Jan. 27, 1959 P. L. STANTON 2,870,763

PRESSURE BREATHING THERAPY APPARATUS

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FIG. 1.

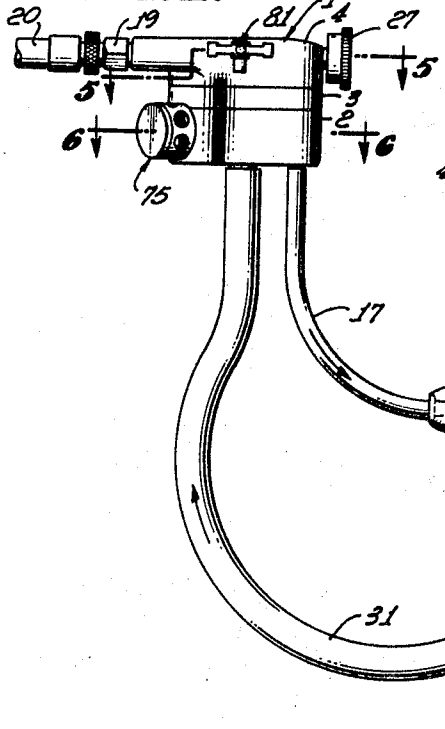


FIG. 2.

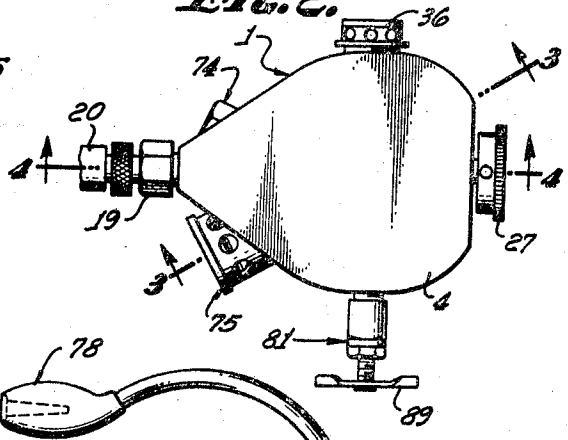
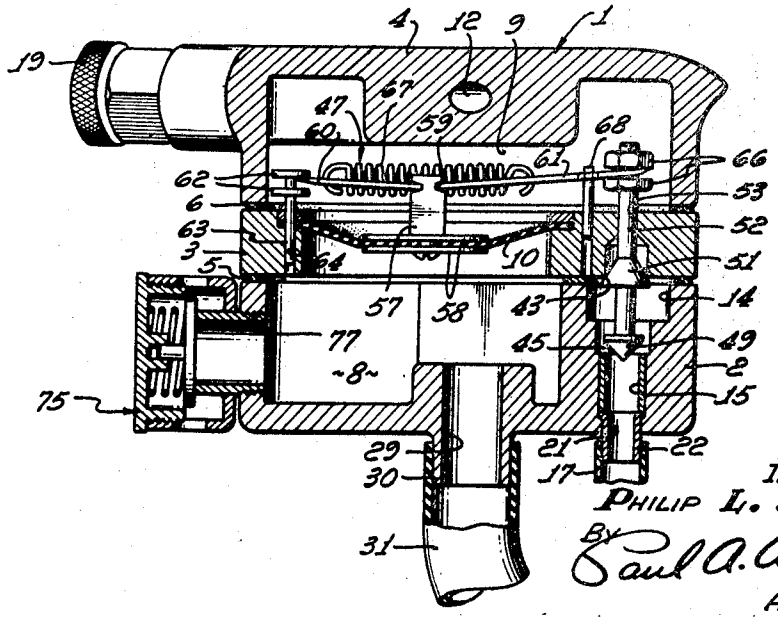


FIG. 3.



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FIG. 5.

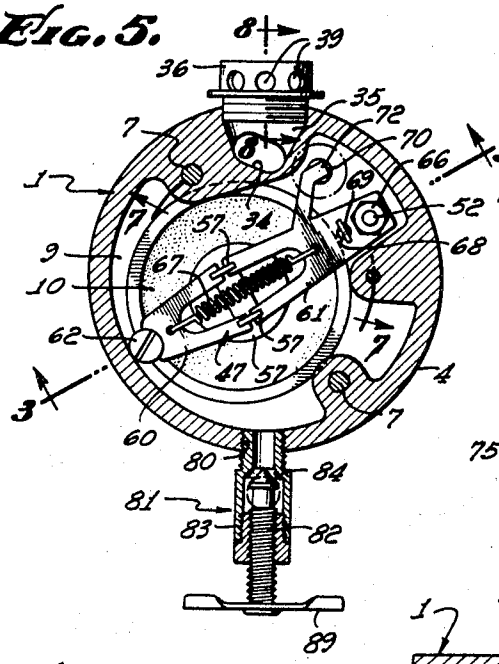


FIG. 6.

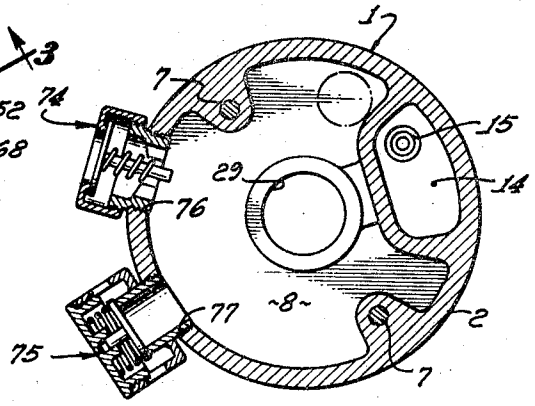


FIG. 8.

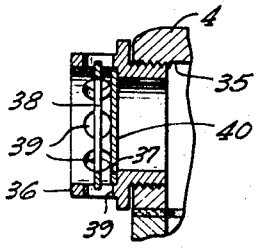
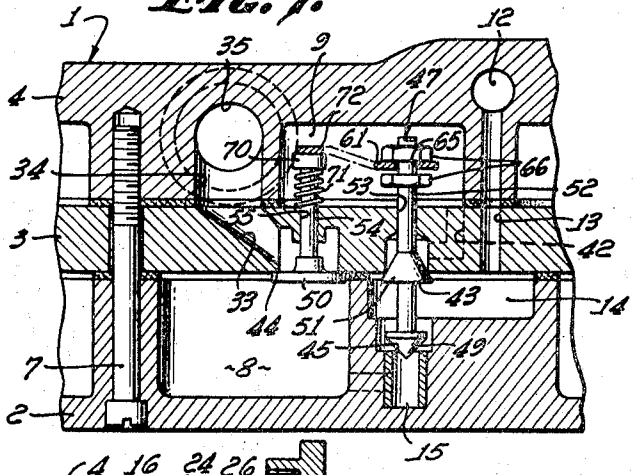


FIG. 7.



