A. SMITH.

METHOD OF CONSTRUCTING AND CEMENTING WELLS.

APPLICATION FILED MAR. 23, 1912.

1,050,244. Patented Jan. 14, 1913.

3 SHEETS—SHEET 1.

Fig. 1.

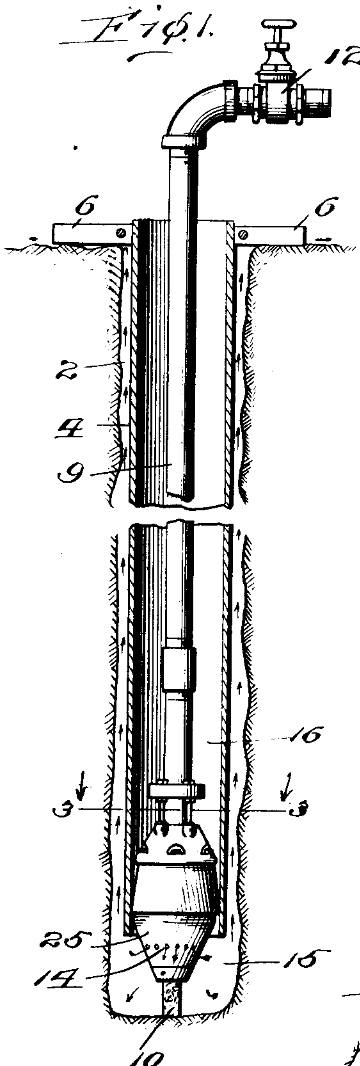


Fig. 2.

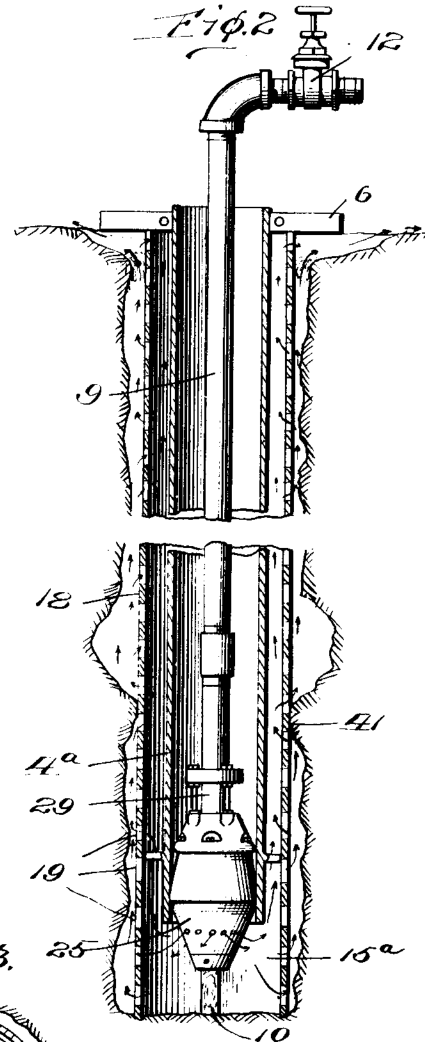
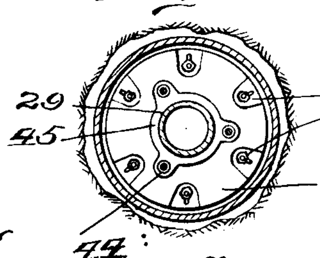


Fig. 3.



Witnesses

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Fig. 4.

