug auf ein Fahrzeug, wobei die Stoßdämpfungsanordnung tendenziell bewirkt, dass die Meeresplattform (200) in einer oberen Ruheposition verbleibt und zur Ruheposition zurückkehrt, wenn eine Kraft, die bewirkt, dass die Meeresplattform (200) sich im Wesentlichen vertikal in Richtung einer unteren Position bewegt, aussetzt;
zwei Holmanordnungen, wobei eine der Holmanordnungen vor der anderen Holmanordnung angeordnet ist und jede Holmanordnung einen ersten Holm (270) und einen zweiten Holm (270) umfasst, wobei jeder Holm an einem proximalen Ende schwenkbar auf dem Fahrzeug befestigt ist und an einem distalen Ende schwenkbar auf der Meeresplattform (200) befestigt ist, wobei:

die proximalen Enden hinter den distalen Enden liegen; und
die proximalen Enden der Holme (270) in Querrichtung voneinander in einem größeren Abstand beabstandet sind als die distalen Enden der Holme (270) in Querrichtung voneinander beabstandet sind;

dadurch gekennzeichnet, dass
die Anbringung von einer der Holmanordnungen an dem Fahrzeug eine relative Vorwärts- und Rückwärtsbewegung zwischen dem Fahrzeug und den proximalen Enden der Holme (270) dieser einen der Holmanordnungen ermöglicht; oder dass
die Anbringung von einer der Holmanordnungen an der Meeresplattform (200) eine relative Vorwärts- und Rückwärtsbewegung zwischen der Meeresplattform (200) und den distalen Enden der Holme (270) dieser einen der Holmanordnungen ermöglicht.

2. Aufhängungssystem nach Anspruch 1, wobei die Anbringung der einen der Holmanordnungen an der Meeresplattform (200) eine relative Vorwärts- und Rückwärtsbewegung zwischen der Meeresplattform (200) und den distalen Enden der Holme (270) dieser einen der Holmanordnungen ermöglicht.

3. Aufhängungssystem nach Anspruch 2, wobei die relative Vorwärts- und Rückwärtsbewegung zwischen der Meeresplattform (200) und den distalen Enden der Holme (270) dieser einen der Holmanordnungen linear ist.

4. Aufhängungssystem nach Anspruch 3, wobei die relative Vorwärts- und Rückwärtsbewegung zwischen der Meeresplattform (200) und den distalen Enden der Holme (270) dieser einen der Holmanordnungen durch eine Schienen- und Wagenanordnung (920) bereitgestellt ist.

5. Aufhängungssystem nach Anspruch 2, wobei die relative Vorwärts- und Rückwärtsbewegung zwischen der Meeresplattform (200) und den distalen Enden der Holme dieser einen der Holmanordnungen bogenförmig ist.

6. Aufhängungssystem nach Anspruch 5, wobei die relative Vorwärts- und Rückwärtsbewegung zwischen der Meeresplattform (200) und den distalen Enden der Holme dieser einen der Holmanordnungen durch eine Schwenkanordnung (950) bereitgestellt ist.

7. Aufhängungssystem nach Anspruch 1, das ferner eine Rolldämpfungsanordnung (220), die zwischen der Meeresplattform (200) und dem Fahrzeug zwischenverbunden ist, umfasst.

8. Aufhängungssystem nach Anspruch 7, wobei die Rolldämpfungsanordnung (220) einen Torsionsstab (240) umfasst, der angebracht ist, um sich in Querrichtung zu erstrecken, wobei der Torsionsstab (240) eine Torsionsfeder (242) umfasst, die an jedem Ende einen Arm (244) aufweist, der sich von der Torsionsfeder (242) aus seitwärts erstreckt, wobei die Torsionsfeder (242) auf einem aus der Meeresplattform (200) und dem Fahrzeug befestigt ist und die Arme (244) mit dem anderen aus der Meeresplattform (200) und dem Fahrzeug zwischenverbunden sind.

9. Aufhängungssystem nach Anspruch 1, wobei in einer der Holmanordnungen (302, 304) der erste und der zweite Holm in der Nähe ihrer distalen Enden aneinander fixiert sind und die Schwenkanbringung ihrer distalen Enden auf der Meeresplattform (200) durch eine gemeinsame Schwenkanbringung (312) erfolgt.

10. Aufhängungssystem nach Anspruch 1, wobei die Stoßdämpfungsanordnung vier Stoßdämpfungsfederbeine (206) umfasst, die jeweils zwischen der Meeresplattform (200) und dem Fahrzeug zwischenverbunden sind.

Revendications

1. Système de suspension pour une plate-forme marine suspendue (200) sur un navire à grande vitesse ayant une direction de déplacement habituelle, le système de suspension comprenant :

un ensemble d'absorption de chocs pour suspendre de manière élastique une plate-forme marine (200) par rapport à un navire, dans lequel l'ensemble d'absorption de chocs a tendance à amener la plate-forme marine (200) à rester dans une position de repos supérieure et à revenir à la position de repos à l'arrêt d'une force entraînant amenant la plate-forme marine (200) à se déplacer généralement verticalement vers une position inférieure ;
deux ensembles de longerons, l'un des ensembles de longerons en avant de l'autre ensemble de longerons, et chaque ensemble de longerons comprenant un premier longeron (270) et un second longeron (270), chaque longeron étant fixé de manière pivotante au niveau d'une extrémité proximale du vaisseau et fixé de manière pivotante au niveau d'une extrémité distale de la plate-forme marine (200), dans lequel :

les extrémités proximales sont à l'arrière des extrémités distales ; et
les extrémités proximales des longerons (270) sont espacées l'une de l'autre d'une distance plus grande que celle dont les extrémités distales des longerons (270) sont espacées l'une de l'autre ;

caractérisé en ce que :

la fixation d'un certain des ensembles de longerons au navire permet un mouvement relatif vers l'avant et vers l'arrière entre le navire et les extrémités proximales des longerons (270) de ce certain des ensembles de longerons ; ou
la fixation d'un certain des ensembles de longerons à la plate-forme marine (200) permet un mouvement relatif vers l'avant et vers l'arrière entre la plate-forme marine (200) et les extrémités distales des longerons (270) de ce certain des ensembles de longerons.

2. Système de suspension selon la revendication 1, dans lequel la fixation du certain des ensembles de longerons à la plate-forme marine (200) permet un mouvement relatif vers l'avant et vers l'arrière entre la plate-forme marine (200) et les extrémités distales des espars (270) de que l'un des ensembles de longerons.

3. Système de suspension selon la revendication 2, dans lequel le mouvement relatif vers l'avant et vers l'arrière entre la plate-forme marine (200) et les extrémités distales des longerons (270) de ce certain des ensembles de longerons est linéaire.

4. Système de suspension selon la revendication 3, dans lequel le mouvement relatif vers l'avant et vers l'arrière entre la plate-forme marine (200) et les extrémités distales des longerons (270) de ce certain

des ensembles de longerons est assuré par un ensemble piste et charriot (920).

5. Système de suspension selon la revendication 2, dans lequel le mouvement relatif vers l'avant et vers l'arrière entre la plate-forme marine (200) et les extrémités distales des longerons de celui des ensembles de longerons, est arqué.

6. Système de suspension selon la revendication 5, dans lequel le mouvement relatif avant et arrière entre la plate-forme marine (200) et les extrémités distales des longerons de ce certain des ensembles de longerons est assuré par un ensemble pivot (950).

7. Système de suspension selon la revendication 1, comprenant en outre un ensemble d'atténuation de roulis (220) interconnecté entre la plate-forme marine (200) et le navire.

8. Système de suspension selon la revendication 7, dans lequel l'ensemble d'atténuation de roulis (220) comprend une barre de torsion (240) montée de manière à s'étendre en travers, la barre de torsion (240) comprenant un ressort de torsion (242) ayant à chaque extrémité un bras (244) s'étendant latéralement à partir du ressort de torsion (242), dans lequel le ressort de torsion (242) est monté sur l'un de la plate-forme marine (200) et du navire, et les bras (244) sont chacun interconnectés à l'autre de la plate-forme marine (200) et du navire.

9. Système de suspension selon la revendication 1, dans lequel dans un certain des ensembles de longerons (302, 304), le premier longeron et le second longeron sont fixés l'un à l'autre au voisinage de leurs extrémités distales et la fixation pivotante de leurs extrémités distales à la plate-forme marine (200) se fait par une fixation pivotante partagée (312).

10. Système de suspension selon la revendication 1, dans lequel l'ensemble d'absorption de chocs comprend quatre entretoises d'absorption de chocs (206), interconnectées chacune entre la plate-forme marine (200) et le navire.

