

DESCRIPTION

Title of the Invention: WALKING EXERCISE MACHINE

Technical Field

[0001] The present invention relates to a walking exercise machine designed for an exerciser to do walking or running for exercise on an endless belt.

Background Art

[0002] Heretofore there is known an exercise machine designed for an exerciser to do walking or running for exercise (although such physical activities will be collectively called "walking exercise" in the following description, there is no clear distinction between "walking" and "running" in the present invention) on a moving endless belt, which is a so-called treadmill. In order to protect an exerciser from a fall or other trouble, as well as to ensure exerciser's safety during exercise, such an exercise machine is provided with a handrail arm extending from an upper frame placed at a predetermined level to both right and left sides of the endless belt. Due to such a structure, the exercise machine is large in volume even when it is not used. In this regard, for example, Patent literature 1 (Japanese Unexamined Patent Publication JP-A 2007-159879) discloses a walking exercise machine in which a handrail arm can be collapsed to a compact form when the machine is not used.

Prior Art Reference

Patent literature

[0003] Patent literature 1: Japanese Unexamined Patent Publication JP-A 2007-159879

Summary of the Invention

Problems to be solved by the Invention

[0004] As attempts to increase the amount of exercise during the use of the exercise machine disclosed in Patent literature 1, an increase in the running speed set for the exercise machine or an increase in the length of time for exercise using the exercise machine can be considered. However, as to the attempt to increase the running speed, a user who lives in a collective housing such as an apartment may find it unfavorable, because it leads to great vibration and high noise. On the other hand, as to the attempt to increase the length of exercise time, a user who does not have plenty spare time for himself/herself may find it inconvenient. Patent literature 1 provides neither disclosure nor suggestion about such a problem and relevant solving means.

[0005] The present invention has been devised in view of the problems as mentioned supra, and accordingly an object of the present invention is to provide a walking exercise machine which is capable of securing an effective amount of exercise even in a short length of time for exercise without generating great vibration and high noise.

Means for solving the problem

[0006] In order to accomplish the above object, the following technical means is adopted for the implementation of

the present invention.

A walking exercise machine pursuant to the present invention comprises: a main body frame having drums rotatably journaled at its front end and rear end, respectively, in a lengthwise direction, and an endless walking belt entrained across the drums; a driving mechanism for driving the walking belt to run from the front to the rear on an upper surface of the main body frame; a handrail section disposed in upstanding condition at a front part of the main body frame; and an operation panel installed on the handrail section. In this walking exercise machine, the main body frame is disposed in a steeply inclined form in which its front part is longer in height than its rear part.

[0007] Moreover, the driving mechanism can be composed of: a driving motor; transmission means for transmitting a driving force of the driving motor to the walking belt; and restraint means for restraining the walking belt from moving backward to an extent greater than the amount of drive by the driving motor during walking action of a user on the walking belt.

Moreover, the transmission means has a worm gear section composed of a worm gear to which torque of the driving motor is inputted, and a worm wheel to which a rotational drive force to the walking belt is outputted, and, the worm gear section is designed to serve as the restraint means.

[0008] It is preferable that the restraint means is

implemented by exploiting a back electromotive force of the driving motor.

It is preferable that the restraint means is designed so that, with power input ends of the driving motor short-circuited, the back electromotive force acts as a brake force for the driving motor, and that the restraint means has a control section for controlling time taken to develop a short circuit in the power input ends of the driving motor.

It is preferable that the restraint means has a resistor connected across the power input ends of the driving motor.

[0009] It is preferable that the restraint means is designed so that, with the power input ends of the driving motor short-circuited via the resistor, the back electromotive force acts as a brake force for the driving motor.

It is preferable that the restraint means has a relay switch connected across the power input ends of the driving motor, and is designed so that, when the supply of utility power is interrupted, the relay switch is operated in a manner to develop a short circuit in the power input ends of the driving motor, thereby exerting a back electromotive force on the driving motor as a brake force.

[0010] Moreover, standing leg members can be provided at the front part of the main body frame so as for the main body frame to be disposed in a steeply inclined form.

Moreover, the operation panel is capable of displaying

the amount of heightwise movement which is obtained through conversion of the amount of walking on the walking belt.

Effects of the Invention

[0011] According to the walking exercise machine of the present invention, by virtue of the steeply inclined form of the main body frame and the provision of the restraint means, it is possible to secure an effective amount of exercise even in a short length of time for exercise without generating great vibration and high noise.

Brief Description of Drawings

[0012] [Fig. 1] Figure 1 is a general perspective view of a walking exercise machine in accordance with the first embodiment of the present invention.

[Fig. 2] Figure 2 is a front view of the walking exercise machine in accordance with the first embodiment of the present invention.

[Fig. 3] Figure 3 is a side view of the walking exercise machine in accordance with the first embodiment of the present invention.

