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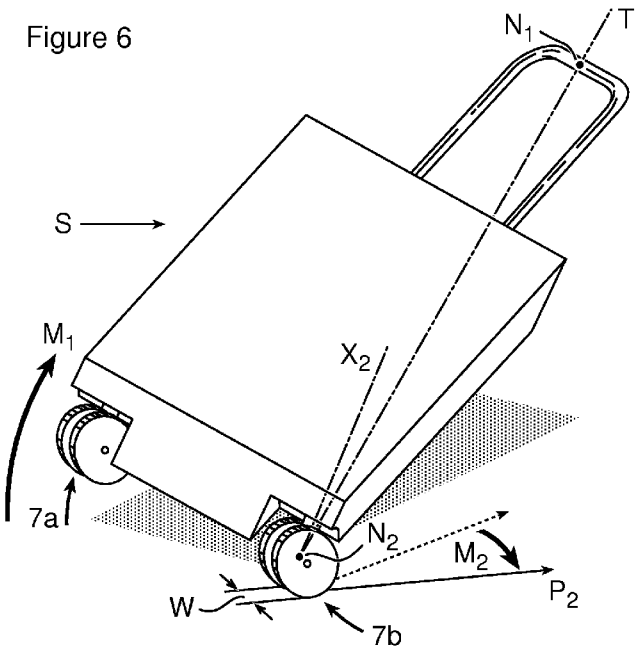
(54) Title: A WHEELED VEHICLE

Figure 6



(57) Abstract: A wheeled vehicle (2) incorporating first and second wheel assemblies (7a,7b) which are provided respectively at laterally spaced apart positions on the vehicle (2). Each wheel assembly (7a,7b) is rotatably mounted to the vehicle for rotation about a respective orientation axis (X_1,X_2). Each wheel assembly has at least one wheel (13a,13b,14a,14b) which is attached rotatably to a mounting device (9a,9b) for rotation about a roll axis (A_1,A_2). The or each wheel having a radius (R), each wheel assembly having a track width (W) which is substantially equal to or greater than the radius (R). The roll axes (A_1,A_2) of the first and second wheel assemblies (7a,7b) are substantially parallel and coaxially aligned with one another in a normal orientation when the vehicle (2) travels over a roll plane (P) in a stable condition. If the vehicle (2) becomes unstable when in use such that one of the wheel assemblies (7a,7b) depart from the roll plane (P), a rotational torque is generated across the track width (W) of the other wheel assembly (7a,7b) in contact with the roll plane (P). The torque causes the said other wheel assembly (7a,7b) to rotate in a predefined arc (M2) about its orientation axis (X_1,X_2) in a direction away from its normal orientation to stabilise the vehicle (2).

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Title: A Wheeled Vehicle

Description of Invention

THE PRESENT INVENTION relates to a wheeled vehicle, and more specifically relates to a wheeled vehicle incorporating a wheel assembly which is configured to improve the rolling stability of the vehicle.

During transit, wheeled vehicles may be subjected to sheer forces that the passive wheels are unable to dissipate. In such instances the wheel that is most loaded may act as a pivot about which the supported load laterally rotates or oscillates. The act of moving forward increases the instability. If the imbalance becomes too great, then one wheel may lift far enough off the ground to bring the vehicle into danger of falling over about the opposite wheel, impeding progress and possibly causing damage or personal injury.

It has been proposed previously to space the wheels of a vehicle as far as possible from one another to minimise rolling instability, with the centre of mass of the vehicle being positioned as low as possible. However, this arrangement is not always practicable and, even when employed, may not always be sufficient to overcome the sheer forces encountered.

It is known to provide a suspension system on a vehicle to dampen lateral shock loading and oscillation of the vehicle. However, a suspension system can only minimise the onset of wheel lift. A suspension system is of little assistance to a vehicle after a wheel has lifted off the ground when instability occurs.

Passive steering systems have been proposed for use on four-wheeled vehicles to reduce the side-slippage of the rear wheels of the vehicle.

However, the prior proposed passive steering systems require the vehicle to remain upright upon its wheels and require the wheels to be subjected to a constant centripetal loading to allow the passive steering system to function. Passive steering systems of this type are therefore also of little assistance in stabilising a vehicle if one of the wheels of the vehicle is lifted off the ground due to vehicle instability.

It is known to those skilled in the art that there is a type of swivel wheel assembly known as a "Chicago pivot" where the orientation axis is inclined from both the vertical and the horizontal and where the overall track width of the wheel or wheels is equal to or greater than the radius of the wheel or wheels. It will be understood that when Chicago pivots are used in pairs on a vehicle, for example a skateboard, they can allow the user a simple means of active steering control by the user leaning laterally to one side or the other of the Chicago pivots. In said prior art arrangements the Chicago pivots are positioned in-line towards the front and rear of the vehicle so that when the vehicle is being steered all of the wheels of the vehicle remain in contact with the ground.

German Utility Model No. 8408911 applied for by Tente Rollen GmbH & Co, describes a shopping trolley which is provided with a pair of laterally spaced apart conventional trailing wheeled swivel castors. The trailing castors are inclined towards the preferred direction of travel of the trolley so that the loaded mass of the trolley induces the inclined castors to swivel upwards, thereby giving the wheels of the trolley a forward bias. However, it will be understood that the trolley must remain upright upon its wheels in order for the forward bias to be maintained.

An international patent application published under International Publication No. WO2005/006912 applied for by the Massachusetts Institute of Technology (MIT), describes a stabilisation device for wheeled luggage

comprising at least one ancillary wheel positioned above and outboard of each of two conventional primary travel wheels. Each ancillary wheel has a roll axis inclined both upwardly and rearwardly from the roll axis of the primary travel wheels.

However, the problem with this prior art arrangement is that the luggage must first become destabilised in order to bring an ancillary wheel into contact with the ground to stabilise the luggage. Furthermore, as the ancillary wheel's roll angle is fixed and unable to respond incrementally to varying degrees of sheer force, the luggage develops a waddling motion should any instability persist above a certain travel speed.

Therefore, it will be understood that there remains a need for a mechanically simple, passive wheeled support to improve the lateral stability of rolling vehicles.

According to one aspect of the present invention, there is provided a wheeled vehicle incorporating first and second wheel assemblies which are provided respectively at spaced apart positions on the vehicle, each wheel assembly comprising a mounting device which is mounted rotatably to the vehicle for rotation relative to the vehicle about an orientation axis; and at least one wheel which is attached rotatably to the mounting device for rotation about a roll axis, the or each wheel having a radius, each wheel assembly having a track width which is substantially equal to or greater than the radius, wherein the roll axes of the first and second wheel assemblies are substantially parallel and co-axially aligned with one another in a normal orientation when the vehicle travels over a roll plane in a stable condition, and if the vehicle becomes unstable when in use such that one of the wheel assemblies departs from the roll plane, a rotational torque is generated across the track width of the other wheel assembly in contact with the roll plane to cause that said other wheel assembly to rotate about its orientation axis in a direction

away from its normal orientation to stabilise the vehicle.

Preferably the vehicle incorporates at least one first support node at which a part of the vehicle is supported relative to the roll plane when the vehicle is in use, the at least one first support node being distal to the first and second wheel assemblies.

Conveniently a point at or near the centre of each of the wheel assemblies defines a respective second support node, an imaginary topple axis being defined between the at least one first support node and the or each respective second support node, the angle of the orientation axis of each of the wheel assemblies being selected to be different from the angle of the topple axis of the corresponding wheel assembly.

Advantageously the orientation axis is not parallel to the roll plane, when the vehicle is in use.

Preferably the orientation axis is not perpendicular to the roll plane, when the vehicle is in use.

Advantageously one end of a link member is attached to the mounting device of the first wheel assembly and the other end of the link member is attached to the mounting device of the second wheel assembly such that rotation of one wheel assembly about its orientation axis moves the link member to drive the mounting device of the other wheel assembly to rotate about its respective orientation axis.

In one embodiment the arrangement further comprises a biasing member which biases at least one of the wheel assemblies towards the normal orientation.

Conveniently the or each mounting device is an elongate shaft which incorporates a first part and a second part which are rotatably mounted to one another at a first rotation point for rotation relative to one another about a first axis which is substantially parallel with the longitudinal axis of the shaft.

In one embodiment the or each mounting device incorporates a third part which is positioned between the first and second parts, one end of the third part being connected to the first part at the first rotation point and the other end of the third part being connected to the second part at a second rotation point, the second rotation point mounting the second and third parts for rotation relative to one another about a second axis which is not substantially parallel to the longitudinal axis of the shaft.

Preferably the or each mounting device incorporates a locking arrangement which is configured to prevent the first part and the third part from rotating relative to one another.

In a further embodiment the vehicle is provided with a mechanism to change the angle of the shaft of the or each mounting device relative to the vehicle when the vehicle is canted relative to the roll plane.

Preferably the or each wheel assembly is provided with a blocking arrangement to block rotation of the wheel assembly about the orientation axis to prevent the wheel assembly from rotating further than a predetermined angle.

In one embodiment the vehicle is a case.

Preferably the case incorporates a handle to be held by a user to allow the user to pull the case along a roll plane, the at least one first support node

being positioned on the handle.

Conveniently the handle is mounted to at least one moveable extension element.

Advantageously the wheeled vehicle is a vehicle which is configured to be pushed when in use.

In another embodiment the vehicle is a trailer.

In a further embodiment the trailer is the trailer of a heavy goods vehicle.

In a yet further embodiment the vehicle is a three wheeled vehicle.

In a still further embodiment the three wheeled vehicle is a sand yacht.

In another embodiment the vehicle is configured as a four wheeled vehicle.

In a further embodiment the vehicle is a multi-wheeled vehicle.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic perspective view of a wheeled vehicle in accordance with a preferred embodiment of the invention, shown in a canted position,

Figure 2 is a diagrammatic sectional view of the underside of part of the

vehicle shown in figure 1,

Figure 3 is a diagrammatic cutaway rear view of part of the vehicle shown in figure 1,

Figure 4 is a diagrammatic side view of part of the vehicle shown in figure 1,

Figure 5 is a diagrammatic side view of the vehicle in accordance with the preferred embodiment of the invention, in a canted position,

Figure 6 is a view corresponding to figure 1, with the vehicle in an unstable condition,

Figure 7 is a view corresponding to figure 3, with the vehicle in an unstable condition, showing the movement of the wheel assembly in relation to the vehicle,

Figure 8 is a view corresponding to figure 4, showing the movement of the wheel assembly in relation to the vehicle,

Figure 9 is a diagrammatic side view of a further embodiment of the invention in a canted position,

Figure 10 is a diagrammatic side view of part of a wheeled vehicle of a yet further embodiment of the invention, in an upright position,

Figure 11 is a view corresponding to figure 10, showing the wheeled vehicle in a canted position,

Figure 12 is a diagrammatic side view of a yet further embodiment of the invention, in an upright position,

Figure 13 is a view corresponding to figure 12, showing the vehicle in a canted position,

Figure 14 is a diagrammatic perspective view of another embodiment of the invention,

Figure 15 is a diagrammatic perspective view of a three wheeled vehicle in accordance with a further embodiment of the invention,

Figure 16 is a diagrammatic perspective view of a lorry of a yet further embodiment of the invention, and

Figure 17 is a diagrammatic perspective view of an articulated vehicle of yet another embodiment of the invention.

