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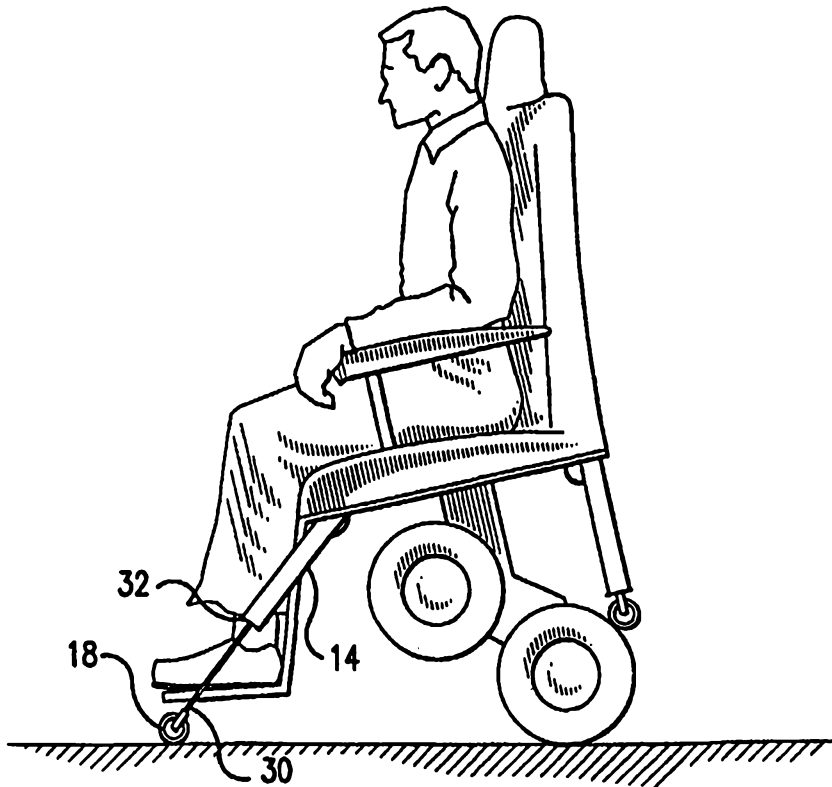
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(54) Title: ANTI-TIPPING MECHANISM

(57) Abstract

An anti-tipping mechanism for a vehicle that provides a strut actively deployed by rotation from a retracted position so as to bring a wheel into ground contact to inhibit tipping of the vehicle.



Anti-Tipping Mechanism

Technical Field

5 The present invention pertains to a deployable anti-tipping mechanism, and, in particular, to a deployable anti-tipping mechanism for preventing the overturning of a wheelchair-type vehicle.

Background of the Invention

Vehicles, whether for the transportation of humans or otherwise, may lack stability
10 either by design, where inherent stability is sacrificed in order to achieve relative mobility, or due to the nature of their use. Many such vehicles are particularly susceptible to tipping, whether due to collision, mechanical failure, sudden turns, steep inclines, or an encounter with a surface irregularity for which the mechanism is incapable of compensating. Indeed, any personal vehicle may tip when sufficiently severe surface irregularities are encountered.
15 Under these circumstances, the occupant or contents of the vehicle must be protected so that injury does not result from propulsion of the occupant toward the ground or other solid obstacle. Unless protected, the occupant may also sustain injury due to trauma or crushing if the vehicle, which may be relatively massive, overturns or is propelled, due to its inertia, into a solid obstacle or on top of the occupant. To protect the occupant of the vehicle from injury
20 and the vehicle from damage, the vehicle must be inhibited from tipping over.

One method which has been employed in a wheelchair in order to prevent tipping under conditions of a sudden stop or sudden acceleration involves the placement of a roller or wheel forward of the front axle or aft of the rear axle. The purpose of the fixed roller or wheel is to contact the ground and roll in case the vehicle tips forwards or backwards, thereby
25 inhibiting the vehicle from overturning. The presence of a fixed wheel extended forward of the frame of the vehicle limits the maneuverability of the vehicle by reducing ground clearance and restricting the vehicle's ability to traverse irregular terrain and obstacles. Limited maneuverability is particularly detrimental if the vehicle is a wheelchair. A similar limitation is imposed by a fixed wheel located aft of the rear axle to inhibit backward tilting
30 of the vehicle.

Another anti-tip mechanism which has been applied to a wheelchair in order to prevent rearward tipping involves a pair of wheels mounted aft of the rear axle beneath the undercarriage of the wheelchair on spring-tensioned articulated supports.

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Summary of the Invention

In accordance with an embodiment of the present invention, there is provided an anti-tipping mechanism for a vehicle. The anti-tipping mechanism has a strut which is mounted so as to permit travel about an axis from a retracted position to a deployed position. A wheel is mounted to an end of the strut. The anti-tipping mechanism also has an actuator which rotates
10 the strut from the retracted position to the deployed position.

In accordance with a further embodiment of the invention, the anti-tipping mechanism may have an engagement mechanism for bringing the wheel into ground contact. Additionally, the anti-tipping mechanism may have a sensor for detection a moment of the center of mass about the ground contact and a controller in communication with the sensor for
15 activating the actuator. The sensor may be an inclinometer. The engagement mechanism for bringing the wheel into ground contact may be an arm received into a sleeve in the strut.