[Fig. 4] Figure 4 is an enlarged perspective view of a driving mechanism of the walking exercise machine in accordance with the first embodiment of the present invention.

[Fig. 5] Figure 5 is a view showing how the walking exercise machine in accordance with the first embodiment of the present invention is to be used.

[Fig. 6] Figure 6 is a general perspective view of a walking exercise machine in accordance with the second embodiment of the present invention.

[Fig. 7] Figure 7 is an enlarged perspective view of the interior of the walking exercise machine in accordance with the second embodiment of the present invention.

[Fig. 8] Figure 8 is a block diagram of restraint means of the walking exercise machine in accordance with the second embodiment of the present invention.

[Fig. 9] Figure 9 is a block diagram of restraint means of a walking exercise machine in accordance with the third embodiment of the present invention.

[Fig. 10] Figure 10 is a block diagram of restraint means of the walking exercise machine in accordance with the third embodiment of the present invention (an example of modified form)

Modes for Carrying out the Invention

[0013] [First embodiment]

Hereinafter, a walking exercise machine 100 in accordance with the first embodiment of the present invention will be described with reference to drawings. In what follows, for the sake of convenience, the machine will be explained with use of a front-rear direction and a vertical direction as indicated by arrows shown in Fig. 1 as the references. These directions conform to a front-rear direction, a right-left direction, and a vertical direction based on the sight of a user U carried on

the walking exercise machine 100.

[0014] Figures 1, 2, and 3 are a general perspective view, a front view, and a side view, respectively, of the walking exercise machine 100 of this embodiment.

As shown in these figures, the walking exercise machine 100 comprises: a main body frame having a drum 121 (front drum) and a drum 130 (rear drum) rotatably journaled at its front end and rear end, respectively, in a lengthwise direction, and an endless walking belt 120 entrained across the drums 121 and 130 (specifically, a vertical frame 130, etc., as will hereafter be described); a driving mechanism for transporting the walking belt 120 from the front to the rear on the upper surface of the main body frame (specifically, a driving motor 128, etc., as will hereafter be described); a handrail section 101 disposed in upstanding condition at the front part of the main body frame; and an operation panel 140 installed on the handrail section 101 (specifically, it is installed near the central area of an upper horizontal frame 102 formed integrally with the handrail section 101 as will hereafter be described).

[0015] In the walking exercise machine 100, an exerciser (user) U performs forward walking exercise, with his/her feet carried on the walking belt 120. In this case, the walking belt 120 is driven to move from the front to the rear (or equivalently user's walking direction) by the driving mechanism. The walking belt 120 is given a width which is greater than the shoulder

width of the user, and does not interfere with walking movement.

The main body frame is composed of: a U-shaped upper horizontal frame 102 disposed so as to lie around the abdominal area of the user; a vertical frame 103 disposed in upstanding condition at each of the right and left sides of the machine, for supporting the upper horizontal frame 102; right and left lower horizontal frames 106 taken as a pair, each of which supports the vertical frame 103, and rotatably retains the drum 121 (front drum) and the drum 130 (rear drum) at its front and rear ends, respectively; right and left front leg portions 104 taken as a pair, and right and left rear leg portions 105 taken as a pair that are shorter in height than the front leg portions 104, that are attached to their respective lower horizontal frames 106; a coupling frame 109 for coupling the paired right and left front leg portions 104; and a suspended frame 107 and a suspended horizontal frame 108 for supporting the driving mechanism in a suspended state.

[0016] As shown in Fig. 3, in the walking exercise machine 100 having the front leg portions 104 and the rear leg portions 105 that are standing leg members attached to the lower horizontal frames 106, the rear leg portion 105 is shorter in height than the front leg portion 104. That is, in this construction, the main body frame has a steeply inclined form in which the vertical position of the front part is higher than that of the rear part. It is preferable that an angle θ as shown in Fig. 3 falls in

a range from 20 to 25 degrees to ensure adequate safety.

[0017] It is preferable that the angle θ is changeable in accordance with the physical prowess and/or the age of the user. This can be accomplished by, for example, permitting a change to the mounting position of the front leg portion 104 relative to the lower horizontal frame 106 in the vertical direction.

Each of the right and left endparts of the upper horizontal frame 102 constitutes the handrail section 101, and, for example, a non-slip raw material is wound on the upper horizontal frame 102. Moreover, the operation panel 140 is mounted near the central area of the upper horizontal frame 102 constituting the handrail section 101. The operation panel 140 is operated by the user U using the walking exercise machine 100 for exercise, as well as provides an indication of information for the user U. The mounting position of the operation panel 140 is not particularly limited, but may be determined arbitrarily so long as the user U using the walking exercise machine 100 is able to operate the operation panel 140 and see information with ease.

