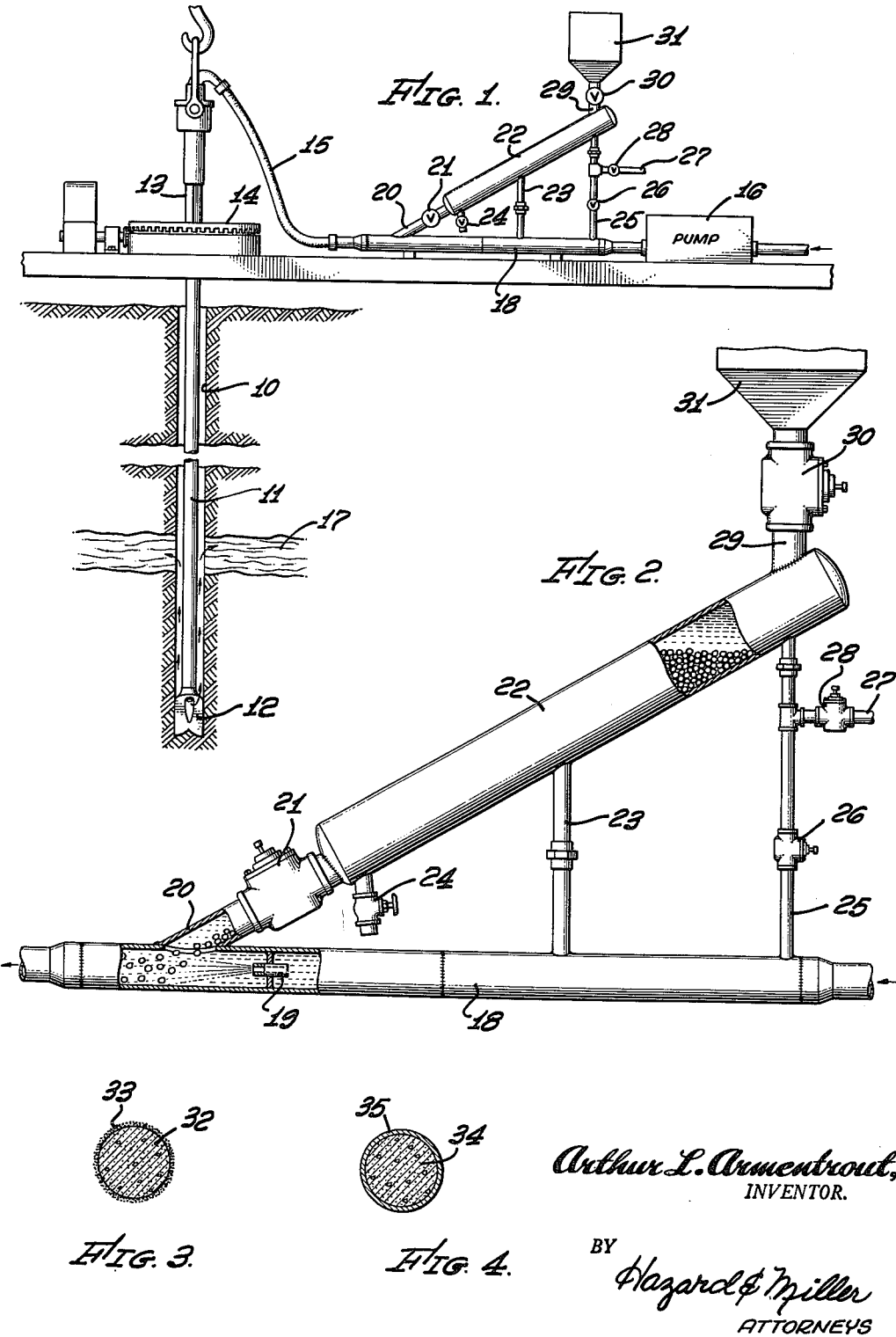


April 7, 1953

A. L. ARMENTROUT
MEANS AND METHOD OF RECOVERING LOST
CIRCULATION IN DRILLING WELLS
Filed Feb. 28, 1948

2,634,098



UNITED STATES PATENT OFFICE

2,634,098

MEANS AND METHOD OF RECOVERING LOST
CIRCULATION IN DRILLING WELLS

Arthur L. Armentrout, Long Beach, Calif.

