March 6, 1951 R. P. VINCENT 2,544,573

METHOD AND MEANS FOR DRILLING

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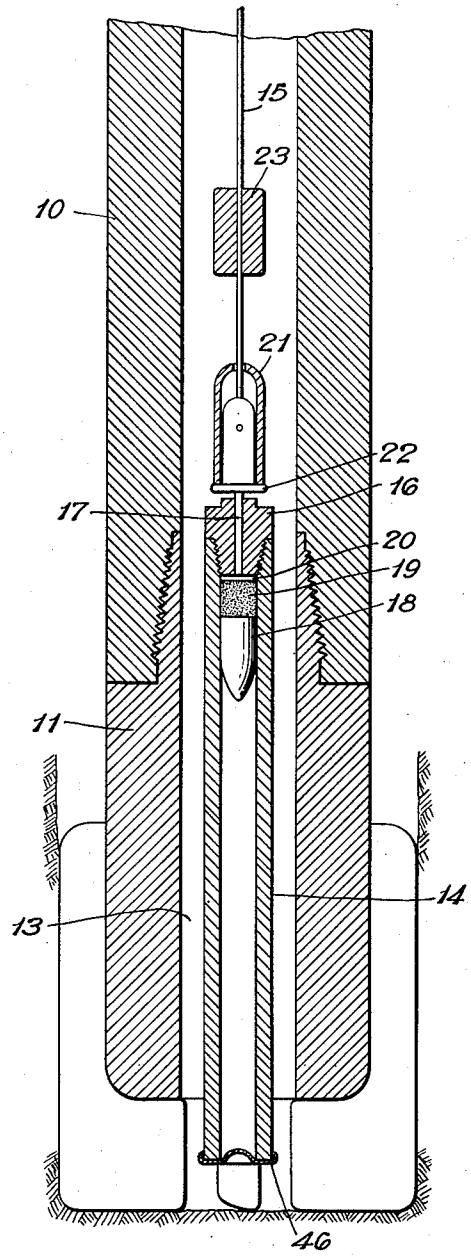

Fig. 1

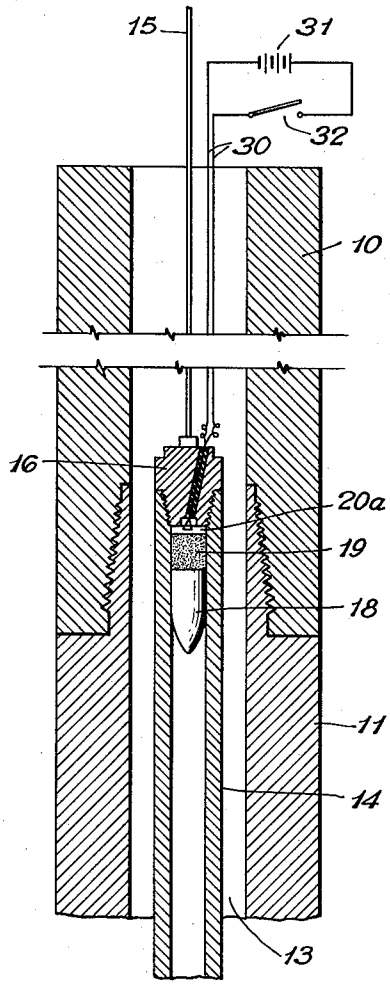

Fig. 1a

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METHOD AND MEANS FOR DRILLING

