

Sept. 22, 1970

A. M. OLSON ET AL
CARDIAC EXERCISER

3,529,474

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3 Sheets-Sheet 1

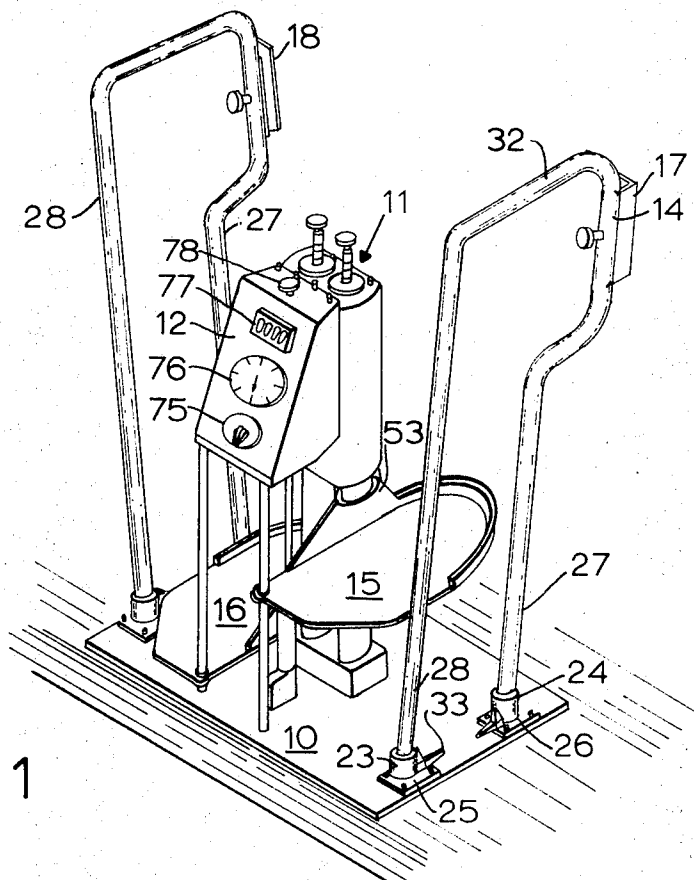


FIG. 1

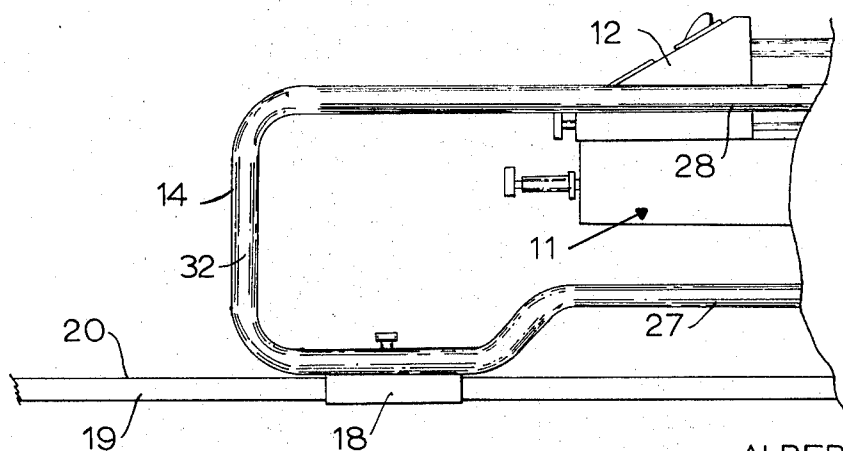


FIG. 2

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FIG. 3

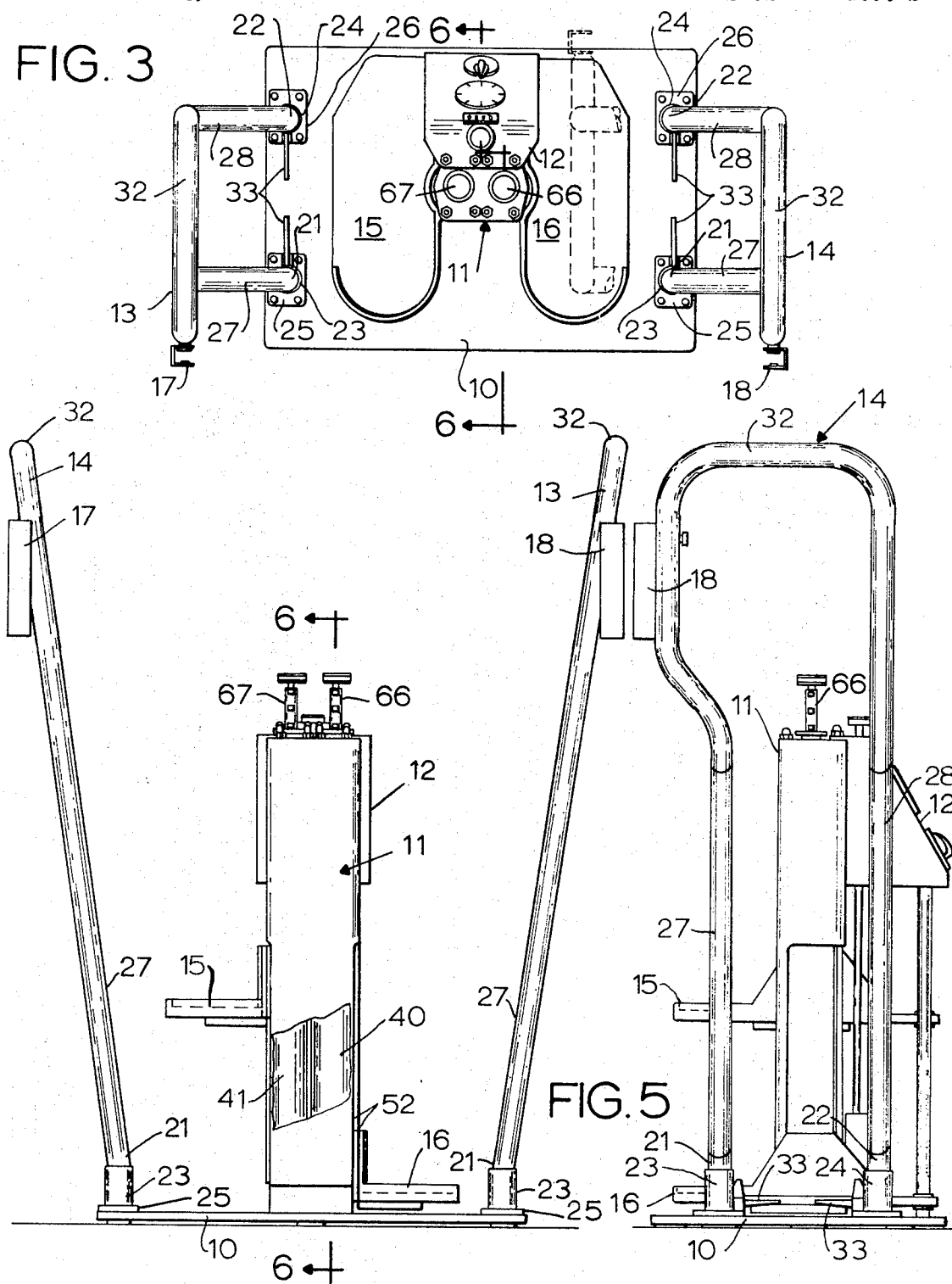


FIG. 4

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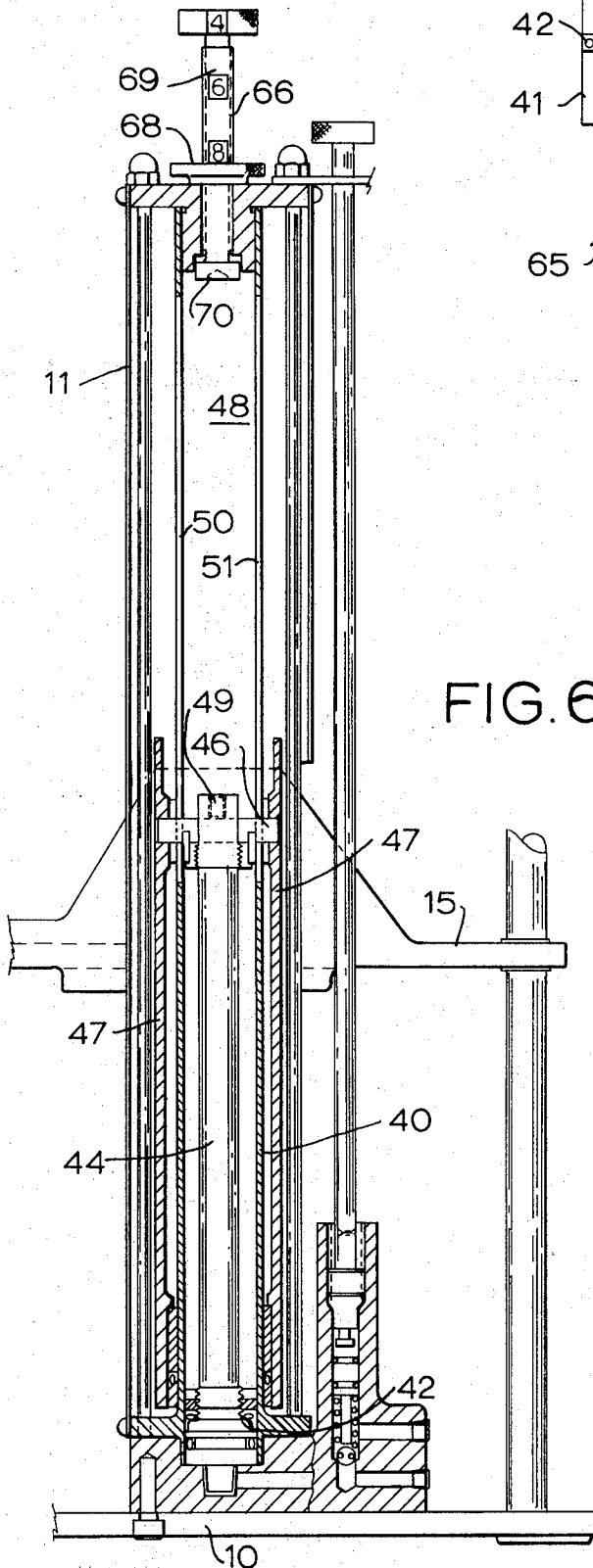


FIG. 6

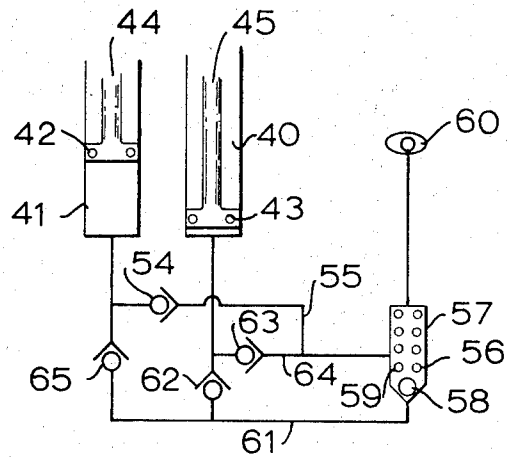


FIG. 7

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CARDIAC EXERCISER

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6 Claims

ABSTRACT OF THE DISCLOSURE

An exercising ergometer. A pair of handrails and a central column are supported on a base. In the column are a pair of hydraulic cylinders, each having a piston and a connecting rod, and a pedal on each side of the column is connected to one connecting rod. There is means for limiting the stroke of each piston and of the pedal associated therewith. An hydraulic circuit connects the two cylinders and includes (a) load valve means for controlling the pressure transmitted, for causing one pedal to rise when the other is depressed and (b) means for measuring the work expended in moving the pedals.

This invention relates to an improved cardiac exerciser.

Heretofore there has been no accurate way of measuring, in small hospitals, clinics, or private cardiologists' offices, the exact amount of energy expended by the exercise which is used in conjunction with electrocardiograph machines. Although tracings were taken before and after exercise, there was, therefore, no way of determining the extent of the exercise which resulted in the changes noted. Attempts to define the extent of exercise by merely counting the number of steps or jogs taken in a walk-in-place or run-in-place exercise, whether timed or not, were not sufficient, because the amount of such exercise depends upon the weight of the person involved. The important thing is the actual energy expended. Such ergometers as do exist have been very expensive, very large, and not suitable for an ordinary physician who must keep his equipment in a relatively small examination room. Some expensive devices designed for physicians have measured degrees of incline and the speed of walk on treadmills but have still not measured the energy expended.

