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METHOD FOR DRILLING BORE HOLES

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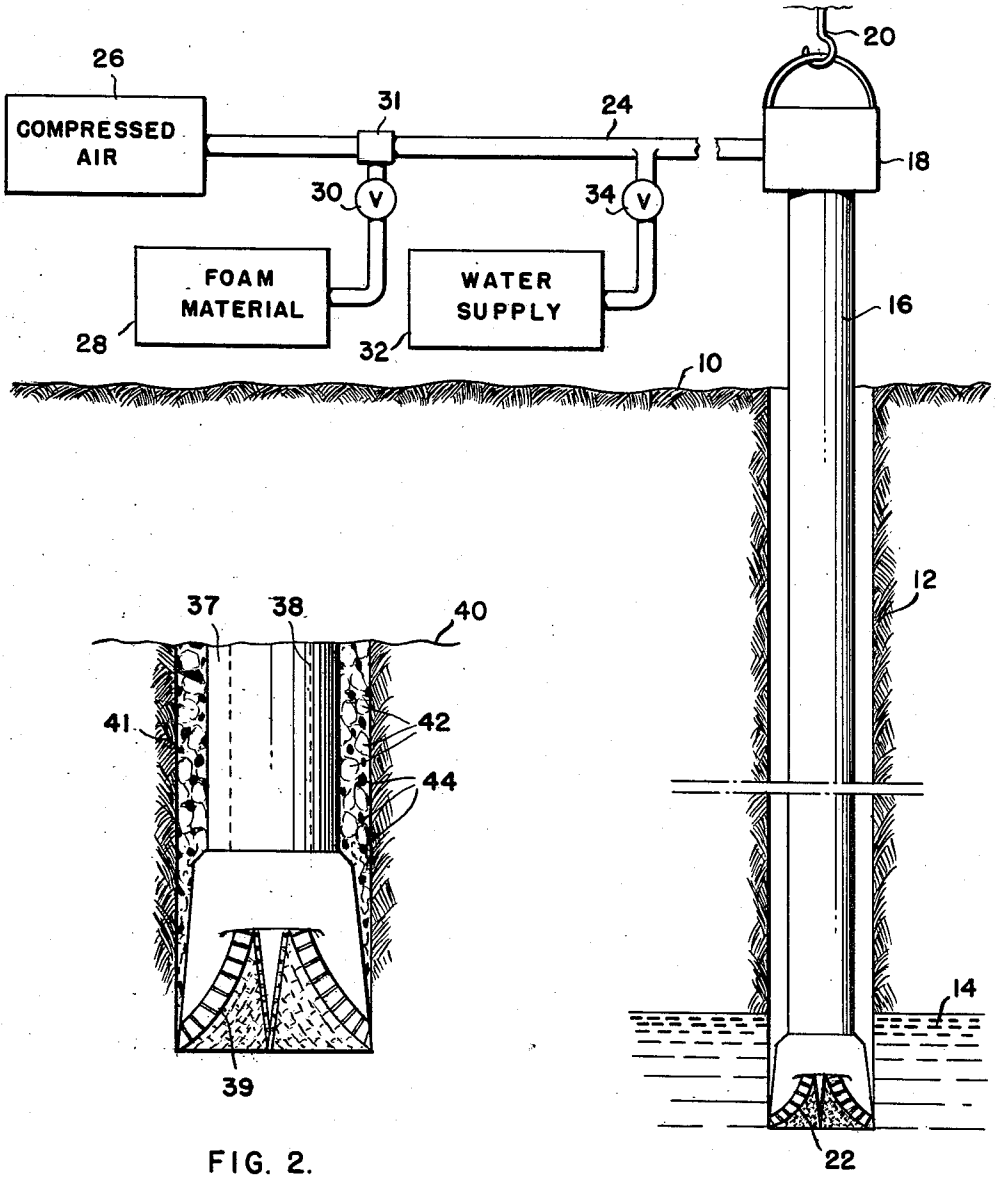

FIG. 1.

FIG. 2.

