July 10, 1962 E. M. SPEARS ET AL 3,043,302

FLOW CONTROL UNIT FOR PORTABLE INHALATORS

Filed May 8, 1958

Fig. 1.

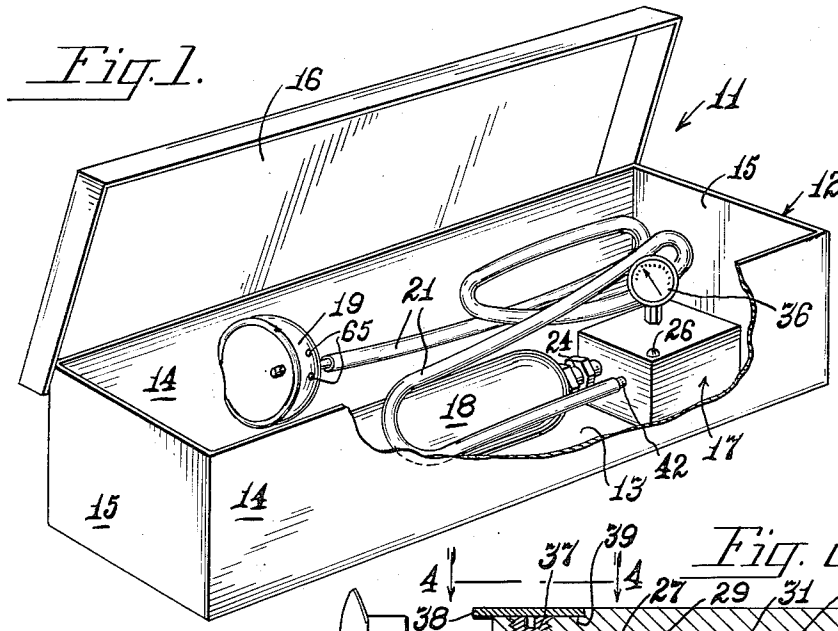


Fig. 2.

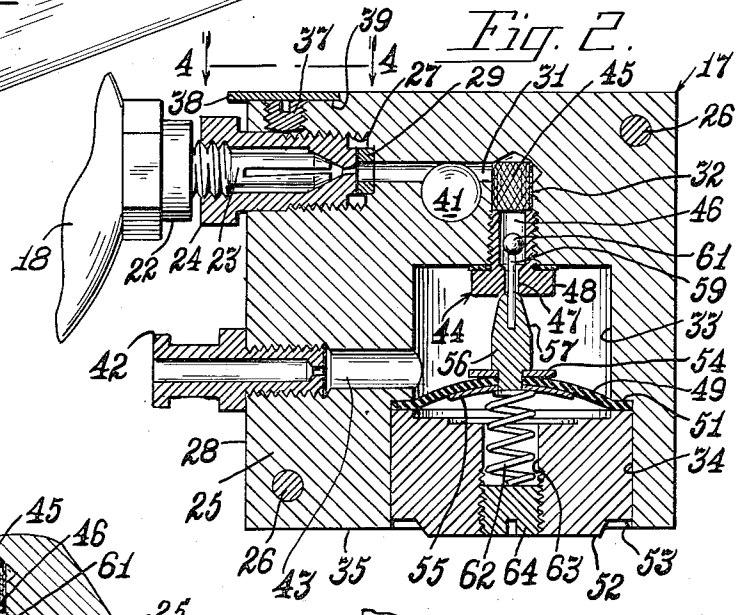


Fig. 3.

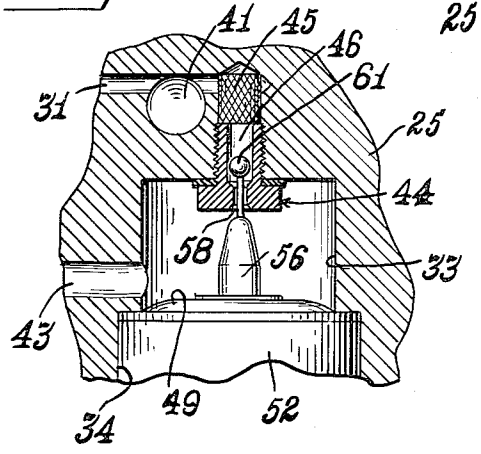
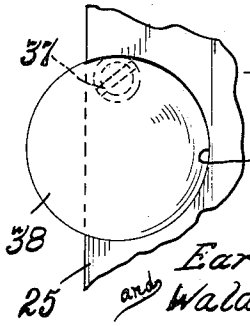


Fig. 4.