[0018] The operation panel 140 is provided at least with a switch to start actuation of the walking belt 120 by the driving mechanism, and a switch to stop operation of the walking belt 120. In addition, it is desirable to provide a switch to change the speed of the walking belt 120. Examples of information to be displayed on the operation panel 140 include elapsed time since the start of exercise and remaining time on exercise in

reference to a period of time preset in a timer at the start of exercise. Moreover, it is preferable that the operation panel 140 is capable of displaying the amount of walking exercise on the walking belt 120 (walking distance) or the amount of heightwise movement which is obtained by converting the walking amount (walking distance) into a distance in a height direction. That is, the walking exercise machine 100 allows the user U to perform walking exercise as if to go uphill, such as climbing stairs or walking on mountain trails. Therefore, it is preferable that the operation panel 140 is capable of displaying messages, for example, "you have arrived at the top of Tokyo Skytree: 600 m" or "you have climbed to the peak of Mount Fuji: 3700 m above sea level".

[0019] Referring to Fig. 4, the driving mechanism of the walking exercise machine 100 will be described.

The driving mechanism comprises: a driving motor 128 which runs under electric power supplied from a household commercial power source; a worm gear 126 coaxially coupled to a motor rotary shaft 127 of the driving motor 128; a worm wheel 125 which engages with the worm gear 126; a gear 123 coaxially coupled to the worm wheel 125 via a rotary shaft 124; and a reduction gear 122 disposed in engagement with the gear 123. The reduction gear 122 is coupled to the front drum 121, with its rotary shaft coinciding with the rotary shaft of the front drum 121. The endless walking belt 120 is entrained across the front drum 121 (driving-side

drum) and the rear drum 130 (driven-side drum). That is, the walking exercise machine 100 is provided with, as means for transmission, a worm gear section composed of the worm gear 126 to which the torque of the driving motor 128 is inputted, and the worm wheel 125 to which a rotational drive force to the walking belt 120 is outputted.

[0020] Moreover, the walking exercise machine 100 is provided with restraint means 150 for restraining the walking belt 120 from moving backward to an extent greater than the amount of drive by the driving motor 128 during walking action of the user U on the walking belt 120. The above-described worm gear section is designed to serve as the restraint means 150. This will be described in detail.

The worm gear section composed of the worm gear 126 and the worm wheel 125 has the property that rotation of an input shaft (the rotary shaft of the worm gear 126) in response to rotation of an output shaft (the rotary shaft of the worm wheel 125) is difficult (rotational resistance 300 is large). This property can be construed as the brake function of the worm gear section.

[0021] The worm gear section can exhibit brake function when (theoretically) a frictional angle is greater than a lead angle (twist angle) in the worm gear 126. Although the frictional angle cannot be measured with high accuracy depending on lubrication conditions, surface roughness conditions, etc., it

is known that, in general, a worm gear starts to slide when the lead angle exceeds 10 degrees. That is, in order to exhibit the brake function, there is a need to adjust the lead angle of the worm gear 126 to be less than or equal to 10 degrees. Thus, in the walking exercise machine 100 of the present embodiment, the lead angle of the worm gear 126 is adjusted to be less than or equal to 10 degrees.

[0022] Since the lead angle of the worm gear 126 is determined in that way, it is possible to restrain the walking belt 120 from moving backward to an extent greater than the amount of drive by the driving motor 128 during walking action of the user U on the walking belt 120.

Where the above-described driving motor 128 is concerned, as the user U walks on the walking belt 120 when the torque from the driving motor 128 is fed to the front drum 121, then the walking belt 120 is transported backward. At this time, there may be a case where a force greater than the torque of the driving motor 128 is imparted to the driving motor 128 through the walking belt 120. The thusly imparted user U's force is, as a regenerative effect of the driving motor 128, conducive to production of electric power. Such a regenerative effect of the driving motor 128 becomes a load to the user U, with the consequent application of a brake.

[0023] In Fig. 5, there is shown a state where the user U is walking while being carried on the walking belt 120 of the

walking exercise machine 100.

More specifically, with his/her feet carried on the walking belt 120, the user U operates the walking belt 120 in a manner to move from the front to the rear by activating the switch to start actuation of the walking belt 120 provided in the operation panel 140.

[0024] The user U walks in concert with the movement of the walking belt 120. At this time, several advantages are gained: (1) since the walking belt 120 is sloped, it follows that the user U walks as if to go uphill (climb), wherefore a larger amount of exercise can be obtained as compared with a case where the walking belt 120 lies flat;

(2) during walking action of the user U on the walking belt 120, it is possible to apply a brake for restraining the walking belt 120 from moving backward to an extent greater than the amount of drive by the driving motor 128 (the brake function of the worm gear); and

(3) also, when the walking belt 120 is about to move backward to an extent greater than the amount of drive by the driving motor 128, a regenerative effect of the driving motor 128 is exhibited. In any of these instances (1) to (3), the amount of exercise performed by the user U is increased.

