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METHOD OF RECOVERING LOST CIRCULATION OCCURRING IN PRODUCTIVE STRATA IN WELLS

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FIG. 1.

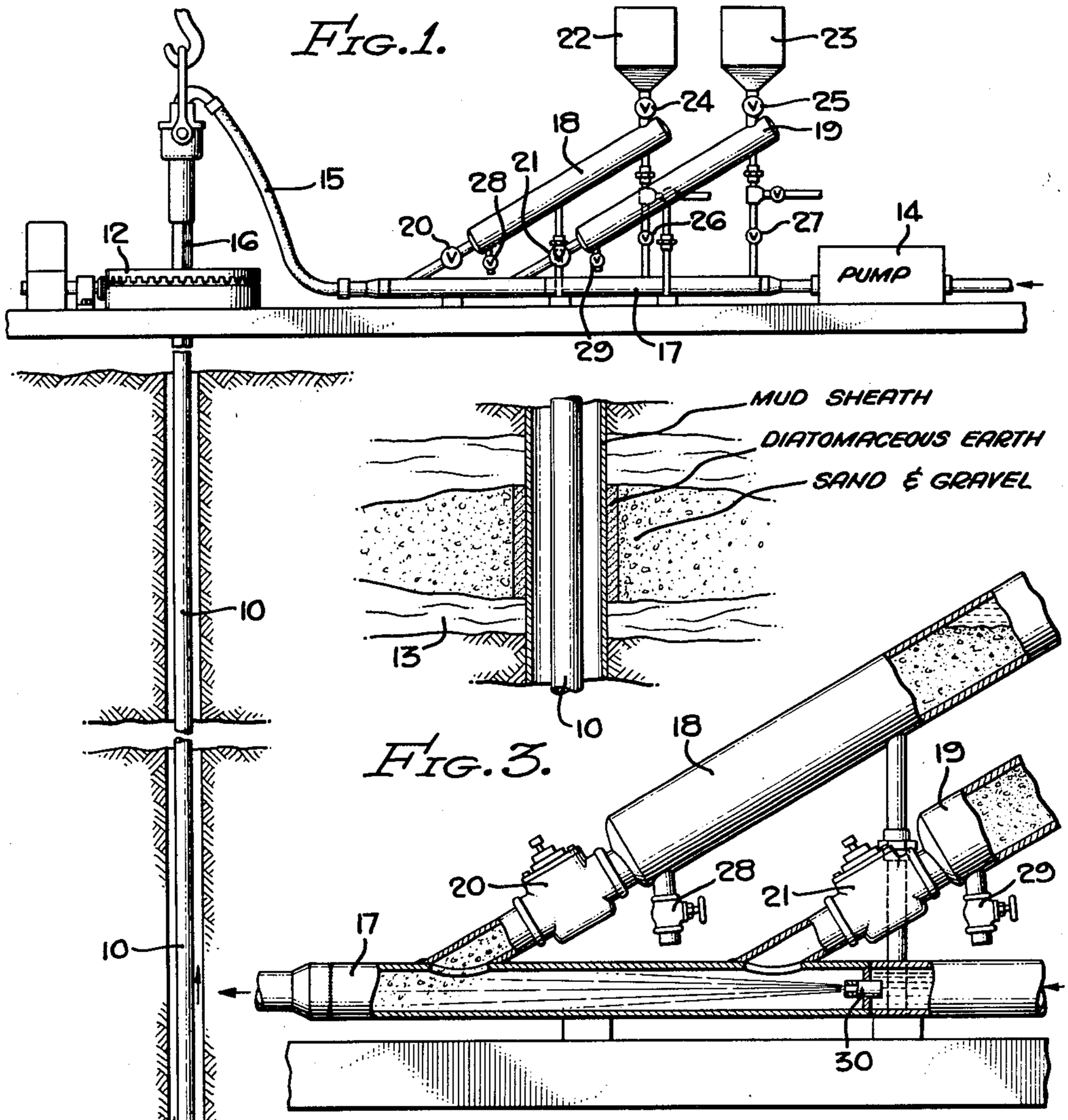

FIG. 3.

