Jan. 5, 1943. J. L. FOSTER 2,307,729

WELL EXPLOSIVE

Filed March 17, 1939

Fig. 1

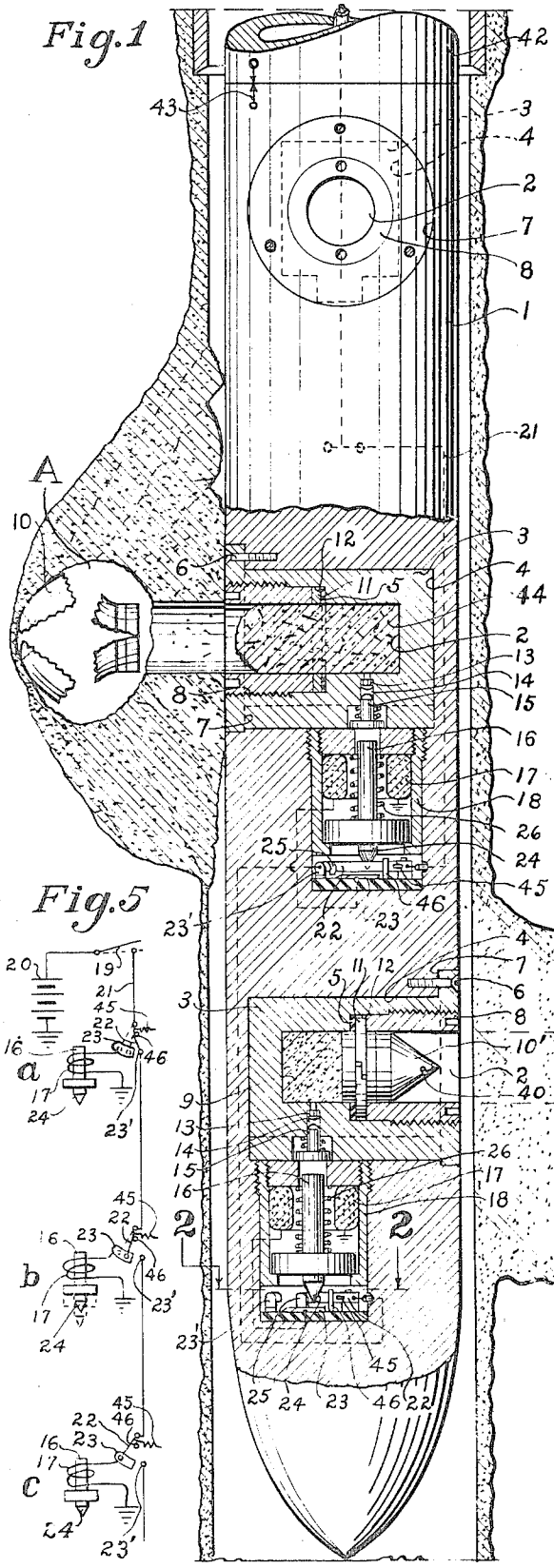


Fig. 2

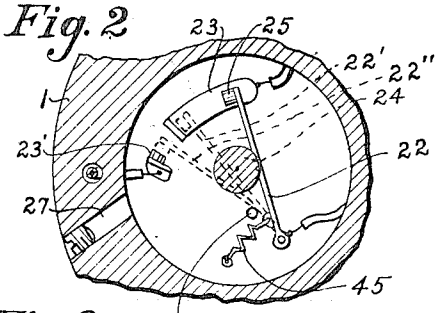


Fig. 3

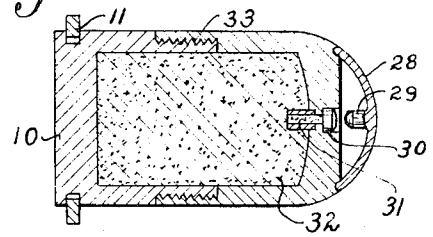


Fig. 4

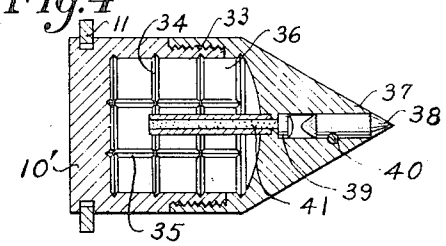


Fig. 5

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WELL EXPLOSIVE

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6 Claims. (Cl. 102—21)

This invention relates to a method of placing an explosive projectile in a subterranean formation, and more particularly to the firing of these projectiles from a well into a fluid-bearing formation to increase the recovery of said fluid.

