United States Patent

Urbanosky

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[54] METHODS FOR INHIBITING THE PRODUCTION OF LOOSE FORMATION MATERIALS

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[52] **U.S. Cl.** **166/278**, 166/285

[51] **Int. Cl.** **E21b 33/134**, E21b 43/04

[58] **Field of Search** 166/278, 276, 51, 280, 285, 166/184, 187

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[57] **ABSTRACT**

As a representative embodiment of the methods of the invention disclosed herein, a through-tubing bridge plug having an expansible packing element and a tubular screen dependently coupled thereto is passed through a production string into a well bore therebelow and positioned adjacent to a perforated formation interval containing loose formation materials. The initial production of connate fluids from the well is controlled at a reduced rate for slowly drawing loose formation materials into the perforated well bore interval to at least substantially fill the annular space around the tubular screen with such formation materials. Then, once it is believed that the annular space around the tubular screen is filled with such loose formation materials, production of the well is commenced in the usual manner with the packed formation materials around the screen serving as a filter media to inhibit the entrance of further formation materials into the well bore.

9 Claims, 4 Drawing Figures

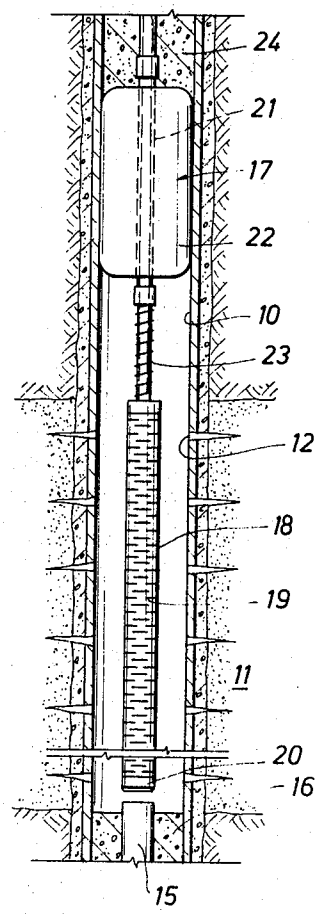


FIG. 1

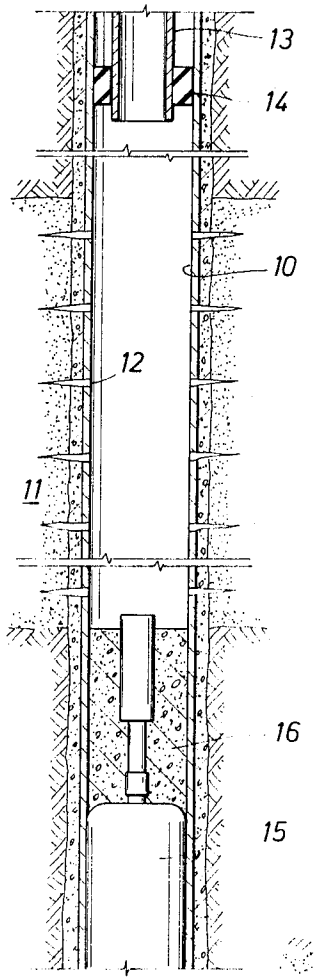
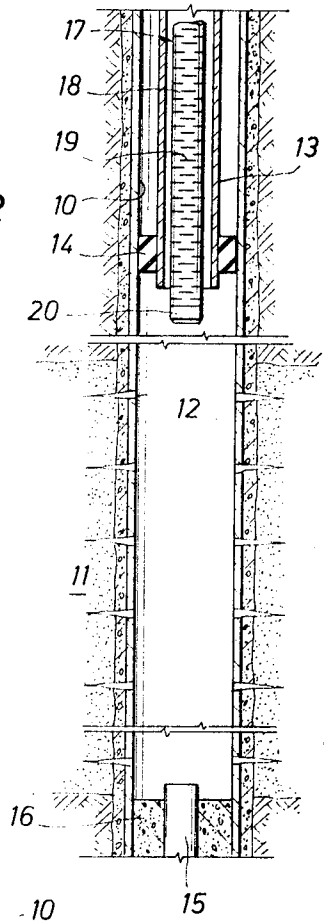


