

Jan. 16, 1968

L. L. FIKE

3,363,801

RUPTURE DISC ASSEMBLY

Filed Dec. 20, 1965

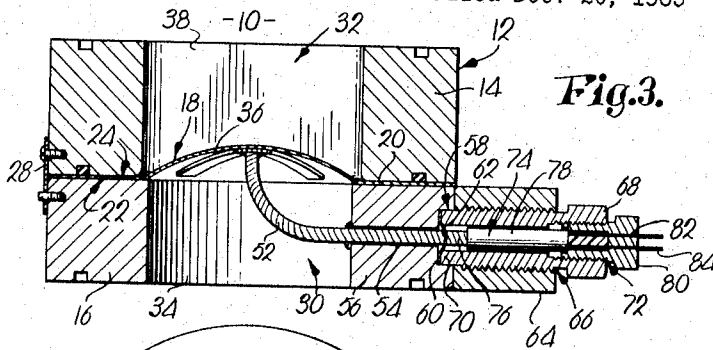


Fig. 3.

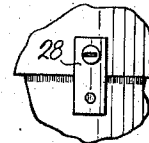


Fig. 5

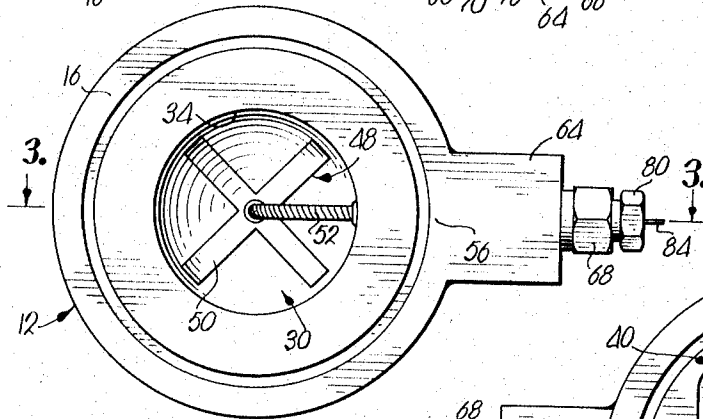


Fig. 2.

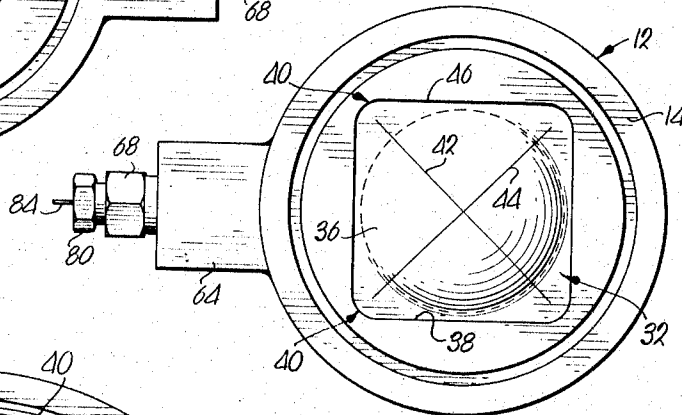
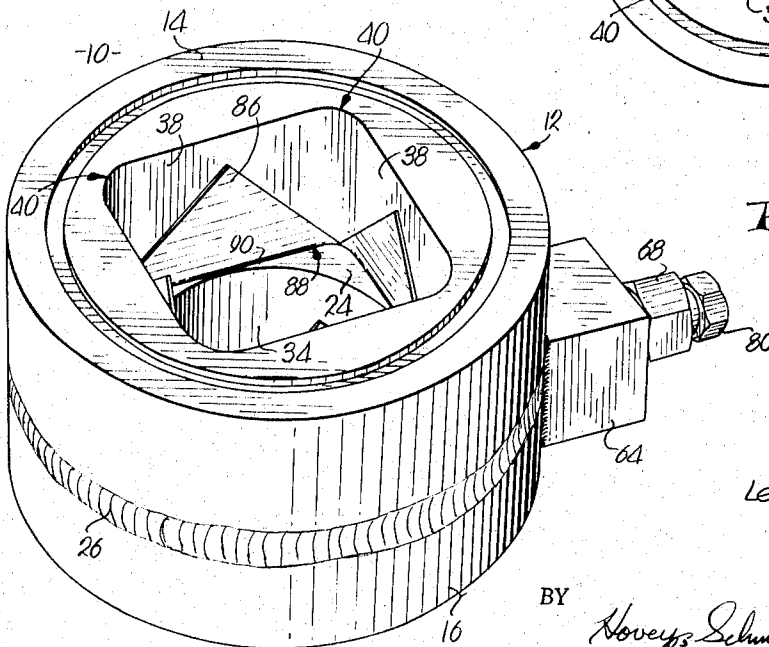


Fig. 4.