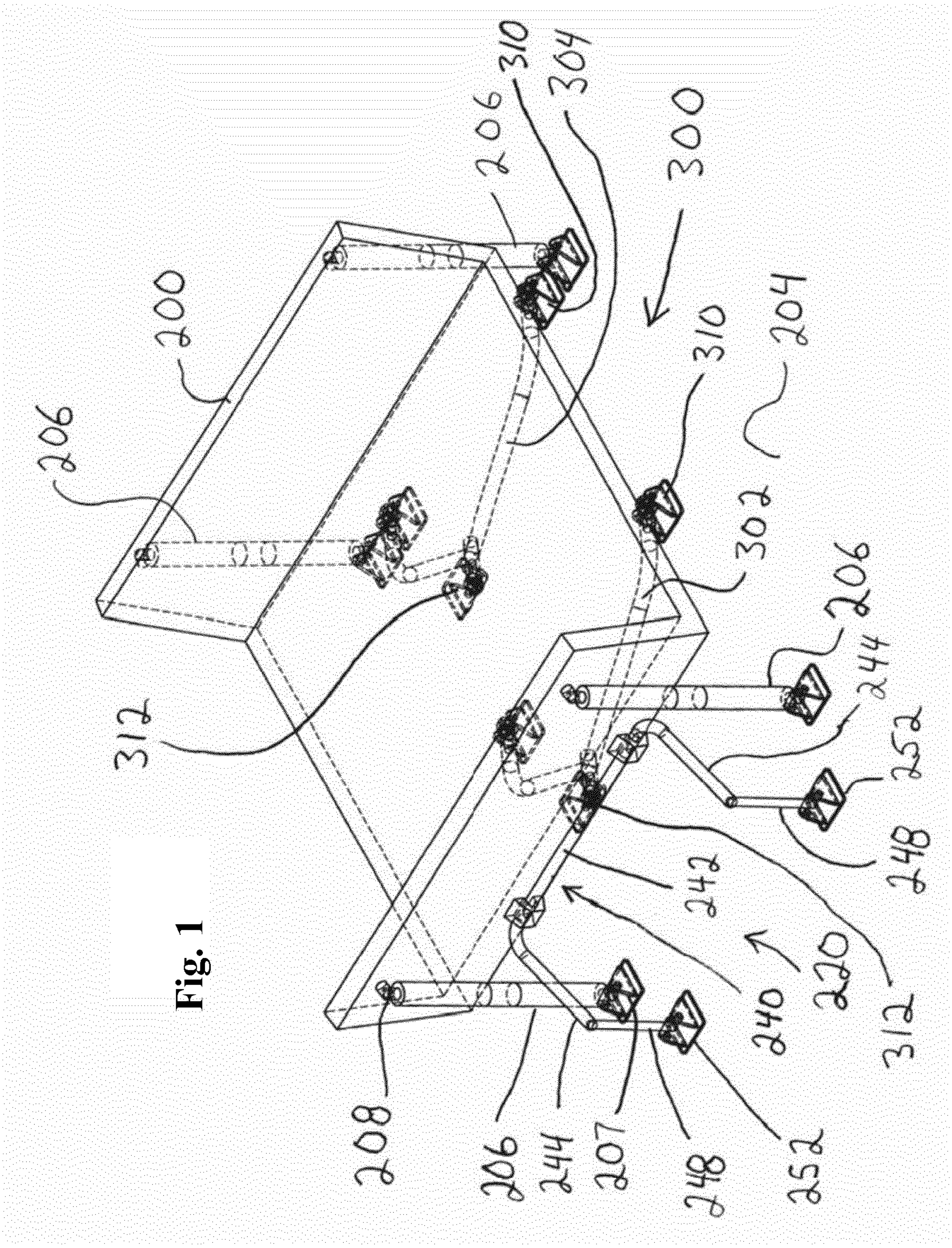


Fig. 1

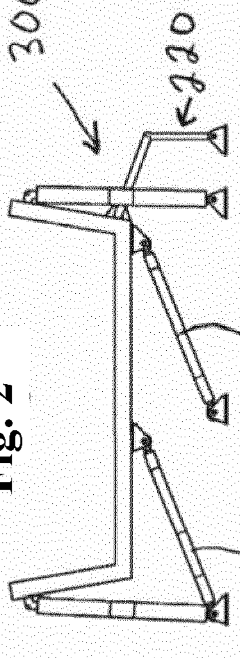


Fig. 2

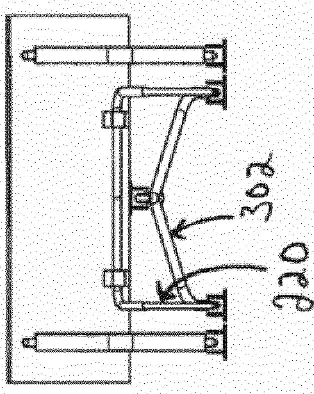


Fig. 3

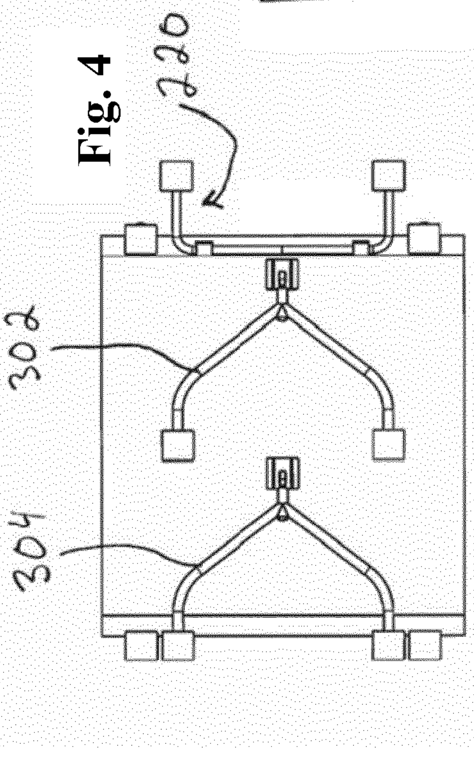


Fig. 4

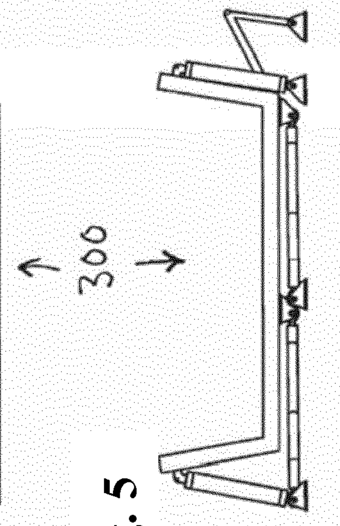


Fig. 5

