(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 417 271 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.08.2024 Bulletin 2024/34

(21) Application number: **24158171.9**

(22) Date of filing: **16.02.2024**

(51) International Patent Classification (IPC):
A63B 22/06 *(2006.01)* ***A63B 21/005*** *(2006.01)*
A63B 22/00 *(2006.01)* ***A63B 22/02*** *(2006.01)*
A63B 24/00 *(2006.01)* ***A63B 71/06*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A63B 22/0664; A63B 21/0059; A63B 22/001; A63B 22/0023; A63B 22/025; A63B 24/0087; A63B 71/0622; A63B 2022/002; A63B 2022/067; A63B 2024/0093; A63B 2071/0625; A63B 2220/13; A63B 2220/30; A63B 2220/52; A63B 2220/803;

(Cont.)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **17.02.2023 US 202363446579 P**
12.02.2024 US 202418439087

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(54) EXERCISE MACHINES AND METHODS FOR CONTROLLING EXERCISE MACHINES HAVING ADJUSTABLE RESISTANCE AND INCLINE SETTINGS

(57) An exercise machine for performing an exercise motion. A resistance mechanism controls a resistance for performing the exercise motion. An incline adjustment device controls an incline for performing the exercise motion. A control system is operatively coupled to the resistance mechanism and the incline adjustment device and is configured to receive a resistance setting for controlling the resistance, receive an incline setting for controlling the incline, and determine a resistance modifier for adjusting the resistance based on the incline setting. The control system is further configured to adjust the resistance setting based on the resistance modifier to provide a modified resistance setting, control the incline adjustment device based on the incline setting, and control the resistance mechanism based on the modified resistance setting to thereby cause an exertion by a user for performing the exercise motion to change when the incline setting is changed.

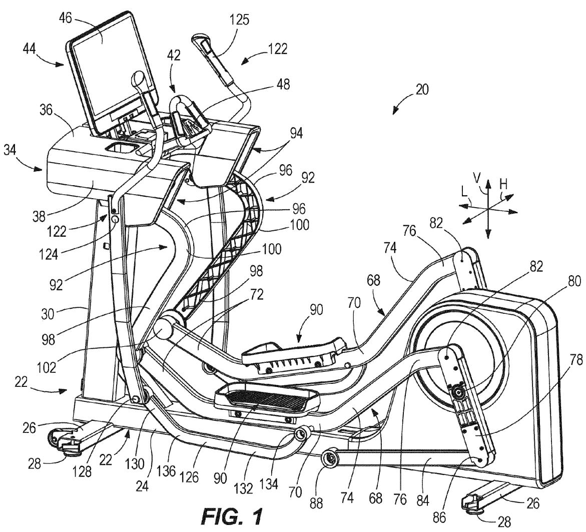

FIG. 1

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(52) Cooperative Patent Classification (CPC): (Cont.)
A63B 2225/20; A63B 2225/50; A63B 2230/062

Description

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/446,579, filed February 17, 2023 and U.S. Patent Application 18/439,087 filed February 12, 2024.

FIELD

[0002] The present disclosure relates to exercise machines and methods for controlling exercise machines, and particularly to exercise machines having adjustable resistance and incline settings.

BACKGROUND

[0003] Relevant background information can be found in the following U.S. Patent and Patent Applications:

U.S. Patent Pub. No. 2021/0275866 and U.S. Patent No. 10,946,238 disclose aspects of exercise machines having frames, whereby pivoting a first frame portion relative to a second frame portion changes a shape of an elliptical path during a striding exercise motion.

U.S. Patent No. 10,478,665 discloses an exercise apparatus having a frame and first and second pedals that are coupled to the frame so that a user standing on the first and second pedals can perform a striding exercise. The first and second pedals each has a tread member that supports the bottom of a user's foot in a manner that encourages movement of the user's foot relative to the tread member during the striding exercise.

U.S. Patent No. 9,925,412 discloses an exercise device including a linkage assembly that links a driving member to a driven member so that circular rotation of the driving member causes generally equal circular rotation of the driven member. The linkage assembly includes a linking member, a first crank arm that connects the driving member to the linking member so that rotation of the driving member causes motion of the linking member, and a second crank arm that connects the linking member to the driven member so that the motion of the linking member causes rotation of the driven member. At least one additional crank arm connects the linking member at a rotational axis that is laterally offset from a straight line through the first and second crank arm rotational axes.

U.S. Patent No. 9,283,425 discloses an exercise assembly having a frame and elongated foot pedal members that are each movable along user-defined paths of differing dimensions. Each foot pedal member has a front portion and a rear portion. Footpads are disposed on the rear portion of one of the first and second foot pedal members. Elongated coupler arms have a lower portion and an upper portion that is pivotably connected to the frame. Crank members have a first portion that is pivotably connected to the front portion of one of the first and second foot pedal members and have a second portion that is pivotably connected to the lower portion of one of the first and second coupler arms, so that each crank member is rotatable in a circular path. Elongated rocker arms have a lower portion that is pivotably connected to one of the first and second foot pedal members in between the foot pad and the crank member and have an upper portion that is pivotably connected to the frame.

U.S. Patent No. 9,138,614 discloses an exercise assembly having elongated first and second rocker arms that pivot with respect to each other in a scissors-like motion about a first pivot axis. A slider has a slider body that slides along a linear axis extending through and perpendicular to the first pivot axis. A linkage pivotably couples the first and second rocker arms to the slider body. Pivoting the first and second rocker arms with respect to each other causes the slider body to slide in a first direction along the linear axis. Opposite pivoting of the first and second rocker arms with respect to each other causes the slider body to slide in an opposite, second direction along the linear axis.

U.S. Patent Nos. 9,126,078 and 8,272,997 disclose an elliptical step exercise apparatus in that a dynamic link mechanism can be used to vary the stride length of the machine. A control system can also be used to vary stride length as a function of various exercise and operating parameters such as speed and direction as well as varying stride length as a part of a preprogrammed exercise routine such as a hill or interval training program. In addition, the control system can use measurements of stride length to optimize operation of the apparatus.

U.S. Patent No. 7,931,566 discloses an elliptical cross trainer that has a rotating inertial flywheel driven by user-engaged linkage exercising a user. A user-actuated brake engages and stops rotation of the flywheel upon actuation by the user.

U.S. Patent No. 7,918,766 discloses an exercise apparatus for providing elliptical foot motion that utilizes a first and second rocking links suspended from an upper portion of the apparatus frame permitting at least limited arcuate motion of the lower portions of the links. Foot pedal assemblies are connected to rotating shafts or members located on the lower portion of the links so that the foot pedals will describe a generally elliptical path in response to user foot motion on the pedals.

U.S. Patent No. 6,846,272 discloses an exercise apparatus in which a stride length portion of an elliptical motion can be increased automatically as a function of exercise parameters such as speed. In addition, arm handles can be disconnected manually or automatically from pedal levers.

U.S. Patent No. 6,217,486; 6,203,474; 6,099,439; and 5,947,872 disclose aspects of an exercise apparatus having a pedal that moves in an elliptical path, whereby an angular orientation of the pedal, relative to a fixed, horizontal plane, such as the floor, varies in a manner that simulates a natural heel to toe flexure.

U.S. Patent App. No. 17/867,062 discloses an exercise machine for performing a striding exercise motion. The exercise machine has a frame, first and second pedal members, first and second foot pads on the first and second pedal members, respectively, wherein the first and second foot pads are configured to move in respective elliptical paths during the striding exercise motion, and first and second rocker arms. The first and second pedal members are pivotably coupled to the first and second rocker arms and move with the first and second rocker arms relative to the frame. An adjustment device pivotably couples the first and second rocker arms to the frame. The adjustment device is configured to actively adjust and set a position of the first and second rocker arms relative to the frame, respectively, which thereby changes an incline shape of the elliptical paths, respectively, during the striding exercise motion.

[0004] Additional U.S. Patents are relevant for disclosing additional types of exercise machines and control thereof. In particular, U.S. Patent Nos. 9,238,158 and 9,216,317 disclose stair climbing type exercise machines. U.S. Patent Nos. 6,572,512; 6,095,951; 4,749,181; 4,664,371; 4,659,074; 4,643,418; 4,635,928; 4,635,927; 4,614,337; and 4,334,676; and, as well as U.S. Patent Pub. No. 2021/0283465 and U.S. Patent App. No. 17/946,295, disclose treadmill type exercise machines.

SUMMARY

[0005] This Summary is provided to introduce a selection of concepts that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0006] Certain aspects of the present disclosure relate to exercise machines for performing exercise motions. A resistance mechanism controls a resistance for performing the exercise motion. An incline adjustment device controls an incline for performing the exercise motion. A control system is operatively coupled to the resistance mechanism and the incline adjustment device and is configured to receive a resistance setting for controlling the resistance, receive an incline setting for controlling the incline, and determine a resistance modifier for adjusting the resistance based on the incline setting. The control system is further configured to adjust the resistance setting based on the resistance modifier to provide a modified resistance setting, control the incline adjustment device based on the incline setting, and control the resistance mechanism based on the modified resistance setting to thereby cause an exertion by a user for performing the exercise motion to change when the incline setting is changed.

[0007] In certain examples, the exercise machine is configured such that the exercise motion comprises a striding exercise motion.

[0008] In certain examples, the control system is configured to determine the resistance modifier such that a given change in the incline setting changes the exertion by the user to correspond to a change in a reference exertion from changing an incline setting of a reference exercise machine by that given change. In certain examples, the reference exercise machine comprises a treadmill. In certain examples, the resistance modifier is determined such that the exertion for performing the exercise motion is approximately the same as the reference exertion. In certain examples, the control system is configured to determine the resistance modifier based also on at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed.

[0009] In certain examples, the control system is configured to determine the resistance modifier based also on at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed.

[0010] Other aspects according to the present disclosure generally relate to methods for controlling exercise machines for performing an exercise motion. In certain examples, the method includes receiving a resistance setting for controlling a resistance for performing the exercise motion, receiving an incline setting for controlling an incline for performing the exercise motion, and determining a resistance modifier for adjusting the resistance setting based on the incline setting. The method further includes adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting, controlling the incline based on the incline setting, and controlling the resistance based on the modified resistance setting. The resistance is controlled based on the modified resistance setting so that an exertion by a user for performing the exercise motion is caused to change when the incline setting is changed.

[0011] Certain examples further include determining the resistance modifier based also on a reference exertion for performing a reference exercise motion with a reference exercise machine having an incline controlled at the incline setting, wherein the reference exertion is stored in memory, and wherein the resistance modifier is determined such that the exertion for performing the exercise motion is approximately the same as the reference exertion.

[0012] Certain examples further include receiving a scale setting and determining the resistance modifier based on the scale setting, wherein the scale setting changes how much the resistance modifier varies as a function of the incline setting. Certain examples further include receiving an input from the user and basing the scale setting on the input.

[0013] Certain examples further include receiving an input from the user and basing at least one of the resistance setting and the incline setting on the input.

[0014] Certain examples further include determining the resistance modifier based also on the resistance setting.

[0015] Certain examples further include determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed and determining the resistance modifier based thereon.

[0016] Other aspects according to the present disclosure generally relate to methods for controlling exercise machines for performing an exercise motion based on a reference exercise machine for performing a reference exercise motion. In certain examples, the method further includes receiving a resistance setting for controlling a resistance for performing the exercise motion, receiving an incline setting for controlling an incline for performing the exercise motion, and determining a resistance modifier for adjusting the resistance setting based on the incline setting and based on a reference exertion for performing the reference exercise motion at the incline setting using the reference exercise machine. The method further includes adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting, controlling the incline based on the incline setting, and controlling the resistance based on the modified resistance setting. The resistance is controlled based on the modified resistance setting so that changing the incline setting changes the reference exertion and causes a change in an exertion by a user for performing the exercise motion correspondingly.

[0017] Certain examples further include receiving a scale setting and determining the resistance modifier based on the scale setting, wherein the scale setting changes how much the resistance modifier varies as a function of the incline setting. Certain examples further include receiving an input from the user and basing the scale setting on the input.

[0018] Certain examples further include receiving an input from the user and basing at least one of the resistance setting and the incline setting on the input.

[0019] Certain examples further include determining the resistance modifier based also on the resistance setting.

[0020] Certain examples further include determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed, and determining the resistance modifier based thereon.

[0021] It should be recognized that the different aspects described throughout this disclosure may be combined in different manners, including those than expressly disclosed in the provided examples, while still constituting an invention accord to the present disclosure.

[0022] Various other features, objects and advantages of the disclosure will be made apparent from the following description taken together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The present disclosure is described with reference to the following Figures. The same numbers are used throughout the Figures to reference like features and like components. Unless otherwise specifically noted, articles illustrated in the drawings are not necessarily drawn to scale.

FIG. 1 is a side perspective view of a non-limiting example of an exercise machine according to the present disclosure, having certain features removed such as support column, base member and stabilizer covers.

FIG. 2 is a rear view thereof having front a stabilizer covers removed.

FIG. 3 is a side view thereof having front and rear covers removed.

FIG. 4 is an opposite side view thereof having front and rear covers and stabilizer covers removed.

FIG. 5 is a top view thereof having base member and stabilizer covers removed.

FIG. 6 is an exploded view of portions of the front of the machine.

FIG. 7 is another exploded view of the portions illustrated in FIG. 6.

FIG. 8 is a schematic view showing a low incline elliptical path of travel of foot pads on the machine.

FIG. 9 is a schematic view showing a medium incline elliptical path of travel of foot pads on the machine.

FIG. 10 is a schematic view showing a high incline elliptical path of travel of foot pads on the machine.

FIG. 11 is a schematic of a control system for controlling an exercise machine according to the present disclosure.

FIG. 12 is a flow chart illustrating a non-limiting example of a method for controlling an exercise machine according to the present disclosure.

FIG. 13 is a representation of a control system for controlling two exercise machines according to the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[0024] Through experimentation and development, the present inventors have identified problems and inconsistencies in the effect that changing an incline of a cross trainer has on the user's exertion. For some fitness machines, such as a treadmill, the user lifts their weight with every step. Changing the incline of the treadmill belt increases the height or distance that this weight must be lifted. Furthermore, exertion is defined a function of force and distance (e.g., lifting a mass, and how far). Thus, increasing the incline of the treadmill increases the distance, which increases the exertion of the user.

[0025] However, the present inventors have recognized that the same mechanics are not true for an elliptical cross trainer. Due to the connecting linkages, moving one pedal downwardly causes the other pedal to move upwardly. Furthermore, the pedals travel in an elliptical path around a crank axis. Thus, pushing one pedal down assists the user in lifting their weight as the other pedal goes up and there is no net increase in the height of the user's weight as the exercise motion is performed. Because the exertion for performing the elliptical exercise motion is not based on the user having to lift their weight by a height with each step, the present inventors have determined that adjusting the incline of these elliptical cross trainers has little to no effect on the user's exertion. This deficiency is both undesired and unexpected by the user.

[0026] The present disclosure identifies this deficiency, the causes of the deficiency, and also provides example systems and methods for addressing the unmet need of providing an elliptical cross trainer that functions in a desirable and predictable manner.

