Aug. 10, 1948. R. F. DAVIS 2,446,640

WELL PERFORATOR

Filed July 19, 1946

Fig. 1.

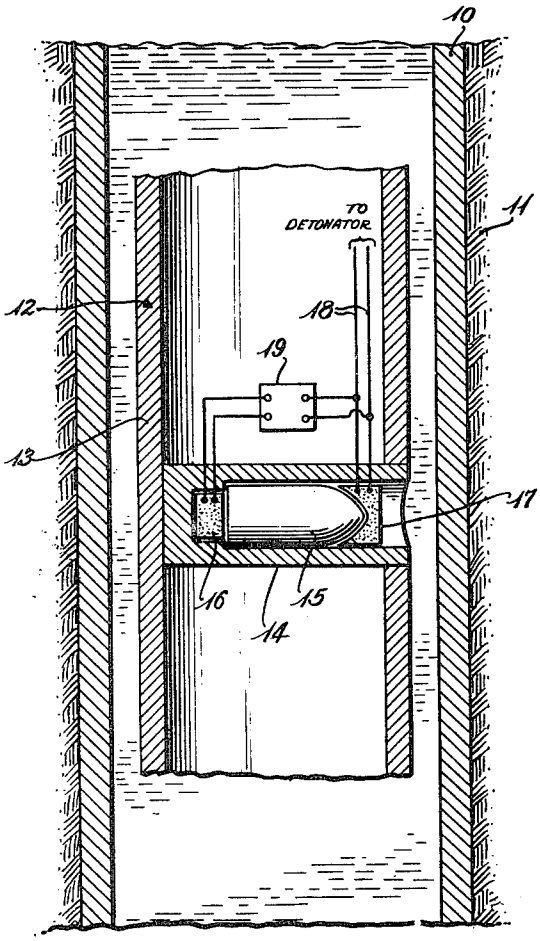
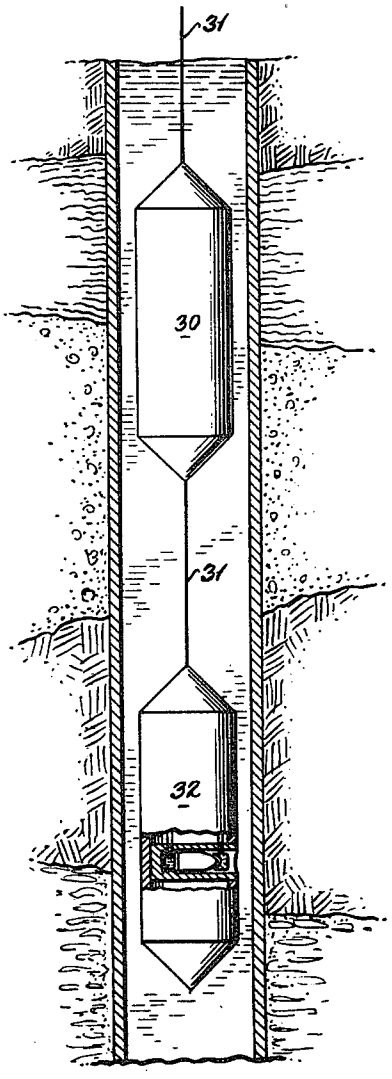


Fig. 2.



Inventor

Robert F. Davis

By James Y. Cleveland

Attorney

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WELL PERFORATOR

Robert F. Davis, Falls Church, Va., assignor to Well Surveys, Incorporated, Tulsa, Okla., a corporation of Delaware

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4 Claims. (Cl. 164—0.5)

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This invention relates to an improved method and apparatus for firing a projectile into the wall of an oil well or other drill hole. More particularly it relates to a method and apparatus for firing a projectile through a steel well casing to provide an opening between the interior of the well casing and the surrounding geological strata.

