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(54) **TREADMILL PROVIDING CONSTANT TORQUE AT MULTIPLE INCLINES**

(71) Applicants: **JARED KUEKER**, ST. CHARLES, MO (US); **JORDAN PAULSON**, GLEN CARBON, IL (US); **DAVID GREEN**, ST. CHARLES, MO (US); **SEAN LEAHY**, ST. LOUIS, MO (US); **TOM RUSSO**, ST. CHARLES, MO (US); **YARNELL BOYD**, FLORISSANT, MO (US)

(72) Inventors: **JARED KUEKER**, ST. CHARLES, MO (US); **JORDAN PAULSON**, GLEN CARBON, IL (US); **DAVID GREEN**, ST. CHARLES, MO (US); **SEAN LEAHY**, ST. LOUIS, MO (US); **TOM RUSSO**, ST. CHARLES, MO (US); **YARNELL BOYD**, FLORISSANT, MO (US)

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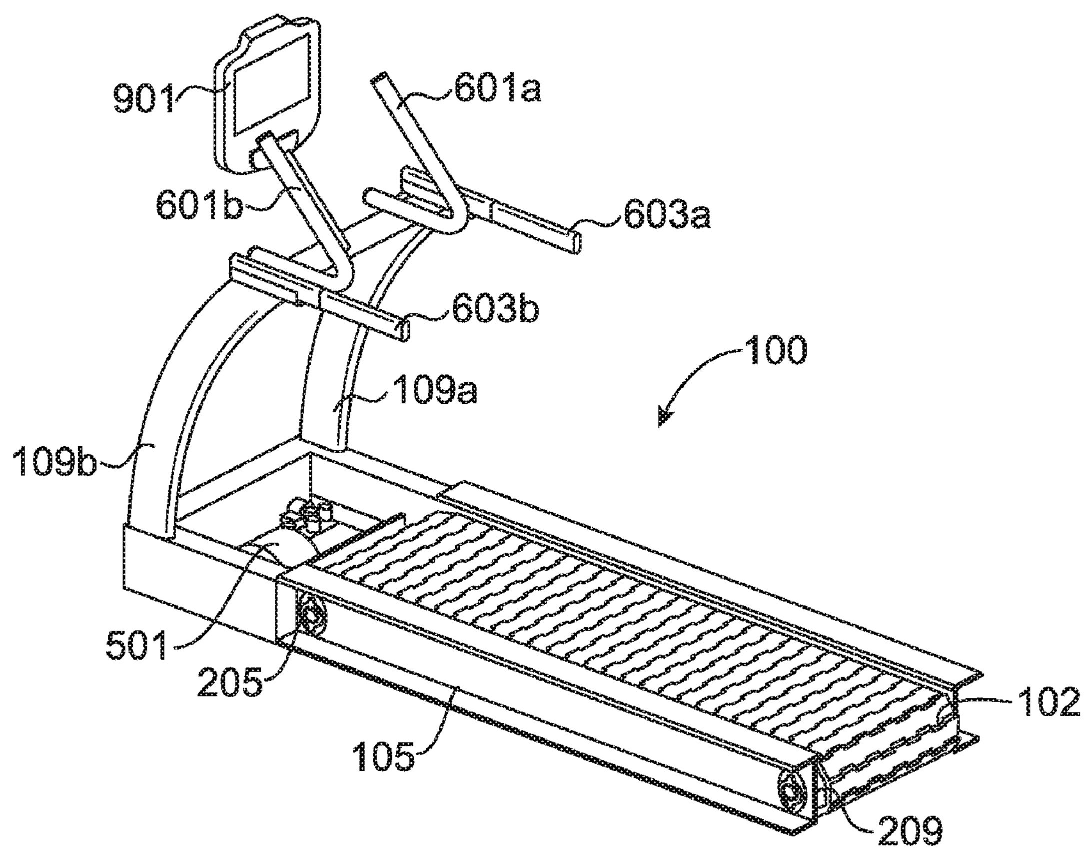
(57) **ABSTRACT**

Treadmills or similar exercise devices which utilize a motor driven belt which can be used to provide a powered running surface, but can also be used to provide a resistance to movement of the belt to allow a user to have to manually drive the belt at a constant resistance or torque regardless of incline. This later mode of operation is akin to the pushing or pulling of a weight sled and can be arranged so that a user can be required to supply a constant torque over a range of inclines.