Referring initially to figure 1 of the accompanying drawings, a wheeled vehicle 1 of a preferred embodiment of the invention takes the form of a canted "trolley" case 2. The term "case" is used hereinafter to encompass various types of luggage, such as suitcases, briefcases, laptop or computer cases, holdalls, attachés, carry-ons, carry-alls and other bags.

It is to be appreciated that in other embodiments the wheeled vehicle may be any other kind of wheeled vehicle. Some alternative wheeled vehicles of further embodiments of the invention are described below.

In this preferred embodiment, the case 2 has a body 3 for housing items (not shown) to be transported. The body 3 incorporates a support frame which comprises two support channels 4. Extender elements 5a,5b are received slidably in the support channels 4. A handle 6 is attached to, or forms part of, the extender elements 5a,5b. The extender elements 5a,5b can be retracted into the channels 4 or extended outwardly from the channels 4 to an

extended position, as shown in figure 1.

The handle 6 can be held by a user to pull the case 2 along. A first support node N_1 is defined at a position on the handle 6 at or near the position on the handle 6 where the user holds the handle when in use. The first support node N_1 is distal to the first and second wheel assemblies 7a,7b.

The case 2 incorporates two laterally spaced apart wheel assemblies 7a,7b which are rotatably mounted in recesses 8a,8b at the canted base of the case 2 which is the lowermost side of the case when the case 2 is canted on its wheels.

The wheel assemblies 7a,7b each comprise a mounting device 9a,9b which takes the form of an elongate rod, as shown in figures 2 to 4. The mounting devices 9a,9b are each split into a fixed part 10a,10b which is fixed to or forms part of the body 3, and a moveable part 11a,11b which is rotatably mounted to the fixed part 10a,10b, as shown in figure 4. The movable parts 11a,11b are configured to rotate relative to the fixed parts 10a,10b, and relative to the body 3 of the case 2 about respective orientation axes X_1,X_2. The orientation axes X_1,X_2 are preferably parallel with one another, as shown in figure 1.

At least one axle 12a,12b extends through one end of the movable part 11a,11b of each of the mounting devices 9a,9b. The axles 12a,12b protrude from each side of the mounting devices 9a,9b. An outer wheel 13a,13b is mounted rotatably to the outer end of the axle 12a,12b and an inner wheel 14a,14b is mounted rotatably to the inner end of the axle 12a,12b, as shown in figure 2. Each wheel assembly 7a,7b therefore incorporates two spaced apart wheels 13a,13b and 14a,14b. In other embodiments, however, the wheel assemblies 7a,7b can each incorporate only one wheel or more than two wheels.

The wheels 13a,13b and 14a,14b of each wheel assembly 7a.7b are attached by the axles 12a,12b for rotation about respective roll axes A_1,A_2. The roll axes A_1,A_2. are substantially parallel and co-axially aligned with one another when the wheel assemblies 7a,7b are in a normal orientation, as shown in figure 2. The wheel assemblies 7a,7b remain in the normal orientation when the vehicle 2 travels over a roll plane P in a stable condition.

In further embodiments, the wheels provided in a wheel assembly may be inclined towards or away from one another, rather than being parallel to one another as in the embodiments described above and as shown in figure 2. In these embodiments, the roll axes A_1,A_2 are the apparent horizontal axes about which the wheels 13a,13b and 14a,14b of each wheel assembly 7a,7b roll in combination with one another across the roll plane P and not the wheel axis about which each individual wheel rotates.

Each wheel 13a,13b and 14a,14b has a radius R, as shown in figure 4. The wheels 13a,13b and 14a,14b of each wheel assembly 7a,7b are spaced apart from one another by a track width W. The track width W is the furthest lateral distance between the parts of the wheels 13a,13b and 14a,14b that contact a roll plane P, as shown in figure 3.

The track width W and the radius R are selected so that, for each wheel assembly 7a,7b, the track width W is substantially equal to or greater than the radius R.

In embodiments in which each wheel assembly 7a,7b incorporates only one wheel, the track width W is the width of the wheel in contact with the roll plane P. In these embodiments, the wheel is a relatively wide wheel with the track width W being substantially equal to or greater than the radius R.

A second support node N_2 is defined substantially at the centres of each of the wheel assemblies 7a,7b. The second support nodes N_2 are substantially mid-way between the centre of each of the pairs of wheels 13a,14a and 13b,14b. In the embodiment where each wheel assembly incorporates only one wheel, the second support node N_2 is defined substantially at the centre of the single wheel.

An elongate link element 15 is received within an elongate recess 16 that extends across the width of the lower part of the body 3 of the case 2. The recess 16 is preferably positioned below the ends of the support channels 4, as shown in figure 2. In other embodiments, the recess 16 is omitted and in these embodiments the link element 15 is positioned adjacent the body 3 of the case 2.

One end of the link element 15 is attached rotatably to the movable part 11a of the first mounting device 9a and the other end of the link element 15 is attached rotatably to the movable part 11b of the other mounting device 9b. The link element 15 provides a parallel linkage between the first and second mounting devices 9a,9b so that when one of the wheel assemblies 7a,7b rotates about its orientation axis X_1,X_2, a force is transmitted along the link element 15 which causes the other wheel assembly 7a,7b to rotate about its orientation axis X_1,X_2.

Resilient elements 17,18 in the form of coil springs are provided at each end of the link element 15. The resilient elements 17,18 have one end fixed to or abutting the link element 15, and the other end fixed to or abutting the body 3 of the case 2. The resilient elements 17,18 bias the link element 15 towards a rest position in which the roll axes A_1,A_2 of the wheel assemblies 7a,7b are parallel and co-axially aligned with one another, as shown in figure 2. The wheel assemblies 7a,7b are thus biased towards the normal orientation in which the wheels are aligned with the body 3 to give the case 2 a neat

appearance. The normal orientation of the wheel assembies 7a,7b also serves to position the wheel assemblies 7a,7b in an orientation which allows the case 2 to start rolling forward along roll paths P_1,P_2 in a stable condition when the case 2 is pulled by a user.

The resilient elements can be in the form of an elastomer or a spring and may be provided elsewhere in the case 2, for example, between the fixed part 10a,10b and the moveable part 11a,11b of the wheel assemblies 7a,7b.

It is, however, to be appreciated that the link element 15 is an optional component, and in other embodiments of the invention, the link element 15 is omitted. In embodiments of the invention which do not incorporate a link element between the wheel assemblies 7a,7b, resilient elements may still be provided at each of the wheel assemblies 7a,7b to bias the wheel assemblies 7a,7b towards the normal orientation.

It is, however, to be appreciated that the resilient elements 17,18 are optional components which may be omitted in other embodiments of the invention.

In further embodiments of the invention, the link element 15 may be a flexible element, such as a belt or chain which connects moveable parts 11a,11b of the the two mounting devices 9a,9b to form a linkage which causes the moveable parts 11a,11b to rotate in unison about the orientation axes X_1,X_2.

Each wheel assembly 7a,7b incorporates a blocking arrangement (not shown) which limits the range of rotation of the wheel assembly 7a,7b about the orientation axes X_1,X_2. In this preferred embodiment, the blocking arrangement is incorporated into the moveable parts 11a,11b and the fixed parts 10a,10b of the mounting devices 9a,9b. The blocking arrangements prevent the wheel assembly 7a,7b from rotating further than a predetermined angle of 75°, or preferably no more than 60°, from the initial position, as

shown in figure 2 where the roll axes A_1,A_2 of the wheel assemblies 7a,7b are parallel and co-axially aligned with one another. It is, however, to be appreciated that the blocking arrangements are optional and, in other embodiments of the invention, the blocking arrangements are omitted.

The canted base of the case 2 is strengthened by a runner board arrangement 19 which extends part-way up each side of the lower part of the case 2. The runner board 19 protects the body 3 of the case 2 from raised obstacles, such as steps, which may be hit by the case 2 as the case 2 is pulled along. In other embodiments, the runner board arrangement 19 may incorporate all or part of the recess 16 which houses the link element 15.

In use, a user holds the handle 6 and supports the handle 6 at the first support node N_1 so that the case 2 is canted on the wheels 13a,13b and 14a,14b, as shown in figure 1. The user pulls the case 2 along in a direction generally indicated by arrow F in figure 1. As the user pulls the case 2 along the roll plane P, the wheels 13a,13b and 14a,14b roll along respective roll paths P_1,P_2.

A topple axis T is an imaginary axis which passes through the first support node N_1 and the second support node N_2 of the second wheel assembly 7b, as shown in figure 5. An imaginary topple axis T also passes through the first support node N_1 and the second support node N_2 of the first wheel assembly 7a.

The topple axis T is the respective axis about which the case 2 rotates in the event that one of the wheel assemblies 7a or 7b departs from and lifts off the roll plane P, for example, after being pulled over a bump in the roll plane P.

The angle of the orientation axes X_1,X_2 relative to the roll plane P are each

different from the angle of the respective topple axis T relative to the roll plane P.

Referring again to figure 5 of the accompanying drawings, for ease of explanation, one topple axis T is shown to be substantially aligned with the underside of the case 2 at an angle β relative to the roll plane P.

The angle at which the wheel assemblies 7a,7b are mounted to the case 2 is selected to be different to the angle of their respective topple axis T. The difference between the angle of the orientation axis X_1,X_2 and the angle of the topple axis T relative to the roll plane P is indicated generally as angle α in figure 5. The angle of the orientation axes X_1,X_2 is selected so that, in use, each orientation axis X_1,X_2 is not substantially perpendicular or substantially parallel to the roll plane P.

For the purposes of simplicity, just the topple axis T which extends through the second support node N_2 of the second wheel assembly 7b will be described hereinafter. The discussion could, however, apply equally to the topple axis T which extends through the second support node N_2 of the first wheel assembly 7a.

The importance of the selection of the angle of the orientation axis X_1,X_2 when in use will now be described with reference to figure 6.

