United States Patent

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[54] LUNG EXERCISING APPARATUS AND METHOD

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 680,657, Nov. 6, 1967, abandoned.

[52] **U.S. Cl.** **128/2.08,** 272/57

[51] **Int. Cl.** **A61b 5/08**

[58] **Field of Search** 128/2.08, 2.07, 25, 145.6–145.8; 272/57

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[57] **ABSTRACT**

A device and method for increasing the capacity and strength of lungs having an expansible bellows chamber, an inlet to the chamber connected to a conduit, a mouthpiece at the end of the conduit for breathing into it, and a selectively adjustable valve in the conduit for constricting the passage from the mouthpiece to the inlet, whereby a force in excess of the normal pressure developed by the lungs is required to expand the bellows, and an outlet for said chamber with a valve and variable control therefor adapted to open the outlet when the bellows has been expanded a preselected amount.

11 Claims, 5 Drawing Figures

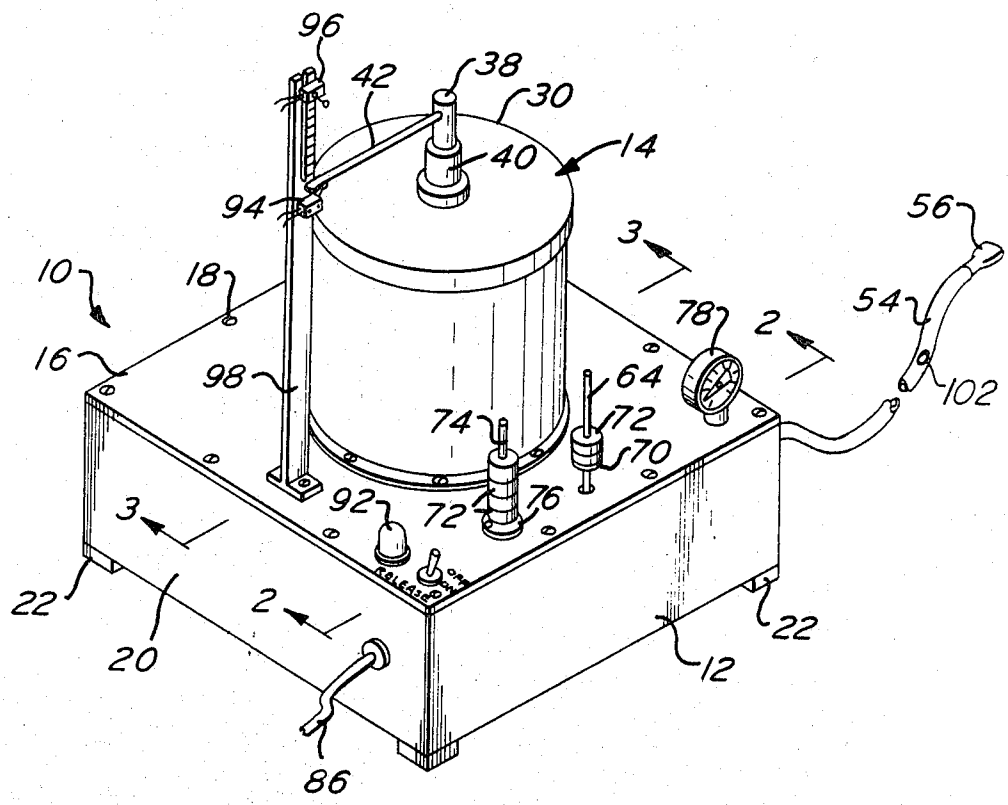
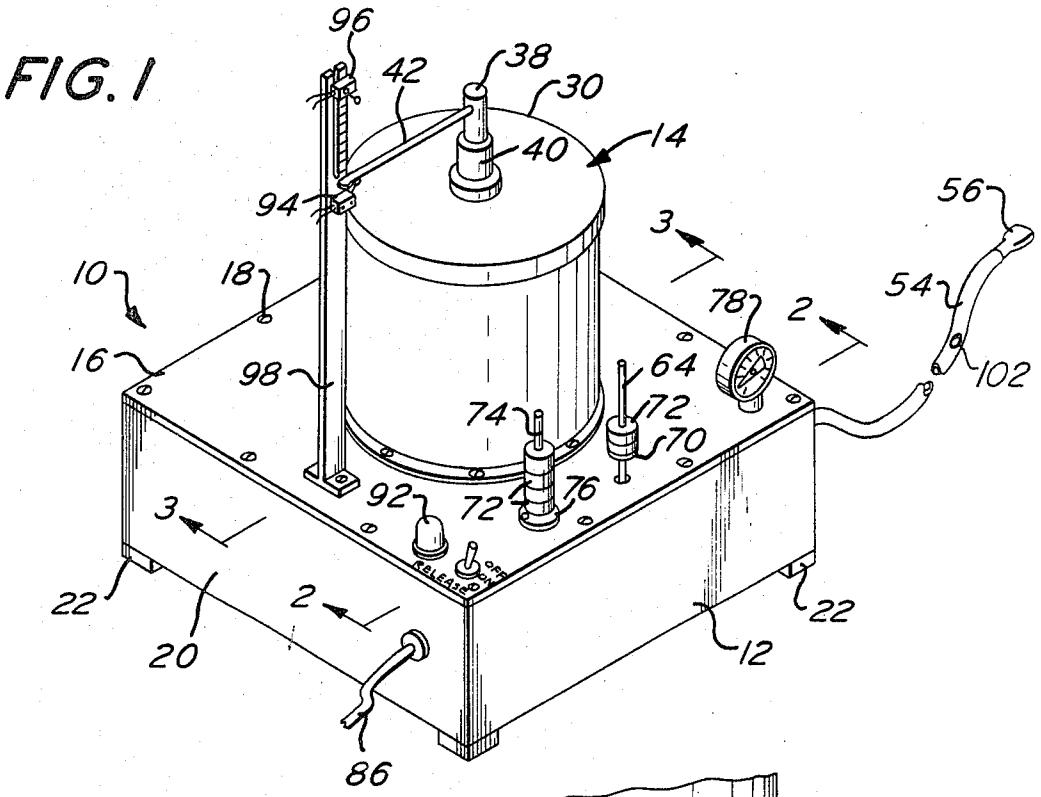