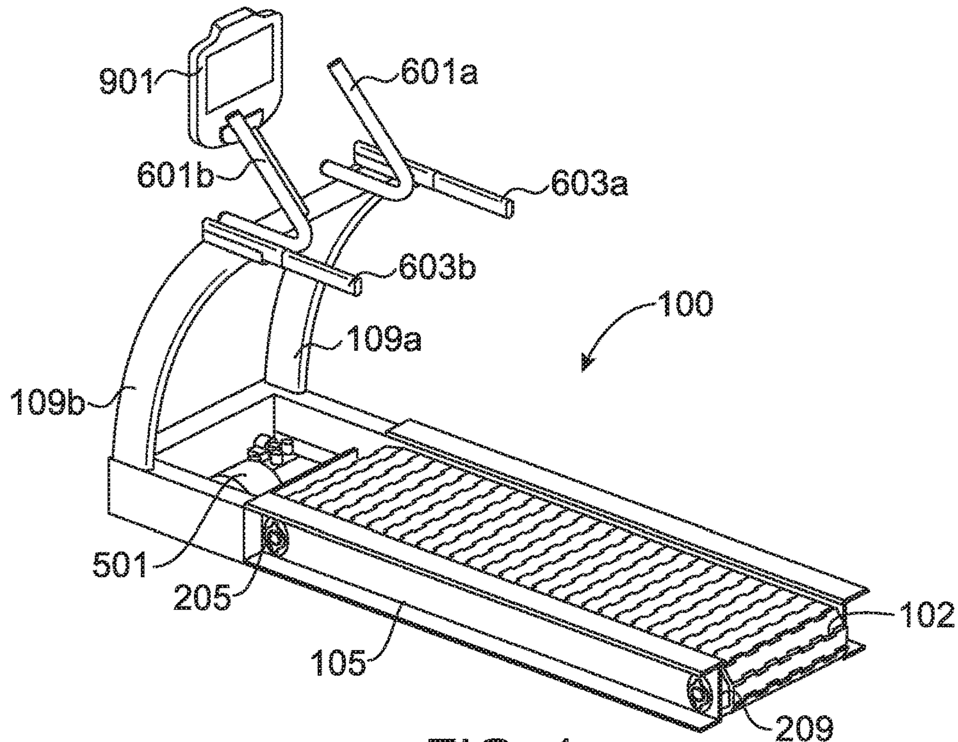

901
601a
601b
603a
603b
100
109a
109b
501
205
102
105
209

FIG. 1

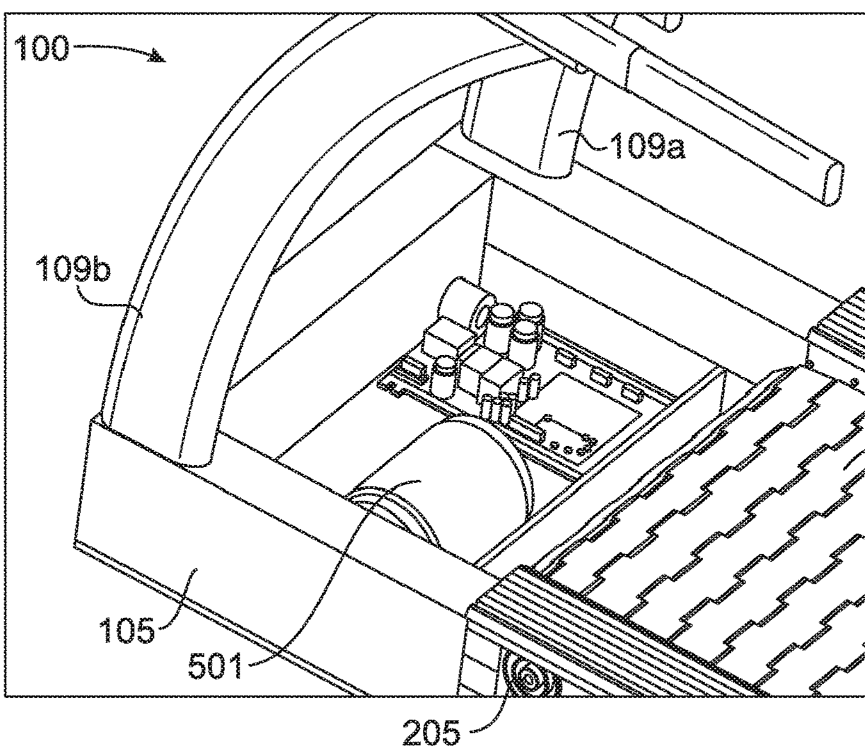
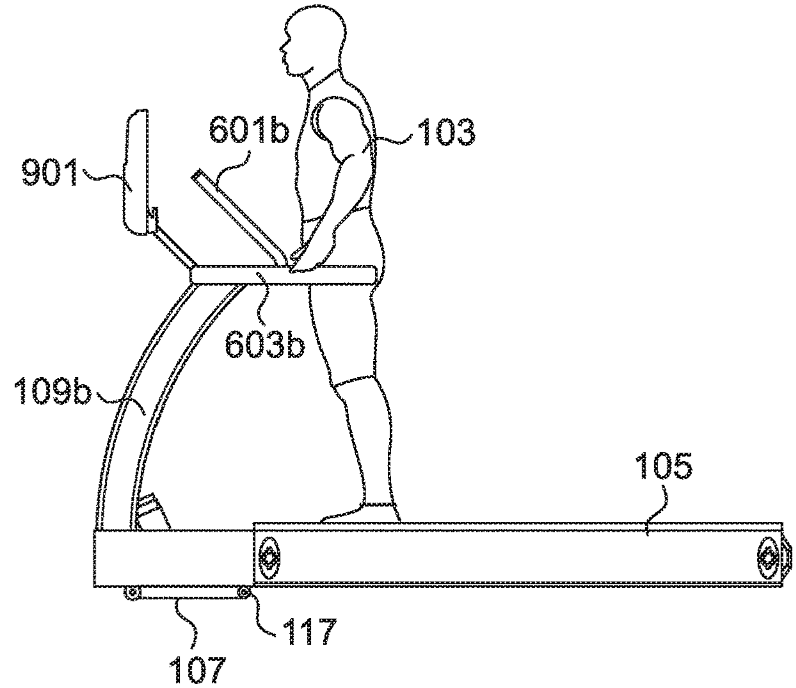
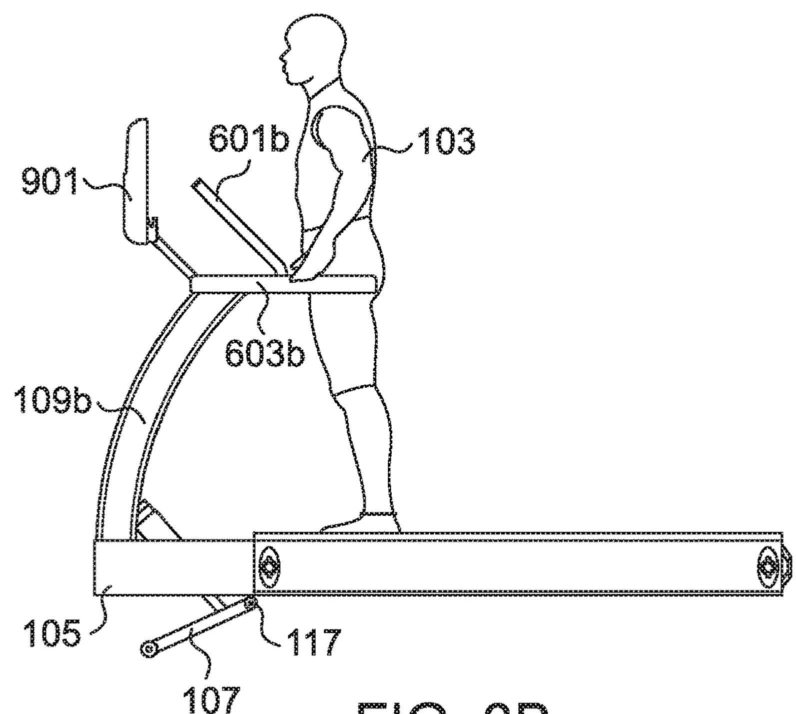

