May 21, 1968 W. E. GORDON 3,384,133

ARRANGEMENT FOR FILLING OR REFILLING A DISPENSER

Filed July 1, 1965 2 Sheets-Sheet 1

Fig. 1.

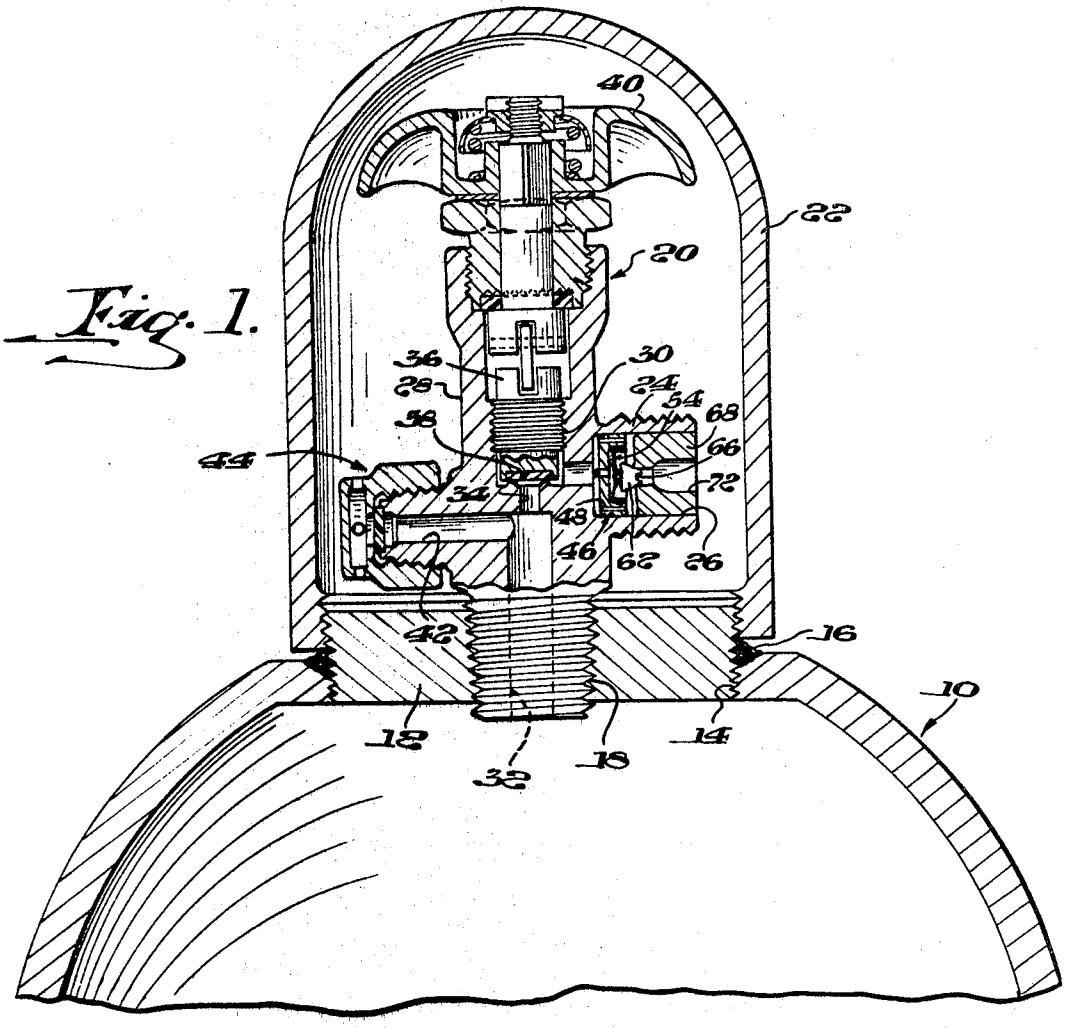
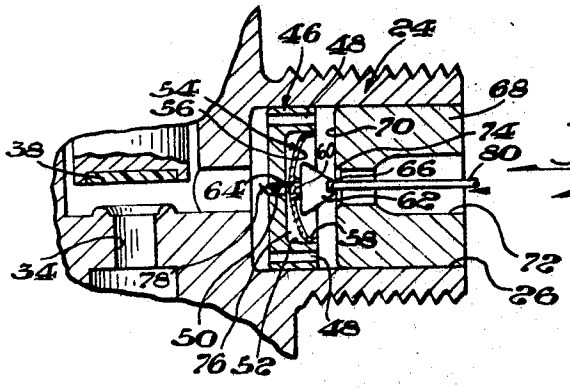


Fig. 2.