[0027] FIGS. 1-5 illustrate a personal exercise machine 20 for performing a striding exercise motion. The machine 20 extends from front to back in a longitudinal direction L, from top to bottom in a vertical direction V, and from side to opposite side in a horizontal direction H. The machine 20 is substantially symmetrical in the horizontal direction H. Therefore, the components on one side of the machine 20 are the same as, or are mirror images of, the components on the opposite side of the machine 20. As such, the descriptions provided below regarding components on one side of the machine 20 equally apply to the components on the opposite side of the machine 20.

[0028] The machine 20 has a frame 22 including a longitudinally extending base member 24. Horizontally extending stabilizer members 26 extend from the front and rear of the base member 24 and prevent the machine 20 from tipping over in the horizontal direction H. Each stabilizer member 26 has feet 28 for supporting the frame 22 above the ground. The frame 22 has a forward support column 30 that extends vertically upwardly from the front of the base member 24. An angular gusset 32 braces and supports the forward support column 30 relative to the base member 24. A bridge 34 is mounted on top of the forward support column 30. The bridge 34 has a horizontally extending body 36 with opposing first and second arms 38 extending rearwardly therefrom. As such, the bridge 34 generally has a U-shape and defines an "activity zone" between the arms 38 for the user's body and/or arms during performance of the striding exercise motion. A generally trapezoidal-shaped stationary handlebar 42 is rigidly mounted on the body 36 between the arms 38 and is at least partially for manually grasping by a user operating the machine 20.

[0029] A user console 44 is mounted to and extends generally upwardly from the bridge 34. The console 44 includes a display screen 46 oriented towards the user operating the machine 20. As is conventional, the console 44 can include a processor and memory and be configured for controlling various devices associated with the machine 20, including for control of resistance and/or incline as for example will be further described herein below. The display screen 46 optionally can be a touch screen wherein the user operating the machine 20 can manually touch the screen to input commands to the console 44 for controlling the machine 20. Optionally, input buttons 48 are located on the stationary handlebar 42 and to manually input commands to the console 44. In some examples, the input buttons 48 are located elsewhere such as on the upper ends of handgrips 125, described herein below. Input commands entered via the display screen 46 and/or the input buttons 48 can for example include an increase or decrease in resistance of the machine 20 and/or increase or decrease in incline of the machine 20, and/or the like. Optionally, biomechanical sensors 45 can be provided on the stationary handlebar 42 and/or on handgrips 125 to sense a heart rate of the user when the user manually grasps the handlebar 42 and/or the handgrips 125.

[0030] It should be recognized that the various devices associated with the machine 20 may be controlled other than via input from the user (e.g., using the touch screen, input buttons 48, and other mechanisms described above). As non-limiting examples, this includes adjustments to the resistance and/or incline in accordance with an exercise program stored and executed by the processor in the console 44 or as changed by an instructor leading the user through an exercise routine. In other words, instructor inputs and exercise programs may also be considered inputs for controlling the exercise machine 20. Additional discussion regarding the control system controlling these various devices is provided below.

[0031] At the rear of the machine 20, the frame 22 further includes a rear support column 50 that extends angularly upwardly and rearwardly from the rear of the base member 24. A resistance mechanism 52 is mounted to the rear support column 50, including for example via a rear frame plate (not illustrated in FIG. 4) mounted to the rear support column 50 and/or the base member 24. The type and configuration of the resistance mechanism 52 can vary from what is illustrated and described. In the illustrated example, the resistance mechanism 52 is a hybrid generator-brake configured to provide a resistance to a striding motion performed on the machine 20, as will be further described herein below, and also configured to generate power based upon the striding motion, for example to power the console 44. In some examples, a suitable resistance mechanism is the "FB Six Series" sold by Chi Hua. The resistance mechanism 52 is connected to a pulley wheel 56 by a belt 58 and is configured so that rotation of the pulley wheel 56 rotates the resistance mechanism 52. The pulley wheel 56 is connected to the rear support column 50 by a center shaft 60 (see FIG. 8). The pulley wheel 56 and center shaft 60 are fixed relative to each other such that these components rotate together.

[0032] At the rear of the machine 20, radially opposed crank arms 62 have radially inner ends keyed to (fixed to) the center shaft 60 so that the crank arms 62 remain radially opposed to each other (i.e., 180 degrees apart) and so that rotation of the crank arms 62 and center shaft 60 causes rotation of the pulley wheel 56 about a pulley wheel pivot axis 64 defined by the center shaft 60. In the illustrated examples of FIGS. 1-5, the resistance mechanism 52 resists rotation of the pulley wheel 56 via an electro magnet 66. In some examples, the resistance mechanism 52 includes another means for resisting movement of the pulley wheel 56, such as via a flywheel, mechanical brake, pneumatic actuators, etc.

[0033] The machine 20 further has first and second pedal members 68 centrally located on opposite sides of the frame 22. The pedal members 68 are elongated in the longitudinal direction L, each having a central portion 70, a front portion 72 that extends generally forwardly and upwardly from the central portion 70, and a rear portion 74 that extends generally rearwardly and upwardly from the central portion 70 to a tail portion 76 that extends rearwardly from the rear portion 74 and substantially parallel to the central portion 70. In some examples, the tail portion 76 is not substantially parallel to the central portion 70.

[0034] At the rear of the machine 20, first and second elongated stride links 78 are freely rotatably (pivotably) coupled to the radially outer ends of the opposed crank arms 62, by for example bearings, at a stride link-crank arm pivot axis 80. Each stride link 78 has a first end that is pivotably coupled to a respective tail portion 76 of a pedal member 68 at a stride link-pedal member pivot axis 82. Each stride link 78 has an opposite, second end that is pivotably coupled to a distal or rear end of an elongated idler link 84 at a stride link-idler link pivot axis 86. The opposite, proximal or front end of the idler link 84 is pivotably coupled to the base member 24 at an idler link-base member pivot axis 88. As illustrated in at least FIGS. 1, 3 and 4, the stride link-crank arm pivot axis 80 is located along the stride link 78 between the stride link-pedal member pivot axis 82 and stride link-idler link pivot axis 86. In some examples, the stride link-crank arm pivot axis 80 is closer to the stride link-pedal member pivot axis 82 than the stride link-idler link pivot axis 86. In other examples, the pivot axis 80 is at the center of the stride link 78 or closer to the pivot axis 86.

[0035] First and second foot pads 90 are supported on the central portions 70 of the first and second pedal members 68. The exercise machine 20 includes the first and second foot pads 90 to support the user's feet during performance of the elliptical striding motion. The first and second foot pads 90 travel along an elliptical path that is incline adjustable, as will be further described herein below.

[0036] The machine 20 further has first and second rocker arms 92 that are pivotably coupled to the frame 22 by an incline adjustment device 94, which will be further described herein below. The type and configuration of the incline adjustment device 94 can vary and additional examples are illustrated in the examples illustrated (with further detail also being provided in U.S. Patent App. No. 17/867,062, which has been incorporated herein in its entirety). The rocker arms 92 have an upper end portion 96, a lower end portion 98, and an elbow portion 100 located between the upper end portion 96 and the lower end portion 98 so that the upper end portion 96 and lower end portion 98 extend at an angle relative to each other. The lower end portions 98 are pivotably coupled to the front portion 72 of the pedal members 68 at a rocker arm-pedal member pivot axis 102 so that the pedal members 68 are pivotably movable relative to the rocker arms 92 and also so that pivoting of the rocker arms 92 relative to the frame 22 causes commensurate pivoting and/or translating of the pedal members 68 relative to the frame 22, i.e., so that these components pivot and/or translate together relative to the frame 22.

[0037] Referring to FIGS. 3, 4, 6 and 7, the incline adjustment device 94 is located in the bridge 34 and extends into the noted arms 38 on both sides of the activity zone. The incline adjustment device 94 is specially configured to facilitate selective adjustment and setting of a position of the rocker arms 92 relative to the frame 22, respectively, specifically the position of pivot axis 108, which thereby changes an incline shape of elliptical paths of travel of the foot pads 90, respectively, during the striding exercise motion, as will be further described herein below. The incline adjustment device 94 can be controlled by the noted controller based upon a stored exercise program or based upon an input by the operator to the console 44. For example this can be controlled via touch screen, input buttons 48 on the stationary handlebar 42 and/or input buttons on the upper ends of hand grips 125. As will be evident from the illustrated examples and the following description, the type and configuration of the incline adjustment device 94 can vary.

[0038] In the first example illustrated in FIGS. 1-10, the incline adjustment device 94 includes an incline link 104 for each of the rocker arms 92, which pivotably couple the upper portion 96 of the rocker arms 92 to the frame 22. More specifically, each incline link 104 has an upper portion that is pivotably coupled to the frame 22 at an incline link-frame pivot axis 106. Each incline link 104 further has a lower portion that is pivotably coupled to the upper end portion 96 of the rocker arm 92 at an incline link-rocker arm pivot axis 108 that is located generally below the incline link-frame pivot axis 106. In some examples, bearings support the noted couplings so that the corresponding incline link 104 is pivotable relative to the noted axes 106, 108.

[0039] The incline adjustment device 94 is configured to pivot each incline link 104 relative to the frame 22 (i.e., about the incline link-frame pivot axis 106) to thereby adjust and set the position of the rocker arms 92 relative to the frame 22, in particular to adjust and set the position of the incline link-rocker arm pivot axis 108 relative to the frame 22 (i.e., about the incline link-frame pivot axis 106). In the illustrated example, the incline adjustment device 94 includes first and second linear actuators 110. Note that the type of linear actuator 110 can vary from what is illustrated and described. In the illustrated example, the linear actuator 110 includes an electro-mechanical linear actuator, which has an electric gearmotor 120, a leadscrew assembly 121 and, a leadnut and tube assembly 125 (see FIGS. 6 and 7). The linear actuator 110 has a forward end pivotably coupled to the bridge 34 by a trunnion assembly 113, particularly at an actuator-bridge pivot axis 114. The linear actuator 110 has an opposite, rear end pivotably coupled to the incline link 104 at an actuator-incline link pivot axis 118 (see FIG. 6). An example bearing, which is best seen in exploded view in FIG. 7, supports the coupling at the actuator-incline link pivot axis 118. The actuator-incline link pivot axis 118 is offset relative to the incline link-frame pivot axis 106 and the incline link-rocker arm pivot axis 108. In certain cases, the actuator-incline link pivot axis 118 is offset forwardly relative to the incline link-frame pivot axis 106 and the incline link-rocker arm pivot axis 108. In the illustrated non-limiting example, the incline link 104 is a member or body having or defining a triangular shape, wherein the incline link-frame pivot axis 106, the incline link-rocker arm pivot axis 108, and the actuator-incline link pivot axis 118 are located at the respective three apexes of the triangular shape.

[0040] The gearmotor 120, leadscrew assembly 121, and leadnut and tube assembly 125 are configured to lengthen or shorten the linear actuator 110 upon an input command from the noted controller, which can be based upon an operator input to the console 44 or based upon a program in the noted controller, as described herein above. Operation of the gearmotor 120 in a first direction rotates the lead screw 123 of the leadscrew assembly 121 in the first direction that causes the leadnut and tube assembly 125 to travel outwardly along the lead screw 123 and outwardly relative to the housing 119 of linear actuator 110, thus lengthening the linear actuator 110. Operation of the gearmotor 120 in an opposite, second direction oppositely rotates the lead screw 123 in the second direction that cause the leadnut and tube assembly 125 to retract inwardly relative to the housing 119, thus shortening the linear actuator 110. Due to the relative locations of the incline link-frame pivot axis 106, incline link-rocker arm pivot axis 108, actuator-bridge pivot axis 114, and actuator-incline link pivot axis 118, extension of the linear actuator 110 pivots the incline link 104 rearwardly along an arc relative to the bridge 34. Such actuation of the linear actuator 110 also moves the incline link-rocker arm pivot axis 108 rearwardly (e.g., relative to the frame 22) and along an arc relative to the incline link-frame pivot axis 106. As illustrated and described herein below, this increases or raises the incline of the elliptical path of the foot pads 90 (e.g., relative to the frame 22). Conversely, shortening the linear actuator 110 pivots the incline link 104 forwardly along the arc relative to the bridge 34, along an arc relative to the incline link-frame pivot axis 106. This moves the incline link-rocker arm pivot axis 108 forwardly along the arc relative to the frame 22. As illustrated and described herein below, this reduces or lowers the incline of the elliptical path of the foot pads 90 (e.g., relative to the frame 22). In examples disclosed herein, the incline adjustment device 94 can adjust the incline of the elliptical path of the foot pads 90 during the striding motion.

[0041] It is important to note that the incline adjustment device 94 does not need to include two actuators, as shown in the first example. In other examples, a single adjustment device connected to more than one incline link 104. In addition to linear actuators, devices for changing the position an incline link 104 include an electric motor driving worm gears, the use of pulleys, and/or any other conventional mechanism for causing the above-noted adjustment of the relative position of the axes.

[0042] Referring to FIGS. 1-5, the machine 20 has movable handle members 122 that are pivotably coupled to opposite sides of the bridge 34 at a handle member-bridge pivot axis 124. Each handle member 122 has an upper end with a hand grip 125 for manually grasping by the user performing the striding exercise motion. Each handle member 122 has a lower end that is pivotably coupled to a coupler link 126 at a handle member-coupler link pivot axis 128. Thus, the handle member 122 and respective coupler link 126 pivot together about the handle member-bridge pivot axis 124 and the coupler link 126 is pivotable relative to the handle member 122 about the handle member-coupler link pivot axis 128. Each coupler link 126 has a forward end portion 130 coupled to the handle member 122 at the handle member-coupler link pivot axis 128 and a rearward end portion 132 pivotably coupled to the central portion 70 of the pedal member 68 at a coupler link-pedal member pivot axis 134. Thus, the coupler link 126 is pivotable relative to the pedal member 68 about the coupler link-pedal member pivot axis 134. An elbow portion 136 is located between the forward and rearward end portions 130, 132 so that the forward end portion 130 extends angularly upwardly relative to the rearward end portion 132. As such, the user standing on the foot pads 90 and manually grasping the hand grips 125 can alternately push and pull on the hand grips 125 to thereby apply pushing and pulling forces on the pedal members 68 via the coupler links 126, which assists the striding exercise motion, as will be further described herein below.

[0043] FIGS. 8-10 are schematic views of the machine 20 showing the paths of travel A1-A3 of the foot pads 90 and the paths of travel B1-B3 of the stride link-pedal member pivot axis 82 during low incline (FIG. 8), medium incline (FIG. 9), and high incline (FIG. 10). In each figure, the rocker arms 92 have a different position of swing range, which is determined by position of the incline adjustment device 94.

[0044] FIG. 8 illustrates low-incline, where the linear actuators 110 are retracted and thus each incline link 104 is pivoted about the incline link-frame pivot axis 106 towards the bridge 34 (i.e., clockwise about the incline link-frame pivot axis 106 in the side view illustrated in FIG. 8). This moves the incline link-rocker arm pivot axis 108 along an arc towards the bridge 34 and via connection of the rocker arms 92 and pedal members 68, positions the foot pads 90 so as to follow the low-incline elliptical path of travel A1.

[0045] FIG. 9 illustrates medium-incline, wherein the linear actuators 110 are moderately extended and thus each incline link 104 is pivoted about the incline link-frame pivot axis 106 away from the bridge 34 (i.e., counter-clockwise about the incline link-frame pivot axis 106 from the side view illustrated in FIG. 9). This moves the incline link-rocker arm pivot axis 108 along an arc away from the bridge 34 and via connection of the rocker arms 92 and pedal members 68, positions the foot pads 90 to follow the medium-incline elliptical path of travel A2.

