TORPEDO AND METHOD FOR SHOOTING OIL WELLS

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Fig. 1

Fig. 2

Fig. 3
This invention relates to a torpedo and method for shooting oil wells and more particularly to an improved torpedo construction and a novel method for shooting a slowly flowing or dry well that has a large oil collecting cavity resulting from an earlier shooting of the well.

According to generally accepted practice, it is customary to plug a well, when it is originally part in order to increase its production. Location of the explosive charge is a simple matter at this stage in the development of a well and may be accomplished by positioning a plug in the bore of the well so that it will support the charge. A description of such practice may be found in the United States patent to Little, No. 733,492 of 1903.

Wells frequently cease to produce, after a period of time, sufficient oil to warrant their operation. This is true even where the well was shot by a method such as Little's at the time of the original drilling. The reduction of oil flow is generally due to a deposit of paraffin or other matter which clogs the pores in the face of the oil bearing stratum surrounding the enlarged cavity. It is a particularly troublesome problem in the art at the present time to remove the paraffin deposit when its position is relatively remote from the bore of the well.

One method for solving the problem is to shoot the well again with the object to tear away or remove the outer layer of the oil bearing stratum which is clogged with paraffin. Heretofore, the explosive material has been lowered down the bore of the well and deposited in the oil-collecting cavity immediately below the well bore. The explosive then rested on the bottom of the cavity which is generally composed of a soft mud-like material. In this position, the explosive is frequently below and at some distance from the oil bearing stratum. When these conditions prevail and the explosive charge is set off, several undesirable results are obtained. First, the destructive action of the explosive force may extend only part of the way up the face of the oil producing stratum and sometimes may not even reach the clogged face. Therefore, only a small part (the lower edge), if any, of the clogged face is removed by the shot. Second, a large part of the explosive force is uselessly consumed in stirring up the soft mud-like material immediately below and at the sides of the explosive charge. Third, as the explosive action is from the area of the mud-like material toward the oil bearing stratum, the disturbed mud is forcefully thrown against and into the face of the oil bearing stratum. Consequently, the clogged condition may not be appreciably relieved and in some cases may be greatly accentuated. Obviously, therefore, in many cases the increase in oil production is negligible, disapp pointing, and not worth its cost.

By the present invention, the above undesirable results may be substantially eliminated and avoided. According to this invention, the charge consists of buoyant torpedoes which float and move in the enlarged cavity to a position at or adjacent the face of the oil bearing stratum where they are set off. To provide for this movement of the torpedoes, a body of liquid, such as water, is collected in or introduced into the oil collecting cavity, and the surface or level of the liquid is preferably determined so as to lie within the upper and lower limits of the oil bearing stratum. Some advantage may only be gained, however, where the liquid level is adjacent but not between the limits of the oil bearing stratum. The torpedo in floating on the liquid surface will reach the clogged face and then be in the most advantageous position for tearing it away. An unbalanced torpedo having its center of gravity somewhat adjacent but to the rear of its longitudinal axis may be used as the unbalanced characteristic probably assists a torpedo in seeking out the edge of the liquid.

Important advantages are achieved in the practice of this invention. Practically all of the destructive force of the explosion is usefully employed as the torpedoes lie against or near the clogged face when set off. Where the liquid level is within the limits of the oil bearing stratum, the explosive does not cause the mud-like material to be blown against the oil bearing stratum so as to clog the newly exposed face. Other results flow from these achievements. The amount of explosive material used in shooting a well may be substantially reduced, and at the same time the increase in oil production will be much greater, than the increase which might have been obtained by the old method and known torpedoes.

This invention also relates to a novel construc tion for oil well torpedoes which gives them a larger factor of safety and makes them buoyant. There are a number of objects which are sought and obtained by the present invention.

It is an object of this invention to provide a new method for positioning torpedoes in oil wells. Another object of this invention is to position torpedoes in the enlarged cavities of oil wells by floating them to the face of the oil bearing stratum.
Another object of this invention is to provide a torpedo which is particularly adapted for position ing in an oil well by floating to the oil bearing stratum.

Still another object of the invention is to increase the safety factor of oil well torpedoes. It is also an object of this invention to provide a torpedo which may be positioned in oil wells at high temperatures without the heat causing premature explosion of the torpedo.

Other objects and advantages of the present invention will be apparent from the accompanying drawings and following description.

Referring to the drawing, Figure 1 illustrates an oil well to be shot in accordance with the present invention.

Figure 2 is a cross sectional view taken along the longitudinal axis of one of the floating torpedoes shown in Figure 1.

Figure 3 is an enlarged view of one of the floating torpedoes in Figure 1, and shows the angle of inclination when the torpedo is floating.