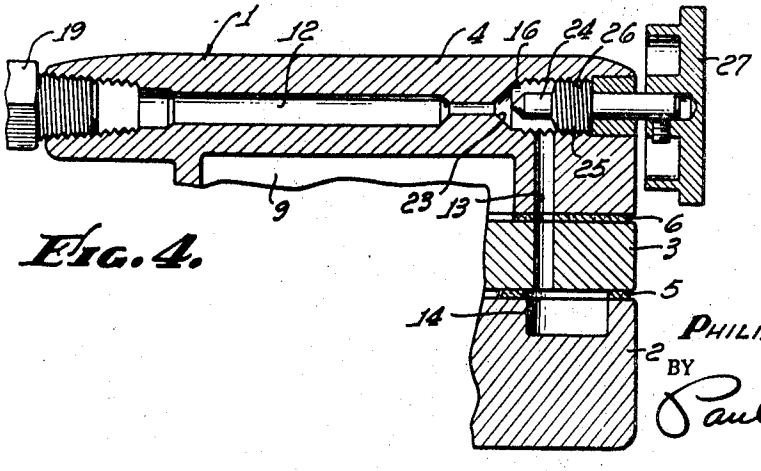


FIG. 4.

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PRESSURE BREATHING THERAPY APPARATUS

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FIG. 9.

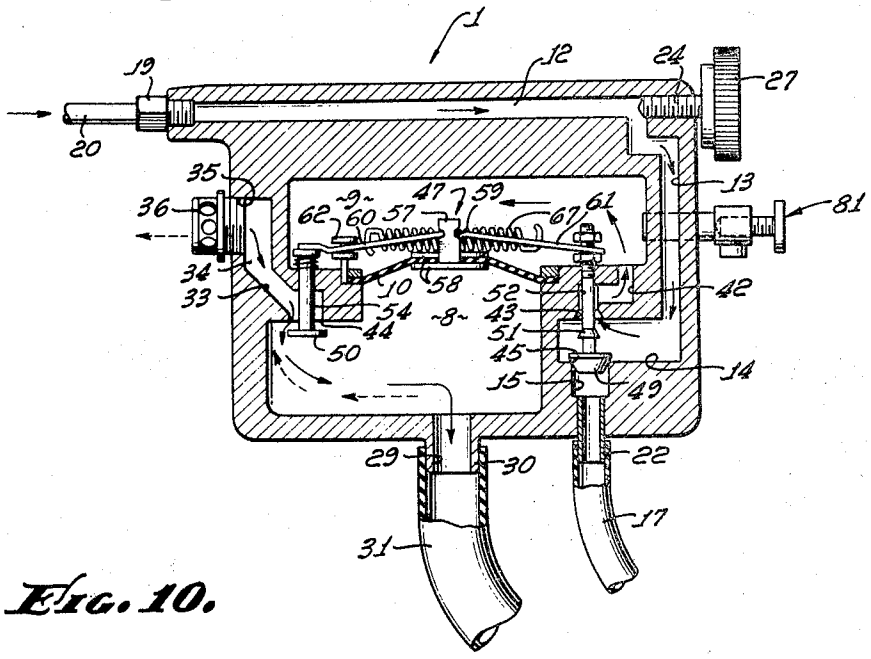
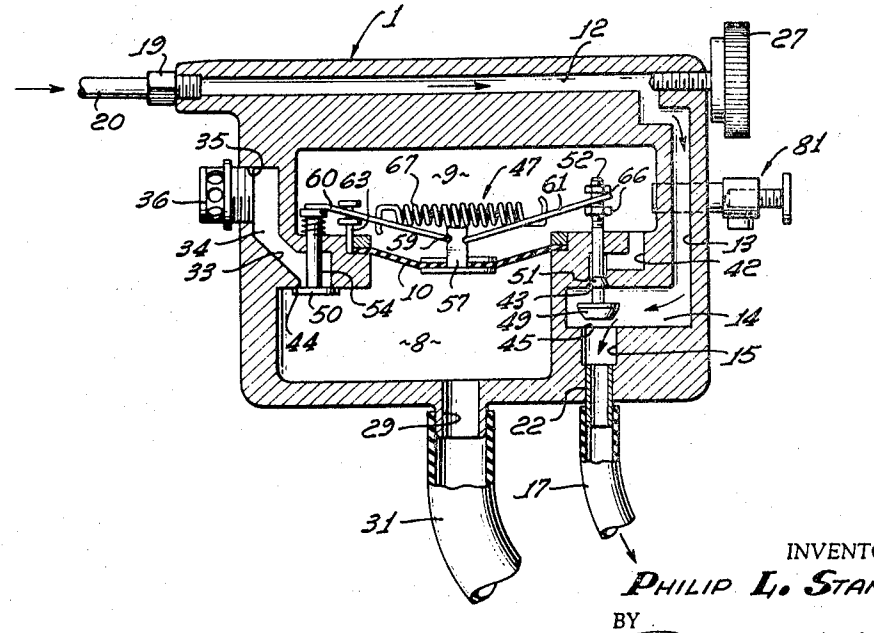


FIG. 10.



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PRESSURE BREATHING THERAPY APPARATUS

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FIG. 11.

