May 29, 1962 C. B. CORLEY, JR 3,036,634

COMPLETION OF WELLS IN A PLURALITY OF FORMATIONS

Filed Oct. 7, 1959

FIG. 1.

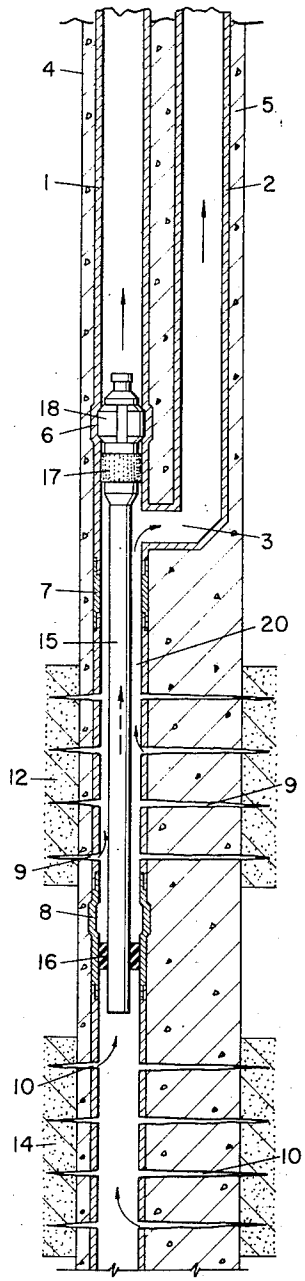


FIG. 2.

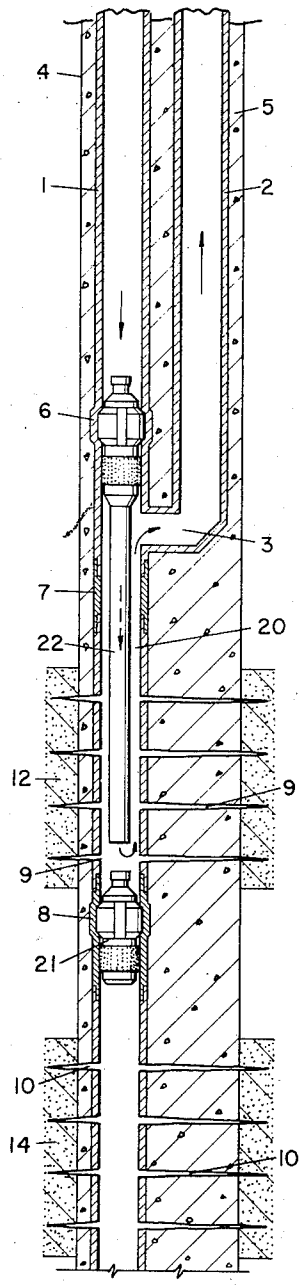
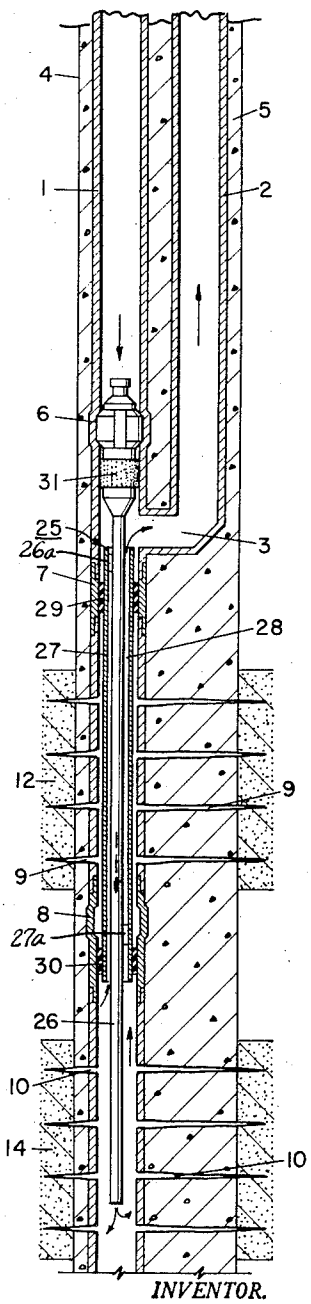


FIG. 3.



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COMPLETION OF WELLS IN A PLURALITY OF FORMATIONS

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The present invention is directed to a method for completing a well in a plurality of subsurface earth formations. More particularly, the invention is concerned with the completion and working over of wells having a plurality of pipe strings arranged therein. In its more specific aspects, the invention is concerned with completing and working over a well having a plurality of pipe strings arranged therein, which workover and servicing operations are conducted in only one of the pipe strings.

The present invention may be briefly described as a method for completing and working over a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zones. Two or more of the zones are perforated from one of the pipe strings and the zones are then isolated from each other, but each zone is in fluid communication with one of the pipe strings. The lower of the zones is produced through the first pipe string and an upper of the zones is produced through the second pipe string. One of the zones is then isolated from the second pipe string and the zone remaining in communication with the second pipe string is then worked over by flowing a fluid down the first pipe string to the particular zone and then up the second pipe string.

