United States Patent [19]

Jensen

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[45] **Mar. 4, 1975**

[54] **STAIR CLIMBING TRACKED VEHICLE**

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[73] Assignee: **Ramby, Inc.**, Bronxville, N.Y.

[22] Filed: **Jan. 2, 1973**

[21] Appl. No.: **320,115**

[52] **U.S. Cl.** **180/9.24**, 280/5.22
[51] **Int. Cl.** **B62d 55/04**, B62b 9/02
[58] **Field of Search** 180/9.24; 280/5.22

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Attorney, Agent, or Firm—Curtis, Morris & Safford

[57] **ABSTRACT**

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.

14 Claims, 21 Drawing Figures

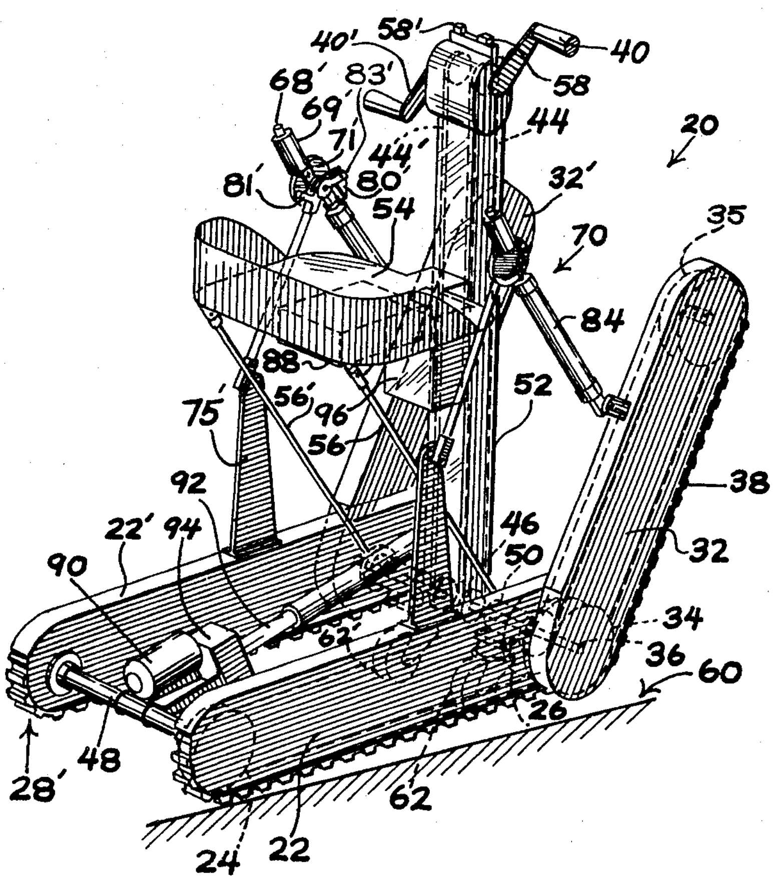


FIG. 1.

