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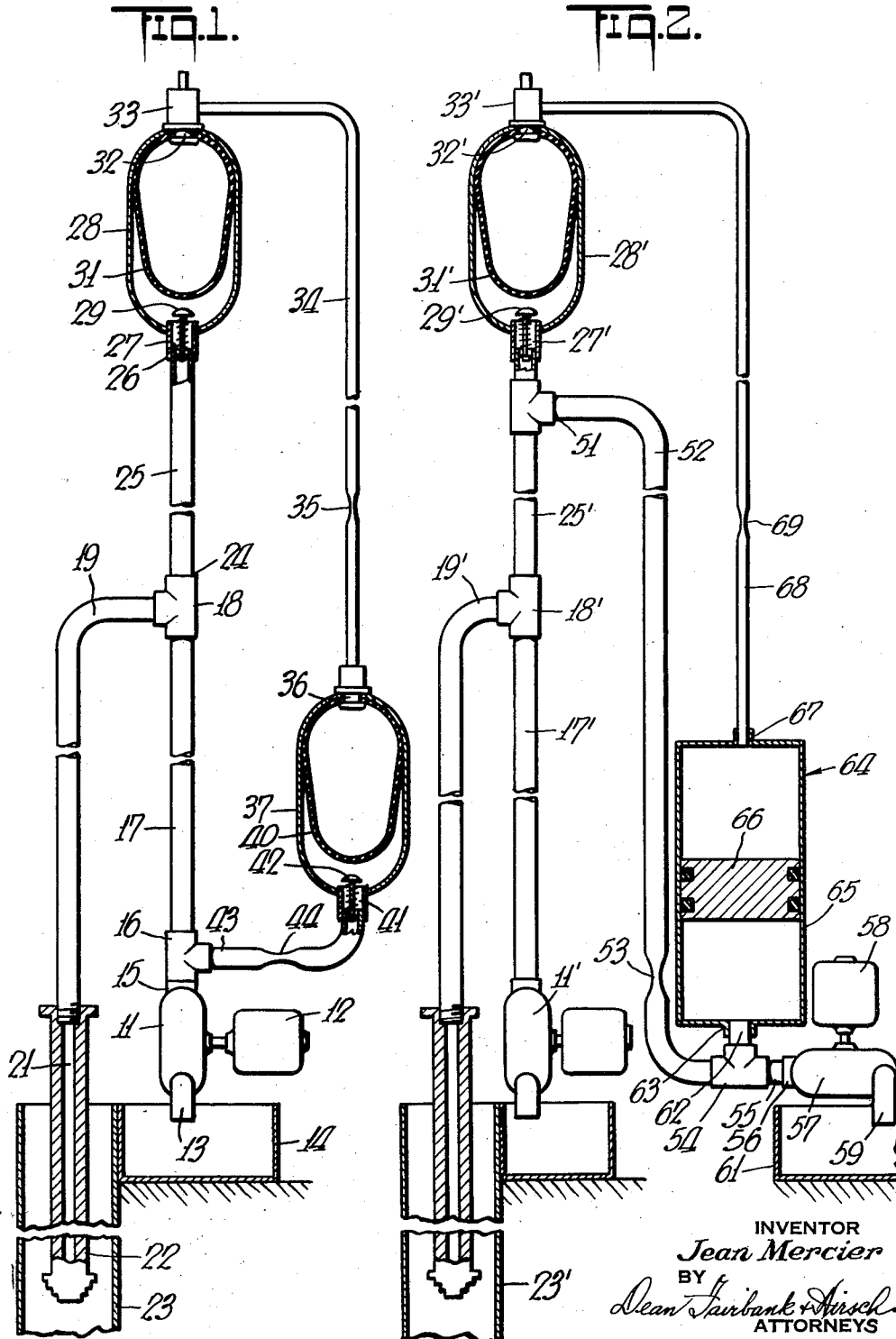
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ACCUMULATOR SYSTEM FOR PRESSURE SURGE RELIEF

Filed June 25, 1953

2 Sheets-Sheet 1



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FIG. 3.

