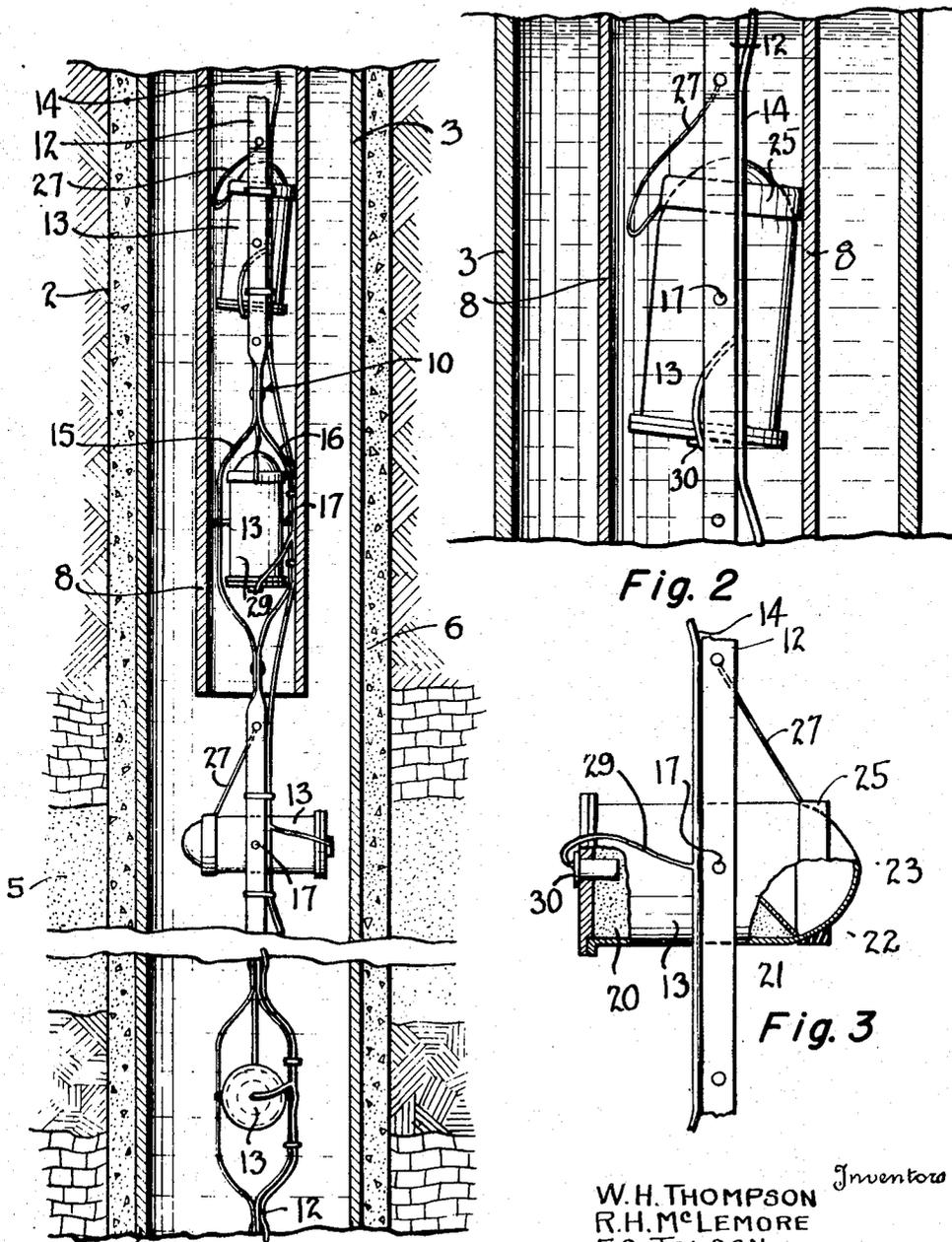


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MEANS AND METHOD OF TILTING
EXPLOSIVE CHARGES IN WELLS
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3 Fig. 1

Fig. 2

Fig. 3

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MEANS AND METHOD OF TILTING EXPLOSIVE CHARGES IN WELLS

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1

The invention relates to a means and method of shooting wells in which a small diameter pipe or tubing is employed.

It is well known to shoot wells with charges of explosives and more recently with lined shaped high explosive charges in order to obtain a maximum of penetration in either the open well bore or through the casing, cement, and into the formation therearound.

