

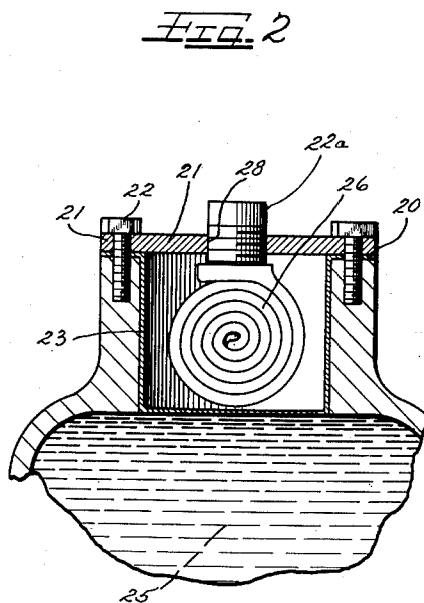
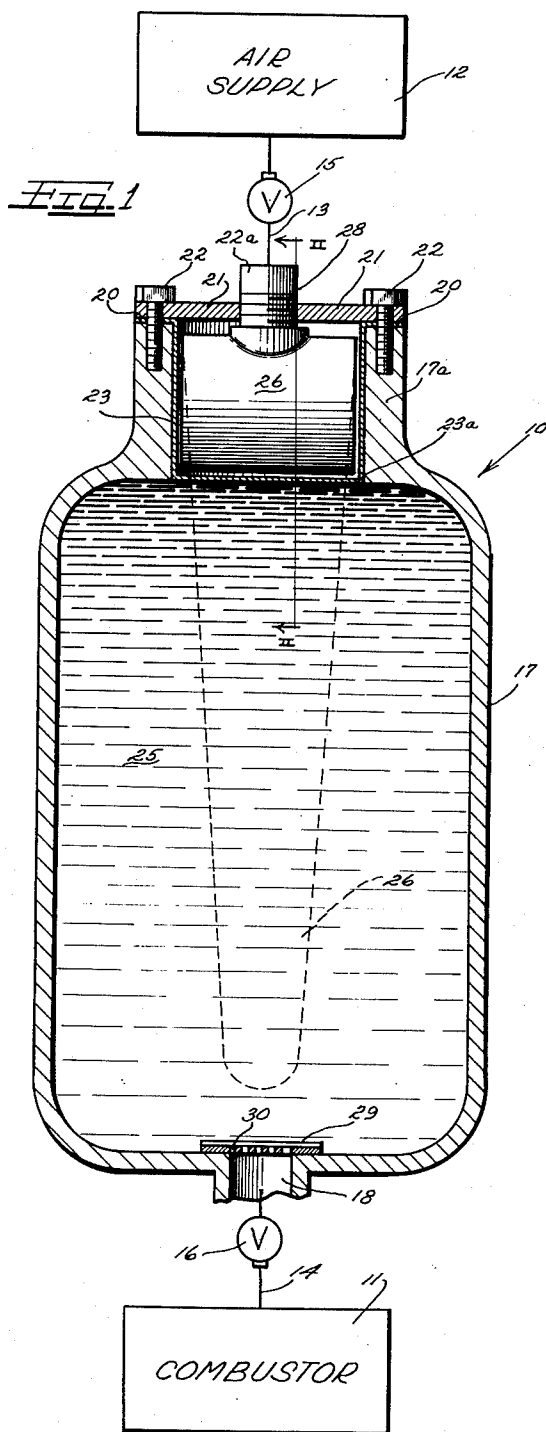
April 2, 1963

P. M. GILLESPIE

3,083,870

REACTIVE LIQUID EXPULSION DEVICE FOR FUEL TANKS

Filed Aug. 29, 1960



INVENTOR.

PAUL M. GILLESPIE

BY

Skell, Sherman, Morris, Cross & Simpson ATTORNEYS

1

3,083,870

REACTIVE LIQUID EXPULSION DEVICE FOR FUEL TANKS

Paul M. Gillespie, Euclid, Ohio, assignor to Thompson Ramo Wooldridge Inc., Cleveland, Ohio, a corporation of Ohio

Filed Aug. 29, 1960, Ser. No. 52,600
3 Claims. (Cl. 222-1)

The present invention relates to improvements in devices for storing and feeding flowable materials, such as liquid fuels, and, particularly, to an improved container for safely storing fuel such as hydrazine over a long period of time and using pressurized air for expelling the hydrazine when the container is in use.

The invention contemplates the provision of a container well suited for use in auxiliary power systems for missiles, rockets and related air, space and extraterrestrial applications. In these containers, the fuel, such as anhydrous hydrazine monopropellant is placed in individual containers for shipment and storage for immediate use, and pressurized air is ordinarily used to start and maintain the flow of fuel into a reaction chamber of the vehicle with which the propulsion system is employed. The individual storage containers are expendable and must be reasonable in cost and be safe for storage and use. The expulsion mechanism must necessarily be completely reliable and withstand shocks of shipping and handling as well as temperature changes.

