Nov. 7, 1939. C. P. BOWIE 2,178,553

WELL SLOTTER

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Fig. 1.

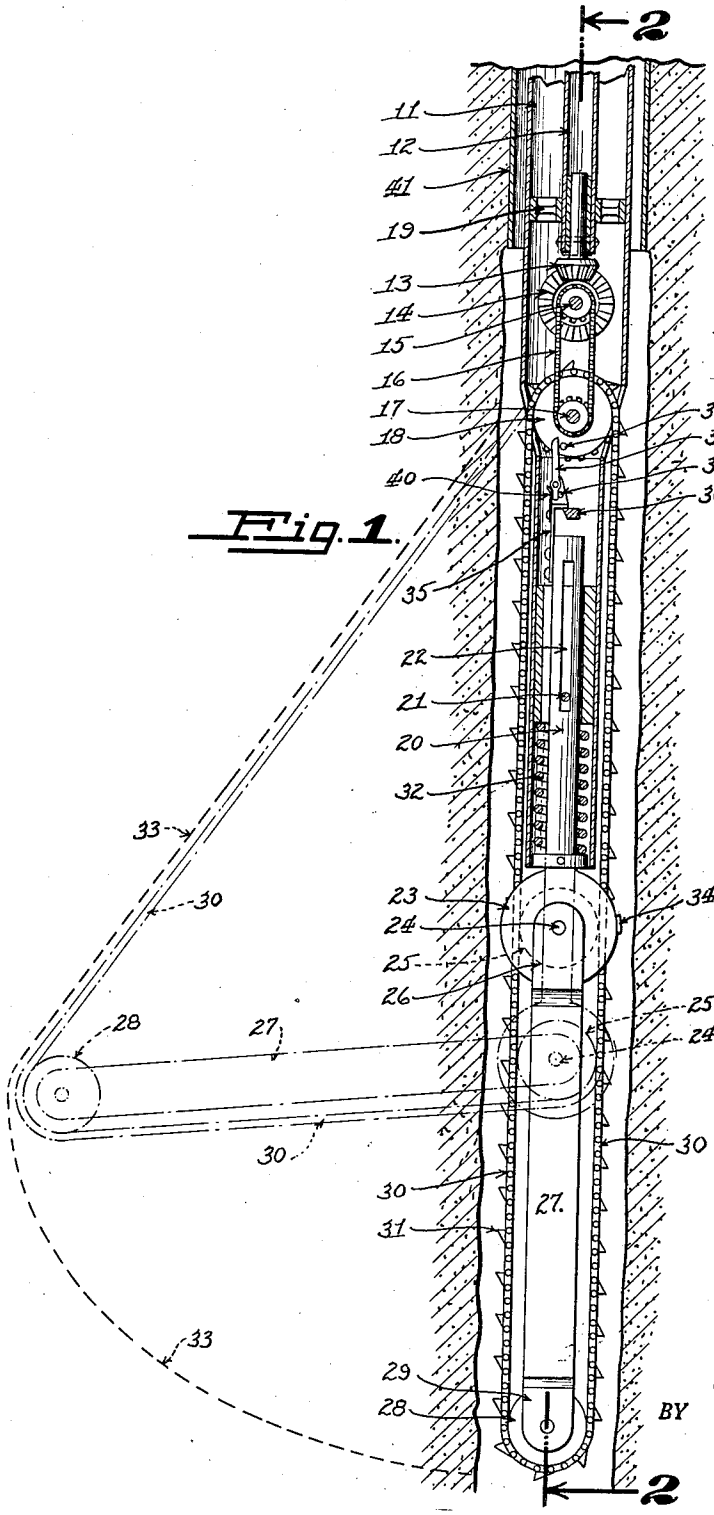
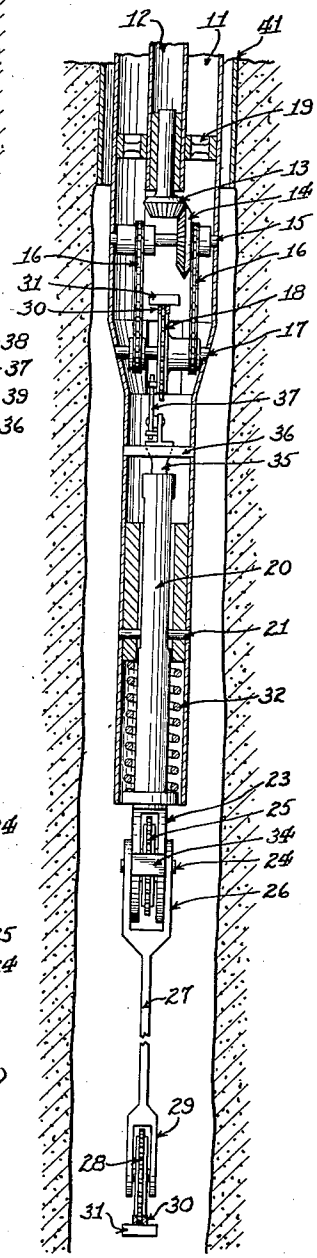


Fig. 2.



