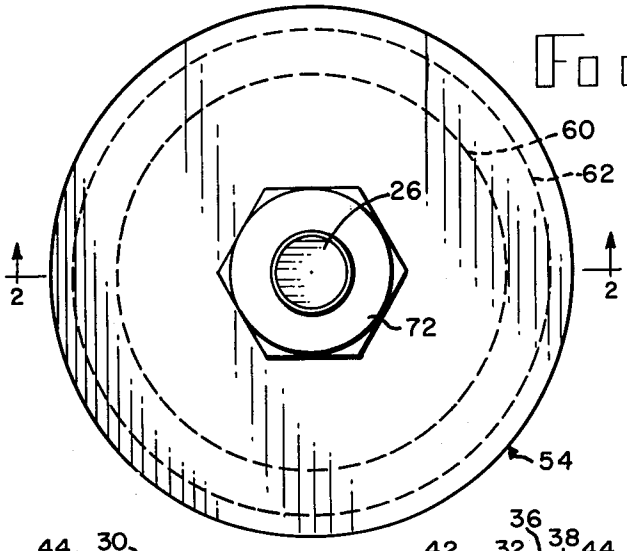
Oct. 9, 1962 O. L. SUTTON ET AL 3,057,372

MUD PUMP VALVE

Filed Sept. 9, 1960

FIG. 1



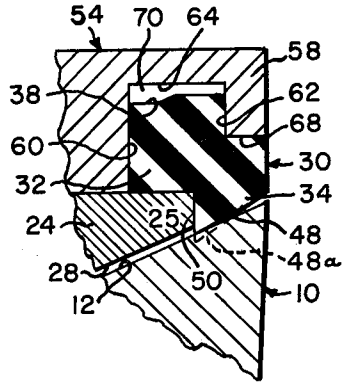


FIG. 3

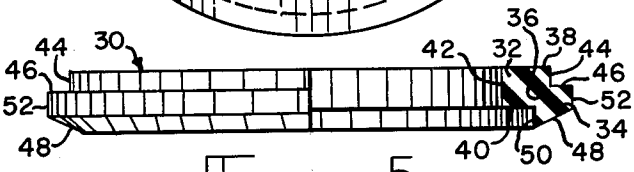


FIG. 5

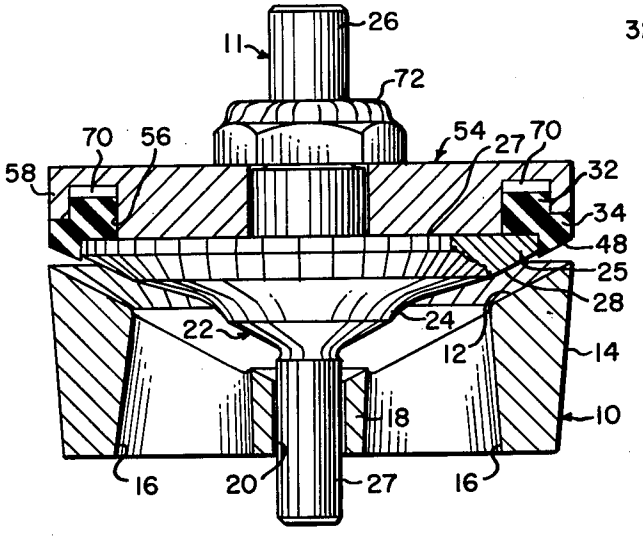


FIG. 2

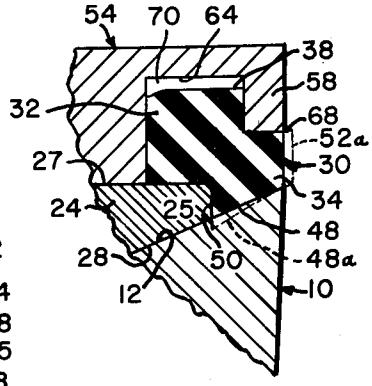


FIG. 4

ORVAL L. SUTTON
VINCIL W. McQUARY
INVENTORS

BY Joseph W. Holloway
ATTORNEY

United States Patent Office

3,057,372

Patented Oct. 9, 1962

3,057,372

MUD PUMP VALVE

Orval L. Sutton, Palmyra, Mo., and Vincil W. McQuary, Quincy, Ill., assignors to Gardner-Denver Company, a corporation of Delaware