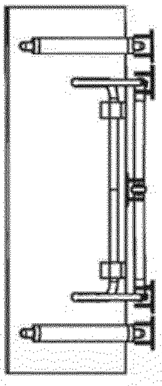


Fig. 6

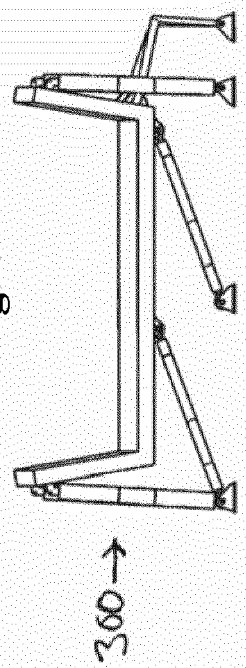


Fig. 7

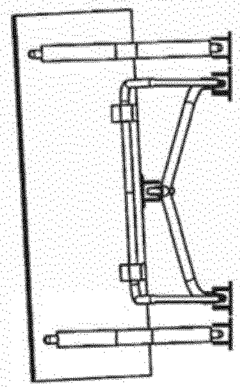


Fig. 8

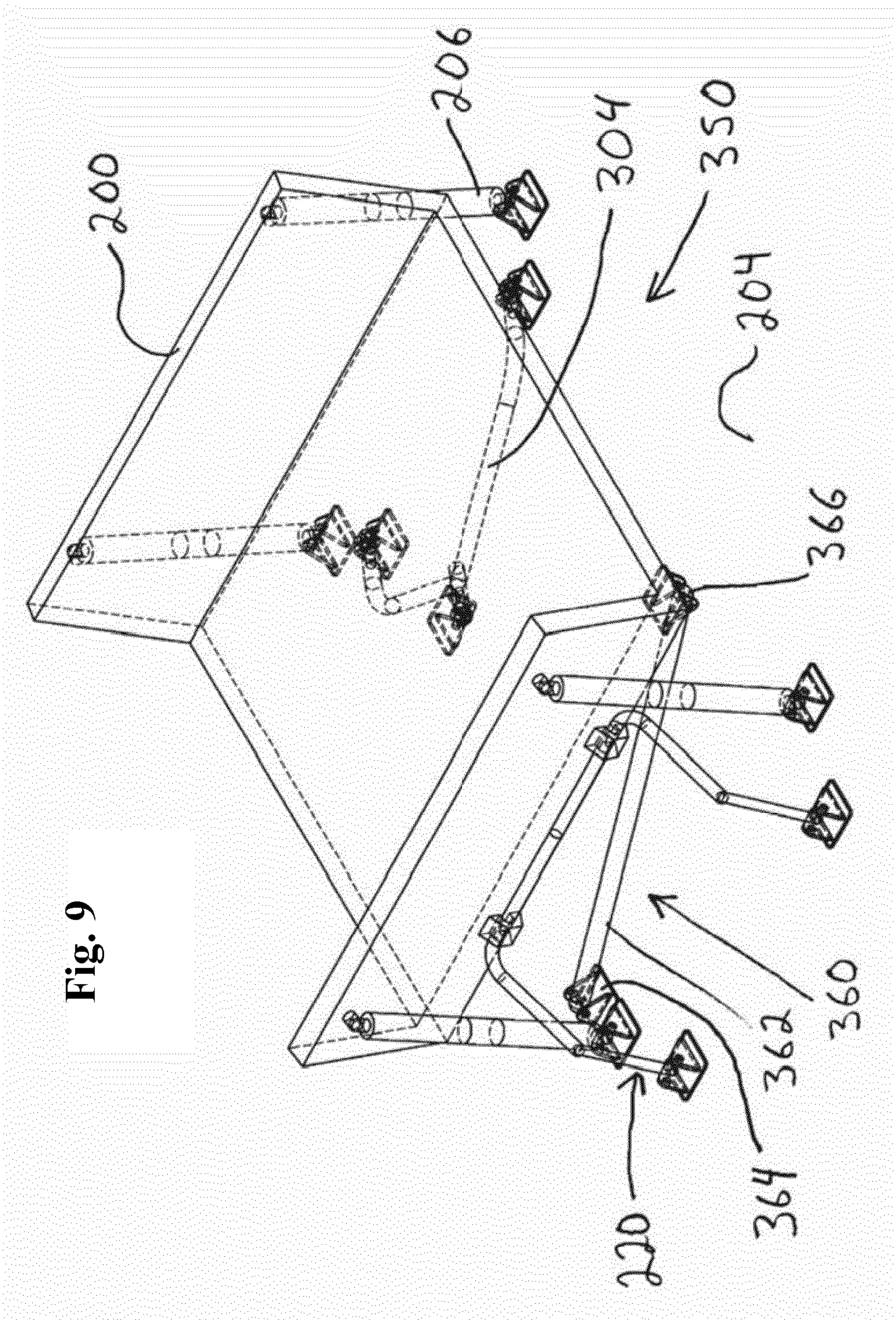


Fig. 9

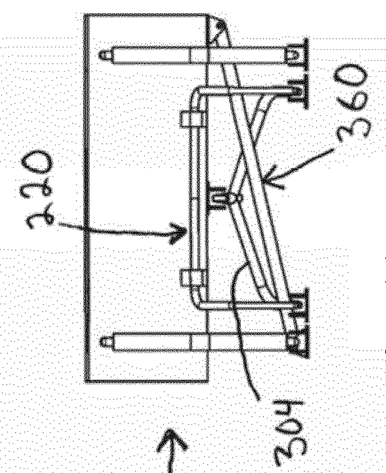


Fig. 11

