Nov. 8, 1960 H. N. POULIOT 2,959,326

FLUID CONTROLLING MEANS

Filed May 4, 1959 2 Sheets-Sheet 1

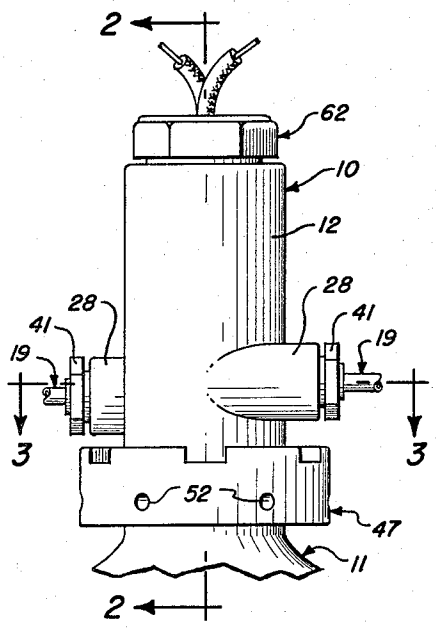


Fig. 1

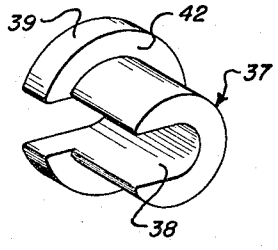


Fig. 7

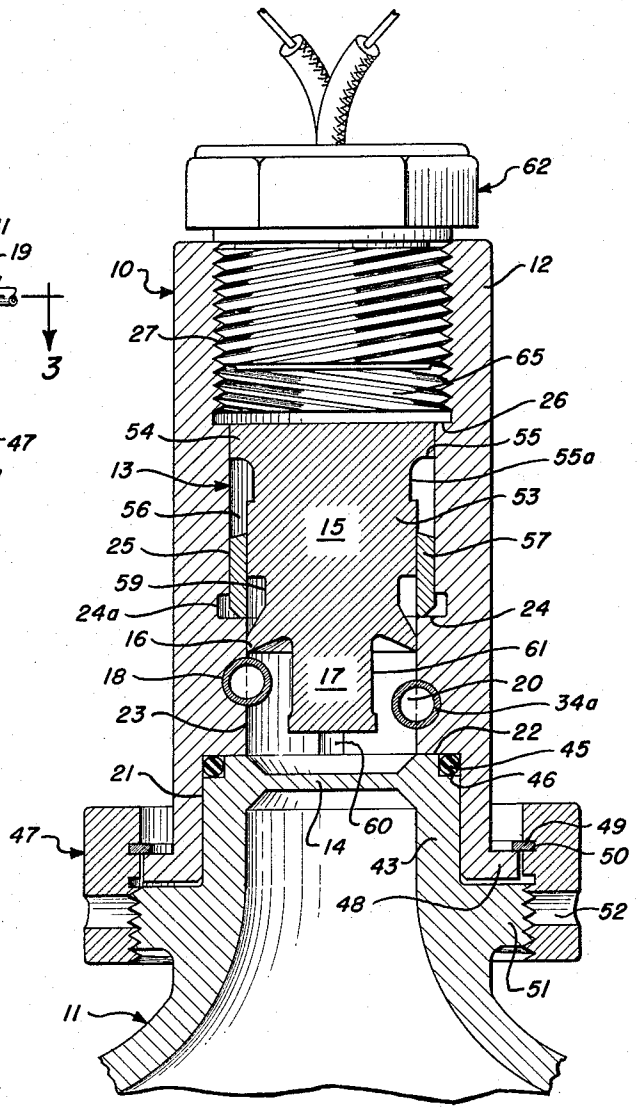


Fig. 2

INVENTOR:
Harvey N. Pouliot
BY
Attorney

Nov. 8, 1960 H. N. POULIOT 2,959,326

FLUID CONTROLLING MEANS

Filed May 4, 1959 2 Sheets-Sheet 2

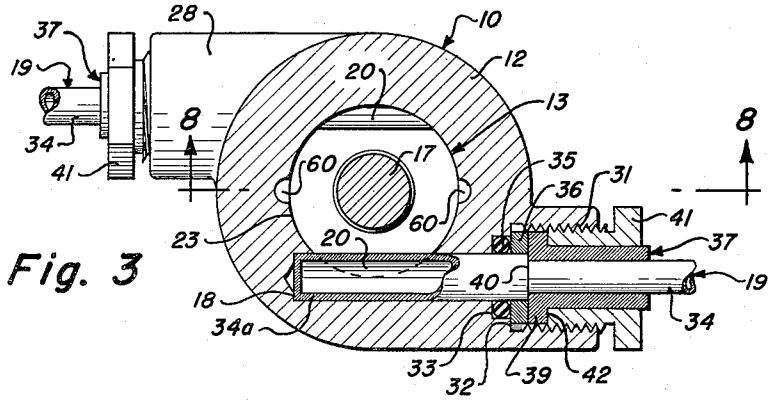


Fig. 3

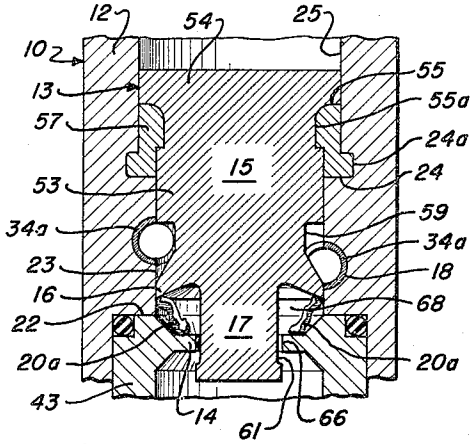


Fig. 4

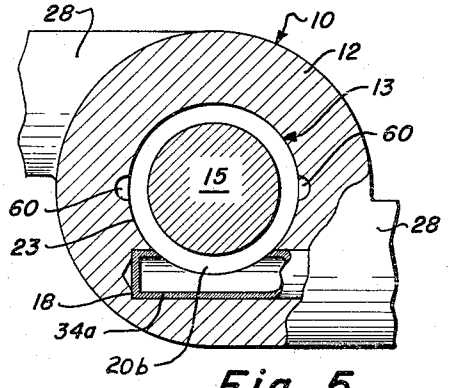


Fig. 5

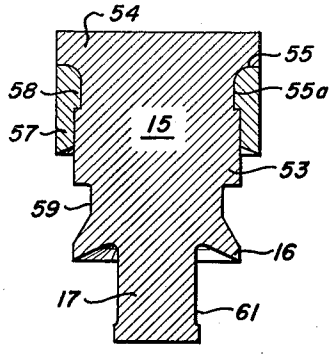


Fig. 6

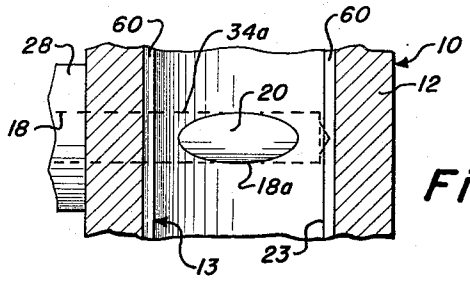


Fig. 8

INVENTOR:
Harvey N. Pouliot
BY
Roland A. Anderson
Attorney

United States Patent Office 2,959,326
Patented Nov. 8, 1960

2,959,326

FLUID CONTROLLING MEANS

Harvey N. Pouliot, Rochester, Minn., assignor, by mesne assignments, to the United States of America as represented by the United States Atomic Energy Commission

Filed May 4, 1959, Ser. No. 810,976

10 Claims. (Cl. 222—5)

My invention relates to means for controlling fluids and more particularly to explosively actuated means for opening and interconnecting a plurality of containers, one or more of which may contain fluid.

The prior art includes numerous remotely actuable "valve" devices which are adapted to separate bodies of fluids and when actuated are adapted to unite said bodies of fluids. All of these devices are intended to function as container closures to isolate such fluid bodies prior to actuation of the devices. In use in order to secure this function, such devices must necessarily be attached to the container of such fluid body by means of some form of fluid conducting mechanical coupling, involving fluid sealing means inherently liable to leakage. Consequently, such prior devices are unsuitable for use in systems wherein the possibility of leakage prior to actuation is undesirable. It is therefore a principal object of this invention to provide a remotely controlled device wherein, prior to actuation of the device, fluids may be confined in one or more of a plurality of hermetically sealed fluid containers in which no reliance is placed on seals to avoid leakage as in the prior art, yet upon actuation of the device all of such containers may be opened and interconnected. Stated in another manner, one of the principal objects is to provide a fluid control device that does not, in itself, constitute a barrier to the flow of fluids apart from the actual walls of containers of fluids to be controlled, but rather when associated with such containers is adapted to be remotely actuated to open and interconnect the containers.