100
109a
109b
102
105
501
205

FIG. 2



601b
901
103
603b
109b
105
117
107

FIG. 3A



601b
901
103
603b
109b
105
117
107

FIG. 3B

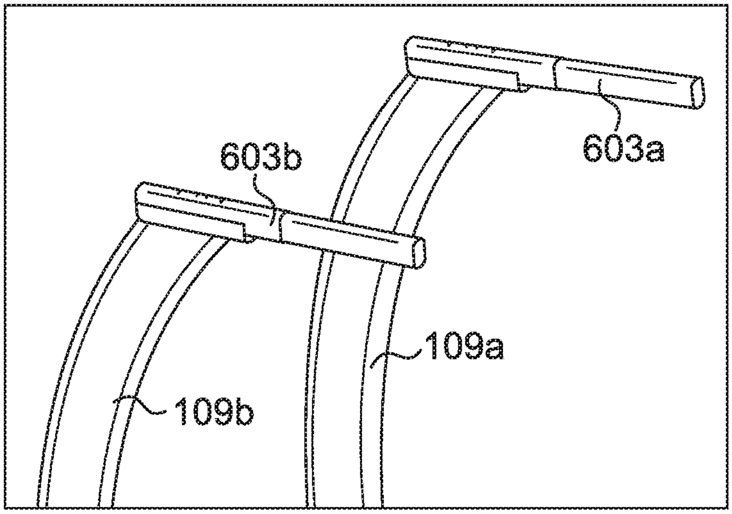


FIG. 4

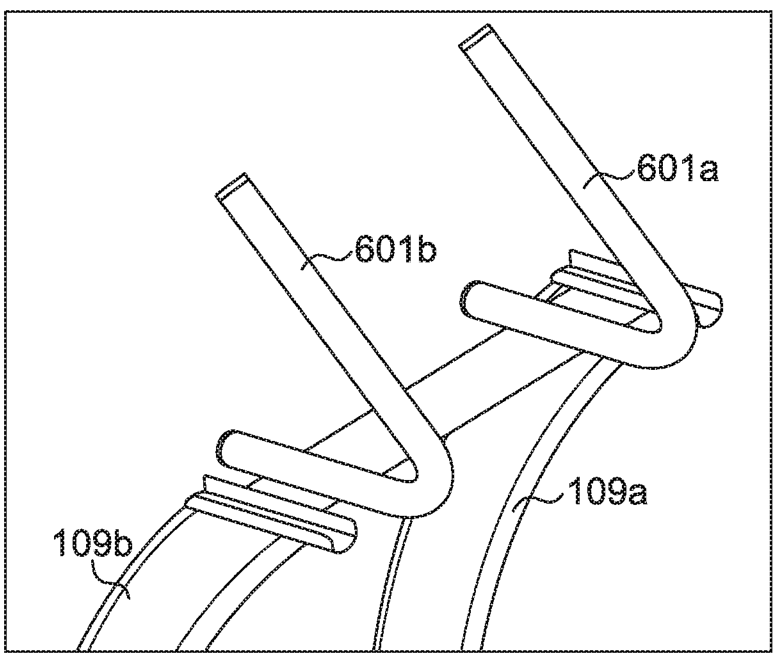


FIG. 5

TREADMILL PROVIDING CONSTANT TORQUE AT MULTIPLE INCLINES

BACKGROUND

1. Field of the Invention

[0001] This disclosure relates to exercise devices, such as treadmills, which utilize both user motion and a motor in various combinations to drive the machine. Specifically, the machines provide for the motor to alter the torque required to move the belt on the treadmill and allow a user to exercise both by simply keeping up with the moving belt, and by the user moving the belt against a constant torque over a variety of inclines.

2. Description of the Related Art

[0002] The benefits of regular exercise on individuals of any age are well documented in fitness science. Exercise can dramatically improve body function, lead to weight loss, increase metabolism, and help ward off a variety of maladies, among other benefits. At the same time, exercise has often been linked to damaging effects, particularly to joints or similar structures, where the impact from many exercise activities can cause injury. Further, while any form of exercise can be beneficial, specific types of exercise are more commonly linked to particular benefits and, therefore, it is desirable to be able to provide users of exercise equipment with equipment that specifically caters to their needs. This is particularly true of exercise machines where particular machine designs can provide exercises that may otherwise be unavailable or difficult to perform.

[0003] Today's conventional treadmills typically operate by employing a motor to rearwardly drive an endless belt upon which the user runs, walks, or otherwise engages in ambulatory leg movement, generally in a direction opposing the rotational direction of the belt. As the user is moving in opposition to the belt, the user therefore "moves" in order to remain in place. Generally, a user of a conventional treadmill is able to vary the speed of the treadmill to obtain a desired level of workout, such as by increasing the speed at which the motor drives the belt to accelerate the speed of the belt and increase the necessary user movement speed. Alternatively, the user can make the workout more difficult by increasing the incline to simulate moving uphill. More sophisticated motorized treadmills, such as those described in U.S. Pat. No. 5,462,504, the entire disclosure of which is herein incorporated by reference, automatically adjust the speed and incline of the treadmill to control the heart rate of the user during the exercise.

[0004] Conventional treadmills of this type function to exercise the user's cardiovascular system (cardio exercise) and, to some extent, the skeletal muscles of the lower body. However, such treadmills are generally not considered to provide resistance exercises designed to tax muscles and bone and result in the body adding muscle and bone mass. Resistance exercises, while they do not necessarily result in the body burning fuel (calories) to the extent that cardio exercise does during the exercise activity, generally serve to make the body stronger and require more fuel to operate. As such, resistance exercises can result in both weight loss benefits and general physiological improvement.

[0005] All resistance training essentially involves strengthening and toning muscles (as well as, to a lesser extent, bones) by contracting the muscles against a resisting force. There are basically two types of resistance training. Isometric resistance involves contracting muscles against a non-moving object, such as against the floor in a push-up and generally utilize the individual's own mass as the resistance, while isotonic strength training involves contracting muscles through a range of motion utilizing an external mass, as in weight lifting.

[0006] Traditional resistance training utilizes gravity to provide the resistive force on the mass that the muscles are used to oppose. For example, the mass is lifted to a vertically higher position by a particular muscle in order to train that muscle. However, it has long been recognized that gravity (acting on a mass) is not the only force that can be used in resistance training. For example, in isotonic exercise, the biasing force of a spring can be used as the resistance, as can friction, electromagnetic, or torsional forces. These other forces are often preferred in certain kinds of exercises as the (generally experienced) force of gravity is in a specific direction relative to the surface of the earth which can limit the type of exercises a human being is physically capable of having their body perform against gravity.

[0007] Most modern treadmills provide relatively minimal resistance to the user. The user has to utilize muscles to propel the user's body off the belt and "forward" to avoid being moved by the belt, but the force required is not in the nature of overcoming a large amount of resistance. Instead, it is of simply carrying out the mechanical action of walking or running, carrying the individual's unaltered weight. The limited resistance is in pushing the body sufficiently upward to allow the leg to swing to the next step. As walking and running are activities frequently performed by the human body, the musculature of the average person is well adapted to this motion. Carrying it out, even for a long time, often does not provide a large amount of strain on the muscles compared to even a small amount of pure resistance training. As the primary strain is on the heart in such an exercise, these types of exercise are good for working the cardiovascular system.

[0008] To get more resistance, treadmill users have traditionally added inclination to the treadbase, which supports the moving belt and/or have increased their weight by carrying dumbbells or wearing weighted clothing. In a higher incline scenario, the user not only needs to carry out the mechanical motion of moving the body "forward," but is effectively having to lift the mass of the body upward with every step. This is why activities such as mountain, stair, or rock climbing are often more akin to resistance exercises than cardio exercises. These exercises utilize the body as a lifted mass to a much greater extent than running or walking on a flat surface.

[0009] Another way to obtain some resistance in a walking or running exercise is to utilize a simple treadmill which does not use a motor to supply the belt's rotary motion. These types of machines instead rely on the user of the treadmill to provide his/her own motion, which is imparted to the belt. To allow for continuous in-place motion, non-powered or "motorless" treadmills traditionally are designed to support the endless belt on some incline such that the belt rotates rearwardly as a result of the weight and forward stride of the user overcoming belt friction. In effect, these types of treadmills add some resistance to the walking or running motion through the use of the internal friction of the components which can often be altered through the inclusion of resistive brakes and similar structures.

[0010] Self-powered treadmills have a couple of major problems, however. Once the incline is set, these types of treadmills can feel unnatural to the user because changes to the belt speed depend only upon the amount of additional rearward force the user is able to apply. A faster running movement is unlike actual running, because the stride must be changed at the time of increasing speed to impart sufficient force to the belt to generate the speed of the belt necessary for the running movement, since no motion is supplied externally by a motor. For example, without interrupting an exercise session to adjust the incline, a user wishing to increase the speed of a user-driven belt must push down and/or forwardly on hand rails or arm members in order to change the amount of rearward force applied to the belt. Such a motion is not a natural change to a person's stride when increasing speed. This can result in stride changes and can be damaging to those training for specific sports.

[0011] Further, traditional motorless treadmills cannot effectively use both incline and speed to independently alter exercise characteristics because the weight of the user, incline, and speed are all related. Therefore, when the incline is increased, the speed also increases and commonly the force required to overcome the friction of the belt components is reduced. Essentially, in a motorless treadmill, while the user gains resistance from having to lift the body, the force of the body being pulled back down by gravity actually serves to counteract the force of friction of the belt components that the body needs to overcome. While in some cases this may be desirable, in many cases it is not.

[0012] In particular, many desirable cardiovascular workouts use periods of walking on high inclines followed by periods of running on low inclines. This type of exercise cannot be performed on traditional motorless treadmills because as the incline is increased, the user necessarily must move faster based on the design of the machine. Further, motorless treadmills typically produce variations in torque based on the type of exercise being performed. For example, a user running at a high incline will generally have to produce less force to maintain or increase his/her speed than a user would need when running at a low incline. Further, the torque required to start moving the belt is often greater than the torque to maintain the belt's movement at a given speed.

