Aug. 13, 1963 P. R. McSTRAVICK ETAL 3,100,529

APPARATUS FOR POSITIONING WELL PIPE

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FIG. 2.

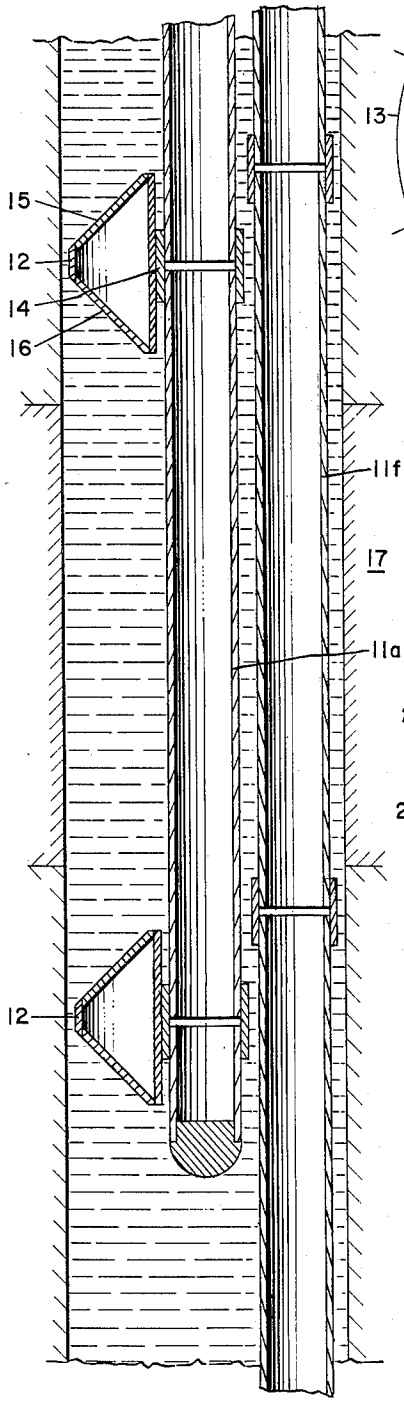


FIG. 1.

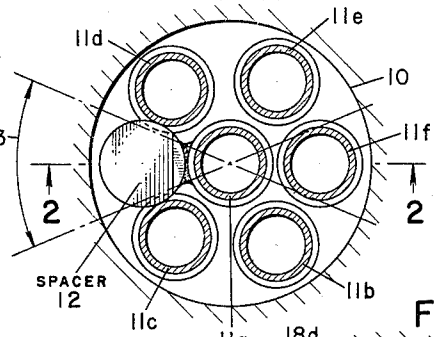


FIG. 3.

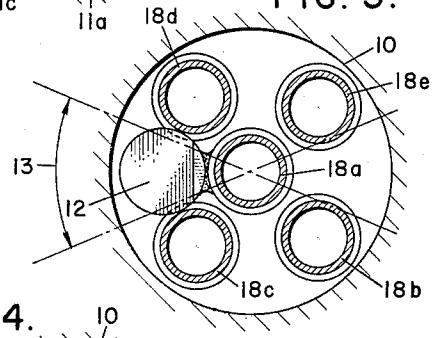
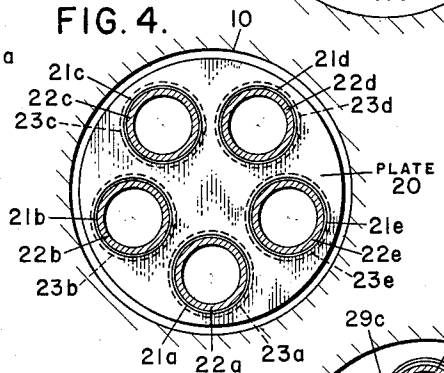


FIG. 4.



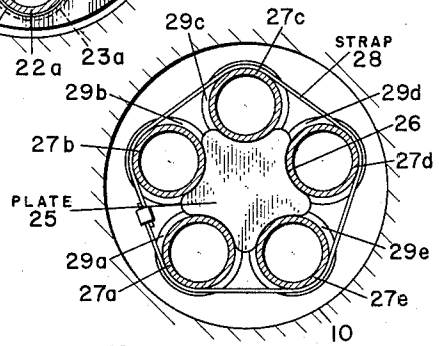


FIG. 5.

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FIG. 9.

