Dec. 7, 1937. W. C. CHONETTE ET AL 2,101,640

METHOD AND APPARATUS FOR CEMENTING WELLS

Filed Oct. 7, 1935 2 Sheets-Sheet 1

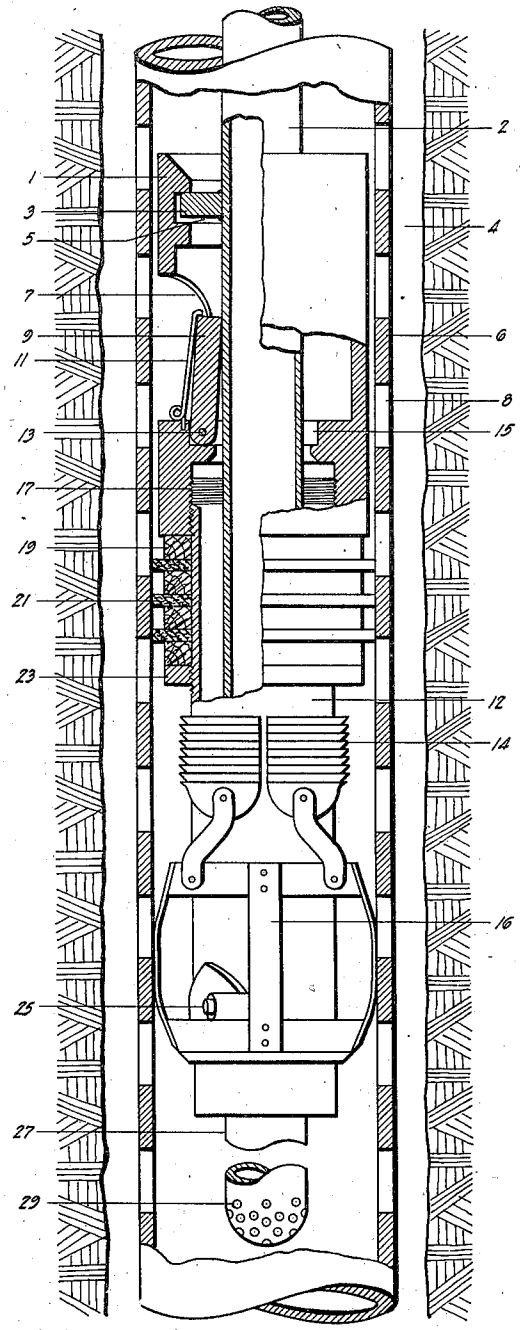

Fig. 1.

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By their Attorney: [illegible]

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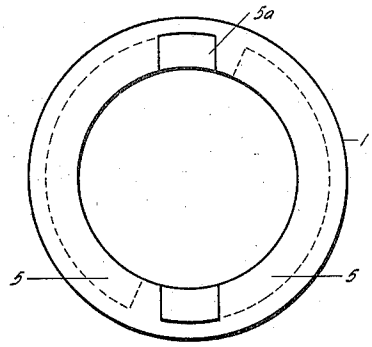

FIG. 3.

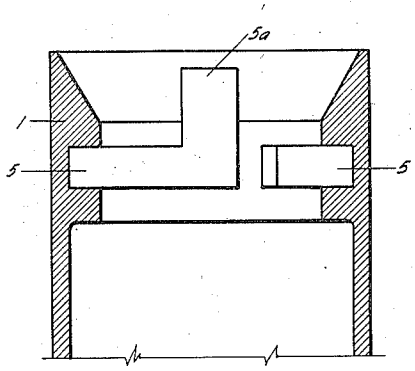

FIG. 2.

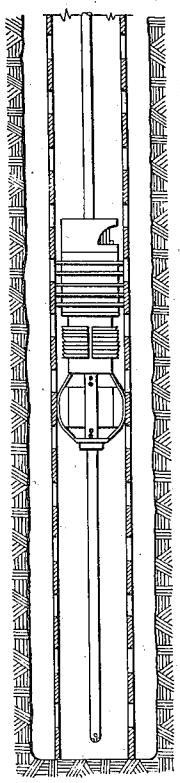

FIG. 4.

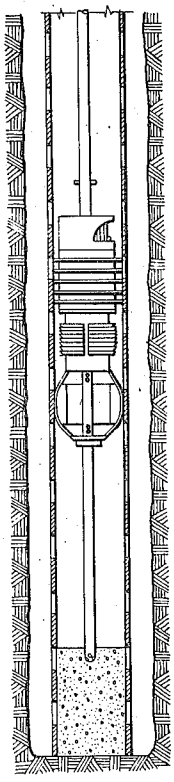

FIG. 5.

