

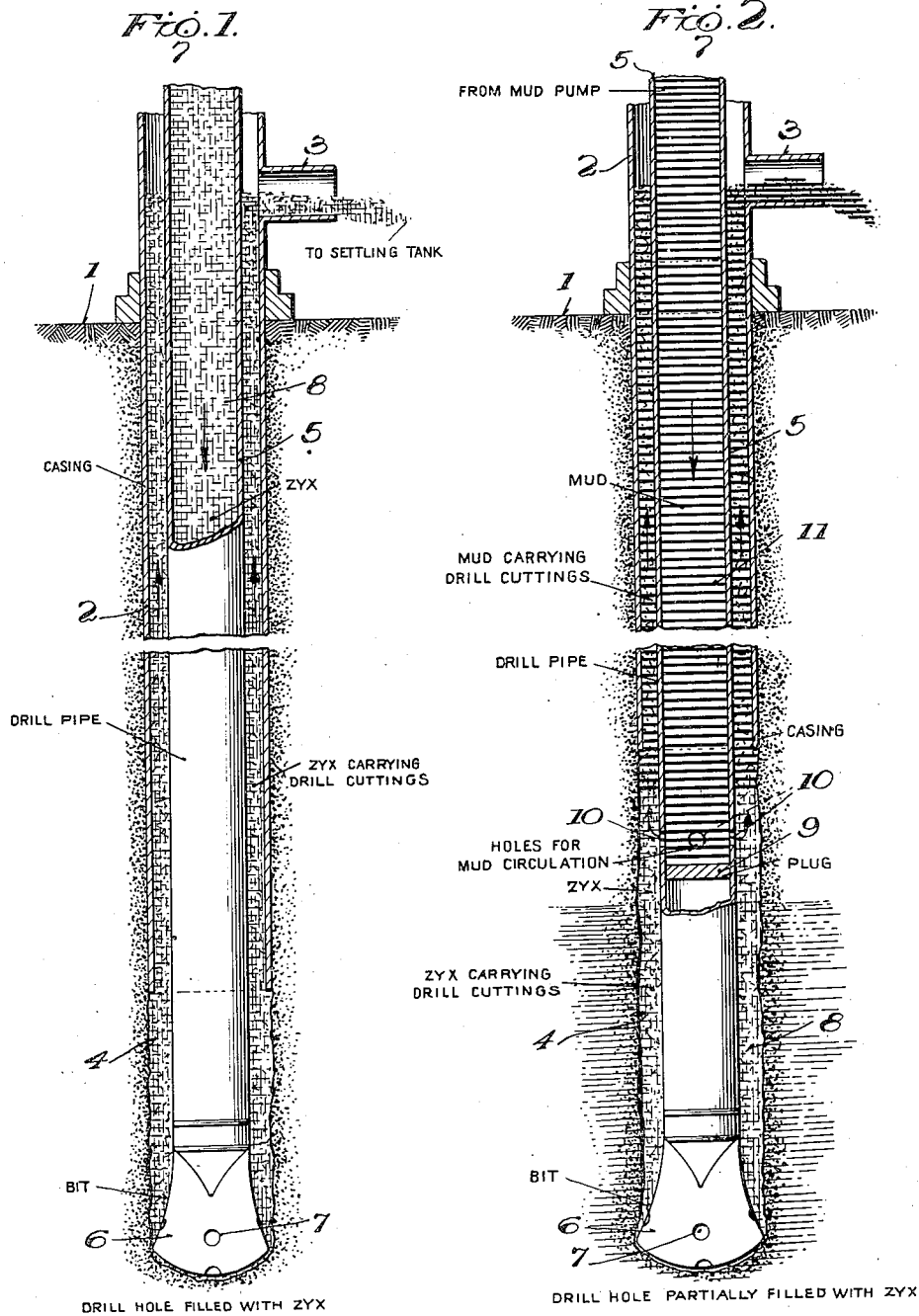
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METHOD OF DRILLING WELLS

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METHOD OF DRILLING WELLS

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This invention relates to improvements in the method of drilling wells and has for its objects to enable wells to be drilled at a greater speed than heretofore employed, to confine more effectively gas, oil or water in their respective formations as said formations are penetrated by the drill, to reduce the liability of sloughing off or caving during the drilling, to drill through rock formations difficult to penetrate by present means, and to freely remove the solid particles resulting from the action of the drill.

