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HOW DEEP WELLS ARE MADE.

In sinking deep wells, whether for water, oil, or gas, American mechanics and engineers are easily a long way in advance of those of the rest of the world, and we export annually considerable of the "plant" required for such work abroad, as well as, in many cases, the expert workmen to conduct the operations. It was, of course, the "striking of oil" in a little town of Western Pennsylvania, in 1859, giving rise to our great petroleum industry, and leading to the subsequent wonderful utilization of natural gas, which caused our rapid progress in improving the machinery for and perfecting the methods of well drilling.

There had long previously been, as there are to-day, in many other parts of the world, equally promising indications of a rich reward for enterprise and skill in this direction, but the discovery of Pennsylvania's hidden resources found men with the genius to make the most of it in a way which has not only added greatly to the national wealth, but has inspired explorers to an activity in similar work that now takes the whole surface of the globe within the sphere of possible operations.

And it is not only for the rewards that may be obtained from a yield of oil or gas that wells are now being largely drilled. The tools with which the drilling is effected furnish also a ready means of examination as to mineral deposits of the earth for a great depth beneath the surface, and thus determining upon the plans of mining operations. But perhaps the highest service of all which is to be rendered by our modern facilities in well sinking is that of affording a water supply in places where water is otherwise unobtainable, a direction in which very large use has already been made of such advantages, but which promises a far wider extension as the public become more generally acquainted with all the conditions which affect the value of such work.

In the accompanying illustration we give a representation of the most approved machinery and the style of construction now employed where deep wells are to be sunk, or those which it is calculated will be 1,000 feet deep or more, the "plant" being such as is built by the Pierce Well Excavator Co., of New York and Long Island City, N. Y. With such an apparatus, where the work may last for several months, care must be taken, after the proper site has been selected, to place the foundation timbers solidly, and, when the drilling is to be carried on in winter, a temporary house may be necessary for the protection of the engine. When a well is to be so large that work will have to be carried on for several months, a temporary shed is provided, which not only covers the engine and belt connections, but also incloses and protects the machinery and workmen in the lower part of the derrick.

The diameter of the well is generally 6 or 8 inches, but may be either smaller or greater, as desired, though seldom less than 5½ inches, all the tools and appliances for wells of several different diameters being regularly manufactured. The principle upon which the well is drilled is that with free falling tools, suspended by a cable and worked by steam power, the weight of the tools shall be so great as to give blows of sufficient force to pierce the hardest rock.

The power from the engine is taken by a large band wheel, on one side of which is a crank that gives the up and down motion to the pitman working the walking beam that raises and drops the tools in the well in the operation of drilling, the crank having, as will be seen, several holes for connecting it with the pitman at different distances from its axis, to vary the length of stroke given by the walking beam. On the opposite side of this band wheel is what is called a tug pulley, which, by means of a crossed rope, styled the bull rope, communicates power to the bull wheel, on a shaft of which is carried the rope for suspending the tools in the wheel, and by the operation of which the tools are taken out of the well. One of the bull wheels has a brake to lower the tools and prevent their too rapid descent, the brake consisting of a strap of iron firmly fastened to the derrick floor and passing over the bull wheel, around which it may be made to clasp firmly by a brake lever. The motion of the engine is under the control of the driller in the derrick, the throttle valve being moved by a grooved wheel, over which runs what is called a "telegraph cord," which also passes around another grooved pulley on a post near the drill hole. The link of the engine, by which its motion can be reversed at will, can also be operated from the derrick by a "reverse" cord, a pull of the cord raising the link and reversing the driving wheel, the link dropping by its own weight when the cord is slackened and the ordinary motion of the engine is restored. The sand pump, which, as well as the regular drilling tools, is shown just touching the derrick floor, is made with a valve in the bottom, and a suction valve on the end of the plunger; and when the pump stops at the bottom of the well, the plunger descends to the bottom of the pump, the leather valve being so constructed as to go down in the pump readily, while on pulling back it flattens and becomes a tight piston. The sand pump line is fastened in an eye at the top of the plunger, from which a rope runs over a pulley block at the top of the derrick, thence down to the sand reel. The sand reel shaft has also a brake, and the reel is so hung that the bearing of the friction wheel is even with the face of the band wheel. The sand pump runs down in the well by its own weight, but is withdrawn by pulling upon a lever which holds the friction pulley against the face of the band wheel, its rate of ascent or descent being always readily controllable. There are several varieties of sand pumps, one having a common leather flap valve, the other a ball and dart valve; the

