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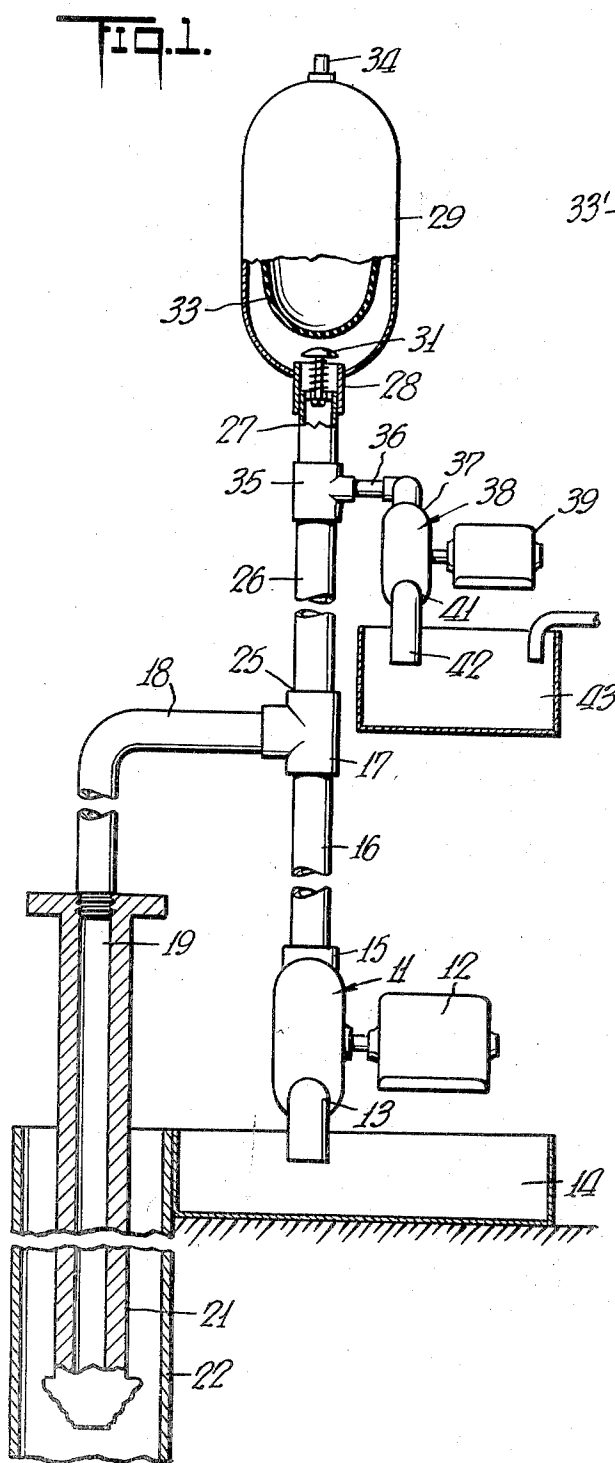
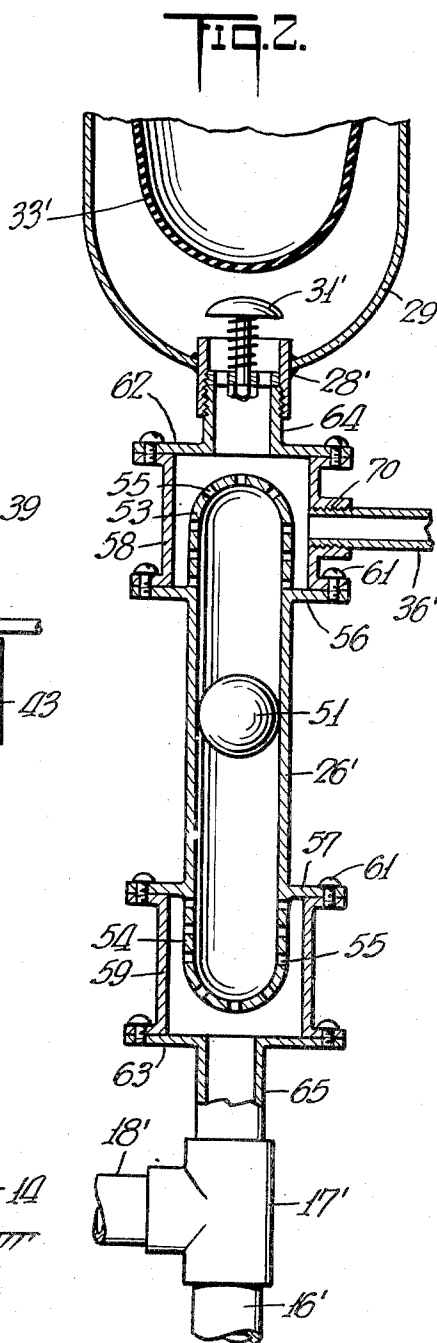
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ACCUMULATOR SYSTEM FOR PRESSURE SURGE RELIEF

