A wheel-chair-like stair-climbing vehicle having a pair of main tracks and a pair of auxiliary tracks hinged in front thereof, an automatic (partly and preferably hydraulic) pitch control mechanism controlling the rate of relative rotation between the main and auxiliary tracks, and a self-leveling seat.
The present invention relates to vehicles particularly adapted for use by a physically handicapped person in ascending and descending stairs (in addition to normal horizontal travel), preferably being self-propelled; although more broadly being capable of transporting a wide variety of loads with or without the assistance of an attendant.

For generations there has been a recognized need for an economically feasible and commercially practical substitute for the common wheel chair, which would at least substantially maintain the desirable attributes of a modern day wheel chair and yet have the added capability of permitting the occupant to traverse the stairs and similar inclined obstructions typically encountered in everyday living.

The search for a vehicle having the foregoing capabilities was given added impetus over a decade ago when the National Inventors Council (now called the Office of Invention and Innovation, National Bureau of Standards, Department of Commerce) sponsored a $5,000 contest for development of such a device.

U.S. Pat. No. 3,276,531, patented Oct. 4, 1966, is an example of the best of the prior art which resulted, and also gives a good summary of the drawbacks of previous prior art as well as a summary of many of the objectives of the present invention (which are hereby incorporated by reference).

In spite of the many solutions proposed by the prior art, there has never resulted to this day a commercially acceptable (nor available) vehicle of this type. Applicant, drawing on personal experience, has discovered and focused upon many major reasons probably responsible for the unacceptability of any of the prior art. The device should be easily operated, i.e. not require any "driving skill" or specialized coordination (particularly since it is primarily intended for persons already having some degree of physical handicap). Secondly, it must give a strong sense, as well as the actuality, of security when in use upon the stairs. Further objectives of this invention are therefore the satisfaction of these two additional criteria. An added sense of control and security is given to the occupant of the vehicle if the ascent and descent are accomplished facing in the direction of travel and in the normal upright sitting position. Furthermore, the transition from the horizontal to the incline of the stairs should be accomplished smoothly and with controlled and automatic simplicity, the accomplishment of which yield still further and major objectives of the present invention.

According to a preferred embodiment of the present invention, these and other objectives (which shall become self-evident in the following discussion) are accomplished by a vehicle having a pair of horizontal main tracks on which is supported a self-leveling seat and to the front of which is pivotally articulated a pair of respective auxiliary tracks. Each main track and its corresponding auxiliary track are pivotally restricted by a pitch-control hydraulic cylinder. An advantage of this pitch-control means is that it can smooth the transition of the vehicle between the horizontal and inclined travel positions by preventing any abrupt change in the angle between the auxiliary and the main tracks. However, the principal and necessary feature of this pair of pitch-control hydraulic cylinders is in at least automatically preventing the vehicle from pitching forward at the top of the stairs in either direction during the transition between the horizontal and the inclined orientation, as the center of gravity of this vehicle passes over the top tread of the stair. The operation of this significant feature (and alternative thereof) will be more fully discussed below. The effectiveness of this and other features described herein have been fully proven by the construction and use of an actual prototype.

Another major feature of the present invention is the self-leveling seat, preferably motorized to be automatic, whereby the occupant is at all times maintained in an upright forward-facing seated position. This not only gives a greater sense of security, but also affords a proper and more normal clear view of the forward progress.

In the preferred embodiment, the vehicle for simplicity is propelled by crank arms through chain and sprocket drives, with one set for independently driving each of the main tracks. Where the strength or handicap of the occupant is such that this is impractical or is otherwise not desired, a motorized substitute propulsion means may be utilized.