Filed Sept. 9, 1960, Ser. No. 55,085
1 Claim. (Cl. 137—516.29)

This invention relates generally to improved valves adapted for use in handling fluids containing abrasive solid material, and particularly relates to an improved closure means for such valves.

In oil well drilling applications, valves of the aforesaid general character are used in pumps intended to circulate a fluid mixture, commonly called "drilling mud," in the well for the purpose of flushing drill cuttings from the bottom of the hole. Such drilling mud is laden with solid particles which produce abrasive wear of metallic valve surfaces over which the mud flows. Furthermore, the operating pump pressures required to circulate mud in the aforesaid manner in deep well applications are extremely high with the result that the pump valves are operated with great speed and force. The combined effects of abrasive wear and of mechanical impact upon the valve members frequently damage metallic sealing surfaces of the valve to such an extent that, in the closed condition, the valve fails to interrupt fluid flow therethrough. One means devised for forestalling such valve failure is the provision of a resilient sealing body or insert mountable upon one or the other or both the engaging metallic members of the valve, i.e. a stationary valve seat and a movable valve bumper. Such a resilient sealing body may comprise an annulus of rubber or equivalent material. In high-pressure valves of the aforesaid character, it is common practice to provide metal to metal contact between a portion of the surfaces of the seat and the bumper; therefore, the sealing body engages only the remaining portion of an oppositely arranged metallic surface. It is also common practice to mount the sealing body so that sealing contact between the body and an oppositely arranged surface is completed well in advance of complete closure of the valve bumper, i.e. prior to metal to metal contact between the seat and the bumper.

It will be obvious that the above-described coaction of the resilient insert with a metallic seating surface will be available only so long as the insert retains substantially its original shape and size and maintains its original assembled relationship with respect to the valve seat and the bumper. It has been observed that inserts having typical configurations and constructed of various known resilient materials may fail to meet the above conditions of continued operativeness; and, in fact such inserts often fail to perform their intended function after relatively short periods of operation. Observation of inserts removed from conventional valves, after periods of continuous operation which have induced insert failure, show that the inserts have been deformed to such a degree that they fail to provide fluid-tight sealing action. Such failure of the insert frequently produces such abrasive pitting and cutting of the seat and bumper that replacement of the entire valve is required. Experimentation to determine the cause of such failure has revealed that the type of resilient insert which is typically carried near the periphery of the bumper or the seat is subjected to deforming compression sufficient to extrude a portion of the insert material between the bumper and seat to the exterior of the valve assembly. The portion of the insert so extruded may become stressed beyond its elastic limit and may be embrittled to such an extent that it mushrooms and rapidly disintegrates. Since this extruded portion of the insert will normally include the aforementioned portion intended to initially engage an opposite metallic surface, the insert must be replaced if the advantages afforded thereby are to be restored.

Therefore, the broad object of the present invention is the provision of an improved resilient sealing structure for a mud pump valve which will solve the various problems above set forth.

Another object is to provide an improved valve structure having a resilient sealing body which is favorably prestressed as an incident to assembling the valve.

Another object is to provide a valve structure of the aforesaid type which is characterized by ease of manufacture and repair, low initial cost and flexibility of use.