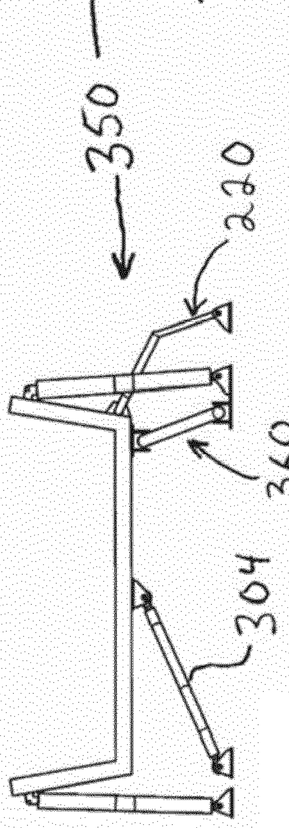


Fig. 10

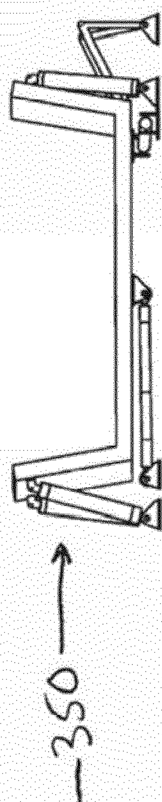


Fig. 13

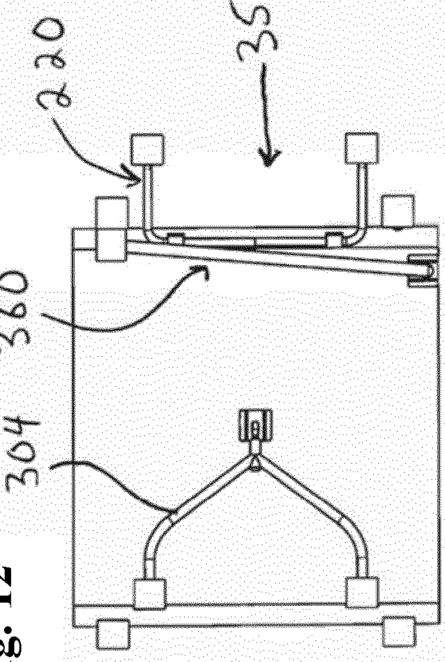


Fig. 12

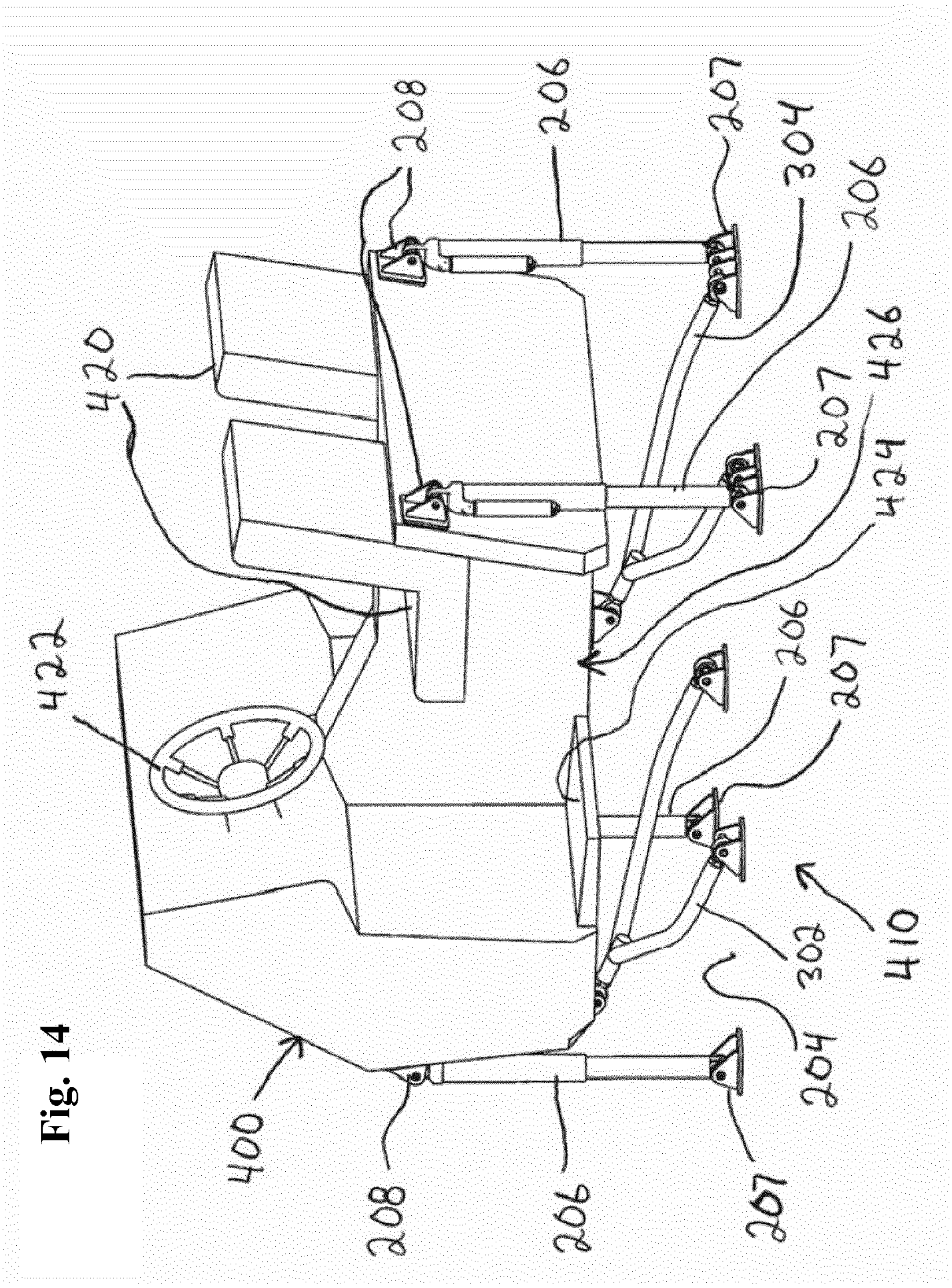

400
208
206
207
204
302
410
207
206
424
426
207
206
304
207
206
208
420