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2 Sheets-Sheet 1



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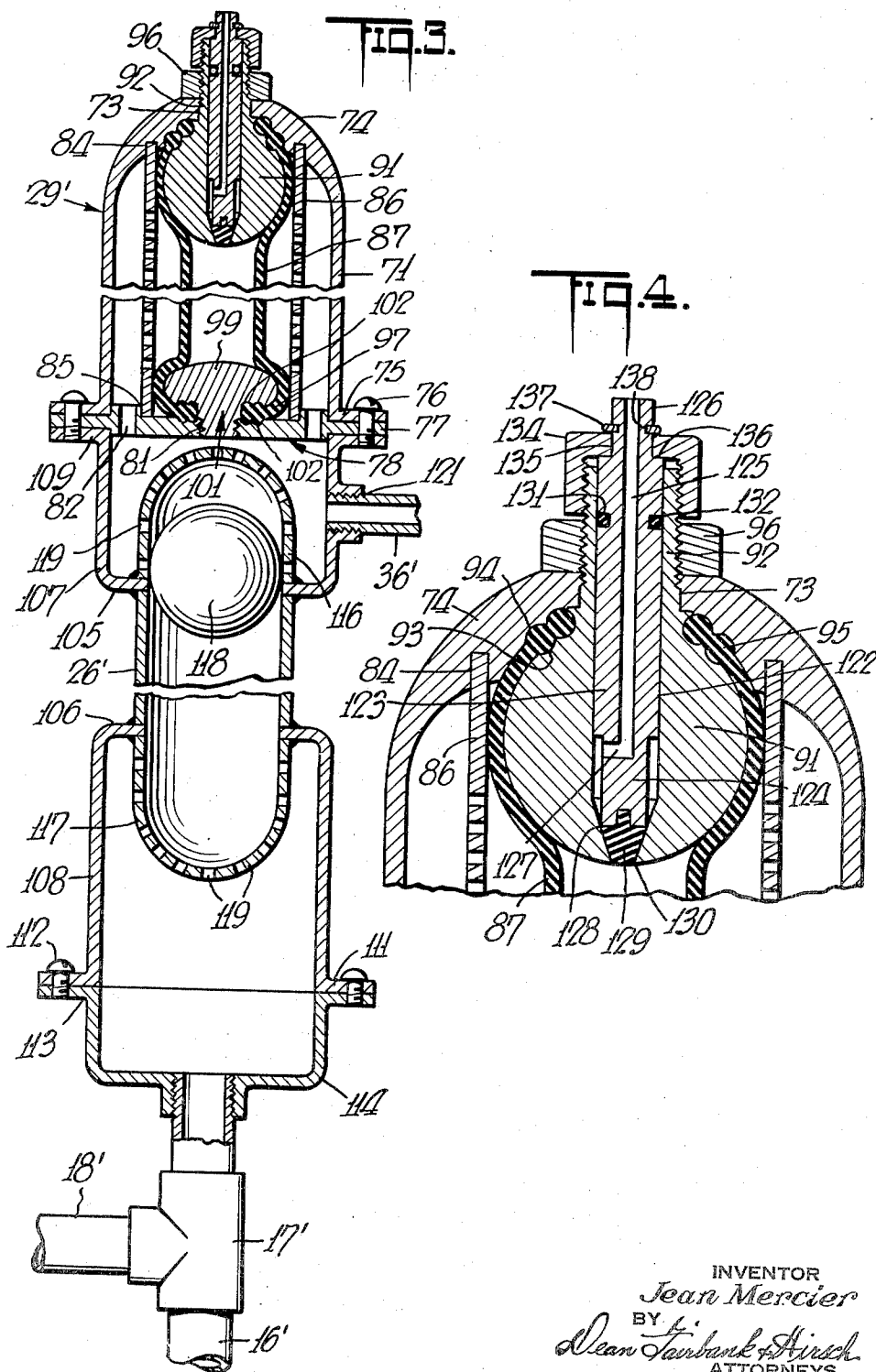
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ACCUMULATOR SYSTEM FOR PRESSURE SURGE RELIEF

