

- [54] **METHODS FOR INHIBITING THE ENTRANCE OF LOOSE FORMATION MATERIALS INTO A WELL BORE**
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- [51] Int. Cl. **E21b 43/02**
- [58] Field of Search **166/276, 278, 295, 51, 227**

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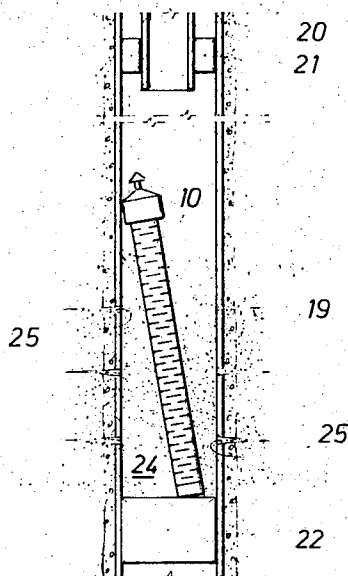
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[57] ABSTRACT

As a representative mode of practicing the methods of the invention disclosed herein, a tubular screen is lowered through a production string and packer and positioned in a well bore adjacent to a perforated formation interval containing loose formation materials. To inhibit the production of such materials as the well is produced, a mixture of loose materials and a hardenable consolidating agent is then deposited around the tubular screen so as to fill the perforated well bore interval leaving only the upper portion of the screen projecting above the annular body of deposited materials. In this manner, once the consolidating agent hardens, production can be commenced through the permeable plug of consolidated materials into the screen and out its exposed upper end.

9 Claims, 4 Drawing Figures



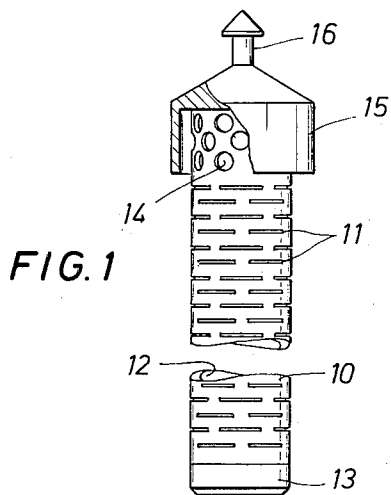
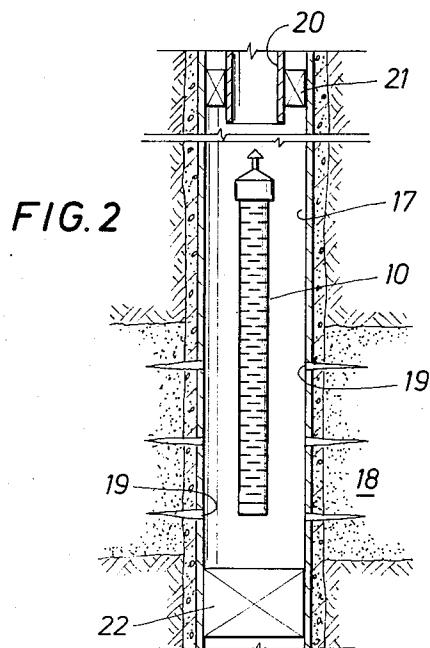


FIG. 3

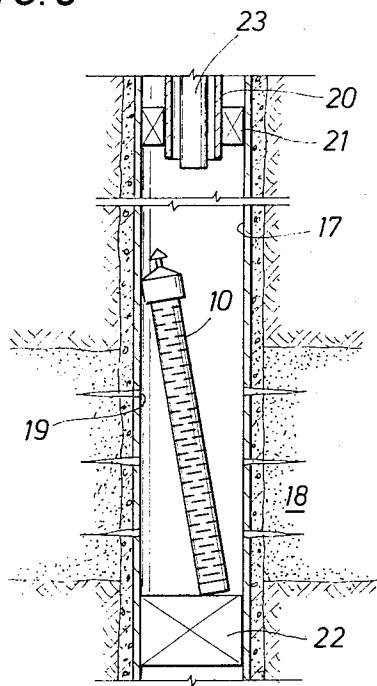
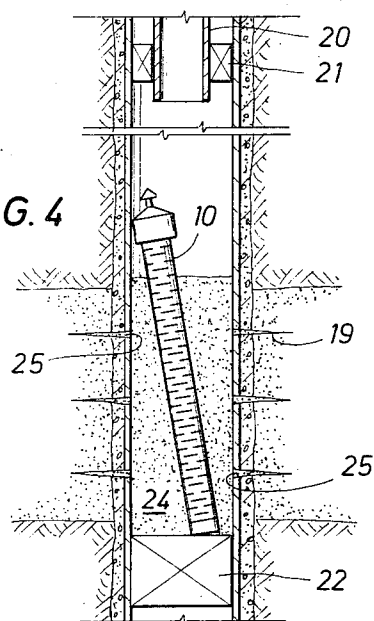