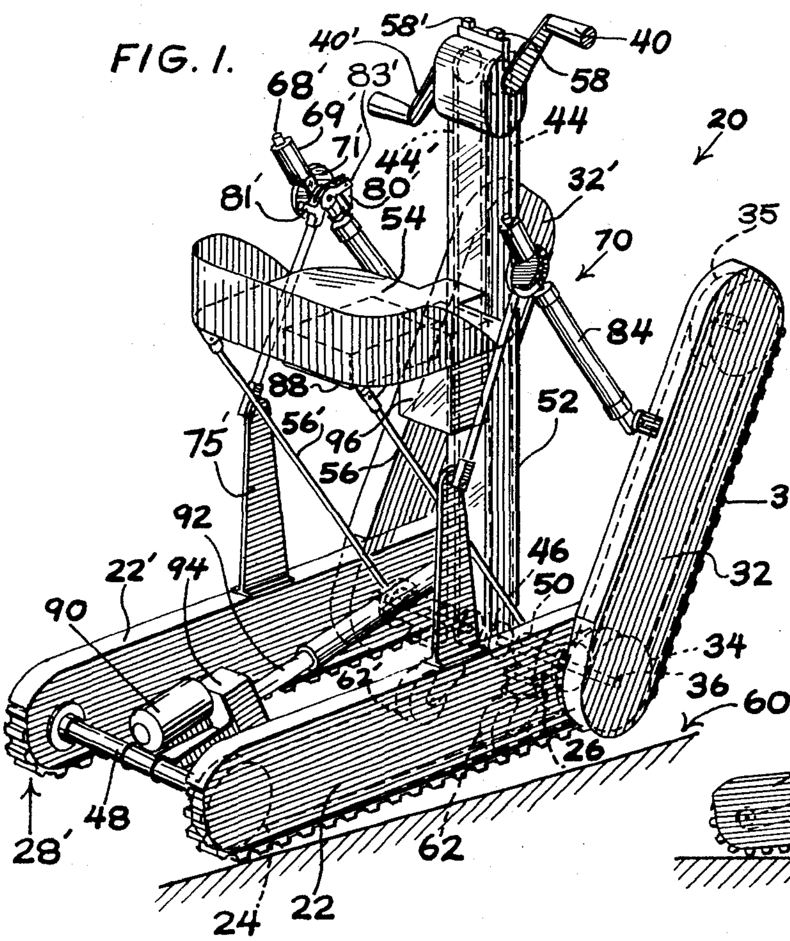


FIG. 2.

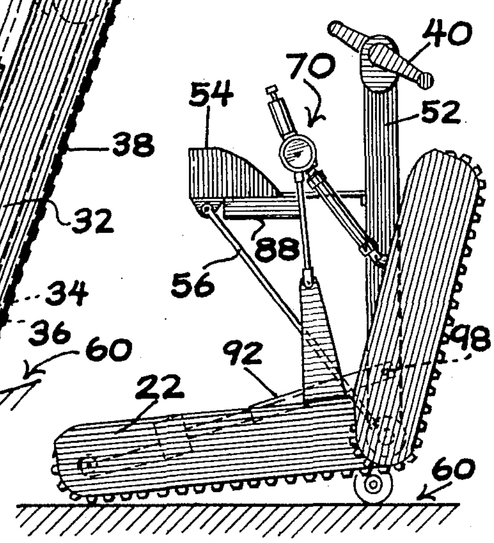


FIG. 4.

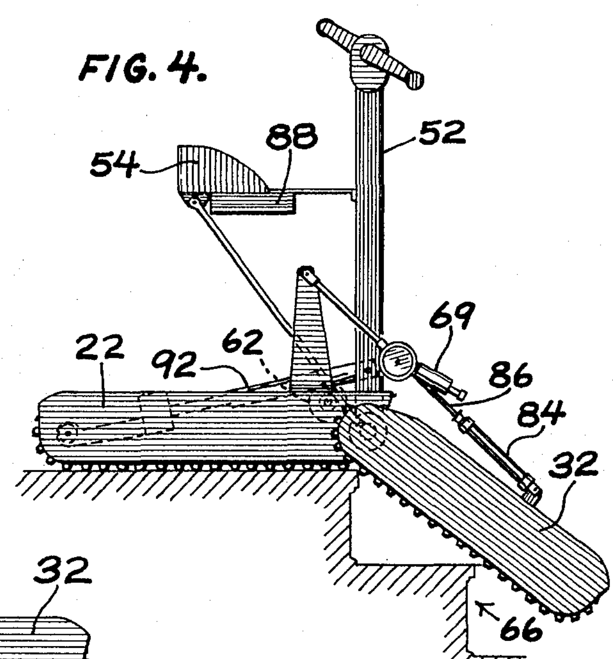


FIG. 3.

