United States Patent [19]

Small et al.

[11] **3,917,261**

[45] **Nov. 4, 1975**

[54] **FOOT EXERCISING DEVICE**

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[22] Filed: **Aug. 5, 1974**

[21] Appl. No.: **494,508**

[52] **U.S. Cl.** ..... **272/57 D;** 128/25 B; 272/79 D

[51] **Int. Cl.²** **A63B 23/04**

[58] **Field of Search** ..... 272/57 D, 79 R; 128/25 R, 128/25 B

[56] **References Cited**

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2,777,439 1/1957 Tuttle ..... 128/25 R

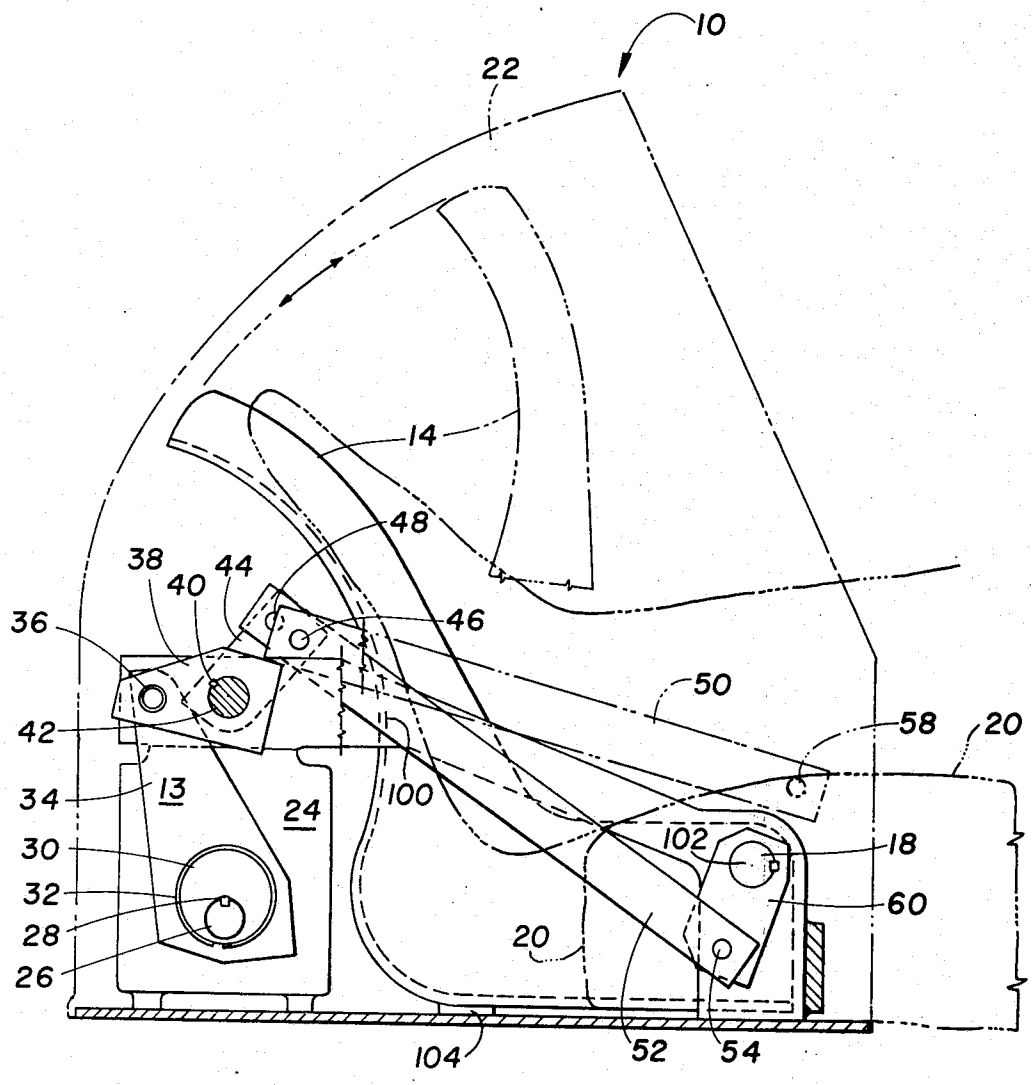
3,526,220 9/1970 Small ..... 128/25 B

Primary Examiner—Richard C. Pinkham
Assistant Examiner—Joseph R. Taylor
Attorney, Agent, or Firm—Bauer & Amer

[57] **ABSTRACT**

A foot exercising device having a pair of foot holders pivotably secured within a housing. The pedals are positively driven to undergo reciprocating motion 180° out of phase to impose motion on an individual's feet. A powering motor drives the foot holders by means of rigid actuating links which are driven by eccentric connection to the motor. A clutch is interposed between the motor and the foot holders which may be operated in different active and passive exercise modes.