Although the broader aspects of my original leveling seat concept has been partially subsequently disclosed in U.S. Pat. No. 3,288,234, issued Nov. 29, 1966; my subsequent tests have also demonstrated that the patentee's disclosed automatic self-leveling mechanism is effectively inoperative; resulting in rapidly failing batteries or burned-out motors. I have ultimately determined that the probable cause of the failure of the prior art design is due to the mercury switches which cause (a) continuously occurring rapid start-stop opposing adjustments (very hard on the motor and demanding of electricity), (b) inaccurate leveling adjustments due to "slashing" of the mercury caused by the motion of travel, and (c) similarly caused short-circuiting or overloading when both mercury switches would be in the "on" mode simultaneously. Accordingly, in an improvement of this aspect of the present invention, the self-leveling mechanism incorporates a dampened level sensor.

A more simplistic alternative, not taught by any of the prior art known to applicant, is to have the seat mounted on gimbals to thereby be kept level by the weight of the occupant. The seat pivot would preferably be dampered, to prevent undue swinging during transition and to increase the occupant's sense of security, and further may have a lock mechanism for the chair during the actual horizontal or inclined travel.

A further feature of the present invention includes fail-safe mechanisms automatically operative for both the ascending and descending mode. The ascending automatic fail-safe is preferably a gravity operated device working on a ratchet principal to allow the gripping cleats of the endless tread of the main track to pass by the fail-safe as the vehicle ascends, but to jam and hold the main track against operating in the reverse direction, unless purposely swung into the inoperative position. Gravity also acts to swing this latter fail-safe into the inoperative position upon horizontal or descending travel.

The descending fail-safe is preferably a friction clutch which is gravity actuated to swing into operative position when the vehicle is inclined in the descending attitude. Preferably the friction clutch is adjusted to hold the vehicle motionless in the descending position and to require a positive, though comparatively mini-
nmal, effort from the propulsion system to overcome the resistance of this friction fail-safe.

In this specification and the accompanying drawings I have shown and described a preferred embodiment of my invention and have suggested various alternatives and modifications thereof; but it is to be understood that these are not intended to be exhaustive and that many other changes and modifications can be made within the scope of the invention. These suggestions herein are selected and included for purposes of illustration in order that others skilled in the art will more fully understand the invention and the principles thereof and will thus be enabled to modify it and embody it in a variety of forms, each as may be best suited to the conditions of a particular use.

In the accompanying drawings:

FIG. 1 shows parallel perspective view of a preferred embodiment according to the present invention, adjusted for normal horizontal travel;

FIG. 2 is a partially schematic side elevation of the vehicle shown in FIG. 1, adjusted for normal horizontal travel;

FIG. 3 is a view similar to FIG. 2 illustrating the vehicle in the operative position for inclined travel just prior to descending a flight of stairs;

FIG. 4 is a view similar to FIG. 2 illustrating the vehicle in the initial stages of effecting the transition from the horizontal to inclined travel;

FIG. 5 is a view similar to FIG. 2 illustrating the vehicle at the stage of descent where the center of gravity of the vehicle has passed beyond the top riser of the stair case and the vehicle is in automatically controlled transition to having its tracks assume the angle of inclination of the stairs;

FIG. 6 is a view similar to FIG. 2 illustrating inclined travel down a staircase;

FIG. 7 is a view similar to FIG. 2 illustrating a typical arrival at the base of the stairs;

FIG. 8 is a view similar to FIG. 2 illustrating the vehicle in the initial stages of climbing a staircase;

FIG. 9 is a view similar to FIG. 2 illustrating the vehicle climbing at the top of a staircase and the initial stage of transition between inclined and horizontal travel;

FIG. 10 is a view similar to FIG. 2 illustrating the vehicle climbing towards the horizontal at the top of a staircase just prior to the center of gravity thereof passing over the top riser;

FIG. 11 is a view similar to FIG. 2 illustrating the vehicle having ascended a staircase and being in the final stage of transition to the horizontal;

FIG. 12a is an enlarged schematic detail of the down fail-safe in inoperative position;

FIG. 12b is an enlarged schematic detail of the down fail-safe in operative position;

