

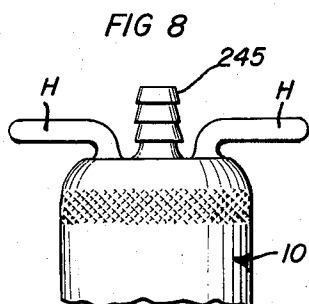
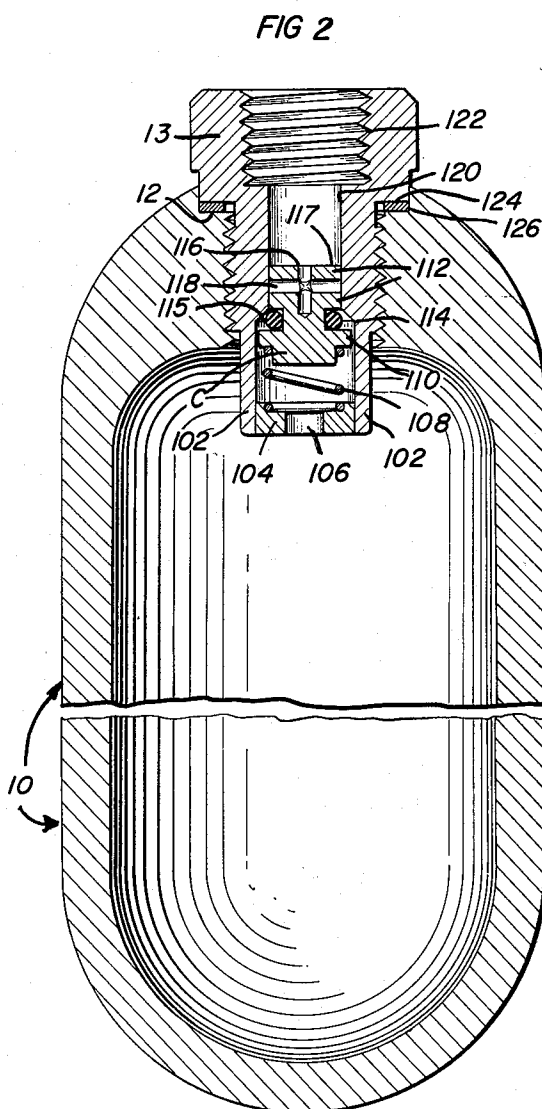
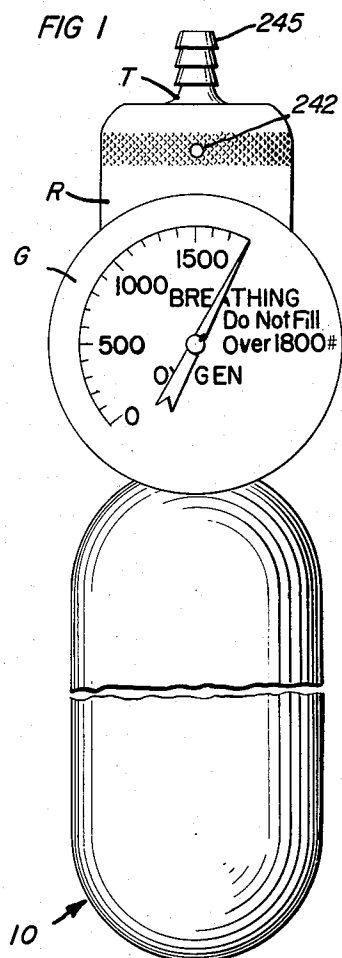
Oct. 17, 1961

