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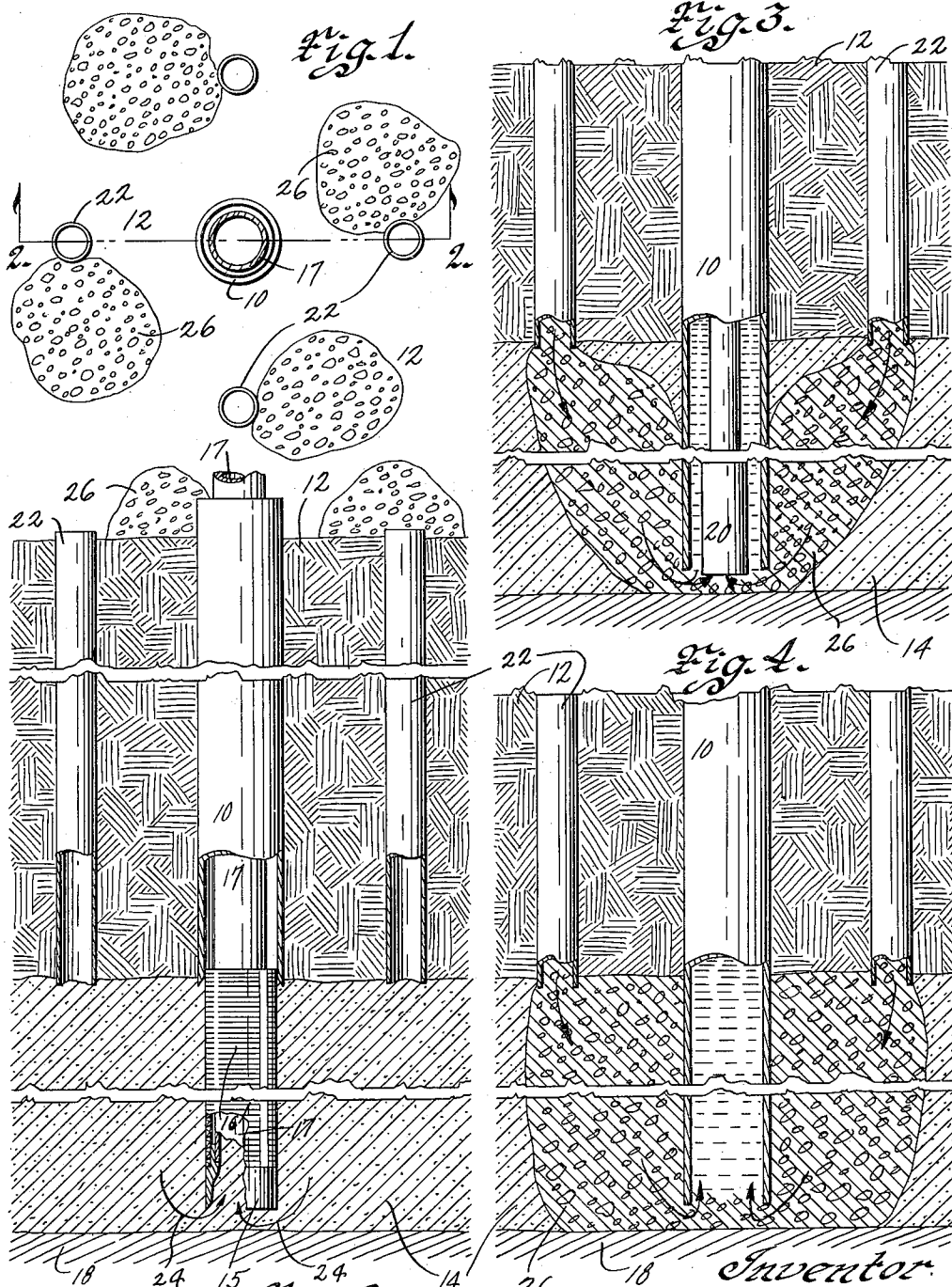
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METHOD OF FORMING GRAVEL PACKS FOR WELLS

