

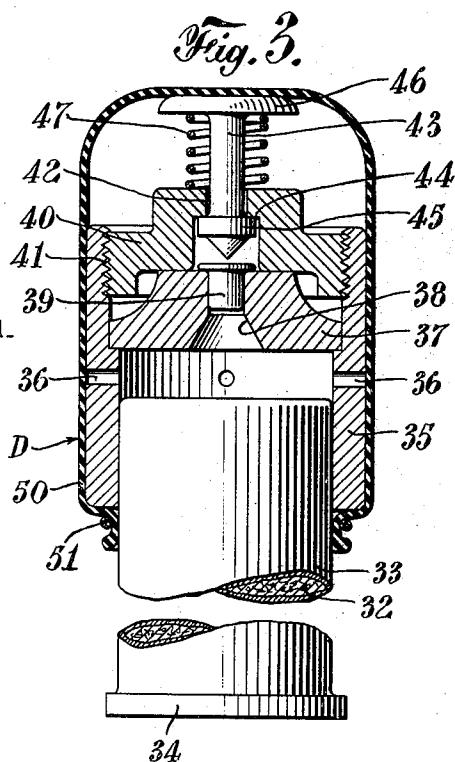
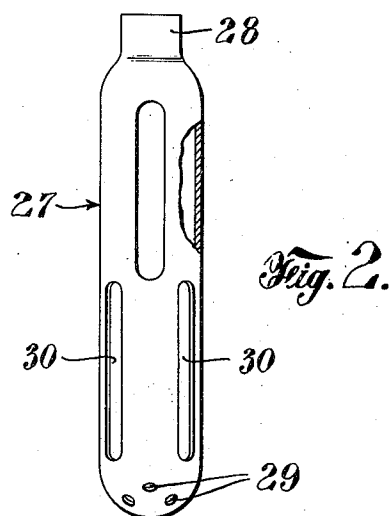
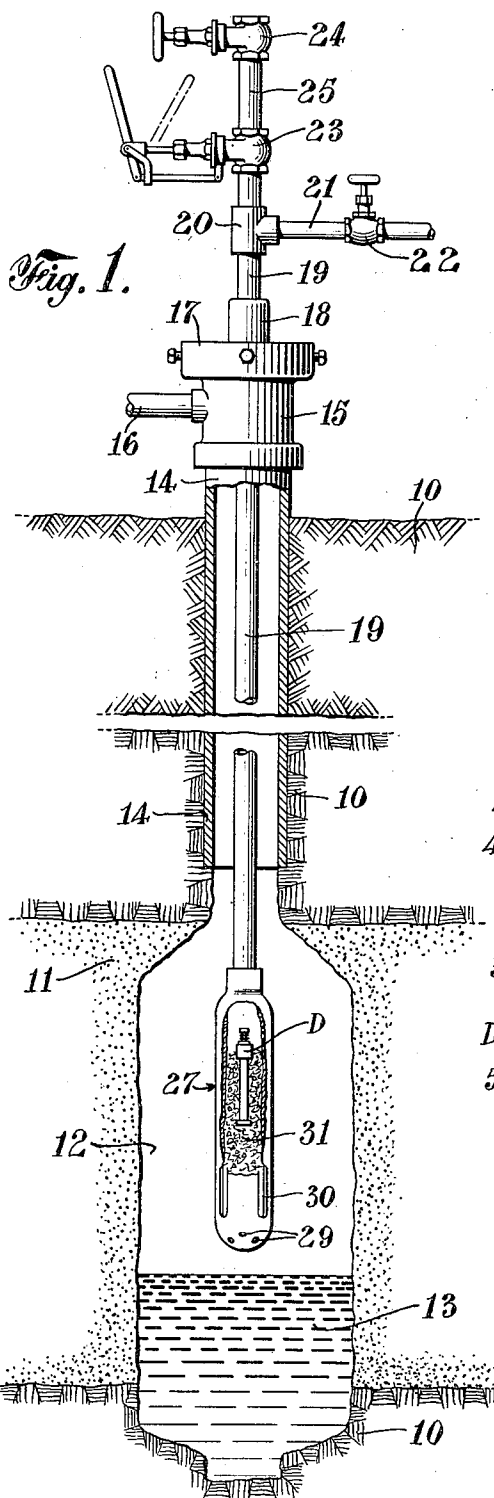
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APPARATUS FOR INCREASING PRODUCTION OF OIL WELLS