[0025] Thus, the amount of exercise can be increased without a speedup in the movement of the walking belt 120 for walking exercise, wherefore neither vibration nor noise will be generated

as is desirable. Moreover, a large amount of exercise can be obtained even in a short length of exercise time as is desirable. In addition, the walking exercise machine 100, being designed as an apparatus for providing walking exercise as if to go uphill, is advantageous in that the length of the walking belt 120 serving as a walking surface in the front-rear direction can be reduced, and correspondingly the length of the main body frame in the front-rear direction can be made as short as possible compared to a conventional treadmill apparatus.

[Second embodiment]

Next, a walking exercise machine 100 in accordance with the second embodiment of the present invention will be described with reference to drawings.

[0026] Figures 6 and 7 show the walking exercise machine 100 of the second embodiment. This walking exercise machine 100 is substantially identical in structure with the walking exercise machine of the first embodiment as shown in Fig. 1. However, the walking exercise machine 100 is remarkably different from the first embodiment in respect of the configuration of the restraint means 150 for restraining the walking belt 120 from moving backward to an extent greater than the amount of drive by the driving motor 128.

Also in the walking exercise machine 100 of the second embodiment, as the user U walks on the walking belt 120 when the torque from the driving motor 128 is fed to the front drum

121, then the walking belt 120 is transported backward.

[0027] As shown in Fig. 7, as a driving mechanism for the walking exercise machine 100, a driving motor 128 which runs under electric power supplied from a commercial power source is attached to the inside of the left side of the lower horizontal frame 106. A motor rotary shaft 127 of the driving motor 128 points in the front-rear direction, and, a worm gear 126 is coaxially attached to the tip of the motor rotary shaft 127. Meanwhile, a worm wheel 125 is coaxially attached to the left end of the front drum 121 about which an endless walking belt 120 is entrained, and, the worm gear 126 engages with the worm wheel 125.

[0028] Thus, as the driving motor 128 is driven to run, the resultant rotational drive force is transmitted, through the worm gear 126 and the worm wheel 125, to the front drum 121, thereby rotating the front drum 121, and as a consequence, the walking belt 120 is transported from the front to the rear.

At this time, there may be a case where, as the result of walking action of the user U, a force greater than the rotational drive force of the driving motor 128 is imparted to the driving motor 128 through the walking belt 120. The thusly imparted user U's force is, as a regenerative effect of the driving motor 128, conducive to production of electric power (back electromotive force). Such a regenerative effect of the driving motor 128 becomes a load to the user U, with the consequent

application of a brake. In the second embodiment, this effect is utilized as restraint means 150. That is, the restraint means 150 is implemented by exploiting the back electromotive force of the driving motor 128.

[0029] It is noted that, in this embodiment, the worm gear section composed of the worm gear 126 and the worm wheel 125 does not serve as the restraint means 150 for restraining the walking belt 120 from moving backward to an extent greater than the amount of drive by the driving motor 128 during walking action of the user U on the walking belt 120.

Moreover, the above-described motor rotary shaft 127 of the driving motor 128 protrudes backward, and, this backwardly-protruding part is fitted with a speed meter (speed detecting sensor) 210 for detecting the RPM of the motor rotary shaft 127, in other words, the moving speed of the walking belt 120. As the speed meter 210, for example, a tachometer using a photosensor can be adopted for use.

[0030] In contrast to the first embodiment, in the second embodiment, the restraint means 150 of the walking exercise machine is designed so that the rotational drive force of the driving motor 128 is electrically controlled by a control section 200. In other words, the restraint means 150 is designed so that, with the power input ends of the driving motor 128 short-circuited, a back electromotive force exerted on the driving motor 128 acts as a brake force for the driving motor

128, and also, the restraint means 150 is provided with the control section 200 for controlling the time taken to develop a short circuit in the power input ends of the driving motor 128.

[0031] Such a restraint means 150 is disposed at the rear of the driving motor 128 so as to lie the inside of the left side of the lower horizontal frame 106.

Figure 8 is a block diagram of the restraint means 150.

As shown in Fig. 8, the control section 200 is composed of: a rectifying portion 201 which converts utility power supplied from outside (AC) into DC and feeds it to the driving motor 128; and a PWM control portion 202 which controls the rotational drive force of the driving motor 128 on the basis of PWM (Pulse Width Modulation) signals.

[0032] The rectifying portion 201 is constructed by means of bridge connection of diodes 204. The PWM control portion 202 comprises: a semiconductor switching device 203 such as a MOS-FET; a CPU 205 for changing the pulse width of a pulse signal to a desired width; and an inverter 206 for inverting the pulse signal. In addition, a half-bridge gate driver 207 and an overcurrent preventive circuit 208 are provided therein.

