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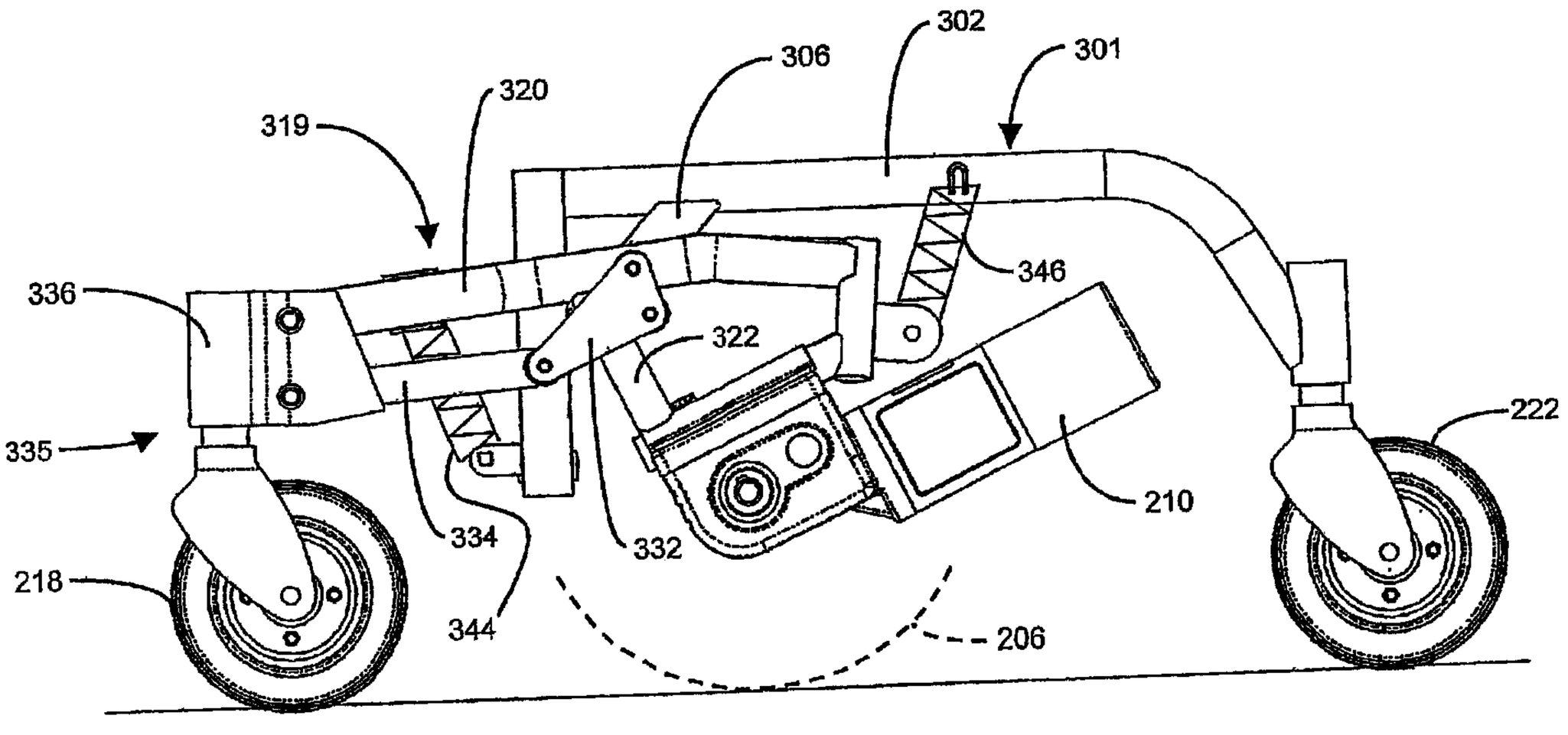
(54) Title: WHEELCHAIR SUSPENSION



(57) Abrégé/Abstract:
The present invention has a plurality of pivoting linkages to lift and retract a front castor assembly to facilitate traversing an obstacle or rough terrain. In this regard, a wheelchair suspension having a frame member and at least one a pivoting assembly is provided. The pivoting assembly has, for example, a first linkage pivotally coupled to the frame member and a second linkage pivotally coupled to the frame member. At least one front caster assembly is coupled to the first and second linkages wherein upward pivotal movement of the first linkage causes the caster assembly to undergo upward vertical movement and upward pivotal movement of the second linkage causes the caster assembly to undergo lateral movement inward toward the wheelchair.

Abstract

The present invention has a plurality of pivoting linkages to lift and retract a front castor assembly to facilitate traversing an obstacle or rough terrain. In this regard, a wheelchair suspension having a frame member and at least one a pivoting assembly is provided. The pivoting assembly has, for example, a first linkage pivotally coupled to the frame member and a second linkage pivotally coupled to the frame member. At least one front caster assembly is coupled to the first and second linkages wherein upward pivotal movement of the first linkage causes the caster assembly to undergo upward vertical movement and upward pivotal movement of the second linkage causes the caster assembly to undergo lateral movement inward toward the wheelchair.

Wheelchair Suspension

FIELD OF THE INVENTION

[0001] The invention relates generally to conveyances and, more particularly, to wheelchair suspensions capable of lifting and retracting a forward caster in traversing an obstacle.

BACKGROUND OF THE INVENTION

[0002] Wheelchairs are an important means of transportation for a significant portion of society. Whether manual or powered, wheelchairs provide an important degree of independence for those they assist. However, this degree of independence can be limited if the wheelchair is required to traverse obstacles such as, for example, curbs that are commonly present at sidewalks, driveways, and other paved surface interfaces.

[0003] In this regard, most wheelchairs have front and rear casters to stabilize the chair from tipping forward or backward and to ensure that the drive wheels are always in contact with the ground. One such wheelchair is disclosed in US Patent No. 5,435,404 to Garin. On such wheelchairs, the caster wheels are typically much smaller than the driving wheels and located both forward and rear of the drive wheels. Though this configuration provided the wheelchair with greater stability, it made it difficult for such wheelchairs to climb over obstacles such as, for example, curbs or the like, because the front casters could not be driven over the obstacle due to their small size and constant contact with the ground.

[0004] US Patent No. 5,964,473 to Degonda et al. describes a wheelchair having front and rear casters similar to Garin and a pair of additional forward lift wheels. The lift wheels are positioned off the ground and slightly forward of the front caster. Configured as such, the lift wheels first engage a curb and cause the wheelchair to tip backwards. As the wheelchair tips backwards, the front caster raises off the ground to a

height so that it either clears the curb or can be driven over the curb.