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14 Claims. (Cl. 103—223)

This invention relates to accumulator systems, more particularly of the type to relieve surges due to the action of a pulsating delivery pump.

As conducive to an understanding of the invention, in an illustrative application in the drilling of oil wells, it is to be noted that in conventional practice a suspension of mud in water, which may contain barium dioxide, is forced into the oil well casing to remove broken rocks and stone due to the drilling action. Where the pump forcing the mud into the well casing is of the pulsating type, momentary surges might result which might cause cracking or breaking of the pressure lines in the system. Where, to reduce such pressure surges, a pressure accumulator of the type having a shell with a deformable bladder therein is connected to the line from the pump which leads into the well casing, the abrasive action of the grit, crushed stones and the like in the mud soon causes breakdown and destruction of the deformable bladder, and if the accumulator is of the poppet valve type, such valve is also likely to break down, thereby necessitating frequent stoppage of the equipment for repair.

It is accordingly among the objects of the invention to provide a system of the above type which requires but few additional components other than the standard elements generally used to reduce the effect of pressure surges due to the pumping action pulsations and which will permit long continuous use of the accumulator without likelihood of injury to its internal elements and without in any way interfering with the normal operation of such accumulator, which system is not likely to become deranged even with such long continuous use and may readily be disassembled for service.

Another object is to provide a system of the above type in which a buffer is interposed between the output of the pump and the accumulator, which will substantially prevent flow of such output into the accumulator without in any way interfering with its efficient operation in reducing the effect of the pumping pulsation.

Another object of the invention is to provide a gas inlet valve for a pressure accumulator which may readily be operated to permit flow of gas into the accumulator for charging of the deformable bladder therein and closed to provide a gas tight seal, which valve will prevent extrusion of the bladder through the valve orifice upon deformation of such bladder in use of the accumulator.

According to the broad aspect of the invention, the system comprises a pressure accumulator having its liquid port connected to the output line from a pump of the pulsating output type. Interposed between the accumulator liquid port and the pump output line is a buffer which substantially prevents passage of fluid from the pump into the accumulator, yet permits movement of a column of fluid from such pump to compress the gas in the accumulator thereby to reduce the effect of pulsations of such pump.

More specifically, a relief line is interposed between the accumulator port and the line from the pump and such line is charged with a non-abrasive, non-corrosive

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liquid which serves as the buffer so that upon operation of such pump, the column of liquid therefrom forced into the relief line will displace the buffer liquid in such line for movement of the latter into the accumulator to compress the gas therein thereby reducing the effect of the pumping pulsations.