Heretofore difficulty had been encountered in the materials of construction of such storage and fuel tanks because of the deleterious effects of the type of highly corrosive fuels employed. If stored over a long period of time, the fuels would react on the materials of construction and permeate the components of the fuel storage tank as well as corroding such materials of construction.

Accordingly, an object of the present invention is to provide an improved storage and supply tank for reactive liquids such as hydrazine which may be stored over long periods of time without damage from the reactive fuel.

Another object of the present invention is to provide an improved storage container for reactive fuels utilizing a bladder which is inflatable with a pressurizing medium for expulsion of the fuel, which is inexpensive to manufacture, which is safe, which will not react with the fuel over long storage periods, and which will expand safely without danger of rupture and without danger of the formation of a potentially explosive reaction between the fuel and the pressurizing medium.

Another object of the present invention is to provide an improved container and expulsion bladder for a reaction fuel which is capable of improved expulsion of the fuel during use.

A still further object of the present invention is to provide an improved reactive fuel container for storage and for feeding the fuel which is not adversely affected by the temperature changes.

These and other objects, features and advantages of the present invention will become more apparent upon a careful consideration of the following detail description when considered in conjunction with the accompanying drawings illustrating the preferred embodiment of the present invention wherein like reference numerals and characters refer to like and corresponding parts throughout the several views.

On the drawing:

FIGURE 1 is a vertical sectional view taken through the center of the container constructed in accordance with the principles of the present invention; and

2

FIGURE 2 is a fragmentary sectional view taken along lines II-II of FIGURE 1.

As shown on the drawings:

As appears in FIGURE 1, a container assembly generally indicated by the numeral 10 provides a device for storage and for feeding a reactive liquid fuel such as hydrazine. At the time of use, the container is connected to a combustor 11 and to a pressurized expulsion gas supply 12 which is preferably air. The air supply is connected at 13 and the combustor at 14 to complete the propulsion system. A valve means 15 is connected to the container assembly 10 for admitting the air for expulsion of the fuel.

The container assembly includes an outer generally cylindrical shaped metal tank or container 17 for the fuel. When the fuel employed is a hydrazine or hydrazine derivative the tank is preferably constructed of either 304 stainless steel or an aluminum coated structural material or any other material non-reactive and non-permeable by the fuel employed.

At one end of the container is an expulsion opening outlet 18. Connected to the expulsion opening 18 is a control valve 16 which is closed during storage. The control valve 16 may take the form of a rupturable disc which is effective to seal the container during storage and which is automatically opened with the build up of sufficient pressure within the container 17.

At the opposite end of the container or housing 17 is an outwardly flaring sleeve 17a apertured to receive a foil diaphragm 23 which is provided with an outturned lip 20 secured to the housing sleeve by an end plate 21 and securing means 22 such as by bolts, welding or the like. The metal foil diaphragm 23 is constructed of a rupturable material such as an aluminum foil which may be ruptured in a manner hereinafter more fully explained. The end wall 23a of the metal foil diaphragm 23 prevents communication between the fuel chamber 25 and the ambient atmosphere.

Positioned within the cup-shaped interior of the metal foil is a coiled expandable bladder 26 as clearly appears in FIG. 2. The bladder is anchored at its base to the end plate 21 by a threaded fitting 22a which projects through the aperture 28 formed in the end plate 21 and is deflated when coiled in order to fit compactly in the cup-shaped housing defined by the foil 23.

The fuel chamber 25 is first filled with the fuel such as hydrazine. The foil cup 23 is then inserted in the sleeve aperture of the container or housing 17, the lips of the foil seated against the end surface of the sleeve of the housing, the bladder 26 coiled and the fitting thereof threaded into the end sleeve aperture 28, the bladder positioned in the cup shaped interior of the foil and the end cap 21 secured as by bolts 22 to the sleeve 17a of the housing 17.

The bladder 26 is formed of an expandable or an elastic material conical in shape in order to stretch for expulsion of the liquid fuel from the fuel tank 25. However, it is well known that, where air is used as the expulsion medium, it is essential that the bladder not rupture during inflation to prevent mixing of the hydrazine and air and the resultant formation of a potentially explosive mixture. Therefore, it is essential that the bladder not deteriorate during storage. The aluminum foil 23 is provided to prevent permeation of the hydrazine vapors and liquid into the materials of construction of the bladder. The bladder is preferably constructed of butyl rubber, buna S rubber, Teflon and similar materials which are expandable and non-permeable and which will not deteriorate during storage. Where hydrazine is employed as a fuel, the foil 23 is preferably constructed of aluminum. Thus, if the foil diaphragm 23 is constructed of a material non-

3

permeable by hydrazine and which is not corroded by hydrazine, the bladder material of construction is not as critical as a design parameter since contact between the material of the bladder and the hydrazine will occur only for a short period of time when the bladder, in expanding ruptures the foil 23 and pressurizes the chamber 25 to force the fuel through the housing outlet.