FIG. 2.

ARTHUR L. ARMENTROUT
INVENTOR.

BY

Hazard & Miller
ATTORNEYS

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METHOD OF RECOVERING LOST CIRCULATION OCCURRING IN PRODUCTIVE STRATA IN WELLS

Arthur L. Armentrout, Long Beach, Calif.

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3 Claims. (Cl. 255—1.8)

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This invention relates to a method of recovering lost circulation occurring in productive strata in the course of drilling wells and placing the well on production when the drilling has been completed.

In the course of drilling oil and gas wells it frequently occurs that the well bore passes through pervious strata including water sands so that the drilling mud or circulation fluid that is pumped down through the drill pipe and which returns to the surface between the drill pipe and the walls of the well passes into such pervious strata and becomes lost. Usually such strata are either non-productive or produce unwanted fluids and in recovering the lost circulation under such circumstances various remedial steps are taken to plug or seal such strata against the entry of circulation fluid. Various types of sealing materials have heretofore been used such as, for example, straw, cotton seed hulls, fragments of sponge rubber, and various types of self-hardening materials. These materials are carried by the escaping circulation fluid into the cracks and crevices and form plugs or seals that retard or prevent the loss of the circulation fluid. As a general rule the plugging material used under these circumstances forms an immovable barrier in the well which is not objectionable when the strata through which circulation has been lost is either non-productive or produces an unwanted fluid.

It frequently occurs, however, that circulation fluid is lost in a productive stratum traversed by the well bore. This may be due to cracks and crevices in such productive stratum or it may be due to the fact that the stratum is not only highly pervious but has a relatively low pressure. Under these circumstances if the sealing materials heretofore used in non-productive strata are employed the sealing material which forms an immovable plug or barrier preventing the escape of circulation fluid subsequently forms a plug or barrier against the entry of the wanted fluid into the well bore. A primary object of the present invention is to provide a method of recovering lost circulation where the circulation is lost in the productive stratum and wherein the plug or barrier formed will effectively prevent the escape or loss of circulation fluid into the productive stratum but when the well is subsequently placed on production it will not prevent or impede the entry of the wanted fluid into the well bore. Stated in another manner, in accordance with the present invention the seal produced in the productive stratum is designed to prevent the loss therein of the circulation fluid used in drilling the well but it will not prevent or retard the flow of the wanted fluid in the reverse direction when the well is ultimately placed on production.

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With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a diagrammatic view of apparatus employed in performing the present method;

Fig. 2 is a partial view in vertical section illustrating details of construction of the apparatus; and

Fig. 3 is a partial vertical section on a somewhat enlarged scale illustrating the manner in which the seal to prevent loss of circulation fluid is formed in the well.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, diagrammatically illustrated in Fig. 1 is a rotary well drilling apparatus wherein the drill pipe 10 having the bit 11 is rotated by the rotary table 12. The drill pipe is illustrated as having passed through a productive stratum 13 which may be assumed to be capable of producing oil or gas and which has cracks or crevices therein through which the circulation fluid pumped down through the drill pipe becomes lost. The loss of circulation fluid may be due to the cracks or crevices in the productive stratum or it may be due to the fact that the productive stratum is highly pervious but has a low natural pressure. The conventional well drilling mud or circulation fluid is supplied to the drill pipe through a pump 14 and after being discharged from the drill pipe the circulation fluid is normally returned to the surface, passed over a conventional shaker screen and returned to a sump from which it is recycled through the pump 14. Between the pump 14 and the hose 15 that leads to the swivel at the top of the kelly 16 there is a manifold 17. Connected to this manifold there are one or more tanks 18 and 19, the outlets from which are connected through valves 20 and 21, respectively, to the manifold. At the top of each tank there are hoppers 22 and 23 which are connected to the tops of the tanks through valves 24 and 25, respectively. Branch connections lead from the manifold 17 to the tops of the tanks and are equipped with valves 26 and 27, respectively. The valves 28 and 29 are merely drain valves

