US 20240252881A1

(19) United States
(12) Patent Application Publication
Abelbeck
(10) Pub. No.: US 2024/0252881 A1
(43) Pub. Date: Aug. 1, 2024

(54) **EXERCISE DEVICE WITH NATURAL GAIT MOTION AND SINGLE SYNCHRONOUS CONTROL SYSTEM**

(71) Applicant: **Blue Goji LLC**, Austin, TX (US)

(72) Inventor: **Kevin Gene Abelbeck**, Fort Collins, CO (US)

(21) Appl. No.: **18/433,390**

(22) Filed: **Feb. 5, 2024**

Related U.S. Application Data

(60) Continuation-in-part of application No. 18/299,017, filed on Apr. 11, 2023, which is a division of application No. 17/405,347, filed on Aug. 18, 2021, now Pat. No. 11,623,117, which is a division of application No. 15/609,910, filed on May 31, 2017, now Pat. No. 11,123,598.

(60) Provisional application No. 62/358,517, filed on Jul. 5, 2016.

Publication Classification

(51) **Int. Cl.**

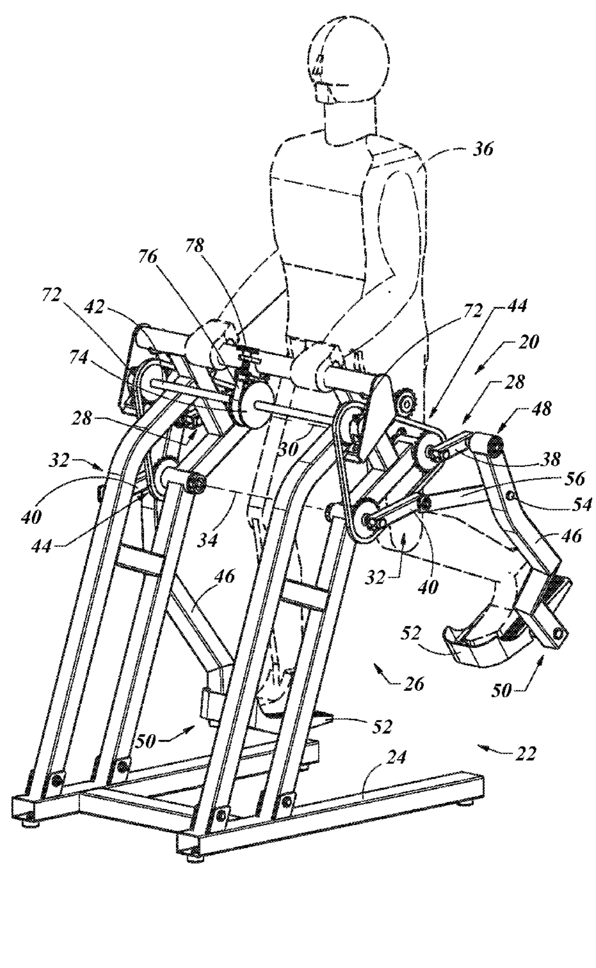
A63B 22/00	(2006.01)
A63B 21/00	(2006.01)
A63B 21/015	(2006.01)
A63B 21/22	(2006.01)
A63B 22/06	(2006.01)
A63B 23/04	(2006.01)
A63B 24/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A63B 22/001*** (2013.01); ***A63B 21/015*** (2013.01); ***A63B 21/154*** (2013.01); ***A63B 21/225*** (2013.01); ***A63B 21/4033*** (2015.10); ***A63B 21/4034*** (2015.10); ***A63B 21/4035*** (2015.10); ***A63B 22/0056*** (2013.01); ***A63B 22/0664*** (2013.01); ***A63B 23/0423*** (2013.01); ***A63B 24/0087*** (2013.01); *A63B 21/151* (2013.01); *A63B 2022/0051* (2013.01); *A63B 2022/0676* (2013.01); *A63B 2022/0688* (2013.01)

(57) **ABSTRACT**

An exercise machine with a more natural gait which, in some embodiments, further allows for a variable stride length while in use. In one configuration, each side of the exercise machine has a first crank assembly connected at an upper location on a pedal arm and a second crank connected at a middle location on the pedal arm, and a pedal is attached to a lower location of the pedal arm. The first crank assembly is connected to the pedal arm by a crank arm. The second crank assembly is connected to the pedal arm via a crank arm pivotally attached to a crank link. The path of each pedal is determined by the lengths of crank arms and crank links of the first and second crank assemblies rotating in synchronous motion.



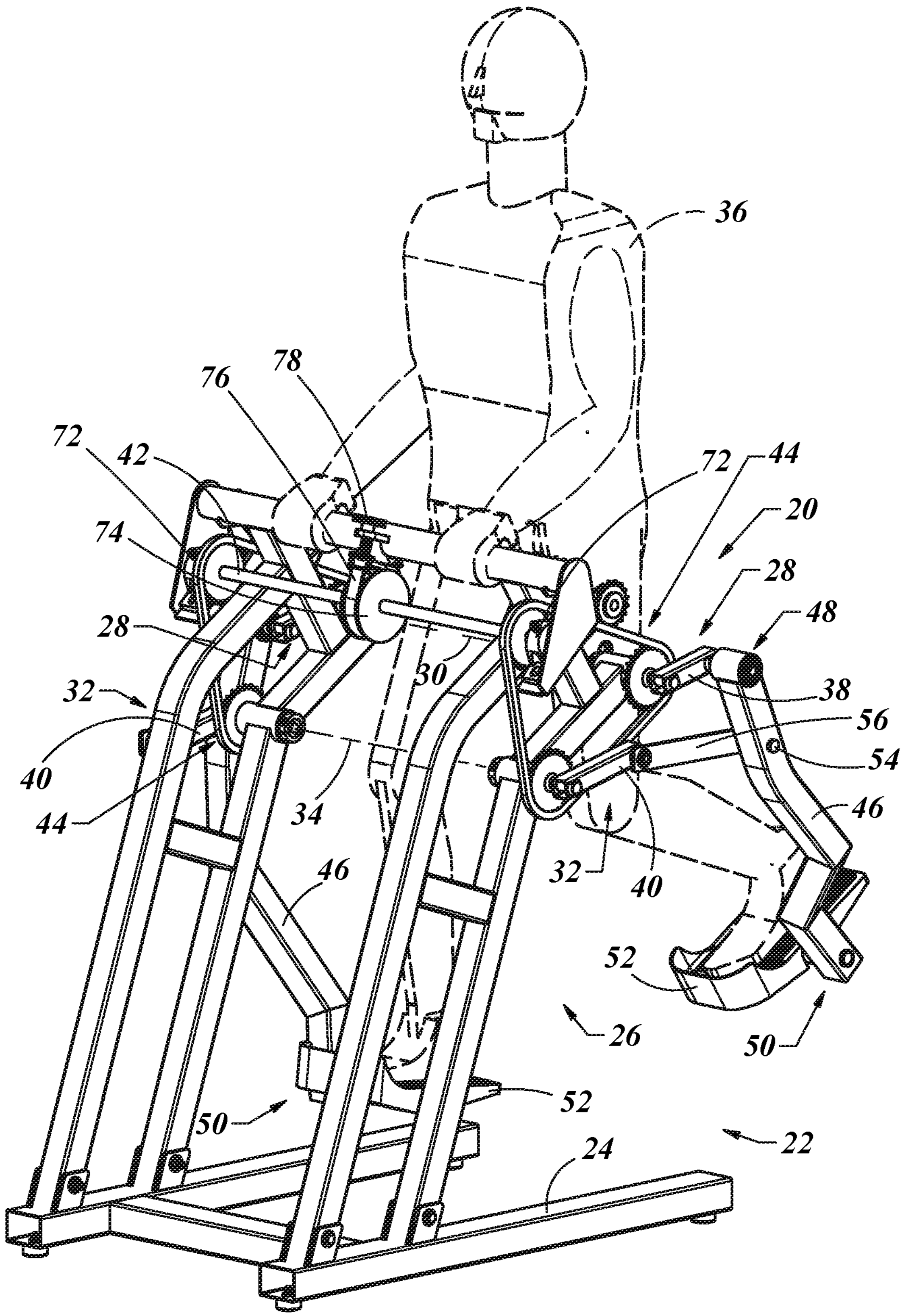

36
78
76
72
42
72
44
20
74
28
28
48
30
38
32
56
54
40
34
44
46
32
40
46
52
26
50
52
50
22
24

Fig. 1

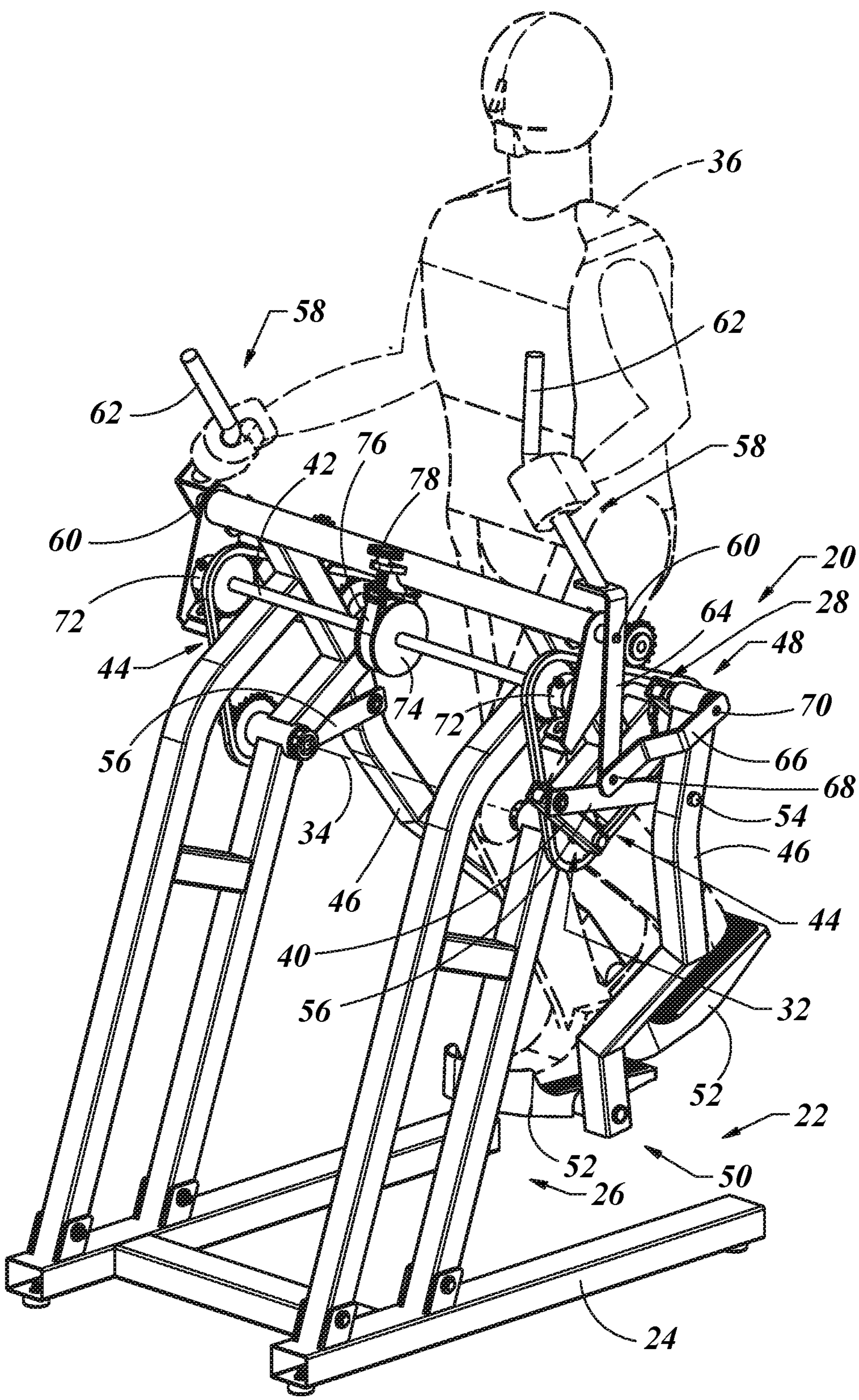

36
58
62
62
58
76
42
78
60
60
20
72
64
28
48
44
74
72
70
56
66
68
34
54
46
46
44
40
32
56
52
22
52
50
26
24

Fig. 2

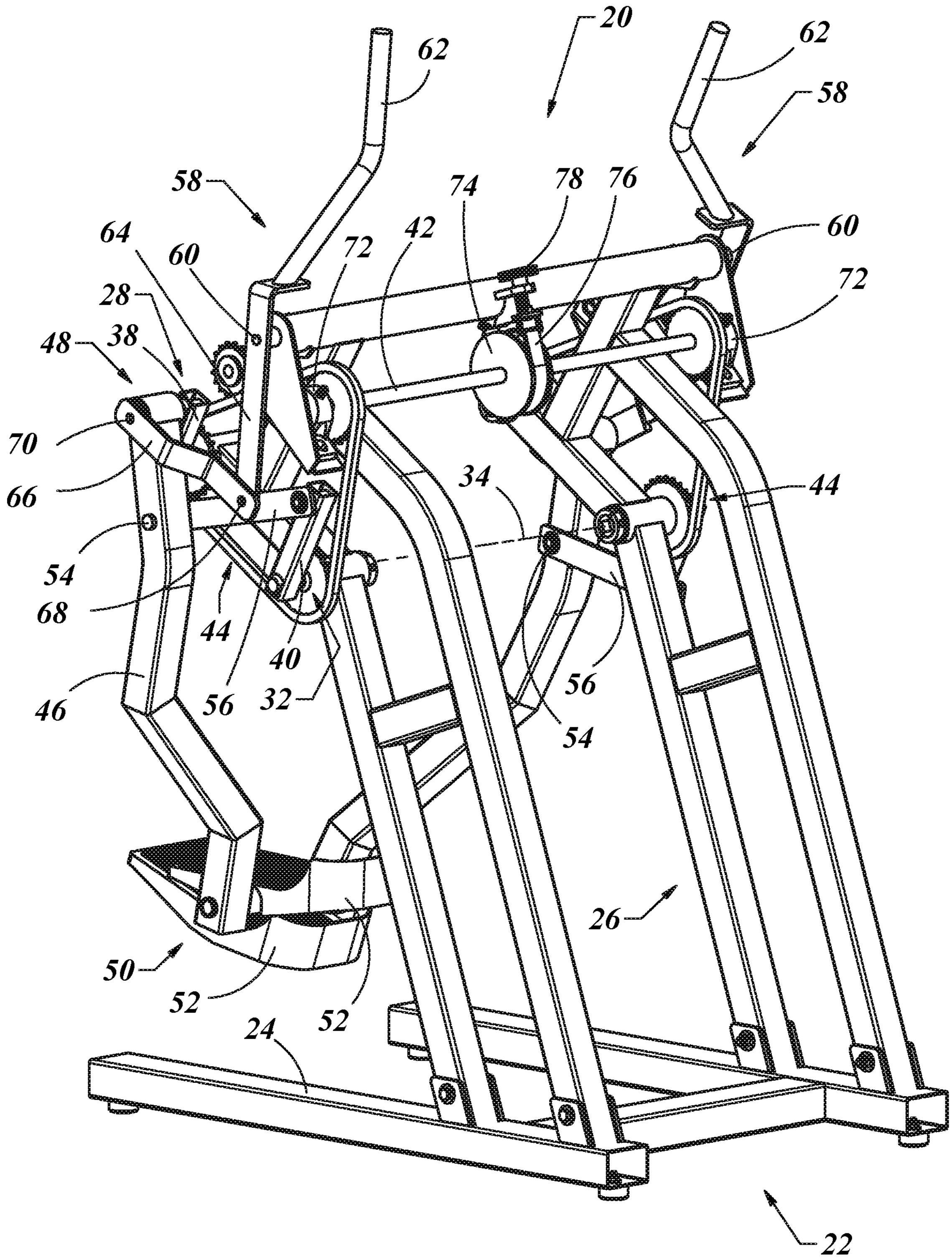

20
62
62
58
58
64
60
72
42
74
78
76
60
72
28
38
48
70
66
54
68
44
40
32
56
46
34
44
56
54
26
50
52
52
24
22

Fig. 3

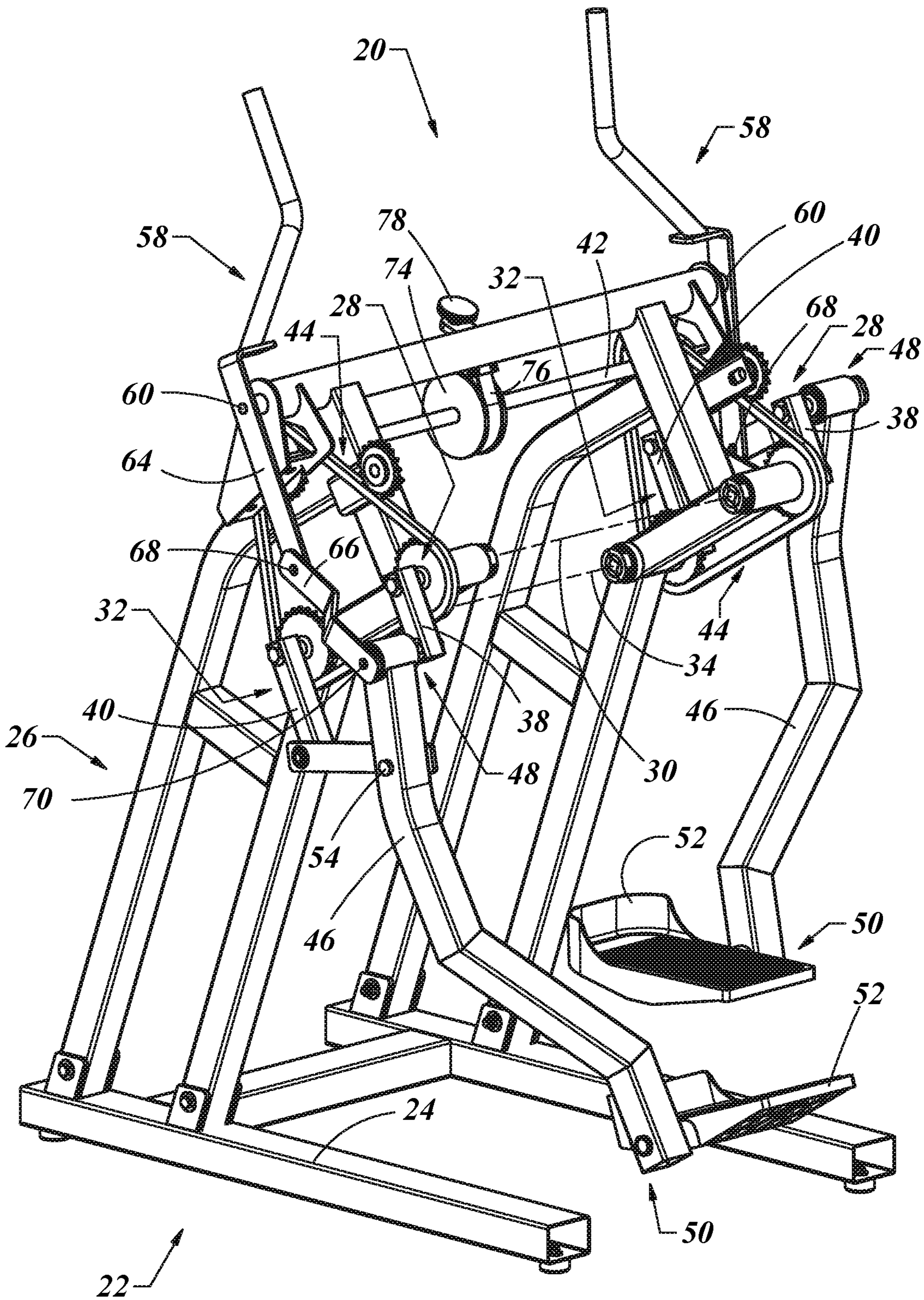

20
58
58
60
40
78
74
42
32
28
44
76
68
28
48
60
38
64
68
66
32
44
34
40
46
26
38
70
48
30
54
52
46
50
52
24
50
22

Fig. 4

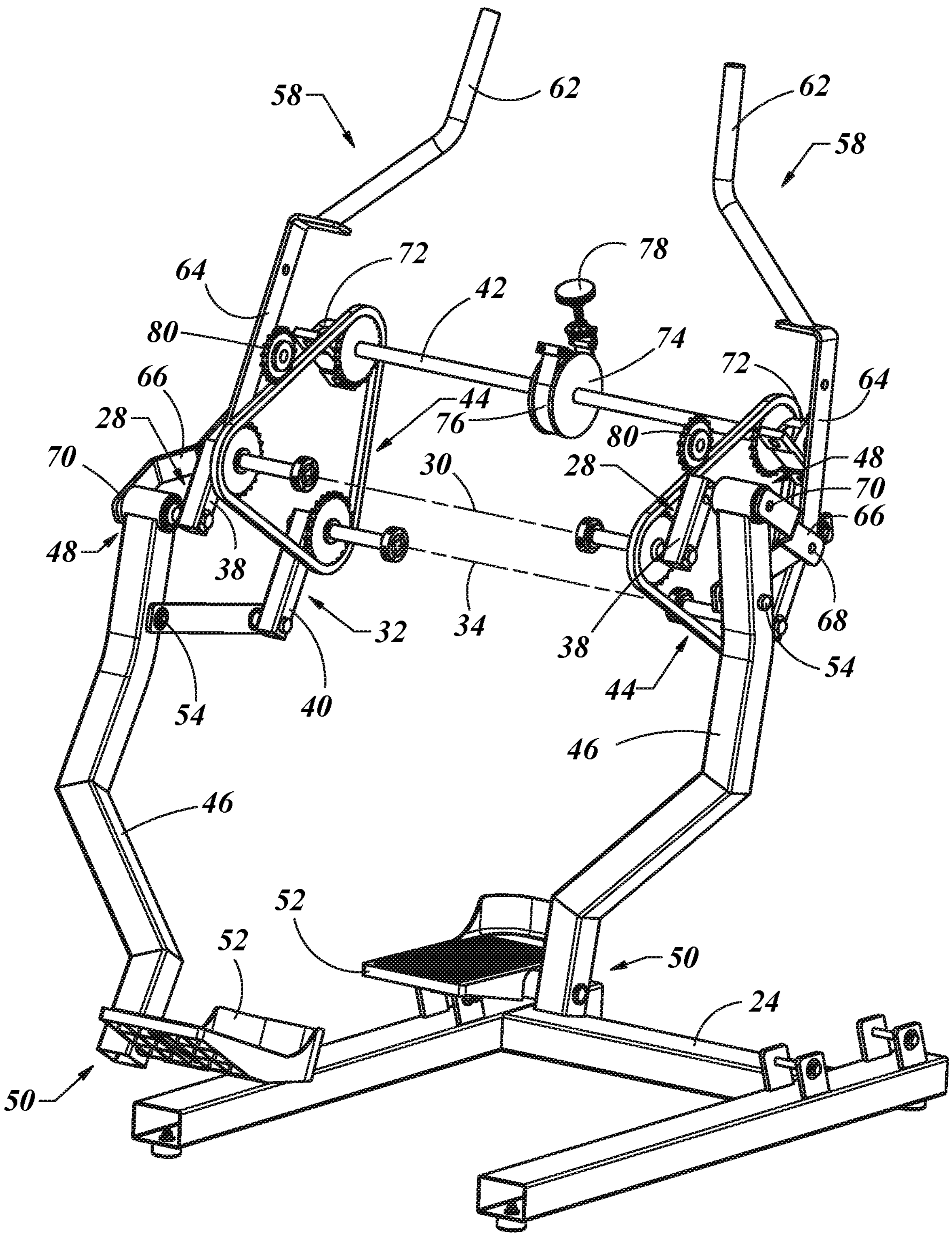

58
62
62
58
78
64
72
42
80
74
66
44
72
64
28
76
80
48
70
30
28
70
66
48
38
68
32
34
38
54
54
40
44
46
46
52
52
50
24
50