The anti-tipping mechanism described herein advantageously provides the capability to deploy a wheel to inhibit the overturning of a vehicle. An additional advantage of the present invention is to provide an anti-tipping mechanism which does not impede the
20 maneuverability of the vehicle when the anti-tipping mechanism is retracted and not deployed. Other objects and advantages of the invention are in part apparent and in part pointed out hereinafter.

Brief Description of the Drawings

25 The invention will be more readily understood by reference to the following description, taken with the accompanying drawings, in which:

FIG. 1 is a side view of a wheelchair-type vehicle employing an embodiment of the invention wherein two anti-tipping mechanisms are shown in a retracted position.

FIG. 2 is a side view of the wheelchair-type vehicle of FIG. 1 wherein one anti-tipping
30 mechanism is shown in a partially deployed forward-facing position.

FIG. 3 is a side view of the wheelchair-type vehicle of FIG. 1 wherein one anti-tipping

mechanism is shown in a partially deployed and partially extended forward-facing position.

FIG. 4 is a side view of the wheelchair-type vehicle of FIG. 1 wherein one anti-tipping mechanism is shown in a fully deployed and fully extended forward-facing position.

FIG. 5 is a front perspective view of the wheelchair-type vehicle of FIG. 1 wherein
5 one anti-tipping mechanism is shown in a fully deployed and fully extended forward-facing position.

FIG. 6 is a side view of the wheelchair-type vehicle of FIG. 1 wherein one anti-tipping mechanism is shown in a partially deployed and partially extended backward-facing position.

FIG. 7 is a side view of the wheelchair-type vehicle of FIG. 1 wherein one anti-tipping
10 mechanism is shown in a fully deployed and fully extended backward-facing position.

FIG. 8 is a bottom perspective view of a wheelchair-type vehicle employing an alternative embodiment of the invention wherein an anti-tipping mechanism is shown in a partially deployed and partially extended forward-facing position.

15 Detailed Description of the Preferred Embodiment

Referring now to FIGS. 1 through 4, wherein a side-view is shown of a wheelchair-type vehicle, designated generally by numeral 10, in progressive stages of a forward-tipping motion. An example of such a vehicle is described in copending U.S. patent application, Serial No. 08/250,693, filed May 27, 1994 for an invention by Kamen et al. Referring,
20 particularly, to FIG. 1, vehicle 10 is shown supported on a pair of laterally disposed wheels 12 which provide ground contact for vehicle 10. The anti-tipping mechanism which is the subject of the present invention is embodied in each of the forward-facing anti-tippers designated generally by numeral 6 and rear-facing anti-tippers designated generally by numeral 8. In the preferred embodiment, two forward-facing anti-tippers 6 and two rear-
25 facing anti-tippers 8 are attached to vehicle 10. In alternate embodiments, a larger or smaller number of anti-tippers may be provided. Struts 14 of anti-tippers 6 and struts 16 of anti-tippers 8 are attached to vehicle 10 so as to be rotatable about an axis in a direction which has a vector component parallel to the direction of motion of the vehicle. In the preferred embodiment, struts 14 of anti-tippers 6 and struts 16 of anti-tippers 8 are attached to vehicle
30 10 so as also to be rotatable in a direction which is perpendicular to the direction of motion of the vehicle. Within the scope of the invention and the appended claims, anti-tippers 6 may

also operate entirely in a direction lateral to the direction of motion of the vehicle.

In FIG. 1, struts **14** and **16** are shown in a retracted position, extending neither forward nor aft of vehicle **10**. The retracted position is shown to be substantially vertical only by way of example and may be slanted either fore or aft of the position shown. In the preferred
5 embodiment, struts **14** are actively deployed by actuators **22** and **24** if an impending tip by vehicle **10** is sensed and the tip cannot otherwise be compensated by means available on vehicle **10**. By way of example, actuators **22** and **24** may utilize energy stored in a spring (not shown), and may also utilize any means known in the art for rotating struts **14** in advance of
10 tipping vehicle **10**. The sensing of tilt is accomplished by one of the means known in the art, such as sensing rotation of wheels **12** with respect to vehicle **10** or by means of an inclinometer (not shown) or other sensor for detecting a moment of the center of mass about point **13** of ground contact. In response to a sensed tilt, a controller such as a microprocessor activates actuators **22** or **24** to deploy struts **14** or **16**. Wheels **18** and **20** are attached to struts
15 **14** distally to actuators **22** and **24** such that when contact is made with the ground at a point forward of wheels **12** it is made by wheels **18**, and when contact is made with the ground at a point aft of wheels **12** it is made by wheels **20**.

