

May 25, 1937.

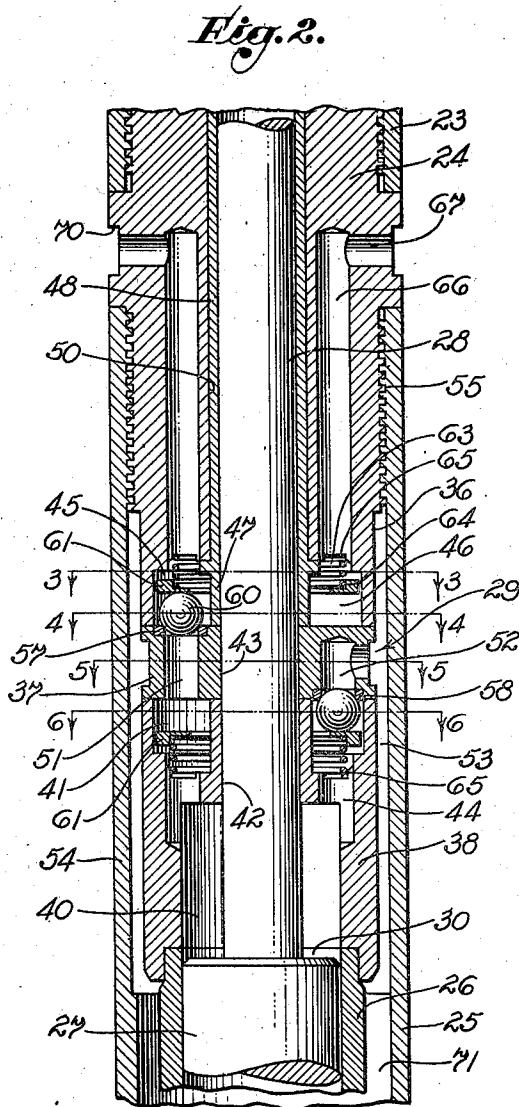
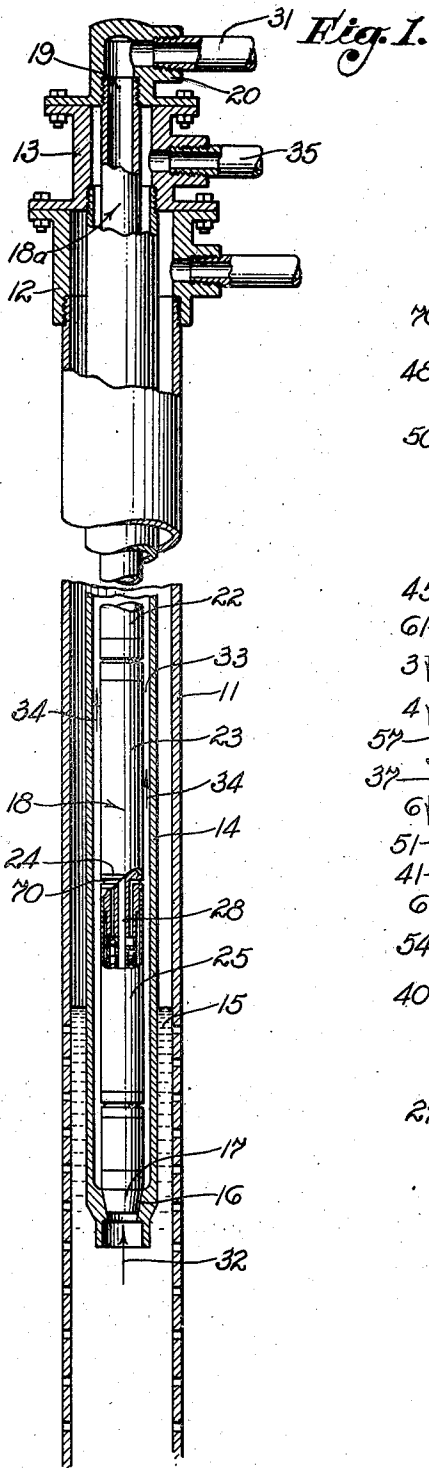
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2,081,222

VALVE FOR FLUID OPERATED PUMPS

Filed April 11, 1934

2 Sheets-Sheet 1



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Fig. 3.

