United States Patent [19]

Davis

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[54] **PNEUMO-INFUFFLATOR APPARATUS**

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[52] **U.S. Cl.** ..... **128/2 R,** 137/253

[51] **Int. Cl.** **A61b 5/00**

[58] **Field of Search** ..... 128/2 R, 2 S, 185–188, 128/145.5, 145.8, 203, 224, 225; 251/57; 137/156–159, 505, 253, 505.16, 505.19

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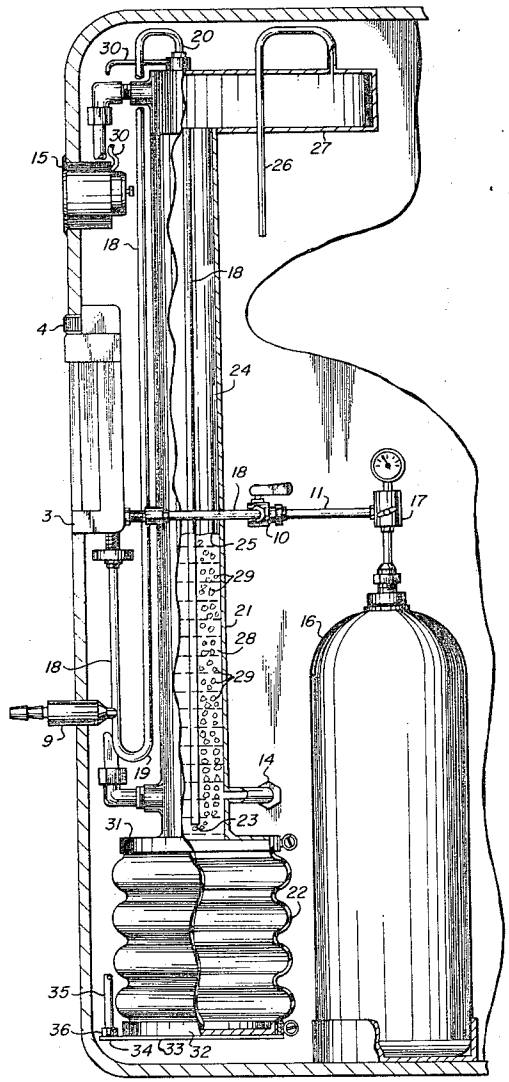
[57] **ABSTRACT**

Apparatus is disclosed for providing pressurized gas to a cavity within a living person or animal for the purpose of assisting a physician or surgeon in carrying out diagnostic or corrective procedures. Very close control over the maximum pressure introduced within the body cavity is achieved by utilizing a water column as a back pressure element in such a manner that, when the gas pressure within the body cavity equals that exerted by the water column, further gas flow results in the escape of excess gas through the water column. The unit includes means for carrying an integral supply of pressurized gas and for selectively switching to an external supply of gas as well as means for rapidly adjusting the height of the water column and the gas flow rate. The water column includes a bellows structure at its lower end, and the means for adjusting the height of the water column operates to raise or lower the bottom of the bellows. The height of the water column is read on a water manometer.