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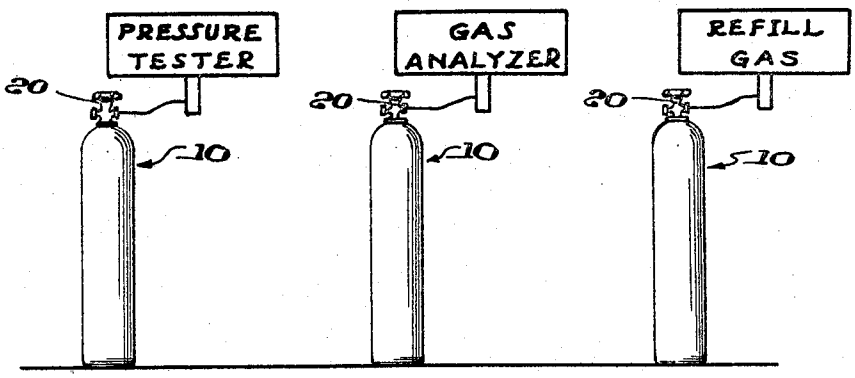


Fig. 3.

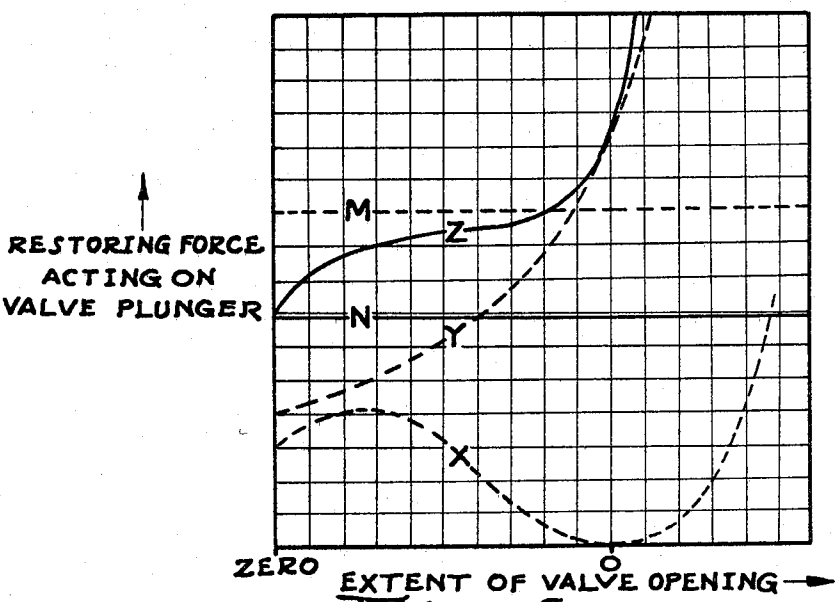


Fig. 4.

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3,384,133

ARRANGEMENT FOR FILLING OR REFILLING A DISPENSER

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ABSTRACT OF THE DISCLOSURE

Method and apparatus to determine whether the interior of a refiillable gas storage cylinder has been contaminated. The outlet passageway of the manually operable control valve has a pressure responsive valve positioned therein. The pressure responsive valve closes the outlet passageway when the gas within the cylinder reaches a predetermined minimum pressure thus retaining a preselected quantity of gas within the cylinder. Since the gas is at a pressure above atmospheric pressure, contaminants cannot enter the cylinder through the valve outlet port. At the refilling staiton, the pressure responsive valve is manually opened and a sample of the residual gas is withdrawn from the cylinder and analyzed for contaminants. The residual pressure of the gas within the cylinder is also measured to determine whether the pressure responsive valve remained closed to retain the preselected quantity of gas therein. To open the pressure responsive valve, a separate mechanical actuator is inserted in the outlet passageway of the manually operable control valve and urges the pressure responsive valve open against the pressure within the gas cylinder.