By placing a small amount of the explosive at various points in the earth formation and detonating this explosive, more advantageous results may be obtained than by placing a large amount of explosive within the bore hole and detonating it there.

Heretofore, it has been common practice to lower large charges of high explosives into a well and to detonate these charges by mechanical or time-clock means. These charges, which consist of from ten quarts to five hundred quarts of pure nitroglycerin, are dangerous to the workmen handling them, dangerous to the public safety, since they must be moved over the public highways, and often do extensive damage to the well casing and equipment. The reason that these charges must be so large is that they depend entirely on concussion and reverberation to achieve the desired result of loosening and removing that part of the formation immediately adjacent the bore hole, wherein they are approximately axially disposed at the time of the detonation.

While the drawing shows apparatus for practicing the invention, it is to be understood that the invention relates to the more advantageous placing of explosives contained in projectiles at a point in the earth's stratum removed from the bore hole, so that the portion of the stratum lying between the point of explosion and the bore hole will be driven toward the bore hole by the force of the explosion.

It is obvious that varied results, such as blasting down a portion of the wall of the well, driving gathering holes with basins at the outer ends thereof, providing entries for formation solvents, providing enlarged sections in the bore hole for the anchoring of cement bridges, and other similar functions may be produced by varying the forces of the explosives involved in the process and by varying the types of projectiles used. These variations of the basic process are to be considered within the scope of the invention herein disclosed.

The accompanying drawing shows a preferred and novel form of apparatus used in carrying out this process, in which:

Fig. 1 is a fragmentary vertical section of an earth formation, showing the tool partly in elevation and partly in section, disposed in a well;

Fig. 2 is a fragmentary horizontal section through the tool, on the line 2—2 of Fig. 1;

Fig. 3 is a longitudinal section through a form of a projectile used in connection with the tool;

Fig. 4 is a similar view of a modified form of projectile used in the tool; and

Fig. 5 is a diagrammatic view of a wiring diagram for sequentially firing a plurality of explosive charges within the tool.

With more particular reference to the drawing, the numeral 1 represents the body of a tool which carries a plurality of radially disposed explosive chambers or cannons 2 which are preferably spaced along the length of the tool, preferably being turned in different radial directions relative thereto. These cannons have removable barrels 3 which may be taken out of the tool 1, being removably placed in sockets 4 in the tool 1. The removable barrels 3 are held in place in recess 7 by bolts 6 and within the outer end of this barrel is disposed the threaded bushing 8 which engages shear ring 11 and causes the ring to seat upon gasket 5. This prevents the moisture from entering the powder chamber 9. This threaded bushing forms an extension of cannon barrel 2 and is removed each time a new projectile is inserted.

Before inserting the tool into a well, an explosive charge 9 is placed in each of the cannon bores 2 behind an explosive projectile 10 or 10' therein, upon which projectile an expansive shear ring 11 has been fitted, is slipped into an annular recess 12 in the cannon bore 2.