FIG. 2



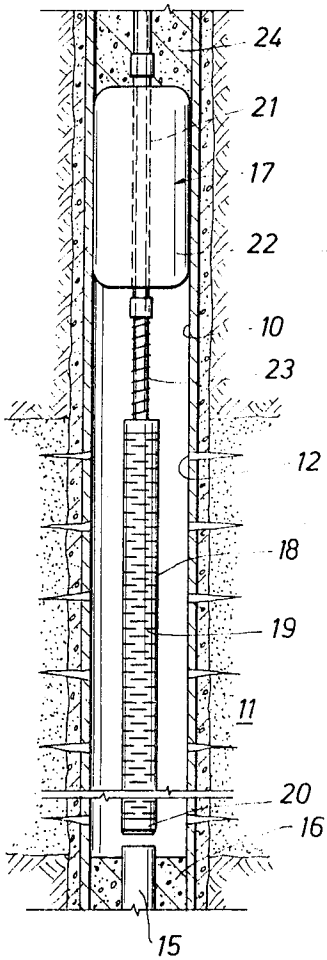


FIG. 3

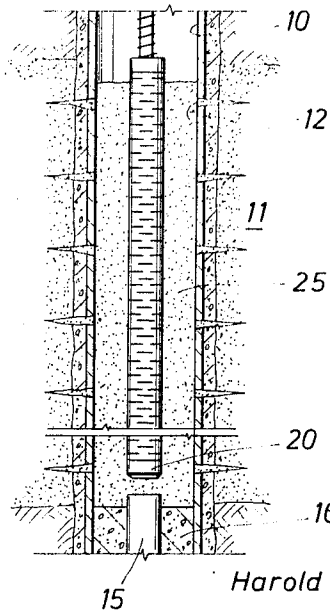


FIG. 4

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METHODS FOR INHIBITING THE PRODUCTION OF LOOSE FORMATION MATERIALS

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 operations 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 arranging a tubular screen on the lower end of a tubular body of a through-tubing bridge plug having an expansible packing element. This assembly is lowered through a production string and into the well bore below the lower end of the tubing string and production packer coupled thereto. The bridge plug is then set and the packing element expanded near the upper limit of a perforated unconsolidated formation interval in the well bore so as to position the tubular screen within or adjacent to the unconsolidated interval. Production from the well is initially controlled at a regulated retarded rate for slowly drawing unconsolidated formation materials into the well bore below the expanded packing element. Once it is believed that at least a substantial portion of the annular space around the tubular screen and below the packing element has been filled with such unconsolidated formation materials, production is then commenced in the usual manner. As a result, the unconsolidated formation materials which are initially admitted into the well bore will thereafter serve as a permeable barrier for preventing the subsequent entrance of additional loose formation materials into the well bore as the well is being produced.

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:

FIGS. 1–4 successively illustrate a preferred manner of practicing the present invention.

Turning now to FIG. 1, a typical cased well bore **10** is illustrated as penetrating a producible unconsolidated earth formation **11**. To gain access to the formation **11**, one or more perforations, as at **12**, have been previously produced with a typical perforating gun (not shown) for providing fluid communication between the earth formation **11** and the cased well bore **10**. As is customary, a production string including a string of small-diameter production tubing **13** is suspended in the well bore **10** and its lower end extended through a typical production packer **14** which is set therein above the perforations **12** for isolating the formation **11** from the well bore above the packer.

If, perchance, the well bore **10** extends a significant distance below the formation **11**, in the practice of the present invention, a so-called "through-tubing bridge plug" as at **15** (such as one of those shown in either a copending application Ser. No. 875,681 filed Nov. 12, 1969, or U.S. Pat. No. 3,460,618, U.S. Pat. No. 3,460,624, or U.S. Pat. No. 3,460,625) is first set a short distance below the lower limits of the earth formation. Setting of the plug **15** will, of course, be accomplished as described in those patents or in the application. Thus, after the plug **15** has been set, a supply of cement, as at **16**, is dumped into the well bore **10** for covering the uppermost portion of the plug to further assure that there is no fluid communication between the perforated interval of the well bore and other earth formations therebelow. Inasmuch as the details of construction of the plug **15** as well as its operation are fully explained in the aforementioned patents and application, it is believed unnecessary to describe these matters further.