Application February 28, 1948, Serial No. 12,056

3 Claims. (Cl. 255-1.8)

1

This invention relates to a means and method of recovering lost circulation in drilling wells.

In the course of drilling oil wells and the like by means of a rotary well drilling apparatus, circulation fluid or mud is pumped down through a rotary drill pipe and discharged at or adjacent the bit at the lower end thereof. In normal drilling operations this circulation fluid returns upwardly through the well bore and is conducted to a sump from which it is returned to the pump and again pumped down the drill pipe. In the course of drilling wells the well bore frequently penetrates highly porous sands, water sands or earth cracks so that when this occurs the circulation fluid discharged at or near the bit, instead of returning to the surface, escapes through such porous strata or earth cracks. To seal off such strata and thus recover the lost circulation it has been the practice to introduce various sealing materials into the circulation fluid which are pumped therewith down through the drill pipe and are discharged into the well. These sealing materials are intended to plug and thus seal the porous strata, earth cracks or other interstices through which the circulation fluid escapes. Quick setting cements and plasters have been used for this purpose and in some instances various grades of asphaltum have been employed. If the sealing material is in the nature of a cement or plaster which will set up or harden on coming in contact with water, such sealing material commences its setting up action or hardening action as soon as it is wetted by the water constituent in the circulation fluid. Consequently as its setting up or hardening action commences at the surface its ability to set up and harden may be materially reduced or exhausted by the time that it reaches the bottom of the drill pipe and is discharged therefrom near the locality that is to be sealed. In the case of asphaltum, due to its sticky nature, the asphaltum is apt to adhere to the interior of the drill pipe or in the discharge ports in the bit and may lodge itself anywhere on the well walls without being carried to the location that it is desired to plug and seal.

An object of the present invention is to provide a method for recovering lost circulation in drilling wells wherein the sealing material is introduced into the circulation fluid in a protected condition and preferably in the form of granules or pellets. Thus if the sealing material is in the nature of a cement or plaster, pellets of the same are coated with a coating that will require a short interval of time to dissolve and disintegrate. Pellets of cement or plaster which are coated with

2

a water-soluble coating may be introduced into the circulation fluid at the surface and pumped down the drill pipe. During their travel down the drill pipe the coating will, of course, dissolve due to its contact with the water ingredient in the circulation fluid. But the time required to thus release the pellet may be reasonably accurately controlled so that the pellet is not exposed to the water of the circulation fluid until it has approximately reached the location that it is desired to plug and seal. If the sealing material is in the nature of a highly expansible material, such as bentonite, it may likewise be protected from coming in contact with the water until it has substantially reached the location that it is desired to seal. At the same time the cement, plaster or bentonite, as the case may be, is then wetted by the water of the circulation fluid and is of maximum effectiveness in effecting the seal.

Other coatings beside water-soluble or water-disintegratable coatings may be employed such as those that may require the introduction of a chemical such as an acid or an alkali into the circulation fluid. Coated pellets of this character may likewise be introduced into the circulation fluid and the required chemical added to the circulation fluid as it enters the pump from the sump. During the downward travel of the pellets in the drill pipe the chemical may dissolve or disintegrate the coating to thus release the pellets for their setting up or hardening action without losing their effectiveness.

Asphaltum may be introduced into the circulation fluid in the form of granules or pellets which are in a pre-cooled condition so that they are relatively hard and non-sticky when first introduced into the circulation fluid. These pellets will slowly have their temperature raised to that of the circulation fluid and to the temperature existing near the bottom of the well. But the time required to raise the temperature will frequently be sufficient to enable the pellets to be delivered at or near the location that is to be sealed before they have warmed up into a plastic plugging or sealing mass. The asphaltum granules or pellets may or may not be protected by an outer protective coating.

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 schematic view of a well that is

3

being drilled by means of a rotary well drilling apparatus illustrating an apparatus as having been incorporated therein enabling the present invention to be performed;

Fig. 2 is a view in side elevation, parts being broken away and shown in vertical section illustrating details of the apparatus;

Fig. 3 is a sectional view of one form of sealing material embodying the present invention; and

Fig. 4 is a sectional view through another form of sealing material embodying the present invention.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, 10 indicates a well that is being drilled by a conventional rotary well drilling apparatus including a string of drill pipe 11 having a bit 12 attached thereto. At the top of the drill pipe there is a conventional kelly 13 rotatable by the rotary table 14. Circulation fluid is supplied to the drill pipe through a rotary hose 15 from a pump 16. 17 indicates a porous stratum, earth crack or other formation that has been penetrated by the well bore and through which circulation fluid that has been discharged from the bit 12 escapes instead of returning to the surface and being conducted to the sump in the normal manner.

