

Title: "FREE CLIMBER SYSTEM"

DESCRIPTION

The present invention is in the technical field of transportation across uneven terrain. Specifically, the present invention is in the technical field of personal transportation of a wheel chaired bound individual between two points on a staircase.

Stairs have been a boon to the mobile but not to a wheelchair bound person. There are many solutions devised to transport an immobile person from one end of the staircase to the other. These solutions can be roughly divided into five categories: lifts, escalators, modified non-motorized wheel chairs, robotic scooters and motorized movers on a track. The two predominant commercial solutions are: motorized wheelchairs and motorized movers on a track which will be referred to as stairlifts in this document.

In the categories of lifts and stairlifts, the disadvantages are that they are expensive and require dedicated spaces especially when living spaces are rapidly shrinking. The remaining three classes of solutions, namely, modified non-motorized wheelchairs, robotic scooters and stairlifts, have the drawback of having the drive mechanism together with the load thus needing double the energy to move around. The present invention is designed to be cheap, easy to install in public areas and uses low power to move the load about.

The present Invention is made In lieu of the deficiencies of the prior arts. The Stairlift solution is inconvenient to the wheelchair bound person as it needs the rider to get out of the wheelchair to ride it. Furthermore the stairlift, motorized wheel chair and modified wheel chairs need high amounts of energy to operate because it needs to carry itself, the drive mechanism and the rider. The high cost makes procuring these solutions out of the majority's reach. The present invention, whose primary objective is to move the wheelchair bound person from one point of the staircase to another, is activated with a Remote (510) which will summon the car (200) to the location of the Remote (510). On the Car (200) is a unique pendulum (230) system which holds Extendable rods (241,243) that can be placed in between the spokes of the wheel chair. The user controls the movement of the Car (200) with the Remote (510). The Car (200) is driven by Cable Drive System (400). A module called the Safety & Handle (300) provides a safety lifeline to the Car (200). The rider can hold onto the handle bar found on the Safety & Handle (300) module.

screwing them together. The curve alloy plate (211) should be made from airplane grade metals to imbue it with the spring like strength, i.e. it is elastic yet able to retain its curvature. The stabilizing plates (213) are made of slightly more tougher metal such as steel to provide support and rigidness to the curve alloy plate (211). The Curve alloy plate (211) has four ports. The port closest to the decent direction is called the dorsal port (222) and the pendulum-dampener (260) is connected to the dorsal port (222) with a high tensile metal pin. This connection can be seen on the top and back view of Figure 4 as well as Figure 5. In the top view of the Figure 5, the biggest port is called the mid-port (215). The mid-port (215) is the dead-center of the curve alloy plate (211). The Pendulum (230) is connected to the curve alloy plate (211) via the mid-port (215). The location of the mid-port (215) is important as the centeredness allows it take full advantage of the spring-like property of the curve alloy plate (211). In the same top view of Figure 5, the cable from the Cable Drive System (400) is connected to the fourth port (219) of the curve alloy plate (211). The car dampener (376) from the Safety & Handle system (300) is connected to the third port (217) of the curve alloy plate (211). The wheels (225) can be found on the four protruded corners of the curve plate (211) via high tensile strength metal pins.

Figure 6 is a detailed picture of the Pendulum (230). The Pendulum (230) supports the wheelchair with the rider still in it and regulates the orientation of the object with respect to the ground. The head (233) of the Pendulum (230) is fastened to mid-port (215) of the curve alloy plate (211) by a high tensile metal pin (231). The pendulum head (233) is connected to the Pendulum's housing block (237) by a metal stem (235). Two holes (239) in the housing block (237) keep the extendable rods (241,243). The extendable long rod (241) has a diameter of five to ten percent smaller than the holes of the housing block (239), is hollow on the side. It (241) in turns houses the extendable short rods (243). The extendable short rod (243) is five to ten percent smaller in diameter than the extendable long rod (241). It (243) is also half the length of the extendable long rod (241). When the rods are fully extended, it should be long enough to fit through the spokes and under the seat of the wheelchair.

Figure 7 illustrates the pendulum-dampener (260) in detail. The pendulum-Dampener's (260) main function is to prevent the pendulum (230) from any unpredictable and violent movements. It (260) does this by absorbing the shocks through the pneumatics pump (265) and plunger (267).