A percussion cap 13 is fitted into an opening 14 in the cannon barrel 3, longitudinally of the tool, so that firing pin 15 will detonate the cap 13 and the adjacent explosive charge 9 upon the striking of the firing pin 15 by the hammer 16. The hammer 16 is operated by an electro-magnetic coil or solenoid 17 when electrical energy is supplied thereto. The entire solenoid mechanism is contained in a casing 18 and may be inserted into or removed from the tool through the recess 4 therein. A single wire, with grounded return circuit, is shown and a relay switch is connected within this wired circuit 21 and has connection with the solenoid which is next to be operated so that the projectiles may be sequentially fired from cannon bores 2 by closing and opening a switch 19 in said circuit (Fig. 5) which switch is located at the surface or at the mouth of the well. Upon closing the switch 19, a source of electrical energy, such as a battery 20 is connected with circuit 21 leading to the solenoids 17, which are in parallel with the circuit through secondary switches.

A switch arm 22 rests on contact plate 23 (Fig. 2) which closes the circuit to the coil 17 and actuates the hammer 16 by the force exerted in magnetic coil 17. As the hammer 16 is moved to strike firing pin 15 (Fig. 1), a pointed end 24 of the hammer, which pointed end 24 is made of fiber or other insulating material and which normally holds the switch arm 22 retracted, is withdrawn and permits switch arm 22 to be moved into the position shown in dotted lines and

indicated at 22' (Fig. 2), by a spring 45 acting on the arm 22 until said switch arm is stopped by a stop pin 46. In this position the contact point 25 is still in contact with plate 23, although having moved to the opposite side of the axis of the hammer 16; however on the breaking of the circuit by the manual release of the switch 19, the solenoid 17 is deenergized, releasing the hammer 16, and upon the return of the hammer 16 under pressure of spring 26 bearing thereagainst, the pointed end 24 will push the switch point off contact plate 23 against contact 23', to dotted line position as indicated at 22'' (Fig. 2). By this movement of the switch arm 22, the first solenoid is entirely disconnected from the circuit and remains de-energized until the tool is removed and the mechanism reset when a new charge is inserted. A plugged opening 27 is provided through the wall of the tool 1 for the insertion of an instrument against switch arm 22 for resetting the same, as shown in Fig. 2.

When the switch arm 22 moves to the dotted line position 22'' and engages contact 23' after firing the first charge, this closes the circuit 21 to the next succeeding solenoid 17 which is then ready to be fired by again closing switch 19, as described. This operation is repeated until all of the charges have been fired. A wire 21 is shown schematically in Fig. 1 for clearness; however, it is to be understood that the tool 1 is to be drilled both longitudinally and transversely to accommodate the wire to the respective solenoids, designated *a*, *b* and *c* in Fig. 5. This wire is shown leading onward from solenoid *c*, as any number of discharge units may be used. When the tool is cross-drilled, the holes will be plugged in the usual manner.

Several types of penetration are desirable, particularly for oil wells two of which are shown. One type is indicated at A, where an explosive projectile is shot into the stratum for a short distance and the force of the explosive is used to blow the formation toward the well. In this manner, a formation which has become sealed with paraffin, asphalt, mud or other foreign material that renders the formation non-productive of oil, may be removed by placing a projectile a short distance beyond the wall of the bore hole and detonating it so that this foreign substance will be loosened, and may be cleaned from the well. A new porous surface is thus produced which has a larger exposed area, thereby giving the well greater productivity.

Another form of shot which may be placed, is that indicated by dotted outline at B. The amount of explosive 9 in chamber 2 is increased so as to drive the projectile a greater distance into the stratum than shown at A. This projectile may be so constructed as shown in Fig. 4, that it will be blown into bits, each of the fragments cutting a channel in the stratum, and in this manner a passage is formed for some distance out into the stratum with a basin at the outer end, and passages radiating from said basin, thus opening up producing stratum, or permitting chemicals to be introduced into certain types of formations where they will work with greater rapidity and effectiveness than if introduced into the immediate bore hole of the well.

Two types of projectiles are shown in Figs. 3 and 4, respectively. The type shown in Fig. 3 has a round nose 28 which is fitted with a firing pin 29 which strikes percussion cap 30. This ignites a fuse 31 which may be varied in length to delay the firing of the explosive charge 32 until the projectile has traveled the desired distance into the stratum. The interior of the projectile is accessible for loading as by forming it in sections screw-threaded together at 33. The nose 28 is crushed upon striking a formation of sufficient hardness and this drives pin 29 against percussion cap 30. A short fuse is shown to indicate the placing of the explosive charge only a short distance from the bore hole. The shear ring 11 retains the projectile within the cannon barrel until the greater part of the explosive charge is burned. In this manner the full effectiveness of the charge is obtained upon the shearing of expansive shear ring 11.