Fig. 5

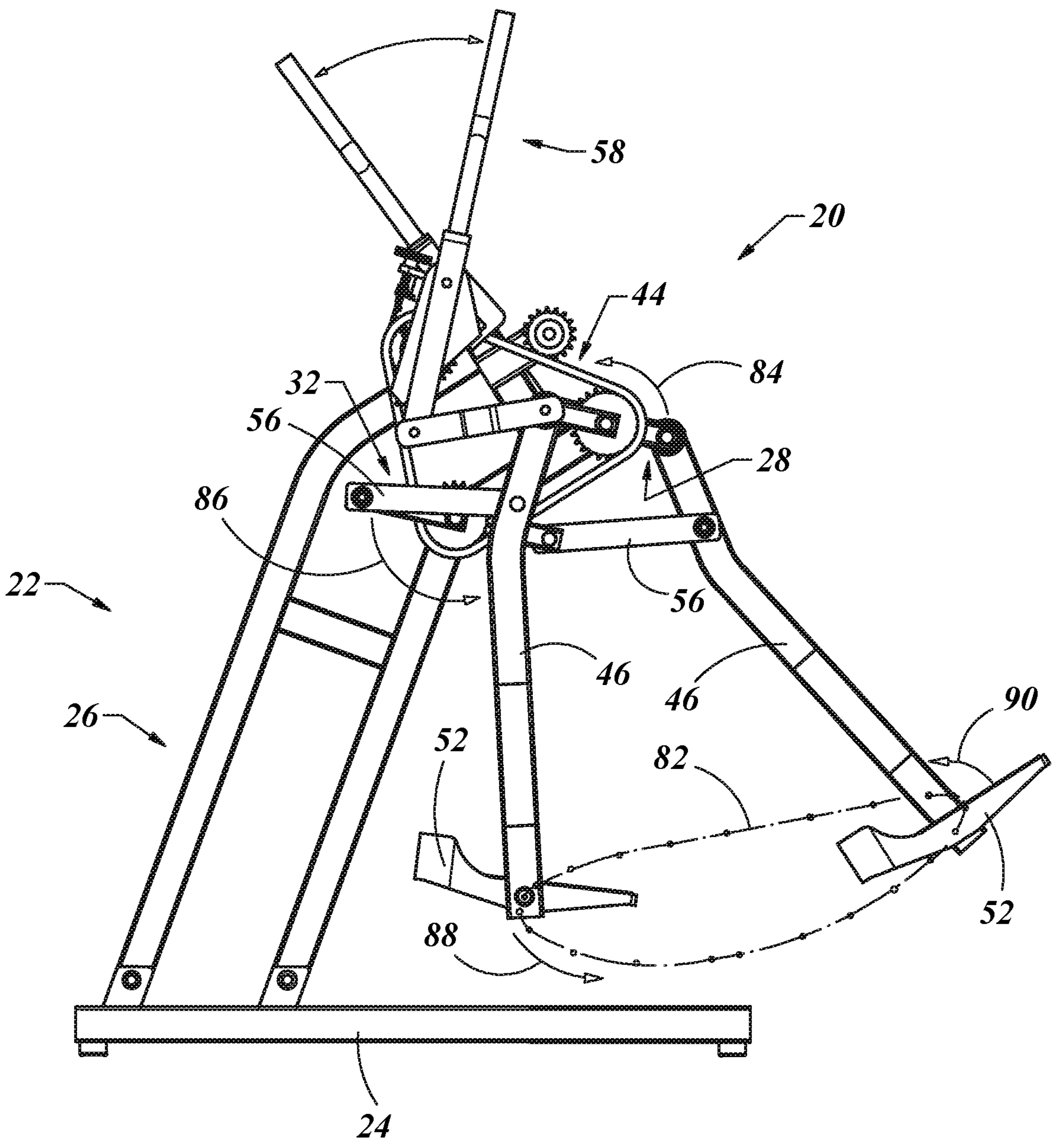


Fig. 6

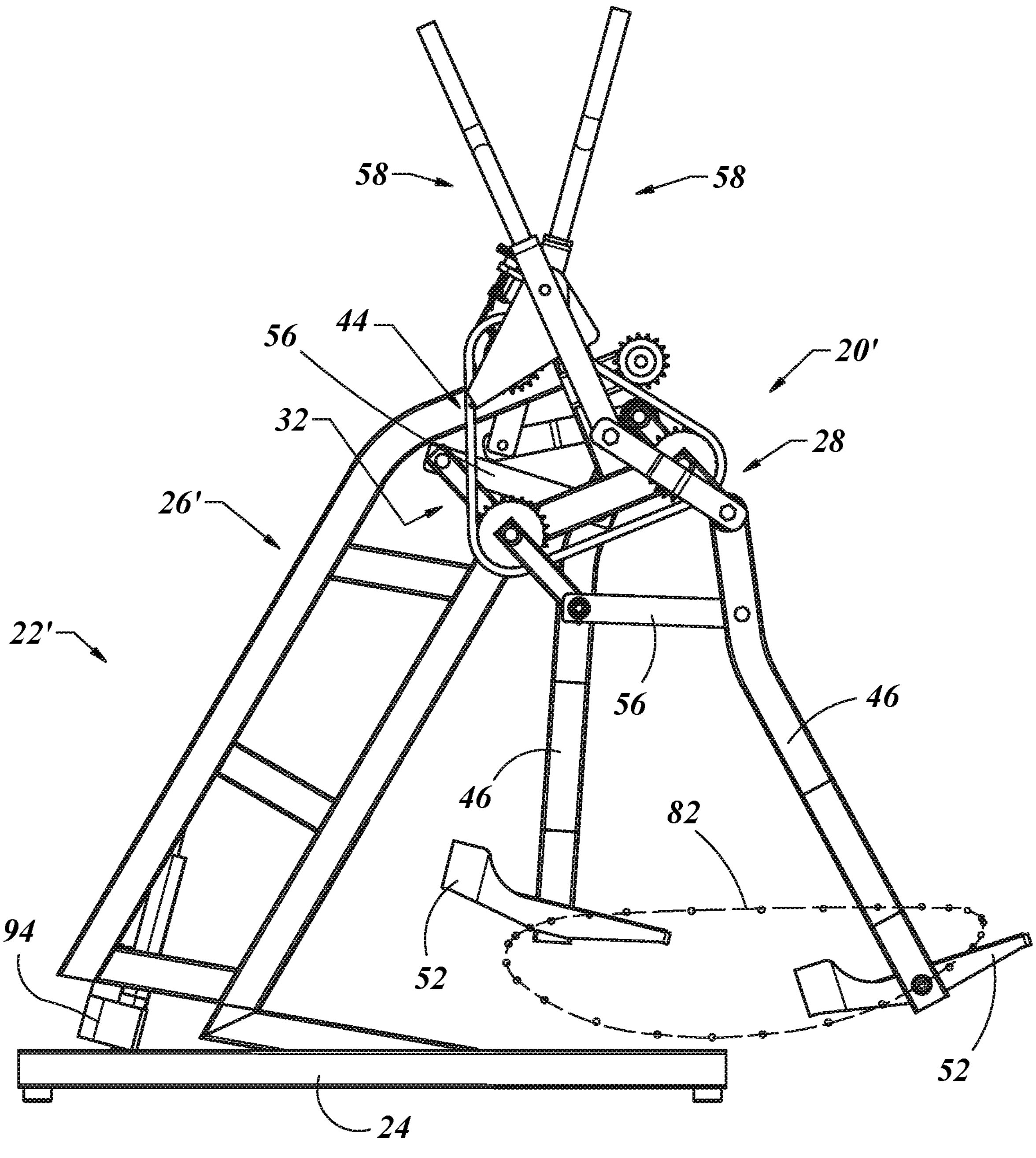


Fig. 7

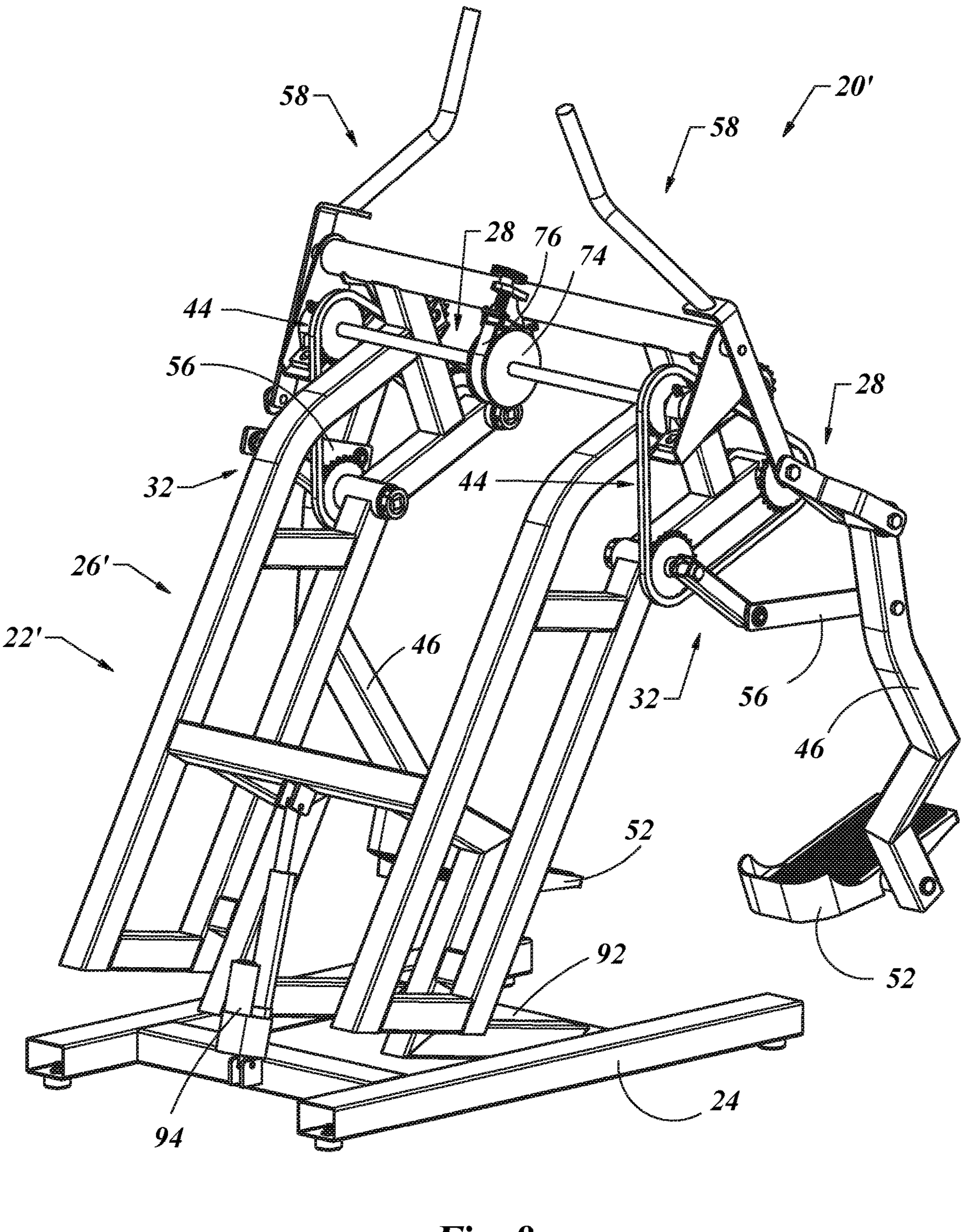


Fig. 8

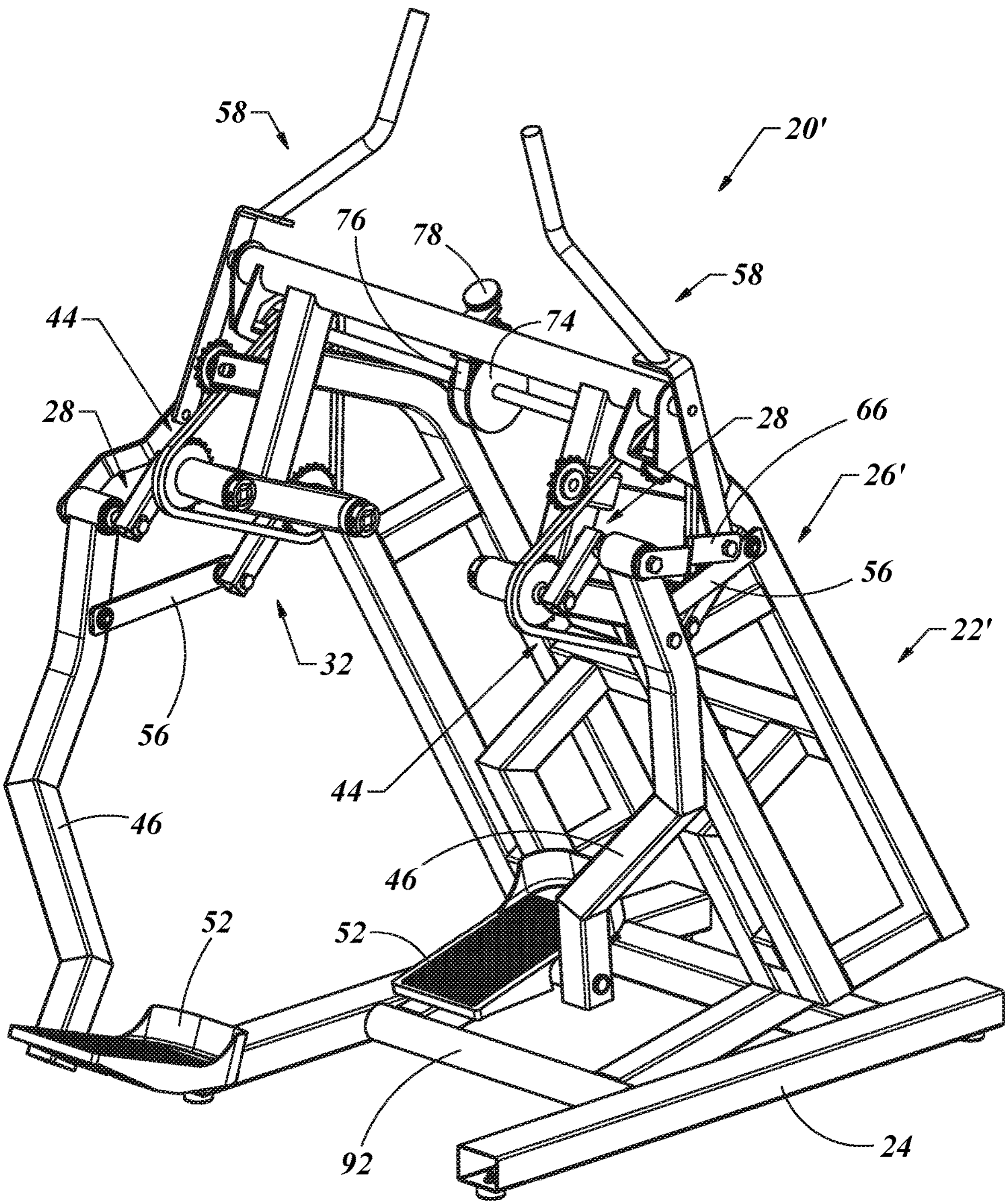


Fig. 9

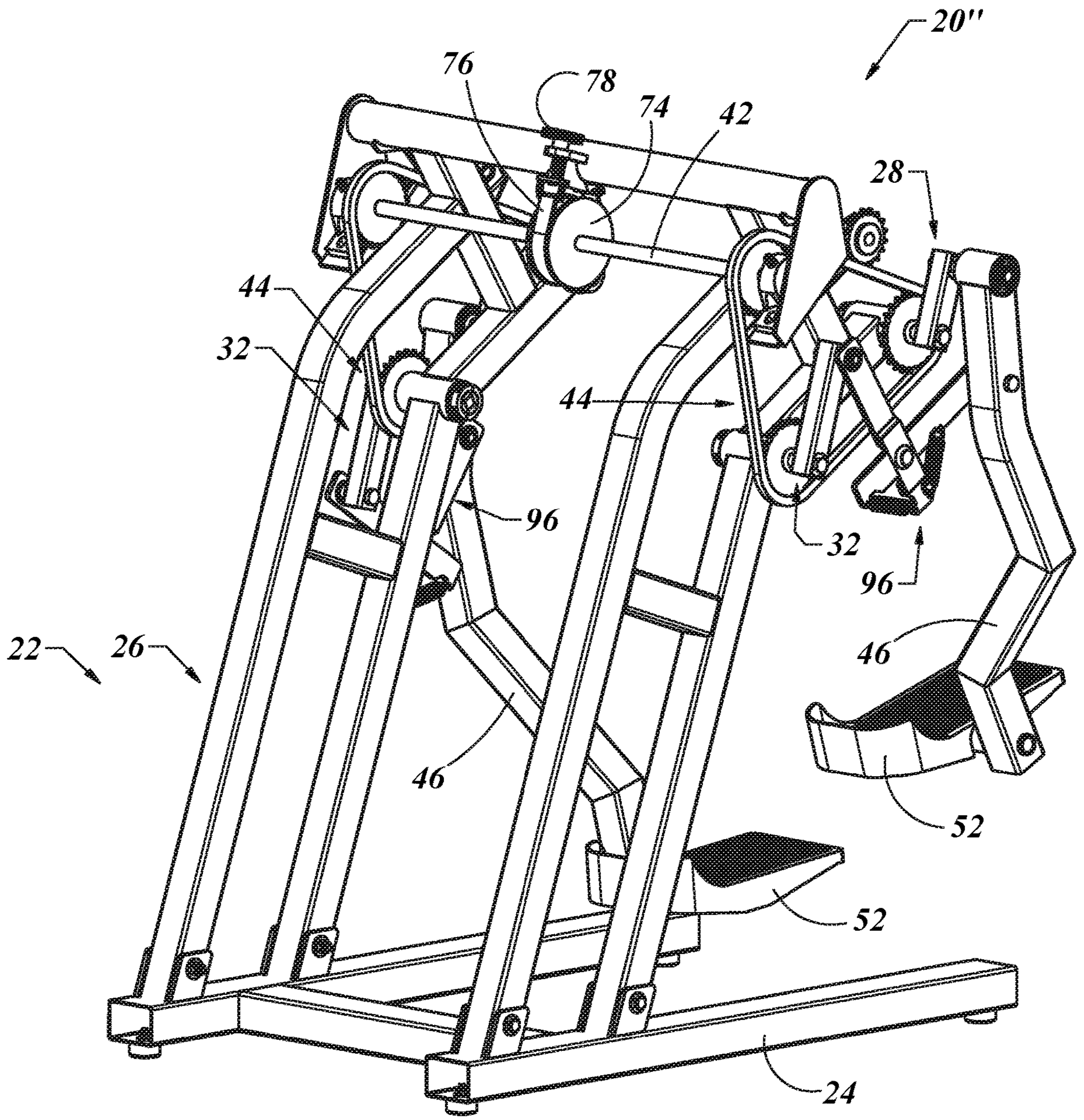


Fig. 10

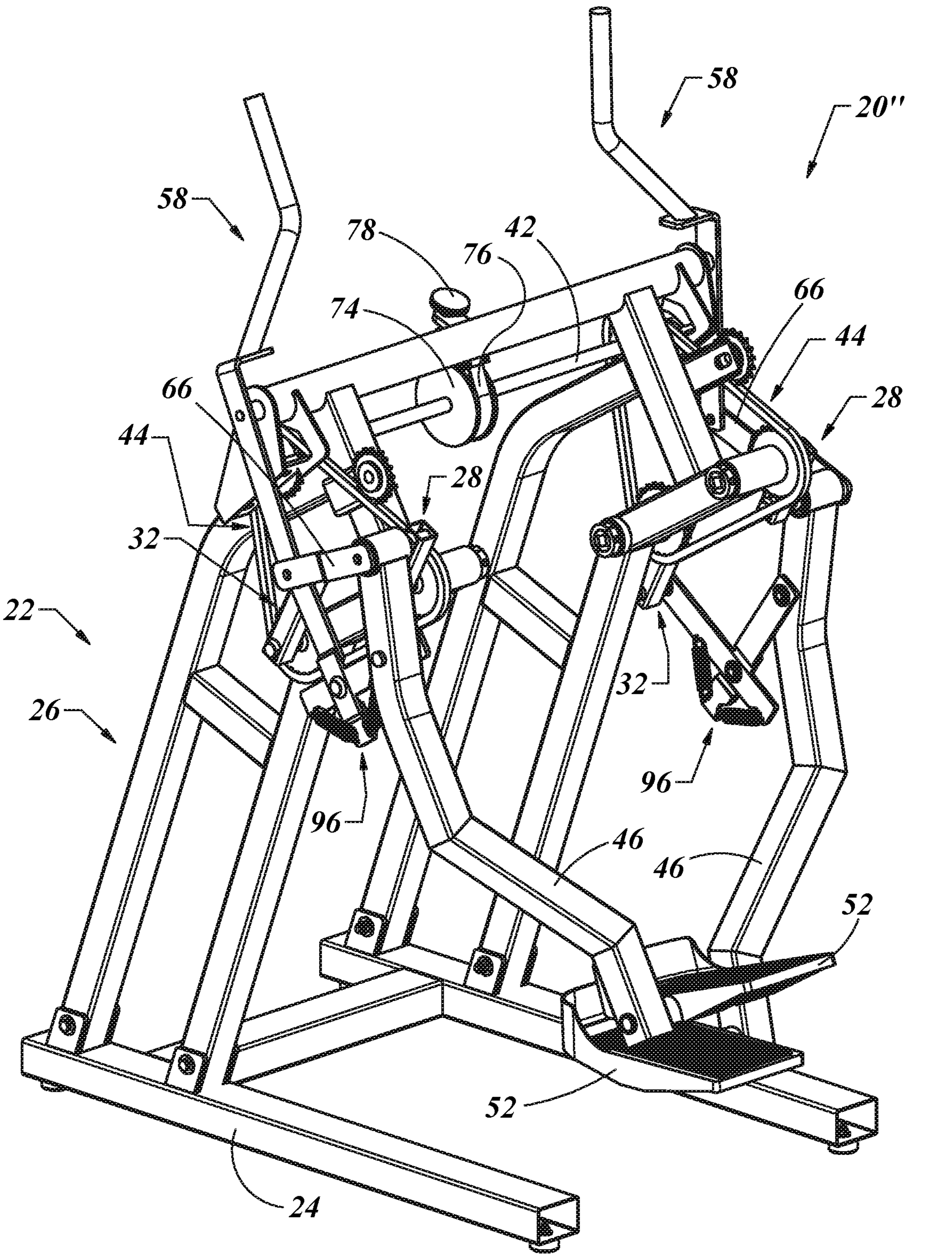


Fig. 11

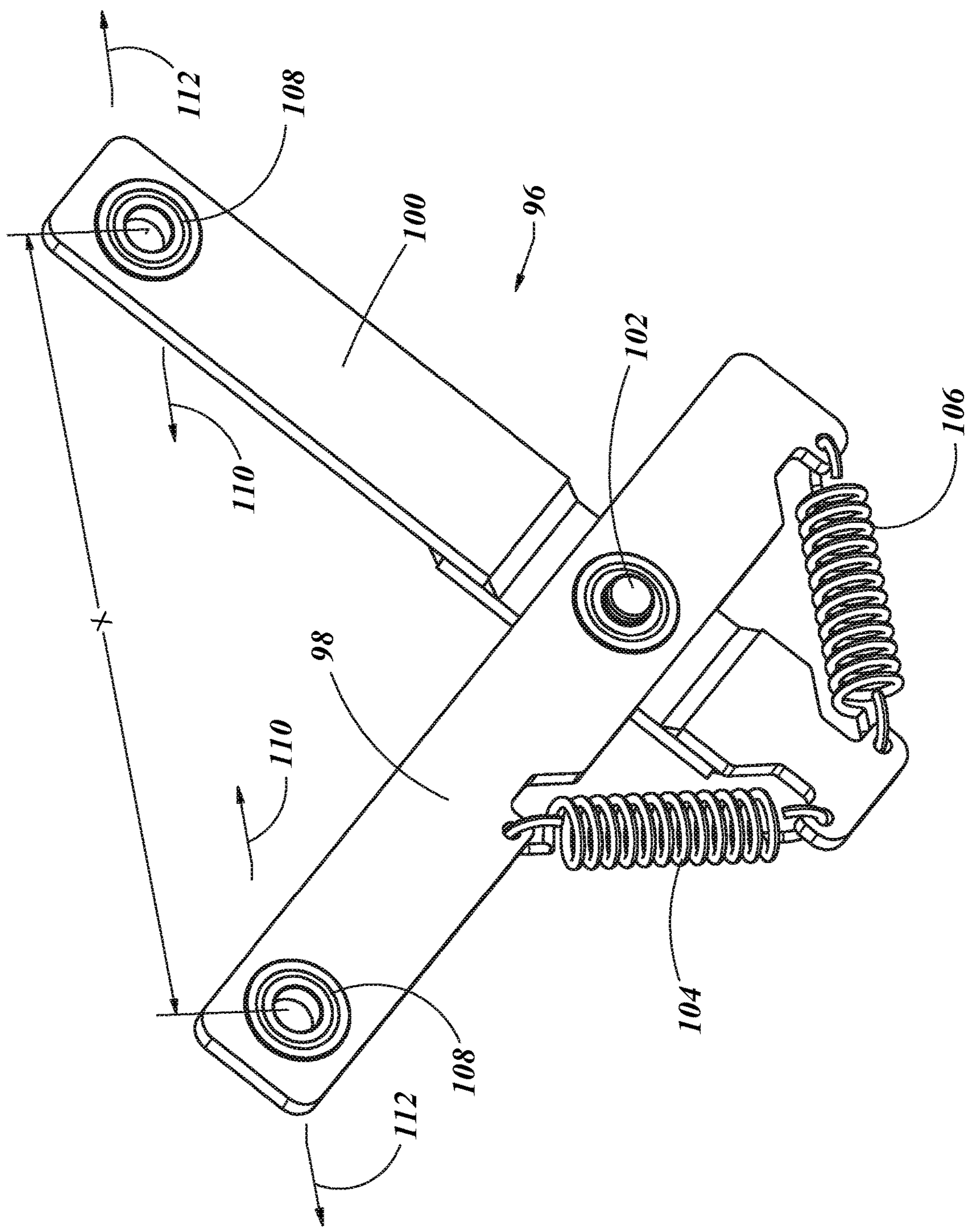


Fig. 12

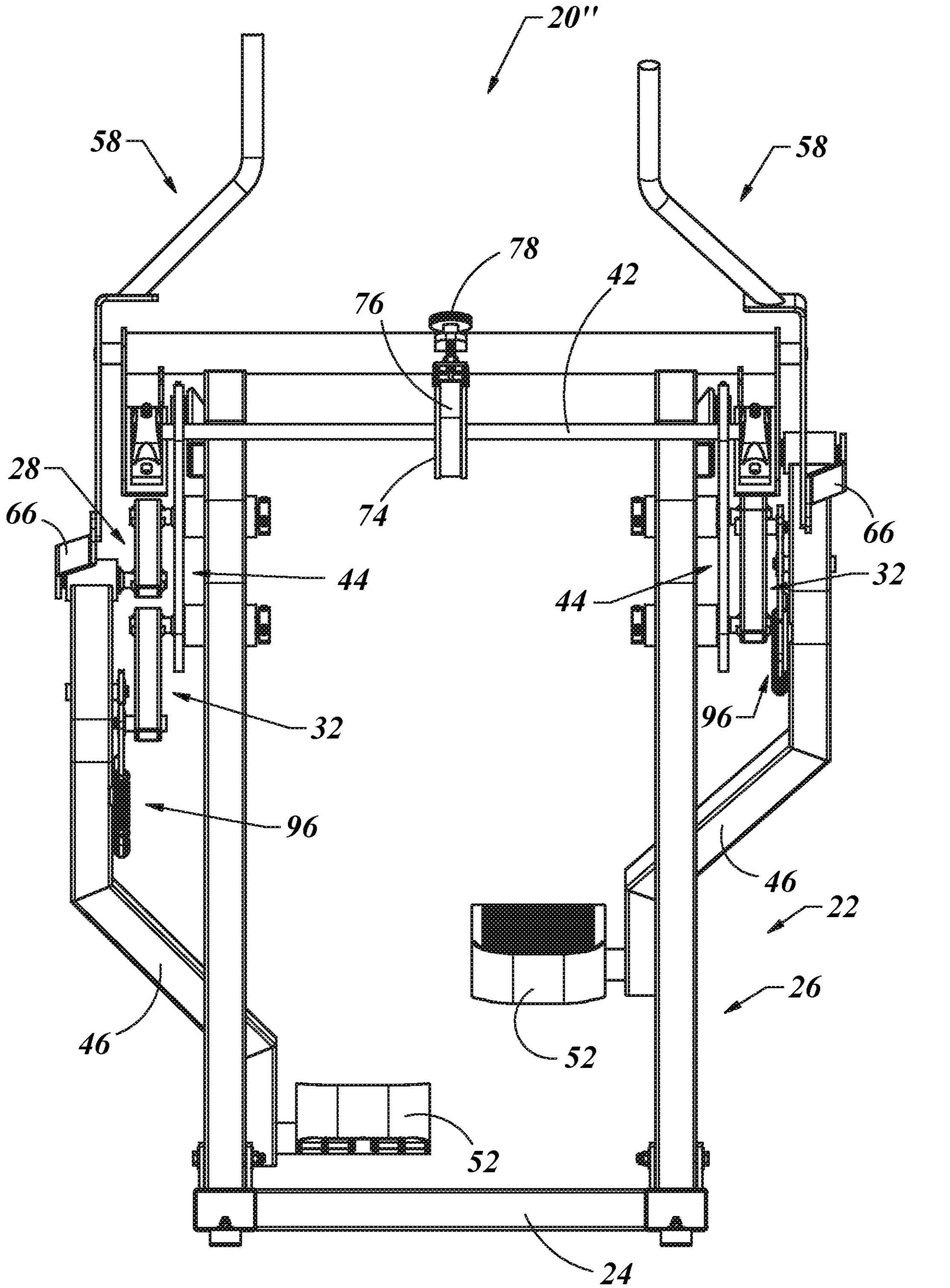


Fig. 13

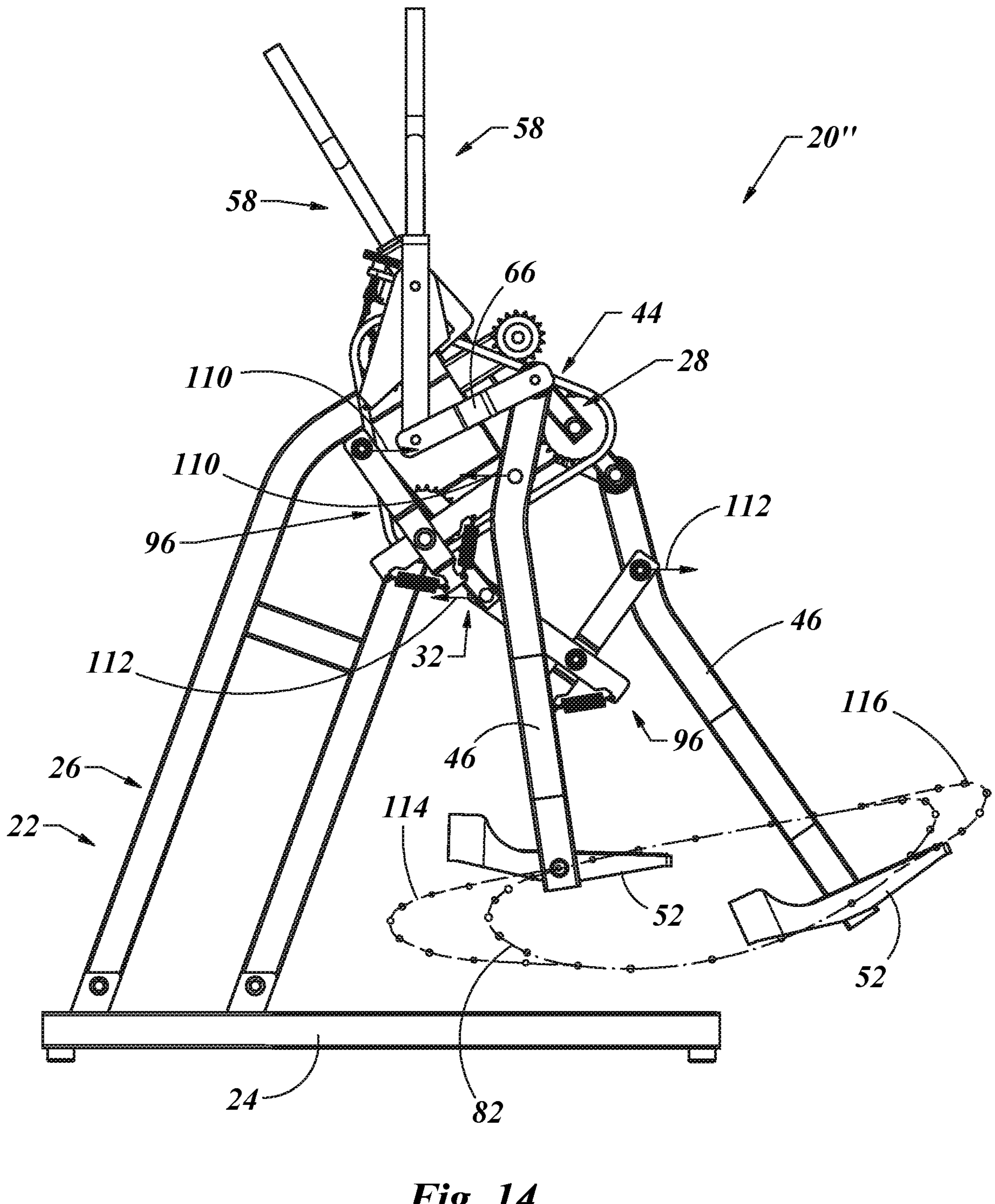

58
20''
58
66
44
28
110
110
112
96
112
32
46
116
96
46
26
114
22
52
52
24
82

Fig. 14

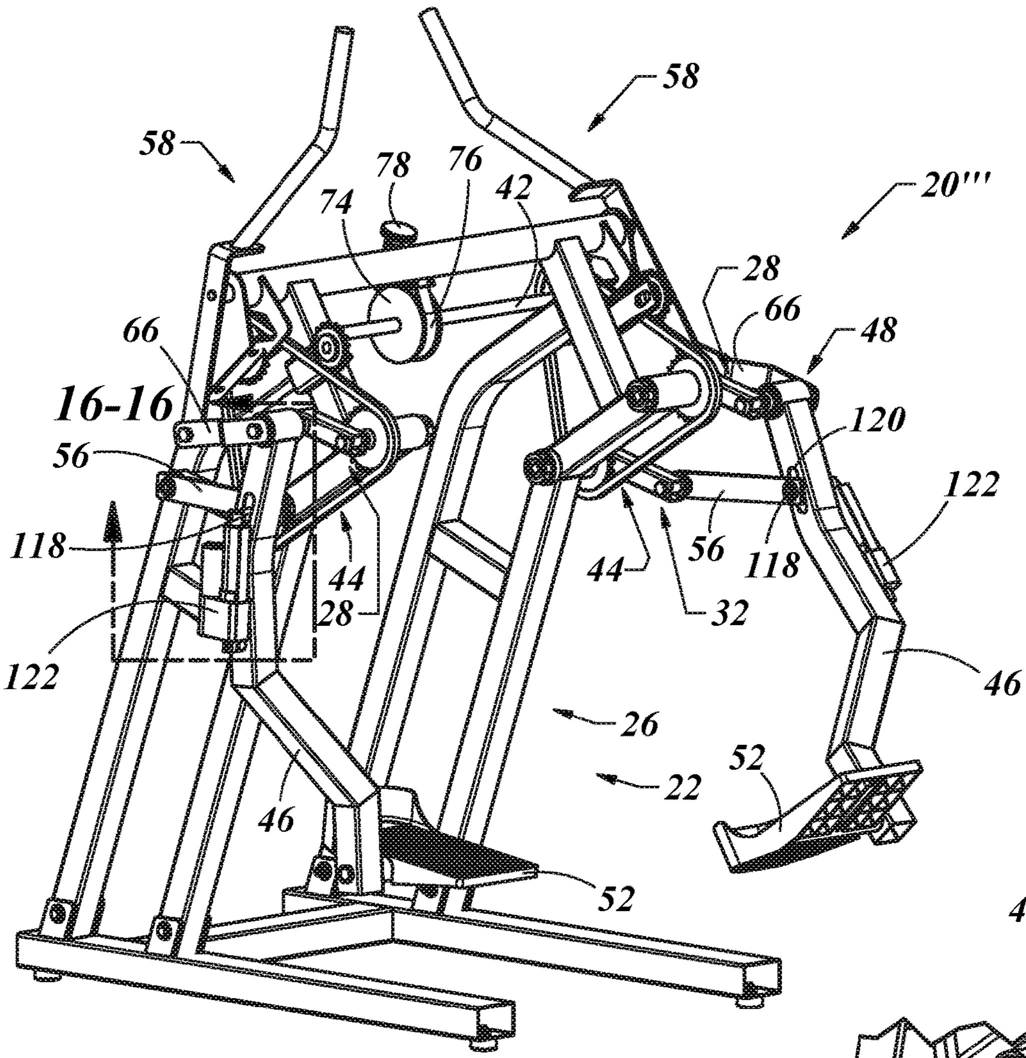

58
58
20'''
78
76
74
42
28
66
48
66
16-16
120
56
122
56
118
44
44
118
28
32
122
46
26
22
52
46
52

Fig. 15

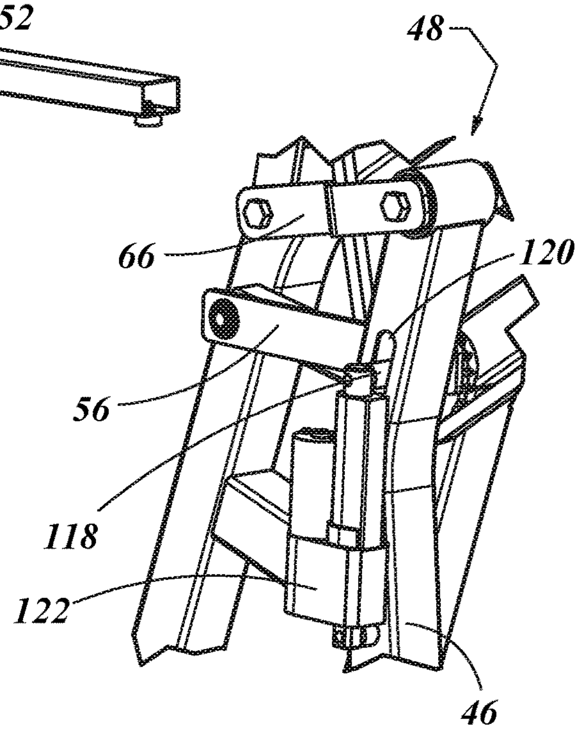

