March 19, 1957 M. E. TRUE 2,785,754

PERMANENT WELL COMPLETION

Filed Oct. 27, 1954 2 Sheets-Sheet 1

FIG. 1.

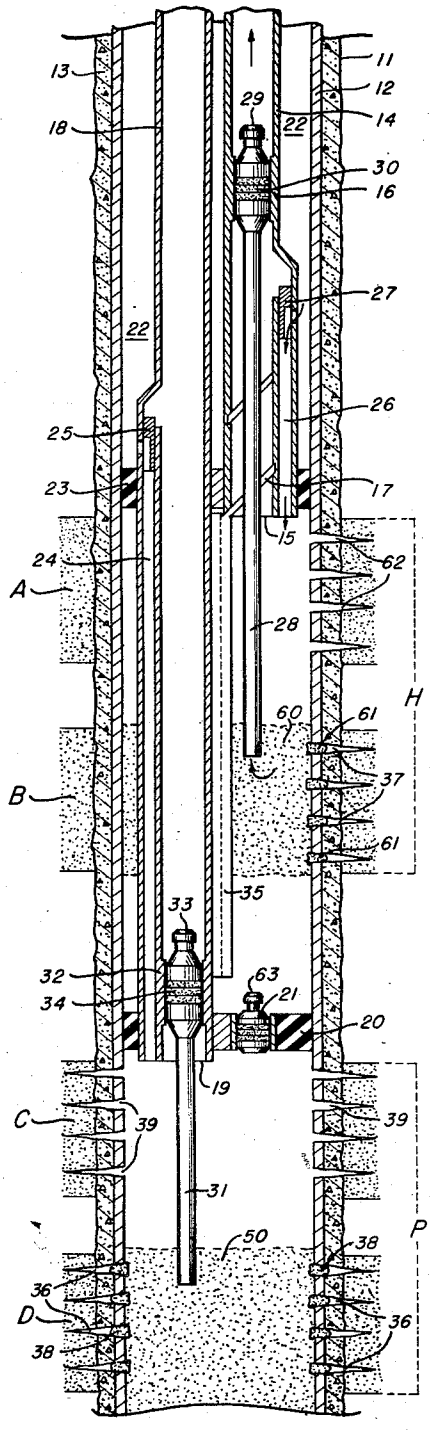


FIG. 2.

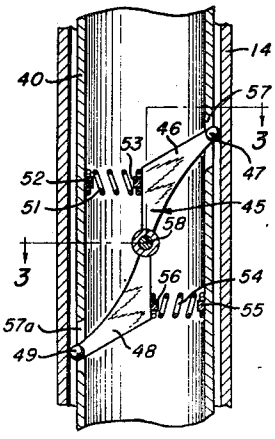


FIG. 3.

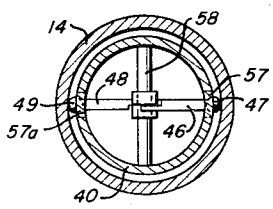
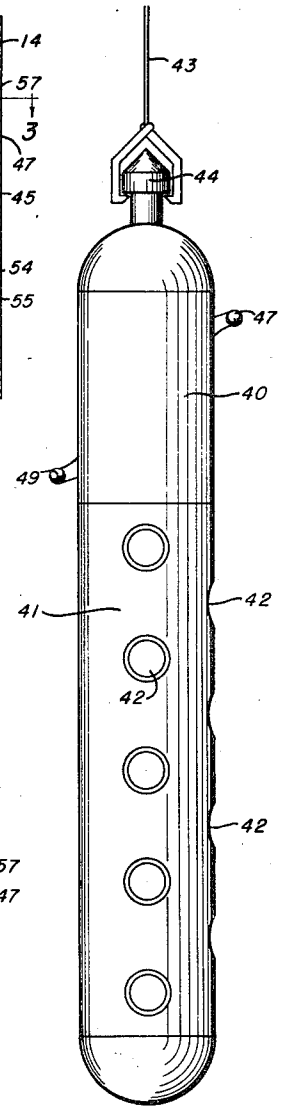


FIG. 4.



