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TANK CLOSURE DEVICE

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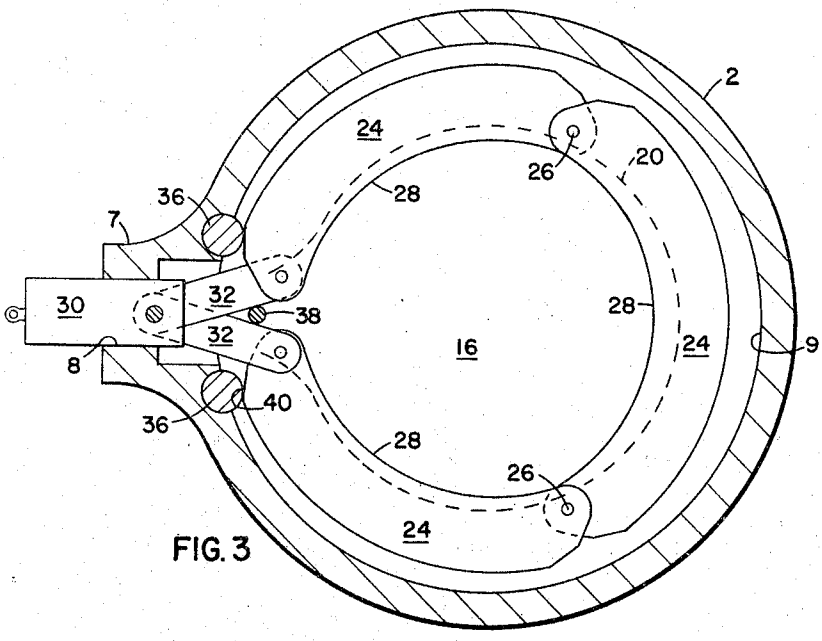


FIG. 3

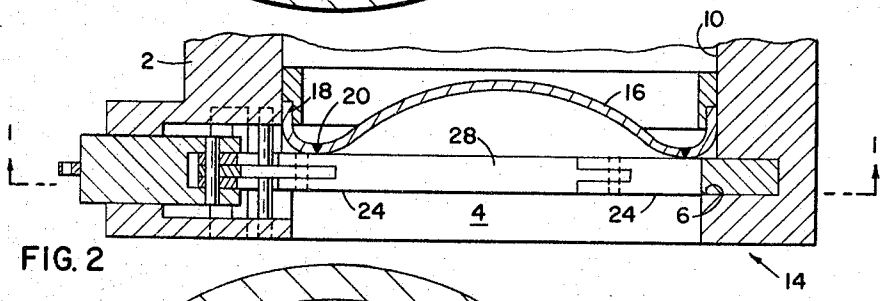


FIG. 2

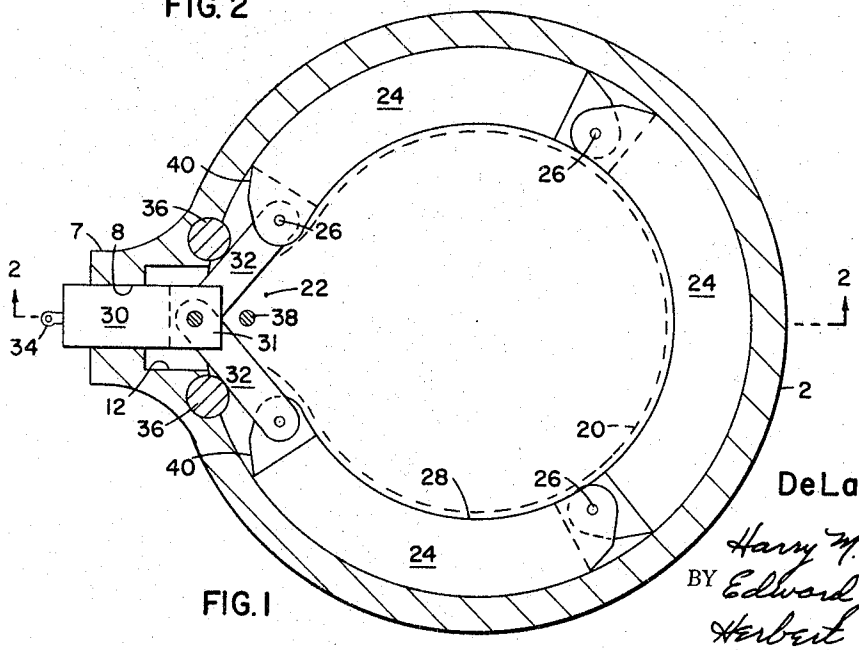


FIG. 1

DeLacy F. Ferris,
INVENTOR.
Harry M. Saragovitz
BY Edward J. Kelly
Herbert Berl
J. Keith Fowler