FIG. 1



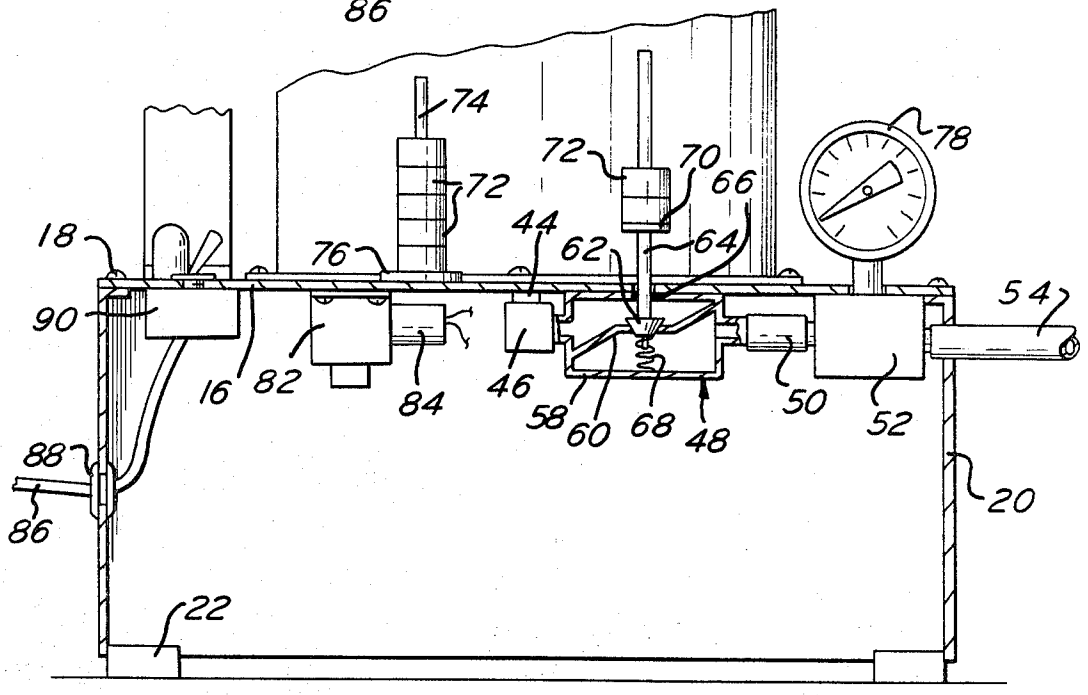


FIG. 2

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