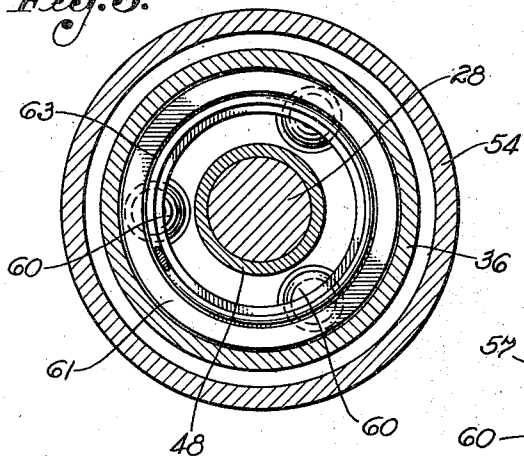


Fig. 4.

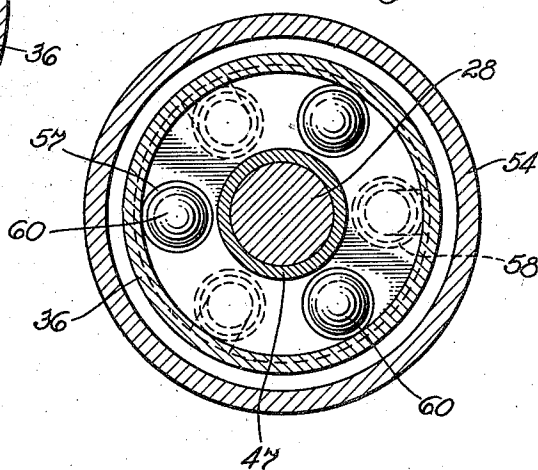


Fig. 5.

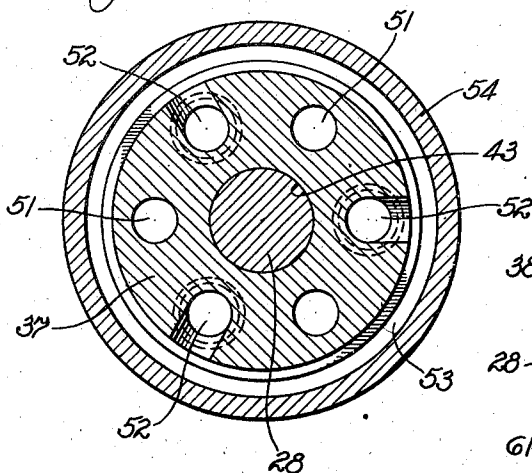
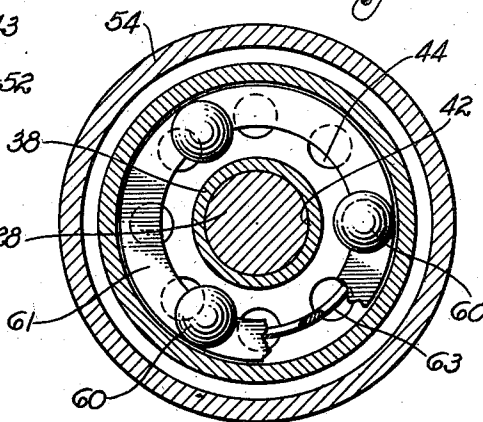


Fig. 6.



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VALVE FOR FLUID OPERATED PUMPS

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Application April 11, 1934, Serial No. 720,060

16 Claims. (Cl. 103—230)

My invention relates in general to check valve devices and relates in particular to a check valve structure especially suited for use as intake and discharge valves for pumps.