48
66
120
56
118
122
46

Fig. 16

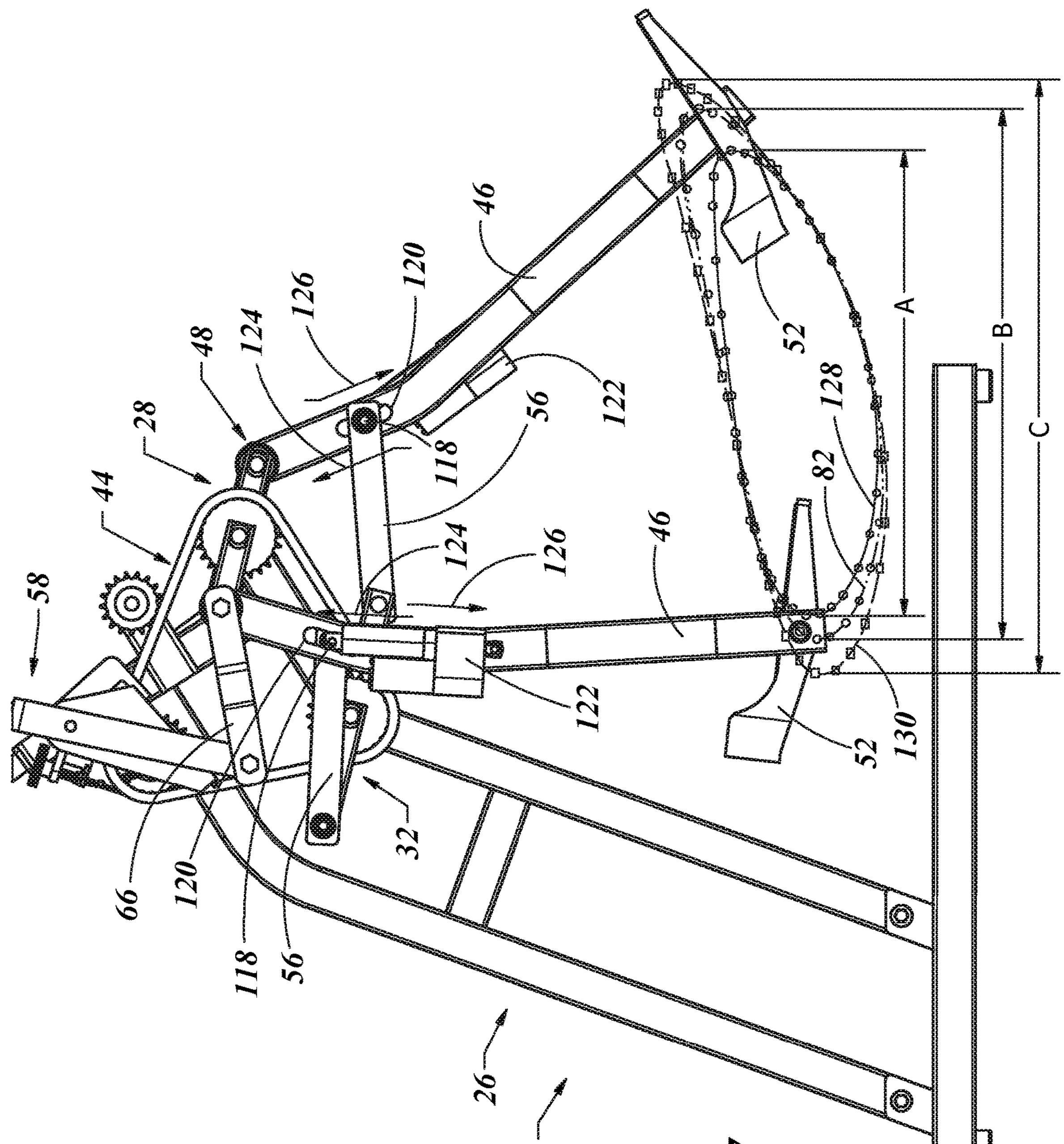

58
44
28
48
124
126
120
46
52
A
B
C
128
82
122
56
118
124
126
46
122
52
130
32
66
120
118
56
26
22

Fig. 17

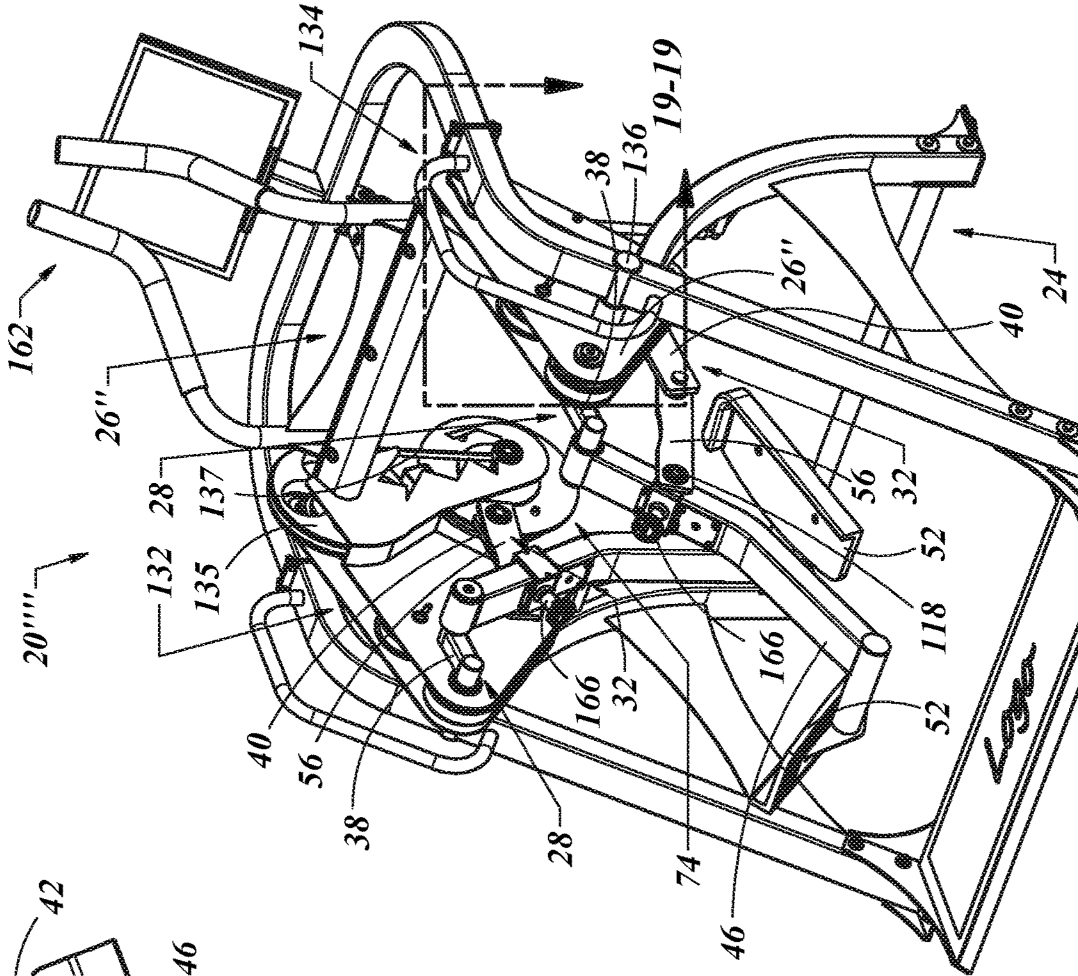

134
19-19
136
38
162
26''
26''
40
24
28
137
32
56
52
118
135
132
20''''
40
56
38
166
32
166
52
28
74
46

Fig. 18

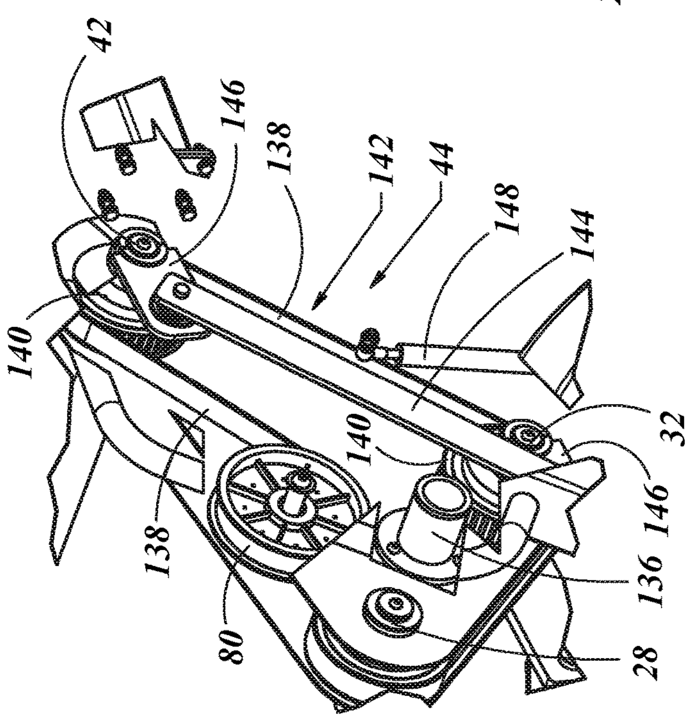

42
146
138
142
44
148
144
140
32
140
146
138
136
80
28

Fig. 19

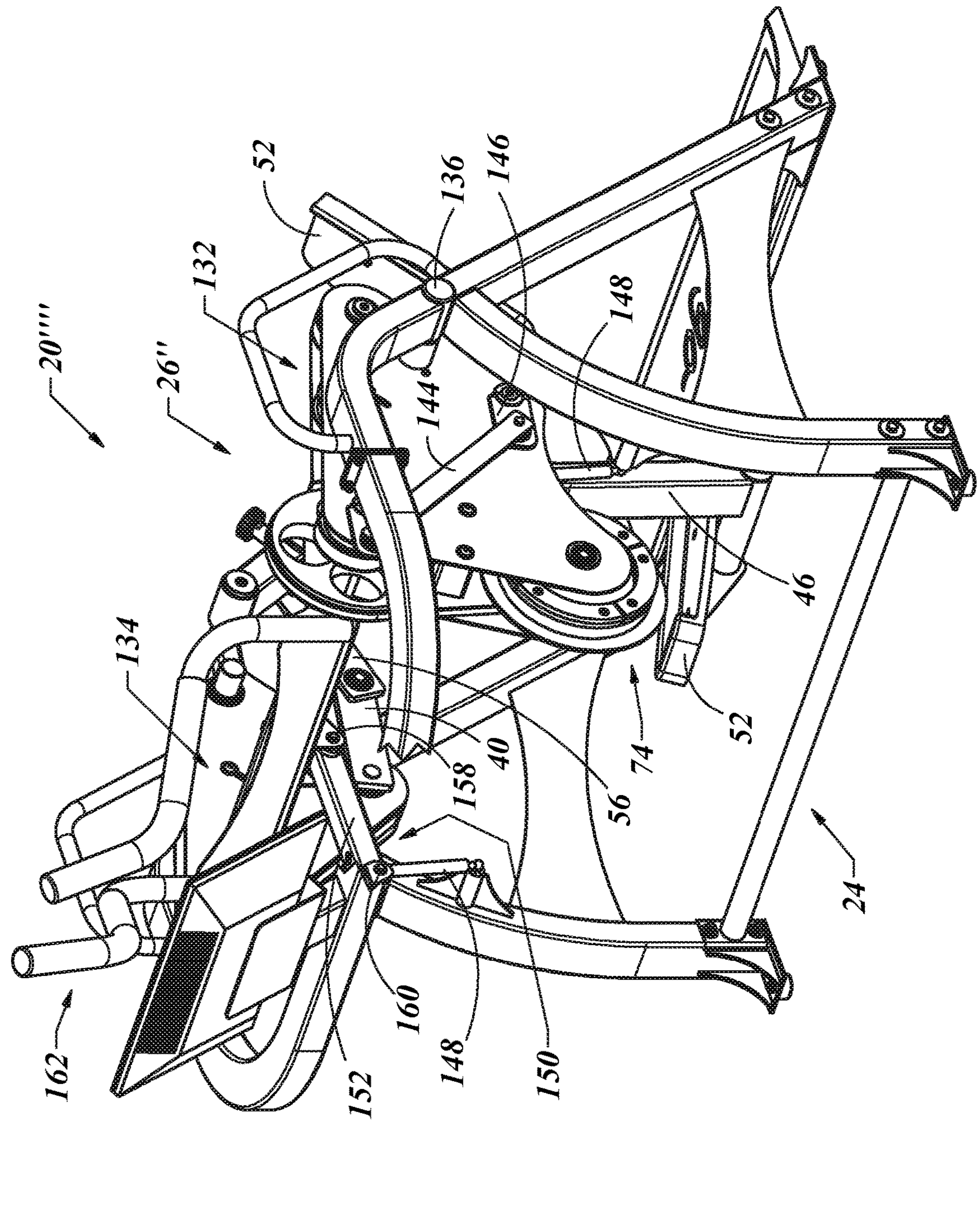

20''''
26''
132
52
136
146
148
144
46
52
74
56
40
158
134
162
152
148
150
160
24

Fig. 20

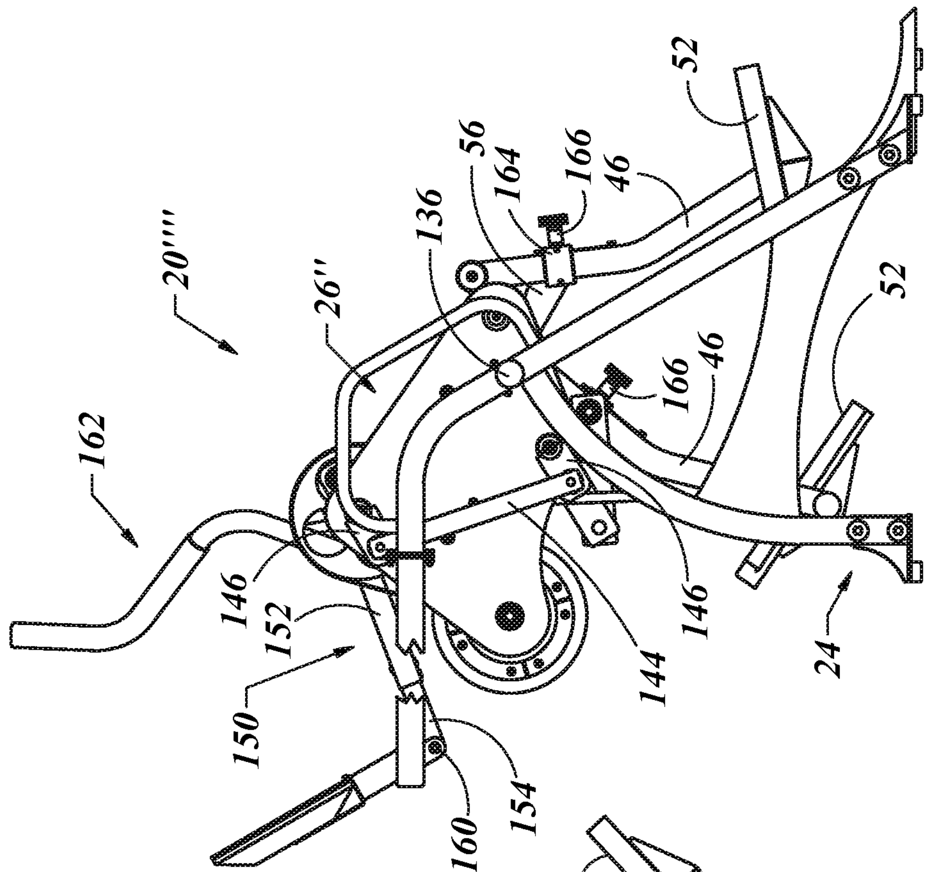

20''''
26''
136
56
164
166
46
52
52
166
46
146
146
162
146
152
150
144
24
160
154

