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APPARATUS FOR SELECTIVELY CEMENTING PIPE CASING

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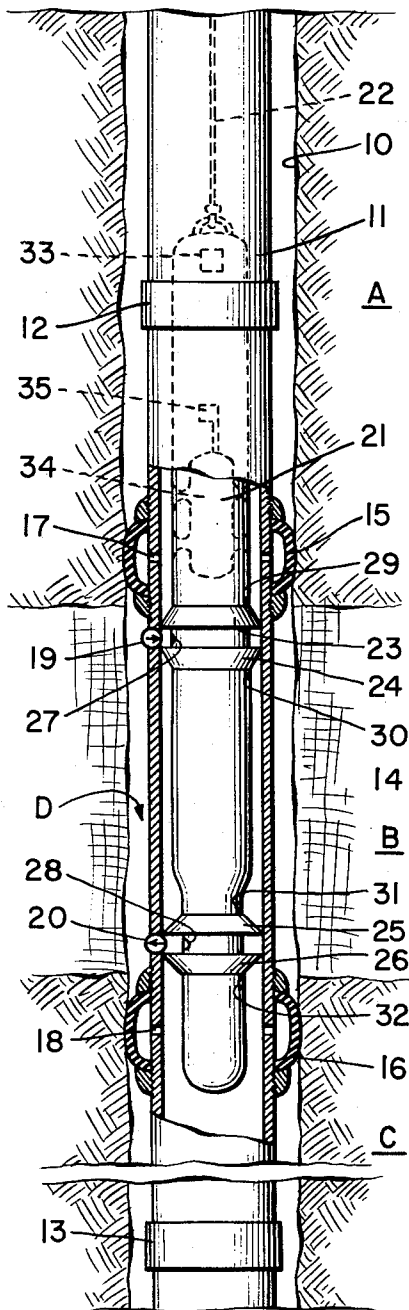


FIG. 1.

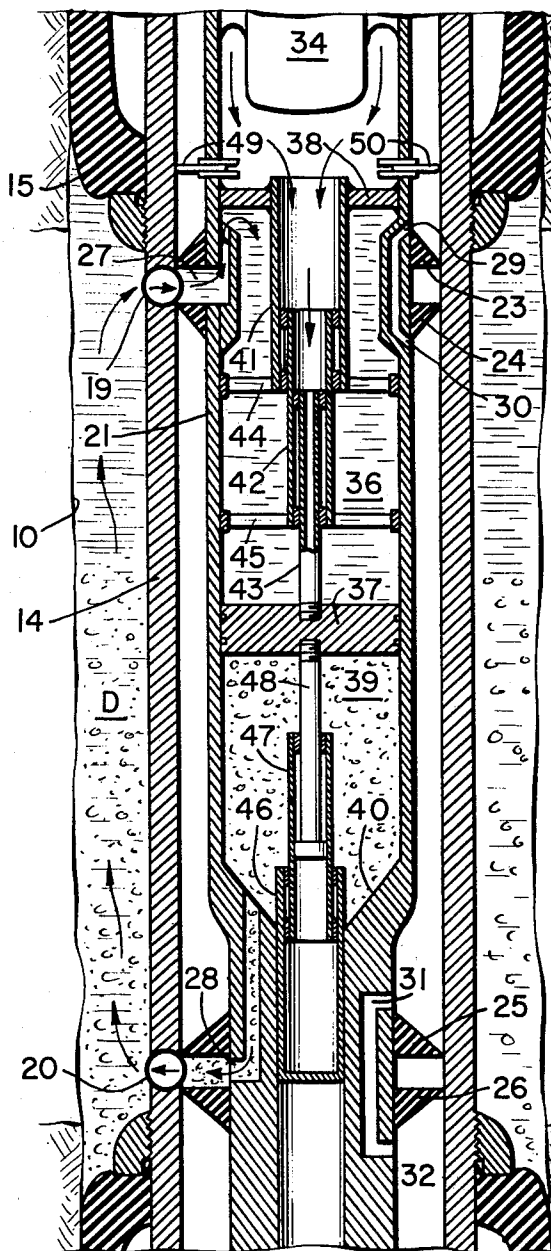


FIG. 2.

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This invention relates generally to oil well operations and more particularly to a novel method and apparatus for selectively cementing certain portions of pipe casing or liners in bore holes.

It is conventional practice in completing a bore hole to cement casing or liners in the bore hole in order to retain the side walls in a stable condition. There are many instances, however, when it would be desirable to cement only selected portions of the well casing so that other portions may be left uncemented in accordance with subsequent desired operations. By selective cementing, complete isolation of various intervals or zones within the bore hole can be effected without exposing productive zones or zones of injection to the various hazards inherent in present day cementing processes. Further, selective cementing could be employed to eliminate the necessity of perforating through the cement itself by zoning off the particular levels at which perforation is to take place with selective cementing above and below such zone.

