

Nov. 7, 1972

C. E. PHILLIPS ET AL
THERAPEUTIC EXERCISER WITH REGULATABLE
HYDRAULIC TORSIONAL RESISTANCE

3,702,188

Filed Aug. 19, 1971

2 Sheets-Sheet 1

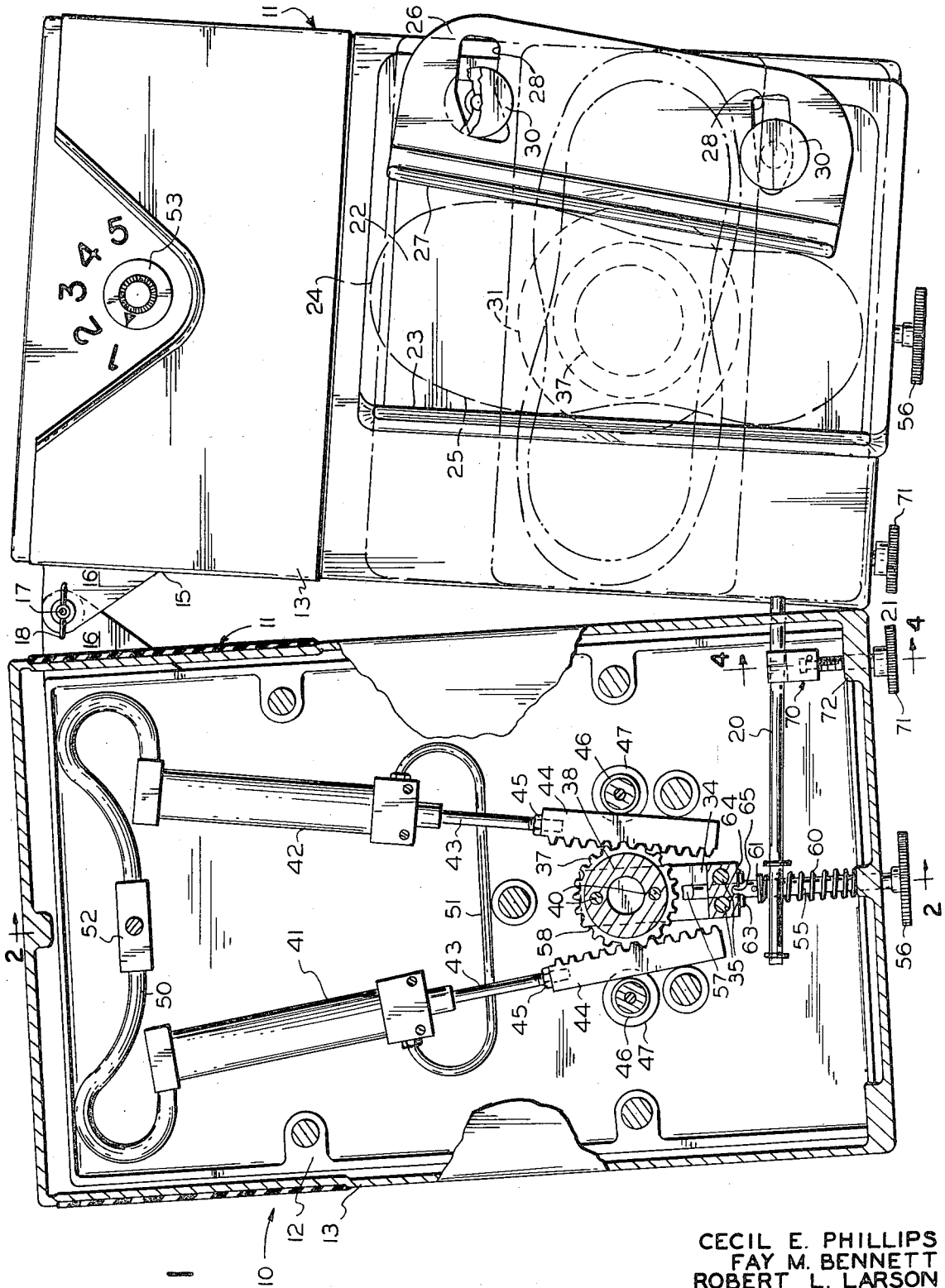


FIG. 1

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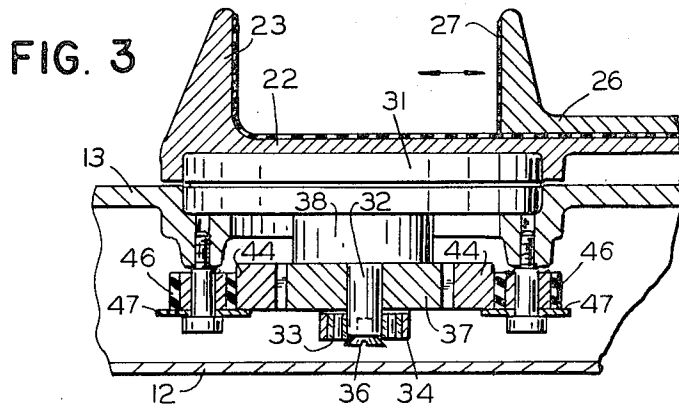
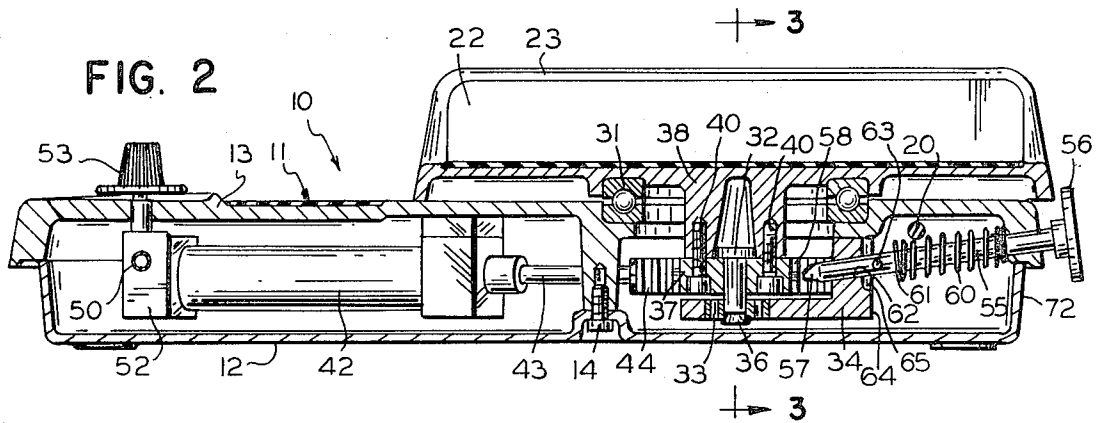


FIG. 4

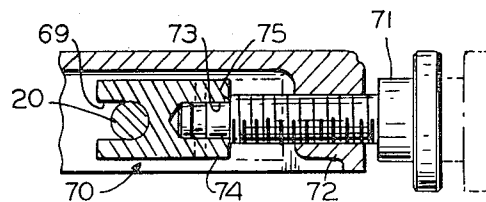
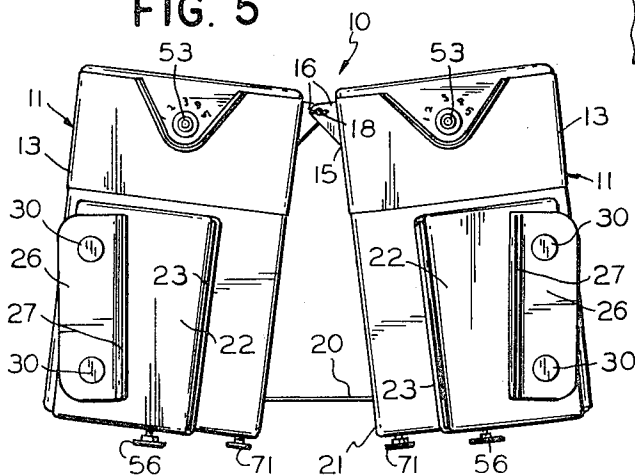


FIG. 5



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THERAPEUTIC EXERCISER WITH REGULATABLE HYDRAULIC TORSIONAL RESISTANCE

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Filed Aug. 19, 1971, Ser. No. 173,127

Int. Cl. A63b 21/22

U.S. Cl. 272—57 A

6 Claims

ABSTRACT OF THE DISCLOSURE

A therapeutic exerciser for active external adductive and abductive rotation of ankles, knees and hips furnishes uniform torsional resistance throughout the complete range of movement thereof. The exerciser includes a pair of floor mounted based members and a rotatable foot-receiving member pivotally mounted on each base member. Hydraulic cylinders mounted in each base member and operatively attached to each foot-receiving member supply constant torsional resistance to each such member throughout the full range of adductive and abductive rotation thereof. A valve is provided to regulate the amount of resistance applied by the cylinders. The exerciser further includes a spring operated plunger in association with each foot-receiving member optionally to lock the same with respect to its base member to permit isometric exercise of the limbs. The distance between base members may be extended selectively to vary the distance between the foot-receiving members.