5 The invention has especial utility with pumps which must be designed so as to operate in a restricted space, such as the interior of a pipe at the bottom of a well. In the present methods of drilling oil wells it is necessary to reduce the size
10 of the casing as the well deepens, so that very often the casing at the bottom of a well is of such small diameter that the production tubing used may be $2\frac{1}{2}$ " or less in diameter. To pump oil from the bottom of such a well requires the
15 use of a pump which will pass into the small diameter piping at the bottom of the well. Since my invention is at present used in a fluid operated pump of the general character shown in my copending application Serial 623,171, filed July
20 18, 1932, entitled "Liquid operated pump", it is believed that the restriction of the hereinafter disclosure of the invention to use with a pump of this character will be fully representative of the general utility of the invention. Pumps of
25 the general character to which my invention is best suited employ a pumping cylinder in which a piston is reciprocated by means of a piston rod actuated from a point exterior of the pumping cylinder by a power device which generally consists of a power piston working in a power cylinder.

An object of the invention is to provide a check, or intake and discharge valve structure, which will operate efficiently but which may be designed
35 so as to occupy a minimum space. In view of the fact that the fluid pumped through this valve structure may contain materials which tend to deposit and clog, such, for instance, as fine silt, sand, etc., contained in oil which is pumped from
40 a well, it is necessary that the valve structure be of such character that the passages thereof will be continuously washed by the passage of fluid therethrough and will not be so formed as to encourage the accumulation of clogging materials therein.

It is a further object of the invention to provide a valve structure of the above character which will be simple in construction and very durable
50 or at least of such durability that it will last as long as the other working parts of the pump, so that premature pulling of the pump will not be necessitated by valve failure.

It is a further object of the invention to provide a valve device which will occupy an annular space
55 at the end of a small-diameter cylinder and around the piston rod which projects from the cylinder.

It is a further object of the invention to provide a simple valve structure in which a plurality of
60 valve closure members, such, for instance, as

balls, and a simple means for resiliently forcing the ball members into positions of engagement with their respective seats, are provided.

It is a further object of the invention to provide a valve structure which will contribute to simplicity in the construction of a slender deep well
5 pumping apparatus such as described hereinabove.

Further objects and advantages of the invention will be brought out in the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a partly sectioned utility view showing a fluid operated pump with which a preferred embodiment of my present invention is of especial
15 value.

Fig. 2 is an enlarged fragmentary section of that portion of the pump of Fig. 1 containing one of the valve structures.

Fig. 3 is a slightly enlarged cross-section on a plane represented by the line 3—3 of Fig. 2.

Fig. 4 is a slightly enlarged cross-section on a plane represented by the line 4—4 of Fig. 2.

Fig. 5 is an enlarged cross-section taken as indicated by the line 5—5 of Fig. 2.

Fig. 6 is an enlarged cross-section taken as indicated by the line 6—6 of Fig. 2.

In Fig. 1 I show piping 11 which extends downwardly from a casing-head 12 to the oil
30 producing formation of a well. From a fitting 13 forming an intermediate part of the casing-head 12 oil discharge piping 14 extends downwardly through the piping 11 into the body of oil
35 15 in the lower portion thereof. The lower end of the discharge piping 14 is equipped with a seat 16 adapted to receive the lower end fitting 17 of a fluid operating pump 18 which is lowered into the oil discharge pipe 14 by means of pressure fluid delivery piping or "macaroni" 18a, the upper end
40 19 of which connects to the cap member 20 of the casing-head 12.