Another object is to provide a new and improved fluid control device actuable by explosive means.

Another object is to provide an improved fluid control device wherein the fluid is protected from contamination by the actuating propellant.

A further object is to provide a fluid control device wherein the actuated element is limited in total operating movement and is thereafter permanently locked against further movement.

Still another object is to provide a fluid control device means for sequentially opening or providing access to a plurality of sealed containers.

A still further object is to provide a fluid control device of simple construction which may be economically manufactured.

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.

A preferred embodiment has been chosen for purposes of illustration and description. The preferred embodiment illustrated is not intended to be exhaustive nor to limit the invention to the precise form disclosed. It is chosen and described in order to best explain the principle of the invention and its application in practical use to thereby enable others skilled in the art to best utilize the

invention in various embodiments and modifications as are best adapted to the particular use contemplated.

In the accompanying drawings:

Fig. 1 is a general external view showing the present device mounted on a container;

Fig. 2 is a longitudinal sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a transverse partially sectional view taken along line 3—3 of Fig. 1;

Fig. 4 is a partial longitudinal sectional view taken along line 2—2 of Fig. 1 and showing the device in a post-actuation position;

Fig. 5 is a transverse partially sectional view taken along line 3—3 of Fig. 1 and showing the device in a post-actuation position;

Fig. 6 is a longitudinal sectional view of an alternate form of piston element for use in the device of Fig. 1;

Fig. 7 is a pictorial view of a slotted shouldered bushing shown at 37 in Fig. 3; and

Fig. 8 is a partial longitudinal sectional view taken along line 8—8 of Fig. 3.

Described generally the present device as shown in Figs. 1–5 comprises a housing and piston assembly which, although not in or of itself, forming a barrier to fluid flow, may, when associated with self-sealed containers, control fluid flow as between such sealed containers by operating to open and interconnect such containers when the piston of the device is actuated.

With further reference to the drawings, the invention is shown embodied in a device, generally indicated at 10 in Fig. 1, mounted on a fluid container 11. The device generally comprises a housing 12 having a bore 13 which is adapted to be secured in opposed relation to a wall 14 of the container. A piston 15 carrying a shearing lip 16 and an extension 17 is actuable lengthwise of the bore in response to a propellant. The housing and piston may be made of any suitable material. The housing contains one or more conduit-receiving passageways 18 which are adapted to receive one or more associated fluid conduits generally indicated at 19 and to expose side wall segments 20 thereof within the bore. Upon actuation of the piston, the shearing lip is adapted to open the conduits by shearing away the exposed side wall segments and the extension is adapted to pierce open the opposed container wall, thereby to interconnect the conduits, the bore, and the container.

The bore 13 is comprised of longitudinally stepped sections delimited by shoulders. The end of the bore adjacent the container is shown defining a container-receiving-and-locating counterbore section 21 which terminates at a stepped container-locating shoulder 22; if desired, the counterbore may be omitted and the container merely abutted against a suitable shoulder. Next in longitudinal succession in said bore is an unenlarged intermediate portion of bore 13 which for convenience will be referred to as shearing section 23. Immediately adjacent the shearing section and demarked therefrom by a stop shoulder 24 is another enlarged portion of the bore 13 which defines a cylinder bore section 25 having an undercut locking groove 24*a* adjacent said stop shoulder. Immediately adjacent the cylinder bore section and demarked therefrom by a shoulder 26 is a further enlarged threaded counterbore 27 of bore 13 which opens onto the opposite end of the housing.

Integral bosses 28 are disposed on the exterior surface of the housing at locations generally opposite the shearing section 23 of the bore to accommodate transverse conduit-receiving passageways 18. The passageways 18 are offset from the axis of the bore but intersect the bore in a generally tangential manner to define communicating openings 18*a* of generally elliptical shape between the shearing section of the bore and the passageways,

Fluid conduits 19 received in the passageway present or expose said partial longitudinal segments 20 of themselves within the shearing section of the bore as may be seen more particularly in Fig. 3.

Although the device has been described thus far as accommodating a plurality of conduits, the invention may be constructed to accommodate only one. Consequently the following, for convenience, will describe the device as having a single such accommodation. This may be done without detriment to understanding since the detailed structures of the conduit accommodating elements are merely duplicated in multiples in a more complex device.

The passageway 18 may be enlarged within the boss to define a threaded conduit-receiving counterbore 31 which terminates at a shoulder 32. The passageway is further counterbored to a shallow depth, but at a lesser diameter than counterbore 31, to form a conduit seal cavity 33.