[0005] US Patent No. 6,196,343 to Strautnieks also describes a wheelchair having front and rear casters. The front casters are each connected to a pivot arm that is pivotally attached to the sides of the wheelchair frame. Springs bias each pivot arm to limit the vertical movement thereof. So constructed, each front caster can undergo vertical movement when running over an obstacle.

[0006] While the above-mentioned art provides various ways of addressing the need for managing a front caster when traversing an obstacle such as a curb, disadvantages still exist. For example, when undergoing vertical movement, many front casters also undergo forward lateral movement. While vertical movement assists in traversing an obstacle, forward lateral movement potentially works against traversing an obstacle because the front caster is usually moved laterally toward the obstacle so as to potentially prematurely make contact with the obstacle.

[0007] Hence, it is desirable to provide a wheelchair suspension that does not suffer from the above-mentioned disadvantages.

[0008]

SUMMARY OF THE INVENTION

[0009] The present invention has a plurality of pivoting linkages to lift and retract a front castor assembly to facilitate traversing an obstacle or rough terrain. In one embodiment, a wheelchair suspension having a frame member and at least one a pivoting assembly is provided. The pivoting assembly has, for example, a first linkage pivotally coupled to the frame member and a second linkage pivotally coupled to the frame member. At least one front caster assembly is coupled to the first and second linkages wherein upward pivotal movement of the first linkage causes the caster assembly to undergo upward

vertical movement and upward pivotal movement of the second linkage causes the caster assembly to undergo lateral movement inward toward the wheelchair.

[0010] Therefore, it is an advantage of the present invention to provide a wheelchair suspension for traversing obstacles and rough terrain.

[0011] It is yet another advantage of the present invention to provide a wheelchair suspension capable of lifting and retracting a front caster assembly when traversing obstacles and rough terrain.

[0012] It is still further an advantage of the present invention to provide a wheelchair suspension that maintains all of its wheels in contact with the ground.

[0012a] Another embodiment of the present invention provides a wheelchair suspension comprising: a frame; at least one rear caster coupled to the frame; a pivoting assembly mounting a front caster and a drive wheel to the frame, the pivoting assembly comprising: an upper link pivotally mounted to the front caster and to the frame at respective upper pivot axes; a lower link pivotally mounted to the front caster and to the frame at respective lower pivot axes; wherein the distance between the upper pivot axes is different than the distance between the lower pivot axes, and the pivoting assembly is coupled to a drive wheel such that torque applied to the drive wheel is transferred to the upper and lower links.

[0012b] Another embodiment of the present invention provides a wheelchair comprising: a frame; a pivoting drive assembly that includes: a drive wheel; a motor drive connected to the drive wheel; and a first pivoting linkage fixedly attached to the motor drive, wherein the pivoting drive assembly is

pivotally coupled to the frame at a first frame pivot axis such that the drive wheel, motor drive, and first pivoting linkage pivot about the first frame pivot axis as a unit; a second pivoting linkage pivotally coupled to the frame at a second frame pivot axis; and a front caster assembly, wherein the first pivoting linkage is pivotally coupled to the front caster assembly at a first front caster pivot axis and the second pivoting linkage is pivotally coupled to the front caster assembly at a second front caster pivot axis.

[0012c] Another embodiment of the present invention provides a wheelchair comprising: a frame; first and second independent pivoting assemblies coupled to opposite sides of the frame, wherein each of the first and second pivoting assemblies includes: a drive wheel; a motor drive connected to the drive wheel; a first pivoting linkage fixedly attached to the motor drive, wherein the first pivoting linkage is pivotally coupled to the frame at a first frame pivot axis such that the drive wheel, motor drive, and first pivoting linkage pivot about the first frame pivot axis as a unit; a second pivoting linkage pivotally coupled to the frame at a second frame pivot axis; and a front caster assembly, wherein the first pivoting linkage is pivotally coupled to the front caster assembly at a first front caster pivot axis and the second pivoting linkage is pivotally coupled to the front caster assembly at a second front caster pivot axis.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In the accompanying drawings which are incorporated in and constitute a part of the specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to example the principles of this invention.

[0014] Figure 1 is a perspective view of a wheelchair incorporating the suspension of the present invention.

[0015] Figure 2 is an exploded perspective view of certain components of the wheelchair of Figure 1.

[0016] Figure 3 is an exploded detail view of certain components of a side frame assembly of the present invention.

[0017] Figure 4 is a side elevational view of the side frame assembly under static conditions.

[0018] Figure 5 is a side elevational view of the side frame assembly traversing an obstacle by ascending an obstacle.

[0019] Figure 6 is a side elevational view of the side frame assembly traversing an obstacle by descending the obstacle.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENT

[0020] The present invention provides a wheelchair and suspension for traversing obstacles and rough terrain. The present invention facilitates the traversing of obstacles and rough terrain by allowing for the vertical and lateral movement of one or more front caster assemblies coupled to the wheelchair. The lateral movement of the present invention is of special assistance when traversing obstacles or rough terrain because it draws the front caster assemblies in towards the wheelchair as the caster assemblies undergo vertical movement. Such operation provides the wheelchair with additional clearance when overcoming the obstacle or rough terrain.

[0021] Referring now to Figure 1, a perspective view of a wheelchair 100 of the present invention is shown. Wheelchair 100 is preferably a mid-wheel drive or rear-wheel drive wheelchair. As shown, wheelchair 100 has a chair 102 having arm supports 104 and 106. A control device such as, for example, a joystick controller 108 is attached to the chair 102 for controlling any power-related aspects of wheelchair 100. Wheelchair 100 further has removable decorative shrouds 110 covering the wheelchair's suspension, drive, and control systems. Projecting forward from the shrouds 110 is footrest 112 for supporting the feet of the wheelchair's user.

[0022] Illustrated in Figure 2 is an exploded perspective view of certain components of wheelchair 100. The suspension system has a sub-frame 200 for accommodating, among other things, removable batteries 226 and 228. Removably attached to sub-frame 200 are first and second side frame assemblies 202 and 204. Side frame assemblies 202 and 204 are removably attached to sub-frame 202 via interfaces preferably in the form of spring loaded hooks and latches. The spring loaded hooks preferably reside on sub-

frame 200 with the corresponding latches residing on side-frame assemblies 202 and 204. In this manner, an individual can manually with out the use of tools take apart wheelchair 100 for easy transportation in, for example, the trunk of a car or other large vehicle.