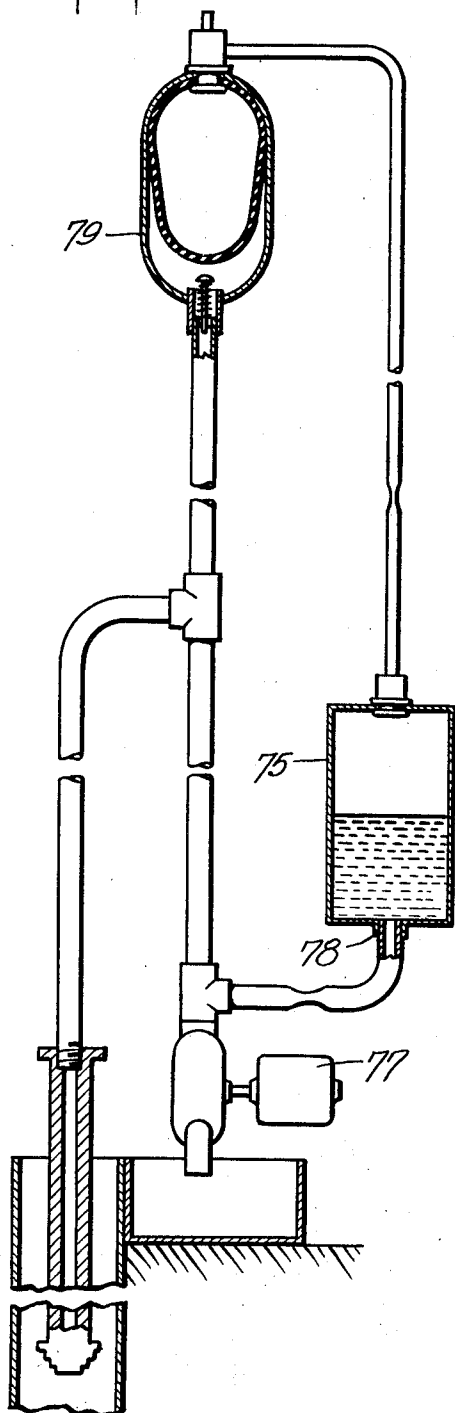
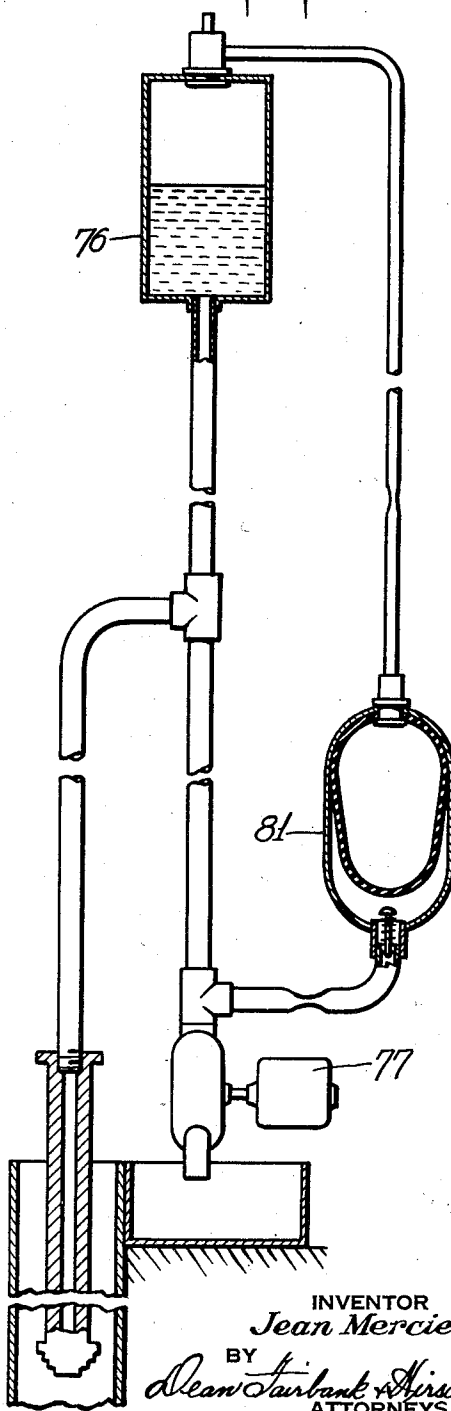


FIG. 4.