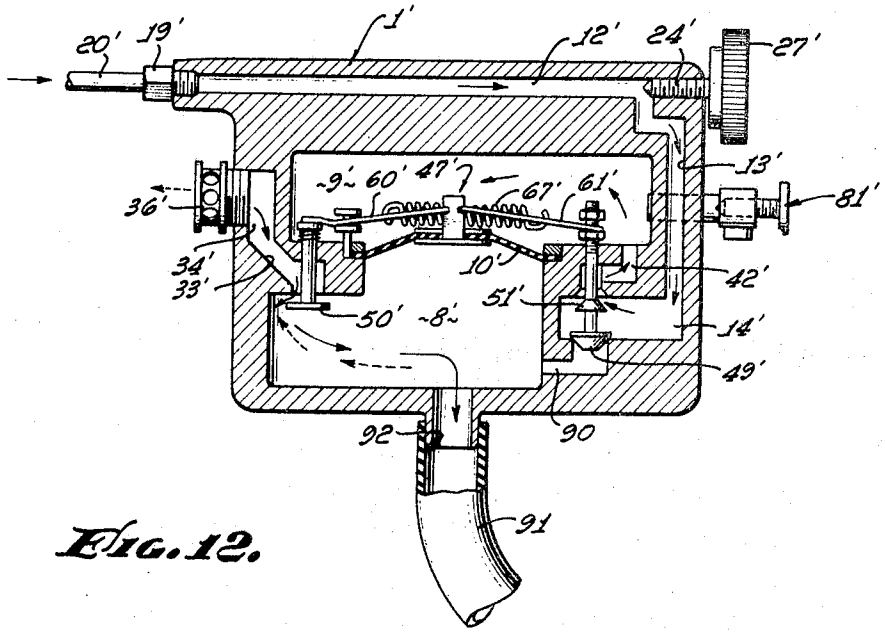
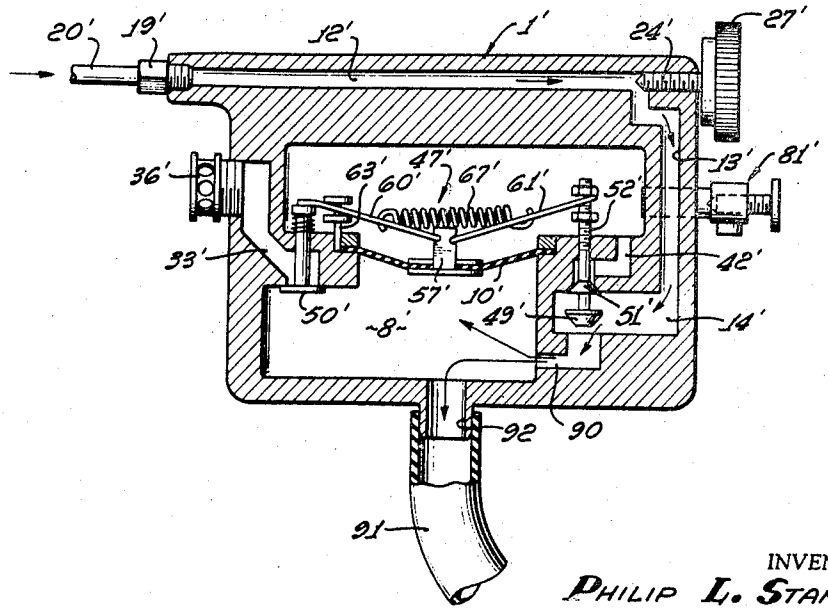


FIG. 12.



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United States Patent Office 2,870,763 Patented Jan. 27, 1959

2,870,763

PRESSURE BREATHING THERAPY APPARATUS

Philip L. Stanton, Pasadena, Calif.

Application March 15, 1957, Serial No. 646,362

23 Claims. (Cl. 128—29)

This invention relates to positive pressure breathing apparatus for use in treating pulmonary disorders, such as emphysema.

Apparatus of this type is operable to effect a controlled intermittent insufflation of the lungs of a patient with medicated or non-medicated oxygen or other gas, responsive to each inspiratory effort of the patient. Each time the administered gas reaches a predetermined pressure in the patient's lungs, such as will expand the lungs for the desired therapeutic treatment, the insufflation operation stops and the patient is permitted to exhale normally.

Apparatus of the type above noted, as heretofore provided, has been made up of a number of control units separated from one another, thereby making the apparatus cumbersome and complicated in that each unit is separately housed and this requires the use of a number of hose lines or conduits as well as supports or standards to operatively connect and support the units.

It is an object of the present invention to provide apparatus of the type above noted which constitutes an improvement in this art in point of its simplicity of construction, compactness and reliability of safe performance.

It is another object of this invention to provide breathing apparatus such as described wherein one control unit of novel form arranged compactly in a single small housing is subject to being completely pulmometrically controlled by the patient as to the breathing rhythm desired.

Another object of this invention is the provision of breathing apparatus such as described which conveniently may be suspended from the mask while the latter is held in position on the patient, the single small unit embodying the complete operating means being adapted to rest upon the chest or in the lap of the patient or to hang freely from the mask whereby the patient may move about while under treatment, rather than sit or stand in a predetermined position.

It is another object of this invention to provide a novel fluid pressure operated actuating means for valves or other control elements wherein a fluid pressure responsive diaphragm or similar element movable between two "valve actuating" positions, may be preloaded with fluid pressure above atmospheric in a particularly novel and efficacious manner to move from one of said positions to the other responsive to a very slight negative pressure, thereby providing for a nicety and sensitivity of operation of a valve or other control beyond that heretofore achieved with diaphragm actuated mechanism.

An additional object hereof is to provide in breathing apparatus of the character described, a novel diaphragm-operated valve mechanism wherein the diaphragm is preloaded by an above-atmospheric pressure of the gas in the apparatus in such a manner that a slight minus pressure developed in the apparatus responsive to a correspondingly slight initial inhalation effort of the patient, will cause actuation of the valve mechanism to

direct gas under pressure into the lungs of the patient, the valve mechanism shutting off the flow of gas to the lungs of the patient when the pressure of the gas in the patient's lungs reaches a predetermined value, whereby the patient may exhale normally.

It is another object of this invention to provide apparatus of the character described wherein flow passages, chambers, valves and operating means for the valves are embodied in a novel arrangement within a small housing, the housing being adapted to be readily connected with a source of gas under pressure and with a mask for communicating the interior of the housing with the lungs of the patient.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of several embodiments of the invention. For this purpose there are shown two forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Fig. 1 is a side elevation of apparatus embodying the present invention;

Fig. 2 is a top plan view of the apparatus shown in Fig. 1;

Fig. 3 is a cross sectional view taken substantially on the line 3—3 of Figs. 2 and 5;

Fig. 4 is a fragmentary sectional view taken substantially on the line 4—4 of Fig. 2;

Fig. 5 is a horizontal sectional view taken substantially on the line 5—5 of Fig. 1;

Fig. 6 is a horizontal sectional view taken substantially on the line 6—6 of Fig. 1;

Fig. 7 is a fragmentary sectional view taken substantially on the line 7—7 of Fig. 5;

Fig. 8 is a fragmentary sectional view taken on the line 8—8 of Fig. 5;

Fig. 9 is a schematic sectional view of the apparatus as it would appear with the parts in position shutting off the flow of gas to the patient and permitting exhalation of the patient;

Fig. 10 is a schematic sectional view similar to Fig. 9 with the parts shown in the position to insufflate the lungs of the patient;

Fig. 11 is a schematic sectional view of a modified form of the invention with the parts in the position to shut off flow of gas to the lungs of the patient and to permit exhalation of the patient; and

Fig. 12 is a schematic sectional view of the modified form shown in Fig. 11 and the parts thereof in the position to effect insufflation of the lungs of the patient.