Figure 8 illustrates the Safety & Handle system (300) with the side and front views. The right pane of Figure 8 illustrates the front view of Safety & Handling System (300). The Safety & Handle system (300) prevents any unpredictable movements from the Car (200). The Safety & Handle system (300) anchors the Car (200) to the staircase's handrails. The side view of Figure 8 shows the outside of the Plate (310) which faces the Car (200). The stair's handrail is clamped by tightening the bolt (357) between the Front Plate (310) and Back Plate (311). The handrailing wheel (353) rolls on the top surface of the staircase handrails. The axel (355) goes through the center of the handrailing wheel (353). Four impact wheels (363), two on the inside of each plate (310), sit horizontally on L-shaped

posts (365) act as cushion to the Plates (310) from the vibration generated by the travel of the Safety & Handles system on the handrailing. The impact wheels (363) are either rubber or polyurethane which is great shock absorbing materials that can overcome uneven surfaces and bumps of the handrail. The Tracker (580) is mounted behind the Back Plate (311). The Tracker is a transponder which transmits the position of the Safety & Handle system (300) to the Controller (530).

Figure 9 illustrates the salient parts of the Brake + Car-Dampener (370) system. The primary braking mechanism can be seen on the left bottom frame of Figure 9. The Brake Blade (381) which is mounted on the Front Plate (310) is designed to lock the Handrailing Wheel (353) when pressed against the Brake Pad (382) essentially stopping Safety & Handle system (300). The Brake Blade (381) is raised or lowered by a Stopper (379) that is connected to the Brake Pneumatic (373). The Brake Pneumatic (373) is on the outside of the Front Plate (310) and is connected to the Stopper (379) by a high tensile screw that sits on the Front Plate's (310) through groove (383). On each side of the Through Groove (383), there are metal guides, called the Guide Edge (384), ensures that the Stopper (379) follows a predetermined path. It's important that the through groove is smooth and lubricated to minimize friction between the plate and the high tensile screw.

Figure 10 further illustrates the Brake Pneumatic (373) and Car-Dampener (376) of the Safety & Handle system (300). The Car-Dampener (376) and the Brake-Pneumatic (373) work in tandem to absorb the shocks generated by sudden movements of the Car (200) and will stop the Car (200) if force of the sudden movements surpasses a predetermined tolerance. The Car-Dampener (376) is the longer single-acting pneumatic cylinder will absorb a majority of the shocks produced by the car (200) and transfer some of this shock to the Brake-Pneumatic (373) which in turn will determine if the brake blade (381) jams the stopper (379) of the Safety & Handle system (300). The tolerance level of stopping the car will be a simple function of the force needed to extend the Car-Dampener (376) fully.

Figure 11 illustrates the push-up handle (330) attached to the front Plate (310) of the Safety & Handle system (300). The handle (336) is kept upright by a spring loaded screw (333). The user pulls down the handle (336) and holds on to it during the duration of the ride.

Figure 12 illustrates the Cable Drive System (400) in two perspectives: internal and front views. The Cable Drive System (400) pulls the Car (200) up the stairs and controls the Car's (200) descend. Visible in the left pane of Figure 12, is the internal workings of the Cable Drive System (400). The reader will be able to view the pulley system comprising of a Cable Spooler (430) that is connected to a Bi-Directional DC Motor (460), a series of Big Wheels (413) and Small Wheels (415) staggered in the prescribed positions to ensure the Cable (433) don't entangle. In the right panel of Figure 12, the reader can see how the Cable Spooler (430) is connected to the Bi-Directional DC Motor (460) via the Drive-Axel (419). The Controller (530), Bi-Directional DC Motor (460) and Re-chargeable battery (490) can also be seen. The Controller (530), Re-chargeable battery (490) and Bi-

Directional DC Motor (460) need not be placed in such close proximity as suggested in the illustrations. The Remote (510) activates the Controller (530) by sending a radio signal. The Controller (530) in turn activates the Bi-Directional DC Motor (460) with an electrical signal. The Bi-Directional DC Motor (460) will draw power from the Rechargeable battery (490) to turn the Drive-Axel (419) either to reel-in or release the Cable (433) depending on the radio signal it receives from the Remote (510).