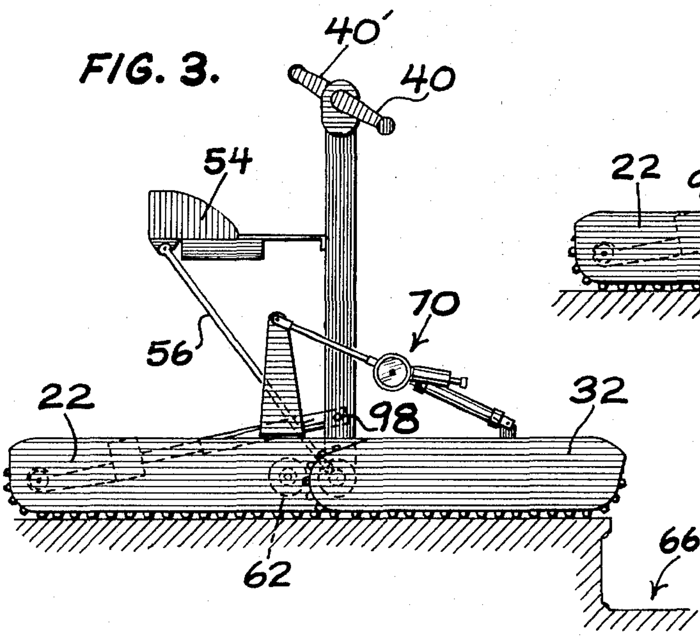


FIG. 5

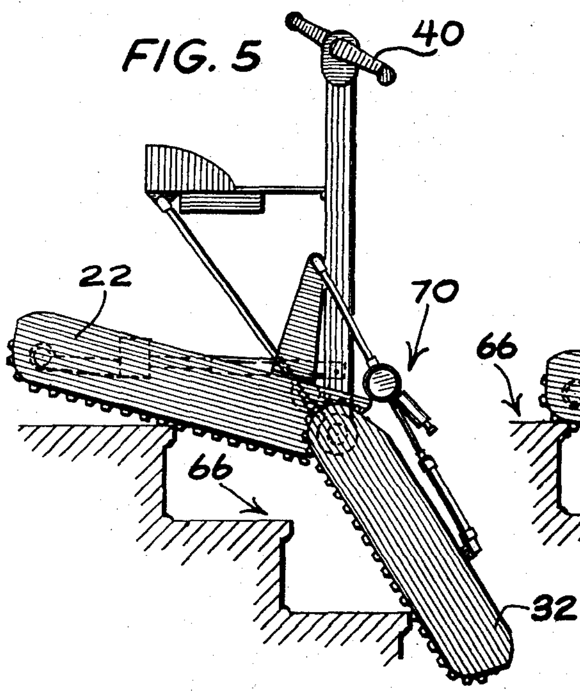


FIG. 7.

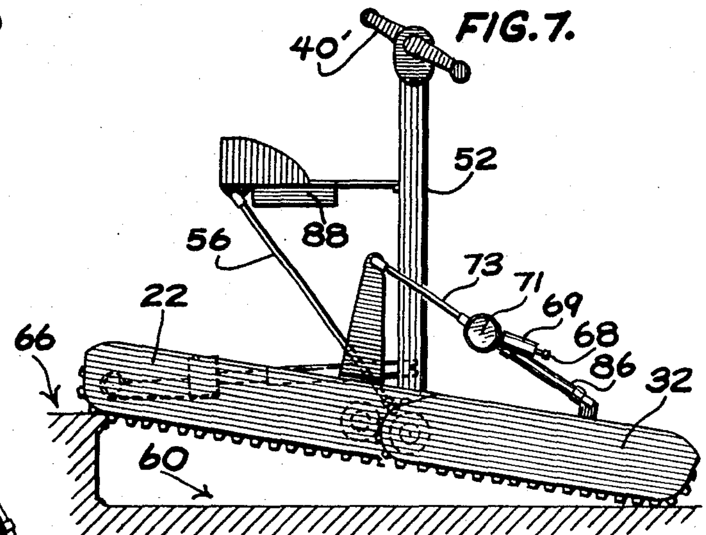


FIG. 11.