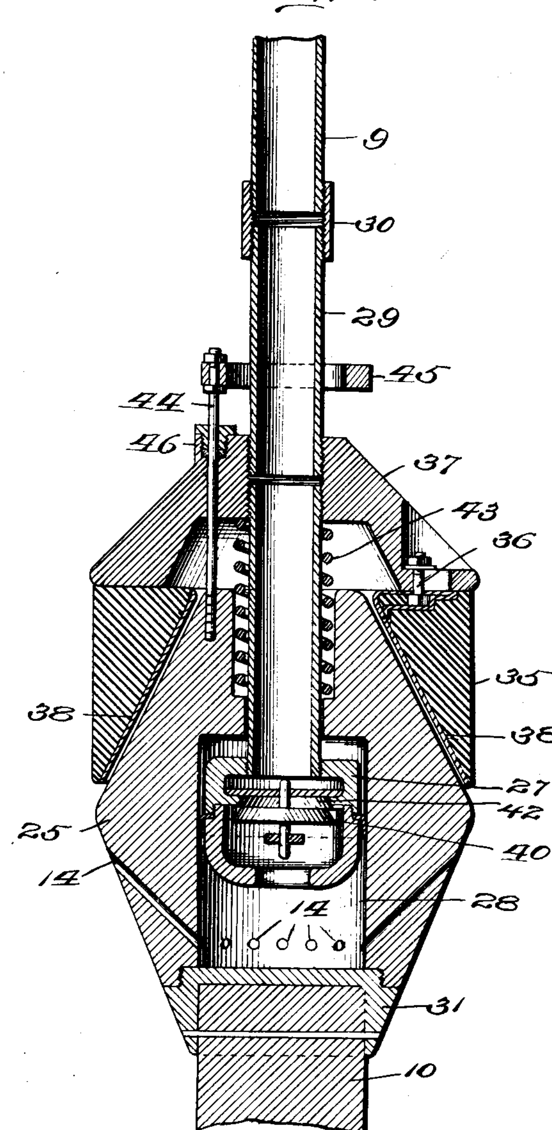


Fig. 5.

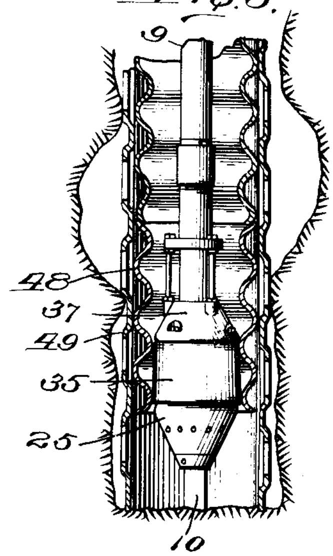


Fig. 6.

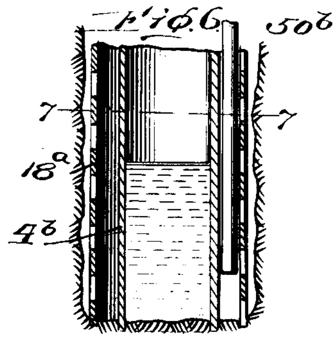
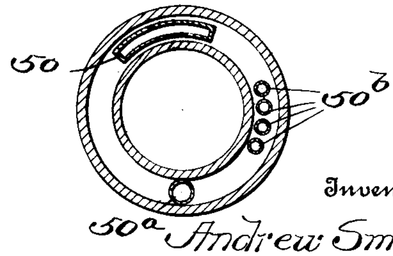


Fig. 7.



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3 SHEETS—SHEET 3.

Fig. 8.