One method heretofore employed in the drilling of oil wells was by means of cable tools. In this method a string of tools, consisting of bit, stem, jars, and rope-socket is suspended by a cable in a drill hole, and the tools are raised and dropped and the cutting action produced by the impact of the bit at the bottom of the hole. At definite intervals the tools are withdrawn and the drill cuttings removed by means of a bailer. This method is still widely used for shallow drill holes, but for deep oil wells it has been almost entirely superseded by what is known as the "rotary rig" or rotary drill. The rotary drill consists essentially of a hollow drill pipe, on the lower end of which is attached a suitable bit, which varies with the formation being drilled. The bit rests in the bottom of the hole and the cutting action is accomplished by rotating the drill pipe through suitable gears at the surface.

The drill pipe and bit remain in the hole and are only withdrawn when the bit is withdrawn to be changed or replaced by a sharp one. The removal of the drill cuttings is an important function of the rotary rig, and the practice in this respect is in sharp contrast to cable tools. The rotary bit is provided with one or more openings in communication with the interior of the hollow drill pipe. Water under high pressure is forced down the drill pipe, flows out through holes in the bit and up between the drill pipe and the walls of the hole. In so doing, the drill cuttings are carried to the surface where they are settled out and the water is then returned down the drill pipe. A continuous circulation is thus maintained. Instead of circulating water alone, it is now a common practice to circulate mud. The reasons for this are important, and may be summarized as follows:

1. To increase the specific gravity of the drilling liquid (mud) in the preparation of which water is employed, so that the greater hydrostatic pressure will confine gas, oil and water to their respective formations when penetrated by the drill.

2. To hold the drill cuttings in suspension so that they may be removed from the hole.

3. To consolidate loose formations and prevent sloughing off and caving into the hole.

4. To lubricate the walls of the hole, the drill pipe and the casing.

Drilling mud must have certain definite properties. It can be made from materials at the location of the well or with special preparations now on the market. It must be heavy, and to give it weight, certain heavy minerals, such as barite in a finely-ground form, are frequently added. It must also be able to hold the cuttings in suspension in the well but drop them readily in the slush pit at the surface. It must also be liquid, otherwise it is impossible to maintain circulation, and other difficulties arise. In every case, however, the characteristics of drilling mud are a compromise between weight and viscosity. It must be heavy enough to perform its function, yet at the same time liquid, or it cannot be successfully handled.

In drilling certain formations, such, for example, as certain shale formations found in the Gulf Coast of Texas, efforts to complete oil wells have failed because these formations have the property of sloughing and swelling when brought into contact with water and as a result the drill holes cave and fill to such an extent that in the end the drilling has to be abandoned. This is the case whether the drilling liquid is water or mud, in the making of which water enters. The water is the apparent cause of the difficulty.

By the present invention the above difficulties are entirely eliminated by the use of a rotary rig employing a drilling liquid whose specific gravity is greater than that of water or of mud made by the use of water, which at the same time will not cause shale or other formations through which the drill hole passes to swell or slough, which is, furthermore, less viscous than mud, while having all of its desirable properties, and has other marked advantages that facilitate drilling operations. The heavy drilling liquid thus employed should be and preferably is heavier than the common rocks.

