Aug. 29, 1944. L. A. LAYNE 2,356,769

WASHING GRAVEL OUT OF PERFORATE WELL CASINGS

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FIG. 1.

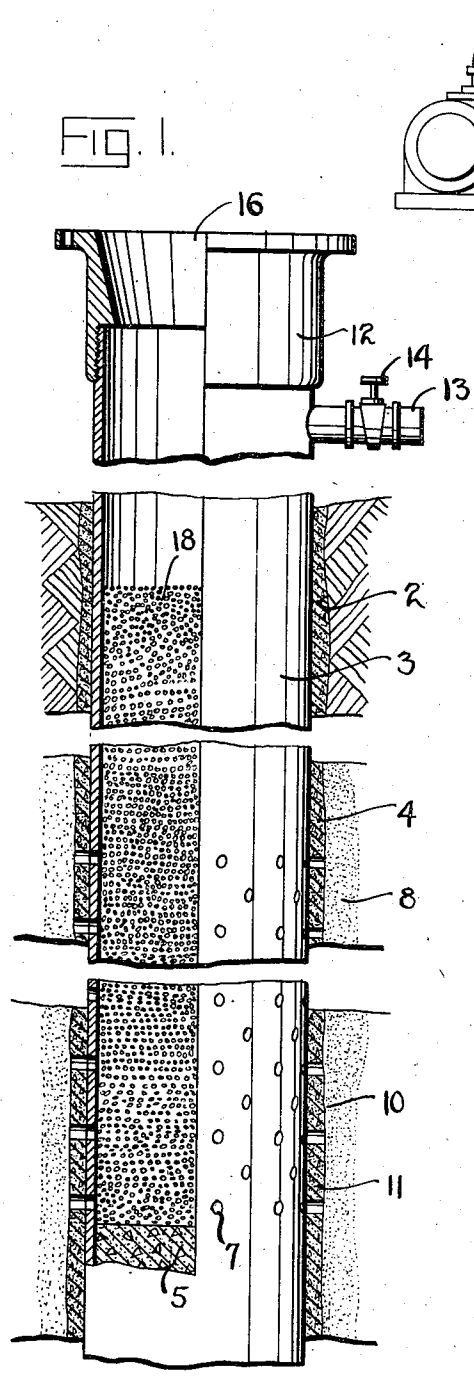
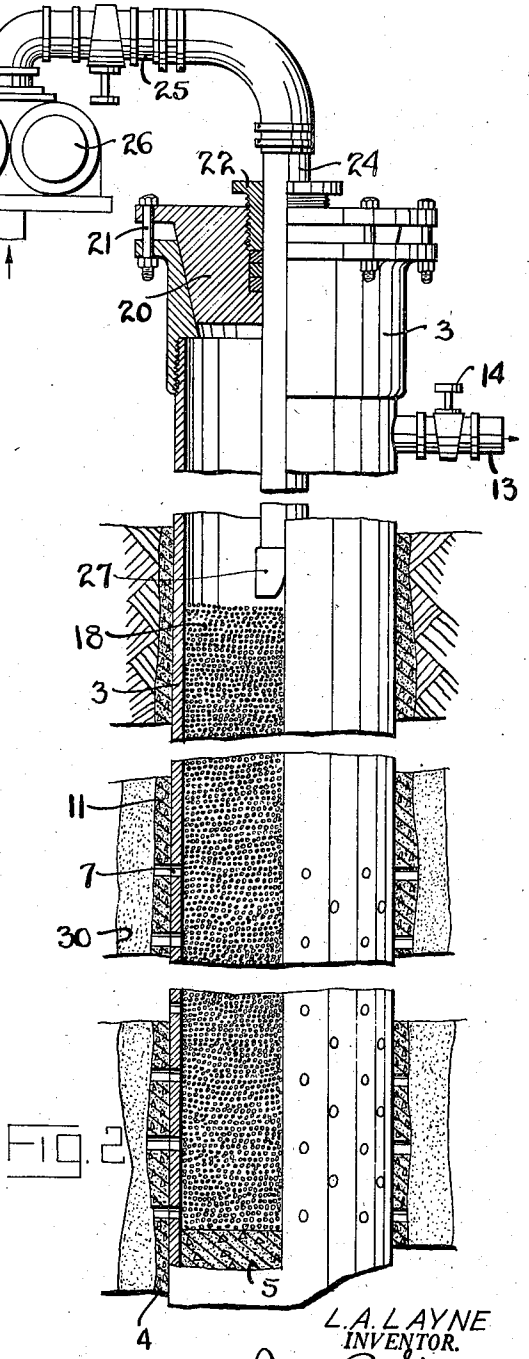


FIG. 2.