[0023] Each side frame assembly has at least one drive assembly having a motor drive 210 and 212 and a drive wheel 206 and 208. Each motor drive 210 and 212 preferably has either a motor/gear box combination or a brushless, gearless motor. Each side frame assembly further has at least one front caster assembly 218 and 220 coupled thereto via pivoting assemblies 214 and 216. At least one rear caster assembly 222 and 224 are also provided for each side frame assembly. Each of the side frame assemblies are identical in construction and, hence, the present discussion will focus on describing side frame assembly 202 with the understanding that such discussion is equally applicable to side frame assembly 204.

[0024] Referring now to Figure 3, an exploded detailed perspective of certain components of side frame simply 202 is shown. In this regard, side frame assembly 202 has a side frame member 301 having sub-members 302, 304, 306, and 318. These side frame sub-members are preferably tubular (i.e., circular, oval, or rectangular in cross-section) and formed and welded together has shown. Pivoting assembly 214 has a first pivoting linkage 319 defined by sub-linkages 320, 322, 324, and 326. These sub-linkages are also preferably tubular in configuration, as described above, and formed and welded together as shown. Sub-linkage 326 has a motor drive assembly mounting bracket 328 attached thereto. A second pivoting linkage 334 is also provided. As shown in Figure 3, the overall length of the first pivoting linkage 319 is greater than the overall length of the second pivoting linkage 334. As will be presently described, this configuration facilitates, for example, the dual functions

of lifting and retracting the front caster assembly 335 away from the obstacle to be traversed and inward toward the wheelchair.

[0025] The first pivoting linkage 319 is pivotally coupled to side frame member 301 via tubular stud or extension 308. The second pivoting linkage 334 is pivotally coupled to side through member 301 via tubular stud or extension 312. A compression plate 332 is provided for additional stability and is coupled to side frame member 301 via tubular studs or extensions 308 and 312 and pivot stop member 310.

[0026] Resilient extension springs 344 and 346 are provided between side frame member 301 and first pivoting linkage 319. In this regard, spring 344 has a first connection to frame member 301 via bracket 314 and a second connection to first pivoting linkage 319 via bracket 330. Spring 346 has a first connection to frame member 301 via bracket 316 and a second connection to first pivoting linkage 319 via bracket 348. As will be described in more detail, extension springs 344 and 346 are connected to first pivoting linkage 319 on either side of the linkages pivotal connection to side frame member 301 and provide a unidirectional bias force around the first pivoting linkage 319 pivotal coupling to side frame member 301. Alternatively, resilient elastomeric members can be integrated into the pivotal coupling between first pivoting linkage 319 and side frame member 301. Similarly, resilient elastomeric members can be integrated into the pivotal coupling between second pivoting linkage 334 and side frame member 301. Such resilient elastomeric members can be "Rosta"-type bearings or other similar structures.

[0027] A front caster assembly 335 is pivotally coupled to each of the first and second pivoting linkages 319 and 334. In this regard, front caster assembly 335 has an integral head tube/bracket 336 for receiving a caster fork 337 and making the aforementioned pivotal couplings to linkages 319 and 334. These pivotal couplings to linkages 319 and 334 are facilitated by first and second holes 338 and 340 in head tube/bracket 336 and

corresponding tubular formations in first and second pivoting linkages 319 and 334. A rear caster is attached to side frame assembly 301 via rear caster fork 342, which is received in sub-frame member 318.

[0028] Configured as such, first and second pivoting linkages 319 and 334 pivot with respect to side frame member 301. Moreover, front caster assembly 335 undergoes spatial displacement with the pivotal movement of first and second pivoting linkages 319 and 334. The rear caster wheel and fork 342 are generally not affected by the pivotal movement of first and second pivoting linkages 319 and 334.

[0029] Referring now to Figure 4, an outer side elevational view of side frame assembly 202 is shown under static conditions (i.e., the wheelchair is standing still or neither accelerating or decelerating). Drive wheel 206 is only partially shown so to not obscure the relevant components of side frame assembly 202. In this state, all wheels including the drive wheels and front and rear caster wheels are in contact and maintain contact with the ground or other riding surface.

[0030] Referring now to Figure 5, an inner side elevational view of side frame assembly 202 is shown as the wheelchair traverses an elevated obstacle. The component displacement shown in Figure 5 normally occurs when the wheelchair is quickly accelerated forward to traverse an obstacle such as curb 500. For purposes of the present discussion, the pivotal coupling between first pivoting linkage 319 and side frame member 301 is designated by pivot P1. Similarly, the pivotal coupling between the second pivoting linkage 334 and side frame member 301 is designated by pivot P2. In relationship to each other, it can be seen that pivot P2 is below and laterally offset from pivot P1 in a direction toward the front caster. In other words, pivot P2 is laterally closer to front caster assembly 335 than is pivot P1. In combination with the respective overall lengths of first and second pivoting linkages 319 and 334, this configuration provides

the dual functions of lifting and retracting the front caster assembly 335 away from the obstacle to be traversed and inward toward the wheelchair.

[0031] In this regard, when the wheelchair is accelerated forward by a high rate, the resulting moment arm generated by the drive wheel 206 will exceed the resultant moment arm generated by springs 344 and 346. This causes first pivoting linkage 319 to pivot or rotate in a clockwise direction about pivot P1 thereby raising front caster assembly 335. This motion also causes second pivoting linkage 334 to undergo pivotal motion. The resulting effect of second pivoting linkage 334 motion is to cause front caster assembly 335 to pivot about its pivotal coupling 338 to first pivoting linkage 319. This pivotal movement causes front caster assembly 335 to be drawn inward toward the wheelchair itself and way from the obstacle 500 being traversed. The maximum amount of pivotal movement is limited by stop 310, which physically engages side frame member 301 sub-linkage 320. The same effect described above is achieved should side frame assembly 202 be driven directly over obstacle 500. Once the resultant movement arm generated by drive wheel 206 is less than the resultant movement arm generated by springs 344 and 346 with respect to pivot P1 front caster assembly 335 is lowered.

[0032] Referring now to Figure 6, an inner side elevational view of side frame assembly 202 is shown as the wheelchair traverses descends an obstacle 600. In this regard, the resultant moment arm generated by springs 344 and 346 is greater than any other moment arm around pivot P1. This causes first pivoting linkage 319 to rotate counter-clockwise and to lower the front caster assembly 335 on the lower supporting or riding surface. In this regard, the respective position of pivot P2 and the overall length of second pivoting linkage 334 compared to the position of pivot P1 and the overall length of first pivoting linkage 319 provide for front caster assembly 335 to descend to

the lower supporting surface. Concurrently therewith, the pivotal motion of second pivoting linkage 334 causes front caster assembly 335 to pivot about its pivotal coupling 338 to first pivoting linkage 319. This motion causes front caster assembly 335 to extend forward. The combined effect of lowering and extending front caster assembly 335 provide the wheelchair with greater stability when descending a obstacle because the wheelchair is sooner and longer in contact with the differing elevations that represent the obstacle. The maximum pivotal movement is once again limited by stop 310, which physically engages side frame member 301 sub-linkage 322 in this scenario.