Prior to this invention it has been an established practice to provide openings branching off from a well bore intermediate its ends by firing projectiles radially from the well bore into the surrounding strata. In most instances, this is done to provide an opening through a steel well casing, but in some instances it may be done merely to provide an opening extending radially from an uncased well.

In most instances wells are filled with liquid and this necessitates the firing of the perforating projectile beneath the surface of the liquid which fills the well. In many instances it is desired to fire the perforating projectile into the wall of the drill hole at a distance several thousand feet from the surface of the earth and several thousand feet below the surface of the liquid in the drill hole.

Under such circumstances a major difficulty is always encountered in that it is necessary for the projectile to move a certain amount of the surrounding liquid out of the way before it can reach and penetrate the wall of the drill hole. Since liquid is practically incompressible, this necessitates the movement of liquid all the way to the surface of the liquid in the drill hole. As this often means the movement of a considerable body of liquid, the inertia of the liquid due to its weight makes extremely difficult the rapid acceleration of the projectile. Hence, in normal operation, the projectile is very considerably slowed down by this phenomena and the penetration into the wall of the drill hole is not nearly so deep as it otherwise would be.

A further difficulty is encountered when other equipment is in the drill hole at the time the perforation is to be accomplished. For example, it is often highly desirable to lower a well exploring unit with the perforator so as to locate the strata into which it is desired to send the perforating projectile. Such an exploring device may be one of the type described in Technical Publication No. 193 of the American Institute of Mining and Metallurgical Engineers (February 1945), and entitled "Some practical aspects of radioactivity well logging," by Warren J. Jackson and John L P. Campbell.

When such a device is lowered into a well along with a perforator and the perforator is then fired,

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a violent shock wave progresses through the liquid in the drill hole and is quite likely to damage the sensitive well logging instrument, particularly if it is anywhere near the perforator.

The purpose of the present invention, therefore, is to increase the effectiveness of perforating projectiles in perforating the well casing and the surrounding strata, and at the same time to avoid the effects of a violent shock wave on nearby sensitive equipment.

Briefly the present invention comprises burning a quantity of slow burning powder at a point adjacent the place where the projectile emerges from the barrel from which it is fired, and then before the gas formed by the burning of the slow burning powder can leave the area, exploding the charge which propels the projectile, so that the projectile will not be forced to displace a large quantity of liquid and will not generate a shock wave extending throughout the fluid in the drill hole.

Since the propellent charge for the projectile is normally ignited by electrical means, it is a relatively simple matter to ignite both the slow burning charge and the propellent charge by the same electrical means and to insert a time delay circuit in series with the igniter for the propellent charge so that there will be the necessary delay between the time the slow burning charge is ignited and the time that the propellent charge is ignited.

Further details and advantages of this invention will be apparent from the appended drawing, and the following detailed description thereof.

In the drawing, Figure 1 is a vertical cross-section of a part of a cased drill hole and a gun perforating device in which are embodied the principles of this invention; and

Figure 2 is a vertical cross-section of a part of a cased drill hole in which is positioned a gun perforator and a well-exploring device in accordance with this invention.

As illustrated in Figure 1, the drill hole consists of a well casing 10 embedded in surrounding earth 11 and containing a gun perforating device 12 (shown only in part). Normally, such a well casing will be filled with liquid to a level far above the point at which it is desired to perforate.

The gun perforator illustrated consists of an outer casing 13 in which is mounted a gun barrel 14 which in turn contains a perforating projectile 15 and a propellent charge 16, which when exploded will drive the perforating projectile 15 through the well casing 10 and into the surrounding strata.

In accordance with this invention, a slow burn-

ing powder charge 17 is placed just ahead of the perforating projectile 15 and a detonator circuit 18 is connected so that upon operation it causes the slow burning powder charge 17 to be ignited. The propellent charge 16 is also connected to the detonating circuit 18 but instead of being connected directly, the propellent charge is connected through a time delay circuit 19 which has a time constant such that the propellent charge 16 will not be fired until sufficient time has elapsed for the slow burning charge 17 to burn and form a gas pocket adjacent the forward end of the projectile.