Fig. 22

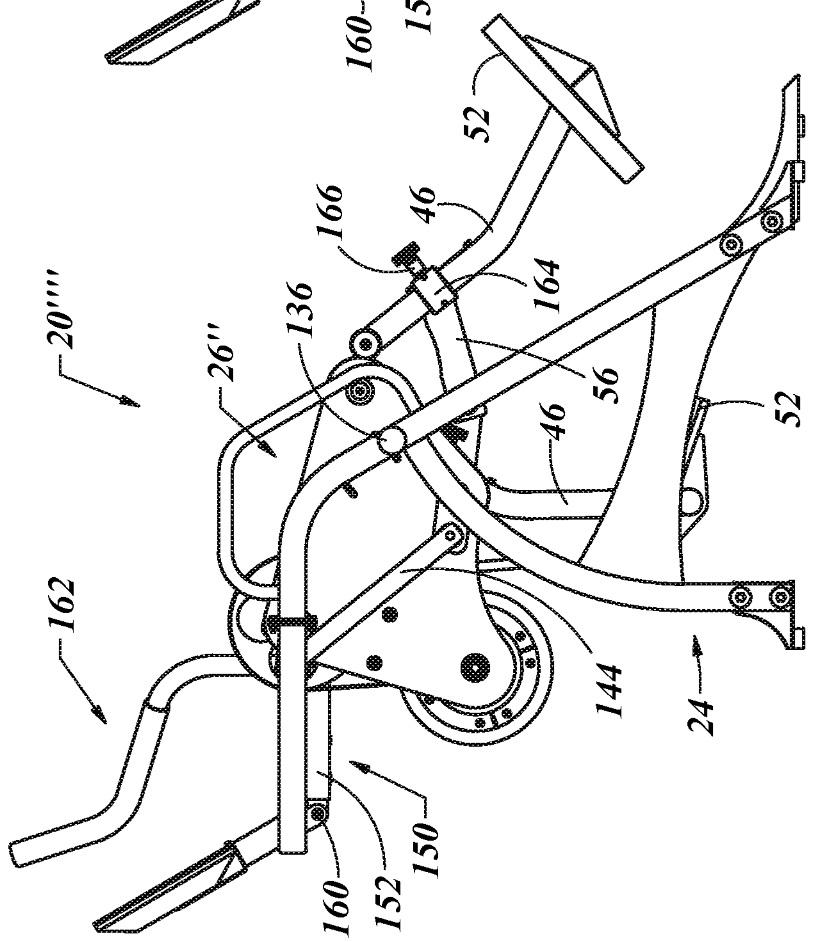

20''''
26''
136
166
46
52
164
56
46
52
162
144
24
150
152
160

Fig. 21

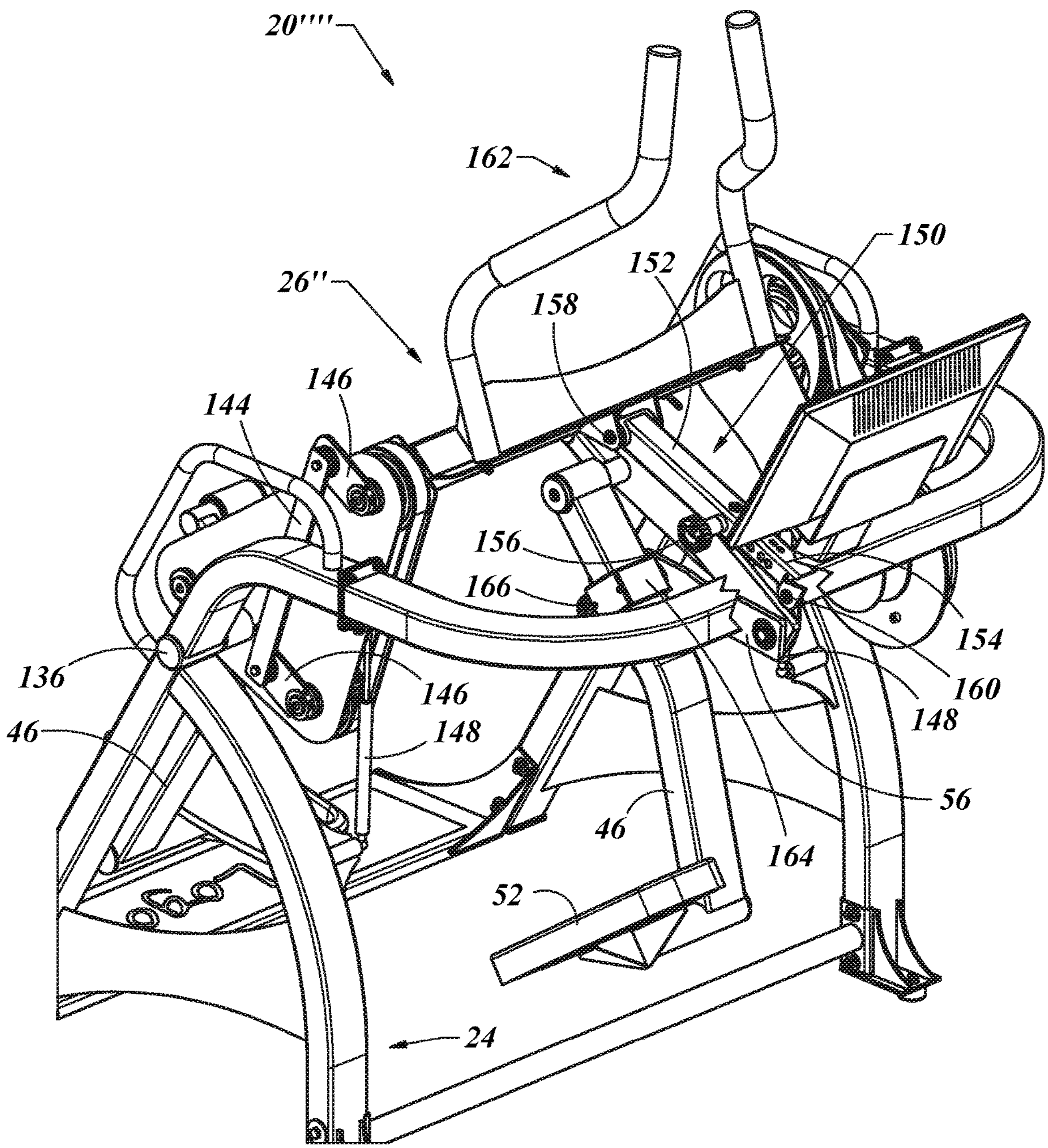

20''''
162
26''
150
152
158
146
144
156
166
136
146
148
46
154
160
148
56
46
164
52
24