Filed March 28, 1928

2 Sheets-Sheet 1



Witness
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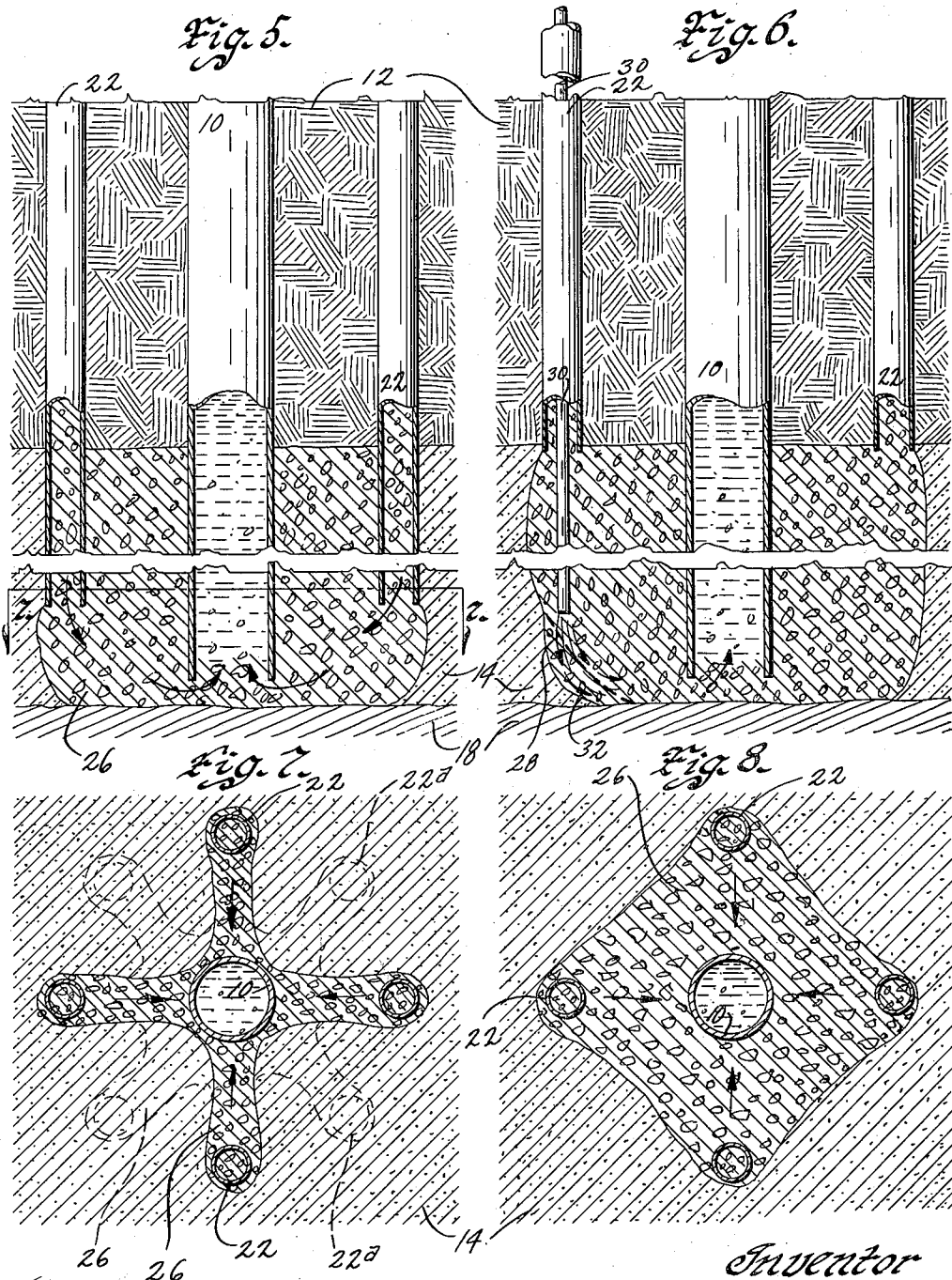
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METHOD OF FORMING GRAVEL PACKS FOR WELLS

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2 Sheets-Sheet 2



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METHOD OF FORMING GRAVEL PACKS FOR WELLS

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The object of my invention is to provide a method whereby gravel packs may be conveniently and easily formed for wells, the method itself being comparatively inexpensive to perform.

5 A further object is to form a gravel pack in a stratum of water bearing said whereby water may be pumped from a well in considerable quantities without running short of
10 water which would be the case where no gravel pack is formed due to the fact that the stratum of water bearing sand includes a fine sand through which it is very difficult for the water to pass quickly.

15 Still a further object is to provide a method wherein a main casing is inserted in the ground down to the stratum of water bearing sand and one or more auxiliary casings are inserted in the ground spaced from the main
20 casing. The auxiliary casings serving to receive gravel whereby pumping of the sand from the main casing will cause the gravel in the auxiliary casing or casings to settle downwardly and take the place of the sand that
25 has been pumped out of the stratum.