Several liquids of this character are available and the following are cited as examples:

	Specific gravity
Methylene iodide CH_2I_2	3.32
Sonstadt's solution $\text{HgI}_2 \cdot 2\text{KI}$	3.20
Klein's solution	
$9\text{WO}_3 \cdot 3\text{B}_2\text{O}_3 \cdot 2\text{CdO} \cdot (\text{OH})_2 \cdot 16\text{H}_2\text{O}$	3.36

All of the above liquids, though having dif-

ferent properties, are heavier than any of the common rocks through which oil wells are drilled. Granite and porphyry are among the heaviest and have a specific gravity of approximately 2.76.

5 These rocks, as well as the lighter ones, will float on the surface of such liquids or any liquid having a higher specific gravity than the rock. Therefore, in drilling an oil well when a liquid
10 formations is used in place of the usual mud, drill cuttings will be buoyed from the bottom of the drill hole to the surface of the liquid. Heavy liquids have other properties that are valuable for drilling operations, and particularly methylene iodide. This chemical compound is as fluid
15 as water in spite of its extreme weight. It is not miscible nor can it be diluted with water. It is also inactive when in contact with the shale formations in the Gulf Coast of Texas mentioned
20 above. Whereas these shales swell and disintegrate when brought into contact with water, they are unaffected by methylene iodide. It will be appreciated that such characteristics as the above are of decided benefit in oil well drilling.

25 The invention may be best understood by reference to the accompanying diagrammatic drawing in which

Fig. 1 is a broken vertical section of a drill hole in which a rotary drill pipe and bit are employed, the hole and pipe being filled with a drilling liquid whose specific gravity is greater than that of any of the rock formations through which the drill hole passes; and

Fig. 2 is a like vertical section of a drill hole also employing a rotary drill pipe and bit, with the drilling liquid, heavier than the rocks through which the drill passes, surrounding the drill pipe and bit in the lower portion of the drill hole while the upper portion thereof and the greater portion
40 of the drill pipe are filled with the usual or any drilling mud.

In the several views of the drawing like reference numerals indicate like parts throughout the several views. Referring to Fig. 1 first, 1 indicates the earth surface, 2 the usual or any suitable casing which at its upper end projects somewhat above the surface 1 and is provided with a slush discharge pipe 3. The lower end of the casing 2, as in usual constructions, extends downward
45 toward but not entirely to the bottom of the drill hole 4. The rotary pipe 5, operated in the usual or any suitable manner (mechanism not shown), has a bit 6, of any usual or preferred construction, at the lower end thereof, and this bit has an opening or openings 7 to the end that the interior of the pipe 5 and the drill hole, exterior to said pipe, may be in open communication. The drill pipe is filled with a drilling liquid 8, heavier than the rocks through which the drill hole is to pass,
50 which, for the purpose of further description, will be referred to as Zyx. The liquid passes downward through the drill pipe 5 and outward through the holes 7 in the bit 6 into and fills the drill hole, and since the liquid Zyx is heavier than the rock in which the drilling occurs, the drill cuttings will rise in the liquid Zyx exterior to the drill pipe and be floated by said liquid to the surface and discharged through the discharge pipe 3 into a suitable tank or receptacle not
60 shown.

It will be readily appreciated that since the liquid Zyx is heavier than any of the rocks through which the drilling occurs, the walls of the hole at any depth are under a greater pressure than the superincumbent pressure of the

overlying rock formations. In other words, the rock formations are being penetrated under an excess of pressure rather than a relief of pressure. This high hydrostatic pressure serves to confine gas, oil, or water to the formations in which they occur and at the same time prevent sloughing or caving into the hole. It will also be observed that while mechanical circulation may be employed, if desired, it is not necessary, since there will be a natural circulation by reason of the fact that the column of Zyx outside of the drill pipe is of less weight per unit volume, due to the included cuttings, than the column inside of the same, and circulation in the proper direction is therefore produced.

15 The immediate buoying of drill cuttings from the bottom of the hole means that the bit is always in contact with a fresh rock surface, and therefore the maximum cutting effect is produced and the speed of drilling is therefore increased. 20 As the Zyx is as liquid as water and is mobile instead of viscous, as is mud, free movement of the solid particles is permitted therein, thus reducing the friction to a minimum not only within the liquid but in the rotation of the drill pipe as well.