A. E. McKEE
PORTABLE OXYGEN INHALATOR

3,004,686

Filed June 6, 1958

3 Sheets-Sheet 1



Albert E McKee INVENTOR

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3 Sheets-Sheet 2

FIG 3

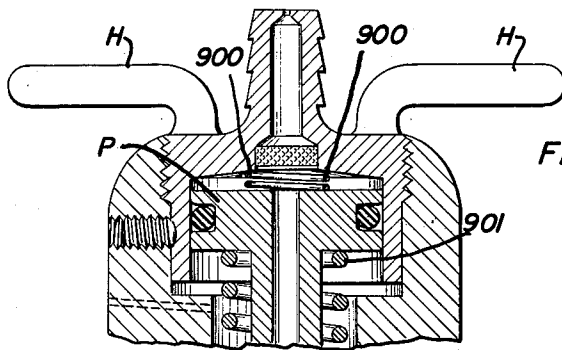
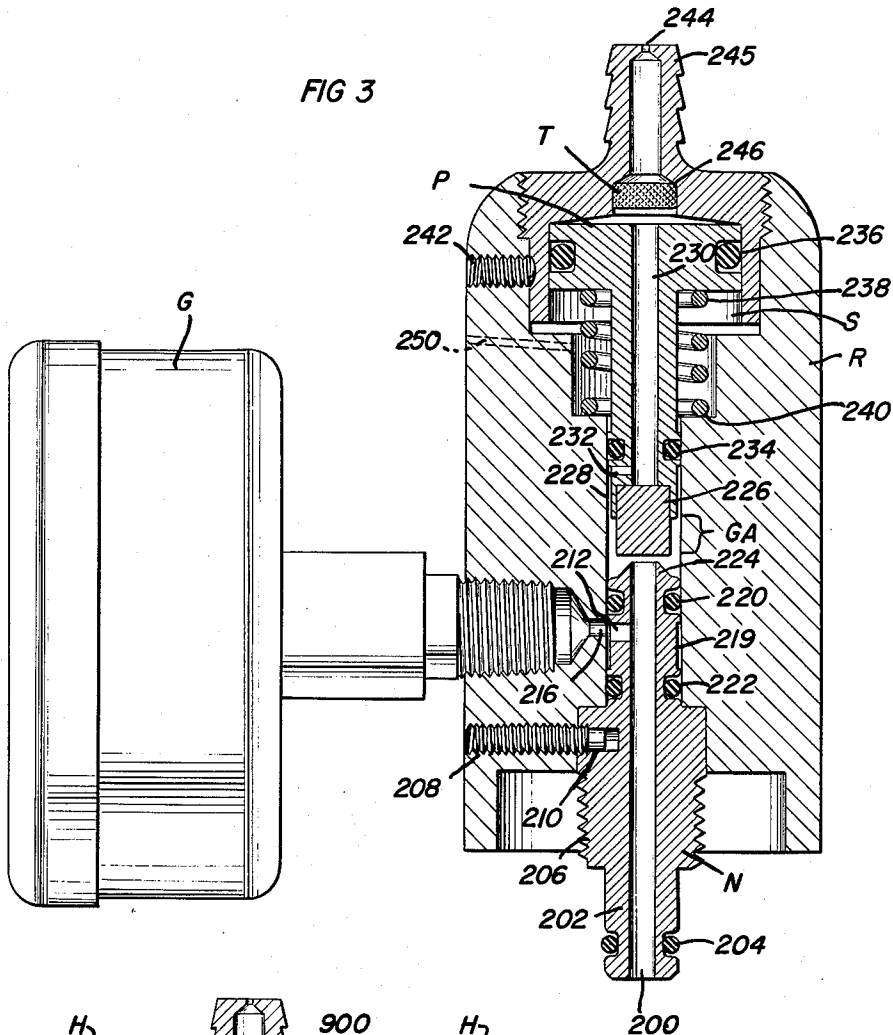


FIG 9

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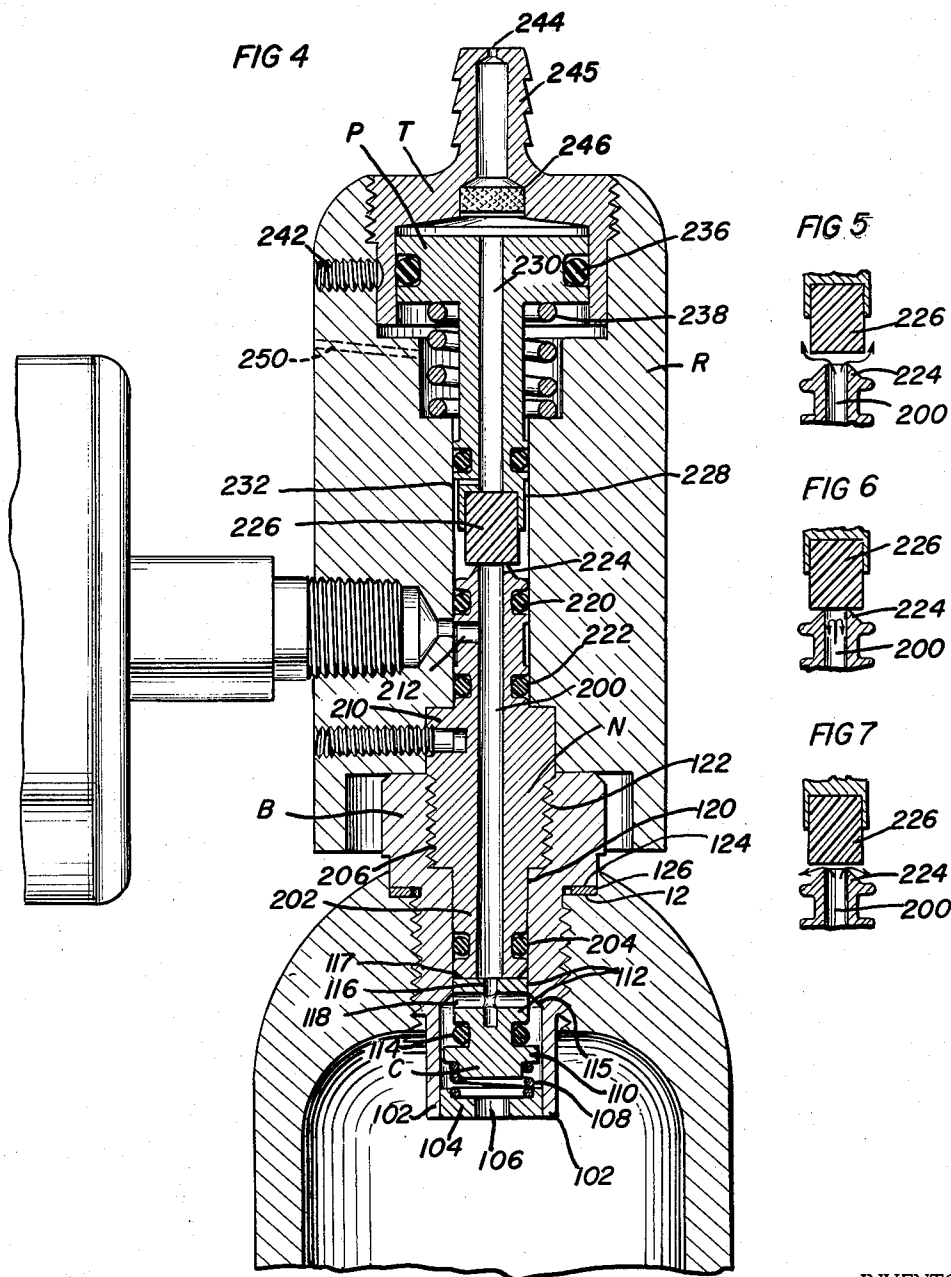
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3 Sheets-Sheet 3



