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SEARCH ROOM

Nov. 23, 1965 L. H. WARD 3,219,113

METHOD AND APPARATUS FOR EFFECTING THE PERMANENT COMPLETION OF A WELL

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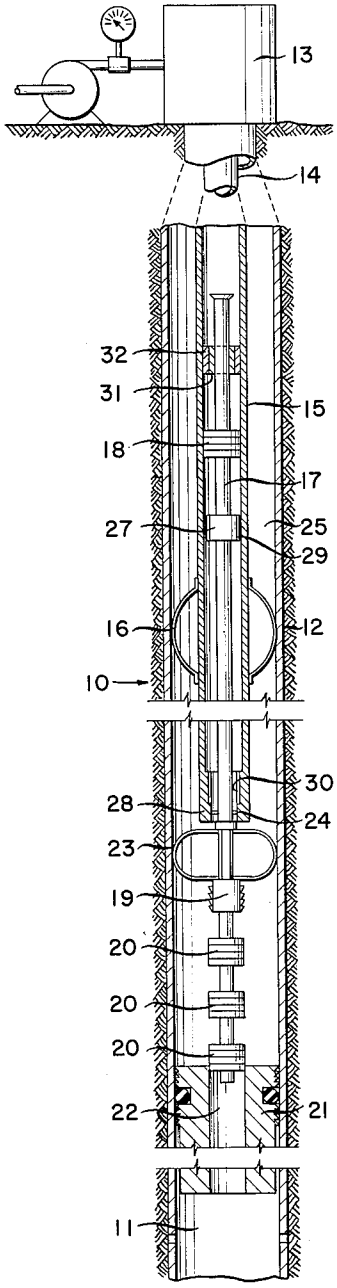


FIG. 1

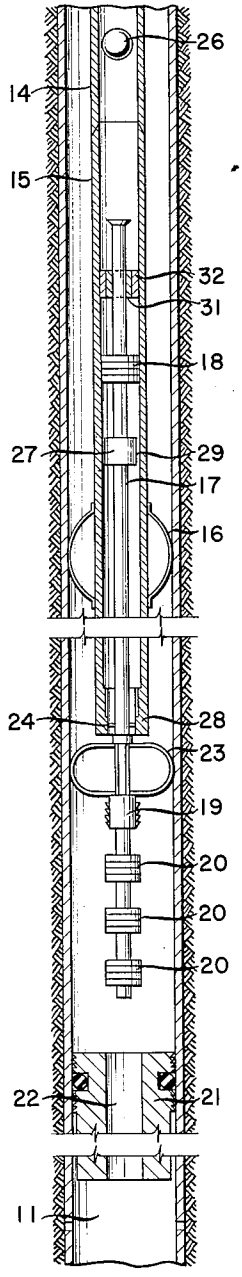


FIG. 2

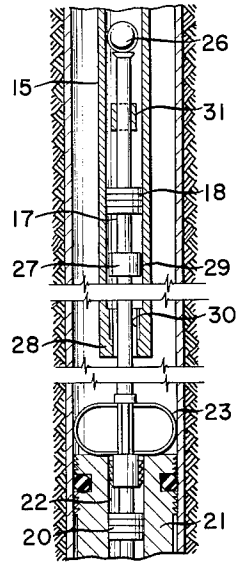


FIG. 3

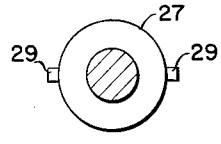


FIG. 4

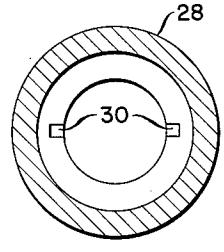


FIG. 5

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METHOD AND APPARATUS FOR EFFECTING THE PERMANENT COMPLETION OF A WELL

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This invention relates to a method and apparatus for effecting permanent completion of a well. More particularly this invention relates to a method and apparatus for permanently completing a well which has just been hydraulically fractured without requiring that the wellhead equipment be removed.

