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DRILLING FLUID CONTAINING EXPLOSIVE COMPOSITION

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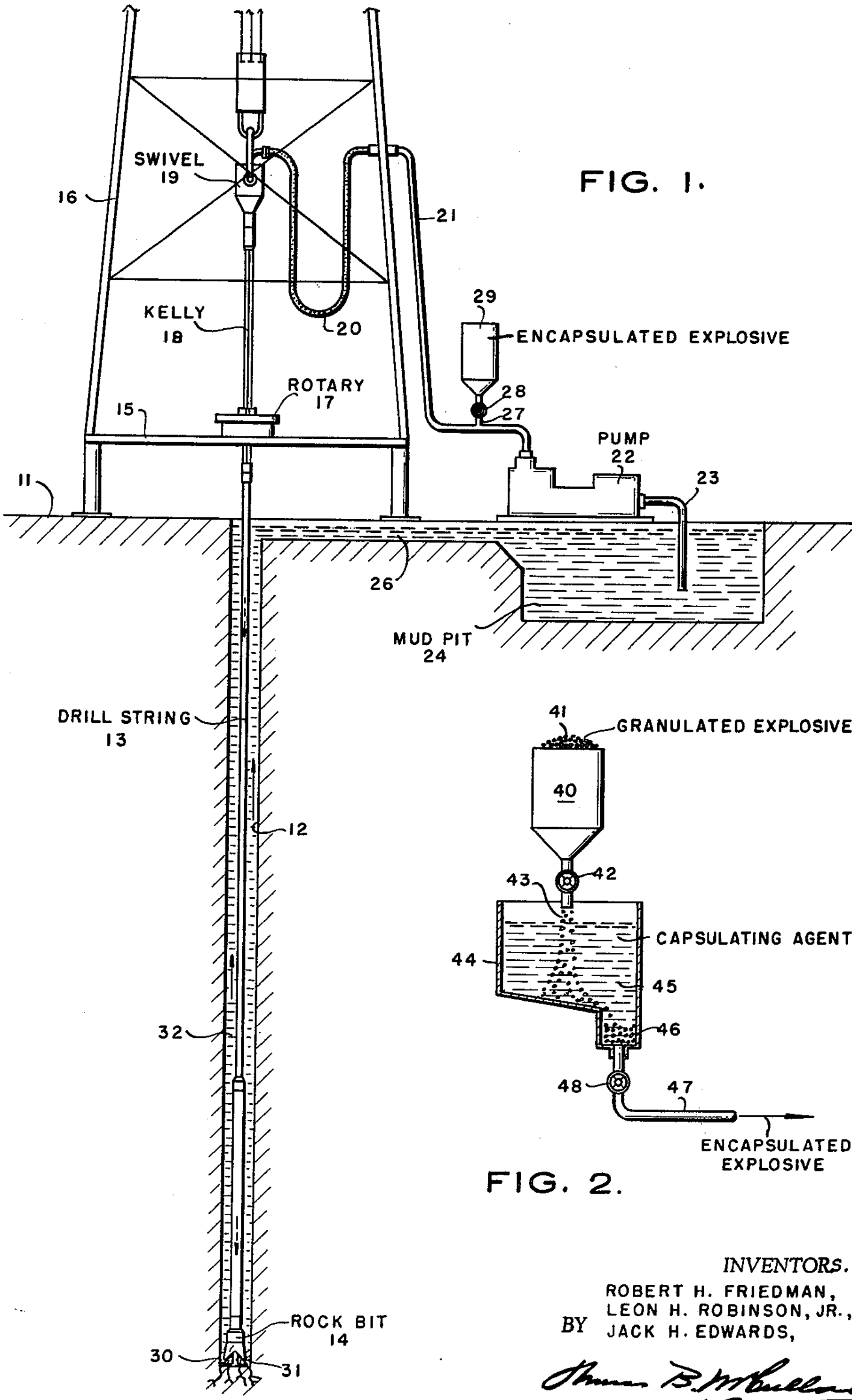

FIG. 1.

FIG. 2.

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DRILLING FLUID CONTAINING EXPLOSIVE COMPOSITION

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5 Claims. (Cl. 149—4)

The present invention is directed to the drilling of wells. More particularly, the invention is concerned with a method for increasing the drilling rate in the drilling of oil and gas wells and the like. In its more specific aspects, the invention is concerned with an improved drilling method in which drilling rates are increased by generation of gas adjacent the drill bit.

This application is a division of Serial No. 31,865, filed May 26, 1960, for Robert H. Friedman, Leon H. Robinson, Jr., and Jack H. Edwards, entitled "Rotary Drilling of Wells Using Explosives."