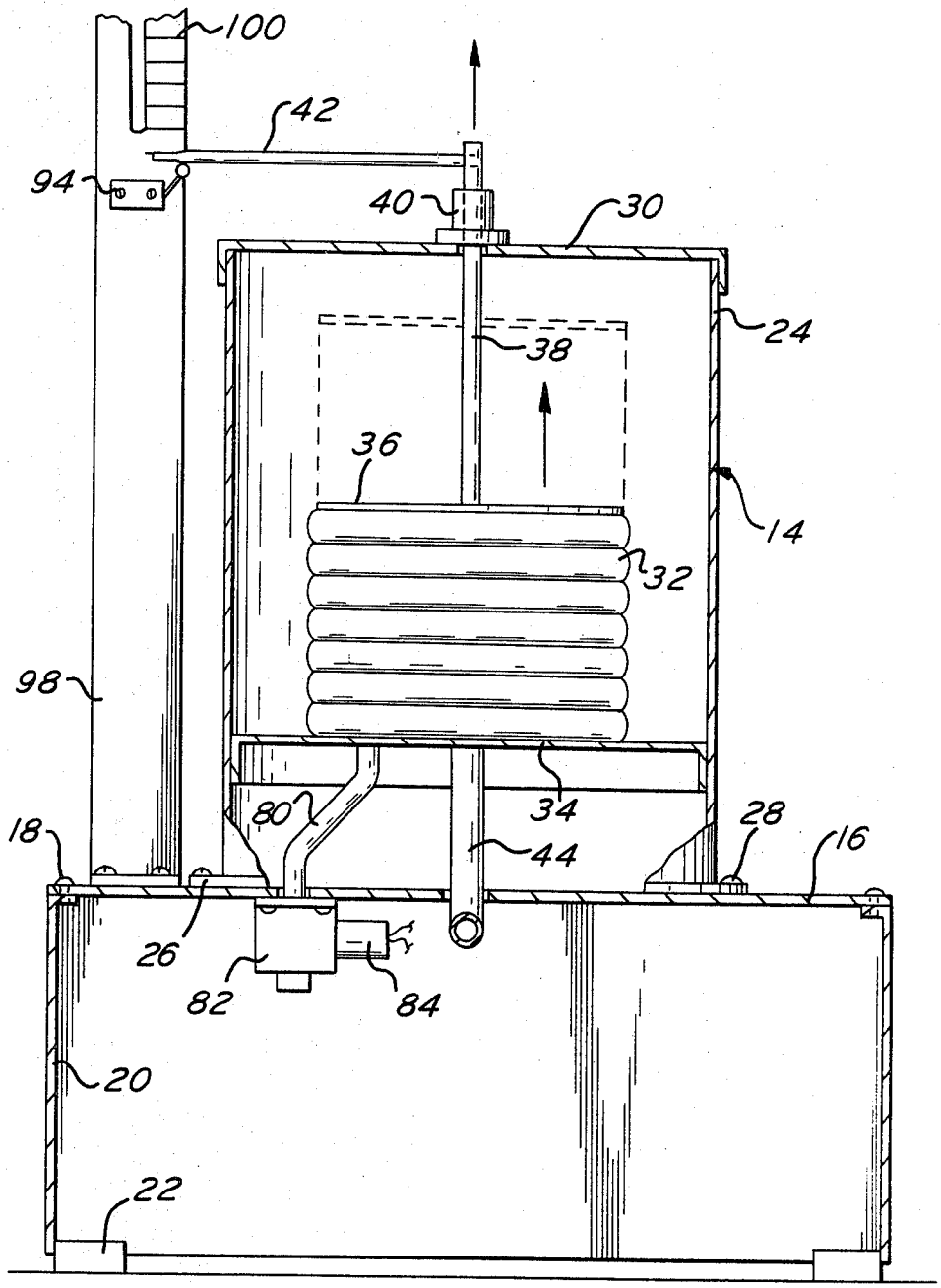

FIG. 3

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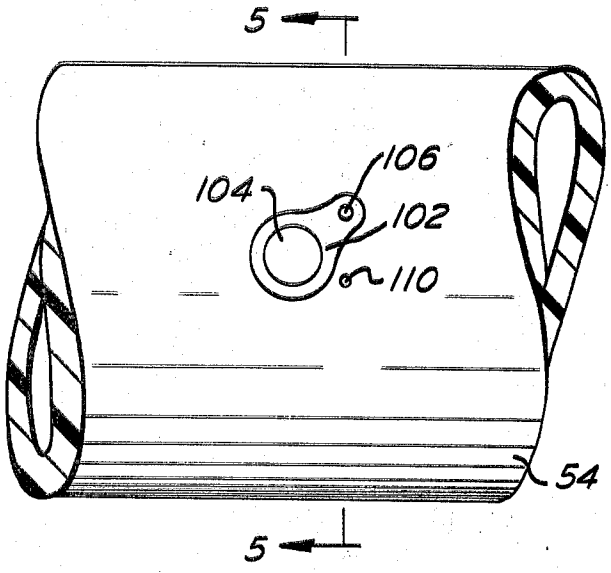