[0013] To deal with some of these problems, U.S. Pat. Nos. 5,688,209 and 5,871,421, the entire disclosures of which are herein incorporated by reference, describe motorless treadmills which allow the user to supplement the motion of the belt with the motion of their arms to eliminate or reduce some of the issues of being unable to control speed and incline separately. These treadmills provide both an upper and lower body workout as they provide for upper body power being transferred to the rotation of the belt. These treadmills also help to eliminate the need to use unnatural leg motions to produce different speeds which improves the natural feeling of the exercise motion and helps to provide separate control over incline and speed. If a user wishes to go faster, the user can increase the speed of the belt by increasing the rate (or power) applied to the arm members which accelerates the belt without the user having to alter the user's stride in an unnatural fashion or stop the exercise and alter the incline of the belt.

[0014] While these devices are an improvement over what was previously available as they allow for, among other things, less incline for similar speed which allows for a generally more normal gait, they still have a noticeable problem. In order to prevent the user from having to alter their stride unnaturally to accelerate the belt beyond a speed easily obtained by a preset incline, the user is required to pump his/her arms harder and/or faster. For many users, this is not a problem, and provides for a natural motion because as they increase in running speed, their arms naturally reciprocate faster to balance. For some, particularly those with less upper body strength, the acceleration's necessarily increased demand on the upper body can be undesirable and potentially feel unnatural. Because of the reliance on the limits of propulsive force of the upper extremities and the requirements of most users, the belt speed may again become dependent on the user's rearward force.

[0015] This problem is still further exaggerated when the treadmill is at a low angle of incline. In this situation, the user's weight is pressing the belt into the platform over which it is supported and little of the user's weight serves to help move the belt as it would if the belt was at a higher incline. Therefore, there is a much greater frictional and inertial component which must be overcome to move the belt than when the belt is at a steeper incline. Further, generally a user will wish to start exercising with the belt at a low angle of incline and with a slower speed as that is generally considered a less rigorous exercise and provides for a warm-up period.

[0016] The inertial component at the start of the exercise and the need for increased arm drive and upper body workout to increase speed are one of the concerns with an arm-driven motorless treadmill. Another is that the steeper the incline of the treadmill and the heavier the user, the easier it is to move the belt. This, sometimes, can create problems where the exercise is undesirably fast. With a motorless treadmill, some users can actually move the belt too easily when the platform is greatly inclined forcing the user to have to run faster to keep up with the change in incline or use the upper body to resist the speed increase. For a heavier user, the belt can be acted upon by significant force just from the weight of the user which can result in the user needing to run at an undesirably high speed to keep from falling off the treadmill or from having to push against the arm movement to resist the speed increase. Therefore, at a high incline, the user may experience an undesirable exercise motion.

[0017] A further problem with utilizing an arm drive to counter the changing resistance needs of the exercise is that this often produces an arm resistance exercise, not a leg resistance exercise. For users that wish to perform an exercise which is designed to focus on leg muscles, this does not work.

[0018] Traditional running or walking exercises that produce greater resistance than normal walking or running often require the user to push with the legs against the resistance as part of the walking or running motion. In a simple case, anyone who has walked a long distance in loose sand will understand how much more taxing it is on the body than simple walking. It is taxing because the sand moves under the foot as the user pushes against it and therefore much more force is required to propel the foot off the surface.

[0019] Another such exercise that allows for increased resistance is to have a user run or walk while pushing or pulling an object. One of the most well known of these exercises is pushing an object commonly referred to as a weight sled or "blocking sled" such as the device shown in U.S. Pat. No. 3,827,690, the entire disclosure of which is herein incorporated by reference. A weight sled is essentially a heavy mass that a user pushes or pulls along the ground on high friction runners as the user attempts to run or walk with the sled. The sled is designed to have a relatively high coefficient of friction against the surface over which it is pushed, and a substantial mass, resulting in the user having to push at a steep angle to the ground to move the sled.

[0020] From a resistance point of view, the pushing of a particularly heavy blocking sled is similar to the classic strongman competition of towing a car, train, tractor-trailer, or other massive object. In all such resistance exercises, the user must utilize major leg muscles to push not just the body, but the entire mass of the object horizontally. As the mass of these objects is typically great and they have large standing inertia, without utilizing the largest leg muscles, the user will have no hope of moving the object efficiently. As such, a user moving such an object will typically lean forward. This allows the legs to become closer aligned with the direction of travel and result in the largest leg muscles working against the inertia and friction related to moving the mass.

[0021] This position of leaning forward and pushing against the ground provides for a unique form of exercise. The user cannot be completely horizontal, as the user would then have nothing to push against to move the object. Similarly, the more vertical the user is, the more force from the long leg muscles that serves to simply lift the user upward as opposed to moving the mass horizontally. Thus, by having an angle with the ground, the user can supply a certain amount of force in the horizontal direction from the long leg muscles. Because of the uniqueness of the motion, a weight sled can be a very valuable piece of exercise equipment. Lighter sleds (less resistance) can provide for excellent endurance exercises and running acceleration improvements while heavier sleds (greater resistance) can provide for good strength exercises.

[0022] While weight sleds are great training tools, they have a major weakness. They require a sled to be dragged or pushed over a surface. This means they often have to be used outside on non-paved surfaces. When used inside they can damage floors (particularly if they are very heavy) and when used on hard surfaces they can be loud and can be damaged by the surface. Many people want to exercise inside their home for various reasons and this can make use of a weight sled very difficult.

SUMMARY

[0023] The following is a summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. The sole purpose of this section is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0024] Because of these and other problems in the art, discussed herein are treadmills or similar exercise devices which utilize a motor driven belt which can be used to provide a powered running surface, but can also be used to provide a resistance to movement of the belt to allow a user to have to manually drive the belt at a constant resistance or torque regardless of incline. This later mode of operation is akin to the pushing or pulling of a weight sled and can be arranged so that a user can be required to supply a constant torque over a range of incline.

[0025] There is described herein, in an embodiment, a treadmill comprising: an endless belt arranged to rotate about at least one roller; a motor, the motor being configured to rotate the roller so as to rotate the endless belt in either direction; and a controller, the controller altering speed and direction of the motor; wherein, the controller controls the motor to rotate the endless belt at a variable speed effective to cause the amount of force required by a user disposed on the endless belt to rotate the endless belt is constant across a plurality of inclines of the endless belt.

[0026] In an embodiment of the treadmill, the amount of force required by a user is a constant amount of force.

[0027] In an embodiment of the treadmill, the constant relation is based on a weight of a user.

[0028] In an embodiment of the treadmill, the roller rotates the endless belt in a direction opposing a direction a user is pushing the belt.

[0029] In an embodiment of the treadmill, the motor changes direction of the endless belt rotation during a user exercise.

[0030] In an embodiment, the treadmill further comprises two sets of handgrips.

[0031] In an embodiment of the treadmill, one of the two sets of handgrips is positioned for a user standing upright and the other of the two sets of handgrips is positioned for a user leaning over.

[0032] In an embodiment of the treadmill, the amount of force required by a user simulates the user pushing a weight sled.

[0033] In an embodiment of the treadmill, the amount of force required by a user simulates the user pulling a weight sled.