Accordingly, it is a primary object of this invention to provide a method and apparatus for carrying out selective cementing of well casing in bore holes to the end that certain portions may be cemented and other portions left free of cement as circumstances dictate.

In accordance with the method of the invention, the following steps are carried out: First, the selected zone or interval of casing and adjacent surrounding earth formations to be cemented are packed off at their upper and lower ends to define an annular space between the selected casing portion and the adjacent formations. Second, suitable communication inlet and outlet passages between the interior of the casing section and the upper and lower interior portions of the annular space are provided. Third, cement is passed through one of the communication passages from within the casing to the annular space. Fourth, the material within the annular space displaced by the cement is passed back into the casing. Finally, the displaced material received within the casing is collected until the entire annular space is filled with cement. The collected displaced material may then be removed from the bore hole.

The preferred apparatus for carrying out the foregoing method contemplates the provision of a special casing sub inserted at the time casing or lining pipe is placed in the bore hole in a position corresponding to the particular earth formations to be cemented. This section of casing includes suitable upper and lower packing means for packing off the selected portion to define an annular space between the packers and the surrounding earth formation. The casing section itself includes inlet and outlet passages.

Cooperating with the foregoing structure is an elongated cylindrical member having a hollow interior filled with cement. This member is arranged to be lowered through the casing pipe to a position within the selected casing portion and includes suitable openings for registration with the inlet and outlet passages in the casing section itself. The hollow interior of the member includes a piston and suitable means for moving the piston to urge cement from the member through one of its openings into the annular space and simultaneously receive material displaced by the cement in the annular space through the other of its openings. The member itself thus serves

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to both dispense the cement and simultaneously collect the material displaced by the cement. When the desired zone has been cemented, the member may then be withdrawn from the bore hole.

A better understanding of both the method and apparatus of the present invention will be had by referring to the accompanying drawings, in which:

FIGURE 1 illustrates a bore hole and surrounding earth formations including a zone to be selectively cemented together with a suitable apparatus for carrying out the cementing operation; and

FIGURE 2 is an enlarged view partly in cross section of the apparatus shown in FIGURE 1.

Referring to FIGURE 1, there is shown a bore hole 10 in which casing pipe 11 has been inserted. The pipe 11 is connected by conventional casing collars such as indicated at 12 and 13. Between the collars 12 and 13, there is provided a casing section 14 positioned in the string of casing pipe such that it will be juxtaposed a zone of earth formation which is to be cemented. For example, in the illustration of FIGURE 1, there are shown different earth strata such as zone A at the upper portion of the drawing, B at the central portion of the drawing, and C at the lower portion of the drawing. Assuming that it is desired to cement the casing section juxtaposed the zone B and leave the zones A and C uncemented, the special casing section 14 is positioned adjacent to the zone B as shown.

To isolate the zone B for the cementing operation, there are provided first and second longitudinally spaced packers 15 and 16 secured to casing section 14. These packers may be expanded through suitable orifices 17 and 18 in the casing section 14 by conventional equipment. The particular type of packers are not relevant to the present invention and therefore are not described in detail. It is only necessary that an annular seal be provided so that the particular zone to be cemented is isolated from the remaining portions of the bore hole.

The casing section 14 also provides inlet and outlet passages provided with check valves 19 and 20. These inlet and outlet passages are disposed adjacent to the respective upper and lower packing members 15 and 16 and provide communication between the casing and annular space D defined by the casing section 14 and the surrounding earth formation.

After the particular casing section 14 has been properly positioned and the packers expanded in sealing engagement, a cementing tool in the form of an elongated cylindrical member 21 is lowered through the casing as by a suitable cable 22 into the casing section 14 as shown. The cylindrical member 21 includes an upper pair of annular sealing lips 23 and 24 longitudinally spaced to define an annulus in communication with the inlet passage check valve 19 in the casing section 14. Similarly, a lower portion of the cylindrical member 21 includes a second pair of annular sealing lips 25 and 26 longitudinally spaced from each other to define a sealed annulus in communication with the outlet passage check valve 20. The interior of the member 21 is hollow and is placed in communication with the respective annuli between the first pair of annular sealing lips 23 and 24 and the second pair of annular sealing lips 25 and 26 as by communication openings 27 and 28. The member 21 also includes by-pass passages having outlet and inlet ports 29 and 30 on either side of the upper annular sealing lips 23 and 24 and outlet and inlet ports 31 and 32 on either side of the lower pair of annular sealing lips 25 and 26. The by-pass passages permit mud or other fluid in the casing to bypass around the annular sealing lips when the cylindrical member 21 is being lowered by the cable 22 into the casing.