FIG. 13a is an enlarged detail schematic of the up fail-safe inoperative position;

FIG. 13b is an enlarged schematic detail of the down fail-safe in the operative position;

FIG. 14a is a side elevation detail of the elbow linkage locating the auxiliary track in the raised inoperative position;

FIG. 14b is a view similar to FIG. 14a but with the elbow linkage locked in the lowered operative position for the auxiliary track;

FIG. 14c is a view similar to FIG. 14a but with the elbow linkage locked in the lowered position and with the pitch-control hydraulic cylinder extended;

FIG. 15 is a schematic parallel perspective view of the dampened seat levelling mechanism;

FIG. 16 is schematic wiring diagram of a modified embodiment of the device illustrated in FIG. 15; and FIG. 17 is view similar to FIG. 2 of an embodiment with modified tracks.

In the foregoing drawings, shading has been indicated by spaced lines parallel to the principal axes of the element being illustrated, with sectioning being indicated by lines diagonal thereto.

Referring to FIG. 1 there is illustrated as a preferred embodiment a vehicle 20 with two main tracks 22, each having sprockets 24 and 26 with endless traction belts 28 extending therebetween. These traction belts are preferably made from commercially available, high quality timing belts having steel cable tension members giving them extremely high strength and having a castellated interior tread, the square teeth 108 of which securely fit into corresponding grooves in the sprockets 24 and 26 to positively assure against slippage. The exterior tread of the traction belts are deeply and transversely grooved in order effectively to grip the stair or other inclined surface. The individual projections 30 (see FIG. 12a) of the belt 28 may advantageously be formed of an approximately one-half inch thickness of a firm density rubber (or the like), preferably molded into the face of the belt 28 in order to provide a non-marring, high fricision surface to give positive traction and gripping. Each of the pair of parallel main tracks 22 have pivotally attached to the forward end elongated stabilizing means in the form of a respective auxiliary track 32 of similar construction, but preferably shorter in length. In the preferred embodiment, the auxiliary track sprocket 34 is mounted on the same shaft 36 as the main track sprocket 26. The shaft 36 drives both the main traction belt 28 and the auxiliary traction belt 38 via their respective sprockets 26 and 34. This drive shaft 36 is in turn driven by crank arm 40 through a gear box 42 and a sprocket chain 44 which passes over a sprocket 46 mounted on its inner end.

Note that for convenient distinction, like structures found on the other side of the vehicle 20 are indicated by like numerals bearing a prime (').

Extending between the sprockets 24 and 24' is an axle 48. Similarly, extending between sprockets 26 and 26' is a hollow axle housing 50 which carries therein bushings for the drive shafts 36 and 36'. Said hollow axle housing 50 incorporates a bridging casting (not shown) in which the drive sprockets 46' rotate and upon which the pedestal 52 is affixed. The pedestal 52 in addition to supporting the gear box 42 and the drive cranks 40, 40', also carries the load support 54 (here illustrated as a seat). The rear of the seat 54 is supported by struts 56, 56', the other end of each being pivoted about the axis of the axle housing 50.

The seat 54 may advantageously be constructed to swivel in order to facilitate the seating of the occupant on the vehicle. Additionally, the structure of the seat may be modified to be vertically adjustable. Alternatively, the pedestal 52 may be hinged at the level of the seat 54 to simplify the seating procedure.

The crank handles 40, 40' are geared to approximately a one to two gear ratio for horizontal travel. By
shifting the gear shift 58, the gear ratio is reduced by a factor of four. This latter ratio is used for ascending or descending a stairway where greater power and control are required.