420
422

Fig. 14

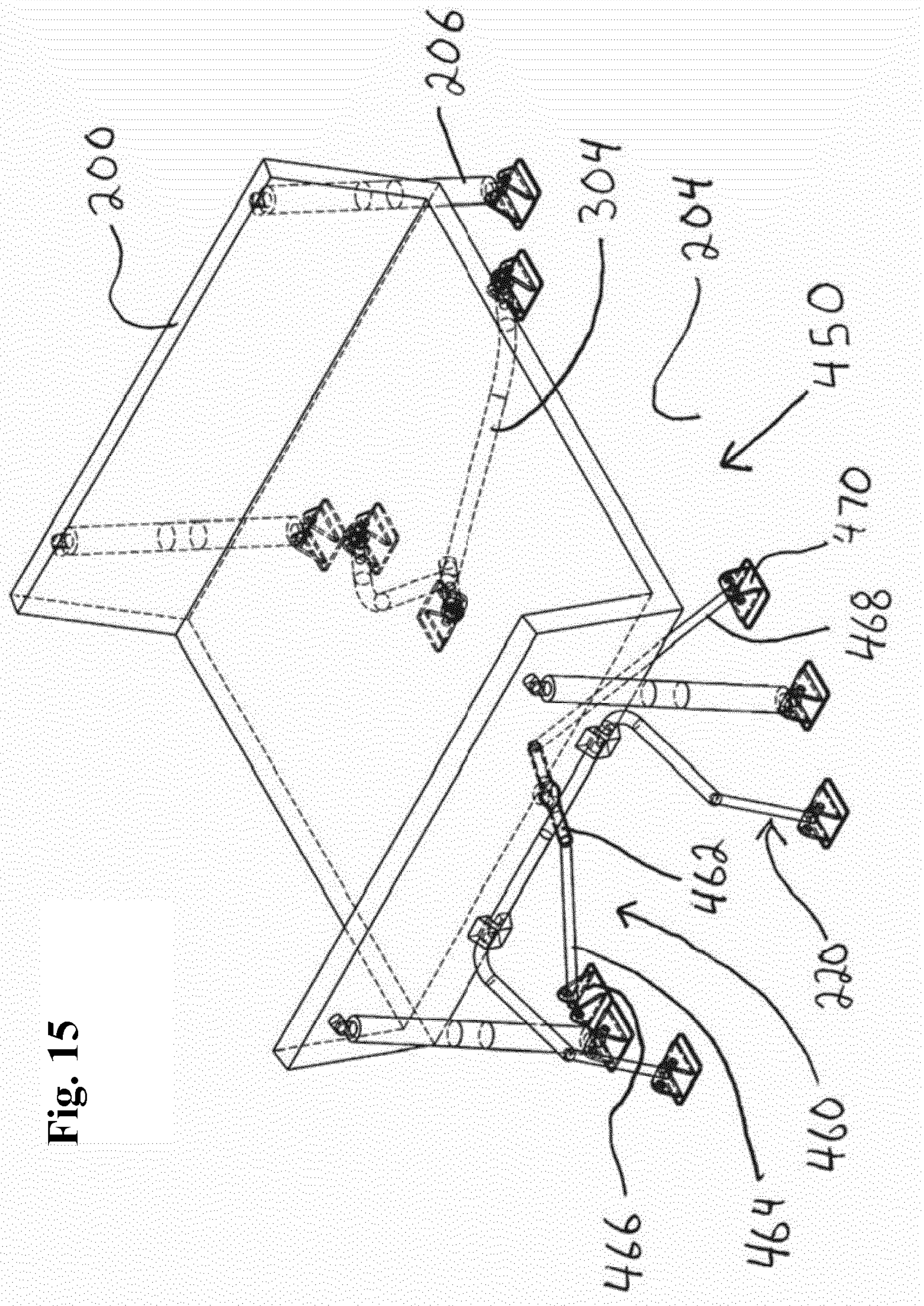


Fig. 15

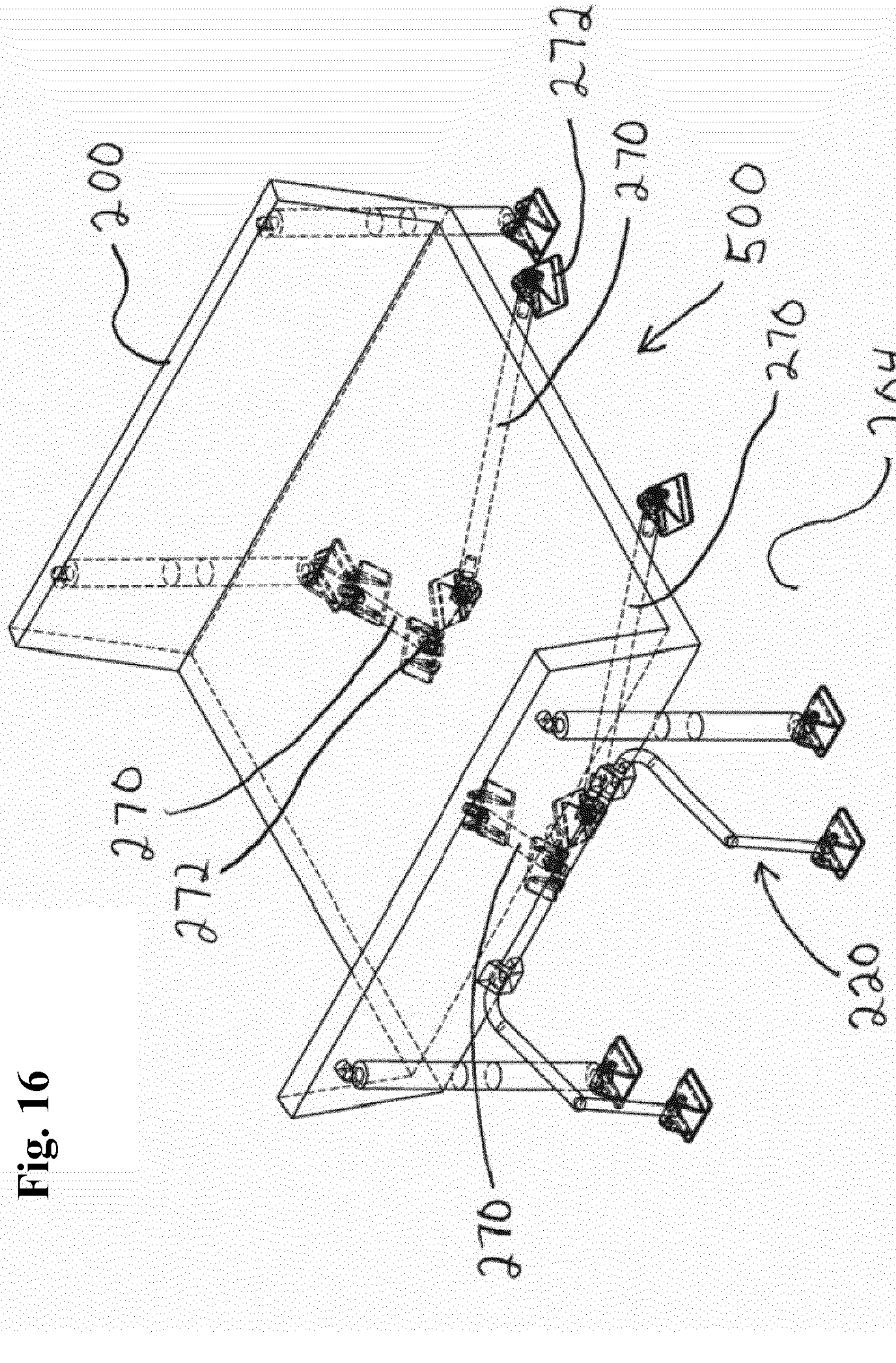


Fig. 16

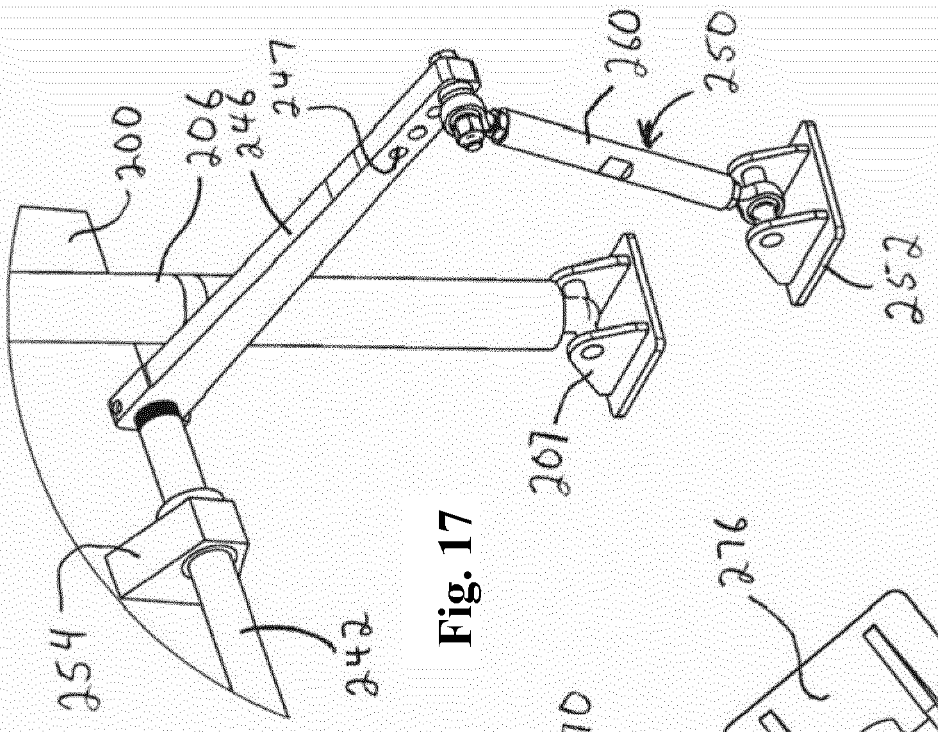


Fig. 17

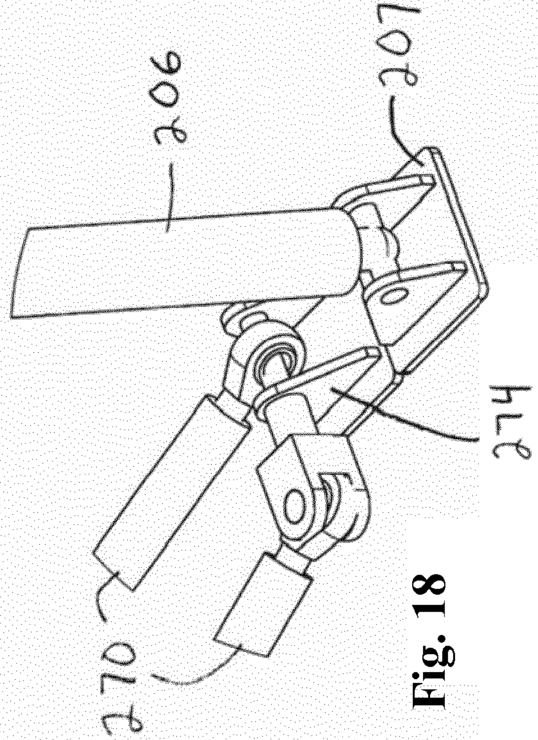


Fig. 18

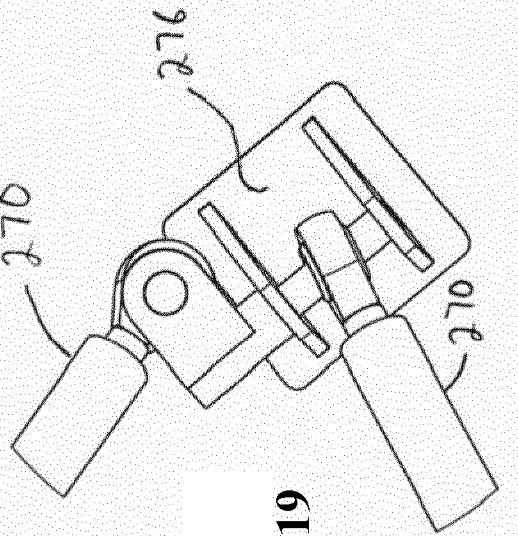


