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PREVENTION OF EROSION OF PIPE STRINGS IN MULTIPLY TUBINGLESS COMPLETED OIL AND GAS WELLS

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FIG. 1.

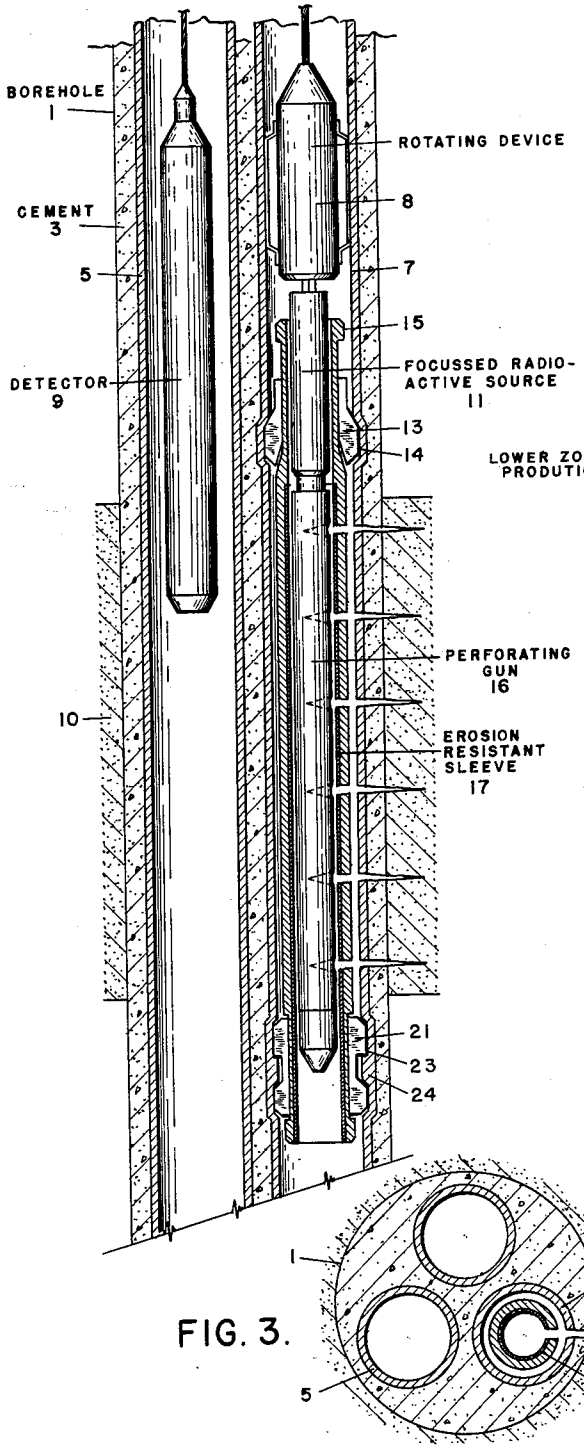


FIG. 2.