FIG. 4

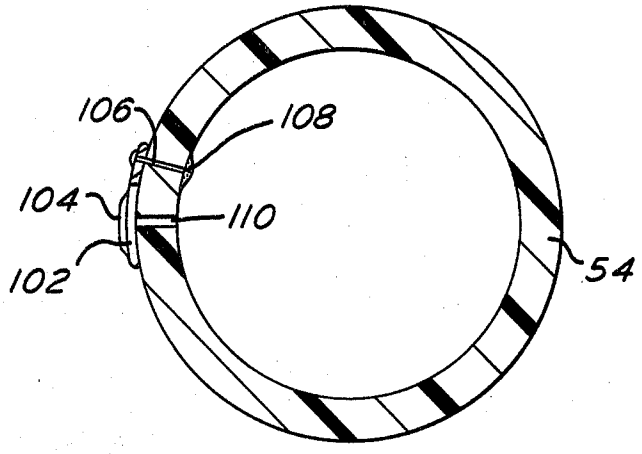

FIG. 5

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LUNG EXERCISING APPARATUS AND METHOD

This application is a continuation-in-part of Ser. No. 680,657 filed Nov. 6, 1967 now abandoned.

This invention relates to a device and method for increasing the capacity and strength of lungs. More particularly, this invention relates to a device and method for exercising the lungs and improving the capacity thereof.

Devices for developing the lungs have been described in the past. Lung devices known in the prior art are lacking in several aspects. They may be capable of increasing the strength of exhalation, but they provide no means for catching the exhaled air to measure any increase or decrease in capacity or volume. The measurement of volume may be just as important as developing increased strength in the lungs. Moreover, it does not follow that developing an increase in the strength of the lungs results in an increase in volume. Another disadvantage of devices in the prior art is the absence of any means for indicating the force required to perform the action. Yet another disadvantage of such devices is the lack of human engineering in that they provide no means for creating an incentive or gauge whereby the user can measure his progress.

The present invention improves upon such prior art devices by overcoming the disadvantage set forth above and providing additional novel, unobvious and advantageous features. As stated above, the present invention increases the strength of exhalation while at the same time catching the exhaled gases and measuring their volume to determine any increase or decrease in exhaled capacity. The exhalation action is resisted by a controllable valve that restricts a passage so that the lungs must work and thereby exercise to perform their function. By providing a means to capture the exhaled air and measure its volume, the present invention measures the increase in lung capacity as well as variations in strength of exhalation.

Another advantage of the present invention is the provision of a means whereby the lungs may develop more contractile strength to be able to force out more carbon dioxide. It is well known that the lungs of a human being do not exhaust to their full capacity with each exhalation. It therefore follows that breathing can be eased for persons of reduced lung capacity by increasing the percentage of captured air and carbon dioxide which they are able to exhaust. This can be done not only by increasing the contractile strength of the lungs but also by increasing the time period of exhalation. The present invention provides a means whereby the user may learn to increase this time period.

Still another advantage of the present invention is to provide a machine which is capable of providing either an isometric, isotonic or isometric-isotonic type of exercise.

These and other advantages of the present invention are secured by providing an expansible chamber in the form of a bellows into which the user may blow through a connected conduit. An adjustable valve designed to restrict the opening in the conduit is positioned between the inlet to the expansible bellows chamber and the mouthpiece of the conduit. By adjusting the opening in the valve, the amount of force required to expand the bellows can be increased or decreased. A pressure gauge is also provided in the conduit between the valve and the mouthpiece. This pressure gauge continuously indicates the amount of pressure being applied by the user and hence is indicative of the strength developed in the lungs. The outlet of the bellows is controlled by a solenoid valve which opens and closes in response to the amount of expansion of the bellows. This control system is designed so that it can be observed by the user and thereby acts as a mental feedback to inspire continued effort. The control is designed so that when the bellows expands to a selected, preset position, the solenoid valve opens the outlet and permits the bellows to collapse.

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a perspective view of a lung device constructed in accordance with this invention.

FIG. 2 is an enlarged partial transverse sectional view of the device shown in FIG. 1 taken along the line 2—2.