As indicated by the dotted line representations, the extreme upper end of the cylindrical member 21 may include a collar locator 33 of a general type as discussed on page 614 of "Petroleum Production Engineering" by Uren, copyright 1956, by McGraw-Hill Book Company Inc., to facilitate positioning of the member 21 such that the pairs of annular sealing lips will register properly with the inlet and outlet passages 19 and 20 in the casing section 14. The upper interior portion of the cylindrical member 21 also includes a source of compressed gas within a suitable container 34 arranged to be released by a control 35 which may be actuated from the surface of the bore hole through the cable 22.

Referring now to FIGURE 2, the details of construction within the cylindrical member 21 will be described. As shown, the hollow interior of the elongated cylindrical member 21 includes a first chamber 36 defined by the upper side of a piston 37 and the under side of an upper partition 38. The piston 37 also defines a second chamber 39 between its under side and the lower bottom portion 40 of the member 21. Piston 37 is arranged to move longitudinally up and down within the interior of the member 21. When the piston 37 moves downwardly, the volume of the second chamber 39 is decreased and the volume of the first chamber 36 is increased.

In an actual physical embodiment of the member 21, the hollow interior is of considerable length and in order to accommodate a suitable piston guiding structure forming the counterpart to a piston rod, there are provided a first plurality of telescoping pipe sections 41, 42, and 43. The pipe sections 41 and 42 are in turn provided with radially extending spider structures 44 and 45 terminating at the side walls of the first chamber 36 in sliding engagement therewith. These spider structures serve to centralize and help guide the various telescoping pipes during movement of the piston 37. A second plurality of telescoping pipes 46, 47, and 48 connect between the under side of the piston and base of the tool as shown. With this arrangement, as the piston 37 moves from its uppermost position towards its lowermost position, the upper plurality of telescoping guide pipes will telescope outwardly and the lower plurality of telescoping pipes will telescope together inwardly.

The second interior chamber 39 is initially filled with cement and the piston 37 is initially in its uppermost position. In FIGURE 2, the piston 37 is shown in an intermediate position. The various first and second communication openings 27 and 28 and by-pass passage ports 29, 30, 31, and 32 are clearly shown in FIGURE 2.

At the upper portion of the elongated member 21, there are provided suitable locking pins 49 and 50 equivalent to slips and arranged to extend laterally from the elongated member to engage the side walls of the casing section 14 to hold the member 21 in its set position.

The operation of the cementing tool shown in FIGURES 1 and 2 will be evident from the foregoing description. As mentioned heretofore, the special casing section 14 is first positioned adjacent the zone to be selectively cemented, and the packers 15 and 16 of FIGURE 1 radially expanded to engage above and below the selected portions of the earth formation defining the annular space D. The tool 21 is then lowered through the casing and accurately positioned by means of the magnetic locating apparatus 33 for detecting the presence of the collars such as the collar 12 of the casing pipe. Magnetic collar locators are well known in the art and form no part of the present invention. Any other suitable means for properly positioning the elongated cylindrical member 21 such that the annulus defined by the upper and lower pairs of sealing lips 23, 24, and 25, 26 properly register with the inlet and outlet check valves 19 and 20 could be used.

When the member 21 is properly positioned, the gas under pressure within the container 34 is released by any suitable actuating mechanism operable from the surface

of the bore hole. The escaping gas is indicated by the arrows in the upper portion of FIGURE 2 and will be confined by the partition 38. This gas will initially serve to eject the locking pins 49 and 50 thereby securing the member 21 in its set position. The gas will also expand within the upper plurality of telescoping pipes as indicated by the arrows to cause the same to telescope outwardly and urge the piston 37 downwardly.

This downward movement of the piston 37 will thus force the cement in the second lower chamber 39 through the outlet opening 28 into the annulus between the sealing lips 25 and 26. This cement will then be forced through the outlet passage check valve 20 into the annular space D.

As the piston moves downwardly, it will create a partial vacuum above its upper surface in the first chamber 36 and this will cause material within the annular space D to be drawn in through the inlet passage check valve 19 and inlet port 27 to the first chamber of the member 21. Thus, as the cement passing into the annulus displaces the material, the displaced material will be drawn back into the cylindrical member 21 above the piston 37.

After the piston 37 has been moved to its lowermost position to force all of the cement within the member 21 into the annular space, the entire member 21 may be withdrawn from the bore hole. The pins 49 and 50 may be secured by suitable shear pins so that they will break off when it is desired to forcibly remove the tool. The lower check valve 20 will prevent any back flow of cement in the annular space D into the casing.

