

Dec. 16, 1941.

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2,265,982

DIRECTIONAL DRILL BIT

Filed Nov. 6, 1939

2 Sheets-Sheet 1

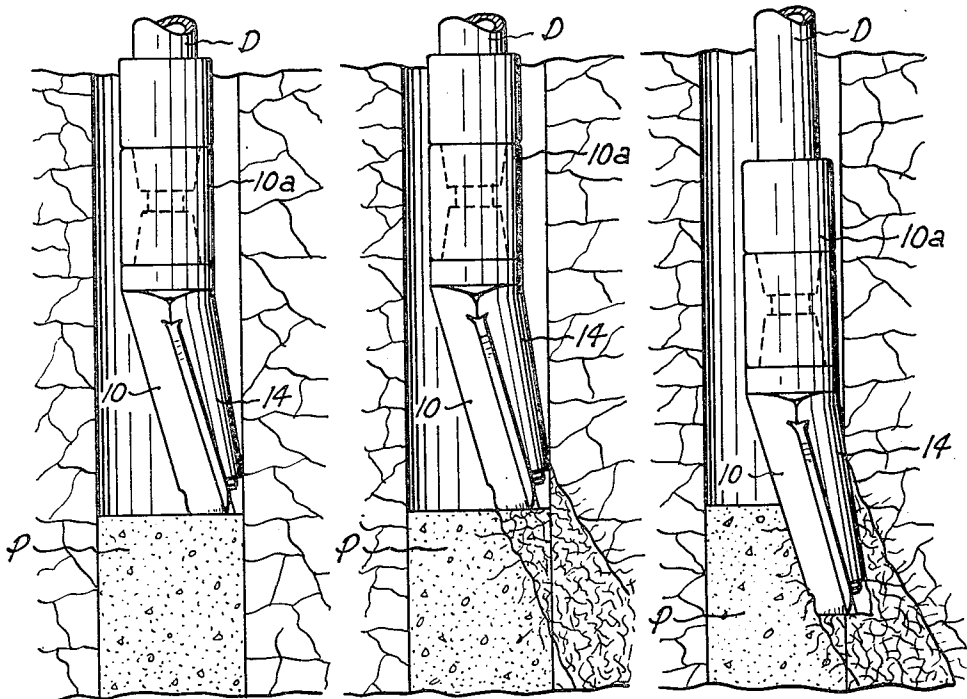


Fig. 1.

Fig. 2.

Fig. 3.

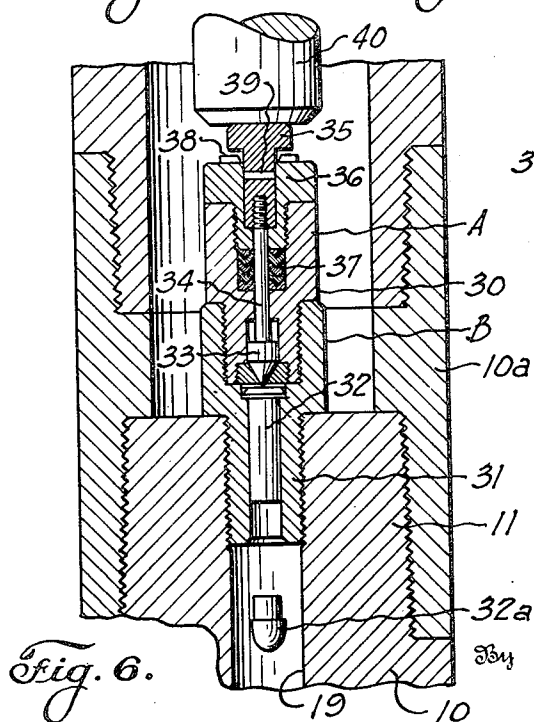


Fig. 6.