The remaining structure of the vehicle 20 will be discussed in connection with a description of the operation of the vehicle. In traveling on the horizontal, the occupant seated astride the pedestal 52 proceeds forward by rotating the cranks 40 and 40' at the same rate thereby driving the traction belts 28 and 28' which engage the floor 60 in the vicinity of the rear sprockets 24, 24'. By varying the relative speed and/or direction in which the respective crank arms 40 and 40' are rotated, the vehicle is thus turned to the left or to the right. This turning is made possible by having the front end of the vehicle ride on casters 62. These casters 62, 62' are mounted so as to rotate with the auxiliary tracks 32, so that when the tracks 32 are lowered, the casters are raised off the floor 60 into an inoperative position (see FIGS. 3 and 11). With the auxiliary track 32 lowered, the main track 22 is flat on the floor or level ground 60 making it impossible as a practical matter to turn the vehicle, particularly when traveling over a deep pile rug or the like. Some maneuverability of the track 22 on a flat surface may be imparted (but at some expense to its traction) by slightly bowing the underside of the main track (see the modified main track 22a illustrated in FIG. 17); this assumes that the auxiliary track is not also in contact with the floor 60 when a turn is attempted.*

*As an alternate to replace each of the illustrated casters 62, 62' could be a castering unit comprising two small castering wheels mounted one behind the other by suspension from a bracket which in turn is hinged at a centrally positioned point (equivalent to the point where the illustrated casters are each fixed.)

The traction belt 28 is supported as it traverses the underside of the track 22 by a guide member 64. As shown in FIGS. 13a and 17, the member 64 may be advantageously supplemented along the middle of the track 22 by support wheels 65; similarly, wheels 65 could completely replace the guide members 64. The guide member 64 is preferably made from a solid bar of Teflon or a solid structural member faced with a strip of Teflon (such as is typically used on a snowmobile runner).

Descending a staircase (or other similarly abruptly inclined ground configuration) 66 is accomplished by the occupant pushing on the spring-loaded lock buttons 68, 68' of handles 69, 69' (see FIGS. 14a to 14c) to unlock the elbow linkages 70, 70' thereby permitting the lowering of the auxiliary tracks from the position in FIGS. 1 and 14a onto the level ground 60, see FIGS. 3 and 14b.

Referring to just one linkage 70, note that the handle 69 is attached to the upper arm 73 by stop-fitting 81 (see the latter particularly in FIG. 14a, mainly in dotted outline). Similarly, note that the free end of the piston rod 86 of the hydraulic cylinder 84 is pinned to the circular elbow plate 71 and to the catch support 83 (see the latter particularly in FIG. 14c, mainly in dotted outline). Thus the handle 69, stop 81, and arm 73 rotate as a unit relative to the unit comprised of the plate 71 (its integral lock ring 78), support 83 and rod 86. These two units of the elbow linkage 70 are fixed relative to one another by the wedge 72 of the handle 69 nesting into one of the grooves 76 in the lock ring 78. The lock ring 78 is preferably integral with the elbow plate 71 (being milled therefrom). The lock shaft 74 is axially journalled within the handle 69 with the wedge 72 connected to one end and with the button 68 connected at the other end. Note that in FIGS. 6, 8, 9, 14a, 14b, 14c the handle 69 is affixed at right angles to the arm 73. This proved difficult to operate in the prototype and therefore an alternative positive at an obtuse angle is shown in the other figures. In all figures (except FIG. 1) the handle 69 and the stop 81 are at the same angle and affixed directly to one another.

In an alternative preferred embodiment, the grooves 76 of the lock ring 78 may be formed to function cooperatively with the wedge 72 as a ratchet, in all except the full-up position (e.g., of FIG. 14d) and with a stop in the aligned-down position (e.g., of FIG. 14b). With the linkage 70 in ratchet form the auxiliary track 32 can rotate down by gravity (particularly useful in ascending the stairs as described below), but can be raised only by pushing on button 68 to release wedge 72.

With the vehicle positioned as shown in FIGS. 3 and 14b, the stop 81 engages the rear of the catch 80 forcing it counterclockwise about the pivot 82 (mounted on support 83-FIG. 14c) against a spring or other biasing means (not shown), thus releasing the hydraulic cylinder 84 from the catch 80.