It will, of course, be recognized that if either the bottom (not shown) of the well bore **10** is only a short distance below the lower limits of the formation **11** or a typical bridge plug has previously been set in the well bore below the formation, the through-tubing bridge plug **15** will not be necessary. However, when it is necessary to block the well bore **10** below the lower limits of the earth formation **11**, in practicing the present invention it is preferred to employ one of those through-tubing bridge plugs as described in the aforementioned copending application and patents.

Turning now to FIG. **2**, the lower portion of a second through-tubing bridge plug **17** is illustrated as it is being lowered through the well tubing **13** into the perforated interval of the well bore **10**. In the preferred manner of practicing the present invention, the through-tubing bridge plug **17** is similar to that shown in the aforementioned copending application except that the lower portion of its body (as illustrated at "98" in the application) has been replaced with an elongated tubular screen **18** having a plurality of restricted openings such as small holes or narrow slots **19** formed therein to prevent the entrance of even finely-divided formation materials into the axial bore of the tubular body. The bottom of the tubular body **18** is capped, as at **20**, to block its lower end.

In short, the slots **19** in the tubular screen **18** are cooperatively arranged for straining fluids entering its axial bore so as to permit the passage of only relatively sand-free fluids on through the central mandrel **21** of the through-tubing bridge plug **17**. In the preferred manner of accomplishing this, the closed housing shown generally at "98" in the copending application is replaced by the tubular screen **18**. The timing mechanism "96" as well as the valve "87", the spring "91" and the ports "86" shown in the aforementioned application are, of course, eliminated or omitted. Otherwise, the through-tubing bridge plug **17** is identical to that shown and fully described in the copending application.

Accordingly, as illustrated in FIG. **3**, the through-tubing bridge plug **17** is lowered into the well bore **10** below the packer **14** and positioned so that the tubular screen **18** will be disposed in the perforated interval with the uppermost end of the screen extending upwardly at least a short distance above the uppermost perforation **12**. Once the bridge plug **17** is positioned, it is operated as fully described in the aforementioned copending application to expand the bag **22**. As explained in that application, the bag **22** is expanded by discharging a quantity of a hardenable fluent substance such as cement or the like into the interior space within the bag. Then, once the bag **22** is expanded into anchoring engagement within the well bore **10**, the spring **23** will be effective for moving the opposite ends of the bag inwardly toward one another so as to form the expanded bag into a generally-toroidal configuration. In this manner, the bridge plug **17** will be securely anchored in position to permit an additional quantity of cement, as at **24**, to be deposited on top of the bag **22**. Thus, once the cement within the bag **22** as well as that deposited on top of the bag, as at **24**, has hardened, the mandrel **21** will serve as a convenient fluid

conduit between the tubing string 13 thereabove and the interior bore of the tubular screen 18.

It will, of course, be recognized that once the bridge plugs 15 and 17 are set at the lower and upper limits of the formation 11, sand and other loose formation materials can still readily enter the well bore 10 by way of the perforations 12 even though the tubular screen 18 and the mandrel 21 represent the sole communication passage between the perforated interval and the tubing string 13 thereabove. Accordingly, to practice the present invention, once the bridge plugs 15 and 17 are in position, production of connate fluids from the formation 11 is commenced at a slow, regulated rate which is calculated to be sufficient to only slowly draw sand and other unconsolidated formation materials into the perforated interval of the well bore 10 without risking damage to the tubular screen 18. Thus, by careful regulation of the initial rate of production from the well, a quantity of sand and the like, as at 25, will be deliberately admitted into the perforated interval of the well bore 10 so as to fill the annular space surrounding the tubular screen 18 as schematically illustrated in FIG. 4. Then, once it is believed that the annular space around the tubular screen 18 has been at least partially if not substantially filled with the sand 25, production of the well may be commenced in the usual manner with the assurance that no further quantity of sand will be produced since the sand that has been packed into the annular space around the tubular screen 18 will serve as a porous filter media.