2 Claims, 3 Drawing Figures



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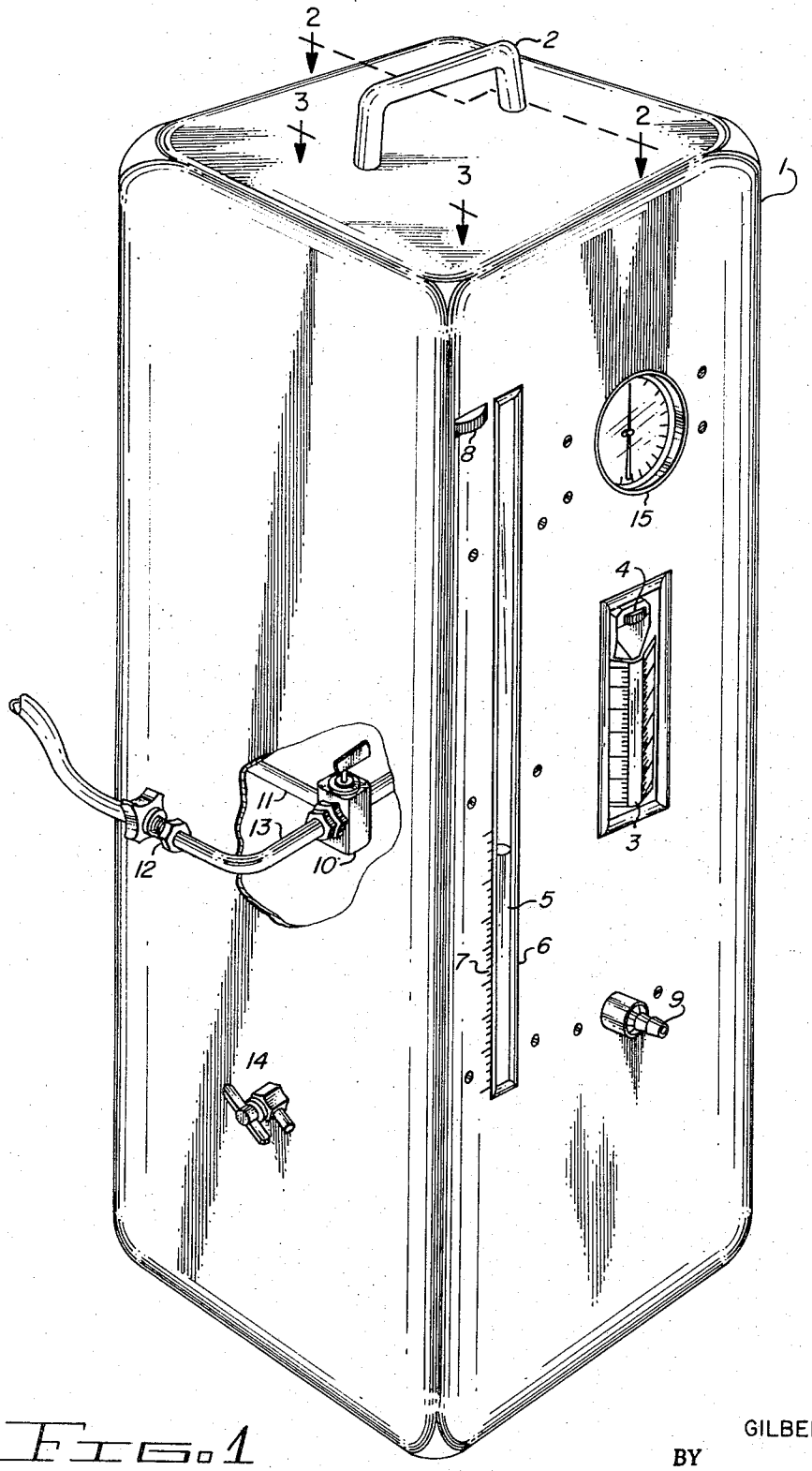