[0046] FIG. 10 illustrates high-incline, wherein the linear actuators 110 are further extended and thus each incline link 104 is pivoted about the incline link-frame pivot axis 106 away from the bridge 34 (i.e., further counter-clockwise about the incline link-frame pivot axis 106 from the side view illustrated in FIG. 10). This moves the incline link-rocker arm pivot axis 108 along the arc further away from the bridge 34 and via connection of the rocker arms 92 and pedal members 68, positions the foot pads 90 to follow the high-incline elliptical path of travel A3. It is important to understand that the three positions illustrated in FIGS. 8-10 are exemplary and other positions are possible via operation of the incline adjustment device 94, which can be automatically controlled by programming of the console 44 and/or by inputs to the console 44 and/or input buttons 48 and/or other input buttons such as on the upper ends of handgrips 125.

[0047] By comparison of FIGS. 8-10, the machine 20 is advantageously configured to maintain a substantially compact and constant length (in the length direction L, see FIG. 1) of the paths of travel A1-A3 throughout the adjustments made by the incline adjustment device 94. The configurations of the various components advantageously take up a relatively small footprint. The ends of the rocker arms 92 advantageously do not swing beyond the front of the frame 22, thus maintaining a small footprint. The paths of travel B1-B3 are also substantially constant, due to the configuration of the stride link 78 as illustrated and described herein above. The rear linkage including the stride links 78 advantageously does not swing beyond the rear portion of the frame 22, thus maintaining a small footprint. The configuration of the movable handle members 122 and the coupler link 126 is advantageous in that the overall path of movement (i.e., swing range of the handle members 122 about the handle member-bridge pivot axis 124) is substantially constant despite changes in incline via the incline adjustment device 94.

[0048] Advantageously, the foot pads 90 are located on the pedal members 68 at a distance rearward of the rocker arm-pedal member pivot axis 102 to create a more natural, vertical height of the paths of travel A1-A3. This feature in combination with the path of travel B1-B3 yields a more natural, and smooth path of travel A1-A3 in all incline settings. Also, the path of travel (arc) along which the incline link travels, as described herein above, is tilted upward towards the rear portion of travel, towards high incline. This tailors/blends some additional vertical height to the overall ellipse height as it adjusts to a high incline setting.

[0049] FIG. 11 illustrates one example of a control system 200 for controlling an exercise machine, such as the exercise machine 20 shown in FIGS. 1-5 and discussed above. Certain aspects of the present disclosure are described or depicted as functional and/or logical block components or processing steps, which may be performed by any number of hardware, software, and/or firmware components configured to perform the specified functions. For example, certain embodiments employ integrated circuit components, such as memory elements, digital signal processing elements, logic elements, look-up tables, or the like, configured to carry out a variety of functions under the control of one or more processors or other control devices. The connections between functional and logical block components are merely exemplary, which may be direct or indirect, and may follow alternate pathways.

[0050] In certain examples, the control system 200 communicates with one or more components of the machine 20 via one or more communication links CL, which can be any wired and/or wireless link. The control system 200 is capable of receiving information and/or control signals via the communication links CL to control one or more operational characteristics of the machine 20 and its various sub-systems. It should be recognized that the term "receiving" should not be construed as limiting how the information becomes available to components described herein. By way of example, the present disclosure contemplates both configurations in which the control system 200 is provided the information from another component outside the control system 200, a component within the control system 200 obtains the information from another component outside the control system 200, or a component within the control system 200 derives the underlying information itself. In one example, the communication link CL is a controller area network (CAN) bus. However, in some examples, other types of links are used. It will be recognized that the extent of connections and the communication links CL may in fact be one or more shared connections, or links, among some or all the components in the machine 20. Moreover, lines representative of the communication links CL are illustrated to demonstrate that the various control elements can communicate with one another, and do not represent actual wiring connections between the various elements, nor do they represent the only paths of communication between the elements. Additionally, the machine 20 may incorporate various types of communication devices and systems, and thus the illustrated communication links CL may in fact represent various different types of wireless and/or wired data communication systems.

[0051] The control system 200 may be a computing system that includes a processing system 210, memory system 220, and input/output (I/O) system 230 for communicating with other devices operatively coupled thereto, such as input devices 199 and output devices 201, either of which can, additionally or alternatively, include elements stored in a cloud 202. The input devices 199 and output devices 201 may also be collectively referred to as peripheral devices. Examples of input devices 199 include the console 44 (e.g., as a touch screen), input buttons 48, and biomechanical sensors 45 as discussed above and shown in FIG. 3. Additional inputs 199 may also be provided depending on the type of exercise machine and the various element provided therewith. With reference to FIGS. 3 and 11, a weight sensor 203 may be provided with the exercise machine 20 and configured to measure a weight of the user (e.g., the weight supported via pedals, stairs, or the like). The weight sensor may be a piezo-electric sensor or another technology known in the art. The weight of the user may alternatively be provided by the user, such as a number entry entered via the console 44, retrieved from memory (e.g., the memory system 220 of FIG. 11) such as by logging into a user account via LF Connect or another software application.

[0052] The exercise machine 20 may also or alternatively have a force sensor 205 (e.g., a piezo-electric sensor or another technology known in the art), for example positioned where the weight sensor 203 is shown in FIG. 3, which is configured to measure a force generated by the user while performing the exercise motion. In certain configurations, the same sensor may serve as both the weight sensor 203 and the force sensor 205. For example, one sensor for a manually rotated treadmill may detect a weight when the user is stationary and a force when the user is rotating the belt. In other configurations and for other exercise machines, such as a rowing machine, the force sensor 205 measures forces at a different location or in a different direction than forces caused by the user's weight. In this case, the force sensor 205 may be configured to measure pull forces in the horizontal direction as the user performs the rowing exercise motion, whereas a separate weight sensor 203 may measure the vertical force of the user's weight on the seat. Another non-limiting example of a location for positioning a force sensor 204 includes the handles of an elliptical cross trainer.

[0053] The exercise machine 20 may also or alternatively have a speed sensor 207 configured to measure a speed in which the user performs the exercise motion, which may be configured in a manner known in the art (e.g., a Hall effect sensor, rotary encoder, etc.). By way of example, the speed sensor 207 may measure rotations per minute (RPM) of rotating portions of an elliptical cross trainer, an RPM or pull frequency for a rowing machine, a number of steps per minute climbed on a stair climbing machine, or other conventionally measured metrics.

[0054] With reference to FIGS. 3 and 11, examples of output devices 201 of the control system 200 include the resistance mechanism 52 that controls the resistance for performing the exercise motion and an incline adjustment device 94 for controlling the incline for performing the exercise motion as discussed above. It should be recognized that certain devices may perform functions that are both inputs devices 199 and outputs devices 201, such as the console 44, whereby the screen 46 of the console 44 can be used to both receive inputs from the user and to display information to the user as an output. Other output devices 201 are also contemplated depending on the type of exercise machine and the devices and functions provided therewith. Additional non-limiting examples of output devices 201 include a motor 209 for rotating the belt of a treadmill, lights, sounds, and/or haptic feedback to convey information to the user, cooling fans, and/or other conventionally known elements. Additional information regarding these outputs may be found in the U.S. patents and patent applications presented at least in the BACKGROUND section above.

[0055] For the control system 200 of FIG. 11, the processing system 210 loads and executes an executable program 222 from the memory system 220, accesses data 224 stored within the memory system 220, and directs the machine 20 to operate as described in further detail below. The processing system 210 may be implemented as a single microprocessor or other circuitry or be distributed across multiple processing devices or subsystems that cooperate to execute the executable program 222 from the memory system 220. Non-limiting examples of the processing system include general purpose central processing units, application specific processors, and logic devices.

[0056] The memory system 220 may comprise any storage media readable by the processing system 210 and capable of storing the executable program 222 and/or data 224. The memory system 220 may be implemented as a single storage device or be distributed across multiple storage devices or sub-systems that cooperate to store computer readable instructions, data structures, program modules, or other data. The memory system 220 may include volatile and/or non-volatile systems and may include removable and/or non-removable media implemented in any method or technology for storage of information. The storage media may include non-transitory and/or transitory storage media, including random access memory, read only memory, magnetic discs, optical discs, flash memory, virtual memory, and non-virtual memory, magnetic storage devices, or any other medium which can be used to store information and be accessed by an instruction execution system, for example.

[0057] In this manner, the control system 200 controls the output devices 201 based on the input devices 199 and based on the executable program 222 stored in the memory system 220 to thereby control the exercise machine 20.

[0058] Through experimentation and development, the present inventors have identified problems with exercise machines and methods for controlling exercise machines presently known in the art. In many cases an exercise machine offers adjustments to change the user's exertion for performing an exercise motion, such as by adjusting a resistance and/or an incline for performing the exercise motion. Such resistance and/or incline adjustments can be effectuated by controlling the resistance mechanism 52 and/or the incline adjustment device 94 as discussed above. It should be recognized that exertion may also be referred to as the work or energy needed for performing the exercise motion, which may be measured as a function of watts, joules, or other conventional units. The user's heart rate, V02, or other physiological measurements may also be used as a means for measuring exertion, which may be measured via conventional techniques.

[0059] The present inventors have recognized that for certain exercise machines in which the incline is adjustable, increasing the incline does not provide the expected result of increasing the exertion. In the case of a conventional treadmill, the user's exertion is typically increased by adjusting either the speed in which the belt rotates, the resistance for the user to rotate the belt (for a manually-powered treadmill), and/or by increasing the incline of the belt relative to a horizontal plane such as the floor. However, in the case of an elliptical cross trainer of the type shown in FIG. 3, increasing the incline does not increase the user's exertion. In fact, the present inventors have identified particular models of elliptical cross trainers and controls for operating them in which increasing the incline actually decreases the user's exertion in use.

[0060] In one experiment, the present inventors determined that increasing the incline for a conventional treadmill caused the user's heartrate to increase between 3.5 and 5.5 beats per minute (bpm) per degree of incline increase. In contrast, the heartrate increase was only between 0.5 and 2.0 bpm per degree for a conventional elliptical cross trainer. As discussed above, in other examples, the present inventors found no change in exertion as the incline of an elliptical cross trainer increased. For certain fitness machines, increasing the incline of the elliptical cross trainer was found to result in a decrease in exertion-which is often the opposite effect desired by the user in increasing the incline.

[0061] The present inventors have identified different explanations for which increasing the incline has little effect to no effect on user exertion for a cross trainer. For a treadmill, the user lifts their weight (e.g., weight of their foot, leg, and/or body) with each step. Changing the incline of the treadmill belt increases the height or distance that this weight must be lifted. Furthermore, exertion is defined a function of force and distance (e.g., lifting a mass, and how far). Thus, increasing the incline of the treadmill increases the distance, which increases the exertion of the user.

[0062] However, the same mechanics are not true for an elliptical cross trainer. Due to the connecting linkages, as discussed above, moving one pedal downwardly causes the other pedal to move upwardly. Furthermore, the pedals travel in an elliptical path around a crank axis. Thus, pushing one pedal down assists the user in lifting their weight as the other pedal goes up. There is no net increase in the height of the user's weight as the exercise motion is performed. Because the exertion for performing the elliptical exercise motion is not based on the user having to lift their weight by a height with each step, it follows that adjusting the incline of this exercise machine (thereby adjusting the height of each step) has little to no effect on the exertion of the user.

[0063] Through further experimentation and testing, the present inventors have developed the presently disclosed exercise machines and methods for controlling exercise machines to provide a change in user exertion from performing the exercise based on a change in incline of an elliptical motion or path. In short, this includes the introduction of a resistance modifier for adjusting the resistance for performing the exercise motion based on the incline, as discussed further below. This is also referred to as providing a dynamic resistance that varies based on incline, rather than simply a fixed resistance that is independent of inline.

[0064] FIG. 12 illustrates one method 300 for controlling an exercise machine according to the present disclosure, such as for controlling the exercise machine shown in FIG. 3. It should be recognized that while this example relates to an elliptical cross-trainer (also referred to as a striding type of exercise machine), the present disclosure also contemplates use with other types of exercise machines, such as a stair climbing type exercise machines or arc trainers (e.g., the Life Fitness Total Body Arc, etc.).

[0065] In step 302 a resistance setting is received for controlling a resistance for performing the exercise motion. As discussed above, the resistance setting may be received via an input device 199 of the control system 200 of FIG. 11 discussed above, such as through user selections on the screen 46 of the console 44, input buttons 48 on the stationary handlebar 42, on the handgrips 125, and/or elsewhere on the exercise machine, from an executable program 222 stored in the memory system 220 (e.g., a particular exercise program selected for the user to perform), and/or other methods known in the art. As discussed, the processing system 210 may actively pull these resistance settings, receive resistance settings pushed from other components, other and/or other mechanisms for communicating this information. Similarly, step 304 provides for receiving an incline setting for controlling an incline for performing the exercise motion, which may be received in the same or a similar manner as the resistance setting received in step 302.

[0066] The control system uses the incline setting to determine a resistance modifier as an adjustment to the resistance setting to ensure that adjustments to the incline are observed or reflected in the user's exertion for performing the exercise motion. In certain methods, which are discussed further below, the resistance modifier is determined also based on reference exertion data for a reference exercise machine. As will become apparent, this provides a mechanism for controlling different exercise machines to provide similar changes in user exertion as incline adjustments are made.

[0067] In other embodiments, the control system is not configured to determine the resistance modifier based on reference exercise data. In certain embodiments, this may be a selectable feature available to the user or operator. For the method 300 of FIG. 12, this provides for proceeding to step 306 after step 304 (path A) (i.e., not performing the optional steps 305 and 307, discussed below). Step 306 provides for determining a resistance modifier based on the incline setting that was received in step 304. As non-limiting examples, the resistance modifier may be determined using one or more algorithms and/or by referencing data stored in the memory system (e.g., a lookup table providing resistance modifiers corresponding to different incline settings), as discussed further below. The resistance modifier may also be determined based on additional factors such as the resistance setting received in step 302, the weight of the user, a heartrate of the user, the force exerted by the user when performing the exercise motion, and/or a speed in which the exercise motion is performed, which may be determined in a manner described above.

[0068] The resistance modifier may be provided as a function of the total range of resistance that can be provided by the resistance mechanism. In other words, if the range of resistances capable of being provided by the resistance mechanism ranges from 0% to 100%, the resistance modifier may be determined to be +5% (or another value) for every 1 degree increase in incline. The resistance capable of being provided by the resistance mechanism may alternatively be referred to in increment levels (e.g., ranging from 0 to 5 lowest to highest), measures of braking force, or other units. The same is true for referring to the incline, which may refer to percentages, increment levels, or other units rather than degrees. It should be recognized that the relationship between the incline and the resistance modifier need not be linear, for example with the resistance modifier being +5% for every 1 degree increase in incline when the incline is between 0.0 and 3.0 degrees and +7% when the incline is between 3.1 degrees and 5 degrees. In some examples, the resistance modifier is limited to only zero and positive values.

[0069] It should be recognized that determining of the resistance modifier based on the incline setting in step 306 would also include determining the resistance modifier based on a change in the incline setting (e.g., a previous incline setting to a new incline setting), since the latter is nonetheless based on the incline setting. Accordingly, the description provided herein may refer to the determination either using the incline setting or the change in incline.

