

March 21, 1944.

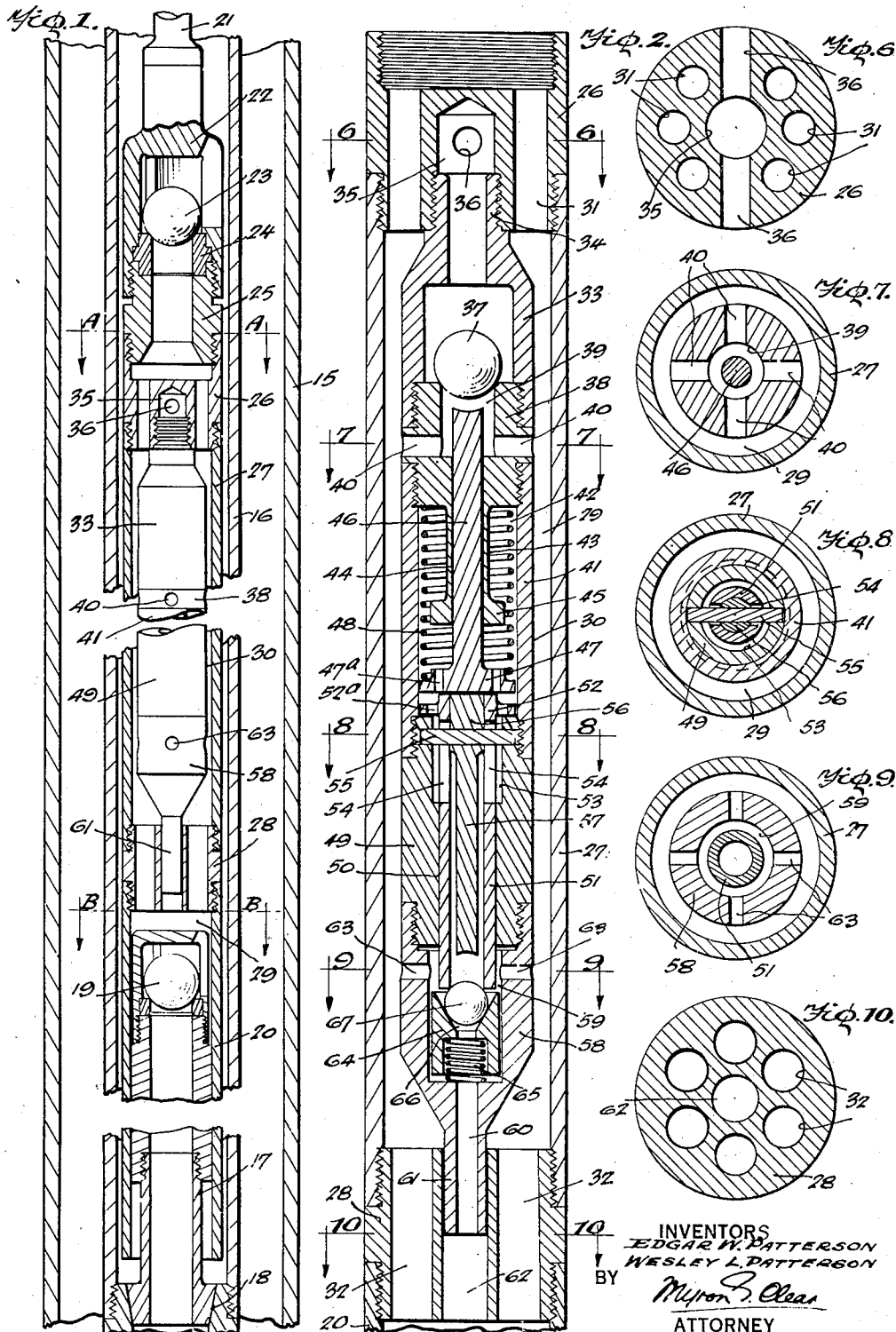
E. W. PATTERSON ET AL

2,344,787

ANTIPOUND PUMP PRESSURE EQUALIZER

Filed May 10, 1943

2 Sheets-Sheet 1



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