[0033] In the PWM control portion 202, two semiconductor switching devices 203 are placed in series, and, one of them, namely a semiconductor switching device 203a has its drain side connected to a plus-side wiring line of the driving motor 128 (plus output side of the rectifying portion 201), and has its

source side connected to a 0 V-side wiring line of the driving motor 128. Moreover, the other one of them, namely a semiconductor switching device 203b has its drain side connected to the source side of the semiconductor switching device 203a, and has its source side connected to a 0 V output side of the rectifying portion 201.

[0034] The CPU 205 produces a PWM pulse signal for exercising PWM control on the torque of the driving motor 128, and also varies the width of the PWM pulse signal. A signal issued from the speed meter 210 provided in the driving motor 128 (that is, data on the speed of the walking belt 120) is inputted to the CPU 205. When the speed of the walking belt 120 is lower than a preset value, output of a PWM pulse signal with a wider pulse width is produced from the CPU 205, whereas, when the speed of the walking belt 120 is higher than a preset value, output of a PWM pulse signal with a narrower pulse width is produced from the CPU 205.

[0035] A PWM pulse signal outputted from the CPU 205 is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203b, and, upon switching of the semiconductor switching device 203b, a voltage applied to the driving motor 128 (voltage across the power input ends of the driving motor 128) varies, so that the RPM and rotational drive force of the driving motor 128 can be controlled. That is, the PWM pulse signal acts as a signal for controlling the

torque of the driving motor 128.

[0036] Meanwhile, a PWM pulse signal outputted from the CPU 205 is also inputted to the inverter 206, and, a PWM inverted pulse signal, which is output from the inverter 206, is inputted to the gate of the semiconductor switching device 203a through the half-bridge gate driver 207. When the gate of the semiconductor switching device 203a is driven High (= 1), then the power input end of the driving motor 128 is short-circuited. In trying to allow the driving motor 128 in a short-circuited state to run, a back electromotive force is exerted on the driving motor 128, which hinders the motor rotary shaft 127 of the driving motor 128 from rotating smoothly, with the consequent application of a brake to the walking belt 120. That is, the PWM inverted pulse signal is a signal obtained by inverting the PWM pulse signal, and thus acts as a signal for exercising braking control on the driving motor 128.

[0037] Moreover, when each and every PWM pulse signal from the CPU 205 stays Low (for example, in a condition where, although utility power is being supplied, a start button has not yet been pressed and thus a command to actuate the belt has not yet been issued), then the PWM pulse signal is inverted by the inverter 206 so as to be outputted as a PWM inverted pulse signal. Since each and every PWM inverted pulse signal stays High, it follows that the driving motor 128 is prevented from running at idle by the output of the PWM inverted pulse signal.

[0038] That is, regardless of whether the belt is at rest or being operated, when the driving motor 128 is not actuated, a brake is applied to the walking belt 120.

Moreover, the restraint means 150 of the walking exercise machine of the second embodiment is provided with the overcurrent preventive circuit 208 for preventing the flow of an overcurrent through the driving motor 128.

[0039] Specifically, a wiring line branching off from the source side of the semiconductor switching device 203b is connected to the overcurrent preventive circuit 208, and, in this overcurrent preventive circuit 208, a current value at the time of actuation of the driving motor 128 is monitored. When the current value at the time of actuation of the driving motor 128 exceeds a predetermined value, then the overcurrent preventive circuit 208 produces output of a Low (= 0) (when no overcurrent is detected, output of a High (= 1) is produced). The output from the overcurrent preventive circuit 208 and the PWM pulse signal outputted from the CPU 205 are ANDed by an adder 209 installed at the input side of the inverter 206, and the computed result is inputted to the inverter 206 and the half-bridge gate driver 207.

[0040] Now, a method of controlling the rotational drive force of the driving motor 128 using the restraint means 150 thus far described, in other words, the brake function of the restraint means 150 will be described.

To begin with, like the first embodiment, the walking belt 120 is operated in a manner to move from the front to the rear by activating the switch to start actuation of the walking belt 120 provided in the operation panel 140. Then, the user U walks in concert with the movement of the walking belt 120 (refer to Fig. 5).

[0041] At this time, the user walks as if to go uphill (climb) due to the inclination of the walking belt 120. During walking action of the user U, when the moving speed of the walking belt 120 deviates by a predetermined amount or even more from a preset value, then the restraint means 150 is activated for a change in the rotational drive force (in other words, RPM) of the driving motor 128.

Specifically, the CPU 205 of the PWM control portion 202 produces output of a PWM pulse signal for adjusting the moving speed of the walking belt 120 to a preset value (for example, 3.0 km/h). This PWM pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203b, thereby effecting switching of the semiconductor switching device 203b. Under such a PWM control, the moving speed of the walking belt 120 is maintained at the preset value.