INVENTOR.
Martin E. True,
BY
James B. McLeod
ATTORNEY

March 19, 1957 M. E. TRUE 2,785,754

PERMANENT WELL COMPLETION

Filed Oct. 27, 1954 2 Sheets-Sheet 2

FIG. 7

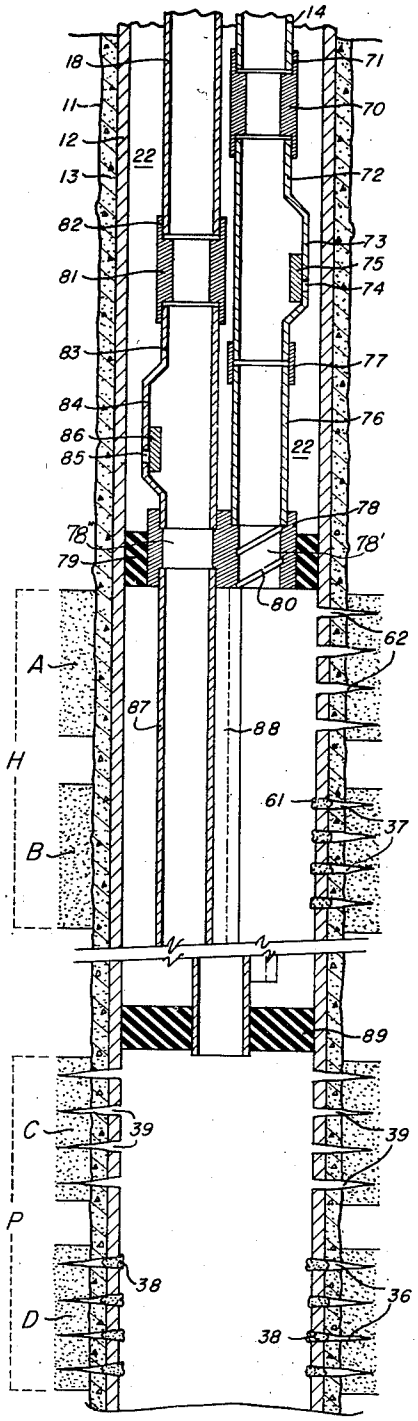


FIG. 5.

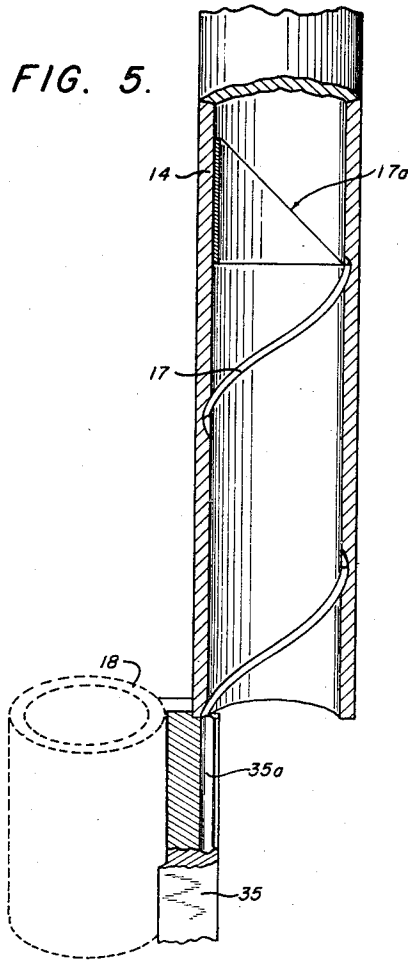
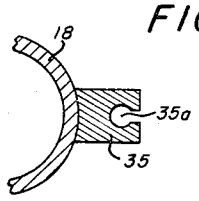


FIG. 6.



INVENTOR.
Martin E. True,
BY
Thomas B. McCulloch
ATTORNEY.

