

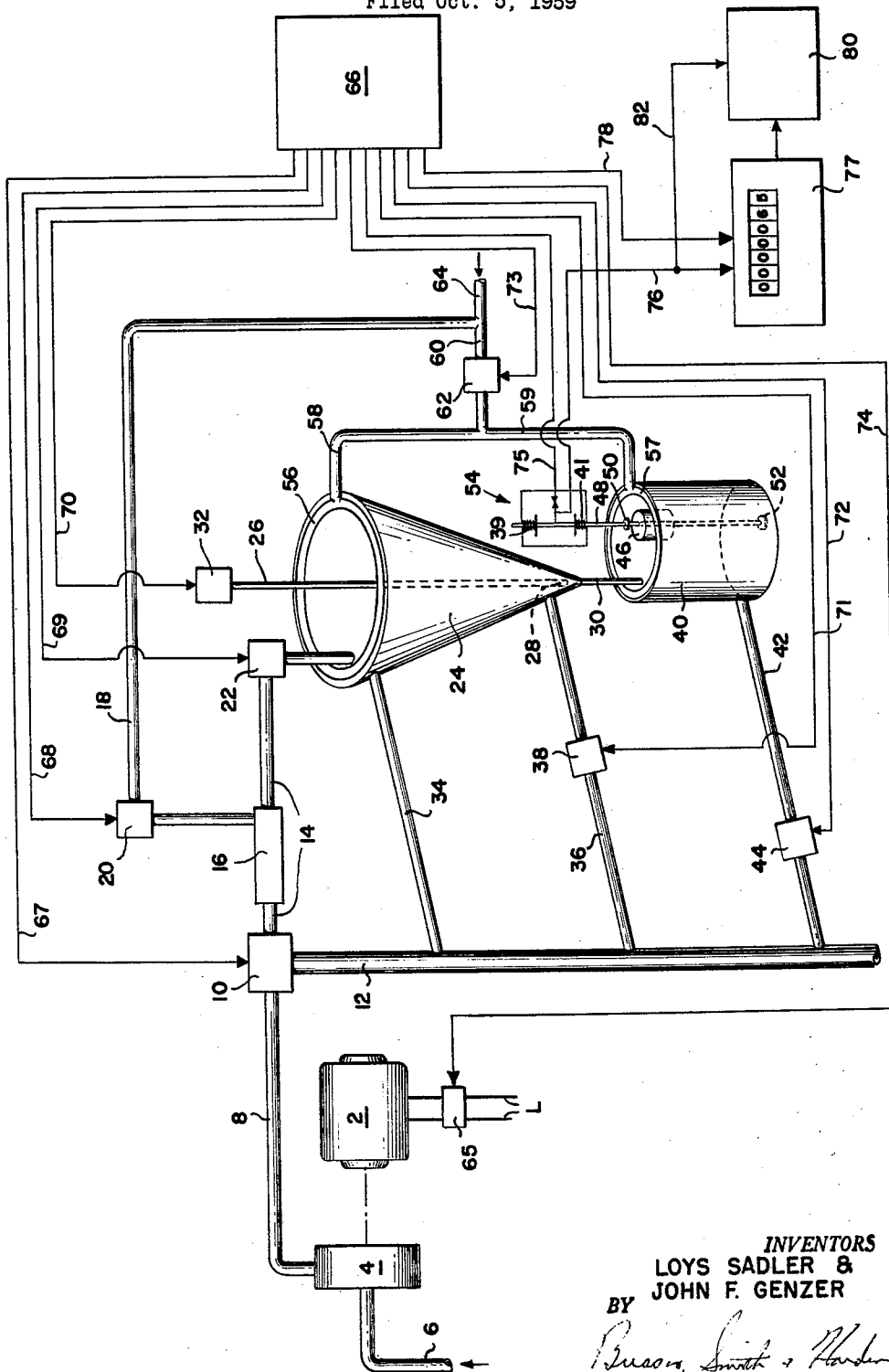
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AUTOMATIC VISCOSITY MEASUREMENT

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AUTOMATIC VISCOSITY MEASUREMENT

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9 Claims. (Cl. 73—55)

This invention relates to means for automatically indicating and, if desired, recording the viscosity of a liquid substance. More particularly, the invention relates to means for automatically and continuously indicating the viscosity of the mud normally circulated in a bore hole during well drilling.