In the fracture treatment of wells, fluid is pumped down the well under high pressure to a confined well interval where it fractures and is forced into the formation. The fluid may be pumped down through the tubing string which is set in a packer or it may be pumped down the casing tubing annulus before a packer is set.

Although the fracture treatment of wells through the tubing string has the advantage that the well is in a position to be produced immediately following the treatment, it has the disadvantage that high pressure drops due to friction impose limitations on the injection pressure and injection rates. It is to reduce this friction loss in the tubing string that it has become common practice to fracture certain wells by pumping fluid down the casing-tubing annulus of small diameter wells. Following treatment by this method, however, it is generally required that the well be killed by mud or other means so that a packer may be installed and the production tubing run. Killing the well can result in impairment of the formation productivity, thereby reducing the effectiveness of the fracture treatment.

It is therefore an object of the present invention to provide a method and apparatus whereby the fracture treatment of wells may be carried out through either the production tubing or the casing-tubing annulus or both after the production packer and production tubing have been run.

Another object of the present invention is to provide a method and apparatus whereby after the fracture treatment of a well using the casing-tubing annulus, the well is immediately in a condition to be produced.

It is a further object of this invention to provide a method and apparatus which permits maximum possible pumping rates during a fracture treatment of a well and yet provides the protection afforded to the well by fracture treatments with the Christmas tree installed and permits the casing-tubing annulus to remain sealed following the fracture treatment and during the producing life of the well.

These and other objects of this invention will be understood from the following description with reference to the drawing, wherein:

FIGURE 1 is a sectional view of the well and the telescoping tool showing the telescoping tool being lowered into the well with the tip of the tool just entering the packer.

FIGURE 2 is a sectional view of the well and the telescoping tool showing the tool in a raised position to enable the fracture treatment of the well.

FIGURE 3 is a sectional view of the well and the telescoping tool showing the telescoping section in an extended position to permanently complete the well.

FIGURES 4 and 5 are plan views of the engageable members used in the preferred embodiment to retrieve the telescoping section from the well.

Referring to FIGURES 1–3 of the drawings, a well 10 is shown which has been drilled through a number of

earth formations including producing zone 11. Arranged in the well 10 are a casing 12 and a production tubing string 14 suspended from the wellhead 13 which is at the surface. Attached to the bottom of the tubing string is a tubular member 15 which is preferably of the same diameter as the tubing string. A centralizer 16 is provided on the tubular member 15 to maintain the tubing in the center of the well casing.

A tubular telescoping section 17 has its upper end extending into the tubular member 15. Suitable sealing means 18, e.g., machined nipples having packing rings or O ring seals, are carried by the tubular telecsoping section 17 to seal the space between the tubular member 15 and the telescoping section 17. The telescoping section 17 is designed such that its lower end will always extend below the tubular member 15. Near the lower end of the telescoping section 17, a latching means 19, as for example described on page 501 of the "Composite Catalog of Oil Field Equipment and Services" (1962–63), and a sealing means 20 are provided, the purpose of which is to secure and seal the telescoping section, when extended, in a production packer 21 having a hole 22 therein. The telescoping section 17 is also provided with a centralizer 23 positioned just above the latching means 19. With the conventional type of latching means 19 referred to above, latching of the tubing string to the packer 21 is attained by the expansion of a latch-ring after the tubing string 14 is seeded in the packer; the expansion being caused by the weight of the tubing string above the latching means. Disengagement of the latching means 19 from the packer 21 may then be achieved by rotating the tubing string and the latching means 19. Once the latching means 19 is lifted, it is automatically reset for any subsequent latching action into the packer 21.

To maintain the telescoping section 17 in a retracted position, latching means 24 are used to connect the telescoping member 17 to the tubular member 15. Although in the preferred embodiment the latching means 24 is shown as one or more shear pins, it is understood that any suitable latching device may be used.

