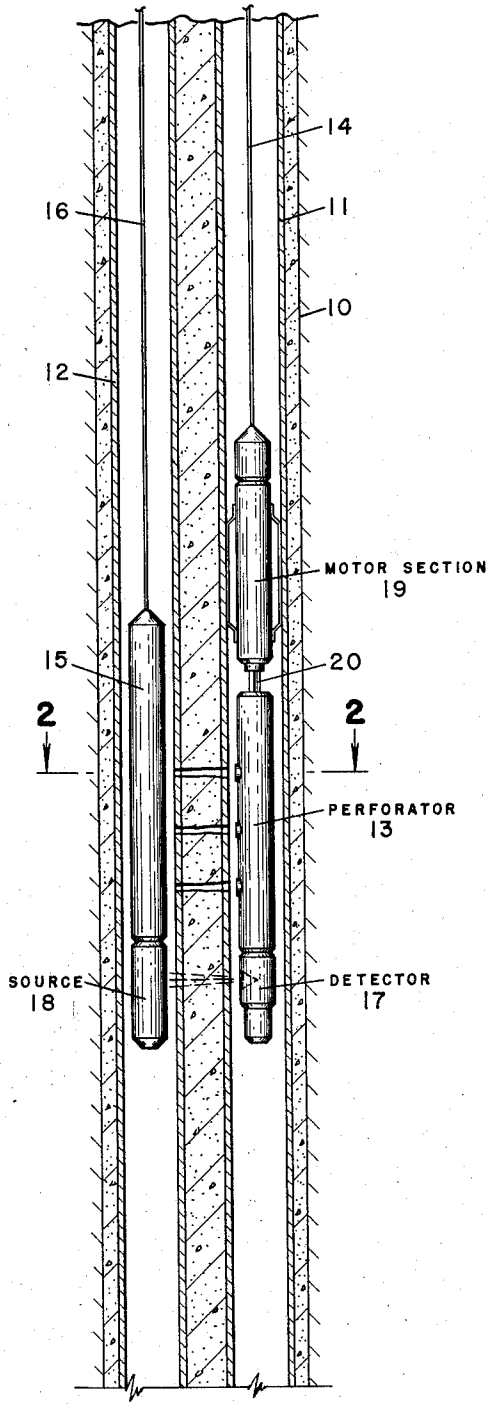
July 16, 1963 G. C. TERREL 3,097,693

METHOD OF PERFORATION OF WELL PIPE

Filed July 21, 1960

FIG. 1.



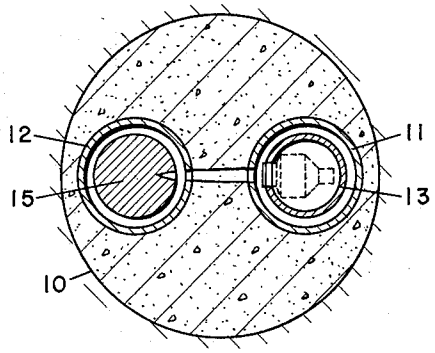


FIG. 2.

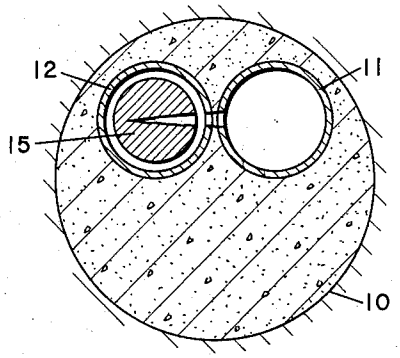


FIG. 3.

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3,097,693

Patented July 16, 1963

3,097,693

METHOD OF PERFORATION OF WELL PIPE

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Filed July 21, 1960, Ser. No. 44,339
1 Claim. (Cl. 166—35)

This invention relates to a method of perforating in wells to establish communication between two parallel, non-concentric, spaced-apart pipe strings.

In certain well operations, as for example when it is desired to establish subsurface communication between pipe strings during blowouts, workovers, etc., it is necessary to direct the fire of a gun perforator positioned in one pipe string to perforate one or more other pipe strings located in a well completed with multiple pipe strings. Various methods are employed for establishing communication between pipe strings arranged in a borehole, and these include the use of bullet, jet, chemical, and abrasive-type perforators as well as various types of perforator orienting devices, such as radio-activity and magnetic devices, gun guides, etc.

In some wells, the distance between any two of a plurality of spaced-apart pipe strings may vary, such that the amount of penetration of the perforator necessary to establish communication between the pipe strings, without penetrating completely through the other side of the pipe string with which communication is being established, cannot be accurately determined. Thus, a perforator that has sufficient penetration energy to penetrate another pipe string with which it is desired to establish communication where the pipe strings are separated by the maximum possible distance may result in perforating completely through this pipe string if the pipe strings are located or positioned a minimum distance apart. Perforation completely through the other pipe string is not desired because the additional opening may fluidly communicate with a surrounding formation, or a third pipe string, etc.