INVENTOR
Lester L. Fike

BY

Hovey, Schmidt, Johnson & Hovey
ATTORNEYS

3,363,801

RUPTURE DISC ASSEMBLY

Lester L. Fike, Blue Springs, Mo., assignor to Fike Metal Products Corp., Blue Springs, Mo., a corporation of Missouri

Filed Dec. 20, 1965, Ser. No. 514,855

5 Claims. (Cl. 220-89)

ABSTRACT OF THE DISCLOSURE

A rupture disc has a concavo-convex diaphragm provided with an explosive charge on the concave side thereof aligned with lines of weakness in the diaphragm which divide the latter into four triangular petals when the diaphragm is ruptured. The rupture disc is held between a pair of clamping rings which define a bore in which the diaphragm is thus disposed in closing relationship thereto. The portion of the bore on the convex side of the diaphragm has a square cross-sectional configuration, presenting four walls which, in turn, define four straight edges at the rupture disc along which the petals bend when the diaphragm is ruptured at the lines of weakness.

This invention relates to an improved rupture disc assembly for containing fluid under pressure capable of being ruptured with an explosive, as disclosed, for example, in U.S. Letters Patent No. 3,109,553, issued Nov. 5, 1963.

Prevention of diaphragm disintegration and uncontrolled fracturing has always been a problem in this field. It is virtually impossible to completely eliminate such uncontrolled fracturing and the resultant carrying of fragments of the disc downstream with the high velocity gases with heretofore known rupture disc assemblies. This problem is magnified when an explosive charge is used to cause the fracturing of the disc.

It is, therefore, the primary object of the instant invention to provide a mount for a rupture disc which will cause the latter to bend along certain edges of the mount and thereby eliminate fragmentation of the disc when the latter is ruptured.

It is another important object of the present invention to combine an explosive charge with the disc together with detonators therefor so strategically located as to further eliminate tear and consequent disintegration of the disc into fragments.

Still another object of the instant invention is the provision of a rupturable seal within the detonator train permitting disposition of the explosive charge on the high pressure side of the rupture disc so that the likelihood of collapse of the detonator is eliminated.

In the drawing:

FIGURE 1 is a top plan view of a rupture disc assembly made pursuant to the present invention; FIG. 2 is a bottom plan view thereof; FIG. 3 is a cross-sectional view taken along line 3-3 of FIG. 2; FIG. 4 is a perspective view of the rupture disc assembly showing the diaphragm subsequent to rupture; and FIG. 5 is a fragmentary, detailed elevational view of the registering means for use during the assembling of the rupture disc unit.

Unit 10, which may or may not be in the nature of an explosion device, as will hereinafter appear, is adapted for insertion in a fluid line and includes a body broadly designated by the numeral 12 which includes a pair of interconnected sections or rings 14 and 16. A rupture disc of bendable material, such as stainless steel and broadly designated by the numeral 18, has a peripheral flange 20 clamped between the proximal end faces 22 and 24 of rings 14 and 16 respectively. The interconnection between

the rings 14 and 16 may consist of a surrounding weld 26 which is established after the two rings 14 and 16 are properly aligned through use of a registering or alignment clip 28 as illustrated in FIGS. 3 and 5.

There is a bore 30 through the body 12, presenting bore portions 32 and 34 within rings 14 and 16 respectively, the bore portion 32 normally being the low pressure chamber of the body 12 and the bore portion 30 being the high pressure chamber of the body 12.

The chambers 30 and 32 are separated by the rupture disc 18, i.e. by that portion thereof which traverses the bore 30, and is in the nature of a dome shaped or concavo-convex, central diaphragm 36, shown in FIG. 3 to be entirely contained within the chamber 32.

While the chamber 30 may be circular or cylindrical as illustrated, the chamber 32 is transversely polygonal and may be square as shown to present a plurality of flat walls, that is to say there are four such walls 38 in the ring 14 and a corresponding number of corners 40 which may be curved slightly if so, desired, as best seen in FIG. 4.

A pair of intersecting lines of weakness 42 and 44 extend diagonally across the convex surface of the diaphragm 36 running diagonally between corresponding corners 40. The lines of weakness 42 and 44 may be scored or creased into the diaphragm 36, preferably before forming it into the dome shape illustrated.

It is important to note that the juncture between each flat wall 38 and the inner face 22 of the ring 14 is in the nature of a straight edge 45 which traverses the rupture disc 18 between the dome shaped diaphragm 36 and the outer peripheral flange 20 thereof.

