

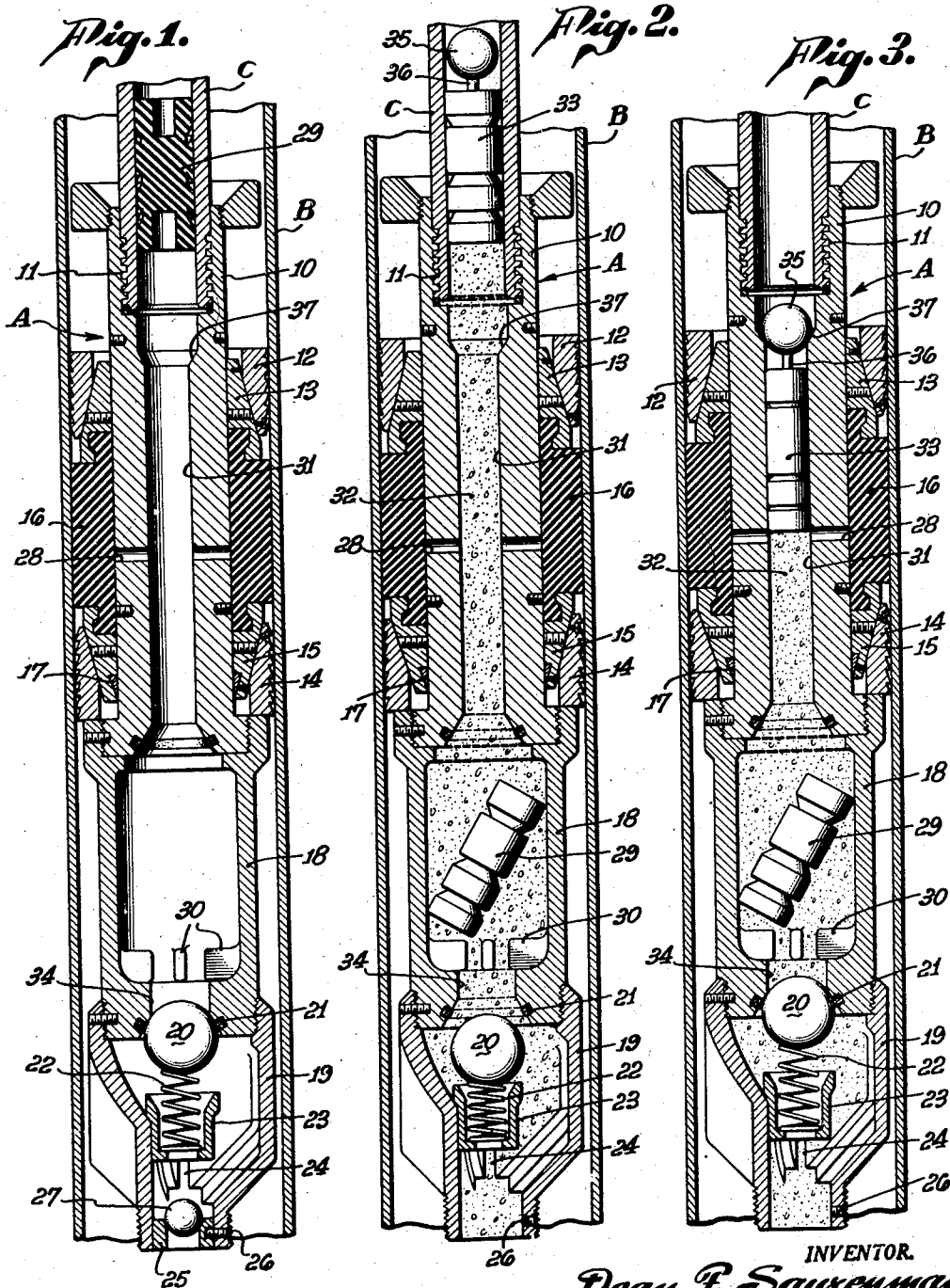
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PLUG TRAP AND INDICATOR APPARATUS

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PLUG TRAP AND INDICATOR APPARATUS

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This invention relates to well tools, and more particularly to subsurface apparatus especially useful in the cementitious sealing of wells with liquid synthetic resin, cement slurry and the like.