United States Patent Office 2,785,754 Patented Mar. 19, 1957

2,785,754

PERMANENT WELL COMPLETION

Martin E. True, Houston, Tex., assignor, by mesne assignments, to Esso Research and Engineering Company, Elizabeth, N. J., a corporation of Delaware

Application October 27, 1954, Serial No. 465,006

8 Claims. (Cl. 166—55)

The present invention is directed to method and apparatus for working over and servicing wells completed in a plurality of productive formations or intervals. In its more specific aspects, the invention has to do with apparatus and method for use in wells drilled in the earth penetrating spaced apart horizons, each having a plurality of productive intervals therein. In its more specific aspects, the invention is concerned with method and apparatus by way of which the effective length of a plurality of tubing strings in a well drilled through a plurality of productive horizons may be effectively varied.

The present invention may be briefly described as apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons. The apparatus comprises, in combination, a first tubing string in the casing extending with its lower open end at a level above a first of a plurality of productive intervals. A second tubing string extends through the casing with its lower open end at a level above a second of a plurality of productive intervals vertically spaced from the first of the plurality of productive intervals. Means are provided in the casing for isolating the first of the plurality of productive intervals from the second of the plurality of productive intervals and means are also provided in the casing for closing off the annulus between said first and second tubing strings and the casing. The first and second tubing strings have first and second supporting means arranged, respectively, adjacent the lower ends of the first and second tubing strings. First and second retrievable tubular extension members are supported, respectively, in the first and second supporting means and are adapted to vary or lengthen the effective length of the tubing string. Each of the first and second tubing strings is provided with a by-pass means for establishing communication between the annulus and the first and second of the plurality of productive intervals when the tubular extension members are supported on the supporting means. A guide member is arranged in the casing in the first of said plurality of productive intervals for positioning a body member, such as a gun perforator, in the first of said plurality of productive intervals when said body member is lowered through the tubing string. The body member or a gun perforator may be positioned to perforate the casing in a direction removed from the other tubing string such that the latter will not be perforated by firing the gun.

The present invention is also directed to a method for working over and servicing a well having a casing arranged in a plurality of productive horizons in which a first tubing string is provided having its lower open end positioned at a level above a first of a plurality of productive intervals and in which a second tubing string is provided having its lower open end positioned at a level above a second of a plurality of productive intervals vertically displaced from the first of the plurality of productive intervals, the invention comprising increasing the effective length of the first and second tubing strings to levels substantially

below the lower open ends of said first and second tubing strings and then treating the well at at least one of the levels through at least one of the tubing strings of increased effective length.

The treating of the well at the level or levels below the open lower ends of the first and second tubing strings may be accomplished by forcing or pumping cement down through at least one of the tubing strings of increased effective length either to seal off a lower zone in the well or to seal off perforations. When cement is used to treat the well, it is preferred to use a modified low water loss cement, such as described in the patent to Salathiel, U. S. 2,482,459. Other modified low water loss cements such as oil-emulsion cements as slurries of cement and oil, and the like, may be used.

The treating of the well may be accomplished also by forcing acid down through the tubing strings of increased effective length to open up a formation which is reactive with the acid. This acid may be used in the form of an acid such as is well known to the art and may include a mineral acid, such as hydrochloric, hydrofluoric, sulfuric, nitric, and mixtures thereof. It is contemplated that the acid may contain a suitable inhibitor to prevent corrosion of corrodible metal surfaces, such as ferrous metal tubing and the like.

The well may also be suitably treated with other media, such as fracturing fluid, which may be forced into a formation under pressure or through perforations under pressure to increase the permeability of the formation by lifting the overburden or forming cracks or separating between incipient or existing fractures. The fracturing fluid may be a hydrocarbon, such as a distillate or a crude petroleum, or a fraction thereof and may contain a suitable bodying or weighting agent, such as sand. Fracturing fluid, such as described in French Patent 987,352, published August 13, 1951, may be used.

The well may also be treated with a washing liquid or fluid, such as oil, fresh or salt water and the like. This washing may be for the purpose of removing drilling mud, sand, and/or other debris which may accumulate in the well which is treated in accordance with the present invention.