Apparatus embodying the present invention includes a housing 1 composed of a bottom section 2, an intermediate section 3 and a top section 4. These sections are joined by means of screw fastenings 7 and have sealing gaskets 5 and 6 therebetween. The housing 1 is provided with a first chamber 8 and a second chamber 9 separated by a diaphragm 10. The diaphragm is secured in place in any suitable manner so that it serves as a gas-tight partition between the chambers 8 and 9.

A gas supply or first passage made up of connected passage portions 12, 13, 14 and 15 is provided in the housing 1 for conducting gas under pressure from a suitable source, not shown, to a sectional hose 17 which may be connected to a mask 18 for application to a patient. Instead of a mask, a mouth piece, not shown, could be used. The passage portion 12 extends across the top section 3 of the housing from a fitting 19 pro-

viding for connection with a flexible hose line 20 for supplying gas to the unit from the source of supply (see Fig. 1). The passage portion 13 extends from the passage 12 downwardly through the intermediate section 3 into the passage portion 14 in the bottom section 1. The passage portion 15 extends from the portion 14 to an outlet port 21 where a nipple 22 provides for connection with the hose 17 leading to the mask 18.

The passage portion 12 is enlarged as at 16 and provided with a seat 23 for a main valve 24. This valve has a screw threaded stem 25 operable in a screw threaded opening 26 in the housing, to move into and from seated position to control the flow through the gas supply passage. A handle 27 of the stem 25 provides for operation of the valve 24.

The passage portion 14 serves as a valve chamber intermediate the passage portions 13 and 15 and provides for operation of valve means to be hereinafter described, for selectively directing the flow of gas to the first and second chambers 8 and 9.

The first chamber 8 is provided with a port 29 and a nipple 30 for connection with a hose 31 leading to the mask 18. With this arrangement the hose 17 conducts gas through the mask into the lungs of the patient whereas the patient exhales through the mask and hose 31 into the chamber 8 thence into the atmosphere as will be hereinafter described.

A second passage for communicating the first chamber 8 with the atmosphere includes a passage portion 33 extending through the intermediate housing section 3 and communicating with a passage portion 34 in the top housing section 1, the passage 34 leading to a discharge port 35 in the latter.

The port 35 is controlled by a check valve including a tubular open ended fitting 36 provided with an annular valve seat 37 and a stop 38 internally thereof. This fitting is screwed into the port 35 and is provided with a circular series of outlet ports 39 between the valve seat 37 and the stop 38. A disk valve member 40 of suitable impervious light material, is operable between the seat 37 and the stop 38. Atmospheric pressure holds the valve member 40 against the seat 37 and thus shuts off communication between the port 35 and the atmosphere. when negative pressure is developed in the chamber 8. When positive pressure is developed in the chamber 8 and passage portions 33 and 34, the valve member 40 is forced against the stop 38 thereby communicating the chamber 8 with the atmosphere through the outlet ports 39.

As a means for communicating the second chamber 9 with the first passage, that is, with the valve chamber portion 14 of said first passage, a third passage 42 extends through the intermediate section 3 of the housing 1, as shown in Fig. 8, between the passage portion 14 and the second chamber 9.

The end of the third passage 42 which opens into the first passage portion 14, is enlarged and formed with a valve seat 43. Similarly the end of the second passage portion 33 opening into the first chamber 8, also the end of the first passage portion 15 opening into the first passage portion 14, are provided with valve seats 44 and 45 respectively.

The diaphragm 10 is connected with a spring-loaded toggle mechanism 47 located in the second chamber 9. Through suitable means this toggle mechanism is connected with three valves for controlling the first, second and third passages. These three valves comprise a first valve 49 movable into and from contact with the seat 45 in the first passage portion 15, a second valve 50 for movement into and from engagement with the seat 44 in the second passage portion 33, and a third valve 51 for movement into and from engagement with the seat 43 in the third passage 42.

The first valve 49 and the third valve 51 have a common stem 52, the upper part of which is slidable

(see Figs. 3 and 7) in a bore 53 in the intermediate section 3 of the housing 1 and extends into the second chamber 9. The second valve 50 has a stem 54 slidable in a bore 55 in the housing section 3 and extended into the second chamber 9.

The toggle mechanism 47 includes a pair of opposed posts 57 fixed to reinforcing disks 58 fastened to the center of the diaphragm 10. These posts are provided with notches 59 in which are mounted the bifurcated inner ends of a pair of toggle arms 60 and 61. The arm 60 has its outer end positioned for movement between opposed stop members 62 on a pin 63 fixed in a bore 64 in the housing section 3. The arm 61 has an opening 65 in the outer end thereof and the stem 52 common to first and third valves 49 and 51, is extended through this opening. Nuts 66 are adjustably mounted on the stem on opposite sides of the outer end of the arm 61 whereby this end may move as required between the nuts in the operation of the toggle mechanism.

A retractile spring 67 is secured at its ends to the arms 60 and 61 so that said arms will move with a snap action past center, responsive to movements of the diaphragm. A T-shaped guide and stop member 68 is fixed to the housing section 3 and extends through an opening 69 in the toggle arm 61 with the head of the T-member above the toggle arm whereby this toggle arm will be held in place and guided and limited as to movement to assure proper actuation of the three valves 49, 50 and 51.

The upper end of the stem 54 of the second valve 50 is provided with a head 70. Between said head 70 and the upper side of the housing section 3, a spring 71 is confined on the stem to urge the valve 50 into engagement with the seat 44. An extension 72 of the toggle arm 61 rests upon the head 70 of the stem 54 so that the second valve 50 will open upon movement of the arm 61 in one direction and close upon movement of the arm 61 in the opposite direction.

As is customary, in pulmometric apparatus, the present apparatus is provided, as shown in Fig. 6, with safety valves 74 and 75 connected with ports 76 and 77 respectively, in the wall of the first chamber 8. The valve 74 is an inwardly opening check valve, spring loaded to open and communicate the chamber 8 with the atmosphere only in case the negative pressure in the chamber 8 exceeds a predetermined value. The valve 75 is an outwardly opening check valve, spring loaded to open and communicate the chamber 8 with the atmosphere only in case the positive pressure in the chamber 8 exceeds a predetermined value.

As a means for introducing a medicament with the gas into the patient's lungs, a suitable nebulizer or vaporizer unit 78 is connected in the sectional hose 17 so that the medicament will be entrained by the gas during the insufflation cycle of the apparatus. If no medicament is to be used, the vaporizer unit 78 may be removed and a suitable connection thus made between the sections of the hose 17, whereby the hose is used solely as a gas line to the patient.