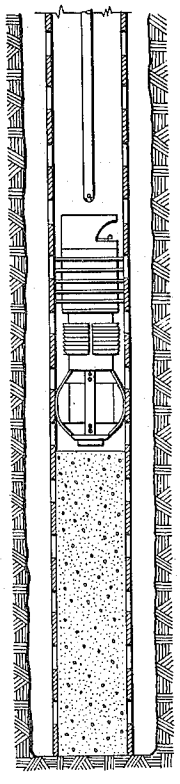

FIG. 6.

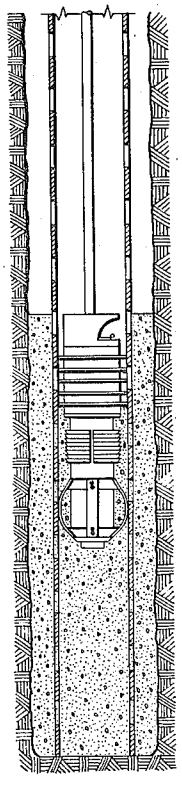

FIG. 7.

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UNITED STATES PATENT OFFICE

2,101,640

METHOD AND APPARATUS FOR CEMENTING WELLS

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Application October 7, 1935, Serial No. 43,848

9 Claims. (Cl. 166—21)

This invention relates to the art of cementing oil wells and pertains more particularly to an improved method and apparatus for cementing oil wells fitted with liners or strings of casing without removing the latter from the well.

During drilling operations, it often becomes necessary to place a cement plug opposite an "interval" that is, a certain vertical stretch of the well where the well penetrates a formation containing water, in order to prevent the water from entering the well. In cases where an oil string or pipe has not already been permanently set by cementing at a level above the desired point, and it is possible to remove the string of casing before attempting to place the cement plug, the operation is relatively simple and may easily be carried out by available methods and devices. However, in cases where a casing is to be cemented which cannot be removed, or a perforated casing is used, considerable difficulties are experienced in effectively cementing a well. Thus, it is known to place a cement mixture inside a perforated pipe at the desired point and to utilize the static pressure due to the difference in specific gravity of the cement mixture and of the well fluid present in the borehole. The pressure developed by this method is, however sometimes insufficient to drive all of the cement charge through the casing perforations, so as to fill effectively the space outside the casing. It is also known to utilize explosives to rupture the casing at the desired point, thereby permitting the cement to flow out of the pipe and to form a bond with the formation. This method is, however obviously expensive and hazardous.

It is an object of this invention to provide a method and apparatus which overcomes the disadvantages of the present methods and equipment by applying the positive mechanical pressure of the weight of part or all of a tubing string on top of a packer lowered into the casing to force the cement slurry into the annular space between the casing and the borehole.

It is a further object of this invention to provide a method and apparatus which could be used in cementing bottom, intermediate and top zones of oil wells provided with perforated casing.

It is another object of this invention to provide a method and apparatus which makes it possible to circulate mud fluid in the well during and after the cementing operation, thereby effectively removing the excess cement slurry from the tubing and casing.

The construction and operation of this cementing device will be understood from the following description of a preferred embodiment, without, however, in any way limiting thereto the present invention, which consists broadly in running a packer or plunger body on a tubing string into a cased well, anchoring it therein, introducing a cement mixture into the space below the packer, and then applying the positive mechanical pressure of the weight of part or all of the tubing string to the top of the packer to force it down, whereby the packer, acting as a plunger or piston, forces the cement slurry around the lower edge of the casing, or through the perforations in said casing, into the annular space between the walls of the borehole and the casing.

In the accompanying drawings:

Figure 1 shows an elevation view, partly in cross-section, of the packer or plunger body;

Figure 2 gives a detailed cross-sectional view of the upper part of the packer or plunger body, the tubing being shown withdrawn therefrom.

Figure 3 is a plan view of figure 2.

Figures 4, 5, 6 and 7 diagrammatically show the relative positions of the packer or plunger body during the successive steps of the cementing process.

Referring to Figure 1, a string of casing 6, which may have perforations 8, is shown lowered into a borehole 4. The packer or plunger body is indicated in general by the numeral 12. It is lowered into the borehole inside the casing at the end of a tubing string 2. The upper section 1 of the packer body 12, which may form an integral part thereof, or may be rigidly connected thereto in any other manner, as, for example, by means of screw-threads 17, has a recess 5 adapted to receive lugs 3, which are integral with the tubing string 2, being, for example, welded thereto. The packer body is rigidly connected to the tubing 2 by means of these lugs. However, as shown in Figures 2 and 3 the lugs may be withdrawn from recess 5 through vertical slots 5A by rotating the tubing 2, and thereby disconnecting it from the packer body. The section 1 has in its lower part a recess 15 wherein a flap-valve 9 is mounted on an axis 13. This flap-valve is under the pressure of a spring 11, and automatically closes the recess 13 as soon as the tubing 2 is withdrawn from the packer body. The section 1 has also an outside opening 7 through which the flap-valve may be raised and set when the device is being prepared for operation. The packing proper is shown as consisting of alternating rings of wood 19 and of leather 21, although it may be constructed in any other suitable manner, and any other fibrous, plastic or semi-plastic material may be used, such,