For the attainment of the above-stated general objects and other more detailed objects which will hereinafter appear, the invention contemplates the provision of a valve comprising a tapered annular valve seat, an annular valve bumper adapted for reciprocating movement relative to said seat and having an oppositely tapered surface providing sealing engagement with an inner portion of the tapered valve seat, a resilient annular insert compressively held about the outer periphery of the bumper by a clamping plate or disc whereby the insert deformably engages the outer portion of the seat in the closed and partially closed condition of the bumper, and the insert is spaced from the clamping plate in such a manner as to define a chamber therebetween for receiving the elastic flow of insert material produced by deformation of the latter thereby preventing destructive extrusion or squeezing of the insert between the seat and the clamping plate.

In the accompanying drawing a practical embodiment illustrating the principles of the invention is shown, wherein:

FIGURE 1 is a top plan view of a valve constructed in accordance with the present invention;

FIG. 2 is a view partly in side elevation and partly in vertical section taken along lines 2—2 of FIGURE 1;

FIG. 3 is a fragmentary sectional view illustrating the details of a portion of the valve shown in FIG. 2;

FIG. 4 is a view similar to FIG. 3; and

FIG. 5 is a side view partly in elevation and partly in section of a resilient sealing insert shown in FIGS. 2, 3 and 4.

Referring to FIG. 2 of the drawing, the illustrative valve structure generally comprises a valve seat **10** and a valve closure assembly **11** including a bumper **22**, a clamping plate **54**, a resilient insert **30** disposed between the bumper and the plate, and a nut **72** for securing the plate, the insert and the bumper in the illustrated assembled relationship.

As best seen in FIG. 2, the valve seat **10**, which is preferably made of hardened steel or an equivalent metal, comprises a generally cylindrical body having an inverted conical seating surface **12** formed thereon. The outer cylindrical wall **14** of seat **10** is suitably tapered to provide a driving fit with an interfitting aperture in a pump cylinderhead (not shown) or the like. A plurality of radially spaced openings **16** extend longitudinally through seat **10** to provide a path for flow of fluid therethrough when the valve is in the open condition, as shown in FIG. 2. The openings **16** are defined in part by a spider **18** which is provided with a central opening **20** in which the lower stem **27** of the bumper **22** is slidably journalled for rectilinear reciprocation.

The bumper **22** generally comprises an inverted frustoconical head **24** having an upper stem portion **26** and a lower stem portion **27** extending normally therefrom in opposite directions. The lower tapered surface of head **24** includes a conical seating surface **28** which is adapted for mating engagement with surface **12** of valve seat member **10** when the valve assembly **11** is operated to its closed position, shown in FIG. 4. The surfaces **12** and **28** provide metal to metal contact therebetween which is effec-

tive for substantially interrupting flow of fluid through apertures 16 and over seating surface 12 as the bumper 22 is urged to its lower limiting position. The instant type of valve may be required to handle fluid mixtures laden with abrasive solid particles; and, frequently these particles, when entrapped between the metallic surfaces 12 and 28, prevent complete closure of the valve and permit high pressure leakage between these surfaces. Such leakage flow of abrasive fluid may erode the mating surfaces of the bumper and the seat with the result that these originally smooth surfaces become roughened and incapable of maintaining a seal. To eliminate such leakage and the resulting erosion of the seat and bumper members, it has been found desirable to provide sealing means for effecting a positive, fluid-tight seal, not withstanding incomplete closure of the bumper 22 against seat 10 due to entrapment of solid particles therebetween. This essential aspect of the present invention is accomplished in the illustrated embodiment of the invention by the provision of an improved valve closure assembly 11 including a resilient sealing member 30 adapted for sealing engagement with surface 12 of seat 10.

The sealing insert 30 preferably comprises an annulus formed from resilient material such as rubber, urethane or an equivalent material which resists abrasion and is elastically flowable under pressure. As best seen in FIG. 5, one embodiment of insert 30 may comprise inner and outer stepped annular portions 32 and 34, respectively, which are joined by an integral neck portion 36. Inner portion 32 is provided with parallel upper and lower walls 38 and 40, respectively, and parallel inner and outer side walls 42 and 44, respectively. Outer portion 34 is provided with an upper wall 46, a sloping lower wall 48, and parallel inner and outer walls 50 and 52, respectively.