In use, when the case 2 is being pulled along, one of the wheel assemblies 7a may strike a bump (not shown) in the roll plane P which causes the case 2 to be subjected to an apparent transverse sheer force S. The sheer force S causes the first wheel assembly 7a to depart from and lift off the roll plane P. The loading between the two wheel assemblies 7a,7b becomes unevenly distributed and the case 2 starts to laterally rotate in a direction M_1 about the topple axis T of the more heavily laden wheel assembly 7b. As the case 2

rotates laterally, a rotational torque is generated between the outermost distal points of the wheel assembly 7b that are in contact with the roll plane P across the track width W of the wheel assembly 7b. The torque occurs because the track width W is substantially equal to or greater than the radius of the wheels, and because the wheel assembly 7b is mounted for rotation about the orientation axis X_2 which is different from the angle of the topple axis T relative to the roll plane P.

The torque which is generated across the track width W of the wheel assembly 7b causes the wheel assembly 7b to rotate about the orientation axis X_2 in a direction away from its normal orientation in a predefined arc M_2 to a position, as shown in figures 6 to 8. The length of the arc M_2 is proportional to the distance M_1 over which the first wheel assembly 7a rotates about the pivot of the second wheel assembly 7b.

The rotation of the wheel assembly 7b about the orientation axis X_2 away from the normal orientation in the arc M_2 causes a change in the roll direction of the wheel assembly 7b so that the case 2 undergoes a small sideways rolling displacement which counteracts the rotation of the case about the topple axis T. The sideways rolling displacement dampens at least part of the inertia experienced by the case 2 as the case 2 rotates about the topple axis T, thereby preventing the case 2 from tipping onto the edge of the outer wheel 13b. The case 2 is thus stabilised.

The stabilising effect of the wheel assemblies 7a,7b on the case 2 minimises lateral instability which can cause the case 2 to wobble or, in some instances, turn completely on its side. The case 2 is therefore easier to pull along at speed or transport over non-planar surfaces, such as uneven ground, steps, kerbs, etc.

In order to generate an orientation altering torque the orientation axis X_1,X_2 should be inclined in relation to the horizontal; the vertical; and the angle β. Therefore, the angle of the orientation axis X_1,X_2 should be set at an angle at least 1° greater or less than 90°, at least 1° greater or less than 0° and at least 1° greater or less than the angle β of the topple axis T. In this example of canted hand-wheeled luggage the topple axis T will generally fall in the region of 45° away from the horizontal. However, in practice the angle β will vary with the height of the user, hence the angle α should allow for this by ensuring that the overall angle of the orientation axis X_1,X_2, being the sum of the angle α and the angle β, be preferably less than 87°, more than 3° and at least 3° greater or less than β, and most preferably be less than 75°, more than 15° and at least 6° greater or less than β.

By a careful choice of the angle of the orientation axis X_1,X_2 combined with the ratio of the wheel assembly track width W to the radius R of the wheel it is possible to obtain the best compromise to reduce rolling instability for a vehicle having an overall track width, predetermined centre of mass, and a general speed of travel over a given terrain. In the example shown in figure 5, that of a hand-pulled trolley case, taking these factors into consideration, the preferred angle of the orientation axis X_1,X_2 is in the region of 63°, being the sum of the topple angle β of approximately 45° and the angle α, away from the topple axis T, of approximately 18°. The preferred track width W of each wheel assembly 7a,7b is in the region of twice the radius R of the wheel, as shown in figures 3 and 4.

Whilst the preferred embodiment described above incorporates two wheel assemblies 7a,7b, other embodiments of the invention incorporate more than two wheel assemblies.

Figure 9 shows a canted wheeled vehicle 20 of a further embodiment of the invention. The wheeled vehicle is another item of wheeled luggage; a

traditional hand pulled "wheelie" suitcase 20. It will be noted that although the topple axis angle β remains generally the same as that of the trolley case 2 of figure 5, the overall track width of the case is typically less than that of a trolley case. The topple axis T here is no longer coplanar with any side of the case but is instead defined by a chord drawn between the node N_1 at the middle of the side pull handle 6, and N_2 at the centre of the wheels. In this example the topple axis angle β is not defined by the cant angle of the case but incorporates the angle at which the case is canted as a component.

The preferred angle of the orientation axis X_1,X_2 for this case may be in the region of 55°, closer to β than the trolley case of figure 5. The topple axis T runs through the middle of the case and the load is more evenly distributed so that instability characteristics are different from the trolley case of figure 5. The wheelie suitcase of this further embodiment is most susceptible to a gradually increasing amplitude of lateral oscillation and not to the higher frequency rapid flip-over characteristic of the case of figure 5 and so, in practice, requires less sideways rolling displacement in order to address the sheer forces encountered.

It will of course be understood that in vehicles in which the topple axis T is not canted but is instead generally horizontal, the angle β will effectively be zero, and so the angle of the orientation axis X_1,X_2, will be one and the same as the angle α. Furthermore, in other embodiments the node N_1 may be at a lower elevation than that of N_2 so that the angle β will effectively be negative.

Referring now to figures 10 and 11 of the accompanying drawings, a yet further embodiment of the invention incorporates modified wheel assemblies 21 (only one of which is shown in figures 10 and 11). As with the other embodiments, the track width W of each of the wheel assemblies 21 is substantially equal to or greater than the wheel radius R.

Each wheel assembly 21 incorporates a mounting device 22 which is similar to the mounting devices 9a,9b which are described above, except that the mounting device 22 of this yet further embodiment of the invention incorporates an angled rotation point 23 which is angled for rotation about an axis which is not substantially parallel to the longitudinal axis of the mounting device 22. A locking arrangement 24 which incorporates a moveable locking pendulum 25 is fixed to one side of a middle section of the mounting device 22. A second rotation point 26 is provided on the mounting device 22 beneath the pendulum arrangement 24. A locking notch 27 is provided on the mounting device 22 beneath the second rotation point 26.

This yet further embodiment may incorporate an optional link element between the middle sections 22 of each of the wheel assemblies 21 which is equivalent to the link element 15 of the preferred embodiment described above.

In use, when the wheel assembly 21 is upright and in an uncanted position, as shown in figure 10, the wheels 28 of the wheel assembly 21 are free to rotate about the second rotation point 26 about an orientation axis which is substantially parallel with the longitudinal axis of the mounting device 22.

When the vehicle to which the wheel assembly 21 is mounted is canted, the wheel assembly 21 rotates upwards to allow the vehicle to obtain its lowest gravitational potential, as is conventional with “spinner” luggage of this kind. As the vehicle is canted, the locking pendulum 25 moves under gravity into the thereby aligned locking notch 27, as shown in figure 11. The locking arrangement 24 prevents the wheels 28 from rotating about the rotation point 26. The wheels 28 instead rotate about the angled rotation point 23 which causes the wheels to rotate about an orientation axis X_1,X_2 which is different from the angle of the topple axis T. This further embodiment therefore allows the wheel assembly 21 to function as a conventional trailing wheeled swivel

castor when the vehicle is in an upright position, but then to function as a stabilising arrangement when the vehicle is canted.

Referring now to figure 12 of the accompanying drawings, a further embodiment of the invention is a wheeled vehicle in the form of a spinner case 29. The spinner case 29 is provided with four trailing wheeled swivel castor assemblies 30,31 at the four corners of its base. The castors 30,31 are each free to rotate about an axis which is parallel to the longitudinal axis of the spinner case 29. The spinner case can therefore be rolled along on all four castors 30,31 by the extender handle 6.

The two castors 31 which are disposed to remain upon the roll plane P as the case is canted by the extender handle 6, are connected to a movement mechanism 32. The movement mechanism 32 incorporates a series of linked pivot rods 33 which are connected to the castors 31. When the spinner case 29 is canted in the direction indicated generally by arrow 34 in figure 13, the movement arrangement 32 moves the rods upwards, as indicated generally by arrow 35, and rearwards, as indicated generally by arrow 36. The movement of the rods 33 changes the angle at which the castors 31 are attached to the spinner case 29 so that the castors 31 rotate about an orientation axes X_1,X_2 which is different from the topple axis T. The canted castors 31 each have a track width W which is substantially equal to or greater than their wheel radius R so that a torque is generated across the track width W of the castors 31 to rotate a castor 31 in contact with the roll plane P in the event that vehicle instability occurs. The castors 31 thus provide a stabilising effect to the spinner case 29 when the spinner case 29 is canted, in the manner described above.

This further embodiment may incorporate an optional link element (not shown) that engages between the castors 31 when the spinner case 29 is canted which is equivalent to the link element 15 of the preferred embodiment

described above.

Referring now to figure 14 of the accompanying drawings, in a further embodiment of the invention, the wheeled vehicle is in the form of a demountable trailer 37. The trailer 37 incorporates a tow bar 38 which is provided with a tow point 39. The trailer 37 is supported at the tow point 39 when the trailer 37 is in use and so the first support node N_1 is positioned on the tow point 39.

For simplicity, the first support node N_1 is treated here as having the same elevation as the second support node N_2.

The trailer 37 incorporates a front pair of wheel assemblies 40 and a rear pair of wheel assemblies 41. The trailer is configured as a four-wheeled vehicle. Each wheel assembly may incorporate one or more than one wheel. For simplicity, the description hereinafter will refer only to the front and rear wheel assemblies 40,41 on the right side of the trailer 37, as shown in figure 14. The wheel or wheels of each wheel assembly 40,41 is attached rotatably to a mounting device (not shown) for rotation about a respective roll axis. Each mounting device is mounted at an angle to the trailer 37 for rotation relative to the trailer 37 about respective front and rear orientation axes X_1 and X_2.

The front and rear wheel assemblies 40,41 each have different imaginary topple axes T_1,T_2 at the front and rear which intersect second support nodes N_2 at each wheel assembly 40,41 and the first support node N_1. The orientation axes X_1,X_2 are different from the topple axes T_1,T_2 by angles indicated generally as α_1 and α_2. The difference between the orientation axes X_1,X_2 and the topple axes T_1,T_2, coupled with the fact that the wheel assemblies 40,41 each have a track width W which is substantially equal to or greater than their wheel radius R, means that the wheel assemblies 40,41 rotate away from their normal orientation to provide a stabilising effect which

counteracts rotation M_1 of the trailer 37 about the topple axes T_1,T_2.

Whilst the further embodiment described above incorporates two pairs of wheel assemblies 40,41, other trailer embodiments of the invention may incorporate one pair of wheel assemblies or more than two pairs of wheel assemblies.

