Feb. 13, 1962 G. H. TAUSCH 3,020,955

SAND WASHING METHOD AND APPARATUS

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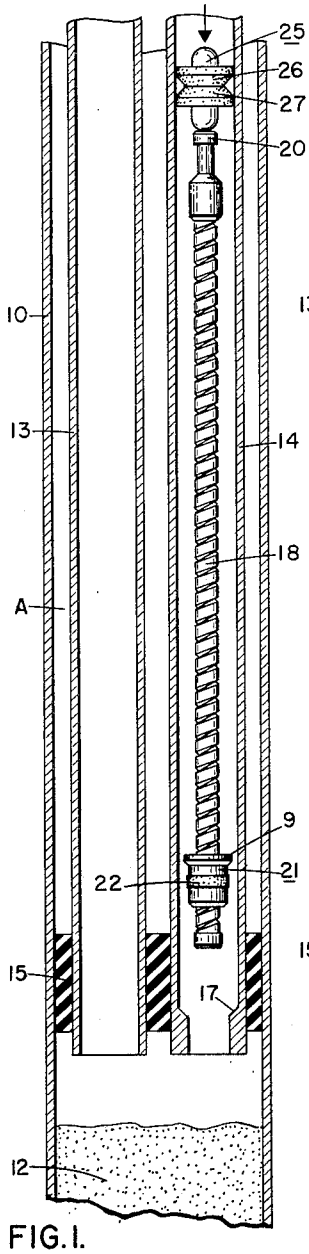


FIG. 1.

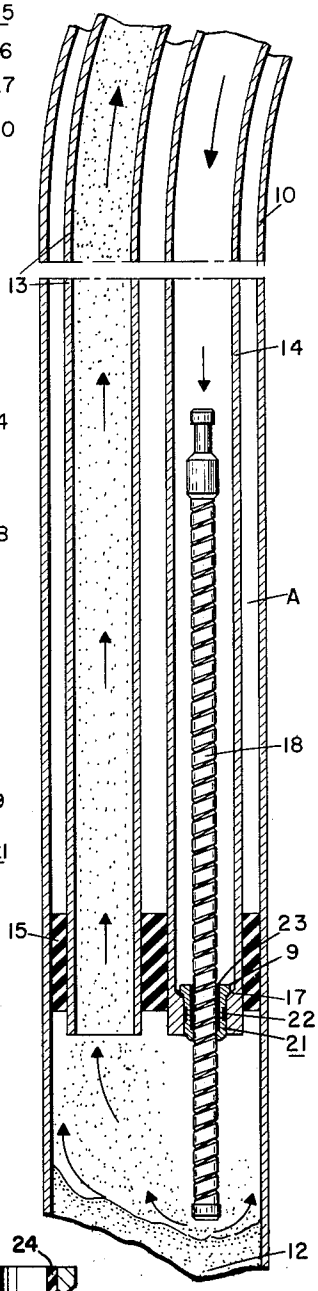


FIG. 2.

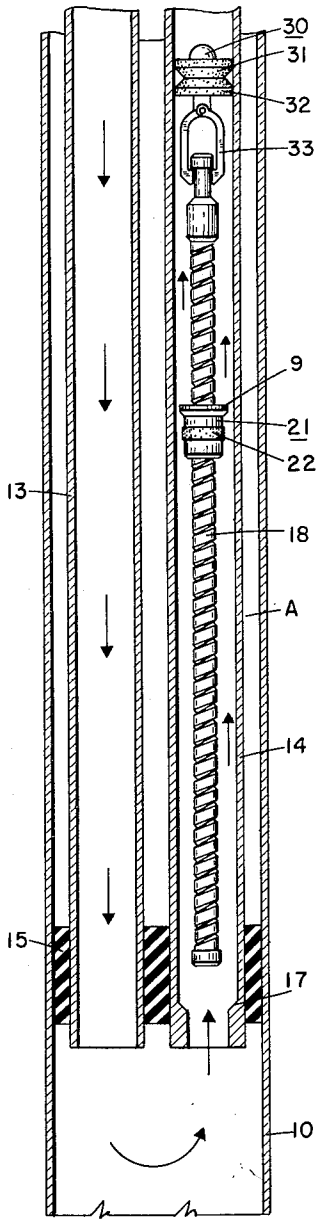


FIG. 3.

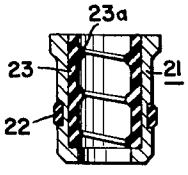


FIG. 4.

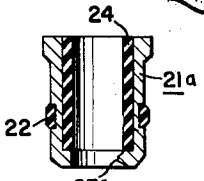


FIG. 5.