In the use of a heavy liquid to facilitate drilling, it may not be necessary to fill the entire drill hole with such a liquid. If a liquid which is not miscible with water is used, such as methylene iodide, the lower portion of the hole for any desired depth can be filled with the liquid and the upper portion with any type of drilling mud. The quantity of the heavy liquid required for a given well is therefore reduced. It may further be desired to use a given heavy liquid in order to penetrate certain formations which may present unusual difficulties, such as those already mentioned. In such a case the heavy liquid would be used in the bottom part of the hole only when these formations are being drilled, and after penetration it may be removed and the well completed with mud in the customary manner. When the heavy liquid is used only in the lower portion of the hole, the removal of the drill cuttings is likewise easily accomplished. The drill cuttings are floated in the heavy liquid to the surface between the heavy liquid and the mud and are there picked up by the mud under circulation and carried to the top of the hole.

Fig. 2 illustrates a method of using a heavy liquid, such as methylene iodide, that is not miscible with water and likewise designated as Zyx, in combination with mud, as just described. In this case the drill pipe is provided near the lower end thereof with a plug 9 entirely closing the pipe, and somewhat above the plug 9 there is a hole or holes 10 in the pipe. The lower portion of the drill hole 4, to a point somewhat above the holes 10 in the drill pipe, is filled with a liquid 8, heavier than mud or any of the rocks through which the drill hole is to pass. The drill pipe above the plug 9 is filled with mud 11 under pressure from a mud pump, and this mud is forced through the holes 10 into the drill hole exterior of the drill pipe and is returned to the surface as indicated by the arrows. This action is similar to the circulation of drilling mud in rotary drilling practice with the exception that here the circulation is above the plug 9 and not the full depth of the drill hole. As the drilling proceeds the chips of the drilled particles of rock, being of less specific gravity than the liquid 8, rise therein to the surface between the said liquid 8 and the mud which is exterior to the drill pipe and, since

this surface is above the holes 10, they are carried upward by the mud and discharged through the discharge pipe 3 to the settling tank.

The separation of the liquid Zyx from the mud and the drill cuttings is accomplished by decantation. The heavy liquid settles to the bottom of the tank, from which it is drawn off and returned to the well, and the mud and drill cuttings may be washed free of any Zyx that is mechanically entrained.

It will be found that by the use of the heavy liquid Zyx as the drilling fluid, the limitations incident to the use of water, either alone or mixed with other materials to form mud, are entirely overcome, the speed of drilling increased, the consumption of power decreased, and, furthermore, the wells may be drilled through formations heretofore impossible of penetration due to disintegration and swelling incident to the use of water in the drilling liquid.

The advantages in the use of a heavy fluid Zyx are not confined to the rotary drill method of drilling wells. In the use of cable tools or churn drilling it will be readily appreciated that if the drill hole is filled with Zyx the drill cuttings will be immediately floated to the surface and thus do away with the necessity of bailing. Furthermore, there would be no settlement of the drill cuttings in the bottom of the hole and the speed of drilling would be increased due to the impact of the bit always on a fresh rock surface. The use of a heavy liquid Zyx is therefore applicable to all methods of drilling wells.

While the invention, for the purpose of illustrating the same, has been herein described in connection with drilling oil wells, it will be understood that such description is for the purpose of illustrating the invention and not for the purpose of defining the limits thereof, since the invention is applicable to the drilling of any kind of a well, whether oil, gas or otherwise, and reference is made to the claims hereto appended for defining the limits of the invention.

Having thus described the invention, what is claimed is:

1. In a process of drilling wells, the step of filling the drill hole with a liquid of greater specific gravity than that of the formation being drilled.

2. In a process of drilling wells, the step of surrounding the drill in the drill hole with a liquid of greater specific gravity than that of the rock formation being drilled.