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APPARATUS FOR INCREASING PRODUCTION
OF OIL WELLS

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3 Claims. (Cl. 166—1)

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This invention relates to apparatus for igniting combustible material in the bottom of an oil well, and more particularly for igniting a pool of hydrocarbon liquid in the shot hole of an oil well to initiate a cleanout treatment for eliminating clogging materials in the oil sand at the shot hole.

After operating for a period of years, oil wells often cease to produce oil and gas at the rate that is theoretically possible according to the state of depletion of the oil reservoir. Such reduction of oil flow into the well from the oil sands of the reservoir is mainly due to an accumulation of clogging material such as sludge and wax formations in the sands at the walls of the shot hole at the bottom of the well. Many methods of eliminating the clogging material have been proposed and tried. A method which is both economical and effective includes providing a supply of combustible in the shot hole and burning such combustible by supplying to it an oxidant such as air or oxygen at a controlled rate to burn the combustible material including the clogging material. The clogging material is thereby substantially completely gasified and removed. The process also includes a controlled spalling or breaking off of sandstone from the walls of the shot hole which serves to renew the oil and gas producing surfaces and eliminate any non-combustible clogging material. Such a cleanout method is described and claimed in a co-pending United States application Serial No. 607,540, filed July 28, 1945, by L. A. Bliss, R. S. Hamilton and B. M. Higginbotham.

When a pool of liquid hydrocarbon is used as the supply of combustible, the ignition thereof is difficult due to the quenching effect of the oil pool. Attempts to effect ignition by merely dropping into the well a cartridge fuse or a flare, either previously ignited or one which ignites by impact, would not be successful as the ignition device would be smothered by the liquid before effective ignition is obtained.

According to the present invention an adequate and certain ignition is obtained by providing a perforated cage or basket secured to the lower end of a pipe line string extending into the well, through which the oxidant is to be fed to the oil pool in the bottom of the well. The basket is preferably made of a combustible material, for example, a combustible metal, such as aluminum, magnesium, or steel, which is combustible with oxygen, so that the basket will be partly or completely burned off and thus allow free access of the oxidant to the combustible in the shot hole. An ignition device fitted with a percussion fuse

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may then be dropped through the pipe string into the basket and when the device strikes the basket or a combustible material placed in the basket, the pyrotechnic material of the ignition device will be ignited by the percussion fuse. The ignition device will create high temperature heat for igniting the combustible material of the basket and the oil pool when the oxidant is supplied through the pipe string. The burning solid materials falling from the basket onto the oil surface will effect a thorough ignition of the oil surface. Alternatively, an ignition device having a percussion fused end positioned upwardly may be packed in the basket before the pipe string is lowered into the well and a weight, such as a cylinder of iron, may be dropped down the pipe string to hit the percussion fuse and set off the ignition device. Instead of a weight, a second ignition device may be dropped down the pipe line upon the one located in the basket. The basket is also preferably filled with a solid easily ignitable combustible material which may be packed around the ignition device for supporting it. The basket is suspended close to the combustible in the shot hole and, if a liquid combustible is used, the basket is positioned just above such liquid pool to insure that the ignition device is not quenched by the liquid. The ignition device, which is packed in the basket, is also preferably water and oil proofed.

