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PREVENTING INTERNAL WEAR OF PRODUCTION PIPE
STRINGS BY ABRASIVE-LADEN FLUIDS
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3,070,171

FIG. 1.

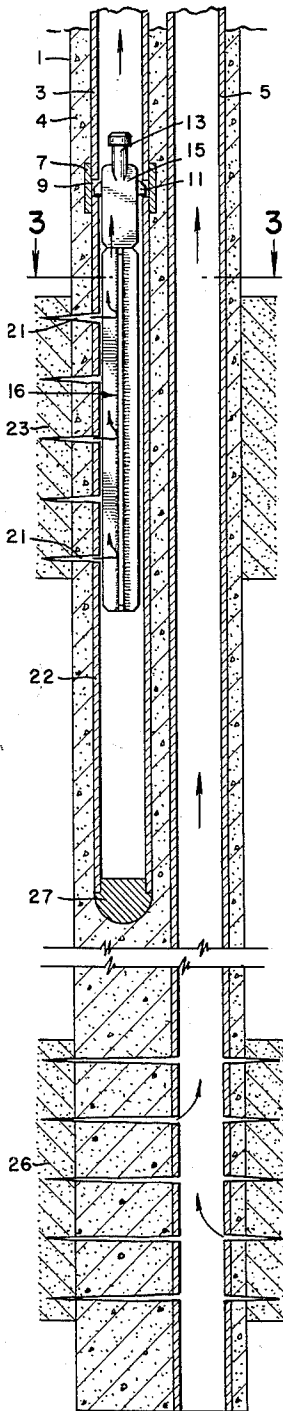


FIG. 2.

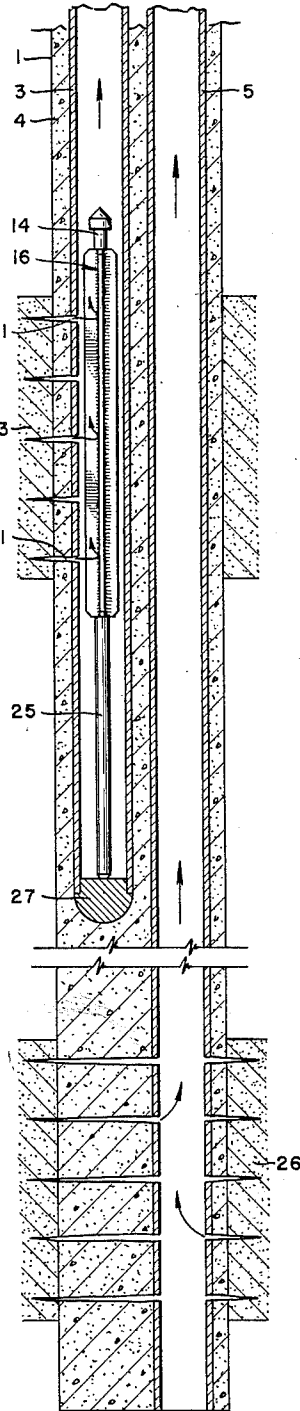


FIG. 3.

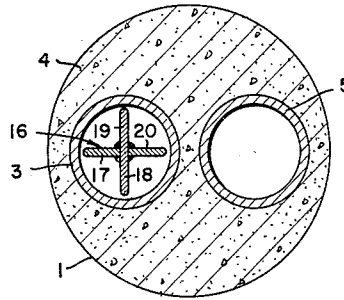
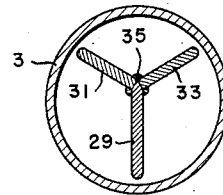


FIG. 4.

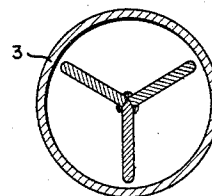


FIG. 5.

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PREVENTING INTERNAL WEAR OF PRODUCTION PIPE STRINGS BY ABRASIVE-LADEN FLUIDS

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This invention relates to the production of hydrocarbons from wells in the earth, and more particularly to the prevention of erosion of the interior of production pipe strings by abrasive-laden fluids from subsurface earth formations.

In a conventional oil well installation, a pipe string is cemented to the sides of a borehole to serve as a borehole liner for the purpose of preventing the sides of the borehole from caving in. One or more production pipe strings, or flow tubings, are suspended from a wellhead apparatus, the number of production pipe strings depending on the number of earth formations to be produced through the well bore. In some areas it has been found practical to eliminate the borehole lining, or casing, and to cement production pipe strings directly to the walls of the borehole. The cementing operation is necessary to prevent fluid communication between productive earth formations and to prevent contamination of fresh water sands near the earth's surface by hydrocarbonaceous fluids. After the production pipe strings have been cemented they are perforated to open fluid communication between the productive earth formations and the interiors of the pipe strings. Inasmuch as it is desirable to have only one pipe string in fluid communication with a given earth formation, various techniques have been developed for the purpose of preventing the accidental perforation of two pipe strings at the same level so as to open up fluid communication between pipe strings.