Figure 13 illustrates the Remote (510) which is part of the Electronic Control System (500). The two diagrams in Figure 13 illustrate its external appearance and schematics of the Remote (510). The left diagram in Figure 13 shows the five functions in the form of keys on the Remote (510). The “come” button (517) on the Remote (510) will cause the Cable Drive System (400) to either unwind or wind-up the Cable (433) connected to the Car (200) depending on the location of the Remote (510). For purposes of illustration, assume that the rider is at the bottom of the staircase. When the rider presses the Remote’s “Come” (617) button, the Remote (510) sends a radio signal to the Cable Drive System’s (400) Controller (530). The Controller (530) will calculate the telemetry it receives, which in this case it would have figured out that the caller is at the bottom of the stairs. It will send an electrical signal to the Cable Drive System’s (400) to unwind the cable thus allowing the Car (200) to descend to the location of the rider. Once the Car (200) arrives, the rider positions the wheelchair beside the Car (200). The rider then extends the rods (241,243) from the Car through the wheelchair’s spokes. The rods will go below the seat and through to the spokes of the wheelchair’s other wheel. The rider then presses the “go” button (519) on the Remote (510). The Remote (510) sends another radio signal to the Controller (300) which causes the Bi-Directional DC Motor (460) to wind-up the Cable (433) and pulls the Car (200) with the rider up the staircase. The Bi-Directional DC Motor (460) rotates the Drive Axel (419) with a start speed that has been configured in the Motor’s Microcontroller (534). The rider can increase the speed by pressing the “Faster” button (515). If the rider wishes to slow down, the rider presses the “Slower” button (513). An activation of the “Faster” (515) or “Slower” (513) button will increase or decrease the speed of the Car (200) by a “unit”. An example of a “unit” of Car speed can be 2 km/hour or 33 meters per minute and can be programmed into the Motor’s Microcontroller (534). The speed of ascend or descend need not necessarily be the same. For example, a unit of ascend speed can be 33 meters per minute while a unit of descend speed can be 25 meters per minute. The rider has the option to stop the Car (200) at anytime during the ride by pressing the “stop” button (511). When the “stop” button (511) is pressed, the Remote (510) sends a radio signal to the Controller (530) which then instructs the Bi-Directional DC Motor (460) to stop rotating the Drive-Axel (419). On the left panel of Figure 13, the reader will find a high level block diagram of the Remote (510). In the schematic, a position sensor (527), connected to the Remote’s Microcontroller (533), collects telemetry information on the Remote’s (510) position. This telemetry information can be encoded by the Remote’s (510) Remote’s Microcontroller (533) and sent to the Controller’s (530) via the transmitter (523). This information will be used by the Controller (530) to calibrate the speed of ascend and descend to the speed of the cable at the Cable Spooler (430). The Remote’s (510) Remote’s Microcontroller (533) can trigger

the sending of the telemetry data upon request from the Motor's Microcontroller (534). A position sensor (527) is placed in the Car (200) to enhance the accuracy of the telemetry. Additionally, in the schematic diagram on the left pane of Figure 13, each of the five functions found on the remote will have a unique radio signal and the correct radio signal is determined by the Remote's (510) Microcontroller (533).