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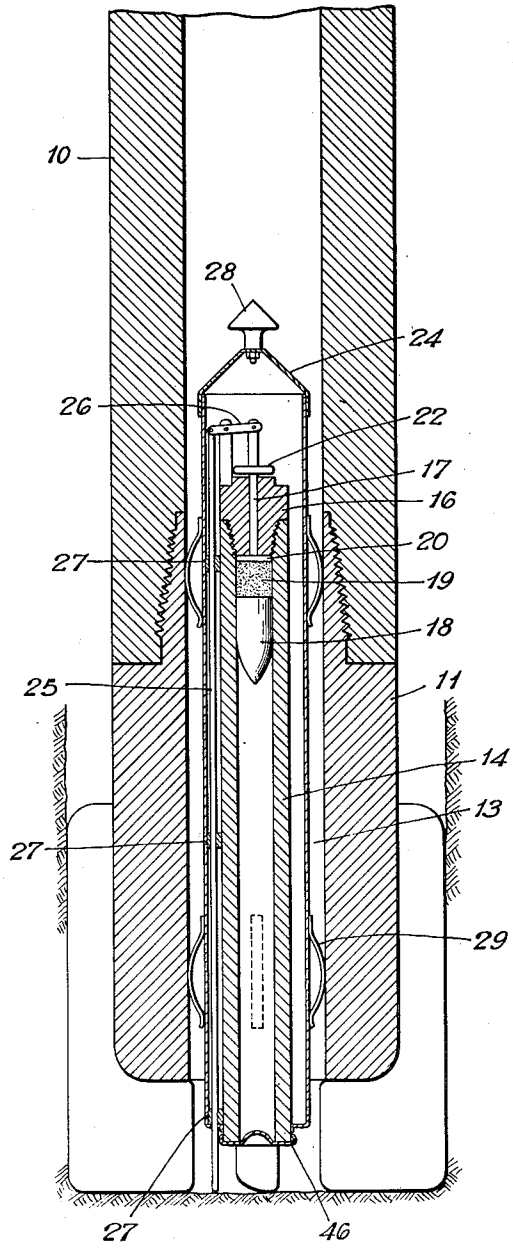

Fig. 2

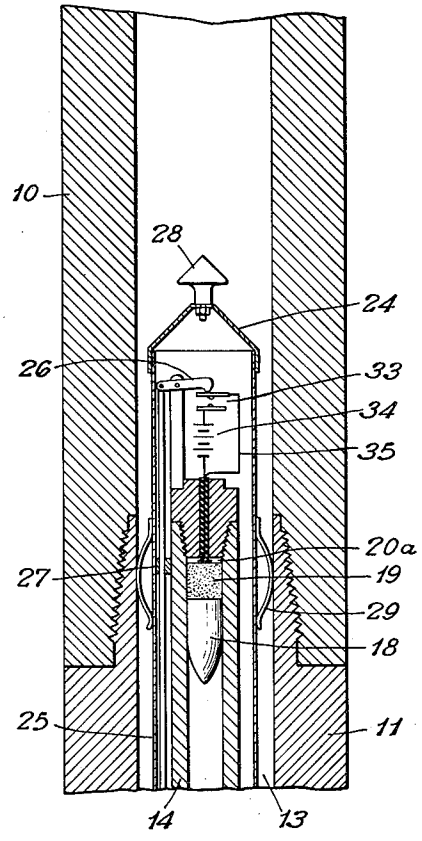

Fig. 2a

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METHOD AND MEANS FOR DRILLING

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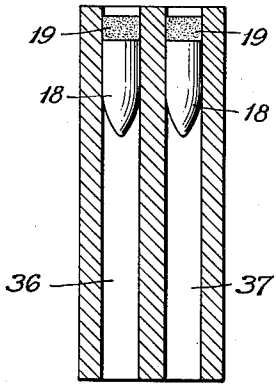

