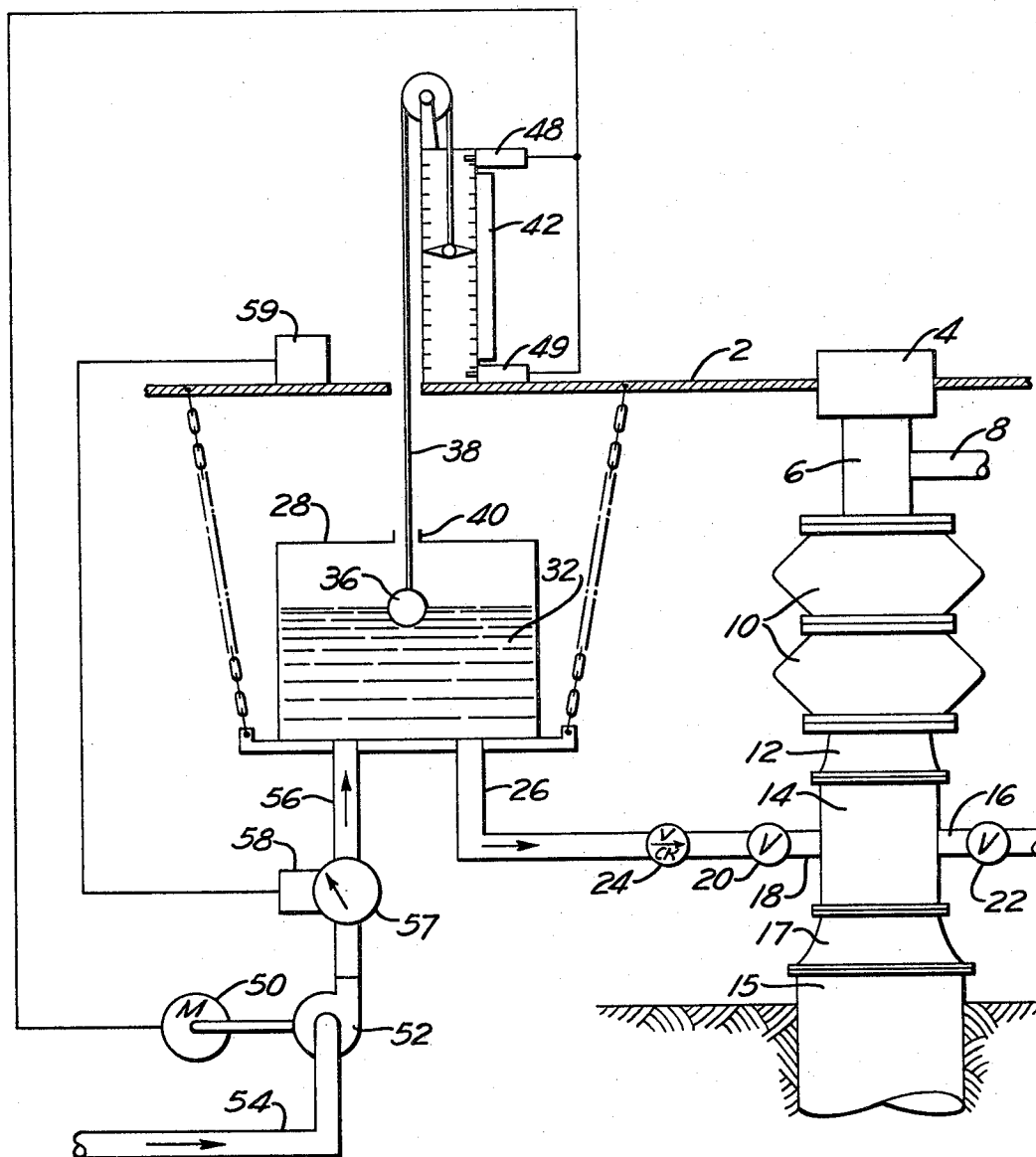


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AUTOMATIC HOLE FILLER AND INDICATOR

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AUTOMATIC HOLE FILLER AND INDICATOR
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ABSTRACT OF THE DISCLOSURE

Apparatus for maintaining the liquid level in the borehole of a well in which a mud tank containing liquid is positioned below the level of a mud return line through which drilling mud is discharged from the well. A mud line extending from the mud tank opens into the well at a position below the level of the mud tank. A check valve in the mud line permits flow only in the direction from the mud tank to the well.