Referring now to FIG. 2, vehicle **10** is shown in the initial stage of a forward tilt. In response to the forward tilt, actuator **22** is shown to have begun to deploy struts **14** by propelling struts **14** in substantially forward rotation. Further tipping of vehicle **10** is shown in
20 FIG. 3, accompanied by further forward deployment of strut **14**. Additionally, an extendable member **30** has been projected out of sleeve **32** by an engagement mechanism (not shown) which is contained within strut **14**. Projection of extendable member **30** out of sleeve **32** is accomplished by any means known in the art for projection of a concentric member such as by employing energy stored in a spring (not shown). Projection of extendable member **30**
25 provides for ground contact of wheel **18** so that vehicle **10** may continue to roll and tipping is inhibited. After wheel **18** comes into contact with the ground, strut **14** may continue to rotate forward. In the preferred embodiment, a plurality of extendable members **30** and **34** are projected successively, as shown in FIG. 4. Referring further to FIG. 4, strut **14** is shown in a fully deployed position, with further forward rotation inhibited by stop **36**. Additionally,
30 extendable members **30** and **34** are shown fully projected such that further tipping of vehicle **10** is prevented. Referring to FIG. 5, the fully deployed position of struts **14** is shown in front

view, along with fully projected extendable members **30** and **34**.

Referring now to FIG. 6, vehicle **10** is shown tipping in a backwards direction, with strut **16** in the process of rearward deployment and extendable member **40** projected to bring wheel **20** into ground contact to initiate rolling of wheel **20**. Projection of extendable member **40** provides for ground contact of wheel **20** so that vehicle **10** may continue to roll and tipping is inhibited. Actuation of actuator **24** in response to tipping of vehicle **10** is in a manner analogous to that described with respect to strut **14** in reference to FIGS. 1-5. In FIG. 7, strut **16** is shown fully deployed, with further rotation inhibited by stop **42**. FIG. 8 shows an alternative embodiment of the invention as implemented on a wheelchair-type vehicle **10**, indicating struts **14**, extendable members **40** and wheels **20**.

The described embodiments of the invention are intended to be merely exemplary and numerous variations and modifications will be apparent to those skilled in the art. All such variations and modifications are intended to be within the scope of the present invention as defined in the appended claims.

WE CLAIM:

1. An anti-tipping mechanism for a vehicle having a point of ground contact and a center of mass, the mechanism comprising:
 - 5 (a.) a strut mounted to permit travel of the strut about an axis from a retracted position to a deployed position;
 - (b.) a wheel mounted to an end of the strut; and
 - (c.) an actuator for rotating the strut from the retracted position to the deployed position.
- 10 2. An anti-tipping mechanism according to claim 1, further comprising an engagement mechanism for bringing the wheel into ground contact.
3. An anti-tipping mechanism according to claim 1, further comprising:
 - 15 (a.) a sensor for detecting a moment of the center of mass about the ground contact; and
 - (b.) a controller, in communication with the sensor, for activating the actuator.
4. An anti-tipping mechanism according to claim 2, wherein the engagement mechanism is provided by an extendable member coupled to said strut.
5. An anti-tipping mechanism according to claim 2, wherein said extendable member is an arm received into a sleeve in said strut.
- 20 6. An anti-tipping mechanism according to claim 3, wherein the sensor is an inclinometer.

