Dec. 14, 1943. F. G. BECKMAN ET AL 2,336,586

MEANS FOR AND METHOD OF SETTING WELL LINERS

Filed Dec. 26, 1940 2 Sheets-Sheet 1

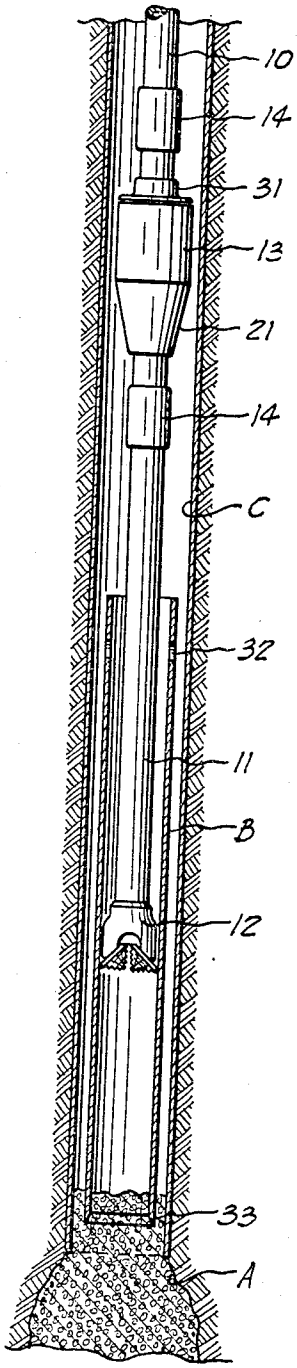


Fig. 1.

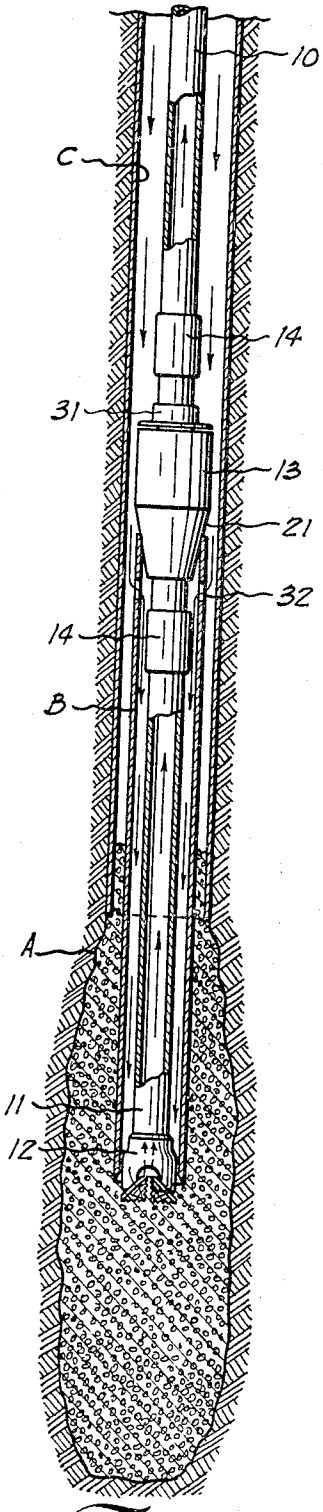


Fig. 2.

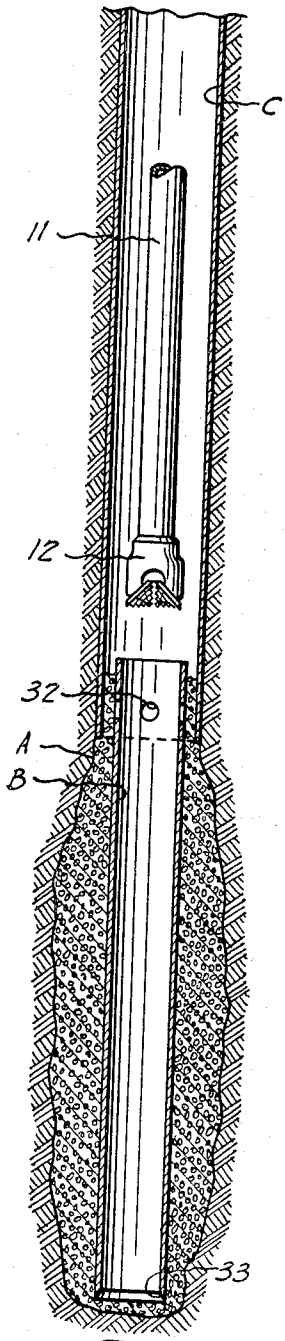


Fig. 3.