The treating may also comprise forcing fluid cement into the well at a level below the lower open end of the first and second tubing strings to seal at least a portion of the perforations in the first and second productive intervals. Thereafter the excess fluid cement may be removed from the well and gun perforators of the small type, sufficiently small in diameter to be lowered through tubing, may be used. The gun perforator may be of the bullet or shaped charge type, such as is available to the industry.

The present invention will be further illustrated by reference to the drawing in which:

Fig. 1 is a view showing an arrangement of apparatus for carrying out the present invention where separate productive horizons each containing a plurality of productive intervals is pierced by a well;

Fig. 2 illustrates apparatus for positioning a gun perforator in an upper of the productive horizons;

Fig. 3 is a cross-sectional view of the apparatus taken on the line 3—3 of Fig. 2;

Fig. 4 shows an arrangement of a gun perforator of the device of Fig. 2;

Fig. 5 is a sectional view of the positioning device of Fig. 1;

Fig. 6 is a partial view of the guide means of Figs. 1 and 5; and

Fig. 7 is a view of another arrangement of apparatus for carrying out the invention.

Referring now to the drawing, and particularly to Fig. 1, in which identical numerals will be employed to desig-

nate identical parts, numeral 11 designates a well bore drilled from the earth's surface, not shown, to penetrate an upper horizon H and a lower horizon P from which hydrocarbons may be produced. Upper horizon H comprises hydrocarbon productive intervals A and B while lower horizon P comprises hydrocarbon productive intervals C and D. It is to be noted that the several productive intervals are vertically spaced from each other.

Arranged in the well bore 11 and extending through the several productive horizons is a casing 12 which is cemented in place with primary cement 13.

In the casing 12 is a first tubing string 14, extending to the earth's surface to conventional well-head equipment, having its lower open end 15 arranged above the uppermost of the hydrocarbon productive interval A. The tubing 14 has a supporting and/or securing means, such as a landing nipple 16, arranged adjacent the lower end 15 of the tubing 14. A description of the landing nipple may be found in the Composite Catalogue of Oil Field and Pipeline Equipment, 19th edition, volume 2, page 4064. The tubing 14 has a positioning spiral 17 terminating at the lower open end 15 of the tubing 14 to position a body member in the region of horizon H, as will be described further hereinafter.

Also arranged in the casing 12 is a second tubing string 18 which extends with its lower open end 19 just above the horizon P and particularly the productive interval C.

The horizon H is isolated from the horizon P by a double packer arrangement generally indicated by the numeral 20 which is provided with a retrievable valve plug 21 for use on top of the packer as will be described further.

The annulus 22 between the tubing strings 18 and 14 is isolated by means of a second double packer 23 which closes off the horizon H. A concentric by-pass means or other suitable by-passing arrangements, such as 24, is mounted on the tubing 18 and allows communication from the horizon P through a by-pass valve 25 to the annulus 22 as will be described further.

The packer 23 or the tubing 14, as may be desired, is provided with a by-pass 26 in which is arranged a by-pass port means 27 which allows communication from the horizon H to the annulus 22 as will be described further hereinafter.

A tubular extension member, such as 28, provided with a retrieving means, such as a fishing neck 29, on its upper end may be lowered through the tubing 14 and landed in the landing nipple 16 as shown in Fig. 1. A packing means, such as chevron packing or other equivalent sealing means 30, may be provided to form a seal between the tubular extension member 28 and the landing nipple 16, such that flow through the tubing may not flow around the landing nipple 16.

A second tubular extension member, such as 31, may be lowered through the tubing 18 by means of a wire line and landed in a landing nipple 32 adjacent the lower end of the tubing 18. This landing nipple 32 is similar to landing nipple 16. The tubular extension member 31 is also provided with a fishing neck, such as 33, for lowering and retrieving same from the tubing 18 and the landing nipple 32. Extension member 31 is provided with a packing, such as 34, similar to packing 30 used on extension member 28.

Mounted on the exterior of the wall of the tubing 18 is a guide rail 35 which extends substantially the length of the productive horizon H and is arranged with its upper end in close proximity to the open end 15 of the tubing 14 and with its lower end in close proximity to the valve plug 21.