The principal object of the present invention is therefore to provide a simple but effective apparatus for igniting combustible in the bottom of an oil well. Other objects of the invention are to provide apparatus for igniting the combustible in an oil well which insure against the quenching of an ignition device by liquid in the well when such device is dropped into the well, or when such device is suspended at the lower end of the oxidant supply tube extending down the well; to provide a basket or cage for the reception of an ignition device and easily ignitable material, which basket is removable after ignition by combustion thereof to allow clear access of oxidant to the oil pool; and to provide an ignition device which is unaffected by water or hydrocarbon liquids in the bottom of the well.

These and other objects and novel features of this invention will become more apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic elevational view, partly in section, of the upper and lower ends of an oil well to be cleaned out, showing therein an exemplary form of apparatus for igniting a combustible such as an oil pool according to the invention;

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Fig. 2 is an elevational view on a slightly enlarged scale of the basket at the lower end of the pipe line extending into the well; and

Fig. 3 is a sectional view on an enlarged scale of a suitable ignition device.

Referring now to the drawing and more particularly to Fig. 1, the earth and rock through which the well is bored is indicated at 10, and the oil bearing formation at the bottom of the well, which in many instances is a porous sandstone, is indicated at 11. The enlarged cavity 12 in the oil sand is termed the "shot hole," and for a cleanout treatment the shot hole 12 is provided with a body of combustible, such as a pool of oil 13 in the bottom thereof. The oil well liner or casing 14 extends upwardly from a point generally some distance above the shot hole to a short distance above the earth where it is provided with a casing head 15. The casing head 15 may have an outlet 16 in the side thereof for exhaust gas and also an upper flange 17 which cooperates with a coupling 18 for supporting a pipe string 19 that extends down the well into the shot hole, the coupling 18 being usually a part of the pipe string.

Above the coupling 18 the pipe 19 has interposed therein a T connection 20, having its side outlet coupled to an oxidant supply pipe 21, controlled by a valve 22. Above the T 20 a means for inserting an ignition device is provided, preferably comprising a quick opening gate valve 23, above which is a second gate valve 24, separated from the first by a section of pipe 25.

As described in the aforementioned United States co-pending application, the lower end of the pipe string 19 preferably includes a section of tubing that is highly resistant to heat and oxidation such as stainless steel pipe to which is secured an ignition basket 27. The basket is shown more clearly in Fig. 2 and is preferably made of a combustible material. A convenient form of basket may be made from a section of steel tubing having a diameter about the same as that of pipe 19 or of larger diameter than the pipe 19 as illustrated in Fig. 2. The upper end may be reduced if necessary and secured to a coupling 28, which is internally threaded for attachment to the pipe 19. The lower end of the basket is closed and may be provided with one or more holes 29. A plurality of slots 30 are preferably cut through the side wall of the basket to ventilate the same. The slots preferably are longitudinally arranged and may be of any size desired. Preferably the slots are sufficient to remove one-third to one-half of the area of the walls. It is preferable that the basket or cage be strong enough to carry the weight of the entire pipe string. The reason for this is that it permits a convenient method of positioning the basket in the shot hole which is preferably suspended close to but above the surface of the oil pool 13, the level of which may vary considerably according to the size of the shot hole. To accurately position the basket, the depth of the oil pool is measured, preferably by lowering a measuring device into the well, withdrawing it and noting the height of the oil level above the bottom. The pipe string is then lowered until the basket touches the bottom of the well. The pipe string is thereafter raised an amount which is determined according to the depth of oil measured until the basket is just above the oil level. The tubing string is then secured in this position.

Before the basket and pipe string is lowered into the well an ignition device D is preferably

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packed and supported in the basket in a position with its fused end upward. Any ignition device that sets off by impact can be used. An effective device is a fusee capable of burning at least three minutes. The type known as a target identification flare is found satisfactory; however, a two and one-half pound incendiary bomb is also effective.