This invention relates to an improved apparatus for maintaining the fluid level at a constant height in a well bore and indicating the delivery of fluid to the well bore.

During drilling operations it is advantageous to maintain the well bore filled with drilling mud at all times. To maintain such a full hole status it is necessary to add fluid to the well bore when certain conditions cause a lowering of the fluid level within the well bore. One drilling operation which causes a lowering of the drilling fluid within a well bore is the necessary practice of the pulling the drill stem from the hole to replace worn drilling bits. When the drill stem is withdrawn from the hole there is a lowering of the fluid level within the hole caused by the absence of the drill stem body which had previously displaced a considerable amount of fluid. The fluid level in a well bore may also be lowered by the filtration of a portion of the liquid into porous formations.

A modern drilling operation's practice is to maintain, within the borehole, a drilling mud whose hydrostatic head will produce a bottom-hole pressure only slightly in excess of the blowout pressures expected to be encountered. It has been found that drilling rates may be increased and mud costs lowered by utilizing such a light drilling mud. When the back pressure held on the formation face by the mud's hydrostatic head is further decreased by a lowering of the level of the mud in the well bore, there then exists the danger of a potential blowout. Due to the fact that a well may be more readily killed when an operator has his drill stem near the bottom of the well, it thereby becomes most important to maintain the borehole full when the drill stem is being removed or is completely out of the hole.

The method heretofore employed to maintain full hole conditions during withdrawal of the drill stem has been for the operator to intermittently terminate withdrawal of the pipe and manually fill the hole. To so shut down the operations of the rig in order to maintain full hole conditions represents a waste of considerable rig time. This proves to be a costly practice. In addition the well may be endangered by the driller miscalculating how often to fill the well bore or by the misfortune of having a less than prudent driller who may completely neglect to fill the hole while removing the drill pipe.

Our invention will forego the possibility of encountering blowouts which are caused by a decrease of the fluid level within the well bore. My apparatus consists of a mud tank placed above the bottom of the blowout preventer with a line connecting this tank, through a check valve, to the casing of the well. By positioning this tank at a height below the drilling mud system's mud recovery line and

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above the connection to the well bore, the mud from the tank will gravitationally flow from the tank into the well when the mud level in the well falls below the liquid level in the mud tank. The check valve, positioned in the mud discharge line between the casing and the mud tank, will prevent well fluids from entering the mud tank during drilling operations while liquid is continuously being discharged from the well bore.

In the accompanying drawing:

The drawing is a diagrammatic view, partially in vertical section, of a well and drill equipment upon which the apparatus of my invention is installed.

Referring to the drawing, reference numeral 2 represents the rig floor on which is mounted the rig turntable 4. Immediately below the turntable 4 is positioned the mud conductor pipe 6 to which is attached a mud recovery line 8 through which mud is returned to the surface during drilling operations. Below the mud conductor pipe 6 there is a system of blowout preventers 10 which are attached by a blowout preventer spool 12 to the casing nipple 14. The casing nipple 14 of the well generally possesses two outlets 16 and 18 normally described as kill lines. Both kill lines 16 and 18 are normally closed by manually operated kill valves 20 and 22 connected to the casing 14. The casing nipple 14 is attached to the casing of the well 15 by a casing spool 17.

Our invention utilizes one of the kill lines 18 and positions the kill valve 20 in an open position. Attached to the kill valve 20 is a check valve 24 with the discharge end opening into the well. A discharge mud line 26 extends from the lower portion of the mud tank 28 to the check valve 24. The mud tank 28 is preferably suspended from the rig floor 2 by chains 30 or other means suitable in strength to sustain the loads imparted upon the chain suspension system 30 by the mud tank 28 and the mud 32 contained therein. The mud tank 28 may, however, be placed at any convenient location on the drilling site so long as proper height of the tank 28 is maintained to permit gravity drainage from the tank 28 into the well.

Due to the expected volume of fluid needed to maintain a constant fluid level in most wells, the mud tank in this invention is sized to contain approximately 30 barrels. Although this tank may be sized to contain a greater or lesser volume, we prefer a tank with a 30 barrel capacity. In the drilling of most wells, a mud volume of 30 barrels will generally be adequate to replace the casing volume occupied by the drill stem.