Fig. 23

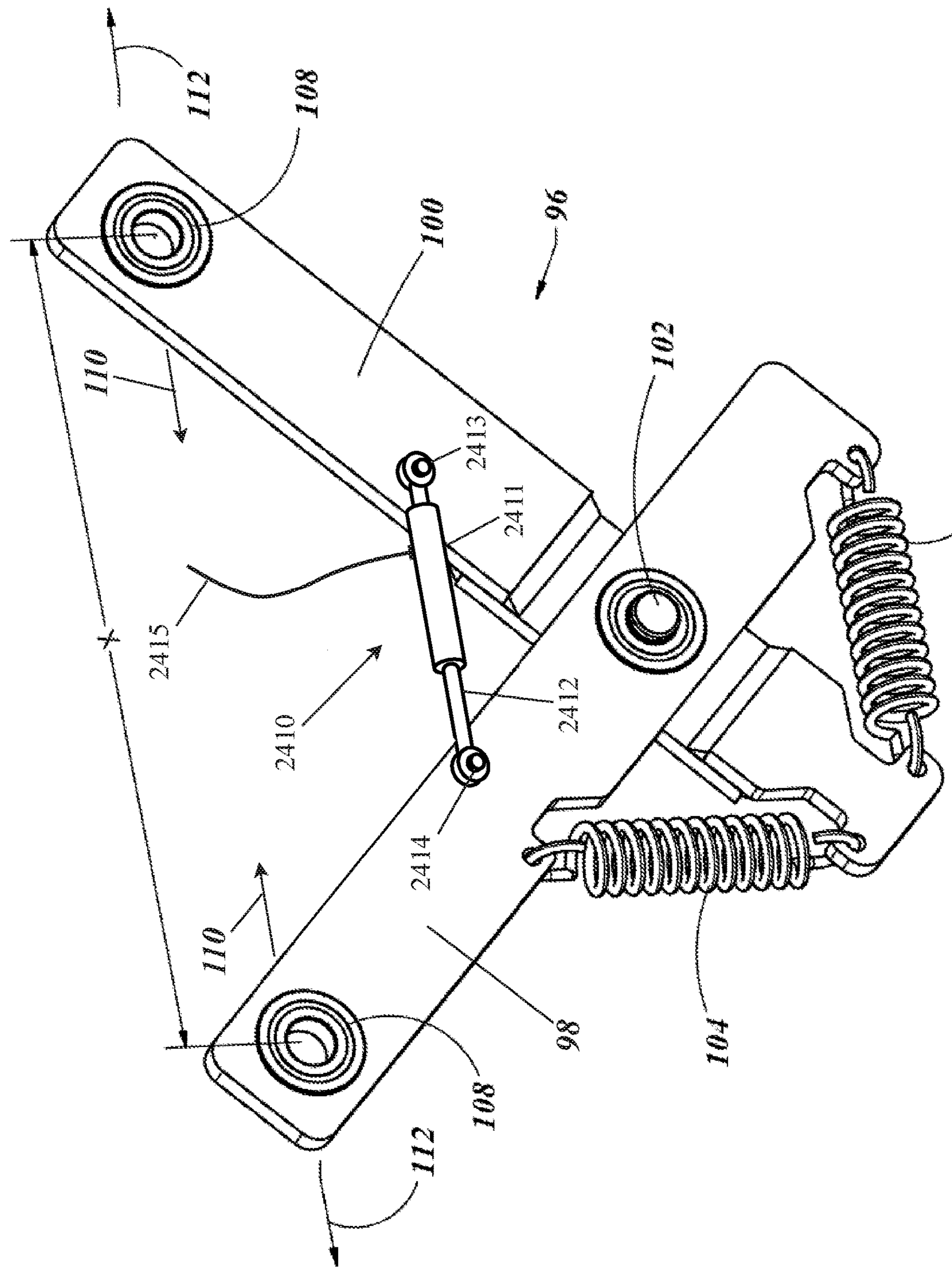

112
108
96
100
110
102
106
2413
2411
2415
2410
2412
2414
110
98
104
108
112

FIG. 24

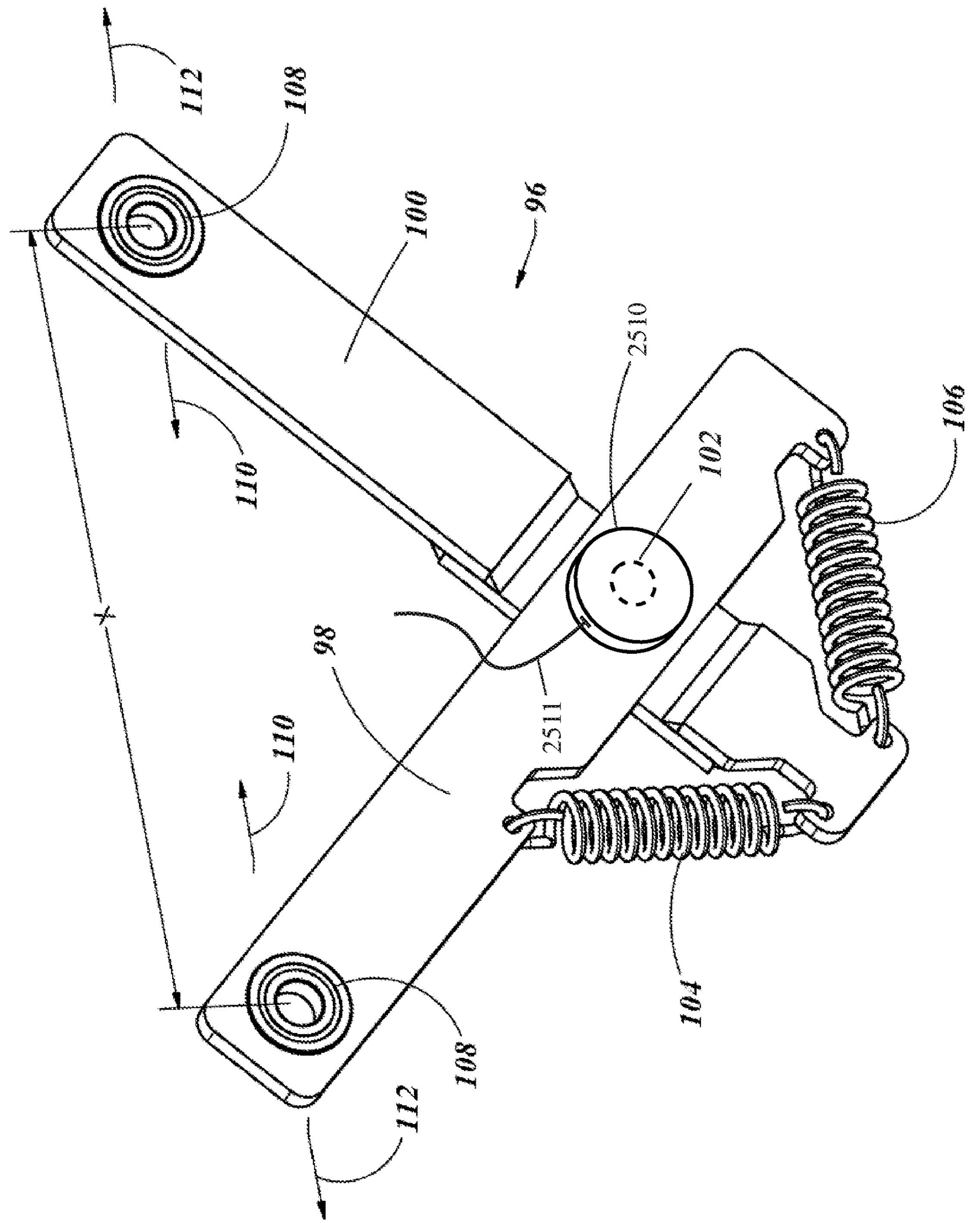


FIG. 25

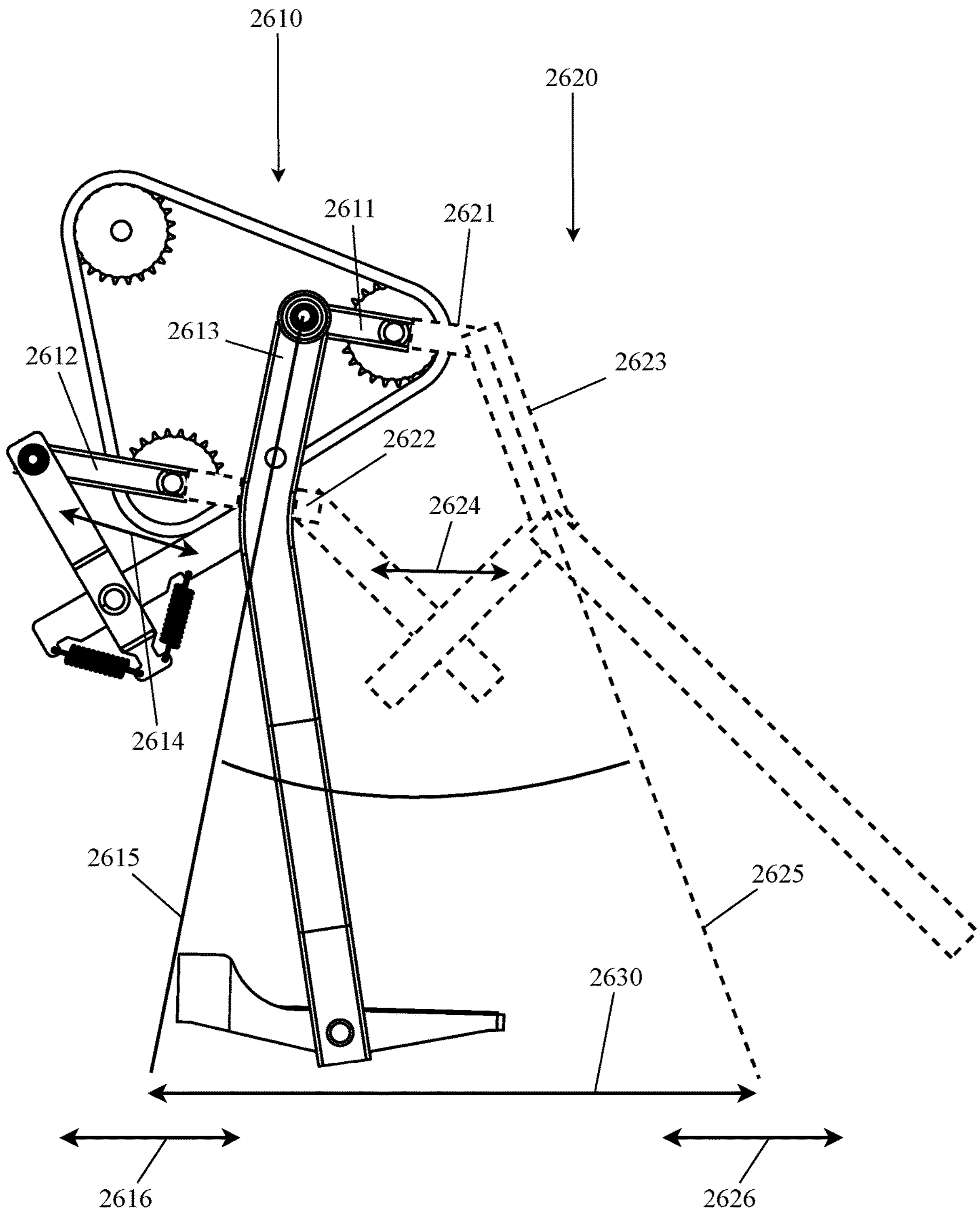

2610
2620
2611
2621
2613
2612
2623
2622
2624
2614
2615
2625
2630
2616
2626

FIG. 26

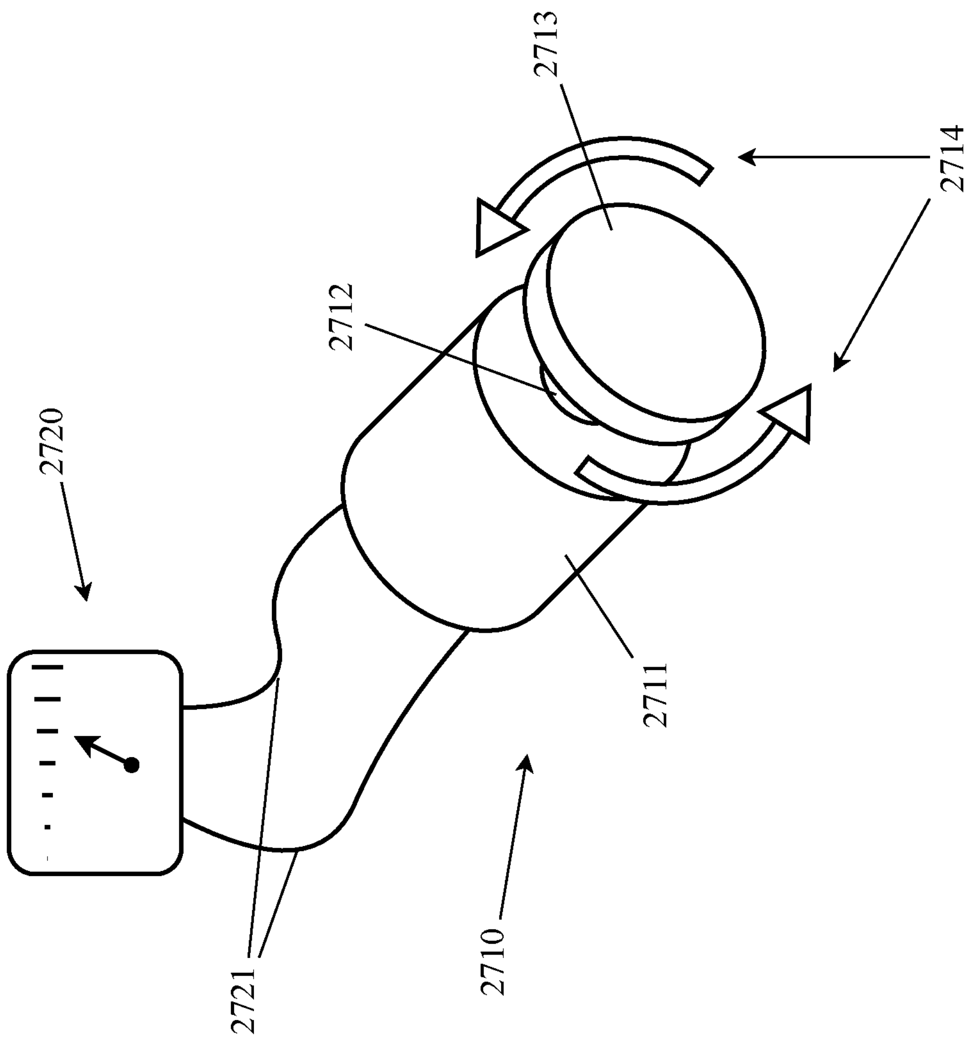


FIG. 27

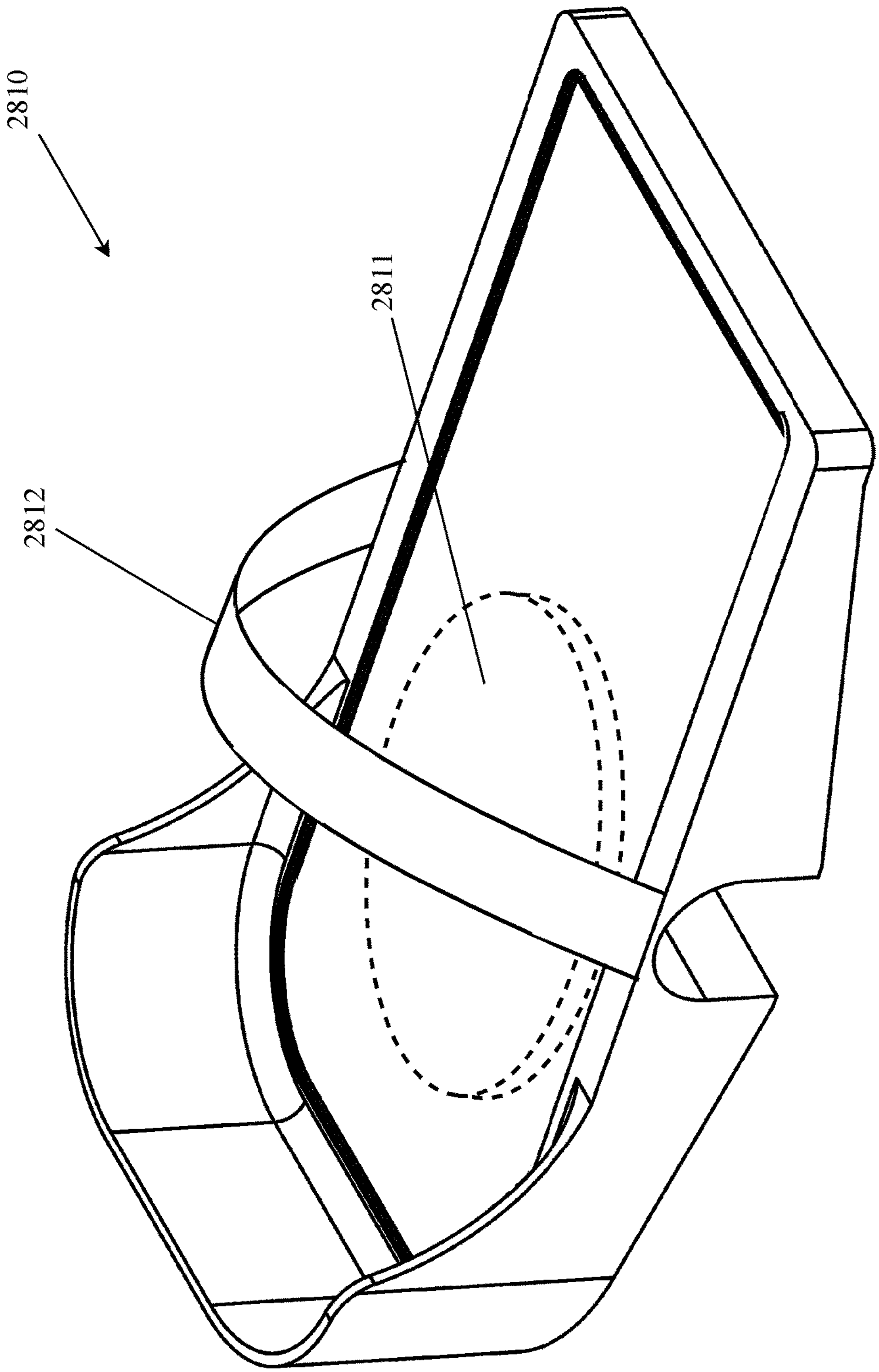


FIG. 28

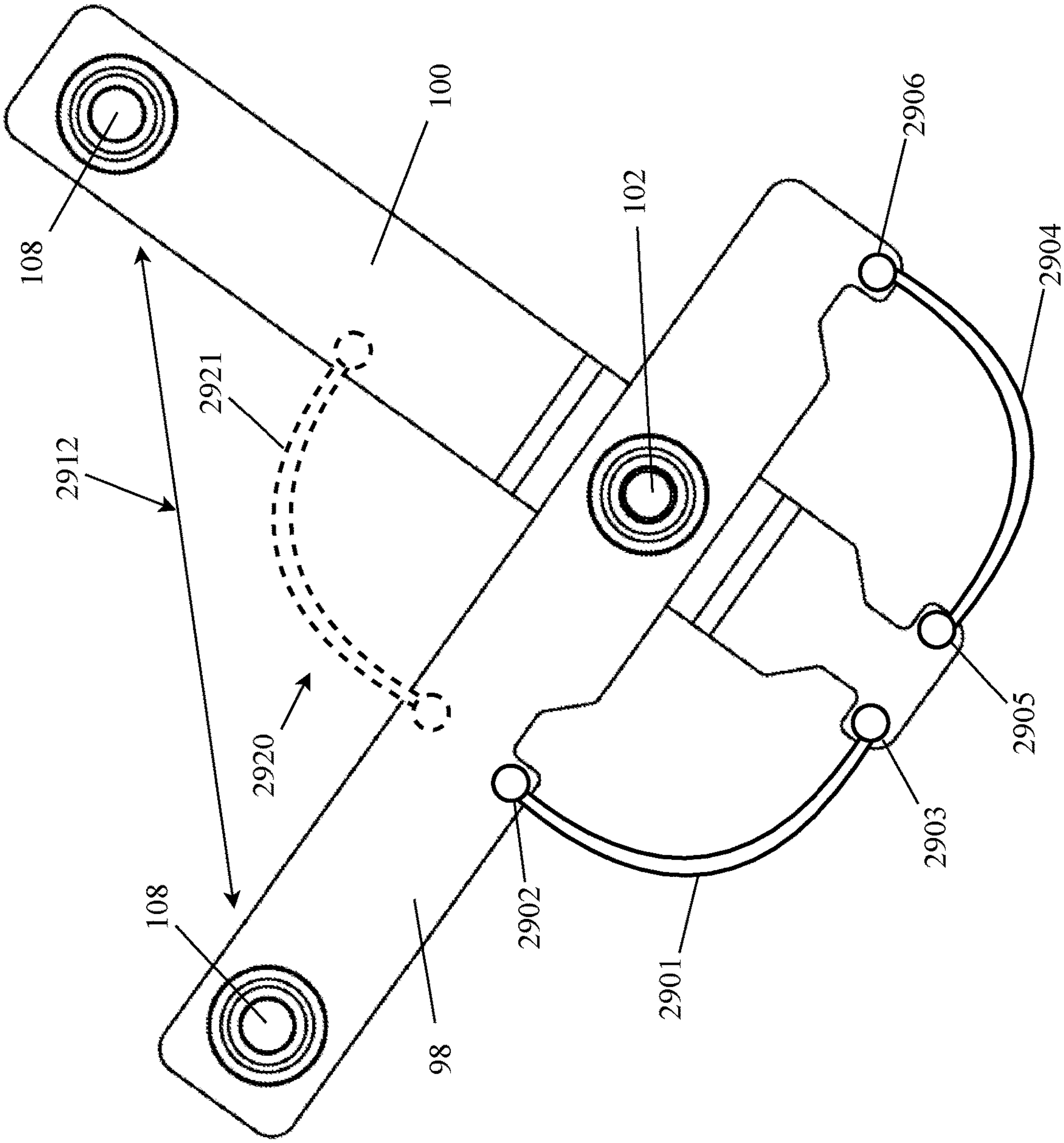

100
102
108
108
2906
2904
2921
2912
2920
2905
2903
2902
2901
98

FIG. 29

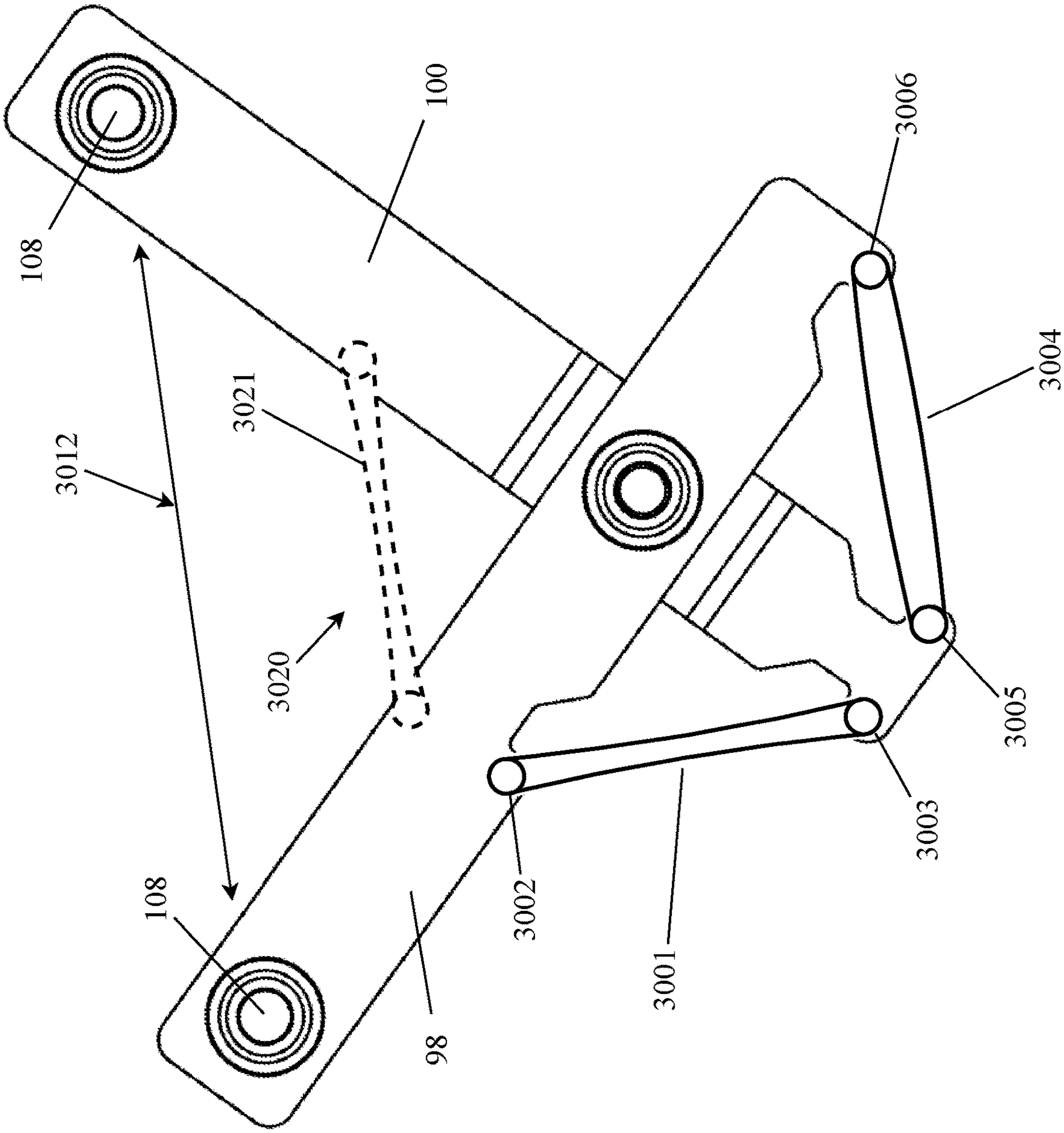


FIG. 30

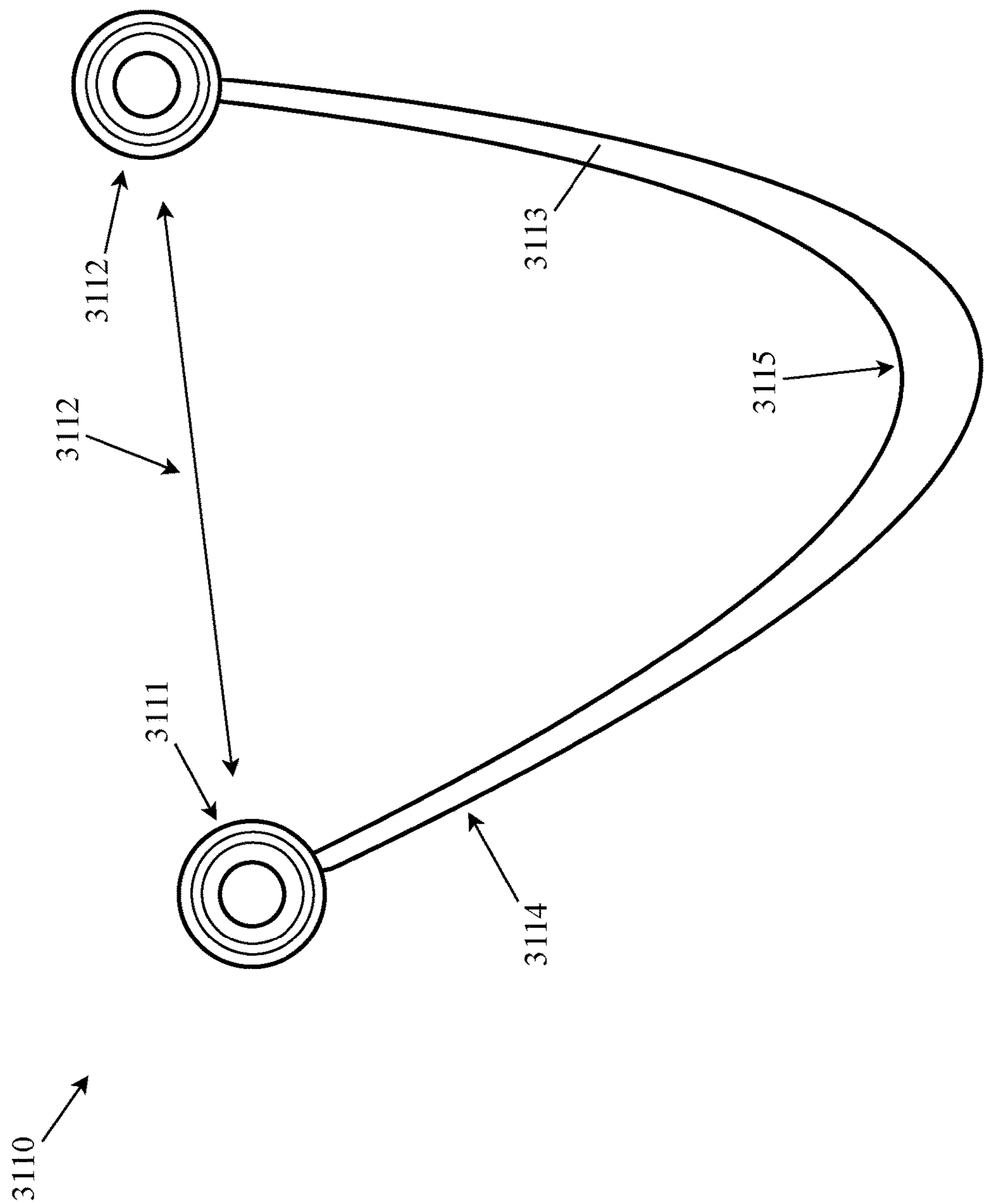


FIG. 31

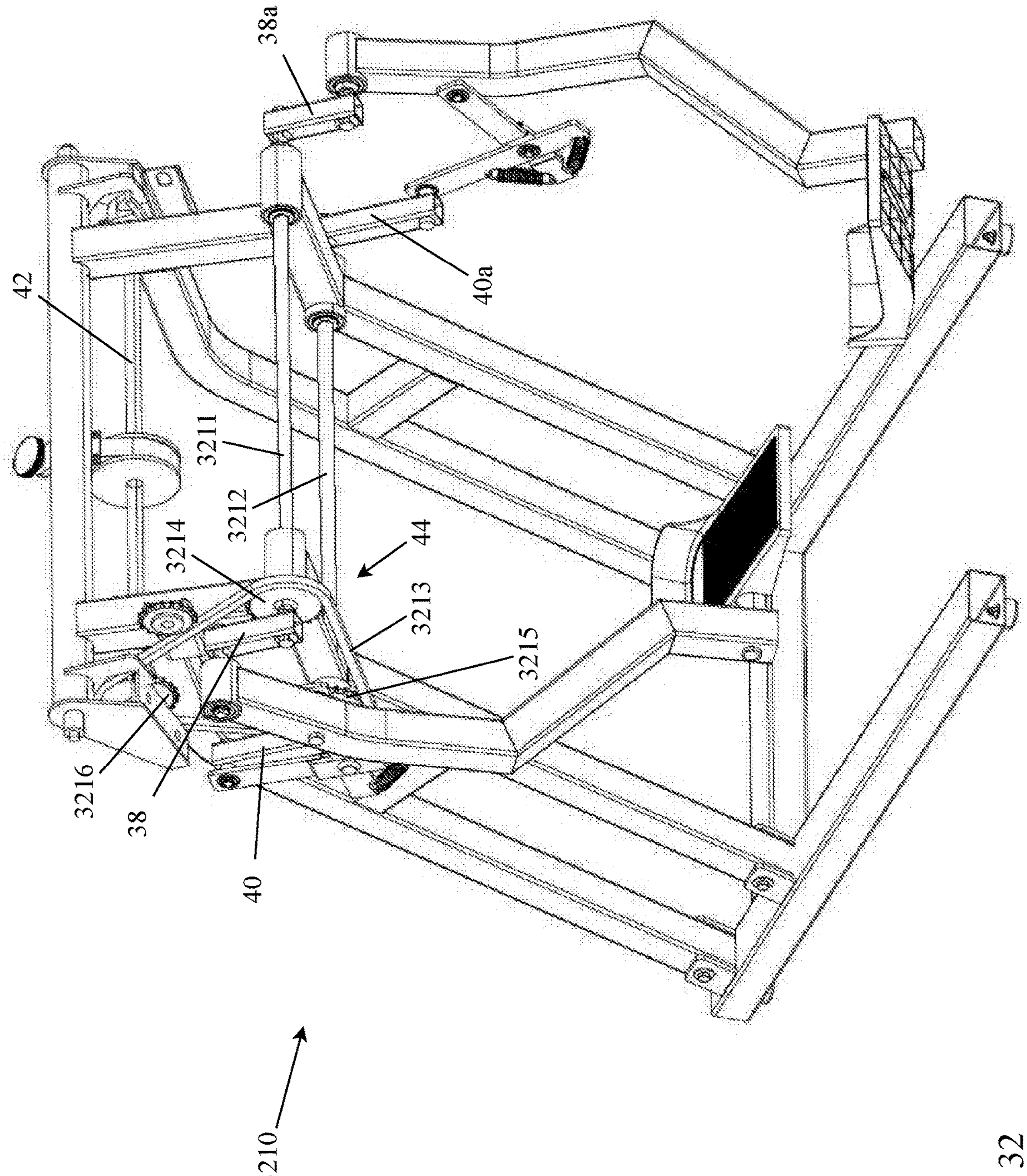


FIG. 32

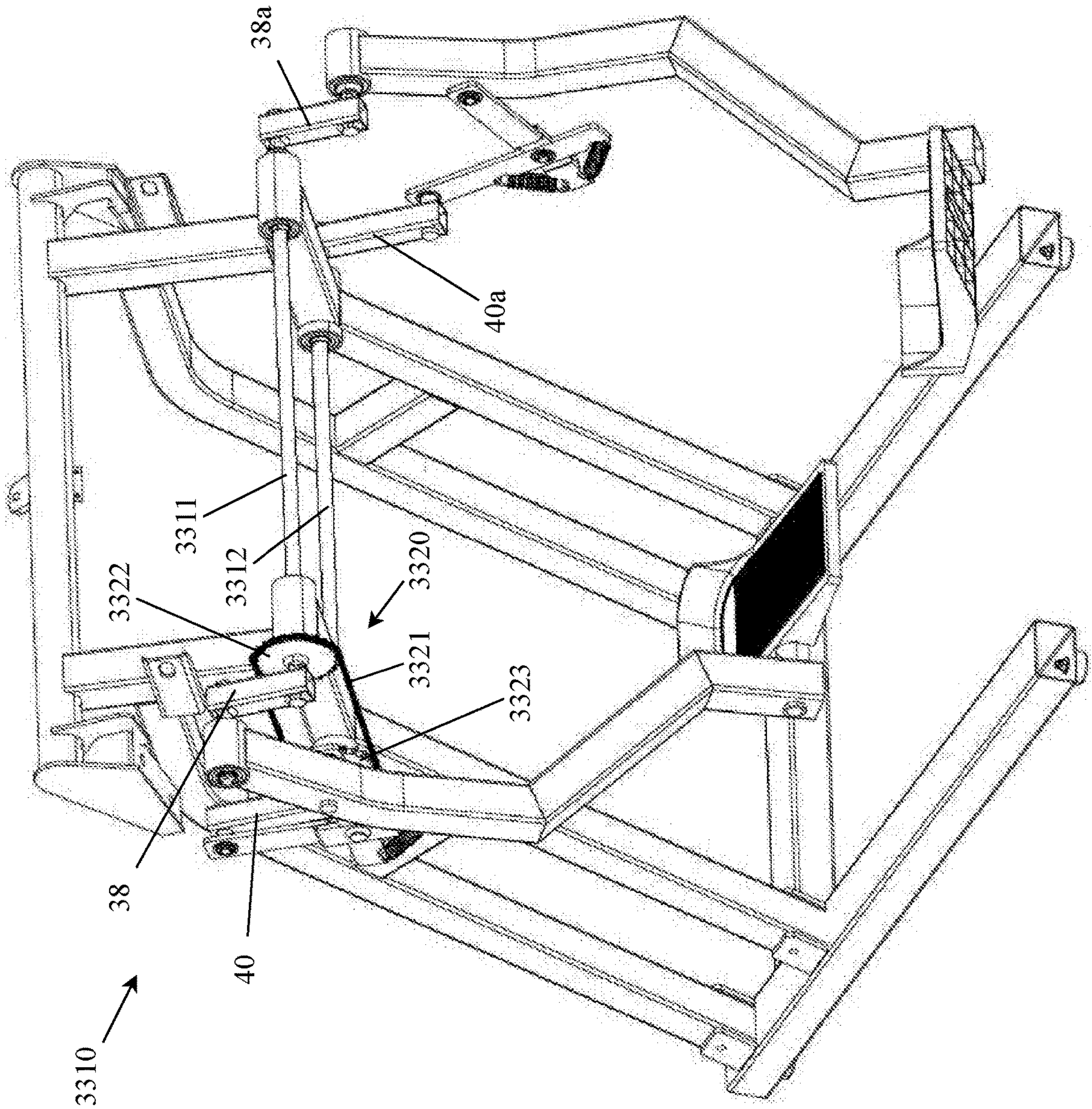


FIG. 33

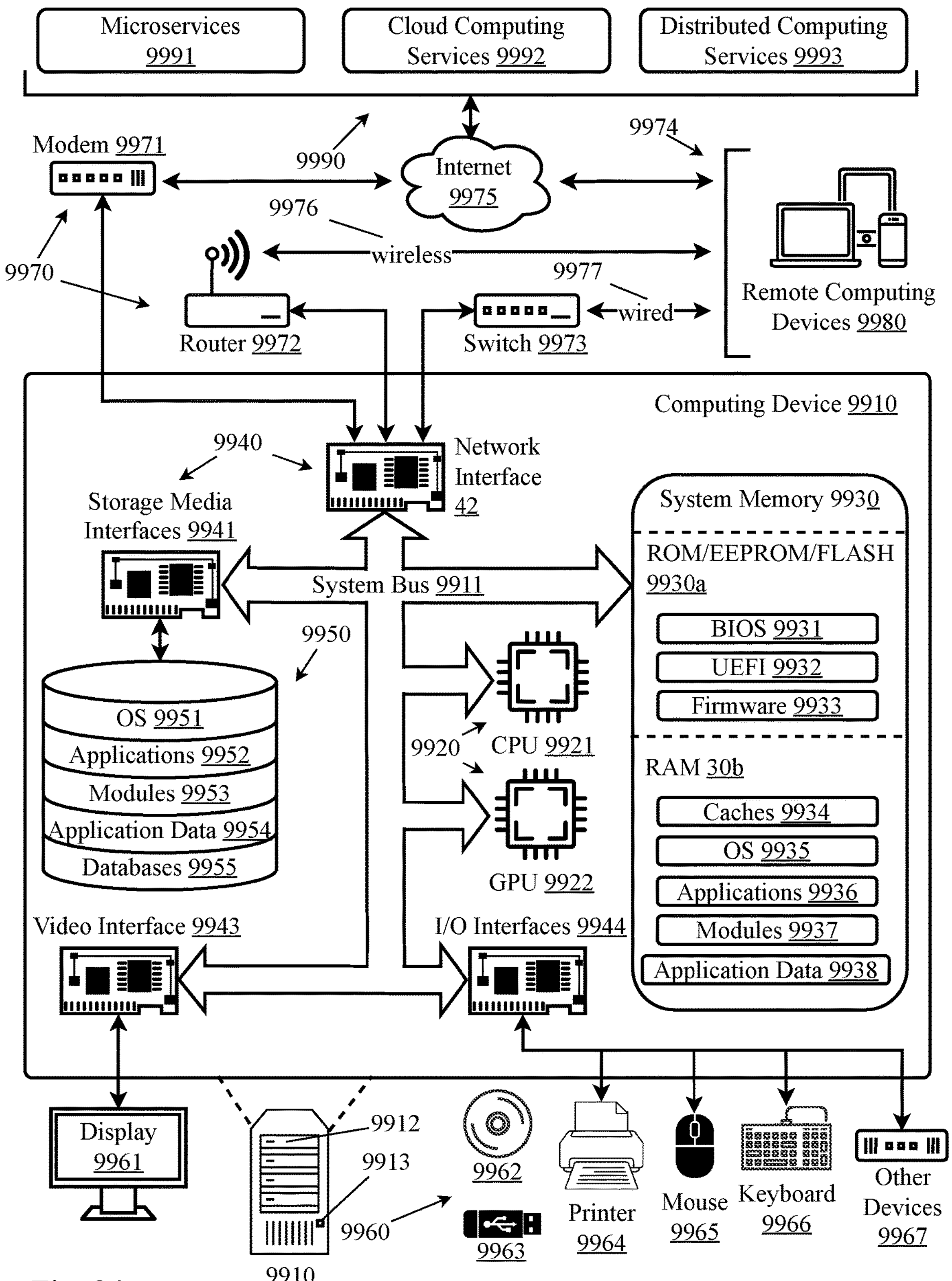

Microservices 9991
Cloud Computing Services 9992
Distributed Computing Services 9993
Modem 9971
9990
Internet 9975
9974
9976
wireless
9970
9977
wired
Router 9972
Switch 9973
Remote Computing Devices 9980
Computing Device 9910
9940
Network Interface 42
Storage Media Interfaces 9941
System Memory 9930
ROM/EEPROM/FLASH 9930a
System Bus 9911
BIOS 9931
UEFI 9932
Firmware 9933
9950
OS 9951
Applications 9952
Modules 9953
Application Data 9954
Databases 9955
9920
CPU 9921
GPU 9922
RAM 30b
Caches 9934
OS 9935
Applications 9936
Modules 9937
Application Data 9938
Video Interface 9943
I/O Interfaces 9944
Display 9961
9912
9913
9960
9910
9962
9963
Printer 9964
Mouse 9965
Keyboard 9966
Other Devices 9967

Fig. 34

EXERCISE DEVICE WITH NATURAL GAIT MOTION AND SINGLE SYNCHRONOUS CONTROL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Priority is claimed in the application data sheet to the following patents or patent applications, each of which is expressly incorporated herein by reference in its entirety:

[0002] Ser. No. 18/299,017

[0003] Ser. No. 17/405,347

[0004] Ser. No. 15/609,910

[0005] 62/358,517

BACKGROUND OF THE INVENTION

Field of the Art

[0006] The present invention generally relates to exercise equipment, and more particularly, to exercise devices providing walking or running motions.