This invention relates to a method and apparatus for determining the contents of a container and more particularly to a method and apparatus for inhibiting corrosion on the interior surfaces of a high pressure gas cylinder and determining the purity of the gas contained therein.

Many gases such as oxygen, nitrogen, hydrogen and helium are commonly dispensed in cylinders initially filled by the vendor to a pressure of about 2,000 p.s.i. The filled cylinders are delivered to the consumer and the consumer attaches a suitable pressure reducing valve in series with the main valve on the cylinder. To use the gas in the cylinder, the customer opens both the main gas valve and the pressure reducer valve and withdraws gas from the cylinder at the desired pressure. When the consumer has exhausted the gas within the cylinder to the extent that the gas pressure has dropped to a level where the consumer can no longer use the gas remaining in the cylinder, the consumer disengages the reducing valve and connects it to another, filled cylinder. The main gas valve on the empty gas cylinder should then be closed and the essentially empty gas cylinder promptly returned to the vendor for refilling. If the consumer adheres to the practice of closing the main gas valve and promptly returning the essentially empty cylinder to the vendor, little, if any, likelihood of contamination would occur.

Unfortunately, the consumers do not all adhere to the recommended practice of closing the main valve on the essentially empty gas cylinder and promptly returning the cylinder to the vendor. Often the main valve is left open, permitting the gas pressure within the cylinder to drop to atmospheric pressure and also permitting air to diffuse through the open valve into the cylinder and contaminate the gas remaining in the cylinder. Under certain circumstances water may also enter the cylinder through the open main valve and collect on the internal surfaces of

the cylinder either by condensing from the atmosphere or by flowing into the cylinder in sizable quantities as, for example, when the cylinder is permitted to remain for any appreciable period of time on its side exposed to the elements in a location where water is likely to collect. Some consumers, after a cylinder, especially an oxygen cylinder, has been emptied, use the empty cylinder for their own purposes and, after the empty cylinder has served its special purpose, return the empty cylinder to the vendor in a very dangerous condition. Instances are known where consumers have used an empty oxygen cylinder as a receiver in a compressed air system. Compressed air invariably contains entrained droplets of lubricating oil from the compressor. The internal surface of the gas cylinder when used in this manner becomes coated with the lubricating oil. The external surface of the cylinder may not reveal the presence of oil within the interior portion of the cylinder. The only manner in which the presence of oil within the cylinder can be detected by the inspection methods now commonly employed is to test for lubricating oil by the odor emanating from the inner portion of the cylinder. There is a substantial probability that lubricating oil contained within the cylinder will not be detected by its odor.

Because of the manner in which the consumer handles empty gas cylinders, the vendor in refilling the cylinder must exercise great care to make certain that the cylinder is not contaminated and that it has not been seriously damaged and weakened by internal corrosion. The problem of contamination is of special concern where it is intended to refill the cylinder with oxygen gas. It is well known that certain combustible liquids such as the hydrocarbons present in lubricating oils may explode when they come in contact with essentially pure oxygen at high pressures. Extremely serious accidents involving multiple deaths and casualties have been attributed to combustible contamination in oxypen cylinders. Responsive vendors, because of this inherent danger, now inspect the cylinders before they are refilled with oxygen. The presently known methods and apparatus for inspecting cylinders have not proven entirely successful and the refilling and use of cylinders filled with high pressure gas remains an inherently dangerous operation.

Briefly, my invention is directed to a method and apparatus for minimizing this inherent danger now present in the refilling and use of cylinders of high pressure gas. I provide a pressure responsive check valve in the outlet opening in the cylinder that limits the amount of gas that can be withdrawn from the cylinder. After the gas within the cylinder has reached a preselected value, the pressure responsive check valve automatically closes the outlet opening and the residual gas remaining within the cylinder can not be exhausted therefrom. The pressure responsive check valve maintains the outlet opening closed and prevents moisture from entering the interior of the cylinder. The vendor upon receiving the exhausted cylinder can quickly and inexpensively determine whether the contents of the cylinder has been contaminated by measuring the pressure of the residual gas remaining in the cylinder and where desired determine the purity of the gas within the cylinder. Where the residual gas pressure is substantially the pressure at which the check valve closes, the vendor may refill the gas cylinder with the same residual gas present in the cylinder. Where the pressure of the residual gas is below the pressure at which the pressure responsive valve is intended to close, the vendor can, by analyzing the residual gas within the cylinder determine whether the pressure responsive valve is inoperative or whether the cylinder has been contaminated.