FIG. 1

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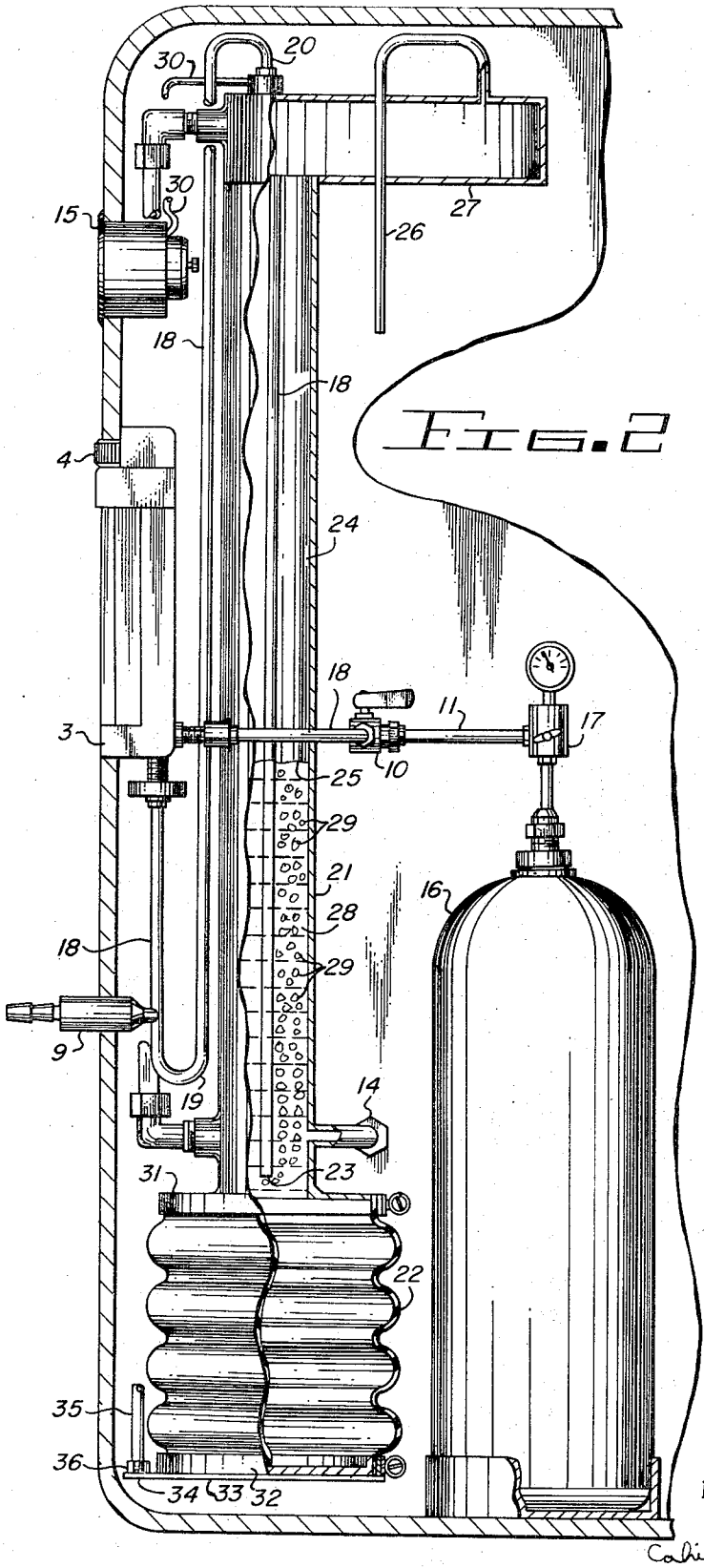

Fig. 2

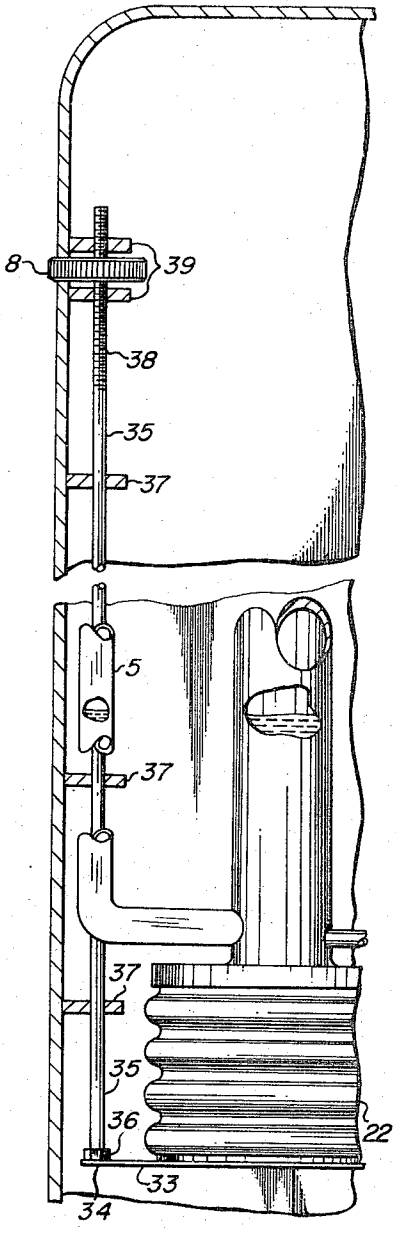

Fig. 3

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PNEUMO-INFUFFLATOR APPARATUS

This invention relates to the medical arts and, more particularly, to apparatus for controllably inflating a body cavity for diagnostic or corrective procedures.

