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METHOD OF GRAVELING WELLS

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Fig. 1.

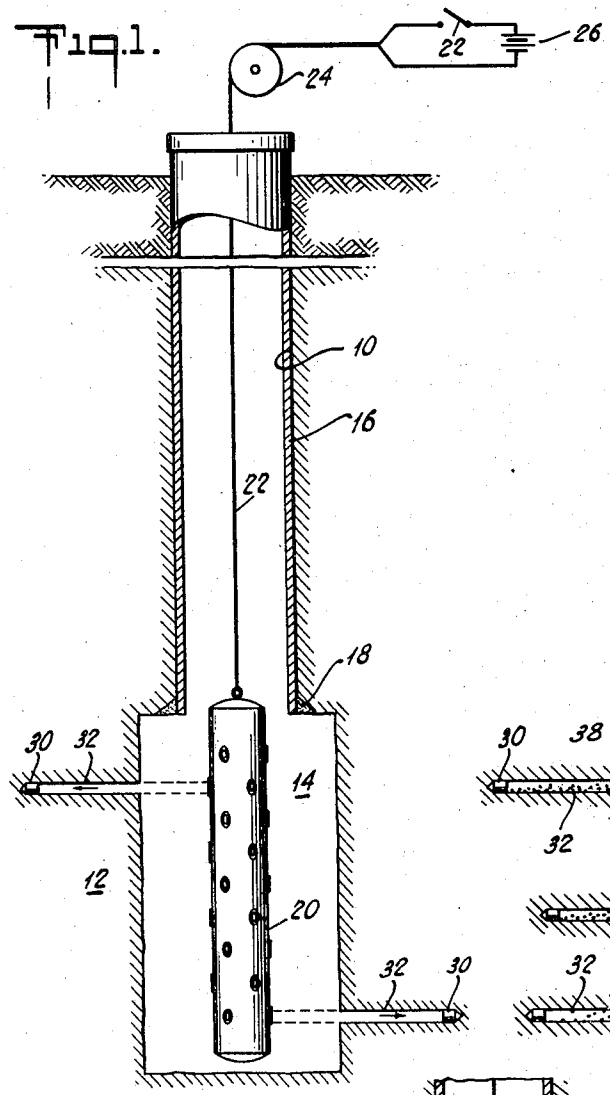


Fig. 2.

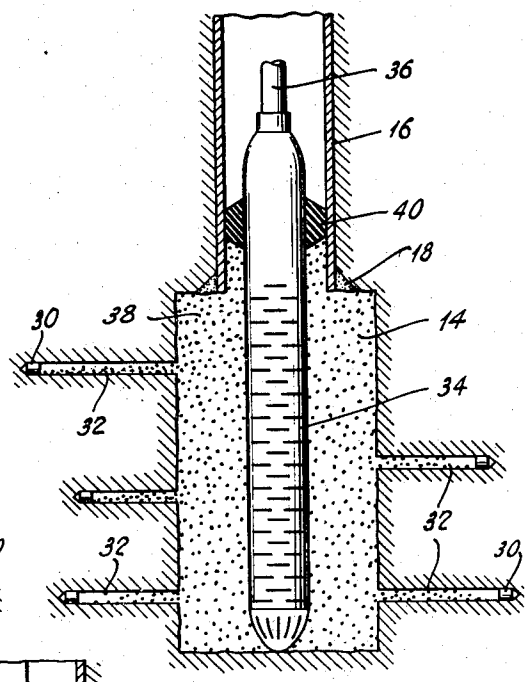
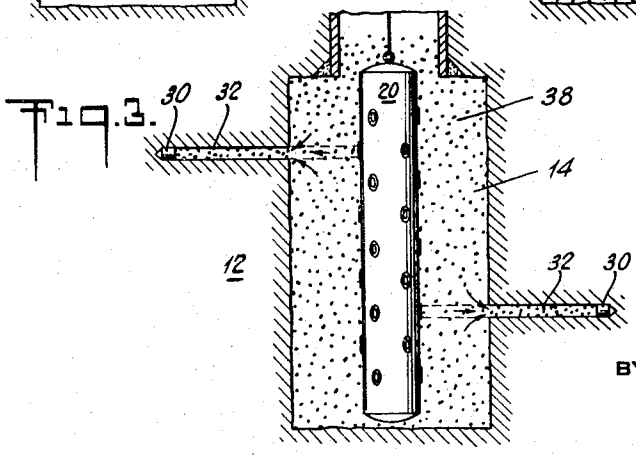