Accordingly, the principal object of this invention is

to reduce the likelihood of a consumer contaminating a refillable gas cylinder.

Another object of this invention is to provide a simple and inexpensive method for the vendor to determine whether the gas cylinder has been contaminated by the consumer.

Another object of this invention is to provide a gas cylinder with a pressure responsive check valve that is actuated at a preselected gas pressure to close the cylinder outlet opening and retain a residual quantity of gas within the cylinder at a preselected pressure.

These and other objects and advantages of this invention will be more completely disclosed and described in the following specification, the accompanying drawings and the appended claims.

In the drawings:

FIGURE 1 is a view in section of a gas cylinder having my improved pressure responsive check valve positioned in the outlet of the main valve.

FIGURE 2 is an enlarged view in section of the pressure responsive valve illustrating the manner in which the pressure responsive valve is opened to determine the residual pressure of the gas within the cylinder and the relative purity thereof.

FIGURE 3 is a diagrammatic view of inspection and refilling stations suitable for use in practicing my invention.

FIGURE 4 is a graphical representation of the pressures required to maintain the valve in an open and closed position.

Although the pressure responsive check valve will be described as associated with the main gas valve, it should be understood that the pressure responsive valve may be positioned elsewhere in the gas cylinder outlet opening and accomplish substantially the same purpose. For proper operation, the diaphragm of the pressure responsive valve should be subjected to the pressure of the gas within the cylinder. Where the pressure responsive valve is positioned in the outlet opening of the main gas valve, the diaphragm is subjected to the pressure of the gas within the cylinder when the main gas valve is opened.

Referring to the drawings and particularly to FIGURE 1 there is illustrated the upper portion of a refillable gas cylinder generally designated by the numeral **10**. An externally threaded closure member **12** is positioned within a threaded aperture **14** in the gas cylinder **10** and is secured therein by means of a threaded connection and the annular weld **16**. The closure member **12** has an axial threaded bore **18** in which a main gas valve generally designated by the numeral **20** is threadedly secured. A cup shaped cap member **22** is threadedly secured to the closure member **12** to protect the main valve **20** during transportation and the like.

The main gas valve **20** is of conventional construction other than the pressure responsive check valve generally designated by the numeral **24** positioned in the valve outlet **26** and will only be described in sufficient detail to explain its association with the pressure responsive check valve **24**. It should be understood that other conventional gas valves may be used in lieu of the main gas valve **20** illustrated in FIGURE 1. The main valve **20** has a body portion **28** with an internal chamber **30**. An inlet passage **32** extends through the body portion **28** into chamber **30** and has an annular valve seat **34**. The outlet passage **26** formed in the valve body portion **28** extends into chamber **30** above the valve seat **34**. A valve stem **36** is suitably threaded in the valve body portion **28** and has a valve member **38** connected to its lower end portion. A handle **40**, upon rotation, moves the valve member **38** toward and away from the annular valve seat **34** to open and close the valve **20**. In an open position, that is where the valve member **38** is spaced from the valve seat **34**, gas within the cylinder **10** will flow through valve inlet passage **32** into chamber **30** and then through valve outlet passage **26**. The valve **20** has a pressure relief outlet **42** that is closed by a suitable pressure relief device generally designated by the numeral **44**. The pressure relief device **44** is a safety device that is arranged to rupture above a predetermined safe maximum pressure of the gas within the cylinder and relieve the gas pressure on walls of the cylinder **10**.

The pressure responsive check valve **24** has a cup shaped body member **46** suitably secured within the valve outlet passageway **26** and has a plurality of passageways **48** therethrough adjacent the peripheral edge portion for the flow of gas from the valve chamber **30** through the valve outlet passageway **26**. The cup shaped member **46** has an axial bore **50** therethrough which opens into the cup shaped internal recessed portion **52**. A diaphragm **54** has a flexible bottom wall **56** and an annular upturned end wall **58**. The diaphragm **54** is positioned within the cup shaped member recessed portion **52** with the diaphragm annular wall **58** fixedly secured to the internal surface of the cup shaped recessed portion **52**. The diaphragm bottom wall **56** has a central aperture **60** therein. A conically shaped valve member **62** has a rearwardly extending stem **64** extending in to the diaphragm central aperture **60** and effectively closing the aperture. The conical valve **62** is preferably fabricated of moderately resilient deformable material to permit limited deflection thereof. The front portion of the valve **62** has an annular portion **66** projecting therefrom forming a socket for a fixture, as will be later described.