Fig. 3

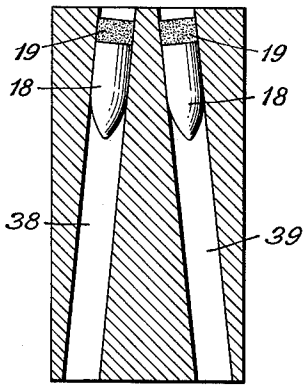

Fig. 4

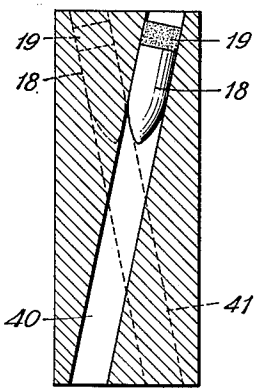

Fig. 5

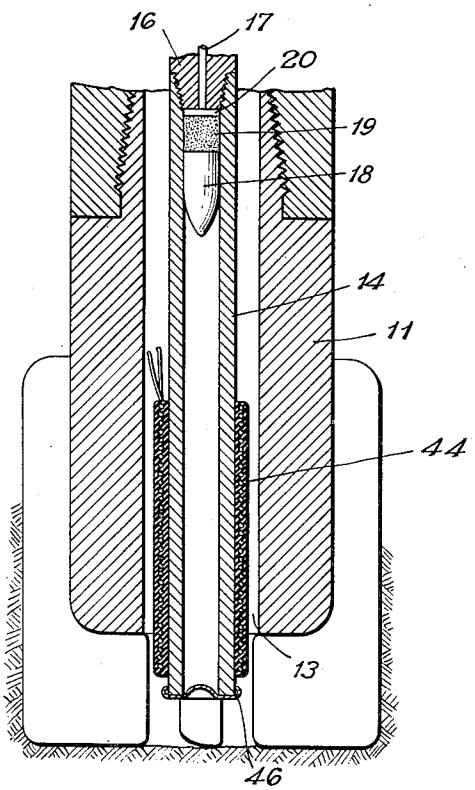

Fig. 7

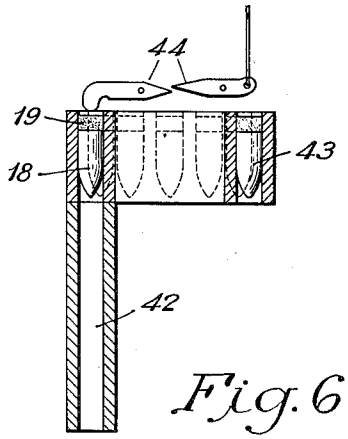

Fig. 6

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UNITED STATES PATENT OFFICE

2,544,573

METHOD AND MEANS FOR DRILLING

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Application January 29, 1946, Serial No. 643,993

6 Claims. (Cl. 255—1.8)

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The present invention relates to method and means for penetrating hard formations, particularly those excessively hard formations such as chert which are expensive and difficult to penetrate by conventional drilling systems. More specifically, this invention relates to an earth boring device comprising a rotary drilling means and a formation fracturing means.

When drilling a well, the bore tool encounters many types of formations, some of which are relatively soft, whereas others are exceedingly hard. Rapid penetration is obtained when passing through relatively soft formations, the drill bit exhibiting little or no damage and wear. However, when exceedingly hard formations are encountered, the drilling rate is decreased and the drill bit is subjected to excessive wear. In some cases, the cutting edges of a rotary drill bit have been completely worn down while passing through less than a foot of a given formation. Such operations are unsatisfactory because the withdrawal of a drill stem and the renewal of a drill bit are expensive and time consuming. The general trend in drilling is in the direction of deeper wells, and it is very desirable to provide improved method and means for penetrating the hard formations usually associated with the deeper wells.

It is therefore an object of the invention to provide a method and means whereby hard formations can be penetrated more economically and more quickly. A primary object is to provide a system for fracturing a formation to be drilled whereby the drill bit advances more rapidly through very hard formations. A further object is to provide a system whereby the shattering of the hard formation can be accomplished without removing the drill stem and bit from the well. An additional object is to provide an apparatus which can be passed within the drill stem. Still another object is to provide method and means for augmenting a rotary drill. Another object of the present invention is to provide an apparatus for shattering and penetrating a hard formation to permit drilling through with a drill bit. These and other objects will become apparent as the description of the invention proceeds.

In general the objects of this invention can be attained by fracturing the formation, for example by providing an explosive charge or a percussion means in the region to be drilled. More specifically, the objects can be attained by providing means for firing a projectile from within the drill collar or bit into the formation below the bit. This fractures the formation and facilitates the drilling operation, reducing the wear on the

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cutting surfaces. The projectile may be of the type used for perforating casing, can comprise an explosive charge within the bullet, or can be frangible. It is also contemplated that a quantity of shot may comprise the shattering mass and these shot can aid the drilling operation.

The method and means which comprise this invention will be described with particular reference to embodiments illustrated in the drawings which form a part of this specification. Similar reference characters in the several figures designate similar or corresponding elements.

In the drawings:

Figures 1 and 2 are elevations partly in section which illustrate devices in accordance with the invention having mechanical means for firing the gun;

Figures 1A and 2A illustrate similar devices wherein electrical means are used for controlling the fire;

Figures 3, 4, and 5 diagrammatically illustrate embodiments in which multiple gun barrels are provided;

Figure 6 is a fragmentary view partially in section which diagrammatically illustrates an arrangement for firing successively a multiplicity of projectiles; and

Figure 7 is an elevation partly in section illustrating an arrangement for retrieving spent magnetic bullets from the bottom of the well.