BACKGROUND OF THE INVENTION

Contact sports and similar activities subject the knee to great stress and frequent injury. Heretofore all knee exercises and indeed all leg exercises were performed merely by opening and closing the knee in a vertical plane, either against a resistance or not.

Knee motion, however, is not a simple hinge action but a spiral (helicoid) movement. As the tibia extends on the femur from a flexed position it also rotates outwardly. Control of excessive outward rotation is primarily by the joint contour and ligament strength, but is enhanced by the muscular action of the internal rotators of the knee. These internal rotators are the medial hamstring group (semimembranosus, sartorius gracilis, and semitendinosus muscles, the vastus medialis). Active external rotation of the knee is through the action of the quadriceps muscle group (primarily the vastus lateralis) and the biceps femoris. In the weight bearing phase of knee motion, the movement becomes one of a synchronous lateral rotation of the tibia with extension of the knee and medial rotation with flexion of the knee. This synchronous action of rotation occurs with the actively contracting quadriceps producing extension and the hamstrings action producing flexion of the knee.

Muscle strength around joints enhance the joint stability and ability to withstand stress. This is particularly important in contact sports where a high incidence of knee injury occurs.

SUMMARY OF THE INVENTION

The therapeutic exerciser of the present invention comprises a floor mounted base member and a pair of rotatable foot-receiving members pivotally mounted on the base member, each of which foot-receiving members is adapted to receive a foot of a person standing on the base member. Means on the base member operatively attached to each of the foot-receiving members supply constant torsional resistance to each such member throughout the full range of adductive and abductive rotation thereof.

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Such means are preferably hydraulic means and are provided with additional means to regulate the amount of torsional resistance supplied.

Means are further provided optionally to lock each of the foot-receiving members with respect to the base member to permit isometric exercise to the limbs. Additionally, the exerciser is provided with means adjustably to extend the distance between the foot receiving members.

The exerciser provides constant resistance to muscle action in the weight bearing phase. A subject standing on the exerciser with the hips and knees flexed has isometrically contracting quadriceps and hamstrings as well as hip flexors maintaining this posture. With active inward and outward rotation of the fixed weight bearing foot, the internal rotators and the external rotators of the tibia are contracted with each movement. The hydraulic resistance produces a load upon these muscle groups to increase strength. Additional load to the extensors, flexors and rotators can be obtained by actively extending and flexing the knees with each movement.

Also acting in the movement of rotation of the legs are the internal rotators of the hip (gracilis, pectineus, adductors, longus and brevis and magnus; gluteus medius and minimus) and the external rotators of the thigh (obturator externus, quadriceps femoris, gemelli obturator internus, piriformis, gluteus maximus). This muscle action can be separated from that of pure knee rotation by having the subject sit on a stool and rotate the knee. Such, however, removes the advantage of the weight bearing phase and synchrony of muscle action.

Concurrently with the above action, isometrically contracted gastrocnemius and soleus action and anterior tibial, posterior tibial and peroneal action is present to maintain foot posture.

Optionally locking the foot-receiving members with respect to the base member to achieve isometric exercise is particularly beneficial after surgery or when inflammation is present in a joint. Exercise may thereby be obtained, yet excessive movement is avoided.

Adjustment of the distance between the foot receiving members to achieve a selectively wider stance makes it possible selectively to bring the aforesaid hip rotators into play.

Regulation of the amount of torsional resistance supplied permits the exerciser to achieve a training effect as well as to provide means of setting a desired torsional resistance.

The exerciser has proven particularly beneficial in instances where there has been hip surgery. The isometric exercise achievable has been found to loosen hip sockets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view, with portions broken away to show interior construction of an embodiment of a therapeutic exerciser according to the present invention, a foot receiving member thereof being illustrated in phantom lines in the extreme positions of adductive and abductive rotation.

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1.

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2.

FIG. 4 is a sectional view taken on line 4—4 of FIG. 1.

