Aug. 22, 1961 W. W. WILLIAMS 2,997,051

EXPLOSIVE ACTUATED VALVE

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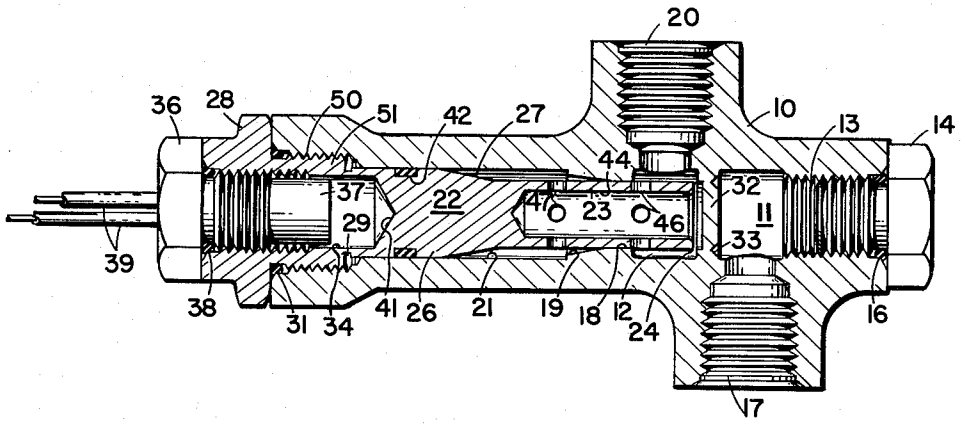


FIG. 1

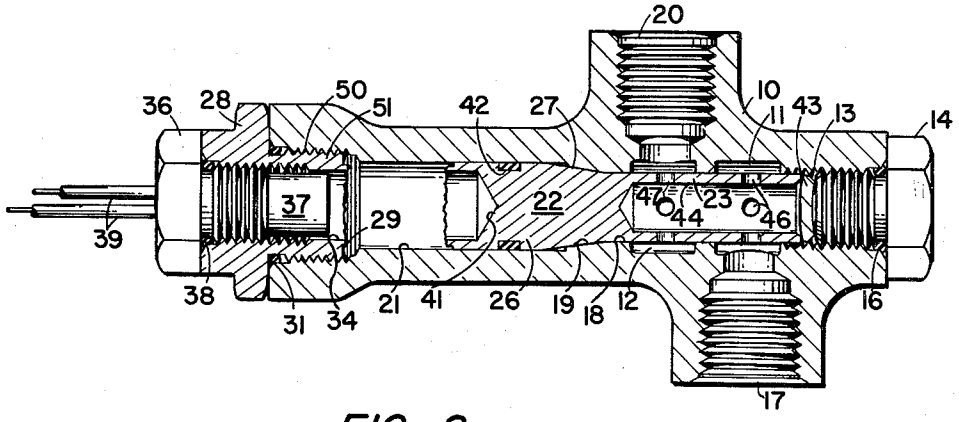


FIG. 2

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EXPLOSIVE ACTUATED VALVE

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This invention relates generally to valves and more particularly to normally closed explosive operated valves.

It is an important object of this invention to provide a new and improved valve which provides complete separation between the inlet and the outlet without depending upon the use of resilient seals or the like when the valve is in its normally closed position and which is operated by an explosive charge to connect the inlet and outlet by rupturing a separating partition therebetween.

It is another important object of this invention to provide an explosive operated valve including a plunger having a frangible section which is fractured by the explosive charge only after sufficient explosive pressure is built up to insure complete operation of this valve.

It is still another object of this invention to provide a new and improved explosive operated valve suitable for use in connection with the storage of fluids at high pressure for long periods of time.

It is another important object of this invention to provide a new and improved explosive operated valve having a diaphragm separating the inlet and outlet, which diaphragm is punched by a hollow punch which insures that fragments therefrom do not pass into the valve outlet.

Further objects and advantages will appear from the following description and drawings, wherein:

FIGURE 1 is a side elevation in longitudinal section showing the valve in its normal closed position; and

FIGURE 2 is a view similar to FIGURE 1 showing the valve at the completion of the operation at which time the inlet and outlet are connected.

A single operation valve, according to this invention, is usually used in connection with the storage of fluids under pressure wherein the storage is for an indefinite period of time and it is essential to prevent any leakage. Such single operation valves require positive operation and find particular application in installations wherein absolute reliability and zero leakage are requirements.