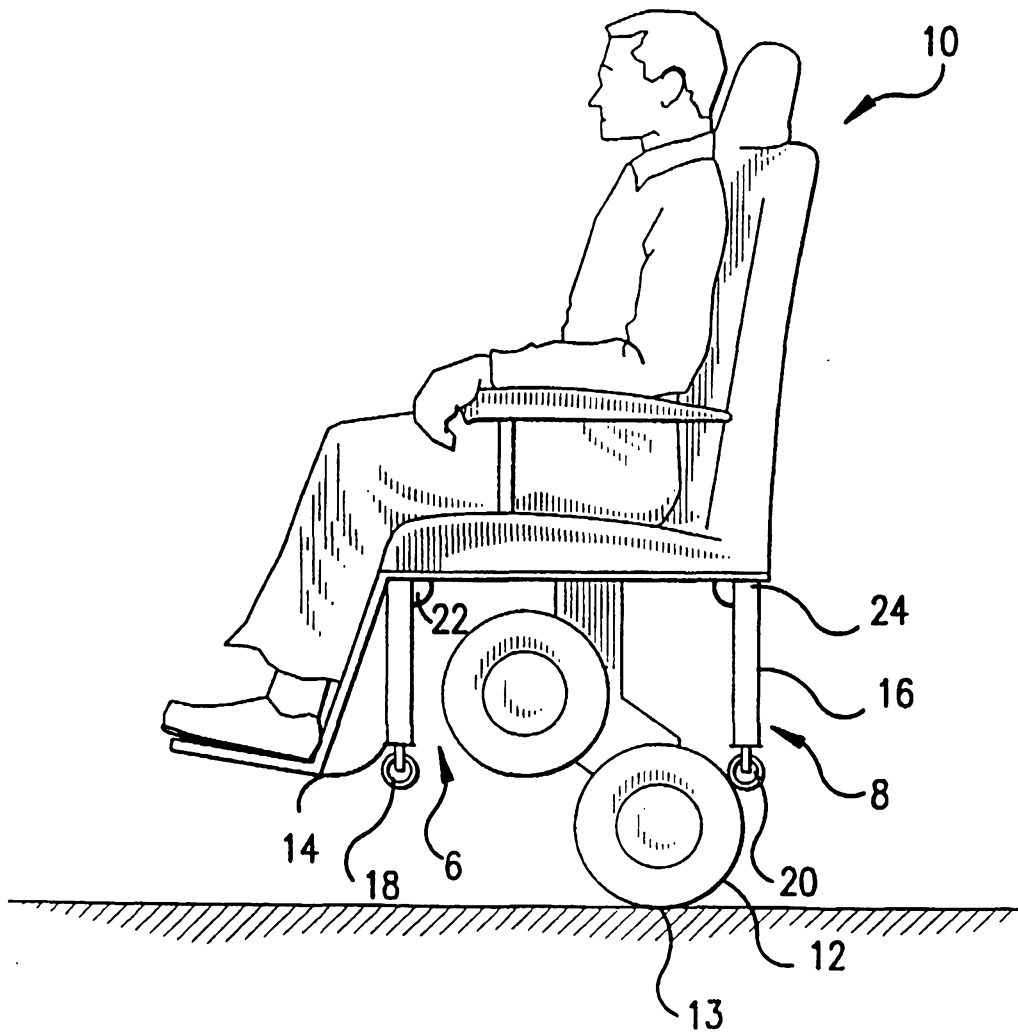


FIG. 1
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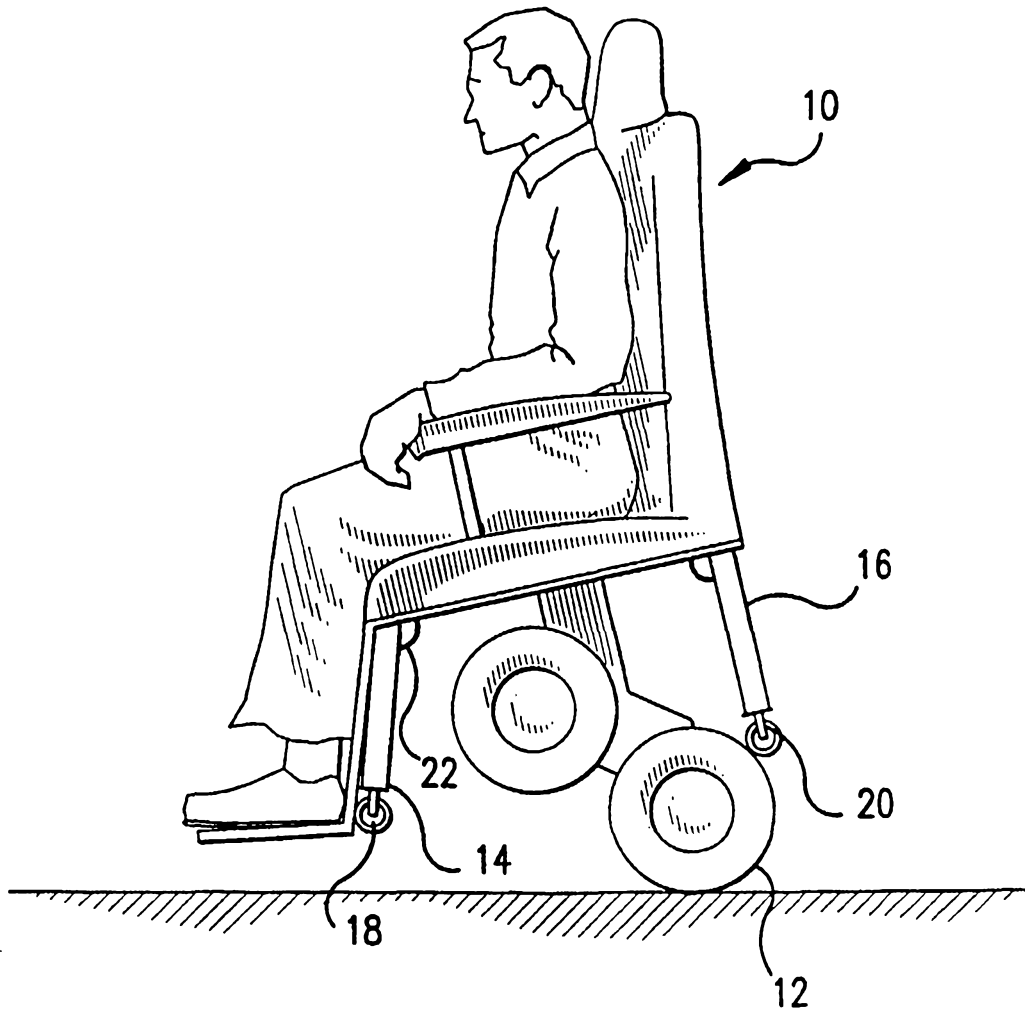