The vehicle is advanced from the position in FIG. 3 to the position in FIG. 4 by rotating the cranks 40, 40' clockwise in the low gear ratio. Preferably the auxiliary track 32 is keyed into the drive shaft 36 to be driven simultaneously with the main track 22 (at least when the auxiliary track is in its lowered position).

The hydraulic cylinder 84 is preferably constructed to have a restricted internal flow past its piston such that it extends on its piston rod 86 in a controlled manner preventing the auxiliary track 32 from dropping precipitously onto the staircase 66 (thereby preventing a jouncing or even hurling of the vehicle).

As the vehicle proceeds from the top of the stairs illustrated in FIG. 4 to traveling along the stairs as illustrated in FIG. 6, this transition is accomplished smoothly and automatically, without any necessity for halting the forward progress of the vehicle nor any skilled manipulation, by rotation retarding means illustrated in this preferred embodiment as principally including the hydraulic cylinder 84 retracting slowly along its rod 86 thereby preventing a precipitous pitching forward of the vehicle. See the intermediate position illustrated in FIG. 5. Although a controlled relatively slow extension of the hydraulic piston 84 is preferable, the controlled retraction thereof is a necessity (in both the ascending and descending mode).

During the foregoing maneuver, a sensing means in the form of a level sensing mechanism 88, illustrated as being positioned under the seat 54, has actuated the load support leveling means which includes a jack screw 92 driven by a motor 90 thereby drawing the pedestal 52 towards the main track 22 so as to keep the pedestal 52 and the attached seat 54 in an upright level position at all times. The motor 90 drives the jack screw 92 through a gear reducer 94 and is supplied by electricity from a battery 96 (carried under the seat 54).

Note that by reference to FIG. 2, one can most clearly see in dotted outline the pivot joint 98 of the jack screw 92 to the pedestal 52.

See FIG. 7 for the position of the vehicle 20 in transit to the horizontal at the bottom of the descent. Experience has shown that there is no need to jacknife the
auxiliary track 32 relative to the main track 22 at this point, since the drop off the bottom step is typically relatively negligible. If this is considered a problem, the modification shown in FIG. 17 may be used, employing two end sprockets 24a and 24b which angle the belt 28 to reduce this drop.

After cranking onto the level ground 60 at the bottom of the stairs, the occupant lifts on the handles 69 of the elbow linkage 70 by depressing the lock button 68 thereby permitting engagement of the catch 80 with the hydraulic cylinder 84 and also permitting rotation of the elbow linkage 70 into its raised angled position illustrated in FIG. 14a. This not only raises the auxiliary track 32 from their previous ground-engaging position, but also lowers the casters 62 into their operative position, all as illustrated in FIG. 2.

The ascent up the staircase is quite similar. The vehicle 20 is driven to the staircase, again facing forwardly, but this time arriving at the bottom. The elbow linkage 70 (pivoted from shoulder stanchion 75) is released dropping the auxiliary track 32, 32 down onto the first stair riser. In the illustrated embodiment, the auxiliary tracks are locked in this position. The vehicle is then driven forward in this attitude until the main tracks 22, 22 assume the inclined position. The auxiliary tracks 32, 32' are then dropped manually (or have dropped by gravity, should ratchets are used in linkage 70) the rest of the way and locked in the aligned position illustrated in FIG. 14b. Upon arriving at the top of the stairs, the hydraulic cylinders 84, 84' extend forward on the piston rods 86, 86', preferably in a controlled manner as before, dropping the auxiliary tracks 32, 32' onto the level ground 60 (see FIG. 9). The vehicle continues to ascend the staircase 66 (as shown in FIG. 10) and pitches slowly forward on the main tracks 22, 22' in a controlled manner as the center of gravity of the vehicle 20 passes over the top riser of the staircase, all in a smooth transition made possible by the pre-set slow retraction of the piston rods 86, 86' into the hydraulic cylinders 84, 84'. The vehicle soon settles from the slightly jackknifed position of its respective main and auxiliary tracks (as shown in FIG. 11) into full floor contact similar to the illustration in FIG. 3, but this time facing away from the staircase 66.