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Filed Dec. 4, 1939 3 Sheets-Sheet 2

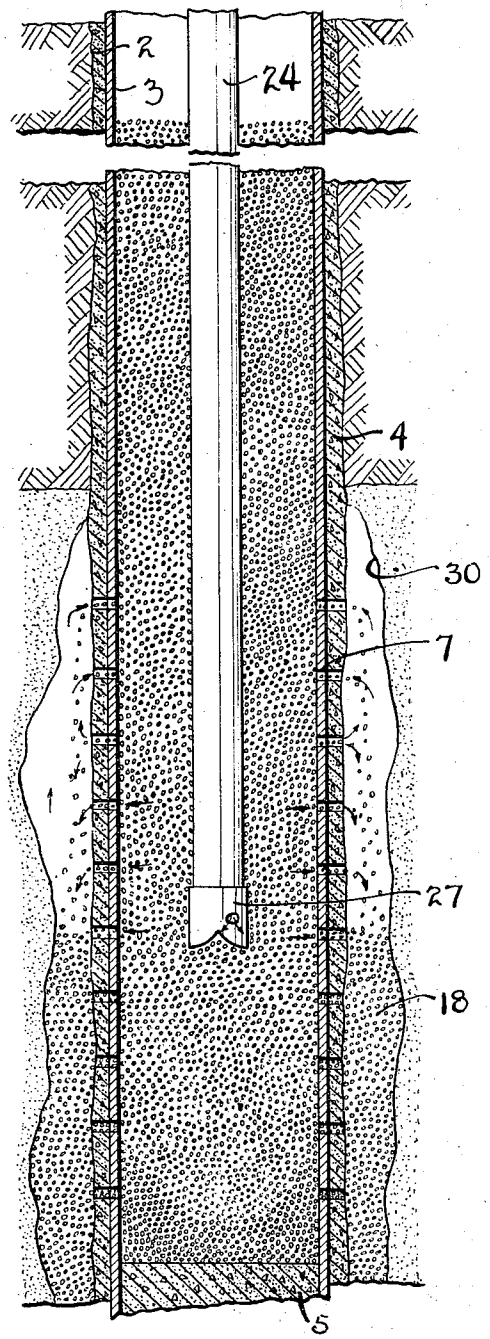


FIG. 3.

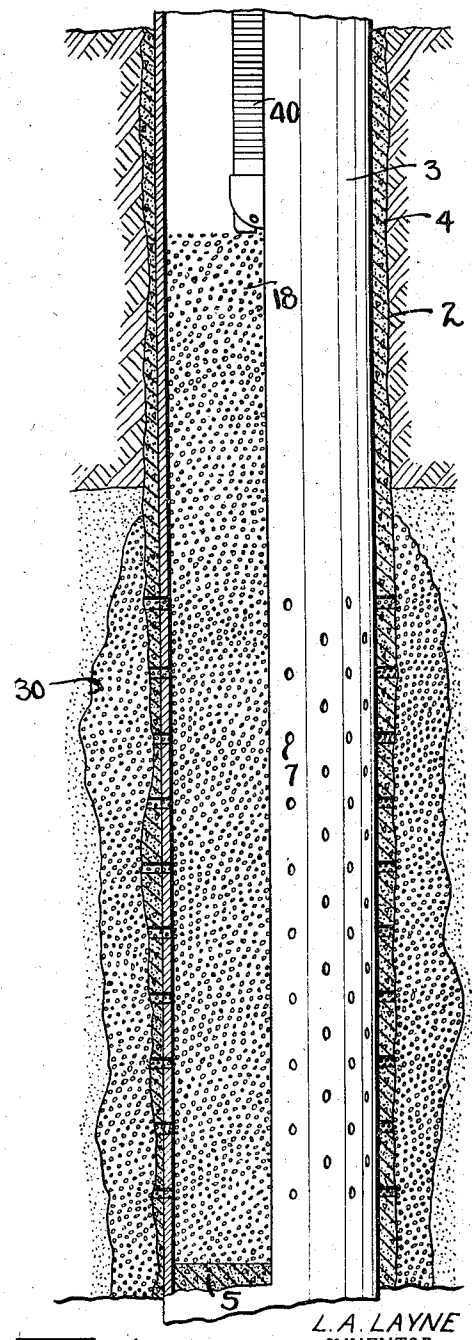


FIG. 4.