A float 36 is suspended within the mud tank 28. A wire line 38, or other suitable material, is attached to the float 36 and extended upward through a port 40 in the tank 28. This wire line 38 passes upward through the rig floor and is attached to an electrical signal means 42 and electrical control means 48 and 49 located on the rig floor.

During the withdrawal of the drill stem or in the event the formation takes fluid, the fluid level in the casing 14 will be lowered to a point below the fluid level in the mud tank 28. As the fluid in the well bore drops below the fluid level in the mud tank 28, mud 32 from the mud tank 28 will gravitationally flow through the discharge mud line 26 and into the well thereby maintaining a constant fluid level within the well bore.

As fluid is emitted from the mud tank 28 the float 26 will be correspondingly lowered into the tank 28 thereby drawing more wire line 38 into the mud tank 28. The uppermost end of the wire line 38 will be connected to electrical signal means 42 installed on the rig floor 2. This electrical signal means 42 will be adapted with two contact warning systems 42. One contact warning system 42 will visually indicate the volume of fluid within the mud tank. A second contact warning system 42 will be manually energized upon the complete removal of the

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drill stem from the well bore. After this second contact warning system 42 has been manually energized, any lowering of fluid level within the mud tank will electrically operate to produce a signal, thereby warning the operator that the well is taking fluid from the mud tank 28.

The mud tank 28 will be automatically filled with mud 32 by operation of the control means, thereby negating the necessity for the operator to stop work and fill the mud tank. This control means will be particularly advantageous where the well demands great volumes of fluid to maintain the well bore in a filled condition. An example of such a condition would be in the case of serious fluid losses into a porous formation.

This electrical control means consists of an upper micro switch 48 and a lower microswitch 49, actuated by the float and adapted to start and stop an electric motor 50 connected to a centrifugal pump 52. The intake of the mud pump 52 is connected to an intake pump line 54 which will deliver mud from the drilling mud pit (not shown) to the mud pump 52. The discharge of the mud pump 52 is connected to the tank 28 through fill line 56.

The two microswitches 48 and 49 are utilized to automatically replenish the supply of mud 32 in the mud tank 28 when the level of the mud 32 has decreased to a predetermined level. As mud 32 gravitationally flows from the mud tank 28 the level of the mud in the mud tank 28 will lower to a point which will actuate micro switch 48. This upper microswitch 48 will actuate the electric motor 50 and start the mud pump 52. Mud pump 52 will deliver mud 32 from the drilling mud system (not shown) to the mud tank 28. The addition of this mud 32 to the mud tank 28 will cause the mud level within the mud tank 28 to rise. As the mud level reaches the top of the mud tank 28 the float 36 will raise and energize the lower microswitch 49. A signal from the energized lower microswitch 49 will operate to stop the electric motor 50 and the mud pump 52.

A positive displacement meter 57, equipped with an impulse transmitter 58 will be connected to the discharge of the mud pump 52. Fluid discharged from the mud pump 52 will be measured by the positive displacement meter 57 and discharged into the mud tank fill line 56. Fluid measurements by the positive displacement meter 57 will be transmitted by the impulse transmitter 58 to an electrically operated counter 59 which will record, preferably in $\frac{1}{10}$ barrel measurements, the amount of mud 32 delivered to the mud tank. An accurate record of the volume of mud delivered to the well during periods of drill stem withdrawal or fluid losses may thereby be maintained.

In the operation of this invention a mud tank, with a preferred capacity of approximately 30 barrels and adjustable in height, will be positioned near the well and at a height slightly below the outlet of the drilling mud recovery line and above the mud tank's inlet into the well. The lower end of this mud tank will possess a discharge mud line connected preferably to the kill line of the casing. This discharge line may however be connected to any portion of the casing below the mud recovery line. Mud contained in the mud tank of this invention will thereby have access to the annular space formed by the drill stem and the casing of the well.

As the drill stem is being pulled from the well the fluid level within the well will be lowered by the removal of the drill stem which previously had been displacing a portion of the drilling mud within the well bore. The drilling fluid within the well bore may likewise be lowered when porous formations begin to take fluid. By having a mud supply in communication with the well bore, fluid contained in the mud tank will gravitationally flow into the casing and maintain the liquid in the well bore at a level corresponding to the level of liquid in the mud tank. Maintaining the well bore in a continuously filled condition will eliminate the possibility of blowouts caused by a decrease in bottom

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hole pressure exerted by the hydrostatic head of fluid in the well bore.