Figure 1 shows a typical oil well which has been shot one or more times and has thereafter ceased to produce oil in quantities which warrant its continued operation. Frequently such a well is abandoned, as known methods have not been adequate to increase production to an extent which would justify the necessary investment.

Shaft 1 is the original bore formed when the well was first developed, and cavity 2 is the result of the well being shot one or more times at an earlier date. Just above a stratum of mud like material 3 is a stratum of oil bearing sand or rock 4 having an exposed surface layer 5 clogged with paraffin or other material. The object of shooting a well by the old or the present method is to remove this layer 5.

Heretofore, the torpedoes have been deposited on the floor of the cavity as indicated by the position of the torpedoes shown in dotted lines at 6 in Figure 1. When these torpedoes are set off, their destructive action may reach only part of the way up the side of the cavity and may not reach the clogged face 5. Also the torpedoes indicated at 6 would spend a great part of their explosive force on the stratum 3 and throw the mud particles and the oil stratum 4 so as to further clog its face.

In practicing the method of the present invention, the first step is to ascertain the position and limits of the oil bearing stratum 4 with reference to the depth of the cavity 2. This information may be obtained by referring to the log of the well made at the time of its original development. The log will show the distances from the top of the well (or ground level) to the upper and lower limits of stratum 4 and from these measurements one can readily calculate the level of the middle of the stratum 4. For example, the upper and lower limits of stratum 4 being at depths of 2,000 and 2,010 feet respectively, the midpoint of the stratum would be at a depth of 2,005 feet.

The next step is to provide the desired liquid level of the water 7 in the cavity 2 which level may be, for example, at a point mid-way of the stratum 4. A conventional thief having windows and a valve operating plunger at its lower end is used in this operation.

The thief is lowered to determine if there is water or another liquid in the cavity 2 and the rate of flow of the liquid into the cavity. The rate of flow may be calculated by testing the liquid level in the cavity at regular intervals.

In using the thief, it is lowered into the well by means of a line and when its plunger strikes the floor of the cavity, it will open a valve and water will rise in the thief until the level of the liquid in the thief is the same as the liquid level in the cavity. When the thief is withdrawn from the well, the liquid level in the cavity may be determined by viewing the height of the liquid in the thief through its window.

If the vertical distance from the floor of the cavity to a point midway up the oil bearing stratum is greater than the length of the available thief, rock or other material may be deposited into the cavity to provide a special support for the thief in its liquid level measuring operation.

Should reading of the thief show that the well cavity is dry or that only a small quantity of water is present, water is poured into the well until it has reached the desired level, the liquid level being ascertained by means of the thief.

If there is an appreciable natural flow of water into the cavity, its rate should be taken into consideration so that the level of water at the time of shooting the well is correct. In some cases it may be necessary to remove some water in the well to obtain the desired level. This is done at the level of the surface of the water 7 midway of the oil bearing stratum 4.

The explosive charge for shooting the well preferably consists of a plurality of unbalanced buoyant torpedoes, for example, about 5 or 10. Each torpedo has its weight so distributed that the center of gravity is adjacent but rearward of the center of its longitudinal axis. These torpedoes, therefore, when floating assume a nearly horizontal position, but with their longitudinal axis slightly inclined in a vertical plane. The angle of inclination might be on the order of three and one-half degrees, but an angle of approximately two and one-third degrees is preferred. This preferred angular position is illustrated by the floating torpedoes in Figs. 1 and 3.

The unbalanced buoyant torpedoes 8 are lowered into the well one at a time by means of a line 9, having a hook 10 which engages the bale 11 of the torpedo. As each torpedo 8 enters the water and line 9 continues to be paid out, hook 10 slips out of engagement with bale 11. The torpedo, now free, rises in the water at an angle to the liquid level and with its nose or pointed end leading seeks out a position similar to that of the torpedoes shown floating at the side of the cavity in Fig. 1.

After the desired number of torpedoes have been placed in the well and they have arranged themselves around the cavity in close proximity to the face of the oil bearing stratum, they may be set off by any suitable means. In some cases, it may be desirable to use a conventional squib, which is dropped down the well. A squib usually has an explosive charge and a time fuse. In other cases, one may use a conventional bump-jack which is lowered on a line down the well. The bump-jack has an explosive charge and a cartridge which is fired by a weight sliding down the line. The explosion produced by the squib or bump-jack is sufficient to set off the torpedoes positioned in the cavity.