Since a low viscosity of the circulated mud will result in settling of the cuttings and sticking of the drill pipe, and high viscosity may cause the required high circulating pressure to fracture the formation and cause lost circulation, it is obviously important that viscosity be maintained within close limits by proper proportioning of liquid (water), chemicals and/or clay, etc.

According to present day methods of measuring and indicating viscosity a manual spot check is taken intermittently by flowing a given quantity of mud through a funnel and measuring in seconds the time required to fill a graduated cup with a standard volume. For example, a funnel holding about 1500 cc. and having a standard efflux tube is emptied into a one quart cup.

It will be readily appreciated that such a manner of checking viscosity in order to determine whether and to what extent the consistency of mud should be adjusted requires the employment of personnel and is subject to the disadvantage that spot checks may not be made frequently enough and with sufficient accuracy. Accordingly, it is an object of the invention to provide a complete system which is automatic in its operation, which does not require the attendance of personnel, which is accurate and which, if desired, will produce a continuous record of viscosity as well as periodic readings.

Further objects and advantages will become apparent from the following description, read in conjunction with the accompanying drawing which is a schematic representation of the mechanical and electrical elements which make up the invention.

Referring to the drawing, an electric motor 2 is employed to drive a pump 4, which may be of the centrifugal or other suitable type, and which draws mud from an inlet line or conduit 6 and discharges it through conduit 8. A conventional three way valve 10 is provided in the conduit 8 and may be operated in the usual manner to divert flow from the conduit 8 to a drain 12 or to a conduit 14. In a third position the valve 10 provides communication between conduit 14 and drain 12 and cuts off conduit 8. A screen 16 is provided in conduit 14 to hold large solid particles but to pass the small dispersed particles of the mud, and a fresh water supply line 18 is adapted for connection with screen 16 to backwash the screen (i.e., back toward valve 10) upon opening of a valve 20.

A valve 22 is installed in conduit 14 to control the flow of mud to a funnel 24 which may be of the type sometimes referred to as a "Marsh" funnel. There is provided a vertically movable rod 26 having a stem 28 adapted to fit closely within the efflux tube or orifice 30 of funnel 24, and when rod 26 is in its lower position it effectively cuts off the flow of mud through funnel 24. This rod 26 is electrically operated by conventional solenoid means 32 in a manner which will be described hereafter. An outlet conduit 34 discharging into drain 12 is provided at the upper rim of funnel 24 while a second outlet conduit 36, which is opened and closed by

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a valve 38, is provided at the lower end of funnel 24 and also discharges into drain 12.

A standard cup or bucket 40 having a known volume is positioned to receive the discharge from efflux tube 30 and empties through an outlet conduit 42 controlled by a valve 44. Within cup 40 a float 46 slides on a rod 48 having fixed thereon upper and lower abutments 50 and 52, respectively. The rod 48 is vertically movable within limits to control a switch 54, the operation of which will be discussed in greater detail hereafter. For the time being, however, when cup 40 is filled with mud the float 46 will rise to the top of cup 40 and will abut the abutment 50, tending to lift rod 48 upwardly. When cup 40 is empty the float 46 will rest on abutment 52, tending to move rod 48 downwardly. The rod 48 is normally urged to its intermediate position by springs 39 and 41 in the absence of displacement by float 46.