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FLOW CONTROL UNIT FOR PORTABLE INHALATORS

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The invention relates to improvements in inhalators, and more particularly to the construction and assembly of a portable inhalator or respirator of a character adapted to accommodate a small-size standard type of pressurized oxygen cylinder, and having a novelly constructed flow-control unit therein.

The apparatus selected for purposes of illustration and shown in the accompanying drawing, is mounted in an assembled condition ready for immediate use in a suitable carrying case. This case is of a size and shape to receive, compactly arranged therein, a small-size conventional oxygen cylinder, the novel flow-control unit and the usual face mask and its flexible hose connecting it to the control unit. Because of its compactness and lightness in weight, the apparatus may thus be transported easily or readily stored, and it may be quickly put to use with a minimum of time and effort.

The flow-control unit which embodies the features of the present invention, is of a type that may be secured firmly in the carrying case and does not require sensitive manipulation while in operation. It includes a novel preset diaphragm valve structure which is entirely automatic in its operation, and which functions to perform the dual function of regulating the rate of the flow of oxygen to the mask and of shutting off the flow of oxygen in the event the pressure becomes dangerously excessive. As is well understood, any excessive pressure on the lungs resulting from the uncontrolled flow of oxygen thereto may result in rupturing or otherwise injuring the delicate lung tissue. Heretofore, such dual regulation of the oxygen flow has been accomplished by the use of two or more distinct, separate and complicated flow-control mechanisms, the use of which involves an amount of equipment unsuited for compact installation in a carrying case unit requiring no assembly operations prior to use.

The use of portable inhalators of known types requires the high degree of skill of persons trained in the use of medical oxygen equipment. Furthermore, known types of portable inhalators require the inclusion of a rebreather bag in the fluid line to the mask, the use of which permits carbon dioxide to be mixed with the oxygen flowing to the mask. The portable inhalator described and claimed herein is suitable for use by nontechnical personnel, such as athletes, operators of small gymnasiums and the like, operators of motor vehicles and small aircraft, and many others, without technical training in the use and operation of medical oxygen equipment. Also, the portable inhalator described and claimed herein enables the delivery of substantially pure oxygen to the mask.

An object of the invention is to provide a portable inhalator which is light in weight, compact, is easily set up for use, may be readily stored, and which includes novel means to regulate the flow of oxygen.

Another object is to provide a novel flow-control unit with novel tamper-proof means to mount an oxygen cylinder directly thereon.

Another object is to provide a novelly constructed and assembled flow and pressure control valve unit.

Still another object is to provide a novel flow-control valve unit of a character that may be mounted firmly in a carrying case and which has means to receive and

mount an oxygen cylinder firmly in place in the case and in flow communication with the unit.

Another object is to provide portable oxygen equipment having means therein to exhaust carbon dioxide to the atmosphere.

Another object is to provide a portable inhalator of the character described which is inexpensive to construct, easy to service, safe in operation, and very efficient in use.

With the foregoing and other objects in view which will appear as the description proceeds, the invention consists of certain novel features of construction, arrangement and a combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in form, proportion, size and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

For the purpose of facilitating an understanding of the invention, a preferred embodiment is illustrated in the accompanying drawings, from an inspection of which, when considered in connection with the following description, the invention, its mode of construction, assembly and operation, and many of its advantages should be readily understood and appreciated.

Referring to the drawings in which the same characters of reference are employed to indicate corresponding or similar parts throughout the several figures of the drawings:

FIGURE 1 is a perspective view of a portable inhalator embodying the features of the present invention and showing a portion of the carrying case broken away.