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SAND WASHING METHOD AND APPARATUS

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This invention relates to the removal of sand from wells. More particularly, this invention relates to sand removal from wells especially wherein the well flow path deviates from the vertical.

It is often necessary to remove produced sand from a well casing to permit the completion of workover operations or to restore production. In one method of sand removal an open-ended tubular extension having telescoping joints is supported in a tubing string positioned in a well casing. The tubular extension extends through the lower open end of the tubing string to the top of the sand located in the casing. The sand is removed by circulating fluid down the annulus between the tubing string and the casing and up the tubular extension and tubing string. Any mobile fluid may be employed for this operation; however, a fluid that will not harm the formations and which has increased gel strength and increased viscosity for improving the sand carrying capacity of the fluid is preferred. Formation salt water and oil are examples of fluids that may be employed in this operation. As sand is removed the telescoping joints extend and lengthen the tubular extension so that the lower end of the tubular extension remains in contact with the top of the sand.

However, the use of telescoping joints for sand removal in a well wherein the flow path deviates from the vertical is impractical since telescoping joints having sufficient flexibility for traversing the deviated flow path would be necessarily extremely short in length.

The use of flexible tubular extensions in well installations and particularly in well installations with deviating flow paths is described in U.S. patent application Serial No. 523,963, now U.S. Patent No. 2,810,440, entitled "Tubular Extension Member for Wells" by G. H. Tausch, J. W. Kenneday and M. E. True, filed July 25, 1955, and in U.S. patent application Serial No. 523,964, now U.S. Patent No. 2,810,440, entitled "Flexible Tubular Extension Member for Wells" by G. H. Tausch, filed July 25, 1955. To position the flexible tubular extension in this type installation, a packoff is arranged on the tubular extension; a wireline is connected to the tubular extension; and the tubular extension is pumped down a well tubing until a hanger assembly arranged on the tubular extension engages a landing nipple positioned on the lower end of the well tubing.

Sand may be removed in an arrangement of this type by circulation of fluid down the tubing and tubular extension and up the tubing-casing annulus. However, this arrangement has the disadvantage of placing the full force of the circulating fluid pressure against the packoff and imposing a very heavy pull on the wireline which pull may be sufficiently great to break the wireline.

Accordingly, an object of the invention is to provide improved sand removal method and apparatus for a well and particularly for a well having a deviating flow path.

Briefly, the method of the invention is as follows:

In a well having first and second parallel tubing strings

arranged therein, the steps of inserting into the first tubing string a flexible tubular extension provided with a packoff, said packoff being adapted to seat in a landing nipple arranged in the lower end of the first tubing string; inserting a first packer in the first tubing string; pumping the first packer downwardly until the packoff seats on the landing nipple, reverse circulating fluid down the second tubing string and up the tubular extension and first tubing string to pump out the first packer; circulating fluid down the first tubing string and tubular extension and up the second tubing string to wash out debris and sand located in the well below the lower open ends of the tubing strings, the tubular extension moving downwardly relative to the packoff during the circulating fluid step; pumping down the first tubing string a second packer adapted to connect with the upper end of the tubular extension; and circulating fluid down the second tubing string and up the first tubing string to remove the tubular extension and connected second packer from the first tubing string.

The apparatus of the invention comprises a well having first and second parallel, eccentric, coextensive tubing strings arranged therein, a landing nipple arranged adjacent the lower open end of the first tubing string, a flexible tubular extension adapted to be pumped through the first tubing string, a packoff arranged on said tubular extension adapted to seat on the landing nipple, the packoff sealing off the space between the landing nipple and the tubular extension when seated on the landing nipple, the tubular extension being restrainedly movable through the packoff when the packoff is seated on the landing nipple whereby the tubular extension has restrained downward movement during fluid circulation down the first tubing string and up the second tubing string.

To restrain movement of the tubular extension through the packoff the inner surface of the packoff may be formed of rubber to provide a frictional engagement with the tubular extension or the inner surface of the packoff may be provided with spiral lands or raised ridges for engaging spiral grooves formed on the tubular extension.

The above object and other objects of the invention will be apparent from a description of the invention taken in conjunction with the drawing, wherein:

FIG. 1 is a cross-sectional view of the well bore showing the flexible tubular extension in running-in position;

FIG. 2 is a cross-section of the well bore showing the flexible tubular extension in sand washing position;

FIG. 3 is a cross-section of the well bore showing the flexible tubular extension being removed from the well bore;

FIG. 4 is a more detailed cross-sectional view of the type of pack-off shown in FIG. 2; and

FIG. 5 is a cross-sectional view of another type of packoff that may be employed.