The fluid conduit 19 comprised of a portion 34 and a relatively large, closed-ended, and cylindrical end portion 34*a* which fits the passageway 18 and is partially exposed within the shearing section of the bore. While any suitable means may be utilized for joining a conduit with the device, in the present instance the fluid conduit is shown sealed with respect to the passageway and secured therein by a series of elements which may be assembled over the large end portion of the conduit. These elements, in order from the inside of the housing outwardly, include: an O ring seal 35 disposed within the seal cavity in sealing relation to both the diameter of the seal cavity and the outer surface of the conduit portion 34*a*; an O ring seal retaining washer 36 disposed about conduit portion 34*a* and abutting shoulder 32; a conduit straddling bushing 37 having a larger outside diameter than said enlarged conduit portion 34*a* (the bushing is adapted to straddle conduit portion 34 by means of a radial longitudinal slot 38 in said bushing) and having a flanged end 39 in abutting relation to both the retaining washer and a conduit shoulder 40 on conduit 19 at the junction of the enlarged conduit portion 34*a* with the conduit portion 34; and an externally threaded bushing-retaining nut 41 disposed about said bushing in abutting relation to a bushing shoulder 42 formed by the flanged end 39 and threadedly engaged within the conduit receiving counterbore 31. The bushing-retaining nut 41, the retaining washer 36, and O ring seal 35 may be assembled over the enlarged cylindrical portion 34*a*. The bushing 37 may be assembled on the conduit portion 34 behind the enlarged portion 34*a* by transversely straddling the conduit by means of the radial and longitudinal slot 38. From the foregoing it is obvious that all the conduit sealing and retaining elements may be assembled on the conduit at its enlarged end and therefore enable the make-up of the conduit connection with the housing without regard to any structure which may be attached to the opposite end of said conduit.

The container 11 is shown having a cylindrical neck 43 closed by the end wall 14 of reduced thickness, with the neck 43 fitting within the locating counterbore 21 in abutting relation to the locating shoulder 22. This insures proper alignment and longitudinal positioning of the end wall with respect to the bore. A conventional O ring seal 45 disposed within a suitable groove 46 in said neck may serve to seal said bore 13 with respect to the neck.

The housing and container may be joined and retained together by an internally threaded coupling nut 47 which is shown revolvably secured in partially overlapping relation to said housing by means of an external nut-mounting flange 48 at the container end of the housing. The flange 48 coacts with a retainer ring 49 installed in a groove 50 within the bore of the nut. The retainer ring is so disposed near one end of the coupling nut and the housing nut-mounting flange is of such a width that a portion of the length of the nut having internal threads extends beyond the end of the housing. This extended nut portion is adapted to threadedly join an externally threaded container flange 51 and urge the retainer ring 49 against the nut-mounting flange 48 and the end of the cylindrical container neck 43 against the locating shoulder 22.

The coupling nut may be tightened or loosened by means of spanner wrench radial holes 52, however other means such as hexagon flats, for example, may be used.

The piston 15 is shown composed of an intermediate portion 53 comprising previously referred to shearing lip 16 located at one end and sized to pass within the shearing section 23 of bore 13, an enlarged flange portion 54 at an opposite end which is sized to slide within the cylinder bore section 25, a piston stop shoulder 55 and adjacent undercut locking groove 55*a* between said intermediate and flange portions, and the previously referred to extension 17 extending beyond the shearing lip 16 of intermediate portion 53. When the piston is in its initial position in the bore (Fig. 2) with the piston flange located near the shoulder 26 and the shearing lip extending slightly within shearing section 23, an annular space 56 is defined radially by the exterior of the intermediate piston portion 53 and the interior of the cylinder bore portion 25 and longitudinally by the stop shoulders 24 and 55 of the piston and bore. A gas check sleeve 57 of aluminum or other deformable material occupies only a part of the length of said space and seals the piston and bore by reason of an interfering or press fit with respect to both the intermediate portion of the piston and the cylinder bore portion of the bore.

While shown in Fig. 2 separate from the piston, the gas check sleeve 27 may be mechanically united with the piston 15 by means of a press fit and an internal upset portion 58 of the gas check sleeve interfitting with the undercut locking groove 55*a* on the piston to form a modified embodiment as shown in Fig. 6.