Referring now to figure 15 of the accompanying drawings, in a yet further embodiment of the invention, the wheeled vehicle is a three-wheeled vehicle, such as a sand yacht 42 which incorporates a front wheel assembly 43 and two spaced apart rear wheel assemblies 44. The term "three-wheeled vehicle" is intended to mean a vehicle such as a tricycle which has three spaced apart wheel assemblies with wheels that contact the roll plane. Each wheel assembly in the three-wheeled vehicle may incorporate one or more than one wheel.

In this further embodiment, the first support node N_1 is defined at the point at which the destabilised front wheel assembly 43 of the sand yacht 42 contacts the roll plane. The two rear wheel assemblies 44 each incorporate a pair of wheels which are rotatably attached to a respective mounting device. Each mounting device is mounted rotatably at an angle to the sand yacht 42 for rotation about an orientation axis X. For simplicity purposes, only the orientation axis X of the right rear wheel assembly 44 will be described hereinafter.

A topple axis T is an imaginary axis which passes through the first support node N_1, and through the second support nodes N_2 that are defined substantially at the centre of each of the rear wheel assemblies 44. The first support node N_1 is below the second support node N_2 when the yacht 42 is in use.

In use, the effective angle of the orientation axis X relative to the roll plane P differs from the angle of the topple axis T relative to the roll plane P by an angle α minus an angle β. The different α between the orientation axis X and the topple axis T, coupled with the fact that the rear wheel assemblies 44 each have a track width W which is substantially equal to or greater than their wheel radius R, means that a rotational torque is generated on the rear wheel assembly 44 about the orientation axis X when instability occurs. The rear wheel assembly 44 therefore rotates away from its normal orientation to counteract rotation M_1 about the topple axis T to stabilise the sand yacht 42, when in use.

Referring now to figure 16 of the accompanying drawings, in a further embodiment of the invention, the wheeled vehicle is a four-wheeled configuration heavy goods lorry 45. Each of the wheel assemblies may incorporate one or more than one wheel. For simplicity, only the right wheel assemblies 46,47 as shown in figure 16 will be described hereinafter. A first support node N_1 is defined at the point at which the front wheel assembly 47 of the lorry 45 contacts the ground. A topple axis T intersects the first support node N_1, and the second support node N_2 which is located substantially at the centre of the rear wheel assembly 46.

The angle of the orientation axis X relative to the roll plane P is different from the angle of the topple axis T. The difference in the angle α, coupled with the fact that the rear wheel assembly 46 has a track width W which is substantially equal to or greater than its wheel radius R means that the rear wheel assembly 46 undergoes a torque to rotate the wheel assembly 46 about the orientation axis X away from its normal orientation to counteract rotational movement M_1 of the lorry 45 about the topple axis T to stabilise the lorry 45.

Referring now to figure 17 of the accompanying drawings, in a still further

embodiment of the invention, the wheeled vehicle is an articulated lorry 48 or heavy goods vehicle (HGV) which incorporates a front drive part 49 and an articulated trailer 50. The articulated lorry 48 is a multi-wheeled vehicle. The trailer 50 incorporates at least two spaced apart rear wheel assemblies 51 which each comprise two wheels that are attached rotatably to respective mounting devices (not shown). The mounting devices are each rotatably mounted at an angle to the trailer 50 to rotate about a respective orientation axis X. Referring again to the wheel assemblies on the right side of the vehicle, a topple axis T is defined between a support node N_1 where the rearmost wheel 52 of the front drive part 49 contacts the roll plane P and second a support node N_2 which is located substantially at the centre of the rear wheel assembly 51.

The angle of the orientation axis X relative to the roll plane P is different from the angle of the topple axis T. The difference in the angle α, coupled with the fact that the rear wheel assembly 51 has a track width W which is substantially equal to or greater than its wheel radius R creates a torque in the rear wheel assembly 51 which rotates the wheel assembly 51 about the orientation axis X away from its normal orientation to counteract rotation M_1 about the topple axis T to stabilise the trailer 50.

Whilst the embodiments described thusfar have been wheeled vehicles which are pulled along when in use, in other embodiments of the invention the wheeled vehicle takes the form of a vehicle which is pushed, such as a trolley, the front part of a forklift truck or a push cart.

In other embodiments of the invention, the or each wheel assembly incorporates a suspension system and/or a passive steering arrangement. Further embodiments may incorporate a mechanism to only enable the stabilisation features in response to an emergency situation. For instance, embodiments of the invention may incorporate electro-mechanical means to

activate the stabilisation features when the vehicle becomes sufficiently destabilised. For example, the stabilisation features may be activated in response to a signal from an accelerometer which is indicative of an emergency situation. Upon activation, a hydraulic release mechanism can be activated to release the appropriate wheel assembly of the vehicle from a fixed configuration to a rotatable configuration in which the wheel assembly can rotate about its orientation axis.

In further embodiments of the invention, the or each wheel assembly is adjustable so that the orientation axis at which the wheel assembly is mounted can be adjusted manually or automatically to a desired angle.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

Claims:

1. A wheeled vehicle incorporating:

first and second wheel assemblies which are provided respectively at spaced apart positions on the vehicle, each wheel assembly comprising:

a mounting device which is mounted rotatably to the vehicle for rotation relative to the vehicle about an orientation axis; and

at least one wheel which is attached rotatably to the mounting device for rotation about a roll axis, the or each wheel having a radius, each wheel assembly having a track width which is substantially equal to or greater than the radius,

wherein the roll axes of the first and second wheel assemblies are substantially parallel and co-axially aligned with one another in a normal orientation when the vehicle travels over a roll plane in a stable condition, and

if the vehicle becomes unstable when in use such that one of the wheel assemblies departs from the roll plane, a rotational torque is generated across the track width of the other wheel assembly in contact with the roll plane to cause that said other wheel assembly to rotate about its orientation axis in a direction away from its normal orientation to stabilise the vehicle.

2. A wheeled vehicle according to claim 1, wherein the vehicle incorporates at least one first support node at which a part of the vehicle is supported relative to the roll plane when the vehicle is in use, the at least one first support node being distal to the first and second wheel assemblies.

3. A wheeled vehicle according to claim 2, wherein a point at or near the centre of each of the wheel assemblies defines a respective second support node, an imaginary topple axis being defined between the at least one first support node and the or each respective second support node, the angle of the orientation axis of each of the wheel assemblies being selected to be

different from the angle of the topple axis of the corresponding wheel assembly.

4. A wheeled vehicle according to claim 2 or claim 3, wherein the orientation axis is not parallel to the roll plane, when the vehicle is in use.

5. A wheeled vehicle according to claim 2 or claim 3, wherein the orientation axis is not perpendicular to the roll plane, when the vehicle is in use.

6. A wheeled vehicle according to any one of the preceding claims, wherein one end of a link member is attached to the mounting device of the first wheel assembly and the other end of the link member is attached to the mounting device of the second wheel assembly such that rotation of one wheel assembly about its orientation axis moves the link member to drive the mounting device of the other wheel assembly to rotate about its respective orientation axis.

7. A wheeled vehicle according to any one of the preceding claims, wherein the arrangement further comprises a biasing member which biases at least one of the wheel assemblies towards the normal orientation.

8. A wheeled vehicle according to any one of the preceding claims, wherein the or each mounting device is an elongate shaft which incorporates a first part and a second part which are rotatably mounted to one another at a first rotation point for rotation relative to one another about a first axis which is substantially parallel with the longitudinal axis of the shaft.

9. A wheeled vehicle according to claim 8, wherein the or each mounting device incorporates a third part which is positioned between the first and second parts, one end of the third part being connected to the first part at the

first rotation point and the other end of the third part being connected to the second part at a second rotation point, the second rotation point mounting the second and third parts for rotation relative to one another about a second axis which is not substantially parallel to the longitudinal axis of the shaft.

10. A wheeled vehicle according to claim 9, wherein the or each mounting device incorporates a locking arrangement which is configured to prevent the first part and the third part from rotating relative to one another.

11. A wheeled vehicle according to claim 8, wherein the vehicle is provided with a mechanism to change the angle of the shaft of the or each mounting device relative to the vehicle when the vehicle is canted relative to the roll plane.

12. A wheeled vehicle according to any one of the preceding claims, wherein the or each wheel assembly is provided with a blocking arrangement to block rotation of the wheel assembly about the orientation axis to prevent the wheel assembly from rotating further than a predetermined angle.

13. A wheeled vehicle according to any one of the preceding claims, wherein the vehicle is a case.

14. A wheeled vehicle according to claim 13 as dependent on claim 2, wherein the case incorporates a handle to be held by a user to allow the user to pull the case along a roll plane, the at least one first support node being positioned on the handle.

15. A wheeled vehicle according to claim 14, wherein the handle is mounted to at least one moveable extension element.

16. A wheeled vehicle according to any one of the preceding claims,

wherein the wheeled vehicle is a vehicle which is configured to be pushed when in use.

17. A wheeled vehicle according to any one of claims 1 to 12, wherein the vehicle is a trailer.

18. A wheeled vehicle according to claim 17, wherein the trailer is the trailer of a heavy goods vehicle.

19. A wheeled vehicle according to any one claims 1 to 12, wherein the vehicle is a three-wheeled vehicle.

20. A wheeled vehicle according to claim 19, wherein the three-wheeled vehicle is a sand yacht.

21. A wheeled vehicle according to any one of claims 1 to 12, wherein the vehicle is configured as a four-wheeled vehicle.