The pump 18, interior details of which do not form a part of the present invention, comprises an upper motor section 22 including a power cylinder 23 which is connected by means of a plug
45 24, Figs. 1 and 2, with a pumping cylinder 25. As shown in Fig. 2, the pumping cylinder is equipped with a liner 26 in which a pump piston 27 is reciprocated by means of a piston or connecting rod 28 which extends downwardly from the power cylinder 23, through the plug 24 and a valve structure 29, into the interior space 30
50 of the cylinder 25. The operation of the pump 18 is accomplished as follows: Fluid, such as clean oil under pressure, is delivered to the cap member 20 through piping 31, and such fluid, at relatively high pressure, passes downwardly through the pressure fluid delivery piping 18a, to be delivered into the motor section of the pump where
60

the pressure thereof is employed in such a manner that vertical reciprocation of the piston rod 28 results. Such reciprocating motion is transmitted to the pumping piston 27, with the result that oil is drawn from the body 15 thereof through the lower end of the pump, as indicated by the arrow 32 of Fig. 1, and is pumped into and upwardly through the space 33 within the oil discharge pipe 14, as indicated by arrows 34, to be finally delivered from the well through oil discharge piping 35 which leads from the fitting 13 of the casing-head 12.

As shown in Fig. 2, the valve structure 29 comprises a wall or section 36 disposed at the lower end of the plug 24, a valve plate 37 which rests against the extreme lower end of the plug 24, and a member 38 which is held against the upper end of the liner 26 forming a part of the pumping piston and which serves as a wall for closing the upper end of the cylinder space 30. The member 38 is of cylindrical form and includes a cavity 40 in the lower portion thereof which serves as the extreme upper end of the interior space of the pumping cylinder 25. The upper end of the member 38 has an annular channel 41 therein concentric to a bore 42 through which the piston rod 28 passes. This channel 41 forms a valve recess which confronts the lower face of the valve plate 37 which is also cylindrical in form and has an opening 43 therethrough for passage of the piston rod 28. A plurality of passages 44 connect the annular channel or recess 41 with the cavity 40 forming the upper extremity of the interior space 30 of the pumping cylinder 25.

The wall 36, disposed at the lower end of the plug 24, has a counterbore 45 therein which is transformed into an annular channel or recess 46 by the lower end portion 47 of a liner 48 which is secured in the bore 50 of the plug 24. The recess 46 confronts the upper face of the valve plate 37 which is provided with ports or passages 51 and 52. The passages 51 are co-axial and connect the recess 41 with the recess 46. The passages 52 are L-shaped and connect the recess 41 with the annular space 53 which exists around the valve structure 28 and within a tubular wall 54 which extends from the pumping cylinder 25 to the plug 24. This wall 54 is preferably integrally formed with the cylinder 25 and has threads 55 for connecting it to the lower portion of the plug 24.

In the preferred practice of the invention there are three passages 51 and three passages 52, each group of passages being substantially equally spaced on a circle, or, in other words, spaced so as to define the points of equilateral triangles, and the passages 51 are preferably disposed intermediately between the passages 52, as best shown in Fig. 5. The upper ends of the passages 51 are provided with valve seats 57 comprising rings of hard metal, such as tungsten carbide, and the lower ends of the passages 52 are likewise provided with seats 58 of the same character. In each of the recesses 46 and 41 valve closure members consisting of hard metal balls 60 are placed in positions to cooperate with the seats 57 and 58. The balls 60 are resiliently forced toward their respective seats 57 and 58 by means of a pair of rings or plates 61, one of which is placed in each recess 46 and 41. With respect to the valve seats, the rings 61 engage the rearward portions of the valve closure members 60 and are forced toward the valve plate 37 by means of helical or spiral springs 63 which