A spray ring 56 is disposed around the upper rim of funnel 24 and a similar spray ring 57 is disposed around the upper rim of cup 40. The spray rings 56 and 57 comprise conduits having spray nozzles on their undersides adapted to direct sprays of fresh water against the sides of funnel 24 and cup 40, respectively, to wash away mud previously deposited on the sides. Spray rings 56 and 57 are respectively supplied with fresh water from lines 58 and 59, which are connected to a high pressure line 60 via a valve 62. The line 18 for backwashing screen 16 and line 60 for spray rings 56 and 57 may have a common high pressure water supply line 64.

The valves 10, 20, 22, 38, 44 and 62 are electrically operated through solenoids. Such valves are conventional and therefore have been only schematically illustrated.

Motor 2, three way valve 10, valves 20, 22, 38, 44 and 62 and solenoid 32 are electrically controlled in their operation by a sequence timer 66. Such timers are well-known and serve to energize or de-energize various circuits connected thereto according to a preset time cycle. Since the operation of such timers is well-known, all of the electrical connections of the system have not been shown in detail, but it will be understood that the schematic conventions employed represent lines of electrical control between the sequence timer and the various solenoid valves, etc. The valve 10 is set in any of its three positions by timer 66 through a connection schematically represented at 67 and according to a cycle of operation to be described hereafter. Similarly, the solenoid valves 20 and 22 are operated by timer 66 through schematically represented connections 68 and 69 respectively, while solenoid 32 is operated through connection 70. Solenoid valves 38 and 44 for the funnel and cup drain lines, respectively, are operated by the timer 66 through schematically represented connections 71, 72. Motor 2 derives its power through power lines L in which is interposed a switch 65 operated by timer 66 through connection 74 to control operation of the motor.

It has been previously mentioned that when float 46 is in its uppermost and lowermost positions, as determined by the level of mud in cup 40, the rod 48 will be moved upwardly and downwardly respectively. When rod 48 is in either its uppermost or lowermost position, the switch 54 is open; but when float 46 is in any position intermediate abutments 50 and 52, the rod 48 likewise is in its intermediate position and switch 54 is closed. When switch 54 is open, a line of control, comprising connections represented at 75 and 76, between timer 66 and an elapsed time counter 77 is interrupted, while closing of switch 54 connects counter 77 to timer 66 for control thereby. However, when switch 54 is closed, the counter 77 will not operate unless line 75 and switch

54 are energized by timer 66. If, therefore, the float 46 is in an intermediate position and switch 54 is accordingly closed at a time when the line 75 is energized, counter 77 will operate. The counter 77 is adapted to be reset to zero by timer 66 through a second connection schematically represented at 78.

Proceeding now to the operation of the invention, at the beginning of a cycle of operation the three way valve 10 is open from supply conduit 8 to drain 12 and the motor switch 65 is closed by timer 66 to initiate operation of the pump driving motor 2. At this time, the back spray valve 20 and spray ring valve 62 are closed, funnel inlet valve 22 and funnel outlet valve 38 are open, and cup outlet valve 44 is closed. Rod 26 has been lowered by solenoid 32 and the open switch 54 is energized from timer 66.

After pump 4 has delivered mud to drain 12 for a sufficient amount of time to insure the supply of a fresh and representative sample, timer 66 operates three way valve 10 to connect conduits 8 and 14. As mud flows for a time interval through open valve 22 into funnel 24 and out through the funnel outlet conduit 36, timer 66 will close valve 38 and funnel 24 will begin to fill. The timer 66 will continue operation of pump driving motor 2 for an interval sufficient to fill funnel 24 and allow overflow to the drain, whereafter it will close funnel inlet valve 22 and open switch 65 to stop the motor 2. A further delay follows to allow mud to flow through upper outlet conduit 34 to drain 12 to insure a definite mud level in the funnel, after which timer 66 operates solenoid 32 to lift rod 26, permitting discharge of mud through efflux tube 30 and into cup 40. Immediately upon upward movement of float 46 from its rest on abutment 52, due to its being floated on the rising mud in the cup, rod 48 will be free to return to its normal intermediate position and close switch 54. The operation of counter 77 is initiated by this closing of switch 54. As soon as a standard quantity of mud is discharged into cup 40, the float 46 will engage upper abutment 50 to raise rod 48 and open switch 54, thereby stopping and disconnecting from timer 66 the counter 77. Timer 66 then opens funnel outlet valve 38 and cup outlet valve 44, and de-energizes switch 54 so that subsiding of the mud level in cup 40 and lowering of float 46 will not cause re-closing of switch 54 and re-starting of counter 77. Thus, the reading of elapsed time on counter 77 is maintained.

