Oct. 10, 1944. W. A. CLARK 2,360,200

METHOD FOR GRAVEL PACKING

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FIG. 1

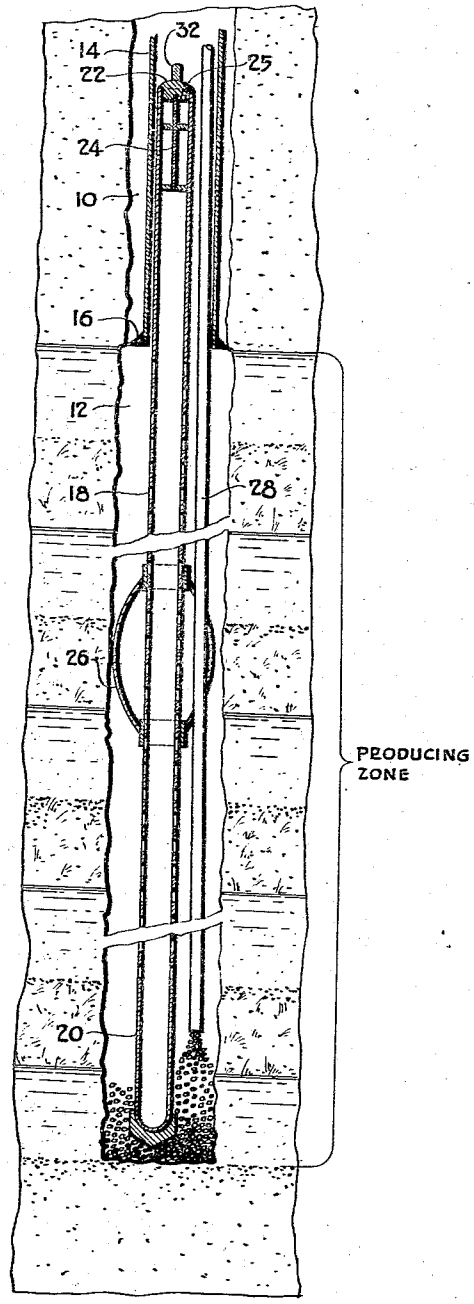
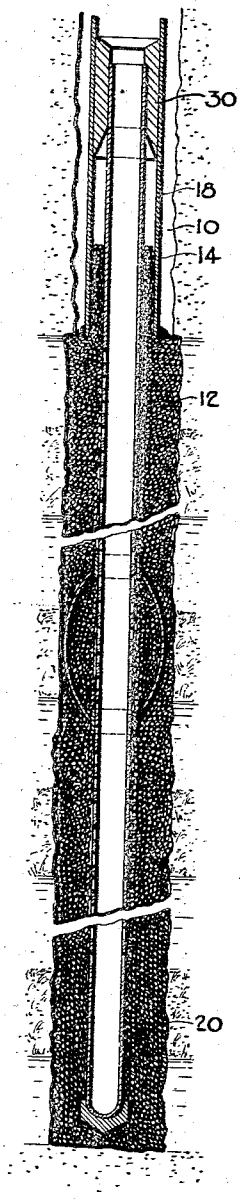


FIG. 2



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METHOD FOR GRAVEL PACKING

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2 Claims. (Cl. 166—26)

This invention relates to the completing of bore holes or wells, and more particularly to a method for introducing granular material such as gravel into a well cavity for forming a filter pack therein.

The principal object of the invention is to provide a simple and reliable method for effectively gravel packing a well in a minimum of time. In connection with the gravel packing of wells, and with particular reference to the packing of oil wells, several methods have proved more or less effective and still others have been tried without success. One of the most successful methods is known generally as the "reverse circulation method," and in accordance with this method gravel is mixed with a carrier fluid such as drilling mud or oil, and is then pumped down through the annular space between the casing and the string of tubing. A perforated liner or screen is usually attached to the lower end of the tubing string, the upper portion of the liner usually extending up into the lower end of the casing. Thus, when the mixture of gravel and carrier fluid reaches the bottom of the well, the fluid enters the liner or screen, and returns upwardly to the surface, while the gravel is screened off and remains in the space around the liner or screen forming a filter pack. In order to force the carrier fluid to pass down through the accumulated gravel, liners have been provided with internal linings, usually of cement, which close the liner perforations and force the carrier fluid to travel downwardly through the gravel outside of the liner to the bottom, where it may enter the liner through perforations in a bottom plug or through perforations at the extreme lower end of the liner. It is, of course, necessary, after the gravel has been placed, to drill out this cement lining.