Fig. 19

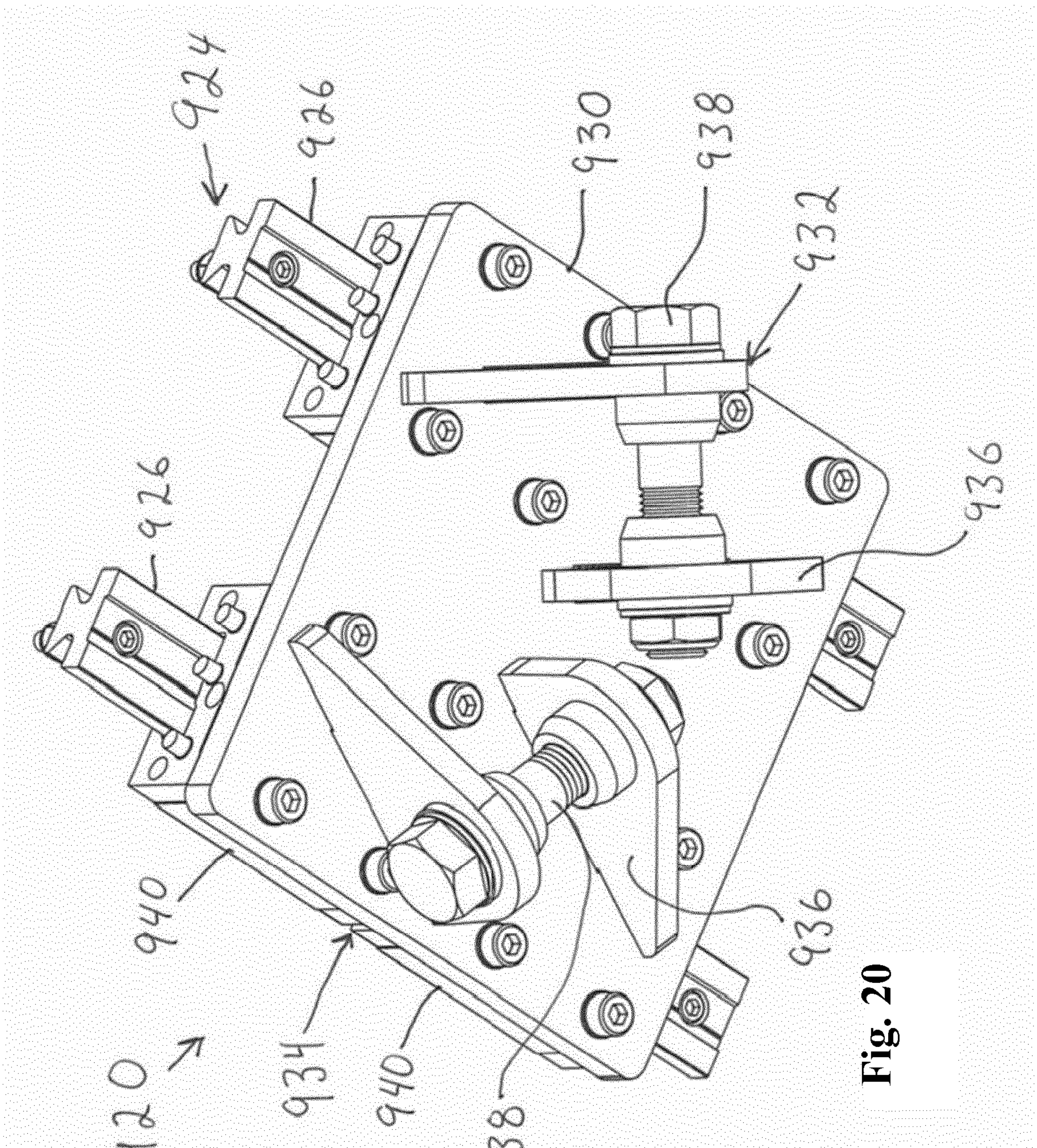


Fig. 20

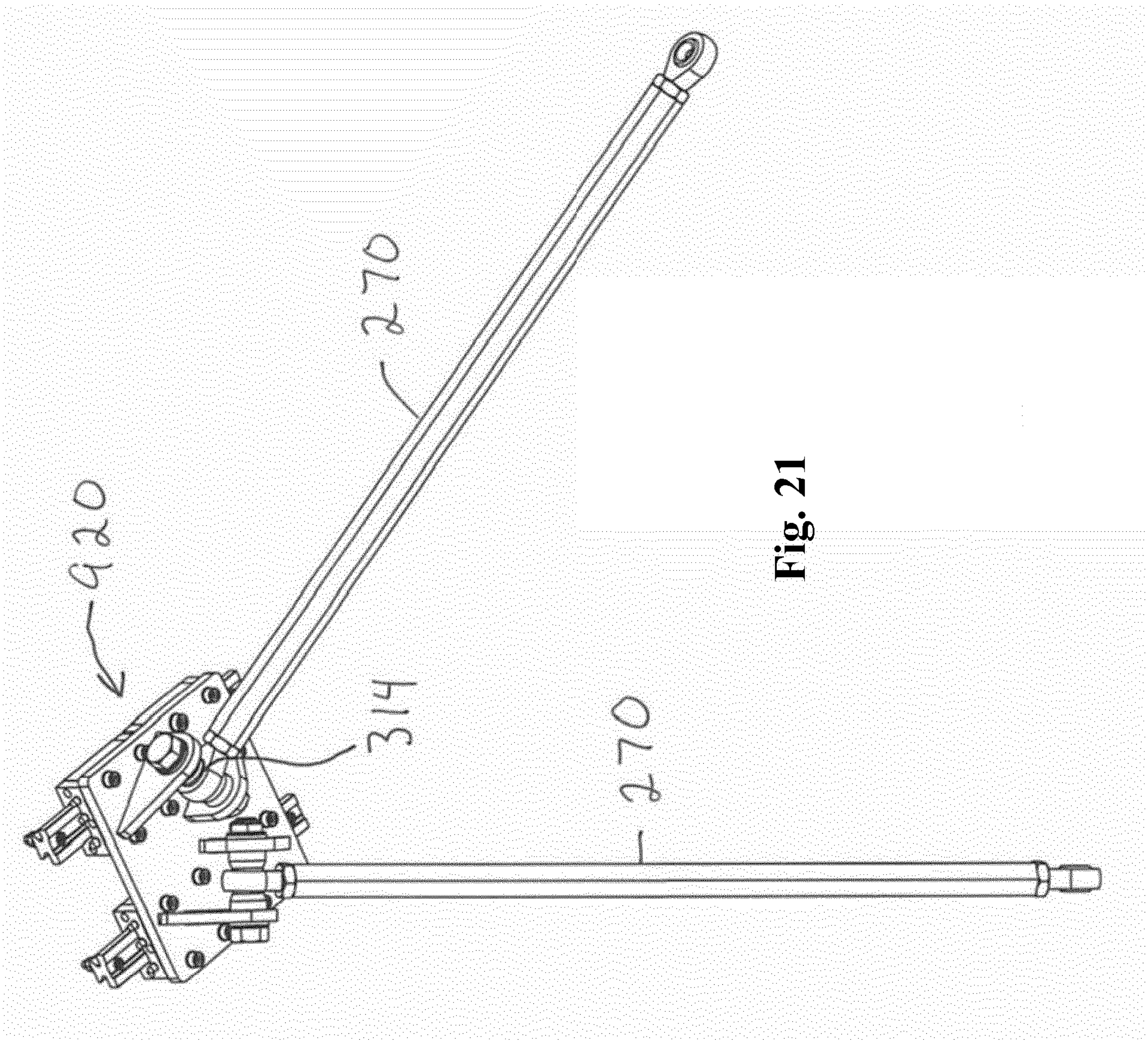


Fig. 21

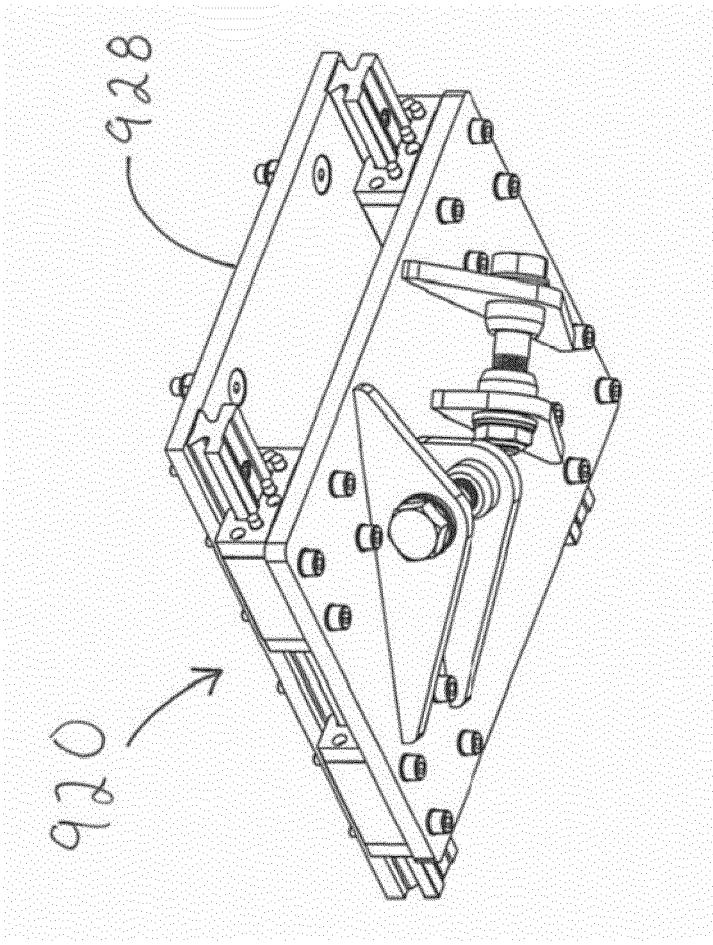


Fig. 22

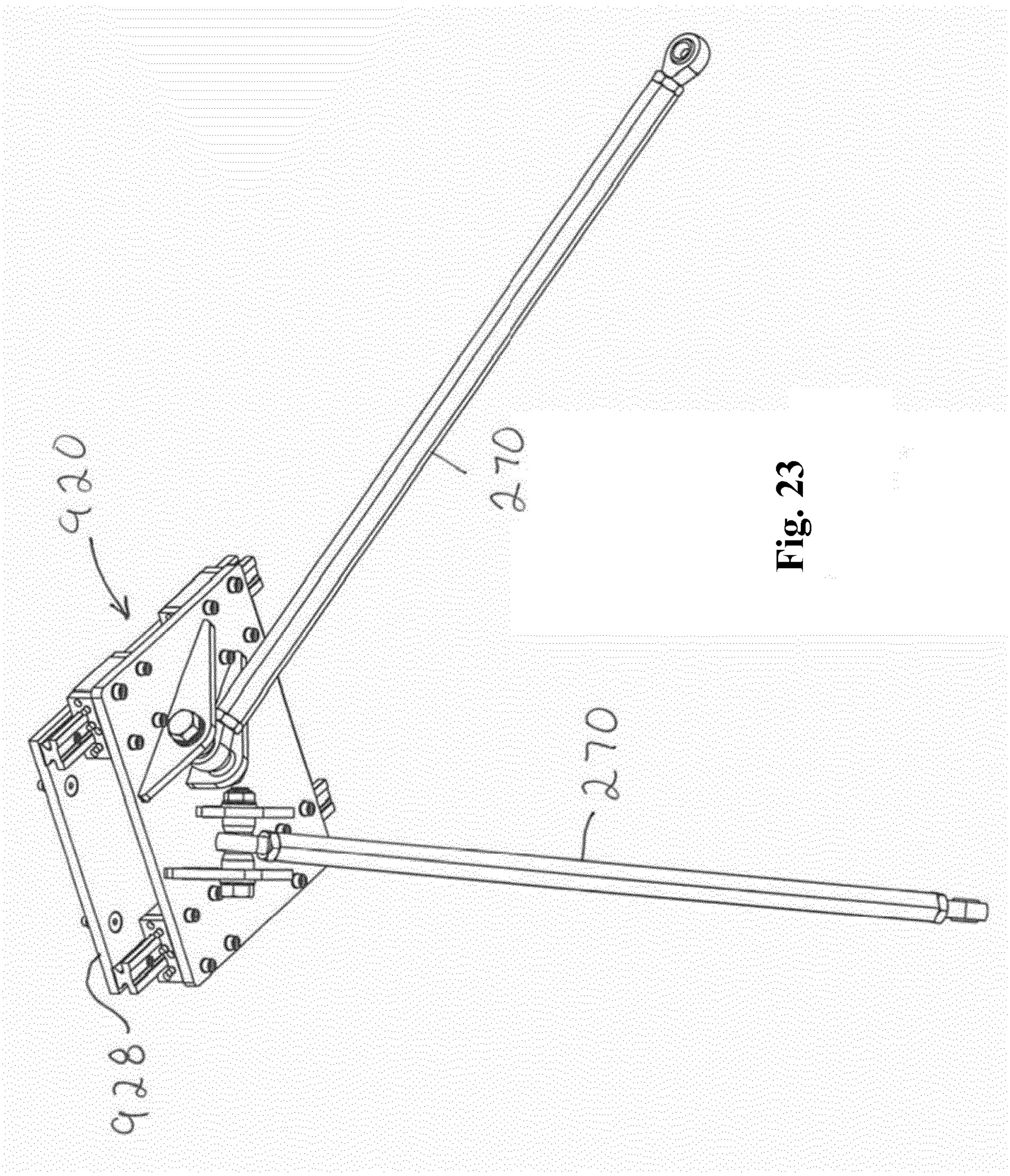


Fig. 23

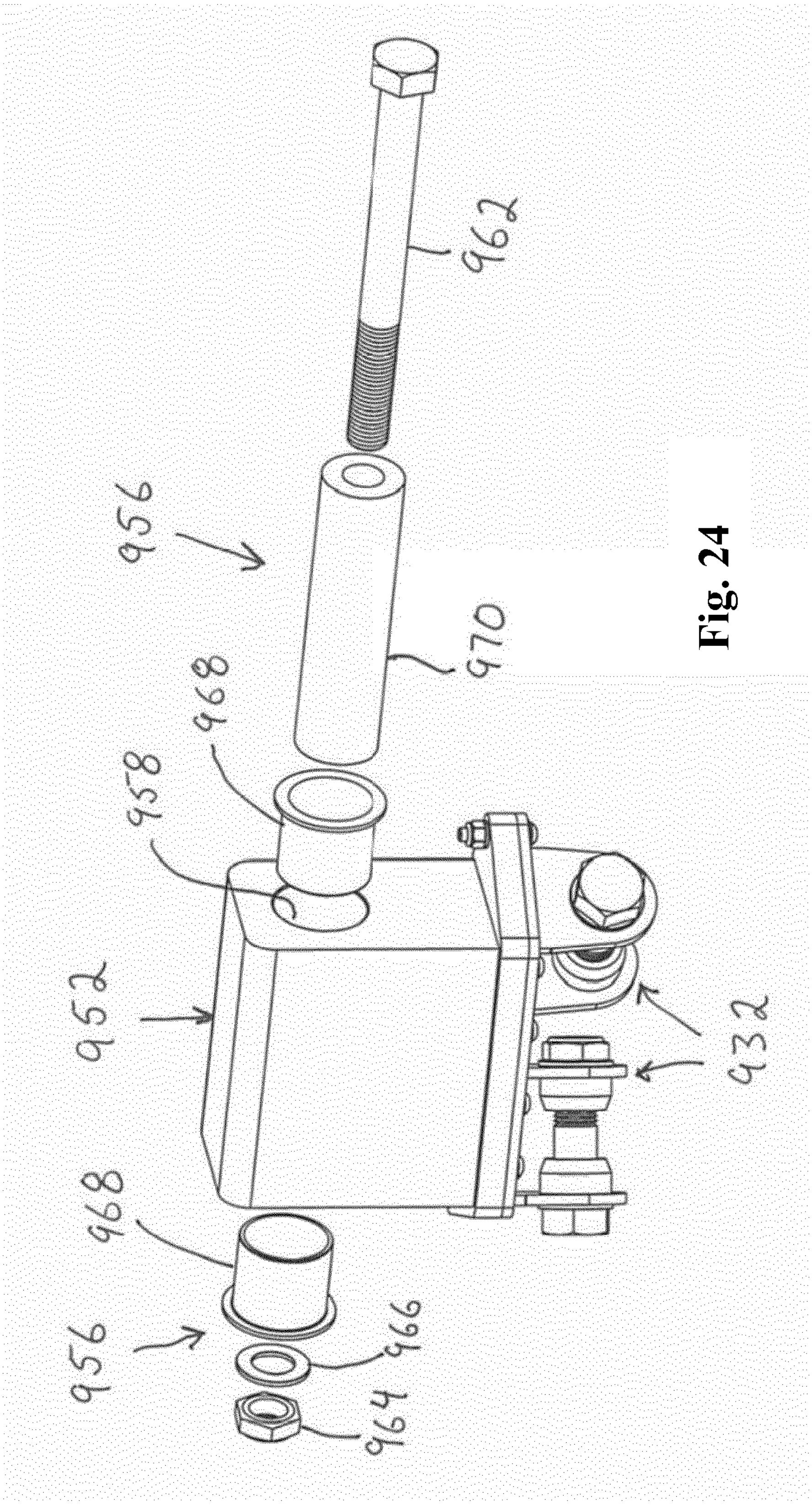