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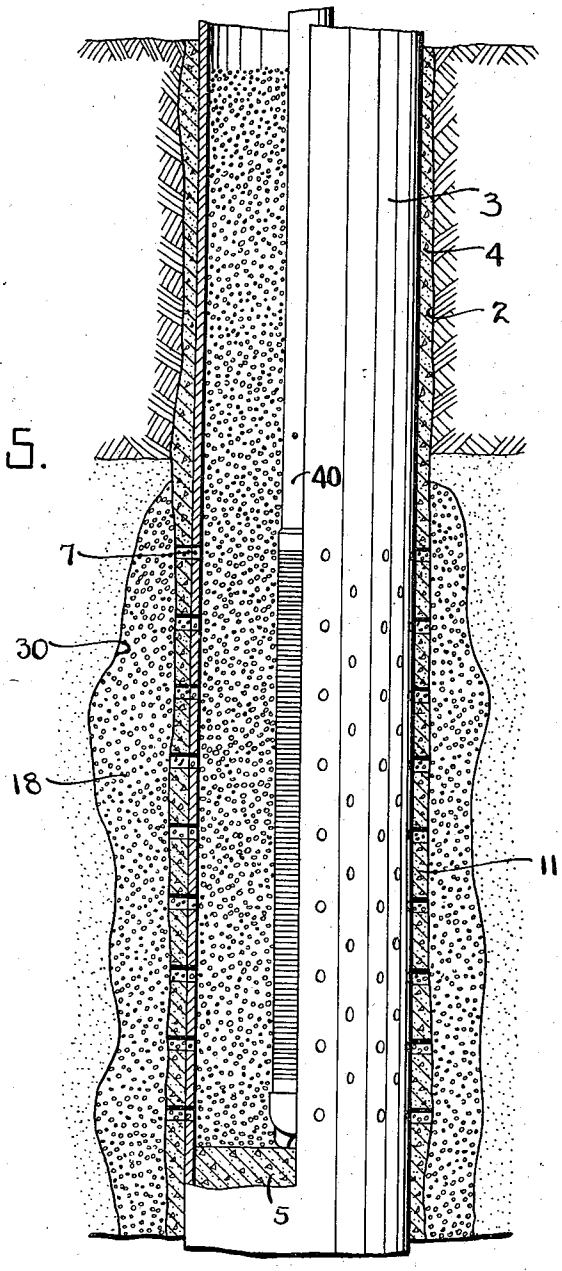
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FIG. 5.



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2,356,769

WASHING GRAVEL OUT OF PERFORATE WELL CASINGS

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Application December 4, 1939, Serial No. 307,467

12 Claims. (Cl. 166—26)

The invention relates to a means and method of washing gravel out of perforated well casings so as to increase the filter pack area to eliminate the entrance of sand and to reduce the rate of flow at the edge of the filter pack.

The present invention finds its greatest advantage in that type of formation where very fine sands are encountered because under such circumstances it is often found that where a strainer or screen of a fine enough gauge to exclude the sand is used that it is impossible to obtain a suitable production through such a fine screen. On the other hand, if a coarse enough screen is used to obtain production, the fine sand will enter the screen and the well becomes sanded up in a very short period of time.

The invention also finds its application in existing wells where the casing is anchored in position by having been cemented in place and perforated, and where the well may have been producing for some time. Under these circumstances the sand is usually packed tightly about the outside of the cement and around the casing so that the well has stopped producing. It is impossible to underream a formation of this sort because of the presence of the casing and it is therefore one of the objects of the present invention to wash out the casing and the sand outside of the casing so as to form a cavity which can be filled with granular material which is deposited in the casing and washed outwardly through the perforations in the casing.