The descent of the vehicle along an inclined surface (such as the staircase 66) is materially assisted by a friction clutch mechanism 100 which also serves as the down fail-safe. This mechanism 100 is carried within the auxiliary track 32 housing 102 and rotatably fixed therein about pivot 104. When the auxiliary track 32 is level, the fail-safe 100 is retained in the operative position against a stop 106 fixed to the housing 102 (see FIG. 12a). When in the descending position illustrated in FIG. 6 and 12b, the sprocket wheel 107 of fail-safe 100 engages the castellated teeth 108 of the traction belt 28 and presses the belt 28 against the pressure plate 110. With the traction belt 28 thus engaged by the fail-safe 100, the belt 28 is held immobile, unless the crank arms 40 are positively driven against the frictional resistance of the friction clutch (not specifically shown) incorporated in the down fail-safe 100.

The up fail-safe is illustrated in FIGS. 13a and 13b, which are substantially self-explanatory. The ratchet lever 112 is swung out of engagement of the cleats 30 of the traction belt 28 when in the horizontal position by action of gravity upon the counterweight 114. When the main track 22 of the vehicle 20 is in the ascending position, the counterweight 114 swings the ratchet lever 112 into engagement with the cleats 30 to catch positively thereon should the traction belt 28 attempt to move back against the ratchet lever 112 (which captures the belt 28 pressing it against backup plate 116).

The level sensing mechanism 88 as disclosed in the preferred embodiment illustrated in FIG. 15, consists of a pendulum 118 suspended in a container 120 which is filled with a viscous dampening medium. On either side of the pendulum 118 are respectively positioned, fore and aft, two sets of reed contacts 122 and 124. Each contact is wired to a respective solenoid 126 and 128 which in turn activates respective pair of dual switches 130 and 132 to close a circuit for ultimately operating the reversible motor 90 in one direction or the other, dependent upon which solenoid is activated.

Thus when the seat 54 and its attached sensing mechanism 88 is substantially level, even though subject to the normal vibrations of travel, the motor 90 is unaffected, because the dampening fluid in the container 120 prevents the pendulum from swinging to engage either of the contacts 122 or 124. However, when the vehicle 20 pitches forward (usually at a rate controlled by the hydraulic cylinder 84), gravity swings the pendulum through the viscous fluid to engage and close one of the contacts 124 or 122 (dependent upon whether the vehicle is pitching forwards or backwards, typically upon ascent or descent). The circuit will remain closed so long as the seat is at an angle to the horizontal thereby causing the motor 90 to turn the jack screw 92 in a direction to bring the seat back to the horizontal.

The alternative control device depicted in wiring diagram of FIG. 16 is substantially identical to that shown in FIG. 15 except that the function of the dual switch 130 and its activating solenoid 126 have been respectively replaced by single switches 130a and 130b and associated individual solenoids 126a and 126b; similarly switches 132a and 132b replacing dual switches 132 and solenoids 128a and 128b replacing solenoid 128.

From FIG. 16 it can be seen that when reed contact 124 is closed, solenoids 126a and 126b are activated closing switches 130a and 130b thus connecting the motor 90 to the battery 96 to adjust the position of the seat 54.

When the pendulum 118 then selectively closes reed contact 122, solenoids 128a and 128b are activated closing switches 132a and 132b, thus connecting the motor 90 to the battery 96 in the reverse direction.