The quantity of buffer liquid is desirably greater than the quantity of liquid forced by the pulse into the relief line so that substantially only the buffer liquid will flow into the accumulator thereby preventing injury to its internal elements such as the bladder or poppet valve which might otherwise occur if the liquid from the pump was abrasive or corrosive. The buffer liquid may be water which is forced into the relief line adjacent the port of the accumulator by means of a suitable relatively small output pump.

In one illustrative embodiment of the invention, a piston which is part of the buffer is positioned in the relief line to provide substantially a complete barrier between the liquid from the pulsating output pump on one side and the buffer liquid on the other. The piston desirably has a specific gravity less than that of the liquid from the pump so that it will float on top of the column thereof in said relief line. To limit the movement of the piston, it desirably travels between two spaced partitions which are perforated to permit flow of fluid therethrough.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention,

Fig. 1 is a diagrammatic view of the system showing an illustrative application thereof,

Fig. 2 is a diagrammatic view of another embodiment of the system in which a piston is utilized,

Fig. 3 is a longitudinal transverse sectional view of an accumulator and piston which may be used in the system, and

Fig. 4 is a longitudinal sectional view of a gas valve. Referring now to Fig. 1 of the drawings, in the illustrative application of the system shown, such system desirably comprises a conventional mud pump 11 of conventional type driven by motor 12. The inlet 13 of the pump 11 is connected to a suitable reservoir 14 which contains a suspension of mud in water. The outlet 15 of the pump is connected by a line 16 to a junction 17 which in turn is connected by line 18 to the bore 19 of the drill member 21 in the oil well casing 22, the suspension of mud flowing up out of said casing being fed to the reservoir 14.

Connected to junction 17 at one end and at 25 is a relief line 26, the other end 27 of which is connected to the fluid port 28 of a pressure accumulator 29 of conventional type such as that put out by Greer Hydraulics, Inc. of Brooklyn, New York. The accumulator 29 may have a poppet valve 31 controlling its port 28 in conventional manner and a deformable bladder 33 which is charged with gas through valve 34. The relief line 26 desirably has an inlet port 35 adjacent the port 28 of the accumulator 29 which is connected by line 36 to the outlet 37 of a pump 38 desirably of a small output constant flow type, which may be driven by a suitable motor 39. The inlet 41 of pump 38 is connected by a line 42 to a reservoir 43 which may contain a non-abrasive liquid such as fresh water.

The volume of relief line 26 between port 35 and junction 17 is desirably greater than the volume of liquid forced into line 26 by pump 11 which would cause the pressure in the lines 16 and 18 to rise above a predetermined or permissible value which might rupture such lines.

In the operation of the system shown in Fig. 1, the fresh water pump 38 is first actuated to force water from reservoir 43 through line 36 and port 35 into relief line

26. Such water will flow into the accumulator 29 to compress the air in bladder 33 which initially is charged to a pressure of say 1,200 p. s. i. The water will also flow through junction 17 to fill line 16 and through junction 17 into line 18.

Assuming that the column of mud in the well casing 22 is of such height as to require a pressure of greater than 1,500 p. s. i. for movement thereof, as soon as the pressure in line 26 rises to above 1,500 p. s. i. due to the output of pump 38, as the column of mud in the casing 22 will be displaced, no further compression will be effected of the charged bladder 33 in the accumulator 29.

At this time, the mud pump 11 is actuated to force mud from reservoir 14 through line 16 to junction 17. As oil wells need high pressure and large output pumps to deliver a sufficient quantity of mud, such pumps are generally of the reciprocating type with an intermittent or pulsating output. The pump pressure may rise from a minimum between pulses to say a maximum of 4,000 p. s. i. at peaks. Consequently, as the pump operates, it will deliver mud under greater pressure than 1,500 p. s. i., thereby forcing mud through junction 17 into relief line 26 and through such junction and line 18 into the oil well casing to cause the crushed rock and stone caused by the drilling action to rise from such casing for discharge into reservoir 14.