Fig. 24

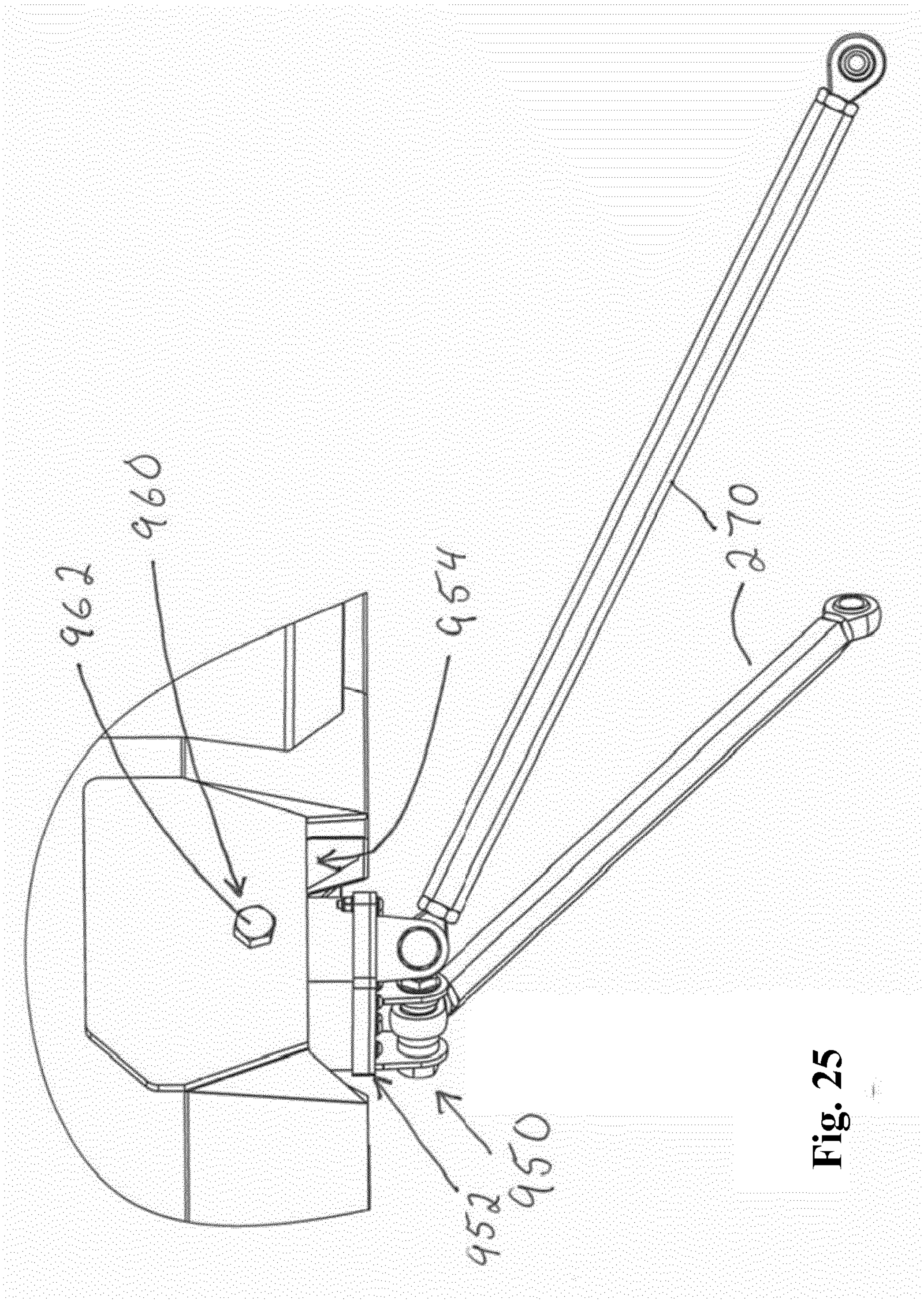


Fig. 25

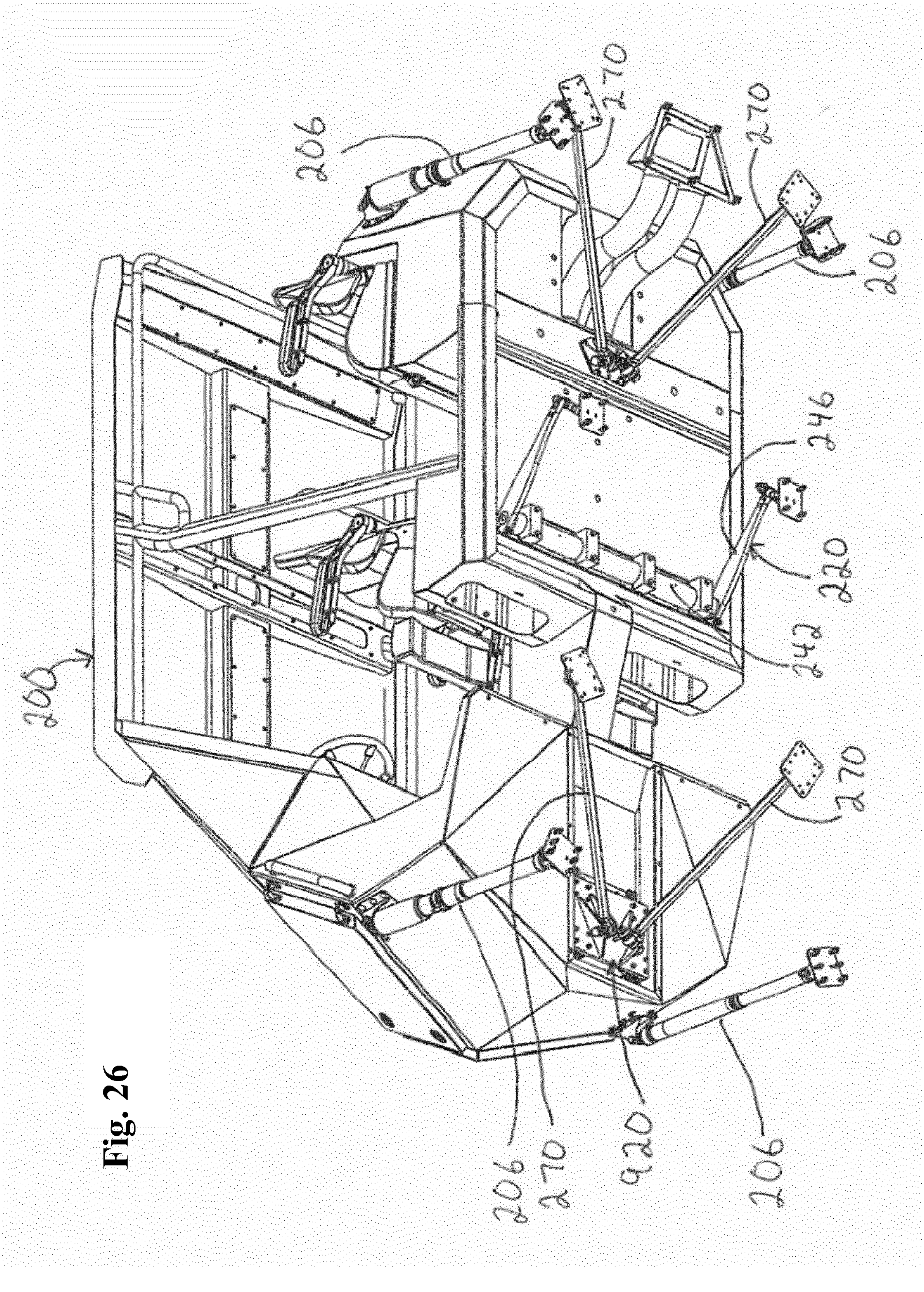


Fig. 26

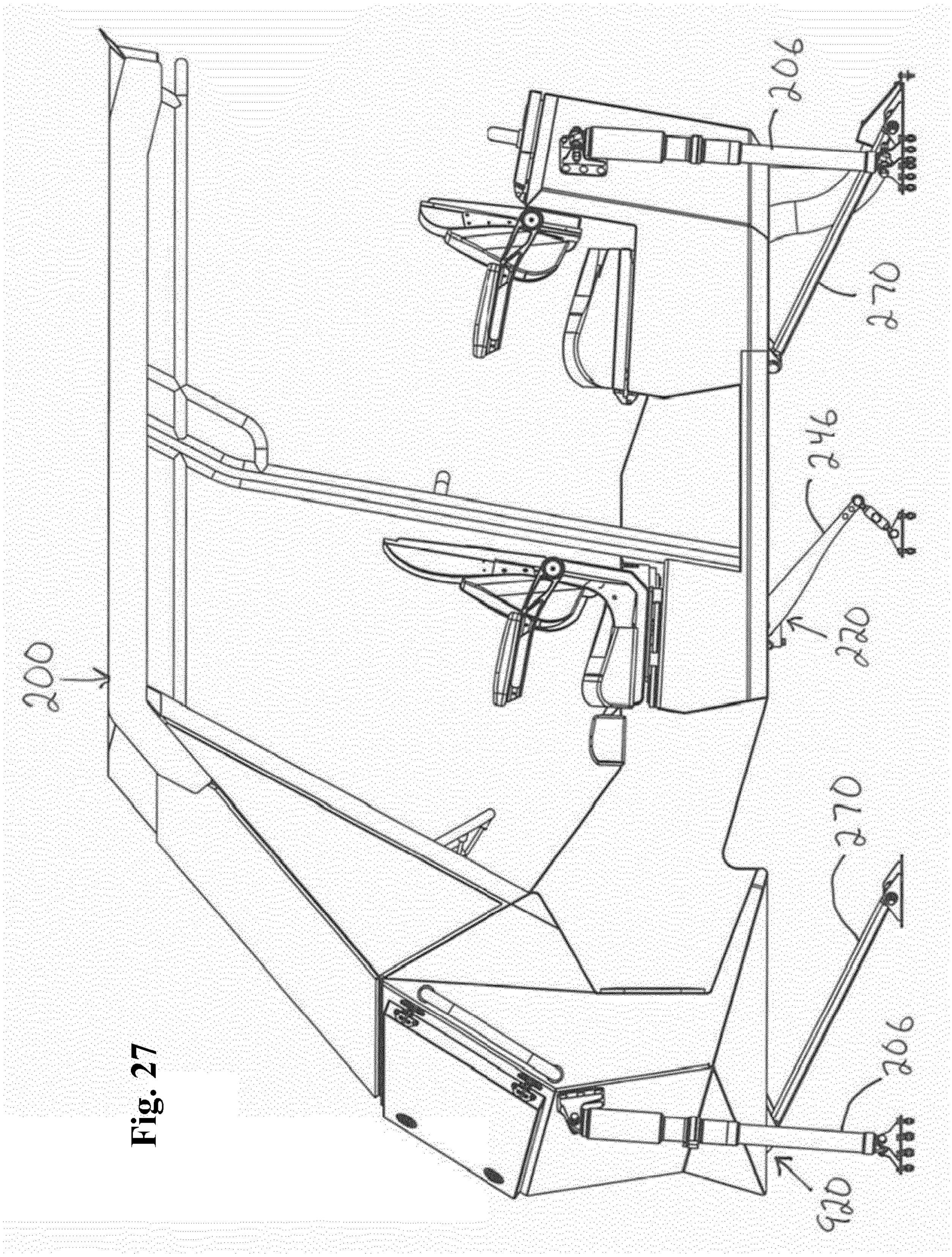


Fig. 27

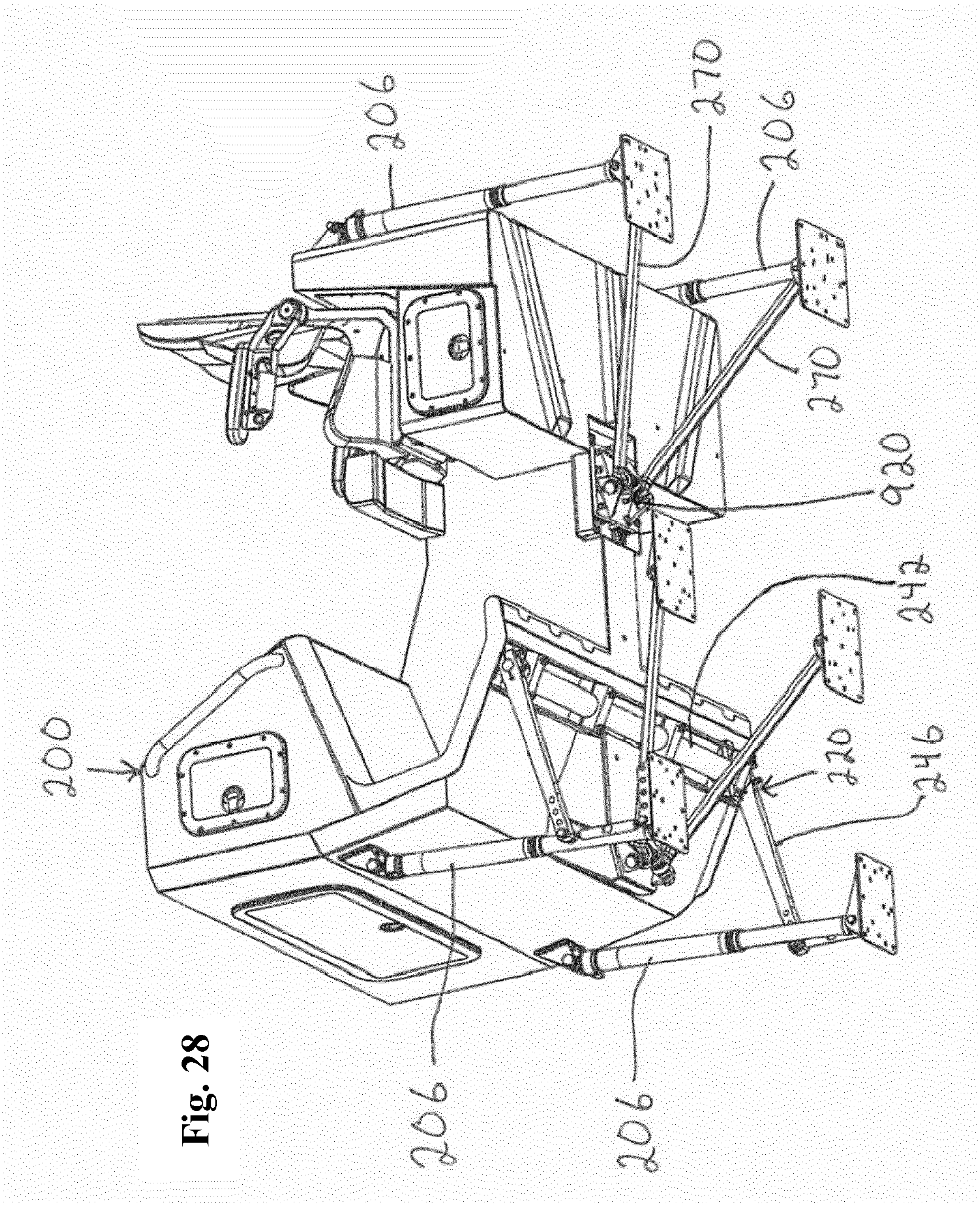
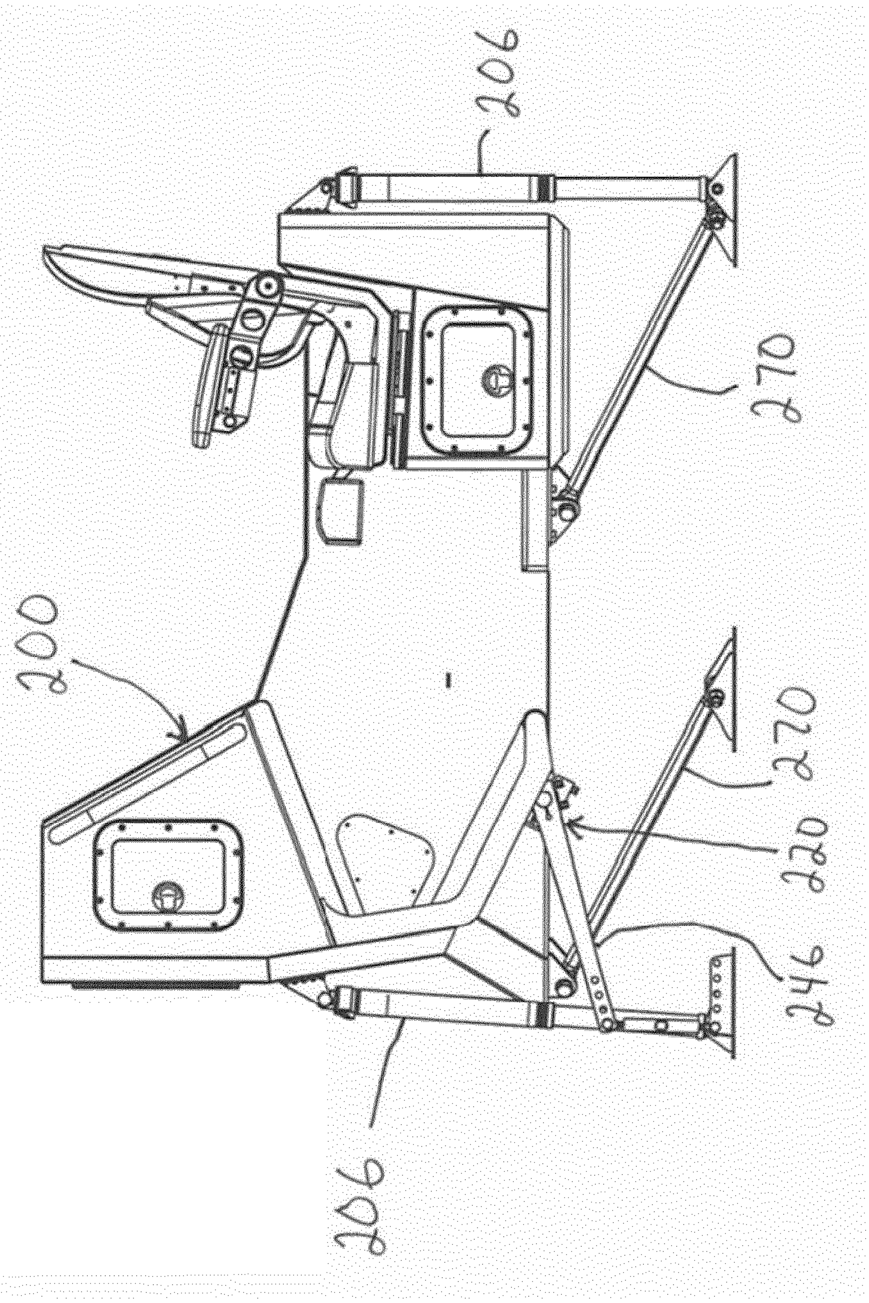