[0070] In certain embodiments, the resistance modifier may also be determined based on a scale setting that adjusts how much the incline (by way of the resistance modifier) will impact the overall resistance provided by the resistance mechanism so as to change the exertion for the user. The scale setting may be provided by the user and/or the executable program of the control system 200. By way of example, the user may make selections via the exercise machine's console among easy, medium, and hard (or mild, standard, and aggressive) for the scale setting. The medium selection may have no effect of the resistance modifier, whereas the easy selection reduces the resistance modifier, and the hard selection increases the resistance modifier relative to the medium selection. Alternatively, the scale setting may relate to absolute or relative changes in resistance. By way of example, the easy selection decreases the resistance modifier from the medium selection by an absolute 1% (as a function of the total resistance possible by the resistance mechanism, e.g., from 6% to 5%). In another example, the easy selection reduces the resistance modifier by 50% relative to the determination when the medium selection is made (e.g., from 6% to 3%).

[0071] With continued reference to the method 300 of FIG. 12, step 308 provides for determining a modified resistance setting, specifically by adjusting the resistance setting based on the resistance modifier. In certain embodiments, the adjustment is an added resistance, in which the resistance modifier is added to the resistance setting to provide the modified resistance setting. For instance, a resistance modifier of +5% and a resistance setting of 10% would provide for a modified resistance setting of 15%.

[0072] Step 310 provides for controlling the incline for performing the exercise motion based on the incline setting received in step 304. It should be understood that this may be performed via control of an adjustment device such as described above and shown in FIG. 3 in a conventional manner.

[0073] Step 312 provides for controlling the resistance for performing the exercise motion based on the modified resistance setting determined in step 308. This may again be performed via control of a resistance mechanism such as described above and shown in FIG. 3, but not in the conventional manner of controlling the resistance simply based on the resistance setting received in step 302.

[0074] The resistance modifier may also be determined based on other factors. In certain embodiments, the resistance modifier is further based on the resistance setting provided in step 302. By way of example, a resistance modifier of +5% may be provided for a 1 degree increase in incline when the resistance setting is 10%, but the resistance modifier may be +3% for the 1 degree incline increase when the resistance setting is 2%. In a further example, resistance modifiers are not provided (or are given a value of 0%) when certain resistance settings are selected, such as one of the lowest five levels of resistance settings. This recognizes that low resistance settings may correspond to users having lower capabilities, thereby not modifying these resistance settings as incline changes. Similarly, in certain embodiments resistance modifiers are not provided if the speed in which the exercise motion is being performed is below a minimum threshold (e.g., the pedals rotating below 40 RPM), again potentially indicating that the user would not desire or be in condition for additional exertion beyond the selected resistance setting. Additionally, or alternatively, a heartrate of the user can be referenced in a similar manner, such as to not provide a resistance modifier when the heartrate exceeds a threshold rate (e.g., 150 bpm, 180 bpm, or an age-dependent threshold rate). In a contrasting example, in embodiments in which the resistance modifier is not based on the resistance setting, the resistance modifier may be 10%, 5%, or another value per 1 degree increase in incline regardless of the resistance setting.

[0075] In certain embodiments, the resistance modifier is determined such that changing the incline causes the exertion to change similarly or approximately the same as changing the incline for performing an exercise motion on another exercise machine (e.g., a treadmill). In particular, the resistance modifier is determined such that a given change in the incline setting causes the exertion of the user to change in a manner that corresponds to a change in a reference exertion based on the same given change in the incline setting of a reference exercise machine. As an illustrative example, if increasing an incline of another exercise machine (the reference exercise machine) by 2 degrees is known to cause a user's exertion (the reference exertion) to increase by 10%, the resistance modifier is determined such that the same 2 degree increase in incline would also increase the exertion for performing the exercise motion with the presently disclosed exercise machine by approximately the same 10%.

[0076] The reference exercise machine may be a different type of machine than the exercise machine being controlled. For example, the reference exercise machine can be a treadmill and the exercise machine being controlled can be an elliptical cross-trainer or stair climber. Moreover, in some examples, the reference exercise machine does not have an adjustable resistance (e.g., a conventional treadmill). The reference exercise machine may also be based on real-world activities that do not literally require an exercise machine, such as the determined or calculated exertion of hiking up an incline or a known grade.

[0077] The relationship between incline and exertion for the reference exercise machine may be determined empirically or through other methods and may be stored as data in the memory system 220 (FIG. 11). The reference exercise machine may also be a modelled version of the exercise machine being controlled in which the mechanical advantages of linkages between the pedals and the like are effectively cancelled out. In other words, if the linkages reduce the effort of a user lifting their weight by 70%, the reference exercise machine may be a model that effectively counteracts this effect. The reference exertion data, regardless of how this is provided or determined, may be stored as a reference table for comparison, as part of an algorithm for determining the resistance modifier, and/or in other data formats for determining the resistance modifier.

[0078] The present inventors have discovered that dynamically changing the resistance such that changes in incline cause changes in exertion as would be expected with real-world activities such as uphill climbing creates a particularly desirable user experience. The resistance may also or alternatively be changed to provide an experience in which exertion changes as a function of incline in a similar manner to other exercise machines. Offering consistency in how different exercise machines are controlled to provide the same or similar exertion allows the user to easily move between the different types of exercise machines for variety, to work on different muscles groups, or to accommodate different exercise machine availability in an exercise facility, such as a gym. The consistency also makes it easier for a user to try a new exercise machine, reducing the learning curve and providing a more comfortable experience in less time. It should be recognized that the exercise machine need not be controlled to literally match the exertion of another exercise machine, nor to match across all ranges of use.

[0079] FIG. 13 depicts an exercise machine 20 (here, an elliptical cross-trainer) that may be configured in a manner discussed above. In the illustrated example, the adjustment mechanism 94 is operating according to an incline setting of 3 degrees (e.g., being provided by the user via the console 44). As such, the exercise machine 20 can also be referred to as having an incline of 3 degrees.

[0080] FIG. 13 further depicts an example treadmill 400 such as that described in U.S. Patent App. No. 17/946,295. The treadmill 400 has a belt 402 that is rotated such that a user can run or walk on the belt 402. The belt 402 includes a running upper strand and a returning lower strand that continuously cycle about belt rollers in a conventional manner. While the present disclosure describes the treadmill 400 as having a motor that rotates the belt 402, the present disclosure also contemplates configurations of treadmills in which the user manually rotates the belt 402. It should be recognized that while a treadmill 400 is used in this example, another type of exercise machine may be used as the reference for controlling the exercise machine 20.

[0081] The treadmill 400 is supported on a base 420 having a front 421 and rear 422, left 423 and right 424, and top 425 and bottom 426. The base 420 is supported on feet 412 with casters. Operation of the treadmill 400 is controlled by a console 410 in a manner known in the art, which for example controls the speed of the belt 402, an incline of the belt 402 relative to a horizontal plane via a height adjustment system 430 in a manner known in the art, resistance levels (for example with bicycles, rowers, elliptical trainers, and/or manual treadmills in which the user rotates the belt), and/or other functions customary for operating treadmills as known in the art. The console 410 may include a control system 440 like the control system 200 of FIG. 11. The control system 440 controls the height adjustment system 430 to provide an incline for performing the exercise motion of the treadmill 400 according to an incline setting (which may be received in one of the manners discussed above for the exercise machine 20). In the illustrated example, the height adjustment system 430 is adjustable via a linear actuator 431 that causes the base 420 to move vertically to change an incline angle 434 of the belt 402 relative to the horizontal plane (e.g., the floor 436). The height adjustment system 430 is shown operating according to an incline setting of 3 degrees (e.g., being provided by the user via the console 410). As such, the treadmill 400 can also be referred to as having an incline of 3 degrees.

[0082] The control system 440 of the treadmill 400 and the control system 200 of the exercise machine 20 each communicate with a control system 500 via a cloud 202. The cloud 200 may be an internet-based computing network as known in the art, for example AWS by Amazon ®. The control system 500, control system 200, and/or control system 440 may also or alternatively communicate via other known networking configurations, including hardwired connections. The control system 500 may be configured like the control system 200 shown in FIG. 11, whereby the control system 440 and the control system 200 are each both input devices and output devices of the control system 500.

[0083] In certain configurations, the control system 200 controls the resistance of the exercise machine 20 to cause the exertion to be similar or equal to the expected exertion of performing the exercise motion of the treadmill 400 at the same incline setting (here both being 3 degrees). The treadmill 400 may store reference exertion data corresponding to performing the exercise motion at the different incline settings in memory to be accessible for controlling the exercise machine 20 though the cloud 202 and control system 500.

[0084] Alternatively, both the exercise machine 20 and the treadmill 400 may be controlled at the same time by the control system 500. In certain embodiments, the control system 500 controls both the exercise machine 20 and the treadmill 400 to cause the same amount of exertion when the respective exercise motions are performed at a given incline setting. This functionality may be particularly advantageous in the case of a training session in which the instructor is leading users that are performing different exercise motions with different types of exercise machines. By way of example, if the instructor wishes to increase the exertion of treadmill users by increasing the incline from 5% to 8%, a scaled adjustment may be provided for a user of an elliptical trainer so as to provide an equivalent increase in exertion.

[0085] Returning to the method of FIG. 12, additional information is now provided for an example of a method for controlling the resistance of an exercise machine based on reference exertion data. Steps 302 and 304 may proceed in the same manner described above. Following step 304, the process continues along alternate path B to step 305, which determines whether the system is configured to control resistance based on reference exertion data. As described above, this may mean determining whether the user has activated this feature for controlling the exercise machine, determining whether resistance exercise data is available, etc. If for any reason the system is not configured to control the resistance based on reference exercise data, the process continues to step 306 and proceeds in the same manner discussed above.

[0086] If instead it is determined in step 305 that the system is configured to control the resistance based on reference exercise data (and such reference exercise data exists and is available), the process continues to step 307. Step 307 provides for determining a resistance modifier based on the reference exertion data in addition to being based on the incline setting received in step 304. Examples for determining the resistance modifier based on the reference exertion data were provided above and are not repeated here for the sake of brevity. Steps 308 through 312 then proceed in the same manner described above, whereby the resistance is ultimately controlled based in part on the reference exercise data via step 307.In this manner, the exercise machines and methods disclosed herein provide for dynamic resistance that varies as a function of incline such that the exertion by the user for performing the exercise motion thereby changes when the incline setting changes. This provides a more desirable user experience that better simulates real-world conditions when changing incline.

Additional Aspects of the Present Disclosure

[0087] Certain aspects of the present disclosure relate to exercise machines for performing an exercise motion. A resistance mechanism controls a resistance for performing the exercise motion. An adjustment device controls an incline for performing the exercise motion. A control system is operatively coupled to the resistance mechanism and the adjustment device. The control system is configured to receive a resistance setting for controlling the resistance and to receive an incline setting for controlling the inline. The control system if further configured to determine a resistance modifier for adjusting the resistance based on the incline setting and to adjust the resistance setting based on the resistance modifier to provide a modified resistance setting. The control system is further configured to control the adjustment device based on the incline setting and control the resistance mechanism based on the modified resistance setting, whereby adjusting the resistance setting causes an exertion by a user for performing the exercise motion to change when the incline setting is changed.

[0088] The exercise motion may include a striding exercise motion. The control system may be configured to determine the resistance modifier such that a given change in the incline setting changes the exertion by the user to correspond to a change in exertion from changing an incline setting of a reference exercise machine by that given change. The reference exercise machine may include a treadmill.

[0089] The control system may be configured to receive at least one of the resistance setting and the incline setting from the user.

[0090] The control system may be configured to determine the resistance modifier based also on the resistance setting.

[0091] The control system may be configured to determine the resistance modifier based also on at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed.

[0092] The control system may include a memory system that stores an algorithm, whereby the control system is configured to determine the resistance modifier at least in part based on the algorithm.

[0093] Further aspects of the present disclosure relate to methods for controlling an exercise machine for performing an exercise motion. The method includes receiving a resistance setting for controlling a resistance for performing the exercise motion, receiving an incline setting for controlling an incline for performing the exercise motion, determining a resistance modifier for adjusting the resistance setting based on the incline setting, and adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting. The method further includes controlling the incline based on the incline setting and controlling the resistance based on the modified resistance setting, whereby the resistance setting is adjusted such that an exertion by a user for performing the exercise motion is caused to change when the incline setting is changed.

[0094] The method may further include determining the resistance modifier based also on a reference exertion for performing a reference exercise motion with a reference exercise machine having an incline controlled at the incline setting. The method may further include determining the resistance modifier such that the exertion for performing the exercise motion is approximately the same as the reference exertion. The method may further include storing information relating to the reference exertion of the reference exercise machine as a function of the incline setting thereof, and referencing the information for determining the resistance modifier.

[0095] The method may further include receiving a scale setting and determining the resistance modifier based on the scale setting. The method may further include receiving an input from the user and basing the scale setting on the input.

[0096] The method may further include receiving an input from the user and basing at least one of the resistance settings and the incline setting on the input.

[0097] The method may further include determining the resistance modifier based also on the resistance setting.

[0098] The method may further include determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed and determining the resistance modifier based thereon.

[0099] Further aspects of the present disclosure relate to exercise machines for performing an exercise motion based on a reference exercise machine for performing a reference exercise motion. A resistance mechanism controls a resistance for performing the exercise motion. An adjustment device controls an incline for performing the exercise motion. A control system is operatively coupled to the resistance mechanism and the adjustment device. The control system is configured to receive a resistance setting for controlling the resistance, receive an incline setting for controlling the incline, determine a resistance modifier for adjusting the resistance based on the incline setting and based on a reference exertion for performing the reference exercise motion at the incline setting, and adjust the resistance setting based on the resistance modifier to provide a modified resistance setting. The control system is further configured to control the adjustment device based on the incline setting and to control the resistance mechanism based on the modified resistance setting, whereby the resistance setting is adjusted such that changing the incline setting changes the reference exertion and changes an exertion by a user for performing the exercise motion correspondingly.

[0100] The reference exercise machine may include a treadmill.

[0101] The exercise motion may include a striding exercise motion.

[0102] The exercise machine may further include a memory system that stores information relating to the reference exertion for performing the reference exercise motion. The information may be part of an algorithm used to determine the resistance modifier.

[0103] The control system may be further configured to determine the resistance modifier based at least one of a weight of the user and a speed in which the exercise motion is performed.

[0104] The reference exertion may also be based on at least one of a weight of a user and a speed at which the reference exercise motion is performed.

[0105] The control system may be configured to determine the resistance modifier based also on the resistance setting.

[0106] Further aspects of the present disclosure relate to methods for controlling an exercise machine for performing an exercise motion based on a reference exercise machine for performing a reference exercise motion. The method includes receiving a resistance setting for controlling a resistance for performing the exercise motion, receiving an incline setting for controlling an incline for performing the exercise motion, determining a resistance modifier for adjusting the resistance setting based on the incline setting and based on a reference exertion for performing the reference exercise motion at the incline setting, and adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting. The method further includes controlling the incline based on the incline setting and controlling the resistance based on the modified resistance setting, whereby the resistance setting is adjusted such that changing the incline setting changes the reference exertion and changes an exertion by a user for performing the exercise motion correspondingly.

