Dec. 7, 1954 W. BIERMAN 2,696,206

LEG EXERCISER

Filed May 20, 1953 3 Sheets-Sheet 1

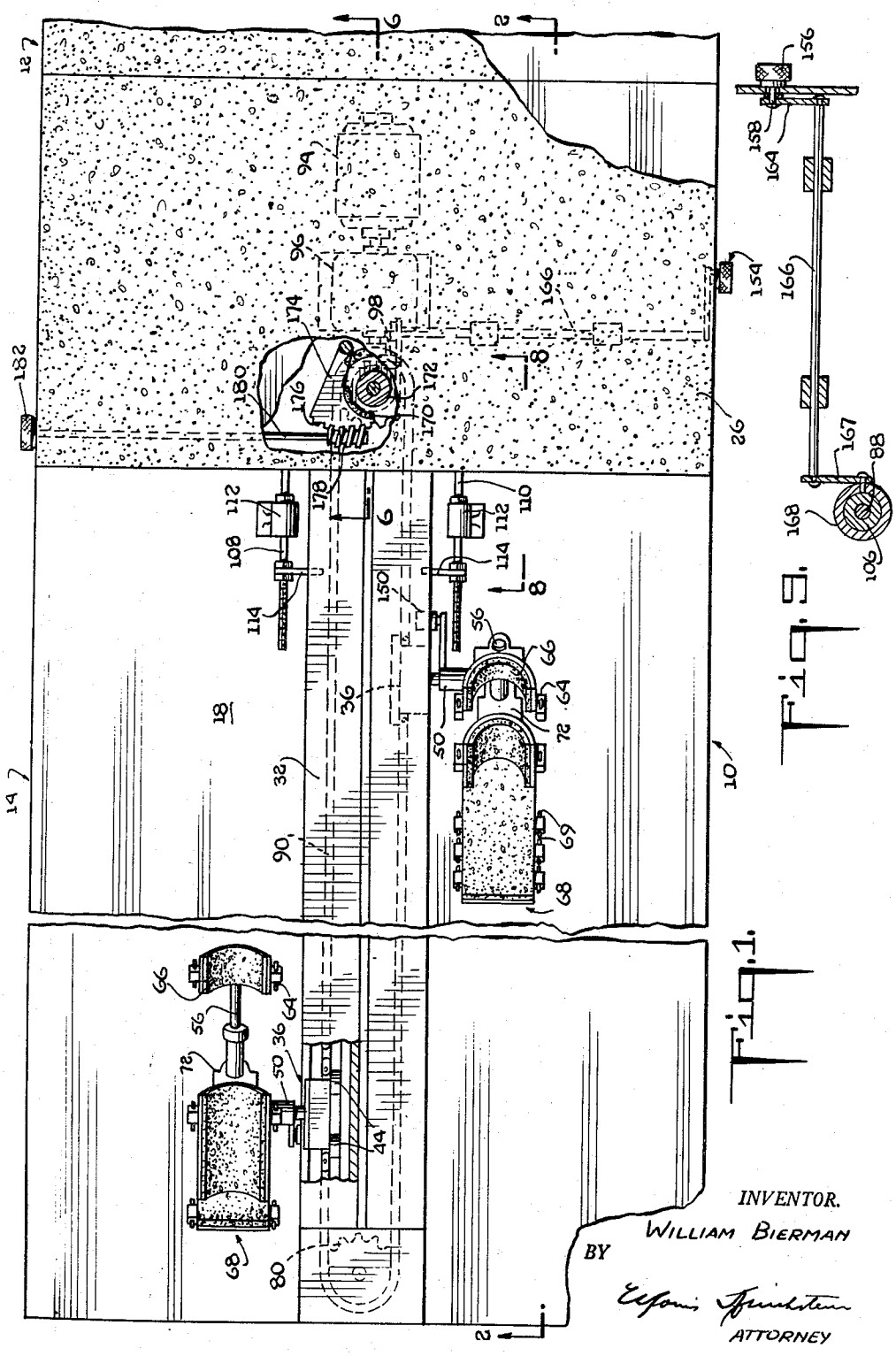


Fig. 5.