In accordance with the present invention I employ an apparatus quite similar to the conventional apparatus for gravel packing wherein there is a manifold 18 between the pump and the rotary hose within which there is installed a jet 19. Downstream from this jet there is a conduit 20 that leads through a valve 21 to the bottom of a container or tank 22. This tank may be supported in its desired position such as by a brace 23 and preferably has a valve-controlled drain 24. Upstream of the jet 19 a conduit 25 leads from the manifold 18 to the top of the tank 22 and is equipped with a valve 26. A branch conduit 27 equipped with a valve 28 leads from this conduit and may be utilized to release pressure in the tank when the valve 26 is closed. Near the top of the tank there is an inlet 29 controlled by a valve 30 over which there may be a hopper 31.

The sealing material employed may be of the character illustrated in Fig. 3 consisting merely of a granule or pellet 32 of such size as to readily pass through the connections 29 and 20, the rotary hose 15, the drill pipe 11 and the discharge ports in the bit 12. This granule or pellet may be composed of any suitable sealing material such as a quick setting cement or plaster, bentonite, or other material that is designed to either seal, harden or expand on coming in contact with the circulation fluid. Each pellet is externally coated with a coating 33 designed to either dissolve or disintegrate slowly in the presence of the circulation fluid. For example, each pellet may be coated with a water-soluble gum such as gum arabic, or a water-soluble carbohydrate. The thickness of the coating may, of course, vary with circumstances and in drilling a deep well where circulation is suspected to be lost at or near the bottom of the well the coating 33 should be of such thickness or of such a character as to require approximately that length of time to dissolve or disintegrate as is required to pump the pellet down through the drill pipe and have it discharged and reach the locality of the formation 17 that it is desired to seal.

In the construction illustrated in Fig. 4, the pellets of sealing material indicated at 34 may

4

be coated or plated as at 35 with a thin layer of metal such as, for example, aluminum foil or aluminum plating. The thickness of the coating is illustrated somewhat exaggeratedly in this figure. Where such coatings are employed acids or alkalis may be introduced into the circulation fluid which will chemically react with the coating to dissolve or disintegrate it, releasing and exposing the contained sealing material.

Various grades of asphaltum may also be employed which are of such characters as to soften and become plastic at the temperature existing at or near the formation 17. The asphaltum is preferably reduced to pellet form and delivered to the well in a refrigerated or pre-cooled condition. When thus cooled the asphaltum pellets are virtually solids and will be pumped through the hose 15 and drill pipe without becoming sufficiently sticky to adhere thereto in an objectionable manner. These pellets on being introduced into the circulation fluid will, of course, be warmed thereby and as they are conducted to the bottom of the drill pipe they may be heated sufficiently by the temperature existing near the bottom of the well to render them soft and plastic so that they may enter and seal the formation 17. The warming of the pellets from their pre-cooled temperature to the temperature existing in the bottom of the well will require a certain lapse of time and, depending on various conditions such as the depth of the well, the temperature existing therein and the temperature to which the pellets have been pre-cooled as well as their relative sizes, it frequently is possible to deliver the pellets at or near the formation 17 at approximately the same time that they have been warmed sufficiently to render them plastic.

For well holes of different depths which usually indicates different temperatures, pellets of air-blown asphalt can be used. The air-blown asphalt can be obtained having various melting or softening temperatures, the variation being from as low as 150° F. up to as high as 240 or 250° F. In the case of a given well a temperature survey may be run to determine bottom hole temperature, or temperature where it is desired to seal off the formation through which the circulation is getting lost. From such temperature determination, that air-blown asphalt can be selected that will have the desired melting or softening temperature. Pellets of this material may be delivered into the path of the circulation fluid either in a pre-cooled condition or at ambient temperatures and if the air-blown asphalt has a relatively high melting or softening point, the time required to elevate its temperature to the softening point may be utilized to conduct the pellets to the locality to be sealed off before the pellets have melted or softened. Then, on reaching the location to be sealed these pellets will be heated and softened by the temperature existing in the well so that they can effectively perform their sealing function.