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ACCUMULATOR SYSTEM FOR PRESSURE SURGE RELIEF

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18 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 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 stones due to the drilling action. Where the pump forcing the mud into the well casing is of the pulsating type, momentary surges might cause cracking or breaking of the pressure lines in the system.

It is further to be noted that as the drilling operation continues and the depth of the oil well increases, due to the increased length of the column of liquid and mud in suspension, and crushed rock and stone, and the increased resistance in the system, the pressure required to force such column out of the well will increase correspondingly.

Where to reduce such pressure surges, a surge relief accumulator, charged with gas under pressure, is connected to the line from the pump which leads into the well casing, unless additional gas under pressure is forced into the accumulator as the pressure in the system increases, as more and more liquid is forced into the accumulator with increased pressure in the system, the original charge of gas in the accumulator will be compressed more and more rendering it substantially inoperative to compensate for the pressure surges.

Where a manually operated valve must be adjusted to regulate the gas pressure in the accumulator as the depth of the well increases, constant supervision by an attendant is required with the possibility of failure to regulate the valve due to inadvertence on the part of the attendant with resultant inoperativeness of the accumulator to relieve pressure surge.

Where the surge relief pressure accumulator is of the type having a shell with a deformable bladder therein and a poppet valve controlling a liquid port which is connected to the line from the pump which leads into the well casing, if the pressure in the bladder between surges is such that the bladder is stretched sufficiently to press against the wall of the accumulator, the repeated rubbing of the bladder against the accumulator wall after each pressure surge due to the pulsating action of the pump may cause rupture or tearing of such bladder with resultant inoperativeness of the accumulator. Where the bladder, after each pressure surge, abuts against the accumulator poppet valve to close the latter, such unnecessary frequent operation thereof may cause breakdown of the valve to render the accumulator inoperative for its intended purpose.

If the pressure in the accumulator bladder is not increased with increase of pressure in the system, the bladder will be compressed more and more by the increased pressure of the pump, rendering it substantially inoperative to compensate for the pressure surges and also causing the wall of the bladder to press against the gas inlet thereto

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with possible extrusion of such bladder and resultant destruction thereof.

It is accordingly among the objects of the invention to provide a system for reducing the effect of pressure surges due to pumping action pulsation and which will automatically regulate the pressure in the surge relief accumulator without any need for manual supervision as the pressure in the system increases.

Another object is 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 pumping action pressure surges; in which the surge relief accumulator has a deformable bladder and a poppet valve controlling the liquid outlet port, and which will automatically regulate the pressure in the surge relief accumulator without any need for manual supervision as the pressure in the system increases, so that the accumulator will dependably compensate for pressure surges in the system without likelihood of either excessive expansion of the bladder with resultant injury thereto due to rubbing against the accumulator wall or with injury to the poppet valve of the accumulator due to unnecessary frequent operation thereof, and without likelihood of excessive compression of such bladder with resultant inability to compensate for the pressure surges and without the possibility of extrusion of the bladder wall through the gas inlet.

Where there is considerable grit, crushed stones and the like in the mud, the abrasive action of such materials may cause breakdown and destruction of the deformable bladder of the accumulator and if the accumulator is of the poppet valve type such valve is also likely to break down thereby necessitating frequent stoppages of the equipment for repair.

Accordingly, still another object of the invention is to provide a system of the above type which will permit long continuous use of the accumulator to reduce the effect of pressure surges 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 servicing.

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 pulsations or its ability to be compensated for variations of pressure in the system.