Referring to Figures 1 and 2, a drill pipe 10 is provided with a drill bit 11 at its lower end. It will be understood, of course, that other types of drill bits can be used, providing they have an opening 13 through which one or more projectiles can be fired. While it is desirable that the shattering mass be projected centrally of the drill bit 11, it is contemplated that the barrel 14 can be located to one side or the other of the axis about which the drill bit is rotated. Although the present invention finds its greatest utility in connection with rotary drilling, it can be employed to advantage with cable drilling systems.

The drill pipe 10 and drill bit 11 are provided with a central opening 13 through which a gun barrel 14 can be passed. The gun can be lowered through the drill pipe 10 to the bottom of the well by means of a wire line 15. The gun comprises in addition to the barrel 14 a breach block 16 and a firing pin 17. A projectile 18 is disposed within the barrel 14 and a powder charge 19 is located behind the projectile 18. The detonator 20 is located beneath the firing pin 17 and operates in a conventional manner.

With particular reference to Figure 1, the firing mechanism comprises a cylindrical member 21 disposed about the wire line 15 and bearing against the disk 22, which actuates the pin 17. To fire the gun a go-devil 23 can be dropped down the wire line 15 thereby urging the tubular member 21 downwardly to actuate the disk 22 and firing pin 17, thereby exploding the detonator 20.

In the modification illustrated by Figure 2, housing or casing 24 may be provided for the gun 14 and firing mechanism so as to exclude the drilling fluid, thereby avoiding interference with the operation of the gun. This housing is adapted to be floated downwardly through the drill stem 10 to the drill bit 11 by the drilling fluid. If desired, leaf spring guides 29 can be used to centralize the housing 24 as it is being floated down the drill stem, these guides minimizing the possibility of jamming and premature firing. The housing 24 can if desired be placed into the drill stem 10 by means of a lubricator or the equivalent (not shown). The gun itself corresponds in general to that described in connection with Figure 1, but the firing mechanism is operated by means of an actuating rod 25 and linkage 26. The rod 25 extends downwardly through packing-supports 27 and the wall of the housing 24 and actuates the firing mechanism when the rod 25 strikes the bottom of the well. It is also contemplated that other types of firing mechanisms can be used which are adapted to actuate the detonator mechanism. After the actuating rod has caused the gun to be fired, the housing 24 can be removed from the well by reversing the direction of circulation of the drilling fluid and floating the gun to the surface where it can be removed from the drill stem. Alternatively, the housing 24 can be recovered by a conventional over-shot lowered on a wire line until it engages the spearhead 28.

In Figure 1A, an electrical system is provided for firing the gun, instead of the go-devil 23 and the associated elements 21 and 22 employed in Figure 1. The leads 30 from the electrical control mechanism can comprise a pair of insulated conductors integral with the wire line 15. The leads 30 are connected to a source of electrical energy 31 and the switch means 32 at the surface. The leads 30 pass through the breach block 16 and terminate in the electrical detonator 20A.

Figure 2A illustrates an arrangement generally similar to Figure 2 but including an electrical means for detonating the gun in response to a rod and linkage mechanism corresponding to that described in connection with Figure 2. In the present modification, rod 25 and linkage 26 actuate the switch 33 closing the circuit which includes battery 34, leads 35 and electrical detonator 20A.

It is contemplated that a multiplicity of gun barrels and projectiles can be used. Thus, for example, in Figures 3, 4, and 5 two barrels are shown. These may be fired simultaneously or in succession. In that event a suitable timing mechanism or delayed-action linkage can be employed as is well known in the art. In Figures 4 and 5, the barrels of the guns are arranged in divergent fashion which gives the additional advantage that a larger area of the hard formation is shattered when the projectiles are fired.

In Figure 6 a means is diagrammatically illustrated in which the gun is provided with a single barrel 42, a magazine 43 and a firing mechanism 44, so that a plurality of projectiles can be fired

in succession through a single barrel. Other modifications of the arrangement of barrels and means for firing a multiplicity of projectiles will become apparent to those skilled in the art.

