EXPLOSIVE ACTUATED VALVE

FIG. 1

FIG. 2

INVENTOR.
WILLIAM WARREN WILLIAMS
BY
ATTORNEY
EXPLOSIVE ACTUATED VALVE

William Warren Williams, Smyrna, Ga., assignor, by mesne assignments, to Pneumo Dynamics Corporation, Cleveland, Ohio, corporation of Delaware

Filed Nov. 20, 1958, Ser. No. 775,281

3 Claims. (Cl. 137—68)

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 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 bore 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 driven into 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 with 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 laterally shorter than the outer edge 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 33 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 plunger 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 conical 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 thinness 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 outlet chamber 12 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 edges 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 be all 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, 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 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 said 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.

References Cited in the file of this patent

UNITED STATES PATENTS

81,027 Stubbins Aug. 11, 1868
1,482,211 Bailie Jan. 29, 1924
2,515,068 Young July 11, 1950
2,557,448 Mathisen June 19, 1951
2,638,167 Jones May 12, 1953
2,815,698 Burrows Dec. 10, 1957
2,815,882 Connell Dec. 10, 1957