Thus a larger selection of bladder materials of construction are permitted since the bladder contacts the fuel for a short period of time. In addition, the storage life of the fuel tank in condition for immediate use, is enhanced considerably.

The bladder is an elongated bag, connected through its fitting 22a to the air source 12. During inflation, the bladder will inflate first to expand and rupture the foil diaphragm 23 and then expand further to first elongate to its full length and then expand forcing the fuel forwardly ahead of the bladder toward the opening 18 at the end of the container.

Perforated disc 29 may be positioned over the expelling opening 18 in the container 17. The disc may be provided with grooves 30 which provide flow path to permit complete draining of the container 17 even when the bladder is inflated to press against the opening 18.

In operation, the container assembly 10 is filled with fuel in the chamber 25 and the area within the bladder may be partially filled, as desired with low pressure air to prevent collapse of the bladder. With the bladder confined in the opening of the sleeve by the foil diaphragm 23, effective means are provided to prevent contact of the fuel with the materials of construction of the bladder. The foil diaphragm 23 is sized to permit contraction and expansion thereof due to changes in temperature conditions and thereby minimize the dangers inherent in rupture of the diaphragm and the dangers inherent in transporting the unit when the fuel is frozen. Hydrazine, for example, has a freezing temperature of 2° C. When the unit is in use, the air supply 12 and the combustor 11 are connected to the container, the valve 16 is opened (or the rupturable disc is ruptured by fuel pressure) and the air supply valve 15 is opened with the bladder inflating first in the coiled position to force itself against the rupturable diaphragm 23 and then elongating through the ruptured diaphragm and expanding to force the fuel gradually out of the expelling opening 18.

As an example of operation under preferred conditions, a container containing hydrazine would be emptied with an expelling air pressure of 750 p.s.i. The container would be emptied in a 20 minute period and the chamber pressure would be approximately 300 p.s.i. The expansion of the bladder will occur over a sufficiently long period of time to prevent premature rupture of the diaphragm in one localized area. This minimizes the possibility of blowing a bubble of the inner layer of the bladder material of construction through a small opening in the diaphragm.

Thus it will be seen that I have provided an improved fuel storage and supply container which is more reliable, less expensive and which meets the objectives hereinabove set forth. The coiled bladder arrangement is reduced in expense, and is more easily inspected than arrangements heretofore provided. The system is lighter in weight and more compact than arrangements heretofore used. The savings in cost are considerable inasmuch as the units are expendable.

Although minor modifications might be suggested by those skilled in the art, it should be understood that I

4

wish to embody within the scope of the patent warranted hereon, all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A flowable material feeding and storage tank comprising:

a tank having an inlet and an outlet,
a rupturable diaphragm dividing the tank interior into at least two chambers,

one of said chambers having a flowable material therein and communicating with said tank outlet, the other chamber housing a coiled and inflatable bladder communicating with the tank inlet, and said coiled bladder being positioned in the other chamber to contact the rupturable diaphragm when inflated whereby pressurized expansion of the bladder forces the bladder against the rupturable diaphragm to rupture the diaphragm and then elongate through the ruptured diaphragm into the one chamber to expand and force the flowable material therefrom through the tank outlet.

2. A hydrazine containing fuel feeding and storage tank comprising:

a housing defining a storage chamber containing hydrazine containing fuel communicating with a housing outlet formed in one end of the housing,
a sleeve on the other end of the housing connected to the storage chamber,

a rupturable hydrazine impervious and hydrazine non-corrosive diaphragm in the sleeve forming a sleeve chamber and separating the storage chamber from the sleeve chamber,

a coiled and inflatable bladder mounted in said sleeve chamber and communicating with an inlet, and said coiled bladder being positioned in the sleeve chamber to contact the rupturable diaphragm when inflated

whereby pressurized expansion of the bladder forces the bladder against the rupturable diaphragm to rupture the diaphragm and then elongate through the ruptured diaphragm into the one chamber to expand and force the hydrazine containing fuel therefrom through the tank outlet.

3. The method of feeding flowing materials from a flowing material containing storage tank through a storage tank outlet comprising:

uncoiling a coiled flexible elongated bladder and forcing the bladder against a rupturable diaphragm which separates the flowable material from the coiled bladder,

expanding the bladder and rupturing the diaphragm by the force of the expanding bladder thereagainst, elongating the bladder through the ruptured diaphragm into the flowable material, and

expanding the elongated bladder to force flowable material gradually out of the outlet.

References Cited in the file of this patent

UNITED STATES PATENTS

1,117,639	Cooley	Nov. 17, 1914
1,977,862	Scholtes	Oct. 23, 1934
2,333,451	Sussman et al.	Nov. 2, 1943
2,387,598	Mercier	Oct. 23, 1945
2,410,310	Smith	Oct. 29, 1946
2,831,492	Bising	Apr. 22, 1958