At the high pressure peaks of the pulses from the mud pump 11, the water in line 26 will be displaced upwardly as a column and forced through port 28 of the accumulator to compress the bladder 33. As a result of the compression of such bladder, the pressure surge due to the pulsating output of pump 11 will be substantially absorbed thereby preventing cracking or breaking of lines 16, 26 and 18, which might otherwise result.

By reason of the fresh water in line 26, even if some mud should flow into the accumulator, it would be sufficiently dispersed so that it would have substantially no abrasive action on the poppet valve 31 or the accumulator bag 33. After the peak of the pulse from the mud pump 11 had been attained, the pressure will thereupon drop. Consequently, the bladder 33 will expand to force the liquid in the accumulator 29 out of port 28 and the constant flow of fresh water from the pump 38 will provide a cleaning action for the accumulator and the line 26 to remove substantially all of the abrasive particles which may be forced therein during the peak of the mud pump output.

In the embodiment shown in Fig. 2, parts corresponding to those shown in Fig. 1 have the same reference numerals primed. A piston 51 is desirably provided between the column of mud and the column of fresh water to reduce intermixing. This piston, which illustratively is a ball of specific gravity less than that of the mud in the system, is positioned in relief line 26' so that it will be free to move longitudinally thereof, yet with substantially no transverse play, thereby providing an effective buffer or barrier between the mud on one side and the non-abrasive liquid on the other. The relief line 26' desirably has a perforated cage 53, 54 at each end respectively, desirably affixed thereto as by welding, the cages being of such size that when the ball 51 abuts thereagainst, fluid may pass through the openings 55 therein. Although the relief line 26' may be interposed between the accumulator 29' and the junction 17' in any suitable manner, in the embodiment herein shown, each end of the relief line 26' has an annular flange 56, 57 which are affixed respectively to the ends of flanged sleeves 58, 59 by screws 61. The other end of each of the sleeves 58, 59 is affixed to the flanged ends 62, 63 of coupling members 64, 65 also as by screws 61, the coupling member 65 desirably being connected to junction 17' and the coupling member 64 being connected to the inlet port 28' of accumulator 29'. As shown, the sleeve 58 has a port 70 to which line 36' from the water pump is connected.

The system shown in Fig. 2 operates in the same man-

ner as that shown in Fig. 1. Thus, as water is originally forced through line 36' it will pass into sleeve 58 and through openings 55 in cage 53 to move the ball 51 downwardly into cage 54 at which time the water will pass through openings 55 in cage 54 and thence through junction 17' into lines 16' and 18'.

Upon actuation of the mud pump, as the mud is forced through junction 17' it will flow into line 18' into the well casing and through openings 55 in cage 54 forcing the ball 51 upwardly thereby moving the column of water thereabove into the accumulator 29' to compress the air in bladder 33' to relieve the pressure surge due to the pulsating output from the mud pump.

In the event that the pressure surge should be of such force as to cause the ball 51 to reach the upper limit of its movement, i. e., against cage 53, at such time only will some of the mud flow through the openings in such cage. As only a small quantity of mud is likely to pass through cage 53, it will have little injurious effect on the poppet 31' or the bladder 33. By reason of the escape of such mud through cage 53, there is no likelihood that an abnormal pressure surge would be blocked by the ball 51 with resultant excessive pressure in lines 16', 18' and 26' which might cause cracking. Thus, the cages serve to limit the movement of the ball 51 yet to permit flow of liquid around the ball in the extreme positions thereof.

The embodiment shown in Fig. 3 is also similar to that shown in Fig. 1 and corresponding parts have the same reference numerals primed. In this embodiment, the accumulator 29' may comprise a substantially cylindro-spherical shell 71, having a port 73 at its rounded end 74 and a laterally extending annular flange 75 at its mouth. Affixed to said flange 75 as by screws 76 is the rim 77 of a ported plate 78 which extends transversely across the shell 71.