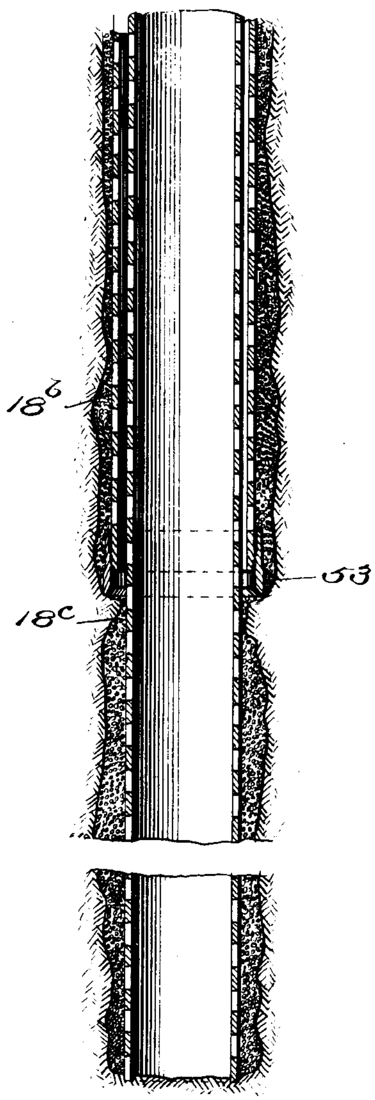
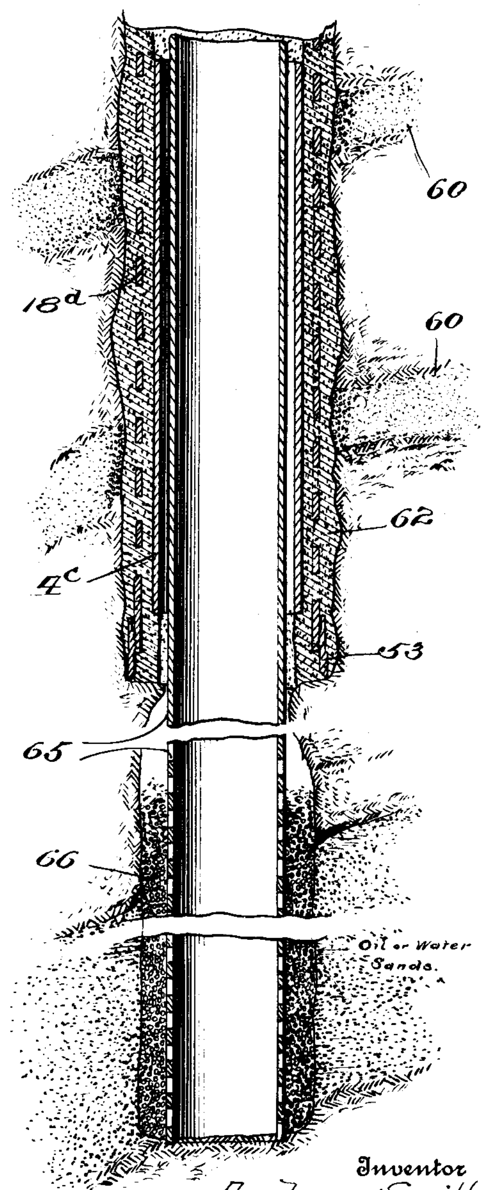


Fig. 9.



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UNITED STATES PATENT OFFICE.

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METHOD OF CONSTRUCTING AND CEMENTING WELLS.

1,050,244. Specification of Letters Patent. Patented Jan. 14, 1913.

Application filed March 23, 1912. Serial No. 685,665.

To all whom it may concern:

Be it known that I, ANDREW SMITH, a citizen of the United States, residing at San Mateo, in the county of San Mateo and State of California, have invented certain new and useful Improvements in Methods of Constructing and Cementing Wells, of which the following is a specification.

This invention relates to a method of constructing and cementing wells for water and oil, and to the apparatus for carrying out the same.

In constructing the walls or linings of wells, it is essential that the surface drainage and the sub-surface water should be absolutely cut off, and that the well curbing or casing should form an effectual seal against all impurities and foreign substances. In the case of water wells, there is not only the danger to health from the entrance of surface drainage or seepage, but also from any sub-surface channels which may lead from a source of pollution at considerable distances, often from unsuspected sources, and which may effect an entrance to the well through subterranean channels at a considerable depth.

The object of my invention is to provide a method of constructing wells and effectually sealing them against the entrance of any surface or subterranean drainage or channels.

In oil well construction, it is exceedingly important to seal the well casing against the entrance of any surface drainage or subterranean streams of water and to be able to effect a perfect seal at any desired depth. It is frequently important to seal the casing against the entrance of water to the oil sands from the surface of the ground.