In some instances it is desirable to retrieve the spent bullets from the fractured formation, and it is proposed that an electromagnetic or solenoid means can be provided for this purpose. I have shown one such means in Figure 7, in which a solenoid is provided around the barrel 14 to attract the steel bullets and permit their being withdrawn with the gun. The solenoid 44 can be operated separately from the gun firing mechanism or can be associated therewith in a manner which permits its operation automatically following the firing of the bullet. The invention is, however, preferably employed in connection with a reverse circulation drilling technique whereby the cores cut by bit 11 are circulated to the surface within the drill stem. The bullet in this operation is thereby circulated to the surface in a formation core and does not interfere with the drilling operations.

Further with regard to the operation of this invention in its preferred embodiment, the kelly is removed to permit insertion of the gun when the drilling rate has decreased; i. e., when it is indicated that the bit has penetrated the hard formation to the depth of the deepest fracture, usually a depth of from 2 to 12 or more inches. Since the drill stem is filled with drilling fluid which might in some instances contact the powder charge 19, I preferably seal the gun barrel 14 at the lower end with a light metal or frangible cap 46 which will withstand the pressure at the bottom of the hole without rupturing. The gun is then lowered on wire line 15 until it reaches the bottom of the well. At the bottom of the well the powder charge 19 is detonated as above described, the gun is withdrawn, the kelly reconnected, and drilling proceeds. In some instances I have found it desirable before lowering the gun to the bottom of the well to rotate bit 11 slightly off bottom and circulate the drilling fluid up through the drill stem for a number of minutes before inserting the gun into the drill stem for the reason that this tends to remove any formation core standing at the bottom of the hole and remove any large cores or cuttings within the drill stem which might prevent the gun from reaching the bottom of the well.

Although the invention has been described with reference to specific embodiments, it is contemplated that modifications can be made therein by those skilled in the art without departing from the scope of the invention. Therefore, it should be understood that the invention is not limited to the particular embodiments illustrated but only by the appended claims.

I claim:

1. The method of penetrating a hard earth formation which comprises the steps of drilling said formation whereby drill cuttings are produced, flowing the drill cuttings from the well in a drilling mud, periodically interrupting the drilling operation, lowering a gun in said drilling mud to a point in proximity to the drilling operation, firing a projectile from said gun against the portion of the formation ahead of the drilling operation and with sufficient violence to effect a shattering of said portion of the formation, withdrawing the gun in drilling mud and resuming drilling operation through the shattered formation.

2. An apparatus for drilling through hard subterranean formations which comprises a hollow drill stem with a hollow drill bit at its lower end constructed and arranged so that drilling mud may be flowed downwardly to the cutting surface and then upwardly, a gun constructed and arranged for vertical passage through said drill stem, means for removably positioning said gun in said drill stem at the lower end thereof, means for firing a projectile from said gun with shattering violence against the formation which is ahead of the drill bit and means for withdrawing said gun after said projectile has been fired.

3. The apparatus of claim 2 including electromagnetic means for withdrawing the spent projectile from the drill bit with said gun.

4. An apparatus for penetrating difficultly drillable substances in a well bore which comprises a hollow drill stem with a hollow drill bit at its lower end constructed and arranged so that drilling mud may be pumped downwardly within the drill stem to the cutting surface and then upwardly, explosive charge means for directing a shattering force below the drill bit, said charge means being constructed and arranged to be passed within said drill stem and be positioned removably within said hollow drill bit, and means for withdrawing said charge means independently of said hollow drill stem and drill bit.

5. The method of producing a well bore traversing hard earth formations which comprises the steps of cutting an initial bore in a formation, flushing drill cuttings from the bottom of the well bore, explosively fracturing the formation below said bore, drilling through the fractured portion of the formation to extend said bore, and repeating the operations in sequence without withdrawing the drill bit and drill stem from the well bore.

6. In the method of producing a well bore traversing hard earth formations, the steps which comprise cutting an initial bore in a formation, flushing drill cuttings from the bottom of the well bore, explosively fracturing the formation below said bore, and drilling through the fractured portion of the formation to extend said bore without withdrawing the drill bit and drill stem from the well bore.

RENIC PRICE VINCENT.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,585,664	Gilman	May 25, 1926
1,861,042	Zublin	May 31, 1932
2,003,345	De Maris	June 4, 1935
2,254,979	Ricou	Sept. 2, 1941
2,307,729	Foster	Jan. 5, 1943
2,308,042	Barnett	Jan. 12, 1943