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METHOD FOR DRILLING BORE HOLES

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2 Claims. (Cl. 175—69)

This invention relates to a method and apparatus for drilling bore holes and, more particularly, to a method and apparatus involving the use of foam for dewatering and/or controlling the amount of water in a bore hole when air or gas drilling is employed.

This application is a continuation of our application Serial Number 530,360, filed August 24, 1955, now abandoned.

It has long been conventional practice in drilling deep bore holes to circulate a drilling mud down through the drill stem and up through the bore hole between the wall of the bore hole and the drill stem for the removal of chips or cuttings from the bore hole and to provide support for the wall of the bore hole. More recently, in the drilling of holes in which wall support provided by drilling mud is not employed, drilling has been carried out with the use of air for chip removal. Such drilling is not only normally faster than mud drilling but is indispensable in areas where the supply of water is limited or when drilling through cavernous formations into which the drilling mud flows and becomes lost.

The increasing popularity of air or gas drilling has come about not only because this method of drilling is frequently faster, as noted above, but for the additional reasons that the drill bits last longer, the provision and handling of water under wide ranges of temperature conditions is avoided, boring samples are easily observed when they are not mixed with mud, and there is no loss involved as in the case of mud drilling when drilling through cavernous formations. Furthermore, prompt removal of water entering the hole maintains a dry hole and the likelihood of wall collapse is thereby reduced.

In a typical air drilling operation there may be provided, for example, an up-flow of air in the bore hole having a velocity of the order of 3,000 feet per minute. This flow of air upwardly through the bore hole, which is produced by air pumped downwardly through the drill stem, provides adequate removal of cuttings. The air is delivered to the drill stem at pressures of 20 to 60 lbs. per square inch and for dewatering or for breaking obstructions, as will be hereinafter described, the pressures may be increased to 180 to 200 lbs. or more per square inch.

Air drilling operations are frequently hampered by the inflow of water into the bore hole when the drill bit is penetrating a water bearing stratum or when the bore hole has passed through a water bearing stratum that has not been cased. Normally, if drilling proceeds uninterruptedly both before and during penetration into a water bearing stratum, the flow of air is sufficient to blow the water out of the bore hole along with the cuttings and drilling dirt. There are, however, two major problems encountered in air drilling when water is entering the bore hole. The first problem occurs when there is a small inflow of water sufficient to cause a dampening of the cuttings which, under certain conditions, will then ball-up, clogging and sometimes jamming the drill bit. The second problem is encountered when there is a substantial amount of water remaining in the bottom of the bore hole during drilling causing a sloughing of the side wall of the bore hole. This latter condition may arise even though the water entering the bore hole is being blown out of the hole as fast as it enters. If there is a substantial inflow of water or if there is a substantial flow of water past a region of the bore hole susceptible to this condition, the water passing that region of the bore hole may cause a sloughing of the side wall.

The primary object of this invention is to provide for the use of foam in connection with air or gas drilling of a bore hole in order to not only dewater a bore hole but in order to control the amount of water in a bore hole.

Further incidental objects of the invention are to provide, by the use of foam in conjunction with air and gas drilling operations, improved cutting removal, a partial cleaning and lubrication of the drill bit and drill bit parts, and fire protection prior to and at the time of breakthrough when the bore hole is being drilled into a gas bearing stratum or at any time when explosive gaseous mixtures may be present.

These and other objects of the invention will become apparent from the following description when read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a vertical section through a portion of the earth showing a bore hole therein and showing apparatus involved at the surface of the earth in the practice of the present invention; and

FIGURE 2 is an enlarged showing of a fragmentary portion of the lower end of the bore hole.

Referring to FIGURE 1 there is shown the surface of the earth 10 and a bore hole 12 extending downwardly therefrom into the earth with the lower end of the bore hole penetrating a water bearing stratum 14. A drill stem 16 is positioned in the bore hole and suspended from a swivel 18 by suitable support means indicated partially at 20. The support means 20, a conventional drilling derrick which would be employed in conjunction therewith, a conventional rotary table and other conventional drilling mechanism which would be employed are well known in the art and need not be described herein.