According to the invention from its broader aspects, the system comprises a pressure surge relief accumulator having its liquid port connected to the outlet line of a pump of the pulsating output type which is designed to deliver its output into the oil well casing through an input line connected between the pump output and the liquid port of the accumulator. The pressure surge relief accumulator is desirably positioned above the pump and has its gas inlet port connected to the gas inlet port of a second pressure compensating accumulator positioned below the first accumulator at a level such that the liquid port of the second accumulator is on substantially the same level as the output of the pump and connected thereto. Desirably, the line connecting the gas ports of the accumulators has a restricted passageway therein and the line connecting the liquid port of the second accumulator to the pump also has a restricted passageway therein.

According to another aspect of the invention, a buffer is interposed between the surge relief accumulator liquid port and the pump output line which substantially prevents passage of liquid from the pump into the accumulator yet permits movement of a column of fluid from

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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 surge relief accumulator port and the line from the pump. Such line desirably adjacent such pump is connected to the liquid port of the pressure compensation accumulator through a restricted passageway and preferably is charged with a non-abrasive, non-corrosive liquid which also fills the relief line and serves as a buffer so that upon operation of such pump, the column of liquid therefrom forced into the relief line will displace the buffer liquid therein for movement of the buffer liquid into the surge relief accumulator to compress the gas therein thereby reducing the effect of the pumping pulsations.

The quantity of buffer liquid in the relief line is desirably greater than the quantity of liquid forced therein by the pulse 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 by means of a suitable pump.

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 one embodiment of the system showing an illustrative application thereof,

Fig. 2 is a view similar to Fig. 1 of another embodiment, and

Figs. 3 and 4 are diagrammatic views of two other embodiments of the invention.

Referring now to Fig. 1 of the drawings, in the illustrative application of the system shown, the system desirably comprises a conventional mud pump 11 driven by a motor 12.

As oil wells need high pressure and large volume pumps to deliver a sufficient quantity of mud in suspension in liquid into the oil well casing to cause the crushed rock and stone due to the drilling action to rise from said casing for discharge into the reservoir, such pumps are generally of the reciprocating type with an intermittent or pulsating output. 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 through junction 16 and line 17 to a junction 18 which in turn is connected by line 19 to the bore 21 of the drill member 22 in the oil well casing 23, the suspension of mud flowing up out of such casing being fed to the reservoir 14.

Connected to junction 18 at one end as at 24, is one end of a relief line 25, the other end 26 of which is connected to the fluid port 27 of a pressure surge relief accumulator 28 of conventional type, such as that put out by Greer Hydraulics, Inc. of Brooklyn, New York, which is positioned above the pump 11. The accumulator 28 may have a poppet valve 29 controlling its port 27 in conventional manner and a movable partition preferably a deformable bladder 31 which is connected to the gas port 32 of the accumulator 28 and through valve 33, line 34, restricted passageway 35 to the gas inlet port 36 of a pressure compensating accumulator 37 of substantially the same type as accumulator 28. The fluid port 41 of accumulator 37, which also is controlled by a poppet valve 42, is desirably connected by line 43 through restricted passageway 44 to junction 16.

The bladder 31 of accumulator 28 desirably has such physical characteristics that when charged to a pressure of say 10 p. s. i., it is slightly distended, being spaced from the wall of the accumulator. For optimum efficiency of the accumulator 28, it is desirable that regardless of the pressure applied to the liquid inlet port 27 from the pump 11 between the pressure surges therefrom, for desired distention of the bladder, a differential of approximately 10 p. s. i. be maintained between the pressure in the bladder 31 and that on the liquid in the accumulator.

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As the accumulator 28 is positioned above the pump 11, the head of the column of liquid in lines 17 and 25 will cause the pressure at the liquid port 27 of accumulator 28 to be less than that at the junction 16. Thus, assuming that the length of the lines 17 and 25 is approximately 20 feet so as to equal $\frac{2}{3}$ of an atmosphere, the differential between the pressure at the outlet 15 of pump 11 and the liquid port 27 will be approximately 10 p. s. i.