As shown in FIGS. 2, 3 and 4, insert 30 is coaxially mounted about the head 24 of bumper 22 in surrounding relationship thereto. More particularly, an annular shoulder 25 of head 24 is tightly engaged by insert surfaces 40 and 50. When properly assembled with head 24, the sloping surface 48 of the outer portion 34 of insert 30 projects downwardly beyond surface 28 of the head. As clearly shown by broken lines 48*a* in FIGS. 3 and 4, the downward slope of insert surface 48 is greater than that of head surface 28 and seat surface 12 for a purpose to be described.

A clamping disc or plate 54, preferably composed of metal or like rigid material, is coaxially disposed about the upper stem 26 of bumper 22 and overlies the valve head 24 and insert 30. Plate 54 is retained upon stem 26 by a nut which threadably engages an intermediate portion of stem 26. An annular recess 56, partially defined by a downwardly depending flange 58, is formed in the plate 54 near its outer periphery to receive insert 30, as shown in FIG. 2. Recess 56 is provided with inner wall 60, an outer wall 62 and an upper wall 64. Flange 58 is provided with a bottom surface 68. As shown in FIG. 2, for example, the inner portion 32 of insert 30 is substantially disposed in recess 56 while the outer portion 34 thereof projects outwardly between the shoulder 25 of the head 24 and the flange 58 toward surface 12 of seat 10. The vertical dimensions of recess 56 and the inner insert portion 32 are such that an annular chamber or void 70 is provided between the upper insert surface 38 and the oppositely arranged recess wall 64 for a purpose to be explained.

An important aspect of the present invention is the provision of an insert clamping means which will compress the outer insert portion 34 tightly against the engaging surfaces of shoulder 25 of bumper head 24. This aspect of the invention is accomplished by arranging recess 56 and flange 58 with respect to insert 30 to concentrate the downwardly exerted compressive forces of the clamping plate upon the outer periphery of insert portion 34. As nut 72 is turned down to tighten plate 54 against surface 27 of the head 24 during assembly of the closure assembly 11, the insert 30 will be clampingly engaged by flange 58 and compressed against head 24 of bumper 22. More particularly, surface 68 of the flange will seat upon the mating insert surface 46, and, at no other point, does plate 54 compress the insert. If the vertical dimension between surfaces 40 and 46 of the insert is greater than the vertical distance between flange surface 68 and the flat upper surface 27 of head 24, the clamping action of plate 54 will compress insert portion 34 downwardly and radially inwardly against shoulder 25 of head 24. Such prestressing of insert 30 as an incident of assembling the valve assembly 11, insures a tight fit between surface 50 of the insert and shoulder 25. Unless a substantially fluid tight seal is maintained along surface 50, fluid-carried solid particles may become lodged in this area to permanently separate the insert 30 from the head 24. Such separation permits additional pressure fluid to impact surface 50, with the result that insert portion 34 may be deformed outwardly between seat 10 and flange 58. Such outward deformation of the insert, if permanent, would destroy the intended orientation of the insert sealing surface 48 with respect to the seating surface 12, and would, accordingly, reduce the efficiency of the resilient seal therebetween.