4 Claims, 8 Drawing Figures



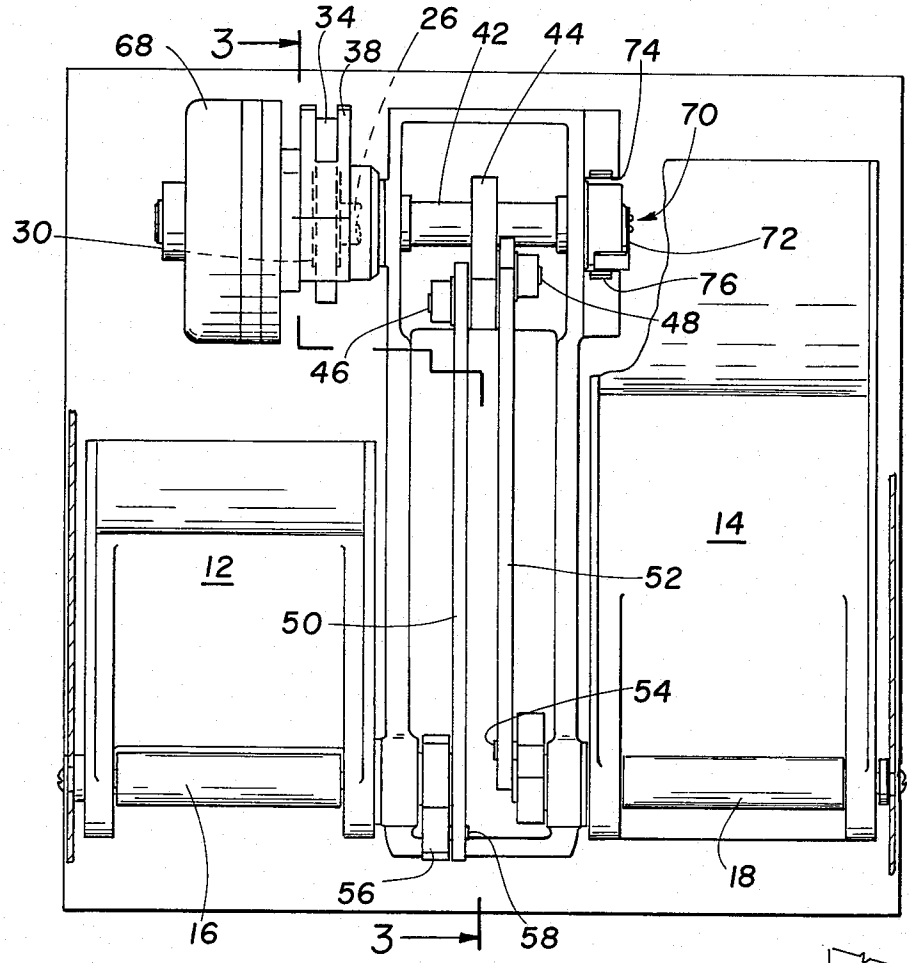

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