If at any stage during the operation of the system the pump 11 between surges is delivering liquid at a pressure of 1,505 p. s. i., the pressure at junction 18, which though it may be at any desired position, illustratively is midway between the pump outlet and the liquid port 27 of accumulator 28, will be 1,500 p. s. i. which is sufficient to move the column of liquid in the well, and the pressure at the port 27 will be 1,495 p. s. i. As the inlet 41 to accumulator 37 is at substantially the same level as the outlet of pump 11, when a pressure of 1,505 p. s. i. is present at the pump outlet, the gas in bladder 40 of accumulator 37 will be compressed to such pressure, thereby similarly charging the bladder 31 of accumulator 28 so that a differential of 10 p. s. i. will still exist between the pressure in the bladder 31 and on the liquid in the accumulator 28, retaining the bladder 31 slightly distended to its desired condition. As the surge from the pump rises say to 1,705 p. s. i., the bladder 31 will be compressed, substantially immediately to absorb such surge thereby preventing injury due to cracking of the rigid fluid lines.

The pulsation or surges from the pump will have little effect on bladder 40 due to the restricted passageway 44 which though it permits flow of liquid and mud into the accumulator 37 will reduce the pressure of such fluid while the restricted passageway 35 will cause the pressure in bladder 40 to rise only slightly with compression of the gas in bladder 31. When the pulse or surge has ceased, the bladder 31 will expand to its normal, slightly distended shape and the bladder 40 will also expand but only slightly as it was not substantially affected by the pressure surge.

It is apparent from the foregoing that at any given depth of the well, the bladder 31 will be distended by the differential pressure of 10 p. s. i. and will be positioned so as to be spaced from the wall of the accumulator 28 and hence may contract and expand without either contacting the wall or the gas inlet port which might cause injury to the bladder.

As the depth of the well increases, greater pressure would be needed to move the column of liquid in such well and the mud pump is designed to provide such needed pressure. Assuming that the pressure required to move the column of liquid is now 2,000 p. s. i. and the pump is delivering mud at a pressure of 2,005 p. s. i., the pressure at the inlet to the accumulator 28 would be 1,995 due to the 10 p. s. i. drop in lines 17 and 25. As the pressure on the liquid applied to the inlet of accumulator 37 from pump 11 would be 2,005 p. s. i., the gas in bladder 40 would be compressed to this pressure and hence the gas in bladder 31 would also be compressed to a pressure of 2,005 p. s. i. with a result that the same 10 p. s. i. differential would be present between the pressure in the bladder 31 and that on the liquid in the accumulator 28 so that the bladder 31 would still be slightly distended as desired.

It is apparent from the foregoing that as the depth of the well increases, the pressure in bladder 31 will automatically be compensated so that between surges a differential of 10 p. s. i. will exist between the pressure in bladder 31 and that on the liquid in the accumulator 28 due to the action of the compensating accumulator 37, the bladder 40 of which will be compressed due to the pressure on the liquid from the pump 11 applied thereto.

Consequently, the bladder 31 at all times between surges regardless of the pressure, will be slightly dis-

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tended and spaced from the wall of the accumulator so that it may be compressed to take up the surges or upon expansion will not rub against the accumulator wall.

As the bladder 40 is substantially unaffected by surges due to the restricted passageway 35 and 44, even though it is materially distorted, it is not likely to rupture and the bladder 40 is of sufficient capacity so that it will supply the required quantity of gas under pressure to retain the bladder 31 inflated.

The embodiment shown in Fig. 2 is in many respects identical to that shown in Fig. 1 and corresponding parts have the same reference numerals primed. In this embodiment in addition to the surge relief, means are provided to prevent injury to the bladder of the surge relief accumulator by abrasive particles from the mud pump.