Figure 14 illustrates the Controller (530), which is the brain of the Electronic Control System (500). Besides doing the calculation heavy lifting, the Controller (530) is also the interface between the Remote (510), Sensors (566) and the Bi-Directional DC Motor (460). It governs the switching of the 5 operation states of the Bi-Directional DC Motor (460) on the Drive-Axel (419). The 5 operations states are start, stop speed up, slow down and change rotational direction. The Controller (530) regulates the 5 states with a collection of three electronics blocks: Communication (531), Motor's Microcontroller (534) and Transducers (532). The Communication block (531) receives two types of data by radio signal: positional or telemetry data from the Remote (510) and sensor data, such as the speed of the car, transmitted wirelessly from sensors within the Electronic Control System (500). The Communication block (531) is divided into three parts: the Antenna (510), Receiver (523) and Transmitter (525). The Motor's Microcontroller (534) processes the telemetry data, sensor data sent from the Communication block (531), position sensor (527), the cable sensors (566) and the actuator (563). then determines the appropriate commands to be issued to the Bi-Directional DC Motor (460) and the Power Management System (535). The Motor's Microcontroller (534) decides real-time by constantly monitoring and reconciling the stream of data. The Transducers (532) executes the instructions from the Motor's Microcontroller (534). The Transducers (532) comprise of a Power Management System (535), sensors or linear encoders (566) and actuators (563). The distinct parts of the Transducers (563) are typically integrated in many of today's commercial power supply solutions and comes with standard communication interfaces referred to application protocol interface (API) for the Motor's Microcontroller (534) to communicate. The Sensor (566) detects the amount of cable spooled and the speed of the Cable (433) moving into and out of the spooler. These sensors (566) are also commercially available in myriad forms, such as magnetic sensors which can be embedded into the Cable Spooler (430) or an infrared sensor place where the Cable (433) comes out of the Cable Drive System (400). The Actuator (563) which is typically a part of commercially intelligent motor systems receives instructions from the Motor's Microcontroller (534) also through standard API.

Figure 15 illustrates the Tracker (580) which is a simple transponder that sends out its location to the Controller (530). The Tracker (580) contains a Power Source (490) which powers up the Position Sensor (527) as described in patent 534263 and sends the telemetry via the transmitter (525). Furthermore, 534 presume a built-in power management module which has the ability to turn on and off the Tracker (580). The Power Source (490) can be a battery or a solar battery combination system.

The following set of heuristic governance by Controller's (530) Microcontroller (534) illustrates the relationships between the various parts of the Remote (510), the Controller (530), the Power Management System (535), the Bi-Directional DC Motor (460).

Rule 1:	If the "Come" (517) signal is sent by the Remote (510) to the Controller's Microcontroller (534), then do the following: instruct the Power Management System (535) to supply power to the Bi-Directional DC Motor (460), instruct the Actuator (563) to release the Cable (433) and start tracking the data from the Sensors (566).
Rule 2:	If the "Faster" (515) signal is sent by the Remote (510) to the Controller's Microcontroller (534), then the Motor's Microcontroller (534) tells the Actuator (563) to increase the speed of the Bi-Directional DC Motor (460) by 1 unit. The Bi-Directional DC Motor (460) will crank the Drive Axle (419) faster by 1 unit as predefined in the program running in the Motor's Microcontroller (534).
Rule 3:	If the "Slower" (514) signal is sent by the Remote (510) to the Controller's Microcontroller (534), then the Motor's Microcontroller (534) tells the Actuator (563) to decrease the speed of the Motor by 1 unit. The 1 unit must be predefined in the Motor's Microcontroller (534) and the quantum can be different than the 1 unit of speed increase.
Rule 4:	If the "stop" (511) signal is sent by the Remote (510) to the Controller's Microcontroller (534), then the Motor's Microcontroller (534) tells the Actuator (563) to stop the Bi-Directional DC Motor (460). There are various means of stopping the Bi-Directional DC Motor (460). The three options are: the Actuator (563) cuts off the power supply or the Power Management System (535) cuts off electricity or both modes are done.
Rule 5:	If the "go" (519) is sent by the Remote (510) to the Controller's Microcontroller (534), then at the Motor's Microcontroller (534) tells the Actuator to start the Bi-Directional DC Motor (460) with a start unit. This start unit is predefined in the Motor's Microcontroller (534) and the quantum can be different than the 1 unit of speed increase or decrease.
Rule 6:	If the Motor's Microcontroller (534) detects an overstrain situation on the cable, then the Motor's Microcontroller (534) implements Rule 4. An overstrain situation is defined as the Bi-Directional DC motor (460) exerting more than the threshold force needed to pull up the Car (200). This threshold is set programmatically in the Motor's Microcontroller (534). There are two possible causes for this occurrence. The first is when the brake of the Safety & Handle system (300) has been engaged. The second is the Car (200) is loaded beyond the weight limit. The Motor's Microcontroller (534) can detect the overstrain situation with sensors (566) which acts as a feedback loop to the Actuator (563). The Motor's Microcontroller (534) will constantly compare the data from the sensors (566) and the actuator (563). For example, if the Actuator (563) estimates from the amount of electricity that it had supplied the