FIG.2

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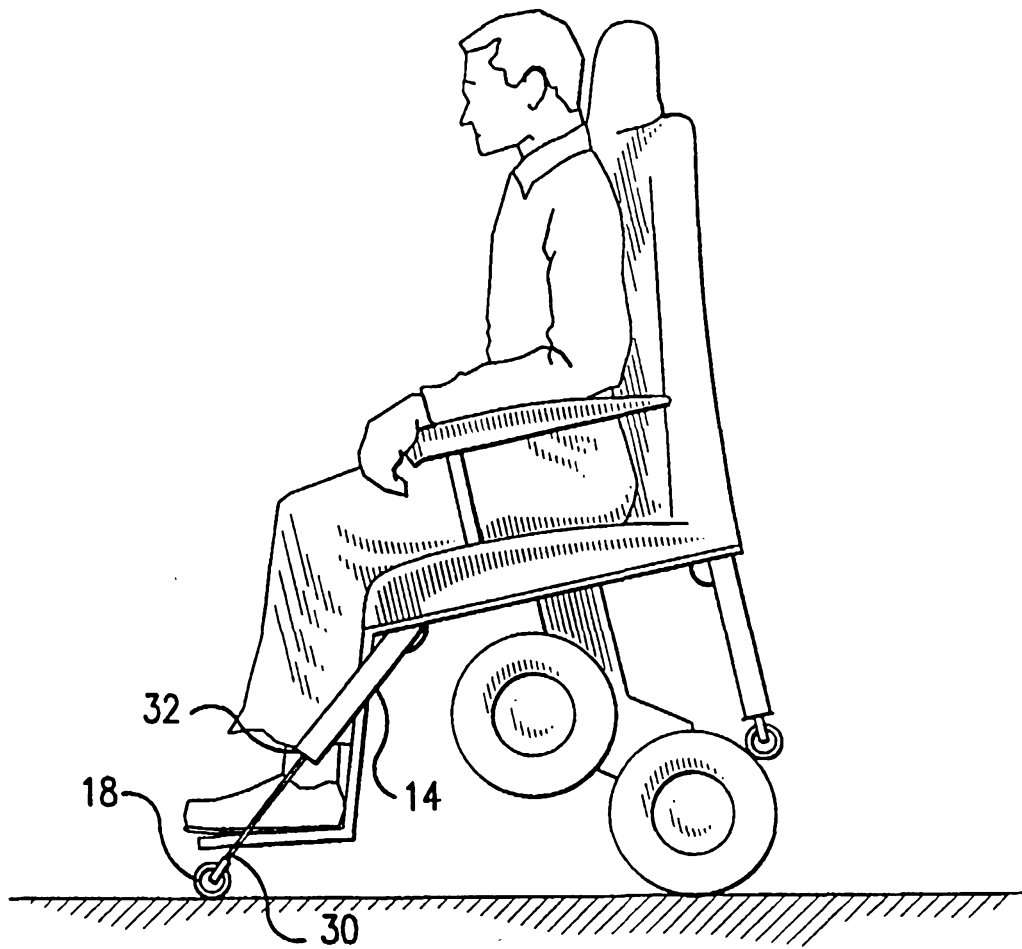


FIG. 3
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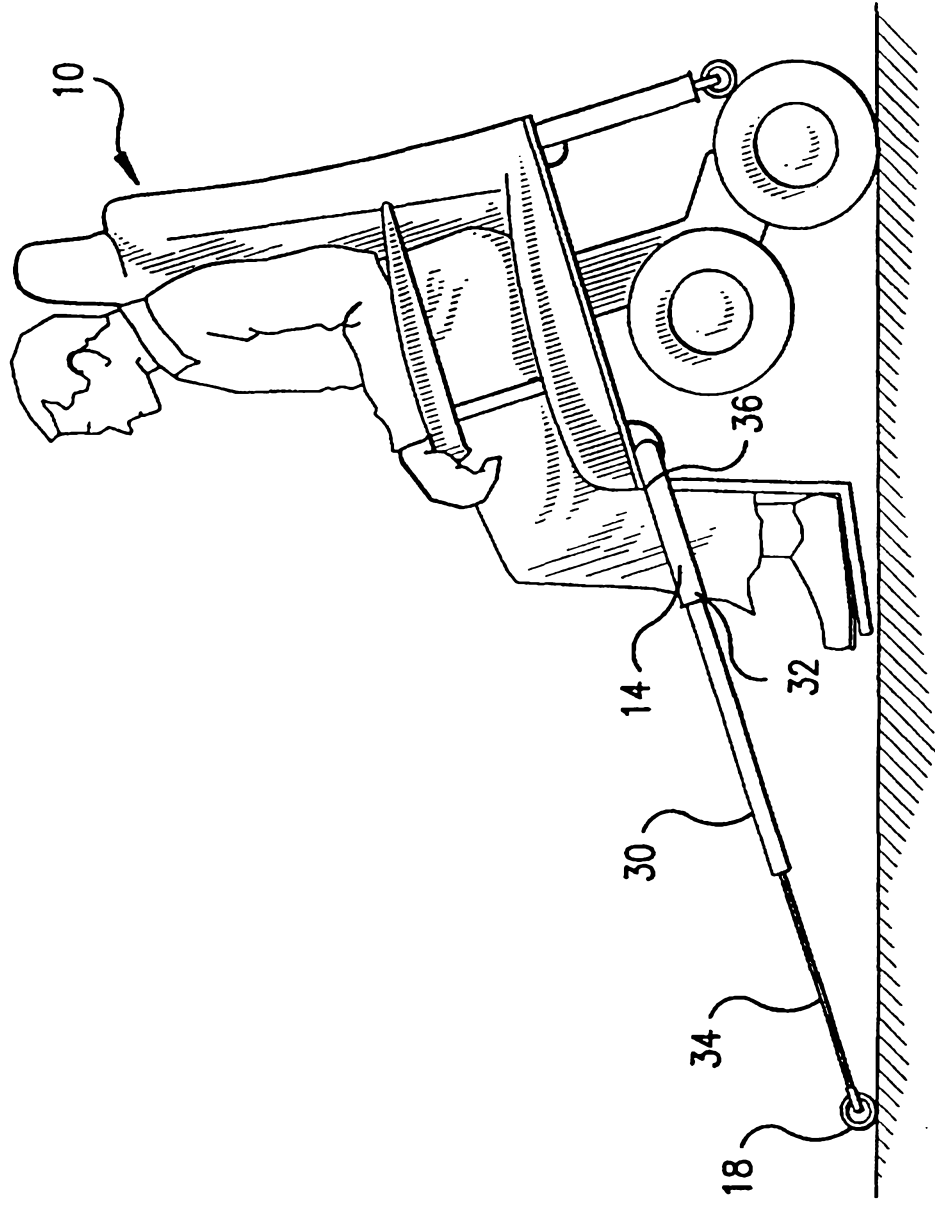