controlling outlets at the bottoms of the tanks whenever it is desired to empty the tanks without introducing their contents into the manifold. The manifold is preferably provided with a nozzle 30 through which the circulation fluid is discharged at high velocity so as to pick up and carry with the circulation fluid the solid material that is introduced into the manifold from the tanks 18 and 19.

It will be appreciated that only a single tank 18 might be employed but preferably two tanks are used and even more tanks may be employed if desired. Two tanks are employed so that while one tank is being emptied into the manifold 17 the other may be in the process of being refilled through its hopper. In the course of refilling a tank the outlet valve 20 or 21 is closed and the pressure inlet valve 26 or 27 is also closed. Valves 24 or 25, as the case may be, are opened to empty the hopper into the tank. Thereafter the valves 24 or 25 are closed and the other valves are opened again to conduct pressure from the pump to the top of the tank and permit its contents to be discharged into the manifold.

In accordance with the present invention when it is suspected or determined that circulation fluid is being lost through the productive stratum 13 a substantial batch or batches of screened sand and gravel is discharged into the manifold followed closely by a batch of diatomaceous earth. The sand and gravel that is introduced into the manifold may have a particle size running as high as ⅜ inch. However, the minimum size will ordinarily be that sand or gravel which will be caught on a screen having a mesh size of .065 inch. Whatever sand is capable of passing through a .065 inch screen is normally discarded. In some instances the minimum sand size may be somewhat larger. In the usual situation in recovering lost circulation in an oil well the sand and gravel is quickly fed to the manifold by using the tanks 18 and 19 consecutively so as to deliver the sand and gravel in batches of from 25 to 100 cu. ft. This sand and gravel is picked up by the circulation fluid pumped by the pump through the manifold and is quickly carried down through the drill pipe and discharged at the bit 11. It is carried by the circulation fluid that is escaping into the formation 13 into the cracks, crevices or interstices forming a sand and gravel foundation for the diatomaceous earth that is supplied to the manifold immediately following the last batch. In the usual situation from 100 to 300 cu. ft. of diatomaceous earth is supplied to the manifold and carried down through the drill pipe. The diatomaceous earth that is discharged from the bit 11 is carried by the circulation fluid to the previously deposited sand and gravel and, in effect, forms a type of filter cake over the sand and gravel which will form a base or foundation for the ingredients in the circulation fluid or well drilling mud. Consequently in a given crevice in the formation 13 there will be first deposited a fill of sand and gravel over which there will be deposited diatomaceous earth on which the sheath of the constituents of the well drilling mud is deposited.

When the drilling of the well is completed the casing is normally installed and the perforated liner is installed opposite the producing stratum. The well may then be brought on production such as by bailing the well down. When the pressure in the well opposite the stratum 13 is less than the pressure existing in the stratum the wanted fluid will commence to flow from the

stratum into the well bore. In so doing the sand and gravel fill being relatively clean will permit the fluid to flow therethrough. The mud sheath and the diatomaceous earth will be carried by the fluid into the well bore and as these are formed of very fine particles they may pass readily through the perforations of the liner into the liner and be removed from the well. The sand and gravel particles, being larger than the perforation size in the liner, will be retained in the well on the outside of the liner but form no serious impediment to the entry of the wanted fluid from the productive stratum into the well bore. In this manner it will be appreciated that where the circulation fluid is lost into the productive stratum the improved method temporarily seals the productive stratum against the entry of the circulation fluid thereto. On the other hand, when it is desired to have the wanted fluid in the productive stratum to flow in the opposite direction, that is, from the stratum into the well bore, the seal formed does not impede such flow.