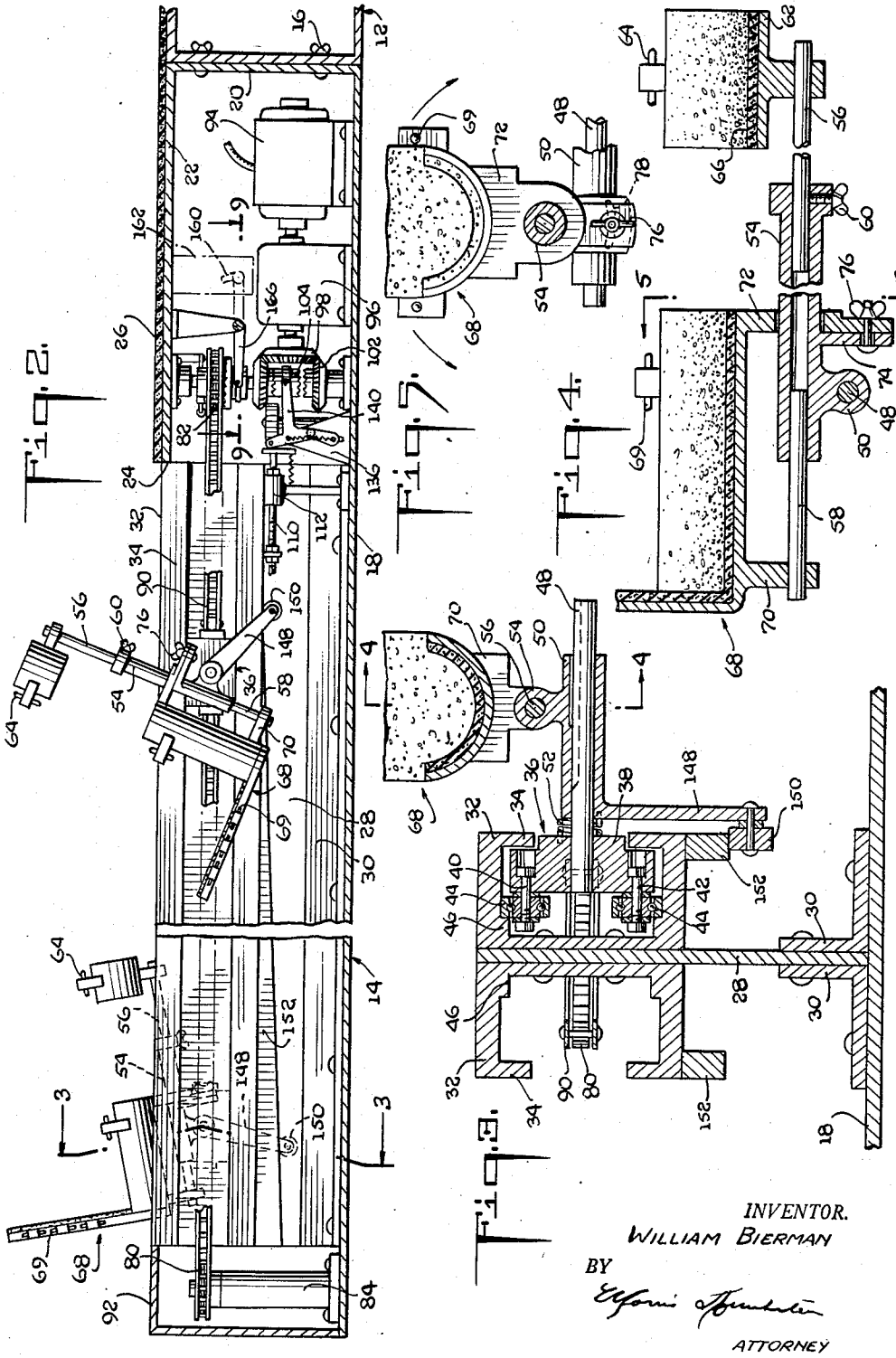
Fig. 1.