preferably have a diameter slightly greater than the internal diameters of the rings 61. The inner ends of the springs 63 engage internal shoulders 64 on the rings 61 so as to hold such rings approximately centralized with respect to the springs, and the outer ends of the springs are seated in channels 65 formed in the members 36 and 38, in such a manner that the springs are held concentric to the piston rod 28. The plug 24 has co-axial passages 66 which extend upwardly from the recess 46 and at their upper ends connect with radial openings 67 disposed on the medial transverse plane of the plug 24 and communicating with an external channel 70 in the plug 24 which is exposed to the space 33 within the oil discharge piping 14. The pumping cylinder 25 is provided with oil transfer passages 71 through which oil to be pumped is carried upwardly from the interior of the lower fitting 17, Fig. 1, to the annular space 53 existing around the valve structure 28. During the downward stroke of the piston 27 oil is drawn in from the space 53 through the passages 52, the balls 60 of the recess 41 being thereby moved downwardly from their seats. When the piston subsequently moves upwardly, the passages 52 are closed, and the discharge oil is forced upwardly through the passages 44, the recess 41, and the passages 51 into the recess 46, from whence the oil passes through the passages 66 into the space 33 exterior of the pump structure, through which space it is conducted to the top of the well.

The upward movement of the rings 61 is limited so that the balls 60 cannot be lifted to such an extent that they may be moved laterally out of position for engagement with the seats 57. This limitation of the movement of the rings 61 may be accomplished in different manners, for example, by engagement with a shoulder or by making the springs 63 so that they will not compress more than a certain distance. The valve balls 60 are disposed in three-point engagement with the rings 61 so that these rings 61 will be at all times in engagement with all of the balls 60. Also, the springs 63 are so formed that the rings may have a rocking or universal movement, which contributes to the three-point engagement with the balls 60 to the effect of holding all of the balls resiliently in engagement with their respective seats. This cannot be accomplished by use of four balls without extremely accurate machining of the various parts involved, and the proper condition of operation would soon become disturbed should one of the balls or its cooperating seat wear faster than the others. The parts 36, 37, and 38 of the valve structure are held in end-to-end, or face-to-face engagement by pressure derived from tension in the tubular wall 54. In the assembling of the parts of the pump shown in Fig. 2, the wall 54 is heated before it is finally screwed up tightly on the plug 24. The shrinkage of the wall 54, upon cooling thereof, forces the parts 26, 36, 37, and 38 into end-to-end engagement with ample force to provide fluid-tight joints between them.

Although I have herein shown and described my invention in simple and practical form, it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be used in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention is not to be limited to the

details disclosed herein but is to be accorded the full scope of the following claims.

I claim as my invention:

1. A valve device of the character described, including: walls forming an annular chamber, there being fluid passages leading from said chamber; an end wall for said chamber having three substantially equally spaced valve ports therein communicating with said annular chamber; three ball members within said chamber, each being disposed in a position to close one of said ports and projecting a distance thereinto; means for resiliently forcing said ball members toward said ports, comprising a ring member encircling said chamber and engaging said ball members, and resilient means urging said ring member toward said ball members and means for limiting the outward movement of said ring member to less than said distance.

2. A valve device of the character described, including: walls forming an annular chamber, there being fluid passages leading from said chamber; an end wall for said chamber having three substantially equally spaced valve ports therein communicating with said annular chamber; a like number of closure members within said chamber, each being disposed in a position to close one of said ports; and means for resiliently forcing said closure members toward said ports, comprising a ring member encircling said chamber and engaging said closure members, and a coil spring circling said chamber behind said ring member and forcing said ring member toward said closure members.

3. A valve device of the character described, including: walls forming a chamber, there being fluid passages leading from said chamber; an end wall for said chamber having three ports communicating with said chamber, said ports being disposed so as to form a triangle; three closure members within said chamber, each being disposed in a position to close one of said ports and projecting a distance thereinto; means for resiliently forcing said closure members toward said ports, comprising a ring member disposed in parallel relation to said end wall of said chamber and resting against the rearward portions of said closure members, and resilient means urging said ring member toward said ports so as to move said closure members into closing relation thereto and means for limiting the outward movement of said ring member to less than said distance.

