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METHOD OF AND APPARATUS FOR GRAVELING WELLS

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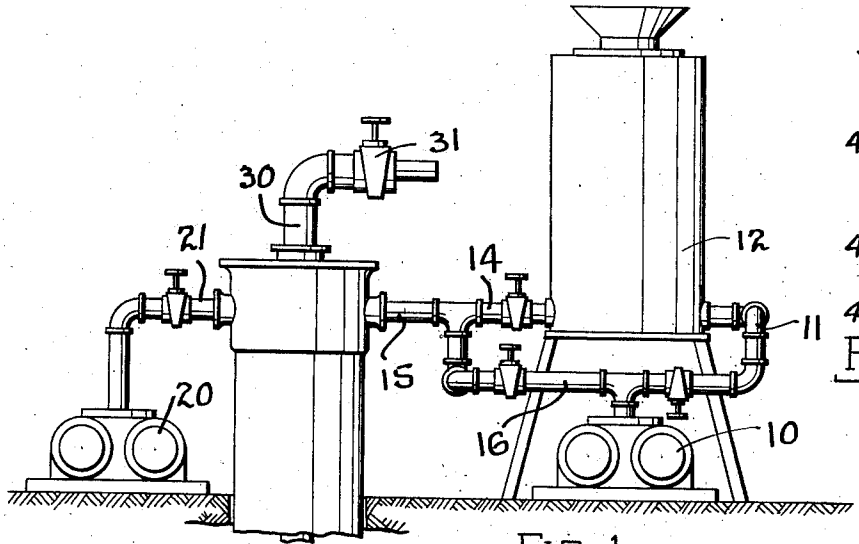


Fig. 1.

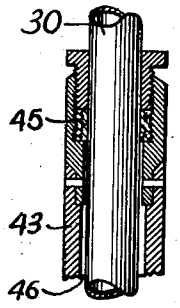
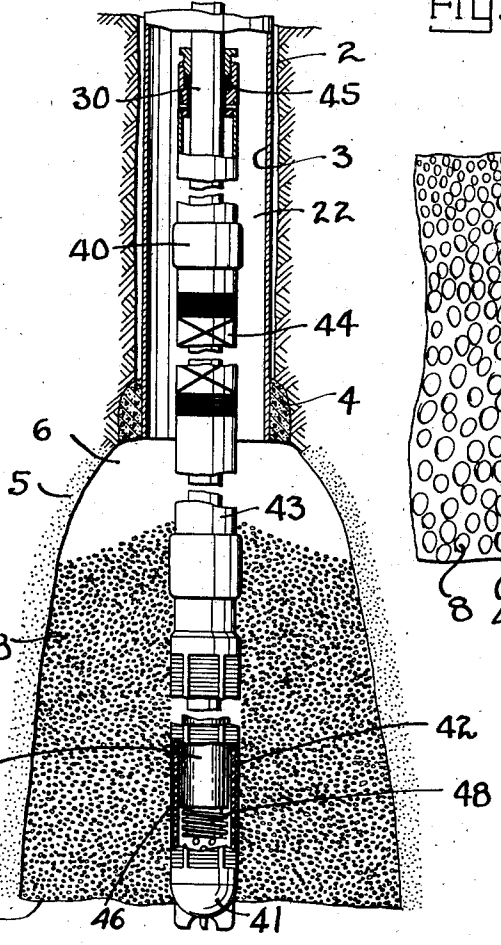


Fig. 3



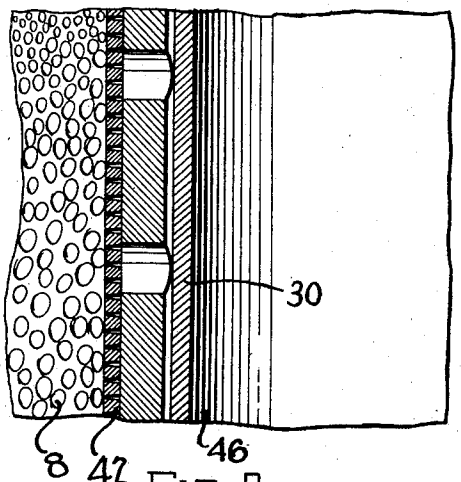


Fig. 2.