FIG. 2

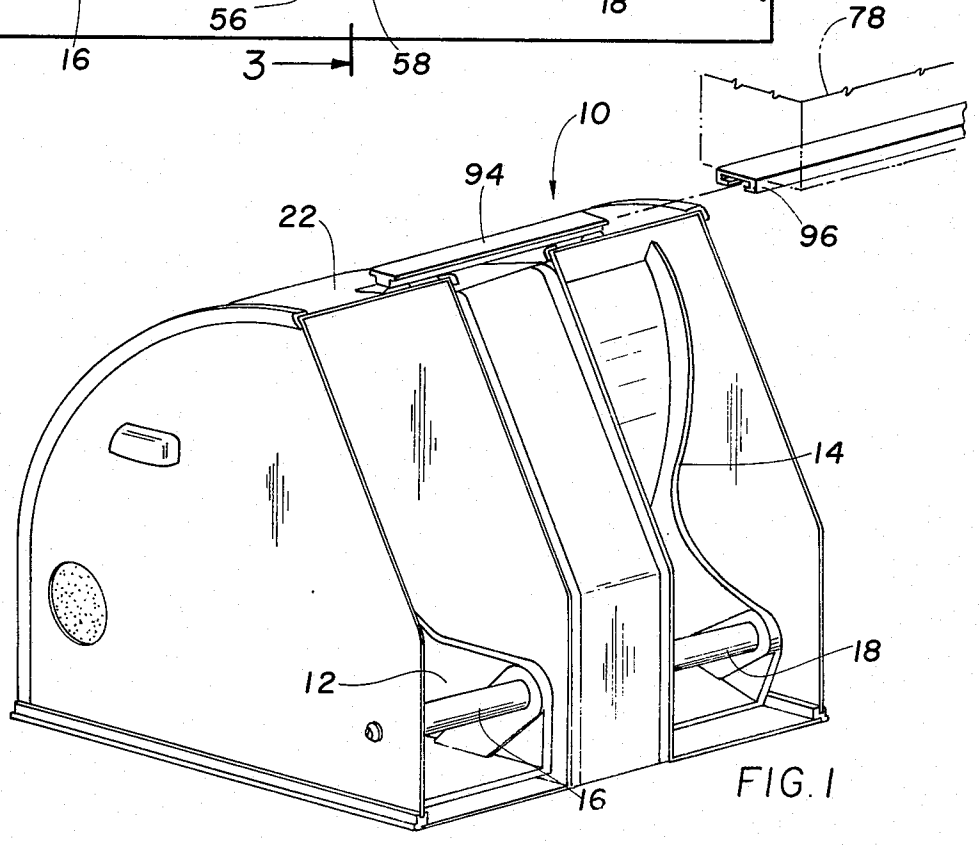
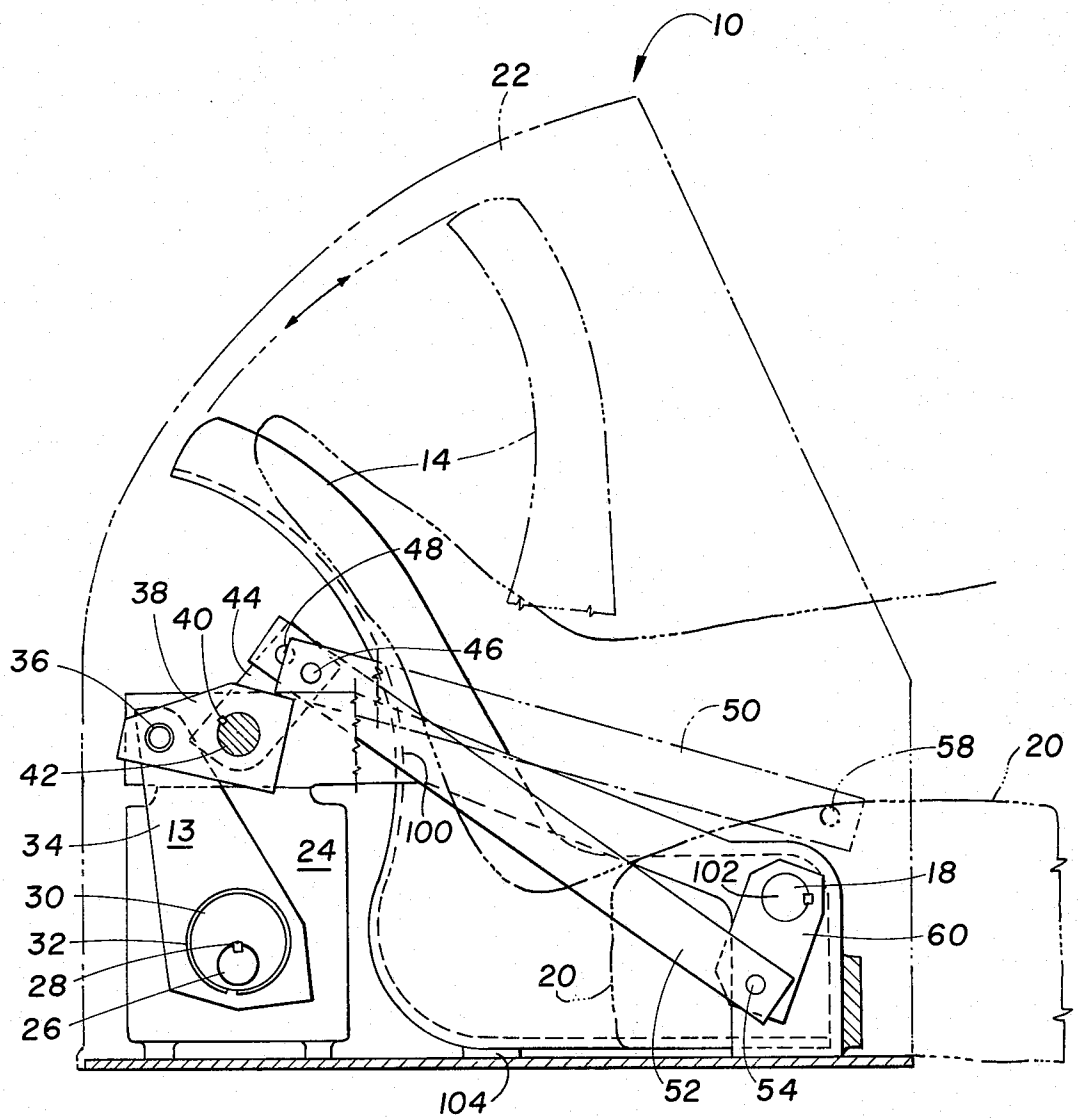