An explosive charge 48 in the form of a plurality of strips 50 of explosive material is secured to the concave surface of diaphragm 36 preferably with strips 50 disposed in direct opposition to and substantially coextensive in length with the lines of weakness 42 and 44. A secondary detonator preferably in the form of an explosive cord 52 is connected to strips 50 proximal to the center of diaphragm 36. Detonator 52 extends downwardly from its point of attachment to strips 50 into chamber 30 and outwardly through a recess 54 provided in wall 56 of ring 16 to terminate in a counterbore 58 provided in the outer surface of ring 16 in fluid communication with recess 54.

The counterbore 58 provides a seat 60 for a rupturable pressure seal 62 of frangible material such as copper. A rupturable seal 62 is disposed in engagement with seat 60 proximal to the outwardly extending extremity of secondary detonator 52 and in overlying, normally closing relationship to recess 54.

A housing 64 with a threaded aperture 66 therethrough is attached to ring 16 with aperture 66 in alignment with counterbore 58. A sleeve 68 is threadably engaged in aperture 66 and has a shoulder 70 which extends into counterbore 58 in engagement with seal 62 to hold the latter in seated relationship within counterbore 58 and in closing relationship with respect to recess 54. Sleeve 68 has a coaxial bore 72 therethrough disposed in fluid communicating alignment with recess 54 but sealed from the latter by member 62.

A primary detonator 74 consisting of a small length of explosive cord 76 disposed adjacent seal 62 and a detonator cap 78 is telescoped into bore 72. A retainer nut 80 is threadably received in bore 72 to hold the primary detonator 74 in position adjacent seal 62. Nut 80 is provided with apertures 82 for the passage of electrical contact wires 84 which are operably coupled with the detonator cap 78 and a suitable source of electrical impulse for use in energizing detonator cap 78.

In operation, diaphragm 36 is disposed in sealing relationship with respect to bore or chamber 30 which is

filled with fluid at a high pressure. Rupturable seal 62 is disposed in sealing relationship with respect to recess 54 which is in fluid communication with chamber 30.

The explosion of detonator cap 78 ignites explosive cord 76 adjacent thereto and to rupturable seal 62. Concussion from the explosion of cord 76 ruptures the rupturable seal 62, and substantially simultaneously detonates the secondary detonator 52. The detonation of the secondary detonator 52 results in the again substantially simultaneous explosion of the explosive charge 48. Concussion from the explosion of the strips 50 of charge 48 results in the rupture of the diaphragm 36 along lines of weakness 42 and 44 which insure the breakage of diaphragm 36 to be accomplished along crossed, straight, clean lines.

As diaphragm 36 is ruptured by the explosive force created by the detonation of charge 48 along lines of weakness 42 and 44, a plurality of triangularly shaped petals 86 are formed. As the petals 86 are continually forced upwardly into bore portion 32 by the force of the explosion, the bases 88 of the petals 86 are thrust against edges 46 and the latter edges are operable to cause a crease 90 at each base 88 of the petals 86 thus causing the latter to be bent evenly around the edges 46 until the petals 86 extend substantially perpendicularly from face 24 of section 14 adjacent walls 38 as best illustrated in FIG. 4.

The force of the pressure of the fluid within chamber 30 supplements the explosive force described above after diaphragm 36 is ruptured along lines 42 and 44 and assists the explosive force in the bending of petals 86 around edges 46 into their positions adjacent walls 38. It is to be noted that bore portion 32 is provided with a transverse dimension somewhat greater than the diameter of bore portion 34 to allow for the petals 86 to open sufficiently to provide a nonrestrictive opening when the petals 86 are bent upwardly into bore portion 32 by the explosive force and the force of the fluid rushing out of the pressure vessel.

Note that the edges 46 are of extreme importance in providing a straight abutment for the petals 86 to bend around as diaphragm 36 ruptures. In the past, rupture disc hold down structures similar to section 14 have been provided with substantially circular bore portions corresponding to bore portion 32 and thus, even when lines of weakness were provided across the diaphragm, the bases of the quadrants formed by the rupturing of the diaphragm were thrust against arcuate abutments resulting in uneven stresses being developed along such bases and causing the quadrants to be torn away from the remaining portions of the diaphragm and hurtled downstream by the force of the escape fluid. The provision of edges 46 eliminates this problem by providing a straight edge adjacent the base 88 of the rupturing petal 86, thereby causing an even bend or crease 90 to occur at the base of the petal thus minimizing the tendency of the diaphragm to tear. It is to be understood that the provision of edges 46 to minimize disintegration and uncontrolled rupturing of the diaphragm 36 is of substantial importance when used in conjunction with a standard rupture disc unit wherein the diaphragm is designed to rupture in response to a preset maximum pressure differential. Additionally, the provision of edges 46 is of extreme importance when a diaphragm 36 is ruptured in response to the explosion of a charge 48 whereby extreme pressure differentials are created across the diaphragm 36.