For a more complete understanding of the invention reference to the drawing in greater detail will now be made.

In FIGS. 1 through 3 is shown a casing **10** in which are arranged parallel, eccentric, coextensive tubing strings **13** and **14**. The lower open ends of tubings **13** and **14** are positioned above the top of debris or sand **12** it is desired to remove from casing **10**.

A packer **15** is arranged adjacent the lower ends of tubing strings **13** and **14** and is adapted to close off the annulus A between the tubing strings and casing **10**.

Tubing string 14 is provided with a landing nipple 17 adjacent the lower end thereof. An open-ended flexible tubular extension 18 adapted to be pumped through tubing string 14 is provided at its upper end with a pulling head 20 and intermediate its length with a packoff 21 which includes a shoulder 9 and a sealing means 22.

As seen in FIG. 2 when shoulder 9 engages landing nipple 17 further downward movement of packoff 21 is prevented and in this position of packoff 21 sealing means 22 seals off the space between packoff 21 and landing nipple 17.

As seen in FIG. 4, pack-off 21 includes an inner surface or liner 23 provided with a spiral land 23*a* which is adapted to engage the spiral groove of the tubular extension to control movement of the tubular extension through the pack-off. However, if desired, a pack-off 21*a*, shown in FIG. 5, may be used. Pack-off 21*a* includes a liner 24 having a smooth surface and a land 23*a* adapted to engage the spiral groove of the tubular extension. Liners 23 and 24 may be formed of a friction type material such as rubber. It is also possible to omit the lands and employ a friction fit alone to control movement of the tubular extension. For example, land 23*b* of FIG. 5 may be omitted and the fit between rubber liner 24 and the tubular extension made sufficiently tight to control movement of the tubular extension through the pack-off. In all of these arrangements restrained downward movement of tubular extension 18 relative to pack-off 21 is obtained.

In FIG. 1 is shown, additionally, a plug 25 engagedly contacting pulling head 20 of tubular extension 18. Plug 25 is provided with upper and lower cup-type packers 26 and 27, respectively.

In FIG. 3 is shown, additionally, a pulling tool 30, including upper and lower cup-type packers 31 and 32, respectively, and latching members 33 connected to pulling head 20 of tubular extension 18.

In operation, as seen in FIG. 1, when it is desired to wash out sand 12, tubular extension 18 with packoff 21 positioned thereon is inserted in tubing string 14 at the upper end thereof. Plug-packer 25 is then inserted in tubing string 14 behind tubular extension 18 and fluid pressure exerted behind plug 25 moves plug 25 and tubular extension 18 through tubing string 14. The fluid pressure acts on upper packer 26 which, in turn, forces plug 25 against pulling head 20 to move tubular extension 18 through tubing string 14. When shoulder 9 of packoff 21 engages landing nipple 17 pumping fluid behind plug 25 through tubing string 14 is stopped and fluid is reverse-circulated down tubing string 13 and up tubular extension 18 to the under side of cup packer 27. Since plug 25 and tubular extension 18 are only engaged and are not connected together, the flow of fluid up tubular extension 18 and tubing string 14 removes plug 25 upwardly through tubing string 14 to the surface of the earth. Tubular extension 18 remains in position.

For washing out sand 12, as shown in FIG. 2, fluid is circulated down tubing string 14 through tubular extension 18 and thence upwardly through tubing string 13, as indicated by the arrows. The fluid circulated downwardly acts on the area of tubular extension 18 only and because of the friction fit between packoff 21 and tubular extension 18 (or as noted supra a lands and grooves spiral fit may be employed) downward movement of tubular extension 18 is restrained. The movement preferably is made commensurate with the rate of removal of the sand. In this manner the lower open end of tubular extension 18 remains positioned adjacent the top of the sand as the sand is circulated out the casing through tubing string 13.

Whenever it is desired to remove tubular extension 18 from tubing string 14 pulling tool 30 is inserted in the upper end of tubing string 14 and pumped downwardly through tubing string 14 by applying fluid pressure behind pulling tool 30. The fluid pressure acts against upper packer 31 forcing tool 30 through tubing string 14 until the latching members 33 connect with pulling head 20 of tubular extension 18. Then fluid pressure behind tool 30 is released and fluid pressure is reverse-circulated down tubing string 13 and up tubular extension 18 to the under side of lower packer 32. The upwardly exerted force on packer 32 moves pulling tool 30 upwardly which also moves tubular extension 18 and packoff 21 attached thereto upwardly. As indicated by the arrows in FIG. 3, fluid circulation continues to act against lower packer 32 until tool 30, tubular extension 18 and pack-off 21 are carried to the surface of the earth.

