Nov. 17, 1953 P. M. W. BRUCKMANN 2,659,364

COUGHING VALVE

Filed Oct. 16, 1952 2 Sheets-Sheet 1

Fig. 1

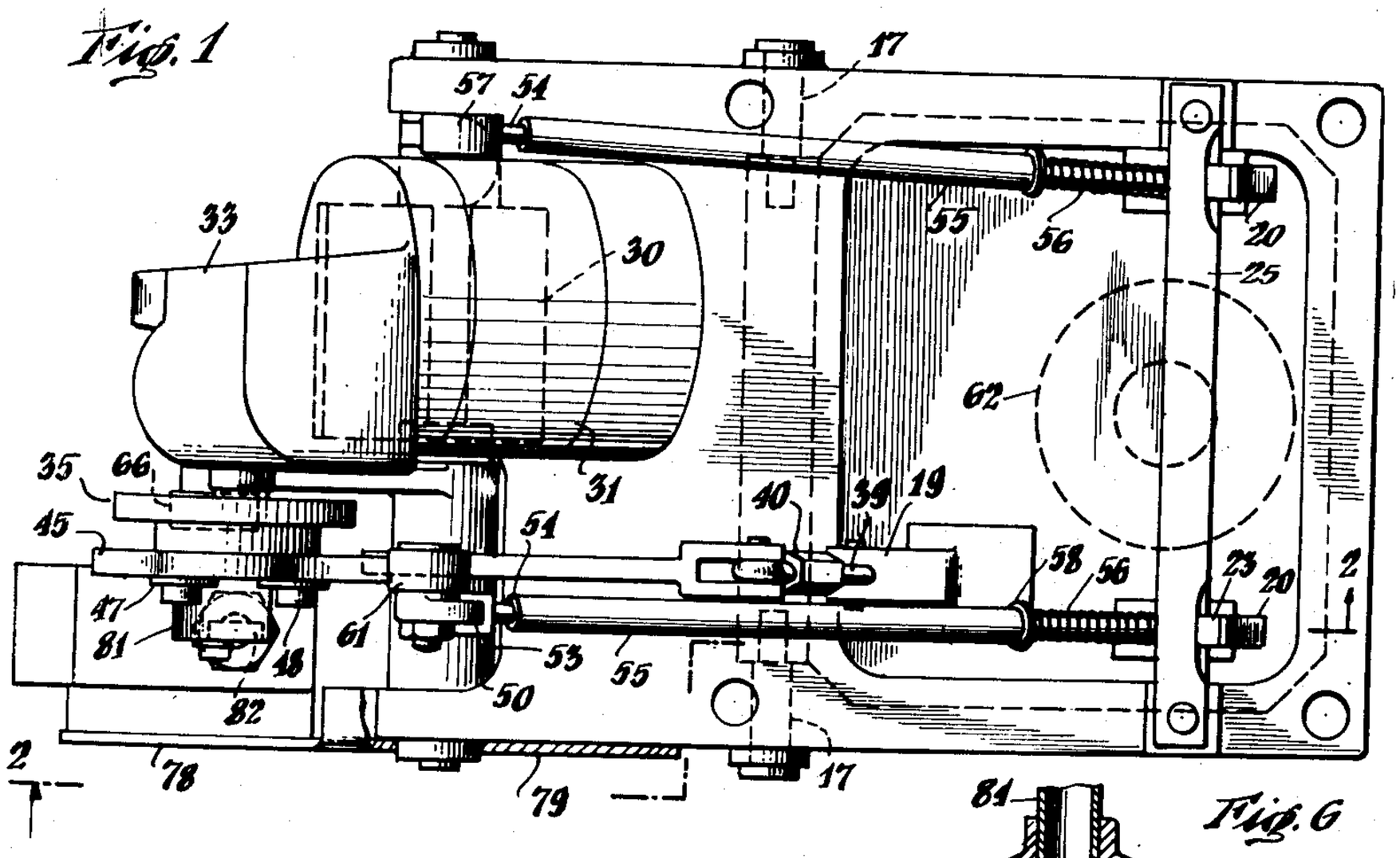

Fig. 6

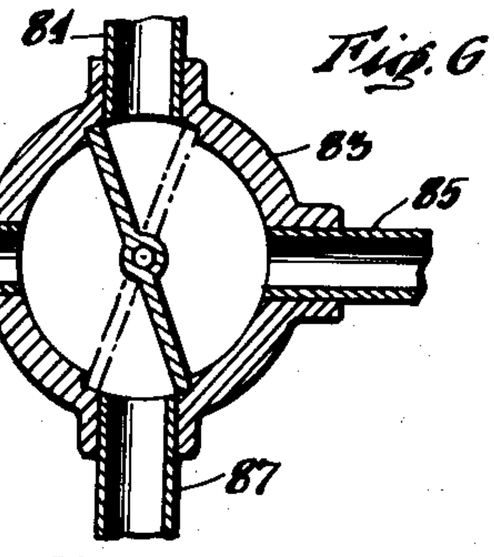