In previously used rupturable disc assemblies utilizing an explosive force to rupture the frangible member, the explosive charge has been placed on the low pressure side of the frangible diaphragm because it has been difficult to properly seal the entrance way for the detonator means. The detonator devices customarily used to explode high order explosives are sensitive to pressure and must be disposed in a low pressure area. Thus, even

though it is desirable for the prevention of uncontrolled fracturing and disintegration of the frangible diaphragm, to have the force from the explosive charge such as charge 48 acting in the same direction as the pressure force from the high pressure fluid present in a chamber such as 30, this has been impractical in the past because there were no known means for locating the detonator in a low pressure area, and yet have the force of the detonation of that detonator cause the explosion of an explosive charge located in a high pressure area. The novel placement of the rupturable pressure seal member 62 of the present invention provides structure capable of preventing the high pressure fluid from chamber 30 from entering the primary detonator housing 64 during normal conditions and yet capable of responding to the detonation of the primary detonator 74 by rupturing and thus allowing the force of the explosion of the primary detonator 74 to be transmitted to secondary detonator 52 for the instantaneous detonation of explosive charge 48.

It is to be appreciated that the novel structure presented by rupturable pressure seal 62 in conjunction with housing 64, sleeve 68, counterbore 58 and recess 54 is suitable for use whenever it may be desirable to cause the explosion of an explosive charge located in a high pressurized region by external means.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. An explosion device comprising:
 - a body having a chamber adapted to be pressurized;
 - an explosive charge in said chamber;
 - a primary detonator having a housing disposed exteriorly of said chamber;
 - a secondary detonator within said chamber having one end thereof terminating adjacent said charge,
 - said body having a wall into which the secondary detonator extends; and
 - a rupturable pressure seal in said wall,
- the opposite end of the secondary detonator terminating adjacent said seal and the primary detonator being disposed proximal to the seal oppositely to the secondary detonator whereby the detonation of the primary detonator ruptures the seal and detonates the secondary detonator to thereby explode said charge.
2. The invention of claim 1,
 - a rupture disc in the body dividing the chamber into two opposed bore portions, whereby to permit creation of differential pressures on opposite sides of the disc,
 - said charge being in the bore of highest pressure and the secondary detonator extending into the last-mentioned bore,
 - the charge being adjacent the disc for rupturing the latter upon explosion of the charge.
3. The invention of claim 2,
 - said disc being bendable and being provided with lines of weakness disposed to present a number of petals adapted to bend into the other bore when the disc is ruptured along said lines,
 - said body having an edge within the chamber adjacent the disc for each petal respectively across which the latter bend upon rupture of the disc, whereby to prevent the disintegration and uncontrolled fracturing of the disc as a result of the explosion.
4. A unit adapted for insertion in a fluid line, said unit comprising:
 - a rupture disc of bendable material;
 - a body having a pair of sections and a bore through said sections, the latter clamping said disc therebetween with the disc closing the bore,
 - said disc having a concavo-convex diaphragm disposed in said bore,
 - the portion of the bore on the concave side of said diaphragm being of circular cross section and having

5

a diameter substantially equal to the diameter of the diaphragm,
 the portion of the bore on the convex side of said diaphragm being of polygonal cross section, presenting a number of walls defining a plurality of corners and each terminating at the disc in a straight edge spaced from the diaphragm,
 said diaphragm having intersecting lines of weakness therein aligned with said corners and defining a number of petals adapted to bend along said edges toward said walls when the diaphragm is ruptured at said lines and a predetermined pressure differential exists in said portions of the bore.

5. The invention of claim 4,

said portion of the bore on the convex side of the disc being of generally square cross-sectional configura-

6

tion, whereby there are four of said walls, edges and corners,
 the spacing between opposed edges being at least equal to the diameter of the diaphragm,
 said lines of weakness extending between said corners diagonally.

References Cited

UNITED STATES PATENTS

2,712,881	7/1955	Mathisen	220—89
3,005,573	10/1961	Dawson et al.	220—89
3,109,553	11/1963	Fike et al.	220—47
3,184,097	5/1965	Kilmer et al.	220—47
3,196,610	7/1965	Anderson	220—47

15 THERON E. CONDON, *Primary Examiner*.

RAPHAEL H. SCHWARTZ, *Assistant Examiner*.