FIG. 4
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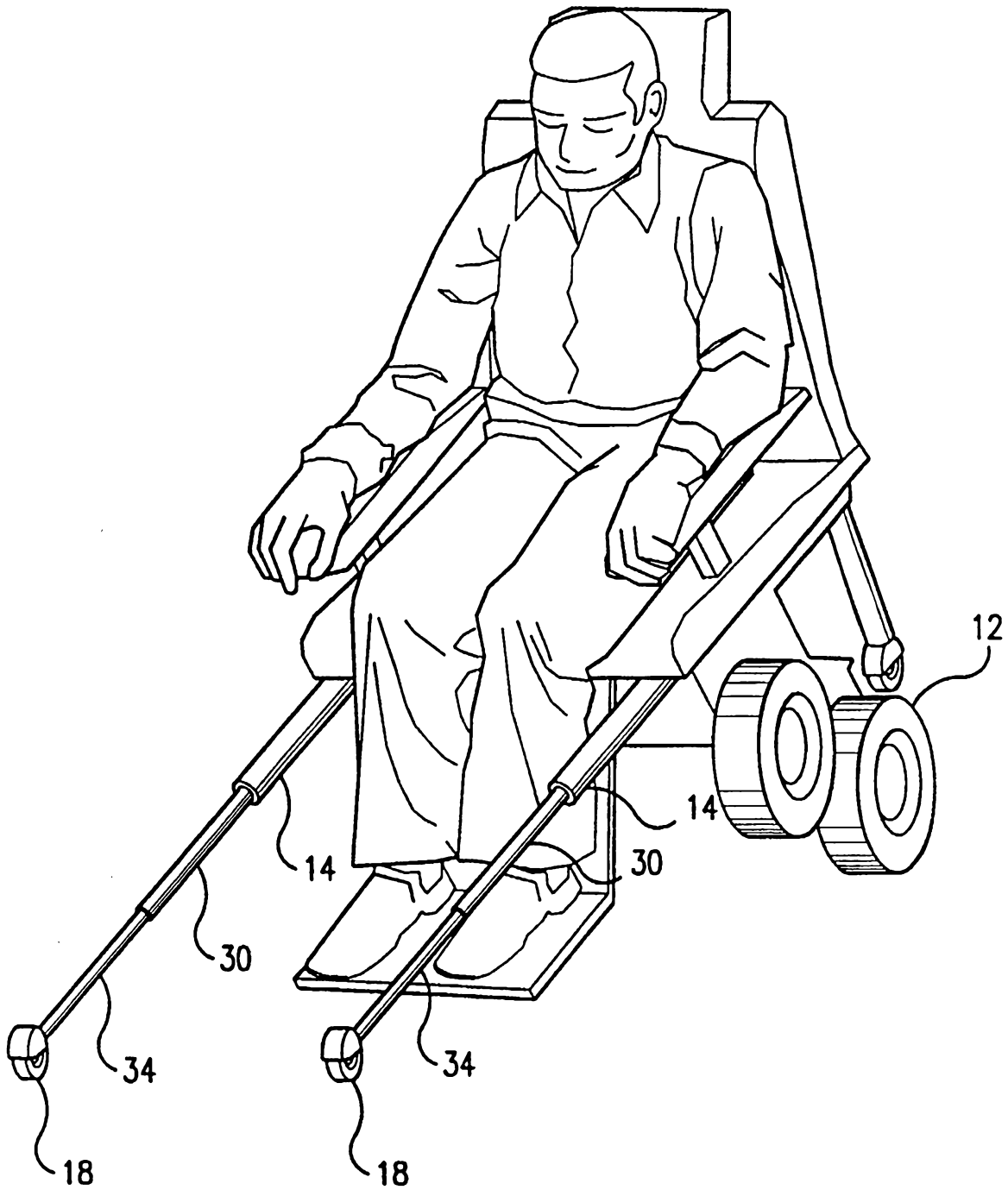