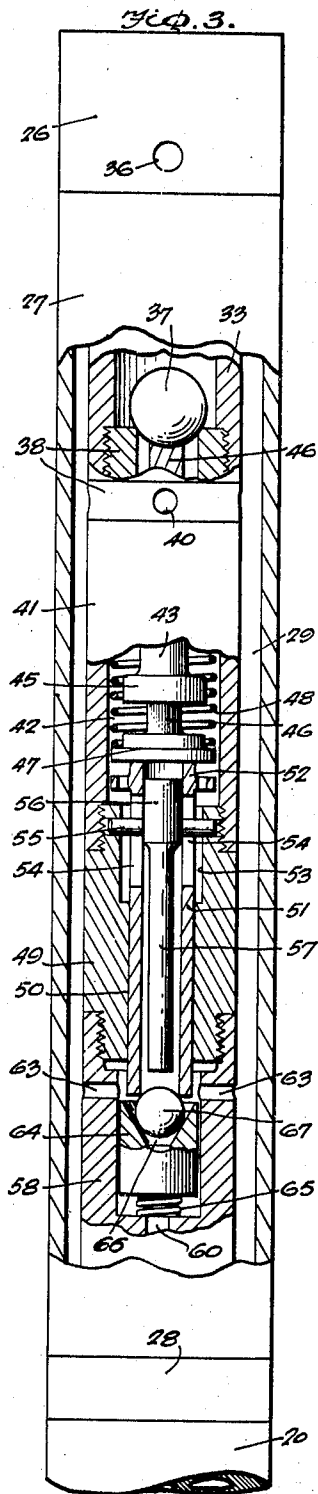
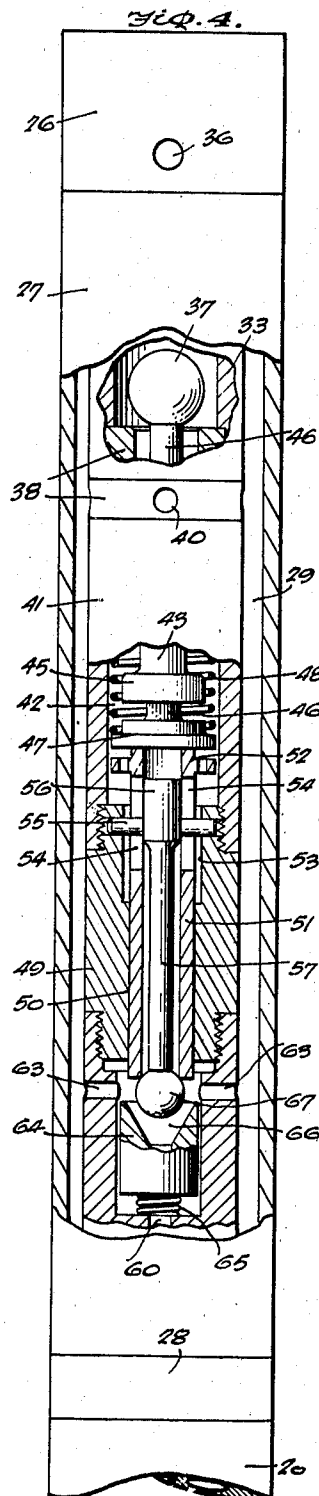
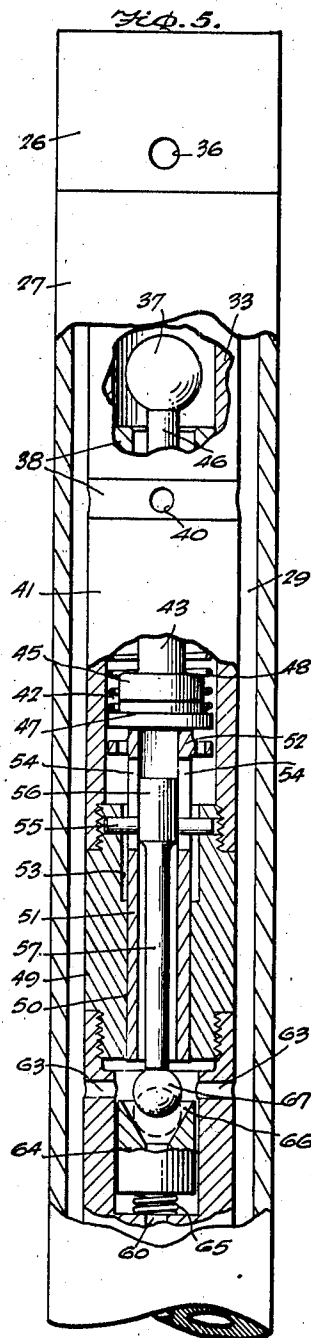
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2 Sheets-Sheet 2