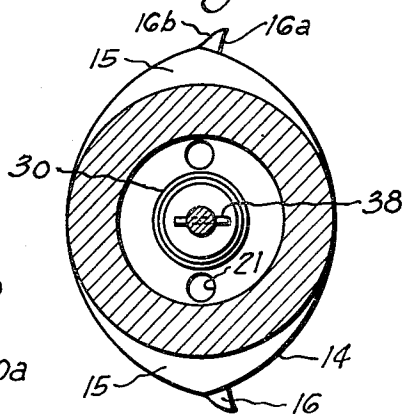


Fig. 7.

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2 Sheets-Sheet 2

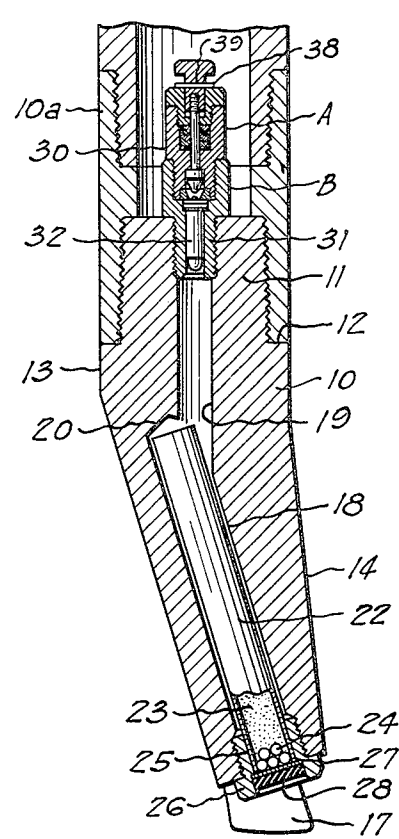


Fig. 4.

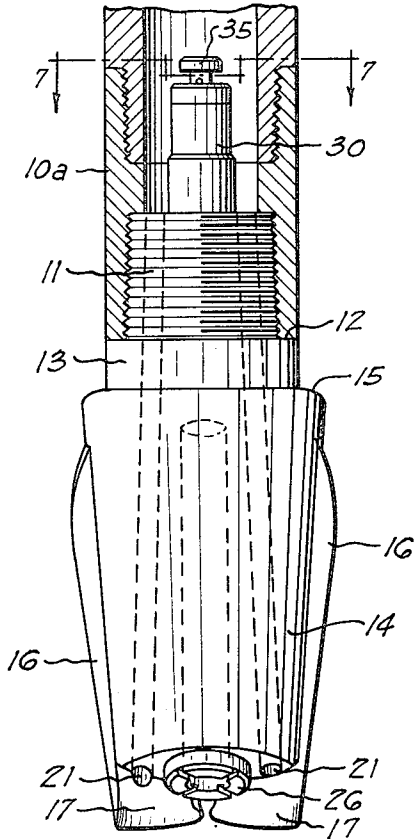


Fig. 5.

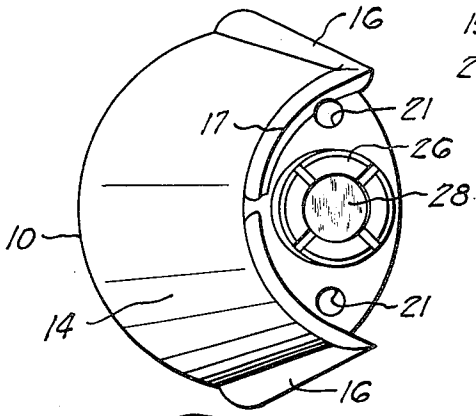


Fig. 8.

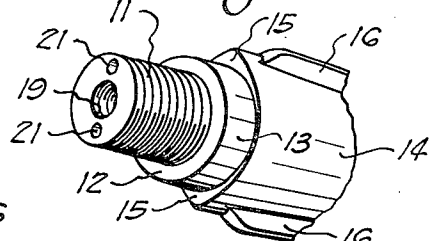


Fig. 9.

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UNITED STATES PATENT OFFICE

2,265,982

DIRECTIONAL DRILL BIT

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Application November 6, 1939, Serial No. 303,074

5 Claims. (Cl. 255-1.6)

This invention relates to new and useful improvements in directional drill bits.