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PORTABLE OXYGEN INHALATOR

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1 Claim. (Cl. 222—3)

INTRODUCTION

This invention generally relates to a novel mechanical unit for the dispensing of compressed gases. More particularly, this invention relates to a novel inhalator for the administration of oxygen or other therapeutic gases. In one specific embodiment this invention pertains to a small portable oxygen inhalator which is of simple construction and which can be easily manipulated by persons of nearly any age without danger.

BACKGROUND

For some time there has existed a need for a low cost inhalator which is of such light weight construction that it can be easily and quickly transported from one place to another. Such a device has many uses. For example, it may be used to revive persons suffering from a respiratory failure resulting from gas poisoning, drowning, disease, nervous shock, and other causes, and to initiate respiration in newborn babies. It also may be used to deliver anesthetic, oxygen or other vapors or gases to individuals for therapeutic purposes and during operations when the patient's respiration is slow and shallow. It may also be used to deliver oxygen to individuals who work in atmospheres containing poisonous gases, dust or a deficiency of oxygen.

Most hospitals and many doctor's offices have inhalator units which will facilitate the administration of oxygen or similar gases to persons who have an oxygen deficiency either due to a heart attack, smoke or other congestion in the lungs, shortness of breath, etc. Such units are quite handy and many lives are saved each year because of them. However, such units are of rather a bulky nature. In addition, they are quite expensive and special training is necessary before one can learn to properly operate the complicated valving arrangements usually associated with such units. These factors have more or less limited the use of such inhalator units to hospitals and larger doctors' offices and have denied the use of oxygen breathing equipment to the ordinary person. When a person has a heart attack in his own home, and a source of oxygen is not available, the heart attack victim frequently dies before oxygen can be obtained and administered. The absence of a portable unit which can be sold at a reasonable price to car owners has also undoubtedly resulted in a number of deaths when auto collisions occur and there is an absence of oxygen to administer to the injured persons.

OBJECTS

It is therefore an object of this invention to provide a portable compressed gas dispensing unit of unusually simple construction and which can readily be operated by persons who have no mechanical knowledge whatsoever.

Another object of this invention is to provide a portable compressed gas dispensing unit which is of simple construction and which can be readily disassembled, repaired or reconstructed.

Another object of this invention is to provide a portable compressed gas dispensing unit which can be safely used by persons of all ages and without any danger whatsoever to persons who may operate the unit in an improper manner.

Still another object of this invention is to provide a valve and gas pressure regulator assembly of very simple construction and of foolproof operation so that com-

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pressed gas may be efficiently and safely dispensed at a uniform rate.

These and other objects are accomplished by the parts, elements, constructions, arrangements and combinations which comprise the present invention, the nature of which is set forth in the following general statement, a preferred embodiment of which is set forth in the following description and illustrated in the accompanying drawings, and which is particularly and distinctly pointed out and set forth in the appended claim forming a part hereof.