An important advantage of the method and apparatus of this invention as described resides in the collecting of material displaced by the cement simultaneously with the forcing of the cement into the annular space. Generally, the elongated member will be filled with more cement than is estimated to be required to fill the annular space. Therefore, as the piston 37 approaches the lower portion, if the annular space D is completely filled with cement already, the additional cement forced in will simply urge the initially received cement out the top of the annular space into the first chamber 36. The excess cement, accordingly, is not lost or caused to flow into the casing itself but is collected and withdrawn when the cementing operation is completed. Thus, it is not necessary to measure exactly the required amount of cement. By always providing more cement than is necessary, the complete filling of the selective annular space to be cemented itself is always assured.

While only one embodiment has been shown and described, various modifications and changes that fall clearly within the scope and spirit of the invention will occur to those skilled in the art. The method and apparatus are therefore not to be thought of as limited to the specific example set forth merely for illustrative purposes.

What is claimed is:

1. An apparatus for cementing a selected portion of well casing in a bore hole comprising, in combination: first and second packing means disposed between said casing and the surrounding bore hole sidewalls in longitudinally spaced relationship at the upper and lower limits respectively of said portion to define an annular space therebetween; a member, having a hollow interior for holding cement, positionable in said selected portion of well casing; first and second communication means between the upper and lower ends of said annular space and the upper and lower ends of the hollow interior of said member respectively; and cement moving means actuable from the well head for urging said cement through said second communication means to said annular space and for drawing material into said hollow interior from said annular space through said first communication means; and means at the well head for effecting actuation of said cement moving means.

2. An apparatus for cementing a selected portion of well casing in a bore hole comprising, in combination:

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first and second packing means disposed between said casing and the surrounding bore hole side walls in longitudinally spaced relationship at the upper and lower limits respectively of said portion to define an annular space therebetween; a member, having a hollow interior for holding cement, positionable in said selected portion of well casing; first and second communication means between the upper and lower ends of said annular space and the upper and lower ends of the hollow interior of said member respectively; and piston means movable from said upper end to said lower end in said hollow interior for urging said cement through said second communication means to said annular space and for drawing material displaced by said cement from said annular space through said first communication means into said hollow interior; and, actuating means for driving said piston means.

3. An apparatus for cementing casing to a selected portion of an earth formation in a bore hole comprising, in combination: a casing section adapted to be positioned in said bore hole adjacent to said selected portion; upper and lower packing means between the upper and lower exterior portions of said casing section and the surrounding earth formation defining an annular space therebetween including said selected portion of the earth formation, said casing including inlet and outlet passages providing communication between longitudinally spaced end portions of said annular space and the interior of said casing section respectively; an elongated cylindrical member; means connected to said member for lowering said member through said casing to a position juxtaposed said inlet and outlet passages, said member having a hollow interior; a piston dividing said interior into first and second chambers, said second chamber designed to be filled with cement; inlet communication means in the wall of said member connecting said first chamber to said inlet passage; outlet communication means longitudinally spaced from said inlet communication means connecting said second chamber to said outlet passage; and means for guiding and moving said piston in a direction to increase the volume of said first chamber and decrease the volume of said second chamber, such that said piston forces cement out said outlet communication means and through said outlet passage to fill said annular space and simultaneously draws in material in said annular space, as it is being replaced by said cement, through said inlet passage and inlet communication means to said first chamber.

4. An apparatus according to claim 3, in which said inlet communication means includes a pair of annular seal-

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ing lips secured in longitudinally spaced relationship about the exterior of said cylindrical member to define a sealed annulus communicating with said inlet passage, said member having an opening in its side wall placing said annulus in communication with said first chamber, said outlet communication means similarly including a pair of annular sealing lips secured in longitudinally spaced relationship about the exterior of said cylindrical member to define a sealed annulus communicating with said outlet passage, said member having an opening in its side wall placing said annulus in communication with said second chamber; and means in the side wall of said member defining by-pass passages about the exterior of said pairs of annular sealing lips respectively whereby bore hole fluid is bypassed through said by-pass passages during movement of said member longitudinally through said casing.

5. An apparatus according to claim 4, in which said means for guiding and moving said piston including a first plurality of telescoping pipes secured between the upper side of said piston and the top of said first chamber communicating above said top and a second plurality of telescoping pipes secured between the lower side of said piston and the bottom of said second chamber; spider structures secured respectively to at least some of said first plurality of telescoping pipes and extending radially to engage in sliding contact the inner walls of said first chamber for centering and guiding movement of said telescoping pipes, and a source of gas under pressure above the top of said first chamber adapted to fill said first plurality of telescoping pipes and act against said piston to urge said pipes to telescope out.

6. An apparatus according to claim 5, including pin means responsive to said gas under pressure to move laterally from the side walls of said member to engage said casing section and hold said cylindrical member in its set longitudinal position.

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