The plate 78 desirably has an axial opening 81 and a ring of passageways 82 therethrough radially displaced from said opening, said passageways defining the liquid port of the accumulator. The inner surface of end 74 of shell 71 and the opposed surface of plate 78 desirably have longitudinally aligned annular grooves 84 and 85 therein in which opposed ends of a perforated sleeve 86 of rigid material may be positioned to be securely retained in fixed position in said shell 71.

Positioned in sleeve 86 is a deformable partition, illustratively a sleeve 87 of resilient material such as natural or synthetic rubber. Although the deformable sleeve 87 may be retained in place in any suitable manner, in the embodiment herein shown a ball 91 is positioned in sleeve 86 with its stem 92 extending through port 73 which is of relatively small diameter. The outer surface of ball 91 adjacent stem 92 desirably has annular grooves 93 therein aligned with corresponding annular grooves 94 in the inner surface of end 74 of shell 71. Thus, when the end 95 of deformable sleeve 87 which has a plurality of annular bosses molded thereon is positioned between ball 91 and end 74 and a nut 96 screwed on the protruding end of stem 92 is tightened, the end 95 will be securely clamped between the ball 91 and end 74. The other end 97 of the sleeve 87 which also may have annular bosses molded thereon, is clamped against plate 78 by means of the rounded head 99 of a screw 101 which is threaded through axial opening 81 in said plate, said head 99 and plate 78 also desirably having associated annular grooves 102 securely to retain the end 97 of sleeve 87 in fixed position.

A relief line 26' is interposed between the liquid port of accumulator 29' and junction 17'. Although the line 26' may be mounted in any suitable manner, in the illustrative embodiment herein, the ends of the line 26' are affixed respectively as by welding to the periphery of inturned flanges 105, 106 at one end of sleeves 107, 108. The out-turned flange 109 of sleeve 107 is affixed to flange 75 of shell 71 as by screws 76 and the outturned flange 111 of sleeve 108 is affixed as by screws 112 to the

corresponding flange 113 of a coupling member 114 connected to junction 17'.

The line 26' desirably has a perforated cage 116, 117 at each end respectively, desirably affixed thereto as by welding, the cages being of such size that when a piston, desirably a ball 118 slidable in line 26' with substantially no transverse play, abuts thereagainst, fluid may pass through the openings 119 therein. As shown, the sleeve 107 has a port 121 to which line 36' from the water pump is connected.

Means are desirably provided to charge the bladder 87 with gas under pressure. To this end, the ball 91 has a bore 122 extending therethrough and through stem 92. Slidably mounted in said bore is a cylindrical plunger 123 of reduced diameter at its lower end as at 124. The plunger 123 has an axial bore 125 extending from the reduced diameter outer end 126 to nearly its inner end and a transverse bore 127 extending through the reduced portion 124 provides communication between bore 125 and the bore 122 in ball 91.

The inner end of bore 122 is desirably conformed as a substantially conical valve seat as at 128 and a conical valve head 129 desirably of resilient material such as nylon is affixed to the inner end of the plunger to coact with valve seat 128 to seal the bore 122 in the manner hereinafter to be described. The plunger 123 may have an annular groove 131 near its outer end in which a resilient member, preferably an O ring 132 is positioned to provide a dependable seal.

Although the valve head 129 may be moved to open or closed position in any manner, in the embodiment herein shown, a hollow cap 134 is threaded on the end 126 of stem 92, said cap having an axial opening 135 through which extends the reduced diameter end portion 126 of plunger 123. The cap is thus restrained between the shoulder 136 formed by such reduced portion and a snap ring 137 positioned in an annular groove 138 therein.