To increase the effectiveness of the floating torpedoes and to confine their explosive action to the desired area, fluid tamping, such as crude oil, may be poured into the cavity after the torpedoes are inserted therein and before they are exploded. Where fluid tamping is used, the torpedoes preferably have such buoyancy that they

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will float on the supporting liquid (generally water) but not in the tamping fluid. The torpedo supporting liquid is preferably water and the tamping preferably oil as the two are immiscible and of different specific gravities, so that the torpedo may float in a position approximately between the two liquids. It is also preferred that the torpedo in floating have only a relatively small part above the top surface of the water so that the water around the torpedo will prevent burning or charring of the oil bearing sands due to the heat of the explosion.

The components of this invention are preferably constructed in accordance with the Fig. 2 illustration. The torpedo has an inner and outer shell 12 and 13 of tin or other suitable material. At their lower or front ends, shells 12 and 13 are pointed or cone-shaped as shown in Fig. 2 and are held in relatively fixed spaced relation by a brace 14. The ends of the brace 14 are formed to snugly fit the pointed ends of the shells as shown in Fig. 2. This brace may be secured in place by soldering, welding or the like. The rear wall 16 of the torpedo is spaced from the shells 12, 13 at that end of the torpedo. Wall 15 is also formed of tin, though, of course, other material may be used. This construction provides a central liquid-proof chamber 16 for the explosive material, such as nitroglycerine, and an outer concentric sealed air chamber 17, which may hold the air under a pressure, for example, of one pound. A tube 18 secured to the end wall 19 provides a filling opening for the explosive containing chamber 16, which opening may be closed by a stopper 18. Two wires 20, secured at their inner ends to the torpedo, when brought together over the stopper and then twisted as shown in Fig. 2, prevent accidental displacement of the stopper.

The torpedo of this invention has two quite distinct but important characteristics achieved by a relatively simple and inexpensive structure. The instant torpedo is buoyant and has a large factor of safety. These characteristics are due to the following features: The outwardly spaced shell 13 eliminates rupturing of the shell 13 while the smaller rear end of the shell 13 is covered with a small casing. A chamber 17 is provided for collecting any leakage coming from explosive containing chamber 16. Accidental explosion is avoided as the ductile characteristic of tin shell 13 permits it to yield to the explosion forces and be recovered and the heat of explosion is not transmitted to shell 12. Accidental explosions are to a great extent also avoided as brace 14 and end wall 15 will tend to maintain shells 12 and 13 in spaced relation and out of frictional contact even when shell 13 is temporarily or permanently deformed while being placed in a well. Furthermore, the ductile characteristic of shell 13 and the underlying air cushion will provide for absorption of shocks without their being communicated to shell 12. The air cushion and brace 14 are used to restore shell 13 to original shape after it receives a blow, as in striking the side of a well casing. The outer air chamber 17 not only imparts a buoyant characteristic to the torpedo but also insulates the explosive in chamber 16 against heat. The insulating feature is quite important as it permits the use of the torpedo in wells having high temperatures without risking a premature explosion.

Wall 15 is preferably thin in cross section and brace 14 preferably small in cross section, so that there will be little heat flow from shell 13 to shell 12 by conduction and the heat insulating effect of air chamber 17 will not be nullified. As previously described, the center of gravity of the present torpedo is displaced, so that the torpedo will float at an angle as shown in Figs. 1 and 3. The degree of displacement may be varied by changing the distance between the cone-shaped lower ends of shells 12 and 13 to alter the size of the air pocket at 21, and/or by changing the size of the indentation provided by end 10 wall 18. It will now be seen from the foregoing description that this invention provides a novel method for shooting oil wells and an improved construction for oil well torpedoes.

While the foregoing description gives a preferred example of how this invention may be practiced, other forms and modifications may be devised within the spirit and scope of the invention, as defined in the following claims.

I claim:

1. A torpedo for shooting oil collecting cavities at the bottom of oil wells wherein liquid is provided for floating the torpedo to the wall of the cavity, comprising an explosive-containing vessel, the ratio of the displacement of the torpedo to the combined weight of the vessel and its charge of explosive being such that the charged torpedo will float in said liquid, and the weight of the vessel and its explosive being so distributed that the center of gravity is rearward of the center of the longitudinal axis of the torpedo, whereby the torpedo when freed in said liquid will assume an inclined position adjacent the surface of said liquid.

2. A torpedo for shooting large oil collecting cavities at the bottom of oil wells wherein liquid is provided for floating the torpedo to the wall of the cavity comprising a closed, explosive-containing vessel having a central elongated and substantially cylindrical portion, a substantially cone-shaped nose, and a substantially cone-shaped depression in its rear end, the ratio of the displacement of the torpedo to the combined weight of the vessel and its charge of explosive being such that the charged torpedo will float in said liquid, and the weight of the vessel and its explosive being so distributed that the center of gravity is rearward of the center of the longitudinal axis of the vessel so that the torpedo 50 when floating assumes a position such that its longitudinal axis is inclined in a vertical plane.