The present invention is a relatively small piece of equipment which measures accurately how much energy is expended during certain exercises, while at the same time being relatively inexpensive and capable of being kept in a doctor's small examination room. With this equipment, an electrocardiogram can be taken before exercise on a normal electrocardiograph machine; then the patient exercised for a definite number of foot pounds of energy per unit of time, and a new electrocardiogram taken for a comparison. Thus the comparison is much more meaningful than when the extent of exercise remained unknown. Similarly, the patient can be placed on a diet to lose a certain amount of weight, or can be placed on a particular therapeutic regimen, and the above procedure repeated to see what improvement has occurred.

The exercising device of this invention is helpful in tracing the origin of chest pains which may be only vague. The patient can be exercised to the point of pain production and a tracing on the electrocardiogram made immediately, so that the doctor can observe both how many foot pounds of energy were expended and also the change in the tracing. Then, following a therapeutic program, a repetition of the test can enable the doctor to see how much more work the patient can do before pain commences or before an electrocardiographic change is

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evident. Heretofore, physicians could only estimate the activity and could not reproduce the same activity at a later date because the patient may have gained or lost an appreciable amount of weight in the meantime. In addition, cardiac output studies can be made during cardiac catheterization, before, during, and after exercise. Heretofore, the available equipment has been clumsy, hard to anchor to an X-ray table, and inaccurate. Equipment embodying the principles of the present invention may be fastened securely to a catheterization table, and may be small enough not to interfere with extensive monitoring equipment. Moreover, it is accurate. Also, simultaneous evaluation of cardiac output and cardiac work can be measured.

The device of this invention can be used both in an upright position, with the patient standing, and in a reclining position, with the patient lying down and exercising only his legs.

The machine also enables adjustment of the amount of work to be done and adaptation to different patients without large or difficult changes in the machine.

Other objects and advantages of the invention will appear from the following description of a preferred form thereof.

In the drawings:

FIG. 1 is a view in perspective of a cardiac exerciser embodying the principles of the present invention.

FIG. 2 is a fragmentary view in side elevation of the upper portion of the exerciser of FIG. 1 as adapted to a prone position, with the apparatus secured horizontally to an X-ray table.

FIG. 3 is a top plan view of the cardiac exerciser of FIG. 1 in upright position.

FIG. 4 is a view in front elevation of the upright cardiac exerciser of FIG. 1.

FIG. 5 is a view in side elevation of the upright cardiac exerciser of FIG. 1.

FIG. 6 is an enlarged view in section taken along the line 6—6 in FIG. 4.

FIG. 7 is a diagram of the hydraulic circuit.

The apparatus, when used in the standing position, incorporates a base 10 which supports the remainder of the apparatus, including a central column or assembly 11, an instrumentation panel 12, handrails 13 and 14, and a pair of pedals 15 and 16. The handrails 13, 14 may be provided with clamps 17 and 18 which may be used to fasten the device in a horizontal position, rather than vertical, as shown in FIG. 2, by clamping the clamps 17 and 18 to the side edges 19 of an X-ray table 20, thereby placing the whole apparatus horizontally. Otherwise, the operation is the same in both positions.

The handrails 13 and 14 are preferably comprised of hollow pipe, each bent to shape to provide a pair of normally vertical base portions 21 and 22 (attached removably to sleeves 23 and 24 of base brackets 25 and 26), and a pair of angularly extending generally vertical portions 27 and 28 which extend up and out to the side and are joined by a top rail 32 to which the patient can hold. The clamps 17 and 18 are mounted to the generally vertical portion 27. The handrails 13 and 14 may be unlocked and removed from the base 10 by releasing a latch mechanism 33 on each bracket 25 or 26.

The central assembly 11 houses a pair of hydraulic cylinders 40 and 41, each having a piston 42 or 43 with a rod 44 or 45 extending therefrom. To each rod 44, 45, near its upper end, is secured a crosshand bar 46 (FIG. 6) to which is attached a guide cylinder 47. An upper part 48 of each cylinder 40, 41 also acts as a guide cylinder having a pair of slots 50 and 51 through which the bar 46 extends and along which it can move up and down. Each guide cylinder 47 is connected by a member

49 to a foot pedal 15 or 16, one for each of the two cylinders 40 and 41.