It is well known that sand and other abrasive materials may be produced along with earth formation fluids. Often the velocity of the formation fluids through the perforations is so great that the abrasive particles therein erode or abrade the inner wall of the pipe string to form openings in the pipe string and the surrounding cement. This erosion is particularly undesirable when the longitudinal axis of a perforation is in line with an adjacent pipe string in a multiply completed well. It is manifest that if the erosion were continued for a sufficiently long interval of time, fluid communication could be opened up between the production pipe strings. Under any circumstances, the erosion is most undesirable.

In accordance with one aspect of the present invention, there is provided an elongated member of an erosion or abrasion-resistant material which is adapted to be positioned in a production pipe string opposite the perforations therein. For the purpose of the present invention, the terms "erosion" and "abrasion" will be used to designate substantially the same concept. The invention contemplates that the pipe strings extend into a borehole from a wellhead at the earth's surface, and that the pipe string is cemented to the sides of the borehole. The abrasion-resistant member comprises at least three wings or fins radially extending from a central axis toward the inner wall of the production pipe string within which it is disposed. Preferably, the fins extend to within about one-eighth inch of the inner surface of the production pipe string. Abrasive-laden fluids entering the pipe string through the perforations will strike the elongated member, and the kinetic energy of the abrasive particles will be absorbed by the elongated member. The fluids may then flow upwardly through the spaces between the fins into the open bore of the pipe string.

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Objects and features of the invention not apparent from the above discussion will become evident upon consideration of the following description of the invention taken in connection with the accompanying drawing, wherein:

FIG. 1 is a sectional view of a well installation making use of the invention;

FIG. 2 is a view similar to FIG. 1 illustrating another embodiment of the invention;

FIG. 3 is a cross-sectional view taken along section 3-3 of FIG. 1;

FIG. 4 is a cross-sectional view of the production pipe string 3 of FIG. 1, similar to FIG. 3, and illustrating another embodiment of the invention; and

FIG. 5 is a view similar to FIG. 4 illustrating still another embodiment of the invention.

With reference now to FIG. 1, there is shown a borehole 1 within which are disposed side-by-side production pipe strings 3 and 5 which extend from a wellhead apparatus (not shown) at the earth's surface. The pipe strings 3 and 5 have been cemented with cement 4 to bond the pipe strings to the sides of the borehole for prevention of fluid migration through the space between the pipe strings and the sides of the borehole. This is in accordance with usual practice and will not be further discussed herein.

The lowermost section 22 of pipe string 3 is connected to the upper section of the pipe string by an elongated collar member 7 so as to form an elongated collar recess 9. The function of this collar recess will be described below.

Lowermost pipe string section 22 is shown as having been perforated so that a plurality of perforations 21 extend from the bore of the pipe string through the surrounding cement 4 into the hydrocarbon-productive earth formation 23. A bull plug 27 is used to close the lower end of the production pipe string 3. Production pipe string 5 is shown as extending at least to the level of hydrocarbon-productive earth formation 26 and as having been perforated so as to open fluid communication between the formation 26 and the bore of pipe string 5.

Elongated member 16 comprises a plurality of fins or wings of an abrasion-resistant material. The fins radially extend from a central axis toward the inner wall of the production pipe string section 22. In the embodiment illustrated in FIGS. 1 and 3, the cross section of the elongated member 16 is an X, or cross, with the angle between the fins being substantially 90°. Preferably, the fins 17, 18, 19, and 20 are at least three in number, and when at least three fins are used, they are substantially equiangularly spaced around the longitudinal axis of the abrasion-resistant member 16. The fins 18 and 19 may comprise a single member, with the fins 17 and 20 welded together.

The material from which the abrasion-resistant member 16 is formed may be any of a number of ceramic materials, abrasion-resistant metals, or other materials. Tungsten carbide is a material that is particularly well suited for use with the present invention.

The length of abrasion-resistant member 16 is at least the distance between the uppermost and lowermost of the perforations 21. Preferably, the abrasion-resistant member 16 extends at least 12 inches above and below the uppermost and lowermost of the perforations.