Still a further object is to perform the method for displacing the sand pumped out with gravel and to provide in the method means for manipulating the auxiliary casings
30 for insuring that a large gravel pack will be formed.

With these and other objects in view my invention consists in the herein described method of forming gravel packs for wells whereby
35 the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims and illustrated in the accompanying drawings, in which:

40 Figure 1 is a plan view illustrating a main casing and a plurality of auxiliary casings inserted in the ground.

Figure 2 is a cross sectional view on the line 2—2 of Figure 1 illustrating the casings and their relation to the various strata formed in
45 the ground.

Figure 3 is a similar sectional view illustrating the method in operation and showing a bucket pump for removing the water bearing sand from the main casing.

50 Figure 4 is a similar sectional view illus-

trating the method completed whereby a relatively large gravel pack has been formed around the main casing.

Figure 5 is a similar sectional view illustrating the auxiliary casings inserted downwardly into the stratum of the water bearing sand to further displace the water bearing sand with gravel. 55

Figure 6 is a similar sectional view illustrating the insertion of means in one of the auxiliary casings for introducing additional gravel or water for properly forming the gravel pack. 60

Figure 7 is a sectional view on the line 7—7 of Figure 5 illustrating the relation of the gravel pack to the main and auxiliary casings; and 65

Figure 8 is a similar sectional view showing the gravel pack more completely formed.

On the accompanying drawings I have used the reference numeral 10 to indicate a main casing. The main casing 10 is the one used for pumping water from the well after it is completed and may be inserted into the ground 12 as illustrated in Figure 2 by any suitable well boring apparatus. The casing 10 is extended downwardly through the ground 12 to a stratum of water bearing sand 14 as illustrated in Figure 2 after which a strainer 16 is extended beyond the lower end of the casing 10 and has its lower end terminating adjacent a stratum 18 of rock or the like which usually occurs below the stratum of water bearing sand. The strainer 16 is generally supported on a shoe 15 to which is connected a sleeve 17 extending up to the well boring machine whereby the strainer and shoe may be raised or lowered as desired. 70 75 80 85

As illustrated in Figure 3 instead of using the strainer 16 the casing 10 itself may be extended to terminate adjacent the stratum of rock 18. 90

In the usual formation of wells as much as possible of the water bearing said 14 is removed by pumping it from the casing 10. The pumping may be done either by any suitable type of pump lowered into the casing 10 for pumping the water and sand up to the surface of the ground or a bucket pump 20 as illustrated in Figure 3 may be used which is 95 100

operated by moving the bucket up and down, the bucket itself having a valve in the lower end so that the sand and water may flow into the bucket and then be lifted upwardly. In the use of my method either type of removing the sand and water may be utilized. The usual practice is to pour gravel into the casing 10 after as much as possible of the water bearing sand has been removed and letting this gravel form a pack for the purpose of providing a quantity of gravel through which the water may flow rapidly so that the capacity of the well is considerably increased by such a pack.

It is obvious that the larger the pack the greater will be the capacity of the well. It is therefore my purpose to provide a method whereby a comparatively large gravel pack may be formed.

To accomplish this result I insert auxiliary casings 22 in the ground 12 which may be done by boring smaller openings surrounding and spaced from the main casing 10. One or more of the casings 22 may be used depending on the condition of the stratum of water bearing sand 14 which in some cases may be a soft sandstone which would require more casings 22 than where the nature of the sand 14 is similar to quick sand.

The casings 22 may be inserted into the upper part of the stratum 14 as illustrated in Figure 2 or may be inserted further into the sand 14 for a purpose which will hereinafter be referred to.

Practical operation

In the operation of my method the water bearing sand 14 is pumped upwardly through the casing 10 as indicated by the arrows 24 in Figure 2. This forms a cavity in the sand itself and to form the gravel pack this cavity must be filled with gravel. To accomplish this I pile adjacent each auxiliary casing 22 a pile of gravel 26. The gravel 26 is poured or scooped into the casings 22 until they are full. Then when the pumping is started and the sand 14 is pumped up the casing 10 the weight of the gravel 26 will cause it to move downwardly in the casings 22 and displace or take the place of the sand which has been removed as illustrated in Figure 3 of the drawings. During the operation of the method the gravel 26 is continually supplied to the casings 22 for keeping them filled.