FIG. 4



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METHODS FOR INHIBITING THE ENTRANCE OF LOOSE FORMATION MATERIALS INTO A WELL BORE

It is, of course, widely recognized that unconsolidated earth formations present serious problems during the useful production life of many oil wells. For example, unless appropriate preventative measures are taken, loose or unconsolidated formation materials such as sand and the like will flow into the well bore and eventually fill the well bore or else be carried to the surface by the produced fluids and damage production equipment. Thus, when a well of this nature is being completed, it is customary either to inject suitable chemical consolidating agents into such loose formations or else to place a screened liner in the well bore over the perforated interval. Once this is done, the production tubing and packer is installed and the well is placed on production.

Regardless of the particular completion technique initially employed, it is not at all uncommon for such wells to sooner or later begin producing sand and the like. When this happens, the usual practices employed heretofore require that the production string be pulled from the well to permit one or more of the typical recompletion procedures to be conducted for inhibiting further production of sand. It will be appreciated, therefore, that the removal of the production string and the subsequent recompletion operation as well as the attendant loss of production will represent a significant expense.

Accordingly, it is an object of the present invention to provide new and improved methods for completing a well bore to preclude the entrance of loose formation materials into the well bore as connate fluids are being produced.

This and other objects of the present invention are attained by lowering a tubular screen into a well bore adjacent to an unconsolidated perforated interval therein. A mixture of loose granulated particles such as sand or the like and one or more initially-fluent hardenable consolidating agents is then discharged into the well bore around the tubular screen so as to completely cover the perforations and leave only the upper end of the body projecting above the discharged material. Thereafter, once the treating agents harden, a plug or barrier of the consolidated material will be anchored in the perforated interval to provide a stabilized, permeable filter for preventing the subsequent entrance of formation materials into the well bore.

The novel features of the present invention are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may be best understood by way of the following description of exemplary methods employing the principles of the invention as illustrated in the accompanying drawings, in which:

FIG. 1 depicts a preferred embodiment of apparatus which may be employed for practicing the new and improved methods of the present invention; and

FIGS. 2-4 successively illustrate a preferred manner of practicing the present invention.

Turning now to FIG. 1, there is illustrated a tubular screen 10 having a plurality of restricted openings such as small holes or narrow slots 11 formed therein to prevent the entrance of finely divided materials into the axial bore 12 of the tubular body. The bottom of the tubular body 10 is capped, as at 13, to prevent the entrance of fluent materials or fluids into its lower end. Although the top of the screen 10 could perhaps be left open, it is preferred to arrange a number of large openings 14 in the upper portion of the screen and mount an inverted cap 15 over the top of the body so as to prevent materials falling into the well bore from entering the openings. In the preferred embodiment of the tubular screen 10, it is preferred to arrange an upright fishing neck 16 on top of the cap 15 which is adapted for selective coupling to a typical wireline overshot (not shown).

Turning now to FIG. 2, the tubular screen 10 is shown as it is being lowered on an overshot or dropped into a typical cased well bore 17 which penetrates a producible unconsolidated earth formation 18. To gain access to the formation, one or more perforations, as at 19, have been previously

produced with a typical perforating gun (not shown) to provide fluid communication between the earth formation 18 and the cased well bore 17. As is customary, a string of small-diameter tubing 20 is suspended in the well bore 17 and its lower end extended through a typical production packer 21 which is set therein above the perforations 19 for isolating the formation 18 from the well bore above the packer. If, perchance, the well bore 17 extends a significant distance below the formation 18, the lower portion of the well bore will have been previously blocked by setting either a typical bridge plug (such as that shown in U.S. Pat. No. 3,298,440) or a through-tubing bridge plug 22 (such as those shown in U.S. Pat. No. 3,460,618, U.S. Pat. No. 3,460,624 or U.S. Pat. No. 3,460,625) a short distance below the lower limits of the earth formation to provide a convenient support or base on which the tubular screen 10 will come to rest. Alternatively, if the bottom (not shown) of the well bore 17 is only a short distance below the lower limits of the formation 18, it will, of course, be appreciated that the plug 22 might not be necessary.

Accordingly, as illustrated in FIG. 3, once the screen 10 has been lowered into the well bore 17, it will come to rest on the plug 22 and assume a somewhat-tilted position as depicted. Particular note should be made that the length of the tubular body 10 is selected in relation to the thickness of the formation 18 so that once the screen has come to rest on top of the plug 22 (or the bottom of the well bore 17), the upper end of the screen will extend at least a short distance above the uppermost perforation 19 of the perforated interval.

