

July 8, 1947.

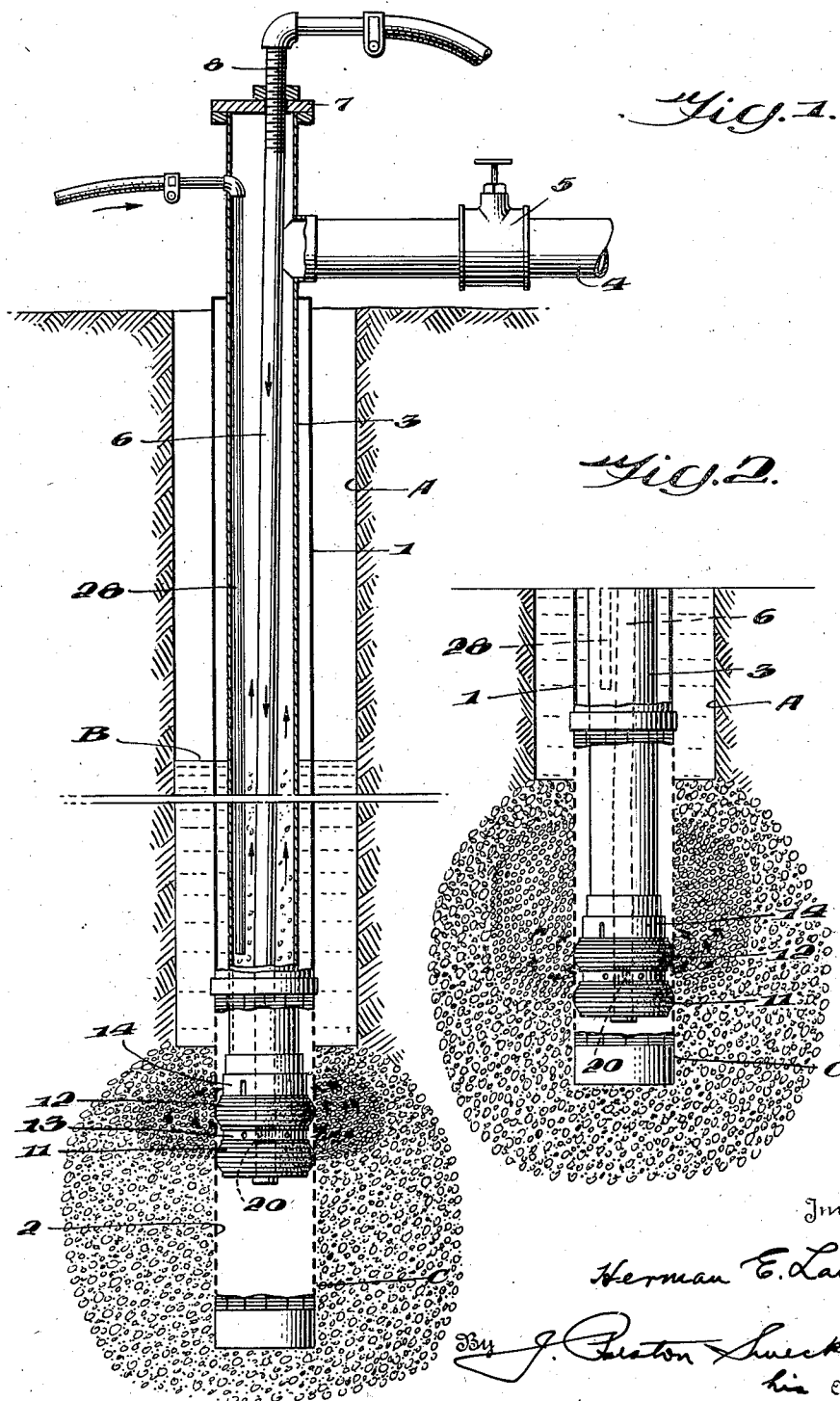
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APPARATUS FOR DEVELOPING WELLS