THE DRAWINGS

FIGURE 1 is a side elevation of the complete dispenser;

FIGURE 2 is a sectional view of the compressed gas reservoir and check valve;

FIGURE 3 is a sectional view of the regulator and gauge (not in section);

FIGURE 4 is a sectional view of the top of the compressed gas reservoir, the check valve assembly, the regulator assembly and the gauge;

FIGURES 5, 6 and 7 are fragmentary sectional views showing the relative positions of several parts of the regulator under varying flow conditions;

FIGURE 8 is a fragmentary side elevation of the top of the regulator housing and its associated handles;

FIGURE 9 is a sectional view of a modified version of the regulator housing shown in FIGURES 3 and 4.

THE INVENTION BROADLY

The novel inhalator of this invention can probably be most easily understood by thinking of it as a plurality of more or less distinct parts or units which are adapted to be interconnected in such a fashion as to function as a unitary whole. These distinct units are as follows:

- (a) A reservoir for compressed gas,
- (b) A check valve located at one end of said reservoir,
- (c) An automatic pressure reducing gas regulator, one portion of which is adapted to engage said check valve and another portion of which is adapted to dispense gas at a pressure which is usually at a lower pressure than the gas in the reservoir.

It is preferable that all of the parts of the check valve assembly and the regulator assembly be made of brass, in accordance with well-known safety practices, although it will be understood that other metals such as steel, iron, aluminum, etc., would be satisfactory if desired.

THE COMPRESSED GAS RESERVOIR

As is shown in FIGURES 1 and 2, the compressed gas reservoir 10 preferably consists of an oblong cylindrical thick-walled chamber of sufficient strength to safely contain the compressed gases under the desired pressure and also of sufficient strength to withstand damage due to accidental jarring, bumping or dropping. The reservoir is preferably made from high-strength steel but other metals are satisfactory. A particularly preferred type of gas reservoir or cylinder is that approved by the Bureau of Explosives and the Interstate Commerce Commission and which is slightly less than 2 inches in diameter and slightly less than 12 inches in length.

It will be understood that the hereinafter described regulator can be used on any size cylinder up to the commercial oxygen cylinder containing 244 cubic feet of oxygen.

The cylinder pressure in the small cylinders usually ranges from 1800 to 2200 pounds pressure and the regulator can easily withstand this pressure.

It will be seen that the reservoir 10 is closed at one end and open at the other end. The open end is threaded to receive corresponding threads on the exterior of the hereinafter described check valve housing. The ex-

act shape of the reservoir is of course not critical and the size and weight may be designed to accommodate any desired volume and pressure of gas.

THE CHECK VALVE ASSEMBLY

As is best shown in FIGURE 2, the check valve assembly can be considered as consisting of a check valve housing B in which is internally threaded in its upper portion, exteriorly threaded on its middle portion and substantially free from threads on its hollow cylindrical lower portion 102. The interior end of lower cylindrical portion 102 is fitted with a retainer plug 104 having a central opening 106 therein. A shallow groove is preferably provided on the upper surface of retainer plug 104 so as to form a seat for coil spring 103. The upper end of coil spring 103 is adapted to engage and push upwardly against a lower shoulder portion 110 of check valve C. Above shoulder 110 of check valve C there is located another shoulder 112, of less diameter than shoulder 110. Between shoulders 110 and 112 a channel section is formed which is adapted to receive O-ring 114. The sides of this channel section need not be rectangular as shown but may instead be curved if preferred. Upper shoulder portion 112 has a central vertical passageway 116 which is in turn in open communication with lateral passageway 118. Upper shoulder 112 is adapted to slide up and down within the internal cylindrical bore 120 of check valve housing B. Bore portion 120 in turn opens upwardly into internally threaded portion 122. The upper portion of check valve housing B is shown as having a shoulder portion 124 which is adapted to press downwardly against a rubber or plastic (e.g. nylon) gasket 126 which is in turn seated in a corresponding receiving groove 12 located in reservoir 10.