Fig. 4

Fig. 5

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Fig. 2

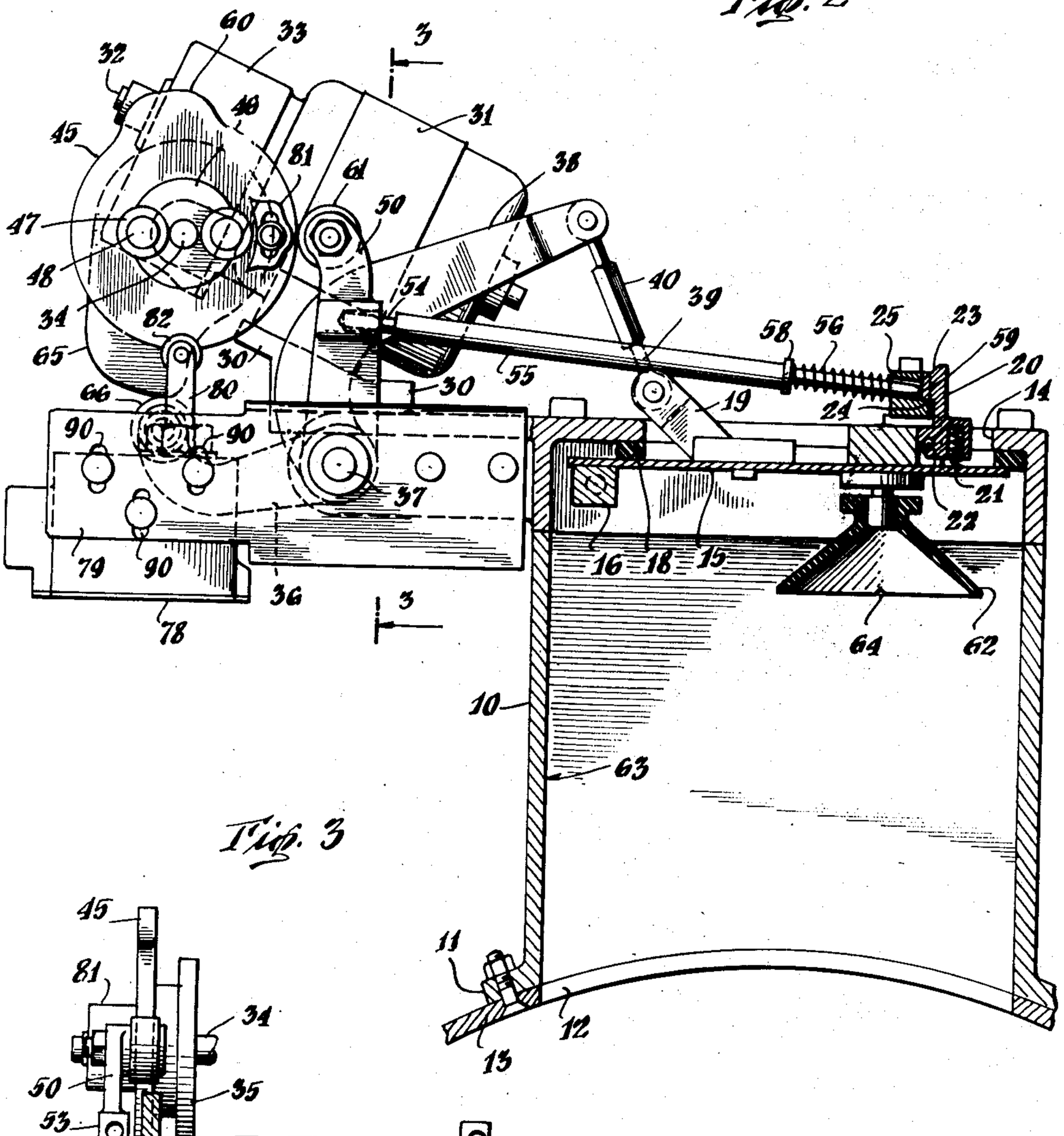
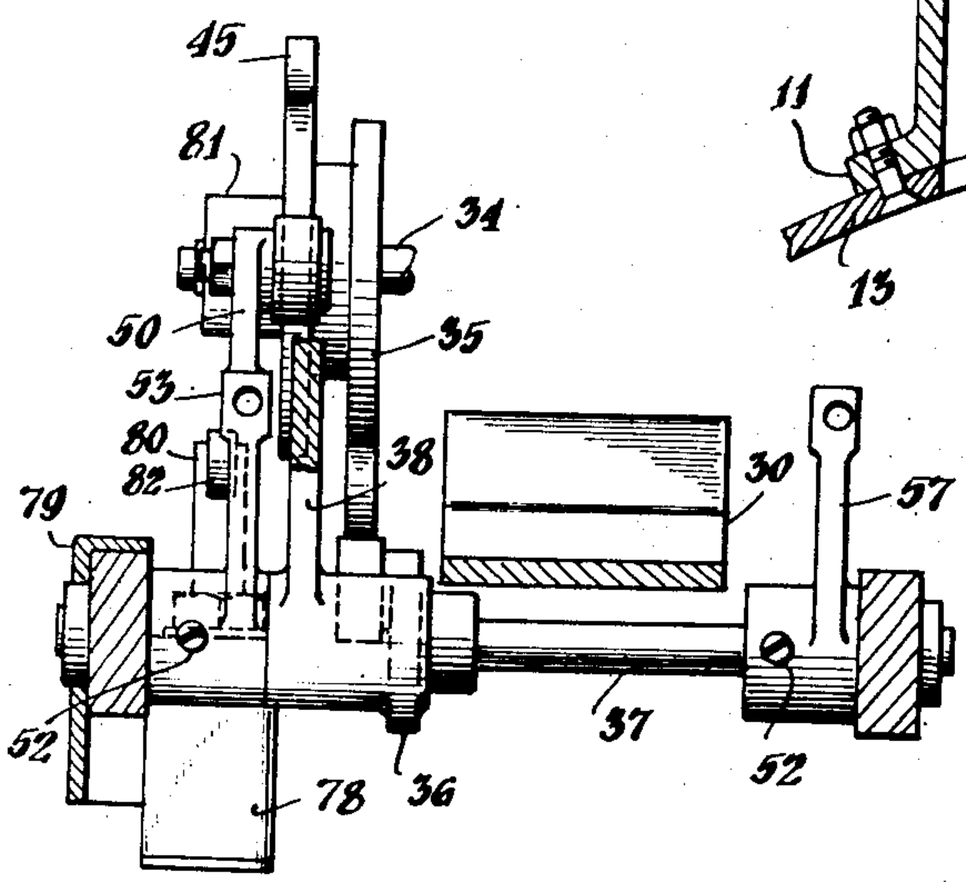