78
10
94
22
96
14
18
12
16

FIG. 1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22
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50
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20
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24
100
102
18
30
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32
28
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104
52
54

FIG. 3

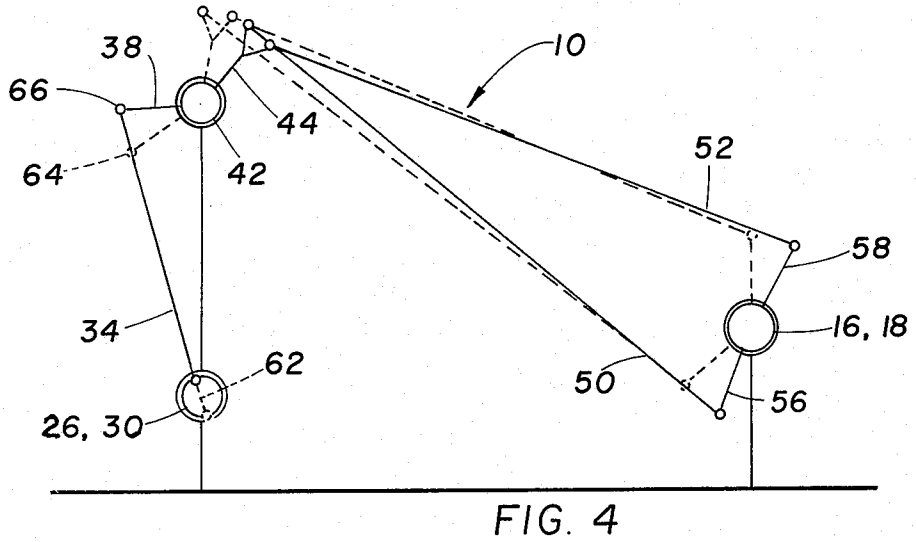
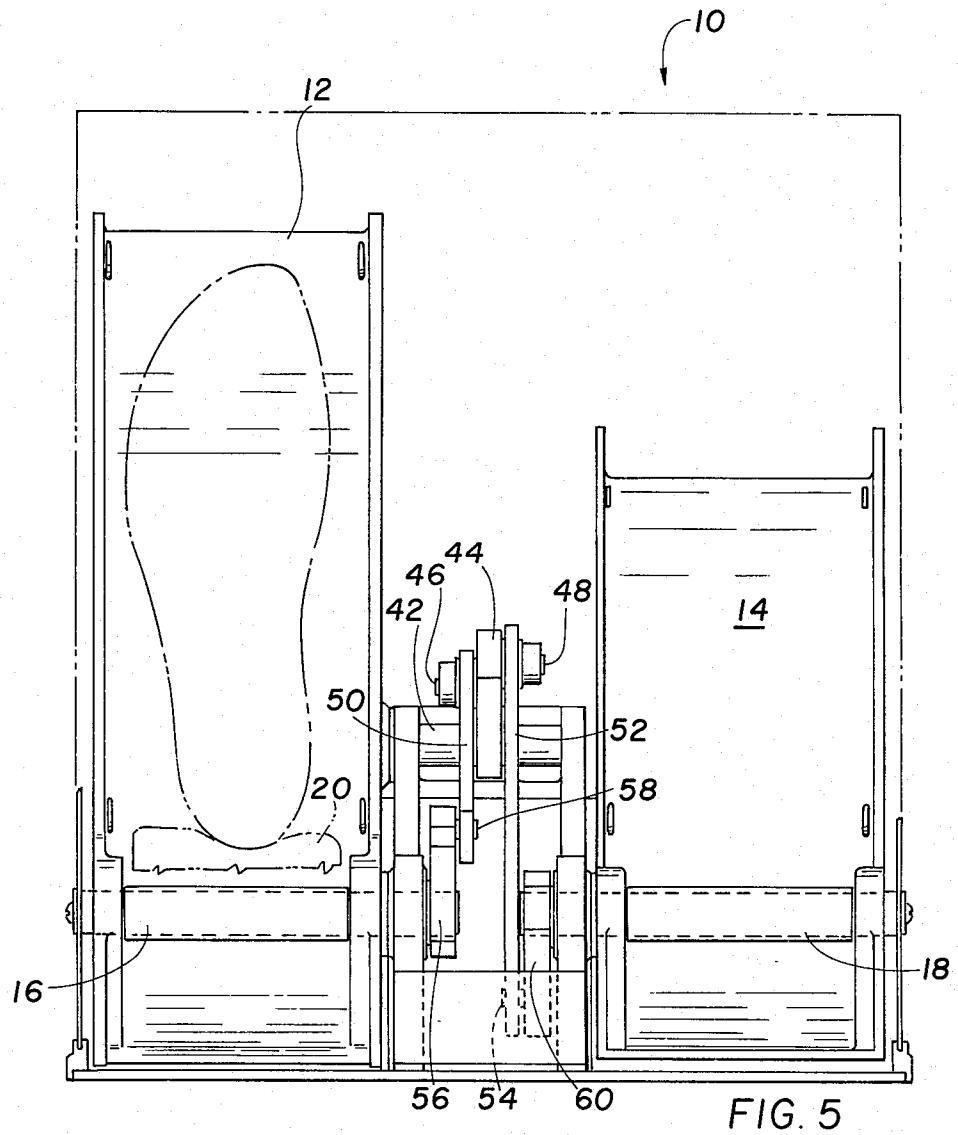

38
10
66
44
52
64
42
58
34
16, 18
62
50
26, 30
56

FIG. 4


10
12
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16
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60

FIG. 5

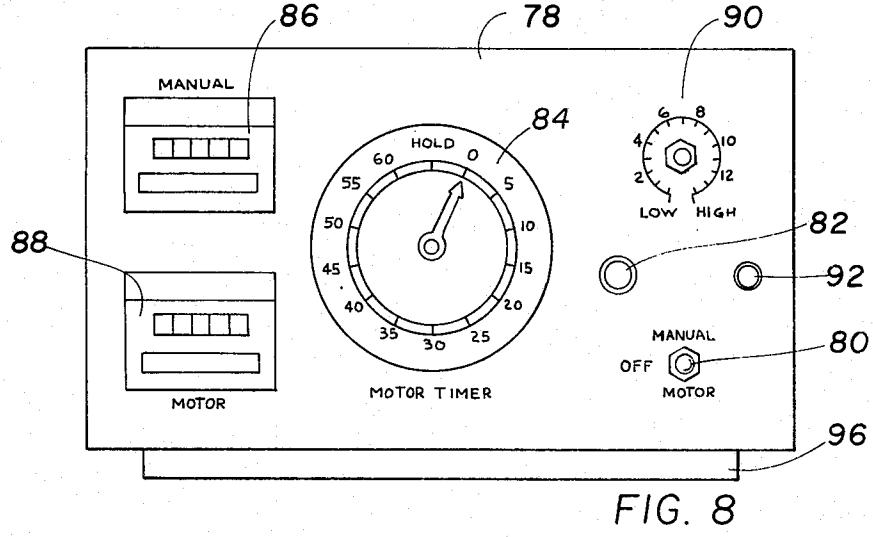
86
78
90
MANUAL
84
HOLD
0
5
10
15
20
25
30
35
40
45
50
55
60
2
4
6
8
10
12
LOW
HIGH
82
88
92
MANUAL
OFF
80
MOTOR
MOTOR TIMER
MOTOR
96