THE GAS REGULATOR ASSEMBLY

As is best shown in FIGURE 3, the gas regulator assembly comprises a main regulator housing R of generally hollow cylindrical shape, the interior of which is adapted to receive a plurality of separate elements. For example, the lower portion of gas regulator housing R contains an opening which is adapted to receive nozzle assembly N. The central hollow portion 200 of nozzle assembly N forms a passageway for gases from one end of the nozzle assembly to the other. Above lower stem section 202 there is located an exteriorly threaded portion 206 which is adapted to engage interiorly threaded portion 122 of check valve housing B, as will be more fully described hereinafter. The portion of nozzle assembly N which is immediately above threaded portion 206 is adapted to slidably fit within a cavity of corresponding diameter provided within the lower portion of gas regulator assembly R. Since the nozzle assembly N does not threadably engage this lower portion of regulator assembly R, the nozzle assembly N is held in place by any appropriate means, preferably by a pin or a dog point set screw 208 that is adapted to pass through the side of regulator assembly R and which is adapted to seat within slightly chamfered hole 210 located in the side of nozzle assembly N. Axial passageway 209 in nozzle assembly N is in open communication with lateral passageway 212 in nozzle assembly N and lateral passageway 212 in turn opens into a wide and shallow circumferential channel 219 disposed in the outer upper periphery of nozzle assembly N. Lateral passageway 212 and channel 219 are so designed that there will always be open communication between the interior of axial passageway 200 and the passageway 216 in the side of regulator housing R. Passageway 216 opens into an internally threaded section 218 and section 218 is adapted to threadably receive the threaded end of pressure gauge G. Channels or grooves are provided on each side of shallow circumferential channel 219 so as to receive O-rings 220 and 222. O-rings 220 and 222 thus act as a gas sealing means and prevent any movement of gases along the

internal bore of regulator housing R. Immediately above O-ring 220 there is located a nozzle exit portion 224.

Immediately above the nozzle exit portion 224 there is disposed axially moveable plunger assembly P having a lower seat portion 226. Seat portion 226 is shown as fitting tightly within an internal cavity in the lower portion of plunger P and as the plunger P moves axially in an up and down direction the seat member 226 will alternately permit and restrict the flow of gases through passageway 200. The outer circumference of the lower portion of the plunger P is also of reduced diameter near its lower extremity so that a circumferential passageway 228 is formed. Circumferential passageway 228 is in open communication with the internal axial passageway 230 of plunger P by virtue of connecting passageway 232. O-ring 234 located closely adjacent to and slightly above circumferential passageway 228 insures that there will be no leakage or flow of gas from the circumferential passageway 228 upwardly along the internal bore of regulator housing R. The upper portion of plunger P widens out into a piston-like member having a channel in its outer circumference containing an O-ring 236.

A coil spring 238 engages and presses against the underside of the upper piston-like cap of plunger P. The lower portion of this coiled spring 238 is seated on the internal shoulder portion 240 of regulator housing R.

Plunger P, although under the stress of an upward force by virtue of spring 238, is limited in its upward movement by upper threaded member T which threadably engages with corresponding internal threads located in the upper portion of regulator housing R. Accidental disengagement of these latter two threaded members may be avoided by the use of a pin or dog point setscrew inserted through threaded passageway 242 located in the side of regulator housing R and a corresponding champhered hole located in the exterior side of threaded member T. As is shown in the drawings, the internal diameter of threaded member T narrows in progressive stages until orifice 244 is reached. It is preferred that the sintered bronze filter 246 be interposed across the internal configuration of threaded member T and above plunger P so as to prevent foreign particles from entering any of the small passageways, but this filter can be omitted if desired. The topmost portion of threaded member T is preferably provided with a coupling nipple 245 so that the dispensed gas can be easily conducted through flexible tubing.

The gas space S between O-rings 236 and 234 is preferably in open communication with a passageway which will permit the pressure within space S to remain at a practically constant level (usually atmospheric). Such a passageway is shown at 250. It has also been found that when the threaded engagement between threaded top portion T and regulator housing R is not gas tight, sufficient bleeding or venting action is obtained so that passageway 250 is not needed.

POSITION OF THE VARIOUS COMPONENTS WHEN THE INHALATOR IS IN AN INOPERATIVE CONDITION AND NO GAS IS FLOWING

FIGURES 2 and 3 clearly illustrate the position of the various components when the inhalator apparatus is in an inoperative condition and when no gas is flowing. With particular reference to FIGURE 2 it will be seen that since spring 103 is pressing check valve C upwardly, O-ring 114 will at the same time be pressed firmly upwardly against slanting shoulder 115 so that no gas from the interior of reservoir 10 will be permitted to rise upwardly along bore 120 and into passages 118 and 116.

Likewise, with reference to FIGURE 3, since there is no force opposing the force of spring 238, the plunger P will be forced upward to its maximum extent against the inner dome of threaded member T and accordingly seat 226 of plunger P will be out of engagement with the upper exit portion 224 of nozzle assembly N.