INVENTOR.
WILLIAM BIERMAN
BY
ATTORNEY

Dec. 7, 1954 W. BIERMAN 2,696,206

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Filed May 20, 1953 3 Sheets-Sheet 2



INVENTOR.
WILLIAM BIERMAN
BY
ATTORNEY

Dec. 7, 1954 W. BIERMAN 2,696,206

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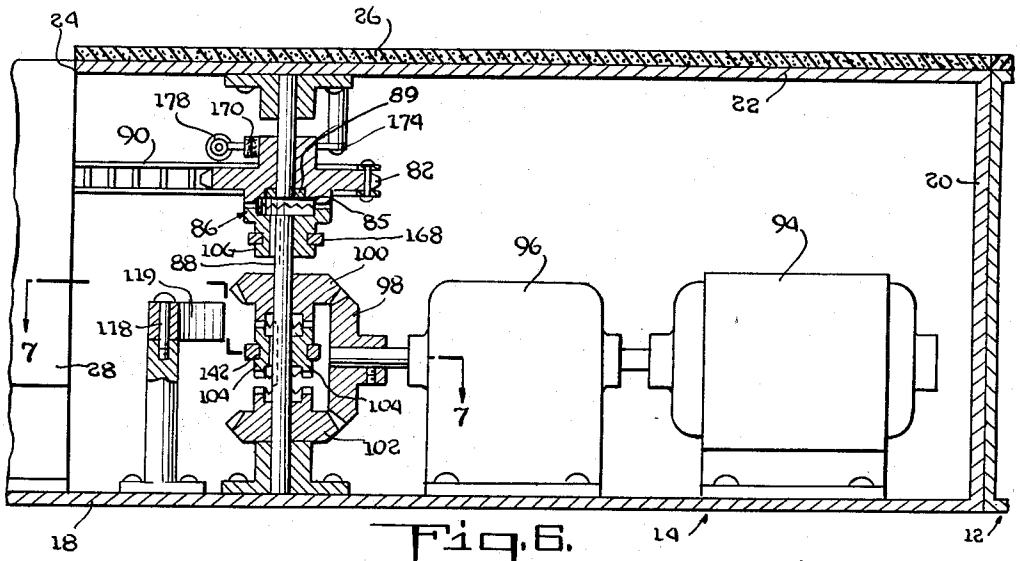
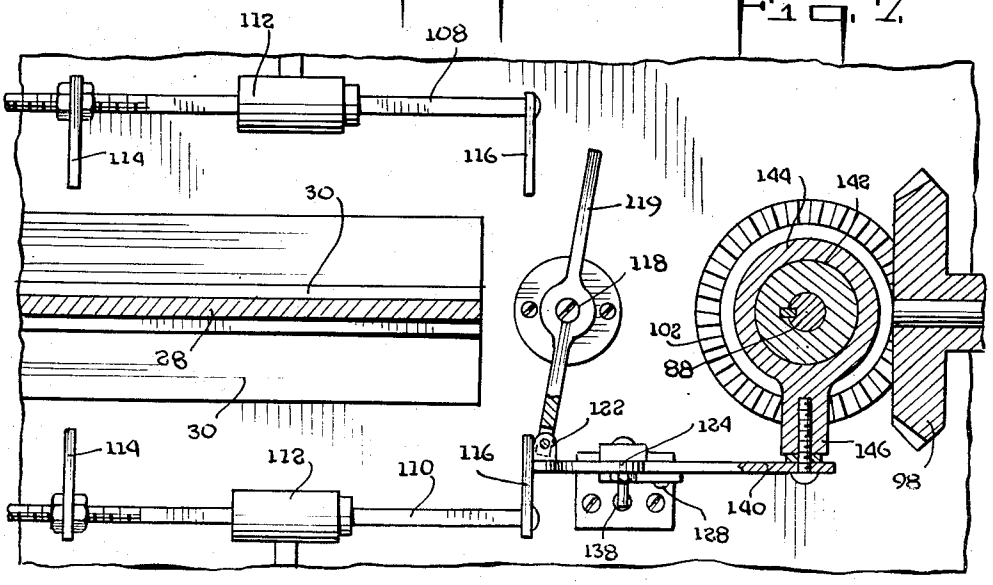


Fig. 6.