The casing 12 is shown as having been perforated to form perforations 36 in productive horizon P and particularly in interval D and to form perforations 37 in productive horizon H and particularly interval B. Referring now to Figs. 2 to 4, it will be seen that the tubing 14 has a spiral follower housing 40 arranged therein which may be part of a gun perforator 41 provided with a plurality of shaped charges 42 which is adapted to be lowered on a wire line 43 attached to fishing neck 44 through tubing 14.

The spiral follower housing has arranged interiorly thereto a spiral follower generally indicated by the numeral 45 and comprised of an upper rocker arm 46 provided with a spherical spiral follower 47 and a lower rocker arm 48 provided with a spherical spiral follower 49. The upper rocker arm 46 is biased outwardly such that the spiral follower 47 may ride through the slot 57 into engagement with the spiral 17 by means of a biasing means, such as a compression spring 51, arranged between inwardly directed shoulder 52 on the interior wall of the housing 40 and shoulder 53 on the rocker arm 46. The lower rocker arm 48 is similarly biased outwardly by biasing means, such as a helical coil spring 54, arranged between a shoulder 55 on the inner wall of the housing 40 and a shoulder 56 on the rocker arm 48. The rocker arm 48 is biased through slot 57*a* such that the spiral follower 49 rides in the spiral guide 17. It is noted that the rockers 46 and 48 are arranged on a pivot 58.

Referring now to the modification of Fig. 7, a borehole 11 is provided with a casing 12 cemented in place with primary cement 13 in which tubings 14 and 18 are arranged. The tubing 14 is provided with a landing nipple 70 which is similar to the landing nipples described supra connected into the tubing 14 by connecting means, such as 71. Connected to the lower end of connecting means 71 is a gas lift valve mandrel 72 which is provided with an offset portion 73 in which is provided a port 74 which may suitably be blocked off with a false gas lift valve, such as indicated by block 75. The gas lift mandrel 72 is connected into a tubing joint 76 by a pipe connecting means 77. The lower end of the section 76 is connected to a mandrel 78 provided with dual bores 78′ and 78″, which is arranged in a dual string packer 79, such as described supra. The mandrel bore 78′ is provided with a positioning spiral 80.

The tubing 18 is provided also with a landing nipple 81 connected thereto by a pipe connection means 82 and connected into the landing nipple 81 is a gas lift valve mandrel 83. The gas lift mandrel 83 is provided with an offset portion 84 having a port 85 therein which may be closed off by a false gas lift valve or block 86.

The lower end of the gas lift valve mandrel 83 connects into the mandrel bore 78″, which, in turn, connects into a conduit 87 which extends through the zones A, B to just above the zone or interval C. Carried by the exterior surface of the conduit 87 is a rail or guide member 88 which extends substantially through the zones A and B and substantially the length of conduit 87. The zones A and B are isolated by means of a packing means, such as a Baker retainer production packer 89 described at page 538 of the Composite Catalog supra.

The apparatus of the present invention may be employed in the following manner:

Thus, for example, a well as illustrated in Fig. 1 may have a plurality of tubing strings, such as 14 and 18, arranged therein with the lower open end 15 of the tubing string 14 above the upper of a plurality of productive intervals, such as A and B, with the tubing string 18 arranged with its lower open end 19 above the upper of producing intervals C and D in horizon P.

Production may be had simultaneously from the horizons H and P from any one of the selected hydrocarbon productive intervals, such as illustrated. For purposes of illustration, however, it may be assumed that production is being or has been obtained simultaneously or sequentially from intervals D and B and these intervals may become progressively depleted or exhausted or production of desirable hydrocarbon fluid may have decreased to a non-commercial extent by water and/or gas invasion and it is desired to work over or service the well. Ordinarily these intervals, such as D and B, will not become depleted or exhausted at the same time. However,