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MEANS FOR AND METHOD OF SETTING WELL LINERS

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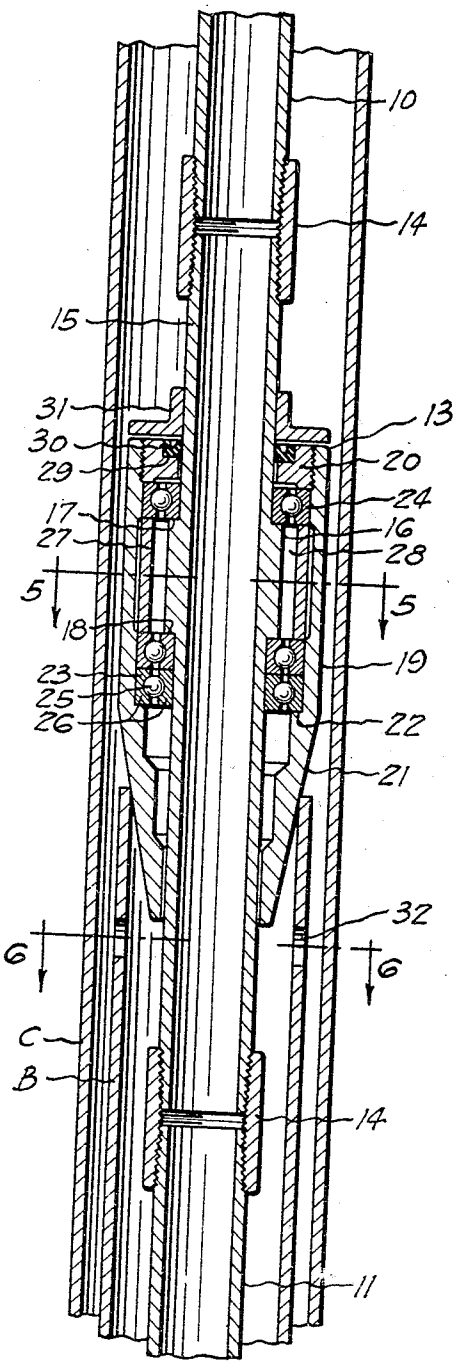


Fig. 4.

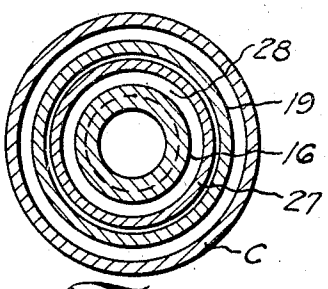


Fig. 5.

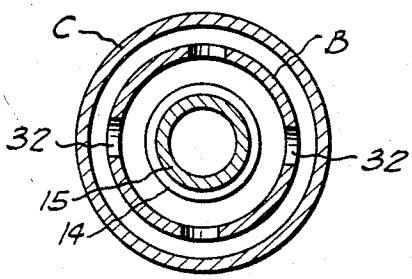


Fig. 6.

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2,336,586

UNITED STATES PATENT OFFICE

2,336,586

MEANS FOR AND METHOD OF SETTING WELL LINERS

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Application December 26, 1940, Serial No. 371,634

5 Claims. (Cl. 166—1)

This invention relates to new and useful improvements in means for and methods of setting well liners.