FIGURE 2 is a central horizontal sectional view of the automatic flow-control unit, showing a portion of the attached oxygen cylinder mounted therein and the valve elements in the positions assumed when the inhalator is not in use.

FIGURE 3 is a fragmentary sectional view similar to FIGURE 2, showing the valve elements in an open flow-control position.

FIGURE 4 is a fragmentary end elevational view, viewed in the direction of the arrows on line 4—4 of FIGURE 2.

The inhalator assembly is mounted within a suitable carrying case 11, which, in the present disclosure, comprises a shallow, substantially rectangular container portion 12 including a bottom wall 13, side walls 14, and end walls 15. A cover 16, having a perimeter flange thereon, may be hinged or otherwise connected to the container portion 12, or it may be entirely removable therefrom.

Mounted within the container portion of the carrying case is a flow-control unit 17, a fluid cylinder 18, a mask 19 and its connecting hose 21. The mask, hose and fluid cylinder are of types commercially available and, as best shown in FIGURE 2, the cylinder, which in this instance may contain liquified oxygen at an initial pressure of substantially eighteen hundred (1,800) pounds, has a normally closed valve outlet nozzle 22 which includes a valve element 23, and a relatively movable complemental valve fitting 24, which also serves as means to mount the cylinder on the flow-control unit 17 in a manner to be described presently.

The flow-control unit 17, which includes a body 25 preferably fabricated from a solid substantially rectangular block of metal, such as aluminum, is secured firmly to the inside face of the container bottom wall 13, and adjacent to one end in any suitable manner, as, for example, by means of screws or bolts 26. The body 25 is suitably bored, drilled, tapped, and recessed in a manner to be more fully described so as to afford numerous cavities and passages therein within which the various

parts of the valve structure and component parts of the inhalator assembly are mounted.

Referring particularly to FIGURE 2, the body 25 has a tapped recess 27 extending inwardly from one end face 28 thereof and within the inner end of which is seated an annular packing gland 29, preferably of pressed fiber. An axially aligned bore or flow passageway 31 of reduced diameter extends inwardly from the inner end of the recess 27. This flow passageway 31 is in communication at its innermost extremity with the smallest diameter bore of a multiple-diameter bore arranged perpendicular to the tapped recess 27 and comprised of bore portions 32, 33, and 34, the latter opening onto a side face 35 of the block. This multi-diameter bore is adapted to mount a flow-control valve structure to be described presently.

The tapped recess 27 is adapted to receive, threaded therein, the externally threaded end of the cylinder outlet closure fitting 24 so as to mount the fluid cylinder 18 firmly on the flow-control unit 17 in the position best shown in FIGURE 1. The fitting 24 is secured against unintended displacement by a set screw 37 threaded into the unit body 25 from the adjacent side face thereof. Tampering with the set screw 37 is prevented by placing thereover a circular plate 38, which is seated in a shallow recess 39 having a downwardly outwardly diverging side wall to frictionally engage the perimeter of the plate. It is to be noted, see FIGURE 4, that a segment of the circular plate 38 projects beyond the body end face 28 so as to permit it to be engaged readily to facilitate its removal for cylinder replacement. To open and close the valved cylinder outlet 23, the cylinder is rotated relative to the held closure fitting 24, as is well understood in the art. A pressure gauge 36 is in communication with the flow passageway 31 through a bore 41.

Also mounted on the body 25 and extending outwardly from the end face 28 is a sleeve fitting or nipple 42 to which the mask hose 21 is attached. The nipple is in direct communication with the intermedaite bore portion 33 through a flow passageway 43.

The flow-control valve structure referred to hereinabove and mounted in the multiple diameter bore 32, 33, and 34, comprises a headed fitting 44 externally threaded at one end to be threadingly received in the smallest diameter bore 32 which is internally threaded for a part of its length. A cylindrical filter screen 45 is enclosed within said bore 32 beneath the fitting 44, and said fitting has an axial bore 46 extending inwardly from its mounted end and terminating in a small axial port 47 opening through the head end 48 of said fitting.