The washing operation of the system is initiated by timer 66 after sufficient time has elapsed to permit emptying of funnel 24 and cup 40. The timer 66 operates three way valve 10 to connect conduit 14 and screen 16 with the drain 12, and the solenoid valve 20 is opened to cause fresh water from line 18 to wash residue collected on screen 16 back into drain 12. The timer 66 also causes valve 62 to open and fresh water under pressure will then flow to spray rings 56 and 57 to wash down the sides of the funnel and cup.

After the washing operation, backwashing valve 20 and spray ring valve 62 will be closed by timer 66. The timer 66 will allow a certain amount of time to permit draining of the funnel and cup, whereafter the system will be conditioned for the next cycle of operation. This involves resetting to zero of the counter 77 by timer 66 through connection 78, and energizing switch 54 through connection 75. The timer 66 will operate three way valve 10 to connect conduit 8 to drain 12 and solenoid 32 will be operated to lower the rod 26 into efflux tube 30. The timer will also close the cup outlet valve 44 and will open the funnel inlet valve 22. Thus, the system comprising the invention is now conditioned as described at the beginning of this description and is ready to repeat an identical cycle of operation.

If desired, a conventional readout device 80 may be provided responsive to the counter 77 to produce a printed record of the elapsed time for each and every run of

mud through the funnel. Readout device 80 is connected to the sequence timer 66 via connection 82 whereby, as will appear from the drawing, the readout device 80 will be operative during the operation of counter 77.

Although solenoid valves have been employed according to the present disclosure, the valves could be pneumatically or electro-pneumatically controlled. The switches and rod 26 operating means could be similarly controlled. Sequence timers suitable for handling these various types of systems are commercially available and may be selected accordingly.

As desired, the sequence timer may be caused to automatically and continuously repeat the cycle of operation or it may automatically do so at preset intervals. Alternatively, the operation of the sequence timer may be initiated manually to carry out only a single cycle of operation.

It will be understood that the efflux time in seconds is to be recorded because according to the standard measurement of viscosity, the efflux time of a given quantity of liquid through a standard orifice is an indication of viscosity. It will also be understood that within the invention it is contemplated that means may be provided for automatically regulating the consistency of mud in the bore hole in response to readings or signals of the elapsed time counter 77 or readout device 80.

Various departures from the specifically disclosed embodiment of the invention may be made without departing from the scope thereof as defined by the following claims.

What is claimed is:

1. An automatic viscosity measuring device comprising a container having an outlet, means for delivering a quantity of liquid to said container, a receiver for the discharge from said container, and means responsive to the liquid level in said receiver for measuring and providing a direct reading of the time which elapses in the rise of said liquid from a first level to a second level in the receiver.

2. An automatic viscosity measuring device comprising a funnel, means for delivering a quantity of liquid to said funnel, a cup receiving the discharge from said funnel, a float in said cup adapted to move upwardly with the rise of liquid therein from a first level to a second level, and means responsive to the liquid level in said cup for measuring and providing a direct reading of the time elapsing during said movement from the first to the second level, the spacing of said levels representing a specific volume of liquid.