FIG.5
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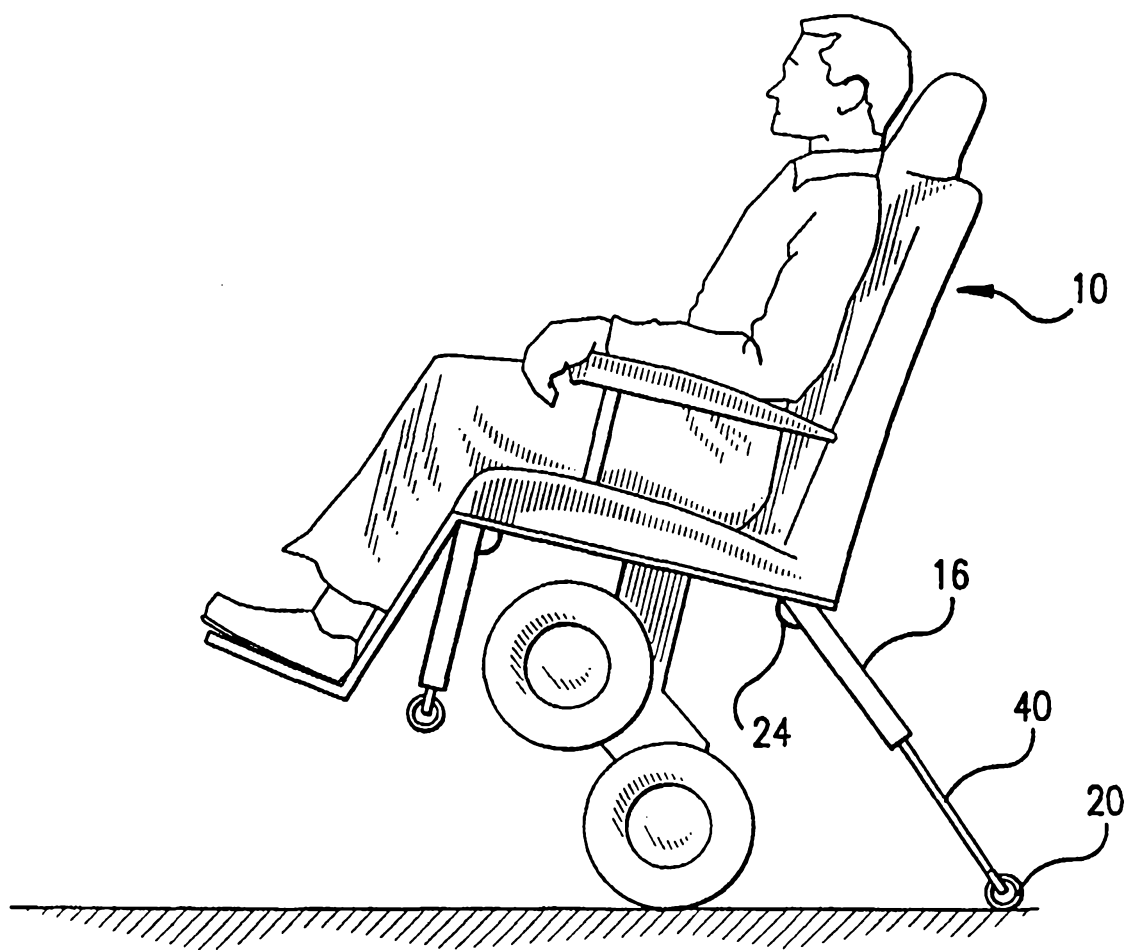