In performing directional or controlled drilling, it has been the practice to employ "spudding" bits for starting the new bore which, of course, angles off from the drilled bore. These spudding bits are first oriented in the old bore by any suitable orienting means and are operated by imparting a reciprocating or hammering action thereto to drive the bit into the formation and thereby begin the new bore at the desired angle. This practice has been found satisfactory in the softer formations because there is little or no resistance to the entrance of the bit, but in hard formations it is most difficult, and practically impossible, to drive the bit into the formation. Further, cement plugs have come into general use for plugging the old bore and in order to start the new bore, the spudding bit must be driven through a portion of the plug and the resistance of the cement to the passage of the bit is so great as to make the usual type of spudder bit unsatisfactory in cases where such plug is employed. Also, the usual spudder bit has no provision for cutting the formation with a rotary action, with the result that after the bit has been driven into the formation as far as possible, it must be removed from the well and a rotary bit substituted therefor. Obviously, this requires considerable time and labor.

It is, therefore, one of the objects of this invention to provide an improved directional bit which may be efficiently operated in hard formations and also in well bores, which have been closed by a cement, or other plug.

An important object of the invention is to provide an improved bit, of the character described, which is so constructed that it may be utilized as a spudder bit and driven downwardly into the formation and may also be employed as a rotary bit by rotating the same to cause the blades to perform a cutting action.

A further object of the invention is to provide an improved directional bit having cutting members thereon, said cutting members being so mounted on the bit body that they will not interfere or materially resist the entry of the bit into the formation when said bit is utilized as a spudding bit and is driven into the formation without rotation.

A particular object of the invention is to provide an improved directional bit having an explosive charge mounted therein, said charge being adapted to be fired after the bit has been lowered into position within the well bore,

whereby the force of said charge is directed at the desired angle into the formation to disintegrate and loosen said formation and thereby facilitate entry of the bit thereinto.

5 Still another object of the invention is to provide an improved directional bit having an explosive charge mounted therein with means for firing said charge to direct the force thereof into the formation; the firing means being adapted to be actuated by means lowered from the surface, whereby the time of firing may be controlled from the surface.

10 A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

15 The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

20 Figure 1 is a side elevation of a directional drill bit, constructed in accordance with the invention and illustrating the same lowered within the well bore,

25 Figure 2 is a similar view, illustrating the action of the explosive charge,

Figure 3 is a similar view showing the bit lowered and penetrating the formation,

30 Figure 4 is a transverse, vertical, sectional view of the device,

Figure 5 is an enlarged front elevation of the bit and taken at a right angle to Figure 1,

Figure 6 is an enlarged, transverse, vertical, sectional view, taken through the firing means,

35 Figure 7 is a horizontal cross-sectional view taken on the line 7-7 of Figure 5,

Figure 8 is a bottom view of the bit, and

Figure 9 is a partial isometric view of the upper portion of the bit body.

40 In the drawings, the numeral 10 designates a bit body having an upstanding pin 11 preferably made integral with its upper end. The pin is formed with external screw threads, whereby the bit body may be connected by the usual coupling 10a with the drill stem or pipe D. The base of said pin has a smaller diameter than the outer diameter of the body so as to provide an external annular shoulder 12 between the pin and body. That portion 13 of the body immediately below the pin is of a constant diameter (Figure 4) and is cylindrical in cross-section, while the remainder of said body is gradually reduced or tapered to form an elongate tapered shank 14. The shank is generally elliptical in cross-section (Figure 9), whereby a pair of diametrically opposite external

shoulders 15 are provided between the cylindrical portion 13 and said shank. The shank is inclined with relation to the vertical axis of the body portion 13 and pin 11 and the angle of this inclination is subject to variation, as will be hereinafter explained.

