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REMOVAL OF CEMENT FROM WELL CASING

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FIG. 1.

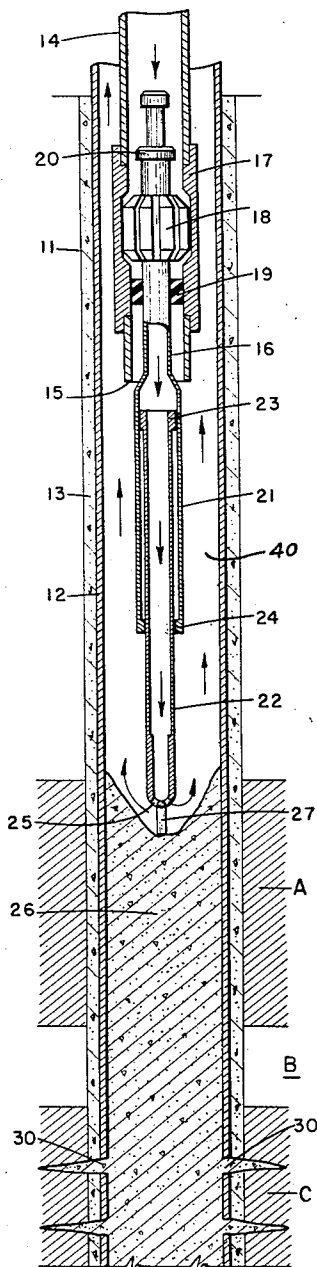


FIG. 2.

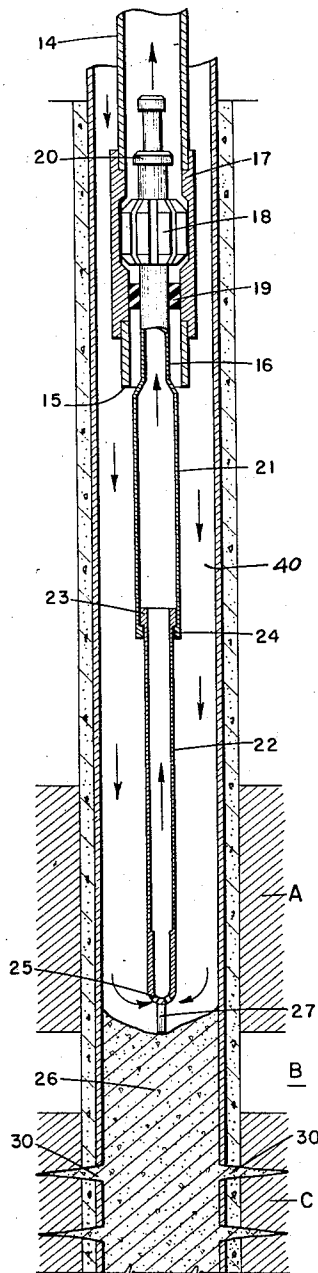
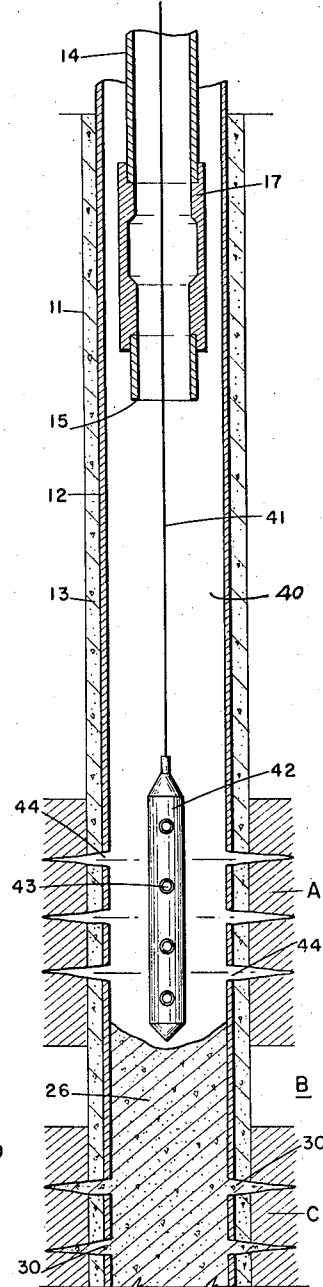


FIG. 3.



