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CARBON DIOXIDE STORAGE

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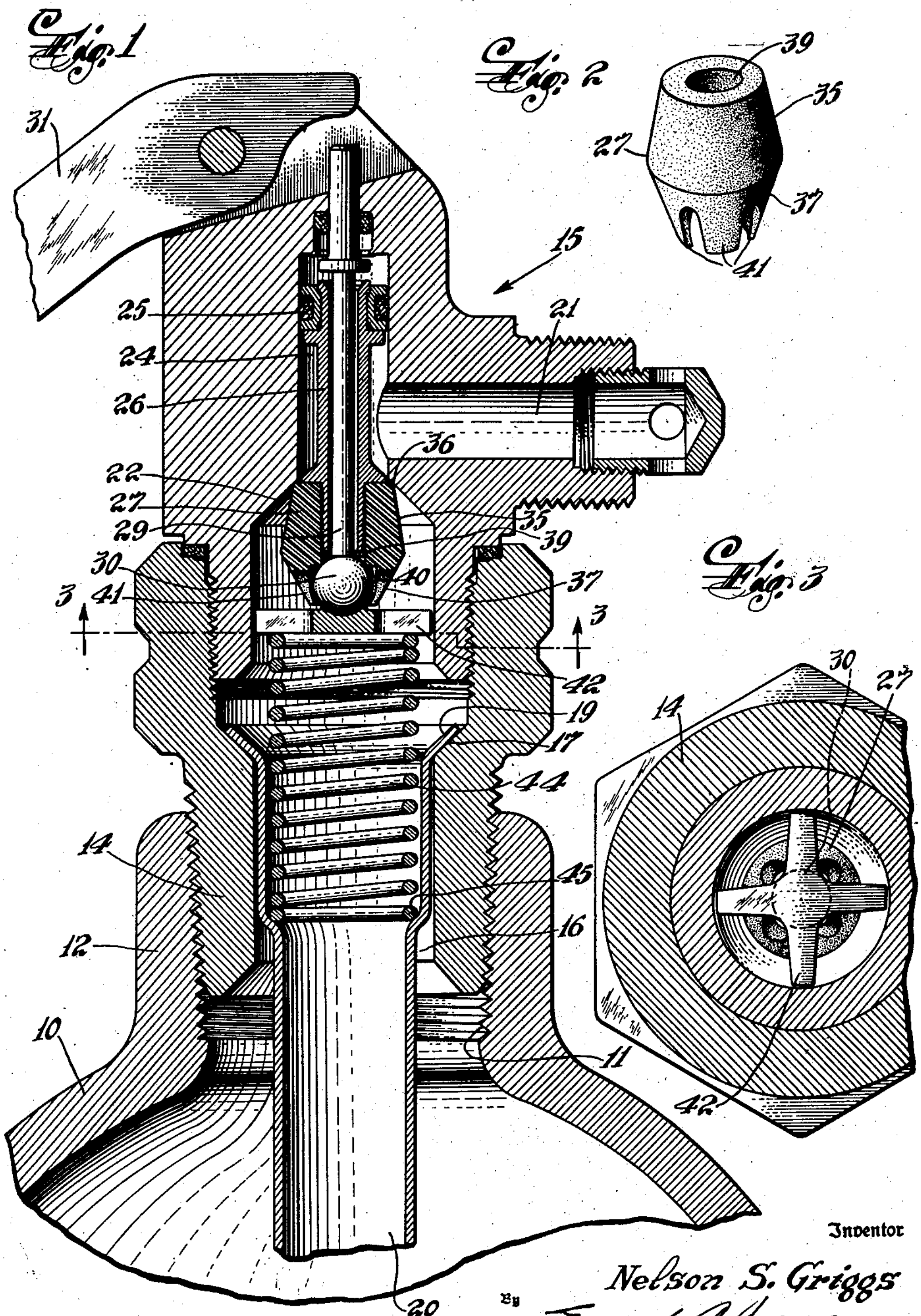

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CARBON DIOXIDE STORAGE

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3 Claims. (Cl. 62—1)

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The present invention relates to the storage of saturated carbon dioxide under pressure, and, more particularly, to an improved portable package of carbon dioxide.

The confinement of saturated carbon dioxide under pressure in containers by means of seat type valve closures has been a serious problem for many years because of the lack of a material capable of providing a satisfactory seal. Many types of materials have been tried heretofore but each had one or more objectionable characteristics.