FIG. 8

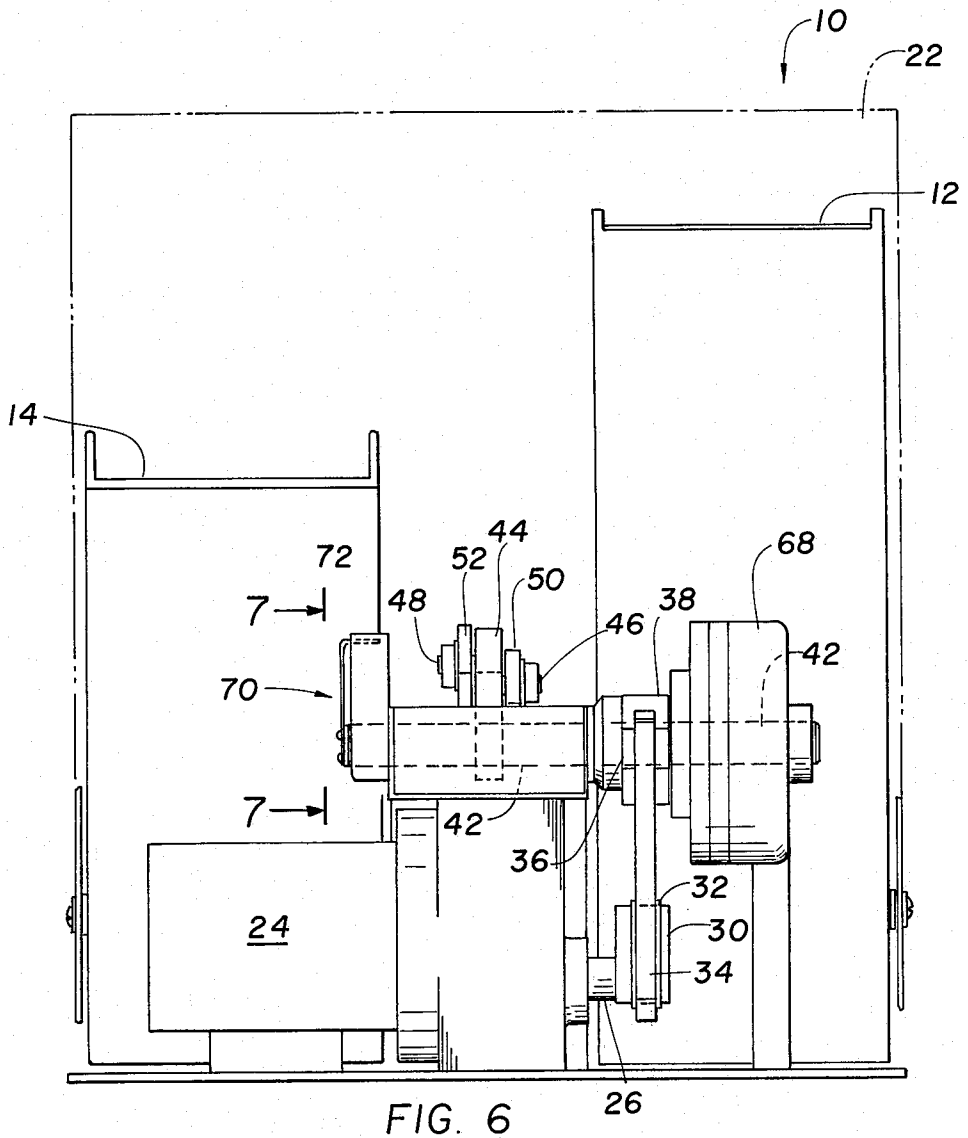
10
22
12
14
72
7
48
52
44
50
46
38
68
42
70
7
42
36
32
30
34
24
26

FIG. 6

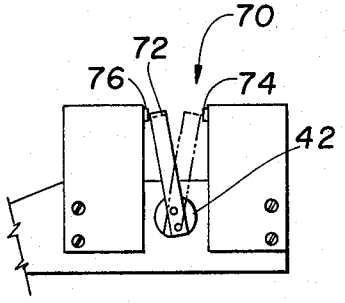
70
72
76
74
42

FIG. 7

FOOT EXERCISING DEVICE

The present invention relates to an improved foot exercising device, and more specifically to improvements for such a device, as exemplified by the device of U.S. Pat. No. 3,526,220, which contribute to greater reliability and control.

As understood, a foot exercise device which is both manually operated as well as operated by motor, is useful in preventive treatment of thromboembolism of bedridden patients. Typically, a patient can manually operate the pedals, thereby deriving the benefits of the exercise this provides even in a prone position; or if too weak, he can have his legs exercised by being manipulated through motion by a motor powering the pedals. In the manual phase of operation of the prior art device, the pedals were operated against spring urgency and an adjusted extent of friction. This provided a corresponding degree of control over the physical effort required on the part of the patient during exercising service of the device. This type of physical-exertion control, although not needed during the passive phase, was not adequately disassociated from the powering connection between the motor and pedals. As a consequence, it was adversely affected during the passive phase. In effect, the cyclical stroking of the motor during said passive phase subjected the springs and the like to the stresses they would experience in a fatigue test. This ultimately contributed to malfunctioning of such components.

Broadly, it is an object of the present invention to provide an improved foot exercising device overcoming the foregoing and other shortcomings of the prior art.

Specifically, it is an object to provide for both manual and motor operation of the pedals, and during these modes to have appropriate control of the extent of physical exertion required for said operation.

A foot exercising device demonstrating objects and advantages of the present invention includes a pedal structure organized about a pivot axis for the pedals, and a motor shaft and an oscillating shaft, both oriented substantially parallel to said pivot axis. During the passive phase, a cranking mechanism operated by rotation of the motor shaft rocks or oscillates the oscillating shaft and this motion is imparted by an appropriate linkage to the pedals. During the manual phase, a motion-opposing brake or clutch restrains motion of the oscillating shaft to any selected extent, such clutch, of course, being connected during motor operation, but operated with selected degrees of slip during the passive phase, to thereby enable regulation of the patient's physical exertion during said passive phase.