for example, as rubber, rubberized canvas, brass, bronze, etc. The rings 19 and 21 are firmly held between the upper section 1 and a steel ring 23 screwed on the mandrel of the packer body 12. Automatic slips 14 are mounted on the packer body 12 below the packing, and are actuated by a tripping mechanism 25 to expand and firmly grip the casing 6 when the tubing 2 is rotated in a direction opposite to that which is used to disengage lugs 3 from the recess 5. The construction of the slips 14 and of the tripping mechanism 25 is conventional, and forms no part of this invention; it is recited here only inasmuch as it is necessary for the operation of the present invention. Guides 16 may be provided on the lower part of the packer body 12. A portion 27 of the tubing 2 extends below the packer body, and is provided with holes 29, through which the cement slurry or the mud fluid may be circulated. This portion 27 is preferably, but not necessarily, externally flush jointed in order that it may pass freely through the recess 15.

The operation of the device will be understood from the following description, taken with reference to Figures 4, 5, 6 and 7, which illustrate the various steps of the present process.

The oil well casing is first cleaned throughout its length from the surface to the bottom of the interval where it is desired to effect the cementing, the perforations of the casing being, if desired, washed. The packer body is then lowered to the desired depth at the end of a string of tubing, with the slips 14 locked in a contracted position and the flap valve 9 held open by the tubing 2, as shown in Figure 4. The length of the tubing 27 is preferably arranged so that when it touches the bottom of the borehole, the packer rings 19 and 21 are slightly above the top of the interval where the cementing is to be effected. If it is desired to cement the borehole opposite an interval which is not adjacent to the bottom thereof, but lies in some intermediate or top zone, an ordinary plug made of wood, leather, rubber, canvas, etc., may be first set in the casing at the desired point, whereupon the device of the present invention is lowered until the tubing 27 touches said plug, or lies in close proximity thereto.

When the device has assumed its correct position in the borehole, the slips 14 are set by rotating the tubing in one direction, for example, to the left, and slightly pulling the tubing up. The tubing is then released from the packer body, but not withdrawn therefrom, by rotating it in the opposite direction, for example, to the right, which frees the lugs 3 from the recess 5, as shown in Figure 5. The circulation of the fluid through the tubing is then established, and the required amount of cement slurry pumped into the bottom of the perforated pipe, or on top of the plug if the cementing is being effected in an intermediate or top zone. The upper level of the cement should preferably be just below the packer body when the tubing is withdrawn from said packer body, as shown in Figure 6. As the end 27 of the tubing is pulled through the recess 15, the flap valve 9 is automatically closed by the action of spring 11, the slips 14 preventing the packer body from being raised with the tubing during this operation. Mud fluid is then circulated through the tubing on top of the packer body to prevent any cement from remaining within the tubing or perforated casing above the packer. While the mud fluid is being circulated, the tubing is again lowered and the pressure due to part or all of its weight is applied to the top of the packer body, closed by flap valve 9. This pressure releases the slips 14 and moves the packer body down the casing. The piston or plunger action of the packer body forces the cement slurry around the lower edge of the casing or through the perforations in the casing into the annular space between the casing and the borehole, as shown in Figure 7, thus effectively cementing the well. Any cement slurry leaking through the packing rings 18 and 19 or passing back into the casing through its perforations above the packer is removed to the surface by the circulating mud or other fluid, whereby the possibility of cementing the tubing or of bridging the casing is eliminated. When the cement has set, the packer remains cemented in the casing, and as it is preferably constructed of such materials as cast iron, bronze, leather, rubber, wood, etc., it may be, if required, easily drilled out during subsequent operations.

The terms "tubing" and "tubing string" used herein are to be construed in a broad sense to mean any hollow tube lowered into a borehole such as oil well tubing, oil well casing, drill pipe, line pipe, etc.

We claim as our invention:

1. In the process of cementing wells provided with casing, the steps of lowering thereinto a packer body detachably attached to a tubing string extending through the packer body, anchoring said body within the casing against upward motion, placing a fluid cementing mixture below the packer body withdrawing the tubing from the packer body, closing the bore in the packer body, and applying the mechanical pressure of the tubing string to the top of the packer body, said pressure being sufficient to move the packer body downward and to force the cementing mixture below the packer body into the space between the walls of the borehole and the casing.