After the one or more of the zones has been worked over, production may then be resumed from a plurality of the zones.

The invention contemplates that the upper zones will be isolated from the second pipe string and the lower zone then worked over by flowing a fluid down the first pipe string to the lower zone and up the second pipe string. The invention also contemplates isolating the lower zone from the second pipe string and working over the upper zone by flowing a fluid down the first pipe string to the upper zone and up the second pipe string. Thereafter, production may be resumed.

The present invention will be further illustrated by reference to the drawing in which FIGS. 1 to 3, inclusive, represent a stepwise preferred mode of practicing the invention.

Referring now to the drawing, which is schematic, in the method of the present invention, two eccentrically arranged parallel casing strings are installed as shown in FIG. 1 with one of the casing strings 1 extending through all of the productive intervals and the second casing string 2 terminating above the uppermost productive interval and fluidly connected to the first casing string 1 by an interconnecting means forming a fluid port 3. The dual casing assembly is sealed in the well bore 4 with cement 5. Casing or pipe string 1 contains selective landing nipple 6 and polished bore nipples 7 and 8. The polished bore nipple 8 may be preferably a second selective landing nipple with a polished bore to facilitate plugback, as will be described later. Perforations 9 and 10 are formed in zones 12 and 14, respectively, by lowering a perforator which may be a bullet gun perforator, a shaped charge perforator, a mechanical, or chemical perforator. Following the perforation in the formation of perforations 9 and 10, a retrievable production tube 15 provided with seal element 16 on the lower end and seal element 17 and an extension hanger 18 on its upper

end is installed by lowering on a wireline to isolate zones 12 and 14 as shown in the drawing. Production from zone 14 is conducted through the retrievable production tube 15 and through the casing string 1 to the surface and through the wellhead installed on the well. Production from zone 12 is conducted into the annulus space 20 between retrievable production tube 15 and casing string 1 through the fluid port 3 into the casing string 2 and then to the surface. With this installation, separate and simultaneous production of hydrocarbons such as oil and gas may be obtained from vertically spaced apart intervals and workover of either or both zones may be accomplished with wireline equipment, as will be described further. In short, the present invention provides a dual completion installation which does not require orienting guns for perforating either zone, and the casing string 2 may be of small size only sufficient to conduct the hydrocarbon fluids to the wellhead since it is unnecessary to conduct workovers through the string 2.

In practicing the present invention, to permanently or temporarily plug zone 14, a plugging device may be installed in or adjacent the lower end of retrievable production tube 15 such that fluids produced from zone 14 are isolated below seal 16 in landing nipple 8. The retrievable production tube 15 is removed from the well by a wireline, not shown, and a plug is installed in or adjacent the lower end of the production tube 15 prior to reinstalling.

Another mode of operation is shown in FIG. 2 in which a wireline retrievable plug 21 is installed in landing nipple 8 to seal zone 14 from the casing assembly above landing nipple 8. Subsequently, production may be had from zone 12 through either or both casing strings 1 and 2, as may be desired. Retrievable production tube 15 is removed prior to this work and need not be reinstalled for subsequent production of a single productive interval.

In working over or squeeze-cementing the upper zone or treating the upper zone 12 with acids or other fluids such as surface active agents and the like, retrievable production tube 15 is removed and a wireline retrievable plug 21 may be installed in landing nipple 8 to plug temporarily zone 14. A tubular member 22 is then lowered on a wireline and suspended from landing nipple 6 for squeeze-cementing zone 12. Circulation is accomplished through casing string 1 through tubular member 22, annulus 20, fluid port 3, and upward to the earth's surface through casing string 2. It is apparent that circulation in the reverse direction is also possible. Following the squeeze-cementing of zone 12, tubular member 22 and the retrievable plug 21 are removed by a wireline, not shown. Zone 12 may then be reperforated or another zone perforated, and retrievable production tube 15 may be reinstalled to obtain production from the two zones or intervals as previously described.

In working over the lower zone such as for squeeze-cementing zone 14 or for treating it with a surface active agent or a sand consolidating agent and the like, apparatus as shown in FIG. 3 may be employed. In this operation, retrievable production tube 15 is removed and a concentric tubular member 25 which is open on both ends is installed to provide circulation to zone 14 while simultaneously isolating zone 12 from the circulating fluids. The concentric production tube or tubular member 25 shown in FIG. 3 is provided with an inner tubular member 26 and an outer tubular member 27 connected together on each end by connecting and spacing means 26*a* and 27*a*, respectively, which provides an annulus 28 therebetween. The outer tubular member 27 is sealed with a deformable sealing means 29 below the fluid port 3 and is sealed with a deformable sealing means 30 above the zone 14. Sealing means 29 and 30 are carried on the

exterior of outer tubular member 27. The inner tubular member is sealed with sealing means 31 above the fluid port 3. Following the treatment of the zone 14 as may be desired, the concentric tubular member 25 is removed, zone 14 may be reperforated, and retrievable production tubular member 15 may be reinstalled for separate and simultaneous production from the two intervals as has been described.