Discussion of the State of the Art

[0007] The need for physical exercise is especially important in today's world of drive through windows and sitting in front of a computer all day. It is suggested that cardiovascular exercise is most beneficial if the user can obtain an elevated heart rate for at least twenty minutes of sustained exercise. This type of exercise may vary according to the needs and personal preference of the user, but for many people a movement that employs larger muscles, such as those which move the legs and hips may be desirable, as these are capable of doing the most work. For many sedentary individuals the accumulation of excess bodyfat may be a concern. The more work the body does, the more energy the body uses to perform that work. In the human body, most energy storage is in the form of bodyfat. Therefore, using larger muscles to do more work may enable a quicker end result on reducing bodyfat and increasing cardiovascular health. Adding an upper body system to an exercise device may further help by taxing additional muscle groups and increase the work output of the body over time.

[0008] It may be beneficial for the user to perform an activity that has a familiar basis to the normal function of the body, such as walking or running. Walking may be preferred for many users, as the impact forces on the legs are less compared to those found in running for the same person, even at the same speed. Using a walking motion may enable some participants to perform the activity that they could not perform under the higher running loads. Also, the lower impact stress may allow some people to perform the activity longer and therefore have a higher cumulative energy expenditure compared to running, even considering the higher energy expenditure per unit of time with running as compared to walking. Increasing the energy expenditure and still maintaining a walking gait may be accomplished by increasing the force required to move the pedals of a machine that simulates walking, or altering the angle to simulate walking up a hill. Either or both may provide a useful alternative to walking on a street or road where the user may be subjected to extreme weather conditions, traffic or physical dangers not found in their home or other controlled environment.

[0009] Treadmills have typically been used, but they can be large, expensive and noisy. The noise is due at least partially to the friction between the moving belt and the supporting deck under the belt that occurs with each step. Where there is friction there is wear. The decks must be regularly replaced or lubricated and the belts replaced.

[0010] It should, therefore, be appreciated that there is a need for an exercise device that allows the user to simulate walking or other bipedal movement that can be done indoors, with a small footprint and with minimal noise and parts wear. The present invention fulfills this need and others.

[0011] Existing elliptical exercise machines attempt to provide a low-impact exercise motion, but force a gait that is strictly elliptical in nature, which is not consistent with a natural walking motion. Further, existing elliptical exercise machines do not allow for a variable stride length. What is needed is a low-impact exercise machine similar to existing elliptical-type exercise machines, but with a more natural gait motion.

SUMMARY OF THE INVENTION

[0012] Accordingly, the inventor has conceived and reduced to practice an exercise machine with a more natural gait which, in some embodiments, further allows for a variable stride length while in use. In one configuration, each side of the exercise machine has a first crank assembly connected at an upper location on a pedal arm and a second crank connected at a middle location on the pedal arm, and a pedal is attached to a lower location of the pedal arm. The first crank assembly is connected to the pedal arm by a crank arm. The second crank assembly is connected to the pedal arm via a crank arm pivotally attached to a crank link. The path of each pedal is determined by the lengths of crank arms and crank links of the first and second crank assemblies rotating in synchronous motion.

[0013] According to a preferred embodiment, an exercise device is disclosed, comprising: a frame; a first and a second crank system mounted opposing sides of the frame adapted for positioning a user therebetween, each of the first and second crank system comprising a first crank assembly rotatable about a first axis and a second crank assembly rotatable about a second axis with the first and second axes each being displaced from the other, each of the first crank assemblies comprising a first crank arm, and each of the second crank assemblies comprising a second crank arm; a first drive shaft mechanically attached between the first crank system and the second crank system along the first axis; a second drive shaft attached between the first crank system and the second crank system along the second axis; a synchronous control system assembly mechanically coupled to the first crank system in a configuration that allows for 360 degrees of synchronous rotation of the first and second crank assemblies, wherein each first crank arm of each first crank assembly rotates in the same direction as the second crank arm of each second crank assembly by the synchronous control system assembly; a pair of pedal arms, one coupled to the first crank system and the other coupled to the second crank system, each of the pair of pedal arms being pivotally coupled at a first end to the first crank arm of the first crank assembly and being pivotally coupled at a second end to a pedal; a pair of movable crank links, one corresponding to each of the first and second crank systems, each of the pair of movable crank links comprising a first attachment point, a second attachment point, and a flexible attachment between the first attachment point and second attachment point, wherein the first attachment point of each movable crank link is pivotally coupled to the pedal arm of its corresponding crank system and the second attachment point of each movable crank is pivotally coupled to the second crank arm of its corresponding second crank assembly.

[0014] According to an aspect of an embodiment, each of the movable crank links of the pair of movable crank links comprises a first link and a second link, wherein the first attachment point of the movable crank link is proximal to a first end of the first link and the second attachment point of the movable crank link is proximal to a first end the second link, and the attachment point comprises a pivoting attachment of the first and second links.

[0015] According to an aspect of an embodiment, the pivoting attachment of the first and second links is at a medial location of both the first and second links, such that a second end of the first link distal from the first attachment point extends past the attachment point and second end of the second link distal to the second attachment point extends past the attachment point.

[0016] According to an aspect of an embodiment, a first force resistance device is attached between the second end of the first link the second end of the second link, and a second force resistance device is attached between the second end of the first link and a medial location of the second link.

[0017] According to an aspect of an embodiment, a first force resistance device is attached between the second end of the second link the second end of the first link, and a second force resistance device is attached between the second end of the second link and a medial location of the first link.

[0018] According to an aspect of an embodiment, a first force resistance device is attached between the first link and the second link at a point on each link between the attachment points and the pivoting attachment.

[0019] According to an aspect of an embodiment, each of the movable crank links of the pair of movable crank links is constructed of a flexible, resilient material or materials between the attachment points, the flexible, resilient material or materials allowing either for compression, expansion, or both, of a distance between the attachment points upon application of a force and return of the movable crank link to its original shape when the force is removed.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0020] Embodiments of the present invention will now be described, by way of example only, with reference to the following drawings, in which:

[0021] FIG. **1** is an isometric view of an exercise device, presented in accordance with the present invention.

[0022] FIG. **2** is an isometric view of an exercise device which includes drive handles, the Figure presented in accordance with the present invention.

[0023] FIG. **3** is an isometric view of the exercise device shown as shown in FIG. **2**, shown without a simulated user and from a right front viewpoint.

[0024] FIG. **4** is an isometric view from the left rear of the exercise device as shown in FIG. **3**.

[0025] FIG. **5** is an isometric view from the right rear of the exercise device as shown in FIG. **3** with a portion of the frame removed to more clearly show detail of the system.

[0026] FIG. **6** is a side view of the exercise device as shown in FIG. **3** and illustrating a tracing of the movement of the pedals.

[0027] FIG. **7** is a side view of a modified version of the exercise device shown in FIG. **3**, wherein the upper frame may be movably mounted to the base frame, a tracing of the pedal path at this inclined position is shown in contrast to the flat position of the upper frame in FIG. **6**.

[0028] FIG. **8** is an isometric view from the front left of the exercise device shown in FIG. **7**.

[0029] FIG. **9** is an isometric view from the right rear of the exercise device shown in FIG. **7**.

[0030] FIG. **10** is an isometric view from the left front of the exercise device as shown in FIG. **1** but where the rigid crank links have been replaced with movable crank links.

[0031] FIG. **11** is an isometric view from the left rear of the exercise device as shown FIG. **2**, but where the rigid crank links have been replaced with movable crank links.

[0032] FIG. **12** is an isometric view of a movable crank link removed from the rest of the exercise device as shown in FIG. **11**.

[0033] FIG. **13** is a front view of the exercise device as shown in FIG. **11**.

[0034] FIG. **14** is a side view of the exercise device as shown in FIG. **11** illustrating the tracing of the pedal paths of the movable crank links in a neutral position and also as may be seen when the movable crank links are moved by the user.

[0035] FIG. **15** is an isometric view from the left rear of an exercise device produced in accordance with the present invention in which the crank link pin is movably mounted on the pedal arm.

[0036] FIG. **16** is a detailed view of the crank link pin and pedal arm as shown in FIG. **15**, the view cut along the line **16-16** in FIG. **15**.

[0037] FIG. **17** is a side view of the exercise device as shown in FIG. **15** including the tracing of the pedals as altered by the movement of the crank link pin on the pedal arm.

[0038] FIG. **18** is an isometric view of an alternative embodiment of the exercise device as shown in FIG. **1**,

[0039] FIG. **19** is a detail cut away of the support frame and transmission of the exercise device of FIG. **18**, cut along line **19-19**.

[0040] FIG. **20** is an isometric view of the exercise device of FIG. **18**, shown from a front, side perspective with a portion of the base frame removed.

[0041] FIG. **21** is a side view of the exercise device of FIG. **18** shown in a non-inclined orientation.

[0042] FIG. **22** is a side view of the exercise device of FIG. **21**, shown in an inclined orientation.

[0043] FIG. **23** is an isometric view of a portion of the exercise device of FIG. **22**, shown from a front, side perspective with a section of the base frame removed.

[0044] FIG. **24** is a diagram illustrating an exemplary sensor for detecting movement of a movable crank link.

[0045] FIG. **25** is a diagram illustrating another exemplary sensor for detecting movement of a movable crank link.

[0046] FIG. **26** is a diagram illustrating an exemplary method for calculation of stride length in an embodiment having movable crank links.

[0047] FIG. **27** is a diagram illustrating use of a direct current generator to determine power output of a user during exercise.

[0048] FIG. **28** is a diagram illustrating an exemplary footpad for detecting pressure and lift of a user's foot during exercise.

[0049] FIG. **29** is a side elevation view of a movable crank link utilizing leaf springs for variable stride length resistance.

[0050] FIG. **30** is a side elevation view of a movable crank link utilizing elastomeric bands for for variable stride length resistance.

[0051] FIG. **31** is a side elevation view of a single-piece movable crank link utilizing a single leaf spring for variable stride length resistance.

[0052] FIG. **32** is a diagram illustrating an embodiment of an exercise device having a single synchronized control system.

[0053] FIG. **33** is a diagram illustrating another embodiment of an exercise device having a single synchronized control system.

[0054] FIG. **34** illustrates an exemplary computing environment on which an embodiment described herein may be implemented, in full or in part.

DETAILED DESCRIPTION OF THE INVENTION

[0055] The inventor has conceived and reduce to practice an exercise machine with a more natural gait which, in some embodiments, further allows for a variable stride length while in use. In one configuration, each side of the exercise machine has a first crank assembly connected at an upper location on a pedal arm and a second crank connected at a middle location on the pedal arm, and a pedal is attached to a lower location of the pedal arm. The first crank assembly is connected to the pedal arm by a crank arm. The second crank assembly is connected to the pedal arm via a crank arm pivotally attached to a crank link. The path of each pedal is determined by the lengths of crank arms and crank links of the first and second crank assemblies rotating in synchronous motion.

[0056] A control system may be provided that may be in communication with the first crank assembly and the second crank assembly, the control system may provide a synchronous movement of the first crank assembly relative to the second crank assembly. A pedal arm may have a first end pivotally coupled to the first crank assembly and a pedal positioned on a second end of the pedal arm. In addition, a crank link may have one end coupled to the second crank assembly and a second end coupled to the pedal arm. The first crank link may be movably coupled to a location on the first pedal arm and then moved to a second position on the first pedal arm, thereby changing the path of movement of the pedals.

[0057] The control system may include a drive shaft rotateably connected to the frame, which may provide mechanical communication between the first crank arm and the second crank arm of the first crank assembly. The control system may also include a drive member selected from the groups consisting of a belt, roller chain, a synchronous belt, a v-belt and a poly-v belt. The control system may also include a torque linkage including a link rod rotateably coupled to the second crank assembly and the drive shaft. The torque linkage may transfer power between the second crank assembly and the drive shaft operating in cooperation with the drive member. A braking system may be provided that may be in mechanical communication with the drive shaft, which may provide a resistance to movement of first crank arm and the second crank arm of the first crank assembly and the second crank assembly.

[0058] The exercise device may also include a support frame which may support the first crank assembly and the second crank assembly. The support frame may be movably mounted to a base frame, such that the orientation of the first axis or the second axis may be altered with respect to the base frame and thereby vary the path of the pedals.

[0059] The system may include a pair of drive handles pivotally coupled to the frame, each one of the pair of drive handles may include a hand grip on a first end and a drive lever on a second end. A handle link may also be provided with a first end pivotally coupled to the first crank assembly and a second end pivotally coupled to the drive lever.

[0060] For purposes of summarizing the invention and the advantages achieved over the prior art, certain advantages of the invention have been described herein. Of course, it is to be understood that not necessarily all such advantages can be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other advantages as may be taught or suggested herein.

[0061] All of these embodiments are intended to be within the scope of the invention herein disclosed. These and other embodiments of the present invention will become readily apparent to those skilled in the art from the following description of the preferred embodiments and drawings, the invention not being limited to any particular preferred embodiment(s) disclosed.

[0062] One or more different aspects may be described in the present application. Further, for one or more of the aspects described herein, numerous alternative arrangements may be described; it should be appreciated that these are presented for illustrative purposes only and are not limiting of the aspects contained herein or the claims presented herein in any way. One or more of the arrangements may be widely applicable to numerous aspects, as may be readily apparent from the disclosure. In general, arrangements are described in sufficient detail to enable those skilled in the art to practice one or more of the aspects, and it should be appreciated that other arrangements may be utilized and that structural, logical, software, electrical and other changes may be made without departing from the scope of the particular aspects. Particular features of one or more of the aspects described herein may be described with reference to one or more particular aspects or figures that form a part of the present disclosure, and in which are shown, by way of illustration, specific arrangements of one or more of the aspects. It should be appreciated, however, that such features are not limited to usage in the one or more particular aspects or figures with reference to which they are described. The present disclosure is neither a literal description of all arrangements of one or more of the aspects nor a listing of features of one or more of the aspects that must be present in all arrangements.

[0063] Headings of sections provided in this patent application and the title of this patent application are for convenience only, and are not to be taken as limiting the disclosure in any way.

[0064] Devices that are in communication with each other need not be in continuous communication with each other, unless expressly specified otherwise. In addition, devices that are in communication with each other may communicate directly or indirectly through one or more communication means or intermediaries, logical or physical.

[0065] A description of an aspect with several components in communication with each other does not imply that all such components are required. To the contrary, a variety of optional components may be described to illustrate a wide variety of possible aspects and in order to more fully illustrate one or more aspects. Similarly, although process steps, method steps, algorithms or the like may be described in a sequential order, such processes, methods and algorithms may generally be configured to work in alternate orders, unless specifically stated to the contrary. In other words, any sequence or order of steps that may be described in this patent application does not, in and of itself, indicate a requirement that the steps be performed in that order. The steps of described processes may be performed in any order practical. Further, some steps may be performed simultaneously despite being described or implied as occurring non-simultaneously (e.g., because one step is described after the other step). Moreover, the illustration of a process by its depiction in a drawing does not imply that the illustrated process is exclusive of other variations and modifications thereto, does not imply that the illustrated process or any of its steps are necessary to one or more of the aspects, and does not imply that the illustrated process is preferred. Also, steps are generally described once per aspect, but this does not mean they must occur once, or that they may only occur once each time a process, method, or algorithm is carried out or executed. Some steps may be omitted in some aspects or some occurrences, or some steps may be executed more than once in a given aspect or occurrence.

[0066] When a single device or article is described herein, it will be readily apparent that more than one device or article may be used in place of a single device or article. Similarly, where more than one device or article is described herein, it will be readily apparent that a single device or article may be used in place of the more than one device or article.

[0067] The functionality or the features of a device may be alternatively embodied by one or more other devices that are not explicitly described as having such functionality or features.

[0068] Thus, other aspects need not include the device itself.

[0069] Techniques and mechanisms described or referenced herein will sometimes be described in singular form for clarity. However, it should be appreciated that particular aspects may include multiple iterations of a technique or multiple instantiations of a mechanism unless noted otherwise. Process descriptions or blocks in figures should be understood as representing modules, segments, or portions of code which include one or more executable instructions for implementing specific logical functions or steps in the process. Alternate implementations are included within the scope of various aspects in which, for example, functions may be executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved, as would be understood by those having ordinary skill in the art.

Detailed Descriptions of the Drawing Figures

[0070] With reference to the illustrative drawings, and particularly to FIG. **1**, there is shown an exercise device **20**. The exercise device **20** may include a frame **22**, which may include a base frame **24** and a support frame **26**. The support frame **26** may be adapted to support a first crank assembly **28**, which may be journaled to the support frame **26** to allow for rotational movement of the first crank assembly **28** about a first axis **30**. A second crank assembly **32** may be journaled to the support frame **26** about a second axis **34**. In this disclosure the locations of the first axis **30** and the second axis **34** may be positioned to cause a potential interference with a user **36** using the exercise device **20**. To solve this problem, the first crank assembly **28** and the second crank assembly **32** may each be split into a left crankset and a right crankset. To maintain that the first crank arms **38** and the second crank arms **40** of the first crank assembly **28** and the second crank assembly **32** respectively, may be positioned to be 180° out of phase with the other crank arm (**38** and **40**) of each crankset (**28** and **32**), a drive shaft **42** may also be journaled to the support frame **26** as illustrated.

[0071] It may be desirable for the first crank assembly **28** and the second crank assembly **32** to move in a synchronous manner with respect to one another. This may be accomplished by the use of a control system **44**. The control system **44** may be comprised of a roller chain, a drive belt, a gearing system or any other mechanical transmission elements known in the art. In that the first axis **30** and the second axis **34** may not allow a direct communication between the right and left portions of the first crank assembly **28** or the second crank assembly **32**, the control system **44** may also be in mechanical communication with the driveshaft **42**. In that the driveshaft **42** may be located in position to mechanically span the entire width of the exercise device **20**, the driveshaft **42** with the control system **44** may then act to connect the left and right portions of each of the first crank assembly **28** and the second crank assembly **32** as well as provide for synchronous rotation of the first crank assembly **28** with respect to the second crank assembly **32**.

[0072] A pedal arm **46** may be rotatably coupled to the first crank assembly **28** on a first end **48** of the pedal arm **46**. On a second end **50** of the pedal arm **46** a pedal **52** may be provided, which may be adapted to support the weight of the user **36**. Between the first end **48** and the second end **50** of the pedal arm **46**, a crank link pin **54** may be provided. The crank link pin **54** may be pivotally coupled to a crank link **56** and the crank link **56** may also be coupled to the second crank assembly **32**, thereby connecting the pedal arm **46** to the second crank assembly **32**.

[0073] It is important to note that in these preferred embodiments of the exercise device **20**, the drive shaft **42** is positioned such that it is not in line with the first axis **30** or the second axis **34**. That is because both the first axis **30** and the second axis **34** may be positioned to potentially interfere with the movement of the user **36**. As such, the drive shaft **42** may be moved to a position that is unlikely to interfere with the movement of the legs of the user **36**. It is possible that the second axis **34**, and the second crank assembly **32**, could be moved far enough forward to avoid the legs of the user **36**. If that were done, the drive shaft **42** could directly connect the second crank assembly **32**. The crank link **56** may then be increased in length in accordance with the increase in dimension of the relocation of the second axis **34** relative to the current position. This would eliminate the need for some components in the system. The applicant recognizes this could be done and hereby includes this as a variation to the disclosed embodiments even though this is not shown in any of the Figures.

[0074] With reference to FIGS. **2-5**, a similar exercise device **20** is shown with the addition of drive handles **58**, which may be pivotally coupled to the frame **22** about a pivot pin **60**. The drive handles **58** may each include a hand grip **62** adapted to be gripped by the hands of the user **36**. The drive handles **58** may also include a drive lever **64**, which may be coupled to a handle link **66** about a pivot **68**. The handle link **66** may include a second pivot **70**, which may be mounted to the first crank assembly **28** at second pivot **70**. Therefore, the user **36** may be positioned on the pedals **52** of the pedal arms **46** and perform a walking motion such that the first crank assembly **28** may **28** may provide a vertical displacement of each pedal arm **46**, and therefore the pedal **52**, while the second crank assembly **32** may provide for horizontal displacement of the pedal **52** by way of the crank link **56**. This movement may drive the driveshaft **42**, thus causing it to rotate about the bearings **72**, which may be mounted to the support frame **26** of the frame **22**.

[0075] To provide a smooth movement of the pedals **52** a flywheel **74** may be coupled to the driveshaft **42**, whereby rotation of the driveshaft **42** about the bearings **72** may cause a similar rotation of the flywheel **74**. It may also be desirable to include a braking system to resist the movement of the pedals **52**. A braking system may include a friction strap **76** mounted to a screw **78**, which may be mounted to the support frame **26**. Therefore, as the screw **78** is advanced this may increase the tension in the friction strap **76**, which may increase the drag and therefore increase the resistance to movement of the flywheel **74**. This may increase the work necessary to be provided by the user **36**, thus increasing the intensity of the exercise. In a similar manner, any magnetic form of resistance known to the art, such as an electric motor, an eddy current brake or any other braking system may be used in place of the combination of the friction strap **76** and screw **78**.

[0076] With particular attention to FIG. **5**, the support frame **26** has been removed to better illustrate this embodiment of the present invention **20**. The elements as previously shown and described are consistent with that as presented above. What may also be more clearly seen in this Figure is the potential use of a tension device to optimize the function of the control system **44**. As noted, the control system **44** may include a roller chain or drive belt. It may be desirable to use an idler pulley **80** positioned relative to the drive belt or roller chain of the control system **44** so as to displace a portion of the roller chain or drive belt, thus creating proper tension in the drive belt or roller chain to optimize the function of the control system **44**.

[0077] With regard to FIG. **6**, a side view of the exercise device **20** is shown with a trace of a pedal path **82**. In this view it can be seen how the pedal arms **46** may be connected to the first crank assembly **28**. As the first crank assembly **28** rotates in the direction of the drive arrow **84** the pedal arm **46** on the left may move downward while the pedal arm **46** on the right may move upward. The control system **44** may provide the same direction of rotation of the second crank assembly **32**, as designated by the second arrow **86**. As the second crank assembly **32** rotates in a counter clockwise direction (in this view), the second crank assembly **32** may drive the crank link **56** to alter the angular orientation of the pedal arms **46**, as they are driven by the first crank assembly **28**. In this view and in this relative position of the pedal arms **46**, the pedal arm **46** on the left may move generally down and to the right, as shown by the first pedal arrow **88**, while the pedal arm **46** on the right may move generally up and to the right until it changes direction to move to the left and moving down as illustrated by the second pedal arrow **90**. An example of a complete path of the pedals **52** may be shown moving along the trace of the pedal path **82**.

[0078] It may be desirable to change the resistance of the exercise device **20**. Any number of users may have different physical capabilities and therefore it may be desirable to have the exercise device conform to those varying capabilities. In addition, as a person uses an exercise device, it is likely the person's physical fitness level will improve. As such, in order to continue to make physiological gains from the exercise, it may be desirable for the exercise device to increase in its ability to stress the body of the user by increasing the workload.

[0079] As noted, one method to increase the workload in the present exercise device **20** is by providing resistance to rotation of the flywheel **74** by way of the friction strap **76** or any other form of resistance, such as any number of electromagnetic braking systems. An alternative may be to increase the angle of the pedal path. A solution to do so is illustrated in FIGS. **7-9**. As was shown in FIG. **6**, the trace of the pedal path **82** may be similar to that of a normal walking gait of a person. This walking gait may be similar to that of a person walking on a treadmill with no incline. To increase the caloric expenditure the user may increase the incline or grade of the treadmill deck. According to the American College of Sports Medicine, a person walking on a flat 0% grade versus walking the same speed at a 10% grade will have an estimated metabolic requirement of over 2.3 times greater walking at the inclined grade. Therefore, changing the angle of incline of the gait pattern of the user may also increase energy expenditure of the user during the exercise session. In that a walking gait may result in significantly lower impact stress on the joints of the user, it may be desirable for a user to exercise in this manner as opposed to running and expend a similar amount of energy per unit of time performing the inclined walking exercise.

[0080] With regard to FIGS. **7-9**, an alternative version of the exercise device **20'** is shown which may incorporate the ability to change the angle of the pedal path of the user. The frame **22'** may include the base frame **24**, which may be supported on the ground or floor as with the other embodiments. The support frame **26'** may include a support frame pivot **92**, which may be coupled to the base frame **24**. This may allow the support frame **26'** to change its angular orientation with respect to the base frame **24** by pivoting about the support frame pivot **92**. An actuator **94** may be positioned between the base frame **24** and the support frame **26'** wherein as the actuator **94** extends, the angle between the support frame **26'** and the base frame **24** may be increased. As may be illustrated in FIG. **7**, the trace of the pedal path **82** may have the same overall shape as that shown in FIG. **6** where the exercise device **20** is at a standard flat position, but the trace of the pedal path **82** may be rotated in FIG. **7** in accordance with the increase in angle of the support frame **26'** relative to the base frame **24**. This may allow a user to increase the workload of the exercise session to a varying degree according to the amount of incline the user selects between the support frame **26'** and the base frame **24**.

[0081] It may be desirable to enable the user to change the stride length of the pedal path. An example of how this may be accomplished is shown in FIGS. **10-14**. The general function of the exercise device **20"** may be the same as previously shown and described with the exception of the crank link **56** may be replaced with a movable crank link **96**. The movable crank link **96** may include a first link **98** and a second link **100**, which may be pivotally coupled about a crank link pin **102**. A first spring **104** may be coupled to the first link **98** and the second link **100** and in a similar but opposite manner, a second spring **106** may likewise be coupled to the first link **98** and the second link **100**. The orientation of the first spring **104** and the second spring **106** may apply a balanced couple to the first link **98** relative to the second link **100** so that the distance "x" between the bearing attachments **108** may be biased to a predetermined dimension. Though the movable crank link **96** may be biased to a dimension "x" between the bearing attachments **108**, if a force is applied to the movable crank link **96** in a direction to decrease the value of "x", the first spring **104** may increase in length and the second spring **106** may decrease in length.