The lowermost end of the drill stem 16 carries a drill bit 22 to which there is supplied through the drill stem 16, the swivel 18 and a suitable conduit 24 compressed air from a source of compressed air indicated at 26. The source of compressed air 26 may be any conventional type of air compressor, either internal combustion engine or electrically driven such as are well known in the art. The air compressor most desirably employed is, however, a compressor capable of operating continuously while providing air in substantial volumes at pressures of from 20 to 60 lbs. per square inch and capable of providing increased pressure output in the range of from 180 to 200 lbs. per square inch for dewatering or breaking blockages in the bore hole. It should be noted that whenever reference is made herein to compressed air the language should be construed as including other compressed elastic fluids such as, for example, inert gases such as nitrogen, helium and carbon dioxide, and where fire prevention is not involved, gases such as propane, butane and methane.

There is also provided a source of foam material, indicated at 28, which is connected to the conduit 24 through a control valve 30, and a source of water 32 connected to the conduit 24 through a control valve 34. A flow of foam material to the conductor 24 can be provided by independent and conventional pumping or other feeding means or be induced by an eductor as indicated at 31. The water flow can be provided by a conventional water pumping and supplying means.

The foam forming material may be preferably of the type of material which, when mixed with water in the presence of air, produces foam in a mechanical foam-making sense. Materials such as these are produced by alkaline hydrolysis of proteinaceous material of which a hydrolysate is prepared by suitable admixture of caustic

soda and lime acting on a hydrolyzing agent. The proteinaceous material may be of vegetable or animal origin. A typical material of this type is sodium stearate which is formed by hydrolysis of glycol stearate by use of sodium hydroxide.

As an example of proportions, there may be desirably employed 1 to 3 gallons of foam making liquid and 4,000 gallons of air at atmospheric pressure delivered under a pressure of approximately 100 pounds accompanying the removal of each 100 gallons of water from the bore hole.

In some instances, there may be desirably employed chemical foam-making materials which would be in the form of CO_2 forming materials which are introduced into the conductor **24** in dry powder form and which would produce chemical foam upon contact with water. Typical materials of this type are sodium bicarbonate and sodium carbonate or other metallic carbonates used with sodium oxalate, oxalic acid, cream of tarter or similar acidic materials capable of being prepared in dry form. In conjunction with chemical foam-making material there may be desirably employed soaps or other similar materials which will further the production and maintenance of foam from the CO_2 and air delivered to the drill bit in the presence of water.

Synthetic foam forming detergents such as alkylaryl sulfonate and alkyl sulfate may also be employed as foam forming materials.

During normal drilling operations, the valves **30** and **34** are closed and only air is supplied to the drill bit. As previously noted, the air may be supplied, for example, in sufficient volume to provide a rate of up-flow of air in the bore hole surrounding the drill stem of approximately 3,000 feet per minute. This rate of flow has been found to be sufficient to provide for the removal of small drill cuttings and dust. Suitable dust catchers well known in the art may be provided at the top of the bore hole or the air rising from the hole may be permitted to discharge freely into the atmosphere.

In FIGURE 2 there is shown a fragmentary portion of the earth **40** at the lowermost end of the bore hole **41** into which there extends a drill stem **37** having a central bore **38** and mounting at its lower end a drill bit **39**. Air, a foam forming material and possibly water are delivered to the hole through the drill stem and the drill bit and the foam produced therefrom passes upwardly between the wall of the bore hole **41** and the outer surface of the drill stem **37**. This foam is indicated at **42** and carries with it solid materials **44** which result from the drilling operation.

By controlling the rate of addition of foam forming material and, if desired, by adding water, the above noted conditions of balling and sloughing can be substantially avoided. The provision of foam having a sufficient water content in the vicinity of the drill bit will generally prevent the balling of drill cuttings, and in a hole experiencing a substantial inflow of water, converting the free flowing water into a foam will generally avoid the sloughing or colllapse of the side wall which may occur when the flow of water is excessive.

It also will be evident that upon the production of foam in the bore hole there is provided an improved chip removal for the reason that the foam rising through the bore hole will carry upwardly with it chips of larger size than could be carried by the air flow. When during normal air drilling operations chips are cut or broken away by the drill bit which are of greater size than the maximum size chip which can become entrained in the upward air flow, the chip must drop down under the bit and be reground into pieces of sufficiently small size as to be removed by the air flow. By the use of foam, much of this redrilling of large chips is avoided.