	Bi-Directional DC Motor (460) and determines that the amount of cable that should have been wound up should have been 10 meters, yet the sensors (566) reads out 9.97 meters, then it will enact Rule 4. The real-time monitoring of Motor's Microcontroller (534) is done through the Controller's (530) communication block (531) where it polls the Remote (510) to ascertain the location of the Car (200). Assuming that the rider is holding the Remote (510) and is on the Car (200), the Microcontroller can verify the overstrain situation through the position sensor (527) of the Remote (510). If the position of the Remote (510) correlates with the amount of cable which in this example are 9.97 meters, then it immediately implement Rule 4. It should be noted that calibration has to be done during set-up so that the Motor's Microcontroller (534) can correlate the length of the cable to the telemetry data.
Rule 7:	If the Motor's Microcontroller (534) calculates an over-slack situation, then the Motor's Microcontroller (534) implements Rule 4. An over-slack situation happens when the Car (200) descends slower than the rate of cable (433) release. An over-slack can be detected by reconciling the data collected on the speed of cable (433) at the sensors (566), the telemetry from the position sensor (527) and the actuator (563). For example, data from the position sensor (527) tells the Motor's Microcontroller (534) that there should be only 10 meters of cable from the cable spooler to the Car (200), yet the sensor (566) at the Controller (530) says that 10.1 meters of cable is out from the cable spooler (430). The Motor's Microcontroller (534) can double check by estimating the amount of cable that is out from the Cable Spooler (430) from the voltage used by actuator (563) to turn the Drive-Axel (419) and if the estimate turns out to be 10.1 meters, then an over-slack situation has happened.
Rule 8:	Rule 8 is designed to take to stop the Car (200) in the event the rider becomes separated with the Safety & Handle system (300). The detection of this event is enabled by the transponder in the Tracker (580) and the Remote (510). In this scenario, it is assumed that the Tracker (580) is affixed to the Safety & Handle system (300) and the Remote (510) is in the hands of the Rider who sits on the Car (200). When the Controller (530) detects that the Tracker's (580) location is more some distance from the Remote (510), the Controller (530) will instantly execute Rule 4. This prevents two possible scenarios, the Safety & Handle system (300) becoming disconnected from the Car (200) or the rider falling off the Car (200). The distance can define programmatically.

Figure 16 illustrates the Track System (600) which supports and guides the Car (200). Figure 16 presents the Track System (600) in three perspectives: side, front and top views. The base plate (645) can be welded or bolted to the joint plates (643). The joint plates (643) support two Horizontal-Bullhead rails (633). The left upper panel of Figure 16

depicts a frontal cross-section of the Track System (600) where the profile of the horizontal-bullhead rail (633) made up of outer ridges (635) and valley (637) can be seen. These profile features are essential to guide the wheels of the Car (200).

Figure 17 illustrates a Connector Rail (660) which connects two straight tracks. The construction of the Connector Rail (660) is very similar to the straight rails except for the semi-circular shapes that allows for corner fittings. The semi-circular shape can be seen from the top view as illustrated in the bottom left panel of Figure 17.

Figure 18 illustrates the Extender Arms (610) of the Track System (600) which are found at the end of the Track System (600). The Extender Arm (610) narrows the height gap between the Horizontal-Bullheadrail (633) and the ground. The Extender Arm (610) allows the Car (200) to reach the wheelchair. Figure 18 has four panels. The top panel shows the lower-arm (613) retracted while lower panel shows the lower-arm (613) extended. In the top right panel of Figure 18, the lower-arm (613) is retracted. It will be extended when the Car (200) rolls over Pawl (617) embedded in the upper-arm (633) which in turn releases the single-tooth-gear (615). The lower-arm (613) sits on the single-tooth-gear's (615) L-bevel. Gravity will pull on the lower-arm (613) with the release of the Pawl ((617) while rotating the single-tooth-gear (615). At this stage, the Pawl (617) will rest on the smooth side of the single-tooth-gear (615). The opposite happens when the Car (200) moves away from the lower-arm (614). The wheels of the Car (200) will push against the protruding part of the single-tooth-gear (615). The L-bevel of the single-tooth-gear (615) in turn will raise the lower-arm (613). The Car (200) clears the single-tooth-gear (625) and pushes down on the Pawl (617) and the Pawl (617) drops back into the groove of the single-tooth-gear (625).