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ANTIPOUND PUMP PRESSURE EQUALIZER

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7 Claims. (Cl. 103—179)

The present invention relates generally to devices for eliminating the objectionable hammer or pound in deep well rod pumps, and more particularly to a means of accomplishing this result by equalizing the pressures of the production column and pump chamber during each working stroke of the pump just prior to normal opening of the traveling valve, as described and claimed in our copending application, filed March 24, 1942, under Serial Number 436,004.

In this application, as in our application above mentioned, certain fundamentals are present, including the use, for the foregoing purpose, of a displaceable member in the pump chamber and between the standing and traveling valves of a standard rod pump, which member is actuated upon its effective stroke by the pressure in said chamber as said pressure increases during the working stroke of the pump; the creation of a low pressure area in advance of said displaceable member during its effective stroke so that there will either be no retarding of its movement or a regulated retarding thereof; means positionable by and during the effective displacement of the said member to place the pump chamber in communication with the high pressure area of the production column whereby to equalize inside and outside pressures at a time substantially in advance of reaching equal pressures in normal pumping operation; means whereby, following equalization of high pressure within and without the pump chamber, there is effected an equalization of pressure between the pump chamber and the low pressure to thus provide for return of the displaceable member to normal or low pressure position, and means effectively providing for the exhausting or unloading of high pressure from the normally low pressure area into the pump chamber when the latter is subsequently at low pressure, in order to restore the said area to normal low pressure before the next working stroke of the pump.

These fundamentals being the same in both applications, the present application presents a specifically different and improved structural embodiment of the invention, designed to promote greater durability and trouble-free operation, compactness, ease and flexibility of adjustment, and to insure continuously effective operation under the high pressures and sandy oil likely to be encountered in deep wells.

With the foregoing in mind, certain other objects, as well as the details of construction, operation and advantages of the present structural form of the invention, will clearly appear in the

course of the following description and by reference to the accompanying drawings. In these drawings, which form a part of this specification,

Figure 1 is a vertical sectional view through the working barrel of a well pump, within well tubing and casing, illustrating the manner of installation of the present invention.

Figure 2 is an enlarged vertical sectional view through the improved pressure equalizer of the present invention, the parts being shown in the position they will assume at the start of the down or working stroke of the pump.

Figure 3 is a view, partly in elevation and partly in section, of the equalizer, the parts being shown in the position they will assume during the working stroke of the pump after initial displacement of the displaceable member during build-up of pressure in the working chamber.

Figure 4 is a similar view, the parts being in the position they will assume immediately after communication has been initially opened between the working chamber and the production column, during further displacement of the displaceable member.

Figure 5 is another similar view with the parts in the final stage of displacement of the displaceable member at substantially the end of the working stroke of the pump, and

Figures 6, 7, 8, 9 and 10 are detail cross sectional views, taken respectively on lines 6—6, 7—7, 8—8, 9—9 and 10—10 of Figure 2.

Referring now to the above described figures of the drawings, and particularly to Figure 1, there is shown, at 15, the casing of an oil well, within which the production tubing 16 forms the outflow line for oil which may rise under production or formation pressure in the casing 15.