A number of methods of cementing the well casing or curbing to the ground or bore of the well have been proposed, but in so far as I am aware, these have been attended with difficulties which rendered them very expensive and frequently impractical. When the well is bored by the rotary method, it is customary to force a stream of water continually through the hollow stem of the rotary drill and through apertures upon the sides of the drill, discharging it against the earth at the end of the bore, so that the water may carry the loosened material in an upward stream around the outside of the casing, flowing out of the mouth of the well upon the surface of the ground. After being allowed to settle, the water is again pumped into the rotary stem, the same water being utilized repeatedly. It has been proposed to seal the annular space between the outer curbing or casing and the bore of the well by filling the same with cement forced downward from the top. While this may be done to a certain extent under favorable circumstances, this method is not reliable and very frequently fails to completely fill the annular space and seal the casing to the well bore. If any obstructions occur in the space surrounding the casing, the flow of cement is stopped, leaving the lower part of the casing unsealed. In some soils it is almost impossible to prevent the earth in the bore from caving in against the casing and "freezing" thereto, as it is termed. Under such circumstances it is impossible to cement the casing from the top downward. Again, if the cement does reach the bottom of the well, it will pass into the casing and close it or even fill the lower portion of the casing, rendering it necessary to drill out the cement before proceeding further with the sinking of the well.

According to my method, the cement is carried downward through a comparatively small pipe, either inside or outside of the casing, and is forced from the bottom of the well upward to the surface of the ground, thereby insuring the complete and perfect sealing of the outside wall of the casing and the bore of the well, and filling in all cavities. I am aware that it has been proposed to force cement downward through the casing, causing it to rise through the annular space between the casing and the bore of the well. This, however, entails great expense in filling the whole interior of the casing, and requiring the use of special mechanism to force it out of the casing, and moreover leaves the lower portion of the casing cemented solidly.

In my method, the casing is maintained free from cement, the minimum amount of cement is required, the interior and exterior pressures upon the casing may be equalized, and provision is made for carrying the cement around any obstructions, or any portions of the casing where the earth has caved in and "frozen" thereto.

For the purpose of disclosing the manner in which my method may be carried out and an apparatus therefor, reference is made to the accompanying drawings, in which—

Figure 1 is a vertical longitudinal section through a well, showing apparatus for cementing wells according to my method; Fig. 2 is a similar view showing the use of a double casing, the outer casing member being perforated for the reasons hereinafter set forth; Fig. 3 is a cross-section on the line 3—3 of Fig. 1; Fig. 4 is an enlarged longitudinal section of the packer employed to close the lower end of the casing during the cementing operation; Fig. 5 is a longitudinal section of a portion of a well and the cementing tool, showing the use of a duplex casing with an inner corrugated member such as disclosed in my Patent No. 1,028,065 dated May 28, 1912; Fig. 6 is a longitudinal section of a modified arrangement in which the cement is forced through a small tube or series of tubes extending down between the inner and outer sections of the duplex casing; Fig. 7 is a cross-section on the line 7—7 of Fig. 6; Fig. 8 is a vertical section of a well, showing the manner of using inner and outer perforated casings during the construction; and Fig. 9 is a vertical section of a well constructed and cemented in accordance with my invention.

When the soil is firm, so that the earth surrounding the bore of the well is self-supporting and is not liable to cave in or "freeze" to the casing, thus leaving a free, continuous annular space, illustrated at 2, Fig. 1, a single imperforate casing 4 may be employed. After the casing has been lowered into the well nearly to the bottom, the sectional units being joined into a continuous casing in a well-known manner, the casing is suspended by means of clamps 6, so that the lower end is held a short distance above the bottom of the bore, and the packer or sealing tool is lowered by means of a tubular stem 9, until it is in the position shown, its lower end protruding below the casing and resting upon a block or post 10. The intermediate portion of the packer is preferably made of a rubber or other expansible annular member, and is expanded against the inner wall of the casing in the manner hereinafter described, thus effectually closing the lower end of the casing. The valve 12 is then opened and liquid cement is forced through the stem 9, passing outwardly through the apertures 14, of the packer, first filling the space or cavity 15, and then passing upwardly as indicated by the arrows, completely filling the annular space 2, and finally overflowing from the mouth of the well upon the ground, thereby indicating that the outer wall of the casing has been completely sealed to the bore of the well. Inasmuch as the casing may be subjected to great pressure if the well is deep, the inner and outer pressures may be equalized by simultaneously filling the space 16 within the casing with water, which may be pumped out after the cementing is completed.