The piston is provided with an annular fluid passageway or groove 59 located in the intermediate portion behind the shearing lip. The shearing portion of the bore is provided with longitudinal fluid passageways or grooves 60 extending from shoulder 22 to a point near shoulder 24. As may be readily seen in Fig. 5, longitudinal grooves 60 are circumferentially located within the shearing section 23 in substantially a ninety degree angular relation to communication openings 18*a*. This relation has for its purpose the obviation of flow interference as will later appear. The piston extension is provided with a shallow annular relief groove 61 which extends in width generally from a point near the distal end of the extension to a point approaching the origin of the extension. The functions of these various grooves will become apparent from a description of the operation of the device.

The threaded counterbore section 27 is adapted to threadedly connect the bore 13 with any suitable propellant to provide power to drive the piston 15, however in the illustrated embodiment a conventional electrically ignited explosive squib 62 is used. When the squib is fired, explosive gases therefrom enter a cavity 65 defined between the ends of the squib 62 and the piston flange 54 and results in a force being exerted on the flange end of piston 15. This force actuates the piston in the bore.

As shown, the actuated piston first engages its shearing lip 16 with the exposed segment 20 of the conduit portion 34*a* and shears the segment 20*a* (Fig. 4) therefrom to form a large flow opening 20*b* (Fig. 5) in communication with the shearing section 23 through the communication opening 18*a*. The flow opening thus created in the side wall of the conduit is substantially elliptical in shape (as is the opening 18*a*) and is larger than the cross-sectional area of the conduit 34*a* itself. This large opening is important in that it minimizes the possibility of throttling losses and consequent pressure drop across the opening. As has been pointed out, the device may be adapted to

open a plurality of conduits as the shearing lip **16** of piston **15** proceeds through the shearing section **23**.

The actuated piston in its continuing movement, carrying the conduit segment before its shearing lip, next brings the distal end of its extension **17** into engagement with and forms an opening in container wall **14**, in a manner well known in the fire extinguisher art.

In order to secure the foregoing sequence of operation, spacing between a particular conduit and container wall **14** is greater than spacing of the distal end of the extension from shearing lip **16**.

The actuated piston in its continuing movement next brings piston shoulder **55** into abutting relation to gas check sleeve **57**. While Fig. 2 shows the sleeve contacting shoulder **24** initially, it may be that it is spaced upwardly of the shoulder. In such a case, after piston shoulder **55** contacts the upper end of sleeve **57**, the piston and sleeve move together until the opposite sleeve end contacts shoulder **24**. A device incorporating the piston embodiment of Fig. 6 may be said to operate in different manner in that the piston and sleeve assembly initially move as one piece. It is apparent that such minor differences or variations do not substantially alter the overall sequence of operation of the device.

There is a final continuing movement of the piston during which the sleeve **57** is shortened by longitudinal forces exerted thereon by stop shoulders **24** and **55**. This force results in the sleeve being internally upset to fill the undercut locking groove **55***a* on the piston and externally upset to fill the undercut locking groove **24***a* in the cylinder bore. This final movement is stopped when volume of the annular space **56** including the volumes of associated grooves has been reduced to the gas check sleeve volume. In a device with the piston embodiment of Fig. 6, the internal upset already exists so that only the external upset is formed during actuation. In other respects the embodiments function in the same manner.

Although the sheared segments **20***a* have been shifted longitudinally by virtue of their being carried in front of shearing lip **16** as it proceeds in shearing section **23**, the sheared segments tend to remain in the same angular position with respect to grooves **60** and when the piston is finally stopped these segments are fixedly trapped (as may be seen at **20***a* in Fig. 4) in this same angular position, i.e., in indexed relation to grooves **60**. In this manner these segments are prevented from blocking the passage of gas through grooves **60**.

In addition to stopping the piston stroke, the sleeve by means of the upsets formed in the locking grooves operates to lock the piston in its post-actuated position within the cylinder and thereby minimizes the possibility of the piston moving toward its previous position under the influence of "bouncing" or pressures from the container or the conduit. In its post-actuated and locked position the piston is permanently held so that its annular fluid passageway or groove **59** communicates with the communication opening **18***a*, its shearing lip is positioned in the shearing section just short of the container-locating shoulder **22**, and the relief groove **61** of extension **17** is extended through the opening **66** so as to provide an annular flow area through said opening around said extension.

Thus it is seen that the device on actuation first opens into the shearing section one or more conduits and then opens a container, all of which, prior to the opening operation, may contain fluids without reliance on seals, i.e., the container and conduits may be integral or hermetic units.