Filed Aug. 3, 1943

2 Sheets-Sheet 1



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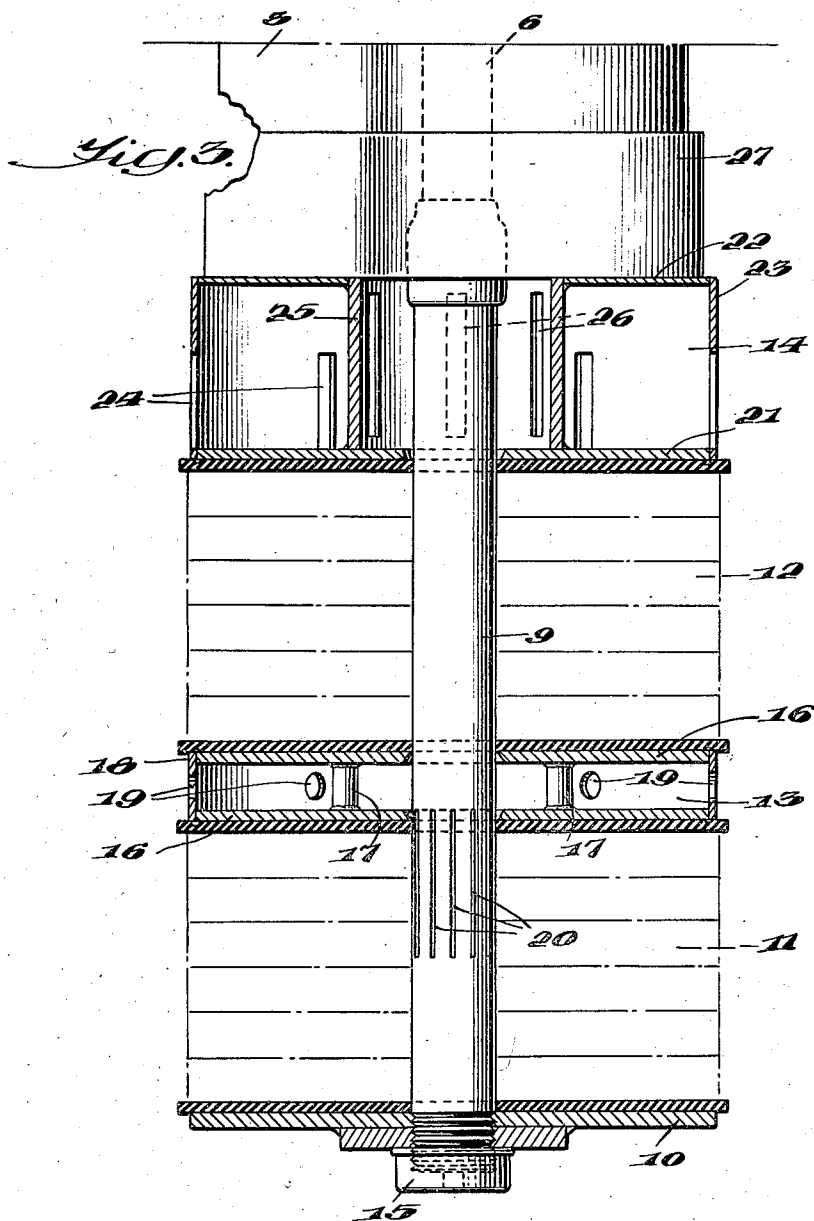
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Inventor

Herman E. Lauman

By *J. Preston Swecker*
his Attorney

UNITED STATES PATENT OFFICE

2,423,653

APPARATUS FOR DEVELOPING WELLS

Herman E. Lauman, Garden City, N. Y.

Application August 3, 1943, Serial No. 497,228

5 Claims. (Cl. 166—2)

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This invention relates to an improvement in apparatus for developing wells, particularly for the development of water from artesian wells to provide for an increase of flow therein.

All major well water development projects are from water borne deposits of sands and gravel, ranging from 30 feet to 1500 feet below ground surface. The greater the depth, the less possible is it to install economically large diameter wells. Therefore, it becomes advisable to "develop" the stratum in which the screen is ultimately placed to as large a diameter as practicable.

By "developing" is meant the removal of the finer sands and clays, those that close the voids in the sand, to a distance as far as possible from the outside of the screen.

Although there are various methods employed for accomplishing this developing of the well, in common practice it is caused by a plunger constructed of rubber and canvas backing that is attached to the end of a heavy drill bar on a well machine. This is operated within the well casing above the screen in a reciprocating motion actuated by the drilling machine similar to the drilling operations. Intermittently, this plunger is removed and the sands that have entered the screen are bailed out. These surging operations range from five minutes, when a developing process is first started, to as high as one hour. In this type of procedure, none of the water is removed from the well, and any clays that may exist in the stratum cause a "muddy" water within the well that is pushed back and forth through the screen during this surging operation. If the clays are of pasty nature and of relatively large percentage in the sand, this use of muddy water is objectionable, occasionally causing more decrease in sand porosity than the increase by the removal of the finer sands.