[0034] There is also described herein, in an embodiment, a method of controlling operation of a treadmill comprising: providing a treadmill including: a running belt arranged to rotate about at least one roller; and a motor, the motor being configured to rotate the roller so as to rotate the running belt a first direction and an opposing second direction; and activating the motor to rotate the running belt in the first direction at a first speed when the running belt is at a first incline; instructing a user to push the running belt in the second direction; altering an incline of the running belt from the first incline to a second incline; and altering a speed of the running belt from the first speed to a second speed; wherein the alteration of the speed from the first speed to the second speed occurs in constant relation to the alteration of the incline from the first incline to the second incline.

[0035] In an embodiment of the method, the amount of force required by the user to push the running belt in the second direction is the same at the first incline and the first speed as at the second incline and the second speed.

[0036] In an embodiment of the method, the constant relation is based on a weight of the user.

[0037] In an embodiment of the method, the treadmill further includes two sets of handgrips.

[0038] In an embodiment of the method, one of the two sets of handgrips is positioned for a user standing upright and the other of the two sets of handgrips is positioned for a user leaning over.

[0039] In an embodiment of the method, the second speed is zero.

[0040] In an embodiment of the method, the amount of force required by a user simulates the user pulling a weight sled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] FIG. **1** is a rear perspective view illustrating an embodiment of a treadmill having a motor located forward of the front drive roller.

[0042] FIG. **2** is a detail view of the embodiment of FIG. **1**.

[0043] FIGS. **3**A and **3**B are side views of the embodiment of FIG. **1** positioned level (FIG. **3**A) and at an incline (FIG. **3**B).

[0044] FIG. **4** is a perspective view of the embodiment of FIG. **1** with the active resistance handgrips removed to illustrate the running handgrips.

[0045] FIG. **5** is a perspective view of the embodiment of FIG. **1** with the running handgrips removed to illustrate the active resistance handgrips.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0046] The following detailed description and disclosure illustrates by way of example and not by way of limitation. This description will clearly enable a person of ordinary skill in the art to make and use the disclosed system and method, and describes several embodiments, adaptations, variations, alternatives, and uses of the disclosed subject matter. As various changes could be made in the above construction without departing from the scope of the disclosure, it is intended that all matter contained in the description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

[0047] It should be recognized that the disclosure herein is focused on treadmills which utilize a running belt formed of individual slats (a conveyor chain) to provide the exercise as this is the device primarily pictured in the FIGS. While this is a valuable exemplary embodiment, one of ordinary skill in the art would understand that such structure is by no means required and the treadmill may use other kinds of running belts such as continuous fabric belts. Further, the systems and method discussed herein are also not limited to treadmills. Other types of exercise machines such as, but not limited to, ellipicals, exercise bikes, stairmills. Jacob's ladder systems, and other machines that utilize the repeated motion of a user's legs and/or arms can benefit from being able to have an alterable torque supplied to user motion where the torque can be selected independently of user mass or machine incline and particularly where torque can be constant within an exercise while other variables are adjusted.

[0048] FIGS. **1** and **2** provide an embodiment of a treadmill (**100**) which includes an endless belt (**102**) formed from a plurality of slats or links riding upon a support surface or treadbase (not visible) and supported by a base (**105**). The treadbase will generally be a low friction support to eliminate as much friction as possible between the belt (**102**) and the treadbase created by the weight of the user (**103**) pressing the belt into the treadbase when the user stands on it. The surface upon which the treadmill (**100**) rests will generally be referred to as a "floor" in this document. If desired, the base (**105**) may be arranged on an inclined floor, and in an alternative embodiment, the base (**105**) may be designed to place the treadbase generally parallel to the floor.

[0049] As shown in FIG. **3**, the incline of the treadbase relative to the floor is preferably variable during or before commencement of exercise by any suitable device, such as by providing manually or automatically adjustable feet or framing members, including pneumatic, hydraulic, or electromagnetic actuators, or motor-driven elevation systems. These systems may move the treadbase relative to the base (**105**) or may move the base (**105**) and treadbase assembly relative to the floor.

[0050] The elevation systems depicted in FIG. **3** comprise lift legs (**107**) which can serve to raise the front of the base (**105**) by rotating about an axis of rotation (**117**) to extend downward into the floor. The rotational motion of the lift legs (**107**) results in the front of the base (**105**) being raised relative to the floor and therefore moving the treadbase to a position with an increased incline such as is shown by comparing FIG. **3**A to FIG. **3**B. In another embodiment, motor driven elevation systems such as those described in U.S. Pat. No. 5,462,504, the entire disclosure of which is herein incorporated by reference, could be used.

[0051] The depicted treadmill (**100**) includes two generally upright arm supports (**109***a*) and (**109***b*). Right and left are arbitrarily assigned in this description and are based on the perspective of the user (**103**) when walking on the belt (**102**) in the preferred exercise direction as shown in FIGS. **3**A and **3**B. Also, for ease of understanding, components which have a symmetrical counterpart on an opposite side of the treadmill are numbered such that those on the right are denoted by the lower case letter "a" and those on the left by the lower case "b."

[0052] As best shown in FIGS. **1** and **2**, the base (**105**) supports the treadbase. The belt (**102**) in turn is arranged so as to rotate over the treadbase around two rollers. In this embodiment, the drive roller (**205**) is generally a roller located toward the front of the treadbase while the idle roller (**209**) is located toward the rear. However, changes to the relative sizes and positions of the drive roller (**205**) and idle roller (**209**) may be made and the location of the two rollers (drive and idle) may also be reversed depending on embodiment.

[0053] Because the depicted belt (**102**) is generally flexible so as to be able to roll around the rollers (**205**) and (**209**), the belt (**102**) is supported on the user (**103**) side of the treadbase by the treadbase, which is generally rigid. The depicted belt (**102**) is preferably tensioned around the two rollers (**205**) and (**209**). In an embodiment, the specific amount of tension may vary based on embodiment and the belt (**102**) will generally be tensioned so as to move in close proximity to the treadbase. Generally, the belt (**102**) will be pushed into the treadbase when the user (**103**) is running or walking on the belt (**102**), because the user's weight will push the belt (**102**) into the treadbase. Preferably, however, there is insufficient friction between the belt (**102**) and treadbase to prevent the belt's (**102**) motion.

[0054] As the drive roller (**205**) rotates, the belt (**102**), which is coupled thereto in a manner so as to not slip under ordinary loads, rotates rearwardly at the top side as the treadbase. The belt (**102**) may be arranged so as to not slip on the drive roller (**205**) by providing proper tensioning, by utilizing proper coefficients of friction, by having treads in the underside of the belt (**102**) which engage with counterpart treads (not shown) on the drive roller (**205**), or by any other method. The idle roller (**209**) is provided at the rear of the treadmill (**100**) to redirect the belt (**102**) forwardly under the treadbase. As can be appreciated, the functions of the rollers (**205**) and (**209**) can be reversed. For example, the idle roller (**209**) can be mechanically arranged to function as the driving roller and the drive roller (**205**) can be arranged to act as an idle roller.

[0055] While the weight of the user (**103**) is generally not principally used to propel the belt (**102**), it does have an effect in propelling the belt (**102**). In particular, the effect is determined by the weight of the user (**103**) in conjunction with the incline. With sufficient incline, the belt (**102**) will move freely due to force imposed by the weight of the user (**103**) and the gravitational interaction on the belt (**102**). So long as a sufficient component of the user's (**103**) weight is directed along the movement direction of the belt (**102**) to overcome the frictional force of the user's (**103**) weight in the direction perpendicular to the belt (into the treadbase) which creates friction, the belt (**102**) will rotate under the user's (**103**) weight. The effect of the user's (**103**) weight on the belt (**102**) may be compensated for by the motor (**501**) as discussed elsewhere herein.