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REMOVAL OF CEMENT FROM WELL CASING

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3 Claims. (Cl. 166—22)

The present invention is directed to the removal of cement from well casing. More particularly, it is directed to method and apparatus for removing at least a portion of a cement plug from a well casing. In its more specific aspects, the invention is directed to method and apparatus for working over wells having a casing arranged therein with a tubing arranged permanently in place with its lower end at a level above the working level in the casing.

The present invention may be briefly described as a method for removing a cement plug and the like from a well casing having a tubing permanently arranged therein with the lower open end of the tubing at a level substantially above the level from which cement is to be removed. The method involves forcing a stream of an acid solution down the tubing and jetting the stream directly against the upper face of the cement plug to disintegrate the plug. During the time the stream of acid is jetted against the plug, the stream of acid solution follows the upper face of the plug as it is being disintegrated. The acid solution containing dissolved and/or disintegrated cement flows up the annulus between the casing and the tubing. Thereafter the acid solution may be returned to the tubing and again forced downwardly against the plug with the stream of acid solution maintained in direct contact with the plug until at least a portion of the plug has been disintegrated and removed from the casing.

In practicing the present invention, it is contemplated that the acid solution may be circulated up the casing between the casing and the tubing and again down the tubing against the upper face of the plug. Likewise, it is contemplated that, where a large amount of acid is not available or is not used, the acid solution may be forced up into the annulus and then forced back from the annulus into the tubing for re-use in jetting against the cement plug.

The present invention also contemplates apparatus for removing and disintegrating a cement plug and the like in well casing in which a tubing is arranged permanently in the casing with the lower end of the tubing at a level substantially above the working level or the level where the cement plug is located. This apparatus comprises an elongated tubular member adapted to be lowered through the tubing. Means are provided for supporting the tubular member in the tubing and the tubular member is provided with at least one telescopic member which is slidably carried by the tubular member for lengthening the effective length of the tubular member when the telescopic member is in a first position and shortening the effective length of the tubular member when the telescopic member is in a second position. The lower end of the telescopic member may be suitably weighted such as by providing several joints of pipe below the point of telescoping for providing weight to and lengthening the member. At least one nozzle is arranged on or adjacent the free end of the telescopic member and the free end of the telescopic member below the nozzles may be

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provided with a nozzle spacer member. The spacer member and the nozzle cooperate to allow the cement plug to be disintegrated by virtue of acid being jetted through the nozzle. The spacer member maintains the nozzle a predetermined distance from the cement to achieve improved jetting effect of the acid.

The present invention is of considerable advantage and utility in the so-called permanent well completion technique in which a tubing is arranged in a well casing with its lower open end located at a level substantially above a working level or a point where a cement plug is arranged or preferably above an uppermost of a series or plurality of hydrocarbon productive intervals, sand, strata, or formations. In the permanent well completion operation, the tubing remains fixed in position, as originally located and all subsequent workover, recompletion and service operations are conducted through the tubing by means of wire line tools and the like. Whenever a cement plug is left in the well and is too extensive or extends to too high a location, the present invention provides apparatus and method for removing same.

This invention involves jetting a stream of a mineral acid solution, such as commercial hydrochloric, nitric or sulfuric acid, hydrofluoric acid, or mixtures thereof against the face of the cement plug to disintegrate and/or dissolve the same. It is contemplated that the acid or acids may be of any suitable concentration and may contain a corrosion inhibiting agent, such as any of the well known mineral acid inhibitors; for example, soluble arsenic compounds, acid extracts of petroleum phenols, and many others too numerous to mention here.

In the present invention, the stream of acid is jetted directly against the cement plug and is maintained against and follows the cement plug as the level of the plug is diminished by disintegration or dissolution.

The present invention will be further illustrated by reference to the drawing in which

Fig. 1 shows the method and apparatus of the present invention for removing a plug from a well casing;

Fig. 2 illustrates the flow of acid solution back into the tubing; and

Fig. 3 shows the perforation of well casing after removal of the plug.