POSITION OF THE MOVABLE COMPONENTS WHEN THE SYSTEM IS IN OPERATION AND WHEN GAS IS FLOWING

The inhalator apparatus of this invention is rendered operative by interconnecting the regulator assembly with the reservoir and check valve assembly. This is easily accomplished by simply inserting the end of the regulator assembly containing the nozzle assembly N downwardly into the check valve housing B. As the two members are brought together in this fashion, the lower portion of threaded member 206 will engage the upper portion of threaded member 122 and consequently in order to effect an interconnection of these two members it is necessary to rotate the two members relative to each other so that the members will threadably engage each other. As the two members move closer to each other during the threading operation the lower portion of nozzle stem member 202 will push downwardly upon the top 117 of check valve C and the check valve C will thus be moved downwardly despite the upward force of spring 108. As the check valve C moves downwardly the lateral passages 118 will reach a point where there is open communication between the interior of reservoir 10 and the outer ends of the lateral passages 118 since the normal sealing action of O-ring 114 is unsealed as the check valve C moves downwardly. When the lateral passageway 118 does come into open communication with the interior of reservoir 10 the gas within reservoir 10 will pass upwardly through passageway 118 then through passageway 116 and upwardly through passageway 200.

FIGURE 4 illustrates most clearly the relative position of the nozzle member N and the check valve C when the high pressure gas is flowing outwardly from the reservoir 10. In this figure it will be seen that O-ring 204 effectively prevents any of the high pressure gas of reservoir 10 from escaping upwardly along the interior bore 120 of check valve housing B.

As the gas in the interior of reservoir 10 rises upwardly through passages 118, 116 and 200, see FIGURE 3, part of the gas enters into passageway 212 and thence into gauge G to register the pressure of the gas within reservoir 10. Another portion of the gas rising from the reservoir 10 through passageway 118, 116 and 200 immediately exits through the exit portion 224 of nozzle member N, passes into annular passageway 228, through passageway 232 upwardly through axial passage 230, through filter 246 and then out through orifice 244. However, since orifice 244 is of very small diameter (e.g. .012 inch or number 80 drill) the outward flow of the gas is considerably restricted and a back pressure is immediately created. This back pressure exerts a downward force on the upper piston-like portion of plunger P with the result that plunger P is forced in a downward direction against the upward force of spring 238. Since the strength of spring 238 is adjusted to a fixed low outlet pressure (e.g., about 80 p.s.i.) the plunger P will move downwardly.

The relative position of seat 226 and the upper exit portion of portion 224 of nozzle member N is perhaps best illustrated in the three sketches shown in FIGURES 5, 6 and 7. These sketches are only fragmentary and not necessarily to scale in order that they might better illustrate the operation. FIGURE 5 shows the relative position of seat member 226 and upper end portion 224 at the first instant that the high pressure gas from the reservoir flows upwardly through passageway 200. When the gas reaches the outlet orifice 224, however, an immediate back pressure is exerted against the top of plunger P and as a consequence seat 226 is forced downwardly against the upper end portion 224 so that gases can no longer pass upwardly through passageway 200. The seat member 226 will remain in the closed position shown in FIGURE 6 until the back pressure upon the top of plunger P decreases to such an extent that the spring 238

can exert enough upward force to separate the seat 226 from the upper end portion 224. It is possible, therefore, that the relative movement of seat 226 and the upper end portion 244 comprise a quick succession of up and down movements as shown in FIGURES 5 and 6. It is also possible, however, that the seat member 226 and upper end portion 224 may quickly assume a relatively fixed positional relationship which is intermediate between the two extremes shown in FIGURES 5 and 6. FIGURE 7 is intended to show seat 226 and end portion 224 in such an intermediate position. If in fact an essentially equilibrium condition as illustrated in FIGURE 7 does exist when the apparatus is in operative steady gas flowing conditions, the clearance between the seat 226 and the upper end portion 224 is probably very minute, being just large enough to permit an amount of high pressure gas from reservoir 10 to flow through the clearance area to replace an equal amount of the lower pressure gas existing through orifice 244 and to maintain the desired low pressure above plunger P.

When it is desired to stop the steady outward flow of gas it is merely necessary to twist the reservoir 10 and the regulator housing R in reverse directions relative to each other so that threaded member 206 disengages threaded member 122, which in turn causes the lower portion of nozzle stem member 202 to exert no downward force on check valve C, thus allowing check valve C to move upwardly until the O-ring 114 is in sealing relationship with shoulder 115, thereby preventing any further flow of high pressure gas from reservoir 10.

NOVEL FEATURES AND ADVANTAGES OF THE PRESENT INVENTION

(1) *Safety*.—When the regulator assembly is purposely or accidentally disengaged from the reservoir and check valve assembly, there is no danger that the compressed gas in the reservoir will escape, since it will be trapped in the reservoir by the check valve. In the event that the orifice 244 becomes restricted in any way (e.g. clogged with dirt) the automatic pressure regulating action of the regulator assembly would immediately shut off any flow of high pressure gas to the orifice area. Moreover, even in the event that seat 226 should become defective and fail to prevent the flow of high pressure gas through exit portion 224, the construction of the parts is strong enough to withstand the full pressure without rupture of any of the critical parts.