In all pumping wells, the oil which is taken into the lower end of tubing 16, is forced to rise in said tubing to discharge, by means of a pump, and in the present instance this pump is shown as the most commonly used working barrel type of pump, the hollow, stationary plunger 17 of which is seen as upstanding in the tubing 16, has a seat 18 at its lower end in the tubing and has a standing valve 19 at its upper end. The working member of this conventional pump, is a traveling barrel 20 which is moved up and down in closely fitting relation around the plunger 17, by means of rods 21 attached at their lower end to the cage 22 of the traveling valve 23.

In the lower portion of the cage 22, the seat 24 of valve 23 is ordinarily confined by a coupling 25 whose upper end threads into the cage 22 and whose lower end normally similarly

threads up to the line A—A of Figure 1, into the upper end of the traveling barrel 20, down to the line B—B of said figure.

For the purpose of installation of the present invention, the coupling 25 is disconnected from the upper end of the barrel 20, since the proposed equalizer is attached between these parts, the coupling 25 being then threaded downwardly into a crossover coupling 26 at the upper end of an equalizer barrel 27. This coupling 26, the details of which will presently appear, is shown as of the same external diameter as the equalizer barrel 27 and the working barrel 20 of the pump, to which the lower end of the equalizer barrel 27 is connected by an equalizer centering coupling 28, also of similar external diameter.

The barrel 27, as thus connected to and between the usual working barrel 20 and its upper coupling normally connecting the same to the valve cage 22, not only houses the equalizer of the present invention, but interiorly thereof it forms a continuation of the working chamber 29 of the pump and is therefore substantially a part of the working barrel of the pump in the present assembly.

It is also seen in Figure 1 that the equalizer, generally indicated at 30 therein, is located wholly within, and spaced from, its barrel 27 so that free passage of oil is provided for around the equalizer and upwardly from the working chamber of the pump through the traveling valve into the production column within the production or outflow tubing 16. For this reason the upper coupling 26 of the equalizer has flow passages 31 grouped around its axis and the lower coupling 28 has similar flow passages 32, as better seen respectively in Figures 6 and 10.

Referring now to Figure 2, in which the equalizer 30 is shown in detail, it is to be noted that its casing includes an upper hollow section 33, the upper reduced portion 34 of which is threaded axially into the cross over coupling, so that its interior is in communication with a downwardly opening axial bore 35 of said coupling. Diametrical ports 36 extend from bore 35 through the wall of this coupling and open exteriorly thereof, so as to thus communicate, in the assembly of Figure 1, with the interior of the outflow tubing 16 and thus with the production column. This is the only point at which the equalizer is interiorly in communication with the production column in use, so that production column pressure acts downwardly upon a ball valve 37 within the hollow upper section 33.

The valve 37 which, in this instance is the equalizer actuated valve controlling the equalization of pressures as between the production column and the working chamber of the pump, seats on a valve seat formed by the upper portion of a coupling 38 threaded at its upper end into the base of the casing section 33. Thus valve 37 is seated by, and subject to, the same production column pressure which acts on, and seats, the traveling valve 23 of the pump.

The valve 37, when seated, closes the upper end of the axial bore 39 of coupling 38, which bore is constantly in open communication at its lower portion, by lateral or diametrical ports 40 of the coupling, with the exterior of the equalizer casing and thus with the working chamber 29 of the pump. Plainly, then the ball valve 37 is subject to production column or outside pressure from above, and to working chamber or inside pressure from below. See also Figure 7.

Below the ports 40, the ball seat coupling 38 has a reduced portion threaded into the upper end of a cylindrical wall 41, within which is formed, in a manner to shortly appear, what is termed a low pressure chamber 42. The last mentioned portion of coupling 38 has an axial stem 43 depending into chamber 42, and is also provided with an axial opening 44 through the same and through said stem 43, and the lower head 45 of the latter. The opening 44 communicates at its upper end with, and is substantially reduced in diameter with respect to, the bore 39 above mentioned.