Whatever type of sealing material is used as above described the pellets may first be introduced into the hopper 31. Then on opening valve 30 these pellets may be allowed to descend into the tank 22. Valve 30 is then closed and valve 26 opened, permitting pressure in the manifold 18 to enter the top of the tank. Valve 21 is then opened so as to feed these pellets from the tank 22 into the path of the circulation fluid. The jet 19 assists in building up a back pressure in the manifold 18 that is conducive to dis-

5

charging the pellets from the tank 22 through the outlet 20 into the path of the jet so that the pellets will be evenly distributed throughout the circulation fluid and will be carried along therewith. After the supply of pellets in the tank 22 has been exhausted, valve 21 may be closed and valve 26 also closed, and valve 23 opened to relieve or release pressure existing within the tank 22. The tank may then be drained of circulation fluid through the drain valve 24 after which an additional supply of granular sealing material may be fed into the tank through hopper 31 and valve 30, as above explained, if an additional tank full of sealing material is required.

It will be appreciated from the above described method and apparatus that in accordance with the present invention it is possible to deliver the sealing material to the location 17 that is to be sealed or plugged in a condition in which it is most effective and that it will not have lost its effectiveness in the course of being transmitted by the circulation fluid to the location to be sealed. Furthermore, introduction of the sealing material can be accomplished without discontinuing or stopping drilling operations. It will also be appreciated that an improved sealing material is provided wherein each granule or pellet is pre-conditioned so that it will not become effective as a sealing medium until it has substantially reached the location to be sealed.

It will, of course, be appreciated that when asphaltum is used or similar thermoplastic sealing material it may or may not be coated in addition to its being pre-cooled and that if it is coated the pre-cooling of the asphaltum may be dispensed with.

Various changes may be made in the details of 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 drilling wells which consists of introducing into the well pellets of sealing material, the sealing effectiveness of which commences on contact with the circulation fluid, which pellets are of such size as to be capable of being carried by the circulation fluid and of being discharged in the well through the drill stem, said pellets being coated with a water soluble coating which temporarily keeps the sealing material from contacting the circulation fluid a length of time commensurate with that estimated to be required for the circulation fluid to carry the pellets to the locality where circulation is being lost whereby on introducing

6

the pellets into the circulation fluid the coating will commence dissolving but will delay the sealing material coming in contact with the circulation fluid until the pellets have had an opportunity to be carried to the locality of lost circulation.

2. The method of recovering lost circulation in drilling wells which consists of introducing into the well pellets of dry bentonite clay of such size as to be capable of being carried by the circulation fluid and of being discharged into the well through the drill stem, said pellets being coated with a water soluble coating which temporarily keeps the bentonite clay material from contacting the circulation fluid a length of time commensurate with that estimated to be required for the circulation fluid to carry the pellets to the locality where circulation is being lost, whereby on introducing the pellets into the circulation fluid the coating will commence dissolving but will delay the bentonite clay coming in contact with the circulation fluid until the pellets have had an opportunity to be carried to the locality of lost circulation.

3. As a sealing material for use in drilling wells where circulation has been lost, pellets of dry bentonite clay coated with a water soluble coating which coating is of such character and thickness as to require a time interval to dissolve it from the bentonite clay estimated to be necessary to pump the pellets to the locality of lost circulation.

ARTHUR L. ARMENTROUT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,352,623	Perry	Sept. 14, 1920
1,781,105	Downard	Nov. 11, 1930
1,807,082	Boynton	May 26, 1931
1,939,391	Curran	Dec. 12, 1933
1,953,898	Reed	Apr. 3, 1934
2,221,175	Bechtold	Nov. 12, 1940
2,223,789	Limburg	Dec. 3, 1940
2,224,120	Hart	Dec. 3, 1940
2,311,389	Hawks et al.	Feb. 16, 1943
2,342,588	Larkin	Feb. 22, 1944
2,347,464	Cuno	Apr. 25, 1944
2,365,033	Williams	Dec. 12, 1944
2,380,156	Dobson et al.	July 10, 1945
2,387,514	Holmes	Oct. 23, 1945
2,445,928	Sommer	July 27, 1948
2,456,437	Miles	Dec. 14, 1948