(2) *Ease of operation*.—No skill or previous training is needed to operate the inhalator. Even children can easily use the inhalator to administer oxygen to stricken adults. Older persons or injured persons, who might have very little strength in the event of an emergency, can easily render the inhalator of this invention operative by a gentle twisting action. The flow of oxygen is preset and therefore needs no calibration or adjustment by the user.

(3) *Simplicity of construction*.—The various parts of the inhalator of this invention are of very simple construction and can readily be mass produced and assembled by assembly line techniques by relatively unskilled workers. The various parts are designed and manufactured in such a fashion that there is practically no need for the assembly line workers to waste any time making fine adjustments, bothering with critical tolerances or worrying about positional relationships of passageways.

(4) *Replaceability of parts*.—If any of the parts of the inhalator becomes damaged, defective or worn, they can very easily be replaced by simply unthreading one or two parts and inserting a new part for the defective part. In emergencies, a defective part in the regulator assembly is most quickly and easily remedied by replacing the entire regulator assembly.

(5) *Ease of maintenance*.—The inhalator device of this invention presents practically no maintenance problems.

(6) *Minimum amount of dead air space.*—The construction of the check valve assembly, regulator assembly and parts adjacent thereto is such that the dead air space is kept at an absolute minimum. Therefore, when the inhalator unit is disconnected or the reservoir and regulator assembly are rotated apart there is only a very small amount of high pressure gas trapped in the regulator assembly. This is both a safety feature and a feature having commercial appeal. It is a safety feature because if there was a large volume of high pressure in either the check valve assembly or the regulator assembly upon disengagement of these two parts there would be the danger that the great volume of escaping high pressure gas would damage one or more of the O-rings. This feature has commercial appeal because if a large volume of high pressure gas escapes through a relatively small orifice the sudden noise created could easily alarm and frighten the user.

(7) *Utility.*—Can be easily lifted, transported, handled, stored and refilled.

(8) *Set flow.*—The regulator of this invention has a predetermined set flow. This is an important feature and a definite advantage because it does not require that the user make any calculations, adjustments, decisions, etc., regarding the flow rate.

MISCELLANEOUS

The compressed gas dispensing unit of this invention is usually employed with certain more or less well-known accessories. Such accessories would, for example, usually include a mask or other similar device to fit over a portion of the users face and sufficient tubing connecting the mask to the coupling nipple 245 of the inhalator. Any number of different types of masks might be employed.

It is most important that the regulator of this invention have a set flow. The set flow is tied in with the fact that the set flow is determined by the particular mask that might be supplied with the unit. It is preferable that the mask which is supplied with the unit have a rebreathing bag on it. This rebreathing bag acts as a storage reservoir for the gas which is flowing during the time the user is exhaling and resting between breaths. The majority of the waste gases in exhaled air is contained in the last $\frac{1}{3}$ or $\frac{1}{2}$ of the exhalation. When the user exhales, the first part of his breath goes into the rebreathing bag, is mixed with fresh oxygen which is flowing into the bag continuously, and when the bag expands to its fullest extent, the last $\frac{1}{2}$ or $\frac{1}{3}$ of the user's breath passes out through an expiratory valve in the mask.

When a properly constructed mask is used with the present invention the gas delivered from the pressure reducing regulator will provide between 75% and 100% oxygen concentration to virtually any lung capacity.

In one preferred embodiment of this invention, the oxygen is arranged so as to flow at about six liters per minute, which is considered as average for various other types of oxygen administration devices such as inhalers, cannula, nasal catheters or even small oxygen hoods or face tents.

The compressed gas cylinders may be filled very simply. For example, if a large commercial oxygen tank or other source of oxygen under high pressure is provided with a discharge means having substantially the same size and shape as the parts 200, 202 and 206 of FIGURE 3, and it was screwed into the threaded top of cylinder 10 and pressure was introduced it would force the check valve open until the cylinder was full of gas at the same pressure as the source.

The gauge G indicates the pressure of the gases within the reservoir 10. This gauge is not essential to the operation of the inhalator but is desirable since as the pressure gauge gradually drops with use, the user is able to obtain an approximate idea as to the amount of gas which remains. Omitting the gauge would eliminate the necessity for passages 216 and 212 and either O-ring 220 or

222. A second gauge could be connected to the regulator assembly to measure the pressure above the piston P by boring an appropriate sized threaded passageway through the regulator assembly adjacent to the area marked with the letters GA. This second gauge could be calibrated in liters per minute being administered. When the inhalator device contains no gauges the construction is considerably simplified and the cost of manufacture reduced.

10 If it is desired to provide an inhalator which would permit one to alternately use a gauge and to omit one, the threaded connection which usually receives the gauge could be easily adapted to receive a threaded plug.