If the ground through which a water well is to be driven is firm so that the soil will not cave in, the well bore may be driven for fifty feet or more before a casing is inserted. An imperforate casing 4 is then lowered and sealed in the manner above described. The surface waters and drainage having thus been cut off, the well may be driven deeper until a vein of pure water is struck, after which a perforated casing may be lowered to the bottom within the outer sealing casing 4, through which the water may enter.

When the soil is such that it will not remain intact for any depth, but requires a support to prevent caving in from the very start, a perforated casing 18, Fig. 2, is lowered section by section, as the well is driven, and when a sufficient depth has been reached which is safely below the surface waters and contaminated sub-surface channels, an imperforate inner casing 4^a may be lowered and held suspended a short distance above the bottom of the bore. The sealing tool is then lowered in the manner previously described, and liquid cement is forced down the tubular stem 9, and out through the openings 14. It first fills the bottom space 15^a, and is then forced upwardly as indicated by the arrows, passing through the apertures 19 and completely filling the spaces between the inner and outer casings and between the outer casing and the bore of the well, thus completely sealing off all surface drainage and sub-surface waters. As soon as the cement has set, the packer or sealing tool may be lifted from the well. The well bore may then be driven to the required depth, and an inner perforated tube may be inserted to extend from the bottom to the top of the well. Heretofore perforated casing has only been used as a strainer at the bottom of the well.

This method of drilling and cementing is not only applicable to the construction of oil, water, and gas wells, but may also be used in driving shafts and tunnels in mine work.

My improved packer or sealing tool is illustrated in the enlarged cross-section shown in Fig. 4. The double conical wedge block 25, is normally supported upon the valve-casing 27, which slides loosely in the recess 28, and is connected with the tubular stem 9, by the sectional tubular support, 29, which is fastened to the stem by the coupling 30. The plug 31, which is threaded to the bottom of the wedge-block and closes the recess 28, may be recessed to form a socket for a wooden or other post 10. A rubber or other expansible annular tapering packing

35, is suspended by means of bolts 36, from the cap-block 37, carried by the support 29. I prefer to embed in the inner flaring wall of the packing 35, a series of spring strips 38, which serve as bearing surfaces for the wedge, insuring the centering of the tool in the casing, and a symmetrical expansion of the packing, and when the packer is released and withdrawn the spring strips assist in contracting the packing ring 35 from the casing.

When it is desired to seal a length of casing to the well bore, the packer is lowered into the position shown in Fig. 2, until the post 10 strikes the bottom of the well, thereby supporting the wedge-block 25, and lifting it from the top of the valve-casing 27, as shown in Fig. 4. The weight of the stem 9 is then allowed to bear upon the cap-block 37, supplemented if desired by additional pressure, which forces tapering rubber packing down over the wedge-block, thereby causing it to spread or expand until it fits tightly against the inner wall of the casing. During this movement the valve casing will descend in the recess 28. Liquid cement may then be forced down the tubular stem 9, passing around the valve 40, and through the apertures or channels 14 into the bottom of the well. As indicated by the arrows in Fig. 2, the cement will pass upwardly between the inner and outer casings and through the slots in the outer casing, completely filling all of the space between the casing and the well bore, and will finally overflow at the top of the well, indicating that the inner and outer casings are completely sealed to the well bore. As previously observed, if the ascending column of cement meets with an obstruction in the well bore, as at 41, Fig. 2, it passes through the slots into the outer casing and out again upon the other side of the casing. Any reverse pressure causes the valve 40 to move up against its seat 42. The column of cement extending from the bottom of the bore to the mouth of the well around and between the casings is thus firmly held up and prevented from flowing backward until it has set.

In order to clean out the tool, a sufficient amount of water may be forced therethrough to wash out the cement while still in liquid form.

While I prefer to place the valve 40 in the casing 27, it may be located in the tubular stem 29.

As soon as the cement sets, the packer is lifted out of the well by means of its stem 9. The initial movement causes the cap-block to slide the rubber packing ring 35 from the wedge-block, this movement being assisted by the coiled spring 43, while the spring strips 38 assist the contraction of the rubber.