As previously stated, the function of insert 30 is to provide a fluid-tight seal with seat surface 12 even though the bumper head 24 may not attain full closure with respect to seat 10 due to the entrapment of solid particles therebetween; therefore surface 48 of insert portion 34 is adapted to sealably engage seat surface 12 well in advance of full closure of the head 24. FIGS. 3 and 4, which show the uncompressed condition of insert surface 48 by broken lines 48*a*, demonstrate that surface 48 progressively engages surface 12 as the bumper head 24 moves from a partially closed position (FIG. 3) to a fully closed position (FIG. 4). Obviously, the projecting outer portion of insert 30 is deformed by compressive engagement with the seat 10, and elastic flow of displaced insert material will result. Unless some internal receptacle is provided for elastic flow of the displaced insert material, the latter may be squeezed or extruded between seat 10 and flange 58 in a manner diagrammatically illustrated in FIG. 4 by broken line 52*a*. As stated earlier such extrusion of the insert material upon closure of the valve may produce rapid embrittlement and deterioration of the insert material. On the other hand, the present invention provides an internal chamber into which the flow of elastically deformed insert material may be directed and contained without permanently deforming the insert material. This essential aspect of the present invention is accomplished by providing the annular chamber 70 between the extreme upper surface 38 of insert 30 and the downwardly facing upper wall 64 of recess 50. The purpose of the annular chamber 70 is to receive that portion of insert 30 which is elastically deformed and caused to flow thereinto by an upward and inward pressure force exerted upon surface 48 of the insert as the valve is operated to its partially closed condition, illustrated in FIG. 3, and the fully closed condition, illustrated in FIG. 4. As shown in FIG. 3, the inner portion of the surface 48 has been displaced or compressed upwardly by surface 12 of valve seat 10 and has produced an upward deformation of the outer insert portion 34, which in turn has caused an upward flow of the inner insert portion 32 into the upper right hand portion of chamber 70. As the deformation of insert 30 is increased to its maximum, as shown in FIG. 4, elastic flow of the insert material will fill the chamber 70 approximately as shown in FIG. 4. As the valve is operated to the open condition shown in FIG. 2, the material displaced into chamber 70 will flow downwardly and outwardly therefrom until the insert 30 assumes its original shape as shown in FIG. 2. Thus it is seen that the sealing force exerted upon the lower surface 48 of insert 30 causes the material to flow upwardly and inwardly be-

tween flange **58** and shoulder **25** of head **24** into the chamber **70** rather than being extruded or squeezed outwardly to the periphery of the valve to assume a position indicated generally by broken lines **52***a* shown in FIG. 4.

It is desirable that the volume of chamber **70** be sufficiently great to more than accommodate maximum displacement of insert material thereinto when the valve ports are new and have their original dimensions. The reason for this is that wearing of the metallic seating surfaces **12** and **28**, incident to normal operation of the valve, will cause surface **28** to recede upwardly; therefore, a greater portion of insert **30** will be compressed and deformed upwardly into chamber **70**. If such provision is not made, the volumetric increment of the insert which must now be compressed upon valve closure will be extruded outwardly between flange **58** and the seating surface **12**.

It will be understood that the above description and accompanying drawings comprehend only a general and preferred embodiment of the improved valve closure assembly **11** and that various changes in construction, proportion and arrangement of the various elements thereof may be made without sacrificing any of the enumerated advantages of the invention.

What we claim as new and useful and desire to protect by United States Letters Patent is:

In a fluid valve, in combination: valve seat means;

valve closure means including a bumper seatable on said seat means and an independent clamping plate coaxially disposed with respect to said bumper and axially abutting the same; an elastically deformable body mounted upon one of said means for fluid sealing engagement with the other of said means; chamber means defined by said body and an annular recess in said plate; said chamber means being remotely spaced from the path of fluid flow through said valve and having volumetric capacity greater than the elastic displacement of said body when said valve is closed; said body being axially clamped between said bumper and said plate; and, said body having a stepped portion being clampingly restrained in fluid-tight engagement with said bumper by a peripheral flange of said plate which seats upon said stepped portion in mating relationship therewith.

References Cited in the file of this patent

UNITED STATES PATENTS

2,107,200	Kennon	Feb. 1, 1938
2,260,381	Kennon	Oct. 28, 1941
2,285,343	Marchand	June 2, 1942
2,417,494	Hoof	Mar. 18, 1947
2,678,187	Peters	May 11, 1954
2,929,401	Cowan	Mar. 22, 1960