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IMPROVED METHOD OF SHOOTING WELLS

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Our invention relates to the art of shooting brine, oil, gas, and other wells with an explosive such as nitroglycerin which is frequently done for the purpose of improving or increasing the yield of the well and relates specifically to a method of protecting the well casing and the walls of the bore from damage by shooting.

Aside from the above-ground danger to property, life, and limb, in handling high explosives, the actual shooting of the well is frequently accompanied by damage to the walls of the bore followed by spalling and caving, or if the casing be not removed, splitting and/or collapsing of the casing. In shooting brine wells, for instance, to improve the yield of flow of brine, it has been customary to lower into the well a charge of nitroglycerin, locate the charge in the brine rock, and there explode it. The well will normally be filled either entirely or partially with water or brine, the inertia of which is, of course, a factor in directing or controlling the work done by the explosive upon the rock. It has been found that serious damage may be done to the well by shooting and in many cases wells have been lost because of damage by shooting. It is customary after the explosion of the charge to bail the well to remove débris and clean out the hole, but it is not in all cases possible to bail the well, since caving or spalling may have closed the hole. If the casing be wholly or partly filled with brine or water and left in the well when it is shot, such casing may be split or collapsed in which case the removal and resetting of the casing is attended by serious risks of loss of the well. In many cases the cleaning out operation following a shooting has been both disappointing and expensive and there are many wells which have had to be abandoned following shooting and sometimes after the loss of several strings of tools in the hole. The removal of a casing prior to shooting is also a risky proceeding, since it may be difficult or impossible to reseat it after the shot. It is accordingly highly desirable that a method be worked out which will permit the safe shooting of a well without damaging the casing in situ even though it be partly or entirely filled with water or brine, oil, etc., and further without risk, or with practical elimination of risk of damage to the wall of the bore. We have invented and tested a method which accomplishes these and other ends.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the steps hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail one mode of carrying out the invention, such disclosed mode illustrating, however, but one of various ways in which the principle of the invention may be used.

Conceiving that the damage to the hole and/or the casing is due to the compressional wave traveling up the bore of the hole, we have directed our efforts to cushioning the shock exerted by such a wave upon the walls confining it. We introduce into the water, oil, brine, or liquid filling the well a gas, either in the form of a relatively large gas-filled space or spaces, or in the form of bubbles more or less distributed. The presence of such gas in the well introduces a shock absorbing element which cushions the effect of the compressional wave upon the walls confining it, such as the bore in the rock and/or the casing.

In order to so introduce a gas we may proceed in a number of ways. For example, (1) we may employ the action of acids on carbonates to liberate carbon dioxide gas in situ, (2) the action of sodium, calcium, potassium, or like metals upon water by means of which hydrogen gas is liberated, (3) the action of water on carbides, such as calcium carbide, to liberate acetylene in situ, (4) introduction of compressed gases, such as air or natural gas or the like, by mean of a tube lowered into the well, (5) introduction of low boiling point liquids which may be released from a cylinder in situ, (6) introduction of so-called dry ice, i. e. solid carbon dioxide, lowered into the hole where it will gasify spontaneously.

We may also use emulsifying agents or colloidal substances, such as soap, foamite, glue, and the like by adding same to the liquid in the well to improve the action of the gas introduced, such agents acting to hold the gas dispersed in the liquid contained in the well.

Although, as indicated above, there are many ways in which a gas may be introduced for the purpose of cushioning the compressional wave, we have found the use of dry ice a convenient and practicable method. After the introduction of the nitroglycerin cartridge and the completion of preparations to shoot, a quantity of solid carbon dioxide may be dropped into the hole, and depending upon the depth of water, brine, or other liquid therein, sufficient time will be allowed for the solid carbon dioxide to fall through the brine or other liquid to a point in the well preferably above but relatively near the explosive charge. By observing the rate of fall of carbon dioxide experimentially in a tube filled with liquid from the hole such time factor may be figured out. After the calculated time has elapsed we shoot the charge in the customary way.

Example

In a salt brine well bored to a depth of 1290 feet into and through a porous sandstone stratum approximately 100 feet in thickness constituting the brine rock, the bore of the hole in the brine rock being approximately 8 inches and 1085 feet of 8 inch casing standing in the hole; a charge of 500 quarts of nitroglycerin was lowered into the well. The brine rose in the hole to an approximate depth of 840 feet measured above the brine rock stratum. When preparations had been completed for shooting 150 pounds of dry ice, i. e. solid carbon dioxide in lump form was dropped freely into the hole in 2 minutes' time and after a lapse of 5 minutes from completing introduction, the charge was shot. The contents of the well were discharged with considerable force following the ground shock usually experienced, but it was found that the bailer could be lowered freely into the well and that there was no leakage from the casing into the well, thus indicating that no damage had occurred to the casing or walls of the bore. This constituted a noteworthy accomplishment inasmuch as the charge was some 200 quarts in excess of usual charges heretofore used in like wells with frequent damage and sometimes loss of wells, indicating the accuracy of the theory that the gas cushion introduced into the brine protected the bore of the well and the casing from damage. The fact that a heavy charge was used in a well containing a heavy salt brine, without removing the casing, without damage to the well or casing proves the efficacy of the method.