The present invention may be briefly described as a method for drilling a well with a drill bit in which a hollow drill string, having a drill bit attached to its lower end, is rotated and in which an aqueous drilling fluid is circulated through a path of flow defined by the hollow drill string and the annulus between the drill string and the wall of the well. The specific feature of the present invention involves introducing into the circulating drilling fluid a sufficient amount of water soluble capsules containing an explosive which is rendered harmless by extended contact with water. The capsules have a size within the range from about 0.01 to about 0.25 inch and the explosive has a sensitivity as measured by the drop-sensitivity test within the range from about 2 to about 10 cm. The capsules are exploded by weight imposed on the capsules by the drill bit such that increased drilling rates are obtained.

The explosive employed in the practice of the present invention should be an explosive which is moderately sensitive in the range from about 2 to about 10 cm. as measured by the standard drop-sensitivity test. This test measures the height in centimeters; a 2 kilogram weight must be dropped to cause explosion. A description of this test will be found in Meyer, Martin, "Explosives," Thomas Y. Crowell, Co., New York, 1943, p. 28. The preferred range of sensitivity is in the range from about 2 to about 5 centimeters.

While the exact composition of the explosive is not critical, the explosive must have the sensitivity set out hereinbefore. As examples of the explosives which are useful in the present invention, there may be mentioned lead picrate and guhr dynamite. These explosives are within the preferred range of sensitivity. Explosives that are in themselevs above the range of sensitivity may be brought to the desired sensitivity by admixture with more sensitive materials which function as igniters. Admixture serves to decrease the sensitivity of the more sensitive material and increase that of the less sensitive material. Thus, by admixing such explosives as mercury fulminate, for example 80 percent mercury fulminate with 20 percent potassium perchlorate; or antimony trisulfide, lead triazide, or nitrogen triiodide with standard explosives like dynamite, trinitrotoluene, and PETN (pentaerythritol tetranitrate), the sensitivity may be adjusted to a sensitivity within the desired range. A desirable characteristic of the explosive is that it is rendered harmless by contact with water. Contact with water prevents dangerous accumulation of the explosives in the drilling fluid.

The encapsulating agent for the explosive may be any

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water impervious, slow-dissolving material. Typical of such materials are the natural gums, such as gelatine, gum arabic, gum tragacanth, or guar seed gum. Other satisfactory materials are the synthetic materials commonly used to encapsulate medicines, polyvinyl alcohols, carboxylated methyl celluloses, or organic compounds slowly soluble in water such as benzoin, camphor or diphenylurea. The granulated, encapsulated explosive should have a particle size in the range from about 0.01 to about 0.25 inch and preferably in the range from about 0.05 to about 0.15 inch.

The amount of the explosive capsules added to the drilling fluid is in the range from about 0.1 to about 10 lbs. per barrel of drilling fluid. A preferred concentration is from about 1 to about 5 lbs. per barrel of drilling fluid. The explosive capsules are preferably added to the drilling mud intermittently but may be added continuously so long as the desired concentration is maintained in the drilling mud and there is sufficient explosive concentrated in the region of the drill bit or in the filter cake on the bottom of the well.

Inasmuch as it is necessary for the capsules to dissolve slowly in water to prevent dangerous accumulation thereof, it is necessary to use an aqueous drilling fluid. In other words, the drilling fluid must contain water to contact the encapsulated explosive such that in case any of the capsules are not exploded by setting down weight thereon by the drill bit, the explosive will be rendered harmless by dissolution of the capsules and contact of the explosive with water.

It will be desirable to provide materials as encapsulating agents which will dissolve in a period of time such that the encapsulating material will slowly dissolve. Thus, the capsules will dissolve at a time within the range from 10 minutes to 10 days such that the explosive is rendered harmless. Little, if any, of the explosive will be in the mud returned to the earth's surface in that most, if not all, of that which is not exploded will be dispersed in the filter cake lining the wall of the well bore. Additionally, the concentration of 0.1 to 10 lbs. of small grain encapsulated explosive is such that it will be widely dispersed in the drilling fluid.

The present invention will be further illustrated by reference to the drawing in which:

FIG. 1 is a flow diagram of a preferred mode; and

FIG. 2 illustrates a mode for encapsulating the explosive.