[0033] Hence, the present invention facilitates the traversing of obstacles and rough terrain by allowing for the vertical and lateral movement of one or more front caster assemblies. The lateral movement of the front caster assemblies is of special assistance when traversing an obstacle because it draws the front caster assemblies in towards the wheelchair as the caster assemblies undergo upward vertical movement. For downward vertical movement, the present invention provides for the front caster assemblies to undergo lateral movement forward and away from the wheelchair.

[0034] While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. For example, a plurality of casters can be used instead of one caster, the casters can be coupled to the pivot arms via shock absorbing fork assemblies, and the specific locations of the pivotal couplings can be modified so long as the above-described overall relationships are maintained.

The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the Description as a whole.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A wheelchair suspension comprising:

a frame;

at least one rear caster coupled to the frame;

a pivoting assembly mounting a front caster and a drive wheel to the frame, the pivoting assembly comprising:

an upper link pivotally mounted to the front caster and to the frame at respective upper pivot axes;

a lower link pivotally mounted to the front caster and to the frame at respective lower pivot axes;

wherein the distance between the upper pivot axes is different than the distance between the lower pivot axes, and the pivoting assembly is coupled to a drive wheel such that torque applied to the drive wheel is transferred to the upper and lower links.

2. The wheelchair suspension of claim 1, wherein the distance between the upper pivot axes is greater than the distance between the lower pivot axes.

3. The wheelchair suspension of claim 1 wherein the torque transferred to the upper and lower links causes the caster to move toward the frame.

4. The wheelchair suspension of claim 1 wherein the front caster is attached to a bracket that is pivotally connected to the first and second linkages.

5. The wheelchair suspension of claim 1 wherein the first linkage includes a first sub-linkage fixedly connected to the drive assembly and a second sub-linkage pivotally coupled to the front caster.

6. The wheelchair suspension of claim 5 wherein the first sub-linkage and the second sub-linkage are fixedly connected together.

7. The wheelchair suspension of claim 1 wherein the upward pivotal movement of the first and second pivot linkages causes the caster to move toward the frame.

8. The wheelchair suspension of claim 1 further comprising a spring attached to each suspension assembly, such that the spring biases the front caster into engagement with the ground.

9. The wheelchair suspension of claim 1 wherein a pair of rear casters are coupled to the frame.

10. A wheelchair comprising:

a frame;

a pivoting drive assembly that includes:

a drive wheel;

a motor drive connected to the drive wheel; and

a first pivoting linkage fixedly attached to the motor drive, wherein the pivoting drive assembly is pivotally coupled to the frame at a first frame pivot axis such that the drive wheel, motor drive, and first pivoting linkage pivot about the first frame pivot axis as a unit;

a second pivoting linkage pivotally coupled to the frame at a second frame pivot axis; and

a front caster assembly, wherein the first pivoting linkage is pivotally coupled to the front caster assembly at a first front caster pivot axis and the second pivoting linkage is pivotally coupled to the front caster assembly at a second front caster pivot axis.

11. The wheelchair of claim 10 wherein the motor drive is fixedly connected to a mounting bracket of the first pivoting linkage.

12. The wheelchair of claim 10 wherein the motor drive is fixedly connected to the first pivoting linkage at a position below the first pivoting linkage.

13. The wheelchair of claim 10 wherein the first frame pivot axis is between an axis of rotation of the drive wheel and the front caster assembly.

14. The wheelchair of claim 10 wherein the second frame pivot axis is between the first frame pivot axis and the front caster assembly.

15. The wheelchair of claim 10 wherein a distance between the first frame pivot axis and the first front caster pivot axis is greater than a distance between the second frame pivot axis and the second front caster pivot axis.

16. The wheelchair of claim 10 further comprising a spring connected to the first pivoting linkage and to the frame at a position that is between the first pivoting linkage and the rear caster.

17. The wheelchair of claim 16 wherein the spring biases a front caster of the front caster assembly downward.

18. The wheelchair of claim 10 wherein torque applied to the drive wheel urges the front caster assembly away from a support surface.

19. The wheelchair of claim 10 wherein torque applied to the drive wheel lifts the front caster assembly off of a support surface.

20. The wheelchair of claim 10 further comprising at least one rear caster coupled to the frame.

21. A wheelchair comprising:

a frame;

first and second independent pivoting assemblies coupled to opposite sides of the frame, wherein each of the first and second pivoting assemblies includes:

a drive wheel;

a motor drive connected to the drive wheel;

a first pivoting linkage fixedly attached to the motor drive, wherein the first pivoting linkage is pivotally coupled to the frame at a first frame pivot axis such that the drive wheel, motor drive, and first pivoting linkage pivot about the first frame pivot axis as a unit;

a second pivoting linkage pivotally coupled to the frame at a second frame pivot axis; and

a front caster assembly, wherein the first pivoting linkage is pivotally coupled to the front caster assembly at a first front caster pivot axis and the second pivoting linkage is pivotally coupled to the front caster assembly at a second front caster pivot axis.

22. The wheelchair of claim 21 wherein the motor drive is fixedly connected to a mounting bracket of the first pivoting linkage.

23. The wheelchair of claim 21 wherein the motor drive is fixedly connected to the first pivoting linkage at a position below the first pivoting linkage.

24. The wheelchair of claim 21 wherein the first frame pivot axis is between an axis of rotation of the drive wheel and the front caster assembly.

25. The wheelchair of claim 21 wherein the second frame pivot axis is between the first frame pivot axis and the front caster assembly.

26. The wheelchair of claim 21 wherein a distance between the first frame pivot axis and the first front caster pivot axis is greater than a distance between the second frame pivot axis and the second front caster pivot axis.

27. The wheelchair of claim 21 further comprising a spring connected to the first pivoting linkage and to the frame at a position that is between the first pivoting linkage and the rear caster.

28. The wheelchair of claim 27 wherein the spring biases a front caster of the front caster assembly downward.

29. The wheelchair of claim 21 wherein torque applied to the drive wheel urges the front caster assembly away from a support surface.

30. The wheelchair of claim 21 wherein torque applied to the drive wheel lifts the front caster assembly off of a support surface.