3. A torpedo for shooting large oil collecting cavities at the bottom of oil wells wherein liquid is provided for floating the torpedo to the wall of the cavity, comprising an elongated, buoyant, explosive-containing, closed vessel which is so constructed that the torpedo when charged will float in said liquid at an angle of approximately two and one-third degrees.

4. A torpedo for shooting large oil collecting cavities at the bottom of oil wells wherein liquid is provided for floating the torpedo to the wall of the cavity, comprising an elongated, buoyant, explosive-containing, closed vessel which is so constructed that the torpedo when charged will float in said liquid at an angle of approximately two and one-third degrees with the forward end of the torpedo at a higher elevation than the rear end.

5. A torpedo for shooting oil wells comprising spaced concentric shells to provide a central chamber for liquid explosive material and an outer concentric closed air pressure chamber, and
means at each end of the torpedo for maintaining said shells in spaced relation, the outer of said shells being of ductile metal so that it will yield to temporary deforming forces without disturbing said inner shell and be returned to its original shape under the influence of the air under pressure and the action of said spacing means.

6. A torpedo for shooting oil wells comprising spaced concentric shells to provide a central chamber for liquid explosive material and an outer concentric closed air pressure chamber, said shells being spaced apart at one end by a transverse wall which serves to close both of said chambers at said end, and a brace member extending longitudinally of the torpedo and interposed between the other ends of said shells to maintain them in the spaced relation, the outer of said shells being of ductile metal so that it will yield to temporary deforming forces without disturbing said inner shell and be returned to its original shape under the influence of the air under pressure and the bracing action of said member.

7. A torpedo for shooting oil wells comprising spaced shells to provide a central explosive containing chamber and an outer closed air chamber for insulating said central chamber against heat, and means for connecting said shells at the opposite ends of the torpedo to maintain them in the spaced relation, said means being relatively small in cross section to reduce heat conduction between said shells.

8. In a method of shooting oil wells in which an enlarged cavity has been formed at the oil bearing stratum, the steps comprising determining the fluid level in the cavity such that its upper surface is at the level of the oil bearing stratum, using the fluid having such level to position a torpedo adjacent the face of the oil bearing stratum, and firing the torpedo when in such position.

9. In a method of shooting oil wells in which an enlarged cavity has been formed at the oil bearing stratum, the steps comprising determining the liquid level in the cavity such that its upper surface is at the level of the oil bearing stratum, using the liquid having such level to position a torpedo adjacent the face of the oil bearing stratum, and firing the torpedo when in such position.

10. In a method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level in the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedo when it is in such position.

11. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level in the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes together when they are in such position.

12. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level in the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes when they are in such position.

13. In a method for shooting enlarged oil collecting cavities in deep wells, the steps of determining the liquid level in the cavity such that its upper surface is at substantially the level of the oil bearing stratum, and positioning an explosive charge by floating the charge to the face of the oil bearing stratum, and firing said explosive charge when in such position.

14. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level in the cavity such that its upper surface is at substantially the level of the oil bearing stratum, positioning an explosive charge by floating the charge to the face of the oil bearing stratum, and firing said explosive charge when in such position.

15. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level in the cavity such that its upper surface is at substantially the level of the oil bearing stratum, positioning an explosive charge by floating the charge to the face of the oil bearing stratum, introducing into the cavity a tamping liquid of less specific gravity than said first mentioned liquid and immiscible therewith, and firing said explosive charge.

16. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level within the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position a torpedo adjacent the face of the oil bearing stratum and firing said torpedo when it is in such position.

17. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level within the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes together when they are in such position.

18. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level within the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes when they are in such position.

19. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level within the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes when they are in such position.

20. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level within the cavity such that it is within the upper and lower limits of the oil bearing stratum, lowering a buoyant explosive torpedo into the well, releasing the torpedo as it enters the liquid, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes when they are in such position.

21. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of determining the liquid level within the cavity such that it is within the upper and lower limits of the oil bearing stratum, using the liquid having said level to position the torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes when they are in such position.
said level to position said torpedoes adjacent the face of the oil bearing stratum and firing said torpedoes when they are so positioned.

22. A method for shooting enlarged oil collecting cavities in deep wells, comprising the steps of obtaining a body of liquid in the cavity, introducing an unbalanced buoyant torpedo into said liquid, using said body of liquid to position said torpedo adjacent the wall of the cavity, and firing the torpedo when it is in such position.

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