Once the tubular screen 10 has come to rest in the well bore 17, a typical so-called "dump bailer," as at 23, is moved into the well bore through the tubing string 20. Then, as illustrated in FIG. 4, the dump bailer 23 is operated to discharge a predetermined volume of an intimate mixture 24 of a loose granular material, such as sand, walnut shells, or the like, and a suitable hardenable consolidated agent which will not harden until after the granular material has been deposited around the tubular body 10.

In the preferred manner of practicing the present invention, a single-component so-called "porous-setting" plastic is preferably used as the consolidating agent so that once the mixture 24 has been placed around the screen 10, a phase separation will take place leaving hardened plastic bonding the sand grains together and providing flow channels or open pore spaces in the interstitial spaces therebetween. Other types of single-component porous-setting plastics which shrink and crack upon setting to form interstitial openings between the consolidated sand particles can, of course, be used with equal success. Those skilled in the art will appreciate there are many consolidating agents of this nature which are typically used in the oil field for conventional formation-consolidating operations.

Alternatively, typical porous-setting consolidating agents employing two or more separate components can also be used. For example, to use a two-component consolidating agent, the mixture 24 will initially consist of the sand and the adhesive component or components of the consolidating agent. Then, once this mixture 24 is discharged into the well bore 17 around the tubular body 10, the catalyzing components of the plastic consolidating agent will be subsequently discharged on top of the mixture and forced therethrough for opening the interstitial spaces between the sand particles to complete the chemical reaction of the consolidating agent. Accordingly, the present invention should not be considered as being limited to any particular one or genus of porous sand-consolidating agents so long as the final result is to provide a well-compacted hardened porous body of the mixture 24 in the well bore 17 around the screen 10.

Particular note should be made that when the mixture 24 is discharged into the well bore 17 around the screen 10, the still-unconsolidated sand particles will hopefully enter the perforations 19. Thus, once the consolidating agent mixed therewith has hardened, the entire mass of the mixture 24 will be firmly anchored against upward or downward movement

by virtue of a number of outstanding projections or hardened plugs of sand, as at 25, extending at least partially into the perforations 19. If believed necessary, it would be expedient to increase the fluid pressure in the tubing string 20 to force the sand particles into the perforations 19 before the mixture 24 has finally hardened.

Accordingly, it will be appreciated that the present invention has provided new and improved methods for preventing the entrance of unwanted loose formation materials into a well bore penetrating an unconsolidated formation. By arranging a tubular screen, the entrance of loose formation materials into the well bore is precluded but without unduly hampering the flow of connate fluids or the like therein.

While a particular mode for practicing the present invention has been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects; and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A method for inhibiting the entrance of loose formation materials into a well bore having a production string disposed therein and terminating above a perforated interval of the well bore traversing an earth formation containing such loose formation materials and comprising the steps of: releasably coupling the upper end of a tubular screen having its lower end covered and a flow passage in its said upper end to the lower end of a suspension cable; lowering said tubular screen by said suspension cable through said production string and into said perforated interval therebelow to place said tubular screen therein with its said flow passage above the upper limit of said perforated interval and below the lower end of said production string; releasing said suspension cable from said tubular screen and withdrawing said suspension cable from said production string to allow said tubular member to assume a free position within said perforated interval; and discharging a mixture of particulate materials and an initially fluent

hardenable consolidating agent into said perforated interval to form an annular plug of said mixture around said tubular screen below said flow passage before said consolidating agent hardens to consolidate said particulate materials into a hardened porous body for inhibiting the subsequent entrance of loose formation materials into said perforated interval.

2. The method of claim 1 further including the step of: increasing the pressure of fluids in said perforated interval before said consolidating agent is hardened to force some of said mixture into perforations communicating with said earth formation with said perforated interval for anchoring said porous body in position therein once said consolidating agent has hardened.

3. The method of claim 1 wherein said particulate materials are substantially particles of sand.

4. The method of claim 1 wherein said particulate materials are substantially walnut shells.

5. The method of claim 1 wherein said consolidating agent is a single-component porous-setting plastic material.

6. The method of claim 5 wherein said consolidating agent is intimately mixed with said particulate materials before said mixture is introduced into said perforated interval.

7. The method of claim 1 wherein said consolidating agent is a multi-component plastic material and at least one of said plastic components are intimately mixed with said particulate materials before said mixture is introduced into said perforated interval.

8. The method of claim 7 wherein the remaining ones of said plastic components are introduced into said production string after said mixture is introduced into said perforated interval.

9. The method of claim 8 wherein said remaining plastic components are introduced into said perforated interval at an increased pressure to force some of said mixture into perforations communicating said earth formations with said perforated interval for anchoring said porous body in position therein once said consolidating agent has hardened.

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