A diaphragm 49, of rubber or like flexible material, is seated against an internal shoulder 51 formed at the juncture of the intermediate and larger bore portions 33—34, and it is secured in place about its perimeter by a circular plug 52 fitted into said larger bore 34 and held in place preferably by spot swagings 53. Said diaphragm is reinforced in its medial area by face plates 54 and 55, arranged on opposed faces thereof and secured in place thereon by the mounted end of a shouldered valve stem 56 which extends in the direction of and is axially aligned with the fitting 44.

The free end of the stem 56 is suitably tapered, as at 57, for seating on an annular valve seat 58 formed on the top face of the fitting head 48 and surrounding the axial port 47 therein. A pin 59 of a diameter smaller than the axial port 47 is carried firmly on the tapered stem end 57 and it extends through said port at all times. The free end of this pin 59 has abutment with a ball valve element 61 arranged in the fitting bore 46, which element is adapted, under certain conditions of operation, to seat against the inside face of the head end 48 of the said fitting so as to close the axial port 47.

A pressure spring 62 for regulating the diaphragm 49 is mounted in an axial bore 63 in the plug 52. One end of this spring bears against the diaphragm and its other end abuts a screw 64 threaded into the bore 63 and adapted to be adjusted manually to increase or decrease the tension of the spring on the diaphragm.

The valve structure is operable to regulate the flow of oxygen from the fluid cylinder 18 to the mask 19. The intermediate bore 33 in the valve body 25 serves as a flow regulator chamber into which the oxygen flowing through the axial port 47 is accumulated under pressure while the mask is in use.

During normal operation of the valve assembly, the ball valve element 61 is held off of its seat by the pin 59. Substantially uniform flow at a predetermined pressure determined by the setting of the screw 64 is, however, maintained by the position assumed by the tapered end 57 of the stem 56 with respect to its seat 58. However, should the pressure be in excess of the pressure determined to be safe for the patient upon whom the mask is fitted, the diaphragm 49 moves against and compresses the regulator spring 62 sufficient to permit the ball valve element 61 to seat and close the axial port 47. As soon as the flow of oxygen out of the regulator chamber 33 through nipple 42 has reduced the pressure in the chamber to normal, the regulator spring 62 again functions to move the diaphragm in a direction to carry the ball valve element out of port closing position.

The mask 19 is of a character adapted to fit over the nose and mouth in such manner that the oxygen flowing thereinto is delivered in close proximity to the nose and it is provided with a pair of exhaust ports 65 in the area of the mouth to allow for the direct flow of carbon dioxide to be exhaled into the atmosphere.

It is believed that our invention, its mode of construction and assembly, and many of its advantages should be readily understood from the foregoing without further description, and it should also be manifest that while a preferred embodiment of the invention has been shown and described for illustrative purposes, the structural details are nevertheless capable of wide variation within the purview of our invention as defined in the appended claims.

What we claim and desire to secure by Letters Patent of the United States is the following:

1. A fluid flow-control valve comprising, in combination, a substantially solid body, an inlet passageway and an outlet in said body, a pressure regulator chamber in said body between the inlet and the outlet, a valve fitting having a passageway constituting a communicating passage between the inlet passageway and pressure regulator chamber, said communicating passageway having a valve seat at each end thereof, a diaphragm in said chamber, an abutment in said body in opposed relation to one face of said diaphragm, a valve stem carried by and extending from the other face of said diaphragm, a spring interposed between said abutment and diaphragm to normally urge the valve stem in a direction to seat the valve stem on one of the valve seats, a pin on the free end of the said stem projecting loosely through the communicating passageway, and a ball valve element in said fitting to coact with the other valve seat for closing the communicating passageway, said pin normally holding the ball valve element in non-seating position, and the diaphragm being responsive to pressure in the pressure regulator chamber to control the relative position of the valve stem with respect to its valve seat and to permit seating of the ball valve element when excessive pressure is present in the pressure regulating chamber.