Fig. 7.



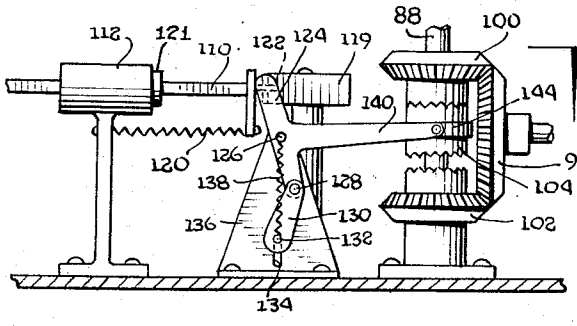


Fig. 8.

INVENTOR.
WILLIAM BIERMAN

BY

ATTORNEY

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LEG EXERCISER

William Bierman, New York, N. Y.

Application May 20, 1953, Serial No. 356,133

7 Claims. (Cl. 128—25)

This invention relates to leg exercisers.

It is the purpose of my invention to provide an exerciser through whose use the legs of a person who cannot or should not move his own legs as, for instance, a paralytic, or someone with a recent heart attack, or a post-operative case, can be passively exercised or, if desired, exercised against light resistance.

More specifically it is an object of my invention to provide an exerciser of the character described which will passively exercise both limbs of a bed-ridden patient at the same time in a to-and-fro manner somewhat resembling walking so as to retain the muscular memory of walking in the legs of a patient who at least temporarily is confined to bed.

It is another specific object of my invention to provide an exerciser of the character described in which the angular positions of both the knee and calf are simultaneously and independently controlled during movement of the legs.

It is a further object of my invention to provide an exerciser of the character described which is relatively light, simple and inexpensive so that it is well within the budget of an average small hospital or sanitarium.

It is still another object of my invention to provide an exerciser of the character described which, optionally under the selective control of the patient himself, can be energized from an electric motor.

It is yet another object of my invention to provide an exerciser of the character described which is rugged, neat in appearance and easy to adjust.

Other objects of this invention will in part be obvious and in part will be pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the construction hereinafter described, and of which the scope of application will be indicated in the appended claims.

In the accompanying drawings, in which is shown one of the various possible embodiments of this invention,

Fig. 1 is a top view of an exerciser constructed in accordance with my present invention;

Fig. 2 is a longitudinal sectional view through said exerciser, the same being taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view through the exerciser, the same being taken substantially along the line 3—3 of Fig. 2 and being illustrative of the mounting for the foot-moving mechanism;

Fig. 4 is a sectional view taken substantially along the line 4—4 of Fig. 3, and being illustrative of the foot support;

Fig. 5 is a sectional view taken substantially along the line 5—5 of Fig. 4, and being illustrative of the angular adjustment of the foot platform;

Fig. 6 is an enlarged sectional view taken substantially along the line 6—6 of Fig. 1, and is illustrative of the reversing mechanism and clutch in the drive for the foot-moving mechanism;

Fig. 7 is an enlarged sectional view taken substantially along the line 7—7 of Fig. 6, and is illustrative of certain details of the reversely mechanism;

Fig. 8 is a sectional view taken substantially along the line 8—8 of Fig. 1, the same showing the reversing mechanism in elevation; and

Fig. 9 is a sectional view taken substantially along the line 9—9 of Fig. 2, the same being illustrative of the kinematic train for actuating the clutch.

Referring now in detail to the drawings, the reference numeral 10 denotes an exerciser constructed in accordance with the present invention. Said exerciser includes a pair of frame elements 12, 14 (see Figs. 1, 2 and 6) which are arranged end-to-end and are secured to one another as by bolts and wing nuts 16. Such arrangement is employed to enable the exerciser to be disassembled into portable units of convenient size.