An easily ignitable and non-sinking solid material may also be packed around the ignition device, for example, charcoal or a mixture of charcoal and excelsior is found effective. This is indicated at 31. These combustible materials catch fire from the action of the ignition device and fall out of the cage onto the oil surface where they float and are very effective in aiding the ignition.

A suitable arrangement of the ignition device is illustrated in Fig. 3. The fusee or flare cartridge of cylindrical shape is indicated at 32. This should preferably have a combustible waterproof casing 33 sealed by a bottom cap 34. The upper end of the casing 33 is secured, for example, by cement to a coupling 35. The coupling 35 has vent holes 36 drilled through its wall at a point just above the open end of the casing 33. The coupling 35 is counterbored from above to provide a shoulder on which is seated a fuse holder 37. The fuse holder comprises a metal disc having a hole 38 therethrough, in which is supported a percussion fuse or cap 39 having a rim which engages the upper surface of the fuse holder disc 37. The disc 37 is held in place by an externally threaded plug 40 that engages cooperating threads 41 in the coupling. The plug 40 has an axial hole 42 therethrough for receiving the firing pin 43, such hole 42 being counterbored from below to provide a shoulder 44, that serves to retain the enlarged lower end 45 of the firing pin, which lower end is also pointed to engage and explode the cap 39. The upper end of the firing pin 43 is provided with an enlarged head 46 that serves as an impact surface and also serves to retain a light compression spring 47, which holds the firing pin normally out of engagement with the cap 39.

The cap 39 and the fusee 32 may be themselves waterproofed, but it is preferable that the ignition device be further protected from the action of water and other liquids by a sealing means that does not interfere with its operation. A suitable sealing means comprises a flexible cap or bag 50, which may be made of rubber, or combustible water and oil proofed plastic material. The sealing bag 50 is slipped over the firing pin end of the device and is sealed to the casing 33 by tying with string or wire 51.

The ignition device shown in Fig. 3, is supported as in Fig. 1, within the basket 27 by packing the mixture of excelsior and charcoal around it so that the firing pin head is disposed upward and immediately under the end of the pipe 19. The pipe string is secured in position in the well as previously described and a second ignition device may be placed within the pipe section 25 with its head or firing pin end downward, the valve 24 being open to allow entry of the ignition device. The head end of the ignition device to be dropped in may preferably be provided with a conical protector to facilitate passage through pipe joints and to protect the bag 50 if the latter is employed. The valve 24 is then closed, a supply of oxidant is permitted to flow from the connection 21 through the pipe 19 until the pipe 19 is completely filled with the oxidant. The

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gate valve 23 is then pulled open and the ignition device falls from the pipe section 25 down the pipe line 19 below where it strikes the ignition device D within the basket 27. Both ignition devices are thus fired. The impact drives the firing pin 43 against the cap 39 which explodes into the end of the casing 33, igniting the self-supporting pyrotechnical material therein. The hot gases at first blow out through the vent holes 36, which destroys the bag 58. The fusee 32 soon burns vigorously and ignites the charcoal and excelsior 31, which falls out of the slots 30 of the cage 27 onto the surface of the oil pool 13. The oxidant flow is now turned on or increased and combustion becomes more vigorous. The heat generated soon raises the iron of the cage 27 to its ignition temperature which then is burned by the oxygen. The lower end of the basket will fall off to the bottom of the well and the path for flow of oxygen toward the oil pool surface will then be clear.

It is not essential to drop a second ignition device down the pipe string 19. It will sometimes be preferable to drop a weight such as a cylinder of iron which falls against the upper end of the ignition device D in the basket 27 and by its impact drives the firing pin 43 against the cap 39. The spring 42 is only strong enough to hold the firing pin normally away from the cap 39, but offers no resistance to the impact of the weight. Alternatively, the ignition device D in the basket 27 may be omitted entirely, and an ignition device may be dropped down the tubing 19 into the basket. Upon the impact the ignition device will become ignited and contained in the basket above the oil level to prevent its becoming quenched.