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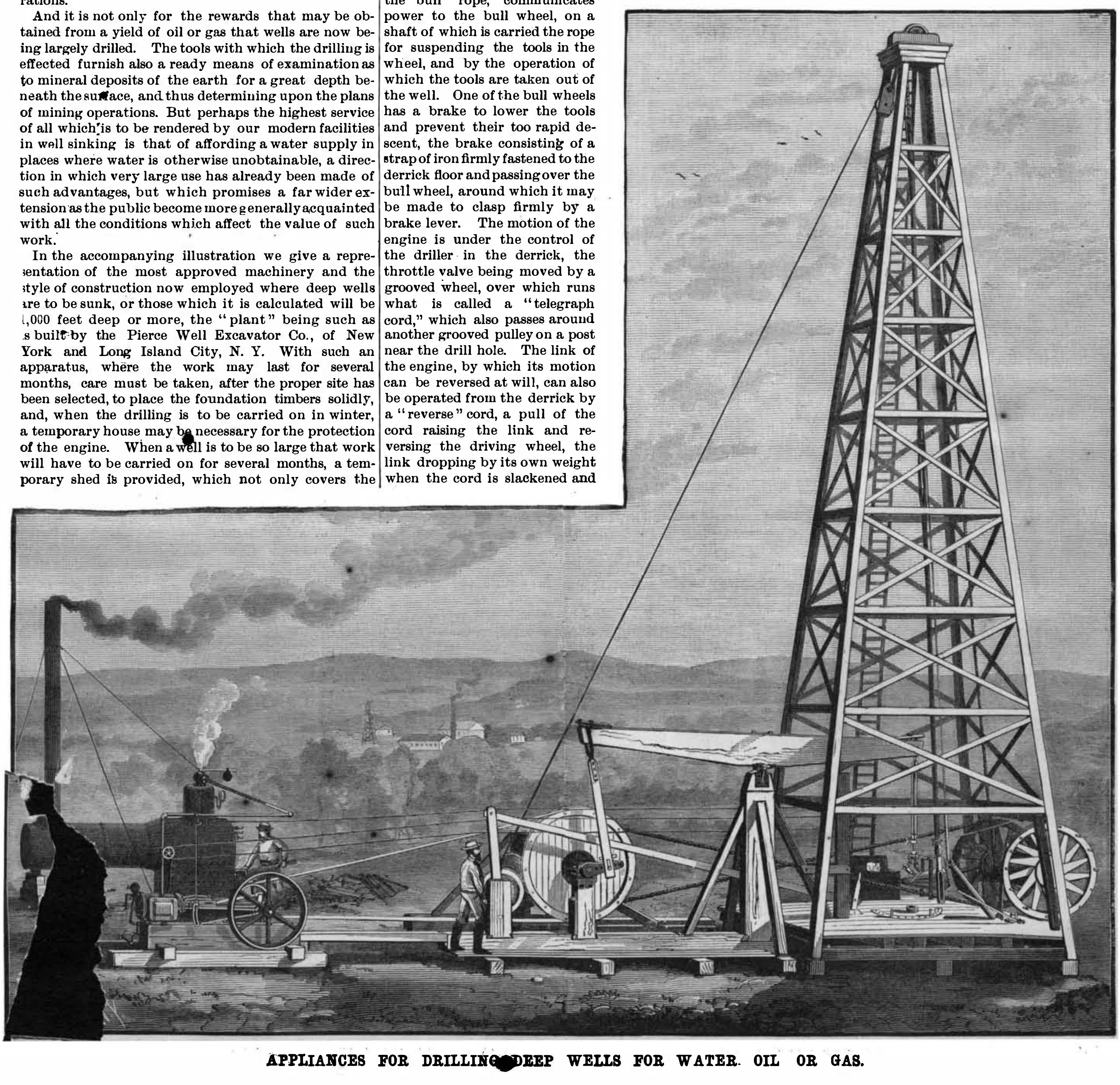


APPLIANCES FOR DRILLING DEEP WELLS FOR WATER, OIL OR GAS.

HOW DEEP WELLS ARE MADE.

(Continued from first page.)

latter will discharge its contents at the surface by resting the dart on the derrick floor.