The abrasion-resistant member 16 is shown in FIG. 1 as being positioned opposite the perforations 21 by means of a collar stop or landing mandrel 15 including a plurality of latching dogs 11 radially spring-biased from the body of the mandrel 15 so as to extend into the collar recess 9. Latching dogs 11 have tapered upper surfaces to permit retrieval of the apparatus from the pipe string. The collar stop 15 may be a device as illustrated

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on page 3990 of the 21st edition of the "Composite Catalog of Oil Field and Pipe Line Equipment" (1955), and may be run into the well on a Type A Otis Collar Stop running tool. A fishing neck 13 is provided which is adapted to be caught by a conventional wire line retrieving tool for the purpose of retrieving the apparatus from the well.

After the pipe strings have been cemented and perforated in the borehole 1, the abrasion-resistant member 16 is dropped into the pipe string 3 or run in on a wire line. When the member reaches the depth of formation 23, dogs 11 are latched in collar recess 9. Formation 23 may then be produced. Abrasive-laden fluid entering the bore of the pipe string through perforations 21 will strike the abrasion-resistant member 16 and will flow upwardly around the mandrel 15 into the open bore of pipe string 3. The kinetic energy of the abrasive particles will be absorbed by the abrasion-resistant member 16 and will not damage the interior of the pipe string 3.

FIG. 2 illustrates another means for positioning the abrasion-resistant member 16 opposite perforations 21. A spacer bar 25 is affixed to the lower end of the abrasion-resistant member 16 so that the lower end of spacer bar 25 rests on bull plug 27 or any solid bottom such as a bridge plug, cement, sand, gravel, etc. Fishing neck 14 is directly connected to the upper end of abrasion-resistant member 16; otherwise, the apparatus of FIG. 2 is the same as the apparatus of FIG. 1, both in operation and in construction.

The cross-sectional configuration of abrasion-resistant member 16 may be different from the cross illustrated in FIG. 3. For example, three fins may be disposed about the central longitudinal axis to form a Y as is shown in FIGS. 4 and 5. As illustrated in FIG. 4, the fins 31 and 33 may be shorter than fin 29 so that the axis 35 is substantially removed from the axis of the production pipe string 3, or the fins may be of equal length as shown in FIG. 5. More than four fins may extend from the central longitudinal axis 35. However, the number of fins should not exceed six to prevent undue restriction of flow upwardly through the space between the fins. In order to insure that the abrasive fluids ejected from the perforations 21 will strike the abrasion-resistant fins, the fins should extend to within about one-eighth inch of the inner surface of the pipe string 3.

The invention is most advantageous in that it is very easy to construct and to position in a well. The apparatus may be easily and inexpensively placed in operating position and retrieved from the well in the event that replacement becomes desirable.

The invention is not necessarily to be restricted to the specific structural details or arrangement of parts herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of the invention.

The objects and features of the invention having been completely described above, what it is desired to claim is:

1. Apparatus for reducing abrasion of the interior of a production pipe string cemented to the sides of the

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borehole, and perforated to open fluid communication to surrounding earth formations, comprising: a plurality of erosion-resistant, elongated fins radially extending from a common axis; and means connected to said fins for positioning said fins opposite the perforations in the pipe string.

2. Apparatus for reducing abrasion of the interior of a production pipe string cemented to the sides of the borehole, and perforated to open fluid communication to surrounding earth formations, comprising: at least three erosion-resistant, elongated fins radially extending from a common axis toward the inner surface of the pipe string; and means connected to said fins for positioning said fins opposite the perforations in the pipe string.

3. Apparatus for reducing abrasion of the interior of a production pipe string cemented to the sides of the borehole, and perforated to open fluid communication to surrounding earth formations, comprising: at least three erosion-resistant, elongated fins radially extending from a common axis to within about one-eighth inch of the inner surface of the pipe string, and substantially equiangularly spaced around said axis; and means connected to said fins for positioning said fins opposite the perforations in the pipe string.

4. The combination of claim 1 wherein the cross-sectional configuration of the fins is substantially that of a cross.

5. The combination of claim 1 wherein the cross-sectional configuration of the fins is substantially that of a Y.

6. In combination: a production pipe string cemented to the sides of a borehole including a plurality of pipe sections connected end-to-end by coupling collars to define a plurality of collar recesses therebetween opening into the bore of the pipe string; a plurality of erosion-resistant elongated fins radially extending from a common axis toward the inner surface of the pipe string; and collar stop means connected to said fins including means extending into one of said recesses to position said fins opposite the perforations in the pipe string.

7. In combination: a production pipe string cemented to the sides of a borehole including a plurality of pipe sections connected end-to-end by coupling collars to define a plurality of collar recesses therebetween opening into the bore of the pipe string; at least three erosion-resistant elongated fins radially extending from a common axis to within about 1/8 inch of the inner surface of the pipe string; and collar stop means connected to said fins including means extending into one of said recesses to position said fins opposite the perforations in the pipe string.

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