In addition to the opening functions, the device provides an interconnecting fluid flow path between the conduits and container as follows. Assuming flow in the direction from the container to the conduit (or conduits), the fluid may pass from the container via the annular flow area between the extension and the opening **66** into a space **68** in the shearing section between the locked position of the shearing lip and the end of the container. Longitudinal fluid passageway grooves **60** conduct the flow around the shearing lip and into the annular fluid passageway **59** which in turn communicates with the conduits by means of the openings **18***a* and the sheared openings in the conduits. It is apparent that this same flow path may conduct fluids in the opposite direction or may accomplish the mixing of two or more fluids in the course of flow to a common receiver.

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 a limiting sense.

I claim:

1. In a fluid flow control device adapted to be secured to a container and connected with a conduit; a housing penetrated by a bore, securing means adapted to secure one end of said housing to said container, and means spaced from said one end of the bore adapted to receive and retain explosive actuator means; receptacle means in said housing in communication with said bore at a location spaced longitudinally of the bore from said securing means adapted to house a conduit and to expose a portion thereof within said bore; and a piston slidable in said bore having container-opening means and conduit-opening means including a shearing lip with the shearing lip having a pre-shearing position adjacent one side of said receptacle means and a post-shearing position adjacent an opposite side of said receptacle means, the former opening means being adapted on actuation of said piston responsive to a said explosive means to open said container and the latter opening means to sever said conduit to thereby interconnect said container, bore, and conduit.

2. The device of claim 1 wherein said receptacle means comprises a passageway disposed generally tangentially to said bore and adapted to expose within said bore only a longitudinal segment of a conduit.

3. The device of claim 2 wherein said housing has a second passageway disposed in non-intersecting relation to said first mentioned passageway and adapted to provide an auxiliary interconnection of said container, said bore, and said conduit.

4. The device of claim 2 wherein said conduit opening means and said container opening means are integral with said piston and respectively comprise a shearing lip and a reduced longitudinal extension, said lip and said extension being respectively adapted to shear a side wall portion from said exposed conduit segment and to perforate said container.

5. The device of claim 3 wherein said lip and the distal end of said extension are longitudinally spaced along the axis of said piston in relation to the spacing of said conduit and said securing means whereby said lip functions prior to said extension.

6. The device of claim 1 wherein said piston has an intermediate portion of lesser diameter than an adjacent wall of said bore and a recess adjacent one end of said intermediate portion, a shoulder is carried by the piston and projects radially outwardly beyond said recess and intermediate portion, said housing is provided with an inwardly extending shoulder and an adjacent recess at a location spaced from the piston shoulder, and a deformable member is disposed intermediate said intermediate portion and adjacent bore wall and intermediate said shoulders of the piston and body, whereby piston actuation is adapted to force portions of the deformable member into at least one of said recesses to positively retain the piston in an actuated position.

7. The device of claim 1 wherein said piston and said bore have coacting shoulders which together with intermediate surfaces of said piston and said bore define an annular space intermediate ends of said bore, and a

deformable sleeve is disposed in said space and adapted to isolate said explosive means and to be compressed between said coacting shoulders to limit the stroke of said piston and retain it in an actuated position.

8. The device of claim 7 wherein said piston and said bore each have a groove exposed to said annular space and located adjacent their respective shoulders, said grooves being adapted to receive upsets from said deformable sleeve when said sleeve is compressed and thereby lock said piston in said bore.

9. The device of claim 7 wherein said deformable sleeve is united with said piston and said bore has a groove exposed within said annular space adjacent the shoulder of said bore, said groove being adapted to receive an upset from said deformable sleeve when said sleeve is compressed and thereby lock said piston in said bore.

10. A fluid flow control device, adapted to be secured to a container and connected with a conduit, comprising: a housing having a bore therein, means adapted to secure said housing to said container with one end of said bore in proximity to said container, and means spaced

from said one end of the bore adapted to receive and retain explosive actuator means; receptacle means in said housing in communication with said bore at a location spaced longitudinally of the bore from said securing means adapted to house a conduit and to expose a portion thereof within said bore; and a piston slidable in said bore carrying container-opening means and conduit-opening means including a shearing lip with the shearing lip having first and second positions in opposed adjacency to said receptacle means, the latter of said opening means being adapted on actuation of said piston responsive to a said explosive means to at least substantially traverse said receptacle means and sever said conduit and the former of said opening means to open said container to said bore to thereby interconnect said container, bore, and conduit.

References Cited in the file of this patent

UNITED STATES PATENTS

2,205,938	Ward	June 25, 1940
2,419,826	Dodelin et al.	Apr. 29, 1947
2,515,068	Young	July 11, 1950