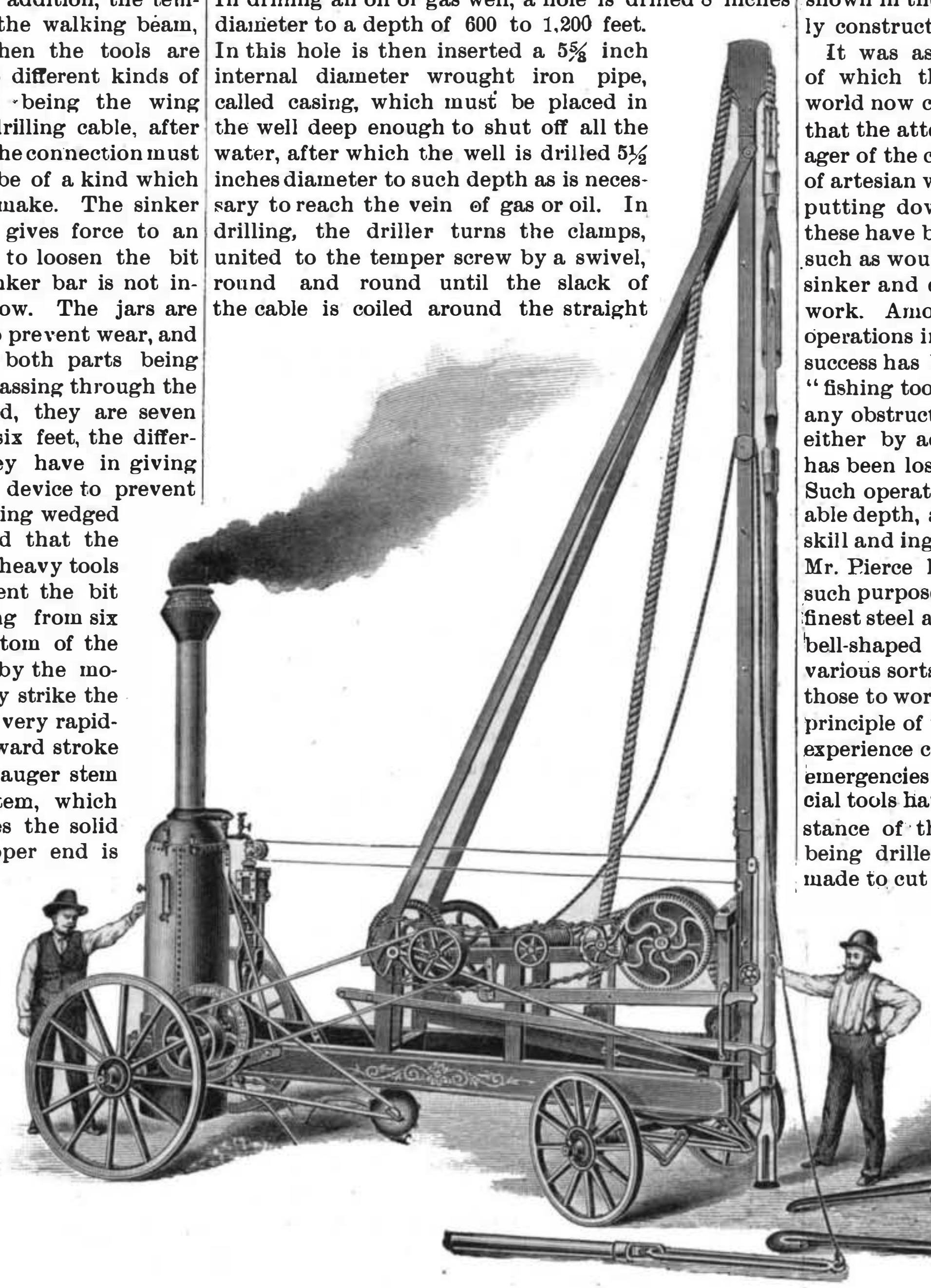
The weight of the tools hung from the rope in the center of the derrick varies considerably, according to the material to be passed through. In the oil regions, for drilling a 5½ inch hole, generally through slate and sand rock, the weight of the tools will be about 2,200 pounds. For a hole of 6 inches in diameter, 1,000 feet and more in depth, and through granite, flint, and other hard formations, as is often necessary in drilling deep wells for water, the weight of the tools will be 3,000 pounds or more. In some of the hard formations found around New York, when deep wells were to be made of six to eight inches in diameter, the Pierce Well Company have used the heaviest tools ever yet employed in such work, the weight of the string suspended from the derrick equaling 4,000 to 4,500 pounds.