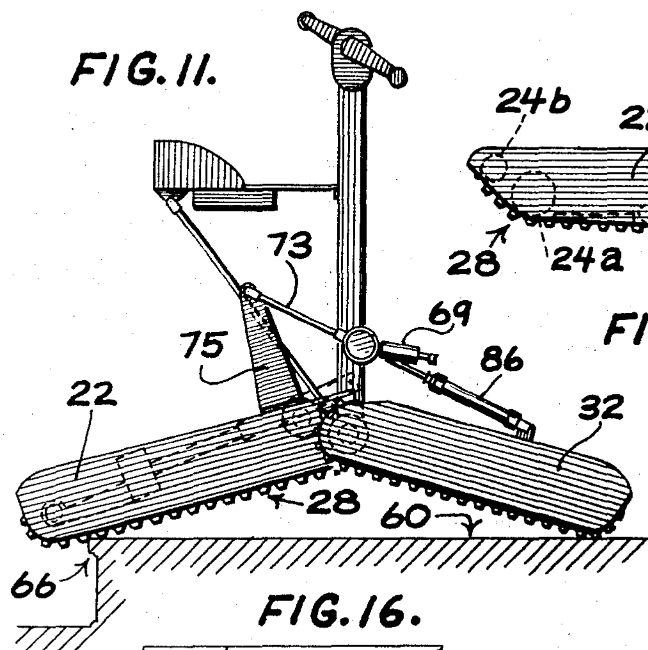


FIG. 17.

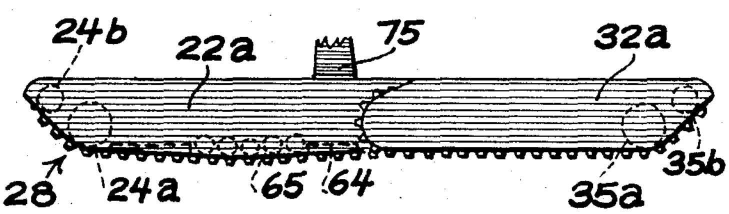


FIG. 10.

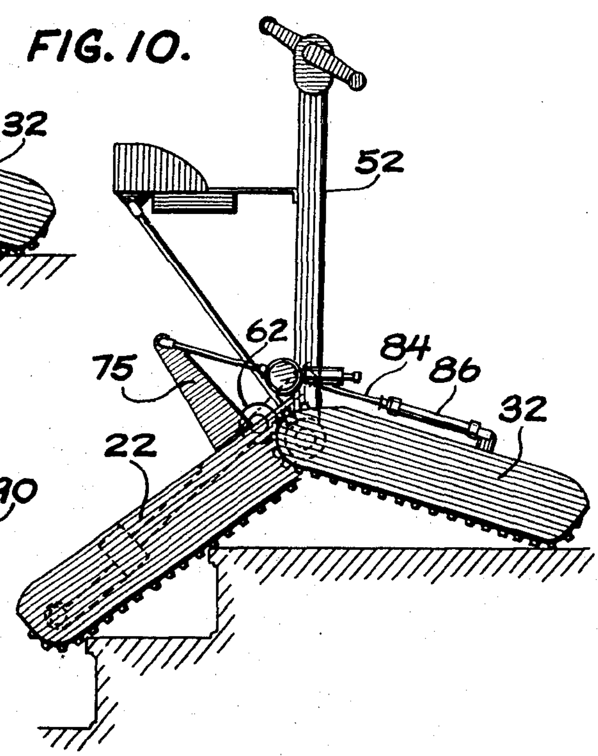


FIG. 16.