Referring now to Fig. 2 of the drawings, the relief line 25' which is connected through junction 18', line 17' to the output of pump 11', desirably has an inlet port 51, adjacent the port 27' of the accumulator 28', which is connected by line 52, through restricted passageway 53, to a junction 54. The junction 54 is connected by line 55 to the output 56 of a pump 57, desirably of a constant flow type, which may be driven by a suitable motor 58. The inlet 59 of pump 57 is desirably connected to a reservoir 61 which may contain a non-abrasive liquid such as fresh water, desirably of specific gravity less than that of the liquid from the pump 11'. The junction 54 is also connected by line 62 to the liquid port 63 of a pressure compensation accumulator 64 illustratively of the type comprising a cylinder 65 having a piston 66 slidably mounted between the liquid port 63 and gas inlet port 67, the latter being connected by line 68 through restricted passageway 69 to valve 33' to which the gas inlet port 32' of accumulator 28' is also connected.

The volume of relief line 25' between port 27' and junction 18' is desirably greater than the volume of liquid forced into line 25' by pump 11' which would cause the pressure in the lines 17', 19' and 25' to rise above a predetermined or permissible value which might rupture such lines.

In the operation of the system, shown in Fig. 2, after the accumulators are initially charged with gas under pressure through valve 33', the fresh water pump 57 is actuated to force water from reservoir 61 through line 55, junction 54 and line 62 into the liquid port 63 of accumulator 65 and through restricted passageway 53 and line 52 into port 51 and thence into accumulator 28' and line 25'. As such water flows into accumulator 64 it will move the piston 66 therein thereby compressing the gas in such accumulator and also compressing the gas in accumulator 28'.

If at any stage during the operation of the system shown in Fig. 2, the pump 11' between surges is delivering liquid at a pressure of 1,505 p. s. i., the pressure at junction 18' which is illustratively midway between the pump outlet and the liquid port 27' of accumulator 28' will be 1,500 p. s. i. which is sufficient to move the column of liquid and water in the well casing 23', and the pressure at the liquid port 27' will be 1,495 p. s. i.

As the liquid inlet 63 of accumulator 64 is connected to relief line 25' adjacent liquid port 27' where the pressure is say 1,495 p. s. i., this pressure plus the pressure due to the column of liquid in line 52, i. e., 10 p. s. i., will be applied to the liquid port 63 of accumulator 64 for a combined pressure of 1,505 p. s. i.

Consequently, when a pressure of 1,505 p. s. i. is present at the outlet of the pump 11', the gas in accumulator 64 will be compressed to such pressure thereby charging the bladder 31' to the same pressure so that a differential of 10 p. s. i. will still exist between the pressure in the bladder 31' and on the liquid in accumulator 28', retaining the bladder 31' slightly distended to its desired condition.

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As the surge pressure from the pump rises to say 1,705 p. s. i., the water in line 25' will be displaced upwardly as a column and forced through liquid port 27' of the accumulator 28' to compress the bladder 31'. As the result of the compression of such bladder, the pressure surge due to the pulsating output of the pump 11' will be substantially absorbed thereby preventing cracking or breaking of lines 17', 19' and 25' which might otherwise result.

By reason of the fresh water in line 25', even if some mud should flow into the accumulator 28', it would be sufficiently dispersed so that it would have substantially no abrasive action on the poppet valve 29' or the accumulator bladder 31'. After the peak of the pulse from the mud pump 11' has been attained, the pressure will thereupon drop. Consequently, the bladder 31' will expand to force the liquid in the accumulator 28' out of port 27' and the constant flow of fresh water from the pump 57 will provide a cleaning action for the accumulator and the line 25' to remove substantially all of the abrasive particles which may be forced therein during the peak of the mud pump action.

By reason of the restricted passageway 53 in line 52, the pressure surges by reason of the pulsating mud pump action will have substantially no effect on the accumulator 64 and as the bladder 31' of accumulator 28' is compressed, the restricted passageway 69 will also prevent the gas from flowing freely through line 68 thereby causing it to have substantially no effect on the gas pressure in accumulator 64.