[0056] There is also included in the depicted treadmill (**100**) a motor (**501**). The depicted motor (**501**) serves to drive the belt (**102**) when the treadmill (**100**) is being used, at least in certain forms of exercise as discussed elsewhere herein. Generally, the motor (**501**) will directly move the belt (**102**) or will serve to rotate the drive cylinder (**205**) in a preferred direction under a source of power not generated by the user (**103**). The motor (**501**) may be located at any location which is able to transfer motion generated by the motor (**501**) to the belt (**102**) or drive cylinder (**205**). In the embodiment of FIGS. **1** and **2**, the motor (**501**) is located in front of the drive roller (**205**) so as to be generally hidden from view during operation. The motor (**501**) may utilize any kind of transmission system known now or later discovered to transfer motion from the motor (**501**) to the belt (**102**). For example, the transfer of drive from the motor (**501**) to the belt (**102**) may be accomplished by a transfer belt or friction roller. Alternatively, the motor (**501**) may be incorporated into the drive roller (**205**) so that the drive roller (**205**) is directly driven.

[0057] It is important to recognize that the motor (**501**) will serve at least two specific functions in most embodiments. Firstly, the motor (**501**) will provide rotation to allow a user (**103**) to walk or run on the belt (**102**) in a standard or first mode operation. Secondly, the motor will provide either assistance or resistance to the user (**103**) in a second mode of operation where the user (**103**) is forcing the belt (**102**) to move. This second mode of operation is self-powering, where the belt (**102**) does not move in a manner that the user (**103**) is walking or running to keep up, but the user (**103**) is instead forcing the belt (**102**) to move as part of the exercise.

[0058] In operation, the treadmill (**100**) will generally operate as follows in the two principle modes of operation. In the first (standard) mode, the treadmill (**100**) will generally operate under power where the vast majority of the motion of the treadmill (**100**) is provided by the motor (**501**) and the user (**103**) is primarily performing a cardio exercise. In this operation, the user (**103**) is primarily using musculature to propel the user "forward" on the moving belt (**102**) at a speed to keep up with the movement generated by the motor (**501**), but the user is not having to utilize leg muscles to move the belt (**102**). The belt (**102**) is instead moved primarily by the motor (**501**). In the second method of operation, the user (**103**) is instead utilizing leg muscles primarily to move the belt (**102**). This is more akin to the user (**103**) pushing or pulling a large mass across the ground, such as when using a weight sled, and the motor (**501**) is acting as a form of resistance in the exercise.

[0059] In the first mode of operation, the principal power will be provided by the motor (**501**), which will serve to rotate the belt (**102**) at a speed selected by the user (**103**) or by a computer or electronic controller (**901**) controlling the operation of the treadmill (**100**). The user (**103**) will then walk or run at a speed to keep from falling off the back of the belt (**102**) based on the motion imparted by the motor (**501**) to the belt (**102**). This motion is essentially the same as the operation of the vast majority of powered treadmills currently available and well understood by those of ordinary skill in the art.

[0060] In the second mode of operation, the treadmill (**100**) provides a resistance type exercise akin to dragging a weight sled. Specifically, the user (**103**) is forced to impart force to the belt (**102**) to cause the belt (**102**) to move at a desired speed. In this embodiment, the belt (**102**) motion is primarily caused by the user (**103**), instead of the motor (**501**), and the motor (**501**) acts as a form of resistance. In this second mode, the motor (**501**) can operate in a number of different ways, in which the motor (**501**) is effectively a form of resistance.

[0061] In one such operation, the motor (**501**) simply freewheels. In this operation, the motion of the treadmill (**100**) is basically the same as a traditional self-powered treadmill with no motor. The force required to move the belt (**102**) is based on the mass of the user (**103**) and the incline of the treadbase. The motor (**501**), at most, operates as a source of internal friction or as a generator imparting minimal modification to the belt (**102**) movement.

[0062] In a second operation, the motor (**501**) will assist the user (**103**) to move the belt (**102**) but still require the user (**103**) to push the belt (**102**) to go faster than the motor (**501**) is driving it. Generally, the motor (**501**) will supply more assistance when the incline is lower than when it is higher. As discussed above, when the incline is high, the user's (**103**) weight provides additional drive to the belt (**102**). The greater the incline of the belt (**102**), the easier it is to move the belt (**102**) as the friction between the belt (**102**) and the treadbase is decreased and the user's (**103**) weight provides additional assistance to move the belt (**102**) as it is a force directed parallel to the belt (**102**). Therefore, at a higher incline the user (**103**) will generally be forced to run faster than at a lower incline with the same amount of motor (**501**) assist.

[0063] At lower inclines, the weight of the user (**103**) provides less or no aid, and the friction is increased, therefore the user (**103**) generally moves slower. Therefore, if the belt (**102**) is more horizontal, additional force may be provided by the motor (**501**). If the belt (**102**) is more inclined, the motor (**501**) can provide less assistance. In this way the user (**103**) can actually maintain a relatively constant speed through multiple inclines, which can allow for the incline to alter the workout difficulty in a more predictable fashion and can allow the user (**103**) to supply a preset or constant torque to the belt (**102**). This is akin to using a weight sled with a constant mass with the user moving over changing terrain.

[0064] The exact amount of assistance provided by the motor (**501**) may be chosen by a variety of different methods. In an embodiment, the assistance is simply a value chosen by the user (**103**) prior to or during the exercise and is an absolute amount of drive imparted by the motor (**501**). In this way, there is effectively more assistance at a higher incline than a lower incline as the motor (**501**) provides a fixed level of assistance regardless of incline (and at a higher incline the user's (**103**) weight provides additional assistance as discussed above). This is generally not preferred as it results in different torque requirements at different inclines, but it may be desirable in certain forms of exercise.

[0065] Additionally, the motor (**501**) may provide a level of assistance based on the incline of the treadmill (**100**). This provides more consistency in the drive force which must be provided by the user (**103**) to produce any given speed of belt (**102**) movement. In an embodiment, the level of assistance may be based on both the user's (**103**) weight and the incline. In this type of operation, the resistance of the belt (**102**) to the movement is more akin to a weight sled of constant mass being moved while the user (**103**) moves over a variety of terrain.

[0066] The user (**103**) may input the user's weight into a control (such as computer controller (**901**)) for the treadmill (**100**). The treadmill (**100**) may then use that value to compute the appropriate assistance for various levels of incline and control the motor (**501**) to provide that assistance. In an alternative design, the motor assist (**501**) could determine the user's (**103**) weight automatically, such as by powering up the motor (**501**) when the user (**103**) is standing on the belt (**102**) and computing the user's weight based on the torque required by the motor (**501**) to move the belt (**102**).

[0067] In the above, it should be clear that the motor (**501**) can lower or increase the resistance the user encounters for some, if not all, arrangements of the speed and incline of the belt (**102**) but also serves to resist the motion of the belt (**102**) since the user (**103**) will generally want to move the belt (**102**) faster than it is being moved by the motor (**501**). In particular, a goal of the motor (**501**) will often be to make relatively constant the amount of torque required to be exerted by the user (**103**) to move the belt (**102**) at a particular speed across a range of inclines, while still having the torque required to be exerted by the user (**103**) to be greater than if the treadmill was in completely motorized operation as done in the first mode. Further, a purpose of assistance is often to provide for an exercise more akin to working out with a relatively light weight sled.