When the top portion T is equipped with one or more 15 key handles H (FIGURE 8), these handles can be used to shut off the flow instead of rotating the pressure reducing regulator or rotating the cylinder. This is particularly helpful when this regulator unit is used with a large medical or commercial type cylinder. The key handle H, however, will only shut the flow off or turn 20 the flow on. If the key handles H are used in conjunction with spring both on the bottom and on the top of plunger P, the key handles can therefore be used to vary the flow of compressed gas in a gradual manner (see 25 upper spring 900, lower spring 901, and handle H of FIGURE 9).

The outlet pressure may be regulated to the desired degree by using stronger or weaker springs (238). The outlet pressure may also be varied by using plungers (P) 30 of different shaft lengths and of different upper surface areas.

Another modification within the scope of this invention would involve placing another coil spring (similar to spring 238) between the top of plunger P and the underside of threaded member T, so as to thus counteract the upward force of spring 238 (thus providing another means for regulating the outlet pressure).

In conclusion, while the foregoing specification and drawings describe the construction, operation and use of one preferred embodiment of the instant invention, it is to be understood that I do not intend to limit myself to the precise construction and arrangements herein disclosed, since the various details of construction, form and arrangement may obviously be varied to a considerable 45 extent by anyone skilled in the art without really departing from the basic principles and novel teachings of this invention and without sacrificing any of the advantages of the invention, and accordingly, it is intended to encompass all changes, variations, modifications and equivalents 50 falling within the scope of the appended claim.

What is claimed is:

A novel dispenser for compressed gases which comprises in combination a reservoir 10 for compressed gas, a check valve assembly located in one end of said reservoir, said check valve assembly comprising a main 55 check valve housing B, a spring-loaded check valve C mounted in the lower portion of said check valve housing B and adapted to move in an axial direction within said check valve housing, said check valve C being pressed 60 upwardly by a coiled spring member 108 seated in a lower portion of the check valve housing B, and the upward movement of the check valve C being limited by a shoulder 115 on the upper interior part of said check valve housing, said check valve C containing a passageway 116 65 which is capable of alternately permitting or restricting the passage of gases through said check valve assembly depending upon the axial movement of the check valve C, an automatic straight-in-line pressuring-reducing gas regulator assembly, one portion of which is adapted to 70 engage said check valve assembly and another portion of which is adapted to dispense gas at a pressure which is at a lower pressure than the gas in the reservoir, said automatic pressure reducing gas regulator comprising in combination a main regulator housing R of generally hollow 75 cylindrical shape, the interior of which is adapted to re-

ceive a plurality of separate elements, a nozzle assembly N fitted into the lower end of said main regulator housing R, said nozzle assembly N containing an interior central passageway 200 extending from the lower to the upper end thereof, an O-ring adjacent to the lower outside end of said nozzle assembly N, an O-ring adjacent to the upper outside end of said nozzle assembly N, said lower O-ring being adapted to provide a seal between the exterior of said nozzle assembly N and the interior of said check valve assembly, and said upper O-ring being adapted to provide a gas seal between the exterior of said nozzle assembly N and the interior of said main regulator housing R, said nozzle assembly additionally containing a first lateral passageway 212 connecting the said interior central passageway 200 of the nozzle assembly N with the outer portion of said nozzle assembly so that the interior of said nozzle assembly is in open communication with the interior of said main regulator housing R and an O-ring is located on the exterior of said nozzle assembly N below said lateral passageway 212 and a second lateral passageway 216 is provided in the main regulator housing adjacent to the outlet of said first lateral passageway 212 in said nozzle assembly N, a top portion T fitted into the upper portion of the main regulator housing R, a spring-loaded piston-like element P mounted within the interior of said main regulator housing R and adapted to slide axially therein, the upper movement of said piston-like member P being limited by said fitted top portion T

and the lower movement of said piston-like element T being limited by said fitted nozzle assembly N, and a continuous passageway 230 for gas through said piston-like element P and a passageway through said threaded top portion which is adapted to be alternately closed or opened depending upon the position of the piston-like element wherein said piston-like element P comprises a hollow shaft portion 230 having a relatively small circumferential seat 226 fixed on its lower portion and having a relatively large circumferential plunger section fixed on its upper portion, an O-ring 236 located around the periphery of said plunger section, an O-ring 234 located in the lower part of said hollow shaft portion adjacent to but above said seat portion, a lateral passageway 232 located in said hollow shaft portion between said lower O-ring and said seat, said lateral passageway 232 being in open communication with an axial passageway 230 extending upwardly from the top of said seat 226 through the length of said hollow shaft portion, and a spring 238 adapted to apply force upwardly against the underside of said plunger-like element P.

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