Fig. 3



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UNITED STATES PATENT OFFICE

2,659,364

COUGHING VALVE

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16 Claims. (Cl. 128—30)

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This invention pertains to a mechanism to be used with an iron lung, or like hospital equipment, for the purpose of simulating a cough so as to force air out of the lungs of the patient at a velocity approximating that which is produced during a normal cough.

It is known that there are many cases where patients become clogged with liquids because of inability to cough in a normal way and the artificial coughing produced by the use of my invention, results in a very great benefit.

It has been determined that a cough can be simulated in an iron lung or other housing in which the chest and abdomen of the patient can be placed, with the head outside the unit, by evacuating the area around the outside of the body and suddenly restoring atmospheric pressure by releasing the vacuum. In operation this sudden release of vacuum and corresponding rise in pressure to full atmospheric condition forces the air out of the lungs at a velocity approaching that which is produced during a normal cough.

In order to successfully perform artificial coughing it is necessary to create and release the vacuum in a time cycle and it is important to the result that the vacuum be released as suddenly as possible.

Iron lungs as usually constructed, and found widely distributed in hospitals and like institutions, are ordinarily made with a rubber curtain or the like at one end which is fitted closely around the neck of the patient so that his head is outside and so that air pressure can be maintained and varied inside the lung. The iron lungs have one or more hand holes provided with a cover plate usually held in place against a flange on the iron lung by four (4) screws and knurled nuts, so that they can readily be unscrewed and the cover lifted off to open the hand hole port.