The measurement of these tools would be about as follows: Rope socket, 3 feet long; sinker bar, 14 feet long; jars, 7 feet long; auger stem, 35 feet long; bit, 4 to 5 feet long. These are screwed together, forming the string of tools, and there is, in addition, the temper screw, hung by a hook from the walking beam, and made to grasp the cable when the tools are down in the well. There are two different kinds of rope sockets, the more common being the wing socket, in which the end of the drilling cable, after being wrapped, is firmly riveted. The connection must be strong and reliable, and should be of a kind which does not call for especial skill to make. The sinker bar, just above the auger stem, gives force to an upward blow made by the "jar" to loosen the bit after the regular stroke. The sinker bar is not intended to strike a downward blow. The jars are made in two parts, are steel lined to prevent wear, and are like two long links of a chain, both parts being slotted, and the cross-head of one passing through the slot of the other. When extended, they are seven feet long, and when closed about six feet, the difference in length being the play they have in giving an upward stroke. The jar is a device to prevent the bit from getting fast or becoming wedged in the rock. Ordinarily, it is found that the spring of the long cable, with the heavy tools attached, will be sufficient to prevent the bit from becoming fast. The tools hang from six inches to two feet above the bottom of the hole, and when they rise and fall by the motion given to the walking beam, they strike the bottom in a way that cuts the rock very rapidly. The action of the jar on the upward stroke is felt through its lower link on the auger stem to loosen the bit. The auger stem, which comes next above the bit, furnishes the solid weight in giving the blow; its upper end is either screwed or welded into the lower part of the jars, and on the lower end of the auger stem is a box into which the drill is screwed.

In the manufacture of all these tools, it is of the utmost importance that only the best quality of metal should be used. The resharpening and tempering of the drills is a work that has to be frequently repeated, and for this purpose a forge is provided in one side of the derrick.

On the end of the walking beam in the derrick is a hook on which is placed what is called a temper screw. This screw is 5½ feet long; it is carried between two wrought iron reins, at the bottom of which is a split nut around which is a clamp and set screw. The split nut is to facilitate raising the screw after it has been paid out while drilling. At the lower end of this screw the cable is solidly clamped, and this clamping need not be disturbed only at such intervals in the drilling as a depth is made equal to the length of the temper screw. When the screw is all out, it must be disconnected from the cable and reset at the top. But when this amount of solid material has been cut out and pulverized in the bottom of the well, it is so churned up with the water as to fill up the well for a good many more feet than the length of the temper screw, and the tools have to be taken out for clearing the well. As the tools are drawn from the well, when the top of the bit appears, the engine is stopped, a wrench is put on the squared portion of the bit just below the collar, and another wrench on the squared part of the auger stem just above the box, when a bar is inserted in one of the arc of holes in the wrench circle fastened to the derrick floor, and with this lever the joint is unscrewed. The joints are always set up by the same leverage, that no risk may be run of their unscrewing in the well.

After the derrick has been erected, the boiler and engine placed in position, the steam and water pipe connections made, the tools hung in the derrick, and everything made ready to commence work, the drilling of the well is commenced as follows: If there is a depth of say 20 feet of earth above the solid rock, a 12 inch hole is usually drilled or spudded down to the rock, in which can be inserted a wood conductor pipe, which can be made of octagon shape, 10 inches diameter inside, or can be made in the shape of a square box of 2 inch plank spiked together. If there is a depth of earth of over 75 feet, in which are bowlders, loose stones, or caving sand, a heavy wrought iron pipe, 8 inches internal diameter, is driven to the rock, and on the bottom of the pipe is placed a steel shoe, which will cut off the loose stones that may lie in the path of the pipe, and to prevent jamming the pipe. On top of the pipe is placed an iron driving cap. This pipe is driven through the earth with a heavy wooden maul, about 18 in. diameter and 15 feet long. This maul is attached to the drilling cable, and is raised and dropped on the pipe to drive it to the bed rock, the drilling and driving being done inside of the pipe alternately every eight feet. In drilling a well for water, the hole in the rock may be drilled 6 or 8 inches diameter, it not being necessary to exclude the water from the well. In drilling an oil or gas well, a hole is drilled 8 inches diameter to a depth of 600 to 1,200 feet. In this hole is then inserted a 5⅝ inch internal diameter wrought iron pipe, called casing, which must be placed in the well deep enough to shut off all the water, after which the well is drilled 5½ inches diameter to such depth as is necessary to reach the vein of gas or oil. In drilling, the driller turns the clamps, united to the temper screw by a swivel, round and round until the slack of the cable is coiled around the straight cable below the temper screw. He then reverses the motion, uncoils it, and recoils it up the other way, and repeats this constantly while the drilling is going on, thus constantly rotating the drill. While the driller is thus at work, his assistant dresses the worn bit previously employed, the forge at the side where this is done having its bellows operated by the motion of the walking beam.