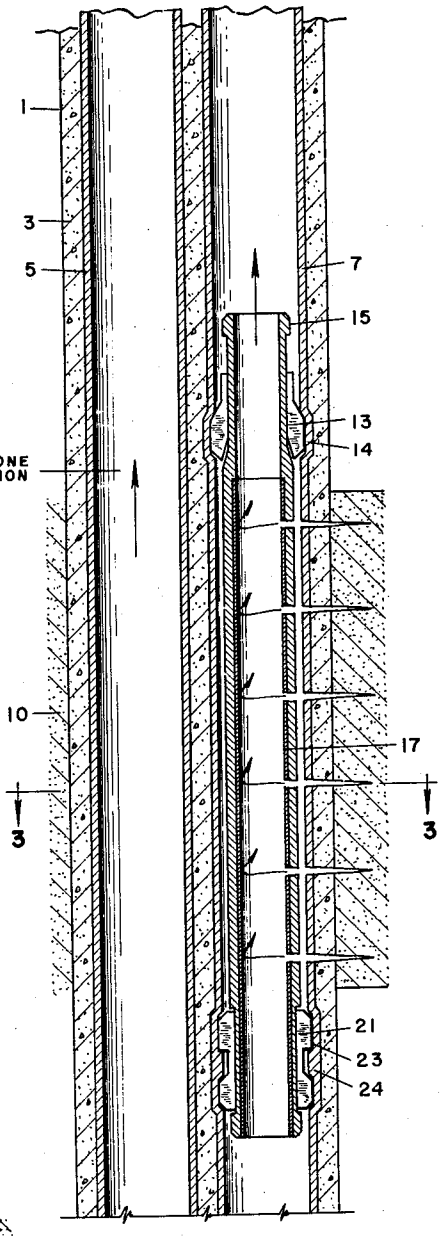


FIG. 3.

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PREVENTION OF EROSION OF PIPE STRINGS IN MULTIPLY TUBINGLESS COMPLETED OIL AND GAS WELLS

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This invention relates generally to production of hydrocarbonaceous earth materials through wells in the earth, and more particularly to the prevention of erosion of the interiors of production pipe string by abrasive-laden fluids from 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 aparatus, 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 formation fluids are produced at a high velocity so as to impart sufficient kinetic energy to the abrasive particles for the particles to erode away the interior of and cement. This erosion is particularly undesirable when the perforations are in a direction opposite to 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 the teachings of the present invention, an abrasion-resistant tubular sleeve of materials such as highly density alumina ceramics, boron carbide, silicon carbide, tungsten carbide, and rubber or similar materials is lowered into one of a plurality of pipe strings cemented in a borehole and is landed therein at the depth of a productive earth formation to be produced through the pipe string. A perforating means, such as a perforating gun, is lowered into the pipe string until it is within the tubular sleeve, is oriented so that its direction of perforation is away from other adjacent pipe strings in the borehole, and is actuated to perforate the tubular sleeve, the pipe string, the cement surrounding the pipe string, and the productive earth formation. The perforating means may then be withdrawn from the well and the formation produced.

The invention will be more completely described with reference to the accompanying drawing, wherein:

FIGS. 1 and 2 are schematic diagrams of an oil and gas well installation illustrating two steps in the method of the invention; and

FIG. 3 is a cross-sectional view taken along section 3—3 of FIG. 2.

With reference now to the figures generally, there is illustrated a borehole **1** containing two side-by-side production pipe strings, or flow tubings, which have been cemented in the borehole with a cementitious slurry **3**. More than two pipe strings may be used, but for the purpose of simplicity the drawing, only two pipe strings are illustrated. Pipe string **7** is assumed to be for the purpose of producing hydrocarbon productive earth formation **10** and pipe string **5** is assumed to be for the purpose of producing a lower hydrocarbon-productive earth formation (not shown). Landing nipples **14** and **24** are included in pipe string **7**, preferably immediately above and immediately below the interval of earth formation **10** to be perforated.

An apparatus including an abrasion-resistant tubular sleeve **17**, a fishing neck **15**, upper landing dogs **13**, and lower retractable, spring-loaded locator keys **21** is lowered into pipe string **7** by means of a conventional wire line running tool, or it may be dropped into pipe string **7** and allowed to fall through the well fluid to its operating position. The landing nipples **14** and **24**, and landing dogs **13** and locator keys **21** may be of the type used in the Type S Landing Nipple and Landing Mandrel manufactured by the Otis Engineering Company illustrated at page 3971 of the "Composite Catalog of Oil Field Equipment and Services," 23rd edition, vol. 3, (1958). The landing nipple **24** is provided with a recess **23** for the purpose of cooperating with locator keys **21** to secure the abrasion-resistant sleeve against further downward movement. The landing dogs and landing nipples are designed so that the apparatus may be easily retracted from the pipe string by suitable wire line equipment. Landing apparatus and techniques of this nature are known in the art and will not be further described herein.