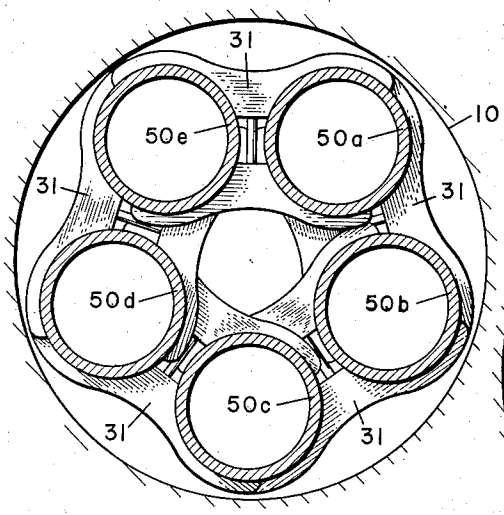
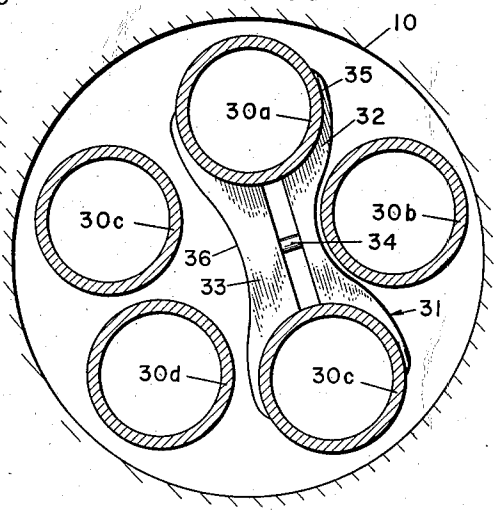


FIG. 6.



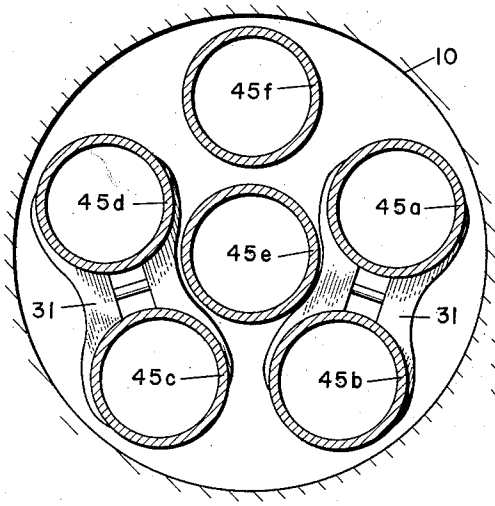


FIG. 8.

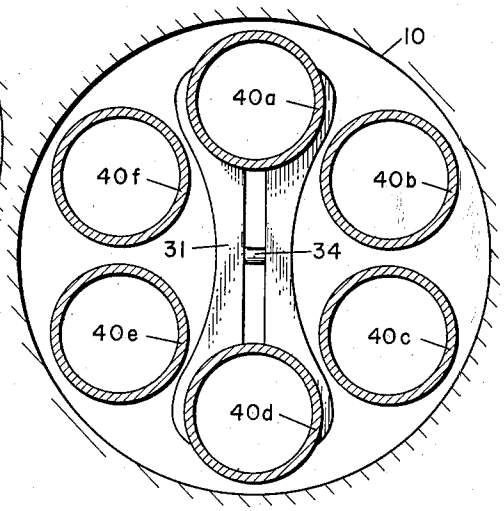


FIG. 7.

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3,100,529

APPARATUS FOR POSITIONING WELL PIPE

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Filed June 6, 1960, Ser. No. 34,170
2 Claims. (Cl. 166—52)

This invention relates to methods and apparatus for positioning well pipe in multiple well completions to prevent damage to adjacent production "casings" or pipe strings when a pipe string is perforated to obtain production of well fluids.

Multiple well completions are desirable in areas where a plurality of reservoirs or productive zones are present in one well or borehole. In this type completion, a multiplicity of pipe strings are set and each productive zone is completed through a selected pipe string.

Although opportunities exist in multiple well completions for the use of more than four pipe strings, heretofore multiple well completions have been limited to the use of four pipe strings because when five or more pipe strings are present adjacent a zone it is desired to produce, it is necessary to insure that this zone and the pipe string through which it is to be produced can be perforated without perforation or damage to the other pipe strings.