The above brief description, as well as further objects, features and advantages of the present invention, will be more fully appreciated by reference to the following detailed description of a presently preferred, but nonetheless illustrative embodiment in accordance with the present invention, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a foot exercise device according to the present invention;

FIG. 2 is a plan view with the upper portion of the housing removed to better illustrate structural features within the housing;

FIG. 3 is a side elevational view, in section taken on line 3—3 of FIG. 2, and wherein positions of movement

of the foot pedal are illustrated in full line and phantom line perspective;

FIG. 4 is a diagramatic view of the mode of operation of the linkage employed by the device hereof;

FIGS. 5 and 6 are front and rear elevational views, respectively, illustrating further structural details;

FIG. 7 is a partial side elevational view, in the direction of line 7—7 of FIG. 6, showing details of the counting switch means; and

FIG. 8 is a front view of the controls of the device hereof.

Reference is now made to the drawings illustrating a foot exercise device, generally designated **10**, which is an improvement of the device of U.S. Pat. No. 3,526,220. As a preventive treatment for thromboembolism, device **10** has a passive mode of operation during which the legs of the bedridden patient are actuated through exercise movement. The proper position for the patient's foot within the foot pedal housing is illustrated in phantom perspective in FIG. **3.** Specifically, the patient's foot when properly positioned in its foot pedal housing, as exemplified by foot pedal housing **14,** is one in which the arch and the ball of the foot is in contact with the curved section of the bottom wall of the housing, designated **100,** and the heel is maintained in a clearance position, as illustrated by a pad **20** which is positioned beneath the patient's calf. To maximize the medical benefits achieved utilizing device **10,** it is important that the pivot axis **18** coincides with a point **102** which is just beyond the patient's heel, and is thus at a location which does not exhibit motion during pivoting or flexuring of the ankle. That is, at reference point **102,** there is substantially no movement in the patient's leg, not even an expansion or contraction of the patient's skin. Thus, there is no rubbing or irritating contact at support point **102** which could seriously detract from the use of the device **10.** It is also important that the exercise movement of the patient be confined to ankle movement only, i.e. that there be no flexuring of the patient's knee or other such foot movement. When confined to only ankle movement, this has the desirable effect of inducing the calf muscles to pump and circulate blood from the lower body extremities throughout the patient's body.

Device **10** is also constructed to have a manual mode of operation, during which the patient actually performs the leg exercises. In both these passive and manual phases of operation, the feet of the patient are projected within left and right foot pedal structures **12** and **14,** respectively. These structures are pivotally connected at a point coincident with reference point **102** noted above, and provide a pivot axis **16** for pedal **12** and an aligned pivot axis **18** for pedal **14.** Omitted from FIG. **1,** but shown in FIG. **5,** is a pad **20** on which the patient's calf rests when his feet are projected within the pedal structures **12** and **14.**

As illustrated in FIG. **1,** pedals **12** and **14** are located generally in the front area of an outer casing or housing **22.** The passive mode of operation of device **10,** which as noted contemplates the actuation or driving of the pedal structures **12** and **14** in alternating pivotal traverses about the pivot axes **16** and **18,** makes use of a motor which is generally located in the bottom rear of the interior of the housing **22.** Connected in driving relation from this motor to the pedal structures **12** and **14** is a linkage, now to be described in detail, which avoids any use of springs, as was used in the device of U.S. Pat. No. 3,526,220. The device hereof is thus not vulnera-

ble to fatigue or wear which adversely affects its operation, particularly after prolonged use. As may best be appreciated by FIGS. 2, 3, 5 and 6 in conjunction with FIG. 1, in one corner of housing 22 there is a powering electric motor 24 having a motor shaft 26 extending transversely therefrom in substantially parallel relation to the pivot axes 16, 18. Mounted on the free end of the motor shaft 26, as at 28, is an eccentric 30 on which there is a bearing 32 and crank arm 34. Thus, the components 30, 32 and 34 define a cranking mechanism which, in response to rotation of the motor shaft 26, results in reciprocating or cranking movement of the arm 34.

As illustrated in FIG. 6, the free or opposite end of crank arm 34 is pivotally connected as at 36, to a bifurcated structure 38. As may best be appreciated from FIG. 3, structure 38 is, in turn, keyed as at 40, to a free wheeling portion of a clutch 68 disposed on a transversely extending shaft 42 which is appropriately journalled in bearings so as to partake of rocking movement. Thus, assuming that the clutch is operative, in response to cranking movement of the crank arm 34, shaft 42 is correspondingly urged through alternating clockwise and counterclockwise traverses about its transverse axis.

As may best be appreciated from FIG. 5, mounted to partake of the oscillating or pivotal traverses of shaft 42 is a radially extending link 44. Pivotally connected on opposite sides of link 44, as at 46 and 48, are additional connecting links 50 and 52 which complete the powering connection between the motor 24 and the foot pedal structures 12 and 14. This connection, however, is made to the pedal structures 12 and 14 to maintain the same in 180° out of phase relationship. Thus, if one pedal structure is in a forward or raised or ready position, the other structure is in a rearwardly depressed position, and the mode of operation contemplates that the movement of one pedal from its ready position through a pedaling stroke will have the effect of raising the other pedal into its ready position, preparatory to another pedaling stroke.

In order to achieve the 180° out of phase relationship it is therefore provided that link 50 have a pivotal connection, as at 54, to a link 56 which is fixedly connected to extend radially from pivot axis 16 of the left pedal structure 12. Link 52, on the other hand, is pivotally connected, as at 58, to a link 60 similarly connected to extend radially of the pivot axis 18, but at an angular orientation which is 180° out of phase with link 56. The angular relation just noted is demonstrated in FIG. 3 by the position of the pivots 54 and 58. Also in FIG. 3 the ready position of pedal structure 14 is illustrated in phantom perspective, and the position thereof after a pedal stroke in full line perspective.