22. A wheeled vehicle according to any one of claims 1 to 12, wherein the vehicle is a multi-wheeled vehicle.

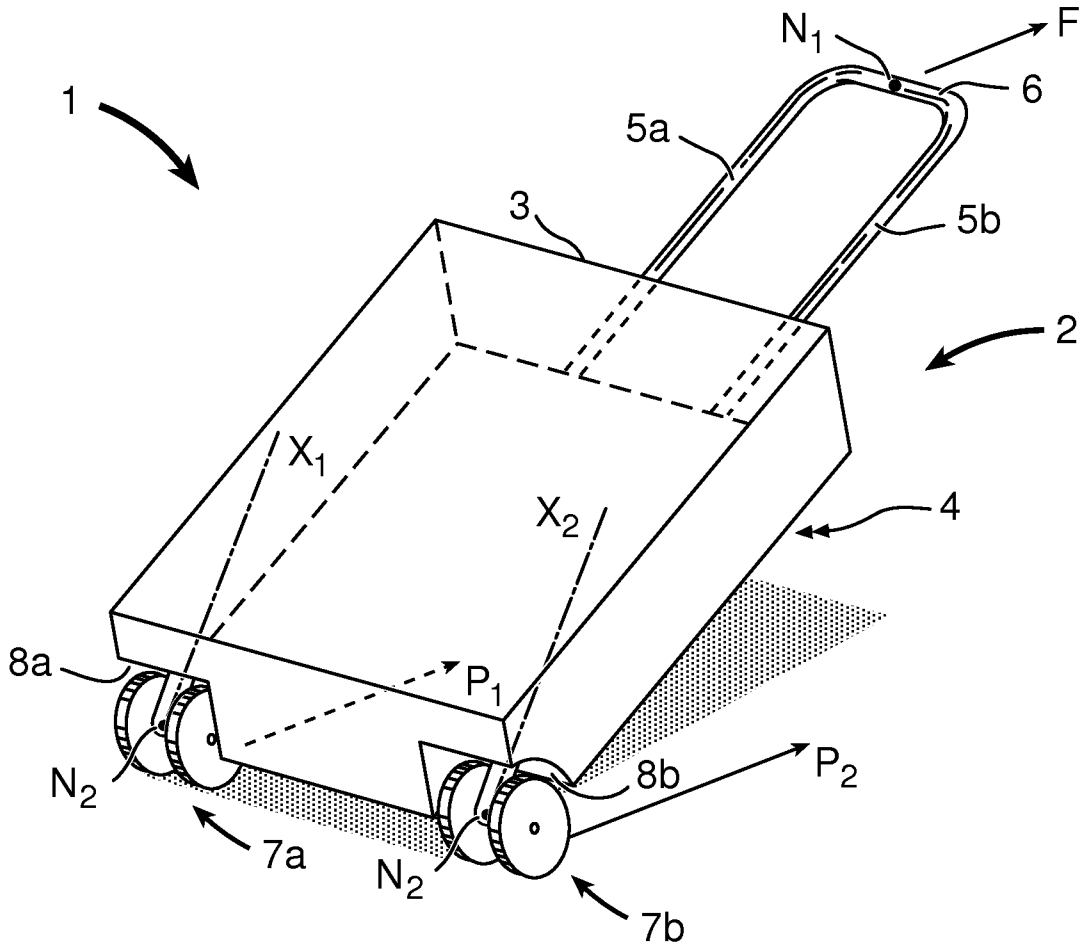

Figure 1

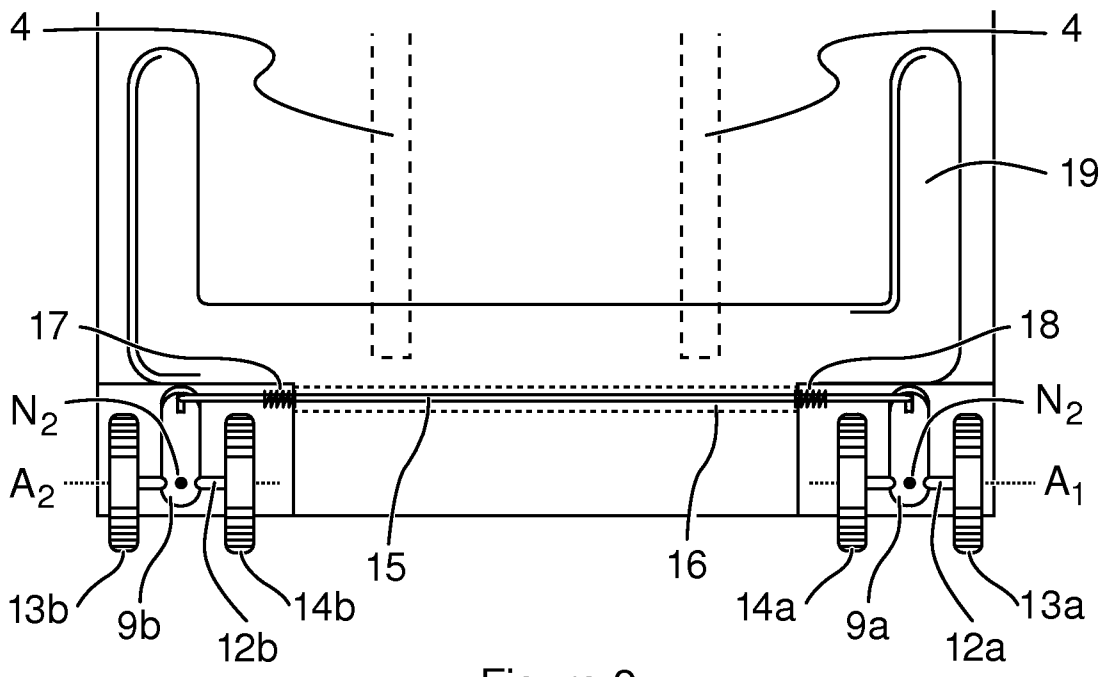

Figure 2

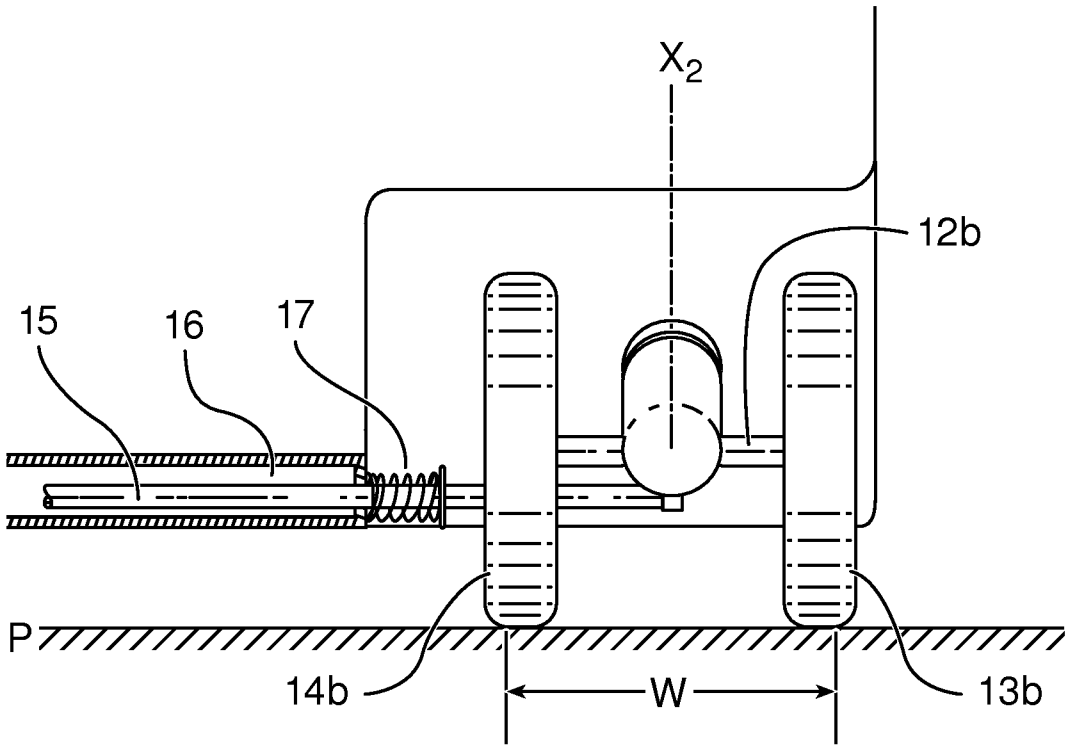