To charge the accumulator shown in Fig. 3, it is merely necessary to rotate the nut 134 to lift the plunger 123 slightly out of bore 122. As a result, the nylon head 129 will be moved away from seat 128. Gas, under pressure, may then be forced through bores 125 and 127, past valve head 129 into deformable sleeve 87. As a result, the latter will expand, until restrained by rigid perforated sleeve 86. As the perforations in such sleeve are relatively small in size, there is no likelihood of extrusion of the bladder therethrough. After the bladder has been charged to the desired pressure, the cap 134 is screwed downwardly until the head 129 abuts against its seat 128 to provide a dependable seal. As the nylon valve head 129 is slightly compressible, there is no leakage therepast and even if the sleeve 87 should be deformed and moved over the inlet 130 to bore 122, as the nylon head 129 completely fills such inlet, it will prevent extrusion of the sleeve therethrough, thereby preventing injury thereto.

The operation of the system shown in Fig. 3 is substantially identical to that shown in Figs. 1 and 2. Thus, water is initially forced into sleeve 107 to pass through openings 82 to fill accumulator shell 71. The water will also move the ball 118 downwardly into cage 119 and thence pass around the ball, through the perforations in such cage, through junction 17' into lines 16' and 18'. When the mud pump (not shown) is actuated, pressure surges will move the ball 118 upwardly also to raise the column of liquid thereabove. By reason of the elongated perforated sleeve 86, substantially the entire length of elongated sleeve or partition 87 will be exposed to fluid flowing through the perforations in sleeve 86. Consequently the pressure surge, due to the pulsating output of the mud pump, will be effectively distributed over substantially the entire length of bladder 87 for prompt relief of the surge, thereby preventing injury to the lines 16', 26' and 18'.

With the systems herein shown and described, it is readily apparent that substantially no mud will be moved

against the deformable partition in the accumulator, thereby preventing injury thereto and insuring long uninterrupted use of the system without need for frequent servicing to replace the accumulator partitions or to repair or replace the poppet valves shown in Figs. 1 and 2.

Although the system has been illustratively described with respect to its application in the oil well drilling industry, it is of course to be understood that the system has many other applications. Thus, for example, it could be utilized in the chemical industry in which the pulsating output pump delivers a corrosive liquid to a pressure system, to prevent such corrosive liquid entering the pressure accumulator with resultant breakdown of its bladder.

These illustrative applications of the system are by no means all inclusive and all applications possible within the ambit of the claims are within the scope of the invention from its broader aspects.

As many changes could be made in the above system and construction, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. A system of the character described, comprising a pulsating type pump for delivering a liquid under pressure, an outlet line connected to said pump, a feed line connected to said outlet line, a relief line connected to said outlet line at one end, the volume of said relief line being greater than a predetermined portion of the liquid forced from said pump during each pumping cycle, a pressure accumulator connected to the other end of said relief line and means connected to said relief line to charge the latter with a buffer liquid.

2. The combination recited in claim 1 in which said buffer liquid comprises a non-abrasive liquid of specific gravity less than the liquid from said pump and means to provide a continuous supply of such non-abrasive liquid into said relief line through the means connected to said relief line.

3. A system of the character described for forcing a suspension of mud in water into the casing of an oil well, said system comprising a pump of the pulsating output type, a reservoir for such suspension, an outlet line from said pump, means to actuate said pump to force such suspension of mud in water into said outlet line, a feed line connected at one end to said outlet line and leading into said oil well casing, a pressure accumulator, a relief line connected at its lower end to said outlet line and at its upper end to the fluid port of said pressure accumulator, the volume of said relief line being greater than a predetermined portion of the volume of the output of said pump during each pumping cycle, said relief line having an inlet port adjacent the liquid port of said accumulator, a reservoir for a buffer liquid, a second pump, and means to actuate said second pump to force buffer liquid from said second reservoir through said inlet to said relief line.

4. The combination set forth in claim 3 in which the pump for the buffer liquid is of the constant output type regardless of the pressure in the system.

5. The combination recited in claim 3 in which the accumulator is of the type having a poppet valve controlling the liquid port and a deformable bladder to provide pressure on the fluid therein.