A plunger 46 has a fluid-tight, sliding fit in the elongated opening 44, the upper end of this plunger upstanding into the bore 39 and the lower end thereof having a head 47 in the low pressure chamber 42 below stem head 45, with sufficient clearance so that upward movement of the plunger is permitted to an extent adapting its upper end to engage and elevate the valve 37 off its seat. The plunger 46 is normally held in lowered position by a compression spring 48 in chamber 42, the lower end of which engages plunger head 47 and the upper end of which bears against the lower end of the ball seat coupling 38.

At its lower end, the cylindrical wall 41 is threaded onto the upper end of a piston cylinder 49 in the axial bore 50 of which is a tubular piston 51. At the upper end of said piston is a head 52 which is slidable in the chamber 42 and engages the lower head 47 of plunger 46. In the normal lowered position of the plunger and piston in which they are held by the spring 48, the piston head 52 rests on the upper inner end portion or surface of the cylinder 49. Both of the plunger and piston heads preferably slidably interfit the cylindrical wall 41 and both are preferably provided with pressure flow openings 47^a and 52^a as plainly seen in Figure 2.

The upper end portion of cylinder 49 is counterbored as at 53 and the upper end portion of tubular piston 51 has diametrically opposed longitudinally slotted openings 54 which, when the head 52 of the piston is in the lowermost position resting on the cylinder 49, extend at their lower ends at least to the bottom of the counterbore 53 and are preferably flush therewith.

Fixed diametrically across the upper end portion of piston cylinder 49 is a cross pin 55 which projects through the slotted openings 54 of the piston and therefore has no limiting function as regards piston movement. This pin 55 extends, at its central portion, through a diametrical opening of the upper enlarged end 56 of a valve unseating stem 57 which is thus anchored against movement. The end 56 of stem 57 slidably interfits the hollow piston 51 and the stem itself depends axially within the piston and is spaced therefrom to provide a pressure transfer passage therebetween. The lower end of stem 57 terminates somewhat above the lower end of piston 51 when the latter is in normal, lower position as seen in Figure 2. Further showing of these parts appears in Figure 8.

At its lower end, piston cylinder 49 threads into a lower valve receptacle 58 which has an upper axial bore 59 receiving the lower end of piston 51 in the lower position of the latter. From the base of bore 59, a reduced axial opening 60 extends through a lower reduced extension 61 of the receptacle, which extension projects into an axial bore 62 of the lower coupling 28 of the equalizer barrel 27 to thus center the lower

end of the equalizer in the working chamber 29 of the pump.

Adjacent to the upper end of its bore 59, the receptacle 58 has diametrical ports 63 extending through its wall to thus place the said bore in open communication with the working chamber 29 in addition to its communication therewith through opening 60. Within the lower portion of the bore 59, below the ports 63, an axially bored valve supporting and centering block 64 is vertically yieldable on a spring 65 and provided at the upper end of its bore with a tapering recess 66 forming a ball seat. This block is thus effective to loosely support and center a valve ball 67 and is so proportioned that when the piston 51 is in its lowermost position, as in Figure 2, the ball valve will be held by the block in seated position partially within, and closing, the lower end of said piston. Thus, while the ball valve 67 and the lower end surface of the piston 51 are exposed, in this position, to the pressure of the working chamber 29 of the pump, through ports 60 and 63, the valve ball 67 closes the tubular piston 51 and prevents communication of such pressure through the piston into the low pressure chamber 42. In respect to these parts, see also Figure 9.

As shown in Figure 1, the working barrel 28 of the pump is in its lowermost position ready to start upwardly on its return or suction stroke, during which oil, usually with gas, is drawn upwardly into the working chamber 29 through the standing valve 19. The initial result of the suction stroke is to place the working chamber 29 under low pressure whereupon, as we shall presently see, all of the working parts of the equalizer of the present invention are restored to the position shown in Figure 2, with the low pressure chamber 42 at the same low pressure existing in the working chamber 29 of the pump. As shown in Figure 2 the parts may be said to be at rest in respect to the equalizer, as they will be substantially throughout the up stroke or suction stroke of the pump, and the initial portion of the down stroke or working stroke.