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 on the lower end of a typical through-tubing bridge plug, the entrance of loose formation materials into the well bore is precluded without having to remove the production string to perform routine workover operations or without unduly hampering the production of connate fluids from the well.

While a particular mode of 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 production of loose formation materials from 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: lowering a tubular screen having its lower end covered and a flow passage in its upper end through said production string and into said perforated interval for positioning said tubular screen therein with its said flow passage below said production string and above the upper limit of said perforated interval; sealing-off the annular space in said well bore around the upper end of said tubular screen for isolating said perforated interval and leaving said flow passage as the sole fluid communication path between said production string and said perforated interval; producing an initial quantity of connate fluids from said earth formation at a selectively-reduced flow rate for slowly drawing loose formation materials into said perforated interval until said tubular screen is believed to be covered with said loose materials to provide a filtering media of said loose materials around said tubular screen; and, thereafter, producing additional connate fluids from said earth formation through said filtering media and into said tubular screen for straining subsequently-entering loose formation materials from said additional connate fluids.

2. The method of claim 1 further including the initial step of: sealing-off said well bore below the lower limit of said perforated interval for isolating said perforated interval from the remainder of said well bore therebelow before said tubular screen is lowered into said well bore.

3. The method of claim 2 wherein said initial step is performed by lowering a through-tubing plug through said production string and beyond said perforated interval for positioning said plug therebelow; setting said plug in position for isolating said perforated interval from said remainder of said well bore; and discharging cement on top of said plug for retaining said plug in its said position within said well bore.

4. A method for inhibiting the production of loose formation materials from 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: lowering a through-tubing plug including a tubular body with a blocked lower end below a plurality of restricted openings therein and having an expansible sealing member arranged around said body above said openings through said production string and into said perforated interval for positioning said sealing member below said production string and adjacent to the upper limit of said perforated interval; expanding said sealing member for isolating said perforated interval from said production string and arranging said tubular body as the sole fluid conduit between said perforated interval and said production string; initially producing connate fluids from said earth formation at a selectively-reduced flow rate for slowly depositing loose formation materials in said perforated interval around said tubular body to cover said restricted openings with a filtering media; and, thereafter, producing connate fluids from said earth formation through said filtering media and into said tubular body for straining loose formation materials from connate fluids subsequently entering said perforated interval.

5. The method of claim 4 further including the step of: depositing a quantity of cement around said tubular body above said sealing member for retaining said plug in position within said well bore.

6. A method for inhibiting the production of loose formation materials from 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: lowering a through-tubing plug including a tubular body with a blocked lower end below a plurality of restricted openings therein and having an expansible sealing member arranged around said body above said openings through said production string and into said perforated interval for positioning said sealing member below said production string and adjacent to the upper limit of said perforated interval; discharging cement into said sealing member for expanding said sealing member in said well bore around said tubular body to pack-off said perforated interval from said production string and leave said tubular body as the sole fluid conduit between said perforated interval and said production string; initially producing connate fluids from said earth formation at a selectively-reduced flow rate for slowly depositing loose formation materials in said perforated interval around said tubular body to cover said restricted openings with a filtering media; and, thereafter, producing additional connate fluids from said earth formation through said filtering media and into said tubular screen for straining subsequently-entering loose formation materials from said additional connate fluids.

7. The method of claim 6 further including the intermediate step of: discharging an additional quantity of cement around said tubular body above said sealing member once it is expanded for retaining said plug in position within said well bore.

8. The method of claim 6 further including the initial step of: sealing-off said well bore below the lower limit of said perforated interval for isolating said perforated interval from the remainder of said well bore therebelow before said through-tubing plug is lowered into said production string.

9. The method of claim 8 wherein said initial step is performed by lowering a first through-tubing plug through said production string and beyond said perforated interval for posi-

tioning said first plug therebelow; setting said first plug in position for isolating said perforated interval from said remainder of said well bore; and discharging cement on top of said first plug for retaining said first plug in its said position within said well bore.

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