[0068] As should be apparent, if the motor (**501**) is free-wheeling at a higher incline, the belt (**102**) motion is entirely supplied by the user (**103**) and the torque required to move the belt (**102**) is simply based on user mass, the incline, and internal friction and similar losses internal to the system. As the incline is reduced, the amount of force is increased since the user's (**103**) mass will contribute less to the motion and increase the amount of friction. This increase can be counteracted by having the motor (**501**) provide additional torque to compensate. If the motor torque is correctly selected based on the changes in the incline (with the other variables being known and generally constant), this allows for the treadmill (**100**) to provide a constant torque (resistance) for a given speed at a variety of inclines.

[0069] The motor (**501**) can also serve to provide exercise variations unavailable in traditional motorless systems or motorized treadmill systems. In particular, in an embodiment, the motor (**501**) can provide for improved characteristics even at inclines above those where the motor (**501**) is no longer needed to assist or at speeds above what the motor (**501**) can provide. In particular, if the user (**103**) wishes to push harder without "moving" faster (an exercise akin to pulling a large mass or pushing a heavy weight sled), the motor (**501**) may reverse direction or actively resist the belt (**102**) moving in the direction it is being forced by the user (**103**). In this case, instead of assisting the motion of the drive cylinder (**205**), it may resist it, allowing the user (**103**) to have an extremely hard workout if desired and to eliminate the need for any type of frictional resistance mechanism, or other device to try and resist the motion of the belt (**102**). Further, the motor (**501**) may do this in conjunction with an assistance operation. Thus, a user (**103**) can effectively change the mass on the weight sled without having to stop the exercise or alter the incline by having the motor actually stop and reverse direction while the user is continuing to move the belt in the same direction through the motor reversal.

[0070] Such an active resistance will often result in the user (**103**) needing to bend over the belt (**102**) in order to better align the long leg muscles with the belt (**102**) to generate enough force to actually move the belt (**105**) against the motor (**501**). To do this, the treadmill (**100**) will commonly provide for active resistance handgrips (**601***a*) and (**601***b*) which provide for a leaned forward position and may also provide a longer treadbase than standard to allow the user (**103**) to be positioned more parallel to the belt (**102**) than in the other modes of operation discussed above.

[0071] FIGS. **4** and **5** provide for individual indications of handgrips, shown together in FIG. **1**, which allow for more comfortable body positioning with regards to the different exercises. The running handgrips (**603***a*) and (**603***b*) of FIG. **4**, are generally horizontal and are primarily designed to assist with balance while performing a cardio exercise and are generally intended to keep the user (**103**) from tipping sideways. While a user (**103**) can push against them to reduce the user's weight on the belt (**102**), they are more designed for balance than as a resistance. These running handgrips (**603***a*) and (**603***b*) are, thus, primarily intended to be used by the user (**103**) when walking or running on the belt (**102**) as it is turned by the motor (**501**) in the first mode of operation.

[0072] The active resistance handgrips (**601***a*) and (**601***b*) of FIG. **5**, however, are designed to better align the hands with a preferred position to push or pull a mass with the user's (**103**) body laid out more parallel to the belt (**102**). These active resistance handgrips (**601***a*) and (**601***b*) are much more vertical and provide for more of a position with the user's (**103**) hands closer to the head than the waist. These are designed to be used when the treadmill (**100**) is providing more of a resistance exercise with the motor (**501**) acting in accordance with any of the three operations of the second mode.

[0073] It should be apparent that in the active resistance operation, as in the assist operation, the motor (**501**) speed can again be selected to provide for a constant torque regardless of incline. Like in the motor assist case, in the motor resist case the amount of resistance provided can alter based on the incline. This allows for the user (**103**) to provide a constant amount of torque against the treadmill (**100**) belt (**102**) regardless of the incline of the treadmill (**100**) or to alter the torque required in a particular way based on the exercise. Thus, a user (**103**) can actually have an exercise that mimics, duplicates, simulates pushing a mass uphill by requiring more torque (effectively increasing the mass) at an incline compared with a lower torque when the treadmill (**100**) is at a lower incline. Further, as should be apparent, the resistance and assistance operations, along with the freewheel operation, can all be combined to allow for the treadmill (**100**) to provide for exercises where a constant torque can be provided across a wide range of inclines, or the torque can be set or controlled during the exercise as desired by a user (**103**) or the controller (**901**).

[0074] The ability to provide constant torque resistance throughout an exercise is not standard movement. Generally, a resistance exercise will have points which require increase torque to be applied and points that require less torque. For example, in a bicep curl, generally the arm has to produce increased torque to move the weight the first inch from the arm hanging vertically compared to the last inch as the forearm approaches horizontal. This exercise, therefore, does not provide a consistent torque because the effect of the gravitational resistance compared to the lever which is the forearm alters. This is why weightlifters will often move their hips (engage a larger muscle) to start the weight moving upward, but have no problem maintaining the movement once commenced.

[0075] In a traditional non-powered treadmill, the issue of changing torque is created at different speeds and different inclines. Specifically, in a motorless treadmill a user will commonly have to provide increased torque to accelerate the speed of a belt (including overcoming resting inertia), and will have to provide increased torque at a flatter incline than a steeper one (due to the influence of gravity on the user's physical mass). High torque throughout an exercise (or more often within an exercise) can provide for a much more beneficial exercise motion as it forces the body to engage muscle much more consistently.

[0076] Heavy weight sleds can often be used to flatten torque requirements because the heavy mass and high coefficient of friction means that the force required to move the sled a first inch and a second inch are more similar than they would be if the sled had wheels. In traditional motorless treadmills, since rollers are required to allow for the running belt to have endless rotation, the torque to start the rollers turning is generally more than that required once the rollers are turning. This previously required relationship can be eliminated with the systems and methods of the present disclosure depending on desired operation.

[0077] In one mode of operation, the present device is designed to provide for a constant or near constant level of torque across an exercise to the user where that level of torque is independent of the incline of the treadmill. Specifically, the force required to rotate the roller any distance is independent of the incline of the treadmill, or the speed that the roller was previously rolling. A user is thus forced to consistently engage large muscle groups to generate the necessary force, and can utilize changes in incline and speed to alter the exercise in different ways. Effectively, the user needs to utilize a constant or near constant force with every step even as the incline alters. This can also be done over various speeds as well.

[0078] The torque actually supplied by the motor may change as the incline changes, but the torque that is to be provided by the user's muscle groups can be caused to remain essentially constant. To illustrate, as the incline increases and the user's mass assists in rotating the belt, the motor may provide an amount of resistance increase equal (or proportional) to the assistance provided by the user's mass. Thus, the torque needing to be produced by the user remains constant. At the same time, in this scenario, the increase in incline will require the user to lift slightly more of their weight with each action, and can actually increase the difficulty of the exercise for that reason. As similar relationship can be performed but with the user altering their speed. Thus, a user may be indicated to speed up their individual steps while each step still provides a constant force for rotation of the belt.

[0079] It should be recognized that the ability to alter the torque required to push the belt (**102**) and the two different modes of operation (resistance and cardio) can be used in a variety of exercises and can be controlled by the user (**103**) or by the controller (**901**) operating in accordance with a preprogrammed workout. For example, in an embodiment, the controller (**901**) can provide for different intervals with different movement options. For example, the user (**103**) may begin with a standard walking motion with the motor powering the treadmill (**100**), they may then begin a running motion as the motor (**501**) accelerates. As the exercise progresses, the running may be interspersed with periods of walking up a high incline. These intervals may correspond to specific exercise goals and desires. This part of the exercise is akin to a simple run or walk and is all performed using mode one of operation.