As the depth of the well increases and the mud pump 11' and water pump 57 operate to deliver liquid under greater pressure, the gas in accumulator 28' will be further compressed. Assuming that the mud pump is delivering fluid at a pressure of 2,005 p. s. i., as previously described, the pressure at the liquid port 27' of accumulator 28' would be 1,995 p. s. i. due to the 10 p. s. i. drop in lines 17' and 25' and the gas in accumulator 64 will be compressed to 2,005 p. s. i. due to the column of liquid in line 52 with the result that the same 10 p. s. i. differential would be present between the pressure in the bladder 31' and that on the liquid in accumulator 28' so that the bladder 31' would still be slightly distended as desired for optimum efficiency as previously described with respect to the embodiment shown in Fig. 1.

Although in the illustrative embodiments of the invention, shown in Figs. 1 and 2, each accumulator has a movable partition intervening between the liquid and the gas, it is within the scope of the invention to dispense with such partition in one or more of the accumulators.

Thus, referring to Fig. 3, as the accumulator 75 is in vertical position, when liquid forced from the pump 77 enters the liquid port 78 of accumulator 75, the level of the heavier liquid at the bottom of the accumulator will rise to compress the gas thereabove, thereby increasing the pressure in accumulator 79 to compensate for pressure increase in the system due to the increased depth of the well.

With respect to the system shown in Fig. 4, the level of the liquid in accumulator 76 will fluctuate with pressure surges in the system and the gas above the liquid will be forced into accumulator 81. As the depth of the well increases, the pressure on the liquid forced into accumulator 81 will increase the gas pressure in accumulator 76 to compensate for pressure increase in the system due to the increased depth of the well.

As the systems shown in Figs. 3 and 4 operate in substantially the same manner as the system shown in Fig. 1, no further description of such operation will be made.

As many changes could be made in the above system and equipment, 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. As an example: an embodiment could be to replace the resilient bladder by a piston associated to a spring compensating the difference of level between the two accumulators.

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 pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator having a liquid port connected to the outlet of said pump, a gas port and a movable partition intervening between said ports, a feed line connected to the outlet of said pump and a second pressure accumulator having a movable partition, a liquid port on one side of said partition connected to the outlet of said pump, a gas port on the other side of said partition connected to the gas port of said first accumulator and means to reduce the surge pressure from the pump on the liquid forced into the second pressure accumulator and to reduce the surge pressure on the gas forced into the second pressure accumulator from the first pressure accumulator.

2. The combination set forth in claim 1 in which the means to reduce the surge pressure is a pair of restricted passageways one of which is provided between the liquid port of said second accumulator and the outlet of said pump and the second of which is provided between the gas ports of said two accumulators.

3. The combination set forth in claim 1 in which said first accumulator is positioned above the level of said pump, a line connects the outlet of said pump to the liquid port of said first accumulator and said feed line is connected to said line.

4. A system of the character described comprising a pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator positioned above the level of the outlet of said pump, said pressure accumulator having a liquid port, a gas port and a movable partition therebetween, a line connecting the outlet of said pump to the liquid port of said pressure accumulator, a feed line connected to said line, a second pressure accumulator having a movable partition, a liquid port on one side of said partition and a gas port on the other side of said partition, a line providing communication between the outlet of said pump and the liquid port of said second accumulator, a restricted passageway in said line, a line connecting the gas ports of said two accumulators and a second restricted passageway in said last named line.

5. The combination set forth in claim 4 in which the outlet of said pump and the liquid port of said second accumulator are at substantially the same level and the line providing communication therebetween is connected at one end to said liquid port and at its other end to the line from said pump outlet adjacent the latter.

6. The combination set forth in claim 4 in which the vertical distance between the outlet of said pump and the liquid port of said first accumulator is predetermined to provide a desired difference between the pressures on the liquid delivered to the liquid ports of said two accumulators.

7. A system of the character described comprising a pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator having a liquid port, a gas port and a movable partition between said ports, a line connecting the outlet of said pump to the liquid port of said accumulator, a feed line connected to the outlet of said pump, a buffer in said first line between said pressure accumulator and said feed line, said buffer being movable in said line, a second pressure accumulator, having a movable partition, a liquid port on one side of said partition connected to the outlet of said pump, a gas port on the other side of said partition connected to the gas port of said first accumulator and

means to reduce the surge pressure from the pump on the liquid forced into the second pressure accumulator and to reduce the surge pressure on the gas forced into the second pressure accumulator from the first pressure accumulator.