For convenience and economy the solenoids 126a and b, 128a and b may be equivalent to automobile starter relays. However, the current required to operate such relays could be too much for the reed contacts 122 and 124. Therefore, to improve the later's reliability two units, each comprising a low current relay (not shown) with an associated higher capacity switch controlled thereby, are introduced. The switch of each unit replaces the function of a corresponding reed contact, and the solenoid is in turn controlled by such respective reed contact.

For the added comfort of the occupant and to * prevent activation of the seat positioning mechanism save electricity and wear of the motor 90, a mercury switch (not shown) is preferably mounted on the auxiliary tracks (or some equivalent location) in order to inactivate the sensing mechanism when the auxiliary tracks are in their raised inactivated position.

Referring now to an alternative embodiment of the vehicle 20, not illustrated, note that the leveling mechanism 88 can be eliminated and replaced by a self-leveling seat mounted on gimbels. The chair 54 thereby
can always maintain a level position. For the comfort of the occupant, the gimbal pivots can be frictionally or otherwise dampened. Also, a lock may be provided to fix the chair relative to the main track when the angle of incline (or horizontal) is not changing. In this embodiment, the pedestal 52 is divided into two separate gear housing standards with respective crank arms.** with the gimbeled seat suspended therefrom.

A separate screw mechanism for reorienting the angle of the gear housing standards and the chair carried thereon relative to the main track may be incorporated should the geometry of construction require a shift in the center of gravity of the occupant relative to the main track during inclined travel.

Additionally an alternative pitch-control means may replace hydraulic mechanism 70 by a gear mechanism for controlling and accomplishing the raising and lowering of the auxiliary tracks.

The auxiliary tracks have two manually controlled positions (up and down-in-line), and one drop position which is automatic. A crank and a pinion gear mounted on the vehicle 20 moves a gear rack (which has one end mounted on the auxiliary track). As the auxiliary tracks reach the position in-line with the main tracks, the end of the gear rack has just passed a lock which automatically drops into position and the auxiliary tracks cannot again move in an upward direction until manually released.

The auxiliary tracks assume the dropped position by their own weight descending. The auxiliary tracks are free to drop since the end of the rack has passed the crank pinion and a ratchet escape in the gear box permits the rack to pass through unhindered. The tracks return to the in-line with the main track position under the weight of the wheelchair and operator at a pre-set speed. The purpose of the gear box is to produce the relatively slow return of the auxiliary tracks from the drop position. The gradual movement is accomplished as follows: The upward rotation of the tracks causes the return of the gear rack through the gear box. In this direction the ratchet-escape locks and causes a large gear to rotate. The large gear in turn is engaged with small gears resulting in a high gear ratio. Fixed on the same shaft with the small gears is a friction wheel. An adjustable friction device working against the smooth perimeter of the friction wheel will determine the speed at which the auxiliary tracks return to the inline with the main track position.

A still further embodiment of the pitch control means may take the form of a rotary hydraulic mechanism operative at the axles 36 (replacing the elbow linkage 70 and in particular the hydraulic cylinder 34).

I claim:

1. A stair-climbing vehicle comprising a pair of main tracks, a pair of auxiliary tracks each being aligned and pivotally joined to a main track adjacent the forward end of said respective main track, propulsion means for driving said main tracks, independently of each other when necessary, self-leveling seat means mounted on said vehicle, automatic pitch-control means mounted to act between each prospective main track and its auxiliary track for limiting at least the rate of pivoting of said auxiliary track with respect to said main track from below said main track towards alignment therewith, said pitch-control means comprising an elbow linkage between each auxiliary and main track pair and having a hydraulic cylinder forming at least part of the linkage forearm and also having a locking means for maintaining the linkage and cylinder in the raised angled position and for locking the linkage and unlocking the cylinder in the lowered position.