Modern diagnostic and surgical techniques include, under certain conditions, the inflation of body cavities such as the abdominal cavity. In order to carry out this procedure, it has been necessary to utilize somewhat makeshift apparatus for injecting gas, such as CO_2 or N_2O, at a closely controlled rate while very carefully observing a maximum pressure for obvious reasons. The necessity for maintaining such close control over pressure and flow rate has occupied an inordinate amount of the attention of the personnel carrying out the precedure. It would be highly desirable to provide apparatus which can be preset to inject gas at a predetermined maximum rate and limit the maximum pressure to which the body cavity is subjected to a predetermined maximum with absolute reliability.

It is therefore a broad object of my invention to provide improved apparatus for controllably injecting gas into a body cavity.

It is a more specific object of my invention to provide such apparatus in which maximum flow rate and maximum pressure to which the body cavity is subjected is automatically controlled with absolute reliability and without the necessity for constant observation by the operating personnel.

It is a still more specific object of my invention to provide such apparatus in which the maximum pressure within a body cavity is controlled by utilizing the back pressure exerted by a water column.

The subject matter of the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification.

The invention, however, both as to organization and method of operation, may best be understood by reference to the following description taken in connection with the accompanying drawing of which:

FIG. 1 is a partially cutaway perspective view illustrating the external configuration of a presently preferred embodiment of the invention;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1 illustrating the internal structure; and

FIG. 3 is a partial cross-sectional view taken along the line 3—3 of FIG. 1 illustrating detailed structure for adjusting the height of the water column which controls the maximum back pressure.

Referring now to FIG. 1, it will be observed that the apparatus of the present invention is contained within a case 1 having a handle 2 on the upper surface thereof to permit ready portability. A gas flow rate meter 3 provides visual indication of the gas flow rate which is adjusted by means of a knob 4. Similarly, the height of a water manometer 5 may be visually observed through a vertical opening 6 and compared against indicia 7 calibrated in pressure units such as centimeters of water. A second knob 8 is utilized to adjust the height of the water column which, in turn, limits the maximum pressure appearing at the outlet 9 as will be described more fully below. A valve 10 permits the selection of an internal source of gas under pressure communicating with the valve through the conduit 11 or external source of gas coupled to the fitting 12 which is also in communication with the valve 10 through the conduit 13. A second manually operable valve 14 communicates with the water manometer 5 for introducing an initial supply of water into the water column or for draining the water column in conjunction with periodic maintenance. A secondary dial readout pressure gauge 15 is coupled in parallel with the water manometer 5 in order to provide a back up indication of the gas pressure appearing at the outlet 9 which is easily read at a glance.

Attention is now directed to FIG. 2 which reveals an internal tank 16 containing gas, such as CO_2 or N_2O under pressure, which gas is supplied to one inlet to the valve 10 through the conduit 11 after passing through a pressure regulator 17 which serves to place an initial upper limitation of the gas pressure to be controlled more closely by the structure to be described below. It will be appreciated by those skilled in the art, that if an external source of inflating gas is relied upon, that source of gas will also be pressure regulated to a predetermined maximum prior to its passing through the valve 10 and into the apparatus for effecting fine regulation.

A conduit 18 couples the outlet of the valve 10 to the gas flow rate metering system 3 which may be of the well known Thorpe tube type in which the rate of gas flow is controlled by adjusting the knob 4 as previuosly noted and is read by observing the height of a ball against calibrated indicia. The inflating gas exits from the gas flow rate metering system 3 through initially downwardly directed conduit 18 which is in direct communication with the outlet 9. The outlet 9 is coupled to a tube leading to the body cavity to be controllably inflated. The conduit 18 is reversed in direction at the elbow 19 to extend upwardly to a second elbow 20 where it loops to extend downwardly into a water column 21 terminating just above a bellows portion 22 constituting the bottom of the water column. The end 23 of the conduit 18 within the water column 21 is open to permit the discharge of gas from the conduit 18 into the water column 21 when the pressure is sufficiently high to overcome the water head.

The space 24 above the water level 25 within the water column is in communication with atmospheric through a conduit 26 which opens into an offset portion 27 at the top of the water column chamber. The upper end of the water column per se, represented by the water level 25, is at atmospheric pressure such that the pressure necessary to permit gas to discharge from the end 23 of the conduit 18 must be slightly greater than the distance below the water level 25 of the end 23 within the water 28.