3. In a process of drilling wells, the step of surrounding the drill in the drill hole with a liquid having a specific gravity not less than 2.80.

4. In a process of drilling wells, the steps of surrounding the drill pipe in the drill hole with a column of liquid having a greater specific gravity than that of the rock formation being drilled and filling the drill pipe with a column of said liquid, the two said columns being in open communication near the bottom of the drill hole.

5. In a process of drilling wells, the steps of surrounding the drill pipe with a column of liquid having a specific gravity not less than 2.80 and filling the drill pipe with a column of said liquid, the two said columns being in open communication near the bottom of the drill hole.

6. In a process of drilling wells, the steps of surrounding the lower part of the drill pipe with a column of liquid having a greater specific gravity than that of the rock formation being drilled, passing a column of mud down within the drill pipe, and passing mud from within the drill pipe

outward into the drill hole and below the surface of the liquid surrounding the lower part of the drill pipe.

7. In a process of drilling wells, the steps of surrounding the lower part of the drill pipe with a column of liquid having a specific gravity of not less than 2.80 passing a column of mud down within the drill pipe, and passing mud from within the drill pipe outward into the drill hole and below the surface of the liquid surrounding the lower part of the drill hole.

8. In a process of drilling wells, the step of surrounding the drill in the drill hole with methylene iodide.

9. In a process of drilling wells, the steps of surrounding the drill pipe in the drill hole with a column of methylene iodide and filling the drill pipe with a column of the same liquid, the two said columns being in open communication near the bottom of the drill hole.

10. In a process of drilling wells, the step of surrounding the lower part of the drill pipe in the drill hole with methylene iodide.

11. In a process of drilling wells, the steps of filling the lower portion of the drill hole exterior to the drill pipe with a column of liquid having a specific gravity greater than the rock formation being drilled, and circulating a column of mud, having a specific gravity less than the rock formation being drilled, in the portion of the drill hole above said column of liquid.

12. In a process of drilling wells, the steps of filling the lower portion of the drill hole exterior to the drill pipe with a column of methylene iodide, and circulating a column of mud, having a specific gravity less than the rock formation being drilled, and in the portion of the drill hole above said column of methylene iodide.

13. In a process of drilling wells, the use of methylene iodide as a drilling fluid in order to penetrate rock formations which are adversely affected by water.

14. The process of removing drill cuttings from around the drill in a well which consists in floating said cuttings upward in a liquid having a greater specific gravity than the cuttings.

15. The process of removing drill cuttings from around the drill in a well which consists in floating said cuttings upward in a liquid having a specific gravity of not less than 2.80.

16. The process of removing drill cuttings from around the drill in a well in rock formations, which consists in surrounding the drill with a liquid having a greater specific gravity than the rock formations.

17. The process of removing drill cuttings from around the drill in a well in rock formations, which consists in surrounding the drill with a liquid having a specific gravity not less than 2.80.

18. The process of removing drill cuttings from around the drill in a well which consists in floating said cuttings away from the drill in methylene iodide.

19. In a process of drilling oil or gas wells, the steps of surrounding the lower part of the drill pipe with a column of liquid having a greater specific gravity than that of the rock formations being drilled, and passing fluid of less specific gravity than the rock formations downward in the drill pipe and outward into the drill hole and below the surface of the liquid surrounding the lower part of the drill pipe.

20. In a process of drilling oil or gas wells, the steps of surrounding the lower part of the drill

pipe with a column of liquid having a specific gravity of not less than 2.80, and passing fluid of less specific gravity than 2.80 downward in the drill pipe and outward into the drill hole and below the surface of the liquid surrounding the lower part of the drill pipe.

5 21. In a process of drilling oil or gas wells, the

use of a column of methylene iodide in the lower portion of the drill hole, and a liquid column having a specific gravity less than the rock formations being drilled in the upper portion of the drill hole.

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