FIG. 3 is an enlarged partial transverse sectional view of the device shown in FIG. 1 taken along the line 3—3.

FIG. 4 is an enlarged partial view of the tubing of FIG. 1 showing the bleed-off line.

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4.

Referring now to the drawings in detail, wherein like numerals indicate like elements, there is shown in FIG. 1 a lung device designated generally as **10**. As shown, the device comprises a lower housing **12** and an upper cylindrical housing **14** supported on the top wall **16**. Top wall **16** is removably connected to the remainer of lower housing **12** as by the screws **18**. If desired, resilient legs **22** may be fixed to the bottom of side walls **20**.

As shown, the cylindrical wall **24** of upper housing **14** is connected to the wall **16** by screws extending through the integral flange **26**. Upper housing **14** is closed at the top by a circular top wall **30** which is welded or otherwise attached to the wall **24**.

Upper housing **14** contains an expansible bellows **32** which is mounted on the circular plate **34** which in turn is fixed to the wall **24** above the wall **16**. One end of the bellows **32** is attached to the plate **34** and its opposite end is free to expand within the housing **14** as indicated by the arrow and phantom line. Bellows **32** is sufficiently airtight to perform the functions of this invention and is manufactured in any conventional form, such as with a plastic treated fabric which has been pleated to fold in accordian-like fashion. The free end of the bellows **32** is closed by a lightweight plate **36** which is sealed to the pleated wall and supports the rod **38**. Rod **38** extends through an opening in top wall **30** and is guided by the bushing **40**. A second rod **42** which acts as a pointer is fixed in cantilever fashion from the end of rod **38** and extends parallel to the top walls **30** and **16**.

An opening (not shown) is provided in plate **34** to form an inlet to the interior of bellows **32**. The inlet is connected to a conduit in the form of tubing **44** which is connected to an elbow **46**. Elbow **46** in turn is connected to the valve **48** which in turn is connected to another portion of the conduit in the form of tubing **50**. Tubing **50** is connected to pressure gauge **52** and to another portion of the conduit in the form of tubing **54**. Tubing **54** is connected to the mouthpiece **56**. If desired, all the tubing in the apparatus may be made of a resilient plastic material. In addition, the mouthpiece **56** may also be made of a plastic material.

Valve **48** comprises a valve body **58** which is fixed to the top wall **16** by any conventional means such as a bolt through a stud (not shown). The valve body **58** is divided into an inlet and outlet section by the valve seat **60** which extends across it. A valve head **62** is adapted to be seated in an opening in the valve seat **60**. The opening provides the only communication between the two sections of the valve body **58**. Valve head **62** is connected to a valve stem **64** which extends through an opening in the body **48** and top wall **16** to project above the lower housing **12**. The opening in valve body **58** is sealed by any conventional means such as an O-ring **66**. A spring **68** is connected to the base of valve body **58** and to the valve head **62** as shown. Spring **68** is of the expansion type and normally biases the valve head **62** and stem **68** out of the opening in valve seat **60**. Thus, the valve **48** is normally open.

A flange **70** surrounds and is fixed to the valve stem **64**. The flange **70** functions as a platform to support a plurality of weights **72** which may be selectively positioned on the valve stem **64**. In the embodiment shown, two weights **72** are supported by the flange platform **70**. The weights **72** are preferably cylindrical in shape and provided with central openings which permit them to readily slide onto the valve stem **64**. The unused weights are supported on a rod-like stem **74** which is supported on a base **76** that in turn is fixed to the top wall **16** by any conventional means, such as for example a threaded fastener.

The bias force of spring **68** normally forces the valve **48** completely open by unseating the valve head **62** from the valve seat **60**. In its open position, there is free passage through the conduit defined by the mouthpiece **56**, tubing **54**,

gauge 52, tubing 50, valve 48, elbow 46 and tubing 44 into the interior of bellows 32. The bias force of spring 68 is overcome gradually by adding weights weights 72 to the valve stem 64. As each weight is added to the valve stem 64, the opening defined between seat 60 and head 62 becomes more and more restricted. It therefore becomes more and more difficult for the user to force air through the conduit into the bellows 32. If desired, sufficient weight can be applied to the valve stem 64 to entirely close the valve 48. This also can be done manually by simply pressing down on the valve stem 64.

In the preferred embodiment, the weights 72 are equal. This allows the restriction created by valve 48 to be increased in equal steps so that there is no increase in resistance that makes the forcing of air into the bellows more difficult than any other. The increase in resistance created by valve 48 is therefore linear and the user would know this. This allows the user to mentally know what to expect with each increase and therefore not become frustrated by too great an increase.