In the art of drilling oil wells, particularly in so-called deep wells, it has become the conventional practice to set or position a liner in the well at the producing formation to prevent caving of the formation and filling of the uncased well bore. This procedure is especially desirable when the producing formation has been treated with acid, "shot" or is extremely soft or porous. Quite frequently, the producing formation caves or "sloughs-off" before the liner can be set with the result that much difficulty is encountered in properly positioning the liner. When the formation caves and fills the well bore, it has become customary to clean out the bottom of the well by circulating a suitable liquid therethrough so as to wash the caved material, as well as any debris in the bore, to the surface. The cleaned well bore is then packed with gravel and the liner is set in the gravel. It is the setting of the liner in a gravel-packed well bore which presents the current problem. Manifestly, since the gravel is coarse and loosely packed, it has been extremely difficult, heretofore, to first drill a hole for the liner, then remove the drill stem and bit and then lower the liner into position. This is chiefly due to the fact that the removal of the drill stem loosens and causes the gravel to cave before the liner can be positioned in the new hole drilled through said gravel.

Therefore, one object of the invention is to provide an improved method of setting a liner in a well bore which consists in lowering the liner into the well bore and then drilling a hole for the reception of said liner, whereby the liner is set in position simultaneously with the drilling operation and whereby caving of the adjacent formation and filling of the hole is eliminated.

An important object of the invention is to provide an improved method of setting a liner in a gravel-packed well bore which includes, lowering the liner into the well bore so that the same is supported by the gravel, lowering the drill stem and drill bit through said liner and drilling a hole through the gravel for the reception of the liner, then withdrawing the drill stem and drill bit from the well bore without removing said liner, whereby a minimum amount of time and labor is required for the setting operation.

A particular object of the invention is to provide an improved method of the character described, wherein the weight of the drill stem may be utilized to force the liner downwardly through the gravel-packed well bore in close proximity to the drill bit to prevent caving and filling of the well bore prior to the setting of the liner, the frictional engagement of said liner with the gravel preventing upward displacement thereof upon removal of the drill stem from the well bore.

A further object of the invention is to provide improved means for setting a liner in a well bore which is so arranged that the liner may be forced downwardly into position by the weight of the drill stem simultaneously with the drilling of a hole for the reception of said liner, the internal diameter of the liner being sufficiently greater than the diameter of drill bit to permit said bit to readily pass therethrough, whereby the bit may be lowered through said liner to drill the hole and then withdrawn without removing the liner from its lowered position.

Still another object of the invention is to provide an improved device for setting a well liner which is adapted to be connected in a drill pipe above the drill bit, the device having a bore communicating with the bore of the pipe to permit a normal circulation of drilling fluid during the drilling operation and being constructed so as to permit free rotation of said drill pipe and bit relative to the liner which is held in a non-rotative position by its frictional engagement with the adjacent formation.

A still further object of the invention is to provide an improved follower, of the character described, having an outer shell which engages the upper end of the liner and an inner portion connected to the drill pipe and rotatable relative to the shell so that said liner may be forced downwardly into its set position by the weight of the drill pipe; the liner having a plurality of ports adjacent its upper end, whereby reverse circulation of a drilling fluid is accommodated.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a transverse, vertical, sectional view of a gravel-packed well bore, showing a liner supported by the gravel and the drill bit and stem being lowered through the liner in accordance with the invention,

Figure 2 is a view, similar to Figure 1, showing the drilling of a hole for the reception of the liner

and the forcing of the same downwardly by the weight of the drill stem,

Figure 3 is a similar view, showing the liner in its set position and the withdrawal of the drill bit and stem,

Figure 4 is an enlarged, transverse, vertical, sectional view of the follower,

Figure 5 is a horizontal, cross-sectional view, taken on the line 5—5 of Figure 4, and

Figure 6 is a horizontal, cross-sectional view, taken on the line 6—6 of Figure 4.