According to my invention I have provided a unitary coughing mechanism which in the preferred form has a flanged housing which fits over the open hand hole port of the iron lung and can be attached thereto by the same nuts which normally hold the hand hole cover in place. Thus, the standard form of iron lung can be used for various purposes and when desired the coughing valve mechanism of my invention may be readily attached thereto.

The coughing valve mechanism consists of a housing with a relatively large valve, means for opening the valve to release vacuum from —40 to 0 mm. of Hg in six hundreths (.06) second.

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The method of artificial coughing can be made still more effective by enclosing the head of the patient in a separate chamber and iron lungs of recent models are provided with such a head canopy as standard equipment. The head chamber is separately sealed and is equipped with a solenoid operated valve, which is normally open. A vacuum pump is connected to the canopy and may run continuously so that it evacuates the head canopy for as long as the solenoid operated valve is closed. By using the head canopy and closing the solenoid valve therein, at the same moment that the main coughing valve connected with the iron lung, is opened, a vacuum is set up at the mouth of the patient just as atmospheric pressure is built up over the chest and abdomen of the patient in the iron lung, with the result that the velocity of air through the bronchial tubes is further increased.

The invention will best be understood if the following description is read in connection with the accompanying drawings in which,

Fig. 1 is a plan view of the valve mechanism;

Fig. 2 is an elevation of the same, shown partially in section on the line 2—2 of Fig. 1;

Fig. 3 is a sectional elevation of the operating mechanism taken on the line 3—3 of Fig. 2;

Fig. 4 is an elevation showing the valve in two positions, partially open and wholly open, together with the valve operating mechanism. This elevation is partially in section to show the interior of the valve housing;

Fig. 5 is an elevation illustrating in outline an iron lung having a head canopy with a solenoid valve, and the coughing valve mechanism, shown in Figs. 1 to 4, inclusive, is mounted on the iron lung; and

Fig. 6 shows a 4-way valve which may be used when both the iron lung and the head canopy are connected to a single vacuum pump.

Referring to the drawings, the valve mechanism illustrated in Figs. 1 to 4, inclusive, comprises a housing 10 having a flange 11 adapted to fit over one of the hand holes 12 of an iron lung shown in Fig. 5 and indicated at 13 in Fig. 2. The housing is bolted in place, with the usual gasket (not shown) to make the joint airtight by means of the same nuts and bolts which normally hold the hand hole cover in place. The outer end of the housing directly opposite the hand hole is provided with a port 14, which is adapted to be closed or opened depending on the position of a valve 15, which is hinged at 16 on hinge pins 17.

The valve closes against a rubber gasket 18, or the like, and has mounted on its outer side, a lug 19 and a pair of latches 20 which are loaded by springs 21 and are mounted on pivots 22 and have outer beveled edges 23. A single latch may be substituted if desired. When the valve is closed firmly, the latches spring back and then hold the valve in position by hooking on to a ledge 24 of a cross bar 25 extending across the valve opening. Attached to the frame of the housing and to one side of the valve opening is a base 30 on which a small electric motor 31 is mounted. The motor shaft 32 is coupled through a conventional gear mechanism 33 to a cam shaft 34. Cam 35 is mounted on shaft 34 and fastened in place by a lock screw. A cam follower 36 which is mounted to rotate through a small angle about shaft 37, comprises a lever arm 38 connected to the lug 19 on the valve by a link 39. The length of link 39 may be adjusted by turning the nut or union 40, into which the two ends of the link are threaded by left and right hand threads in the usual manner. When the valve is in the closed position where it is held by the latches 20, the cam 35 is so shaped that the follower 36 leaves the cam surface.

Another cam 45 is adapted to open the valve and is concentrically mounted with the cam 35 and is rotatably adjustable with reference to it. This is arranged by a concentric flange 46 on cam 35, the cam 45 being bored out to fit on to the flange. Cam 45 is fixed in any desired position with reference to the cam 35 by lock washers 47, which are tightened against its sides by bolts 48. By loosening the bolts and adjusting the cams relative to one another, it is possible to vary the time the valve stays in the open or closed position in each cycle. This adjustment provides the time ratio of inhale to exhale periods for the patient.

Cam 45 has a follower 50 affixed to the shaft 37 by means of set screw 52, arranged so that as the follower rides up over the cam surface, the shaft 37 rotates.