for purposes of this description, the work over of interval D and B will be described in sequence. It is assumed that the interval D has become exhausted and it is desired to seal off the perforations 36. The tubular extension member 31 would be lowered through the tubing 18 on a wire line, such as 43, until it is landed in the landing nipple 32. A cement slurry, such as 50 may be flowed down through the tubing 18 and the extension member 31 into the region of interval D adjacent the perforations 36 with cement flow being down the tubing 18 and displaced fluid flow such as drilling mud or oil being up the by-pass 24 and through by-pass valve 25 to annulus 22 and then to the earth's surface. Possibly mud or other fluid will underlie cement 50. If so, the cement bulk 50 in Fig. 1, may be squeezed into the perforations 36 by means of pressure asserted above the level of the cement. After the perforations have been sealed to form buttons or rivet heads of a filter cake of cement 38, the excess fluid cement and mud, if present may be reversed out from the interval D by flowing a washing fluid, such as water, down the annulus 22 through by-pass port means 25 and through by-pass 24 and thence upwardly through tubing extension 31 and tubing 18.

Thereafter the tubing extension member 31 is retrieved from the well on a wire line, such as 43, and a gun perforator, such as gun perforator 41, without the spiral follower housing, is lowered through the tubing 18 adjacent, for example, the productive interval C and fired to form perforations, such as 39, therein to open up production of desirable fluids, such as hydrocarbons from interval C. Thereafter production may be had from interval C up through the tubing 18 after withdrawing the gun perforator.

It is contemplated that only portions of the perforations 36 may require sealing off when water and/or gas is invading the well from the interval D. Under these circumstances, it may be unnecessary to reperforate in a vertically displaced hydrocarbon productive interval. It is contemplated, however, that the interval D may be reperforated, as desired, after performing the cementing job when the invading undesirable fluid has been excluded or controlled. It is further contemplated that the interval D may be treated by washing same with a washing liquid to remove sand and/or debris from back of the well casing or to acidize the interval D or, if necessary, to treat same with a fracturing fluid such as has been described by imposing pressure on the fracturing fluid to open up fractures and to increase the permeability of the interval D.

The interval B in the horizon H may be treated in a similar manner as may be desired. A tubular extension member, such as 28, is run into the tubing 14 on a wire line, such as 43, attached to the fishing neck 29 and landed in the landing nipple 16. Thereafter fluid cement may be circulated down the tubing 14 and the tubular member 28 to seal the perforations 37 with cement, the flow being down the tubing 14, tubular extension member 28, up the by-pass 26 and through by-pass port means 27 into annulus 22 and thence to the earth's surface to deposit a body of cement, such as 60, in the region of hydrocarbon productive interval B to form in the perforations 37 filter cakes or buttons or rivet heads of cement, such as 61, to seal off the perforations 37. As in the case of the lower interval, the space between the lowermost portion of the cement bulk 60 and the upper portion of the packer 20 may contain a suitable fluid such as heavy mud upon which the cement rests, as shown in Fig. 1. Thereafter, the cement and mud, if present may be reverse circulated out by flowing a fluid down the annulus 22, through by-pass port means 27 and by-pass 26 and upwardly through the tubular extension member 28 and tubing 14 to the earth's surface, the flow being indicated by the arrows. Thereafter after the excess fluid cement has been removed, the tubular extension member 28 is retrieved from the tubing 14 on wire line 43 and a gun perforator, such as 41, provided with the spiral follower 40 lowered on wire line 43, down the tubing 14. The spiral follower comprised of spiral members 47 and 49 enter the positioning spiral 17 which causes the gun to be positioned with track engaging means on the track 35 which provides the shaped charges 42 to face away from the tubing 18 to perforate the casing 12 in a predetermined direction such that the tubing 18 may not be damaged. After firing of the gun perforator, for example, in the interval A to open up hydrocarbon production therefrom by forming perforations 62 and retrieving same, production may then be had from the perforations 62 into the open end 15 of the tubing 14. Fig. 5 shows in greater detail the positioning spiral groove 17 and how it engages with or is attached to track or rail 35. Although it is not necessary a guide means 17*a* is shown positioned just above spiral 17. Guide means 17*a* assures the entrance of the lower or first follower 49 into the spiral groove 17. Track 35 defines a slotted opening 35*a* to receive the follower 49 and assures a predetermined positioning of the gun perforator 41.