[0042] However, when the moving speed of the walking belt 120 decreases due to walking action of the user U (for example, 2.8 km/h), then the current moving speed (reduced moving speed)

of the walking belt 120 is measured via the speed meter 210, and an actually measured speed is inputted to the CPU 205. The CPU 205 produces output of a PWM pulse signal with a pulse width which has been increased by an amount required for speeding up the walking belt 120 so as to return its speed to a preset speed. This PWM pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203b, thereby effecting switching of the semiconductor switching device 203b. At this time, as indicated by alternate long and short dashed lines in Fig. 8, a control current (acceleration current) flows. Under such a PWM control, output from the rectifying portion 201 is fed to the driving motor 128 while being adjusted to a predetermined voltage, so that the moving speed of the walking belt 120 is maintained at the preset value.

[0043] On the other hand, when the moving speed of the walking belt 120 increases due to walking action of the user U (for example, 3.2 km/h), then the current moving speed (increased moving speed) of the walking belt 120 is measured via the speed meter 210, and an actually measured speed is inputted to the CPU 205. The CPU 205 produces output of a PWM pulse signal with a pulse width which has been reduced by an amount required for speeding down the walking belt 120 so as to return its speed to a preset speed (preset value). This PWM pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203b, thereby effecting switching of the

semiconductor switching device 203b.

[0044] At the same time, output of a PWM inverted pulse signal, which is obtained by inverting a PWM pulse signal in the inverter 206, is produced. This PWM inverted pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203a, thereby effecting switching of the semiconductor switching device 203a. Upon the switching of the semiconductor switching device 203a, the driving motor 128 is brought into a short-circuited state, and, in trying to allow the driving motor 128 in this state to run, a regenerative effect is exerted on the driving motor 128 (a back electromotive force is generated). At this time, as indicated by broken lines in Fig. 8, a control current (braking current) flows. This regenerative effect becomes a load to the user U, with the consequent application of a brake against an action to operate the walking belt 120 in a manner to move faster. That is, the moving speed of the walking belt 120 returns to the preset value.

[0045] In this way, by narrowing the pulse width of a PWM pulse signal, as well as widening the pulse width of a PWM inverted pulse signal, it is possible to restrain the walking belt 120 from moving backward to an extent greater than the amount of drive by the driving motor 128 during walking action of the user U on the walking belt 120.

It is noted that, also in the case where the moving speed

of the walking belt 120 decreases and thus output of a PWM pulse signal with a wider pulse width is produced, output of a PWM inverted pulse signal obtained by inverting the PWM pulse signal in the inverter 206 is produced. This PWM inverted pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203a. However, since the PWM inverted pulse signal has a narrow pulse width, it follows that there is little brake effect.

[0046] When an overcurrent flows through the driving motor 128 during the interval when the walking belt 120 is being operated with the driving motor 128 running, the overcurrent flows into the overcurrent preventive circuit 208 from the source side of the semiconductor switching device 203b. Upon detection of this overcurrent in the overcurrent preventive circuit 208, the overcurrent preventive circuit 208 produces output of a Low (= 0), and, this output "0" and a PWM pulse signal outputted from the CPU 205 are ANDed by the adder 209. Since output from the adder 209 becomes output "0" regardless of the nature of the PWM pulse signal, it follows that the semiconductor switching device 203b is in an OFF state, and the semiconductor switching device 203b is in an ON state, whereby a brake is constantly applied to the walking belt 120.

[0047] By virtue of the working of the restraint means 150 thus far described, the walking belt 120 is allowed to move at substantially uniform speed, wherefore an effective amount of

exercise can be secured even in a short length of time for exercise without generating great vibration or high noise.

It is noted that constituents and functional effects of the second embodiment other than those as above described are substantially the same as those associated with the first embodiment, and therefore detailed description thereof will be omitted.

[Third embodiment]

Next, a walking exercise machine 100 in accordance with the third embodiment of the present invention will be described.

[0048] The walking exercise machine 100 of the third embodiment has an outer appearance and a mechanical structure that are substantially identical with those of the walking exercise machine 100 of the second embodiment. However, the walking exercise machine 100 of the third embodiment differs from the second embodiment in respect of the structure of the control section 200 (restraint means 150) provided therein.

Figure 9 shows a block diagram of the third embodiment.

As shown in Fig. 9, the control section 200 is composed of: a rectifying portion 201 which converts utility power supplied from outside (AC) into DC and feeds it to the driving motor 128; and a PWM control portion 202 which controls the rotational drive force of the driving motor 128 on the basis of PWM pulse signals.