[0107] The method may further include receiving a scale setting and determining the resistance modifier based on the scale setting. The method may further include receiving an input from the user and basing the scale setting on the input.

[0108] The method may further include storing information relating to the reference exertion of the reference exercise machine as a function of the incline setting thereof, and referencing the information for determining the resistance modifier.

[0109] The method may further include receiving an input from the user and basing at least one of the resistance setting and the incline setting on the input.

[0110] The method may further include determining the resistance modifier based also on the resistance setting.

[0111] The method may further include determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed and determining the resistance modifier based thereon.

[0112] Although specific advantages have been enumerated above, various examples may include some, none, or all of the enumerated advantages. Other technical advantages may become readily apparent to one of ordinary skill in the art after review of the following figures and description. Modifications, additions, or omissions may be made to the systems, apparatuses, and methods described herein without departing from the scope of the disclosure. For example, the components of the systems and apparatuses may be integrated or separated. Moreover, the operations of the systems and apparatuses disclosed herein may be performed by more, fewer, or other components and the methods described may include more, fewer, or other steps. Additionally, steps may be performed in any suitable order. As used in this document, "each" refers to each member of a set or each member of a subset of a set.

[0113] The functional block diagrams, operational sequences, and flow diagrams provided in the Figures are representative of exemplary architectures, environments, and methodologies for performing novel aspects of the disclosure. While, for purposes of simplicity of explanation, the methodologies included herein may be in the form of a functional diagram, operational sequence, or flow diagram, and may be described as a series of acts, it is to be understood and appreciated that the methodologies are not limited by the order of acts, as some acts may, in accordance therewith, occur in a different order and/or concurrently with other acts from that shown and described herein. For example, those skilled in the art will understand and appreciate that a methodology can alternatively be represented as a series of interrelated states or events, such as in a state diagram. Moreover, not all acts illustrated in a methodology may be required for a novel implementation.

[0114] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to make and use the invention. Certain terms have been used for brevity, clarity, and understanding. No unnecessary limitations are to be inferred therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes only and are intended to be broadly construed. The patentable scope of the invention is defined by the claims and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have features or structural elements that do not differ from the literal language of the claims, or if they include equivalent features or structural elements with insubstantial differences from the literal languages of the claims.

[0115] The following clauses set of features of the invention which may or may not be presently claimed, but which may form the basis for claim amendments or future divisional applications.

CLAUSES

[0116]

1. An exercise machine for performing an exercise motion, the exercise machine comprising:

   a resistance mechanism that controls a resistance for performing the exercise motion;

   an incline adjustment device that controls an incline for performing the exercise motion; and

   a control system operatively coupled to the resistance mechanism and the incline adjustment device, the control system being configured to:

receive a resistance setting for controlling the resistance;

receive an incline setting for controlling the incline;

determine a resistance modifier for adjusting the resistance based on the incline setting;

adjust the resistance setting based on the resistance modifier to provide a modified resistance setting;

control the incline adjustment device based on the incline setting; and

control the resistance mechanism based on the modified resistance setting;

wherein controlling the resistance mechanism based on the modified resistance setting causes an exertion by a user for performing the exercise motion to change when the incline setting is changed.

2. The exercise machine according to clause 1, wherein the exercise machine is configured such that the exercise motion comprises a striding exercise motion.

3. The exercise machine according to clause 1, wherein the control system is configured to determine the resistance modifier such that a given change in the incline setting changes the exertion by the user to correspond to a change in a reference exertion from changing an incline setting of a reference exercise machine by that given change.

4. The exercise machine according to clause 3, wherein the reference exercise machine comprises a treadmill.

5. The exercise machine according to clause 3, wherein the resistance modifier is determined such that the exertion for performing the exercise motion is approximately the same as the reference exertion.

6. The exercise machine according to clause 5, wherein the control system is configured to determine the resistance modifier based also on at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed.

7. The exercise machine according to clause 1, wherein the control system is configured to determine the resistance modifier based also on at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed.

8. A method for controlling an exercise machine for performing an exercise motion, the method comprising:

receiving a resistance setting for controlling a resistance for performing the exercise motion;

receiving an incline setting for controlling an incline for performing the exercise motion;

determining a resistance modifier for adjusting the resistance setting based on the incline setting;

adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting;

controlling the incline based on the incline setting; and

controlling the resistance based on the modified resistance setting;

wherein the resistance is controlled based on the modified resistance setting so that an exertion by a user for performing the exercise motion is caused to change when the incline setting is changed.

9. The method according to clause 8, further comprising determining the resistance modifier based also on a reference exertion for performing a reference exercise motion with a reference exercise machine having an incline controlled at the incline setting, wherein the reference exertion is stored in memory, and wherein the resistance modifier is determined such that the exertion for performing the exercise motion is approximately the same as the reference exertion.

10. The method according to clause 8, further comprising receiving a scale setting and determining the resistance modifier based on the scale setting, wherein the scale setting changes how much the resistance modifier varies as a function of the incline setting.

11. The method according to clause 10, further comprising receiving an input from the user and basing

the scale setting on the input.

12. The method according to clause 8, further comprising receiving an input from the user and basing at least one of the resistance setting and the incline setting on the input.

13. The method according to clause 8, further comprising determining the resistance modifier based also on the resistance setting.

14. The method according to clause 8, further comprising determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed and determining the resistance modifier based thereon.

15. A method for controlling an exercise machine for performing an exercise motion based on a reference exercise machine for performing a reference exercise motion, the method comprising:

receiving a resistance setting for controlling a resistance for performing the exercise motion;

receiving an incline setting for controlling an incline for performing the exercise motion;

determining a resistance modifier for adjusting the resistance setting based on the incline setting and based on a reference exertion for performing the reference exercise motion at the incline setting using the reference exercise machine;

adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting;

controlling the incline based on the incline setting; and

controlling the resistance based on the modified resistance setting;

wherein the resistance is controlled based on the modified resistance setting so that changing the incline setting changes the reference exertion and causes a change in an exertion by a user for performing the exercise motion correspondingly.

16. The method according to clause 15, further comprising receiving a scale setting and determining the resistance modifier based on the scale setting, wherein the scale setting changes how much the resistance modifier varies as a function of the incline setting.

17. The method according to clause 16, further comprising receiving an input from the user and basing the scale setting on the input.

18. The method according to clause 15, further comprising receiving an input from the user and basing at least one of the resistance setting and the incline setting on the input.

19. The method according to clause 15, further comprising determining the resistance modifier based also on the resistance setting.

20. The method according to clause 15, further comprising determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed, and determining the resistance modifier based thereon.

Claims

1. An exercise machine for performing an exercise motion, the exercise machine comprising:

- a resistance mechanism that controls a resistance for performing the exercise motion;
- an incline adjustment device that controls an incline for performing the exercise motion; and
- a control system operatively coupled to the resistance mechanism and the incline adjustment device, the control system being configured to:
- receive a resistance setting for controlling the resistance;
- receive an incline setting for controlling the incline;
- determine a resistance modifier for adjusting the resistance based on the incline setting;
- adjust the resistance setting based on the resistance modifier to provide a modified resistance setting;
- control the incline adjustment device based on the incline setting; and
- control the resistance mechanism based on the modified resistance setting; wherein controlling the resistance mechanism based on the modified resistance setting causes an exertion by a user for performing the exercise motion to change when the incline setting is changed.

2. The exercise machine according to claim 1, wherein the exercise machine is configured such that the exercise motion comprises a striding exercise motion.

3. The exercise machine according to claim 1 or 2, wherein the control system is configured to determine the resistance modifier such that a given change in the incline setting changes the exertion by the user to correspond to a change in a reference exertion from changing an incline setting of a reference exercise machine by that given change.

4. The exercise machine according to claim 3, wherein the reference exercise machine comprises a treadmill.

5. The exercise machine according to claim 3 or 4, wherein the resistance modifier is determined such that the exertion for performing the exercise motion is approximately the same as the reference exertion.

6. The exercise machine according to any one of the preceding claims, wherein the control system is configured to determine the resistance modifier based also on at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed.

7. A method for controlling an exercise machine for performing an exercise motion, the method comprising:

- receiving a resistance setting for controlling a resistance for performing the exercise motion;
- receiving an incline setting for controlling an incline for performing the exercise motion;
determining a resistance modifier for adjusting the resistance setting based on the incline setting;
- adjusting the resistance setting based on the resistance modifier to provide a modified resistance setting;
- controlling the incline based on the incline setting; and
- controlling the resistance based on the modified resistance setting,
wherein the resistance is controlled based on the modified resistance setting so that an exertion by a user for performing the exercise motion is caused to change when the incline setting is changed.

8. The method according to claim 7, further comprising determining the resistance modifier based also on a reference exertion for performing a reference exercise motion with a reference exercise machine having an incline controlled at the incline setting, wherein the resistance modifier is determined such that the exertion for performing the exercise motion is approximately the same as the reference exertion.

9. The method according to claim 8, wherein the reference exertion is stored in memory of a control system of the exercise apparatus.

10. The method according to any one of claims 7-9, further comprising receiving a scale setting and determining the resistance modifier based on the scale setting, wherein the scale setting changes how much the resistance modifier varies as a function of the incline setting.

11. The method according to claim 10, further comprising receiving an input from the user and basing the scale setting on the input.

12. The method according to any one of claims 7-11, further comprising receiving an input from the user and basing at least one of the resistance setting and the incline setting on the input.

13. The method according to any one of claims 7-12, further comprising determining the resistance modifier based also on the resistance setting.

14. The method according to any one of claims 7-13, further comprising determining at least one of a weight of the user, a heartrate of the user, a force exerted by the user when performing the exercise motion, and a speed in which the exercise motion is performed and determining the resistance modifier based thereon.

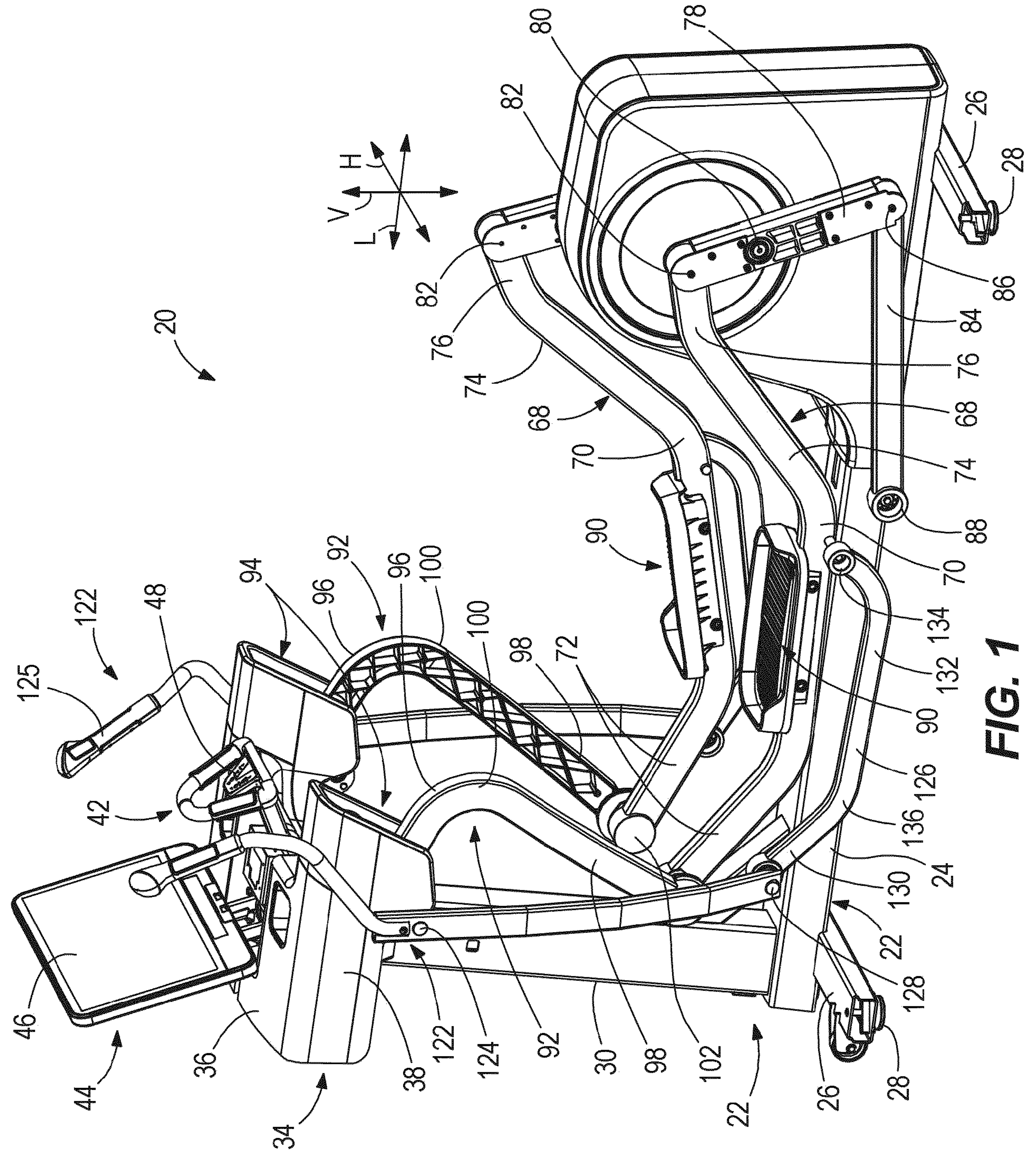
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FIG. 1