A pair of elongate cutting blades 16 are secured to the exterior of the shank 14 and extend longitudinally thereof from below the lower end to a point below the top of said shank. The blades are disposed on opposite sides of the shank, being aligned vertically with the shoulders 15 (Figure 7), and extend at the same inclination, or parallel to, the longitudinal axis of the shank. As shown in Figure 7, the blades have a general triangular shape in cross-section and are welded, or otherwise secured, to the shank. One side 16a of each blade is disposed substantially radially of the bit body while the other side 16b is curved so as to merge into the outer surface of said body, the point of intersection of these sides forming the cutting edge.

The lower end of each blade 16 projects in a plane below the lower end of the shank and has an arcuate cutting element 17 made integral therewith. The cutting element follows the external surface of the lower portion of the shank and is secured thereto by welding, or other means. The arcuate cutting elements terminate short of each other, as shown in Figure 5 and the outer surfaces of said elements merge into the exterior surface of the shank so as to form a continuation thereof. Manifestly, the elements co-act to provide a substantially semi-elliptical cutting member at one side of and below the shank 14, said member being a continuation of the elongate cutting blades 16. The lower edges of the elements 17 are preferably sharpened to provide a cutting edge. When the bit body is driven into a formation, the cutting member formed by the arcuate elements 17 will enter the formation to lead the bit into the formation. Since the outer surfaces of the cutting elements 17 as well as the surfaces 16b of the blades 16 merge into the exterior surface of the bit body, it will be obvious that substantially no resistance to the entry of the body into the formation is produced by these parts. When the bit body is rotated, both the blades 16 and cutting elements 17 perform a drilling operation.

The tapered shank 14 of the bit body is provided with a longitudinal, cylindrical bore 18 which extends upwardly from its lower end. This bore is disposed at an angle to the longitudinal axis of the shank and has its upper end communicating with a vertical bore 19 which extends axially through the cylindrical portion 13 of the body and through the pin 11. The bore 19 is of a smaller diameter than the bore 18 whereby an inclined overhanging lip or shoulder 20 is formed at the upper end of the bore 18. A pair of diametrically opposed water courses 21 extend longitudinally through the body on each side of the bores 18 and 19 and the lower ends of the courses terminate adjacent the inner face of the arcuate cutting elements 17. Manifestly, when drilling fluid is circulated downwardly through the passages, said fluid washes the faces of the cutters 17 and also circulates around the lower portion of the bit to remove cuttings in the usual manner.

An elongate, tubular casing 22 is insertable within the bore 18 and this casing may be constructed of a light metal or other suitable material. The casing contains powder or other ex-

plosive 23, and may also have shot 24 placed in its lower end, as illustrated in Figure 4. The lower end of the tubular casing is disposed within the bore 25 of a retaining nut 26, which nut is threaded into the lower end of the bore 18 of the shank. The casing is retained within the nut and also within the bore 18 by a frangible disk 27 which is shouldered and suitably secured within the bore of the retaining nut 26. A suitable packing disk 28 overlies the disk 27 to seal the end of the casing and make the same water-proof.

From the foregoing, it will be seen that the casing 22 having the explosive therein, is mounted within the shank, being disposed at an angle from the vertical, such angle being dependent on the angle of inclination of the bore 18. When the explosive 23 within said casing is discharged, the disks 27 and 28 are fractured and the shot 24, as well as the force of the explosive, is directed outwardly into the formation in advance of the drill bit. The force of the exploded charge is sufficient to disintegrate and loosen the formation, whereby entry of the bit into the formation is facilitated.

Any suitable means may be employed for discharging the explosive within the casing, but it is preferable to employ a cartridge for this purpose. As illustrated in Figure 6 the firing means includes a cylindrical housing 30 which is constructed of an upper section A and a lower section B, the sections being connected together by screw threads. The lower section is formed with a depending screw-threaded sleeve 31, which is threaded into the upper end of the bore 19 of the bit body, whereby the bore of the section B communicates therewith. A cartridge 32 is mounted within the bore of the section B and has its upper end contiguous to the lower end of the section A. A firing pin 33 is disposed within the section A and is capable of limited movement therein, said pin being adapted to strike the cap of the cartridge to fire the same. The firing pin is secured to an operating rod 34 which extends upwardly through the section A and which has its upper end secured to a flanged head 35. The head is slidable within the bore of a closure 36 which closes the upper end of the section A, the flange of said head overlying said closure exteriorly thereof. A suitable packing 37 is mounted within the section A and surrounds the rod 34 to prevent fluid from passing into the cartridge chamber.