It is one of the objects of the invention to form a granular filter pack on both the inside and outside of a perforated casing which is anchored in a well bore.

Another object of the invention is to deposit granular material in a perforated casing in a well bore and to wash a quantity of such granular material outwardly through the perforations in the casing to replace the sand about the casing.

Another object of the invention is to agitate or churn a body of granular material in a perforated casing in a well bore so as to wash it outwardly through the perforations and to thereafter wash a strainer or screen into the granular material remaining in the casing.

Still another object of the invention is to provide a method of procedure and the apparatus for forming a double filter pack outside of a perforated casing and inside of the casing around a strainer therein.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings, wherein:

Fig. 1 is a vertical elevation partly in section, of the perforated casing anchored in the well bore with the body of gravel therein.

Fig. 2 is a side elevation with the equipment arranged ready to begin the washing out of the gravel.

Fig. 3 is a vertical section illustrating an intermediate step in the method, wherein the cavity outside of the casing has been enlarged and almost filled with granular material.

Fig. 4 is a side elevation partly in section, wherein the washing out string has been removed and the strainer is about to be washed into position.

Fig. 5 is a side elevation partly in section showing the filter pack as having been completed both inside and outside of the casing and with the strainer in position.

In Fig. 1 the well bore is indicated generally at 2 and has been provided with a casing 3 which is anchored in the formation by the cement 4. This cement is usually pumped downwardly through the casing leaving a portion 5 thereof in the bottom of the casing to exclude foreign material.

The perforations 7 may have been formed in the casing in any desired manner so as to admit the fluid being produced from the formation 8. For purposes of this invention the well may be a newly drilled and cased well or it may be a well which has been producing for some time. In either event, the fine sand 10 will be closely adjacent the layer 11 of cement around the outside of the casing and if it is an old well which is being re-worked the sand 10 will be closely packed in position because in all probability the well is being reworked because of the fact that the packing of this sand has cut down the production of the oil, gas, or water as the case may be.

The upper end of the casing 3 carries a casing head 12 and a flow line 13 which may be controlled by a valve 14. The casing head 12 has a tapered bowl 16 in the inner upper end.

A body of granular material 18 is shown as having been deposited inside of the casing 3 in a sufficient quantity as may have been estimated to be desirable in forming a suitable filter pack. This body of granular material may have been deposited by shovelling it into the top of the casing or it may have been deposited hydraulically, or otherwise, and it will be noted that the granular material is deposited to an elevation above the uppermost perforations 7.

With the granular material in place the equipment shown in Fig. 2 will be installed, which includes a closure head 20 which may be held in place by the bolts 21 and carries a stuffing box 22 to form a seal about the washing out pipe or tubing 24. This tubing is connected by a pipe 25 to a pump 26 so that a flow of liquid through the washing out pipe 24 is forced downwardly into the well bore. In some instances the agi-

tating liquid may be pumped downwardly through the casing by omitting the pipe 24 which is within the casing.

The lower end of the pipe 24 may carry a bit 27 which will contact the gravel 18 to assist the discharge of liquid in agitating, churning and maintaining a circulation. It is intended that this circulation of liquid will agitate the granular material 18 and cause it to be suspended in the flow of liquid so that the liquid will tend to pass outwardly through the perforations 7.

This liquid discharging from the perforations 7 will tend to form a cavity 30 about the casing 3 by washing away some of the fine sand 10 which was packed about the casing as seen in Fig. 1. This sand will be picked up by the circulating liquid and as the washing out pipe 24 is gradually advanced by lowering it in the casing some of the liquid will return through those perforations which have been passed by the bit 27 and this returning liquid will carry some of the fine sand with it upwardly in the well casing to discharge from the flow line 13. Of course, some of the liquid will pass into the porous formation 8 in some instances. If desired the cavity 30 may have been partially or wholly formed by a washing operation prior to the introduction of the granular material 18 or due to the fact that the well might have produced considerable sand prior to the reworking operation which would have left a cavity about the casing.