The present invention provides a solution to this problem by arranging an energy absorber tool in the second pipe string to absorb the energy of the perforator and prevent perforation or damage of the opposite wall of this pipe string. The tool is retrievable, and once the perforation has been made, may be retrieved, if desired, to prevent obstructing the bore of the second pipe string.

Therefore, a primary object of the present invention is to provide an improved method of perforating in wells to establish subsurface communication between two nonconcentric, spaced-apart pipe strings.

This and other objects of the invention will be apparent from a more detailed description of the invention taken in conjunction with the drawings wherein:

FIG. 1 is a cross-sectional view of the earth's subsurface showing two parallel, spaced-apart pipe strings arranged in a borehole; in one is arranged a pipe perforator and in the other pipe string is positioned an energy absorber tool; also illustrated in this figure is one type of pipe perforator orienting instrumentation;

FIG. 2 is a view taken on lines 2—2 of FIG. 1 and illustrates the positions of the pipe strings when they are spaced some distance apart; and

FIG. 3 is a view similar to that shown in FIG. 2 illustrating these pipe strings positioned close together.

Referring to the drawings in greater detail, in FIG. 1 is shown a borehole **10** which has arranged in it two parallel, non-concentric spaced-apart pipe strings **11** and **12**. A pipe perforator **13** is suspended on a wire line **14** in pipe string **11**. Perforator **13** may be of any desired type; i.e., jet, bullet, chemical, or abrasive. An

energy absorbing tool **15** is suspended in pipe string **12** on a wire line **16**. The absorber may be an iron, steel or lead bar, or in the case of the use of chemical or abrasive perforators, the absorber may be formed of rubber or ceramic material. Although the tool as shown appears cylindrically shaped, any desired configuration may be employed instead.

For the purpose of illustration, a particular type radioactivity orienting device is provided. In this case, the radioactivity technique utilizes a focused radiation detector **17** connected to pipe perforator **13** and a radiation source **18** connected to energy absorber tool **15**. This technique and apparatus for performing it are shown and described in U.S. patent application Serial No. 780,517 entitled "Method and Apparatus for Well Operations," dated December 15, 1958, by James T. Brumble, Jr.

As mentioned previously, other techniques may be employed. For example, both the source of radiation and a focused detector may be positioned on the perforator. This latter technique is shown and described in U.S. patent Serial No. 780,524 entitled "Method and Apparatus for Operating in Wells," filed December 15, 1958, by Harry S. Arendt.

Another technique may be used which places the radioactive source on the perforator and the focused detector on the energy absorber tool. Any of these techniques are applicable. Various means may be used to rotate the gun perforator to ascertain the direction of the other pipe string. In FIG. 1 a motor **19** is shown which by means of the shaft connection **20** rotates perforator **13** and detector **17** in a 360° arc in order to establish location of pipe string **12**, and thus the direction of fire of pipe perforator **13**. U.S. patent application Serial No. 780,387 entitled "Well Operation Method and Apparatus" filed December 15, 1958, by John C. McDuffie, Jr. discloses equipment for carrying out this operation. The patent applications mentioned previously disclose other mechanical type means for rotating the pipe perforator and detector through a 360° arc, and these means may be utilized instead of the motor-driven rotator.

In operation, pipe perforator **13**, detector **17** and motor **19** are lowered on wire line **14** to the subsurface location at which it is desired to establish communication between pipe strings **11** and **12**. The energy absorber **15** and radioactive source **18** are lowered on wire line **16** in pipe string **12** to the same depth location so that radioactive source **18** is at approximately the same level as detector **71**. Motor **19** is the actuator which rotates pipe perforator **13** and focused detector **17**. In its circumferential traverse the direction of radioactive material **18** and thus the direction of pipe string **12** are established. The perforator elements of perforator **13** are then faced in the direction of pipe string **12** and activated to penetrate both pipe string **11** and pipe string **12**.

As shown in FIG. 2, the perforator penetrates the interior of pipe string **12** and establishes communication between the pipe strings. Probably, it would not be necessary to utilize the energy absorber tool **15** when the pipe strings **11** and **12** are spaced sufficiently far apart as shown in FIG. 2. However, the distance between pipe strings **11** and **12** is not known, and they may be positioned adjacent to each other as illustrated in FIG. 3. In that event, the perforator would penetrate through the wall of pipe string **12** adjacent to pipe string **11** and continue on and penetrate the opposite wall of pipe string **12**. By using the energy absorber **15**, penetration of the opposite wall of pipe string **12** is prevented.

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

A method for perforating in wells to establish communication between two parallel nonconcentric pipe strings comprising the steps of lowering a pipe perforator

in one pipe string having a selected radial direction of perforation to adjacent the depth in a well to which it is desired to establish communication between the two pipe strings; lowering in the other pipe string perforator energy absorbing means to the same depth to which the perforator was lowered; detecting the radial direction of said other pipe string relative to the direction of perforation of said perforator; orienting said perforator so that the direction of perforation faces in the direction of the other pipe string; and then actuating the perforator to perforate both pipe strings to establish communication between the pipe strings, the energy absorbing means absorbing energy of the perforator in excess of that necessary to perforate and establish communication between the pipe strings.

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