Referring now to the drawing, numeral 11 designates the earth's surface from which a well bore 12 has been drilled by rotating a hollow drill string 13 carrying on its lower end a rock bit 14, suitably a toothed bit, but other well-known rock bits may be used. The hollow drill string extends to the floor 15 of a derrick 16 wherein it is rotated by a rotary table 17 driven by a suitable power means, not shown. Connected into the upper end of the drill string 13 is a kelly joint 18 which connects by means of a swivel 19 to a flexible conduit 20 which, in turn, connects by pipe 21 to a mud pump 22. Mud pump 22 takes suction by pipe 23 with the mud pit 24.

Connected into pipe 21 by a conduit 27 controlled by a valve 28 is a tank 29 which contains a supply of encapsulated explosives. As the mud is drawn into the pump 22 through line 23 and pumped by line 21 a sufficient amount of the encapsulated explosive is discharged by line 27 into line 21 to maintain in the drilling mud the desired concentration of explosive and the mud containing the explosive is then pumped down the hollow drill string 13 then out through the drill bit 14. The explosive then concentrates in the filter cake at the bottom of the well bore and the concentrated encapsulated explosive is then crushed by the weight of the drill string and thus exploded.

By virtue of the explosion of the explosive by the drill bit 14, the drilling rate is enhanced to a considerable degree by microscopic fissures or cracks created under the drill bit by the plurality of explosions occurring. This allows the drill bit to fracture the rock formation easily and results in increased drilling rates. Not only is the present invention useful in increased drilling rate but explosions in the region of drill bit 14 cause microscopic fissures in the rock which allows the rock to be fractured easily by the drill bit and removed as chips. With generation of gas in the immediate vicinity of the rock bit teeth, the pressure dfferential across the rock chips is reduced and the rock chips are efficiently dislodged and microscopic fissures that are formed are widened rather than healed as encountered in conventional drilling operations.

The exploding capsules 30 thus create a plurality of miniature explosions 31 in the region of the rock bit 14 speeding the drilling rate and allowing improved drilling operations.

Any of the capsules which emerge from under the drill bit 14 without exploding are carried into the annulus 32 and deposited in the filter cake lining the well bore wall and by virtue of the time elapsing, the capsules are slowly dissolved and the explosives are eventually rendered harmless by contact with the aqueous drilling fluid.

The present invention is quite advantageous and useful in increasing the speed of drilling through earth formations.

Referring now to FIG. 2, a mode is described of encapsulating the granulated explosive. In FIG. 2, numeral 40 designates a hopper containing granulated explosive 41 of sufficiently small size to form capsules of a size within the range given. The hopper 40 is controlled by valve 42 which allows a stream 43 of the granulated explosive 41 to be discharged into a tank 44 containing a volume 45 of encapsulating agent such as has been described. The stream 43 of the granulated explosive 41 falls downwardly within the encapsulating agent 45 and is coated thereby and by gravity flows into the boot 46 for removal of the encapsulating agent by way of line 47 controlled by valve 48. The encapsulated explosive may then be dried as desired and then placed in the tank 29 for introduction into line 21 as has been described. While one method has been described of encapsulating the granulated explosive, other methods may be used. For example, the explosive may be encapsulated by a spray-drying technique.

The practice of the present invention has been illus-

trated by conventional circulation down the drill string and up the annulus. It is to be understood, however, that reverse circulation may be employed such that the mud is flowed down the annulus 32 and up the drill string 13. In such instances, of course, it would be necessary to change the flow system to provide for returns of the mud to the mud pit.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and secure by Letters Patent is:

1. An aqueous drilling fluid comprising drilling mud containing particles of explosive selected from the group consisting of lead picrate, guhr dynamite, mixtures of mercury fulminate with potassium perchlorate, and mixtures of antimony trisulfide, lead triazide, and nitrogen triiodide with dynamite, trinitrotoluene, and pentaerythritol tetranitrate, having a drop sensitivity as measured by the drop sensitivity test within the range from about 2 to about 10 cm. and having a dry encapsulating coating selected from the group consisting of gelatine, gum arabic, gum tragacanth, guar seed gum, polyvinyl alcohol, carboxylated methyl cellulose, benzoin, camphor, and diphenyl urea, said particles being of a size within the range from about 0.01 to about 0.25 inch, the coating on said particles being water soluble, said explosive being rendered harmless by contact with water for a time within the range from 10 minutes to 10 days.

2. A drilling fluid in accordance with claim 1 in which the explosive is lead picrate.

3. A drilling fluid in accordance with claim 1 in which the explosive is guhr dynamite.

4. A drilling fluid in accordance with claim 1 in which the explosive is a mixture of mercury fulminate and potassium perchlorate.

5. A drilling fluid in accordance with claim 1 which contains from about 0.1 to about 10 pounds of said particles per barrel of drilling fluid.

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