Each of the elements 12, 14 includes a base plate 18 and end walls 20 suitably braced to form a rigid structure. In addition, the top of the entire element 12 and of a portion of the element 14 adjacent the element 12 are covered by top walls 22. The lower edge 24 of the top wall 22 on the element 14 terminates in the region of the patient's hips, the elements 12, 14 jointly being about the length of a bed and being intended to be placed over a bed spring or on the bed frame.

The top walls 22 preferably are covered by a cushioning material, as, for example, a layer 26 of foam rubber, in order that a patient may rest on the same with reasonable comfort. From the edge 24 downward the element 14 is open at the top in order to provide access to the active exercising parts of the device.

A vertical plate 28 runs along the center of the frame element 14 from the edge 24 to substantially the lower, i. e. foot, end of said element. The plate is suitably held in place, as by channel irons 30 which secure the plate to the bottom wall 18 of the element 14. Tracks 32 are suitably attached, as by welding, on opposite sides of the plate 28. The tracks are located near the top edge of the plate and extend longitudinally thereof. Since the tracks are of like construction and function, except that they are mirror images of one another because they are on opposite sides of the plate, only one of the tracks, e. g. the track 32, and its affiliated elements will be described in detail.

The track is of channel shaped cross section (as best seen in Fig. 3) being provided with vertical flanges 34 which extend inwardly toward one another from the tips of the two legs of the channel so as to form a guideway for a sliding shoe 36. The shoe has a projection 38 extending into the space between the inturned flanges 34 and slidable on the edges thereof. The body of the shoe is disposed within the track.

Two pins 40 extend from the shoe toward the base of the channel adjacent the top edge of the shoe and two similar pins 42 are located near the bottom edge of the shoe. Each of these pins supports a roller 44 on an antifriction bearing, the upper rollers riding on the undersurface of the top leg of the track and the lower rollers riding on the upper surface of the bottom leg. Thus the shoe can be slid easily back and forth along the length of the plate 28. The rollers 44 ride in the tracks against longitudinal shoulders 46 thus preventing transverse shifting of the shoe 36 whereby the shoe is constrained against all movement except free movement parallel to the longitudinal axis of the track 32.

Each of the shoes serves to support a different one of the patient's feet. To this end the shoe 36 is provided with a sturdy outwardly extending horizontal shaft 48 which is moved to-and-fro longitudinally of the plate 28 by said shoe. The shaft 48 is rotatably encircled by a sleeve 50. A torsion spring 52 fixed at opposite ends to the sleeve and shoe is interposed therebetween. Said spring serves as a biasing means which functions to maintain a cam follower against a cam track in a manner that will hereinafter be described in detail.

Integral with the sleeve 50, as by being formed in one piece therewith, is a second sleeve 54 which is perpendicular to the sleeve 50. A shaft 56 extends from the head end of the sleeve 54 and a second shaft 58 extends from the foot end of said sleeve.

The position of the shaft 56 is fixed as by a set screw 60 and said shaft 56 carries a curved support 62 on which a patient's calf is adapted to be rested. The edges of this support preferably are provided with T-bars 64 which function as anchors for bandages and the like that can be employed to strap the patient's calf to the support. The outer surface of the support desirably is covered with a cushioning layer 66 such, for example, as foam rubber.

Also carried by the sleeve **54** is a foot support **68** comprising a foot platform having the usual T-bars **69** for strapping a foot in place. The foot support includes two rearwardly extending legs **70**, **72** the lower of which is fixed to the shaft **58**. The upper leg **72** rests on an ear **74** integral with the sleeve **54**, said ear and the leg **72** desirably being secured to one another as by a bolt and wing nut **76**. The leg **72** is apertured for rotatable movement about the sleeve **54** thereby permitting angular movement of the foot support to enable said support to be adjusted to a patient's natural foot position. In order to permit such rotation the ear **74** includes an arcuate bolt-receiving slot **78** concentric with the longitudinal axis of the sleeve **54**. Thus, the bolt and nut **76** can be tightened in any adjusted position of the foot support. It will be appreciated that by loosening the set screw **60** a similar adjustment may be effected for the calf support **62**.