Figure 19 illustrates the bobbin (670) which ensures that the cable does not get entangle or cut into any parts of the Handrailing. The Bobbin (670) will sit above the connector railing (660).

Figure 20 illustrates on how the Car (200), Cable Drive System (400) and Extender Arm (610) interacts. The top panel of Figure 20 depicts the Car (200) being pulled towards the Extender Arm (610). The lower panel of Figure 20 depicts the Car (200) resting on the lower-arm (613) of the Extender Arm (610).

CLAIMS

What is claimed:

Claim 1: a method comprising of 5 sub-systems working in conjunction to transport a wheelchair bound person from one point to another. The five subsystems are a Car sitting on a track system bounded to a safety system called the Safety & Handle driven by a Cable Drive System and controlled by an electronic control system.

Claim 2: the Car comprising of a flexible alloy body reinforced by metal plates with four wheels on protruding prongs on each of its corner. The car has four ports in its flexible alloy body: dorsal, mid-port, third and fourth ports. The dorsal port holds the pendulum-dampener with a high tensile metal pin. The mid-port is located in the dead-center of the curve alloy body holds the pendulum. The car dampener from the Safety & Handle system is connected to Car via the third port. The cable from the Cable Drive System is connected to the fourth port.

Claim 3: the Pendulum on the Car supporting the weight of the object being transported and balances the object being transported by keeping the object parallel to the ground.

Claim 4: the Pendulum-Dampener in a shape of a pneumatic pump is connected to the Pendulum to ensure the Pendulum does not swing unpredictably.

Claim 5: a metal block that forms the pendulum head housing two extendable long rods which contain two shorter extendable rods provide the means to carry the wheelchair.

Claim 6: the Safety & Handle system anchored to the staircase's handrails design to prevent unpredictable movements from the Car. The stopping and stabilizing mechanism is enabled by the Brake Pneumatic situated outside of the Front Plate of the Safety & Handle system and connected to the Stopper by a high tensile screw which in turns is able to run the Brake Blade along the Guide Edges until it hits the Brake Pad forcing the Safety & Handle system to halt.

Claim 7: the plates of the Safety & Handle system are shaped like two "broad beans" or the head of eagles to minimizes the weight and reduce the area needed to house the components.

Claim 8: the Brake Pneumatic and Car Dampener on the Safety & Handle system are compound pneumatic systems design to absorb shocks coming from the Car.

Claim 9: the Electronic Control System consists of transceivers affixed to the Safety & Handle system, remote control and Cable Drive System enables real-time control of the Car movements.

Claim 10: the Motor's Microcontrollers ability to control the Car by comparing telemetry data from the Remote, Safety & Handle system against the data from the sensor that tracks of the length of cable spooled, data from the actuators and the power data from the Power Management Unit.

Claim 11: the heuristics rules placed on the motor's microcontroller to coordinate the Cable Drive System, Safety & Handle System and the rider on the Car.

Claim 12: A double track system with curve connectors which can be affixed to any staircase to support the Car.

Claim 13: the track extender which closes the gap between the track rails and the ground. The extender allows the rider on a wheel chair to get off the Car smoothly.

Claim 14: the Bobbin to prevent the cable from cutting into any of the handrailing. The Bobbin is typically found on corners of stairs and mounted on balusters or walls.

Claim 15: the Cable Drive System comprising of an electronic system as in Claim 9 controlling a bi-directional DC motor with a system of four rollers controlling the spooling and unspooling of the cable.

Abstract
Free Climber System

The Free-Climber System (100) is a system for transporting a wheelchair bound person from one point of a staircase to another. The system comprise of a Car (200) connected to a Safety & Handle system (300) and driven by a Cable Drive System (400). An electronic control system (500) enables the Car (200), Cable Drive System (400) and Safety & Handle system (300) to communicate. The Car (200) is supported on a Track System (600).

Figure 1