Gauge 52 is any conventional type of pressure gauge which will measure and indicate the pressure in the conduit between valve 48 and mouthpiece 56. This pressure is created when the user forces air from his lungs into the conduit against the restrictive force of the valve 48. The amount of pressure is indicated on the gauge dial 78 in any convenient nomenclature, such as pounds per square inch or some other preselected breakdown. The pressure gauge 52 and dial 78 permits the user to clearly observe the amount of force which he is applying. By keeping a record of this force, the user knows whether he is increasing the contractile force of his lungs.

The bellows 32 is also provided with an outlet which is connected through tubing 80 to the solenoid controlled valve 82 which in turn is vented to atmosphere. Valve 82 is normally closed by the solenoid 84 which is controlled in the manner explained below.

Electrical power for operating the solenoid 84 is applied through the conductors 86 which extend through an insulating grommet 88 in side wall 20 and are connected to the control switch 90. Conductors 86 may be connected to any conventional source such as a 120 volt alternating current. Control switch 90 is preferably a three position toggle switch having an off position, an on position and a release position. In the on position, current from the conductor 86 is fed to the pilot light 92 to indicate that the device 10 has been energized. Simultaneously, current is also fed to the microswitches 94 and 96 which control the operation of the solenoid 84 and solenoid valve 82. Microswitch 94 is fixed to an upright bar 98 which is supported on top wall 16. Upright 98 is bifurcated at its uppermost end so that the microswitch 96 may be adjustably positioned along its longitudinal axis. Microswitch 96 is adjustably positioned by any conventional means such as a threaded screw extending through the bifurcated portion. A plurality of graduations 100 are formed on the upright 98. Graduations 100 are preferably scaled to indicate the amount of expansion of bellows 32. The amount of expansion is determined by observing the position of pointer 42 relative to the graduations 100. The pointer 42 is displaced by the rod 38 which in turn is moved by the bellows 32. Accordingly, it is a direct indication of the amount of expansion of the bellows 32.

When the bellows 32 is collapsed, the pointer 42 will engage the toggle of microswitch 94 and close the same to cause a relay (not shown) to close. The relay in turn connects power directly to the solenoid 84 which closes valve 82 and in turn seals the outlet of bellows 32. The relay is preferably connected in a circuit which causes it to latch closed once the microswitch 94 has been engaged by the pointer 42. Thus, pointer 42 functions to trip both switches 94 and 96.

Therefore, the user may blow into the mouthpiece 56 in the manner described above. The combination of air and carbon dioxide forced out of the user's lungs and into the bellows causes it to expand. The amount of such expansion is of course the measure of the capacity of the lungs under the particular condition set by a number of weights 72 on stem 64. As the user forces air and carbon dioxide into the bellows 32 and causes it to expand, the pointer 42 rises. This continues until the user can no longer cause the expansion of bellows 32, preferably, until the pointer 42 engages the toggle of microswitch 96. Thus, it is preferred that the microswitch 96 be set within the bifurcated portion of upright 98 to a position where the pointer 42 will engage it before the user has exhausted his lung capacity. When the pointer engages toggle 96, the latching circuit on the relay is open and the solenoid 84 releases valve 82 causing the outlet from the bellows to also open. The result is that the bellows immediately collapses.

The graduations 100 on the upright 98 permit the microswitch 96 to be adjusted as explained above. The user can therefore slowly increase the amount of expansion of the bellows before the valve 82 opens. By keeping a record of the graduations, the user will have a definite knowledge of how he is improving.

As the user exercises his lungs by continuously exhaling, the pressure exerted by the user will decrease until weights 72 will force valve head 62 into contact with valve seat 60. In order to allow the user the maximum amount of time of exhalation exercise, a bleed-off line is provided which may be activated when the user no longer exerts enough pressure to force valve head 62 out of contact with valve seat 60. This bleed-off line may take the form of a small opening in tubing 54. Because the opening is of such a small size, the exhaled gases lying between valve head 62 and mouthpiece 56 will be gradually rather than rapidly vented to the atmosphere. This allows the user to continue the exhalation process until the dial 78 slowly reaches its zero marking indicating that atmospheric pressure exists between valve head 62 and mouthpiece 56.