[0082] A spring may obey "Hook's Law" in that the force needed to deform a spring by some distance is proportional to that distance. Therefore in this example, if a force is applied to cause the distance "x" to decrease, as depicted by the compression arrows **110** shown in FIG. **12**, the length of the first spring **104** may increase and therefore the force applied by the spring to the first link **98** and the second link **100** would also proportionally increase. The length of the second spring **106** may decrease, and therefore the force applied to the first link **98** and the second link **100** by the second spring **106** may proportionally decrease. The opposite may be found in that as force is applied to the movable crank link **96** that results in increasing the dimension "x", as depicted by the extension arrows **112**, the first spring **104** may decrease in length (and applied force) and the second spring **106** may increase in length (and applied force).

[0083] The result is the movable crank link **96** may allow for the dimension "x" to be increased or decreased by forces applied to the movable crank link **96**, but the action of the first spring **104** and the second spring **106** may provide a pair of forces that may be balanced optimally when the dimension "x" is at a predetermined value. This combination may allow for displacement of the first link **98** relative to the second link **100** of the movable crank link **96** to allow the value of "x" to vary, but yet provide a bias to return the orientation of the movable crank link **96** to that so the dimension "x" may be a predetermined value.

[0084] When used on the exercise device **20"**, the force applied to the movable crank links **96** may be applied by the user to the pedals **52**. This may be illustrated in more detail in FIG. **14**, where the previously illustrated trace of the pedal path **82** is presented as it may be generated if the movable crank links **96** maintain a set angular orientation of the first link **98** relative to the second link **100**, so as to provide a constant dimension "x", as shown in FIG. **12**. If the user provides a force to the forward pedal **52** (left one pedal in FIG. **14**) to extend it forward beyond the trace of the pedal path **82**, a force may be applied to the movable crank link **96** coupled to the forward pedal arm **46** (left one in FIG. **14**) to provide a force to move the movable crank link **96** in the direction of the compression arrows **110**, or to reduce the value of dimension "x". This may allow the pedal **52** supporting the front foot to extend beyond the trace of the pedal path **82** on the forward pedal **52** (left in FIG. **14**) to generate a front pedal path trace extension **114**.

[0085] In a similar but opposite manner, if the user wishes to extend the pedal **52** supporting the back foot farther back than what may be illustrated by the trace of the pedal path **82**, the user may apply a force to the rear pedal **52**, (right one in FIG. **14**) which may cause the movable crank link **96** connected to the pedal arm **46** supporting the rear pedal **52** (right one in FIG. **14**) to move in the direction of the extension arrows **112**, or to increase the value of dimension "x". This may allow the pedal **52** supporting the rear foot to extend beyond the trace of the pedal path **82** on the rear pedal **52** (right one in FIG. **14**) to generate a rear pedal path trace extension **116**. The combination may provide an increased stride length of the pedals **52**, which may accommodate a taller person, or anyone else that may want a longer stride length. This may be accomplished by the user overcoming the resistance provided by the first spring **104** and the second spring **106** as needed and to the extent desired by the user.

[0086] Another option to vary the stride length of the pedals **52** is presented in FIGS. **15-17**. In this embodiment of the exercise device **20'''** the crank link **56** may be used, or the movable crank link **96** as disclosed previously. As previously noted, the movable crank link **96** may enable a system in which the user may alter the stride length by simply using a longer stride length in their gait and the exercise device **20"** may conform to the user's foot path of travel. In FIGS. **15-17** a system is illustrated which may provide a set stride length that is adjustable. It is possible to use both the movable crank link **96** as disclosed with the adjustable system illustrated in FIGS. **15-17**. That combination is not shown though it is understood that this combination is inherently part of this disclosure.

[0087] With regard to FIGS. **15-17**, an exercise device **20'''** is shown in which the crank link pin **54** of the previous embodiments may be replaced with a movable link pin **118**. The movable link pin **118** may be slidably or pivotally mounted to the pedal arm **46**. It is shown to be received by a slot **120** in the pedal arm **46**, but this slot **120** is not critical. The movable link pin **118** may be mounted to the linear slide, or pivotally coupled to the pedal arm **46**, in any way that is known in the art, so that a controlled movement of the movable link pin **118** may be provided. An actuator **122** may be used to move the movable link pin **118** on the pedal arm **46** closer to, or further from, the first end **48** of the pedal arm **46**. If the movable link pin **118** is moved up closer to the first end **48** of the pedal arm **46**, as illustrated by the up arrows **124**, the stride length of the pedal **52** may be increased. If the movable link pin **118** is moved down, farther from the first end **48** of the pedal arm **46**, as illustrated by the down arrows **126**, the stride length of the pedal **52** may be decreased. This adjustment of the relative position of the movable link pin **118** as moved by the actuator **122** may be adjusted by the user before an exercise session begins or with a system that may be powered, such as with the actuator **122**, the adjustment may be also accomplished while the user is performing the exercise. A simple screw adjustment or even a movable but locking movable link pin **118** system may be used where the user may adjust and lock the movable link pin **118** in a set position prior to beginning the exercise session.

[0088] The horizontal displacement of multiple stride lengths of the pedals **52** that may be provided by varying the position of the movable link pin **118** is illustrated in FIG. **17**. The trace of the pedal path **82**, as previously presented, may be shown as a midpoint of the location of the movable link pin **118**. This may provide a horizontal dimension of the trace of the pedal path **82** as identified by the value "B". If the movable link pin **118** is moved in accordance with the down arrows **126**, thereby increasing the distance between the movable link pin **118** and the first end **48** of the pedal arm **46**, a shorter pedal path **128** may result. The shorter pedal path **128** may be associated with a smaller horizontal displacement identified as "A". If the movable link pin **118** is moved closer to the first end **48** of the pedal arms **46**, as noted by the up arrows **124**, a greater stride length may result. The longer pedal path **130** may be associated with the greater horizontal displacement identified as "C".

[0089] If the movable link pin **118** is used with a constant length crank link **56**, as shown, the adjustment in the stride length may provide a series of set pedal paths (**82**, **128**, **130**) or any infinite number of variations to those shown. Each path may be a result of the settings of the exercise device **20'''** and therefore stable to the user, as the user may not be able to alter the pedal paths without making an adjustment to the position of the movable link pin **118**. This stability may be desirable to some users in that their body may be fully supported on the pedals **52** of the exercise device **20'''**. Using the movable crank link **96** with the adjustable stride length system as provided by the movable link pin **118** together may provide a system which allows for the user to vary their stride length where the path of the pedals **52** comply with that of the user, and an adjustable baseline path of the path of the pedals **52** may be provided by the movable link pin **118** and set in accordance with the desire or some physical characteristics of the user.

[0090] Another embodiment of the exercise device **20''''** is shown in FIGS. **18-23**. With attention to FIGS. **18-20**, the support frame **26"** may be comprised of first drive **132** and a second drive **134**, each coupled to the support frame **26"**. The support frame **26"** may be movably coupled to the base frame **24** by way of a pivot joint **136**. The first drive **132** and the second drive **134** may be positioned such that a person may position themselves between the first drive **132** and the second drive **134**. The support frame **26"** may also support the drive shaft **42**, which may be in mechanical communication with the flywheel **74**. The first drive **132** and the second drive **134** may each support a first crank assembly **28** and a second crank assembly **32** in such a manner such that the first crank arm **38** of the first crank assembly **28**, coupled to the first drive **132** may be one hundred and eighty degrees out of phase from the first crank arm **38** of the first crank assembly **28**, coupled to the second drive **134**. In a similar manner, the second crank assembly **32** may include a second crank arm **40** coupled to the first drive **132** that may be one hundred and eighty degrees out of phase from the second crank arm **40**, coupled to the second drive **134**. The first crank arm **38** and the second crank arm **40** may be parallel to each other on both the first drive **132** and the second drive **134**.

[0091] A drive pulley **135** may be mounted to the drive shaft **42**. The drive pulley **135** may be in mechanical communication with the flywheel **74** by way of a drive belt **137**. A braking system may be coupled to the flywheel **74** so that resistance provided to the flywheel **74** may offer a resistance to movement of the drive shaft **42**, which in turn may offer a resistance to movement of the pedals **52**. This combination may offer a form of exercise resistance to the user.

[0092] The control system **44** may include a drive member **138**, which may take the form of a belt, roller chain, a synchronous belt, a v-belt, a poly-v belt or any other power transmission system known in the art. The drive member **138**, as shown here in the form of a belt, may be tensioned by the idler **80**. A drive pulley **140** may be secured to the first crank assembly **28** and the second crank assembly **32** on both the first drive **132** and the second drive **134**. The drive member **138** may be limited to a belt or other power transmission system alone. Alternatively it may be advantageous to provide a secondary power transmission system in the form of a torque linkage **142**. This may include a link rod **144** that may be coupled to the second crank assembly **32** and the drive shaft **42** by way of a pair of clamp links **146**. This torque linkage **142** may be used to supplement the drive member **138** when high torque is applied to the second crank assembly **32** by the user. The braking system may be applied to the flywheel **74**, as such, the highest load may be seen between the second crank assembly **32** and the drive shaft **42**. The use of the torque linkage **142** may allow the drive member **138** to be designed for the lower torque associated with extended use by a user and when high forces are applied by the user, such as during sprinting or high incline "hiking" movements, the torque linkage **142** may supplement the power transmission, taking any excessive stress off the drive member **138**. This may help eliminate the possibility of drive member **138** jumping a tooth of one of the drive pulleys **140** without the need to over engineer the drive member **138** and drive pulleys **140** for stresses that are only seen occasionally and for short durations.

[0093] The torque linkage **142** is shown here to connect the second crank assembly **32** to the drive shaft **42**, which may be connected to the braking system. This combination may experience the highest forces and that is why it is shown in this configuration. It is understood that one or more torque linkages **142** may connect any one or more combinations between the first crank assembly **28**, the second crank assembly **32** and the drive shaft **42**.

[0094] The transfer of the higher forces that may be added by the user to the torque linkage **142** may be generated by the user by positioning the exercise device **20''''** in a configuration so as to simulate walking up a hill. In this embodiment, this may be accomplished by altering the position of the support frame **26"** and all the elements supported by the support frame **26"** with respect to the base frame **24**. One method of doing this is illustrated in FIGS. **21-23**. The support frame **26"** may be pivotally coupled to the base frame **24** about the pivot joint **136**. One or more counterbalance springs **148** may be coupled to the support frame **26"** and to the base frame **24** to counter any torque the support frame **26"** may provide at rest about the pivot joint **136** due to the weight of the support frame **26"** and the other elements coupled to the support frame **26"**. This counterbalance spring **148** may be in the form of a gas spring. An actuator, such as a linear screw actuator, may be substituted for one or both of the counterbalance springs **148** shown here. In that embodiment, the actuator may drive the front portion of the support frame **26"** up or down and thereby change the angular orientation of the support frame **26"** relative to the base frame **24**. By changing this orientation, the pedal path, as shown in previous Figures, may also change, as inclining the front of the support frame **26"** up may cause the pedal path to simulate walking up a hill.

[0095] To reduce production costs, compared to using linear actuators in place of the counterbalance springs **148**, the gas springs may be used as the counterbalance springs **148** with an incline adjustment **150**. The incline adjustment **150** may include a first support **152**, which may articulate with a second support **154**, and a locking pin **156** to releasably secure the first support **152** to the second support **154** at desired positions. This may securely alter the dimension between a support frame pin **158** and a base frame pin **160**. By increasing the dimension between the support frame pin **158** and the base frame pin **160**, exercise device **20""** may produce an inclined pedal angle from flat (as shown in FIG. **21**) to an inclined position (as shown in FIG. **22**). The user may disengage the locking pin **156**, move the support frame **26"** to a desired position, being aided by the counterbalance springs **148**, and then engaging the locking pin **158** to secure the support frame **26"** and therefore the first drive **132** and the second drive **134**, to a desired level of incline.

[0096] In this embodiment the drive handles **58** of previous embodiments have been removed and a set of stationary leaning handles **162** are shown. These handle types are not mutually exclusive to any embodiment. The leaning handles **162** may be desirable in some angular orientations of the exercise device **20** and the moving drive handles **58** may be desirable in other orientations, or as a personal preference in any orientation. Either form of handles (moving drive handles **58** or stationary leaning handles **162**) may be interchangeably used or in combination together on any embodiment.

[0097] A method of altering the pedal path by varying the position of the crank link **56** on the pedal arm **46** has been disclosed. This embodiment of the exercise device **20""** illustrates a manually adjustable version to accomplish this task. An adjustment bracket **164** may be releasably secured to the pedal arm **46** at one or more positions on the pedal arm **46**. A leg lock pin **166** may be used to releasably secure the adjustment bracket **164** to a position on the pedal arm **46**. The crank link **56** may be pivotally secured to the adjustment bracket **164** at the movable lock pin **118**, and as noted before, also to the second crank arm **40**. Therefore, by adjusting and securing the adjustment bracket **164** at different positions on the pedal arm **46**, the path of the pedals **52** may be altered to achieve more than one pedal path, as previously disclosed.

[0098] The foregoing detailed description of the present invention is provided for purposes of illustration, and it is not intended to be exhaustive or to limit the invention to the particular embodiment shown. The embodiments may provide different capabilities and benefits, depending on the configuration used to implement key features of the invention.

[0099] FIG. **24** is a diagram illustrating an exemplary sensor for detecting movement of a movable crank link. Movable crank link **96** shown in this diagram is the same as that shown and described for FIG. **12**, but with the addition of a linear position sensor **2410** to provide data regarding the amount of movement of movable crank link **96** during operation. Linear position sensor may be of any suitable type including, but not limited to, analog or digital type, resistive type, inductive type, and variable differential transformer type. Linear position sensor of this embodiment comprises a body **2411** comprising a fixed operational sensor component (e.g., a resistor coil or an inductive coil) and a traveling arm **2412** comprising movable operational sensor component (e.g., an electrical contact for causing an electrical connection along the resistor coil or a magnet for causing an induction in the inductive coil). Body **2411** is affixed to one link **100** of movable crank link **96** via pivoting attachment **2413** and traveling arm **2412** is affixed to the other crank link **98** via a pivoting attachment **2414**. Compression of the ends of movable crank link **96** in the direction shown at **110** or elongation of the ends of movable crank link **96** in the direction shown at **112** will cause traveling arm **2412** to push into, or pull out of, body **2411**, causing a position signal to be transmitted via wires **2415** to an appropriate computing device for data capture, storage, and use. As the mechanical characteristics of exercise machine are known (e.g., lengths, attachment points, and attachment angles, of crank links **98**, **100**, crank arms **38**, **40**, pedal arms **46**, etc.), changes in positional data from linear position sensor can be translated into useful exercise statistics such as stride length and stride period.

[0100] Many other configurations are possible including, but not limited to, mounting of the linear position sensor inside or alongside one or more of the springs **104**, **106**, or mounting of the linear position sensor at a position on the side of the crossed links opposite to spring **104**. Other types of position sensors may be used in a manner similar to linear position sensors including, but not limited to, ultrasonic distance sensors, optical distance or position sensors, and strain gauges.

[0101] FIG. **25** is a diagram illustrating another exemplary sensor for detecting movement of a movable crank link. Movable crank link **96** shown in this diagram is the same as that shown and described for FIG. **12**, but with the addition of an angular position sensor **2510** to provide data regarding the amount of movement of movable crank link **96** during operation. Angular position sensor may be of any suitable type including, but not limited to, analog or digital type, resistive type or optical type, and incremental position encoding type or absolute position encoding type. Angular position sensor of this embodiment comprises a body **2510** comprising a fixed operational sensor component (e.g., a resistor coil or an encoded optical disk) and a rotating shaft (not shown) affixed to pivot **102** of movable crank link **96**. comprising movable operational sensor component (e.g., an electrical contact for causing an electrical connection along the resistor coil or a magnet for causing an induction in the inductive coil). Body **2510** is affixed to one link **98** of movable crank link **96** rotating shaft (not shown) is affixed to pivot **102** which, in this configuration must be affixed to the other crank link **100** such that movement of crank links **98**, **100** causes rotating shaft (not shown) to rotate inside body **2510** proportionally to the movement of the crank links **98**, **100**. Compression of the ends of movable crank link **96** in the direction shown at **110** or elongation of the ends of movable crank link **96** in the direction shown at **112** will cause rotating shaft (not shown) to rotate within body **2510** either clockwise or counter-clockwise, causing a position signal to be transmitted via wires **2511** to an appropriate computing device for data capture, storage, and use. As the mechanical characteristics of exercise machine are known (e.g., lengths, attachment points, and attachment angles, of crank links **98**, **100**, crank arms **38**, **40**, pedal arms **46**, etc.), changes in positional data from linear position sensor can be translated into useful exercise statistics such as stride length and stride period.

[0102] Many other configurations are possible including, but not limited to, mounting of the linear position sensor inside or alongside one or more of the springs **104**, **106**, or mounting of the linear position sensor at a position on the side of the crossed links opposite to spring **104**. Other types of position sensors may be used in a manner similar to linear position sensors including, but not limited to, ultrasonic distance sensors, optical distance or position sensors, and strain gauges.

[0103] FIG. **26** is a diagram illustrating an exemplary method for calculation of stride length in an embodiment having movable crank link. As movement data is obtained from sensors place about exercise device **20**, useful exercise statistics such as stride length and stride period can be calculated. As the mechanical characteristics of exercise machine are known (e.g., lengths, attachment points, and attachment angles, of crank links **98**, **100**, crank arms **38**, **40**, pedal arms **46**, etc.), changes in positional data from position sensors located about exercise device **20** can be translated into useful exercise statistics such as stride length and stride period.

[0104] An example of such calculations is shown in this diagram. Here, a simplified view of a single side of the natural motion exercise mechanism is shown without frame **22**. The components of the natural motion exercise mechanism are shown in a first position **2610** corresponding to rotation of crank arms **2611**, **2612** in a forward position (shown in solid lines) and in a second position **2620** corresponding to rotation of crank arms **2621**, **2611** to a backward position (180 degrees of rotation from the forward position; shown in dashed lines). As the length and angles of attachment of the various components of the natural motion exercise mechanism are known a stride length can be calculated as a base stride length **2630** from a forward-most position of the pedal **2615** in the first position **2610** to a backward-most position of the pedal **2625** in the second position, plus an offset at each end **2616**, **2626** of base stride length corresponding to compression or extension of movable crank link **2614** in first position **2610** and compression or extension of movable crank link **2624** in second position **2620**.

[0105] This principle of using sensor position information with known mechanical characteristics of exercise device **20** can be used to calculate other useful exercise statistics including, but not limited to, stride length variability, stride period variability, stride height, stride height variability, instantaneous or average power expended during exercise, and total work performed during exercise.

[0106] FIG. **27** is a diagram illustrating use of a direct current generator to determine power output of a user during exercise. Several means exist for capturing data related to power output of a user during exercise. A common method for determining power output on bicycles, for example, is to affix a strain gauge to the crank arms of the cranks (or integrate the strain gauge in to the crank arms), take a reading of the force applied to the crank arms during use, and calculate the power applied to the pedals during each rotation of the cranks using the force readings. The same method could be applied to exercise device **20** by affixing a strain gauge to some component of the natural motion exercise mechanism, such as the pedal arms, and making similar calculations. The method shown here uses a direct current (DC) generator **2710** comprising a generator housing having internal induction coils as in a typical DC motor, a drive shaft **2712** having permanent magnets arranged to generate an electrical current in the induction coils during rotation of the drive shaft, and a pulley or gear **2713** engaged with the belt or chain of control system **44**. Rotation of control system **44** causes the belt or chain (e.g., belt **137**) engaged with pulley or gear **2713** to rotate pulley or gear **2713**, generating a current along wires **2721**, measurable by a current meter **2720**. Using the known electrical characteristics of DC generator such as the current known to be generated by DC motor as various revolution per minute (RPM) speeds, combined with the known characteristics of exercise device **20** such as the length of the pedal arms and the known resistance to movement of its braking system at its current braking setting, the measured current can be converted into an instantaneous power output in watts. In other embodiments, particularly those in which the braking system comprises a electromagnetic resistance mechanism, the power might be measured directly from the braking system as a proportion of the current flowing through the electromagnetic resistance mechanism (which is generally proportional to the rotation speed of the shaft or disc of the electromagnetic resistance mechanism).

[0107] FIG. **28** is a diagram illustrating an exemplary footpad for detecting pressure and lift of a user's foot during exercise. For some applications, such as walking or running gait detection or analysis, it is useful to have sensor data showing a downward pressure applied by a user's foot onto a footpad or pedal or an upward lift pressure of the user's foot away from the footpad or pedal. Here, an pressure sensor **2811** is shown integrated into a footpad or pedal **2810**, along with a strap **2812** configured to rest across the top of a user's foot.

[0108] Pressure sensor **2811** is configured to measure a downward pressure applied by a user's foot onto footpad or pedal **2810** which can be sent to a computing device as pressure data comprising a magnitude of the force applied, the speed at which the force is applied, a time of application of the force, etc., which pressure data can be captured over time to provide additional information such as a period of application of force. Depending on configuration, pressure sensor **2811** may **2811** may be of various configurations such as having a resistive, capacitive, piezo-electric, or optical, or other force sensor technology.

[0109] Strap **2812** is configured to measure an upward lift pressure of the user's foot away from the footpad or pedal applied by the top of a user's foot against strap **2812** which can be sent to a computing device as pressure data comprising a magnitude of the force applied, the speed at which the force is applied, a time of application of the force, etc., which pressure data can be captured over time to provide additional information such as a period of application of force. Depending on configuration, strap **2812** may be of various configurations such as having a strain gauge integrated into its material, having a pressure sensor affixed to the underside of strap **2812**, or having one or both ends of strap affixed to a strain gauge or force sensor.

[0110] In another configuration (not shown), footpad or pedal **2810** may be configured on a rotational platform with a rotary encoder or other mechanism for determining the angle of rotation of the user's foot during exercise.

[0111] Data from the above-described pressure sensors and rotational sensors can be used to calculate useful exercise statistics including, but not limited to, a periodicity of a user's gait, variations in the periodicity of a user's gait, discrepancies in sided-ness of the user's gait (e.g., indicating a preference for right side over left side or vice-versa, possibly indicating a disability or movement restriction), changes in, or discrepancies in, a user's foot angle or rotation during certain exercises or motions, or discrepancies in sided-ness of the user's foot angle or rotation (again, possibly indicating some disability or movement restriction).

[0112] FIG. **29** is a side elevation view of a movable crank link utilizing leaf springs for variable stride length resistance. As described above in relation to FIG. **12**, movable crank link **96** allows the stride length of exercise device to naturally adjust to a user's stride length by virtue of compression of attachment points **108** toward one another at one end of the stride and/or expansion of attachment points **108** away from one another at the other end of the stride, allowing the pedals to move further forward or backward than they would with a fixed distance **2912** between attachment points **108**. This compression and/or expansion occurs naturally as the user drives pedals forward and backward exceeding toward each end of the stride the neutral position of movable crank link **96** (i.e., without force applied by the user during a stride).

[0113] Movable crank link **96** as shown and described is not limited to coiled springs. Any suitable force resistance device or mechanism may be used including, but not limited to, coiled or wound springs, flat or leaf springs, torsion bars, elastomeric materials such as rubber and synthetic polymers capable of deformation and return to their original form after deformation. The chosen resistance mechanism or mechanisms may be configured to resist pulling, pushing, or twisting, and its location on and attachment to movable crank link **96** may differ depending on that configuration, so long as they allow for compression, elongation, or both, of a distance **2912** between two attachment points **2910**, **2911** of movable crank link **96** when force is applied and a tendency to return to the original distance when the force is removed.

[0114] Here, leaf springs **2901**, **2904** are substituted for coiled springs of FIG. **12**. Leaf springs, also known as flat springs, laminated springs, and carriage springs, depending on their application, are lengths of a flexible material which bend to provide resistance. They are typically flat, thin bars of material formed into an arc shape. They are typically made of spring steel, but any suitable material may be used including, but not limited to, other metals, plastics, and even wood. Leaf springs of this embodiment are shaped with a strong arc and attached at their ends **2902**, **2903**, **2905**, **2906** between first link **98** and second link **100**, providing resistance to both compression of, and expansion of, the distance **2912** between attachment points **108**, and a tendency to return to their original shape when force is removed. The strong arc allows not only for compression of each leaf spring **2901**, **2902** between their respective attachment points, but also expansion between their respective attachment points.

[0115] An example of an alternate location of, and configuration of, a leaf spring of this example is shown at **2920**. Wherein a single leaf spring **2921** is attached between first link **98** and second link **100** at a point on each link between the attachment points **108** and the pivot point created by crank link pin **102**.

[0116] FIG. **30** is a side elevation view of a movable crank link utilizing elastomeric bands for for variable stride length resistance. As described above in relation to FIG. **12**, movable crank link **96** allows the stride length of exercise device to naturally adjust to a user's stride length by virtue of compression of attachment points **108** toward one another at one end of the stride and/or expansion of attachment points **108** away from one another at the other end of the stride, allowing the pedals to move further forward or backward than they would with a fixed distance **3012** between attachment points **108**. This compression and/or expansion occurs naturally as the user drives pedals forward and backward exceeding toward each end of the stride the neutral position of movable crank link **96** (i.e., without force applied by the user during a stride).