Accordingly, one object of the present invention is to provide method and apparatus which permits, for perforating purposes, proper spacing and positioning of pipe strings in a multiple well completion operation.

In one embodiment of the invention, the apparatus comprises a spacer member or members attached to one of the multiplicity of pipe strings arranged in the well to position the pipe strings to allow perforation of a productive zone without perforation of or damage to the other pipe strings. The plurality of pipe strings may be run independently or simultaneously. In either manner of running the pipe strings, the spacer member or members are positioned on one of them in a manner that will provide proper spacing of the pipe strings adjacent the zones to be perforated.

In another embodiment of the invention, the apparatus comprises a spacer plate provided with a plurality of openings through each of which one of the multiplicity of pipe strings extends. Another form of this apparatus comprises a spacer plate member surrounded by a multiplicity of pipe strings strapped together. This apparatus requires that the multiplicity of pipe strings be run simultaneously. When running the pipe strings, the spacer members or spacer plates preferably are located at spaced intervals which insures proper spacing of the pipe strings adjacent the zones to be perforated.

In still another embodiment of the invention, the apparatus comprises clamp means arranged on at least a pair of the multiplicity of pipe strings. If more than one pair of the pipe strings are connected together, overlapping of the clamped together pairs may be employed. The clamps are located on the pipe strings so that proper spacing is provided adjacent the zones to be perforated. The pipe strings may be run simultaneously or, if desired, the clamped together pipe strings may be run first and the remaining pipe strings may be subsequently run independently.

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

FIG. 1 is a top view of a well bore showing an arrangement therein of six pipe strings, one of which has attached thereto a spacer member in accordance with one embodiment of the invention;

FIG. 2 is a view taken on lines 2—2 of FIG. 1;

FIG. 3 is a view similar to that of FIG. 1, however, only five pipe strings are illustrated;

FIGS. 4 and 5 are top views of another embodiment of the invention in which five pipe strings maintained spaced-apart by plate members are shown; and

FIGS. 6 to 9 are top views showing various arrangements of still another embodiment of the invention in which at least one pair of the multiplicity of pipe strings is clamped together.

In FIG. 1 is shown a well bore **10** in which are arranged six pipe strings **11***a* to **11***f*. A spacer member **12** is connected to the "casing" or pipe string **11***a* to insure that the remaining pipe strings are properly spaced to permit perforation of a zone to obtain production of well fluids through pipe string **11***a* without damage to the other pipe strings **11***b* to **11***f* in the event the upper zone casing is the central casing in the arrangement. The arc, designated **13**, indicates the adequate space provided by spacer member **12** through which the fire of a gun perforator may be safely directed.

Any desired number of spacer members **12** may be used. Two spaced-apart spacer members **12** affixed to pipe string **11***a* in any desired manner are shown in FIG. 2. If desired, spacer member **12** may be formed as an integral part of the casing collar **14** of pipe string **11***a*. The top surface **15** of spacer member **12** and the bottom surface **16** thereof may be tapered, as shown, to minimize interference with the spacer member when running the other pipe strings. Spacer members **12** are arranged on pipe string **11***a* so that they are positioned adjacent an upper productive zone **17** when pipe string **11***a* is in its landed position. The multiplicity of pipe strings may be run in the well bore independently or simultaneously.

FIG. 3 shows a five pipe string arrangement. In this illustration, a centrally located pipe string **18***a* is spaced from the four other pipe strings **18***b* to **18***e* by spacer member **12** connected to pipe string **18***a* to permit firing of a gun perforator in pipe string **18***a* in the direction of the space designated again by the arm **13**. Within the hole size limitations, the diameter of spacer member **12** may be varied to give the angular clearance desired.

In FIG. 4 is shown a spacer plate **20** provided with five spaced-apart openings **21***a* to **21***e* through which extend five pipe strings **22***a* to **22***e*, respectively. Openings **21***a* to **21***e* are arranged in plate member **20** such that no one of the pipe strings can be surrounded by the other pipe strings to prevent perforating from the one pipe string without damage to the other pipe string. The pipe string collars, indicated by the dotted lines **23***a* to **23***e*, may be employed to anchor plate **20** on the pipe strings or plate **20** may be affixed to the pipe strings in any other desired manner.

In FIG. 5, a spacer plate **25**, having curved sides **26**, is positioned in the center of a group of five pipe strings **27***a* to **27***e*. The curvature of the sides **26** is designed to fit the curvature of the pipe string with which it is in contact. Pipe strings **27***a* to **27***e* are strapped together by means of strap **28**. Plate **25**, preferably, is positioned above and adjacent to pipe collars **29***a* to **29***e* of pipe strings **27***a* to **27***e*, respectively, although it may be positioned at any other desired location.