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METHOD OF AND APPARATUS FOR GRAVELING WELLS

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3 Claims. (Cl. 166—1)

The invention relates to a means and method of graveling wells where it is desired to deposit the gravel by the circulation of a carrier liquid into and out of the well bore and to compact the gravel as it is depositing so that there will be no bridging or clogging of the gravel.

An object of the invention is to provide an apparatus to be lowered into the well bore so that as the gravel is deposited the carrier liquid will be compelled to pass through the deposit and to in this manner compact the gravel.

Another object of the invention is to provide in connection with a well bottom assembly a return line or wash pipe for the carrier liquid during the graveling operation, which wash pipe is of such a size that it will create a friction loss upon the flow of liquid inside of the strainer and around the wash pipe which will be greater than the friction loss per unit of length due to the passage of the carrier liquid through the deposited gravel.

Another object of the invention is to provide a flush joint wash pipe in combination with a stuffing box carried by the well bottom assembly so that any inflow into the well bottom assembly will be compelled to pass through the wash pipe.

It is also an object of the invention to direct a flow of carrier liquid through a deposit of gravel about a strainer in the well bore by creating a greater friction loss inside of the strainer than occurs in the deposited gravel.

Another object of the invention is to provide a wash pipe of such a size as compared to the inside diameter of the strainer assembly that there will be a small annular space between them so that a resistance to flowing of the carrier liquid through this small space will be greater than the resistance to the flow of the carrier liquid through the gravel which has been deposited about the strainer.

Other and further objects of the invention will be readily apparent to those skilled in the art when the following description is considered in connection with the accompanying drawing wherein:

Fig. 1 is a side elevation of a well to which the equipment has been applied and where the method is being practiced.

Fig. 2 is an enlarged broken detailed sectional view showing the relative position of the strainer, wash pipe, and the gravel.

Fig. 3 is an enlarged broken sectional view showing the stuffing box between the pipe **30** and the upper end of the liner **43**.

In Fig. 1 a well bore **2** has been drilled and a casing **3** cemented in place by the cementitious material **4**. A producing formation **5** has been penetrated and a cavity **6** has been formed therein. The well is now ready to have the deposit of gravel **8** positioned in the cavity **6** so as to form a filter bed for the fluid being produced from the formation **5**.

It is intended that the pump **10** will circulate a flow of liquid through the pipe **11** and into the gravel drum **12**. A stream of gravel suspended in the carrier liquid will be discharged from the pipe **14** and is directed into the well through the flow line **15**.

A bypass **16** may be used to pump liquid directly into the well from the pump **10** and to thus bypass the gravel drum **12**, or the stream from the outlet **14** may be diluted with additional water or other carrier liquid from the pipe **16** before it enters the pipe **15**. If desired a second pump **20** may discharge through the flow line **21** to add its volume to the body of liquid being directed downwardly through the passage **22** in the casing.

When granular or gravel material is deposited in a well bore to form a filter bed by means of a stream of carrier liquid it is, of course, necessary to return this liquid to the surface. A return pipe **30** has been provided which emerges from the head of the well and is controlled by a valve **31**.

A well bottom assembly **40** has been deposited in the well by means of the return line **30** which serves as an operating string. This well bottom includes the shoe **41**, the strainer **42**, the liner **43**, the packer **44**, and the stuffing box **45** arranged in the order named leading from the bottom of the assembly.

This assembly is lowered into the well bore or cavity **6**. If it is desired to wash the well either the pump **10** or the pump **20** may be started and a circulation of the liquid maintained until the drilling mud in the well has been washed out or until the column of liquid in the well attains the desired specific gravity. This circulation may either be inwardly through the pipe **30** and discharging from the well at the flow lines **15** or **21** if they are disconnected from the pumps, or it may be from the pumps downwardly through the casing and upwardly through the return line **30**.