2. A vehicle as claimed in claim 1 wherein said self-leveling seat means comprises a dampered pendulum, two electrical switches respectively activated by said pendulum swinging forward or backward relative to said vehicle when said vehicle pitches forward or backward, the first such switch controlling a solenoid menas for closing two additional switches to connect the seat-leveling motor means to operate to bring the seat back up to the level position, the second such switch controlling a second solenoid means for closing two other additional switches to connect the seat-leveling motor means to operate in the opposite direction, neither such first mentioned switches being closed by the pendulum when the seat is in the level position.

3. A vehicle as claimed in claim 1 further comprising castors mounted near the front of said main tracks so as to move from an inoperative position to an operative position extending slightly below the front of the main tracks as the auxiliary tracks are moved from their inoperative position to their operative position.

4. A vehicle as claimed in claim 1 wherein each track comprises an endless tread having an elongated substantially flat lower run extending between at least two sprocket wheels, said tread having interior teeth for non-slip engagement with said sprockets and having exterior cleats, and an anti-friction support positioned on the upper side of the lower run of said tread.

5. A vehicle as claimed in claim 4 where each main track has the lower run of its tread supported in a slightly downwardly bowed shape.

6. A vehicle as claimed in claim 5 where each track at its free end is upwardly and outwardly inclined.

7. A vehicle as claimed in claim 4 further comprising a friction-clutch down fail-safe means mounted in an auxiliary track so as to engage the interior teeth of its tread when the auxiliary track is inclined downwardly and to disengage in any other position for preventing unpropelled downward forward motion of the vehicle.

8. A vehicle as claimed in claim 7 further comprising a ratchet up fail-safe means mounted in a main track so as to swing into locking engagement with said outer cleats of its tread when said main track is inclined upwardly and to swing out of engagement by gravity in any other position for preventing backward motion of the vehicle.

9. A stair-climbing vehicle for transporting a load comprising a parallel pair of main tracks; a load support carried on said vehicle; elongated stabilizing means for preventing precipitous pitching forward of said vehicle, being pivotally joined to said vehicle and, when operatively positioned, extending forwardly from such pivot joiner to engage the ground beyond the combined center of gravity of said vehicle and of its load; propulsion means for driving said main tracks; rotation retarding means mounted to act between said vehicle and said elongated stabilizing means pivoted thereto for slowing automatically at least the rate of pivoting of said elongated stabilizing means upwardly against gravity so as to control the rate of pitching forward of said vehicle; sensing means mounted on said vehicle for sensing the inclination of said load support and for signaling any significant variation of said load support from the horizontal; load support leveling means for moving said load support relative to said main track responsive to the signaling of said sensing...
means so as to keep said load support substantially level and for moving the same at a rate of rotation at least substantially equal to the rate of rotation of said elongated stabilizing means.

10. A vehicle as claimed in claim 9 wherein said elongated stabilizing means is a pair of auxiliary tracks each pivoted to a respective main track adjacent the front thereof, and said main and auxiliary tracks include nonslip endless belts being a multiplicity of external cleats.

11. A vehicle as claimed in claim 10 wherein said rotation retarding means comprise two hydraulic cylinders each mounted between the vehicle and a respective auxiliary track pivoted thereon, said cylinders being contracted to be retractable under pressure at a controlled predetermined rate.

12. A vehicle as claimed in claim 10 wherein said rotation retarding means comprises two elbow linkages each respectively mounted between each auxiliary track and said vehicle and having a hydraulic cylinder forming at least part of the linkage forearm and also having a locking means for maintaining the linkage and cylinder in the raised angled position and for locking the linkage and unlocking the cylinder in the lowered position.

13. A vehicle according to claim 1 wherein said self-leveling seat means comprises a gimbeled seat.

14. A vehicle according to claim 1 wherein said self-leveling seat means comprises a seat; sensing means mounted on said vehicle for sensing the inclination of said seat and for signaling any significant variation of said seat from the horizontal; leveling means for moving said said seat relative to said main track responsive to the signaling of said sensing means so as to keep said seat substantially level and for moving the same at a rate of rotation at least substantially equal to the rate of rotation of said pitch-control means.

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