31. The wheelchair of claim 21 further comprising at least one rear caster coupled to the frame.

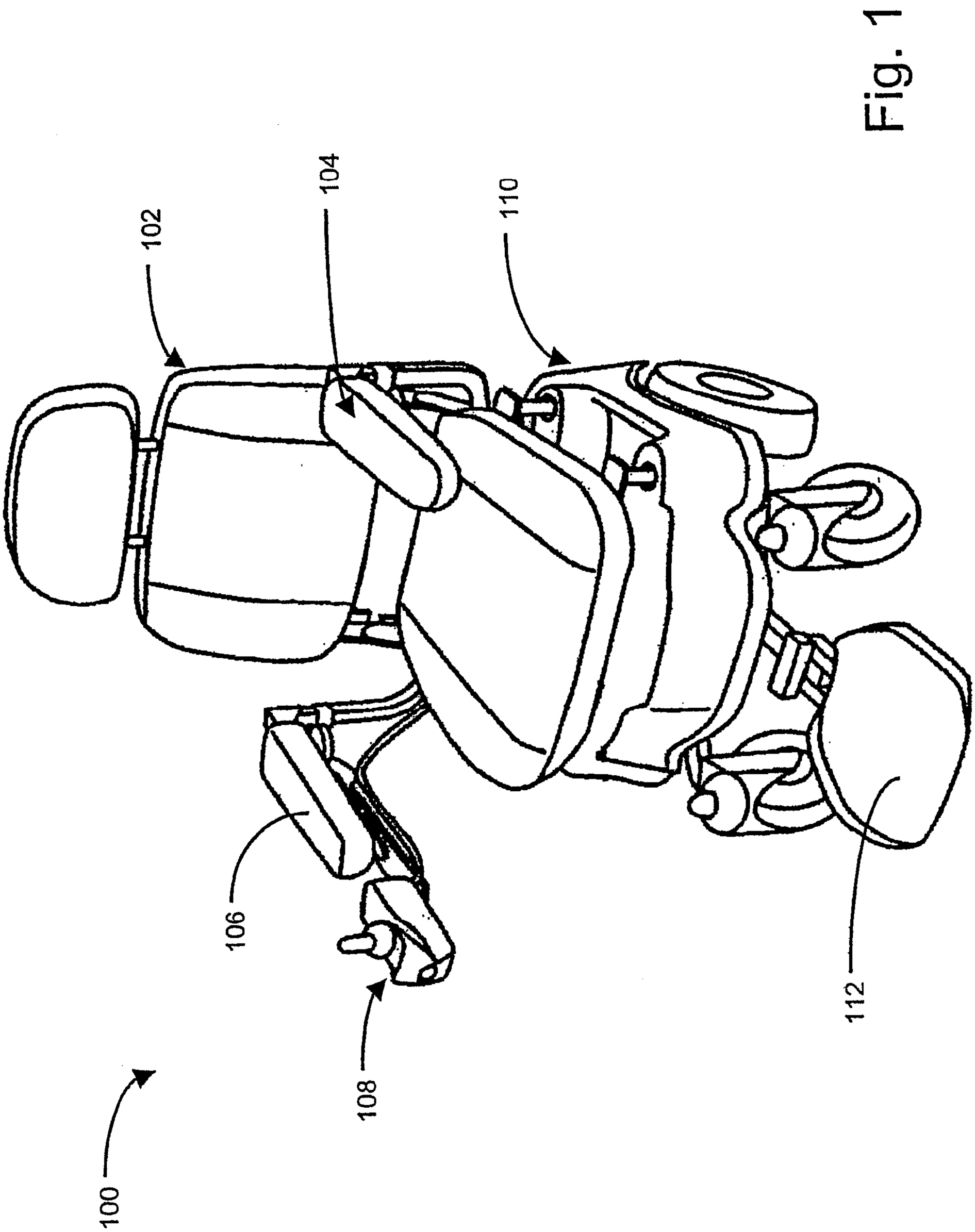


Fig. 1

Fig. 2

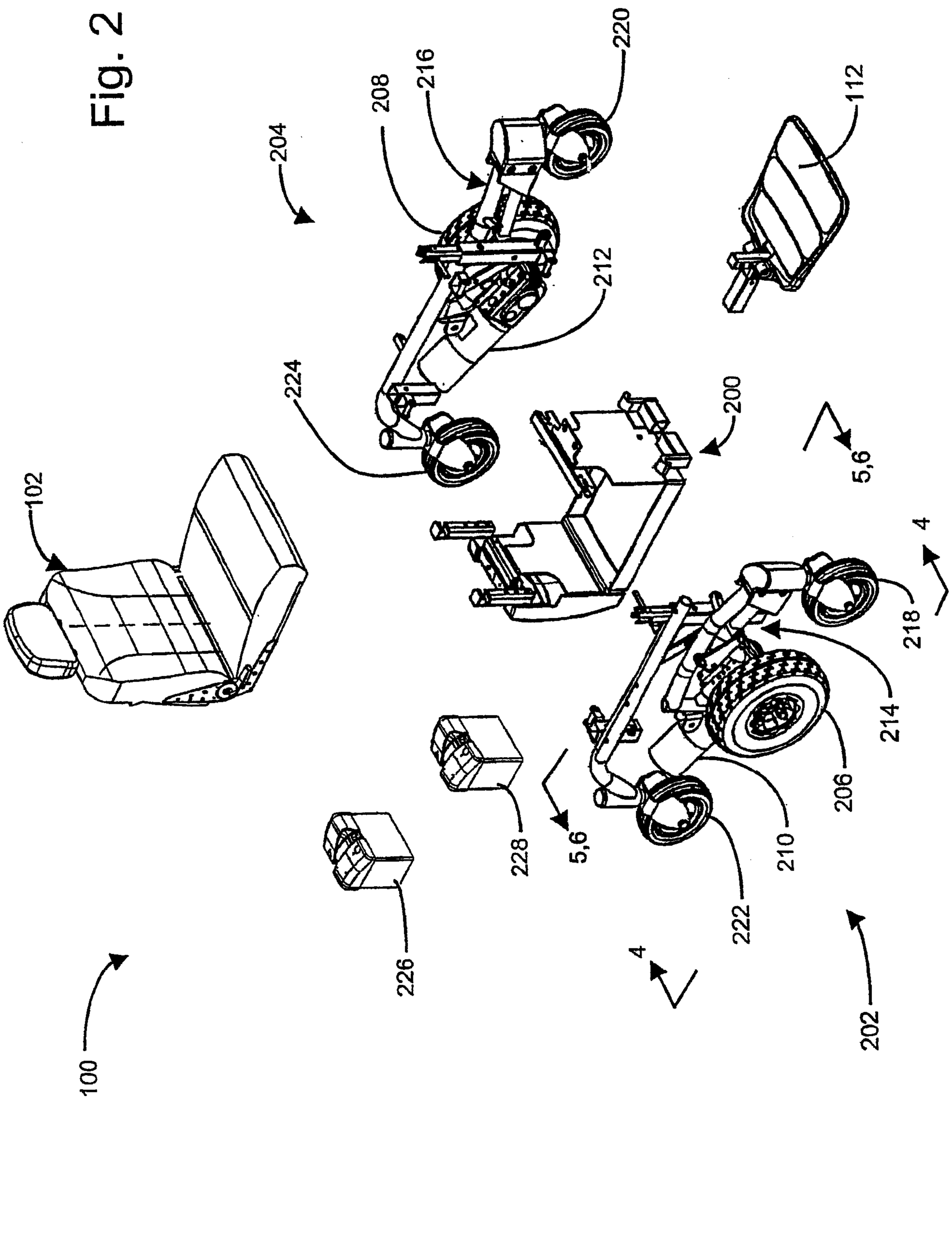