Gravel has also been placed by means of the "direct circulation method," and in accordance with this method the gravel and carrier fluid passes downwardly through a tubing string and out through a suitable opening at the bottom of the spring or the liner, the carrier fluid then returning to the surface through the space between the tubing and the casing, while the gravel remains in the space around the liner.

With both the direct and reverse circulation methods, the circulating carrier or mud fluid sometimes adheres to the gravel particles, thus plugging up some of the interstices in the pack. It is also usually necessary to subject the producing zone to rather high pressures in order to obtain an efficient pack.

In accordance with the present invention, a method has been provided for graveling a well in a time less than that usually required by other methods, and through the use of which it is not necessary to apply high pressures to the formation, or to use a liner having a cement lining which must be subsequently drilled out. In using this method, the circulating fluid does not have to pass through the body of gravel, and there is thus less likelihood of plugging the interstices in the pack.

In carrying out the invention, a perforated liner having a closure in its upper end is placed in the well cavity, the upper end of the liner extending up into the lower portion of the casing. A string of tubing is then lowered into the hole, the lower end of the tubing passing between the upper end of the liner and the casing, and extending downwardly almost to the bottom of the hole. Gravel is then circulated downwardly through the tubing string, and the string is gradually raised as the gravel accumulates below its lower end. After the gravel has filled the cavity and extends up a short distance into the casing, the tubing string is removed. An adapter is then lowered and slipped over the top of the liner, closing the space between the liner and the casing. The cover, or closure member for the upper end of the liner is then removed and the well is in condition for production.

For a better understanding of the invention, reference may be had to the accompanying drawing in which

Figure 1 is a vertical sectional elevation through the lower portion of a well in which the gravel is being placed, and

Figure 2 is a similar view, but showing the gravel in the cavity, and the adapter in place sealing the upper end of the liner from the casing.

A hole 10 having an underreamed portion forming a cavity 12 is provided with a casing 14 suitably cemented in place as indicated at 16. A liner 18, the lower portion of which is perforated, and the lower end of which is provided with a suitable plug or nipple 20, is shown in the cavity 12, the upper end of the liner extending upwardly into the lower portion of the casing 14. The liner may be run to the bottom of the hole by any suitable means as by a releasing socket attached to the lower end of the string of drill pipe. Before being run into the hole, a bonnet or cover 22 is placed in the upper end of the liner, thus effectively closing that end. This closure member may comprise a bonnet portion

fitting within and resting upon the liner and guide means **24** extending downwardly a short distance into the liner so as to hold the bonnet in place until after the graveling operation. The bonnet may be provided with a hole **25** so as to relieve pressure which might build up in the upper imperforate portion of the liner. The liner is also preferably provided with a spring guide means **26** secured to its periphery so as to center it during the lowering operation.

After the liner **18** has been placed in the hole, a string of tubing **28** is run into the well, the lower end of the string passing between the upper end of the liner and the casing and extending downwardly to a point near the bottom of the hole. The cover member **22** prevents the tubing from entering the liner. Gravel is then pumped into the hole through the tubing **28**, and as the gravel fills the annular space **12** between the liner and the walls of the cavity, the tubing string is gradually withdrawn so as to keep the lower end of the string slightly above the level of the deposited gravel. After the gravel has reached a point below the upper end of the liner **18**, but above the lower end of the casing **14** the pumping is stopped and the tubing string **28** pulled from the hole. A packing device, such as a slip-on adapter **30** is then run into the hole and slipped over the top of the liner **18**. This serves as a centering device for the upper end of the liner and also to close the annular space between the liner and the casing. After the adapter has been set, means such as a small overshot may be run on a wireline and attached to a suitable projection **32** on the bonnet of the closure member **22**, after which the closure member is pulled out, leaving the well in condition for production.

Obviously, many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. The method of completing a well having a cavity in a producing formation below a string of casing and a perforated liner in said cavity, said liner being covered at its upper end, which comprises forcing granular material through a string of tubing extending downwardly through said casing and between said liner and said casing into said cavity while gradually raising the tubing until the gravel fills the cavity, removing the tubing string, sealing the space between the upper end of the liner and the casing and uncovering the upper end of the liner.

2. The method of placing granular material in the space at the bottom of a bore hole below the casing so as to form a filter pack around a perforated liner, which comprises closing the upper end of said liner, lowering a string of tubing into the hole until its lower end is near the bottom of the hole opposite the lower end of said liner, forcing the granular material down through said tubing so as to fill the space around the liner while raising said tubing string so as to maintain its bottom end above the upper level of the granular material being deposited until the upper level of said material has reached a point above the perforations in the liner, removing said tubing string, closing the space between the upper end of said liner and said casing and uncovering said liner.

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