It has been found that ordinary rubber could not be used as a seal forming material because it became vulcanized to the element in contact therewith at pressures to which it was ordinarily subjected and because it exhibited other undesirable properties. Hard rubber likewise has been found to be unsuitable. Materials composed of synthetic rubber and finely divided cork particles have been used, but such materials were readily permeated with and absorbed carbon dioxide gas and thereby were subject to dimensional changes upon expansion of the absorbed gas. These materials also exhibited cold flow tendencies upon being subjected to pressure for prolonged periods. To minimize these tendencies, the sealing members of valve elements and the like were encased in specially constructed metallic cups serving to reinforce the material and to prevent the same from being distorted by expending carbon dioxide. Such practices increased the cost of the valve elements; and, even so, the sealing material, upon prolonged seating, assumed the shape of the seat, and, after being unseated, had to be reseated in exactly the same position to again form an effective seal. Consequently, the valve elements or seals had to be replaced after each use, thereby involving additional labor, material and expense in servicing the equipment in which the valve elements were embodied.

Accordingly, an object of the present invention is to overcome the foregoing difficulties and objections.

Another object is to provide an improved package for confining saturated carbon dioxide under pressure.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

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In accordance with the present invention, it has been discovered that the foregoing objects can be accomplished by providing a package comprising a portable fluid-tight storage container having a discharge passage, a closure for controlling the discharge passage including a seat element and a valve element cooperating with the seat element to form a seal, and a charge of saturated carbon dioxide under pressure confined in said container by the closure, one of the elements consisting of a synthetic polymer material characterized in that it has negligible cold flow at temperatures between −65° F. and 160° F. and at mechanical pressures up to 3500 pounds per square inch, in that it substantially completely resists permeation by saturated carbon dioxide when exposed thereto at the aforementioned temperatures and pressures and in that it resists dimensional changes upon rapidly reducing the carbon dioxide pressure from 3500 to 0 pounds per square inch (gauge).

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawing, forming a part of the specification, wherein:

Fig. 1 is a fragmentary sectional view of a package embodying the present invention.

Fig. 2 is a perspective view of a valve element.

Fig. 3 is a fragmentary sectional view taken substantially along the line 3—3 on Fig. 1, illustrating a detail of the valve.

Referring to the drawing in detail, there is shown in Fig. 1 a portion of a container 10 for storing a fluid medium under pressure, such as carbon dioxide. The container has a threaded opening 11 in its neck 12 for receiving a threaded shank section 14 of a discharge head or valve 15 for confining the stored medium and controlling its release from the container.

The valve 15 generally comprises a body or housing having an inlet conduit 16 provided with a shoulder 17 for supporting a flange 19 of a syphon tube 20, an outlet conduit 21, and a main valve seat 22 surrounding a port between the inlet and outlet conduits. The upper portion of the valve housing is provided with a bore 24 serving as a piston cylinder for receiving a piston 25 of a valve and piston assembly comprising a tubular stem 26 having the piston mounted thereon at its upper end, a main valve member 27 secured to the lower end of the stem, and a rod 29 extending through the stem for unseating a pilot or auxiliary valve member 30.

The rod is adapted to be actuated by a lever 31.

In accordance with the invention, the main valve member 27 comprises a one piece body integrally formed of a single piece of material. The body has an upwardly and inwardly tapered exterior surface 35 at its upper end provided with an annular edge portion 36 for abutting the tapered valve seat 22, and has a downwardly and inwardly tapered exterior surface 37 at its lower end whereby the body is generally streamlined to minimize flow resistance in the portion of the inlet conduit serving as a valve chamber.

The body has a central bore 39 extending therethrough, in which the stem 26 is secured. The lower end of the bore provides a seat 40 for the pilot valve member 30 herein shown as a ball or sphere which is retained in proximity to its seat by a cage (Fig. 2) formed at the lower end of the body comprising a series of fingers 41 having portions extending inwardly beneath the ball. The fingers 41 are slightly resilient to enable the ball to be forced into the cage.

In order to hold the pilot valve member 30 against its seat a spider 42 (Fig. 3) is secured to the ball, for example by spot welding, and the legs of the spider are engaged by the upper end of a cylindrical helical spring 44 having its lower end seated on a shoulder 45 formed in the syphon tube 20. The ball 30 will form a good seal regardless of the squareness of the spring.