Referring now to the drawing and particularly to Fig. 1, numeral 11 designates a well bore which has been drilled from the earth's surface, not shown, to penetrate a hydrocarbon productive interval "A" separated by an unproductive interval "B" from a second hydrocarbon interval "C." Arranged in the well bore 11 is a casing 12 which is cemented in place with a primary cement sheath 13. Suspended from the wellhead, not shown, at the earth's surface, is a tubing 14 which is arranged with its lower end 15 arranged at a level above the hydrocarbon productive interval A which may be the uppermost of a plurality of hydrocarbon productive intervals. Arranged in the tubing 14 and projecting from the lower open end 15 is a tubular member 16 which is supported by a hanger assembly 18 at a point adjacent the lower end 15 of the tubing 14 in a landing nipple 17, such as described in the Composite Catalogue of Oil Field and Pipe Line Equipment, 19th edition, 1952-3, vol. 2, page 4052, Fig. 14. It is to be understood, however, that other supporting and/or securing means may suitably be used for securing the upper end of the tubular member 16 in the tubing 14. The upper end of the tubular member 16 is also provided with a suitable packing, generally indicated as 19, which may include a sealing means, such as chevron packing and the like.

The tubular member 16 is also provided with a fishing neck, such as 20, which engages with a fishing tool on

the end of a wire line for lowering same and retrieving the tubular member 16 from the tubing 14.

Carried within the lower end 21 of the tubular member 16, which is of increased dimensions, is a slidable telescopic member 22 which is arranged to increase and decrease the effective length of the tubular member 16 within the limits shown in Figs. 1 and 2. The telescopic member 22 is provided with an external shoulder 23 which cooperates with an internal shoulder 24 of the member 16 to retain the telescopic member 22 within the member 16. The lower or free end of the member 22 is provided with a plurality of nozzles 25 for jetting a stream of a liquid, such as acid, against the cement plug 26, as will be described further. Adjacent the nozzles on the free end of the member 22 is a nozzle spacer member 27, which is used to correctly space the nozzles 25 above the cement plug.

It is to be noted that the tubular member 16 and the telescopic member 22 cooperate with the tubing 14 to define a continuous passageway leading to the earth's surface.

In the practice of the present invention, the perforations 30 in the casing 12 in the hydrocarbon productive interval C have been formed and it is desired to seal same off due to water and/or gas invasion and the like. Under these conditions, a body or plug of cement 26 is arranged in the well casing to seal the perforations 30 and form the plug 26 therein. Under some conditions the height of the plug 26 is not controlled carefully and it may extend up into and through the hydrocarbon productive interval A from which it is desired to obtain production. In instances in accordance with the prior art, it would be necessary to manipulate and raise the tubing string 14 and attach a bit thereto to drill out the plug 26. However, in accordance with the present invention the tubular member 16 is lowered on a wire line and landed in the landing nipple 17. This tubular member is provided with a telescopic member 22 with the nozzle spacer member 27 resting on the upper face of the plug 26. A stream of an acid solution is then forced or pumped down the tubing 14 and caused to issue through the nozzles 25 against the plug 26 dissolving and/or disintegrating same, the flow being as indicated by the arrows with the acid flowing down the tubing 14, the tubular member 16, and telescopic member 22 and up the annulus 40 between the tubing 14 and the casing 12 and recirculated back again down tubing 14. It may be desirable to filter or screen the acid solution before it is again circulated down the tubing. Since it may not be desirable to circulate a sufficient amount of acid or to pump acid continuously to form a continuous stream down the tubing and up the annulus to the earth's surface, it is also contemplated with the present invention that the acid in the annulus 40 after it has dissolved out at least a portion of the plug 26, as shown in Fig. 2, may be forced back down the annulus 40, through the nozzles 25, and up the telescopic member 22 through member 21 and to the tubular member 16 and the tubing 14. Thereafter fluid pressure is imposed on the wellhead at the earth's surface, not shown, and the acid caused to be jetted again against the upper face of the partially removed plug 26.

After the plug 26 has been cut off or diminished to a point, as shown in Figs. 2 and 3, the tubular extension member 16 and the telescopic member 22 may be pulled from the landing nipple 17 and the tubing 14 by means of a wire line, leaving a full open tubing 14 for lowering of other equipment through the lower open end 15. In accordance with this invention, a perforator, such as a gun perforator 42, is lowered on the wire line 41 from the wellhead until it has reached a level in the casing adjacent the interval A above the diminished plug 26. This perforator may be a gun perforator of the bullet or shaped charge type or may be a mechanical perforator. The gun perforator may be lowered on a wire line or a conductor cable, both of which are generally indicated

by the numeral 41, and the shaped charges or bullets may be fired by electrical impulse through the conductor cable 41 or fired from a power pack arranged in the perforator 42 as may be desired. In any event, perforations, such as 44, are formed in the casing 12 and the cement sheath 13 to penetrate the stratum or interval A and allow production to be had therefrom into the tubing 14 after withdrawal of the perforator 42.