The passive mode of operation of the device 10 can perhaps best be understood from the diagramatic illustration of the linkage of FIG. 4. Specifically, as illustrated in that figure, powering rotation of the motor shaft 26 results in reciprocating movement of the eccentric 30 to the extent of the crank arm throw 62. This, in turn, results in alternating reciprocating movement in link 34, and thus in cranking movement between positions 64 and 66 of the bifurcated structural link 38. As a result, shaft 42 oscillates through pivotal traverses and, in turn, actuates link 44 through corresponding pivotal traverses. Assuming link 44 is in its full line position as illustrated in FIG. 4, when this link is rotated in a counterclockwise direction, this results in simultaneous movement from right to left of both of the connecting links 50 and 52. This directional movement of link 50 causes clockwise movement of link 56 relative to the pivot axes 16, 18. In contrast, the right to left movement of link 52 produces counterclockwise movement in the link 58 relative to the pivot axes 16, 18.

Thus, clockwise movement of pedal structure 12 raises it into its elevated or ready position preparatory to a pedal stroke, while counterclockwise movement of pedal structure 14 lowers the same from its raised or ready position into a forward depressed position. Naturally, this passive mode of operation of the device 10 is utilized when the bedridden patient is not in a physical condition where it is advisable for him to exert physical effort in manually operating the pedals 12 and 14.

When, however, the patient is physically able to manually operate the pedals 12 and 14, and this form of mild exercise is medically desirable, the device 10 hereof is readily converted to its manual mode of operation. This conversion naturally includes, as a part thereof, termination of the operation of the motor 24, following which the patient manually operates the pedals 12 and 14 about the pivot axes 16, 18. It is commercially desirable that this manual phase of operation require more than merely allowing the patient to depress the raised pedal against the opposition, or resistance to movement, provided by the other pedal which is in its forward depressed position. To this end, it is provided that in the manual utilization of the within device 10 there is the capability of increasing, to any selected degree or extent, an amount of resistance of movement to be overcome by the patient in depressing the raised pedal during a pedaling stroke.

In accordance with the present invention, this is achieved using an electric clutch 68 conveniently and strategically located adjacent one end of shaft 42. Clutch 68 may be of conventional construction and mode of operation, and is readily available commercially, as for example from Electroid Corporation. As understood, by increasing the magnetic field of clutch 68 there is imposed a correspondingly increased resistance to movement of the shaft 42. This, in turn, requires an increased physical effort on the part of the patient to actuate the pedals 12, 14 through pedaling movement. There are two additional important functions of the electric clutch 68 which now will be described.

During motor opereration of device 10, the powering motor 24 operates through a gear reduction train which provides control over its output rotation. These gears, however, unavoidably exert a holding forced on the shaft 42, and thus shaft 42 cannot partake of pivotal movement during the active or manual operation of the device 10 so long as this holding function is exerted upon it by the motor 24. Accordingly, the present invention contemplates utilizing the clutch 68 to disconnect the motor 24 from the shaft 42 and thus frees the shaft from holding or restraining influence of the motor 24.

From the preceding description it should be readily apparent that one of the significant advances of the device 10 hereof is the ability of the patient to exercise manually, as during the active mode of the device, and also with the aid of the motor 24, and to change from one mode to the other as desired. This contemplated variation in use of the device 10 is possible, in part, because of the automatic synchronization which is inher-

ent in the operation of the device **10,** and which is contributed in large measure by the electric clutch **68.** Specifically, it should be readily apparent that motor operation of the device **10** can be terminated at any point in the pivotal traverse of the foot pedals **12, 14,** and the patient thereafter might continue with manual operation of these foot pedals. It should further be readily appreciated that the interval of manual operation of the device **10** can then theoretically, and in fact most probably, be terminated with the foot pedals **12, 14** in some other position than their starting positions. This, however, presents no problems because when the pedals **12, 14** are driven by the motor **24** they must of necessity reach an extreme position in their pivotal traverse in which they are in physical abutment against a stop pad **104.** In this extreme position, the foot pedal cannot proceed any further in the direction of travel which brought it against the stop **104.** Meanwhile, the linkage powered by the motor may not be in its position of pivotal traverse corresponding to that of the foot pedal, and thus said linkage will partake of movement imparted to it by the motor **24.** However, the clutch **68** which occupies an advantageous position between the moving linkage and the stationary foot pedal will allow for the relative movement therebetween as slippage until ultimately the linkage and the foot pedal are in proper synchronization and move in unison with each other. Stated another way, during the time that the stop **104** holds the foot pedal against movement and the motor **24** nevertheless drives the linkage through movement, the pressure that this creates is relieved by slippage in the clutch **68.** However, this pressure is automatically relieved when the linkage powered by the motor **24** attains that position at which continued movement of the linkage raises the foot pedal **14** from the stop **104** and thus in a direction in which the foot pedal **14** is free to move.

As may be readily appreciated and understood from prior Pat. No. 3,526,220, effective utilization of the device **10** dictates timing of the various phases and modes of operation of the device **10,** and also the counting of each cycle of operation so that the attending physician can judge the performance of the patient. In accordance with the present invention, the counting mechanism, generally designated **70,** is conveniently provided adjacent the opposite end of shaft **42,** as clearly illustrated in FIGS. **6** and **7.** As illustrated in these figures, mechanism **70** includes a radially extending switch arm **72** which is actuated back and forth between the illustrated full line and phantom line positions of movement during oscillating or rocking movements of the shaft **42.** In said positions of movement of the arm **72,** physical contact is made with electrical contacts **74** and **76** which, in a well understood manner, actuate a stepping switch or other counting mechanism to reach each pivotal traverse of shaft **42,** and thus each pedal stroke of the pedals **12, 14.**

As a practical matter, during use of the device **10** in its manual mode it cannot be expected that the patient will at all times operate the foot pedals **12** and **14** through a full and complete pivotal traverse, i.e. a traverse in which each foot pedal is in turn moved into abutment against the stop pad **104.** In most instances the pivotal traverse will be only partial, perhaps only two-thirds of a theoretical full stroke. Thus, it is desirable to adopt the counting means **70** to record a stroke if the pivotal traverse is two-thirds or more of the theoretical distance that can be traveled. This may be achieved in any number of ways, as for example by using a contact arm **72** of a resilient construction material so that when contact is made at two-thirds of the stroke the remaining portion of the stroke is allowed for in the resiliency, and thus bending, of the construction material.