The present invention, however, directs itself to an arrangement whereby shaped lined high explosive charges can be lowered into a well bore through a small diameter pipe or tubing and then tilted into detonating position in order to get the maximum penetration.

Another object of the invention is to provide an assembly for shooting wells which is made up of a string or support member carrying one or more explosive charges which can tilt to a horizontal position after having been lowered into the well bore through a small diameter pipe.

Another object of the invention is to provide a means and method of shooting wells drilled by the rotary method, after setting the casing, lowering the tubing and washing the well.

Still another object of the invention is to lower one or more explosive charges through a tubing into a well bore for shooting the well where the charge is of greater length than the diameter of the tubing.

Still another object of the invention is to provide a combination of a supporting member and a shaped lined explosive charge which is pivotally mounted therein so as to tilt to detonating position after the charge has been lowered through the tubing in the well therebelow.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings, wherein:

Fig. 1 is a side elevation of a well bore equipped with a cemented casing and tubing and illustrating a string of explosive charges as in the process of being lowered into detonating position.

Fig. 2 is an enlarged view of one of the charges which is of greater length than the diameter of the tubing shown in tilted position while passing downwardly through the tubing.

Fig. 3 is an enlarged view with certain parts in section illustrating one of the cartridges which has tilted by gravity to detonating position.

In Fig. 1 the well bore 2 has been drilled by the rotary method of drilling, where a drill bit and drill pipe are rotated while being lowered into the earth. A drilling fluid or mud is cir-

2

culated down through the drill pipe and discharged from the drill bit to move upwardly in the well bore for the purpose of carrying away the cuttings from the bit, supporting the wall of the well, and maintaining a predominate pressure upon the earth formations to hold back any pressures encountered therein.

When the drilling of the well is completed, it is usual to run a survey of the well for the purposes of locating porous formations in which it is believed that gas or oil will be encountered. The surveys indicate the elevation of such formations and such surveys are considered as standard practice.

After the survey has been made, the usual procedure is to run a string of large diameter pipe or casing 3 which substantially fills the well bore 2. This pipe is usually extended to the bottom of the well bore and say for instance the formation 5 is a productive formation from which it is desired to obtain production, such formation will be closed off by the casing and in order to anchor the casing securely in position, cement is pumped downwardly through the casing, upwardly around the lower end thereof, and is seen at 6 as filling the space between the casing and the well bore.

The casing and the cementing are both accomplished while the heavy drilling mud remains in position so as to prevent any gas pressure in the formation 5 from blowing into the well.

The usual practice as now conducted is to then lower the perforating gun into the well and discharge bullets laterally of the casing in an effort to penetrate the casing and the cement opposite the formation 5 as indicated by the survey so as to form openings in the pipe to admit fluid to the well. When such an operation is performed, the heavy drilling mud usually penetrates the openings and oftentimes mudds off the porous formation 5 and prevents the entrance of the production liquid.

The present invention contemplates a procedure whereby the perforating operation is deferred until after the tubing 8 has been lowered into position and the well head and other equipment affixed at the surface. The gun perforating operation is performed with the drilling mud in place because the pressure of the drilling mud is required to hold back the formation pressure until the perforating gun can be removed from the well. The present invention contemplates an arrangement whereby the tubing will be run into place and the well head equipment affixed and then the heavy drilling mud washed from the well prior to the time of perforating the casing.

3

Fig. 1 shows the well as having been thus washed with a liquid of lesser specific gravity than the drilling mud, and as a matter of fact, a liquid is usually employed which will apply a pressure against the producing formation 5 which is less than the pressure in the formation.

After the well has been washed as described, the explosive assembly 10 will then be lowered through the tubing 8 into the well. This assembly 10 is made up of a string or support member 12 which may be of any suitable material such as scrap iron, plastic or other material which will support a plurality of explosive cartridges 13. The weight of these cartridges is usually but a few ounces and it is evident therefore that almost any type of material will be suitable for the string 12. This string 12 may terminate a short distance above the uppermost cartridge and the weight of the entire assembly thus carried by suitable means such as a conductor cable 14 which will carry a current of electricity for detonating the explosive cartridges.

A particular feature of this assembly is best illustrated at the second cartridge from the top in Fig. 1, where the support member is shown as divided into the straps 15 and 16 which are spaced apart for a distance sufficient to receive the cartridge 13 therebetween. Suitable pivot supports 17 on each side of the cartridge and the straps serves to retain the cartridge in pivotal position so that it may be tilted toward the vertical as seen in the upper part of Fig. 1. Such an arrangement is desirable because of the fact that the length of the cartridges 13 is greater than the internal diameter of the tubing 8 and tilting of the cartridge therefore permits it to be lowered through the tubing.