The slow burning powder or charge can be of any desired material that will burn slowly and produce a considerable volume of gas without causing any abrupt pressure increase in the well or any appreciable shock wave. The time delay circuit 19 may be of any desired type, the only requirement being that it produces sufficient delay between the firing of the slow burning charge and the firing of the propellent charge. A slow burning powder fuse may even be substituted for the time delay circuit to produce the same result.

The construction of the gun perforator casing, the gun barrel, the projectile and the propellent charge is conventional, except that it usually is desirable to so form the gun barrel that an annular ring is formed around the propellent charge, which ring serves to prevent the projectile from being forced backward against the propellent charge when the slow-burning powder charge is fired. This avoids any possibility of the pressure from the slow-burning powder charge being transmitted through the projectile and causing detonation of the propellent charge sooner than desired. The slow burning powder charge need not necessarily be placed in the gun barrel but may be placed in a separate chamber near the gun barrel and this chamber may be vented either into the gun barrel or into the well at a point near the gun barrel. It is desirable, but not essential, that the liquid in the gun barrel immediately ahead of the projectile be blown out by the slow burning powder charge before the propellent charge is ignited. The desirable result will be partially realized even if the gas formed by the slow burning powder charge is at some little distance from the gun barrel, when the explosion occurs. It is desirable, however, that the slow burning powder charge clear the barrel and the surrounding area and that all be clear of liquid at the time the propellent charge is ignited.

In many instances it is desirable to accurately position the perforator by the use of a well surveying instrument suspended on the same cable from the surface of the earth. In order to position the perforator accurately it is desirable that the surveying instrument be positioned relatively close to the perforator.

Following the principles of this invention and as illustrated in Figure 2, a well surveying instrument 30 may conveniently be suspended from the same cable 31 and positioned a short distance above a perforator 32. The gas formed by the slow burning powder charge will then act to absorb the shock wave produced by the explosion of the propellent charge and avoid damage to the surveying instrument.

A protecting disk may be placed between the slow-burning powder charge and the outer end of the gun barrel as shown in United States Patent 2,029,454, granted February 4, 1936, to Walter T. Wells.

What is claimed is:

1. A method of perforating the wall of a drill hole that comprises igniting a charge of slow burning powder in a drill hole adjacent the place where the wall is to be perforated and immediately thereafter, before the gas formed by the slow burning powder has had a chance to leave the area, firing a projectile into the wall of the drill hole at the place where the drill hole is to be perforated.

2. A perforator for the wall of a drill hole that comprises a capsule adapted to be lowered into a drill hole, a radially directed gun barrel in said capsule, a projectile in said gun barrel, a propellent charge behind said projectile, a slow burning powder charge adjacent the forward end of said projectile and means to detonate said slow burning powder charge and said propellent charge sequentially and at predetermined intervals of time.

3. Apparatus for perforating the wall of a drill hole that comprises an exploring device and a gun perforator suspended from a single cable one above the other, said gun perforator including a slow burning powder charge vented into the area surrounding the perforator and means to fire the slow burning powder charge at a predetermined interval of time prior to the firing of the propellent charge for the projectile.

4. A gun perforator for perforating the wall of a drill hole that comprises a capsule adapted to be lowered into a drill hole, a projectile in said capsule, a propellent charge arranged to propel the projectile into the surrounding strata, a slow burning powder charge positioned adjacent the point where the projectile emerges from the capsule and means to electrically ignite said slow burning charge and said propellent charge, said means including a time delay circuit connected to delay the ignition of the propellent charge until the slow burning charge has been ignited and had a chance to burn.

ROBERT F. DAVIS.

REFERENCES CITED

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

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Number	Name	Date
2,029,478	Haines	Feb. 4, 1936
2,246,542	Smith	June 24, 1941