It will be noted in Figure 3 that the formation of the gravel pack is in a path from the lower ends of the casings 22, to the lower end of the casing 10. When the pack has been formed as illustrated in Figure 3 and the pumping is continued, gravel will start coming up the casing 10 which will indicate that the pack has been formed. It is desirable, however, to have the pack formed as illustrated in Figure 4 which will result in case of the stratum 14 being of fine sand. Where

the stratum 14 is somewhat harder, however, as when being of sand stone, the formation in Figure 3 will occur.

If it is desirable to form the pack larger than illustrated in Figure 3, the casings 22 may be inserted into the stratum of sand 14 as illustrated in Figure 5 which will result in the pack being formed as shown. To form a proper pack the piles of gravel 26 are equal in volume so that the auxiliary casings 22 may be supplied with equal quantities of gravel. In case that one of the casings 22 does not take the gravel as fast as the other ones so that the sand assumes a formation as illustrated by the dotted lines 28 in Figure 6, a pipe 30 may be inserted in this casing 22 and water or gravel and water may be forced down through the pipe 30 for loosening the sand as indicated by the arrows 32.

The gravel pack when being formed in fine sand will assume the outline illustrated in Figure 8. Where the stratum 14 is of sand stone or the like the formation may be as illustrated in Figure 7. In the latter case if a bigger pack is desired it is necessary to insert auxiliary casings 22^a into the ground so that the spoke like formation will have a greater number of spokes and consequently a greater volume of gravel in the pack.

From the foregoing description it will be apparent that I have provided a method for forming gravel packs wherein the natural tendency of the gravel is to displace the water bearing sand being withdrawn from the main casing. The method is much more efficient than trying to blast a large opening adjacent the lower end of the casing where the force of the explosion tries to drive a portion of the water bearing sand against the great body of sand composed of the rest of the stratum.

The capacity of a well having a gravel pack of this character is greatly increased over the capacity of ordinary wells wherein a smaller gravel pack is formed by other methods. The size of the gravel pack may be increased or decreased as desired by regulating the distance of the auxiliary casings 22 with respect to the main casing 10.

If the stratum 14 is of such hard material that it is difficult to remove it and displace it with gravel, the stratum may be loosened by blasting before the pumping is started.

Some deviation from the method herein disclosed and described may occur without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims, any modified methods or use of mechanical equivalents, which may be reasonably included within their scope.

I claim as my invention:

1. A method of forming a gravel pack for a well comprising the boring of a main opening downwardly to water bearing sand, the boring of a plurality of auxiliary openings

surrounding and spaced from said main opening, the pumping of the water bearing sand from the main opening and the supplying of gravel to the auxiliary openings.

2. A method of forming a gravel pack for a well comprising the inserting through an opening of a casing into the ground downwardly to water bearing sand, the inserting through a second opening of a second casing downwardly to water bearing sand, the withdrawal of the water bearing sand through said first casing and the introducing of gravel into said second casing whereby a gravel pack may be formed between the lower ends of the two casings.

3. A method of forming a gravel pack for a well comprising the inserting of a main casing through an opening in the ground downwardly to water bearing sand, the inserting of an auxiliary casing through a second opening downwardly to water bearing sand, the pumping of the sand from the space between the lower ends of the casings and the introducing of gravel into said auxiliary casing whereby the gravel will displace the sand being pumped out and the forming of a gravel pack will result.

4. A method for forming a gravel pack comprising the inserting of a casing through an opening in the ground and partially through a stratum of water bearing sand to a position with the lower end of the casing spaced from a stratum below the water bearing sand, the inserting of a second casing through a second opening spaced from the first one in the ground and partially through the stratum of water bearing sand, the supplying of gravel to the second casing and the pumping of the water bearing sand from below the first casing.

5. A method for forming a gravel pack comprising the sinking of two separate wells to a stratum of water bearing sand, the removing of such sand from one of said wells and the supplying of gravel to the other well whereby the gravel displaces the sand being pumped from the first well and thereby fills the space in the stratum between said two wells.

6. A method of forming a gravel pack in a stratum of water bearing sand comprising the forming of spaced openings from the surface of the ground to the top of said stratum, one of said openings to serve as a reception opening and the other opening to serve as a discharge opening, the withdrawal of the water bearing sand from the discharge opening and the introduction of gravel into the reception opening whereby the gravel settles by gravity and fills the space in the stratum of water bearing sand from which the sand has been withdrawn.

7. The method of making and maintaining a well including sinking separate wells to a water stratum, and supplying gravel

through one of the wells to replace fine material removed from the stratum with water pumped through the other well.

Des Moines, Iowa, February 21, 1928.

THOMAS W. THORPE.

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