A second crank 57 is also attached to the shaft 37 by set screw 52. The cam follower 50 and the crank 57 have corresponding sockets 53, into which the ends 54 of latch releasing rods 55 extend loosely. The opposite ends of the latch releasing rods have springs 56 mounted thereon which press the cam follower 50 against the cam surface. This is accomplished by mounting the springs 56 on the releasing rods 55 between shoulders 58 and the bar 25, which has loose holes through which the outer ends of the releasing bars extend into contact with the faces 59 of the latches 20 when the valve is closed and latched.

The cam follower 50 and the crank 52 may be adjusted to act concurrently and actuate the latch releasing rods simultaneously, by loosening the set screws 52 and setting the parts 50 and 57.

The electric motor 31 is provided with a rheostatic control equipment to control the speed of the output shaft between 5 and 11 revolutions per minute, so that the coughing cycle best adapted to the patient may be selected.

The coughing valve mechanism operates as follows:

Assuming that the valve 15 is shut as shown in Fig. 2 and that there is a substantial vacuum existing in the iron lung, then as the motor rotates and the extended surface 60 of the cam 45 contacts the roller 61 on the cam follower 50, the latter is forced towards the valve, rotates the shaft 37 slightly in a clockwise direction and thereby pushes the latch release rods 55 outwardly and compresses the springs 56. The ends of the release rods thus force the latches 20 back against the pressure of springs 21 and the valve is suddenly released and immediately and rapidly swings open as shown in Fig. 4 due to the normal atmospheric pressure on its outer surface.

To prevent the valve from chattering or swinging partially closed on the rebound and thus to keep it fully open so that the patient will get the full force of the change from vacuum which previously existed in the iron lung to atmospheric pressure admitted through the valve, the valve is provided with a suction cup 62 formed of rubber or the like, which is adapted to be expanded against the side wall 63 of the housing.

The cup is preferably provided with one or more small notches 64 designed to limit the time during which the valve is held in wide open position and thus not interfere with the closing of the valve which is the next step in the operation.

As the output shaft continues to rotate at the speed determined by the rheostatic controller, the projection 65 of the cam 35 engages the roller 66 of the cam follower 36 and causes the lever 38 to exert tension on the line 39 so as to pull the valve closed.

When the valve swings closed the bevelled edges 23 on the latches 20 come in contact with the bar 25 and are thus released and then snap closed by hooking on to the ledge 24 of the bar 25. As long as the motor continues to drive the mechanism this cycle is repeated.

The periodicity of the cycle is determined by the speed of the motor which is adjustable, as already described. The ratio of inhale to exhale in each cycle is determined by the relative setting of cam 45 to cam 35.

Thus the attending physician determines, in accordance with the needs of the patient, the length of the run, the periodicity of the cycle and the ratio of inhale to exhale in each cycle.

In all cases the valve is opened suddenly and rapidly and held wide open so that the full effect of the change of pressure is felt by the patient. Thus the various objects of my invention are fully met.

Figs. 5 and 6 illustrate an iron lung of modern type, having a main section 70 which is largely employed for hospital use either without or with a head canopy 71. The lung can be opened along the joint A—A to permit the patient to enter, whereupon a flexible curtain, not shown, is fitted around the patient's neck to inhibit air passing between the body of the iron lung and the head canopy. The moving valve mechanism illustrated in Figs. 1 to 4 is indicated as attached to the lung at 72, hand holes are shown at 73 and 74, vacuum pump 75 is connected to the iron lung and a second vacuum pump 76 is connected to the head canopy.

A butterfly valve 77 is arranged to open and close the head canopy to the outside atmosphere. A spring 91 tends to hold the valve 77 open and a solenoid 92 closes it when energized.

When the valve mechanism of my invention is employed with both the iron lung and the head canopy, it is provided with a microswitch 78, which is attached to the frame of the valve mechanism and consists of a plate 79, having a cam follower projection thereon 80, which extends toward the center of the cam shaft 34 and is actuated by a small adjustable cam attachment 81

having a slight circumferential adjustment and mounted on the cam 45.

The plate 79 is mounted so as to have a radial adjustment and the microswitch is closed when, and remains closed so long as, the cam attachment 81 is in contact with the roller 82 at the outer end of the projection 80. The microswitch is not shown in detail but is spring pressed to open position and is closed when the cam follower is depressed by cam 81.