Suitable means is included to oppositely oscillate the shoes **36** in the tracks **32**, **34** and thereby exercise the patient's legs by a to-and-fro motion. Said means comprises a pair of coplanar sprockets **80**, **82**. The sprocket **80** is an idler sprocket and is located near the foot of the exerciser being supported for rotation about a vertical axis by a pedestal **84** fixed to the base wall **18** of the element **14**. The sprocket **82** is a driving sprocket. It is attached to and turns with the driven half **85** of a clutch **86**, the sprocket and driven half being loose on a vertical shaft **88** but held against axial movement by a collar **89**. A chain **90** trained about the sprockets **80**, **82** is secured to the shoes **36** in both tracks **32**, **34**, said chain serving to kinematically interconnect the shoes for opposite synchronized movement. The longitudinal flights of the chain extend through the aforesaid tracks and only are exposed adjacent the sprockets where they are guarded by the cover **24** and another cover **92** (see Fig. 2). It thus will be apparent that if the chain is oscillated the shoes will be reciprocated back and forth in their respective tracks.

The means for oscillating the chain comprises an electric motor **94** which preferably is mounted on the base plate **18** near the head of the element **14**. The output shaft of the motor drives a suitable reducing gear train **96** to whose horizontal output shaft a bevel gear **98** is fixed, said bevel gear constituting the power input end of a reversible power means. The bevel gear meshes with an upper horizontal bevel gear **100** and a lower horizontal bevel gear **102**, both of which are freely rotatable on the shaft **88** whereby as long as the motor **94** is in operation the two bevel gears **100**, **102** will rotate. However, since they mesh with diametrical opposite teeth on the gear **98** the gears **100**, **102** turn in opposite directions.

The portion of the shaft **88** between the gears **100**, **102** is formed with splines on which there is slidable longitudinally of the shaft a driving sleeve **104** whose opposite ends are toothed. The facing hubs of the gears **100**, **102** are similarly toothed to mesh with the teeth on the ends of the driving sleeve **104** so that when the driving sleeve couples with one of the gears, e. g. the gear **100**, the shaft **88** will be turned in a given direction and when the driving sleeve couples with the other gear **102** the shaft **88** will be turned in a reverse direction.

Thus, by moving the sleeve **104** intermittently against first one and then the other of the gears **100**, **102** the direction of rotation of the shaft **88** will be intermittently reversed.

The shaft **88** also is splined above the gear **100**. Slidable on said spline is the driving half **106** of the clutch **86**. It now will be appreciated that the sprocket **82** either may be oscillated intermittently in different directions under power or may be uncoupled from the electric motor, depending upon the state of the clutch.

The exerciser is so constructed that the driving sleeve **104** of the reversing mechanism is actuated as the shoes **36** approach the head ends of their strokes. More particularly the exerciser includes a pair of tappet shafts **108**, **110** (see Fig. 7) disposed on opposite sides of the plate **28** adjacent the head of said plate. The tappet shafts are horizontal and are non-rotatably slidable in bushings **112**. The foot end of each tappet shaft is threaded for adjustably receiving a tappet arm **114** which lies in the path of travel of the associated shoe **36** and will be engaged by the shoe as the shoe approaches the head end of the associated track **32**, **34**. The head end of each tappet shaft fixedly mounts a tappet hammer **116**. Mounted for oscillation about a vertical shaft **118** (see Fig. 6) immediately in back of and in line with the plate **28** is a walking beam **119** (see Fig. 7) whose opposite ends are aligned with the tappet hammers. Thus, when one of the tappet shafts is urged toward the head of the exerciser by engagement with a shoe moving in that direction, the associated tappet hammer will strike an end of the walking beam and move the same toward the shaft **88**. When the other shoe strikes the other end of the walking beam said beam will be oscillated in an opposite direction. Each tappet is urged by a spring **120** to an extreme forward position defined by abutment of a collar **121** against the bushing **112**.