The manner of assembly of the equalizer in connection with the pump has been previously explained, and the explanation of the operation will proceed, assuming the parts to be at rest, as in Figure 2, and that the pump is starting on its down or working stroke, with the traveling valve 23 held tightly on its seat by the high pressure of the production column in the tubing 16. The equalizing valve 37 is similarly held on its seat by the same high production column pressure to which it is exposed through the bore 35 and ports 36 of Figures 2 and 6.

At this time the working chamber 29 of the pump is charged as a result of the previous suction stroke, with a mixture of compressible gas and incompressible oil and hence the initial downward movement of the working barrel or member of the pump encounters minimum resistance during the initial compression of the compressible portion of the charge. During this time, its downward movement is relatively fast and accelerated by production column pressure on the working member.

As pressure increases in the working chamber 29, it soon reaches a point where, acting against the lower end surface of piston 51 and against the ball valve 67 closing the same, through the ports 60 and 63, the piston is shifted upwardly from the position shown in Figure 2 to the posi-

tion shown in Figure 3. In this movement the pressure of the working chamber, plus the slight power of expansion of spring 65, overcomes the pressure of the return spring 48 in the low pressure chamber 42, with the result that the valve unseating plunger 46 is shifted upwardly until it engages the lower surface of the equalizing ball valve 37. The parts remain in this position for a portion of the working stroke and until pressure has increased in the working chamber 29 until it approaches production column pressure to a degree permitting transfer of the high outside pressure into the working chamber without danger of cutting out the valves and ports through which transfer is effected.

When, in the further progress of the working stroke, pressure is built up in the working chamber 29 to a sufficient extent so that, acting on the lower end of piston 51 and ball valve 67, and directly against ball valve 37 it develops sufficient power to force the piston upwardly from the position shown in Figure 3 to that shown in Figure 4, the plunger 46 acting against equalizing valve 37, lifts the latter from its seat and thus opens the way for transfer of production column pressure into the working chamber so that these pressures become equalized and the traveling valve 23 is free to open and thus eliminate all danger of pound within the pump when its working member comes suddenly into contact with that portion of the fluid of the working chamber which is substantially incompressible.

In the movement of the parts from the position of Figure 3 to that of Figure 4, it is to be noted that there is a differential as between the area of the equalizing valve 37 exposed to high outside pressure, and the areas of this valve and the lower end of piston 51 and valve 67, exposed to working chamber pressure through ports 40, 60 and 63, which is sufficient to enable a lesser working chamber pressure to unseat the valve 37 against a higher outside pressure. It should be remembered that during this time the chamber 42 is still at low pressure which imposes no resistance to upward movement of the piston, since the lower valve 67 follows the piston in its upward movement and only comes into contact with the unseating stem 57 when the position of Figure 4 has been reached.

When the parts have reached the position of Figure 4, further upward movement of the piston 51 quickly follows, since the equalizing valve 37 is unseated, and they move to the position of Figure 5. During this movement the lower valve 67 is unseated by reason of presence of the unseating stem 57, as shown in full lines in Figure 5 and drops to the dotted line position within the upper centering recess of guide block 64. Upon the uncovering of the lower end of the tubular piston 51, in this manner, low pressure chamber 42 is charged with the high pressure of the working chamber 29, and the piston 51 and plunger 46 being thus balanced, they are promptly restored to the position of Figure 2 by the action of the return spring 48. Chamber 42 remains at high pressure, however, until after the working member of the pump has completed its working stroke and starts upon its succeeding return or upward movement. Thereupon, the working chamber 29 being again at low pressure, the high pressure within chamber 42 discharges or exhausts into the working chamber since the piston closing valve 67 is free to be moved down-

wardly with its guide block 64 against the slight tension of spring 65.

