

Feb. 8, 1944.

A. L. SMITH

2,340,993

METHOD OF TESTING WELLS

Filed Nov. 24, 1939

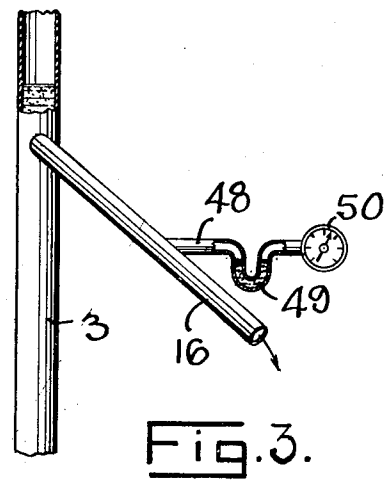
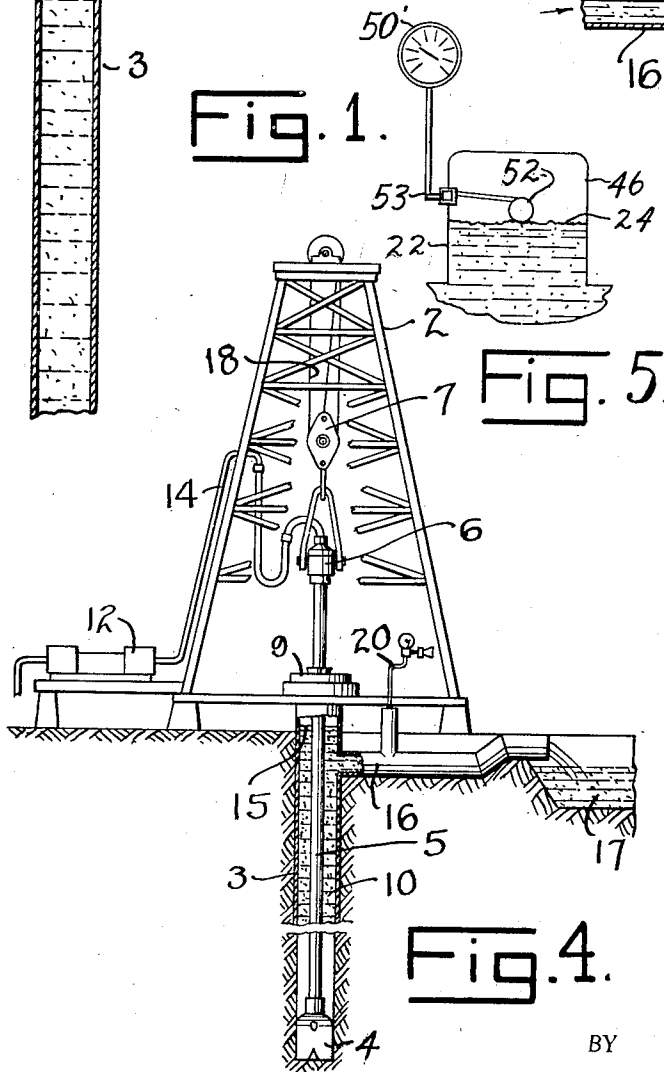
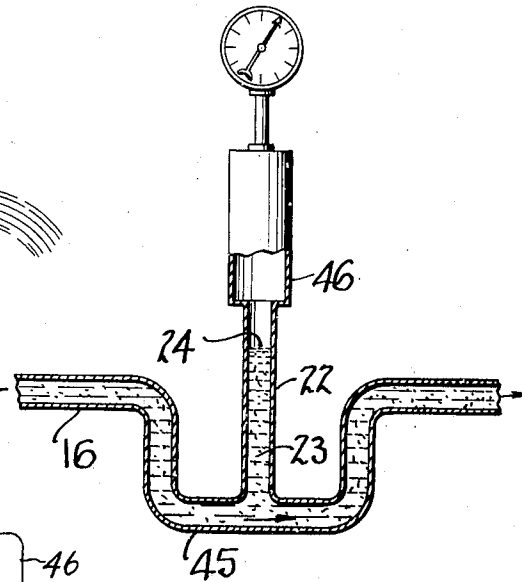
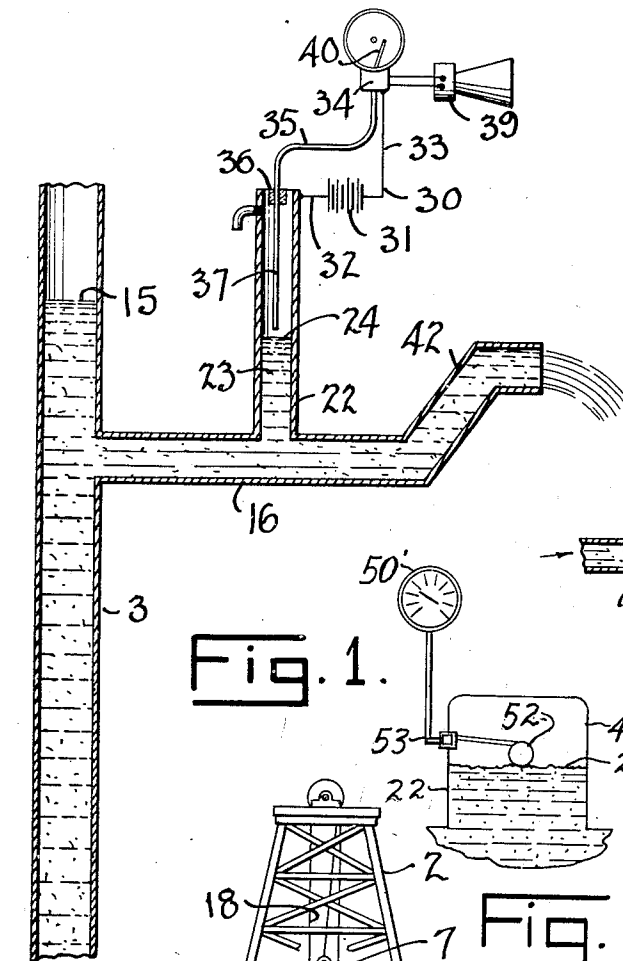