This bleed-off line may be located in tubing 54 as is shown in FIG. 1. FIG. 4 shows an enlarged partial view of the tubing of FIG. 1 wherein the bleed-off line is contained. FIG. 5 shows a sectional view taken along line 5—5 of FIG. 4. As shown in FIGS. 4 and 5, tubing 54 has a small opening 110 contained therein. Port opening 110 is sealed off from the atmosphere by cover 102. Cover 102 is affixed to tubing 54 by pin 106. Seal 108 insures that the exhalation gases contained within tubing 54 will not be vented to the atmosphere by the opening in tube 54 caused by pin 106.

When the exhalation pressure is no longer sufficient to force valve head 62 out of contact with valve seat 60, the user may rotate cover 102 about pin 106 in order to provide atmospheric access to port opening 110. The user may readily rotate cover 102 by making finger contact with projection 104 thereon.

Two important advantages are secured by allowing the user to connect the exhalation gases within tubing 54 to the atmosphere through port opening 110 when the exhalation pressure is insufficient to displace valve head 62. Firstly, since port opening 110 is of such a size so that the exhalation gases are not immediately vented to the atmosphere, the user may continue exhaling until the pressure on dial 78 indicates that only atmospheric pressure exists between valve head 62 and mouthpiece 56. This gives the user additional time of exhalation exercise. Secondly, by allowing the user to continue the exhalation exercise, there is no necessity for the user to psychologically prepare himself to stop pushing.

Although the bleed-off line as shown is actuated by the user, it is well within the scope of the invention to have the bleed-off line actuated by other means. For example, the reduction of pressure in the line may be utilized to automatically activate the bleed-off line.

In some instances the user of the machine may not be able to raise the pointer 42 to a position where it strikes the toggle of microswitch 96. This may be the result of taking an insufficient breath or overconfidence in the user's ability. Whatever the reason, the control switch 90 is provided with a third, release position which connects the switch 90 in parallel with the microswitch 96 and unlatches the circuit permitting the solenoid 82 to open and the bellows 32 to collapse. Thus, if the user cannot go on for some reason, the machine can be reset by moving the switch 92 to release position.

The machine can be used to perform isometric exercises with the muscles which contract the lungs. This is accomplished by removing all of the weights from the stem **64** and manually closing the valve **48** by using a finger to force the valve head **62** into the opening in valve seat **60**. In this manner, the user can force air against the closed valve **48** until the dial **78** on gauge **52** indicates a particular pressure and then release the valve **48**. This isometric action builds up a strong tensile strength in the muscle tissue thus allowing an explosive type of contraction when the valve **48** is opened. This explosive type of contraction is helpful in increasing the recoil of the lung tissue.

From the foregoing it should be apparent that the apparatus described herein provides a lung exercising machine which catches the exhaled gases and gives an indication of any increase or decrease in volume. The volume of the exhaled gases is of course directly indicated by the position of pointer **42** in relation to the graduations **100** when it strikes the microswitch **96**. The machine helps the user increase contractile strength in the lungs and thereby increase the ability to squeeze out more carbon dioxide filled gases. Thus, even if the user is not able to increase the volume of his lungs, he can assist his ability to breathe.

Another advantage of the present invention is that it enables the user to increase the time of exhalation. Time of exhalation is directly related to the contractile strength in that it increases the amount of carbon dioxide filled gases that can be exhausted. The user may observe the rise of the pointer **42** and and the indicated pressure on the dial **78**. This knowledge, when fed back to the user, acts as a incentive to continue blowing into the mouthpiece **56** and therefore increase the time of exhalation.

The present invention may be used in combination with inhalation devices which meter drugs or other chemicals into the user's lungs. Thus, both inhalation and exhalation therapy can be simultaneously applied.

Another advantage of the present invention is that the adjustability of microswitch **96** permits the user or supervisor to preset the system so that only a certain volume of exhaled air is required before the system automatically exhausts. The benefit of this is that it eliminates any possibility of hyperventilation of the user's lungs or otherwise results in overexertion.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof.

I claim:

1. A lung exercising device comprising an expansible chamber, said chamber having inlet and outlet openings to permit the passage of gaseous fluid into and out of said chamber, means coupled to said chamber for sensing expansion of said chamber to a predetermined volume, an inlet conduit connected to said inlet opening, an inlet valve in said inlet conduit, said inlet valve being movable in a range between open and closed positions, first means for yieldably retaining said inlet valve in its open position to permit gaseous fluid to enter said chamber, restraining means to act oppositely of said first means for selectively urging said inlet valve through said range toward its closed position, an outlet valve, said outlet valve being connected to said outlet opening, actuable means coupled to said outlet valve, and said actuable means is operative to open said outlet valve when said sensing means senses said predetermined volume so that said gaseous fluid is exhausted from said chamber.