6. A system of the character described for forcing a suspension of mud in liquid into the casing of an oil well, said system comprising a pump of the pulsating output type, a reservoir for such suspension, an outlet line from said pump, means to actuate said pump to force such suspension of mud in liquid into said outlet line, a feed

line connected at one end to said outlet line and leading into said oil well casing, a pressure accumulator, a relief line connected at its lower end to said outlet line and at its upper end to the fluid port of said pressure accumulator, the volume of said relief line being greater than a predetermined portion of the output of said pump during each pumping cycle, means connected to said relief line to charge said accumulator and said relief line with a buffer liquid and a piston slidably mounted in said relief line interposed between the buffer liquid and the suspension of mud in water.

7. The combination recited in claim 6 in which said relief line has an annular flange at each end, a pair of flanged sleeves are affixed at each end respectively to said relief line flanges, a pair of flanged couplings connected at one end respectively to the other end of said flanged sleeves and at their other end to the outlet line and to the liquid port of said accumulator respectively, said relief line having a perforated cage at each end positioned in the associated sleeve, a liquid port leading into the sleeve adjacent the pressure accumulator for charging of said accumulator and said relief line, said end cages being conformed so that at the limit of the movement of the piston, fluid may pass around the latter through said cages.

8. A system of the character described, comprising a pump of the pulsating output type for delivering a liquid under pressure, an outlet line connected to said pump, a feed line connected to said outlet line, a relief line connected to said outlet line at one end, a pressure accumulator connected to the other end of said relief line and a buffer in said relief line between said pressure accumulator and said outlet line, said buffer being movable in said relief line, said accumulator comprising an elongated cylindrical shell having a gas inlet port at one end, a perforated rigid sleeve extending longitudinally in said shell, a deformable bladder in said sleeve extending longitudinally thereof, means to charge said relief line with liquid, said relief line having a perforated cage at each end, said buffer comprising said liquid and a piston slidably mounted in said relief line, said cages being conformed to permit flow therethrough around the piston at the limits of the movement of said piston in said relief line.

9. The combination set forth in claim 8 in which said bladder is an elongated sleeve and means are provided to seal the ends of the bladder and to retain the latter in fixed position in said rigid sleeve.

10. The combination recited in claim 8 in which said

bladder is an elongated sleeve and means are provided to seal the ends of the bladder and to retain the latter in fixed position in said rigid sleeve, one of said means comprising a curved member having a stem extending through the port in said shell, said curved member clamping the adjacent end of said sleeve against the end of said shell, said curved member and its stem having a bore therethrough and valve means in said bore to control the flow of gas therethrough.

11. The combination recited in claim 10 in which said bore is conical in shape at its inner end and said valve means comprises a cylindrical plunger slidably mounted in said bore, said plunger having a substantially resilient inner end adapted to engage the conical wall of said bore, said plunger having a bore therethrough for passage of gas, and means to reciprocate said plunger in said bore to open and close the latter.

12. The combination set forth in claim 11 in which the inner end of the plunger is a valve head of nylon.

13. A system of the character described comprising a pump for delivering a liquid under pressure, an outlet line connected to said pump, a feed line connected to said outlet line at one end, a pressure accumulator connected to the other end of said relief line, means connected to said relief line to charge the latter with a buffer liquid, a piston slidably mounted in said relief line adapted to be interposed between said buffer liquid and the liquid from said pump, and means to limit the sliding movement of said piston.

14. A system of the character described, comprising a pump for delivering a liquid under pressure, an outlet line connected to said pump, a feed line connected to said outlet line, a relief line connected to said outlet line at one end, a pressure accumulator connected to the other end of said relief line, said relief line having a perforated cage at each end, means connected to said relief line to charge the latter with a non-abrasive buffer liquid, a piston slidably mounted in said relief line adapted to be interposed between the buffer liquid and the liquid from said pump, said piston at the end of its movements permitting flow of liquid thereby through the perforations in said cages.

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