Fig. 28

Fig. 29



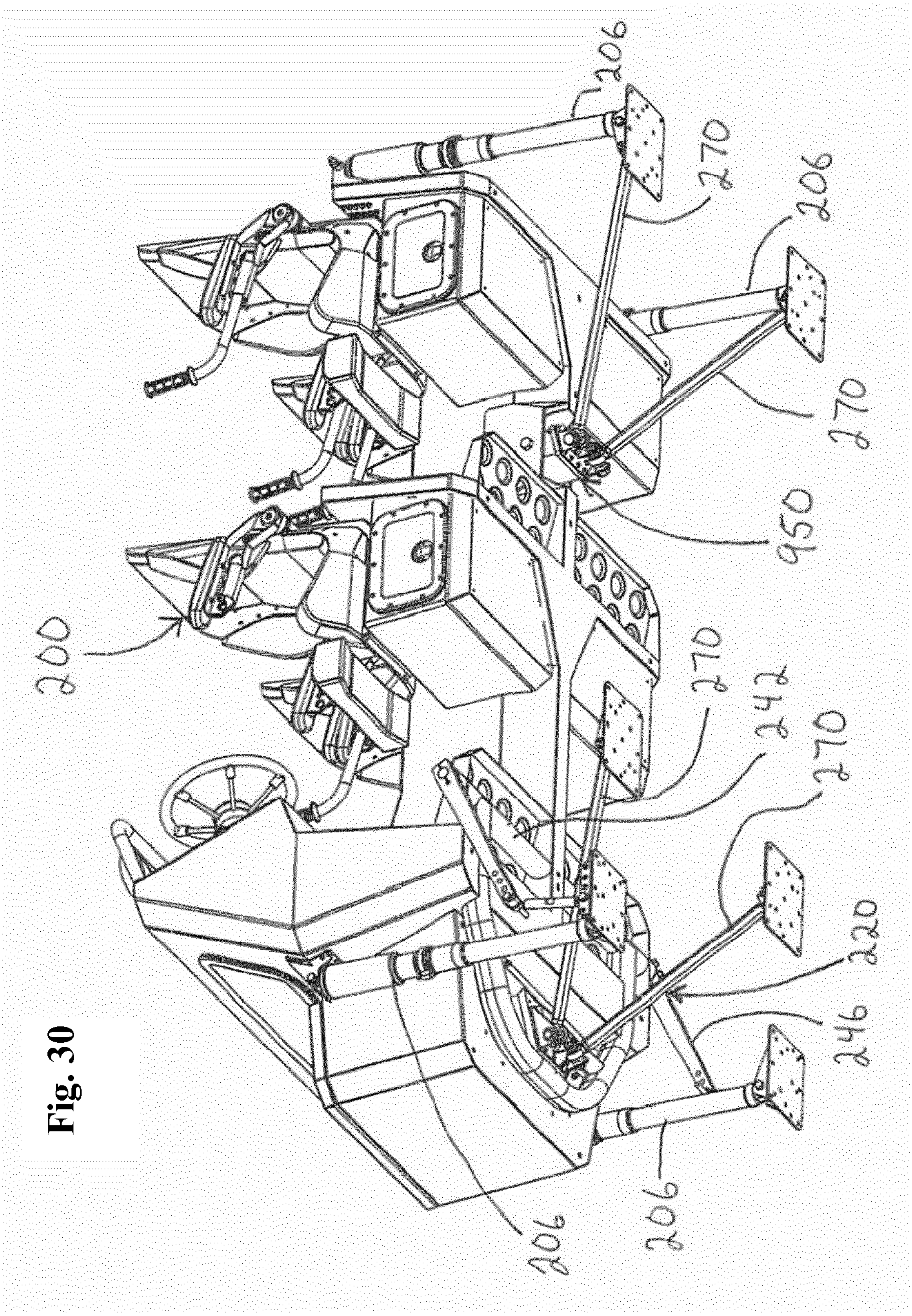


Fig. 30

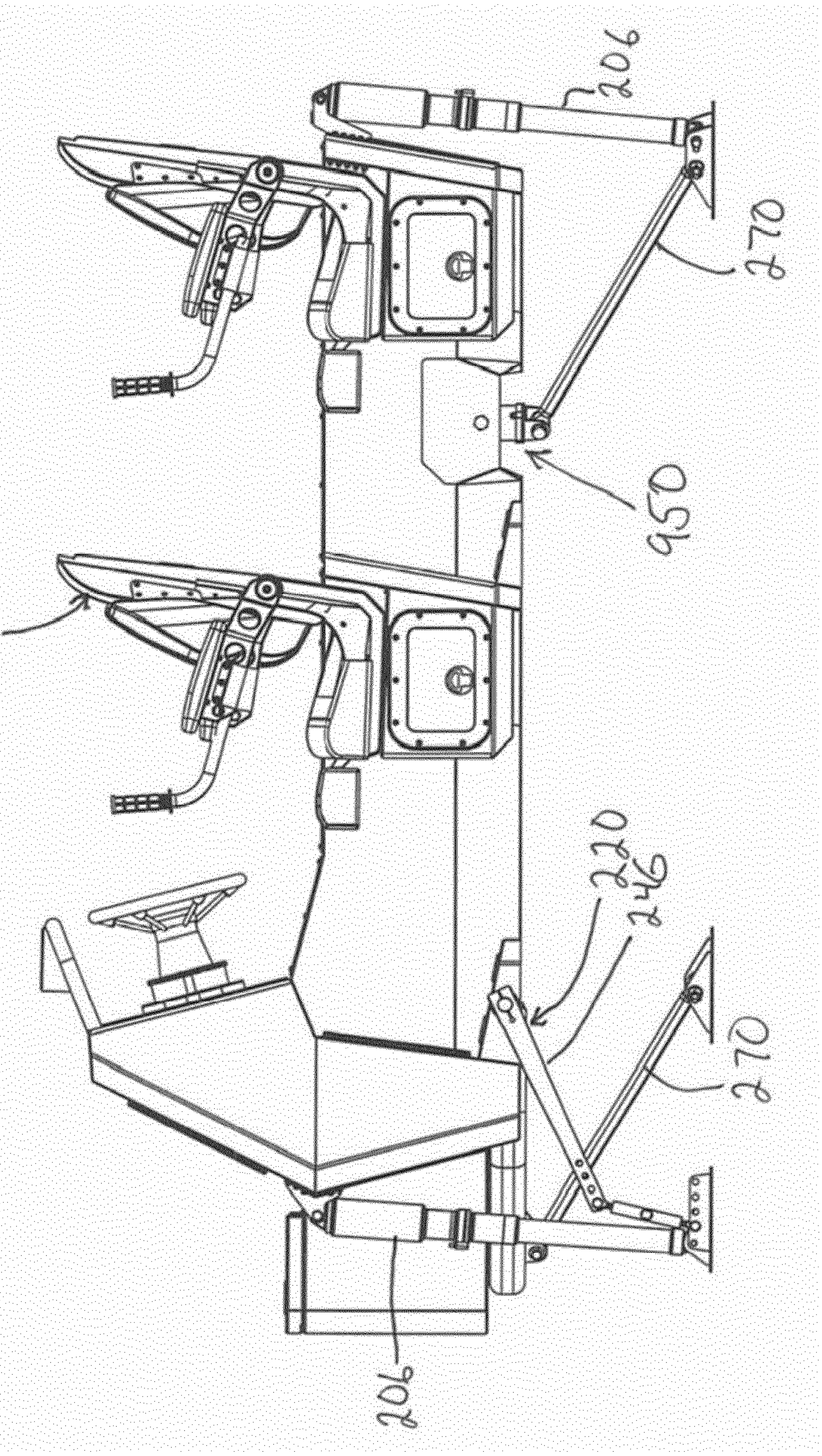


Fig. 31

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 14639091 B **[0001]**
- US 6786172 B **[0006]**
- WO 2012129665 A **[0006]**
- US 4349167 A **[0007]**
- US 4523730 A **[0007]**
- US 4911381 A **[0007]**
- US 5125598 A **[0007]**
- US 5152578 A **[0007]**
- US 5657950 A **[0008]**
- US 907931 **[0008]**
- US 3572828 A **[0008]**
- US 3994469 A **[0008]**
- US 4047759 A **[0008]**