The cam 81 is so set with reference to the cam 45 that the microswitch is actuated so as to close the butterfly valve 77 on the head canopy at the instant that the main coughing valve 15 is opened.

Upon release of the microswitch when the cam member 81 has passed the cam follower 80, the butterfly valve 77 immediately reopens to the atmosphere.

When the butterfly valve 77 is closed the vacuum pump 76 immediately exhausts the head canopy so that when air pressure is exerted on the patient's lungs and abdomen in the iron lung 70, his bronchial tubes and other head passages are subjected at the same instant to vacuum, thus increasing the effectiveness of the cough.

The adjustment between cams 35 and 45 to vary the inhale and exhale periods of the coughing cycle, does not affect the relation between the opening of the main valve and the head canopy valve which is independently adjustable by varying the position of the cam 81 on the cam 45 and by varying the position of the switch 80 closer to or further away from the cam 81 as herein described.

As an alternative arrangement, it is quite feasible to use a single vacuum pump in which case the main pump 75 attached to the iron lung is provided with a 4-way valve 83 in the intake throat 84, as shown in Fig. 6. The four-way valve housing is connected on one side to the vacuum pump and on the other side to the atmosphere. When the valve is in position, as shown in the full lines in Fig. 6, the pump exhausts from the iron lung 70 through a port 85 and when the valve is in the opposite position as shown in dotted lines in Fig. 6, the vacuum pump exhausts from the head canopy through a port 86. When the port 85 is connected to the vacuum pump, the port 86 is connected through the valve to air inlet port 87 and when the head canopy port 86 is connected to the vacuum pump, the lung 35 is connected to the atmosphere through port 87.

The butterfly valve as illustrated in Fig. 5 or the four-way valve as illustrated in Fig. 6 are actuated electrically by the action of the microswitch in complete synchronism with the coughing valve mechanism.

While it is now believed to be best to actuate the butterfly valve or the four-way valve at the instant that the main valve of the coughing valve mechanism is actuated, it is possible to adjust the position of the cam 81 circumferentially on the cam 45 to a slight extent in one direction or the other so as to actuate the solenoid valve a little before or a little after the main valve is open. The microswitch itself can be adjusted since it is bolted to the frame through parallel slots 90 to a position either slightly closer to or further from the cam 81 and in this way the time interval during which the switch remains compressed can be varied.

While certain embodiments of my invention have been described in detail in the foregoing

specification, for the purpose of fully describing the invention, it is to be understood that my invention is not limited thereto, but includes all changes and modifications which fall within the scope of the appended claims.

I claim:

1. A coughing valve mechanism adapted to be readily attached to or detached from an iron lung, comprising a housing which connects with the interior of the lung, an intake opening in the housing, a valve mounted on the housing and adapted to be seated to cover said opening, means for cyclically closing the valve, latches for holding the valve closed against external air pressure, and means coordinated with the closing means for releasing the latches to suddenly open the valve.

2. A coughing valve mechanism adapted to be readily attached to or detached from an iron lung, comprising a housing which connects with the interior of the lung, an intake opening in the housing, a valve mounted on the housing and adapted to be seated to cover said opening, means for cyclically closing the valve, latches for holding the valve closed against external air pressure, means coordinated with the closing means for releasing the latches to suddenly open the valve, and means for positively holding the valve fully open for a limited time.

3. A coughing valve mechanism adapted to be readily attached to or detached from an iron lung, comprising a housing which connects with the interior of the lung, an intake opening in the housing, a valve mounted on the housing and adapted to be seated to cover said opening, means for cyclically closing the valve, latches for holding the valve closed against external air pressure, and means coordinated with the closing means for releasing the latches to suddenly open the valve, means for holding the valve open for a limited time, the aforesaid means for opening and closing the valve being coordinated and adjustable relative to each other to determine the time during which the valve remains closed in each cycle.

4. A unitary coughing valve structure adapted to be readily attached to or detached from an iron lung having a hand hole port and removable cover, comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor, means actuated by the motor for closing the valve, latches for holding the valve closed against the external air pressure, and means also actuated by the motor for releasing the latches to suddenly open the valve.

5. A unitary coughing valve structure adapted to be readily attached to or detached from an iron lung having a hand hole port and removable cover, comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor, a cam rotated by the motor to cyclically close the valve, latches for holding the valve closed against the external air pressure, another cam also rotated by the motor for releasing the latches to suddenly open the valve.