A tubular member **68** with a central outlet passageway **72** is positioned in the main valve outlet passageway **26** and is suitably secured to the internal cylindrical surface thereof. The tubular member **68** has an annular end wall **70** that is adjacent to the cup shaped member **46**. A valve seat **74** is formed in the passageway **72** adjacent to the end wall **70** and has an outwardly diverging annular surface. The conical valve member **62** is arranged to seat in the frusto conical valve seat **74** and close the main valve member passageway **26**.

Between the diaphragm bottom wall **56** and the internal surface of the cup shaped recess **52** there is a chamber **76**. The chamber **76** is filled with a gas at a preselected pressure through the cup shaped member axial passageway **50**. A suitable stop member **78** seals the passageway **50** to maintain a preselected gas pressure within the chamber **76**. By proper adjustment of the shape of the cup shaped member **46** that supports the diaphragm **54**, the depth of the recess **52** in which the diaphragm **54** is positioned and the quantity of the gas introduced into the sealed chamber **76** through passageway **50**, the force acting on the valve **62** may be varied as desired. The essential features of the pressure responsive valve are illustrated in FIGURE 4 which is a graph of the force acting on the diaphragm **54** and tending to move it outward to seat valve **62** in valve seat **74** and the annular opening between the valve **62** and the valve seat **74**. In FIGURE 4 the dashed curve X represents the force obtained if the diaphragm were free. Thus with no other forces acting on the diaphragm, the force on the valve is at a minimum and the position of the valve is therefore stable when it is either closed or when it is open at the position corresponding to the point O in FIGURE 4. The dash curve Y represents the force on the diaphragm caused by the gas pressure in the sealed chamber **76** when the amount of gas and the shape and size of the chamber are suitably adjusted. The total restoring force is the sum of the "free" force represented by the curve X and the internal pressure force represented by the curve Y. This summation is illustrated by the solid curve Z in FIGURE 4. Curve Z, it may be seen, has the desired shape so that there is no minimum except in the valve closed position. There is, however, a broad, almost flat, plateau in curve Z which indicates that a small increment in external pressure brings about a relatively large increment in the valve movement toward an opening position. Thus,

with an external pressure that would exert a force represented by the level N in FIGURE 2, or for any pressure less than this force, the valve **62** would be closed and seated against the valve seat **74**. When, however, the external pressure, that is the pressure on the external surface of the diaphragm, is increased by only a relatively small amount above the level corresponding to the level indicated by the letter N so as to create a force represented by the level M, the diaphragm **52** will collapse and the valve **62** will open and remain open as long as the external pressure equals or exceeds the level M. As previously stated, the valve member **62** is preferably formed of a relatively resilient or deformable material and the connection of the valve **62** by stem **64** provides a flexible coupling therebetween so that there is a limited amount of deflection between the diaphragm **54** and the valve **62**. This deflection is desirable to provide a positive seal between the valve and valve seat when the valve is moved to a valve closed position.

It should be noted that the pressure responsive check valve generally designated by the numeral **24** requires only a minor modification of the main valve **20**. The check valve is preferably mounted on the inside of the valve outlet passageway **26** and the plurality of passages **48** in the cup shaped member **46** allow free passage of the gas from the cylinder through the valve outlet **26** to act on the external surface of the diaphragm **54**.

The pressure responsive check valve **24** operates in the following manner and as far as the consumer is concerned the operation of the main valve **20**, modified by the installation of the check valve **24**, is essentially the same. When the cylinder **10** is filled with gas at high pressure and the main valve **20** is closed, the check valve **24** will also be closed. When main valve **20** is opened, check valve **24** will open immediately as long as the pressure of the gas within the cylinder exceeds a critical pressure P_c required to move the diaphragm **54** against the gas pressure within the chamber **76**. When the main gas valve **20** is closed, gas will continue to flow out of the main gas valve outlet **26** until the pressure within the outlet **26** drops to the critical pressure P_c. At the critical pressure P_c the pressure responsive check valve will close. The opening and closing of pressure responsive check valve **24** will not be apparent to the consumer and use of the gas cylinder will be the same as with a conventional main gas valve **20**.