In the tubing method of cementing wells it is desirable to prevent contamination in the tubing between the cementitious material and the fluids which precede and follow it, and also to be assured that the required amount of cementitious material has been placed in the well bore at the proper point. Separating plugs between the cementitious material and such other fluids may be used to prevent their comingling and contamination, but it is, nevertheless, difficult for accurate measurements to be made for the purpose of insuring that the sealing material has been ejected in the required quantity. This is particularly important where small batches of cementing materials, such as liquid synthetic resins, are employed, since only a relatively small error in the displacement fluid may result in failure to pump all of the required liquid resin from the tubular string, or the liquid resin may be pumped beyond the area at which a seal in the well bore was to have been formed. Following the placement of the cementitious material in the well bore, conditions sometimes dictate the necessity of preventing further fluid pressure from being imposed on a cementitious seal until it has thoroughly set and hardened.

It is an object of the present invention to provide an improved well apparatus for positively separating cementitious material from the fluids which precede or follow it, insuring the proper placement of the sealing material in the well bore.

It is a further object of the invention to provide a cementing apparatus designed for use in conjunction with a string of tubing or drill pipe, and capable of furnishing a positive indication at the top of the well bore of the displacement conditions of the cementitious material pumped through the tubular string.

Another object of the invention is to provide a well packer embodying a self-contained trap or catcher for a tubing cementing plug.

A further object of the invention is to incorporate a plug trap or catcher in a well packer without disturbing the normal setting operation or functioning of the well packer.

Yet another object of the invention is to provide a well packer embodying a trap for a lower tubing cementing plug, and an indicator for a top tubing cementing plug capable of closing the well packer against downward movement of fluid therethrough.

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Still a further object of the invention is to provide an apparatus embodying bottom and top tubing cementing plugs which provide for the positive displacement of the cementitious material disposed between the plugs into the well bore, and which prevents the hydrostatic head or other pressure of fluid above the top cementing plug from being imposed on the displaced cementitious material.

This invention has other objects which will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification. This form will now be described in detail to illustrate the general principles of the invention, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawings:

Figure 1 is a longitudinal section through a well packer embodying the invention, anchored in packed-off condition within a well casing;

Figure 2 is a view similar to Figure 1, disclosing another operative condition of the well packer and its cooperable tubing plugs; and

Figure 3 is a view similar to Figure 1, disclosing still another operative condition of the well packer and its cooperable tubing plugs.

As shown in the drawings, a well packer A is run in a well casing B on the lower end of a tubular string C of tubing or drill pipe for anchoring to the casing in leakproof relation.

The well packer is of the general type described in United States Patents Nos. 2,121,051 and 2,222,014, and includes a tubular body 10 detachably secured to the lower end of the tubing string C, as by a left hand threaded connection 11. The packer is prevented from moving in an upward direction by a set of upper segmental casing engaging slips 12 cooperable with an upper conical expander 13 slidable on the body 10, and from moving in a downward direction by a set of lower segmental casing engaging slips 14 cooperable with a lower expander 15 slidable on the body. A leakproof seal is obtained between the body and casing wall by a packing sleeve 16 disposed between and secured to the upper and lower expanders 13, 15. Downward movement of the body 10 within the lower expander 15 is prevented by a wedge shaped, one-way lock 17.

A plug catcher or plug trap 18, in the form of a chamber or housing, is threaded on the lower end of the packer body 10 and has a packer

guide 19 threaded, in turn, on its lower end. This guide contains a back pressure valve, in the form of a ball 20, urged upwardly against a co-operable valve seat 21 in the plug catcher by a helical spring 22 received within and bearing against a cup-shaped spring retainer 23 resting against spaced ribs 24 in the guide. A trip ball seat 25 is secured in the lower end of the guide 19 below the spring retainer 23 by a shear screw 26, and is engaged by a trip ball 27 to close the seat 25 against downward movement of fluids through its central bore.