Fig. 3.



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METHOD OF GRAVELING WELLS

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5 Claims. (Cl. 166—26)

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This invention relates to the graveling or gravel packing of wells and more particularly to a method of providing gravel-filled, finger-like passages extending from a well cavity substantially laterally into a producing formation. The principal object of the invention is to provide a method of completing a well whereby the rate of flow of well fluid into the well will be materially increased.

The advantages of gravel packing bore holes are well recognized. A gravel pack properly placed serves to retain the walls of the producing formation and also serves as a filter mass preventing sand from being carried by the oil into the well strainer or perforated liner, with attendant damage due to its abrasive action. During the past several years many oil wells have been gravel packed, the gravel being placed usually around a screen or perforated section of a liner in the annular space between the screen or liner and the walls of the producing formation. In accordance with the present invention small lateral or radial passages are formed in the producing formation so as to lead into the well bore or cavity, and these passages are also gravel packed.

The practice of "gun perforating" well casing is in fairly common use and, while most of the perforating devices shoot bullets of not more than one-half inch in diameter, there are now available gun perforating tools which will shoot much larger bullets—in fact, as large as one and a half inches in diameter.

In accordance with the present invention, a device of the gun perforator type is used to shoot bullets, preferably of a fairly large size, from the well cavity into the producing formation, and the holes or passages thus formed in back of the bullets are filled with gravel or other granular material such as coarse sand, thus providing a plurality of finger-like passages filled with granular material and extending substantially laterally from the well bore into the producing formation. Obviously there is much less resistance to the flow of the well fluid through the gravel filled passages than there would be through the solid formation, and the rate of flow of the well fluid into the well is thereby substantially increased. It has been found that the bullets from a gun perforator often penetrate several feet into the earth formation depending, of course, upon the nature of the stratum, and the benefits derived from the provision of a plurality of gravel filled passages leading into the well bore are obvious. These approach those which would result from using a well cavity several feet in diameter.

In carrying out one form of the invention a

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device of the gun perforator type is placed in the well bore or cavity and discharged to provide the finger-like passages in the formation. Gravel is then placed in the well cavity by any suitable method while pressure is exerted to force some of the gravel into the lateral passages.

In another form of the invention the gun perforator is placed in the well cavity and the space around the perforator then filled with the gravel. The bullets are then discharged through the surrounding gravel into the formation and the suction in back of the bullets causes an appreciable amount of the gravel to be drawn into the passages. The perforating device can then be replaced by a suitable well screen or perforated liner, the top of which may be packed off from the lower end of the well casing. Prior to the setting of the packer, additional gravel may be placed in the well cavity so as to fill the space around the screen completely. In some instances, as in the case of low pressure wells, it may not be necessary to use a screen. Thus, after the perforating device is withdrawn, the cavity may be filled with gravel, the flow of well fluid being through the gravel pack and upwardly into the casing.

In the following description, where gravel is mentioned it is to be understood that any suitable type of granular material, such as oil-wettable, coarse sand, may be used.

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

Figure 1 is a sectional elevation through a well in which a gun perforator is pushed in the well cavity;

Figure 2 is a sectional elevation of the well cavity with a screen in position and showing the gravel which has been forced into the lateral passages; and

Figure 3 is another elevation of the well cavity showing the bullets discharged by a gun perforator through a surrounding mass of gravel so as to draw some of the gravel into the passages in back of the bullets.