When, however, the consumer exhausts the gas within cylinder **10** to an extent that the pressure decreases below the critical pressure P_c the pressure responsive check valve **24** will close even though main gas valve **20** is open and a residual amount of gas will remain within cylinder **10**. This feature is to be distinguished from a gas cylinder having a conventional main valve thereon. The gas in the latter instance continues to exhaust from the cylinder until the pressure within the cylinder is substantially equal to atmospheric pressure if the main valve is permitted to remain open.

For example, if the pressure reported by the threshold level N in FIGURE 4, that is the pressure needed to just open the pressure responsive valve **24**, is, for illustrative purposes, 5% of the initial pressure in the full cylinder, the pressure required to make the pressure responsive check valve **24** move to a fully open position is about only 7% of the initial pressure in the full cylinder. Thus, the consumer will experience no perceptible diminution in the rate of gas delivery from the cylinder until 93% or more of the gas is used and exhausted from the cylinder. When 95% of the original gas content has been removed, the pressure responsive check valve **24** will close and the consumer will be unable to exhaust any more gas from the cylinder **10**. With the arrangement above described, it is virtually impossible for contamination to enter the cylinder because there is a substantial positive gas pressure inside the cylinder even after the consumer has finished using the cylinder. Only if the action of the pressure responsive check valve were mechanically countermanded would it be possible to force a foreign substance into the cylinder. Even when the valve is mechanically countermanded, a substantial pressure would be required to force a contaminant into the cylinder. The force of the contaminant would have to exceed the pressure remaining within the cylinder. It will thus be seen that the pressure responsive check valve prevents the entry of any contaminant into the cylinder.

By retaining a preselected residual gas pressure within the cylinder the vendor can quickly ascertain whether the cylinder has been tampered with, the condition of the pressure responsive check valve and the relative purity of the gas within the cylinder.

The process for testing the cylinder **10** before refilling it with a gas includes two simple and decisive steps. The first step, if positive, will, in a majority of instances, suffice and the second step will not be absolutely necessary. The cylinder as it is returned to the vendor is positioned in the refill line, as diagrammatically illustrated in FIGURE 3. The main gas valve **20** is opened and a conventional pressure tester such as a Bourdon gauge is attached to the main valve outlet **26**. The Bourdon gauge has a suitable fixture diagrammatically indicated in FIGURE 2 by the numeral **80** which is arranged to extend into the central outlet passageway **72** and suitably fits in the annular portion **66** of valve member **62**. The fixture **80** is moved in a direction from right to left as viewed in FIGURE 2 to move the valve **62** against the gas pressure in the chamber **76** behind diaphragm **54** and open the pressure responsive check valve **24**. The Bourdon gauge will then measure the pressure of the gas within the cylinder **10**. If the pressure within the cylinder **10** is essentially the same as the critical pressure P_c for which the valve is designed, it is almost certain that the internal portion of the cylinder has not been contaminated and the gas remaining in the cylinder is the same gas with which the cylinder was previously filled. If the pressure is significantly below the critical pressure, the vendor may perform a second test to determine whether the pressure responsive check valve **24** is defective or whether the cylinder and pressure responsive check valve **24** have been tampered with by a consumer.

The second test is to determine the purity of the residual gas within the cylinder. A sample of the gas is removed from the cylinder and is permitted to flow through a suitable and conventional gas analyzing instrument. In a majority of instances the analytical instrument will be an oxygen analyzer either testing for high purity, in the case of oxygen cylinders, or for oxygen traces, in the case of nitrogen, hydrogen or helium cylinders. If the gas purity is not significantly different from that of the gas with which the cylinder is customarily filled, this second test is a sufficient indication that no impurity has entered the cylinder, even though the check valve has leaked and the pressure within the cylinder is somewhat below the critical pressure P_c. If the gas purity is different from what it should be, the second test is an indication of contamination within the cylinder and the cylinder should be dismantled, inspected and cleaned before refilling. Where the previously described tests indicate that the pressure responsive check valve has functioned properly and the gas content of the cylinder is substantially as pure as when the cylinder was filled on the prior occasion, the vendor may thereafter proceed to fill the cylinder without removing the residual gas remaining therein. In a majority of instances, after making one or both of the previously described brief but positive tests, the vendor will be able to refill the cylinder without first evacuating it to remove the gas remaining inside.