The hydraulic circuit (see FIG. 7) is such that the left pedal 15, when depressed, also operates to raise the right foot pedal 16; and when the right pedal 16 is depressed, it operates to raise the left foot pedal 15. The hydraulic cylinder 41 for the left pedal 15 is connected by a check valve 65 and conduit 61 to a load valve 56 which includes a chamber 57 with a ball valve 58, normally urged into closed position by a spring 59. From the valve 56 a conduit 64 leads by way of a check valve 63 to the cylinder 40 for the right pedal 16, so that pressing on the left pedal 15 sends a fluid under pressure through the first check valve 65 to the load valve 56 and from there by the check valve 63 to the other hydraulic cylinder 40. Similarly, the right hydraulic cylinder 40 operates the same way through a check valve 62, a conduit 61, the load valve 56, the conduit 55, and a check valve 54, to the cylinder 41.

An adjustable foot-load is provided through the series of check valves and the load valves. As the foot pedals 15 and 16 are worked up and down, the hydraulic piston 42 or 43 on the downstroke forces the fluid to circulate through the check valve 65 or 62 and the load valve 56. The return fluid from the secondary side of the load valve 56 passes through the check valve 63 or 54 and returns to the cylinder 41 or 40 of the upstroke piston. This closed-circuit application has no reservoir or accumulator.

Each of the cylinders 40 and 41 is provided with a step height adjustment member 66 or 67, each of which is provided with a threaded locking device 68 and is adapted to be set in any desired position, the height being indicated on an outside portion 69. A stop 70 engages the top of the rod 44 or 45 when that is at its upper height limit and therefore sets that limit and hence the limit of the stroke.

The unit is self-contained and needs no outside connections, requires no electricity or outside hydraulic or pneumatic equipment. Each of the two pistons 42 and 43 is connected to its respective foot pedal through the guide sleeve 47 which slides on the outside of the cylinder 40 or 41. The cylinders 40 and 41 have two functions: (1) retarding means for the foot-load and (2) as a support and bearing column for the foot pedal step-height travel. Self-lubricated nylon bearings provide a minimum frictional resistance. Dual packings provide effective seal against oil leakage.

The instrument panel 12 includes a timer 75, which may be a clock set in minutes and may or may not be provided with an alarm, depending on what is desired, a gauge 76 for the foot-load in pounds, a cycle counter 77, and a foot-load regulator 78. The cylinder area may be sized to give one p.s.i. on the hydraulic pressure gauge 76 for a one pound foot-load. In this manner the hydraulic gauge 76 shows directly the actual foot pedal setting and enables easy calculation of the energy output.

In use, load valve 56 may be set at a low pressure, the person to be tested steps onto the pedals, and slowly starts stepping up and down as if climbing a stairway. During this preliminary operation the load valve 56 is set by the regulator 78 to a desired gauge pressure which is also the pounds of foot-load for the person being tested. The step cycle counter 77 is set to zero and the timer clock 75 may then be started. Now the exact amount of work output in foot pounds exerted by the person tested can be calculated and recorded for future reference. As an example, a 150-lb. person being tested using a 120-lb. foot-load setting, and the maximum 8-inch step-height, in

ten minutes of test time the step-cycle counter may read 500 cycles. One step-cycle equals 16 inches or 1.33 feet of piston travel. Then the actual energy output is

$$120 \times 500 \times 1.33 = 79,800$$

5 foot-pounds.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

We claim:

1. An exercising ergometer, including in combination: supporting means, a central column supported by said supporting means, a pair of hydraulic cylinders carried by said supporting means, in said central column, each having a piston and a connecting rod, a pedal connected to each said connecting rod, hydraulic circuit means connecting said cylinders and including load valve means for controlling the pressure transmitter, for causing one pedal to rise when the other is depressed, and means for measuring the work expended in moving said pedals.
2. The ergometer of claim 1 having means for limiting the stroke of said pistons and of the pedals associated therewith, for changing the work per stroke.
3. A cardiac exerciser, including in combination: a supporting base, a pair of handrails secured to said base, a central column, supported on said base midway between said handrails, a pair of hydraulic cylinders in said central column, each having a piston and a connecting rod, a pedal on each side of said column, each connected to said connecting rod, hydraulic circuit means connecting said cylinders and including load valve means for controlling the pressure transmitted, for causing one pedal to rise when the other is depressed, and means for measuring the work expended in moving said pedals.
4. The exerciser of claim 3 having means for varying the stroke of said piston and of the pedal associated therewith.
5. The exerciser of claim 3 having means for detaching said handrails from said base.
6. The exerciser of claim 3 having clamping means on said handrails for securing them to a table for horizontal operation, said handrails extending horizontally of the table and said column then likewise extending horizontally.

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