In the practice of the present invention, the retrievable plug member 21 may be a plug member such as has been described in Serial No. 769,343, entitled "Apparatus for Use in a Well Bore," filed October 24, 1958, now Patent No. 2,966,946.

The workover fluid employed in the present invention may suitably be low strength cementitious material as a slurry, acid which is used as a stimulating medium, servicing fluids and consolidation agents, and other workover fluids such as oil-water emulsions and the like may be used.

The present invention is quite advantageous and useful in that in the present invention all workover operations are conducted through one of the casing or pipe strings while the other casing or pipe string is used solely for conducting fluids. In the practice of the present invention, zones may be isolated from each other without cementing perforations and all operations are conducted using wireline tools. Thus, in the practice of the present invention, it is unnecessary to maintain heavy duty lifting equipment on the well and all operations may be conducted by a service truck and the drilling rig may be moved away for drilling another well.

The nature and objects of the present invention having been completely described and illustrated what I wish to claim as new and useful and secure by Letters Patent is:

1. In a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zone for fluid communication between said strings, the method which comprises separately perforating at least two of said zones from said first pipe string, isolating said zones from each other, said isolated zones each being in fluid communication with one of said pipe strings, producing a lower of said zones through a selected one of said pipe strings and producing an upper of said zones through the other of said pipe strings, isolating one of said zones from said other pipe string, the other of said zones being in fluid communication with the other of said pipe strings, and then working over said other zone by flowing fluid down said selected one pipe string and up said other pipe string.

2. A method in accordance with claim 1 in which the lower zone is produced through the first pipe string and the upper zone is produced through the second pipe string.

3. In a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zones for fluid communication between said strings, the method which comprises separately perforating at least two of said zones from said first pipe string, isolating said zones from each other, said isolated zones each being in fluid communication with one of said pipe strings, producing a lower of said zones through the first pipe string and producing an upper of said zones through the second pipe string, isolating one of said zones from said second pipe string, the other of said zones being in fluid communication with said second pipe string, working over said other zone by flowing fluid down said first pipe string and up said second pipe string, re-establishing fluid communication between said one zone and said second pipe string, isolating said zones from each other, and then resuming production from a plurality of said zones.

4. In a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zones for fluid communication between said strings, the method which comprises separately perforating at least two of said zones from said first pipe string, isolating said zone from each other, a lower of said isolated zones being in fluid communication with the first pipe string and an upper of said isolated zones being in fluid communication with the second pipe string, producing the lower of said zones through the first pipe string and producing the upper of said zones through the second pipe string, isolating said upper zone from said second pipe string, said lower zone being in fluid communication with said second pipe string, and working over said lower zone by flowing a fluid down said first pipe string and up said second pipe string.

5. In a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zones for fluid communication between said strings, the method which comprises separately perforating at least two of said zones from said first pipe string, isolating said zones from each other, a lower of said isolated zones being in fluid communication with the first pipe string and an upper of said zones being in fluid communication with the second pipe string, producing the lower of said zones through the first pipe string and producing the upper of said zones through the second pipe string, isolating said lower zone from said second pipe string, said upper zone being in fluid communication with said second pipe string, and working over said upper zone by flowing a fluid down said first pipe string and up said second pipe string.

6. In a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zones for fluid communication between said strings, the method which comprises separately perforating at least two of said zones from said first pipe string, isolating said zones from each other, a lower of said isolated zones being in fluid communication with the first pipe string and an upper of said zones being in fluid communication with the second pipe string, producing the lower of said zones through the first pipe string and producing the upper of said zones through the second pipe string, isolating said upper zone from said second pipe string, said lower zone being in fluid communication with said second pipe string, working over said lower zone by flowing a fluid down said first pipe string and up said second pipe string, isolating said lower zone from said second pipe string, said upper zone being placed in fluid communication with said second pipe string, and working over said upper zone by flowing a fluid down said first pipe string and up said second pipe string.

7. In a well having a first pipe string arranged therein penetrating a plurality of spaced apart hydrocarbon productive zones and an eccentric second pipe string connected by its lower end to the first pipe string at a point above said zones for fluid communication between said strings, the method which comprises separately perforating at least two of said zones from said first pipe string, isolating said zones from each other, a lower of said isolated zones being in fluid communication with the first pipe string and an upper of said zones being in fluid communication with the second pipe string, producing the lower of said zones through the first pipe string and producing the upper of said zones through the second pipe string, isolating said upper zone from said second pipe string, the lower zone being in fluid communication with the second pipe string, working over said lower zone by flowing a fluid down said first pipe string and up

said second pipe string, isolating said lower zone from said second pipe string, the upper zone being placed in fluid communication with the second pipe string, working over said upper zone by flowing a fluid down said first pipe string and up said second pipe string, re-establishing fluid communication between said lower zone and said second pipe string, isolating said zones from each other,

and then resuming production from a plurality of said zones.

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