Figure 3

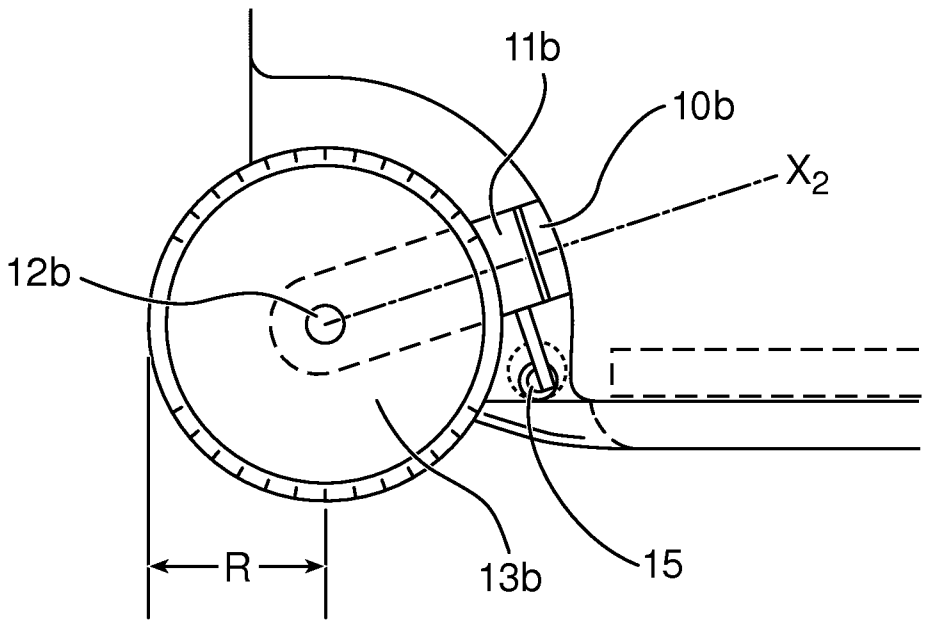

Figure 4

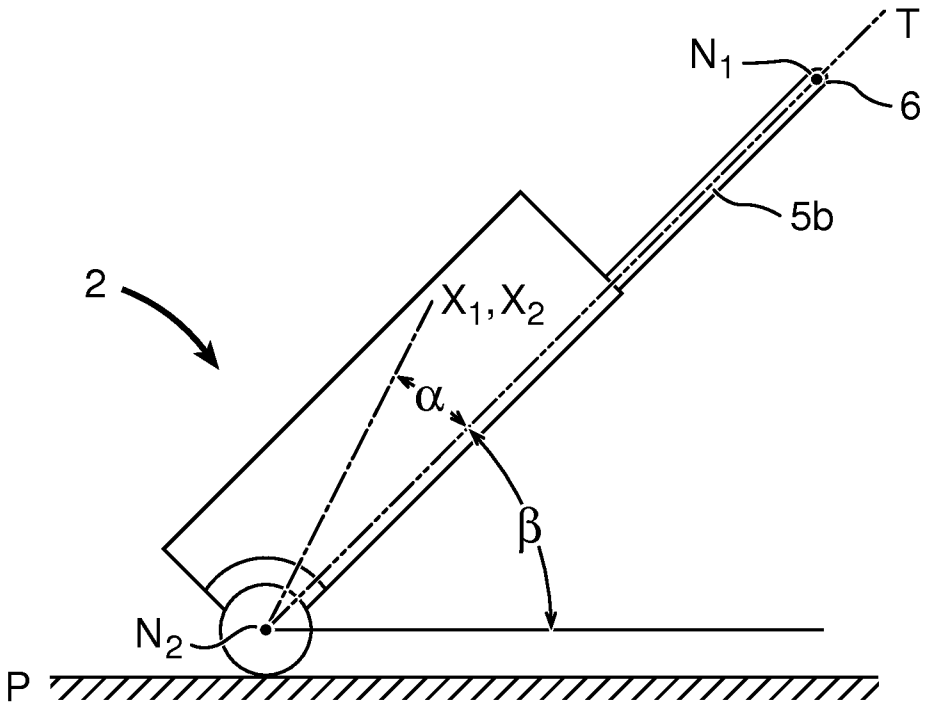

Figure 5

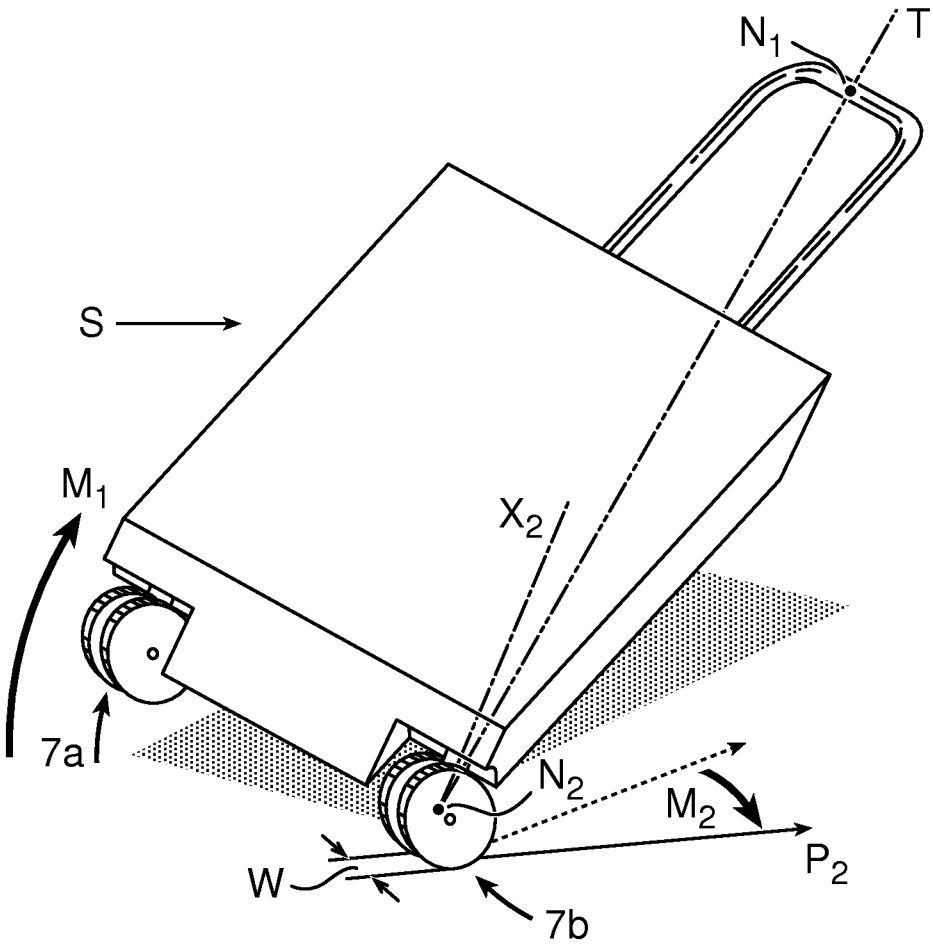

Figure 6

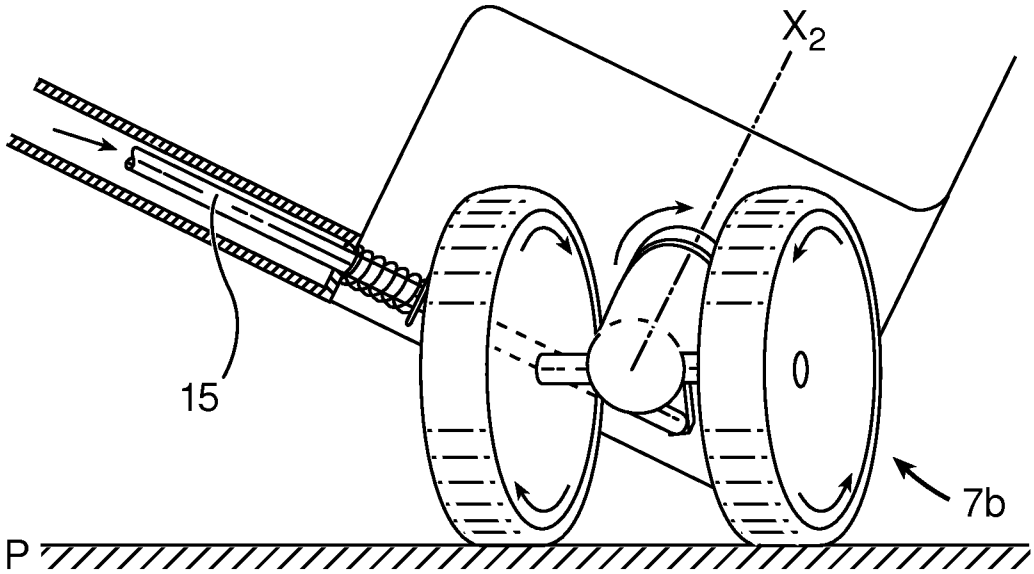

Figure 7

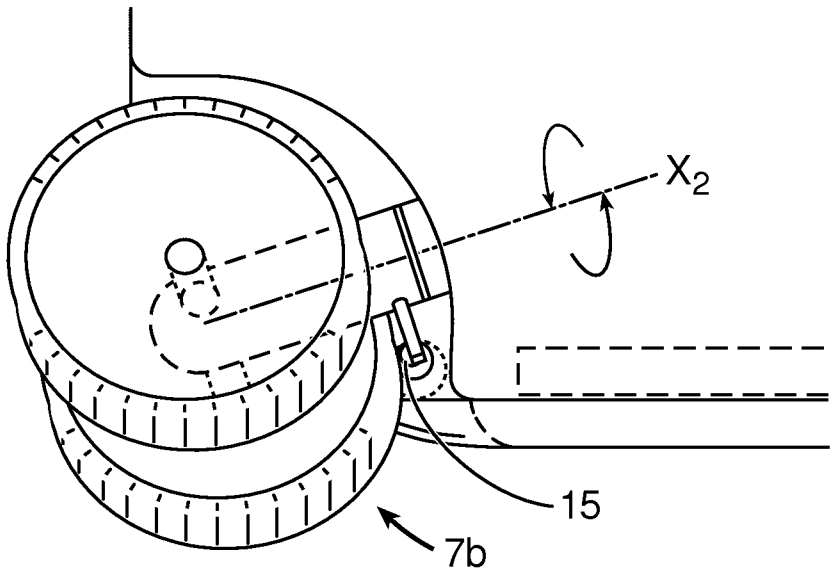