I have shown the wedge-block connected by bolts 44 to a heavy ring 45, a tight connection through the cap-block being insured by the stuffing-boxes 46. If it is desired to use the packer at any intermediate point in the well, the wedge block may be securely supported by means of a cable fastened to the ring 45, and the rubber packing ring may then be expanded against the casing in the manner previously described.

Instead of the construction just described, the cap-block may be supported by means of another tubular stem surrounding the tube 9.

I have shown in Fig. 5, the use of an inner imperforate casing 48, such as disclosed in my copending application, Serial Number 684,177, filed March 16, 1912. It will be seen how the cement, meeting an obstruction in the well bore, may pass around the corrugations from one vertical channel to the next in outer casing 49, these channels being arranged in staggered relation around the circumference of the casing, and thus work its way into all of the crevices, forming a perfect seal between the casings and the bore of the well, which is an important feature.

While the packer will usually be used in cementing the well, yet when an inner casing considerably smaller than the outer casing is used, I may introduce the cement between the casings through a pipe 50, or 50^a, or a group of smaller pipes 50^b, as shown in Figs. 6 and 7. In this case the inner pipe should be embedded in the bottom of the well to form a seal against the entrance of cement, the lower end carrying the usual shoe.

In sinking an oil well, it frequently happens that it is unnecessary to seal the casing until the bore has reached the oil sands. Under these conditions, a perforated casing is lowered as the well is being driven. It frequently happens that after a considerable depth has been reached, it is impossible to force the casing beyond a certain point, owing to obstructions of various kinds or on account of, the "freezing" or adherence of the earth to the casing, and it is necessary to lower another perforated casing within the outer one. In Fig. 8, I have shown an outer casing 18^b, carrying the usual shoe 53, upon its lower end, which has met with an obstruction, and within this a smaller perforated casing 18^c has been lowered and the well has then been driven to the required depth. Under these circumstances, it is desirable to afterward lift the outer perforated casing from the well, but it has frequently happened in the past that it was impossible to dislodge it. This difficulty may now be obviated to a great extent by using my improved perforated casing disclosed in my copending application, Serial Number 684,177 filed March 16, 1912, in which narrow smooth walled slits are sheared into the sheet metal casing, the slits being preferably flaring inwardly so that silt and small particles of sand which can enter the slits will freely pass into the casing.

When drilling wells to great depths, extending down frequently two thousand feet or more, the crushing pressures exerted upon the casing become very great, and subject it to an enormous strain. By employing my perforated casing, the water, oil, or gases may pass from the outside to the inside of the casing, thus equalizing the pressures and relieving the strains. This is an important matter in well work. Prior to my invention of constructing well casings having narrow slits inserted in the wall of the metal, as disclosed in my Patent No. 1,028,065, it was not feasible to use a perforated casing during the process of driving the well. Casings with large slots or openings, and those having an exterior strainer portion formed of wire mesh or wound with convolutions of wire can not be forced down through the earth. On the other hand, my slitted casing offers substantially no additional resistance, and is strong and rigid so that it may withstand the grinding and frictional resistance offered by the different strata of the earth through which it must be forced.

When the well is drilled in the ordinary manner by means of the well-known standard rigging, the drill is continually reciprocated and the constant agitation or swish of the water within the well washes the sands adjacent the outer wall of the casing and causes the silt and finer sand to be carried through the slits of the casing into the well, where it is lifted out by the buckets. In this manner, only the coarser sands are left against the outside of the casing, as illustrated at 66 in Figs. 8 and 9, and this greatly facilitates the lowering of the casing, since the coarse sand offers less resistance to its passage owing to the fact that the silt, clay, and fine particles which would otherwise adhere to the casing have been washed out. Again, as the washed sand does not stick or "freeze" to the casing, it may be removed far more readily than heretofore. The great importance of this feature of my method will be appreciated by engineers familiar with the sinking of deep wells. The perforations also expose any rocks in the bore to the disintegrating action of the air.