It is also possible to omit the excelsior and charcoal or other combustible packing from the basket so that the flare alone will act to ignite the combustible in the well. As described in the aforementioned co-pending application, the rate of input of the oxidant at the time of ignition and for a short time thereafter must be kept relatively low until the combustion has been well started. The preferred rate of oxygen input varies according to the amount of combustible and size of shot hole as well as certain other conditions encountered and may at first be as low as 500 cubic feet per hour, this rate later being increased to 1,000 to 9,000 cubic feet per hour.

Any unburned portion of the basket 27 that falls to the bottom of the well under the oil pool 13 will usually be burned after the oil pool is consumed. Other steel objects such as broken tools or pieces of pipe in the shot hole are also burned and reduced to iron oxide which settles to the bottom of the well and is easily removed by the tools employed to remove the cavings. The paraffin and sludge will also be eliminated and the oil producing surfaces will be spalled away and renewed to restore the well to high operating efficiency.

It will be clear that the ignition device disclosed in Fig. 3 is merely an exemplary construction and that the percussion fuse portion in particular may be of any known type that is initiated by impact or alternatively a time fuse could be employed. The specific shape and dimensions of the basket 27 can also be varied considerably so long as it is transversely small enough to pass down the well but big enough to receive or hold the ignition device. The tubing 19 is usually two inch nominal pipe size and the basket can be formed of similar sized tubing. It is also not

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essential that the basket be strong enough to support the weight of the entire pipe string but it is preferable that it be at least strong enough to support part of the weight so as to indicate by a reduction of tension at the derrick when the basket touches the bottom of the well.

What is claimed is:

1. Apparatus for igniting combustible material in the bottom of an oil well, which apparatus comprises a pipe string extending down the well; a perforated basket secured to the bottom of the pipe string; combustible easily ignitable material disposed within said basket; means for suspending the pipe string so that the basket is positioned at a predetermined distance above the bottom of the well; and means at the upper end of the pipe string for dropping an ignition means down the pipe string into the basket.

2. Apparatus for igniting combustible material at the bottom of an oil well, which apparatus comprises a pipe string extending down the well; a perforated basket secured to the bottom of the pipe string; a percussion fused ignition device disposed in said basket below the pipe string; combustible easily ignitable material within said basket and packed around and under said ignition device; means for suspending the pipe string so that the basket is positioned at a predetermined distance above the bottom of the well; and means at the upper end of the pipe string for dropping an ignition means down the pipe string into the basket.

3. Apparatus for igniting combustible material in the bottom of an oil well, which apparatus comprises a pipe string extending down the well; an elongated basket secured to and communicating with the lower end of the pipe string, said basket being perforated in at least its lower portion and being formed of a metal combustible by oxygen; combustible, easily ignitable, and gas-pervious material disposed within said basket; means for suspending said pipe string so that the basket is positioned above the bottom of the well in predetermined relationship with respect to the oil-producing walls of the well; means for supplying oxidant comprising mainly oxygen to said pipe string; and means at the upper end of the pipe string for dropping an ignition means down the pipe string into the basket.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
60 Re. 4,770	Noble	Feb. 27, 1872
106,793	Dickey	Aug. 30, 1870
797,529	Oliphant et al.	Aug. 15, 1906
1,239,247	Allison	Sept. 4, 1917
1,457,479	Wolcott	June 5, 1923
65 1,473,343	Howard	Nov. 6, 1923
1,701,133	Ulmer	Feb. 5, 1929
2,067,408	Morris	Jan. 12, 1937
2,188,737	Hixon	Jan. 30, 1940
70 2,382,471	Frey	Aug. 14, 1945

OTHER REFERENCES

Uren-Petroleum Production Engineering, 2nd edition, 1939, Oil Field Exploitation, pages 365, 366, McGraw-Hill, New York, N. Y.