[0049] The rectifying portion 201 is constructed by means of bridge connection of diodes 204. The PWM control portion

202 comprises: a semiconductor switching device 203 such as a MOS-FET; a CPU 205 for changing the pulse width of a pulse signal to a desired width; and an inverter 206 for inverting the pulse signal. In addition, a half-bridge gate driver 207 and an overcurrent preventive circuit 208 are provided therein.

[0050] Moreover, the control section 200 of the third embodiment is provided with wiring for connection between the plus-side wiring line of the driving motor 128 and the 0 V-side wiring line of the driving motor 128, and, a resistor 300 is disposed on this wiring. The following are functional effects afforded by the resistor 300.

During walking action of the user U, when the moving speed of the walking belt 120 deviates by a predetermined amount or even more from a preset value, then the control section 200 is activated for a change in the rotational drive force (in other words, RPM) of the driving motor 128.

[0051] This condition is the same as discussed in the explanation of the second embodiment; that is, when the moving speed of the walking belt 120 increases due to walking action of the user U (for example, 3.2 km/h), then the current moving speed (increased moving speed) of the walking belt 120 is measured via the speedmeter 210, and an actually measured speed is inputted to the CPU 205. The CPU 205 produces output of a PWM pulse signal with a pulse width which has been reduced by an amount required for speeding down the walking belt 120 so as to return its speed

to a preset speed (preset value). This PWM pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203b, thereby effecting switching of the semiconductor switching device 203b.

[0052] At the same time, output of a PWM inverted pulse signal, which is obtained by inverting a PWM pulse signal in the inverter 206, is produced. This PWM inverted pulse signal is inputted, through the half-bridge gate driver 207, to the gate of the semiconductor switching device 203a, thereby effecting switching of the semiconductor switching device 203a. Upon the switching of the semiconductor switching device 203a, the driving motor 128 is brought into a short-circuited state, and, in trying to allow the driving motor 128 in this state to run, a regenerative effect is exerted on the driving motor 128 (a back electromotive force is generated). At this time, as indicated by broken lines in Fig. 9, a control current (braking current) flows. This regenerative effect becomes a load to the user U, with the consequent application of a brake against an action to operate the walking belt 120 in a manner to move faster. The back electromotive force generated under such a condition is applied to an electronic component mounted inside the control section 200, for example, the semiconductor switching device 203 and a non-illustrated capacitor. At worst, it could cause damage to such an electronic component.

[0053] In this regard, the third embodiment is designed

so that the resistor 300 attached to the driving motor 128 consumes the thusly generated back electromotive force for prevention of detrimental effects on the electronic component mounted inside the control section 200.

In order to effectively dissipate heat produced in the resistor 300 as the result of the consumption of the back electromotive force, it is advisable to attach the resistor 300 to, for example, the lower horizontal frame 106 of the walking exercise machine 100, so that it can be cooled down by a wind from a fan or the like attached to the driving motor 128.

[0054] With the placement of the resistor 300, the input end of the driving motor 128 is in a nearly closed state (closed circuit having a predetermined resistance value R). That is, the input end is brought into a short-circuited state, although not in a complete short-circuited state, with the resistance value R of the resistor 300. Therefore, the placement of the resistor 300 allows constant production of a certain extent of back electromotive force, with the consequent application of a brake to the walking belt 120. Thus, by setting the resistance value R properly, as shown in Fig. 10, it is possible to eliminate the need to provide the semiconductor switching device 203a, and thereby achieve cost reduction.

[0055] Moreover, the control section 200 of the third embodiment is provided with wiring for connection between the plus-side wiring line of the driving motor 128 and the 0 V-side

wiring line of the driving motor 128, and, this wiring is capable of ON/OFF switching that is done by a relay switch 301. The following are the workings of the relay switch 301 and functional effects that it affords.

Under circumstances where the user U is walking on the walking belt 120, let it be assumed that, for example, the machine is abruptly unplugged from a receptacle for power supply, or the supply of utility power is interrupted (power failure). Moreover, let it be assumed that, as the load on the driving motor 128 increases, a fuse blows or a safety circuit is activated. In this situation, it is apparent from the block diagram shown in Fig. 9 that the input end of the driving motor 128 is brought into an open state, wherefore the back electromotive force acting thereon is no longer exhibited at all. In this case, the walking belt 120 moves idly, which interferes with normal walking action of the user U with safety.

[0056] Thus, in the event of interruption of the supply of utility power, a blown fuse, or activation of a safety circuit, the relay switch 301 is operated in a manner to connect its contact to the A-side so as to bring the input end of the driving motor 128 into a closed state.

Specifically, a "relay switch of power interlock type" is adopted for use as the relay switch 301. When utility power is supplied, a contact of the relay switch 301 is connected to the B-side so as to bring the input end of the driving motor

128 into an open state. On the other hand, when utility power is not supplied, the relay switch 301 is operated in a manner to connect its contact to the A-side so as to bring the input end of the driving motor 128 into a closed state. Then, a maximum back electromotive force is exerted on the driving motor 128, wherefore the walking belt 120 is subjected to a brake force. This makes it possible to avoid idling, and thereby allow the user U to stop his/her walking action with safety.