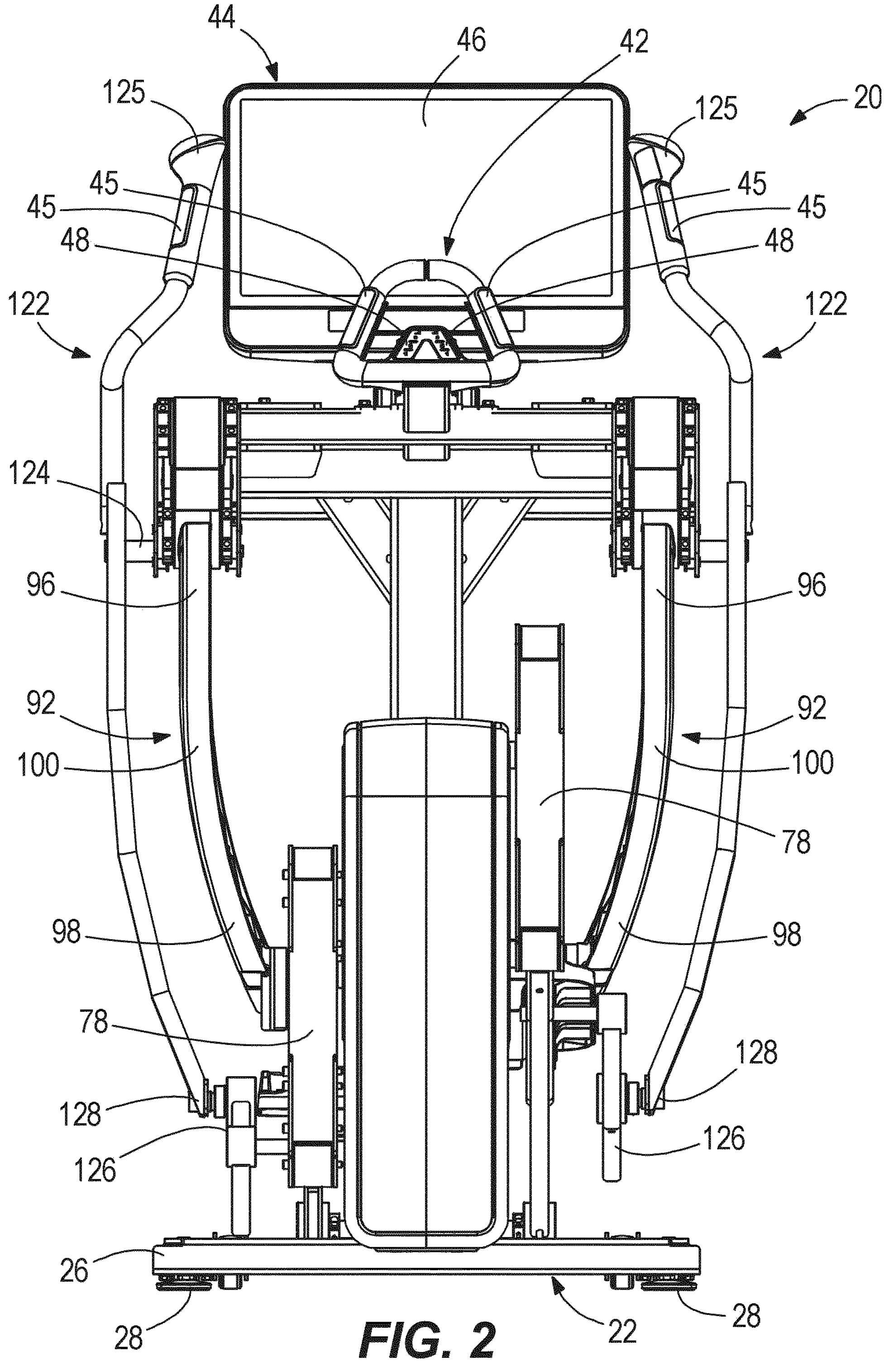
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FIG. 2

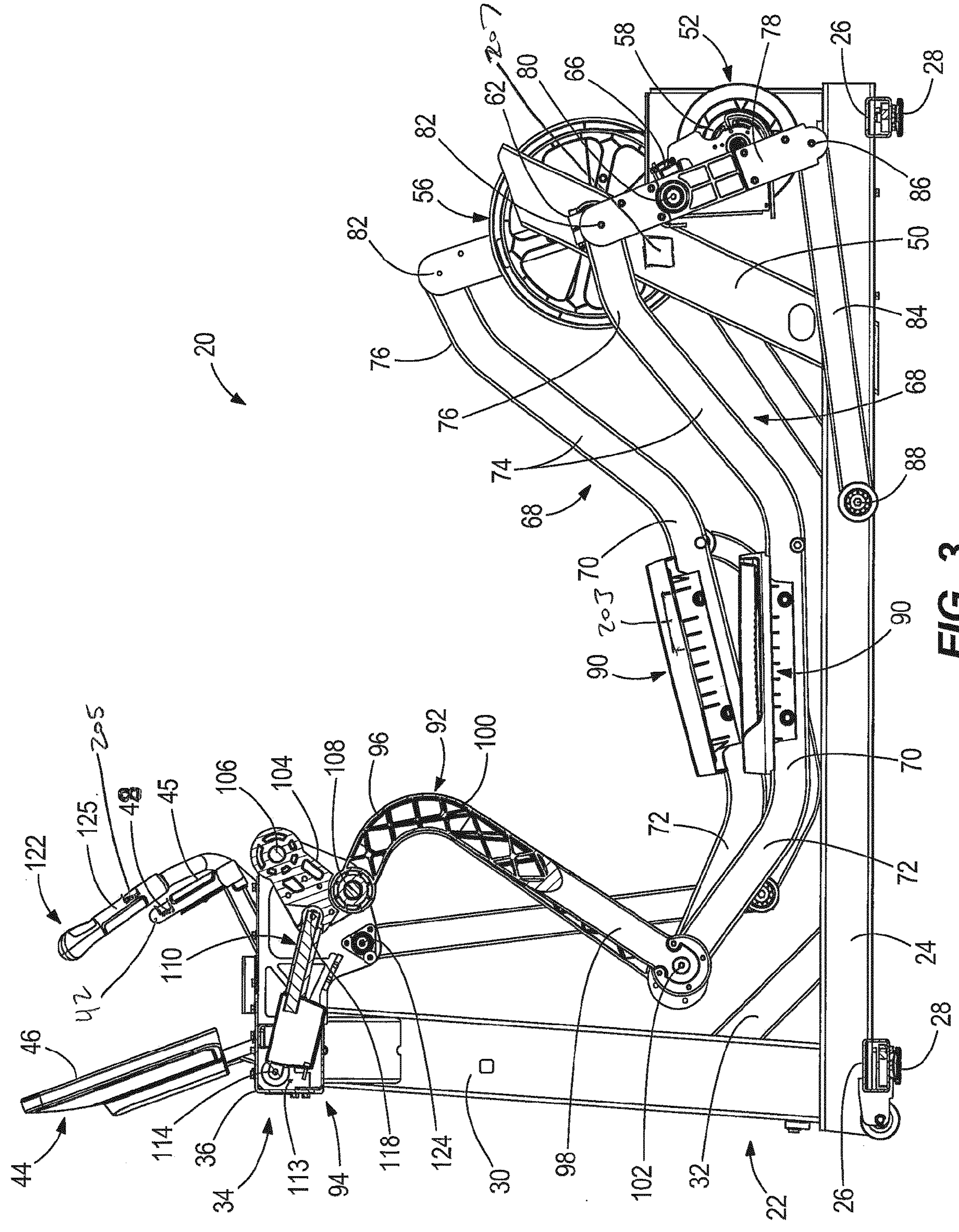
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FIG. 3

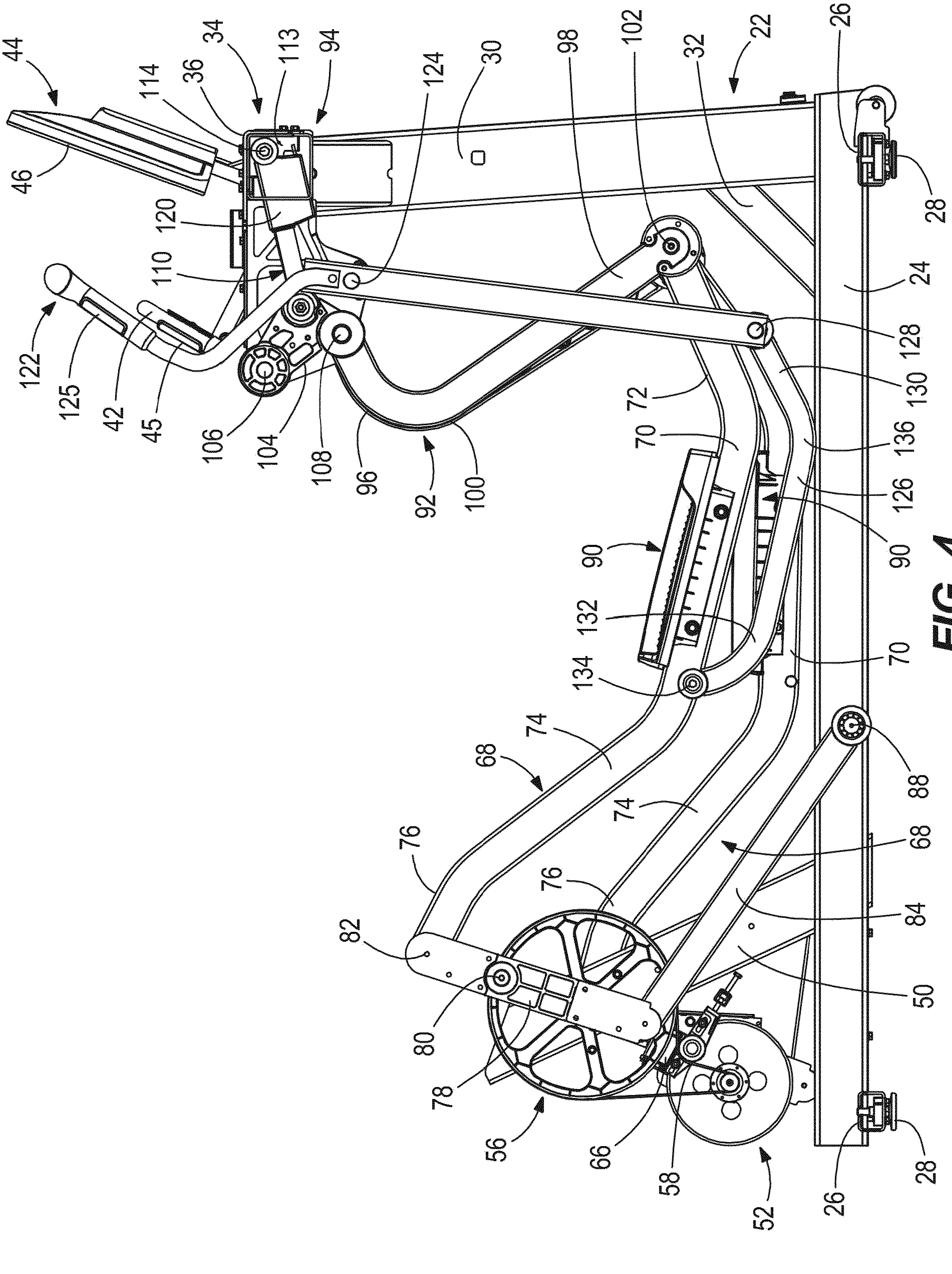
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FIG. 4

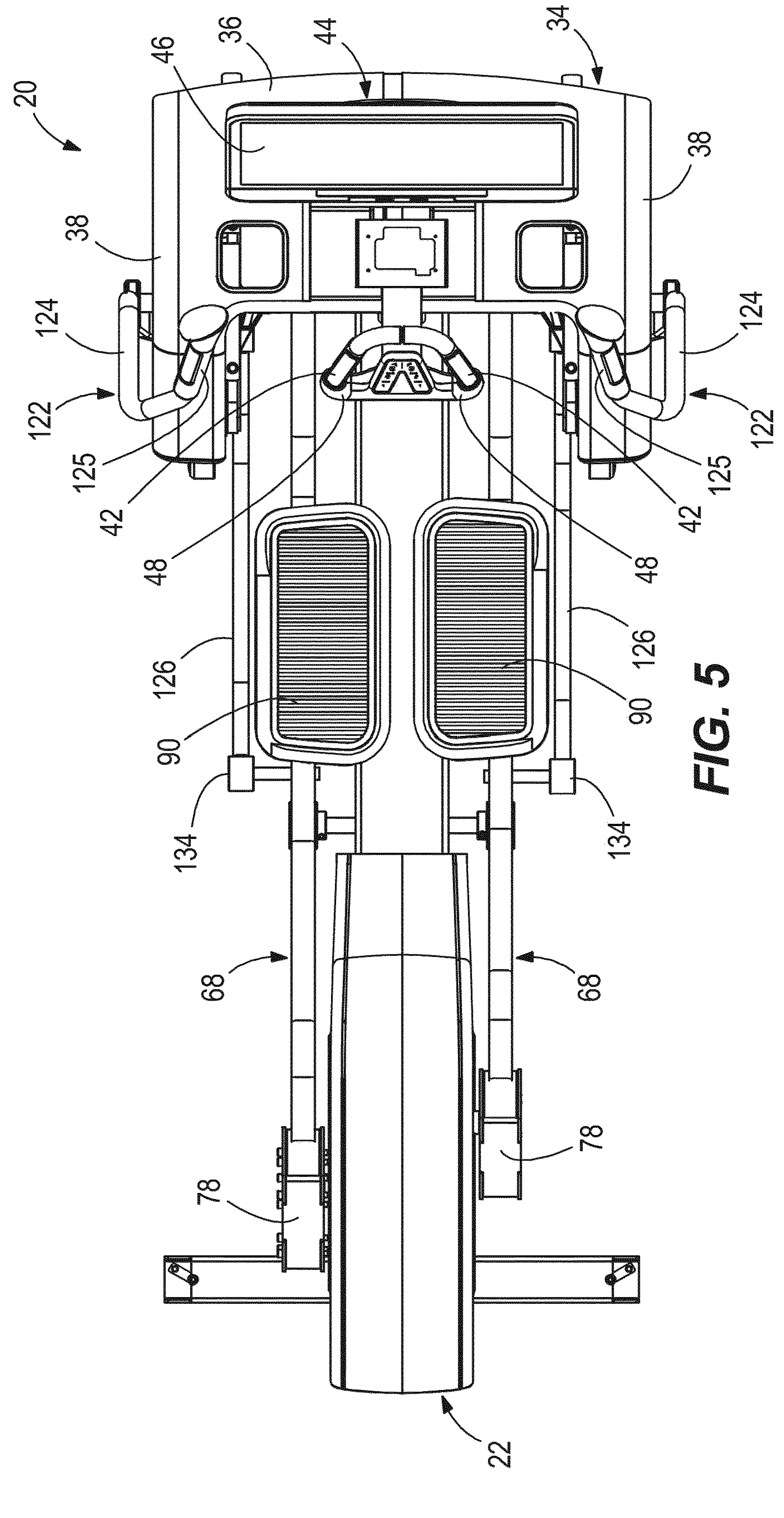
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FIG. 5