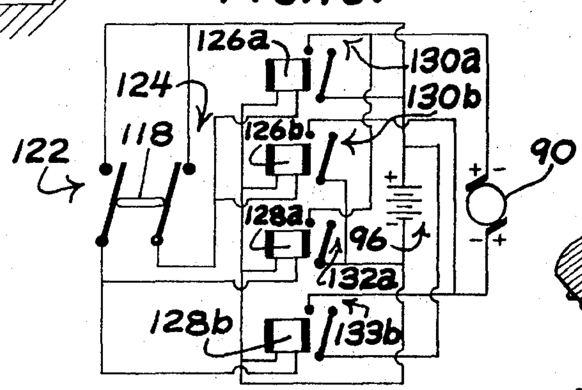


FIG. 8.

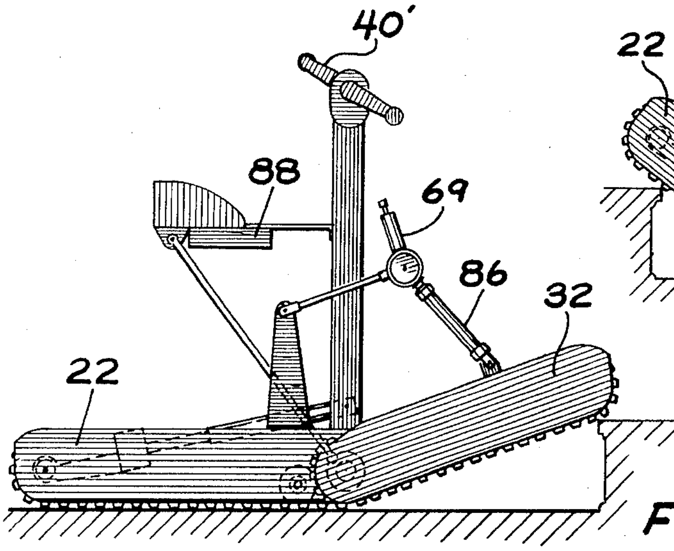


FIG. 6

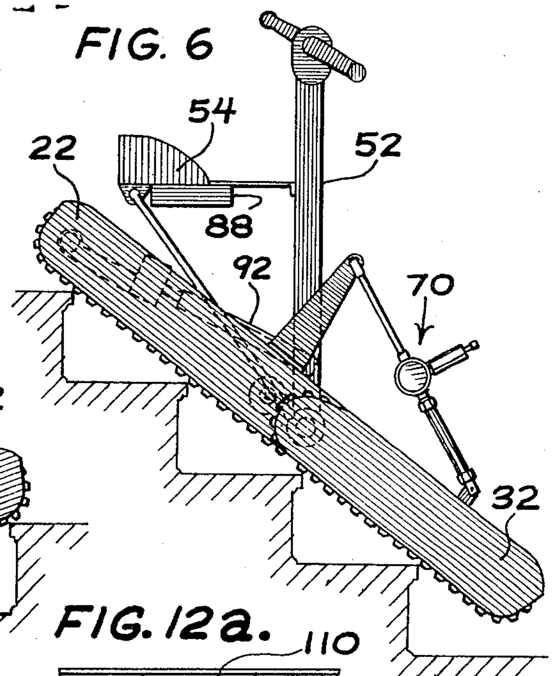


FIG. 12a.

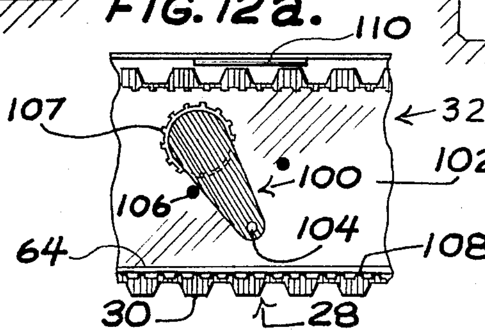


FIG. 9.