The form of projectile as shown in Fig. 4 is preferably made of cast metal, in two parts also screw-threaded together at 33', and has annular and longitudinal grooves 34 and 35 respectively, disposed within the chamber 36 which is designed to carry the explosive charge. This form is shown with a sharp nose and pointed firing pin 38, which may be advantageous in penetrating hard types of formation. The pointed firing pin 38 is in position to strike percussion cap 39 upon impact with a substantially non-yielding formation. To prevent the firing pin 38 from striking percussion cap 39 too readily, a shear pin 40 is provided which will shear when the projectile is driven into a hard formation. Upon the detonation of cap 39 a powder train 41 will be ignited. The length of this powder train, together with the speed with which the powder burns, will be computed, so as to permit the projectile to travel the desired distance into the formation before detonating the explosive contained in the chamber 36. This type of projectile will form a long passage with a basin at the end thereof and radiating passages outward therefrom, in the formation.

The tool may be lowered into the well by any suitable means such as pipe 42 or a cable. If used on a drill stem, it can be screwed together in such manner that the direction of the cannon barrels can be determined, as by matching index marks 43 as the joints are screwed together. In this manner the direction in which the projectile is fired may be determined from the surface.

The tool may also be used to obtain samples of formation in the proximity of the detonated projectile, as the force of the explosion of the projectile 10 or 10' will force a portion of the formation into a cannon barrel, as indicated at 44, which portion may be removed from the well for analysis.

On reloading the device, a new gasket 5 and a new shear ring 11 as well as a new projectile, will be required, as the projectile will shear these each time the cannon is detonated.

The lower end of the tool is preferably tapered to a point to facilitate its insertion into, as well as its removal from the well after the explosion of the projectiles when the explosions would have forced a quantity of the formation into the bore hole.

I claim:

1. The herein described method of treating oil wells which consists in firing a projectile into the surrounding formation, and subsequently exploding the projectile in said formation.

2. A process of treating a well having a surrounding fluid-bearing earth formation, comprising firing a projectile into said surrounding fluid bearing earth formation, and subsequently exploding the projectile in said formation.

3. A process of treating a well having a bore hole with a surrounding fluid-bearing earth formation, comprising firing a projectile from within said bore hole laterally at an angle to the axis thereof into said formation, and subsequently exploding the projectile in said formation.

4. A process of treating a well having a bore hole with a surrounding fluid-bearing earth formation, comprising firing a projectile from within said bore hole laterally at an angle to the axis thereof into said formation, subsequently exploding the projectile in said formation forming one or more passageways from the point of detonation into the bore hole, and flowing the fluid from said formation through said one or more passageways into the bore hole.

5. A process of obtaining a sample from a well bore hole having a surrounding fluid bearing earth formation, comprising introducing into the bore hole a gun having a recess in the periphery thereof with said recess immediately adjacent the surrounding wall of the bore hole, discharging an explosive shell from said recess into the formation beside the bore hole, therefore detonating said explosive shell in the formation while holding the open side of said recess adjacent the point of detonation forcing a sample of the formation into the recess, and lifting said sample out of the bore hole.

6. A process of obtaining a sample from a well bore hole having a surrounding fluid bearing earth formation, comprising introducing into the bore hole a gun having a recess in the periphery thereof with said recess immediately adjacent the surrounding wall of the bore hole, discharging an explosive shell from said recess into the formation beside the bore hole, therefore detonating said explosive shell in the formation while holding the open side of said recess adjacent the point of detonation forcing a sample of the formation into the recess, and lifting said gun out of the bore hole and removing the sample therefrom.

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