From the foregoing description it will be apparent that by providing a pressure responsive check valve in the gas cylinder **10** that closes at a preselected critical pressure to retain a residual quantity of gas within the cylinder the vendor can now determine, by performing simple inspec-

tion tests, whether the cylinder has been contaminated since the cylinder was last refilled.

The inexpensive pressure check valve and the simple inspection tests performed by the vendor now eliminate a substantial number of the hazards encountered in the use of refillable high pressure gas cylinders.

According to the provisions of the patent statutes, I have explained the principle, preferred construction, and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In a refillable gas cylinder the combination comprising,

a gas cylinder having an outlet passageway,

a manually operable main valve in said passageway arranged to control the flow of gas through said cylinder,

said main valve having an outlet opening,

a pressure responsive valve positioned in said main valve,

the pressure responsive valve operable at a preselected pressure of the gas within the cylinder to close the cylinder outlet passageway and retain a residual quantity of gas within the cylinder at a pressure above atmospheric pressure, and

an access opening through said outlet passageway for the insertion of a mechanical actuator to open said pressure responsive valve against said preselected gas pressure within said cylinder.

2. In a refillable gas cylinder the combination comprising,

a gas cylinder having an outlet passageway,

a manually operable main valve in said passageway arranged to control the flow of gas through said cylinder outlet passageway,

said main valve having an outlet opening,

a pressure responsive valve positioned in said main valve outlet opening axially aligned therewith, said pressure responsive valve operable at a preselected pressure of the gas within the cylinder to close the main valve outlet opening and retain a residual quantity of gas within the cylinder at a pressure above atmospheric pressure, and

said outlet opening having an axial passageway forming an access opening for the insertion of a mechanical actuator, said mechanical actuator operable to open said pressure responsive valve against said preselected gas pressure within said cylinder.

3. In a refillable gas cylinder the combination comprising,

a gas cylinder having an outlet passageway,

a pressure responsive valve positioned in the gas cylinder outlet passageway,

the pressure responsive valve having an outlet opening,

an annular valve seat formed in the valve outlet opening,

a valve member operable to seat on the annular valve seat and close the valve opening,

a cup shaped housing positioned in the cylinder outlet passageway and having a recessed portion therein,

a flexible diaphragm positioned in the recessed opening and forming a sealed chamber with the cup shaped member recessed portion,

the valve member connected to the diaphragm and movable therewith,

the sealed chamber containing a gas at a preselected pressure and urging the diaphragm outwardly and the valve into sealing relation with the valve seat, and

the exterior surface of the diaphragm subjected to the pressure of the gas within the cylinder so that above a preselected pressure of the gas within the cylinder the valve is maintained in spaced relation to the valve seat and below a preselected pressure of the gas within the cylinder the valve is maintained in a seated position on the valve seat to close the valve outlet opening and retain a residual quantity of gas within the cylinder at a pressure above atmospheric pressure.

4. A pressure responsive check valve comprising,

a housing having a cylindrical passageway therethrough,

the passageway having an annular shoulder portion forming a valve seat,

a cup shaped member secured in said passageway in spaced relation to said valve seat,

said cup shaped member having a plurality of passageways adjacent the peripheral edge portion,

a flexible diaphragm positioned in the cup shaped member recessed opening and forming a sealed chamber with the cup shaped member recessed portion,

a valve member connected to the flexible diaphragm and extending forwardly therefrom and movable therewith, the valve member operable to seat on the annular valve seat and close the valve outlet passageway,

the sealed chamber containing a gas at a preselected pressure to urge the diaphragm outwardly and the valve into sealing relation with the valve seat, and

the exterior surface of the diaphragm subjected to the pressure of a gas within the valve passageway so that above a preselected pressure of the gas in the valve passageway the valve is maintained in spaced relation to the valve seat to permit the flow of gas therethrough and below a preselected pressure of the gas in the passageway the valve is maintained in a seated position on the valve seat to close the valve opening.

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