The firing pin 33 and rod 34 are normally held in a raised position, as shown in Figure 4, by a frangible pin 38 which passes through a diametrically extending opening 39 in the head and which has its ends resting on the top of the closure. Obviously, when the parts are in this position, the firing pin is spaced from the cartridge cap. When it is desired to fire the cartridge, a weight 40 may be dropped, as a "go-devil," or may be lowered by suitable means into contact with the head 35, whereby said head is driven downwardly to fracture the frangible pin 38 and the firing pin 33 is moved downwardly to strike the cartridge cap and fire the cartridge. Firing of the cartridge ejects the bullet 32a (Figure 6) and said bullet travels downwardly through the bore 19 and punctures the casing 22 to discharge the explosive 23. As explained, the force of the exploded charge is directed into the formation in advance of the bit.

In the operation of the device, the casing 22 having the explosive therein is inserted into the

bore 18 of the shank 14 of the bit, being secured therein by the retaining nut 28. The firing means if mounted on the top of the connecting pin 11, being threaded into the upper end of the axial bore 19. The firing pin 33 is locked in its uppermost position by means of the transversely extending frangible pin 38, as has been explained. The bit is then coupled to the drill stem or pipe D by means of the coupling 10a and the device is lowered into the well bore. Assuming that the well bore is closed by a cement plug P, the bit is lowered until it strikes the top of said plug. After striking the plug, further downward movement of the bit is halted and then, by means of a suitable orienting means (not shown), the shank of said bit is disposed or directed in the proper direction. After this is done, the bit is in the position shown in Figure 1, and the explosive charge within the shank of the bit is ready to be fired.

After the bit is properly placed, as above explained, the weight 40 is dropped downwardly through the drill stem D into contact with the head 35 which is secured to the upper end of the firing pin. The weight is sufficient to drive the head downwardly so as to fracture the pin 38 which permits downward movement of the firing pin 33. When this occurs, the pin 33 is driven into contact with the cartridge cap, whereby the cartridge 32 is fired to eject the bullet 32a and said bullet travels downwardly through the bore 19, puncturing the upper end of the casing 22 to enter the explosive mixture 23 within said casing and thereby set off said mixture. When the explosive charge 23 is fired by the entrance of the bullet 32a, the force of said charge is directed outwardly to fracture the disks 27 and 28 and eject the charge into the formation. Of course, the shot 24 within the casing 22 is also forcibly ejected when the charge explodes. The explosion of the charge breaks off the upper edge portion of the cement plug P and also disintegrates and loosens the formation in the path of said charge, as indicated in Figure 2. The penetration of the charge into the formation is dependent upon the amount of explosive 23 within the casing and also upon the character of the formation and manifestly, the formation in advance of the shank 14 of the bit is disintegrated and loosened to an extent whereby the bit may be readily forced into said formation.

The bit is forced into the formation, as shown in Figure 3, by imparting a reciprocating or hammering action to said bit. Thus, the bit is utilized as a spudder bit so as to start the new bore, which is disposed at an angle to the old bore. It is noted that the arcuate or curved cutting elements 17 which project below the lower end of the shank 14 facilitate the entry of the bit into the formation because said cutting elements have their lower edges sharpened. It is also pointed out that due to the fact that the outer surfaces of the cutting elements 17 merge into the exterior surface of the shank, said cutting elements do not impede or resist the entrance of the bit during the spudding action.