It will be seen that the practice of the present invention allows the removal of cement plugs or lowering the level of the cement plug in a well casing as desired without resorting to manipulation of the tubing string which involves heavy duty lifting equipment and without resorting to rotary drilling operations.

As an example of the practice of the present invention, approximately 85 feet of a cement plug in a 5½ inch casing was removed by jetting approximately 3,000 gallons of acid against the plug employing apparatus as illustrated in Figs. 1 and 2 with the acid stream impinging directly on the upper face of the plug and following the plug's upper face downward as the plug was removed from the casing. This operation was completed within 83 working hours of which only 9¼ hours were actual jetting time.

Cement removal is dependent on many factors such as the degree of hardness of the cement, the amount of cement to be removed, the amount of acid used per batch and the number of telescopic joints employed. Therefore, the invention is not to be restricted by any specific examples which are given by way of illustration and not by way of limitation.

While the invention has been described and illustrated employing a telescopic means, such as 22, provided with nozzles 25 and nozzle spacer 27, it is contemplated that the operation may be conducted with an open end member, such as 22, without using nozzles 25 or nozzle spacer 27 although it is desired and preferred to use nozzles, such as 25 and a spacer member such as 27 in the practice of the present invention in order to afford a higher velocity of jetting action. A specific feature of the present device is that the nozzle spacer 27, during the cement disintegrating operation, is constantly abutting the upper face of the cement plug thereby automatically keeping the jetting action in a fixed relationship to the top of the plug.

The practice of the present invention serves to remove or cut a cement plug by the action of the acid impinging on the plug at high velocity. This allows the cement plug to be removed at a satisfactory rate. For example, cement plugs may be removed from well casing at a rate in the range from about 15 to about 5 feet per hour for casing having diameters in the range from about 5½ inches outside diameter to about 9½ inches outside diameter.

It will be seen that the practice of the present invention is quite advantageous since workover rigs are not required and it is unnecessary to pull tubing and return the tubing with the bit for drilling out cement.

The nature and objects of the present invention having been completely described and illustrated, what I wish to claim as new and useful and to secure by Letters Patent is:

1. A method for removing a cement plug and the like from a well casing having a tubing permanently arranged therein with the lower open end of the tubing at a level substantially above the level from which cement is to be removed which comprises forcing a stream of acid solution down the tubing to cause a jetting action directly against the upper face of said cement plug to disintegrate at least a portion of said plug, maintaining the maximum force of said jetting action of acid solution in direct contact with the upper face of said cement plug as it is disintegrated, and circulating said acid solution including the disintegrated cement up the annulus between the casing and tubing, filtering said solution and again forcing said

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solution down the tubing directly against the upper face of the plug until at least a portion of said plug has been disintegrated and removed from the casing.

2. A method for removing a cement plug and the like from a well casing having a tubing permanently arranged therein with the lower open end of the tubing at a level substantially above the level from which cement is to be removed which comprises forcing a stream of acid solution down the tubing to cause a jetting action directly against the upper face of cement plug to disintegrate at least a portion of said plug, maintaining the jetting action of said stream of acid solution in a fixed spaced relation with the upper face of said cement plug as it is disintegrated, and circulating said acid solution up the annulus between the casing and tubing, returning the acid solution from the annulus to the tubing, and then again forcing the acid solution returned to the tubing down the tubing and directly against the upper face of the plug until at least a portion of said plug has been disintegrated and then circulating said solution and said disintegrated cement from the well.

3. Apparatus for removing and disintegrating a cement plug and the like from a well casing having a tubing arranged therein with the lower open end of the tubing at a level substantially above the level of the cement plug which comprises in combination an elongated tubular member adapted to be lowered through the tubing, means

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for releasably latching said tubular member in the tubing, packing means between said tubular member and said tubing, at least one substantially rigid telescopic member slidably arranged in said tubular member for lengthening the effective length of said tubular member when in a first position and shortening the effective length of said tubular member when in a second position, means for maintaining said telescopic member in said tubular member, at least one nozzle positioned adjacent the free end of said telescopic member for directing a stream of acid solution directly against said cement plug as said telescopic member moves from the second to the first position and a nozzle spacer member positioned on the free end of said telescopic member adjacent said nozzle for maintaining a constant spacing between said nozzle and said cement plug.

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