Float means and electrical signal and control devices are installed in conjunction with the mud tank. The signal devices of this invention are adapted to continuously indicate the fluid level with the mud tank and to warn the operator of any fluid flow from the mud tank during periods when the well is shut-in. The electrical control device is utilized to automatically fill the mud tank when the mud level within the mud tank is lowered to a predetermined height.

A positive displacement meter is utilized in this invention to measure the amount of fluid delivered to the mud tank. The recording of this measurement will maintain an accurate record of mud deliveries to the well by this automatic well filling apparatus.

Our invention will thereby operate to maintain a well bore in a filled condition and forestall the possibility of encountering blowouts caused by a decrease of fluid level within the well bore.

Therefore we claim:

1. In an apparatus for drilling a well in which casing extends down the well, drill pipe extends down the well within the casing, and drilling mud is circulated down through the drill pipe, returned up through the annulus surrounding the drill pipe and discharged from the well through a mud return line, apparatus for maintaining the well full of drilling mud comprising a mud tank positioned below the level of the mud return line, a mud line from the tank opening into the well at a position below the level of the mud tank, and a check valve in the mud line permitting flow from the mud tank to the well and eliminating backflow from the well into the mud tank.

2. An apparatus for maintaining the liquid level in a well bore comprising a mud tank positioned below the level of a mud return line through which mud is discharged from the well, a mud line from the mud tank opening into the well below the level of the mud tank, and a check valve in the mud line permitting flow from the mud tank to the well and eliminating backflow from the well into the mud tank.

3. An apparatus for maintaining the liquid level in a well bore comprising a mud tank adjustable in height positioned below the level of a mud return line through which mud is discharged from the well, a mud line from the mud tank opening into the well below the level of the mud tank, and a check valve in the mud line permitting flow from the mud tank to the well and eliminating backflow from the well into the mud tank.

4. An apparatus for maintaining the liquid level in a well bore and indicating the flow of liquid into the well bore comprising a mud tank adjustable in height positioned below the level of a mud return line through which mud is discharged from the well, a float located within the mud tank, electrical signal means operated by the float to indicate the amount of liquid and any change of liquid level within the mud tank, a mud line from the mud tank opening into the well below the level of the mud tank, and a check valve in the mud line permitting flow from the mud tank to the well and eliminating backflow from the well into the mud tank.

5. An apparatus for maintaining the liquid level in a well bore, measuring and recording the amount of liquid delivered to the well bore and automatically supplying mud to a mud tank comprising a mud tank adjustable in height positioned below the level of a mud return line through which mud is discharged from the well, a float located within the mud tank, upper and lower microswitches operated by the float and adapted to actuate and deactuate an electric motor, a pump operated by the electric motor, an intake line whose intake end is connected to the drilling mud system and whose outlet end is connected to the intake of the pump, a mud fill line from the pump to the mud tank, a positive displacement meter equipped with an impulse transmitter located in the mud

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fill line, an electrical counter adapted to be operated by the positive displacement meter, a mud line from the mud tank opening into the well below the level of the mud tank, and a check valve in the mud line permitting flow from the mud tank to the well and eliminating backflow from the well into the mud tank.

6. An apparatus for maintaining the liquid level in a well bore, indicating the flow of liquid into the well bore, measuring and recording the amount of liquid delivered to the well bore and automatically supplying mud to a mud tank comprising a mud tank adjustable in height positioned below the level of a mud return line through which mud is discharged from the well, a float located within the mud tank, electrical signal means operated by the float to indicate the amount of liquid and any change of liquid level within the mud tank, upper and lower microswitches operated by the float and adapted to actuate and deactuate an electric motor, a pump operated by the electric motor, an intake line whose intake end is connected to the mud system and whose outlet end is con-

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nected to the intake of the pump, a mud fill line from the pump to the mud tank, a positive displacement meter equipped with an impulse transmitter located in the mud fill line, an electrical counter adapted to be operated by the positive displacement meter, a mud line from the mud tank opening into the well below the level of the mud tank, and a check valve in the mud line permitting flow from the mud tank to the well and eliminating backflow from the well into the mud tank.

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