Furthermore, in the course of dry air drilling, no lubrication is provided at the drill bit. When, however, there is some water flowing into the bore hole and a foam forming material is carried into the bore hole with the air flow, the foam which will exist at the bottom of the bore hole will serve to lubricate the drill bit bearings and the drill bit cutting edges.

In applications where this cleaning and lubrication is desirably provided and the bore hole is not passing through water bearing stratum, water may be supplied to the bore hole through the drill stem and the conduit **24** from the water source **32** in proportions with the air flow and the flow of a suitable foam forming material as may be required to produce a desired quantity of foam in conjunction with the air flow employed.

This method of producing foam by the addition of both water and a foam forming material to the air flow passing downwardly into the bore hole through the drill stem is advantageously employed as fire protection when gas wells are being drilled. During the drilling of gas wells as the bottom of the bore hole approaches the gas bearing stratum or pockets there is frequently encountered a seepage of gas into the bore hole and the possible danger of explosion and fire. This danger is substantially eliminated by the use of foam drilling. The provision of foam within the bore hole at the time of breakthrough of the bore hole into a gas bearing strata in conjunction with the use of a check valve, as is conventionally employed in such applications at the lower end of the drill stem and the conventional sealing and valving arrangement at the upper end of the casing makes possible the safe removal of the drill stem from the bore hole after the reservoir has been entered and when gas flow is taking place up through the well in conjunction with the removal of the drill stem.

From the foregoing it will be apparent that the addition of foam forming materials to the air flow when air drilling is employed in conjunction with sufficient water to provide foaming gives rise to numerous advantages in drilling operations. The water may be introduced either through a water bearing stratum being penetrated by the drill bit or, alternatively, if the hole is dry, water may be introduced from the surface of the earth through the drill stem in conjunction with the delivery of compressed air and foam forming material through the drill stem to the drill bit. In either case the water may be said to be existing in the bore hole.

It should be noted that while the foregoing description has referred only to the flow of compressed air downwardly in the bore hole through the drill stem and upwardly through the bore hole outside of the drill stem, it will be evident that the reverse flow may be employed, namely, a flow downwardly through the bore hole outside of the drill stem and a flow upwardly through the bore hole inside of the drill stem. This latter arrangement of flow is sometimes employed when a higher velocity of up-flowing materials is desired such as may be useful in the removal of gravel from the bottom of the bore hole. The arrangement also provides for a somewhat greater pressure on the wall of the bore hole. Furthermore, particularly in foam drilling operations, when the entire bore is filled with foam, the increased pressure on the inside of the wall of the bore hole may serve to reduce the rate of inflow of water. Hereinafter, when the expression "flow through the bore hole" is employed, it should be considered as including both flow inside of the drill stem and flow outside of the drill stem.

What is claimed is:

1. The method of drilling a deep bore hole downwardly into the earth at a location wherein the bore hole penetrates a stratum from which water will enter the bore hole, comprising lowering into the bore hole a hollow drill stem mounting a drill bit at its lower end, the drill stem in the bore hole providing two passages between the vicinity of the bit and the surface of the earth, at least one of said passages extending through the drill stem, effecting drilling by said drill stem while providing a gas under pressure through one of said passages downwardly to the vicinity of the bit to effect removal of cuttings through the other of said passages, and, at least during drilling involving entry of water from the aforemen-

tioned stratum, entraining in said gas a material which, upon admixture with water and the gas, will form a foam, thereby to effect removal of water entering the bore hole from said stratum as part of the resulting foam passing to the surface of the earth through the last mentioned passage.

2. In a well drilling operation wherein cuttings produced by a rotating drill bit positioned at the lower end of a string of drill pipe are brought to the earth's surface by entrainment in a stream of gas injected into the bottom of the well through said drill pipe and wherein cuttings tend to accumulate in said well in the presence of subterranean water, the improvement which comprises adding a foaming agent to said gas stream when subterranean water is encountered, forming a foam, and circulating said foam in said well at a rate sufficient to remove subterranean water to the earth's surface.

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