In any event when it is desired that the body of gravel be deposited the pump **20** is started and gravel and carrier liquid circulated downwardly through the passage **22** and discharged into the cavity **6**, it being understood that this cavity

is filled with liquid which may be drilling mud, water or oil, or any other suitable carrier liquid. The first gravel is, of course, deposited near the base 47 of the cavity 6 and as the gravel is deposited the carrier liquid must return to the surface. Inasmuch as the flow is downwardly through the casing 22 the carrier liquid having divested itself of its load of gravel will enter the strainer 42. In the meantime the return line 30 has been rotated somewhat so as to unscrew the threads 48 on the lower end thereof from their connection in the bottom of the assembly. The pipe is raised slightly, as seen in Fig. 1, and this carrier liquid may return to the surface by entering the lower end of this pipe 30.

As the gravel deposit increases there will be a tendency of the carrier liquid to deposit its gravel and immediately enter the strainer or screen 42, at an elevation above the lower end of the return line 30. In this manner the gravel might remain in a clogged condition or it might bridge over and leave a cavity in the entire gravel pack. It is therefore desirable to avoid these conditions by compelling the carrier liquid to continue to flow downwardly through the deposit of gravel and in this manner compact the gravel and form the best filter possible.

There are various ways of preventing the carrier liquid from entering the strainer, such as lining the strainer with an impervious material such as cement. Such material must thereafter be removed, however, and the present invention therefore contemplates positioning the return line 30 inside of the strainer 42 and having such return line of a size that will fit relatively closely on the inside of the strainer and thus provide a very small area 46 through which the carrier liquid might flow in reaching the lower end of the return line. Thus if the resistance encountered by the carrier liquid inside of the screen and outside of the return line is greater than the resistance created by the flow of the carrier liquid through the gravel deposit, then, of course, the carrier liquid will follow the path of least resistance and will pass directly through the gravel deposit. Thus by the expedient of merely proportioning the return line and the strainer so as to cause the desired resistance a beneficial effect has been obtained.

After a suitable amount of gravel has been deposited in this manner the well may be washed or agitated by the introduction of air or gases under pressure and, if desired, additional gravel may be added after such agitation. In either event the packer 44 is then set so as to close the passage 22 around the well bottom assembly and inside of the casing so that the gravel is trapped in a closed chamber and the well is then ready for production.

Broadly, the invention contemplates an arrangement of equipment whereby a flow of carrier liquid will be caused to pass through the deposit of gravel to compact the gravel.

What is claimed is:

1. In a well having a cavity in the producing formation and a well strainer positioned therein the method of depositing a pack of granular material in the cavity so as to provide a uniform compactness of such material while it is being deposited by a stream of carrier liquid which comprises positioning a return pipe within the strainer where the end of such pipe is closely adjacent the lower end of the strainer so that the carrier liquid must move to the base of the well to escape, and providing such pipe of a size so as to create a frictional resistance to flowing of the carrier liquid in the areas between the inside of the strainer and the outside of the return pipe which resistance is greater per unit area of length than the resistance to flowing of the carrier liquid thru the granular material deposited in the cavity about the strainer so that the flow of carrier liquid is compelled to pass through and compact and wash the granular material.

2. A well bottom comprising a well bore, a well bottom assembly therein, a strainer in said assembly, a strainer pipe leading from said strainer to the surface, a body of gravel being deposited by a carrier liquid around said assembly and strainer in said bore and means for preventing said carrier liquid from passing through said strainer so as to by-pass the body of gravel, said means comprising an extension of said pipe within said strainer and of a size but slightly smaller in diameter than the inside of said strainer so that the resistance to flowing of the carrier liquid through the space between the strainer and the pipe extension will be greater than the resistance through the body of gravel.

3. A well bottom comprising a well bore, a well bottom assembly therein, a strainer in said assembly, a body of gravel being deposited about said assembly in said bore, a wash pipe in said assembly inside of said strainer, said pipe being of a size relative to the inside diameter of said strainer so that the resistance to flowing of the carrier liquid for said gravel through the space between the pipe and the strainer will be greater than the resistance to flowing through the body of gravel.

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