Fig. 5.

BY

A. L. SMITH
INVENTOR.
Jesse R. Stone
Lester B. Clark
ATTORNEYS

UNITED STATES PATENT OFFICE

2,340,993

METHOD OF TESTING WELLS

Alonzo L. Smith, Houston, Tex.

Application November 24, 1939, Serial No. 305,794

5 Claims. (Cl. 73-51)

The invention relates to a method of determining the condition of a well which is being drilled by the rotary method of drilling where drilling mud is circulated into and out of the well bore.

In the drilling of wells by the rotary method various techniques have been developed for the conditioning and treating of drilling mud which is introduced into the well bore for the purpose of walling up the sides of the bore to shut off various formations, making the mud heavy to overcome formation pressures which are encountered, creating a mud with the desired slimming effect so that it will be readily pumpable, having the mud of a consistency so that it will remove the cuttings from the drill bit and at the same time preventing the retention of gas by the mud which would tend to reduce specific gravity of the mud as a whole.

With the development of these various techniques it becomes desirous at all times to know the rate of discharge of the drilling mud from the well. It will be understood that slush or mud pumps are operated to force the mud into the well bore at a definite rate and naturally if all of the conditions in the well were normal the rate of discharge of the mud would be the same as the input. In event, however, the mud should be forced into a formation then the rate of discharge would decrease while, on the other hand, if fluid enters the well then the rate of discharge will increase to take care of the increase in volume due to the entrance of the fluid.

The same is true for a liquid such as oil or water entering the drilling mud. Various other conditions such as blowout of the well and other features can be combated much more readily if the operator obtains some advance information relative thereto. Naturally any additional fluid or liquid entering the column of drilling mud rising in the well would increase the volume of that column and there would be a consequent increase in the rate of discharge of the drilling mud from the well. In most instances the mud rises in the open casing to an elevation which will be almost constant under normal conditions and a normal input of drilling mud. Inasmuch as it might be difficult to determine this elevation inside of the casing, the present invention concerns itself with attachments for the casing whereby any variation in elevation of the column of mud in the well bore can be ascertained. If the rate of discharge increases, the elevation of the column of mud will increase,

whereas, the opposite is true in event of a decrease.