8. The combination set forth in claim 7 in which said buffer comprises a liquid.

9. The combination set forth in claim 7 in which said buffer comprises a non-abrasive liquid of specific gravity less than that of the liquid from said pump.

10. The combination set forth in claim 7 in which said buffer comprises a non-abrasive liquid of specific gravity less than the liquid from said pump and means are provided to deliver a continuous supply of such non-abrasive liquid to the line between the pressure accumulator and the feed line.

11. A system of the character described comprising a pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator positioned above the level of the outlet of said pump, said pressure accumulator having a liquid port, a gas port and a movable partition therebetween, a line connecting the outlet of said pump to the liquid port of said pressure accumulator, a feed line connected to said line, a second pressure accumulator having a movable partition, a liquid port on one side of said partition and a gas port on the other side of said partition, a second line providing communication between the outlet of said pump and the liquid port of said second accumulator, means in said second line to reduce the surge pressure from the pump on the liquid forced through said second line, a second pump having its outlet connected to said line to charge the latter with a second liquid, a line connecting the gas ports of said two accumulators and means in said last named line to reduce the surge pressure on the gas forced into the second accumulator from the first accumulator.

12. The combination set forth in claim 11 in which the volume of the line between the first accumulator and the feed line is greater than a predetermined portion of the volume of the liquid forced from said first pump during each pumping cycle.

13. A system of the character described comprising a pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator positioned above the level of the outlet of said pump, said pressure accumulator having a liquid port, a gas port and a movable partition therebetween, a line connecting the outlet of said pump to the liquid port of said pressure accumulator, a feed line connected to said line between said liquid port and said pump outlet, the volume of the portion of said line between said feed line and said liquid port being greater than a predetermined portion of the volume of liquid forced from said pump during each pumping cycle, a second pressure accumulator having a movable partition, a liquid port on one side of the partition and a gas port on the other side, a second line connected at one end to said first line adjacent the liquid port of said first accumulator and at its other end to the liquid port of said second accumulator, a restricted passageway in said line, means to force a second liquid into said second line, a line connecting the gas ports of said accumulators, and a restricted passageway in said last line.

14. The combination set forth in claim 13 in which the outlet of said pump and the liquid port of said second accumulator are at substantially the same level and the means to force a second liquid into said second line comprises a second pump.

15. A system of the character described comprising a pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator having a liquid port connected to the outlet of said pump and a gas port, a feed line connected to the outlet of said pump and a second pressure accumulator below the level of the first accumulator having a liquid port connected to the outlet of said pump and a gas port connected to the gas port

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of said first accumulator and means to reduce the surge pressure from the pump on the liquid forced into the second pressure accumulator and to reduce the surge pressure on the gas forced into the second pressure accumulator from the first pressure accumulator.

16. A system of the character described comprising a pump of the pulsating output type for delivering a liquid under pressure, a pressure accumulator having a liquid port connected to the outlet of said pump and a gas port, a feed line connected to the outlet of said pump and a second pressure accumulator below the level of the first accumulator having a liquid port connected to the outlet of said pump and a gas port connected to the gas port of said first accumulator, means to reduce the surge pressure from the pump on the liquid forced into the second pressure accumulator and to reduce the surge pressure on the gas forced into the second pressure accumulator from the first pressure accumulator, said two

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accumulators being at different levels, one accumulator having a movable partition between its liquid and gas ports and the other accumulator having its gas port at a level higher than its liquid port.

5 17. The combination set forth in claim 16 in which the first accumulator is at a level above that of the second accumulator and the movable partition is in said first accumulator.

10 18. The combination set forth in claim 16 in which the first accumulator is at a level above that of the second accumulator and the movable partition is in the second accumulator.

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