4. A valve device for a pump of the character described, having walls forming a cylinder, and a piston rod projecting from said cylinder, comprising: a wall closing the end of said cylinder, there being an opening in said wall through which said piston rod passes, and an annular channel in said wall around said piston rod forming a valve chamber having passages connecting with the interior of said cylinder; an end wall closing the outer end of said chamber, said end wall having three valve ports therein connecting with said chamber; a plurality of closure members in said chamber one each of which cooperates with one of said valve ports; and a spring pressed ring in said chamber forcing said closure members toward said ports.

5. A valve device for a pump of the character described, having a cylinder, a piston in said cylinder having a projecting piston rod, a tubular wall extending from said cylinder, and a plug in the end of said tubular wall, including: a wall member for closing the end of said cylinder fac-

ing said plug, said wall member having an opening therethrough for said piston rod and an annular recess in the end thereof facing said plug, there being passages connecting said recess with the interior of said cylinder; a wall disposed at the inner end of said plug and having an annular recess facing said first named recess, there being discharge passages in said plug connecting such annular recess with the exterior of said plug; an annular valve plate between said end wall of said plug and said wall member closing the end of said cylinder, said valve plate having three passages extending co-axially therethrough so as to connect said recesses and three passages connecting said first named recess with the interior of said tubular wall extending from said cylinder; valve closure means in said first named recess for closing said passages which lead from said first named recess to the interior of said wall extending from said cylinder; and valve closure means in said second named recess for closing said passages which connect said recesses.

6. A valve device for a pump of the character described, having a cylinder, a piston in said cylinder having a projecting piston rod, a tubular wall extending from said cylinder, and a plug in the end of said tubular wall, including: a wall member for closing the end of said cylinder facing said plug, said wall member having an opening therethrough for said piston rod and an annular recess in the end thereof facing said plug, there being passages connecting said recess with the interior of said cylinder; a wall disposed at the inner end of said plug and having an annular recess facing said first named recess, there being discharge passages in said plug connecting such annular recess with the exterior of said plug; an annular valve plate between said end wall of said plug and said wall member closing the end of said cylinder, said valve plate having a passage extending co-axially therethrough so as to connect said recesses and a passage connecting said first named recess with the interior of said tubular wall extending from said cylinder; valve closure means in said first named recess for closing said passage which leads from said first named recess to the interior of said wall extending from said cylinder; and valve closure means in said second named recess for closing said passage which connects said recesses.

7. A valve device for a pump of the character described, having a cylinder, a piston in said cylinder having a projecting piston rod, a tubular wall extending from said cylinder, and a plug in the end of said tubular wall having an opening for said piston rod and passages therein, including: a wall member for closing the end of said cylinder facing said plug, said wall member having an opening therethrough for said piston rod; an annular valve plate between said end wall of said plug and said wall member closing the end of said cylinder, there being an annular recess formed between said cylinder and said plate and being connected to the interior of said cylinder, and there being a recess formed between said plug and said plate and being connected to said passages of said plug, said valve plate having a passage extending co-axially therethrough so as to connect said recesses and a passage connecting said first named recess with the interior of said tubular wall extending from said cylinder; valve closure means in said first named recess for closing said passage which leads from said first named recess to the interior of said

wall extending from said cylinder; and valve closure means in said second named recess for closing said passage which connects said recesses.

5 8. A valve device for a pump of the character described, comprising: a cylinder; a body spaced from the end of said cylinder, said body having a passage therein; a wall closing the end of said cylinder; a valve plate disposed between
10 said wall and said body, there being an annular recess formed between said plate and said wall connected to the interior of said cylinder, and there being an annular recess formed between said plate and said body and connected to said
15 passage of said body, said valve plate having a passage extending co-axially therethrough so as to connect said recesses and having a passage connecting with said first named recess and bending radially outwardly to the exterior of said
20 valve plate; valve closure means in said recesses for closing said passages of said valve plate; and means for connecting said body to said cylinder and holding said valve plate in fluid-tight engagement with said wall.