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WELL SLOTTER

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9 Claims. (Cl. 255—1)

The present invention relates to apparatus for increasing the effective producing area of a drilled well.

The principal object of the invention is to provide an apparatus which is capable of being lowered into a drilled well, and which can be operated from the surface, to cut slots in the formation into or through which the well has been drilled. The slots are vertical and extend out radially from the well, and there may be as many such slots cut, one at a time, as is desired. Each slot greatly increases the exposed area of the formation, from which the fluid may exude. Some wells which, when drilled in the ordinary way as cylindrical holes, produce comparatively little fluid because of certain adverse conditions of underground structure or pressure, can be greatly improved by increasing their effective area and thereby securing greater production. By cutting a plurality of narrow slots in the fomation, instead of reaming it out into an enlarged cylindrical chamber, the exposed area is greatly increased, without the danger of destructive caving.

A second object of the invention is to provide an apparatus for the purpose described above which is simple and rugged in construction and easy to operate, and which requires only one source of power or power transmitting connection to provide both its cutting and feeding movements. Other objects and advantages of the invention will be apparent from the following description, which should be read with the understanding that changes, within the scope of the claims hereto appended, may be made in the form, construction and arrangement of the several parts herein shown and described.

A preferred embodiment of the invention is illustrated in the accompanying drawing, in which

Fig. 1 is a vertical section showing the device in position in the well.

Fig. 2 is a vertical section taken at right angles to the plane of Fig. 1.

The apparatus requires suitable means for locating or orienting it in the well and holding it securely in position, and suitable driving means for supplying the cutting and feeding power. These holding and driving means may be located either in the well in proximity to the apparatus itself, or at the surface and connected with the apparatus by strings of tubing. The latter arrangement is shown in the drawing, the reference numeral 11 indicating a string of tubing to which the apparatus is attached and by which it is lowered or raised and held in position, and 12 indicating a smaller string of either tubing or rods which are rotated to provide the power. The means at the surface for holding the string 11 and rotating the string 12 are not shown.

The drive tubing 12 has a bevel pinion 13 secured to its lower end, which meshes with a gear 14 secured upon a horizontal shaft 15 mounted in the supporting tubing 11. Chains 16 connect said shaft 15 with a second horizontal shaft 17, on which is a sprocket 18. Suitable support must be provided for the bevel pinion 13, such as a spider 19 which provides a journal for the lower end of the tubing 12.

The diameter of the supporting tubing 11 is reduced below the shaft 17. Within this reduced portion is a vertically slidable extension 20, which is prevented from rotating by a guide pin 21 and slot 22. The lower end of said extension is enlarged, flattened and slotted, as shown at 23, and carries a horizontal spindle 24, upon which an idler sprocket 25 is mounted in the slot of said end 23. The spindle 24 also serves as a pivot for the forked upper end 26 of an arm 27, said arm extending downwardly and having an idler sprocket 28 mounted in its forked lower end 29.

A flexible endless cutter in the form of a chain 30, having spaced projecting teeth 31, operates over the sprockets 18, 25 and 28. When the drive tubing 12 is rotated in such a manner as to cause the left hand run of the chain to move upwardly, the pull of said chain will swing the arm 27 to the left (Fig. 1). The teeth 31 will, therefore, dig into the left hand side of the well, cutting a narrow slot in the formation. This continues as long as the drive tubing is rotated, the chain pulling up on the lower sprocket 28 and swinging the arm 27 more and more to the left as the cutting progresses. At the same time, the extension 20, carrying the sprocket 25, moves down to keep the chain tight. A spring 32 may be provided if necessary to assist the weight of the extension 20 to force the sprocket 25 down.

When the device has reached the position shown in broken lines, the slot in the formation will have the shape shown by the dotted line 33. The drive tubing 12 is then raised sufficiently to disengage the bevel gears 13 and 14, after which the supporting tubing 11 is pulled up, thereby straightening out the chain and forcing the arm 27 back to vertical position. The supporting tubing 11 is then turned to a new position and lowered again, whereupon a new slot can be cut. If necessary, the drive tubing 12 can be rotated in the reverse direction to help straighten out the arm 27. A bearing plate 34 is provided upon the back of the fork 23, to keep the right hand run of the chain from rubbing against the side of the well opposite the slot.