[0117] Movable crank link **96** as shown and described is not limited to coiled springs. Any suitable force resistance device or may be used including, but not limited to, coiled or wound springs, flat or leaf springs, torsion bars, elastomeric materials such as rubber and synthetic polymers capable of deformation and return to their original form after deformation. The chosen resistance mechanism or mechanisms may be configured to resist pulling, pushing, or twisting, and its location on and attachment to movable crank link **96** may differ depending on that configuration, so long as they allow for compression, elongation, or both, of a distance **3012** between two attachment points **3010**, **3011** of movable crank link **96** when force is applied and a tendency to return to the original distance when the force is removed.

[0118] Here, elastomeric bands **3001**, **3004** are substituted for coiled springs of FIG. **12**. elastomeric bands are bands, tubes, rods, or other lengths of a flexible material which deform by elongation or compression to provide resistance. They are typically made of rubber or synthetic polymers. Elastomeric bands **3001**, **3004** of this embodiment are cylindrical rods of synthetic polymer, attached at their ends **3002**, **3003**, **3005**, **3006** between first link **98** and second link **100**, providing resistance to both compression of, and expansion of, the distance **3012** between attachment points **108**, and a tendency to return to their original shape when force is removed. Elastomeric bands **3001**, **3004** stretch under pulling force as shown at **3001** (showing elastomeric band **3001** stretched and thinner in the middle section) and compress (or bend) under compressive force as shown at **3004** (showing elastomeric band **3004** bulging slightly in the middle section; further compression would cause elastomeric band **3004** to bend).

[0119] An example of an alternate location for elastomeric band **3001** is shown at **3020**, wherein elastomeric band **3001** is attached between first link **98** and second link **100** at a point on each link between the attachment points **108** and the pivot point created by crank link pin **102**.

[0120] FIG. **31** is a side elevation view of a single-piece movable crank link utilizing a single leaf spring for variable stride length resistance. As described above in relation to FIG. **12**, movable crank link **3110** allows the stride length of exercise device to naturally adjust to a user's stride length by virtue of compression of attachment points **3111**, **3112** toward one another at one end of the stride and/or expansion of attachment points **3111**, **3112** away from one another at the other end of the stride, allowing the pedals to move further forward or backward than they would with a fixed distance **3112** between attachment points **3111**, **3112**. This compression and/or expansion occurs naturally as the user drives pedals forward and backward exceeding toward each end of the stride the neutral position of movable crank link **3110** (i.e., without force applied by the user during a stride).

[0121] Movable crank link **3110** as shown and described is not limited to a leaf spring. Any suitable force resistance device or may be used including, but not limited to, coiled or wound springs, flat or leaf springs, torsion bars, elastomeric materials such as rubber and synthetic polymers capable of deformation and return to their original form after deformation. The chosen resistance mechanism or mechanisms may be configured to resist pulling, pushing, or twisting, and its location on and attachment to movable crank link **3110** may differ depending on that configuration, so long as they allow for compression, elongation, or both, of a distance **3112** between two attachment points **3110**, **3111** of movable crank link **3110** when force is applied and a tendency to return to the original distance when the force is removed.

[0122] Here, a single leaf spring **3113** is substituted for the mechanism of FIG. **12**. Leaf springs, also known as flat springs, laminated springs, and carriage springs, depending on their application, are lengths of a flexible material which bend to provide resistance. They are typically flat, thin bars of material formed into an arc shape. They are typically made of spring steel, but any suitable material may be used including, but not limited to, other metals, plastics, and even wood. Leaf spring **3113** of this embodiment is shaped with a strong arc and attached at its ends to attachment points **3111**, **3112** providing resistance to both compression of, and expansion of, the distance **3116** between attachment points **3111**, **3112**, and a tendency to return to its original shape when force is removed. Leaf spring **3113** of this embodiment has a thicker section in its middle **3115** to provide resistance from breakage as the curved portion is subjected to the most stress, and with thinner sections at its ends **3114** to provide additional flexibility. The materials and dimensions of leaf spring **3113** can be changed to increase or decrease resistance. The strong arc allows not only for compression leaf spring **3113** between its respective attachment points **3111**, **3112**, but also expansion between those attachment points.

[0123] FIG. **32** is a diagram illustrating an embodiment of an exercise device having a single synchronized control system. Exercise device **3210** of this embodiment has similar characteristics as those described in other embodiments above. However, in this embodiment, only a single control system **44** is used, in this case having the same characteristics for control system **44** described above in other embodiments. However, in this case, instead of transferring the synchronized motion to a second control system **44** on the opposite side of exercise device **3210** via drive shaft **42**, transfer of synchronized motion to the opposite side of exercise device **3210** is performed by a plurality of drive shafts **3211**, **3212**, each being connected in a fixed orientation with a crank arm **38**, **40** and corresponding sprocket or pulley **3214**, **3215** to the opposite of exercise device **3210**. Crank arm **38** and sprocket/pulley **3214** are connected in a fixed orientation with drive shaft **3211** which is connected in a fixed orientation with crank arm **38*a*** on the opposite side, wherein crank arm **38** and crank arm **38*a*** are aligned 180 degrees opposite one another about the longitudinal axis of drive shaft **3211**. Crank arm **40** and sprocket/pulley **3215** are connected in a fixed orientation with drive shaft **3212** which is connected in a fixed orientation with crank arm **40*a*** on the opposite side, wherein crank arm **40** and crank arm **40*a*** are aligned 180 degrees opposite one another about the longitudinal axis of drive shaft **3212**. As in other embodiments, a drive belt/chain **3213** provides synchronized motion to a sprocket/pulley **3216** which is in a fixed orientation with drive shaft **42**. While control system **44** of this embodiment is shown as being on one side of exercise device **3210**, control system **44** may be located on the other side or in any suitable location, such as in the center of exercise device **3210**.

[0124] FIG. **33** is a diagram illustrating another embodiment of an exercise device having a single synchronized control system. Exercise device **3310** of this embodiment has similar characteristics as those described in other embodiments above. However, in this embodiment, only a single control system **3320** is used, in this example synchronizing only movement of pedal arms (and not an auxiliary system like drive shaft **42** and its resistance mechanism). In this case, instead of transferring the synchronized motion to a second control system on the opposite side of exercise device **3310** via drive shaft **42**, transfer of synchronized motion to the opposite side of exercise device **3210** is performed by a plurality of drive shafts **3311**, **3312**, each being connected in a fixed orientation with a crank arm **38**, **40** and corresponding sprocket or pulley **3322**, **3323** to the opposite of exercise device **3310**. Crank arm **38** and sprocket/pulley **3322** are connected in a fixed orientation with drive shaft **3311** which is connected in a fixed orientation with crank arm **38*a*** on the opposite side, wherein crank arm **38** and crank arm **38*a*** are aligned 180 degrees opposite one another about the longitudinal axis of drive shaft **3311**. Crank arm **40** and sprocket/pulley **3323** are connected in a fixed orientation with drive shaft **3312** which is connected in a fixed orientation with crank arm **40*a*** on the opposite side, wherein crank arm **40** and crank arm **40*a*** are aligned 180 degrees opposite one another about the longitudinal axis of drive shaft **3312**. As in other embodiments, a drive belt/chain **3321** provides synchronized motion between sprocket/pulley **3322** and sprocket/pulley **3323**. While control system **3320** of this embodiment is shown as being on one side of exercise device **3310**, control system **3320** may be located on the other side or in any suitable location, such as in the center of exercise device **3310**.

Exemplary Computing Environment

[0125] FIG. **34** illustrates an exemplary computing environment on which an embodiment described herein may be implemented, in full or in part. This exemplary computing environment describes computer-related components and processes supporting enabling disclosure of computer-implemented embodiments. Inclusion in this exemplary computing environment of well-known processes and computer components, if any, is not a suggestion or admission that any embodiment is no more than an aggregation of such processes or components. Rather, implementation of an embodiment using processes and components described in this exemplary computing environment will involve programming or configuration of such processes and components resulting in a machine specially programmed or configured for such implementation. The exemplary computing environment described herein is only one example of such an environment and other configurations of the components and processes are possible, including other relationships between and among components, and/or absence of some processes or components described. Further, the exemplary computing environment described herein is not intended to suggest any limitation as to the scope of use or functionality of any embodiment implemented, in whole or in part, on components or processes described herein.

[0126] The exemplary computing environment described herein comprises a computing device **9910** (further comprising a system bus **9911**, one or more processors **9920**, a system memory **9930**, one or more interfaces **9940**, one or more non-volatile data storage devices **9950**), external peripherals and accessories **9960**, external communication devices **9970**, remote computing devices **9980**, and cloud-based services **9990**.

[0127] System bus **9911** couples the various system components, coordinating operation of and data transmission between, those various system components. System bus **9911** represents one or more of any type or combination of types of wired or wireless bus structures including, but not limited to, memory busses or memory controllers, point-to-point connections, switching fabrics, peripheral busses, accelerated graphics ports, and local busses using any of a variety of bus architectures. By way of example, such architectures include, but are not limited to, Industry Standard Architecture (ISA) busses, Micro Channel Architecture (MCA) busses, Enhanced ISA (EISA) busses, Video Electronics Standards Association (VESA) local busses, a Peripheral Component Interconnects (PCI) busses also known as a Mezzanine busses, or any selection of, or combination of, such busses. Depending on the specific physical implementation, one or more of the processors **9920**, system memory **9930** and other components of the computing device **9910** can be physically co-located or integrated into a single physical component, such as on a single chip. In such a case, some or all of system bus **9911** can be electrical pathways within a single chip structure.

[0128] Computing device may further comprise externally-accessible data input and storage devices **9912** such as compact disc read-only memory (CD-ROM) drives, digital versatile discs (DVD), or other optical disc storage for reading and/or writing optical discs **9962**; magnetic cassettes, magnetic tape, magnetic disk storage, or other magnetic storage devices; or any other medium which can be used to store the desired content and which can be accessed by the computing device **9910**. Computing device may further comprise externally-accessible data ports or connections **9912** such as serial ports, parallel ports, universal serial bus (USB) ports, and infrared ports and/or transmitter/receivers. Computing device may further comprise hardware for wireless communication with external devices such as IEEE 1394 ("Firewire") interfaces, IEEE 802.11 wireless interfaces, BLUETOOTH® wireless interfaces, and so forth. Such ports and interfaces may be used to connect any number of external peripherals and accessories **9960** such as visual displays, monitors, and touch-sensitive screens **9961**, USB solid state memory data storage drives (commonly known as "flash drives" or "thumb drives") **9963**, printers **9964**, pointers and manipulators such as mice **9965**, keyboards **9966**, and other devices **9967** such as joysticks and gaming pads, touchpads, additional displays and monitors, and external hard drives (whether solid state or disc-based), microphones, speakers, cameras, and optical scanners.

[0129] Processors **9920** are logic circuitry capable of receiving programming instructions and processing (or executing) those instructions to perform computer operations such as retrieving data, storing data, and performing mathematical calculations. Processors **9920** are not limited by the materials from which they are formed or the processing mechanisms employed therein, but are typically comprised of semiconductor materials into which many transistors are formed together into logic gates on a chip (i.e., an integrated circuit or IC). The term processor includes any device capable of receiving and processing instructions including, but not limited to, processors operating on the basis of quantum computing, optical computing, mechanical computing (e.g., using nanotechnology entities to transfer data), and so forth. Depending on configuration, computing device **9910** may comprise more than one processor. For example, computing device **9910** may comprise one or more central processing units (CPUs) **9921**, each of which itself has multiple processors or multiple processing cores, each capable of independently or semi-independently processing programming instructions. Further, computing device **9910** may comprise one or more specialized processors such as a graphics processing unit (GPU) **9922** configured to accelerate processing of computer graphics and images via a large array of specialized processing cores arranged in parallel.

[0130] System memory **9930** is processor-accessible data storage in the form of volatile and/or nonvolatile memory. System memory **9930** may be either or both of two types: non-volatile memory and volatile memory. Non-volatile memory **9930***a* is not erased when power to the memory is removed, and includes memory types such as read only memory (ROM), electronically-erasable programmable memory (EEPROM), and rewritable solid state memory (commonly known as "flash memory"). Non-volatile memory **9930***a* is typically used for long-term storage of a basic input/output system (BIOS) **9931**, containing the basic instructions, typically loaded during computer startup, for transfer of information between components within computing device, or a unified extensible firmware interface (UEFI), which is a modern replacement for BIOS that supports larger hard drives, faster boot times, more security features, and provides native support for graphics and mouse cursors. Non-volatile memory **9930***a* may also be used to store firmware comprising a complete operating system **9935** and applications **9936** for operating computer-controlled devices. The firmware approach is often used for purpose-specific computer-controlled devices such as appliances and Internet-of-Things (IoT) devices where processing power and data storage space is limited. Volatile memory **9930***b* is erased when power to the memory is removed and is typically used for short-term storage of data for processing. Volatile memory **9930***b* includes memory types such as random access memory (RAM), and is normally the primary operating memory into which the operating system **9935**, applications **9936**, program modules **9937**, and application data **9938** are loaded for execution by processors **9920**. Volatile memory **9930***b* is generally faster than non-volatile memory **9930***a* due to its electrical characteristics and is directly accessible to processors **9920** for processing of instructions and data storage and retrieval. Volatile memory **9930***b* may comprise one or more smaller cache memories which operate at a higher clock speed and are typically placed on the same IC as the processors to improve performance.

[0131] Interfaces **9940** may include, but are not limited to, storage media interfaces **9941**, network interfaces **9942**, display interfaces **9943**, and input/output interfaces **9944**. Storage media interface **9941** provides the necessary hardware interface for loading data from non-volatile data storage devices **9950** into system memory **9930** and storage data from system memory **9930** to non-volatile data storage device **9950**. Network interface **9942** provides the necessary hardware interface for computing device **9910** to communicate with remote computing devices **9980** and cloud-based services **9990** via one or more external communication devices **9970**. Display interface **9943** allows for connection of displays **9961**, monitors, touchscreens, and other visual input/output devices. Display interface **9943** may include a graphics card for processing graphics-intensive calculations and for handling demanding display requirements. Typically, a graphics card includes a graphics processing unit (GPU) and video RAM (VRAM) to accelerate display of graphics. One or more input/output (I/O) interfaces **9944** provide the necessary support for communications between computing device **9910** and any external peripherals and accessories **9960**. For wireless communications, the necessary radio-frequency hardware and firmware may be connected to I/O interface **9944** or may be integrated into I/O interface **9944**.

[0132] Non-volatile data storage devices **9950** are typically used for long-term storage of data. Data on non-volatile data storage devices **9950** is not erased when power to the non-volatile data storage devices **9950** is removed. Non-volatile data storage devices **9950** may be implemented using any technology for non-volatile storage of content including, but not limited to, CD-ROM drives, digital versatile discs (DVD), or other optical disc storage; magnetic cassettes, magnetic tape, magnetic disc storage, or other magnetic storage devices; solid state memory technologies such as EEPROM or flash memory; or other memory technology or any other medium which can be used to store data without requiring power to retain the data after it is written. Non-volatile data storage devices **9950** may be non-removable from computing device **9910** as in the case of internal hard drives, removable from computing device **9910** as in the case of external USB hard drives, or a combination thereof, but computing device will typically comprise one or more internal, non-removable hard drives using either magnetic disc or solid state memory technology. Non-volatile data storage devices **9950** may store any type of data including, but not limited to, an operating system **9951** for providing low-level and mid-level functionality of computing device **9910**, applications **9952** for providing high-level functionality of computing device **9910**, program modules **9953** such as containerized programs or applications, or other modular content or modular programming, application data **9954**, and databases **9955** such as relational databases, non-relational databases, and graph databases.

[0133] Applications (also known as computer software or software applications) are sets of programming instructions designed to perform specific tasks or provide specific functionality on a computer or other computing devices. Applications are typically written in high-level programming languages such as C++, Java, and Python, which are then either interpreted at runtime or compiled into low-level, binary, processor-executable instructions operable on processors **9920**. Applications may be containerized so that they can be run on any computer hardware running any known operating system. Containerization of computer software is a method of packaging and deploying applications along with their operating system dependencies into self-contained, isolated units known as containers. Containers provide a lightweight and consistent runtime environment that allows applications to run reliably across different computing environments, such as development, testing, and production systems.

[0134] The memories and non-volatile data storage devices described herein do not include communication media. Communication media are means of transmission of information such as modulated electromagnetic waves or modulated data signals configured to transmit, not store, information. By way of example, and not limitation, communication media includes wired communications such as sound signals transmitted to a speaker via a speaker wire, and wireless communications such as acoustic waves, radio frequency (RF) transmissions, infrared emissions, and other wireless media.

[0135] External communication devices **9970** are devices that facilitate communications between computing device and either remote computing devices **9980**, or cloud-based services **9990**, or both. External communication devices **9970** include, but are not limited to, data modems **9971** which facilitate data transmission between computing device and the Internet **9975** via a common carrier such as a telephone company or internet service provider (ISP), routers **9972** which facilitate data transmission between computing device and other devices, and switches **9973** which provide direct data communications between devices on a network. Here, modem **9971** is shown connecting computing device **9910** to both remote computing devices **9980** and cloud-based services **9990** via the Internet **9975**. While modem **9971**, router **9972**, and switch **9973** are shown here as being connected to network interface **9942**, many different network configurations using external communication devices **9970** are possible. Using external communication devices **9970**, networks may be configured as local area networks (LANs) for a single location, building, or campus, wide area networks (WANs) comprising data networks that extend over a larger geographical area, and virtual private networks (VPNs) which can be of any size but connect computers via encrypted communications over public networks such as the Internet **9975**. As just one exemplary network configuration, network interface **9942** may be connected to switch **9973** which is connected to router **9972** which is connected to modem **9971** which provides access for computing device **9910** to the Internet **9975**. Further, any combination of wired **9977** or wireless **9976** communications between and among computing device **9910**, external communication devices **9970**, remote computing devices **9980**, and cloud-based services **9990** may **9990** may be used. Remote computing devices **9980**, for example, may communicate with computing device through a variety of communication channels **9974** such as through switch **9973** via a wired **9977** connection, through router **9972** via a wireless connection **9976**, or through modem **9971** via the Internet **9975**. Furthermore, while not shown here, other hardware that is specifically designed for servers may be employed. For example, secure socket layer (SSL) acceleration cards can be used to offload SSL encryption computations, and transmission control protocol/internet protocol (TCP/IP) offload hardware and/or packet classifiers on network interfaces **9942** may be installed and used at server devices.

[0136] In a networked environment, certain components of computing device **9910** may be fully or partially implemented on remote computing devices **9980** or cloud-based services **9990**. Data stored in non-volatile data storage device **9950** may be received from, shared with, duplicated on, or offloaded to a non-volatile data storage device on one or more remote computing devices **9980** or in a cloud computing service **9992**. Processing by processors **9920** may be received from, shared with, duplicated on, or offloaded to processors of one or more remote computing devices **9980** or in a distributed computing service **9993**. By way of example, data may reside on a cloud computing service **9992**, but may be usable or otherwise accessible for use by computing device **9910**. Also, certain processing subtasks may be sent to a microservice **9991** for processing with the result being transmitted to computing device **9910** for incorporation into a larger processing task. Also, while components and processes of the exemplary computing environment are illustrated herein as discrete units (e.g., OS **9951** being stored on non-volatile data storage device **9951** and loaded into system memory **9935** for use) such processes and components may reside or be processed at various times in different components of computing device **9910**, remote computing devices **9980**, and/or cloud-based services **9990**.

[0137] Remote computing devices **9980** are any computing devices not part of computing device **9910**. Remote computing devices **9980** include, but are not limited to, personal computers, server computers, thin clients, thick clients, personal digital assistants (PDAs), mobile telephones, watches, tablet computers, laptop computers, multiprocessor systems, microprocessor based systems, set-top boxes, programmable consumer electronics, video game machines, game consoles, portable or handheld gaming units, network terminals, desktop personal computers (PCs), minicomputers, main frame computers, network nodes, and distributed or multi-processing computing environments. While remote computing devices **9980** are shown for clarity as being separate from cloud-based services **9990**, cloud-based services **9990** are implemented on collections of networked remote computing devices **9980**.

[0138] Cloud-based services **9990** are Internet-accessible services implemented on collections of networked remote computing devices **9980**. Cloud-based services are typically accessed via application programming interfaces (APIs) which are software interfaces which provide access to computing services within the cloud-based service via API calls, which are pre-defined protocols for requesting a computing service and receiving the results of that computing service. While cloud-based services may comprise any type of computer processing or storage, three common categories of cloud-based services **9990** are microservices **9991**, cloud computing services **9992**, and distributed computing services **9993**.

[0139] Microservices **9991** are collections of small, loosely coupled, and independently deployable computing services. Each microservice represents a specific computing functionality and runs as a separate process or container. Microservices promote the decomposition of complex applications into smaller, manageable services that can be developed, deployed, and scaled independently. These services communicate with each other through well-defined application programming interfaces (APIs), typically using lightweight protocols like HTTP or message queues. Microservices **9991** can be combined to perform more complex processing tasks.

[0140] Cloud computing services **9992** are delivery of computing resources and services over the Internet **9975** from a remote location. Cloud computing services **9992** provide additional computer hardware and storage on as-needed or subscription basis. Cloud computing services **9992** can provide large amounts of scalable data storage, access to sophisticated software and powerful server-based processing, or entire computing infrastructures and platforms. For example, cloud computing services can provide virtualized computing resources such as virtual machines, storage, and networks, platforms for developing, running, and managing applications without the complexity of infrastructure management, and complete software applications over the Internet on a subscription basis.

[0141] Distributed computing services **9993** provide large-scale processing using multiple interconnected computers or nodes to solve computational problems or perform tasks collectively. In distributed computing, the processing and storage capabilities of multiple machines are leveraged to work together as a unified system. Distributed computing services are designed to address problems that cannot be efficiently solved by a single computer or that require large-scale computational power. These services enable parallel processing, fault tolerance, and scalability by distributing tasks across multiple nodes.

[0142] Although described above as a physical device, computing device **9910** can be a virtual computing device, in which case the functionality of the physical components herein described, such as processors **9920**, system memory **9930**, network interfaces **9940**, and other like components can be provided by computer-executable instructions. Such computer-executable instructions can execute on a single physical computing device, or can be distributed across multiple physical computing devices, including being distributed across multiple physical computing devices in a dynamic manner such that the specific, physical computing devices hosting such computer-executable instructions can dynamically change over time depending upon need and availability. In the situation where computing device **9910** is a virtualized device, the underlying physical computing devices hosting such a virtualized computing device can, themselves, comprise physical components analogous to those described above, and operating in a like manner. Furthermore, virtual computing devices can be utilized in multiple layers with one virtual computing device executing within the construct of another virtual computing device. Thus, computing device **9910** may be either a physical computing device or a virtualized computing device within which computer-executable instructions can be executed in a manner consistent with their execution by a physical computing device. Similarly, terms referring to physical components of the computing device, as utilized herein, mean either those physical components or virtualizations thereof performing the same or equivalent functions.

[0143] The skilled person will be aware of a range of possible modifications of the various aspects described above. Accordingly, the present invention is defined by the claims and their equivalents.

What is claimed is:

1. An exercise device comprising:

a frame;

a first and a second crank system mounted opposing sides of the frame adapted for positioning a user therebetween, each of the first and second crank system comprising a first crank assembly rotatable about a first axis and a second crank assembly rotatable about a second axis with the first and second axes each being displaced from the other, each of the first crank assemblies comprising a first crank arm, and each of the second crank assemblies comprising a second crank arm;

a first drive shaft mechanically attached between the first crank system and the second crank system along the first axis;

a second drive shaft attached between the first crank system and the second crank system along the second axis;

a synchronous control system assembly mechanically coupled to the first crank system in a configuration that allows for 360 degrees of synchronous rotation of the first and second crank assemblies, wherein each first crank arm of each first crank assembly rotates in the same direction as the second crank arm of each second crank assembly by the synchronous control system assembly;

a pair of pedal arms, one coupled to the first crank system and the other coupled to the second crank system, each of the pair of pedal arms being pivotally coupled at a first end to the first crank arm of the first crank assembly and being pivotally coupled at a second end to a pedal;

a pair of movable crank links, one corresponding to each of the first and second crank systems, each of the pair of movable crank links comprising a first attachment point, a second attachment point, and a flexible attachment between the first attachment point and second attachment point, wherein the first attachment point of each movable crank link is pivotally coupled to the pedal arm of its corresponding crank system and the second attachment point of each movable crank is pivotally coupled to the second crank arm of its corresponding second crank assembly.

2. The system of claim **1**, wherein each of the movable crank links of the pair of movable crank links comprises a first link and a second link, wherein the first attachment point of the movable crank link is proximal to a first end of the first link and the second attachment point of the movable crank link is proximal to a first end the second link, and the attachment point comprises a pivoting attachment of the first and second links.

3. The system of claim **2**, wherein the pivoting attachment of the first and second links is at a medial location of both the first and second links, such that a second end of the first link distal from the first attachment point extends past the attachment point and second end of the second link distal to the second attachment point extends past the attachment point.

4. The system of claim **3**, wherein a first force resistance device is attached between the second end of the first link the second end of the second link, and a second force resistance device is attached between the second end of the first link and a medial location of the second link.

5. The system of claim **3**, wherein a first force resistance device is attached between the second end of the second link the second end of the first link, and a second force resistance device is attached between the second end of the second link and a medial location of the first link.

6. The system of claim **2**, wherein a first force resistance device is attached between the first link and the second link at a point on each link between the attachment points and the pivoting attachment.

7. The system of claim **1**, wherein each of the movable crank links of the pair of movable crank links is constructed of a flexible, resilient material or materials between the attachment points, the flexible, resilient material or materials allowing either for compression, expansion, or both, of a distance between the attachment points upon application of a force and return of the movable crank link to its original shape when the force is removed.

* * * * *