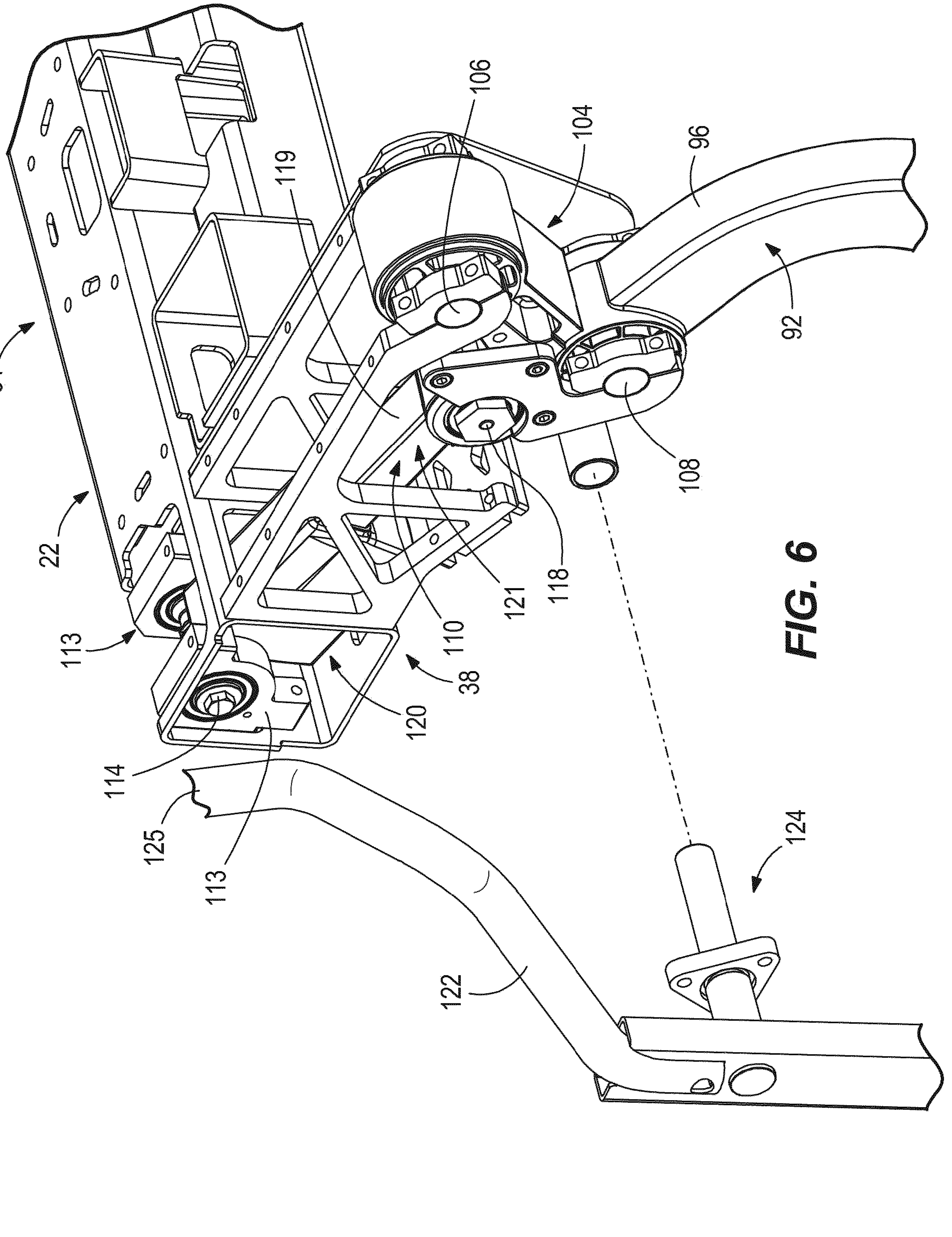
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FIG. 6

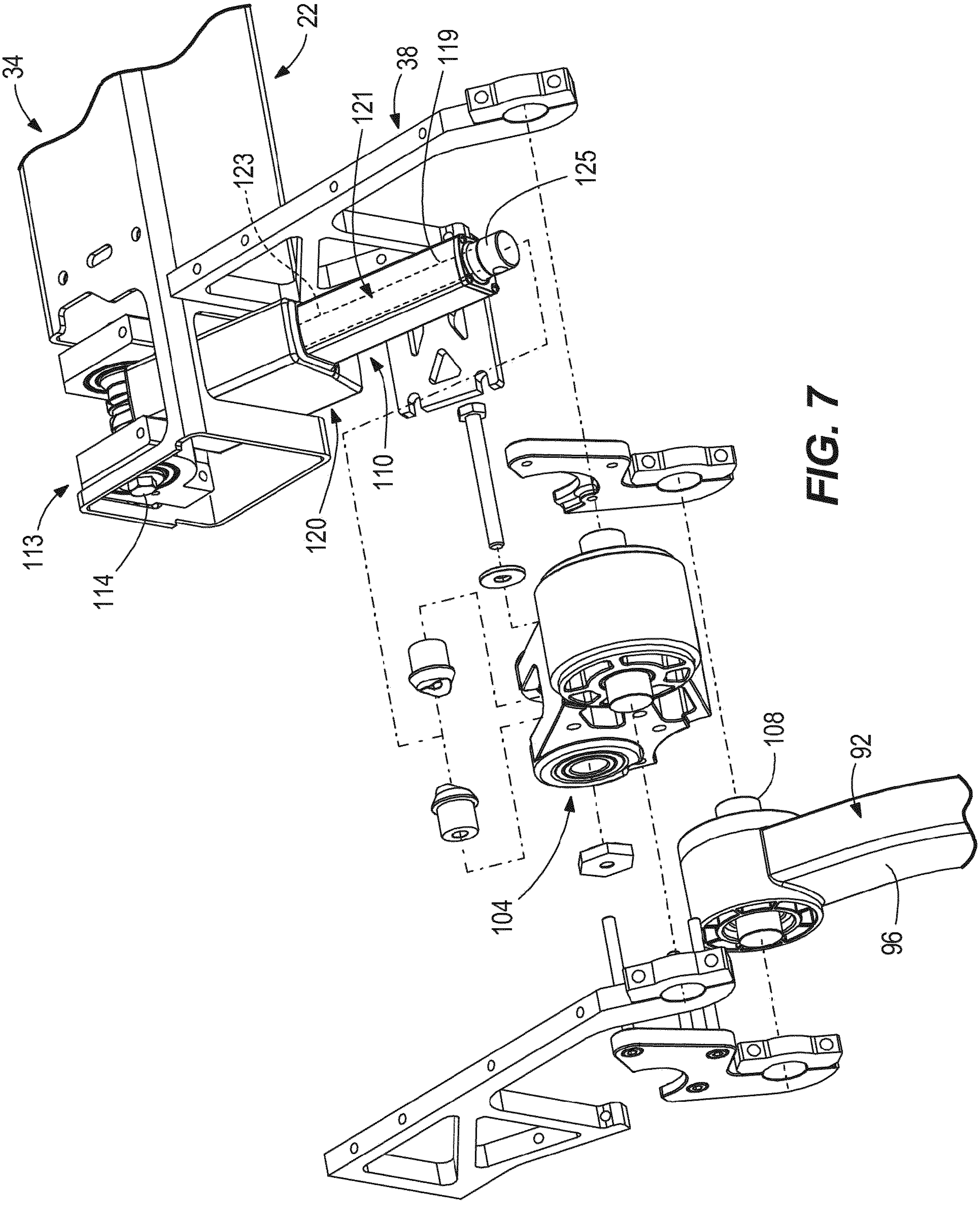
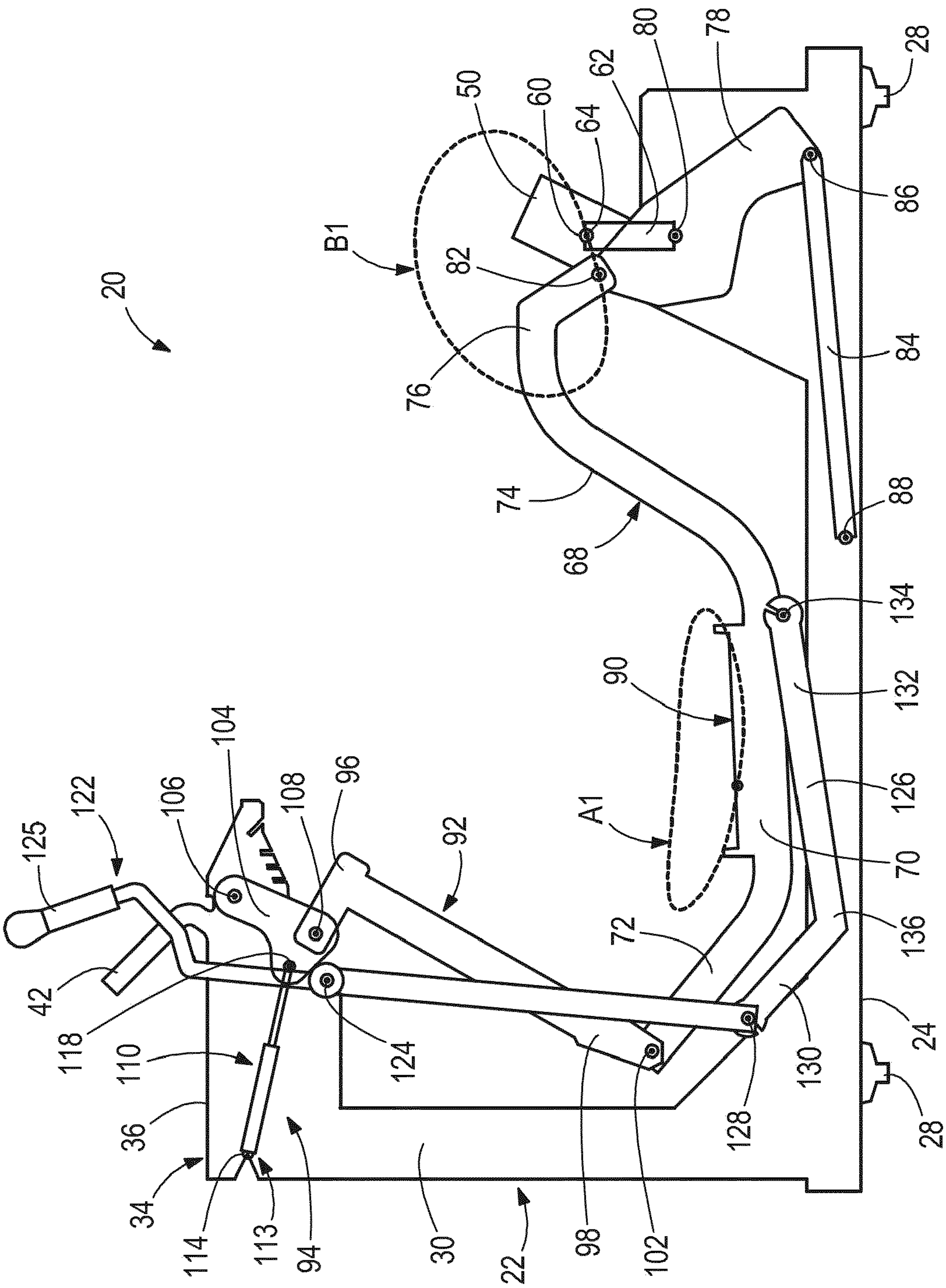


FIG. 7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106
122
125
92
A1
126
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FIG. 8