The above described method may be employed whenever it is known or suspected that circulation fluid is being lost in the productive stratum. However, where conditions are such that lost circulation into the productive stratum is to be anticipated, I maintain sand and gravel in the circulation fluid at all times to the extent of about five to ten percent and observe the condition of the shaker screen and the sump at all times. If the sand and gravel is not returned to the shaker screen along with the circulation fluid this indicates that the sand and gravel is being deposited in the well and if the level in the sump falls, indicating that circulation is being lost, I then quickly dump one or more batches of sand and gravel into the manifold 17 by the apparatus illustrated and immediately follow the last batch with a substantial batch of diatomaceous earth.

It will be readily appreciated that the improved method primarily concerns the recovering of lost circulation which has been lost in a productive zone or stratum and that herein a temporary barrier is formed that prevents the escape of the drilling mud from the well bore into the zone 13 but that it does not prevent or impede flow of fluid in the opposite direction. To this extent the present method is readily distinguished from other methods of recovering lost circulation wherein plugging or sealing materials are introduced into the circulation fluid which when deposited will form more or less permanent plugs or seals that not only retard or prevent the flow of drilling mud in a direction from the well bore but also would equally prevent or retard the flow of fluid from the formation into the well bore.

The minimum screen size of the sand and gravel introduced should bear a definite relationship to the perforation size in the liner that is finally installed so that although the mud sheath and diatomaceous earth may enter the liner substantially all of the sand and gravel will be retained in the formation by the liner. This sand and gravel, however, being screened and being relatively clean will form no substantial impediment to the entry of the wanted fluid into the well bore.

While diatomaceous earth is preferably employed, other finely divided siliceous materials suitable for forming filter cakes can be substituted therefor such as for example the fines obtained from the manufacture of expanded pearl-

ite. Even pumice stone powder can be employed. The diatomaceous earth or other siliceous material should be of a mesh size of around 100 or smaller. Ordinarily, diatomaceous earth has a particle size ranging from 275 mesh particles to 375 mesh particles. That is, the individual particle of diatomaceous earth are capable of passing through a screen having 275 meshes per inch to 375 meshes per inch. Diatomaceous earth that is suitable for making filter cakes in various filtering processes is suitable for this process and when other siliceous materials are substituted for diatomaceous earth they should have comparable particle sizes.

Various changes may be made in the details of the construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. The method of recovering lost circulation in a drilling well wherein the circulation has been lost into a productive stratum which consists of introducing into the circulation fluid screened sand and gravel so that it will be carried thereby to the interstices or fractures in the productive formation and immediately thereafter introducing into the circulation fluid diatomaceous earth so as to form a filter cake on the screened sand and gravel for the deposit thereon of the mud sheath produced by the circulation fluid.

2. The method of recovering lost circulation in a drilling well wherein the circulation has been lost into a productive stratum which consists of introducing into the circulation fluid screened sand and gravel having a minimum size larger than the size of the perforations in the liner subsequently to be installed in the well, thereafter introducing into the circulation fluid diatomaceous earth to form a filter cake for the deposit thereon of the mud sheath produced by the circulation fluid and on completion of the well installing the liner and bailing down the well causing the mud sheath and diatomaceous earth to enter the liner and be removed from the well and the sand and gravel to be retained in the well by the liner whereby the sand and gravel left in the well will not impede the flow of fluid from the productive formation into the well.

3. The method of recovering lost circulation in a drilling well wherein the circulation has been lost into a productive stratum which consists of introducing into the circulation fluid sand and gravel so that it will be carried thereby into the interstices or fractures in the productive formation and immediately thereafter introducing into the circulation fluid finely divided siliceous material of a particle size finer than 100 mesh so as to form a filter cake on the sand and gravel for the deposit thereon of the mud sheath produced by the circulation fluid.

ARTHUR L. ARMENTROUT.

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