In any event, it is the intention to wash the granular material 18 outwardly through the perforations to form a filter pack about the outside of the casing. This is desirable because of the fact that a larger diameter filter pack may be in this manner provided. The larger diameter filter pack is of advantage because the velocity of flow of the fluid being produced is materially less in a geometric proportion to a diameter of the bore filled with the granular material.

In this manner the entrance of sand is eliminated by the large filter pack. In this manner a double filter pack is formed, part of which is on the outside of the casing and part of which remains inside of the casing.

Fig. 3 shows the washing out pipe advanced almost to the bottom of the casing and the cavity 30 as having been practically filled with granular material so that the washing out operation is practically complete.

When it is determined that the desired amount of granular material has been washed out of the casing the washing out pipe may be gradually withdrawn while maintaining circulation so as to leave the granular material settled inside of the casing. This fact may be determined either by the increase in the pressure required for the washing out operation because of the fact that the filter pack has increased in diameter or that a greater pressure is required to maintain the granular material inside of the casing in suspension than is required when it is being washed out of the perforations. Another indication is the fact that no sand is returned to the surface with the circulating liquid.

One of the particular advantages of the invention is the loosening and washing out of the sand around the casing and the replacing of this sand with granular material which will in the future filter out the fine sands. This is true because it has been found that where a fine sand is encountered and a strainer of a sufficiently fine gauge to exclude the sand is placed in the well that the packing of the fine sand restricts the production to such an extent that the well may become unprofitable, while on the other hand if a sufficiently coarse strainer is placed in the well to obtain a practical production then the entrance of sand occurs through the strainer to sand up the well and require a clean-out job.

If a filter pack is formed as has been described it seems obvious that it will exclude this fine sand and permit the introduction of a coarse enough strainer to obtain the desired production.

Fig. 4 shows the arrangement of the parts after the washing out pipe 24 has been removed and the strainer string 40 being lowered into position so as to be washed into the granular material within the casing. This strainer string may be washed into position in any desired manner but preferably by the circulation of liquid to suspend the granular material as the strainer advances.

Fig. 5 shows the strainer 40 after having been washed into position and the double filter pack in place both on the inside and outside of the casing.

Under some circumstances the formation may be such that a sufficient filter pack may be provided by merely washing out the granular material to form the filter pack outside of the casing and the granular material will then bridge over the perforations and the granular material remaining inside of the casing may be removed. The well will thus produce through the gravel pack outside of the casing and the fluid thus produced removed from the well in any desired manner.

Under other circumstances the producing formation may be such that the gravel pack will be desired on the outside and the inside as well so that the granular material may be left inside of the casing and the well produced through the double gravel pack with no strainer.

Under still a third set of circumstances it may be desirable to place a screen or strainer adjacent the top of the filter pack inside of the casing but above the perforations.

A fourth circumstance may require that the strainer be arranged within the gravel pack inside of the casing as has been described in detail above.

These various arrangements will be adopted and used depending upon the circumstances encountered, which may vary with the volume of production, the fineness and condition of packing of the sand, the type of fluid being produced and the character of strainer required.

Attention is directed to the fact that the circulating of the granular material out through the perforations continues the agitation of the material in the cavity 30 outside of the pipe and that this agitation loosens the sand to assist in its removal and replacement by the granular material. When the granular material settles or is deposited after the circulation is reduced or discontinued, it may be desirable in some instances to pack it in position and this may be accomplished by restricting the discharge through the flow valve 14 so as to apply pressure to the granular material and force it into any soft spots or cavities which might be present. This causes the granular material to also pack the particles thereof together more compactly.

In some types of wells the washing out pipe or strainer 24 may have the strainer incorporated therein so that the washing out and agitating of the gravel and the setting of the strainer may be accomplished in a single operation. If this pro-

cedure is followed it may be desirable to have a smaller diameter wash pipe incorporated inside of the strainer to conduct the agitating liquid to the bottom of the strainer to be discharged from the shoe thereof.

Broadly, the invention contemplates a method and apparatus for forming a filter pack by washing granular material out through a perforate casing anchored in a well bore.