Attached to an end of the walking beam by a flexible connection such as a swivel **122** is the upper end of a lever **124** (see Figs. 7 and 8). The lever **124** is pivoted, as at **126**, for rotation about a horizontal axis. The lower end of the lever is secured by a pivot pin **128** to the upper end of a short arm **130**. The lower end of said arm carries a pin **132** which slides in a vertical slot **134** formed in a bracket **136** secured to the base plate **18**. The arm **130** and the lower half of the lever **124** jointly act as a toggle in cooperation with a tension spring **138** which is stretched between the pin **132** and pivot **126**.

It will be appreciated that, referring to Fig. 8, when the upper end of the lever **124** is urged rearwardly it will move the toggle to a point slightly past a dead-center whereupon the toggle will snap to its other extreme position. The same action will take place when the position of the lever is reversed.

The lever **124** is provided with a bell crank arm **140** whose tip is located alongside the reversing driving sleeve **104**. Said sleeve has an annular groove **142** (see Fig. 6) in which a collar **144** is rotatable. A radius arm **146** on the collar is pivotally attached to the bell crank arm whereby when the toggle moves to one extreme position it will move the reversing driving sleeve into engagement with one of the bevel gears, e. g. the gear **100**, and when the toggle moves into its other extreme position it will move the sleeve into engagement with the other bevel gear **102**.

From the foregoing it now will be apparent that when either shoe in its movement toward the head of the exerciser strikes a tappet arm **114** the toggle joint will be actuated, first to uncouple the reversing driving sleeve from one of the bevel gears and then to snap the sleeve into engagement with the other bevel gear, the inertia of the shoes sufficing to carry the toggle past dead center.

By adjusting the position of the tappet arms the throw of the shoes can be changed to suit the patient on whom the exerciser is being used, it being appreciated that the length of the throw which is best for exercise will vary inter alia in proportion to the length of the patient's legs.

It is most undesirable for an exerciser of the type herein described simply to push the feet back and forth and rely upon the bending action of the knee to enable the calf to experience angular motion relative to the thigh. Although such motion will take place it is accompanied by strain on the patient's ankles and knees. This is particularly bad for patients whose disability requires the use of the exerciser, inasmuch as it may strain the muscles or wrench ligaments or joints of the leg. To avoid such difficulty the present machine is provided with suitable means for positively varying the angularity of the calves in synchronism with the to-and-fro oscillation of the feet. Said means in part has been described already and consists of the provision for permitting rotation of the sleeve **50** about the horizontal shaft **48**. The means further includes a dependent arm **148** (Figs. 2 and 3) formed integrally with the sleeve **50**. A cam follower **150** rotatable on the arm **148** engages an edge cam **152** which is suitably secured, as by screws, to the underside of the track **32**, there being one edge cam for each track. The follower is held against the cam by the torsion spring **52** hereinbefore referred to.

The edge cam extends from adjacent one end of the track to adjacent its opposite end and varies in height from end to end, the height of said cam being greatest adjacent the foot end of the track and least adjacent the head end. It will be seen from inspection of Fig. 2 that increase in height of the edge cam rocks the lever

148 in a clockwise direction as viewed in Fig. 2 causing the sleeve 50 to oscillate the foot and calf supports to an almost horizontal position. Thereby when the shoe 36 is near the foot of the exerciser the foot and calf supports will be properly oriented to support an outstretched foot, and as the shoe moves the foot toward the head of the exerciser the calf will be positively rotated to jack-knife the knee without unduly straining the patient's legs.

As thus far described the exerciser is used entirely for passive exercising, that is to say, for the exercising of patients who should not or cannot move their own legs against any resistance whatsoever. Such exercising, as is well known, will maintain the tone of the muscles and retain the habit of motion in the patient. However, when recovery has proceeded far enough to enable the patient to move his own legs, but not far enough to permit normal use of the legs, the exerciser can be employed to provide varying degrees of resistance to to-and-fro motion of the legs. To permit this to be accomplished the clutch 86 is uncoupled.