An important feature of the invention is the provision for rendering the diaphragm-toggle mechanism subject to movement to initiate the insufflation cycle responsive to a very slight inhalation effort of the patient. For this purpose the second chamber 9 above the diaphragm 10 is preloaded with gas under a predetermined positive pressure above atmospheric pressure, whereby this pressure tends to move the diaphragm but does not move the diaphragm for opening the first valve 49 to allow gas to be delivered to the patient, until a negative pressure is produced in the chamber 8 responsive to a slight initial inhalation effort of the patient.

Accordingly, provision is made for introducing gas under pressure from the first passage portion 14 through the third passage 42 into the second chamber 9 when the third valve 51 is opened. Provision is also made for

a controlled constant venting of the gas from the chamber 9 to preload the diaphragm without causing premature movement thereof, whereby only in response to the inhalation effort of the patient, will the diaphragm and toggle mechanism operate to open the first valve 49 and allow gas to be administered to the patient.

The venting of gas from the second chamber 9 may be accomplished by providing a vent port 80 in the wall of the chamber 9 and controlling this port by means of a valve 81 manually operable from the exterior of the housing. Instead of the valve 81, a vent or bleed port of predetermined size (not shown) could be employed to maintain the desired predetermined above atmospheric pressure in the second chamber 9. The valve 81 as here shown (see Fig. 5) is provided with a threaded stem 82 operable in an internally screw threaded fitting 83 and fixed to the housing section 4 in the port 80. The fitting 83 is provided with a valve seat 84 for the valve 81. A handle 89 on the stem provides for the desired setting of the valve 81.

It will now be apparent that the diaphragm 10 and toggle mechanism are movable between a first position in which the second and third valves 50 and 51 are open and the first valve 49 is closed, and a second position in which the first valve 49 is open and the second and third valves 50 and 51 are closed.

When the diaphragm 10 and nozzle mechanism are in the first position and the apparatus has been connected with a source of gas under pressure, upon opening the main valve 24, gas will flow through the first passage portions 12, 13 and 14 into the passage portion 15. As the first valve 49 is now closed and the valves 50 and 51 are open, gas will flow from passage portion 15 through the passage 42 into the second chamber 9. The valve 81 may be preset to permit of venting of gas to the atmosphere from the chamber 9 in the desired amount to cause a predetermined above atmospheric pressure to be maintained in the chamber 9, such that the diaphragm 10 is pressure loaded but will not be moved by this pressure until a negative pressure is developed in the chamber 8. At the instant the patient commences to inhale, a slight negative pressure is developed in the first chamber 8 and second passage portions 33 and 34 responsive to the initial slight inspiratory effort, thereby causing the check valve 40 to close the outer end of the passage portion 34 and at the same time causing the above atmospheric pressure in the chamber 9 to move the diaphragm into the second position. When the diaphragm is moved in this manner, the first valve 49 is opened to permit flow of gas through the hose 17 to the mask 18 so as to insufflate the lungs of the patient, the valves 50 and 51 being then closed.

When the pressure in the patient's lungs reaches a predetermined value, this pressure, due to the valve 50 being closed, is effective in the hose 31 and first chamber 8 to move the diaphragm from the second position into the first position, thereby causing the first valve 49 to close and shut off flow to the hose 17, as well as causing the valves 50 and 51 to open, whereby the patient may exhale normally through the mask 18, hose 31, first chamber 8, open valve 50 and passage portions 33 and 34 to the atmosphere. The check valve 40 opens immediately responsive to this exhalation pressure.

The vent port 80 permits the fluid pressure above atmospheric in the chamber 8 to escape during the insufflation cycle, whereby the diaphragm will move to cause the shutting off of the flow of gas to patient's lungs when the pressure in the lungs reaches a predetermined value.

When the next inhalation effort of the patient takes place, the insufflation cycle starts again and is repeated following each normal exhalation of the patient.

In a modified form of this invention, as schematically shown in Figs. 11 and 12, the parts thereof corresponding to those shown in the first described form are identified by like reference numerals accompanied by the prime character. This modified form differs from the first described form in that first or gas supply passage in the housing discharges gas through a port 90 into the main or first chamber 8' and in that a single hose line 91 connected with a port 92 for the first chamber is employed to communicate the housing with a mask not shown. This form of the invention does not provide for administering a medicament to the patient, as the single hose 91 serves as an exhalation line to the first chamber as well as a line for conducting gas to the patient. Otherwise, this form of the invention is of the same construction and arrangement as shown in Figs. 1–10.

Apparatus embodying the present invention is advantageous in that it serves as a reliable means for assisting the breathing of the patient, and is controlled by the patient as to the breathing rhythm desired. In operation, this apparatus provides for unrestricted inspiratory and expiratory flow and the operation thereof is initiated in response to a very slight inspiratory effort of the patient.

Another advantage is that all of the working parts and controls are contained in or provided on the housing in a simple and compact arrangement, the housing being comparatively small. No valves or controls remote from the housing need be employed. Thus the one small housing constitutes a compact and complete breathing unit subject to ready use when connected with a source of gas under pressure and with a mask, a mouth piece or other conduit means for application to the patient.

When the mask 18 is held in position of use on the patient, the housing 1 may be suspended therefrom to rest on the chest or in the lap of the patient or to hang from the mask. The hose lines between the mask and the housing obviously may be of any length to provide for the desired suspension of the housing from the mask. In fact the mask could be directly attached to the housing. The flexible hose for connecting the housing 1 with a source of supply of gas may be of any length desired. These provisions and the small size of the housing 1, also the absence of standards or supports, provide for desired freedom of movement of the patient during treatment.

While the novel diaphragm actuated, spring-loaded toggle mechanism adapted to be preloaded with fluid pressure is here shown as applied to intermittent breathing apparatus, it is to be understood that this mechanism may be used to advantage in any assembly wherein it is desired to control flow of fluid under pressure by preloading the diaphragm so that it will respond to a slight negative pressure.

I claim:

1. In apparatus for insufflating the lungs of a patient responsive to an inspiratory effort of the patient and for permitting the patient to exhale normally, wherein a housing is adapted to intake gas from a source of gas under pressure and contains fluid pressure operated, pulmometrically controlled means for starting and stopping the flow of gas to the patient: the improvement which includes means operable to preload said fluid pressure operated means with gas at a pressure above atmospheric in response to the stopping of the flow of gas to the patient by said fluid pressure operated means; and means in the housing for regulating said preloading pressure whereby said preloading pressure is effective to actuate said fluid pressure operated means for starting flow of gas to the patient only when a negative pressure is created in said housing responsive to an inspiratory effort of the patient.