The valve includes a body **10** formed with a cylindrical inlet chamber **11** and an outlet chamber **12**. The inlet chamber **11** is machined in the body **10** by a tool inserted through a threaded opening **13** which is thereafter hermetically closed by a plug **14** and an O-ring seal **16**. The body **10** is also formed with a tapped inlet **17** open to the inlet chamber **11** through which the vessel or system containing fluid under pressure is connected by any suitable fitting. Similarly, a threaded outlet **20** connects to the outlet chamber **12** to provide for a connection to the system to be supplied with the fluid under pressure when the valve is operated.

The outlet chamber **12** connects through a reduced diameter throat **18** to a conical section **19** and a cylindrical bore **21**. A cylindrical plunger or punch **22** is located within the bore **21** and is formed with a hollow forward end of uniform diameter **23** which projects through the throat **18** to the outlet chamber **12** where its end is provided with a sharp cutting or shearing edge **24**. The punch **22** is also formed with a piston portion **26** which closely fits in the cylindrical bore **21** and a conical portion **27** corresponding to the conical section **19** of the bore **21** and adapted to engage and seat itself within that section when the valve is operated. Normally, the plunger conical section **27** is axially spaced from the bore conical section **19** as clearly shown in FIGURE 1. The left end of the bore **21** is enlarged and threaded as at **50**, in which is

screwed the threaded shank **51** of a head or mounting portion **28**. An O-ring type seal **31** assures a fluid tight joint between the mounting portion **28** and the bore **21**. Adjacent to the bottom of the threaded portion **50** of the bore **21**, the plunger **22** is provided wtih an external annular groove **29** constituting a frangible portion, the purpose of which will be explained hereinafter. Thus, it will be understood that normally the plunger **22** is an integral part of the threaded shank **51** of the head or mounting portion **28**.

Normally, the inlet chamber **21** is separated from the outlet chamber **12** by a partition **32** made an integral part of the body **10** and located in alignment with but slightly spaced from the shearing edge **24** of the punch **22**. To insure proper shearing of this partition by the punch as the punch moves to the right as hereinafter explained, the partition is formed with an annular V-shaped groove **33** the inner edge of which is of a diameter substantially equal to that of the punch shearing edge **24** and located co-axially therewith. To insure proper thickness of the partition and accurate alignment of the groove **23** with the shearing edge **24** of the plunger, this partition is preferably produced by a coining type operation wherein a mandrel is positioned against the left side of the partition and a coining die is pressed against the right side thereof to a position accurately spaced from the mandrel to produce a shearing section beneath the groove of a predetermined thickness.

The mounting portion **28** of the punch **22** is formed with a bore **34** which extends through the frangible section **29** which bore, together with the annular groove **29**, determines the thickness of the frangible portion. The outer end of the bore **34** is threaded to receive a squib **36** containing an explosive charge **37**. A static O-ring **38** prevents leakage between the bore **34** and the squib **36**. The squib **36** is provided with ignition wires **39** through which the igniting current passes to set off the explosive charge **37** when the valve is to be operated.

When it is desired to open the valve, the explosive charge **37** is ignited causing a rapid increase of gas pressure within the bore **34** which produces a reaction force on the end of the wall **41** of the bore **34** urging the piston portion **26** of the punch **22** to the right and causes the rupture of the frangible section **29**. In practice, care is exercised to maintain the thickness of this frangible portion to a predetermined dimension, thereby assuring its rupture by the explosion of a given squib **36**. As soon as the frangible section **29** is ruptured, the area of the entire left side of the piston portion **26** is exposed to the pressure of the explosive gases, thus resulting in an effective area equal to the area of the bore **21**. The action of the explosive gases on the piston portion **26** drives the piston to the right and causes the shearing edge **24** to impact and shear the partition **32** out in a single slug **43** defined within the annular groove **33**. This slug is carried by the punch **22** past the inlet chamber **11** into the threaded bore **13** where it is trapped between the end of the plunger **22** and the end of the plug **14**. In practice, the distance between the end of the plunger **22** and the end of the plug **14** is such that the slug **43**, while trapped therebetween, does not limit the forward movement of the plunger. To prevent leakage of explosive gases past the piston portion **26** during its forward travel, a seal **42** is provided on the piston **26** which engages the wall of the bore **21**.