2. In the process of cementing wells provided with perforated casing, the steps of lowering thereinto a packer body detachably attached to a tubing string extending through the packer body, anchoring said body within the perforated casing against upward motion, placing a fluid cementing mixture below the packer body withdrawing the tubing from the packer body, closing the bore in the packer body, and applying the mechanical pressure of the tubing to the top of the packer body, said pressure being sufficient to move the packer body downward and to force the cementing mixture below the packer body through the perforations in the casing into the space between the walls of the borehole and the casing.

3. In the process of cementing wells provided with casing, the steps of lowering thereinto a packer body detachably attached to a tubing string passing through a bore in said body, anchoring said body within the casing against upward motion, placing a cementing mixture through the tubing into the space below the packer body, withdrawing the tubing from the packer body, closing the bore in the packer body, and circulating a fluid mixture in the tubing and the casing above the packer body while applying the mechanical pressure of the tubing string to the top of the packer body, said pressure being sufficient to move the packer body downward and to force the cementing mixture below the packer body into the space between the walls of the borehole and the casing.

4. In the process of cementing wells provided

with perforated casing, the steps of anchoring a plug in the casing near the bottom of the interval where the cementing is to be effected, lowering into the well a packer body detachably attached to a tubing string passing through a bore in said body, anchoring the packer in the casing at a point above the plug, placing a cementing mixture through the tubing into the space between the plug and the packer body, withdrawing the tubing from the packer body, closing the bore in the packer body, and circulating a fluid mixture in the tubing and the casing above the packer body while applying the mechanical pressure of the tubing string to the top of the packer body, said pressure being sufficient to move the packer body downward and to force the cementing mixture between the packer body and the plug into the space between the walls of the bore hole and the casing through the perforations in said casing.

5. A device for cementing wells provided with casing, comprising a string of tubing, an elongated cylindrical packer body, a vertical bore through the packer body, said bore providing an unobstructed passage for said tubing, means unitary with the tubing for discharging a fluid into the casing below said packer body, means detachably attaching the packer body to the tubing, means on the packer body adapted for gripping engagement with the casing, means for disconnecting and withdrawing the tubing together with the fluid discharge means from the packer body, and a valve adapted to close the vertical bore in the packer body when the tubing is withdrawn therefrom.

6. A device for cementing wells provided with casing, comprising a string of tubing, an elongated cylindrical packer body, a vertical bore through the packer body, said bore providing an unobstructed passage for said tubing, means unitary with the tubing for discharging a fluid into the casing below said packer body, means detachably attaching the packer body to the tubing, means on the packer body adapted for gripping engagement with the casing, means for disconnecting and withdrawing the tubing together with the fluid discharge means from the packer body, and means to apply the downward pressure of the tubing string to the top of the packer body.

7. A device for cementing wells provided with casing, comprising a string of tubing, an elongated cylindrical packer body, a vertical bore through the packer body, said bore providing an unobstructed passage for said tubing, means unitary with the tubing for discharging a fluid into the casing below said packer body, means detachably attaching the packer body to the tubing, means on the packer body adapted for gripping engagement with the casing, means for disconnecting and withdrawing the tubing together with the fluid discharge means from the packer body, and means to apply the downward pressure of the tubing string to the top of the packer body, said last means comprising a valve adapted to close the vertical bore in the packer body when the tubing is withdrawn therefrom.

8. A device for cementing wells provided with casing, comprising a string of tubing, an elongated cylindrical packer body, a vertical bore through the packer body, said bore providing an unobstructed passage for said tubing, means unitary with the tubing for discharging a fluid into the casing below said packer body, means detachably attaching the packer body to the tubing, means on the packer body adapted for gripping engagement with the casing, means for disconnecting and withdrawing the tubing together with the fluid discharge means from the packer body, and means to apply the downward pressure of the tubing string to the top of the packer body, said packer body being made of a material adapted to be drilled out of the borehole.

9. In the process of cementing wells provided with casing, the steps of lowering thereinto a packer body detachably attached to a tubing string extending through said packer body, anchoring said packer body within the casing against upward motion, placing through the tubing a cementing mixture below the packer body, withdrawing the tubing from the packer body, closing the bore in the packer body, circulating a fluid mixture in the tubing and casing above the packer while applying a mechanical pressure by means of the tubing string to the top of the packer body, said pressure being sufficient to move the packer body downwardly and to force the cementing mixture below the packer into the space between the walls of the borehole and the casing, withdrawing the tubing from the borehole, allowing the packer body to remain embedded in the cement mixture, allowing said mixture to form a hard cement plug by setting, and drilling through said cement plug.

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