Such uncoupling is under the control of the patient and is exercised by manipulating a clutch control 154 (see Figs. 1 and 9) alongside the exerciser. The clutch control includes a handle 156 mounted on a pin 158 that moves in an arcuate slot 160 (see Fig. 2) provided in a bracket plate 162 attached to the side of the element 14. The pin 158 is secured to a crank arm 164 fixed to a shaft 165 that extends toward the center of the element 14. The inner end of the shaft carries a second crank arm 167 that is pivotally secured to the clutch collar 168.

When the clutch is uncoupled the patient can move his own legs back and forth against only the resistance offered by raising the weight of his legs. The machine itself offers very little resistance due to the provision of the anti-friction bearings for rollers on the shoes.

As the patient improves it is desirable to increase the amount of resistance offered to movement of the legs and to this end the exerciser further includes a brake shoe 170 which is adapted to engage a brake drum 172 revolvable with the drive sprocket 82.

When the legs are being exercised passively the brake shoe is out of contact with the drum. Adjusting means is included to delicately move the shoe against the drum and thereby increase in small increments the amount of resistance offered to movement of the leg when the clutch is uncoupled. The brake shoe is mounted on a pivoted brake lever 174 which is formed with a worm gear segment 176. Said segment meshes with a worm 178 carried by a long shaft 180 that protrudes from the side of the element 14 where it carries a handle 182 for convenient manipulation.

It will thus be seen that there is provided a device in which the several objects of this invention are achieved, and which is well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiment above set forth, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention I claim as new and desire to secure by Letters Patent:

1. A leg exerciser comprising a pair of shoes, a pair of foot supports, means mounting each foot support on a different shoe for rotation about a horizontal axis with respect to such shoe, side-by-side track means parallelly guiding said shoes for translation, means kinematically interconnecting said shoes for opposite synchronized movement, and means for rocking the supports about their axes in synchronism with the movement of the shoes.

2. A leg exerciser comprising a pair of shoes, a pair of foot supports, means mounting each foot support on a different shoe for rotation about a horizontal axis with respect to such shoe, side-by-side track means parallelly guiding said shoes for translation, means kinematically interconnecting said shoes for opposite synchronized movement, means for rocking the supports about their axes in synchronism with the movement of the shoes, and power means for reciprocating said shoes and rocking the supports.

3. A leg exerciser comprising a pair of shoes, a foot support carried by each shoe, side-by-side track means parallelly guiding said shoes for translation, means kinematically interconnecting said shoes for opposite synchronized movement, power means for reciprocating said shoes, and clutch means connecting the power means and the shoes.

4. A leg exerciser comprising a pair of shoes, a pair of foot supports, means connecting each foot support to a different shoe for rotation about a horizontal axis relative to such shoe, side-by-side track means parallelly guiding said shoes for translation, means rocking the foot supports about their axes in synchronization with the movement of the shoes, and clutch controlled power means for reciprocating said shoes.

5. A leg exerciser comprising a pair of shoes, a foot support carried by each shoe, side-by-side track means parallelly guiding said shoes for translation, means kinematically interconnecting said shoes for opposite synchronized movement, and reversible power means driving said interconnecting means, said reversible power means including a reversing member, a pair of elements in the paths of travel of the shoes and means controlled by said elements for reversing said power means.

6. A leg exerciser comprising a support for a patient's hips and back, a pair of shoes, a foot support carried by each shoe, side-by-side track means extending away from the hip and back support and parallelly guiding said shoes for translation, and means kinematically interconnecting said shoes for opposite synchronized movement.

7. A leg exerciser comprising a foot support, means guiding said support for reciprocable translation, power means for driving said support back and forth, clutch means connecting the power means and the support, and brake means associated with said support for selectively and variably frictionally opposing movement of the support.

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