Referring to the drawing, a well bore hole 10 is shown as penetrating a producing formation 12 in which an enlarged cavity 14 has been formed as by underreaming. A casing 16 extending downwardly to the upper boundary of the producing formation is cemented at 18. A gun perforating device 20 is suspended in the well cavity by means of a cable 22 passing over a suitable measuring drum 24. The cable 22 contains wires forming part of an electrical circuit which in-

cludes a source of electrical supply 26 and a switch 28, which when closed causes the device 20 to discharge bullets 30 into the formation 12. With the discharge of the bullets, passages or holes 32 are formed in the stratum 12 in back of the bullets.

After the bullets have been fired into the formation 12, gun perforator 20 may be withdrawn and a suitable well screen or perforated liner 34 is lowered into position on a tubing string 36 extending to the surface, as shown in Figure 2. Gravel represented at 38 is then placed in the cavity 14 by any suitable method, such as by reverse circulation in a carrier fluid, and pressure exerted in the hole causes gravel to enter and to fill substantially the passages 32. After the graveling operation, a suitable packer 40 may be placed so as to seal the space between the upper end of the screen and the lower end of the casing 16, and the well can then be placed on production.

In another form of the invention, as shown in Figure 3, the gun perforator 20 is placed in the cavity 14 and gravel 38 is then placed in the cavity so as to surround the perforator. The perforator 20 is then actuated to discharge bullets 30 into the formation 12, these bullets being discharged through the gravel mass 30. The suction formed in back of the bullets when they are discharged causes a portion of the gravel 38 to be drawn into the holes or passages 32. The perforator 20 is then withdrawn from the well and a suitable screen, such as that shown at 34 in Figure 2, may be lowered into position. If necessary, the lower end of the screen can be provided with a tapered or pointed end which will facilitate the forcing of the screen into the gravel in the cavity. If necessary, additional gravel can be added so as to completely fill the cavity and preferably to extend upwardly a short distance into the lower end of the casing, as is shown in Figure 2.

As stated hereinbefore, it may be found desirable to fill the space previously occupied by the perforator with gravel and to dispense with the screen or perforated liner entirely.

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

We claim:

1. The method of graveling a well penetrating a producing formation, which comprises placing granular material in that portion of the well bore within the producing formation, shooting bullets from within the well bore through said granular material into the formation, the suction back of the bullets causing some of the granular material to be pulled into the tubular spaces back of the bullets.

2. The method of graveling a well having a well cavity in a producing formation, which comprises placing granular material in said cavity, shooting bullets from substantially the center of said cavity through said granular material into the formation, the suction back of the bullets causing granular material to be pulled into the tubular spaces back of the bullets.

3. The method of graveling a well having a well cavity in a producing formation, which comprises filling said well cavity with granular material, shooting bullets from substantially the center of the cavity into the formation, the suction back of the bullets causing some of the granular material to be pulled into the tubular spaces back of the bullets to form drainage passages filled with granular material extending from the well cavity into the surrounding formation.

4. The method of graveling a well having a well cavity in a producing formation, which comprises lowering into said cavity a device of the gun perforator type, filling the space around said device with granular material, shooting bullets from said device through the granular material into the walls of the producing formation whereby some of the granular material is drawn into the tubular passages formed in the formation back of said bullets, removing said device from the well cavity and placing sufficient additional granular material in said cavity to fill the cavity.

5. The method of graveling a well having a well cavity in a producing formation which comprises lowering into said cavity a device of the gun-perforator type, filling the space around said device with granular material, shooting bullets from said device through the surrounding granular material into the walls of the producing formation whereby some of the granular material is drawn into the tubular passages formed in the formation back of said bullets, replacing said device with a well screen, and placing sufficient additional granular material in said cavity to fill the space around said screen.

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