PORTABLE APPARATUS FOR DRILLING WELLS 100 TO 600 FEET DEEP.

The Pierce Well Excavator Company has been particularly successful in the drilling of large and deep wells in the exceptionally hard rock and difficult strata to work found in New York city and vicinity, its angle of inclination and the crevices and small caves met with making such work very difficult. They have drilled several wells for the Manhattan Elevated Railway Company, some of them over 1,500 feet deep. The bit in this case weighed over 500 lb., and had a cutting edge of eight inches. The string of tools was all of the heaviest description, which is an indispensable condition for work of this character; but the task proceeded with as much celerity and regularity as though it had been a job of much smaller dimensions, although several previous attempts of other contractors in the same neighborhood had failed after the drilling had been carried down about 600 feet. Another well recently completed for a New York brewer, drilled to a depth of 685 feet, and 9 inches in diameter, has proved a remarkable success. The rock was the hardest kind to drill in, but the work was done in five weeks. The temperature of the water is 50° F., and, after a thorough pumping test, night and day, for a week, it was found that the well would supply over 300 gallons of water a minute without apparently diminishing the supply. The company has put down many such wells for brewers and others in Newark, Paterson, Westchester County, and other places in the vicinity of New York. One well was also put down for the Anglo-Swiss Condensed Milk Co., at Middletown, N. Y., that was over 2,000 feet deep. It is an 8 inch flowing well, and the machinery used is that from which our first page sketch was made.

Besides the plant required for making deep wells, the Pierce Well Company are manufacturers of appliances which will more economically serve for making smaller wells. They make three sizes of such machines, the first being for wells from 50 to 200 feet deep, to be operated by horse power or a small portable engine; the second size may be similarly operated for depths up to 350 feet; but beyond this depth steam power is necessarily applied, and for such wells the machinery shown in the illustration on this page has been specially constructed.

It was as a resident of Kansas, in many sections of which there is some of the richest soil in the world now comparatively worthless for want of water, that the attention of Mr. Charles D. Pierce, the manager of the company, was first directed to the subject of artesian wells. His first patents for machines for putting down such wells were granted in 1873, and these have been followed by numerous improvements, such as would suggest themselves to a practical well sinker and experienced mechanic in a wide variety of work. Among the important features of well-drilling operations in which Mr. Pierce has met with marked success has been his construction of what are called "fishing tools." These are for removing from a well any obstruction or broken tool, or other article, which, either by accident, carelessness, or malicious design, has been lost in the well or intentionally placed there. Such operations, when the well has attained considerable depth, are often extremely difficult, and tax the skill and ingenuity of the operator to the last degree. Mr. Pierce has a great variety of forms of tools for such purposes, many of them very heavy, and of the finest steel and best workmanship, some of them with bell-shaped mouths and openings above, others with various sorts of cutting and binding edges, as well as those to work one within another, something after the principle of the jar, but all such as only an extended experience could determine the form of to meet such emergencies as arise in drilling wells. Very often special tools have to be made for such cases, and an instance of this kind occurred in one well which was being drilled in New York city. A tool had to be made to cut a new pin, 3 inches diameter and 4 inches long, on the end of a 5 inch bar of iron that was several hundred feet below the surface. Another tool was made to fit the pin thus cut on this bar of iron, and grasp it firmly; then, with the auger stem on top of the jars to which this tool was attached, a force was exerted equal to over 150 tons, which jarred the iron loose from the hole. This class of tools is but seldom used except for the deepest wells, the lighter tools used with the portable rigs seldom breaking, even when the same apparatus is used for putting down hundreds of wells.

The Pierce Iron Works are at the foot of Sixth Street, Long Island City, just opposite Thirty-fourth Street, New York. Here they have extensive and complete appointments for the manufacture of all the machinery, tools, and appliances necessary for sinking oil and artesian wells, and for making the work throughout of that thoroughly good quality which is so indispensable a requisite of success in this branch of business.

Blindness due to Decayed Teeth.

Dr. Widmark, a Swedish surgeon, having as a patient a young girl in whom he was unable to detect the slightest pathological changes in the right eye, but who was yet completely blind on that side, observing considerable defects in the teeth, sent her to M. Skogsborg, a dental surgeon, who found that all the upper and lower molars were completely decayed, and that in many of them the roots were inflamed. He extracted the remains of the molars on the right side, and in four days' time the sight of the right eye began to return, and on the eleventh day after the extraction of the teeth it had become quite normal. The diseased fangs on the other side were subsequently removed, lest they should cause a return of the ophthalmic affection.