2. A fluid flow-control valve comprising, in combination, a body, an inlet passageway and an outlet in said body, a pressure regulator chamber in said body in communication with the outlet, a communicating passageway between the inlet passageway and pressure regulator chamber, said communicating passageway having a valve seat at each end thereof, a diaphragm in said chamber, an abutment in said body in opposed relation to one

face of said diaphragm, a valve stem carried by and extending from the other face of said diaphragm, resilient means interposed between said abutment and diaphragm to normally urge the diaphragm and valve stem in a direction to seat the valve stem on one of the valve seats, a pin on the free end of said stem projecting loosely through the communicating passageway, and a ball valve element in said fitting arranged to coact with the other valve seat for closing the communicating passageway, said pin normally holding the ball valve element in non-seating position, and the diaphragm being responsive to pressure in the pressure regulator chamber to control the relative position of the valve stem with respect to its valve seat and to permit seating of the ball valve element when excessive pressure is present in the pressure regulating chamber.

3. A fluid flow-control valve comprising, in combination, a body, an inlet and an outlet in said body, a pressure regulator chamber in said body in communication with the outlet, a valve fitting having a port therein constituting a communicating passageway between the inlet and pressure regulator chamber, said communicating passageway having a valve seat at each end thereof, a diaphragm in said chamber, an abutment in said body in opposed relation to one face of the diaphragm, a valve stem projecting from the other face of the diaphragm, a spring interposed between said abutment and the diaphragm to normally urge the valve stem in a direction to seat on one of the valve seats for closing the passageway, an extension on the free end of the said stem projecting loosely through the communicating passageway, a valve element in said fitting arranged to coact with the other valve seat for closing the communicating passageway, said extension normally holding the valve element in non-seating position, and the diaphragm being responsive to fluid pressure in the pressure regulator chamber to control the relative position of the valve stem with respect to its valve seat and to permit seating of the valve element when excessive pressure is present in the pressure regulating chamber.

4. A fluid flow-control valve comprising, in combination, a body, a pressure regulating chamber in said body, said chamber having a fluid inlet and an outlet, a diaphragm in said chamber, a first normally closed diaphragm controlled valve element in said inlet adapted to open in response to the pressure of fluid delivered to said inlet for admitting fluid to said chamber, said diaphragm being responsive to the fluid pressure in said chamber for regulating the degree of opening of said valve element, and a second valve element operably connected with the diaphragm controlled valve element effective to shut off the flow of fluid to said chamber when the pressure in said chamber exceeds a predetermined maximum.

5. A fluid flow-controlled valve comprising in combination, a body, a pressure regulating chamber in said body, said chamber having a fluid inlet and an outlet, a valve element normally closing said fluid inlet and movable into an open condition in response to fluid flow in said inlet to admit fluid into the chamber, diaphragm means connected to said valve element and responsive to fluid pressure in said chamber for adjusting the position of said valve element to regulate the flow of fluid to said chamber, and a normally open auxiliary valve element in said inlet operably connected with said diaphragm means and operable in response to movement of the first named valve element into maximum open position to shut off the flow of fluid to said chamber.

6. In a portable inhalator including a flow-control unit and a pressurized fluid cylinder having an outlet mounted on and in communication with the flow-control unit, said unit comprising a normally inaccessible valve assembly mounted in said flow-control unit and through which fluid flowing through the unit passes, said unit having a fluid inlet and an outlet, a pair of valve elements in said inlet, a pressure actuated diaphragm in said unit and connected with said valve elements, said diaphragm being responsive to fluid pressure in the unit for operating a first of said valve elements to control the rate of the flow of fluid through the unit, and the second of said valve elements being operable in response to excessive fluid pressure on said diaphragm to stop the flow of fluid through the inlet.

7. In a portable inhalator including a flow-control unit and a pressurized fluid cylinder having an outlet in communication with an inlet to the flow-control unit, said unit comprising a multiple valve assembly mounted in said inlet and through which fluid flowing through the unit passes a pair of valve elements in said assembly, a pressure actuated valve operating diaphragm in said assembly responsive to fluid pressure in the unit for positioning a first of said valve elements to regulate the rate of flow of fluid through the inlet, and a second of said valve elements being operable in response to excessive fluid pressure on said diaphragm to stop the flow of fluid from the cylinder.

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