Thus the last action in every cycle of operations as above set forth, is a pressure exhaust from the low pressure chamber or area 42, and during this exhaust into the working chamber of the pump, any sand or other foreign matter in the oil or gas is blown out of the equalizer through ports 60 and 63 so as to maintain the parts in clean, efficiently operating condition at all times, and prevent the scoring of the valve balls and seats.

It is to be particularly noted that in the present construction the equalizer does not, as in our previous case, actuate the traveling valve of the pump, but includes its own equalizing valve which, upon unseating, accomplishes the desired transfer of pressures and leaves the traveling valve free to unseat of its own accord.

It is further to be noted that the present construction is compact, with all working parts protectively housed in the equalizer casing, and of rugged, durable nature, and that one of its principal differences, as regards the earlier application above referred to, is that it makes provision for equalizing and exhausting the pressure within the isolated low pressure chamber 42 by means of a ball valve instead of a sleeve valve as used in the structure of the former application.

Having thus fully described the foregoing invention, what is claimed is:

1. In an anti-pound device for well pumps of the type including standing and traveling valves and having a working chamber therein between said valves, and production tubing receiving discharge from said working chamber to form therein a production column, said device comprising a shell connected to form therein a part of said working chamber, a casing within said shell having therein spaced pressure ports respectively opening interiorly and exteriorly of the shell, an equalizing valve for closing off communication between said ports, said casing having therein a low pressure chamber, a hollow piston slidable in the casing with one end opening within the low pressure chamber at all times, and exposed at its opposite end to pressure within the shell for moving the piston in one direction, a valve member seatable to close the last mentioned end of the piston during its pressure-actuated movement, means actuated by the piston during its said movement for unseating the equalizing valve, means positioned to unseat the piston valve during said movement of the piston after unseating of the equalizing valve, to thus equalize pressures in the shell and the low pressure chamber, and means to subsequently return the piston, said piston valve opening away from the said low pressure chamber for exhaust of pressure from the chamber when the interior of the shell is at low pressure.

2. In an anti-pound device for well pumps, having therein a working chamber and having production tubing into which well fluid is discharged from said working chamber, said device comprising an outer shell connected to be subject, in use, exteriorly thereof to pressure in said tubing and interiorly thereof to working chamber pressure, a casing within said shell having intermediately thereof a low pressure chamber and having above said chamber vertically spaced pressure ports, one of which opens through the shell exteriorly thereof and the other of which

opens interiorly of the shell, an equalizing valve seated in the casing to close off communication between said ports, a hollow piston slidable in the casing below said chamber, having its upper end opening into the chamber and exposed at its lower end to pressure within the shell, a valve member seatable to close the lower end of the piston during a portion of its upward movement, means actuated by the piston during its upward movement for unseating the equalizing valve, means positioned to unseat the piston valve during upward movement of the piston after unseating of the equalizing valve, and spring means for returning the piston after unseating of its valve.

3. In an anti-pound device for well pumps, having therein a working chamber and having production tubing into which well fluid is discharged from said working chamber, said device comprising an outer shell connected to be subject, in use, exteriorly thereof to pressure in said tubing and interiorly thereof to working chamber pressure, a casing within said shell having therein spaced pressure ports respectively opening interiorly and exteriorly of the shell, an equalizing valve for closing off communication between said ports, said casing having therein a low pressure chamber, a hollow piston slidable in the casing with one end opening within the low pressure chamber at all times, and exposed at its opposite end to pressure within the shell for moving the piston in one direction, a valve member seatable to close the last mentioned end of the piston during its pressure-actuated movement, means actuated by the piston during its said movement for unseating the equalizing valve, means positioned to unseat the piston valve during said movement of the piston after unseating of the equalizing valve, to thus equalize pressures in the shell and the low pressure chamber, and means to subsequently return the piston.