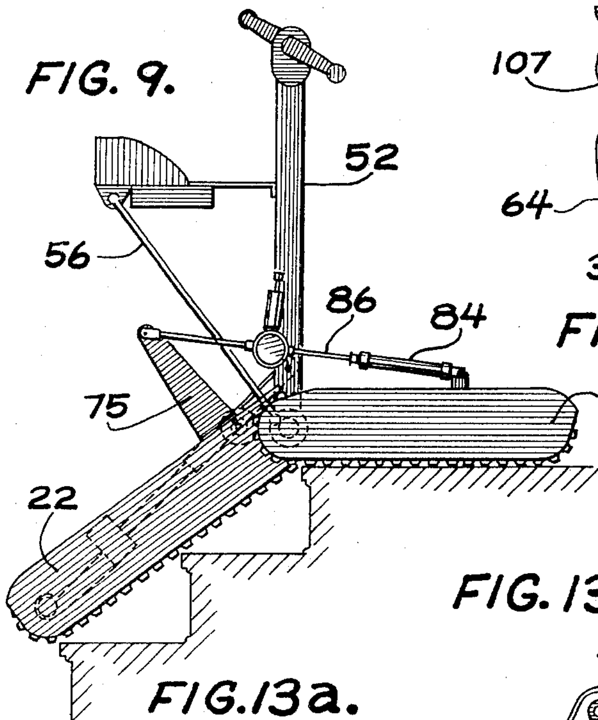


FIG. 12b.

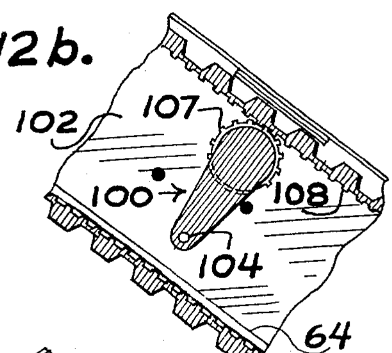


FIG. 13b.

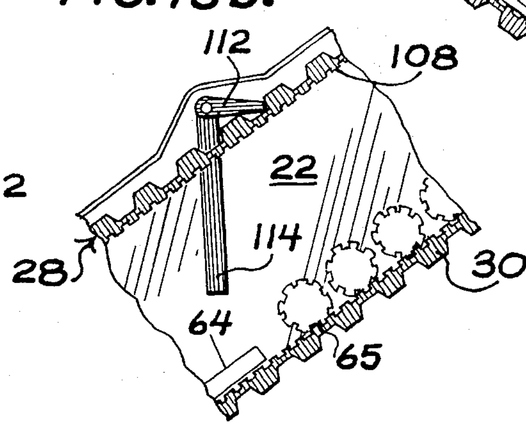


FIG. 13a.

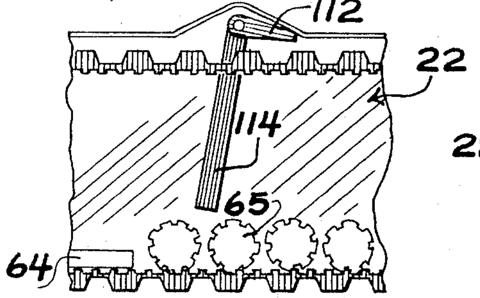


FIG. 14a

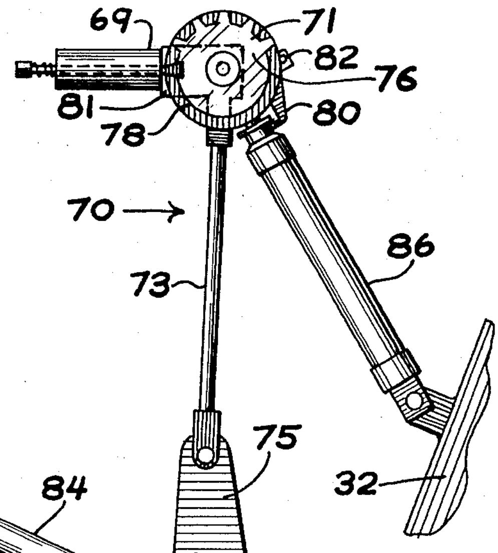


FIG. 14b.