[0080] The mode may then transition from the first to the second mode. This will often be by slowing the motor and allowing the user (**103**) to slow down and get ready to push against resistance, when the user (**103**) is ready, or the controller (**901**) indicates that the user (**103**) should commence, the user (**103**) will begin to try and move the belt (**102**) faster than it is currently moving. The exercise can begin with the user (**103**) still moving, but now attempting to speed up the pace and accelerate the belt (**102**) above the speed the motor (**501**) is providing. As the user (**103**) begins to force the belt (**102**) movement above that of the motor (**501**), incline may be altered to provide for an exercise akin to dragging a lighter weight sled or speed may be altered to control the user's speed against the sled.

[0081] As the user (**103**) continues, the assistance of the motor (**501**) may decrease until the motor (**501**) begins to actively resist the motion of the user (**103**). This simulates adding of mass to the sled or may be necessary to compensate for the torque provided by the user (depending on their strength and desired speed). As should be apparent, all these types of exercises can be performed without the user (**103**) having to stop (or only minimally stopping) forward motion, an exercise arrangement generally not available with traditional equipment. Still further, the user can push against the belt and have it actively resist movement with the same torque even as incline is increased (which now makes the movement harder) and regardless of speed. Thus, a user moving faster is effectively doing more reps of the resistance exercise in less time, as opposed to having the reps become easier and decreasing their effectiveness.

[0082] Different exercise modes may also be used in conjunction with entertainment elements provided by the controller (**901**). For example, the user (**103**) may see on screen that simulated terrain is moving at the speed of the user (**103**) and the incline of the treadbase corresponds to an incline indicated onscreen. The user (**103**) may also see a simulated mass approaching that the user will then slow down, adjust position, and push.

[0083] In addition to controlling the specifics of the workout, the controller (**901**) may also provide instruction to direct the user (**103**) on how to perform the workout. When switching from the first cardio mode of operation to the second resistance mode, it is generally undesirable to have the transition occur suddenly without warning to the user (**103**). Specifically, if the user (**103**) is running on the treadmill, it cannot suddenly and unexpectedly slow or stop to have the begin moving the belt (**102**) under their own power, the user (**103**) would likely fall. Thus, the controller (**901**) will often allow for smooth transitions and may even control the motor (**501**) in a fashion that helps the user (**103**) to transition. For example, the controller (**901**) may instruct the user (**103**) to slow down and to switch from the running handgrips (**603***a*) and (**603***b*) to the active resistance handgrips (**601***a*) and (**601***b*) to better position the user (**103**) for simulated pushing with a brief stop of the belt (**102**) motion to allow the user to get ready. Once the user (**103**) commences pushing the belt (**102**), the controller (**901**) may rapidly have the motor (**501**) react to provide for desired torque.

[0084] Also, although not necessary, in a still further embodiment, a braking device, generally a frictional resistance mechanism, may be added to further regulate the amount of force needed to be generated to drive the belt (**102**), by providing an adjustable frictional force against movement of the belt (**102**). Such a device can also provide assistance to transition the motor (**501**) through the assist and resist operations without having a freewheel between them.

[0085] Throughout this disclosure, relative terms such as "generally," "about," and "approximately" may be used, such as, but not necessarily limited to, with respect to shapes, sizes, dimensions, angles, and distances. One of ordinary skill will understand that, in the context of this disclosure, these terms are used to describe a recognizable attempt to conform a device to the qualified term. By way of example and not limitation, components such as surfaces described as being "generally planar" will be recognized by one of ordinary skill in the art to not be, in a strict geometric sense, planar, because in a real world manufactured item a surface is generally never truly planar as a "plane" is a purely geometric construct that does not actually exist, and no component is truly "planer" in the geometric sense. Thus, no two components of a real item are ever truly planar, as they exist outside of perfect mathematical representation. Variations from geometric descriptions are inescapable due to, among other things; manufacturing tolerances resulting in shape variations, defects, and imperfections; non-uniform thermal expansion; design and manufacturing limitations; and natural wear. There exists for every object a level of magnification at which geometric descriptors no longer apply due to the nature of matter. One of ordinary skill will understand how to apply relative terms such as "generally," "about," and "approximately" to describe a range of variations from the literal meaning of the qualified term in view of these and other considerations.

[0086] Further, use in this description of terms such as "upward" and "downward" do not actually require that certain surfaces or objects be closer or further away from a surface upon which an exercise machine is resting at any given time. Instead, they are generally used to denote opposite directions in conjunction with the standard arrangement of the FIGS. provided herein so as to give relative positioning of elements. Similarly, terms such as "inward" and "outward", "left" and "right", and "top" and "bottom" are used to show relative directions or positions as opposed to absolute location.

[0087] While the invention has been disclosed in conjunction with a description of certain embodiments, including those that are currently believed to be the preferred embodiments, the detailed description is intended to be merely illustrative and should not be understood to limit the scope of the present disclosure. As would be understood by one of ordinary skill in the art, embodiments other than those described in detail herein are encompassed by the present invention. Modifications and variations of the described embodiments may be made without departing from the spirit and scope of the invention.

1. A treadmill comprising:

an endless belt arranged to rotate about at least one roller;

a motor, the motor being configured to rotate said roller so as to rotate the endless belt in either direction; and

a controller, said controller altering speed and direction of said motor;

wherein, said controller controls said motor to rotate said endless belt at a variable speed effective to cause the amount of force required by a user disposed on said endless belt to rotate said endless belt is constant across a plurality of inclines of said endless belt.

2. The treadmill of claim **1** wherein said amount of force required by a user is a constant amount of force.

3. The treadmill of claim **1** wherein said constant relation is based on a weight of a user.

4. The treadmill of claim **1** wherein said roller rotates said endless belt in a direction opposing a direction a user is pushing said belt.

5. The treadmill of claim **1** wherein said motor changes direction of said endless belt rotation during a user exercise.

6. The treadmill of claim **1** further comprising two sets of handgrips.

7. The treadmill of claim **6** wherein one of said two sets of handgrips is positioned for a user standing upright and the other of said two sets of handgrips is positioned for a user leaning over.

8. The treadmill of claim **1** wherein said amount of force required by a user simulates said user pushing a weight sled.

9. The treadmill of claim **1** wherein said amount of force required by a user simulates said user pulling a weight sled.

10. A method of controlling operation of a treadmill comprising:

providing a treadmill including:

a running belt arranged to rotate about at least one roller; and

a motor, the motor being configured to rotate said roller so as to rotate the running belt a first direction and an opposing second direction; and activating said motor to rotate said running belt in said first direction at a first speed when said running belt is at a first incline;

instructing a user to push said running belt in said second direction;

altering an incline of said running belt from said first incline to a second incline; and

altering a speed of said running belt from said first speed to a second speed;

wherein said alteration of said speed from said first speed to said second speed occurs in constant relation to said alteration of said incline from said first incline to said second incline.

11. The method of claim **1** wherein an amount of force required by said user to push said running belt in said second direction is the same at said first incline and said first speed as at said second incline and said second speed.

12. The method of claim **1** wherein said constant relation is based on a weight of said user.

13. The method of claim **1** wherein said treadmill further includes two sets of handgrips.

14. The method of claim **13** wherein one of said two sets of handgrips is positioned for a user standing upright and the other of said two sets of handgrips is positioned for a user leaning over.

15. The method of claim **1** wherein said second speed is zero.

16. The method of claim **1** wherein said amount of force required by a user simulates said user pulling a weight sled.

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