In operation, when the lever 31 is operated to actuate the rod 29, the pilot valve member is unseated enabling pressure medium from the container to flow through the bore of the tubular stem 26 and act on the piston 25. While the area of the piston as shown is such that it will not by itself effect unseating of the main valve member 27, the force of the pressure medium on the piston minimizes the force to be applied by the lever to move the stem 26 downwardly to move the main valve member from its seat. When the main valve member is unseated, pressure medium flows through the main valve port to the outlet conduit.

In accordance with the invention, the body of the main valve member is formed of synthetic polymers of the polyamide type such as, for example, hexamethylene diamine sold under the trade name of "Du Pont FM–10001 (formerly FM–1) Nylon" by E. I. du Pont de Nemours & Company, Wilmington, Delaware. Such materials and the process of making the same are described generally in United States patent to Wallace H. Carothers, No. 2,071,250, issued February 16, 1937.

This material provides an excellent fluid pressure confining seal for the main valve port by means of the annular edge portion 36, abutting the metallic frustoconical seat 22, and provides a similar seal for the pilot valve port by means of the metal ball 30 abutting the seat 40.

It further has been found that this material has negligible cold flow at temperatures between —65° F. and 160° F. while being subjected to pressures up to 3500 pounds per square inch for a period of over six months, this period being believed to be of a sufficient duration to conclude that the material will resist cold flow indefinitely. It also was found that at —65° F. the material did not become brittle and had sufficient resilience to form a good seal.

Also, it has been found that this material has the property to substantially completely resist carbon dioxide permeation at temperatures up to 160° F. while being subjected to carbon dioxide at pressures up to 3500 pounds per square inch.

This latter property was determined by placing cylindrical sample pieces of the material having a length of one inch and a diameter of one quarter inch in a pressure vessel, charging the vessel with liquid carbon dioxide and heating the vessel to build up a pressure therein of between about 3200 to 3500 pounds per square inch. After maintaining these conditions for over two weeks, the carbon dioxide was released rapidly from the vessel and the sample pieces were removed from the vessel and placed immediately in a beaker containing water at a temperature of about 65° F. The sample pieces were observed through a fifteen power magnifying glass for a period of ten minutes and no gas bubbles were seen, thereby establishing that the material resists permeation by carbon dioxide. The sample pieces were then measured microscopically and it was found that they did not undergo any dimensional changes. The sample pieces did not twist, swell, bloat, warp or exhibit any other visible distortion or change in appearance.

The same tests were repeated but using sample pieces of the same dimensions of a material which for many years was believed to be the best available material for use in connection with valve seals for confining carbon dioxide under pressure. When placed in water, the sample pieces fizzed like an effervescent material, thus indicating that the material was permeated to a point of saturation with carbon dioxide. Also, the material exhibited dimensional changes, distortion due to absorbed gas being quickly released therefrom, and other ill effects, thereby serving to indicate that the best heretofore known material was inferior beyond compare to the material used in connection with practicing the present invention.

From the foregoing description, it will be seen that the present invention provides an improved package of carbon dioxide wherein a simple, inexpensive valve member is constructed of a material which is light and strong and resists carbon dioxide permeation, has negligible cold flow, and is not distorted after being subjected to high gas pressures, and thereby is adapted for all types of valve seals used in connection with confining saturated carbon dioxide. The material exhibited the foregoing characteristics within temperature and pressure ranges extending beyond the temperature and pressure ranges usually specified for sealing material for high pressure carbon dioxide confining and releasing valves.

As various changes may be made in the form, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

This application is a continuation-in-part of my copending application Serial Number 698,855, filed September 23, 1946, now abandoned.

I claim:

1. A package comprising a portable fluid-tight storage container having a discharge passage, a closure for controlling said discharge passage including a seat element and a valve element cooperating with said seat element to form a seal, and a charge of saturated carbon dioxide under pressure confined in said container by said closure, one of said elements consisting of a synthetic polymer material of the class described

and being characterized in that it has negligible cold flow at temperatures between —65° F. and 160° F. and at mechanical pressures up to 3500 pounds per square inch, in that it substantially completely resists permeation by saturated carbon dioxide when exposed thereto at the aforementioned temperatures and pressures and in that it resists dimensional changes upon rapidly reducing the carbon dioxide pressure from 3500 to 0 pounds per square inch (gauge).

2. A package according to claim 1, wherein said seat element consists of said synthetic polymer material.

3. A package according to claim 1, wherein said valve element consists of said synthetic polymer material.

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