What is claimed is:

1. A method of arranging a granular filter about a perforated casing which is anchored in a well bore which comprises the steps of depositing a body of granular material within the casing, running a washing out string into the casing, pumping liquid through said string while lowering the string into the body of granular material in the casing, agitating or churning the material with the liquid so that the material will be washed out through the perforations in the casing while some of the liquid may pass into the formation and some return to the casing through those perforations which have been passed by the liquid discharge, maintaining such circulation of liquid until the cavity has been washed out as indicated by the sand returning to the surface and the cavity filled with material, withdrawing the washing out pipe while circulating to leave material in the casing, and washing a string of strainer into the granular material in the casing so as to provide a filter pack about the strainer in the casing and between the formation and the outside of the casing.

2. A method of forming a filter pack of granular material inside and outside of an anchored perforated casing in a well bore which comprises washing the well by circulating liquid so as to loosen sand packed about the outside of the casing, depositing a body of granular material within the casing, agitating such material with a liquid circulation so as to wash a portion thereof out through the perforations in the casing into the cavity, and washing a strainer into the material remaining in the casing so as to provide a double filter about the strainer.

3. A method of forming a filter pack of granular material inside and outside of an anchored perforated casing in a well bore which comprises washing the well by circulating liquid so as to loosen sand packed about the outside of the casing, depositing a body of granular material within the casing, agitating such material with a liquid circulation so as to wash a portion thereof out through the perforations in the casing into the cavity to further enlarge the cavity by replacing some of the sand with granular material, and washing a strainer into the material remaining in the casing so as to provide a double filter about the strainer.

4. A method of forming a double filter pack of granular material in a well bore having a perforated casing therein which comprises depositing a body of such material inside the casing, washing some of the material outwardly through the perforations with an agitating liquid, and washing a strainer into the granular material inside the casing.

5. In the art of reworking existing oil, gas, or water wells where a sand has packed about a perforated string of pipe anchored in the well bore, the steps of depositing a body of granular material in the perforated pipe, agitating the material with a flow of liquid so that the flow will pass outwardly through the perforations and carry some of the granular material therewith to form a filter pack both on the inside and the outside of said pipe.

6. A method of excluding sands from wells where the sand is too fine to be excluded by a strainer through which production of oil may be had where the well is equipped with a perforate casing anchored therein which comprises depositing granular material in the casing and washing it outwardly through the perforate casing into the area about the outside of the casing, and arranging a strainer within the casing through which production may be had, while the casing contains granular material so that a filter pack to exclude the fine sand is formed both inside and outside of the casing.

7. A method of providing a filter pack about a perforate pipe anchored in a well bore which comprises circulating a granular material from the inside to the outside of the casing through the perforations, depositing such material about the pipe as a filter, and discontinuing circulation so as to leave a filter pack of granular material inside of the pipe.

8. A method of providing a filter pack about a perforate pipe anchored in a well bore which comprises circulating a granular material from the inside to the outside of the casing through the perforations, depositing such material about the pipe as a filter, discontinuing circulation so as to leave a filter pack of granular material inside of the pipe, and arranging a strainer pipe closely adjacent the top of the inside filter pack to receive the fluid being produced.

9. A method of providing a filter pack about a perforate pipe anchored in a well bore which comprises circulating a granular material from the inside to the outside of the casing through the perforations, depositing such material about the pipe as a filter, discontinuing circulation so as to leave a filter pack of granular material inside of the pipe, and arranging a strainer pipe closely adjacent the top of the inside filter pack above the perforations in the pipe to receive the fluid being produced.

10. A method of providing a filter pack about a perforate pipe anchored in a well bore which comprises circulating a granular material from the inside to the outside of the casing through the perforations, depositing such material about the pipe as a filter, discontinuing circulation so as to leave a filter pack of granular material inside of the pipe, and arranging a strainer pipe inside of the filter pack within the casing to receive the fluid being produced.

11. A method of forming a filter pack about a perforate pipe anchored in a well bore which comprises agitating a granular material within the pipe and conveying a portion of the material through the perforations to the outside of the pipe, and allowing such granular material to settle as a double filter pack on the inside and outside of the pipe.

12. A method of forming a filter pack about a perforate pipe anchored in a well bore which comprises agitating a granular material within the pipe and conveying a portion of the material through the perforations to the outside of the pipe so as to form a double filter pack on the inside and outside of the pipe, and packing the deposited material in position by restricting the return of the conveying liquid so as to apply an added pressure to the granular material.

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