Figure 8

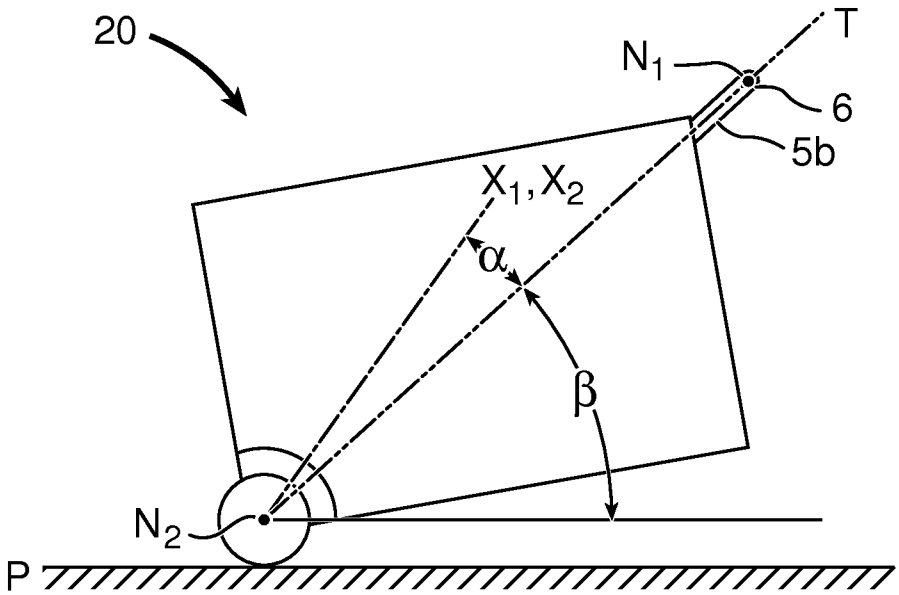

Figure 9

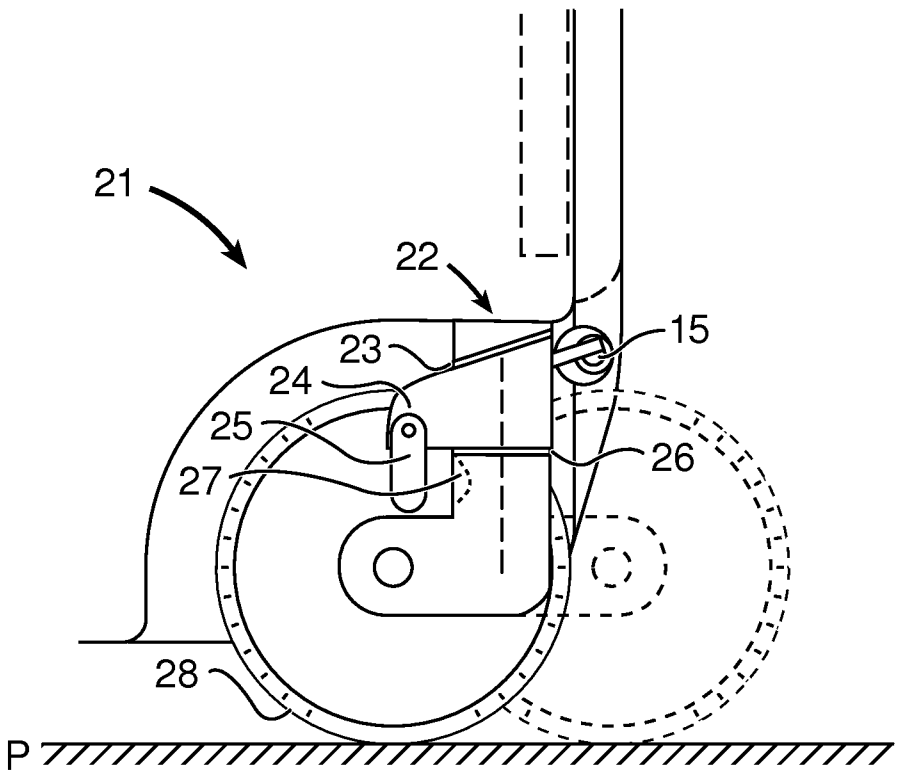

Figure 10

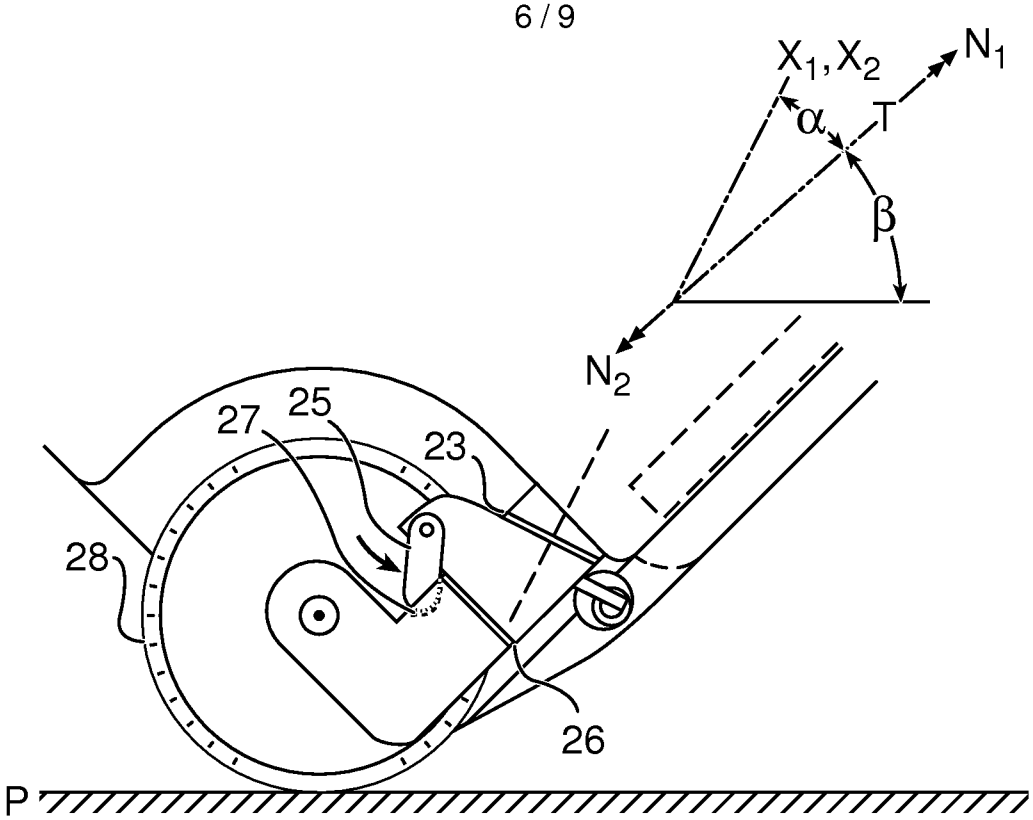

Figure 11

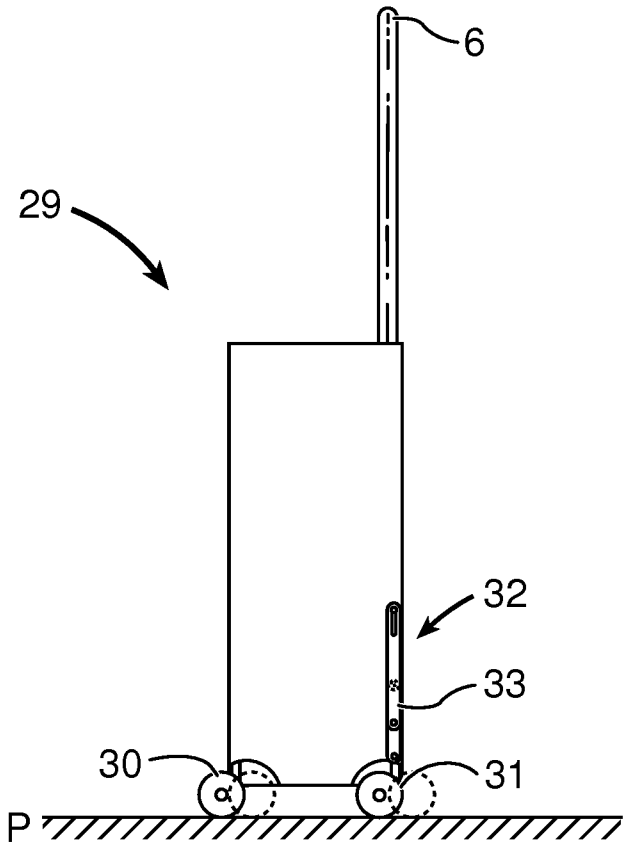

Figure 12