4. In an anti-pound device for well pumps, having therein a working chamber and having production tubing into which well fluid is discharged from said working chamber, said device comprising an outer shell connected to be subject, in use, exteriorly thereof to pressure in said tubing and interiorly thereof to working chamber pressure, a casing within said shell having intermediately thereof a low pressure chamber and having above said chamber vertically spaced pressure ports, one of which opens through the shell exteriorly thereof and the other of which opens interiorly of the shell, an equalizing valve seated in the casing to close off communication between said ports, a hollow piston slidable in the casing below said chamber, having its upper end opening into the chamber and exposed at its lower end to pressure within the shell, a valve member seatable to close the lower end of the piston during a portion of its upward movement, means actuated by the piston during its upward movement for unseating the equalizing valve, means positioned to unseat the piston valve during upward movement of the piston after unseating of the equalizing valve, to thus place the low pressure chamber in communication through the piston with the pressure space and provide for return movement of the piston, said piston valve opening away from the low pressure chamber whereby the latter may exhaust pressure therefrom through the piston when the interior of the shell is at low pressure.

5. In an anti-pound device for well pumps,

having therein a working chamber and including a moving member for filling and discharging said chamber, said device comprising an outer cylindrical member, having means at its opposite ends for connecting the same as a part of the moving member of the pump, and forming a pressure space therein in communication with the working chamber of the pump, a casing mounted within the pressure space of said member, means in said casing for establishing and cutting off communication between said pressure space and the exterior of the member and including a normally closed pressure equalizing valve, means forming a normally low pressure chamber in said casing, means in said casing, exposed to, and movable by, pressure in said pressure space, for opening the equalizing valve in the course of said pressure actuated movement, said last named means including a valved element affording communication between the pressure space and said chamber when its valve is open, means to open the valve of said element subsequent to the opening of the equalizing valve, and means for returning said pressure movable means to normal position subsequent to opening of the valve of said element, said valve of said element being positioned to open independently of its said opening means after return of the pressure movable means, for the exhaust of pressure from the low pressure chamber when the pressure space is at low pressure.

6. In an anti-pound device for well pumps, having therein a working chamber and including a moving member for filling and discharging said chamber, said device comprising an outer cylindrical member, having means at its opposite ends for connecting the same as a part of the moving member of the pump, and forming a pressure space therein in communication with the working chamber of the pump, a casing mounted within the pressure space of said member, means in said casing for establishing and cutting off communication between said pressure space and the exterior of the member and including a normally closed pressure equalizing valve, means forming a normally low pressure chamber in said casing, a hollow piston slidable in the casing, having one end thereof opening into the low pressure chamber at all times, and exposed at its opposite end to pressure within

said pressure space for moving the piston in one direction, a valve member seatable to close the last mentioned end of the piston during the major portion of its pressure actuated movement, means actuated by the piston during its said movement for opening the equalizing valve, means for unseating the piston valve during said piston movement after opening of the equalizing valve, means for returning the piston subsequent to the unseating of its valve.

7. In an anti-pound device for well pumps, having therein a working chamber and including a moving member for filling and discharging said chamber, said device comprising an outer cylindrical member, having means at its opposite ends for connecting the same as a part of the moving member of the pump, and forming a pressure space therein in communication with the working chamber of the pump, a casing mounted within the pressure space of said member, means in said casing for establishing and cutting off communication between said pressure space and the exterior of the member and including a normally closed pressure equalizing valve, means forming a normally low pressure chamber in said casing, a hollow piston slidable in the casing, having one end thereof opening into the low pressure chamber at all times, and exposed at its opposite end to pressure within said pressure space for initially moving the piston in one direction and subsequently providing for exhaust of pressure from the low pressure chamber, a valve seatable to normally close the piston to the movement of pressure to the low pressure chamber, means actuated by the piston during its said pressure actuated movement for opening the equalizing valve, means for unseating the piston valve during said piston movement after opening of the equalizing valve, to thus open the low pressure chamber to the pressure space, and means for returning the piston when the low pressure chamber is thus opened, the piston valve being yieldable under pressure within the low pressure chamber and providing for exhaust of pressure therefrom subsequent to return of the piston when the pressure space is at low pressure.

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