By supporting packoff 21 by landing nipple 17 rather than by tubular extension 18 or by a wireline, the fluid pressure employed in removing the sand, as illustrated in FIG. 2, is imposed only on the cross-sectional area of the tubular extension.

The fit of packoff 21 around tubular extension 18 may be made sufficiently tight as to allow the tubular extension to move downwardly very slowly. The lower portion of the tubular extension 18 below packer 15 is maintained in tension while the upper portion of the flexible extension above packer 15 is maintained in compression. Although in compression, the upper portion is protected by the small internal diameter of tubing string 14.

The apparatus and operation of the invention has been shown and described herein utilizing two tubing strings. Two tubing strings are preferred in order to facilitate workover operations and also for injection of corrosion inhibitors and paraffin inhibitors. Further, the dual strings are advantageous for providing storm chokes or safety valves. Additionally, when employing a single tubing string mud in the annulus between the tubing string and the casting may prevent use of the annulus as a fluid circulation path. However, the invention does contemplate employing a single tubing string in place of the dual strings of tubing disclosed. In the event a single tubing string is used circulation and reverse-circulation in effecting the various steps of the invention would be down the tubing string and tubular extension and up the annulus between the tubing string and the casing and vice-versa.

Having fully described the nature, objects, method, and elements of my invention, I claim:

1. A method for conducting sand operations in a well having a tubing string arranged therein provided with a landing nipple adapted to engage a pack-off arranged movably on an open-ended flexible tubular extension comprising the steps of inserting said tubular extension in said tubing string, inserting a plug packer behind said tubular extension, pumping said plug packer and said tubular extension downwardly through said tubing string until said pack-off engages said landing nipple, reverse circulating up said tubing string through said tubular extension to reverse circulate said plug packer from said tubing string, then pumping fluid down said tubing string through said tubular extension to wash sand from the well below said tubing string, said tubular extension being restrainedly movable relative to said pack-off whereby the tubular extension moves downwardly as the sand is circulated out, then pumping a plug packer pulling tool down said tubing string until said pulling tool latches onto said tubular extension, and then pumping fluid up said tubing string to remove said pulling tool and tubular extension therefrom.

2. A method for conducting sand operations in a well having two parallel, spaced-apart tubing strings arranged therein, one of said tubing strings being provided with a landing nipple adapted to engage a packoff arranged movably on an open ended flexible tubular extension comprising the steps of inserting said tubular extension in said one tubing string, inserting a plug packer behind said tubular extension, pumping said plug packer and said tubular extension downwardly through said one tubing string until said packoff engages said landing nipple,

reverse circulating fluid down said other tubing string and up said one tubing string through said tubular extension to reverse circulate said plug packer from said one tubing string, then pumping fluid down said one tubing string through said tubular extension to wash sand from the well below said one tubing string up said other tubing string, said tubular extension being restrainedly movable relative to said packoff whereby the tubular extension moves downwardly as the sand is circulated out, pumping a plug packer pulling tool down said one tubing string until said pulling tool latches onto said tubular extension and then pumping fluid down said other tubing string and up said one tubing string to remove said pulling tool and tubular extension from said one tubing string.

3. Apparatus for conducting sand washing operations in a well comprising at least one tubing string arranged in said well; a landing nipple arranged in said tubing string adjacent the lower end thereof; an open-ended flexible tubular extension adapted to be pumped through said tubing string; a pack-off arranged on and engaged with said tubular extension and provided with means adapted to engage with and seat in said landing nipple to prevent further downward movement of said pack-off and also provided with sealing means adapted to seal off the space between said landing nipple and said pack-off when said pack-off is seated in said landing nipple; and means arranged on the interior surface of said pack-off and means on the exterior surface of said tubular extension cooperating to restrain the rate of downward movement of said tubular extension relative to said pack-off after said pack-off engages and seats in said landing nipple and said tubular extension is moved downwardly through said pack-off by the pressure differential existing across said pack-off and tubular extension caused by fluid circulated down said tubing string during sand washing operations.