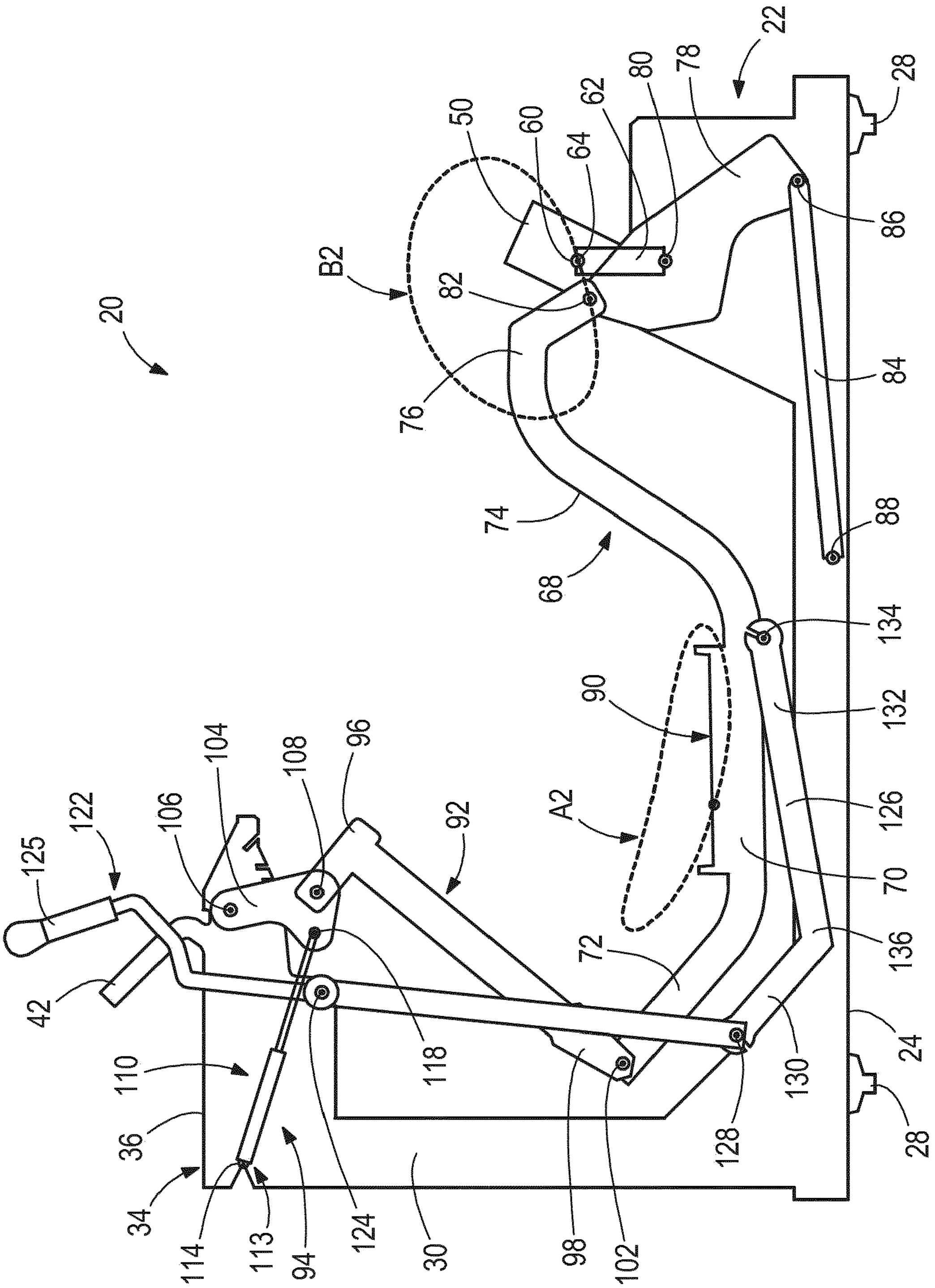
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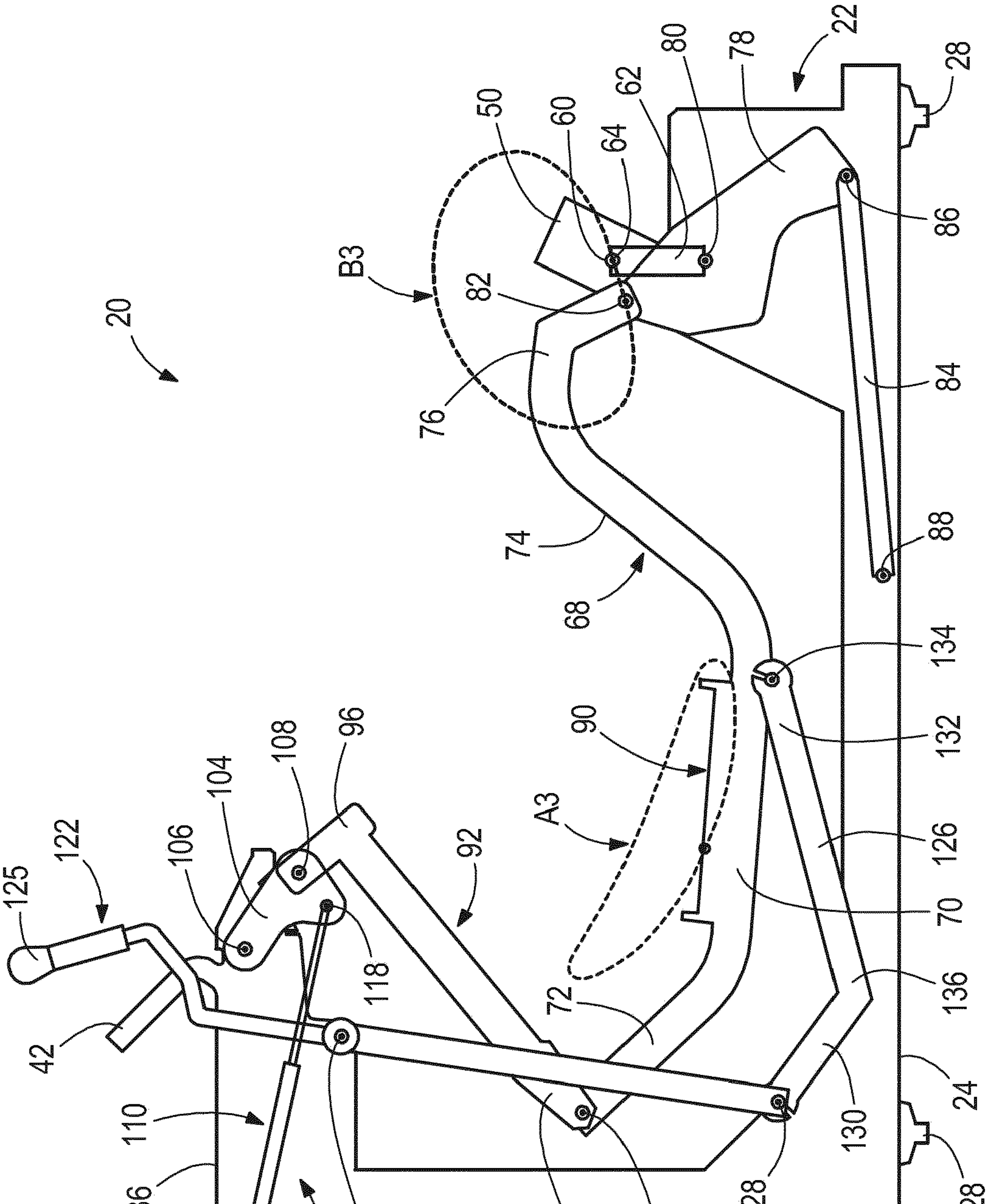
FIG. 9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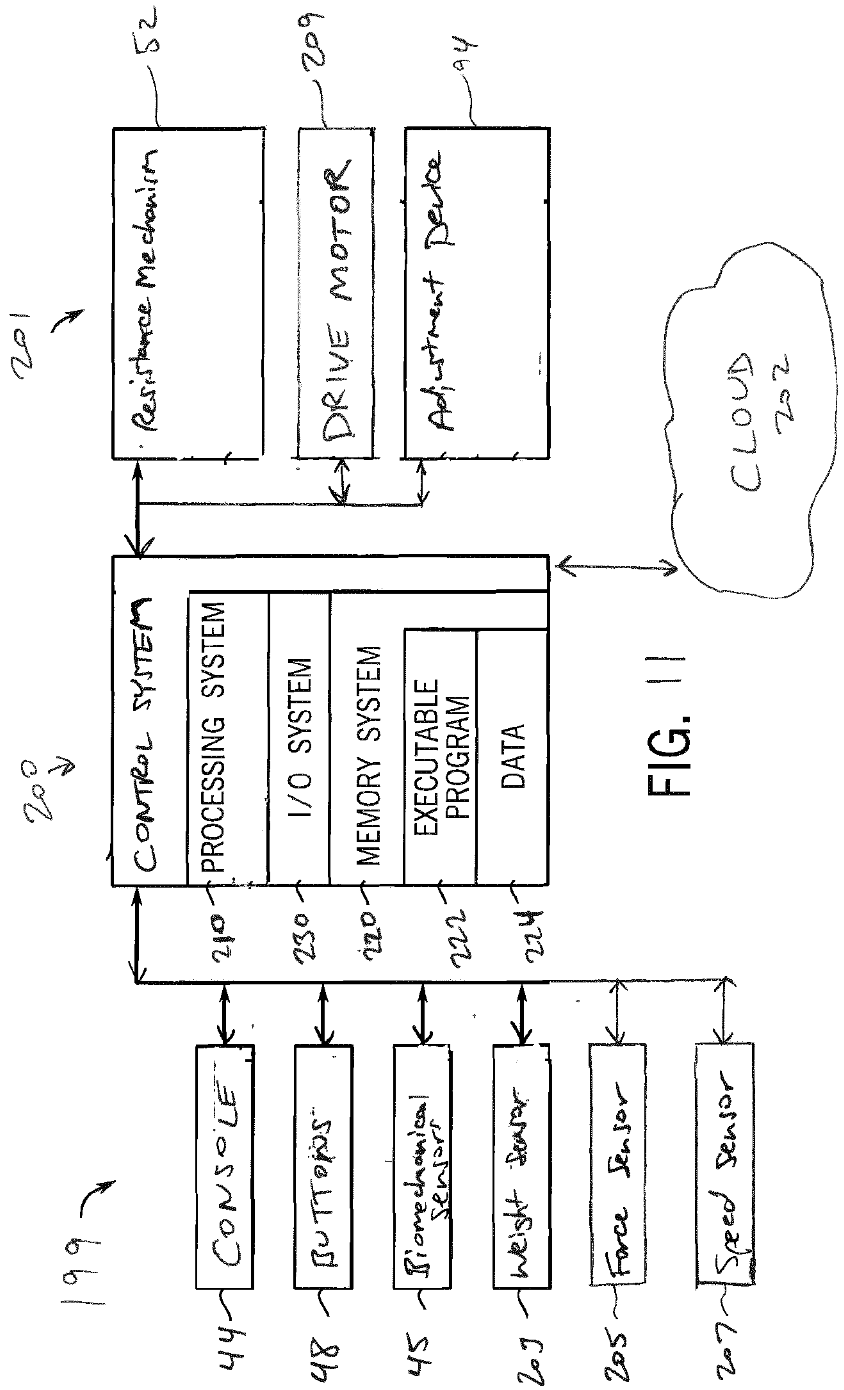
A3
B3

FIG. 10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Resistance Mechanism
52
DRIVE MOTOR
209
Adjustment Device
94
200
CONTROL SYSTEM
PROCESSING SYSTEM
210
I/O SYSTEM
230
MEMORY SYSTEM
220
EXECUTABLE PROGRAM
222
DATA
224
CLOUD
202
199
CONSOLE
44
BUTTONS
48
Biomechanical Sensors
45
Weight Sensor
203
Force Sensor
205
Speed Sensor
207

FIG. 11

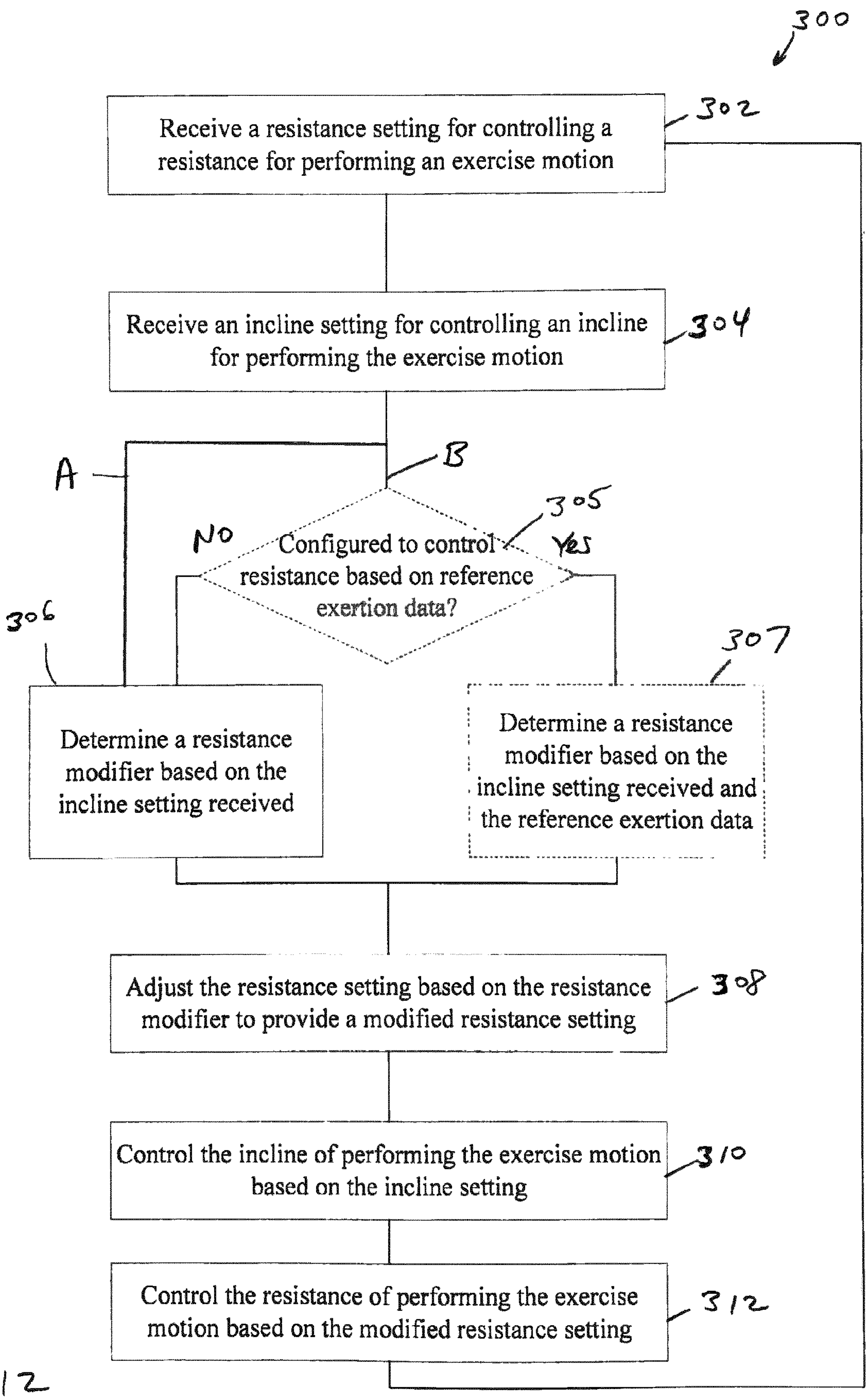
300
Receive a resistance setting for controlling a resistance for performing an exercise motion
302
Receive an incline setting for controlling an incline for performing the exercise motion
304
A
B
Configured to control resistance based on reference exertion data?
305
NO
YES
306
Determine a resistance modifier based on the incline setting received
307
Determine a resistance modifier based on the incline setting received and the reference exertion data
Adjust the resistance setting based on the resistance modifier to provide a modified resistance setting
308
Control the incline of performing the exercise motion based on the incline setting
310
Control the resistance of performing the exercise motion based on the modified resistance setting
312

FIG. 12

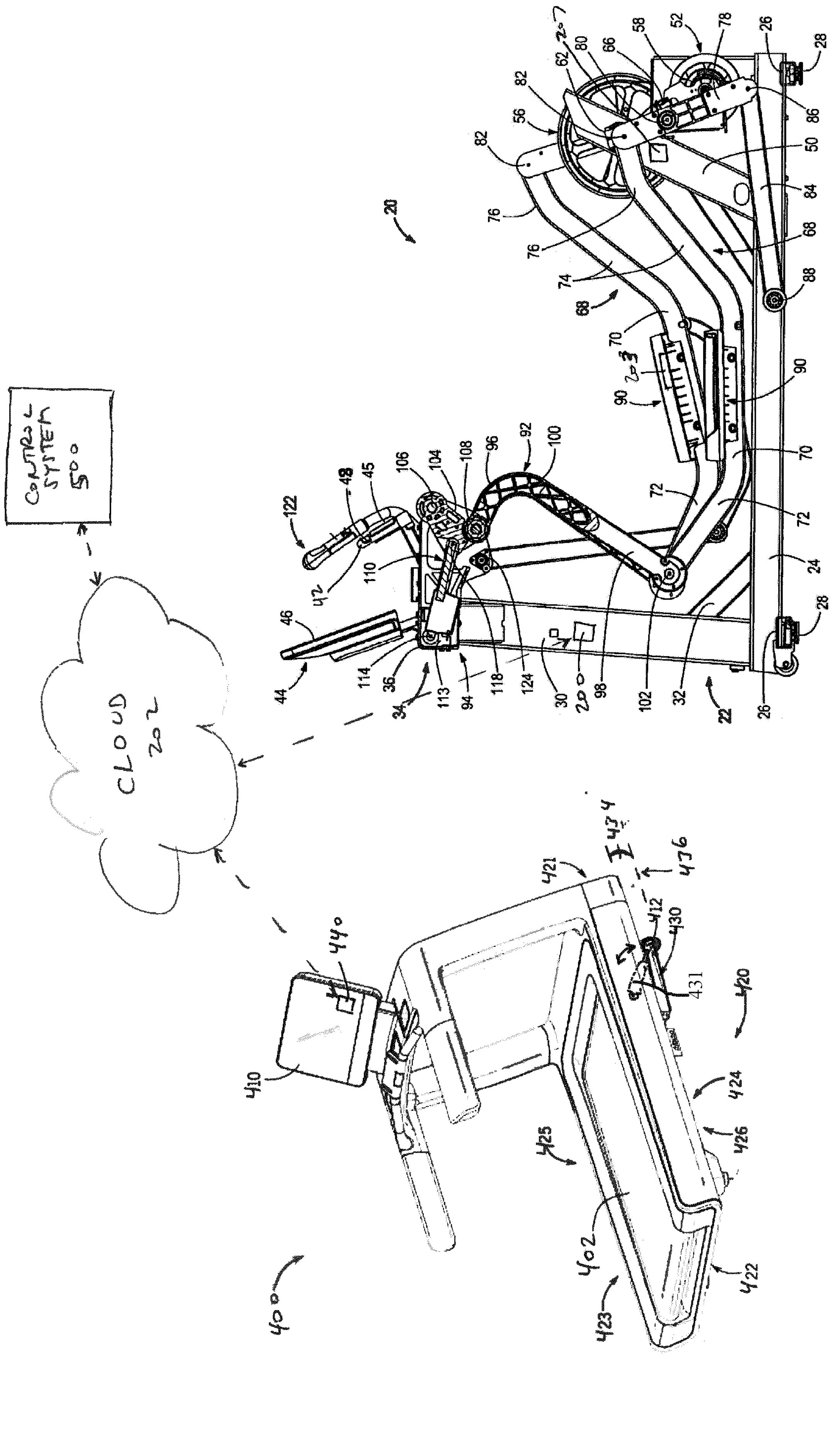

FIG. 13

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 15 8171

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,P	WO 2023/250432 A1 (LIFE FITNESS LLC [US]) 28 December 2023 (2023-12-28) * paragraph [0047] - paragraph [0048] * * paragraphs [0085], [0088] * * paragraph [0105] * * paragraph [0107] *	1-14	INV. A63B22/06 A63B21/005 A63B22/00 A63B22/02 A63B24/00 A63B71/06
X	US 2011/172059 A1 (WATTERSON SCOTT [US] ET AL) 14 July 2011 (2011-07-14) * claims 2,9 * * paragraph [0079] * * paragraph [0108] - paragraph [0110] *	1,6,7,14	
X	EP 3 209 394 B1 (COREPACT LLC [US]) 21 August 2019 (2019-08-21) * paragraph [0053] * * paragraph [0073] * * paragraph [0098] *	1,6,7,14	
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