As explained in the patents above referred to, setting of the packer is initiated hydraulically by subjecting the fluid in the tubing string C and packer A to pressure, which forces fluid through body ports 28 into the interior of the sleeve 16, elongating the latter in an upward direction and setting the upper slips 12 firmly in anchoring engagement with the casing wall. Thereafter, the tubing string C and attached packer body 10, plug trap 18 and guide 19 are elevated to foreshorten the packing 16 and expand it into firm sealing engagement with the casing wall and also to embed the lower slips 14 firmly into the casing wall. The pressure of the fluid in the tubing string and well packer may now be increased to shear the trip ball shear screw 26 and blow the seat 25 and trip ball 27 down and out of the well packer, permitting fluid to be displaced or pumped through the well packer.

The plug trap 18 has a larger inside diameter than the outside diameter of an elongate plug 29 adapted to be pumped down the tubular string C in sealing engagement with its wall. The plug trap 18 is also longer than the length of the plug 29, and has spaced bottom fingers or supports 30 on its lower portion on which the plug may rest; so that fluid may be circulated around the plug upon its disposition within the chamber 18.

The plug 29 is pumped down the tubing string C and passes through the body 10 of the well packer and into the plug trap 18. The passage 31 through the body is preferably of substantially less diameter than the unrestrained diameter of the plug 29, to require the pressure of the fluid above the plug to be increased in forcing the latter through the body, and thus give an indication at the top of the well bore, as on a pressure gage, or through stalling or laboring of a pump, that the plug has reached the location of the well packer. The plug is made of rubber or rubber-like material, capable of compressing or collapsing inwardly and of elongating in being forced through the restricted body passage 31. After its discharge into the plug trap 18, the plug may reassume its original unconfined state.

The well packer A is run on the tubing string C in the well casing to the desired location, where it is anchored in leakproof relation against the casing wall. The bottom plug 29 is then inserted in the tubing string, followed by the desired quantity of liquid synthetic resin 32, on top of which is placed a top cementing plug 33, similar to the bottom plug. The liquid synthetic resin, or other cementitious material, is then pumped down through the tubing by displacement fluid above the top plug 33, the plugs 29, 33 confining the charge of fluent material and preventing its contamination with the fluid ahead of the bottom plug and with the displacement fluid above the top plug. When the bottom plug 29 reaches the restricted passage 31 in the well packer, additional pressure must be imposed on the fluid in

the tubing string C to squeeze the bottom plug through the body passage and into the enlarged plug trap 18, where it comes to rest on the lower supporting fingers 30. The operator at the top of the well bore is thus apprised of the fact that the cementitious material has reached the well packer. Continued pumping then forces the top plug 33 toward the bottom plug 29, and pumps the cementitious material into the plug trap 18 and around the bottom plug 29, between the fingers 30, and through the trap outlet 34, unseating the downwardly opening back pressure ball valve member 20, and flowing through the guide 19 into the well bore.

Pumping may be continued until the top plug 33 reaches the restricted passage 31 in the packer body 10, which will advise the operator, through the obtaining of a rise in pressure indication at the top of the well bore, that the required amount of cementitious material has been ejected from the well packer. Pumping may then stop.

The displaced liquid synthetic resin, or other cementitious material, is prevented from returning by the upward engagement of the spring pressed ball valve 20 with its valve seat 21. The tubing string C may then be rotated to the right to detach it, at the left hand threaded connection 11, from the packer body 10, allowing removal of the tubing C from the well bore.

It is sometimes desirable to prevent the liquid plastic or cementitious material placed in the well bore from being subjected to the hydrostatic head of fluid in the casing above the well packer A. This may be accomplished by attaching a ball 35 to the upper end of the top cementing plug 33, as by means of a short length of rod 36. When the top cementing plug 33 enters the restricted passage 31 in the well packer, the ball 35, which is of a greater diameter than the diameter of the restricted passage, engages a seat 37 in the packer body 10 and functions as a valve to shut off further downward flow of fluid through the well packer, and also prevents any pressure above the well packer from being imposed on the well bore below the well packer.

Thus, upon disconnection of the tubing string C from the packer body 10, and removal of the former from the well casing, the static head of fluid in the well casing cannot be exerted through the packer passage 31 against the cementitious material in the well bore. Downward flow of fluid, or downward imposition of pressure, is prevented by the upper bridging valve 35, and upward passage of fluid is also prevented by the upwardly seating back pressure valve 20.