4. Apparatus for conducting sand washing operations in a well comprising at least one tubing string arranged in said well; a landing nipple arranged in said tubing string adjacent the lower end thereof; an open-ended flexible tubular extension adapted to be pumped through said tubing string; a pack-off arranged on said tubular extension and provided with means adapted to engage with and seat in said landing nipple to prevent further downward movement of said pack-off and also provided with sealing means adapted to seal off the space between said landing nipple and said pack-off when said pack-off is seated in said landing nipple; the inner surface of said pack-off and the outer surface of said tubular member being engaged and formed of materials having coefficients of friction such that friction of sufficient magnitude is provided between the surfaces to restrain the rate of downward movement of said tubular extension relative to said pack-off after said pack-off engages and seats in said landing nipple and said tubular extension is moved downwardly through said pack-off by the pressure differential existing across said pack-off and tubular extension caused by fluid circulated down said tubing string during sand washing operations.

5. Apparatus for conducting sand washing operations in a well comprising at least one tubing string arranged in said well; a landing nipple arranged in said tubing string adjacent the lower end thereof; an open-ended flexible tubular extension adapted to be pumped through said tubing string; a pack-off arranged on said tubular extension and provided with means adapted to engage with and seat in said landing nipple to prevent further downward movement of said pack-off and also provided with sealing means adapted to seal off the space between said landing nipple and said pack-off when said pack-off is seated in said landing nipple; the inner surface of said pack-off being provided with a spiral land and the outer surface of said tubular extension being provided with a spiral groove, said spiral land being engaged with said spiral groove to restrain the rate of downward movement of said tubular extension relative to said pack-off after said pack-off engages and seats in said landing nipple and said tubular extension is moved downwardly through said pack-off by the pressure differential existing across said pack-off and tubular extension caused by fluid circulated down said tubing string during sand washing operations.

6. Apparatus for conducting sand washing operations in a well comprising two parallel, spaced-apart tubing strings arranged in said well; a packer arranged on said tubing strings adapted to seal off the annulus between said tubing strings and said well wall; a landing nipple positioned in one of said tubing strings adjacent the lower end thereof; an open-ended flexible tubular extension adapted to be pumped through said one tubing string; a pack-off arranged on and engaged with said tubular extension and provided with means adapted to engage with and seat in said landing nipple to prevent further downward movement of said pack-off and also provided with sealing means adapted to seal off the space between the landing nipple and the pack-off when said pack-off is seated in said landing nipple; and means arranged on the interior surface of said pack-off and means on the exterior surface of said tubular extension cooperating to restrain the rate of downward movement of said tubular extension relative to said pack-off after said pack-off engages and seats in said landing nipple and said tubular extension is moved downwardly through said pack-off by the pressure differential existing across said pack-off and tubular extension caused by fluid circulated down said one tubing string and up said other tubing string during sand washing operations.

7. Apparatus for conducting sand washing operations in a well comprising two parallel, spaced-apart tubing strings arranged in said well; a packer arranged on said tubing strings adapted to seal off the annulus between said tubing strings and said well wall; a landing nipple positioned in one of said tubing strings adjacent the lower end thereof; an open-ended flexible tubular extension adapted to be pumped through said one tubing string; a pack-off arranged on and engaged with said tubular extension and provided with means adapted to engage with and seat in said landing nipple to prevent further downward movement of said pack-off and also provided with sealing means adapted to seal off the space between the landing nipple and the pack-off when said pack-off is seated in said landing nipple; the inner surface of said pack-off and the outer surface of said tubular member being engaged and formed of materials having coefficients of friction such that friction of sufficient magnitude is provided between the surfaces to restrain the rate of downward movement of said tubular extension relative to said pack-off after said pack-off engages and seats in said landing nipple and said tubular extension is moved downwardly through said pack-off by the pressure differential existing across said pack-off and tubular extension caused by fluid circulated down said one tubing string and up said other tubing string during sand washing operations.

8. Apparatus for conducting sand washing operations in a well comprising two parallel, spaced-apart tubing strings arranged in said well; a packer arranged on said tubing strings adapted to seal off the annulus between said tubing strings and said well wall; a landing nipple positioned in one of said tubing strings adjacent the lower end thereof; an open-ended flexible tubular extension adapted to be pumped through said one tubing string; a pack-off arranged on and engaged with said tubular extension and provided with means adapted to engage with and seat in said landing nipple to prevent further downward movement of said pack-off and also provided with sealing means adapted to seal off the space between the landing nipple and the pack-off when said pack-off is seated in said landing nipple; the inner surface of said pack-off being provided with a spiral land and the outer surface of said tubular extension being provided with

a spiral groove, said spiral land being engaged with said spiral groove to restrain the rate of downward movement of said tubular extension relative to said pack-off after said pack-off engages and seats in said landing nipple and said tubular extension is moved downwardly through said pack-off by the pressure differential existing across said pack-off and tubular extension caused by fluid circulated down said one tubing string and up said other tubing string during sand washing operations.

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