While a single ended shaped lined explosive charge has been illustrated, it is obvious that a double ended charge may be employed. It should be noted that for effective penetration with a shaped lined charge, there should be preferably provided a stand-off distance or space at the mouth of the cone which is of sufficient width to the closure of the charge so as to permit collapse of the cone upon detonation. Various factors affect and determine this stand-off distance but in actual practice in test shots, it has been found generally that the foregoing is true. The relative dimensions of the cartridges are fixed to a substantial extent due to the arrangement of the explosive charge 20. As seen in Fig. 3 the shaped cavity, the liner 22 therefor, and the closure end 23 must come within certain requirements relating to shaped lined closed high explosive cartridges. A description of a general nature of such a cartridge is to be found in the Australian Patent 113,685 accepted August 14, 1941 in Class 89.9 to Sabeg. There are certain ratios of length to diameter of the explosive charges which permit the detonation wave to flatten sufficiently by the time it contacts the apex of the cone or liner 22 which is deposited in the shaped area 21. The space inside of the end 23 must be sufficient to allow collapse of the liner and for such liner to act as a projectile and attain its velocity before penetrating the closed end 23. It has been found, therefore, that the length of a charge having sufficient ability to penetrate the casing and cement therearound, in all probabilities exceeds the usual internal diameter of the tubing and the provision for the tilting of the cartridges has therefore been made.

In order to facilitate tilting of the cartridge, a

4

band or ring 25 of lead or other relatively heavy material will be applied so that the tendency for the cartridge is to tilt to the horizontal position. Of course the pivot 17 can be arranged longitudinally of the cartridge so that it will tilt by gravity with the ring 25.

In order to check the tilting movement of the cartridge and stop it in a substantially horizontal position, any suitable means may be provided. A check string 27 is shown in Fig. 3.

The conductor cable 14 may be arranged along the support member 12 in any suitable diameter so long as it is capable of extending at 29 to the detonator 30 arranged in the base of the cartridge 13. The same conductor extends to all of the cartridges. While the mechanism has been shown as being detonated by electricity, it seems obvious that any suitable method could be used to effect detonation of the mechanism either in series, or simultaneously as a unit.

A particular advantage of the present arrangement is the manner in which the entire assembly 10 will be consumed by the explosion and little or no foreign material will remain in the well bore after the shooting operation. Only the cable 14 need then be removed. Such a cable can be readily sealed at the surface and it seems obvious that each of the charges will tilt to its horizontal position as it passes through the lower end of the tubing.

Broadly the invention contemplates a means and method of lowering spaced charges through a small diameter pipe or tubing into a well bore to shoot the well and also to a method of completing wells by perforating the well after the well has been washed.

What is claimed is:

1. An assembly for shooting wells comprising a support member, a plurality of cylindrical explosive cartridges, and means connecting said cartridges to said member to allow tilting of the cartridges from vertical to horizontal position, each cartridge including a closed, lined shaped charge of high explosive.
2. An assembly for shooting wells comprising a support member, a plurality of cylindrical explosive cartridges, means connecting said cartridges to said member to allow tilting of the cartridges from vertical to horizontal position, each cartridge including a closed, lined shaped charge or high explosive, and additional means to detonate said cartridges.
3. A device for shooting wells comprising a cylindrical explosive cartridge, means to pivotally support said cartridge by lowering into the well bore through a pipe of lesser diameter than the length of the cartridge so that the cartridge tilts to a horizontal position as it emerges from the pipe at the area to be shot.
4. A method of shooting wells equipped with a casing and tubing which comprises assembling one or more high explosive cartridges for pivotal movement upon a support string, lowering the string and cartridges through the tubing so that the cartridges tilt toward a vertical position while passing through the tubing and tilt toward a horizontal position as they emerge from the lower end of the tubing into the casing or open well bore, and detonating the cartridges.
5. An assembly for shooting wells comprising a support member, a plurality of cylindrical explosive cartridges, means connecting said cartridges to said member to allow tilting of the cartridges from vertical to horizontal position,

5

each cartridge including at least one closed, lined shaped charge of high explosive, and additional means to detonate said cartridges.

6. An assembly for shooting wells comprising a support member, a plurality of cylindrical explosive cartridges, and means connecting said cartridges to said member to allow tilting of the cartridges from vertical to horizontal position, each cartridge being overweighted at one end.

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