A technique can be readily developed whereby variations in the elevation of the column of mud which represents a change in the rate of flow, can be interpreted in view of the conditions encountered and the experience which will be derived so that variations can be readily diagnosed as indications of certain conditions.

It is an object of the invention to provide a method of testing a well while being drilled by forcing mud into the well at a constant rate, measuring the rate of flow of the mud out of the well, and determining variations between the rates of inflow and outflow.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawing thereon wherein:

Fig. 1 is a diagrammatic view in vertical section illustrating an arrangement whereby the variation in elevation of the mud in the well can be used to operate an indicator.

Fig. 2 shows another form of the invention wherein variation in pressure due to the rise and fall of the column of mud can be utilized to operate an indicator.

Fig. 3 shows another form of the invention where the indicator or recording gauge is sealed off from actual contact by the mud and is actuated by the operating liquid.

Fig. 4 shows a schematic arrangement of the drilling rig, pumps, well bore and equipment which go to make up the present invention.

Fig. 5 shows a broken detail view of a float operated indicator.

The invention can be best understood generally by reference to Fig. 4 wherein a derrick 2 has been illustrated as mounted over the well bore 3 which is being drilled by the bit 4. The drill is rotated by the drill stem 5 which is connected to a swivel 6, a traveling block 7 and the hoisting lines 18. This drill stem is rotated by a rotary table 9 which receives its power from a suitable source. The well bore 3 is indicated as being filled with a drilling mud 10 which is forced downwardly by a pump 12 thru a rotary hose 14 and into the upper end of the drill stem 5. This mud is picked up by the pump 12 from the slush pit and forced out of the bit at the bottom of the well bore. The mud circulates upwardly in the casing and will rise to a level such as 15 in the casing, dependent upon the rate of circulation which is being maintained by the pump 12. The return or discharge line 16 allows drilling

mud to discharge from the well bore into a ditch 17 which leads to the slush pit from which the mud has been withdrawn by the pump 12.

In order to determine any fluctuation or variation in the elevation 15 of the column of mud in the well bore an attachment indicated generally at 20 has been previously arranged on the return discharge line 16.

The apparatus of Fig. 4 is shown best in detail in Fig. 1 where a standpipe or upright 22 in the form of a pipe has been attached to the discharge line 16. This pipe may be of any length or diameter desired but it opens into the return line so that the elevation 15 of the mud in the casing 3 will be represented by a column of mud 23 in this standpipe. The elevation 24 of this mud will be representative of the elevation 15 of the mud in the casing 3. Thus, under normal conditions at a normal rate of input of mud, if no unexpected conditions are encountered in the well bore the rate of discharge of the mud would cause it to rise to the elevation 24 in the standpipe 22. If, however, some abnormal or out of the ordinary condition was encountered in the well bore, such for instance, as the introduction of gas from a formation into the drilling mud, then the mud rising to the surface brings this gas upwardly in the casing, the pressure on the gas would be reduced due to a reduction of the weight in the column of liquid above it and as it approached the top the gas would naturally expand. This expansion would in turn increase the composite volume of the mud discharging from the well. Inasmuch as the pipe 16 is of uniform diameter, if the rate increases it would result in a greater pressure in the pipe 16 and rise in the elevation of the level 15. Inasmuch as the level 24 is representative of the level 15, there would be a significant rise in the pipe 22. The pipe 22 of Fig. 1 is vented to the atmosphere to allow it to breathe and avoid undue pressure therein.

In order to determine any variations in the level 24 a device has been attached thereto which is in the form of an electric circuit 30. This circuit includes a source 31 which is connected by a wire 32 to the metal of the pipe 22. The wire 33 from the source passes into an indicator or recording gauge 34 which has an electrode 35 projecting therefrom. This electrode passes thru an insulator 36 and has a portion 37 extending downwardly inside of the standpipe 22. This circuit would be opened as it has just been described but as the mud rises in the pipe 22 it would form a connection between the electrode 37 and the pipe 22 which forms the other electrode of the circuit. The amount of current which would pass thru the drilling mud would depend upon the elevation to which the mud rises around the electrode 37 and therefore the indicator 34 can be suitably calibrated so that it will give an accurate indication of the elevation to which the mud rises around the electrode 37.