After the bit has been driven into the loosened formation as far as possible, said bit may be rotated, whereby the cutting elements 17 and the longitudinal cutting blades 16 may perform a drilling operation to move the bit further into the formation. Manifestly, the bit can be driven into the formation only a certain amount and the provision of the blades and cutting elements

makes it possible to increase the distance penetrated by the bit. This is an important feature of the invention for obviously, when the bit may be rotated, the new bore may be made of an increased depth by means of this bit. After the bit has penetrated the formation as far as desired through both the spudding and rotary action, said bit is removed and the usual type of rotary drilling bit is substituted therefor.

From the above, it will be seen that a simple and efficient directional bit is provided. The provision of the cutting blades makes it possible to supplement the spudding action with a rotary action, thereby assuring that sufficient formation is removed to start the new bore and thereby guide the usual bit, which will be subsequently lowered into said bore. The use of the explosive charge within the bit makes it possible to employ said bit in the hardest of formations for manifestly, the hammering action of the bit is not wholly depended upon to penetrate the formation. The explosive charge disintegrates or loosens the formation in advance of the bit, whereby penetration of said bit is assured. As explained, any suitable firing means may be employed for discharging the explosive 23 but it is, of course, preferable that said firing means be controlled from the surface. With the arrangement shown and described, the weight 40 provides a positive means for firing the cartridge 32 when desired.

What I claim and desire to secure by Letters Patent is:

1. A directional drill bit including, a bit body having its lower portion inclined from the vertical, curved cutting elements secured to the lower end of the body and depending in a plane below the body, said elements extending around substantially one-half of the periphery of the body and having their lower edges sharpened to provide a cutting edge, the outer vertical surfaces of the elements merging into the exterior surface of the bit body, whereby said elements do not resist the entry of the bit into the formation, the bit body having longitudinal water courses therein which courses terminate adjacent the inner surfaces of the cutting elements, and elongate cutting blades extending longitudinally of the bit body on the exterior thereof.

2. A directional drill bit including, a bit body having its lower portion inclined from the vertical and having a bore extending therethrough, a casing containing an explosive charge insertable within the lower portion of the bore, frangible means for engaging the lower end of the casing for retaining the same within the bore, and firing means mounted in the upper end of the bore above the casing for firing the explosive charge, whereby the charge fractures the frangible retaining means and is ejected from the bore into the formation in advance of the bit to disintegrate and loosen said formation.

3. A directional drill bit including, a bit body having its lower portion inclined from the vertical and having a bore extending therethrough, a casing containing an explosive charge insertable within the lower portion of the bore, frangible means for engaging the lower end of the casing for retaining the same within the bore, firing means mounted in the upper end of the bore above the casing for firing the explosive charge, a frangible element for normally preventing actuation of the firing means, and means adapted to be lowered from the surface for breaking the frangible element to actuate the

firing means and thereby fire the explosive charge, whereby said charge is ejected from the lower end of the bore into the formation in advance of the bit.

4. A directional drill bit including, a bit body having its lower portion inclined from the vertical and having a bore extending therethrough, a casing containing an explosive charge insertable within the lower portion of the bore, frangible means for engaging the lower end of the casing for retaining the same within the bore, firing means mounted in the upper end of the bore above the casing for firing the explosive charge, whereby the charge fractures the frangible retaining means and is ejected from the bore into the formation in advance of the bit to disintegrate and loosen said formation, and cutting elements on the lower end of the bit body for facilitating the entry of the bit into the loosened formation after the charge has been fired.

5. A directional drill bit including, a bit body

having its lower portion inclined from the vertical and having a bore extending therethrough, a casing insertable within the lower portion of the bore, frangible means for engaging the lower end of the casing for retaining the same within the bore, firing means mounted in the upper end of the bore above the casing for firing the explosive charge, whereby the charge fractures the frangible retaining means and is ejected from the bore into the formation in advance of the bit to disintegrate and loosen said formation, cutting elements on the lower end of the bit body and depending in a plane below the body for facilitating the entry of the bit into the loosened formation after the charge has been fired, and elongate cutting blades extending longitudinally on the exterior of the body, the blades and cutting elements acting to remove the loosened formation through a drilling operation when the bit is rotated.

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