The operation of the apparatus is as follows:

Following the completion of the drilling of the well and with the drilling mud still in the well, and the producing zone open (either by perforating or open hole completion), a production packer 21 is lowered into the well and secured to the casing 12 just above the production zone 11. After the packer 21 has been installed in the well, the tubing string 14, with the tubular member 15 and telescoping section 17 connected at its lower end, is inserted in the well. As the tubing string is lowered, the mud is circulated down through the tubing string and up through the casing-tubing annulus 25 by means of a pump at the surface. The pressure of the circulating fluid in the well is detected at the surface by any standard pressure indicating means and observed by an operator. When the sealing means 20 enters the hole 22 in the packer 21 as shown in FIGURE 1, the pressure on the pump at the surface increases and the lowering of the tubing string by the operator is stopped. The tubing string 14 is then raised a distance less than the length of the telescoping section 17 as shown in FIGURE 2. For example, with a telescoping section 17 having a length of 20 feet the tubing string 14 may be raised approximately 10 feet. This allows the telescoping section 17 to reach the packer when it is released and also leave some room for contraction. The tubing string is then secured to the wellhead and the top of the well is then closed, i.e., the Christmas tree is attached. The drilling mud is then removed from the well by circulating a fluid such as oil or water down through the tubing string and up through the casing-tubing annulus by means of a surface pump. A fracture treat-

ment of the well is then carried out by forcing fracturing fluid into the producing zone through the casing-tubing annulus 25 and simultaneously through the tubing string 14 if desired. After the fracture treatment is completed, the telescoping section 17 is extended. In the preferred embodiment this is accomplished by dropping a ball or go-devil device 26 into the tubing string which seats itself on the top of the telescoping section 17. The pump pressure is then increased causing the rupture of the shear pin 24 and resulting in the telescoping section 17 traveling downwardly and properly latching and sealing the lower end of the telescoping section 17 in the packer 21 (see FIGURE 3). The ball or go-devil device 26, if of the floatable type, can then be floated to the surface by means of well pressure after the pump pressure is released, or if not of the floatable type, can be retrieved by a wire line. Once the telescoping section 17 has latched and sealed into the packer 21, the well is ready to be produced.

In the event that the well on which applicant's novel method and apparatus is to be used is one which has previously been a producing well, no drilling mud will be present in the well. If a well killing mud has been inserted into the well, then the procedure outlined above is carried out using the killing mud in place of drilling mud. If, however, no mud of any kind is present in the well, then a suitable fluid must be circulated down into the well during the lowering of the tubing string. In this latter procedure, the removal of any mud prior to the fracture treatment is of course unnecessary.

To enable retrieval of the tubing string including telescoping section 17 from the well, movement-limiting means are provided. In the preferred embodiment, the movement-limiting means consists of a pair of engageable members 27 and 28. As shown in FIGURE 4, the first engageable member 27 is mounted on the upper portion of telescoping section 17 and is in the form of a collar having one or more lugs 29. The second engageable member 28 as shown in FIGURE 5 is an internal shoulder mounted on the lower end of the tubular member 15 and contains one or more slots of grooves 30 into which the lugs 29 will fall when they are properly oriented. It is understood that there will be at least as many grooves 30 as there are lugs 29.

To retrieve the tubing string from the well, the well is opened and the tubing string is raised until the collar 27 rests on the internal shoulder 28. The tubing string 14 is then rotated until the lugs 29 and grooves 30 engage. Further rotation disengages the packer latching means 19 after which the tubing string may be pulled from the well.

Although the operation of the apparatus described above is the preferred mode of operation, the lower end of the telescoping section 17 may also be positioned above the packer 21 by lowering the tubing string 14 down into the well until the packer latching means 19 engages the packer 21. The tubing string 14 is then rotated until the latching means 19 disengages. Following the disengagement of the latching means 19, the tubing string 14 is raised the required distance as described in the preferred mode of operation. The rotation of the tubing string to disengage the latching means 19 will, however, cause a twisting of the shear pins 24 which might cause them to shear before the desired time. To avoid this twisting of the shear pins 24, a second pair of engageable members 31, 32 is provided. The engageable members 31 and 32 may be identical to the pair of engageable members 27 and 28 respectively, with the member 32 inverted and positioned above the member 31. Preferably, however, the member 31 has a rectangular periphery and the member 32 has a corresponding rectangular internal surface. The members 31 and 32 are positioned relative to one another so that they remain engaged as long as the telescoping section 17 is in a retracted position. While the members 31 and 32 are engaged no rotational movement of the telescoping section 17 relative to the tubular member 15 is possible thus avoiding any twisting of the shear pins 24.