The object of this invention is to improve the apparatus for developing a well by providing for greater velocity to be exerted at the specific area in the bore of the well from which the fine sand is to be removed, and simultaneously removing the debris from the well by creating a high velocity which will carry it up from said localized area. By introducing a fluid, preferably air, in the localized area which is sealed off in the well bore, this fluid may be directed out into the surrounding strata and taken into the well at a specific point. Besides carrying the finest sands and rubble out of the water bearing strata creating greater voids therein, the fluid

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serves also to carry out the clays that have a tendency to seal up the voids in the strata.

All water bearing sands, particularly those that need extreme methods of developing into high yields are interspersed with small layers or permeated throughout with a portion of clay or fine silt. These must be opened up to form veins or channels for the water to travel through to the bore of the well, but the reciprocating operation of the plunger used heretofore has not been effective for this purpose because the reciprocating motions or surging operations have not removed the debris from the localized area but have left these in sealing relation with the gravel. In the average well that requires an extreme amount of developing, the plunger method is not effective because it does not remove the incoming sands simultaneously with the surging action. Instances are encountered where enough sand is drawn into the well to fill completely the well screen within a very short time. This requires the dismantling and removal of the apparatus from the well too frequently to be economically effective. It is also found that the plunger could easily be fouled in a sand well if the apparatus were operated within the screen, and it could readily sand-bind itself to a point where it would be practically impossible to remove the apparatus from the screen.

This invention is directed further to an apparatus for carrying out the process, by providing for the sealing off of a localized portion of the well from which fluid, preferably air, can be directed into the surrounding stratum and through the water therein for flow to and through the eduction pipe. The discharge of air into the water-bearing stratum creates an air lift which will cause the water to be discharged through the eduction pipe in the well bore, carrying with it particles of clay and fine sand which are thus directed from the surrounding stratum, thus leaving the coarse gravel uniformly disposed around the screen of the well, providing for a maximum of water supply therefor.

This is accomplished by lowering a head structure into the well bore, carried by an air pipe, with spaced packers adapted to be expanded against the walls of the bore, and from which pipe air may be discharged between the packers into the surrounding stratum. The upper end of the head structure has provision for discharging the air, water and sand into an eduction pipe carried thereby, which will cause the fine sand and clay to be carried off from the surrounding stratum.

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The method and apparatus exemplifying this invention, are illustrated in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view, partly in elevation, showing a water well being developed in accordance with this invention, and the apparatus used in connection therewith;

Fig. 2 is a similar view illustrating the developing head in another position with respect to the screen of the well; and

Fig. 3 is a vertical sectional view through the developing head structure.

Referring to Figs. 1 and 2 of the drawings, A designates an artesian well formed to any desired depth through rock or sand strata. The well bore A should extend to a point below the static water level, designated in Fig. 1 at B. The lower end portion of the enlarged hole A may be extended by a bore hole C into the surrounding water bearing strata.

A well casing is shown at 1, extending downward in the bore hole A and connected at its lower end with a screen 2, which may be of the usual construction employed in artesian wells. Extending downward through the well casing 1, is an eduction pipe 3 which extends preferably to a point within the screen 2, and has a discharge pipe 4 connected with the upper end portion thereof and adapted to extend to the usual weir or other point of discharge. A control valve 5 may be provided in the discharge pipe 4 for control of the flow therethrough, if desired.

An air line 6 extends downward through the eduction pipe 3, to which it is connected at the head 7 of said pipe by an adjustable connection such as that shown threaded at 8 for relative adjustment of the eduction pipe and air line.

Connected with the lower end portions of the eduction pipe 3 and air line 6 is a developing head shown more in detail in Fig. 3. This head includes a central pipe 9 connected with the air line 6 to receive the air therefrom and to discharge the same outwardly into the surrounding strata. Telescoped over the pipe 9 is a bottom cap plate 10, a plurality of packing discs 11 and 12 preferably formed of soft resilient material, such as sponge rubber, bottom and top cages 13 and 14, respectively. The cap plate 10 is held in place on the pipe 9 by a screw cap 15 threaded on the pipe, and which confines the assemblage at the bottom. The other parts mentioned of the developing head are loose and endwise slidable relative to the pipe.

The bottom cage 13 is constructed of plates 16 held in spaced relation by separating pins 17 rigidly secured as by welding, to the respective plates. The peripheries of the plates 16 are surrounded by a cylindrical ring 18 perforated at intervals as at 19. This forms a chamber within the cage, designated generally by the numeral 13, which is capable of and adapted to be in communication with the interior of the pipe 9 through peripheral slots 20 formed in the pipe. These slots 20 are adapted to be disposed centrally of the cage 13 and in open communication therewith when the developing head is placed in the proper position in the screen 2 of the well, and the parts compressed lengthwise of the pipe, as hereinafter described.