After the abrasion-resistant sleeve **17** has been landed in pipe string **7** and the wire line apparatus has been retracted from pipe string **7**, an apparatus including a perforating means **16**, a focussed radioactive source **11**, and a rotating device **8** is lowered into pipe string **7** until the perforating means **16** is within the abrasion-resistant sleeve **17**. The perforating means is here illustrated as a perforating gun and may be of the shaped charge type or the bullet type. Other perforating apparatus well known to the art may be used. The rotating device **8** may include retractable slips, bow springs, or other devices for more or less fixedly securing the housing thereof to the inside of the pipe string **7**. The rotating device may be either of the motor-driven type or of the type illustrated in copending application Serial No. 780,517, filed on December 15, 1958 by James T. Brumble. A radioactivity detector **9** is lowered into pipe string **5** adjacent the focussed radioactive source **11** for the purpose of detecting radioactive emanations emitted by the radioactive source **11**. Apparatus of this nature is now available in a well service provided by the Schlumberger Well Surveying Corporation and will not be further described herein.

The radioactive source **11** is focussed so that the radioactive emanations therefrom are directed in a direction opposite to the direction of perforation of perforating device **11**. The rotating device **8** is actuated until the gamma ray detector **9** indicates that radioactive emanations of maximum intensity are being received from radioactive source **11**. When the output signal from gamma ray detector **9** is at a maximum value, the rotation of rotating device **8** is stopped. The perforating means **16** is actuated to perforate the abrasion-resistant sleeve **17**, the pipe string **7**, the surrounding cement **3**, and the earth forma-

tion 10. The gamma ray detector 9 is then withdrawn from pipe string 5 and the apparatus including perforating gun 16 is withdrawn from pipe string 7.

The well is now produced as illustrated in FIG. 2. Earth fluids from formation 10 will pass through the perforations and the abrasive particles will strike the interior of abrasion-resistant sleeve 17. The operating lifetime of the abrasion-resistant sleeve 17 is very long and it will be practically unaffected by the erosive action of the sand and other abrasive particles from formation 10. However, if replacement should become necessary, the abrasion-resistant sleeve 17 may be pulled out of pipe string 7 by means of a conventional wire line pulling tool, such as is illustrated at page 4159 of the "Composite Catalog of Oil Field Equipment and Services," 22nd edition (1957). A new sleeve may be landed in the landing nipples 14 and 24, and the new sleeve and the pipe string 7 may be reperforated as described above.

The invention having been fully described, what we wish to claim is:

1. A method of preparing for production a well that comprises a plurality of side-by-side production pipe strings coextending in a well bore from the earth's surface and cemented to the sides of the well bore, said method comprising: positioning an abrasion-resistant sleeve in one pipe string at the level of a given earth formation to be produced; and perforating the abrasion-resistant sleeve, said one pipe string, and the surrounding cement in a direction away from any adjacent pipe strings at the level of said given earth formation.

2. A method of preparing for production a well that comprises a plurality of side-by-side production pipe strings coextending in a well bore from the earth's surface and cemented to the sides of the well bore, said method comprising: positioning an abrasion-resistant sleeve in one pipe string at the level of a given earth formation to be produced; orienting a perforating gun in said abrasion-resistant sleeve so that the direction of perforation thereof is away from other adjacent pipe strings at the level of said given earth formation; actuating said perforating gun; and withdrawing said perforating gun from the well.

3. In a well that comprises a production pipe string cemented to the sides of a well bore, the method of preparing the well for production of earth fluids that comprises: positioning and abrasion-resistant sleeve in the pipe string at the level of a given earth formation to be produced; and perforating the abrasion-resistant sleeve, the pipe string, and the surrounding cement outwardly from within the abrasion-resistant sleeve.

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