Obviously, various modifications of the present invention are possible in the light of the above teachings. It is therefore to be understood that the invention is not limited to the particular form illustrated but is capable of embodiment in other forms without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. A method of increasing the productivity and of completing a cased well comprising:
   (a) setting a production packer in said well above a zone to be fractured;
   (b) inserting into the well, a tubing string having at the lower end a telescoping section in a normally retracted position;
   (c) positioning the lower end of the string a distance above the packer less than the length of the telescoping section;
   (d) securing the string at the top of the well and closing the top of the well by installing the Christmas tree;
   (e) hydraulically fracturing said zone by pumping fluid under pressure through the casing-tubing annulus into said zone; and
   (f) completing the well by extending the telescoping section from its retracted position to sealingly engage the packer, whereby said well is ready to be produced without requiring that the well be reopened.

2. The method of claim 1 wherein the tubing string is positioned by: circulating a fluid in the well while the tubing string is being lowered; measuring the pressure of said circulating fluid; and, raising the tubing string a distance less than the length of the telescoping section when said pressure suddenly increases indicating that the lower end of the string has entered the packer.

3. The method of claim 1 wherein said zone is fractured by pumping fluid under pressure through the casing-tubing annulus and the tubing string simultaneously.

4. Apparatus for servicing a cased well in which the production tubing has been run and in which a production packer has been set comprising:
   (a) a tubular member connected to and forming the lower end of the production tubing;
   (b) a tubular telescoping section of a length greater than said tubular member, the upper portion of said tubular telescoping section extending within said tubular member and slidably engageable therewith in a fluidtight manner;
   (c) means connected to the lower end of said tubular telescoping section for securing said telescoping section to said production packer to prevent axial movement therebetween in both an upward and a downward direction when said telescoping section is extended; and
   (d) latching means for maintaining the telescoping section in a retracted position,
      whereby when the latching means is released, the telescoping section will travel downward in the well until it is seated in and secured to the packer by said means connected to the lower end of said tubular telescoping sections.

5. Apparatus as in claim 4 wherein said latching means comprises at least one shear pin interconnecting said tubular member and said tubular telescoping section.

6. Apparatus for servicing a cased well in which the production tubing has been run and in which a production packer has been set comprising:
   (a) a tubular member connected to and forming the lower end of the production tubing;
   (b) a tubular telescoping section of a length greater than said tubular member, the upper portion of said tubular telescoping section extending within said tubular member and slidably engageable therewith in a fluid-tight manner;

(c) means connected to the lower end of said tubular telescoping section for securely latching said telescoping section to said production packer to prevent axial movement therebetween when said telescoping section is extended;

(d) a pair of cooperating engageable members, one of said engageable members being on the upper portion of said tubular telescoping section and the other of said cooperating members being on the lower end of said tubular member, said pair of cooperating members engaging upon substantially complete extension of said telescoping section to prevent relative rotation between said tubular member and said telescoping section; and

(e) latching means for maintaining the telescoping section in a retracted position, whereby when said latching means is released, the telescoping section will travel downward in the well until it is seated in and latched to said production packer by said means connected to the lower end of said tubular telescoping section.

7. Apparatus as in claim 6 wherein said first cooperating member comprises a collar having at least one protruding lug and said second cooperating member comprises an internal shoulder having at least one notch whereby said lug can lock in said notch.

8. Apparatus as in claim 7 wherein said latching means comprises at least one shear pin interconnecting said tubular member and said tubular telescoping section.

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