2. A lung exercising device in accordance with claim **1** wherein said inlet valve includes a vertically disposed, elongated stem, with said valve stem said restraining means include a plurality of weight means associated with said weight means being operative to selectively displace said elongated stem in response to the weight of said weight means.

3. A lung exercising device in accordance with claim **1** including a mouthpiece, a conduit connecting said mouthpiece to said inlet valve, and a pressure gauge connected between said inlet valve and said mouthpiece.

4. A lung exercising device in accordance with claim **3** wherein said conduit connecting said mouth piece to said inlet valve defines an aperture connecting its interior with the atmosphere, said aperture being disposed intermediate said pressure gauge and said mouth piece, and means for selectively closing said aperture.

5. A lung exercising device comprising a bellows, said bellows having inlet and outlet openings to permit the passage of gaseous fluid into and out of said bellows, an inlet conduit connected to said inlet opening, an inlet valve in said inlet conduit, said inlet valve being movable in a range between open and closed positions, first means for yieldably retaining said valve in its open position to permit gaseous fluid to enter said chamber, restraining means to act oppositely of said first retaining means for selectively urging said inlet valve through said range toward its closed position, a rod connected to said bellows for movement therewith, said rod supporting trip means, an outlet valve connected to said outlet opening, said outlet valve being movable between open and closed positions, an actuator for opening and closing said outlet valve, first and second spaced switches operably connected to said actuator for respectively opening and closing said outlet valve, means for supporting said switches adjacent said bellows for engagement by said trip means upon expansion and contraction of said bellows for selectively energizing and deenergizing said actuator, and at least one of said switches is adjustably mounted on said supporting means so that its position can be adjusted with respect to said other switch.

6. A lung exercising device comprising an expansible bellows chamber, said bellows having a fixed wall and a movable wall and having inlet and outlet openings for gaseous fluid, a conduit connecting said inlet to a mouthpiece, an inlet valve in said conduit for restricting the flow of gaseous fluid into said bellows, said inlet valve being movable in a range between open and closed positions, means for normally biasing said inlet valve to its open position, said inlet valve including a movable portion and an elongated stem extending therefrom, weight means on said stem for opposing the force of said biasing means so that said valve may be selectively moved through said range to its closed position, an outlet valve movable between open and closed positions connected to said bellows outlet for venting said bellows to the atmosphere, an actuator, said actuator being operably connected to said outlet valve for moving it between said open and closed positions, support means, first and second spaced switches disposed in spaced linear relation to the direction of expansion of said bellows on said support means, trip means connected to said movable wall of said bellows for engaging and operating said switches when said bellows expands and contracts, said trip means including a rod positioned to engage said switches, and at least one of said switches includes adjustable mounting means for changing its position on said support relative to said other switch.

7. A lung exercising device comprising an expansible chamber, said chamber having an inlet and an outlet for gaseous fluid, a conduit, said conduit having one end connected to said inlet so that gaseous fluid may be conducted into said chamber, an inlet valve in said conduit, said inlet valve being movable in a range between open and closed positions, means for biasing said inlet valve to said open position; weight means for selectively positioning said valve against the force of said biasing means in said range to restrict the flow of gaseous fluid into said expansible chamber, an outlet valve coupled to said outlet, said outlet valve being operative to vent said chamber to atmosphere, sensing means for sensing expansion of said chamber to a predetermined volume, and means for opening said outlet valve in response to signal means from said sensing means when said chamber has expanded to said predetermined volume.

8. A method for increasing the capacity and strength of the lungs comprising the steps of filling the lungs with air, forcing the air out of the lungs and through a conduit with sufficient force against a member in said conduit to dis-place and flow

past said member, said member having means for resisting said displacement, collecting the air forced out of the lungs and past said member, measuring the amount of air collected, recording the amount, and repeating each of the foregoing steps.

9. A method in accordance with claim **8** including the step of varying the resistance of said means for resisting said displacement of said member after each repetition of said method so that the amount of force required to displace said member is varied.

10. A method of exercising the lungs comprising the steps of repeatedly exhaling gases from the lungs into conduit means, utilizing the exhaled gases to open a pressure responsive valve in said conduit means which is biased to a normally closed position, utilizing the exhaled gases passing through said valve to expand an expansible chamber, and opening a second valve disposed before said pressure responsive valve when the pressure of said exhaled gases fall below a pressure sufficient to maintain said pressure responsive valve in an open condition.

11. A method of exercising the lungs in accordance with claim **10** including the step of measuring the volume of gases passing into said expansible chamber.

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