The top cage 14 is formed by the bottom plate 21, a top plate 22, and a peripheral cylindrical ring 23 extending therearound, these parts being readily secured together as by welding. The ring 23 is slotted at intervals at 24 with the slots located substantially at the level of the bottom

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plate 21 of said cage. An inner ring 25 is mounted within the cage 14 and preferably slotted at 26 for flow of fluid from cage 14 into the ring 25. Surrounding the ring 25 and surmounted upon the cage 14 is a collar 27 with which the lower end of the eduction pipe is connected.

An additional air line may be provided, as shown in Fig. 1, for agitating purposes or to start the operation, as indicated at 28, which line extends downward within the eduction pipe 3 to a point adjacent the lower end thereof. This line, as well as the main air line 6, should be connected with a source of air under sufficient pressure to provide the necessary operation.

In operation, after the sinking of the bore hole A into the water bearing strata, together with the extended bore hole C, the well casing 1 with its extended screen 2 should be positioned within these bore holes and adequately secured in place.

The eduction pipe 3 is assembled in the casing 1, as well as the air line or air lines to be used.

Then upon applying opposed pressures to opposite ends of the developing head, by pulling upward on the air line 6 and its suspended pipe 9 while pushing down relatively upon the eduction pipe 3, the elastic packing discs 11 and 12 will be expanded tightly against the inner wall of the screen 2, at a local point as may be desired to develop the surrounding stratum. The apparatus is then ready for operation.

To start the operation, air is introduced under pressure into the air lift pipe 28, if such starting action be required or desired. This causes an upward bubbling of air from the lower end of the pipe 28 through the water column thereabove within the eduction pipe 3, thus aerating the water sufficiently to cause its outward flow through the eduction pipe and its discharge through the pipe 4 to the weir. During this operation, the water is entering at the lower end of the eduction pipe 3 through the slots 24 of the top cage 14, and slots 26 in the ring 25, thus rising into the lower end of the eduction pipe, or the lower end of the eduction pipe may be slotted at its periphery for the direct flow of water thereto, if desired.

Then air under pressure is introduced through the air line 6, thence to the pipe 9 from which it is discharged through the slots 20 into the cage 13. The packing discs 11 and 12 confine the discharge of this air from the cage 13 to a small surrounding area and directing it out through the screen into the surrounding stratum, creating turbulence therein. The course of least resistance for this air is to go up and back through the screen at the top cage, thence back into the well. Inasmuch as direct flow at that time exists, due to the operation of the air-lift pipe 28 described above, this flow of air will take place readily upward through the eduction pipe, increasing the aeration of the water therein. Such flow of air and water into and through the eduction pipe will carry with it the clays and fine sand from the stratum through which the air travels immediately at the periphery of the developing head, and will thus be carried off from this region, leaving only the better gravel of uniform size.

When the operation ceases to discharge clays and sands with the water after intermittent operations at a given location within the screen, this is indicative of the fact that such location has been fully developed. Then the compressing pressures applied to the developing head may be released, allowing the head to expand lengthwise, thus releasing the packing rings 11 and 12 from

packing relation with the screen, after which the head may be moved lengthwise of the screen to another position either above or below that first developed, as illustrated in Fig. 2. This second position may be developed then in the manner described, and the device moved again to a new location after which the operation may be repeated. This may be continued until the well has been developed throughout the desired area or length of the screen after which the apparatus may be removed readily from the well.

The use of an air-lift in connection with this developing apparatus, is of material benefit, because it permits much greater velocity to be exerted at the specific area under pressure, and, simultaneously, it removes the debris from the well by creating a high velocity out of the screen and back into the well at a specific point. Besides carrying the finest sands and rubble out of the water-bearing stratum, creating greater voids, it also carries out the clays that have a tendency to seal up the voids in the strata, thus leaving a fully developed well of uniform gravel around the screen, so as to produce a natural filter which will provide for freer movement of water into the well.

This developing apparatus is so constructed that no sand can settle on top of it in a manner that would cause binding or fouling of the apparatus. The intake openings are directly at the top of the developing head. The compressing action applied to the localizing means is caused by a tension on the inside air line, which tension is taken from the top. A release of this tension from the top plus the weight of the air line plus the ability to force it down, is ample protection against any freezing or sand-binding that could possibly occur.