The shooting of other wells, such as oil or water wells, will follow along the lines of the above example, it being obvious that although a general plan will be followed in cases, due regard should be given to depth, head of liquid and weight thereof in the hole, the capacity of the liquid to absorb the gas introduced, and the character of gas used and the methods employed to introduce same. By whatever method the gas is introduced or whatever gas be so introduced, the effect will in all cases be to cushion the shock upon the walls of the well and upon the casing of the compressional wave traveling up the well from the exploding charge and by reason of such cushion to avoid damage to an otherwise vulnerable bore or casing or to so reduce the damage upon the bore as not to seriously interfere with the cleaning operation and further use of the well.

Many variations of methods and means to introduce the gas cushion will be obvious to those skilled in the arts, among which may be mentioned the following. In order to limit the depth to which the gas producing ingredients shall penetrate in the well we have found that a stock plate may be inserted conveniently in the form of a metal disc with a central hole through which the cable suspending the explosive passes. Such a disc will catch and arrest the gas generating material and thereby the depth at which gas generation proceeds. Such a disc may rest upon the cartridge containing the explosive or may be affixed to the suspending cable at any point thereon. Another method involves the use of a thin cylinder, such as can be formed of sheet metal closed at the top and suspended from a wire or light cable. Such a cylinder will be open at the bottom but provided at such opening with a grate or screen. The gas generating material such as carbide or dry ice may be inserted into this cylinder, which on account of its weight characteristics, may be rapidly lowered into the well to any desired depth therein. The gas evolved will bubble out from the open lower end of the cylinder and be introduced into the liquid in the well.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

We therefore particularly point out and distinctly claim as our invention:—

1. The method of shooting a deep well while materially reducing the damage thereby to the walls of the well (including a casing if present) above the stratum to be shot when the well contains a liquid, which comprises placing a charge of explosive in the well, bringing about the presence in the liquid above the said charge of a gaseous medium to cushion the effect upon said walls of the compression wave transmitted therethrough following the explosion of the charge and exploding the charge.

2. The method of shooting a deep well while materially reducing the damage there-

by to the walls of the well (including a casing if present) above the stratum to be shot when the well contains a liquid, which comprises placing a charge of explosive in the well, bringing about the presence in the liquid above the said charge of CO_2 gas to cushion the effect upon said walls of the compression wave transmitted therethrough following the explosion of the charge and exploding the charge.

3. The method of protecting a well casing in situ in a well from substantial damage when shooting such well by exploding a charge of explosive in the bore thereof below said casing when said well contains a liquid extending up into said casing, which comprises bringing about the presence in the liquid above the charge of a gaseous medium to cushion the effect upon said casing of the compression wave transmitted therethrough following the explosion of the charge, and then exploding the charge.

4. In a method of shooting a bored well containing a casing in situ and a liquid in said bore extending into said casing while substantially avoiding damage to said casing, the steps which consist in placing an explosive charge in the bore below said casing, bringing about the presence of a cushion of a gaseous medium in the liquid above said charge, and then exploding the charge.

5. In a method of shooting a bored well containing a casing in situ and a liquid in said bore extending into said casing while substantially avoiding damage to said casing, the steps which consist in introducing an explosive charge into said bore below said casing, introducing then into the liquid above the charge solid carbon dioxide, allowing said carbon dioxide to evaporate in said liquid and then exploding the charge.

6. The method of shooting a deep well containing liquid which comprises placing an explosive charge in the bore at the elevation therein at which it is desired to concentrate the effect of the shot, bringing about in the liquid above the charge the presence of a gaseous medium and exploding the charge whereby damage to the walls of the bore above the charge is at least materially reduced through the cushioning action of said gaseous medium upon the compression wave transmitted through the liquid from the exploding charge.

7. The method of shooting a deep well containing liquid which comprises placing an explosive charge in the bore at the elevation therein at which it is desired to concentrate the effect of the shot, introducing solid carbon dioxide into the liquid to generate therein a cushion of carbon dioxide gas, and exploding the charge whereby damage to the walls of the bore above the charge is at least materially reduced through the action of said cushion upon the compression wave transmitted through the liquid from the exploding charge.

8. The method of confining the destructive effect of the explosion of a charge of explosive in a deep well containing liquid substantially to that portion at or below the limit at which the explosive is located which comprises placing the charge in the well at an elevation therein corresponding to the zone to be affected by the shot, introducing a gaseous medium into the liquid in the well above the shot to cushion the effect of the compression wave transmitted from the shot through the liquid, and exploding the charge.

Signed by us this 2nd day of June, 1930.

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