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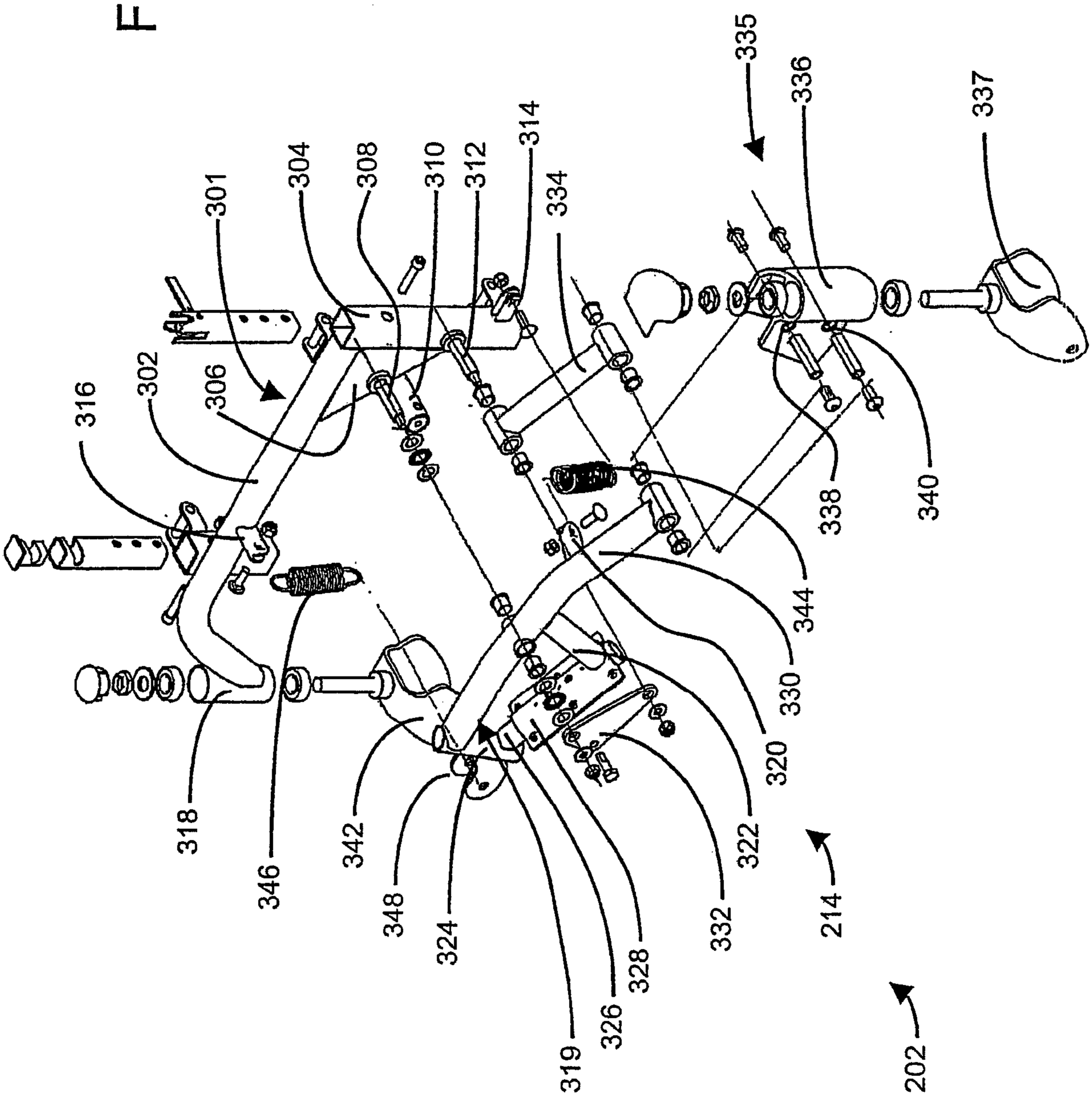
Fig. 3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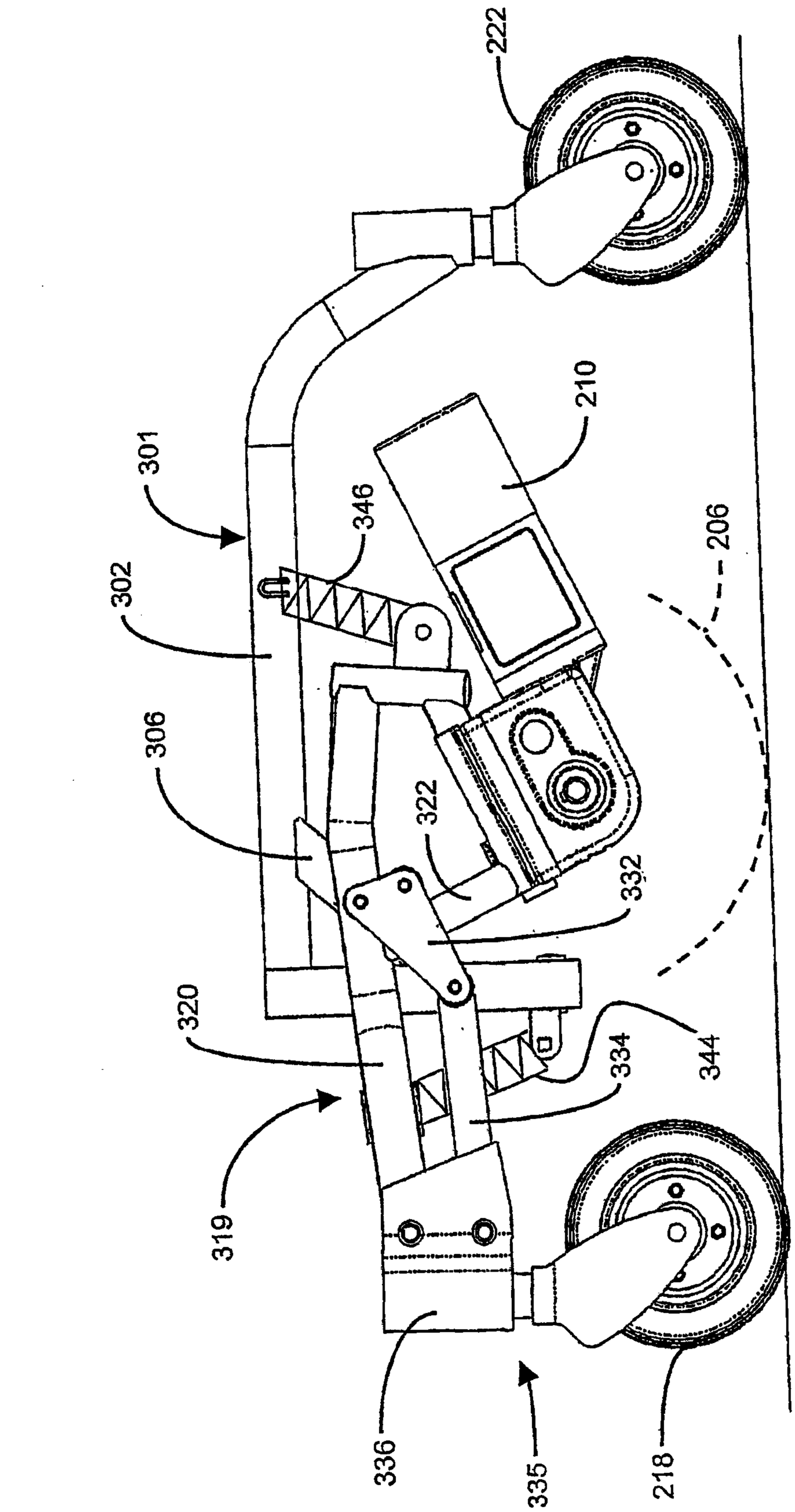