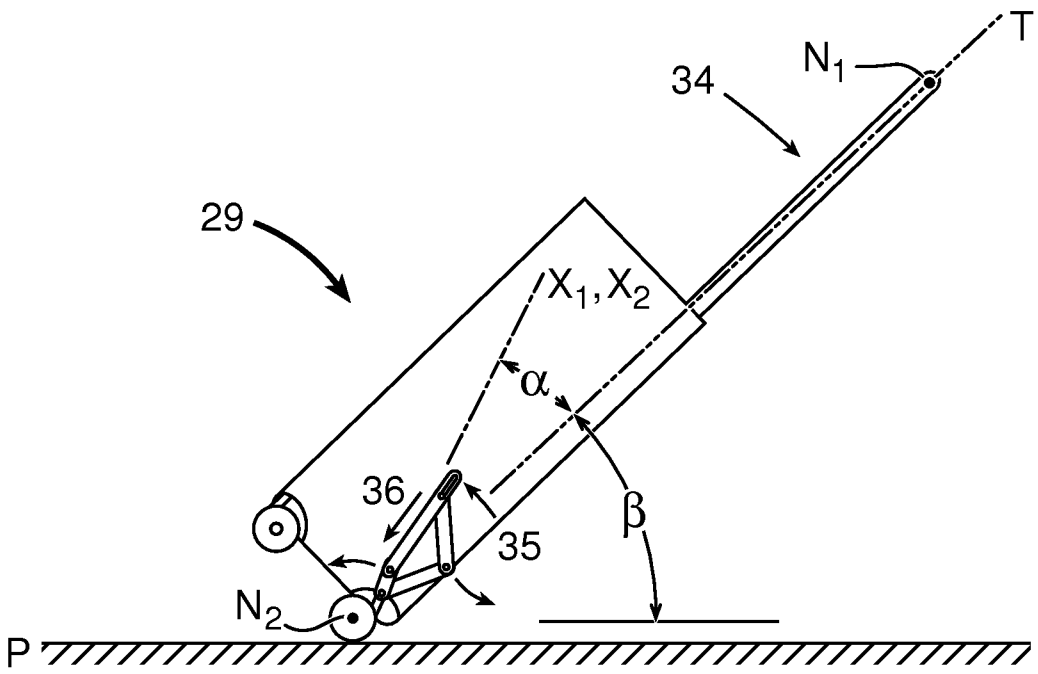

Figure 13

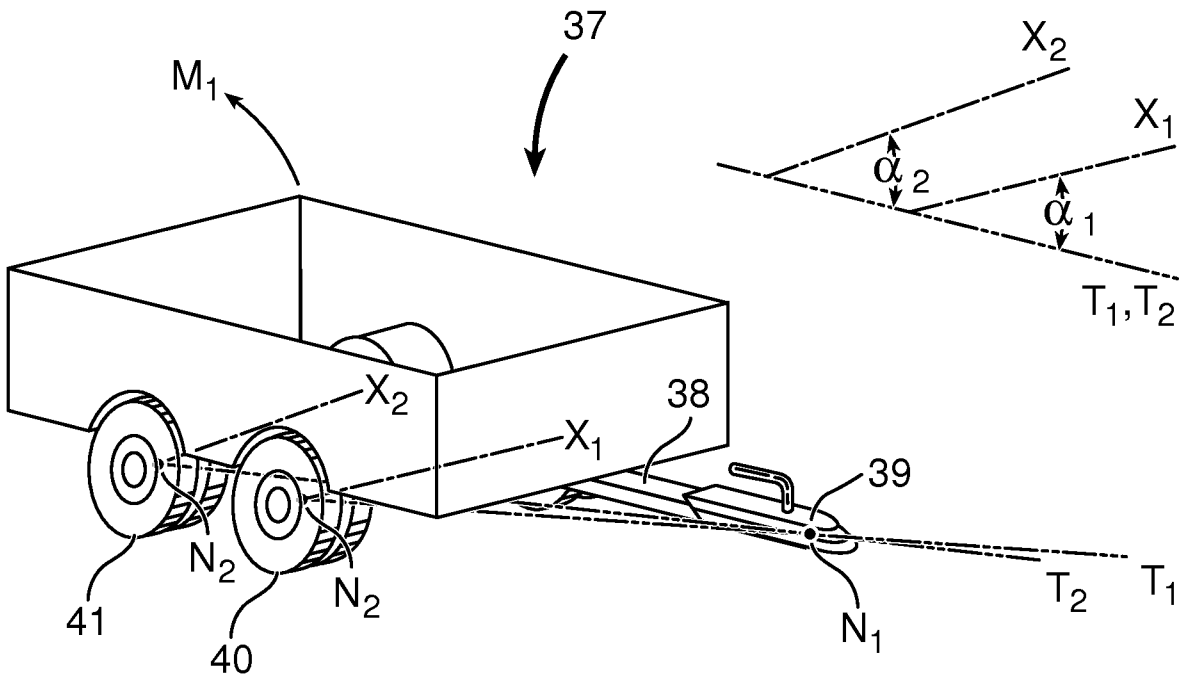

Figure 14

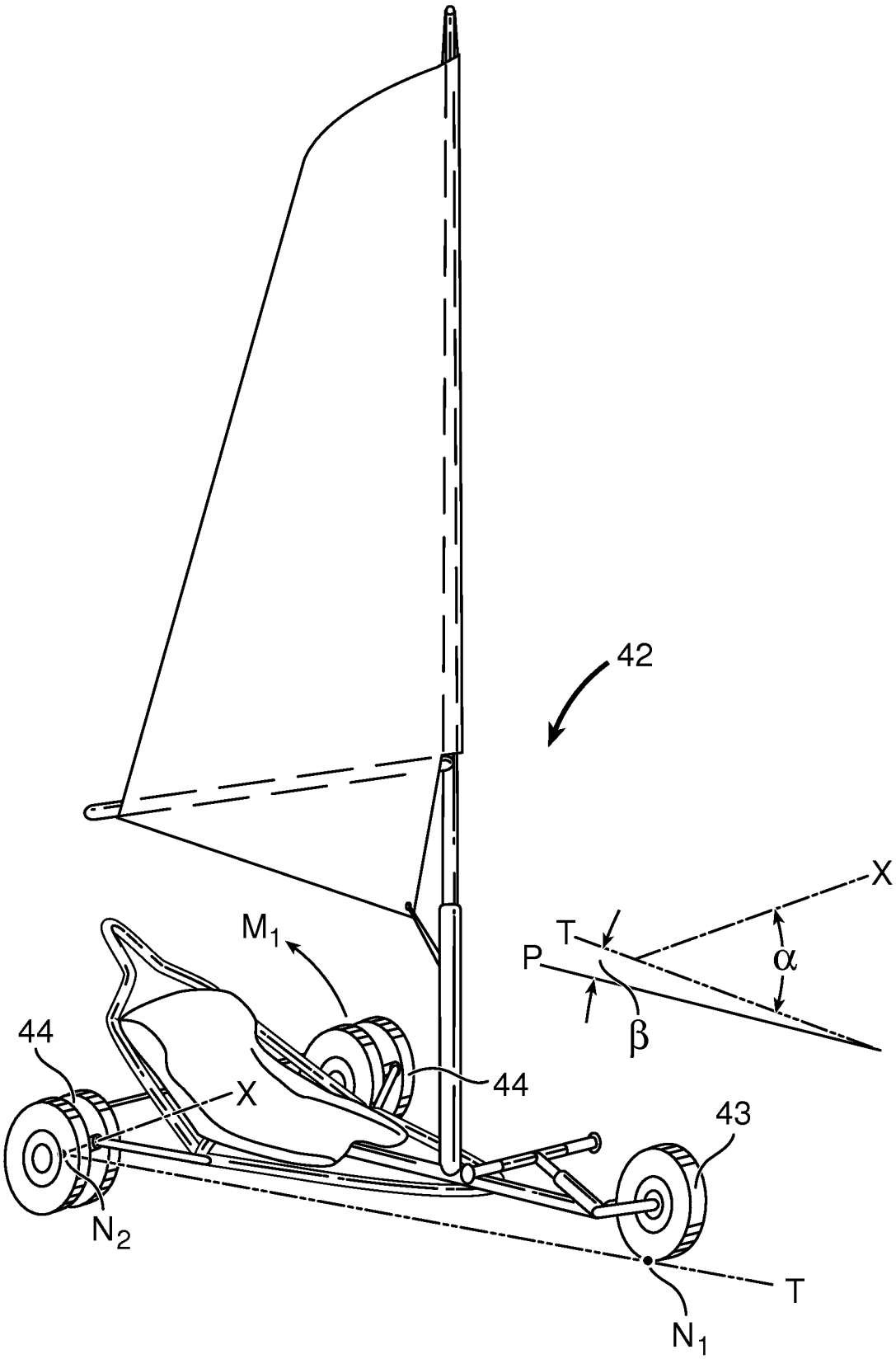

Figure 15

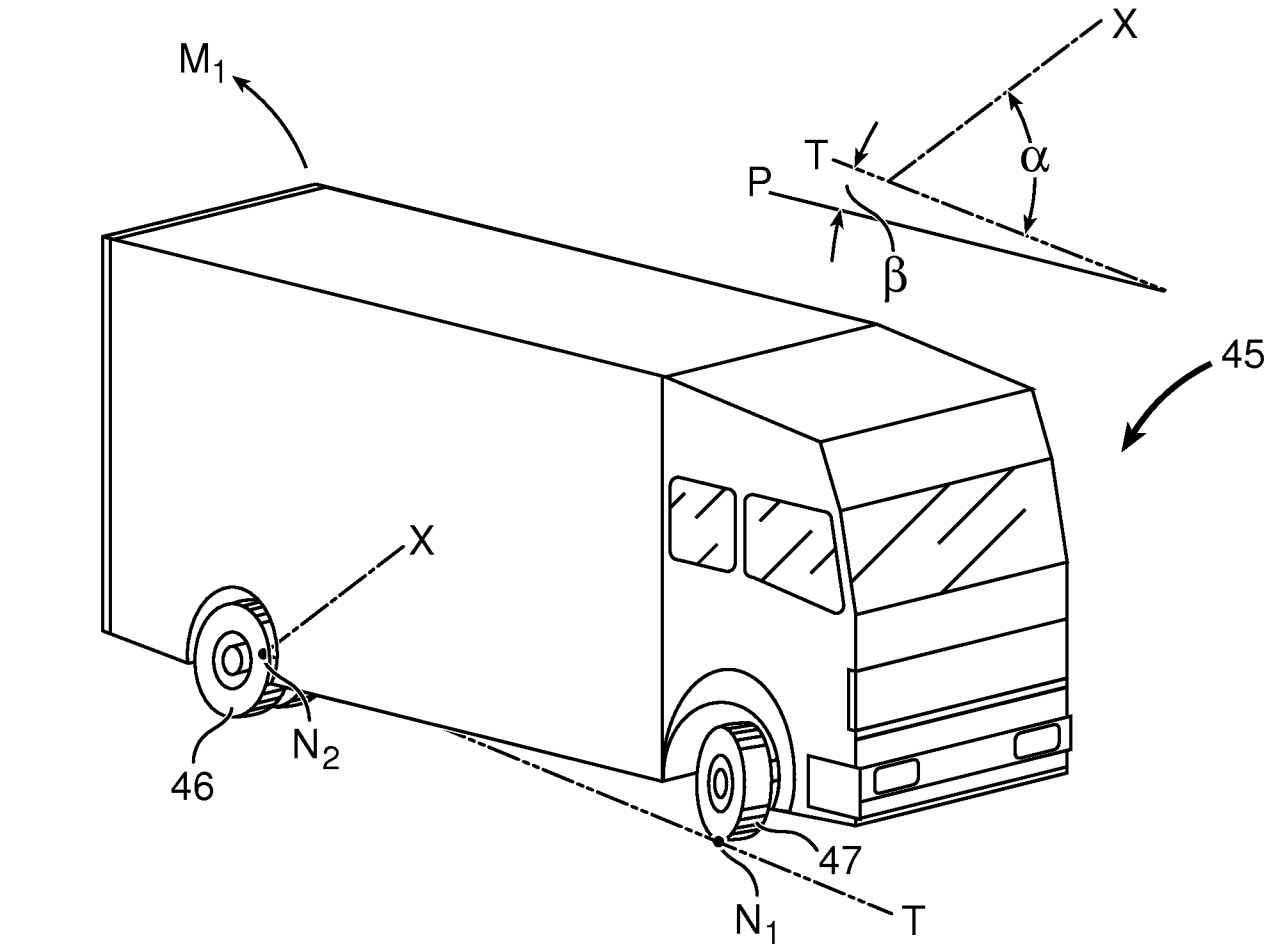

Figure 16

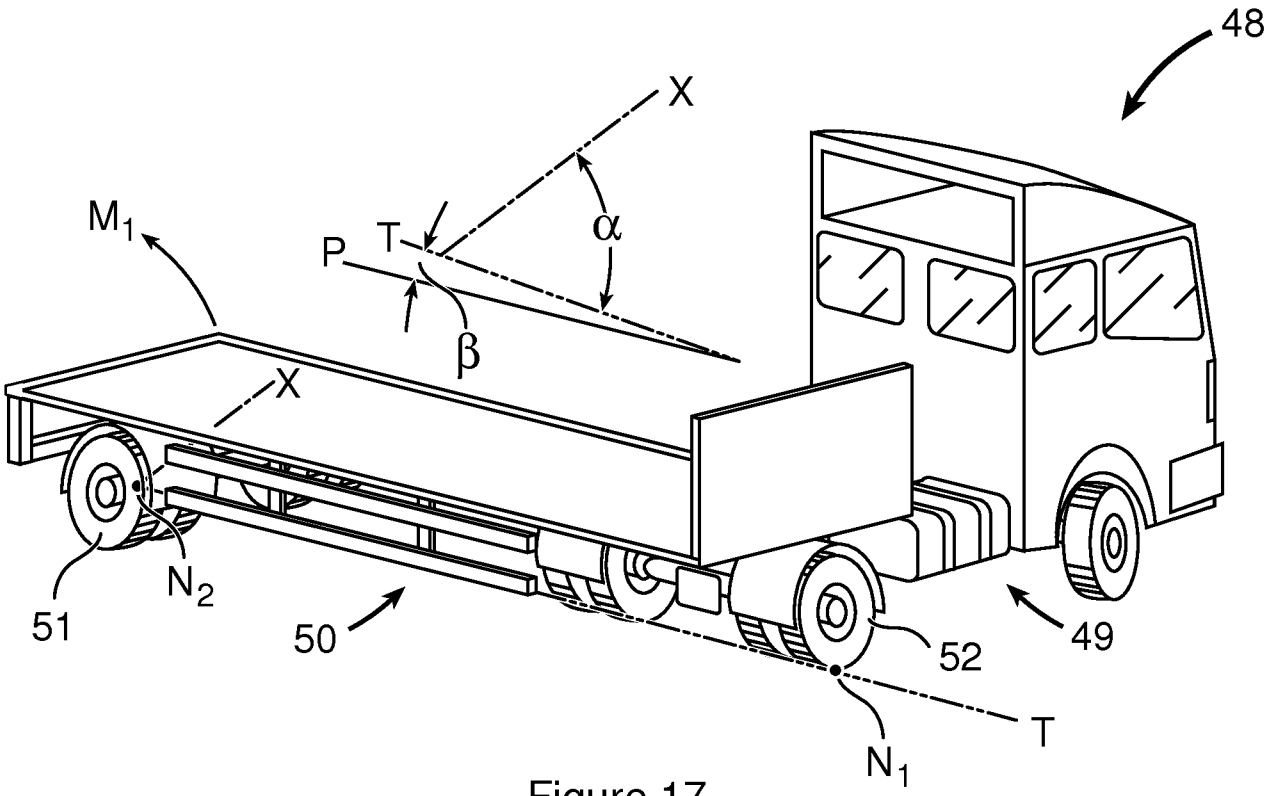

Figure 17