[0057] Moreover, it is very preferable that the relay switch 301 is activated in response to a signal from the CPU 205. In this structure, at the time of causing the walking belt 120 to stop, the relay switch 301 is operated in a manner to connect its contact to the A-side so as to bring the input end of the driving motor 128 into a closed state, thereby exhibiting the brake action of the driving motor 128. After that, when the walking belt 120 starts to move, even slightly, the contact of the relay switch 301 is connected to the B-side so as to bring the input end of the driving motor 128 into an open state, thereby releasing the brake action. This makes it possible to ensure safer walking action of the user.

[0058] It is noted that constituents and functional effects of the third embodiment other than those as above described are substantially the same as those associated with the second embodiment, and therefore detailed description thereof will be omitted.

It should be understood that the embodiments as set forth hereinabove are considered in all respects as illustrative only and not restrictive. Particularly, as to particulars that are not explicitly specified in the embodiments as disclosed hereinabove, for example, working conditions, operating conditions, relevant parameters, and the dimensions, weights, and volumes of constituent components, values that do not depart from the scope of the invention to be fulfilled by those skilled in the art and are easily conceivable by persons having ordinary skill in the art are adopted.

Explanation of reference symbols

[0059]

- 100 walking exercise machine
- 101 handrail section
- 102 upper horizontal frame
- 103 vertical frame
- 104 front leg portion
- 105 rear leg portion
- 106 lower horizontal frame
- 107 suspended frame
- 108 suspended horizontal frame
- 109 coupling frame
- 120 walking belt
- 121 drum (front drum, driving-side drum)
- 122 reduction gear

123 gear
124 rotary shaft
125 worm wheel
126 worm gear
127 motor rotary shaft
128 driving motor
130 drum (rear drum, driven-side drum)
140 operation panel
150 restraint means
200 control section
201 rectifying portion
202 PWM control portion
203 semiconductor switching device
203a semiconductor switching device
203b semiconductor switching device
204 diode
205 CPU
206 inverter
207 half-bridge gate driver
208 overcurrent preventive circuit
209 adder
210 speed meter (speed detecting sensor)
300 resistor
301 relay switch

CLAIMS

1. A walking exercise machine comprising:
a main body frame having drums rotatably journaled at its front end and rear end, respectively, in a lengthwise direction, and an endless walking belt entrained across said drums;
a driving mechanism for driving said walking belt to run from front to rear on an upper surface of the main body frame;
a handrail section disposed in upstanding condition at a front part of said main body frame; and
an operation panel installed on said handrail section, said main body frame being disposed in a steeply inclined form in which its front part is longer in height than its rear part.
2. The walking exercise machine according to claim 1, wherein said driving mechanism comprises: a driving motor; transmission means for transmitting a driving force of said driving motor to the walking belt; and restraint means for restraining the walking belt from moving backward to an extent greater than an amount of drive by the driving motor during walking action of a user on the walking belt.
3. The walking exercise machine according to claim 2, wherein said transmission means has a worm gear section

composed of a worm gear to which torque of said driving motor is inputted, and a worm wheel to which a rotational drive force to said walking belt is outputted,

and wherein said worm gear section is designed to serve as said restraint means.

4. The walking exercise machine according to claim 2, wherein said restraint means is implemented by exploiting a back electromotive force of the driving motor.

5. The walking exercise machine according to claim 4, wherein said restraint means is designed so that, with power input ends of said driving motor short-circuited, said back electromotive force acts as a brake force for the driving motor,

and wherein said restraint means has a control section for controlling time taken to develop a short circuit in the power input ends of said driving motor.

6. The walking exercise machine according to claim 4, wherein said restraint means has a resistor connected across the power input ends of said driving motor.

7. The walking exercise machine according to claim 4, wherein said restraint means is designed so that, with

the power input ends of said driving motor short-circuited via a resistor, said back electromotive force acts as a brake force for the driving motor.

8. The walking exercise machine according to any one of claims 4 to 7,

wherein said restraint means has a relay switch connected across the power input ends of said driving motor, and is designed so that, when the supply of utility power is interrupted, said relay switch is operated in a manner to develop a short circuit in the power input ends of said driving motor, thereby exerting a back electromotive force on the driving motor as a brake force.

9. The walking exercise machine according to claim 2,

wherein standing leg members are provided at a front part of the main body frame so as for said main body frame to be disposed in a steeply inclined form.

10. The walking exercise machine according to claim 2,

wherein said operation panel is capable of displaying the amount of heightwise movement which is obtained through conversion of the amount of walking on the walking belt.