6. A unitary coughing valve structure adapted to be readily attached to or detached from an

iron lung having a hand hole port and removable cover, comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor, and a cam rotated by the motor for cyclically closing the valve, latches for holding the valve closed against the external air pressure, another cam also rotated by the motor for releasing the latches to suddenly open the valve.

7. A unitary coughing valve structure adapted to be readily attached to or detached from an iron lung having a hand hole port and removable cover, comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor, means actuated by the motor for closing the valve, latches for holding the valve closed against the external air pressure, means also actuated by the motor for releasing the latches to suddenly open the valve, a suction cup adapted to hold the valve open for a limited time to prevent fluttering, said actuating means being operatively coordinated and adjustable relative to each other to determine the time during which the valve is open and closed in each cycle.

8. A unitary coughing valve structure adapted to be readily attached to or detached from an iron lung having a hand hole port and removable cover, comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor, a cam rotated by the motor for cyclically closing the valve, latches for holding the valve closed against the external air pressure, another cam also rotated by the motor for releasing the latches to suddenly open the valve, and means for varying the motor speed to fix the coughing cycle of the patient.

9. A unitary coughing valve structure adapted to be readily attached to or detached from an iron lung having a hand hole port and removable cover comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor, means actuated by the motor for closing the valve, latches for holding the valve closed against the external air pressure, means also actuated by the motor for releasing the latches to suddenly open the valve, a suction cup adapted to act as a soft stop to lock the valve fully open for a limited time to prevent fluttering, said actuating means being operatively coordinated and adjustable relative to each other to determine the time during which the valve is open and closed in each cycle, and means for varying the motor speed to fix the coughing cycle of the patient.

10. The invention of claim 6 in which the iron lung has an auxiliary head canopy attachment comprising an electrically operated head valve, a cam operatively mounted to respond to the movement of the cams on the coughing valve structure and adapted to actuate a solenoid switch to close the head valve when the main valve opens.

11. The invention of claim 6 in which the iron lung has an auxiliary head canopy attachment comprising an electrically operated head valve, a cam operatively mounted to respond to the movement of the cams on the coughing valve structure and adapted to actuate a solenoid switch to close the head valve when the main valve opens, and means for adjusting the cam for actuating the solenoid switch so as to slightly advance or retard the closing of the head valve when the main valve opens.

12. The invention of claim 4, and means for adjusting the speed of the motor to determine the coughing cycle.

13. The invention of claim 6 in which the iron lung has an auxiliary head canopy comprising an electrically operated head valve, a cam operatively mounted to respond to the movement of the cams on the coughing valve structure and adapted to actuate a solenoid switch to close the head valve when the main valve opens, and means for adjusting the position of the switch towards or from the cam to increase or decrease the time the switch, and therefore the head valve, are closed.

14. The invention of claim 6 in which the iron lung has an auxiliary head canopy, an electrically operated head valve thereon, a spring for holding the cam open and a solenoid for closing the valve, a switch mounted on the coughing valve structure, a cam for operating said switch adjustably mounted on the cam which opens the main switch, whereby the head valve is closed when the main valve is opened.

15. The invention of claim 6 in which the iron lung has an auxiliary head canopy, an electrically operated head valve thereon, a spring for holding the cam open and a solenoid for closing the valve, a switch mounted on the coughing valve structure, a cam for operating said switch adjustably mounted on the cam which opens the main switch, whereby the head valve is closed when the main valve is opened, the adjustment of the switch operating cam being such as to permit the head valve to be closed slightly in advance or slightly after the opening of the main valve.

16. A unitary coughing valve structure adapted to be readily attached to or detached from an iron lung having a hand hole port and removable cover, comprising a housing having a flange adapted to be attached to the iron lung and to surround the hand hole port when the cover is removed, said housing having a relatively large intake opening, a valve mounted on the housing and adapted to be seated to cover said opening, a motor and a cam rotated by the motor for cyclically closing the valve, latches for holding the valve closed against the external air pressure, another cam also rotated by the motor for releasing the latches to suddenly open the valve, said cams being adjustably attached the one to the other so as to permit variation in the ratio of inhale to exhale in each cycle, the adjustment of the cams for opening and closing the main valve being independent of the adjustment of the switch actuating cam whereby the relation of the head valve to the main valve can be set without disturbing the ratio of inhale to exhale and vice versa.

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No references cited.