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TANK CLOSURE DEVICE

De Lacy F. Ferris, Sepulveda, Calif., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army

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This invention relates to tank closure devices and more particularly to a quick-opening closure device for rocket fuel system tanks.

It is desirable to hermetically seal packaged liquid rocket propellant tanks with a closure device which will resist high pressures during storage and transportation but which will quickly open at low pressures when the tanks are pressurized and the rockets are started. Moreover, it is desirable that such device be capable of rapid movement from a closed, completely sealed condition or position in the outlet of the tank to a fully open, unsealed condition or position.

In the past, this has been done by using a burst diaphragm formed from a thin sheet of metal welded into the tank outlet and locally weakened by coining or scoring. The thin sheet of metal was supported by a member which slides across the tank outlet from one side of the outlet to the other. To unsupport the burst diaphragm from this storage position or condition to the rocket firing position or condition, it has been necessary to move the support member a distance greater than the diameter of the tank outlet so as to allow bursting of the diaphragm for the missile firing. Furthermore, the support member for the diaphragm, in bridging the entire diameter of the tank outlet, carried the entire load in the tank as a beam.

The present invention provides a quick-release tank closure device including a burst diaphragm which is supported around the periphery thereof so that the tank loads imposed thereon are shear loads; thus, reducing the size or axial length required for the closure device and allowing the tank to be longer. Furthermore, the diaphragm is scored or coined in a manner which will prevent pieces of the ruptured diaphragm from going downstream and provide a relatively large, unobstructed, open passageway when ruptured.

Therefore, the primary object of the present invention is to provide a closure device for the outlet passage of a liquid propellant tank which is highly effective for sealing the tank against high pressures but capable of rapid operation for quickly opening the passage of a predetermined time.

Another object of the invention is to provide a tank closure device which is relatively small in size, or short in axial length, so as to allow the axial length of the tank to be longer.

A further object of the invention is to provide a tank closure device which utilizes a burst diaphragm but prevents ruptured pieces thereof from going downstream, thereby allowing a relatively large unobstructed passage when opened.

An important feature of the herein described invention resides in the provision of a burst diaphragn type hermetic sealing element disposed in a tank flow passage and formed with a circumferentially extending frangible line which may be ruptured at the instant the closure is opened or at a predetermined time thereafter.

Another feature of the invention is to provide a tank closure which may be actuated between closed and open positions by remote control means.

Other objects, features and advantages of the invention will become evident from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a plan view of a tank closure constructed in accordance with this invention and disposed in closed position with a fuel tank outlet, portions of the tank outlet being shown in section to show certain details of the closure operator in operative position, said view being taken from outside the tank looking axially inwardly;

FIGURE 2 is a sectional view taken substantially on line 2—2 of FIGURE 1 and illustrating the closure parts in operative position; and

FIGURE 3 is a plan view similar to FIGURE 1 but illustrating the closure in storage position.

Referring generally to the drawings for illustrative purposes, the closure device of the present invention is shown as closing and hermetically sealing the downstream portion of the flow passage of a generally cylindrical tank outlet body **2**. The closure device, generally indicated by reference numeral **14**, includes shearable, hermetic sealing sheet or burst diaphragm **16**. Burst diaphragm **16**, which is preferably formed of thin sheet metal, is secured as by welding about its peripheral edge **18** to inner cylindrical surface **10** of flow passage **4** (FIGure 2). The burst diaphragm is formed like a pressure vessel header with its concave side on the outlet or downstream side of the flow passage. The diaphragm is locally weakened as by scoring in a manner as indicated by the circumferentially extending frangible line or score pattern **20**.