It is contemplated, like with horizon P, that horizon H and particularly interval B may be treated with acid or fracturing fluid, washed with water, oil and/or the like to increase production or to remove material which may clog the well. Such operations have been described with respect to horizon P.

It is contemplated that a suitable tool having an upper housing, such as 40, may be lowered through the tubing 14 to engage with the fishing neck 63 of the valve plug 21 to remove same to allow thorough washing of the horizon H and remove material which may accumulate on top of the packer.

The apparatus of Fig. 7 operates in a similar manner to the apparatus described in Figs. 1 to 6 with with the exception in Fig. 7 that other means are provided to by-pass fluid from the annulus 22 into the conduit 87 and into the zone isolated by the packers 79 and 89.

The operations with respect to Fig. 7 are identical with those with respect to Figs. 1 and 2 with the exception that fluid from annulus 22 may be forced through the port 85 into the mandrel 83 and thence down the conduit 87 when a tubing extension, such as tubular member 31 as shown in Fig. 1, is in the landing nipple 81. Likewise, with respect to tubing 14, fluid from the annulus 22 may be caused to pass into the gas lift valve mandrel 72 when a tubular extension member, such as 28, is in the landing nipple 70.

The ports 74 and 85 are closed with a false gas lift valve which serves as a plug and the false gas lift valve may be removed therefrom by suitable tools available to the industry and described in the Composite Catalog supra at page 1059.

The operations of cementing, treating, acidizing and the like, described supra with respect to Figs. 1 to 6, are the same with respect to Fig. 7; likewise, with respect to the gun perforating and positioning of the gun perforator, such as 41, on the guide member 88.

It may be seen from the foregoing description taken with the drawing that I have provided a very useful apparatus and method for working over and servicing a well penetrating a plurality of productive horizons each having a plurality of hydrocarbon productive intervals therein. Thus each of the hydrocarbon productive intervals may be serviced or worked over without the necessity of using heavy duty lifting equipment which has heretofore been necessary since with the present invention all operations may be conducted with wire line tools using a service truck; therefore, the invention is of considerable advantage and utility in the industry.

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

1. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive

horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above a first of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a second of a plurality of productive intervals vertically displaced from the first of the plurality of productive intervals, means in said casing isolating the first of said plurality of productive intervals from the second of said plurality of productive intervals, means in said casing closing off the annulus between said tubing strings and the casing above said first of a plurality of productive intervals, first and second supporting means arranged, respectively, in said first and second tubing strings, first and second retrievable tubular extension members adapted to be supported, respectively, in said first and second supporting means and adapted to vary the effective length of said tubing strings, by-pass means in each of said first and second tubing strings for communication, respectively, between the upper closed off annulus and said first and second of the plurality of productive intervals, and a guide member arranged below the lower open end of said first tubing string in the first of said plurality of productive intervals for positioning a body member in the first of said plurality of productive intervals.

2. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above a first of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a second of a plurality of productive intervals vertically displaced from the first of the plurality of productive intervals, means in said casing isolating the first of said plurality of productive intervals from the second of said plurality of productive intervals, means in said casing closing off the annulus between said tubing strings and the casing above said first of a plurality of productive intervals, supporting means arranged in said second tubing string, a retrievable tubular extension member supported in said second supporting means adapted to vary the effective length of said second tubing string, by-pass means in each of said first and second tubing strings for communication, respectively, between the upper closed off annulus and said first and second of the plurality of productive intervals, a guide member arranged below the lower open end of said first tubing string in said casing in the first of said plurality of productive intervals and a body member positioned on said guide means in the first of said plurality of productive intervals.

3. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above a first of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a second of a plurality of productive intervals vertically displaced from the first of the plurality of productive intervals, means in said casing isolating the first of said plurality of productive intervals from the second of said plurality of productive intervals, means in said casing closing off the annulus between said tubing strings and the casing above said first of a plurality of productive intervals, supporting means arranged in said second tubing string, a retrievable tubular extension member supported in said supporting means adapted to vary the effective length of said second tubing strings, by-pass means in each of said first and second tubing strings for communication, respectively, between the upper closed off annulus and said first and second of the plurality of productive intervals, a guide member arranged on the exterior wall of said second tubing string in the first of said plurality of productive intervals and a gun perforator positioned on said guide means in the first of said plurality of productive intervals.

4. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above an upper of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a lower of a plurality of productive intervals, packing means in said casing isolating the upper of said plurality of productive intervals from the lower of said plurality of productive intervals, second packing means in said casing closing off the annulus above said first of a plurality of productive intervals between said tubing strings and the casing, supporting means arranged in said second tubing string, a retrievable tubular extension member supported in said supporting means adapted to vary the effective length of said second tubing string, by-pass means in each of said first and second tubing strings for communication, respectively between the upper closed off annulus and said upper and lower of the plurality of productive intervals, a guide member arranged on the exterior wall of the second tubing string in the upper of said plurality of productive intervals and a body member positioned on said guide means in the first of said plurality of productive intervals.

5. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above an upper of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a lower of a plurality of productive intervals, a first packer in said casing isolating the upper of said plurality of productive intervals from the lower of said plurality of productive intervals, a second packer in said casing closing off the annulus above said first of said plurality of productive intervals between said tubing strings and the casing, a by-pass means arranged on said second tubing string of sufficient length for communication between the upper closed off annulus and the lower of the plurality of productive intervals, a second by-pass means arranged adjacent the lower end of the first tubing string for communication between the upper closed off annulus and the upper of the plurality of productive intervals when said first tubular member is supported in said first supporting means, a guide member arranged on the exterior wall of the second tubing string in the upper of said plurality of productive intervals and a gun perforator positioned on said guide means in the upper of said plurality of productive intervals.

6. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above an upper of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a lower of a plurality of productive intervals, a first packer in said casing isolating the upper of said plurality of productive intervals from the lower of said plurality of productive intervals, a second packer in said casing closing off the annulus above said upper of a plurality of productive intervals between said tubing strings and the casing, first and second supporting means arranged, respectively, in said first and second tubing strings, a first and second retrievable tubular extension member supported, respectively, in said first and second supporting means adapted to vary the effective length of said tubing strings, a by-pass means arranged on said second tubing string of sufficient length for communication between the upper closed off annulus and the lower of the plurality of productive intervals when said second tubular extension member is supported in said second supporting means, a second by-pass means arranged adjacent the lower end of the first tubing string for communication

between the upper closed off annulus and the upper of the plurality of productive intervals when said first tubular member is supported in said first supporting means, a guide member arranged on the exterior wall of the second tubing string in the upper of said plurality of productive intervals for positioning a gun perforator in the upper of said plurality of productive intervals, said guide member extending substantially the distance between the first and second packer and having its lower end adjacent the second packer, and means in said second packer adjacent the lower end of said guide member for cleaning out above the second packer.

7. Apparatus in accordance with claim 6 in which the means in the second packer is a retrievable plug valve.

8. Apparatus for servicing and completing a well having a casing arranged in a plurality of productive horizons which comprises, in combination, a first tubing string in said casing extending with its lower open end at a level above a first of a plurality of productive intervals, a second tubing string extending with its lower open end at a level above a second of a plurality of productive intervals vertically displaced from the first of the plurality of productive intervals, means in said casing isolating the first of said plurality of productive intervals, means in said casing closing off the annulus between the said tubing strings and the casing above said first of a plurality of productive intervals, by-pass means in each of said first and second tubing strings for communication respectively between the upper closed off annulus and said first and second of the plurality of productive intervals, a guide member arranged on the exterior wall of said second tubing string in the first of said plurality of productive intervals, and a gun perforator positioned on said guide means in the first of said plurality of productive intervals.

References Cited in the file of this patent

UNITED STATES PATENTS

1,079,690	Bowler et al.	Nov. 25, 1913
1,723,682	Deming	Aug. 6, 1929
1,861,332	Waitz	May 31, 1932
2,208,775	Rurup	July 23, 1940
2,274,756	Travers, Jr.	Mar. 3, 1942
2,316,402	Canon	Apr. 13, 1943
2,335,355	Penick et al.	Nov. 30, 1943