FIG. 5 is a plan view of the embodiment of FIG. 1 illustrated to a reduced scale and showing the exerciser in a laterally extended position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the exerciser 10 of the present invention includes a pair of identical floor mounted base members 11 each of which comprises a bottom housing plate 12 and a top housing plate 13 connected to-

gether by threaded fasteners 14. The members 11 are hingedly connected at their forward ends 15 by brackets 16 bolted to the lower housing plates 12 and connected together by a bolt 17 and wing nut 18. A connecting rod 20 adjustably connects members 11 together at their rearward ends 21 in a manner to be hereinafter described.

A pedestal 22 having an inwardly extending vertical flange 23 is pivotally mounted on each base member 11 and is adapted to receive a foot 24 of a user, the inside portion 25 of the foot being retained by the flange 23. A guide 26 also having an inwardly extending vertical flange 27 is mounted on each pedestal 22. Guides 26 are slotted as at 28 and provided with knurled adjusting bolts 30 selectively to regulate the transverse distance between flanges 23 and 27, thereby to accommodate differing shoe widths.

The pedestals 22 are mounted on thrust bearings 31 supported by the top housing plate 13 and retained thereagainst by a bolt 32 received in a bearing 33 disposed in a bracket 34 attached to plate 13 by two screws 35, bolts 32 being retained by a locking screw 36. The bracket 34 is further adapted to serve as a part of the means optionally to lock the pedestal 22 in any desired position, as will be described hereinafter.

A pinion gear 37 is attached to a cylindrical extension 38 depending from each pedestal 22 by two bolts 40 and is rotatable therewith.

A pair of hydraulic cylinders 41, 42 are mounted in each base member 11 symmetrically with respect to the pedestal 22 and disposed one on each side thereof. A piston and rod 43 is received in each cylinder as shown. Each rod 43 is threadedly received in a rack 44 engageable with the pinion gear 37, being retained in the rack by a lock nut 45. A pair of rubber guide rollers 46 mounted on the bottom housing plate 12 and having annular shoulders 47 for cooperative engagement with the racks 44 maintain the same symmetrically in engagement with the pinion gear 37 during rotation of the pedestal 22.

As shown in FIG. 1, both ends of the cylinders 41, 42 are connected by lengths of tubing 50, 51. An adjustable needle valve 52 is disposed centrally of tubing 50 and has adjusting dial 53 exterior of the top housing plate 13 for selective adjustment of the valve 52. By this means it is seen that rotation of a pedestal 22 in either direction causes one of the piston rods 43 to enter into one cylinder 41 of a pair and the other piston rod simultaneously to be withdrawn from the other cylinder 42 of the pair, the tubing 50, 51 permitting the hydraulic fluid contained in the cylinders to be forced from one cylinder through the valve to the other. Obviously, adjustment of the resistance provided by valve 52 selectively adjusts the difficulty required to rotate the pedestals. The use of hydraulic cylinders and their positive rack and gear connection with pedestals 22 in the manner shown makes it possible to supply a constant torsional resistance to each pedestal throughout the full range of rotative motion thereof. A constant torsional resistance is important in apparatus of this type in order to avoid lag, sudden movement and consequent shock especially in cases of surgical repair.

The apparatus is further provided with means optionally to lock the pedestals 22 in any desired rotational position with respect to the base members 11. Such comprises a plunger 55 extending outwardly of each member 11, terminating in an exterior knob 56, and having a tapered inner end 57 engageable between the teeth 58 of the gears 37. A compression spring 60, abutting a plate 61 fixed on each plunger 55 at one end and the interior of the back of the member 11 at the other, urges the plunger through a supporting guide opening 62 in bracket 34 into engagement with the pinion gear 37.

A roll pin 63, inserted through each plunger 55 inwardly of the plate 61, is selectively engageable either with the rear surface 64 of the bracket 34, in which position the plunger 55 is retracted out of engagement with

the pinion gear 37 permitting restrained rotation of the pedestal 22, or is receivable in a vertical groove 65 in surface 64, in which latter position the spring 60 is permitted to force the plunger 55 into engagement with the gear 37 locking the pedestal 22 in whatever rotative position is desired. Pulling the knob 56 outwardly of the base member 11 and rotating the plunger 55 so that the pins 63 abuts the surface 64 of bracket 34 withdraws the plunger from the gear 37 and permits the pedestal to rotate against the resistance furnished by the cylinders 41, 42. If isometric exercise is desired, the pedestals 22 are placed in the desired rotative position with respect to the base members 11, and the knobs 56 are rotated so that the pins 63 fall into the grooves 65 permitting the plungers 55 to engage the gears 37 and lock the pedestals.