Fig. 4

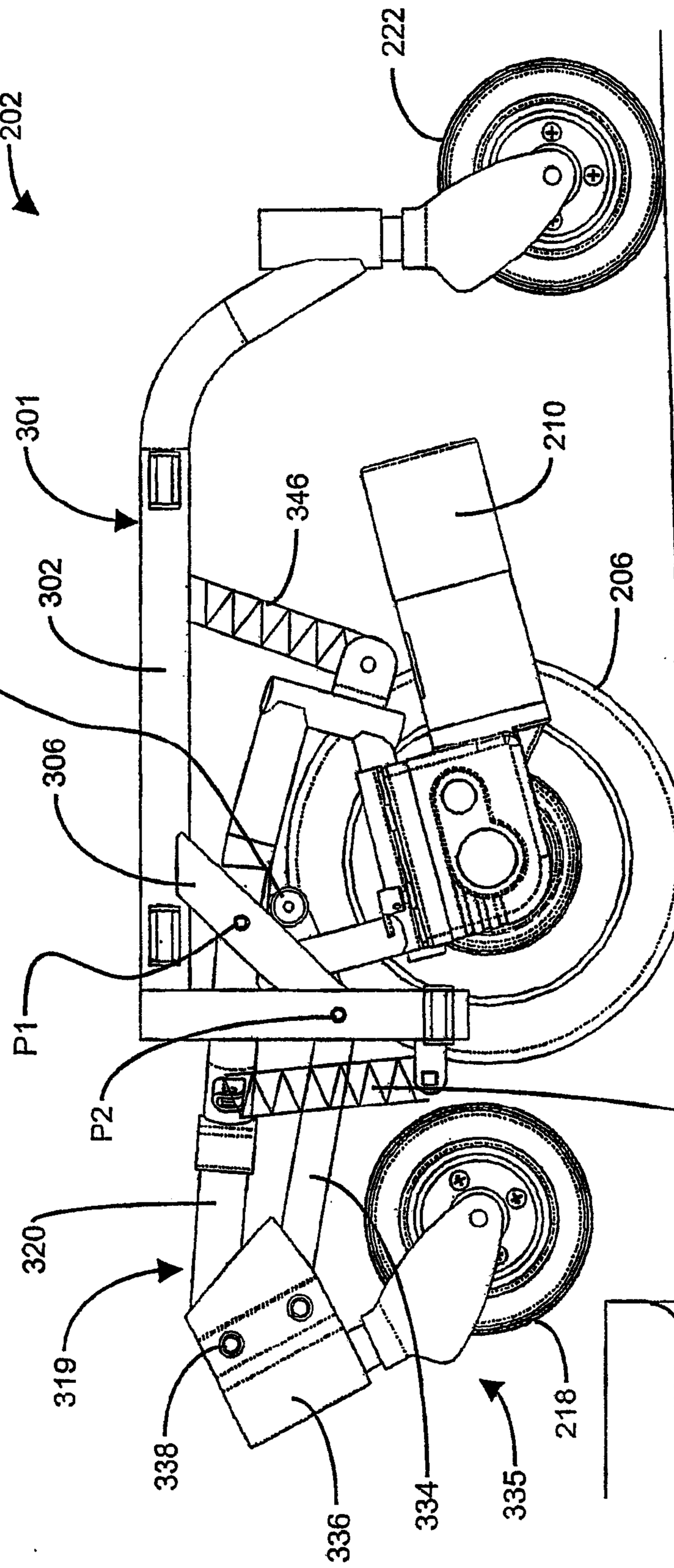
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Fig. 5