Forward movement of the plunger is limited by the engagement of its conical portion **27** driven into the conical portion **19** of the bore **21**. These two conical portions **19** and **27** are formed with locking angles so that their engagement provides an absolute seal which prevents leakage of the fluid from the outlet chamber **12** past the piston portion **26** and also positively locks the punch **22** into

its forward position and prevents pressure from the inlet and outlet chambers **11** and **12** acting on the front end of the punch to drive it toward the left, thus assuring that the plunger **22** will remain in the open position shown in FIGURE 2 in which position the slug **43** is held between the cutting edge of the plunger and the end of the plug **14** and is prevented from entering the inlet passage of the valve.

The hollow portion **23** of the punch **22** is formed with a first plurality of radial ports **46** which are positioned in the inlet chamber **11** when the valve is operated and a second plurality of ports **47** positioned within the outlet chamber **12** when the valve is operated. Therefore, fluid communication is provided between the inlet chamber **11** and the outlet chamber **12** through the ports **46**, the central passage **44**, and the ports **47**.

Those skilled in the art will recognize that prior to the operation of the valve, leakage cannot take place from the inlet chamber **11** and that positive sealing of the outlet chamber **12** is also provided. Therefore, the system cannot be contaminated by leakage either between the chambers or from the environment into the chambers. Also, by utilizing the frangible section **29** to insure a proper buildup of pressure in the bore **34** before the plunger starts to move, an impact is always developed when the shearing edge **24** engages the partition **32**. Therefore, both kinetic energy of the plunger movement and the force developed by the explosive gases insures that the partition **32** will be sheared by the punch **22**. The various proportions are arranged so that the shearing edge **24** is spaced from the partition **32** prior to the operation of the valve so that this kinetic energy will be available for shearing and also so that the force of the exploded gases will initially all be applied to the frangible section **29** to insure its rupture.

Although a preferred embodiment of this invention is illustrated, it will be realized that various modifications of the structural details may be made without departing from the mode of operation and the essence of the invention. Therefore, except insofar as they are claimed in the appended claims, structural details may be varied widely without modifying the mode of operation. Accordingly, the appended claims and not the aforesaid detailed description are determinative of the scope of the invention.

I claim:

1. A valve comprising a valve body having an inlet chamber and an outlet chamber, a partition wall in said body between said inlet and outlet chambers and sealing said chambers one from the other, a valve element in said body disposed in alignment with said wall, said valve element including a portion formed with an open ended bore terminating in an annular shearing punch disposed adjacent the partition wall, means to impel the valve element towards the partition wall to drive the shearing punch into the wall to pierce the wall with the portion of the valve element including the bore extending to opposite sides of the wall and into each of the inlet and outlet chambers, and ports in said valve element providing communication from said outlet and inlet chambers to said bore for flow from said inlet passage through the bore to said outlet passage.

2. A valve comprising a valve body having an inlet chamber and an outlet chamber, a partition wall in said body between said inlet and outlet chambers and sealing said chambers one from the other, a valve element in said body disposed in alignment with said wall, a mounting portion for said valve element engaged with the valve body and securing the valve element in the valve body, a frangible section integrally formed with the valve element and the mounting portion and securing the valve element to the mounting portion, said valve element including a portion formed with an open ended bore terminating in an annular shearing punch disposed adjacent the partition wall, means to impel the valve element towards the partition wall and fracturing the frangible section to drive the shearing punch into the wall to pierce the wall with the portion of the valve element including the bore extending to opposite sides of the wall and into each of the inlet and outlet chambers, and ports in said valve element providing communication from said inlet and said outlet chambers to said bore for flow from said inlet passage through the bore to said outlet passage.

3. A valve comprising a valve body having an inlet chamber and an outlet chamber, a partition wall in said body between said inlet and outlet chambers and sealing said chambers one from the other, a valve element in said body disposed in alignment with said wall, a mounting portion for the valve element engaged with the valve body and mounting the valve element in said body, a frangible section integrally formed with the valve element and the mounting portion and securing the valve element to the mounting portion, said mounting portion including an explosion chamber adapted to receive an explosive device to be mounted therein, said valve element including a piston portion forming one wall of the explosion chamber, said valve element including a portion formed with an open ended bore terminating in an annular shearing punch disposed adjacent the partition wall, an explosive device in the explosion chamber for impelling the valve element towards the partition and fracturing the frangible section to drive the shearing punch into the wall to pierce the wall with the portion of the valve element including the bore extending to opposite sides of the wall and into each of the inlet and outlet chambers, and ports in said valve element providing communication from said inlet and said outlet chambers to said bore for flow from said inlet passage through the bore to said outlet passage.

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