In Fig. 9, I have illustrated in vertical section the manner of constructing and cementing a well in accordance with my invention. As previously described, an outer perforated casing 18^d is first sunk with the drilling of the well until the various water-bearing strata 60 liable to be in a polluted condition have been passed, in the case of water wells, and until the oil-bearing sands have been reached, in the case of oil wells. An inner imperforate casing, 4^c, is then lowered, after which this double casing is cemented in the manner previously described, using one of my packers, so that the cement 62 completely seals the inner and outer casings to each other and to the bore of the well, filling all crevices and shutting off all water. The well is then drilled down into the oil or water-bearing sands and another casing 65 is lowered, usually simultaneously with the drilling. For this last-named casing, I prefer to employ imperforate sections for the upper portion and perforated sections for the lower or strainer portion. I have indicated at 66, the coarse washed sands which will lie adjacent the outer wall of the strainer portion, these sands having been washed of all the silt and finer particles by the motion of the drilling tool, as previously explained. While the slits in my perforated casing are large enough to permit the passage of the cement in the cementing operation, and permit the passage of the finer particles of sand and the silt, yet they do not allow the coarser sand to enter. I have pointed out the peculiar advantages arising from the adjacent washed sand in facilitating the lowering of the casing, and also in permitting the outer perforated casing to be removed where it becomes necessary to employ more than one in driving the well. Another great advantage of washing the earth adjacent the casing and leaving the coarser washed sand immediately against the same, arises from the fact that the coarse sand forms an excellent filter and assists in maintaining the slits in the casing free and unobstructed. The bottom of the perforated casing may be closed by cement, but it is preferable to close it with a strainer plug, as will be apparent.

I have described in detail the construction of the several features illustrated in the accompanying drawings for the purpose of clearly disclosing my method of constructing and cementing, but it is evident that many changes may be made, both in the apparatus shown and in the steps described for carrying out my method.

I claim:—

1. The method of drilling oil, water or gas wells, which comprises sinking a perforated casing into the earth, thereby equalizing the subterranean pressures upon the inner and outer walls of the casing, sinking an inner imperforate casing to a point below the sub-surface waters, and cementing the inner and outer casings to each other and to the bore of the well to thereby seal off the water above the desired stratum.

2. The method of drilling oil, water or gas wells, which comprises sinking a perforated casing into the earth, thereby equalizing the subterranean pressures upon the in-

ner and outer walls of the casing, sinking an inner imperforate casing to a point below the sub-surface waters, cementing the inner and outer casings to each other and to the bore of the well to thereby seal off the water above the desired stratum, and continuing a perforated casing into the oil or water bearing stratum.

3. The method of drilling oil, water or gas wells, which comprises sinking a perforated casing into the earth, thereby equalizing the subterranean pressures upon the inner and outer walls of the casing, washing the earth adjacent the outer wall of the casing, and causing the silt and fine particles of the adjacent earth to pass within the casing, and leaving the coarser particles surrounding the exterior of the casing, thereby facilitating the movement of the casing within the well bore.

4. The method of drilling oil, water, or gas wells, which comprises sinking a perforated casing into the earth, sinking an inner imperforate casing within said outer casing, inserting a closure within the inner casing to close the lower orifice thereof, and forcing cement through said closure and upward between said casings and through the perforations in said outer casing to seal the space between said outer casing and the bore of the well.

5. The method of drilling oil, water or gas wells, which comprises sinking a perforated casing into the earth, sinking an inner imperforate casing within said outer casing, closing the lower orifice of the inner casing, and flowing cement upwardly between the casings and through the perforations in the outer casing, thereby completely cementing the casings to each other and the outer casing to the bore of the well.

6. The method of drilling oil, water or gas wells, which comprises sinking a perforated casing into the earth, sinking an inner imperforate casing within said outer casing, closing the lower orifice of the inner casing, and flowing cement upwardly between the casings and through the perforations in the outer casing, thereby completely cementing the casings to each other and the outer casing to the bore of the well to seal off the water stratum above the orifice of the inner casing, and then sinking a third casing within said inner casing into the oil or water-bearing stratum, said third casing having a perforated lower portion.

In testimony whereof I affix my signature, in presence of two witnesses.

ANDREW SMITH.

Witnesses:
EUGENE C. BROWN,
CHARLES N. MURRAY.