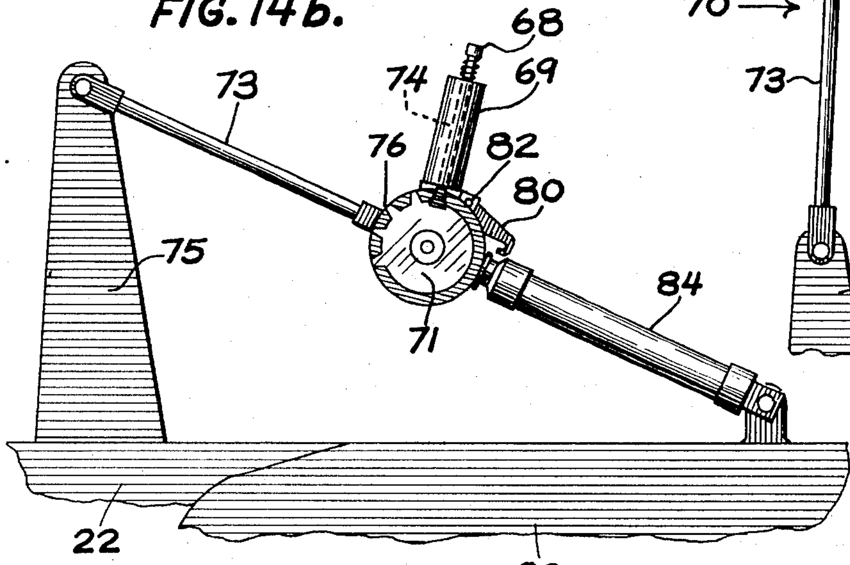


FIG. 14c.

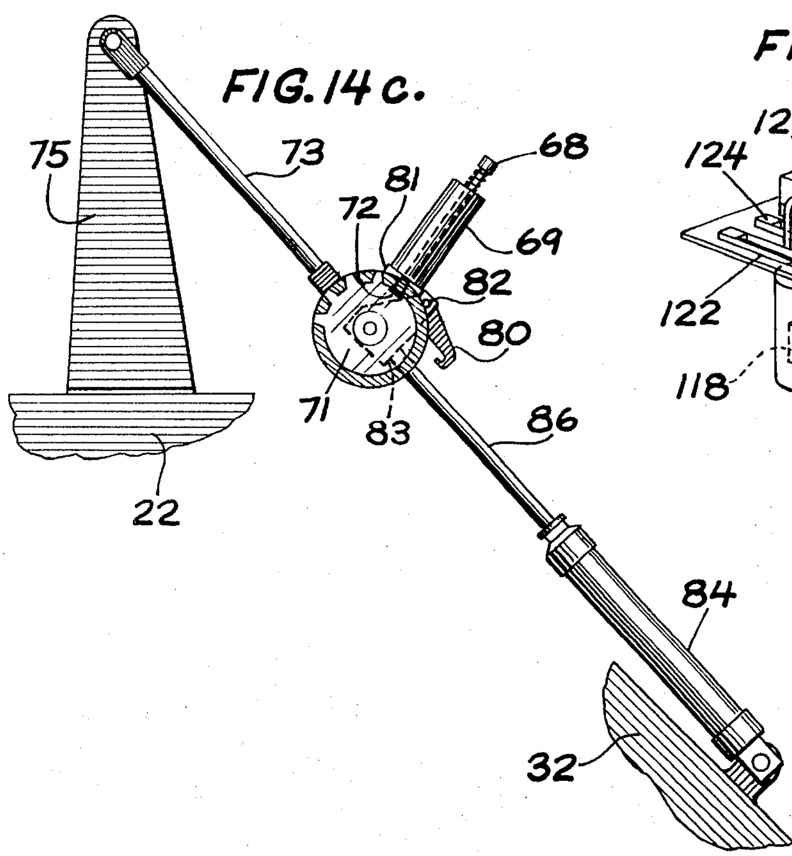
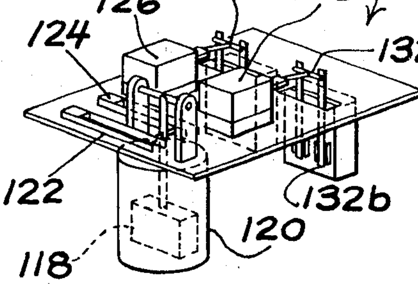