The close proximity of the upper cage to the inside of the screen makes it possible to educe water jets through the slots in the cage against the wall of the screen and cause turbulence immediately outside of the screen. This is accomplished either by the introduction of large quantities of water through the valve 5 or by closing the valve and blowing air on top of the static level within the eduction pipe, causing it to discharge outward through the cage and then through the screen. In other words, the agitation outside the screen can be accomplished either with air or with water or alternately at the discretion of the operator.

The developer head can be left in an unexpanded position and moved up and down similar to a surge block while the air-lift is operating. This will give it the benefits of a surge block inasmuch as it is operated within the screen without danger of sand-locking and at the same time scavenging the finer sands and clays that are brought in during the developing procedure.

This apparatus also permits preliminary testing to establish the specific capacity of the well without removing the apparatus from the well. This is accomplished by inserting a small draw down tube to take the readings of the draw down in the well and measuring the output through a weir box. Under ordinary procedure with surge block developing, it would require the removing of the surge block, and installation of a test pump, which would entail considerable time and expense. However, with this unit, during the procedure of development, the capacity of the well can be checked constantly and improvements noted during the process, also eliminating the costly installation of test pump equipment.

I claim:

1. In apparatus for developing a well formed by a bore in surrounding strata, the combination of a pipe section adapted to extend downwardly in the bore, a fixed abutment on the pipe section, a cage containing a chamber opening outwardly and slidably mounted on the pipe section for movement lengthwise thereof, said cage having inner openings, and yieldable packing surrounding the pipe section intermediate the cage and the abutment, said pipe section having openings therein in position to register with the inner openings in the cage and establish communication from the pipe section into the cage upon sliding movement of the cage lengthwise in a direction to expand the packing.

2. In apparatus for developing a well formed by a hole in surrounding water-bearing strata, the combination of packing means for sealing off the hole of the well above and below a localized area of the strata, a hollow cage disposed between the packing means and having means for discharging fluid therefrom into the strata, a second hollow cage above the packing means and having peripheral openings for receiving fluid from the strata thereinto, means in communication with said second cage for directing fluid therefrom upwardly through the well, and a fluid discharge pipe extending through the cages and packing means and having means of communication with the first-mentioned cage when the packing means is in sealing relation with the hole, said packing means being slidably lengthwise relative to the pipe for expansion and contraction of the packing means, and means for holding the packing means in expanded relation.

3. In apparatus for developing a well formed by a bore in surrounding strata, the combination of a pipe adapted to extend downwardly in the bore, a fixed abutment on the lower end of said pipe, a cage containing a chamber opening outwardly and slidably mounted on the pipe for movement lengthwise thereof, said cage having inner openings, yieldable packing surrounding the pipe intermediate the cage and the abutment, said pipe having openings therein normally out of registry with the inner openings in the cage when the packing is in normal unexpanded position and in position to register with the inner openings in the cage and establish communication from the pipe into the cage upon sliding movement of the cage lengthwise of the pipe in a direction to expand the packing, and means manipulated from the top of the well to move the cages lengthwise of the pipe and expand the packing and move the inner openings in the cage into registry with the openings in the pipe.

4. In apparatus for developing a well formed by a bore in surrounding strata, the combination of a pipe adapted to extend downwardly in the bore, a fixed abutment on the lower end of said pipe, a cage containing a chamber opening outwardly and slidably mounted on the pipe for movement lengthwise thereof, said cage having inner openings, yieldable packing surrounding the pipe intermediate the cage and the abutment, said pipe having openings therein normally out of registry with the inner openings in the cage when the packing is in normal unexpanded position and in position to register with the inner openings in the cage and establish communication from the pipe into the cage upon sliding movement of the cage lengthwise of the pipe in a direction to expand the packing, a second cage slidably mounted on the pipe above and

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spaced from the first-mentioned cage, a casing connected with the second cage in communication therewith for directing fluid therefrom upwardly through the bore, and a second expandible packing interposed between the cages and adapted to be expanded upon movement of the second-mentioned cage toward the first-mentioned cage, said pipe being movable lengthwise relative to the casing to move the second-mentioned cage relative to the first-mentioned cage.

5. In apparatus for developing a well formed by a bore in surrounding water-bearing strata, the combination of a packing in the bore, means for creating an air lift in the lower portion of the bore above the packing for aerating water therein and flowing the same upwardly through the bore from the water-bearing strata, means for introducing air downwardly through the packing into the surrounding water-bearing strata at a point below said air lift for aerating the water in the strata, and means for flowing the aerated water from the surrounding strata into the bore.

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above the packing and adjacent the air lift carrying off therein fine particles in suspension from between coarse pebbles surrounding the bore.

HERMAN E. LAUMAN.

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