25 9. A valve device for a pump of the character described, having walls forming a cylinder, and a piston rod projecting from said cylinder, comprising: a wall closing the end of said cylinder, there being an opening in said wall through
30 which said piston rod passes, and an annular channel in said wall around said piston rod forming a valve chamber having passages connecting with the interior of said cylinder; an end wall closing the outer end of said chamber, said
35 end wall having valve ports therein connecting with said chamber; closure members in said chamber one each of which cooperates with one of said valve ports; and means in said chamber forcing said closure members toward said ports.

40 10. A valve device for a pump of the character described, having walls forming a cylinder, and a piston rod projecting from said cylinder, comprising: a wall closing the end of said cylinder, there being an opening in said wall through
45 which said piston rod passes, there being annular walls forming an annular valve chamber against the outer face of said wall closing said cylinder, said chamber being separated from said piston rod opening, and said wall closing said
50 cylinder having passages connecting with the interior of said cylinder; an end wall closing the outer end of said chamber, said end wall having valve ports therein connecting with said chamber; and closure members in said chamber one each of which cooperates with one of
55 said valve ports.

11. A valve device for a fluid operated pump having a cylinder with a piston therein provided with a piston rod projecting from the end of
60 said cylinder, comprising: walls forming a valve casing around said rod in a position adjacent the end of said cylinder, said valve casing having an internal port connecting with the interior of said cylinder and having an external port connecting with the exterior of said valve casing through the lateral wall thereof, there being
65 check valve means in said casing disposed between said internal and external ports; and a shell extending around said valve casing, said
70 shell having passage means therein connecting with the outer end of said external valve port of said valve casing.

12. A valve device of the character described, including: walls forming an annular chamber, there being fluid passages leading from said chamber; an end wall for said chamber having three substantially equally spaced valve ports therein communicating with said annular chamber; a like number of closure members within said chamber, each being disposed in a position to close one of said ports; and means for resiliently forcing said closure members toward
10 said ports, comprising a ring member encircling said chamber and engaging said closure members, and resilient means in said chamber behind said ring member operating to force said ring member toward said closure members. 15

13. A valve device of the character described, including: walls forming a valve chamber, one of the walls of said chamber having three valve ports therein communicating with said chamber; a plurality of ball members within
20 said chamber, each being positioned so as to close one of said ports and projecting a distance thereinto; a pressure member engaging all of said ball members; means for exerting a force on said pressure member so as to seat said ball
25 members in said ports; and means for limiting the movement of said ball members away from said ports to less than said distance.

14. A valve device of the character described, including: walls forming a valve chamber,
30 one of the walls of said chamber having three valve ports therein communicating with said chamber; three ball members within said chamber, each being positioned so as to close one of said ports and projecting a distance thereinto; a
35 pressure member engaging all of said ball members; means for resiliently exerting a force on said pressure member so as to seat said ball members in said ports; and means for limiting the movement of said ball members away from said
40 ports to less than said distance.

15. A valve device of the character described, including: walls forming a valve chamber, one of the walls of said chamber having three valve ports therein communicating with said
45 chamber; a plurality of ball members within said chamber, each being positioned so as to close one of said ports and projecting a distance thereinto; a pressure member engaging all of said ball members, said pressure member being
50 held in floating engagement with said ball members; means for exerting a force on said pressure member so as to seat said ball members in said ports; and means for limiting the movement of said ball members away from said ports to
55 less than said distance.

16. A valve device of the character described, including: walls forming a valve chamber, one of the walls of said chamber having three valve ports therein communicating with said
60 chamber; a plurality of closure members within said chamber, each being positioned so as to close one of said ports and projecting a distance thereinto; a pressure member engaging all of said closure members; and a coil spring in said
65 chamber engaging said pressure member so as to yieldably force said pressure member and said closure members toward said ports so as to seat said closure members with respect to said
70 ports.

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