FIG. 15.



STAIR CLIMBING TRACKED VEHICLE

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 two 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-levelling 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-levelling seat, preferably motorized to be automatic, whereby the occupant is at all times maintained in an upright forward-facing seated postion. 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 levelling 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-levelling 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 levelling adjustments due to "sloshing" 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-levelling 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 dampened, 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 rachet 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 minimal, 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 staircase 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. **12***a* is an enlarged schematic detail of the down fail-safe in inoperative position;

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

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

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

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

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

FIG. **14***c* is a view similar to FIG. **14***a* 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. **12***a*) 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 nonmarring, high friction 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** through **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 **22*a*** illustrated in FIG. **17**); this assumes that the auxiliary track is not also in contact with the floor **60** when a turn is attempted.*

* 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. **13*a*** 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 steel 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. **14*a*** to **14*c***) to unlock the elbow linkages **70, 70'** thereby permitting the lowering of the auxiliary tracks from the position in FIGS. **1** and **14*a*** onto the level ground **60,** see FIGS. **3** and **14*b***.

Referring to just one linkage **70,** note that the handle **69** is affixed to the upper arm **73** by stop-fitting **81** (see the latter particularly in FIG. **14*a***, 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. **14*c***, 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, 14*a*, 14*b*, 14*c*** 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. **14*a***) and with a stop in the aligned-down position (e.g., of FIG. **14*b***). 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 **14*b***, the stop **81** engages the rear of the catch **80** forcing it counterclockwise about the pivot **82** (mounted on support **83**-FIG. **14*c***) 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 lurching 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 transition 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 **24***a* and **24***b* 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. **14***a*. 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 tracks **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, if ratchets are used in linkage **70**) the rest of the way and locked in the aligned position illustrated in FIG. **14***b*. 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 inoperative position against a stop **106** fixed to the housing **102** (see FIG. **12***a*). When in the descending position illustrated in FIG. **6** and **12***b*, 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. **13***a* and **13***b*, 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 a 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 **130***a* and **130***b* and associated individual solenoids **126***a* and **126***b;* (similarly switches **132***a* and **132***b* replacing dual switches **132** and solenoids **128***a* and **128***b* replacing solenoid **128**).

From FIG. **16** it can be seen that when reed contact **124** is closed, solenoids **126***a* and *b* are activated closing switches **130***a* and *b* thus connecting the motor **90** to the battery **96** to adjust the position of the seat **54.** When the pendulum **188** then selectively closes reed contact **122,** solenoids **128***a* and *b* are activated closing switches **132***a* and *b*, thus connecting the motor **90** to the battery **96** in the reverse direction.

For convenience and economy the solenoids **126***a* and *b*, **128***a* and *b* may be equavalent 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 gimbel 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 therebetween.

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 will have 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 gear resulting in a high gear ratio. Fixed on the same shaft with the small gear 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 dampened 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 operative position to their inoperative 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 joinder 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 thereon 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 auziliary tracks include non-slip 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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