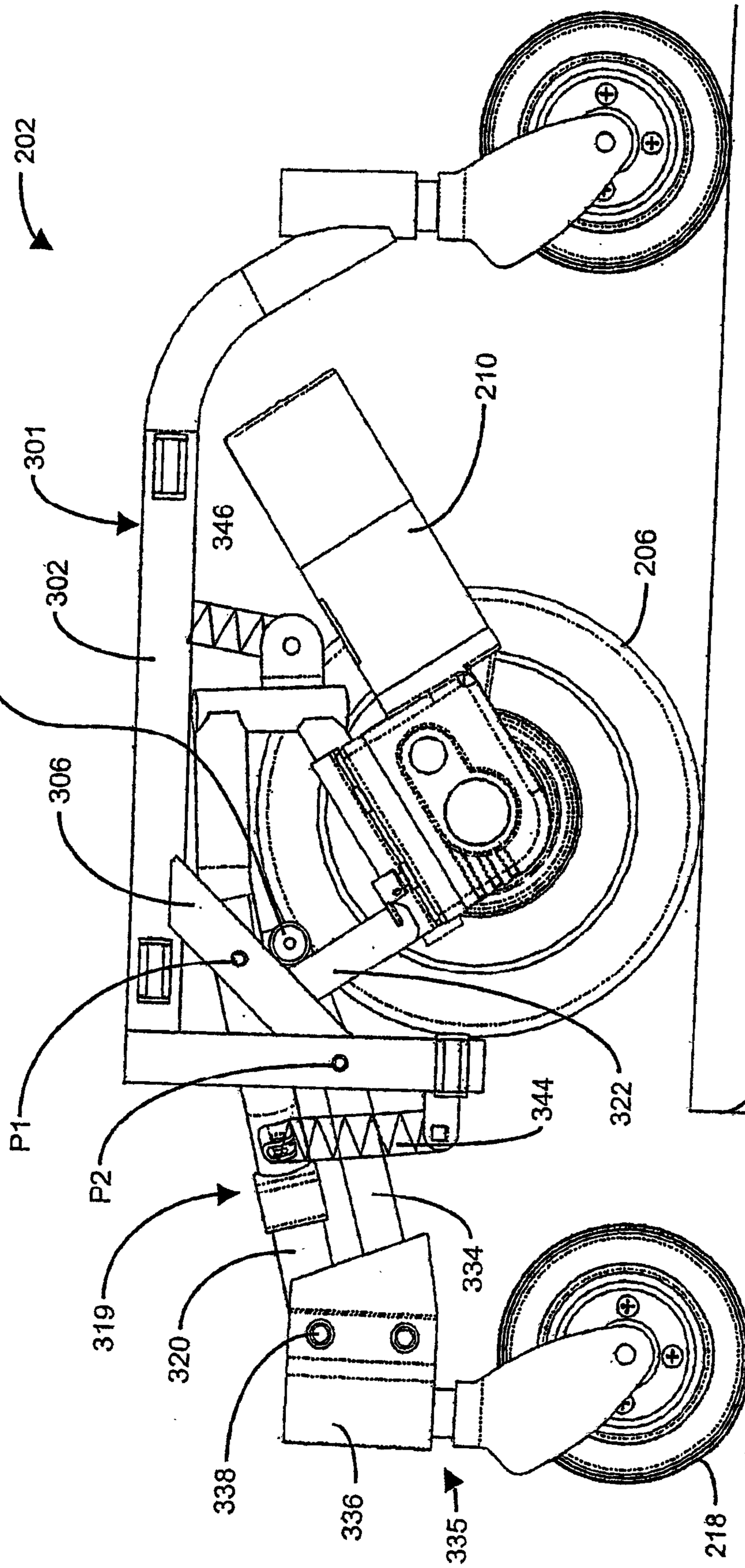
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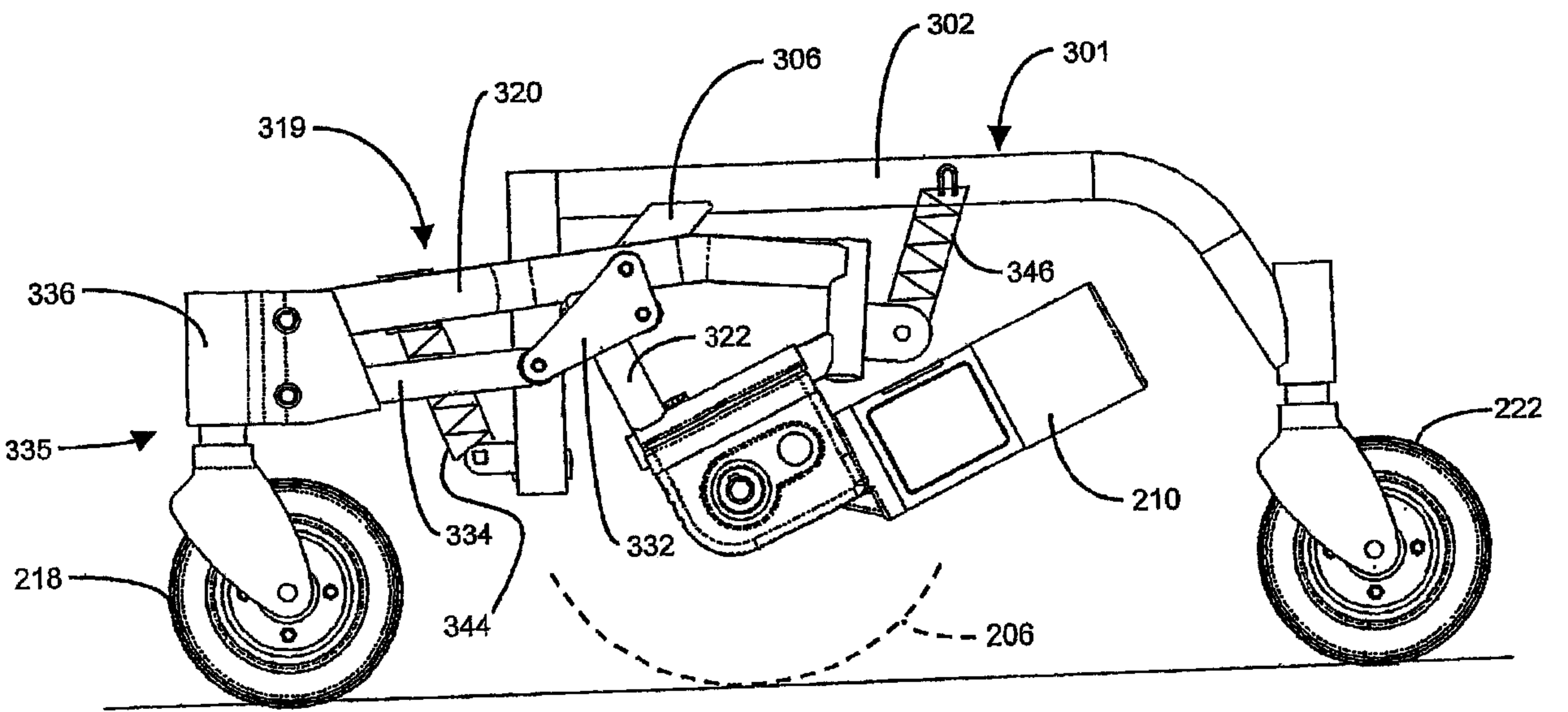
Fig. 6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