In both of the apparatus shown in FIGS. 4 and 5, the tubing strings are run simultaneously and the spacer plates are positioned along the lengths of the pipe strings so that when the pipe strings are in landed position, the spacer plates are positioned adjacent the productive zones.

In FIGS. 6 to 9, various arrangements are shown for clamping one or more pairs of pipe strings together. In FIG. 6, five pipe strings **30***a* to **30***e* are arranged in well bore **10** and maintained in desired spaced-apart relation-

ship by a clamp **31** which grips and holds together pipe strings **30***a* and **30***c*. Clamp **31** includes identically configured halves **32**, **33** locked together by a bolt **34**. The ends of halves **32** and **33** are configured to conform to the circular configuration of the pipe strings, as shown at **35**, and the intermediate portion between the ends is narrowed to form a smoothly curved portion as shown at **36**. A similar arrangement is shown in FIG. 7 as that shown in FIG. 6; however, in FIG. 7, six pipe strings **40***a* to **40***f* are arranged in borehole **10** instead of the five pipe strings of FIG. 6. Clamp **31** in this arrangement grips and maintains in spaced relationship pipe strings **40***a* and **40***d*. In the arrangements of FIGS. 6 and 7, the pair of pipe strings clamped together may be run independently first and then the other pipe strings run separately or, if desired, all of the pipe strings may be run simultaneously. As in the previous embodiments, the pipe strings are clamped together at locations along the lengths of the pipe strings to insure the desired spacing of the pipe strings adjacent the zone or zones it is desired to perforate.

In FIG. 8, six pipe strings **45***a* to **45***f* are arranged in well bore **10**, two pairs of which **45***a*, **45***b* and **45***c*, **45***d* are clamped together by clamps **31**. In this arrangement, the clamped together pairs of pipe strings may be run independently and then the pipe strings **45***e* and **45***f* may be run independently or all of the pipe strings may be run simultaneously.

In FIG. 9, five pipe strings, **50***a* to **50***e*, are arranged in borehole **10**. One clamp **31** clamps together pipe strings **50***a* and **50***b*. Another clamp **31** clamps together pipe strings **50***b* and **50***c*; another clamp **31** clamps together pipe strings **50***c* and **50***d*. Still another clamp **31** clamps together pipe strings **50***d* and **50***e* and another clamp **31** clamps together pipe strings **50***e* and **50***a*. Thus, a plurality of clamps **31** clamp together pairs of the pipe strings in an overlapping arrangement. The pipe strings in this arrangement are run simultaneously. As in the previous embodiment, the clamps are arranged on the pipe strings in the pair clamping embodiment of FIGS. 6 to 9 so that the pipe strings are properly spaced adjacent the zone or zones it is desired to perforate.

Perforation of the desired zones may be carried out employing known gun perforator orienting techniques and uni-directional perforators such as those disclosed and claimed, for example in U.S. patent application Serial No. 780,387, by John C. McDuffie, Jr., filed December 15, 1958, entitled "Well Operation Method and Apparatus"; and U.S. patent application Serial No. 780,524, by Harry S. Arendt, filed December 15, 1958, entitled, "Method and Apparatus for Operating in Wells."

Having fully described the apparatus, method, and objects of our invention, we claim:

1. Multiple well completion apparatus adapted to space a plurality of pipe strings in a well bore to insure that the pipe strings through which subsurface hydrocarbon-containing formations are produced may be perforated without damage to other pipe strings arranged in said well bore comprising:

a plurality of vertically spaced-apart, vertically aligned spacer means connected to one of said pipe strings and positioned relative to at least two other of said pipe strings in a manner such that angular clearance relative to said two other pipe strings is provided;

each of said spacer means having a selected cross section, the extent of which determines a degree of angular clearance provided by said spacer means; and

each of said spacer means being of circular configuration and being tapered on the upper side downwardly away from said one pipe string to which it is attached and on the underside upwardly away from said one pipe string to which it is attached.

2. Apparatus as recited in claim 1 including having at least five pipe strings arranged in said well bore, one of which is arranged in the center of the others, said spacer means being connected to said center pipe string and positioned so as to insure a radial opening between two of the other surrounding pipe strings.

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