3. An automatic viscosity measuring device comprising a funnel, means for delivering a quantity of liquid to said funnel, a cup receiving the discharge from said funnel, a float in said cup adapted to move upwardly with the rise of liquid therein from a first level to a second level, means for measuring and providing a direct reading of the time elapsing during said movement from the first to the second level, the spacing of said levels representing a specific volume of liquid, means for emptying the cup at the end of said time, and sequential timer means controlling said measuring and emptying means.

4. An automatic viscosity measuring device comprising a funnel, means for delivering a quantity of liquid to said funnel, a cup receiving the discharge from said funnel, a float in said cup adapted to move upwardly with the rise of liquid therein from a first level to a second level, means for measuring and providing a direct reading of the time elapsing during said movement from the first to the second level, the spacing of said levels representing a specific volume of liquid, means for emptying the cup at the end of said time, and sequential timer means controlling said measuring and emptying means, said timer means automatically repeating the cycle of operation of the measuring and emptying means at predetermined time intervals.

5. An automatic viscosity measuring device compris-

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ing a container having a closed orifice of given dimension, a quantity of liquid in said container, a receiver positioned beneath said orifice, a float within said receiver free for vertical movement between upper and lower positions, a switch adapted to be opened by said float in its upper and lower positions and closed during movement between said positions, an elapsed time counter operable by closing of said switch and means for opening said orifice, the resulting discharge of liquid therefrom raising said float and initiating operation of said counter.

6. An automatic viscosity measuring device comprising a container having a closed outlet of given dimension, a quantity of liquid in said container, a receiver positioned beneath said orifice, a float within said receiver free for vertical movement between upper and lower positions, a switch adapted to be opened by said float in its upper and lower positions and closed during movement between said positions, an elapsed time counter operable by closing of said switch, means to open said outlet and permit discharge of said liquid into the receiver, means operable subsequent to filling of said receiver and re-opening of said switch by the float at its upper position to empty said receiver, and means operative during emptying to prevent operation of said counter due to re-closing of said switch.

7. An automatic viscosity measuring device comprising a container having a closed outlet of given dimension, a quantity of liquid in said container, a receiver positioned beneath said orifice, a float within said receiver free for vertical movement between upper and lower positions, a switch adapted to be opened by said float in its upper and lower positions and closed during movement between said positions, an elapsed time counter operable by closing of said switch, means to open said outlet and permit discharge of said liquid into the receiver, means operable subsequent to filling of said receiver and re-opening of said switch by the float at its upper position to empty said receiver, and means operative thereafter to wash the container and receiver.

8. An automatic viscosity measuring device comprising a receiver having an outlet, means for opening and closing said outlet, a container having an outlet adapted

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to discharge liquid into said receiver, means for opening and closing said container outlet, means for delivering a quantity of liquid to the container, means for measuring and providing a direct reading of the time which elapses during the discharge of a predetermined volume of said liquid into the receiver, and a sequential timer automatically and repetitively controlling the aforesaid means in a preset cycle of operation wherein their respective functions are carried out in the following order, the timer having previously closed the container outlet: delivering said quantity of liquid to the container, opening the container outlet, measuring said elapsed time, and opening the receiver outlet, the receiver outlet being closed by the timer after said emptying of the receiver and prior to said opening of the container outlet.

9. An automatic viscosity measuring device comprising a receiver, a float in said receiver free for vertical movement between upper and lower positions, a switch operated by said float, said switch being open when the float is at said upper and lower positions and closed when at intermediate positions, an elapsed time indicator actuated by closing of said switch, a funnel having an efflux tube positioned above the receiver, means for opening and closing said tube to liquid flow, means for delivering a quantity of liquid to the funnel, means for draining the receiver, and a sequential timer automatically controlling the aforesaid means in a preset cycle of operation wherein their respective functions are carried out in the following order, said tube having been previously closed: delivering said quantity of liquid to the funnel, opening said tube and draining the receiver after the float has reached said upper position and closed said switch, the timer serving also to de-activate said indicator during said draining and re-set the indicator thereafter.

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