2. In apparatus for insufflating the lungs of a patient responsive to an inspiratory effort of the patient and for permitting the patient to exhale normally, wherein a housing is adapted to intake gas from a source of gas under pressure and contains fluid pressure operated, pulmometrically controlled means for starting and stopping the flow of gas to the patient, the improvement which includes means operable to preload said fluid pressure operated means with gas under a pressure above atmospheric in response to the stopping of the flow of gas to

the patient by said fluid pressure operated means; means for regulating said preloading pressure whereby said pressure is effective to actuate said fluid pressure operated means for starting flow of gas to the patient only when a negative pressure is created in said housing responsive to an inspiratory effort of the patient; and means operatively connected with said housing operable to introduce a medicament into the gas supplied to the patient.

3. In apparatus for insufflating the lungs of a patient responsive to an initial inhalation effort of the patient and for permitting the patient to exhale normally: a housing having provision for intaking gas under pressure from a source of such gas; conduit means connected with the housing for establishing communication between the lungs of the patient and the interior of the housing; means operable in the housing for controlling flow of such gas between the housing and the patient; said control means including valve means and associated diaphragm actuated mechanism wherein the diaphragm thereof is movable in response to fluid pressure between positions for operating said valve means to permit flow of gas to the patient and to shut off such flow respectively; and means in the housing operable in response to movement of the diaphragm into one of said positions, to preload the diaphragm with gas at a pressure above atmospheric and such that the diaphragm will be moved into the other of said positions when a negative pressure is developed within the housing in response to an initial inhalation effort of the patient.

4. In apparatus for insufflating the lungs of a patient responsive to initial inhalation efforts of the patient: a housing having provision for intaking gas under pressure from a source of gas; conduit means connected with the housing for establishing communication between the lungs of the patient and the interior of the housing; means operable in the housing for controlling flow of gas between the housing and the patient; said control means including valve means and associated diaphragm actuated mechanism wherein the diaphragm thereof is movable in response to fluid pressure between a first position for operating said valve means to shut off flow of gas to the patient and a second position for actuating said valve means to permit flow of gas to the patient; and means in the housing operable in response to movement of the diaphragm into said first position, to preload one side of the diaphragm with gas at a pressure above atmospheric and such that the diaphragm will be moved into said second position only when a negative pressure is developed within the housing on the other side of said diaphragm in response to an initial inhalation effort of the patient.

5. In apparatus for insufflating the lungs of a patient responsive to initial inhalation efforts of the patient: a housing having provision for intaking gas under pressure from a source of gas; conduit means connected with the housing and operable for establishing communication between the lungs of the patient and the interior of the housing; means operable in the housing for controlling flow of gas between the housing and the patient; said control means including valve means and associated diaphragm actuated mechanism wherein the diaphragm thereof in response to fluid pressure is movable between a first position for operating said valve means to shut off flow of gas to the patient and a second position for operating said valve means to permit flow of gas to the patient; and means in said housing operable when said diaphragm is in said first position, to preload the diaphragm with gas under a predetermined pressure above atmospheric and such that only in response to negative pressure being developed in the housing in the presence of said diaphragm, will said diaphragm move into said second position.

6. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient: a housing having a first chamber and a second chamber as well as provision for intaking gas under pressure from a source of such gas; conduit means connected with the housing for conducting gas to and from the lungs of the patient; said housing having a port for venting gas to the atmosphere from said first chamber; said conduit means communicating with said first chamber whereby exhalation gas from the patient may be vented through said port; means operable in the housing for controlling the flow of gas to the patient; said control means including valve means and associated diaphragm operated mechanism wherein the diaphragm thereof serves as a gas tight partition between said chambers and is movable in response to fluid pressure in said chambers, between a first position in which said valve means operates to shut off flow of gas to the patient, and a second position in which said valve means permits flow of gas to the patient; and means in said housing operable in response to movement of said diaphragm into said first position, for introducing gas into said second chamber to preload the diaphragm at a predetermined above atmospheric pressure such that the diaphragm will move into said second position only in response to the negative pressure created in said first chamber by an inhalation effort of the patient.

7. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient: a housing having a first chamber and a second chamber as well as provision for intaking gas under pressure from a source of such gas; conduit means connected with the housing and operable for conducting gas to and from the lungs of the patient; said housing having a port for venting gas to the atmosphere from said first chamber; said conduit means communicating with said first chamber whereby the patient may exhale through said port; a check valve associated with said port and operable in response to positive pressure in said first chamber to open said port; said check valve operating to close said port in response to negative pressure in said first chamber; means operable in the housing for controlling the flow of gas to the patient; said control means including valve means and associated diaphragm operated mechanism wherein the diaphragm thereof serves as a gas tight partition between said chamber; said diaphragm being movable in response to fluid pressure in said chambers between positions for actuating said valve means to permit flow of gas to the patient and to shut off such flow respectively; other valve means operable to close communication between said first chamber and said check valve in response to movement of said diaphragm to the position which permits flow of gas to the patient; said other valve means operating to open communication between said check valve and said first chamber when said diaphragm is in said shut-off position; and means in said housing operable in response to movement of said diaphragm into said shut-off position, for introducing gas into said second chamber to preload the diaphragm at a predetermined above atmospheric pressure such that the diaphragm will move to actuate said valve means for permitting flow to the patient only in response to negative pressure in said first chamber.

8. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chamber; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chambers; a first passage adapted to be connected with a source of gas under pressure; port means for connection with means operable to communicate said first chamber and said first passage with the lungs of a patient; a second passage for communicating said first chamber with the atmosphere; a third passage between said first passage and said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said second passage and to open said second passage to the atmosphere responsive to positive pressure in said second passage; a first valve for controlling flow of gas through said first passage for delivery to the patient; a second

valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; spring loaded toggle mechanism connected with said diaphragm; means connecting said toggle mechanism with said first, second and third valves operable to open said second and third valves and close said first valve when said diaphragm is in said first position, and to open said first valve and close said second and third valves when said diaphragm is in said second position; and means operable for maintaining in said second chamber while said third valve is open, a gas pressure above atmospheric pressure and effective to move said diaphragm from said first position to said second position only responsive to negative pressure in said first chamber.

9. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chamber; a first passage adapted to be connected with a source of gas under pressure; port means for connection with means operable to communicate said first chamber and said first passage with the lungs of a patient; a second passage for communicating said first chamber with the atmosphere; a third passage between said first passage and said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said second passage and to open said second passage to the atmosphere responsive to positive pressure in said second passage; a first valve for controlling flow of gas through said first passage for delivery to the patient; a second valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; spring loaded toggle mechanism connected with said diaphragm; means connecting said toggle mechanism with said first, second and third valves operable to open said second and third valves and close said first valve when said diaphragm is in said first position; and to open said first valve and close said second and third valves when said diaphragm is in said second position; and means for venting an amount of gas from said second chamber such as will create in said second chamber a predetermined above atmospheric pressure effective to move said diaphragm from said first to said second position responsive to negative pressure in said first chamber.

10. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chamber; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chambers; a first passage adapted to be connected with a source of gas under pressure; port means for connection with means operable to communicate said first chamber and said first passage with the lungs of a patient; a second passage for communicating said first chamber with the atmosphere; a third passage between said first passage and said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said second passage and to open said second passage to the atmosphere responsive to positive pressure in said second passage; a first valve for controlling flow of gas through said first passage for delivery to the patient; a second valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; spring loaded toggle mechanism connected with said diaphragm; means connecting said toggle mechanism with said first, second and third valves operable to open said second and third valves and close said first valve when said diaphragm is in said first position; and to open said first valve and close said second and third valves when said diaphragm is in said second position; a vent port in said second chamber; and a vent valve for controlling said vent port whereby gas introduced into said second chamber will be discharged therefrom in an amount to maintain in said second chamber a predetermined above atmospheric pressure effective to move said diaphragm from said first position to said second position only when negative pressure is created in said first chamber.

11. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chambers; a first passage adapted to be connected with a source of gas under pressure; a second passage for communicating said first chamber with the atmosphere; a third passage between said first passage and said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said second passage and to open said second passage to the atmosphere responsive to positive pressure in said second passage; an outlet port through which gas passes from said first passage for delivery to the patient; said first chamber having an intake port; said ports being adapted for connection with means operable for communicating said ports with the lungs of the patient; a first valve means for controlling the flow of gas from said first passage through said outlet port; a second valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; spring loaded toggle mechanism connected with said diaphragm; means connecting said toggle mechanism with said first, second and third valves operable to open said second and third valves and close said first valve when said diaphragm is in said first position; and to open said first valve and close said second and third valves when said diaphragm is in said second position; and means operable for maintaining in said second chamber while said third valve is open, an above atmospheric pressure effective to move said diaphragm from said first position to said second position responsive to negative pressure in said first chamber.

12. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chambers; a first passage leading into said first chamber adapted to receive gas from a source of gas under pressure; a port in said first chamber adapted to be connected with means for establishing communication between said first chamber and the lungs of the patient; a second passage for communicating said first chamber with the atmosphere; a third passage for conducting gas from said first passage into said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said first chamber and second passage, and to open said second passage to the atmosphere responsive to positive pressure in said second passage and first chamber; a first valve for controlling flow through said first passage into said first chamber; a second valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; means connecting said first, second and third valves with said diaphragm operable to open said second and third valves and close said first valve when said diaphragm is in said

first position, and to open said first valve and close said second and third valves when said diaphragm is in said second position; and means operable when said third valve is open to provide in said second chamber a predetermined gas pressure above atmosphereic whereby incident to a negative pressure being created in said first chamber, said diaphragm will move into said second position.

13. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chambers; a first passage leading into said first chamber adapted to receive gas from a source of gas under pressure; a port in said first chamber adapted to be connected with means for establishing communication between said first chamber and the lungs of the patient; a second passage for communicating said first chamber with the atmosphere; a third passage for conducting gas from said first passage into said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said first chamber and second passage, and to open said second passage to the atmosphere responsive to positive pressure in said second passage and first chamber; a first valve for controlling flow through said first passage into said first chamber; a second valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; means connecting said first, second and third valves with said diaphragm operable to open said second and third valves and close said first valve when said diaphragm is in said first position, and to open said first valve and close said second and third valves when said diaphragm is in said second position; said third passage conducting gas under pressure into said second chamber when said diaphragm is in said first position; and means for venting gas from said second chamber to the atmosphere for maintaining in said second chamber while said diaphragm is in said first position, a pressure above atmospheric such that incident to a negative pressure being developed in said first chamber said diaphragm will move into said second position.

14. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressures in said chambers; a first passage leading into said first chamber adapted to receive gas from a source of gas under pressure; a port in said first chamber adapted to be connected with means for establishing communication between said first chamber and the lungs of the patient; a second passage for communicating said first chamber with the atmosphere; a third passage for conducting gas from said first passage into said second chamber; a check valve operable to shut off communication between said second passage and the atmosphere responsive to negative pressure in said first chamber and second passage, and to open said second passage to the atmosphere responsive to positive pressure in said second passage and first chamber; a first valve for controlling flow through said first passage into said first chamber; a second valve for controlling communication between said second passage and said first chamber; a third valve for controlling flow of gas through said third passage into said second chamber; means connecting said first, second and third valves with said diaphragm operable to open said second and third valves and close said first valve when said diaphragm is in said first position, and to open said first valve and close said second and third valves when said diaphragm is in said second position; said third passage conducting gas under pressure into said second chamber when said diaphragm is in said first position; means for venting gas from said second chamber to the atmosphere; and means for regulating the volume of gas venting from said second chamber to provide a predetermined above atmospheric pressure in said second chamber.

15. In apparatus for insufflating the lungs of a patient responsive to inhalation efforts of the patient: a housing having a first chamber and a second chamber as well as provision for intaking gas under pressure from a source of gas; conduit means connected with the housing for conducting gas to and from the lungs of the patient; said housing having a port for venting gas to the atmosphere from said first chamber; said conduit means communicating with said first chamber whereby exhalation gas from the patient may be vented through said port; control means operable in the housing for controlling the flow of gas to the patient; said control means including valve means and associated diaphragm operated mechanism wherein the diaphragm thereof serves as a gas tight partition between said chambers and is movable in response to fluid pressure in said chambers, between a first position in which said valve means operates to shut off flow of gas to the patient and a second position in which said valve means permits flow of gas to the patient; means in said housing for introducing gas under pressure into said second chamber responsive to movement of said diaphragm into said first position; and means for venting gas from said second chamber to the atmosphere in an amount such that said diaphragm is pre-loaded with a pressure above atmospheric whereby said diaphragm will move into said second position responsive to negative pressure created in said first chamber in response to an inhalation effort of the patient.

16. In apparatus for insufflating the lungs of a patient responsive to an initial inhalation effort of the patient and permitting the patient to exhale normally; a housing having provision for intaking gas under pressure from a source of such gas; conduit means connected with the housing for establishing communication between the lungs of the patient and the interior of the housing; means operable in the housing for controlling flow of such gas between the housing and the patient; said control means including valve means and associated diaphragm actuated mechanism wherein the diaphragm thereof is movable in response to fluid pressure between positions for operating said valve means to permit flow of gas to the patient and to shut off such flow respectively; means connected with said conduit means operable by gas flowing to the patient for introducing a medicament into the lungs of the patient with the gas; and means in the housing operable in response to movement of the diaphragm into one of said positions, to preload the diaphragm with gas at a pressure above atmospheric and such that the diaphragm will be moved into the other of said positions when a negative pressure is developed within the housing responsive to an initial inhalation effort of the patient.