In operation, gas from the integral tank 16 or from an external source, according to the position of the valve 10, passes through the gas flow rate metering system 3 at a rate controlled by setting the knob 4 to achieve a predetermined flow rate. The gas passes downwardly from the flow rate metering system 3 through the conduit 18 which is thus pressurizwd, and also flows from the outlet 9 to the patient. As the body cavity is inflated, the back pressure reflected therefrom is observed within the conduit 18 and will continue to rise until the gas pressure within the conduit 18 is sufficient to overcome the pressure appearing at the position in the water column at which the end 23 of the conduit 18 is located. When the back pressure reaches this level, excess gas will discharge from the end 23 of the conduit 18 and rise as bubbles 29 through the water 28 for discharge to atmospheric through the space 24 above the

water level 25 and through the conduit 26. Hence, the maximum back pressure, the reflected body cavity pressure, which can be achieved is goverened by the height of the water 28 in the water column 21 so long as the flow rate is kept within nominal bounds. Therefore, the body cavity pressure may be read directly on the water manometer 5 and also on the pressure gauge 15 which is coupled between atmospheric and the conduit 18 by a tap conduit 30 in the obvious manner.

The inflation of different body cavities, the utilization of the apparatus of the invention for other medical procedures such as continuous positive pressure ventilation, and for that matter, the personal preferences of an individual surgeon, make it highly desirable to provide means for adjusting the maximum back pressure reflected from the patient by effecting a corresponding change in the height of the water within the water column. Such adjustment is carried out by raising and lowering the bottom of the bellows 22 by turning knob 8 as may best be understood with reference to FIGS. 2 and 3. The bellows 22, which is sealed at its upper and lower ends, respectively, by clamp rings 31 and 32, rests on a plate 33 which is provided with an extension 34 to which a vertical rod 35 is fixed by threading its lower end into a nut 36 which is welded or otherwise secured to the plate 33. It will be appreciated that there are many equivalent ways in which the vertical rod 35 may be fixed to the plate 33 in order that vertical movement of the rod 35 correspondingly raises and lowers the plate 33.

The vertical rod 35 extends upwardly through a series of guides 37 to terminate in a threaded portion 38 onto which the knob 8 is fixed. The knob 8 is constrained between guide bars 39 which fix its vertical position. Thus, as the nut 8 is rotated, the vertical rod 35 is pulled upwardly or pushed downwardly to adjust the position of the plate 33, and hence the volume of the bellows 22 to alter the water level 25 of the water 28 within the water column 21 as observed by reading the water manometer 5. Since the volume of the bellows 22 is considerable as compared with the tube constituting the upper portion of the water column 21, a moderate change in the position of the plate 33 brings about a substantial change in position of the water level 25 such that the nut 8 and the threaded portion 38 of the vertical rod 35 may usefully have relatively fine threads for setting the water column to the desired predetermined level.

While the principles of the invention have now been made clear in an illustrative embodiment, there will be immediately obvious to those skilled in the art many modifications of structure, arrangement, proportions, the elements, materials, and components, used in the practice of the invention which are particularly adapted for specific environments and operating requirements without departing from those principles.

I claim:

1. Apparatus for providing pressurized gas to a cavity within a living person or animal for the purpose of assisting a physician or surgeon in carrying out diagnostic or corrective procedures, said apparatus comprising in combination:

A. a source of pressurized gas, including means for regulating the flow of gas from said source; said regulating means including an inlet and an outlet;

B. a flow meter having an inlet and an outlet, said inlet being connected to the output of said regulating means;

C. a gas delivery means communicating with the outlet of said flow meter;

D. a first conduit having one open end and another end, said other end communicating with the outlet of said flow meter and said gas delivery device;

E. a column of fluid for receiving said open end of said first conduit;

F. a second conduit circumscribing said fluid column and having one open end and another end, said open end permitting said column of fluid to be vented to the atmosphere;

G. an adjustable volume bellows having a vertically oriented longitudinal axis, said bellows being in communication with said other end of said second conduit for selectively varying the height of said fluid column within said second conduit; and

H. a plate for supporting the base of said bellows, said plate having vertically variable means to compress or extend said bellows to decrease or increase the volume of said bellows and correspondingly vary the height of said fluid column within said second conduit; whereby, the height of said fluid column determines the pressure at said open end of said first conduit and regulates the gas pressure present within said first conduit and said gas delivery device.

2. The apparatus as set forth in claim 1 further including adjacent means for controlling the vertical position of said plate.

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