A latch is provided to keep the extension 20 in elevated position, and thereby to keep the chain straight and the arm 27 vertical, while the machine is being lowered into the well and while it is being turned from one cutting position to another. As an example of such a latch, I have

shown a spring hook 35 secured to the upper end of the extension 20 to engage a transverse keeper 36 extending across the supporting tube. A finger 37 is pivotally connected with said hook and is positioned to be engaged by a pin 38 on the sprocket 18. The finger 37 is so mounted, between a stop lug 39 and a spring 40, that when the sprocket 18 rotates clock-wise, the hook 35 is disengaged from the keeper 36, but when said sprocket is reversed, the finger only is moved without affecting the hook.

As long as the keeper 36 is engaged by the hook 35, the extension 20 is held up, and the arm 27 has no tendency to swing away from its vertical position. However, when the sprocket 18 begins to rotate in the cutting direction, the hook is released, thereby allowing the extension 20 to drop down as soon as the arm 27 swings out. The hook and keeper are provided with inclined faces as shown, so that they automatically engage when the extension 20 is raised by the straightening out of the chain.

The machine is illustrated as operating below the bottom of the well casing, which is shown at 41. It is entirely possible, however, that with cutters 31 of the proper material, the slots could be cut through the casing. Thus the machine can be operated at any point in the depth of the well.

It will be seen that the cutting means, i. e., the chain, 30 is self-feeding. The same power, applied through the rotating tubing 12, not only moves the chain linearly but also, on account of the pivotal mounting of the arm 27, causes the cutting run of said chain to swing out and feed itself laterally and upwardly into the formation. Thus only one power connection is necessary, outside of that for raising, lowering and holding the entire machine.

It will also be seen that, when the device is in inoperative position the cutter chain forms an elongated loop with substantially vertical parallel side runs, and the three supporting sprockets 18, 25 and 28 are substantially in vertical alignment, thus enabling the machine to be lowered into the well. The cutting movement of the chain, however, pulls said supporting sprockets out of alignment, and causes the side runs of the chain to spread apart into the form of a triangular loop, one of said side runs being forced against the side wall of the well to cut a slot therein.

I claim:

1. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter carried by said body, said cutter having two substantially vertical runs, means for moving said cutter, and means for spreading said runs apart to cause said cutter to cut a slot in the wall of the well.

2. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter, supporting means therefor positioned to hold said cutter when inoperative in the form of an elongated loop with susbtantially vertical side runs, and driving means for moving said cutter, the force exerted by said driving means causing the side runs of said cutter to spread apart so that at least one of said runs will cut into the wall of the well.

3. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter, movably connected supporting members therefor positioned to hold said cutter when inoperative in the form of an elongated loop with substantially vertical side runs, driving means for moving said cutter, the force exerted by said driving means causing the side runs of said cutter to spread apart so that at least one of said runs will cut into the wall of the well, and said supporting members following the spreading movement of said cutter to keep the loop thereof tight.

4. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter, movably connected supporting members for said cutter, releasable locking means for retaining said members in position to hold said cutter when inoperative in the form of an elongated loop with susbtantially vertical side runs, driving means for moving said cutter, the force exerted by said driving means causing the side runs of said cutter to spread apart so that at least one of said runs will cut into the wall of the well, and the movement of said cutter releasing said locking means to permit said supporting members to follow the spreading movement of said cutter, thereby keeping the loop thereof tight.

5. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter carried by said body, means for moving said cutter, a plurality of supporting means over which said cutter runs, said supporting means being substantially in vertical alignment to maintain the cutter in the form of an elongated loop with susbtantially vertical side runs when inoperative, and said supporting means being movable out of vertical alignment to spread the side runs of said cutter apart to cause at least one of them to cut into the wall of the well.

6. A well slotter comprising a pair of movably connected body sections, a flexible endless cutter passing around said sections, said cutter having the form of a vertically elongated loop and said sections being in substantial alignment when in inoperative position, said sections being movable out of alignment to spread the loop of said cutter laterally to cause it to cut into a wall of the well, and means for moving said cutter.

7. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter carried by said body, said cutter being in the form of a loop with two substantially vertical runs, means for moving said cutter, and means for changing the shape of said loop to spread said runs apart and cause one of them to cut a slot in the wall of the well.

8. A well slotter comprising a body capable of being lowered into a well, a flexible endless cutter carried by said body, means for moving said cutter, a plurality of supporting means over which said cutter runs in the form of a loop, and means for changing the relative positions of said supporting means to change the shape of the loop of said cutter.

9. A well slotter comprising a body capable of being lowered into a well, a vertically movable member carried by said body, a second member pivotally connected with the first member for horizontal swinging movement, a flexible endless cutter, guiding means for said cutter carried by said body and said second member, said cutter causing said second member to swing horizontally when said first member is moved vertically, and means for moving said cutter.

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