As previously mentioned, the base members 11 are connected at their rearward ends 21 by a connecting rod 20 which passes through a slot 69 in a supporting bracket 70 disposed in the rear of each member 11. An adjusting bolt 71 threadedly received in the rear wall 72 of the member 11 and supported in a cylindrical recess 73 in the rear surface 74 of bracket 70 has a shoulder 75 adapted to exert pressure on surface 74 to force bracket 70 forwardly against rod 20 to prevent any motion thereof with respect to bracket 70. By this means the distance between the rearward ends of base members 11 can be adjusted by loosening the bolts 71 and letting the rod 20 pass through the slots 69. Thereafter the bolts 71 can be tightened to lock the rod 20 in position, setting the lateral distance between the base members 11 as desired. FIG. 1 illustrates the exerciser with the members 11 close together. FIG. 5 illustrates the device with the base members 11 in a laterally extended position.

We claim:

1. A therapeutic exerciser for active external adductive and abductive rotation of the legs of a user, comprising:

a floor mounted base member;

a pair of rotatable foot-receiving members pivotally mounted on said base member, each of said foot-receiving members being adapted to receive a foot of a person standing on said base member;

means on said base member operatively attached to each of said foot-receiving members for supplying constant torsional resistance to each of said foot-receiving members throughout the full range of adductive and abductive rotation thereof;

said torsional resistance supplying means comprising

a pair of hydraulic cylinders for each of said foot-receiving members, said cylinders being mounted on said base member one on each side of and symmetrically with respect to each of said foot-receiving members;

a piston member received in one end of each of said cylinders;

conduit means joining said cylinders in each of said pairs at both their ends; and

means to attach said foot-receiving members to said piston members,

whereby rotation of one of said foot-receiving members in either direction causes simultaneous insertion and retraction of the piston members in the pair of hydraulic cylinders associated with said one foot-receiving member to force hydraulic fluid from one of said associated pair of cylinders through said conduit means into the other of said associated pair of cylinders; and

means to regulate the amount of said torsional resistance supplied by each of said torsional resistance supplying means.

2. A therapeutic exerciser as in claim 1 in which said regulating means comprise valve means disposed in said conduit means.

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3. A therapeutic exerciser for active external adductive and abductive rotation of the legs of a user, comprising:

a pair of floor mounted base members;
means to connect said base members together;
pedestal means pivotally mounted on each of said base members;

adjustable foot-receiving means on each of said pedestal means, each of said foot-receiving means being adapted to receive a foot of a person standing on said base member;

a pair of hydraulic cylinders mounted in each of said base members, said cylinders being disposed one on each side of and symmetrically with respect to said pedestal means;

a piston member received in one end of each of said cylinders;

means to attach said piston members to said pedestal means symmetrically with respect to the axis of rotation thereof;

conduit means joining each of said pairs of cylinders at their ends, whereby rotation of one of said pedestal means in either direction causes simultaneous insertion and retraction of the piston members in the cylinders of the pair associated with said one pedestal means to force hydraulic fluid from one cylinder of said associated pair through said conduit means to the other;

valve means disposed in said conduit means to regulate the resistance furnished by said hydraulic cylinders to rotation of said pedestal means;

means selectively to lock said pedestal means to prevent rotation thereof with respect to said base members; and

means associated with said connecting means adjustably to extend the distance between said base members, thereby to adjust the distance between said foot-receiving means.

4. A therapeutic exerciser as in claim 3 in which said base members are hingedly connected at their forward

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ends, said adjustably extending means being disposed at the rearward ends of said base members.

5. A therapeutic exerciser as in claim 3 wherein said means to attach said piston members to said pedestal means comprises:

rack means attached to each of said piston members; gear means attached to said pedestal means; and guide means disposed on one side of each of said rack means and adapted to maintain said rack means symmetrically in contact with said gear means during rotation of said pedestal means.

6. A therapeutic exerciser as in claim 5 wherein said means to selectively lock said pedestal means comprises:

plunger means received in each of said base members, said plunger means being adapted to engage said gear means and lock the same in selected positions of rotation of said pedestal means;

spring means adapted to urge said plunger means into engagement with said gear means; and

means optionally to prevent said plunger means from engaging said gear means.

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U.S. Cl. X.R.

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