FIG. 6
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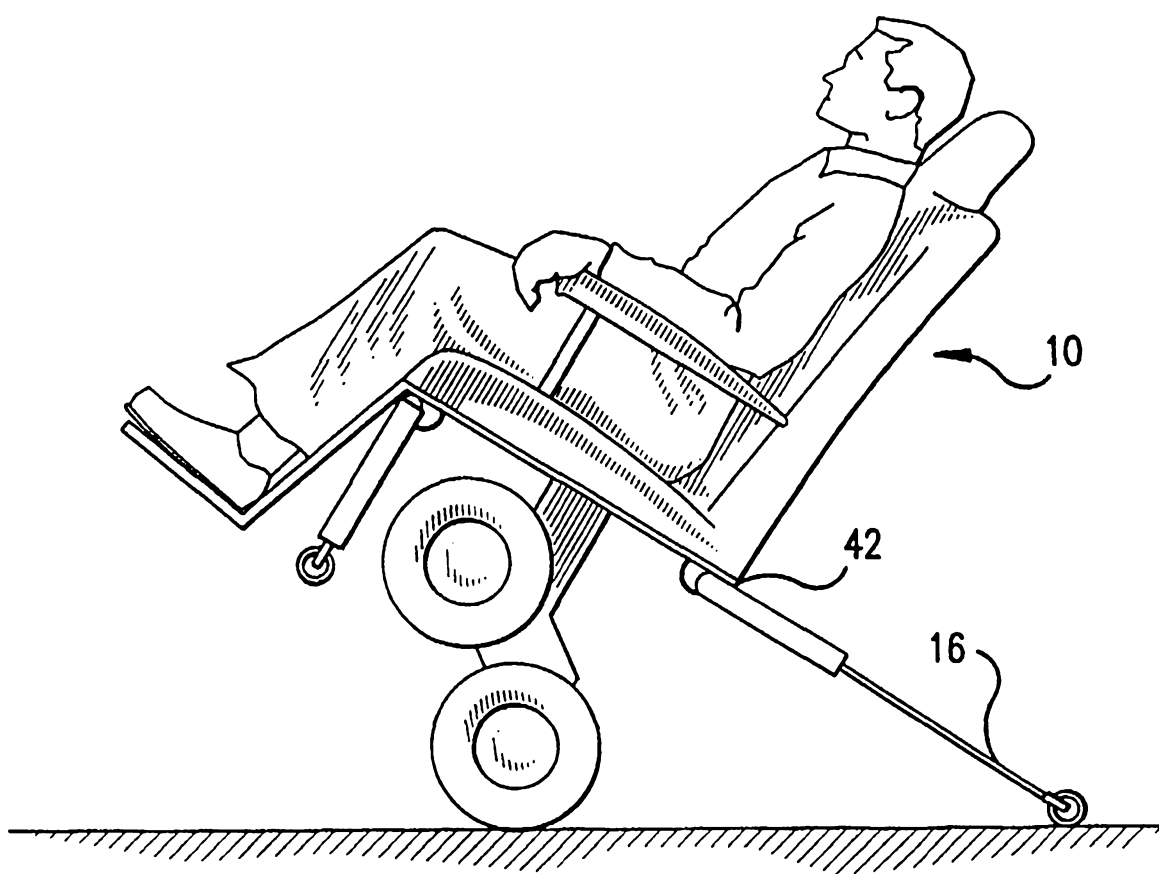


FIG. 7
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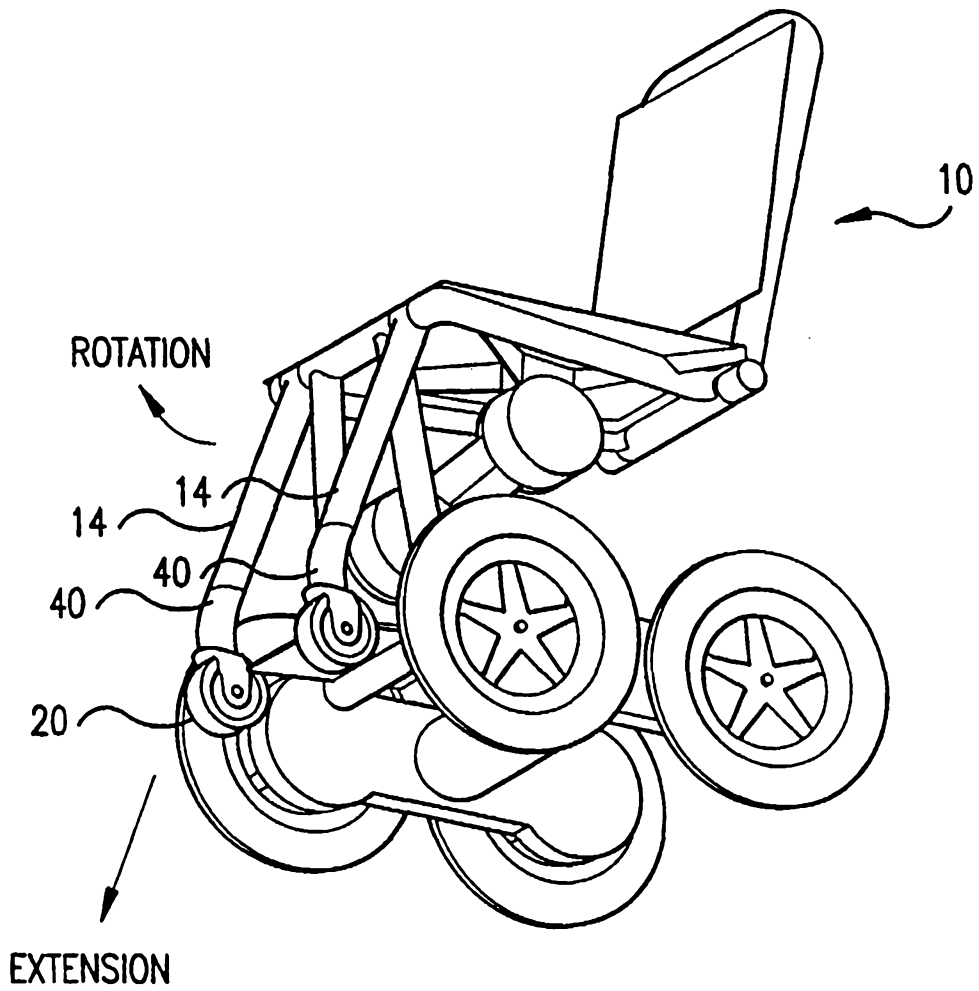


FIG. 8
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