As illustrated in FIG. **8,** other suitable controls for the device **10** are appropriately housed in a box-like structure **78** and include a manual on-off switch **80** for commencing and terminating operation of the motor **24** to, in turn, provide the passive or manual mode of operation of the device **10.** When motor **24** is operating, this may be conveniently indicated by energization of a pilot light **82.** Located centrally of the control panel unit **78** is an electro-mechanical timer **84.** Resettable digital displays or counters **86** and **88** are provided for monitoring the manual and motor operation of the device **10.** Another desirable control is that designated **90,** which will be understood to be a calibration of the magnetic field of the electric clutch **68** in terms of physical units, such as pounds per square inch or the like, which, in an obvious manner, facilitates selecting an appropriate resistance to movement in the manual operation of the pedals **12** and **14.** Completing the controls **78** is a fuse **92** limiting the current utilized during operation of the device **10** to safe limits.

As illustrated in FIGS. **1** and **8,** a T-shaped bracket **94** is secured along the top of the housing **22** to accommodate a cooperating shaped connecting bracket **96** mounted in depending relation along the bottom of the control box **78.** The T-shaped member **94** is convenient for holding the control box **78** during shipment of the device **10.** At point of use, however, it is contemplated that the control box **78** will be disconnected from its mount **94** and either hand held or positioned adjacent the patient, so that he can follow any schedule of passive and active exercises.

To prevent loss of the pad **20,** the same may be conveniently integrated in the device **10** by using the pivot axis structure **16** and **18** as holders for each of the pads. This has the additional benefit of providing each pad **20** with a storage position, wherein it is pivoted about the holding structure **16, 18** into the compartment occupied by the foot pedal housings **14** and **16.**

From the foregoing it should be readily appreciated that there has been described herein an improved foot exerciser that has both a passive and manual phase of operation in which, among other desirable features, there has been wholly eliminated any need for springs or other components which are subject to fatigue and vulnerable to changes in physical characteristics over prolonged periods of use. A latitude of modification, change and substitution is intended in the foregoing disclosure, and in some instances some features of the invention will be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

What is claimed is:

1. An improved foot exercise device comprising a pair of foot pedal structures operatively mounted for pivotal movement 180° out of phase with each other about a front pivot axis oriented transversely of the plane of pivotal movement of said foot pedal structures, a first shaft journalled for rotation along a second motion axis disposed rearwardly and substantially parallel to said front pivot axis, a powering motor and a

cranking mechanism disposed at opposite ends of said first shaft, a second shaft disposed along a third motion axis above and substantially parallel to said second motion axis and operatively connected to be actuated in oscillating movement by said cranking mechanism of said first shaft, link means connected between said second shaft and said foot pedal structures for transmitting oscillating movement of said second shaft so as to cause 180° out of phase pivotal movement in said foot pedal structures, said link means including two cooperating first links which are each connected to extend radially of said first pivot axis in 180° out of phase relationship, and two second links which are each connected from said second shaft to each of said first links, a counting switch means mounted in counting relation adjacent one end of said second shaft to record each oscillating traverse of said second shaft, and a movement-opposing device mounted adjacent the opposite end of said second shaft to selectively resist oscillating movement thereof, whereby said motor operates said exercise device during a passive phase and at other intervals the patient operates said device using an effort dictated by said selected resistance to movement of said second shaft.

2. An improved foot exercise device as claimed in claim **1** wherein said movement-opposing device is a magnetic clutch.

3. An improved foot exercise device as claimed in claim **1** wherein said counting switch means includes a switch contact arm mounted to extend radially of said second shaft so as to partake of the oscillating traverses of said second shaft, and at least one switch contact mounted so as to be contacted during said oscillating traverses of said switch contact arm.

4. An improved foot exercise device comprising a pair of foot pedal structures operatively mounted for pivotal movement 180° out of phase with each other about a front pivot axis oriented transversely of the plane of pivotal movement of said foot pedal structures, a first shaft journalled for rotation along a second motion axis disposed rearwardly and substantially parallel to said front pivot axis, a powering motor and a cranking mechanism disposed at opposite ends of said first shaft, a second shaft disposed along a third motion axis above and substantially parallel to said second motion axis and operatively connected to be actuated in oscillating movement by said cranking mechanism of said first shaft, a counting switch means mounted in counting relation adjacent one end of said second shaft to record each oscillating traverse of said second shaft, a magnetic clutch mounted adjacent the opposite end of said second shaft to selectively resist oscillating movement thereof, and at a central intermediate location on said second shaft between said magnetic clutch and said counting switch means a pair of first links connected to extend radially of said first pivot axis in 180° out of phase relationship, and a cooperating pair of second links connected from said second shaft to each of said first links for transmitting oscillating movement of said second shaft so as to cause 180° out of phase pivotal movement in said foot pedal structures, whereby said motor operates said exercise device during a passive phase and at other intervals the patient operates said device using an effort dictated by said selected resistance to movement of said second shaft.

* * * * *