The packer parts and plug members are preferably made of readily drillable materials, to permit removal of the well packer from the well casing by a drilling operation after the cementitious material has set and hardened in the well bore.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A well packer adapted to be lowered in a well conduit on a tubular string, including a body having a central continuous cylindrical passage of substantially uniform diameter extending upwardly from the lower region of said body throughout a major portion of its length, means for anchoring said body in leakproof relation to said conduit, a chamber at the lower end of said body having an outlet and adapted to entrap and confine a resilient tubing plug pumped down the tubular string and through and out of said central passage, said chamber being larger than said confined plug to allow fluid to flow around said plug

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through said outlet when said plug is in said chamber, and means in said chamber for preventing said plug from closing said outlet.

2. A well tool adapted to be lowered in a well conduit on a tubular string, including a body having a central passage, normally retracted means on said body engageable with said conduit, a chamber at the lower end of said body having an outlet and adapted to entrap and confine a resilient tubing plug pumped down the tubing string and through and out of said central passage, said central passage having a substantially lesser diameter than the normal diameter of said plug, thereby requiring a rise in pressure to pump said plug through said passage, and said chamber being larger than said confined plug to allow fluid to flow around said plug through said outlet.

3. In combination, a well tool adapted to be lowered in a well conduit on a tubular string, including a body having a central passage, normally retracted means on said body engageable with said conduit, a chamber at the lower end of said body and having an outlet, a resilient tubing plug adapted to be pumped down the tubular string and through and out of said central passage into said chamber, said tubing plug having a substantially greater diameter than said central passage and a lesser diameter than the internal diameter of said chamber, in order to require a rise in pressure to pump said plug through said passage and to allow by-passing of fluid around said plug and through said outlet when said plug is in said chamber, and means for preventing said plug from closing said outlet.

4. In combination, a well tool adapted to be lowered in a well conduit on a tubular string, including a body having a central passage, normally retracted means on said body engageable with said conduit, a chamber at the lower end of said body having an outlet, a resilient tubing plug adapted to be pumped down the tubular string and through and out of said central passage into said chamber, said tubing plug having a substantially greater normal diameter than said central passage and a substantially lesser diameter than the internal diameter of said chamber, in order to require a rise in pressure to pump said plug through said passage and to allow by-passing of fluid around said plug and through said outlet when said plug is in said chamber, and means in said chamber for preventing said plug from closing said outlet.

5. In combination, a well tool adapted to be lowered in a well conduit on a tubular string, including a body having a central continuous cylindrical passage of substantially uniform diameter extending upwardly from the lower region of said body throughout a major portion of its length, a chamber at the lower end of said body and having an outlet, a resilient tubing plug adapted to be pumped down the tubular string in sealing engagement therewith and through and out of said central passage into said chamber, means for pre-

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venting said plug from closing said outlet, said tubing plug having normally a greater diameter than said central passage and normally a lesser diameter than the internal diameter of said chamber, and means adapted to be lowered through said tubing string into engagement with a valve seat on said body to close its central passage against the downward flow of fluid there-through.

6. In combination, a well tool adapted to be lowered in a well conduit on a tubular string, including a body having a central continuous cylindrical passage of substantially uniform diameter extending upwardly from the lower region of said body throughout a major portion of its length, a chamber at the lower end of said body and having an outlet, a tubing plug adapted to be pumped down the tubular string in sealing engagement therewith and through and out of said central passage into said chamber, means for preventing said plug from closing said outlet, said tubing plug having normally a greater diameter than said central passage and normally a lesser diameter than the internal diameter of said chamber, and an upper tubing plug adapted to be pumped down the tubular string into said central passage to close the latter against fluid flow there-through.

7. In combination, a well tool adapted to be lowered in a well conduit on a tubular string, including a body having a central continuous cylindrical passage of substantially uniform diameter extending upwardly from the lower region of said body throughout a major portion of its length, a chamber at the lower end of said body and having an outlet, a tubing plug adapted to be pumped down the tubular string in sealing engagement therewith and through and out of said central passage into said chamber, means for preventing said plug from closing said outlet, said tubing plug having normally a greater diameter than said central passage and normally a lesser diameter than the internal diameter of said chamber, an upper tubing plug adapted to be pumped down the tubing string into the central passage, and a valve member secured to said upper plug and engageable with a valve seat on said body to close the central passage through said body against downward flow of fluid.

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