To provide means for supporting the burst diaphragm whereby the same may effectively resist high pressures encountered during storage and transport operations, there is provided a support mechanism which includes a plurality of arcuate support links **24** joined together in end-to-end relationship. The arrangement illustrated utilizes three such links, two end links and an intermediate link, pivotally interconnected as by link pins **26** and clevis type connections at adjacent ends thereof. Links **24** are disposed for sliding movement within an annular groove **6** formed in inner surface **10** of tubular body **2**. Thus, links **24** are adapted for radial movement within groove **6**, i.e., movement in a plane transverse to the axis of the outlet flow passage. The radial width of each link **24** is such that when inserted in groove **6**, its inner arcuate edge surface **28** will lie contiguous but radially outside score pattern **20** when in the operating position illustrated in FIGURES 1 and 2. Thus, the score pattern lies just radially inwardly of edge surface **28** (FIG. 1) when the closure device is in operating position.

To move the support linkage from an operating position (FIGURES 1 and 2) to a storage and transport position (FIGURE 3), an actuating mechanism is provided, which mechanism includes force transmitting lever **30** slidably received in a transverse bore **8** formed in a protrusion **7** of body **2**, said bore opening into enlarged recess **12** (FIGURE 1) in the body, and a pair of connecting links **32** each having one end pivotally connected to inner end **31** of lever **30** and the opposite end pivotally connected to a respective support link **24**. To guide the linkage upon operation of lever **30** to cause the support links to move either radially inwardly or radially outwardly, three cam pins or rollers are journaled in outlet body **2** within a portion of groove **6** for engagement by the outer side edges of connecting links **32**. Thus, two cam pins **36** are disposed for engagement by the outer edges of connecting links **32** while a third cam pin **38** is disposed intermediate links **32** for engagement by the inner edges thereof. It is noted that cam pin **38** may be smaller than cam pins **36**. The outer end of lever **30** is formed with a connecting means **34** whereby the same may be connected with any convenient actuating means or remote control means (not shown).

With reference to FIGURE 3, it is seen that support

links **24** have been moved radially inwardly to a position wherein the inner, arcuate adge of each support link is disposed radially inwardly of score pattern **20**. Thus, in this position, the support links entirely support the weakened portion or score pattern **20** of burst diaphragm **16**. This position (FIGURE 3) will hereinafter be referred to as the storage and/or transport position. Since the center or central section of the diaphragm has rigidity by virtue of its bell-shape, it will tend to distribute its pressure load to the support links without deforming itself. Thus, the central section of the diaphragm is also effectively supported. An added desirable feature of the arrangement according to this invention is that pressure loading tends to put the weakened portion of the diaphragm in compression rather than tension. Because of the effectiveness of the support structure, the frangible line or score pattern may be formed substantially around the entire circumference of the burst diaphragm, there being only a small segment **22** (FIGURE 1) between the adjacent ends of the two end links which is not scored. Hence, this segmental portion allows the diaphragm to be hinged or swung to one side when ruptured and prevents the same from going downstream when it bursts, thereby leaving the passage substantially unobstructed and offering substantially no resistance to flow.

In operation of the closure device to a storage position (FIGURE 3), operating lever **30** is shown to be pulled radially outwardly in a direction away from the tank outlet flow passage placing tension on connecting links **32**, thus, causing the support linkage including links **24** to be draw radially inwardly. In this operation, the links are guided by cam pins **36** and **38** in such manner that the outer edges of connecting links **32** slidably engage cam pins **36** while the opposite, inner edges of links **32** engage cam pin **38**. The ends of support links **24** are provided with beveled portions **40**; and, as the ends of the end support links are drawn inwardly, the beveled portions or flats **40** rest on cam pins **36**. Thus, the middle or intermediate support link will be drawn out of groove **6** in a radially inward direction to a position underneath the score pattern. As heretofore noted, the radial width of each support link **24** is such that the inner arcuate edges thereof are positioned radially inwardly of the score pattern when in the storage and transport position. A suitable latch or lock means (not shown) may be provided for lever **30** if desired so as to positively hold the same in a desired position.

When lever **30** is moved radially inwardly, support links **24** are forced radially outwardly until they abuttingly engage against the radially outer wall **9** of annular groove **6**. The toggle-like arrangement of the linkage makes it possible to place a relatively large force on the links at the end of the stroke of lever **30**. The closure device is then in the operating condition or position (FIGURES 1 and 2), wherein the inner arcuate edges of links **24** are contiguous but radially outward of the score pattern. In the latter position, application of pressure on the tank side of the outlet passage causes the burst diaphragm to tear or rupture rapidly along the score pattern. This failure closely approaches a shear failure which makes the pressure at which failure occurs more reproducible. If the pressure is suddenly applied, the center or central portion, i.e., that portion inside the score pattern, of the diaphragm will be thrown downstream and segment **22** will hold the same against the wall **10** of the tank outlet, thus, preventing said central portion from being carried downstream. Hence, free passage of liquid will then be permitted through the opened, unobstructed passage.