17. In apparatus for insufflating the lungs of a patient responsive to an inspiratory effort of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressure in said chambers; a first passage adapted to be connected with a source of gas under pressure; a first conduit means connected with the housing so as to communicate said first passage with the lungs of the patient; a second conduit means connected with said first chamber and operable to establish communication between said first chamber and the lungs of the patient; a second passage for communicating said first chamber with the atmosphere; a third passage for conducting gas from said first passage into said second chamber; a check valve operable to close and open said

second passage responsive to negative and positive pressure in said first chamber respectively; a first valve for controlling flow through said first passage to the patient; a second valve located between said check valve and said first chamber for controlling communication between the first chamber and said check valve; a third valve for controlling flow through said third passage into said second chamber; means connecting said first, second and third valves with said diaphragm operable to close said first valve and open said second and third valves when said diaphragm is in said first position and to open said first valve and close said second and third valve when said diaphragm is in said second position; and means operable when said third valve is open to provide in said second chamber a predetermined gas pressure above atmospheric whereby incident to a negative pressure being developed in said first chamber responsive to an inspiratory effort of the patient, said diaphragm will be moved into said second position.

18. In apparatus for insufflating the lungs of a patient responsive to an inspiratory effort of the patient, a housing provided with: a first chamber; a second chamber; a diaphragm separating said chambers; said diaphragm being movable between a first position and a second position responsive to fluid pressure in said chamber; a first passage adapted to be connected with a source of gas under pressure; a first conduit means connected with the housing so as to communicate said first passage with the lungs of the patient; a second conduit means connected with said first chamber and operable to establish communication between said first chamber and the lungs of the patient; a second passage for communicating said first chamber with the atmosphere; a third passage for conducting gas from said first passage into said second chamber; a check valve operable to close and open said second passage responsive to negative and positive pressure in said first chamber respectively; a first valve for controlling flow through said first passage to the patient; a second valve located between said check valve and said first chamber for controlling communication between the first chamber and said check valve; a third valve for controlling flow through said third passage into said second chamber; means connecting said first, second and third valves with said diaphragm operable to close said first valve and open said second and third valves when said diaphragm is in said first position and to open said first valve and close said second and third valve when said diaphragm is in said second position; means operable when said third valve is open to provide in said second chamber a predetermined gas pressure above atmospheric whereby incident to a negative pressure being developed in said first chamber responsive to an inspiratory effort of the patient, said diaphragm will be moved into said second position; and means connected with said first conduit means operable responsive to flow of gas to introduce a medicament into the lungs of the patient with said gas.

19. In apparatus for controlling the flow of fluid under pressure from a housing provided with valve means for starting and stopping flow of fluid from the housing, and wherein said housing contains diaphragm controlled operating means for said valve means, the diaphragm is movable between two positions responsive to fluid pressure to start and stop such flow, and said housing has two chambers separated by said diaphragm; the improvement which includes means in the housing operable to introduce into one of said chambers a fluid pressure above atmospheric responsive to movement of said diaphragm into one of said positions; and means for regulating said above atmospheric pressure of fluid in said one chamber whereby said diaphragm will be moved by said above atmospheric pressure into said other position only when a negative pressure is developed in the other of said chambers.

20. In apparatus for controlling the flow of fluid under pressure from a housing provided with valve means for starting and stopping flow of fluid from the housing, and wherein said housing contains diaphragm controlled operating means for said valve means, the diaphragm is movable between two positions responsive to fluid pressure to start and stop such flow, and said housing has two chambers separated by said diaphragm; the improvement which includes means in the housing operable to introduce into one of said chambers a fluid pressure above atmospheric responsive to movement of said diaphragm into one of said positions; and constantly open vent means providing for the escape of an amount of the fluid under pressure from said one chamber such as will produce in said one chamber an above atmospheric pressure which is effective to move said diaphragm into said other position only when a negative pressure is developed in the other of said chambers.

21. In apparatus for controlling the flow of fluid under pressure from a housing provided with valve means for starting and stopping such flow, and wherein said housing contains fluid pressure controlled operating means for said valve means; said fluid pressure controlled operating means being movable between two positions in response to fluid pressure to operate said valve means for starting and stopping such flow and said housing having two chambers separated by said fluid pressure controlled operating means: that improvement which includes means in said housing operable in response to movement of said fluid pressure controlled operating means into one of said positions, to introduce into one of said chambers a fluid pressure above atmospheric pressure; and means for regulating said above atmospheric pressure in said one chamber whereby said fluid pressure controlled operating means will be moved in response to said above atmospheric pressure into said other position when negative fluid pressure is developed in the other of said chambers.

22. In apparatus for insufflating the lungs of a patient in response to inhalation efforts of the patient: a housing having a first chamber and a second chamber as well as provision for intaking gas under pressure from a source of gas; conduit means connected with the housing for conducting gas to and from the patient's lungs; said housing having a port for venting gas to the atmosphere from said first chamber; said conduit means communicating with said first chamber; control means operable in said housing for controlling the flow of gas to the patient; said control means including valve means and associated fluid pressure responsive means which latter separates said chambers from one another and is movable in response to fluid pressure in said chambers; said fluid pressure responsive means being movable between a first position in which said valve means operates to shut off the flow of gas to the patient and a second position in which said valve means permits flow of gas to the patient; means in said housing for introducing gas under pressure into said second chamber in response to movement of said fluid pressure responsive means into said first position; and means for venting gas from said second chamber to the atmosphere in an amount such that said fluid pressure responsive means is pre-loaded with a fluid pressure above atmospheric and will move into said second position in response to negative pressure developed in said first chamber as a result of an inhalation effort of the patient.

23. In apparatus for introducing gas into the lungs of a patient; a housing having provision for intaking gas under pressure; said housing having a port through which gas may pass to and from a patient; means operable in the housing for controlling the flow of gas between the housing and the patient; said control means including fluid pressure responsive means and valve means actuated thereby; said fluid pressure responsive means being movable by fluid pressure in said housing between a position for operating said valve means to permit flow of gas to the patient and a position for shutting off said flow, re-

spectively; and means in said housing operable in response to movement of said fluid pressure responsive means into one of said positions, to pre-load said fluid pressure responsive means with gas at a pressure above atmospheric and such that said fluid pressure responsive means will be moved into the other of said positions when a negative pressure is developed in said housing in response to an inhalation effort of the patient.

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