In the drawings, the numeral 10 designates the conventional rotatable drill stem or pipe which is adapted to be lowered through the well bore A and which has the usual drill collar 11 and drill bit 12 connected to its lower end. A follower sleeve 13 is coupled in the drill pipe, one or more sections above the collar 11, by suitable coupling collars 14. The follower sleeve 13 includes an elongate, tubular mandrel 15 which is co-axial and communicates with the bore of the drill pipe, as is clearly shown in Figure 4. A collar 16 is preferably made integral the external intermediate portion of the mandrel to provide an upwardly-disposed external, annular shoulder 17 and a complementary downwardly-disposed shoulder 18, as is clearly shown in Figure 4. A cylindrical shell or sleeve 19 surrounds the mandrel 15 and has its upper end internally screw-threaded to receive a collar or ring 20. The lower external portion of the shell 19 is reduced in diameter and is tapered or inclined inwardly, as shown at 21, to provide a frusto-conical bearing surface. However, the bore of this reduced portion of the shell is of greater diameter than the mandrel 15 so as to be spaced therefrom. An internal, annular seat or shoulder 22 is formed within the bore of the shell immediately above the tapered portion 21, whereby suitable ball bearings 23 may be supported within said shell.

For rotatably supporting the shell 19 relative to the mandrel 15, a ball bearing 24 is interposed between the upper annular shoulder 17 of the mandrel and the collar 20. When the shell is supported by the underside of the ring 20 engaging the ball bearing 24, the ball bearings 23 will be confined between the seat 22 of said shell and the downwardly disposed shoulder 18 of the mandrel. These ball bearings are constructed in the usual manner and include a plurality of balls 25 confined between annular inner and outer races 26. Of course, the internal diameter of the inner races is substantially equal to the external diameter of the mandrel so as to have a snug fit therewith, while the outer races have an external diameter substantially equal to the internal diameter of the shell which they engage. Thus, free rotation of the mandrel with relation to the shell is permitted. For maintaining the ball bearings in position, an annular spacer member or sleeve 27 of the same length as the collar 16 of the mandrel is interposed between the ball bearings 24 and the uppermost ball bearing 23. The diameter of the spacer 27 is sufficiently greater than the collar 16 to permit said spacer to engage the outer races 26 of the ball bearings and to provide an annular space 28 between said spacer and said collar for lubrication purposes (Fig. 5).

An annular recess or groove 29 is formed within upper, inner peripheral portion of the collar 20 for supporting a V-shaped, pressure-seal packing ring, of rubber, synthetic rubber or other resilient material. A circular cap 31, of metal or other suitable material, surrounds the mandrel 15 immediately above the packing ring 30 and engages the upper surfaces of said ring, collar 20 and the shell 19, which lie in substantially the same horizontal plane, to prevent fluid from entering the upper end the follower 13. From the foregoing, it is readily apparent that the mandrel 15 is rotatable with the drill stem, to which it is directly connected, without rotating the shell 19 due to the provision of the ball bearings 23 and 24.

The tapered portion 21 of the shell 19 is arranged to engage within the upper end of a liner or sleeve B which is normally positioned within the lower uncased portion of the well bore immediately below the lower end of the casing C. A plurality of ports or openings 32 are formed in the upper end of the liner (Figure 6) to permit circulation of the drilling fluid down through the casing, past the follower 13, into the annular space between the liner and the drill stem to the bit, then up through the bit, drill stem and mandrel to the surface. As shown in Figure 1, the diameter of the bore of the liner is greater than the diameter of the bit 12 to permit the same to pass therethrough. For facilitating the setting of the liner, the lower end thereof may be sharpened or bevelled inwardly as shown at 33.