If it is desired to return the closure device from the operating position to the storage position prior to application of pressure to the tank and, thus, prior to rupture of the diaphragm, the operating lever may be pulled outwardly, thus, causing the connecting links to slide over the cam pins and drawing the adjacent ends of the end support links together directly underneath the score pattern of the burst diaphragm. It should be apparent that the arrangement of the cam pins is such that the support links will be centered automatically thereby. However, if it is found that the links do not center as desired, a groove (not shown) could be cut in the downstream side of the center support link and engaged with a pin (not shown) rigidly affixed within the downstream wall of annular groove **6**.

Accordingly, it is seen that a closure device is provided which is particularly adapted for use in hermetically sealing packaged liquid rocket propellant tanks. A closure device is provided which will resist relatively high pressures during storage and transportaton but which may be rapidly opened at low pressures when the tank is pressurized. An important feature of the invention resides in the provision of a closure device for a rocket fuel tank outlet which device may be changed from a storage position to an operating position, or vice versa, at any time prior to application of pressure on the tank side sufficient to cause shearing of the burst diaphragm.

While the present description is drawn specifically to a closure for fuel tanks and the like, it should be obvious that the closure device is equally useful with many other fluid installations and systems. For example, the device has utility as a one-shot gate type valve.

It is to be understood that the specific embodiment of the invention described herein is merely illustrative of the principles of the invention and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A closure device for hermetically sealing the outlet passage of a tank comprising, in combination: a tubular tank outlet body defining an axially extending flow passage and having an annular groove formed in the interior wall thereof, a protrusion extending radially outward from a peripheral portion of the exterior of said body, said protrusion having an axial bore extending therethrough and opening on its inner end into said annular groove; a burst diaphragm secured about its peripheral edge to the interior wall of said outlet flow passage at a location axially inward of said annular groove, said diaphragm having a score pattern formed therein, said score pattern including a substantially circular frangible line concentric with but spaced radially inwardly from said peripheral edge; a generally circular support means disposed in said annular groove; and, actuating means extending through said protrusion bore and connected with said support means for moving said support means radially inwardly and radially outwardly to, respectively, support and unsupport the burst diaphragm in the area of the score pattern.

2. A closure device as defined in claim **1**, wherein said support means includes a plurality of arcuate support links pivotally interconnected to each other at adjacent ends, said links being adapted for slidable movement transversely of said flow passage from a storage position wherein the links directly support the score pattern of the diaphragm to an operative position wherein the links are moved fully into said groove radially outwardly beyond said score pattern so as to allow said diaphragm to be sheared along said score pattern on application of pressure on the tank side thereof.

3. A closure device as defined in claim **2** wherein said actuating means includes: a force transmitting lever disposed for slidable movement within said protrusion bore, and a pair of connecting links each pivotally connected at one end to the inner end of said lever and at the opposite end to one of the support links; and wherein guide means are provided adjacent the opening of said axial bore, said guide means including a pair of cam pins positioned on said tubular body each being adapted for engagement by one side of one of said connecting links and a smaller cam pin disposed between said connecting links

for engagement by the opposite sides of said connecting links, whereby movement of said lever radially outwardly causes said support links to move radially inwardly to said storage and movement thereof in the opposite direction causes the support links to move radially outwardly to said operative position.

4. A closure device as defined in claim 3, wherein the radial width of each of the support links, when in the operative position housed within said annular groove, is slightly less than the distance from the inner wall of said groove to said score pattern, whereby the inner arcuate edge of each said support link lies radially outwardly of the score pattern.

5. A closure device as defined by claim 4, wherein the central portion of the diaphragm defined by the portion lying inside the score pattern is bell-shaped with the convex side thereof facing inwardly toward the tank side of the outlet passage.

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THERON E. CONDON, *Primary Examiner.*

R. H. SCHWARTZ, *Assistant Examiner.*