If desired a suitable alarm or signal such as the horn 39 can be connected into the circuit so as to be sounded when the current passing thru the circuit increases to a predetermined amount. This alarm might not operate immediately upon a slight rise but when the rise is sufficient to indicate that danger was approaching, then the circuit could be arranged to send the alarm.

The gauge or indicator 34 may be of any desired type, the present one having a needle indicator 40 thereon which can be readily observed

by the driller. A recording gauge could be utilized, however, which might be correlated with the rate of drilling so that an accurate log of the conditions encountered in the well might be made.

The pipe 16 has been shown as turned upwardly at 42 so as to create a sufficient back pressure or restriction in the discharge so as to maintain a constant rate in the pipe 22 if the rate of discharge is constant. This construction prevents the loss of mud while the drill stem is being withdrawn by trapping the mud which rises due to friction with the drill stem.

Fig. 2 is quite similar to Fig. 1 but indicates the return line 16 as having been formed with a U portion 45 from which the stand pipe 22 rises. The upper end 46 of the standpipe may be utilized to receive any suitable type of liquid level indicator. The upper end 46 may be closed to form a pressure chamber, a suitable pressure gauge attached, and a variation in this gauge utilized to indicate variation in the elevation 24 of the column of mud 23 in the standpipe. Fig. 5 shows a float 52 pivoted at 53 to move with the liquid level to actuate a gauge such as 50'.

Fig. 3 shows another form of the invention wherein the discharge line 16 has a side pipe 48 attached thereto which has a sealing area 49 so as to protect the gauge 50. Any suitable liquid may be placed in the trap portion 49 so as to exclude the drilling mud but at the same time any variation in pressure in the line 16 would be transmitted to this operating liquid in the trap 49 and thence to the gauge.

In some instances a blowout occurs while the drill stem 5 and drill bit 4 are being removed from the well because if the bit is of considerable size it may create a suction in the well bore as the bit is raised. This is particularly true if the bit is raised at too rapid a rate. In such event it becomes necessary to provide a fill in pipe so that additional mud can be added to the casing in order to compensate for the volume of the drill pipe and bit which are being removed. Under these circumstances it would be necessary to introduce mud into the well at the same rate that the volume of metal was being withdrawn if a constant elevation were to be maintained. Such an operation could be practiced, however, if it were desired that an accurate indication of whether or not gas was entering the well bore as the drill bit was raised.

Broadly the invention contemplates a method of determining the rate of discharge of mud from a well as compared with the rate of input as an indication of conditions which are being encountered in the well.

What is claimed is:

1. A method of determining when the rate of discharge of drilling mud from a well being drilled by the rotary method varies from the rate of input of mud so as to determine the conditions being encountered in the well which comprises the step of indicating changes in the elevation of the column of mud discharging from the well while the input remains constant.

2. A method of determining when the rate of discharge of drilling mud from a well being drilled by the rotary method varies from the rate of input of mud so as to determine the conditions being encountered in the well which comprises the steps of observing or indicating changes in the elevation of the column of mud discharging from the well while the input remains constant

and signalling when the change exceeds a predetermined amount.

3. A method of determining when the rate of discharge of drilling mud from a well being drilled by the rotary method varies from the rate of input of mud so as to determine the conditions being encountered in the well which comprises the steps of trapping the stream of discharging mud, indicating the rate of flow thereof so as to compare such rate of flow thereof with the normal rate of flow at that rate of input so as to ascertain variation in conditions in the well such as loss of mud to the formation, increase in volume due to gas, or displacement of mud by fluid from the formation.

4. A method of detecting variation in the return of drilling mud from the well in the rotary

method of drilling as compared with the input so as to obtain information as to conditions and characteristics of the well which comprises restricting the return flow of mud from the well, and indicating variations in the volume of the returning mud by fluctuations in the restricted area.

5. In the drilling of wells by the rotary method where a balanced circulation of drilling fluid is maintained during drilling, the method of determining any unbalancing of the circulating fluid which comprises the steps of determining a normal input and output, and comparing the input with the output as an indication of an abnormal occurrence in the well bore.

ALONZO L. SMITH.