After the uncased portion of the well has been cleaned by a suitable wash tool (not shown), the same is packed with gravel, as shown in Figure 1. The liner B is then lowered in position by a suitable tool (not shown) and allowed to rest upon the gravel. Due to the provision of the knife-edge 33 and the weight of the liner, the lower end of said liner will be embedded some distance in the gravel. The drill stem 10, having the follower 13 and drill bit 12 connected to its lower end, is moved downwardly within the casing C and liner B until said bit strikes the gravel within the lower portion of the well bore. At this time, the drilling operation is commenced with the drilling fluid being circulated downwardly through the casing outside of the drill stem, then through the ports 32 of the liner, through the annular space between said liner and the lower portion of said drill stem and upwardly through the bit, drill stem and mandrel 15, as indicated by the arrows in Figure 2. As the drilling continues, the bit penetrates a portion of the gravel and the cuttings which are removed by the rotating bit are carried to the surface of the well by the circulating drilling fluid. When the drilling has progressed a sufficient distance, the tapered portion 21 of the shell 19 of the follower 13 will engage the upper end of the liner B so as to force the same downwardly through the gravel as shown in Figure 2. Since the liner is held stationary by its frictional engagement with the gravel, the shell 19 will also remain stationary after it has been moved into engagement with said liner. However, as has been hereinbefore explained, free rotation of the drill bit, stem and mandrel 15 relative to said shell is not interfered with due to the provision of the ball bearings. Thus, the weight of the drill stem may be utilized to force the liner downwardly through the gravel, while said drill stem is being rotated in the usual manner, whereby the setting of the liner and the drilling of a hole for the reception of said liner may be effected simultaneously.

After the liner has been forced downwardly to the bottom of the well bore, the drill bit and stem may be withdrawn from the well as shown in Figure 3. This removal of the drill stem and bit after the completion of the setting operation is

permitted because the diameter of said bit is smaller than the bore of the liner. Due to the frictional engagement of the liner with the gravel-packed well bore, said liner will remain in its set position upon the removal of the drill stem and drill bit.

From the foregoing, it is readily apparent that after a well bore has been cleaned and packed with gravel, a liner may be set in said gravel-packed well bore simultaneously with the drilling of a hole for the reception of said liner. The provision of the follower 13 with its shell 19 rotatable relative to the mandrel 15 and drill stem 10 permits the utilization of the weight of said drill stem in forcing the liner through the gravel without interfering with the normal rotation of the stem during the drilling operation. Since reverse circulation of drilling fluid is employed in this improved method of setting a well liner, the provision of the circular cap 31 and pressure-seal packing ring 30 at the upper end of the follower is sufficient to pack off the interior thereof and prevents said fluid from entering the same. Obviously, this method is much more positive, economical and quicker than the conventional methods of setting well liners.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What we claim and desire to secure by Letters Patent is:

1. The method of setting a liner in a well bore which includes, packing the lower portion of the well bore with gravel, lowering the liner into the well bore, and then drilling a bore through the gravel for the reception of said liner, whereby the liner may be set in position simultaneously with the drilling operation.

2. The method of setting a liner in a well bore which includes, packing the well bores with gravel, lowering the liner into said well bore into supporting engagement with the gravel, then drilling through the gravel below the liner to form a bore for the reception of said liner, and simultaneously forcing the liner downwardly through said gravel.

3. The method of setting a liner in a well bore which includes, packing the well bore with gravel, lowering the liner into said well bore into supporting engagement with the gravel, then lowering a drill stem and drill bit into the well bore and through said liner, rotating the stem and bit to drill a bore through the gravel for the reception of the liner, utilizing the weight of said stem to force said liner downwardly through said gravel into the drilled bore simultaneously with the drilling operation, and then withdrawing the stem and bit from said drilled bore and well bore.

4. An apparatus for setting a liner in a well bore including, a rotatable drill pipe having a drill bit secured to its lower end, the bit being of less diameter than the bore of the liner to be set in order to permit said bit to pass therethrough to drill a bore for the reception of said liner, and a sleeve connected to the pipe above the bit and rotatable relative thereto for engaging the upper end of the liner to transmit the weight of said pipe thereto, whereby said liner may be forced downwardly into the drilled bore by the weight of the pipe simultaneously with the drilling of said bore without rotation of the liner.

5. In combination with a well liner adapted to be set within a well bore, an apparatus for setting the same including, a rotatable drill pipe, a drill bit having an external diameter less than the bore of the well liner attached to said drill pipe so that it may be lowered through said liner, and a follower carried by the drill pipe and rotatable relative thereto for engaging and transmitting the weight of said pipe to the upper end of the liner, whereby the weight of the pipe may be imposed on said liner to force the same downwardly within the bore without rotating the liner.

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