

March 12, 1963

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3,080,922

MULTIPLE ZONE WELL PRODUCTION APPARATUS

Filed Jan. 30, 1956

2 Sheets-Sheet 1

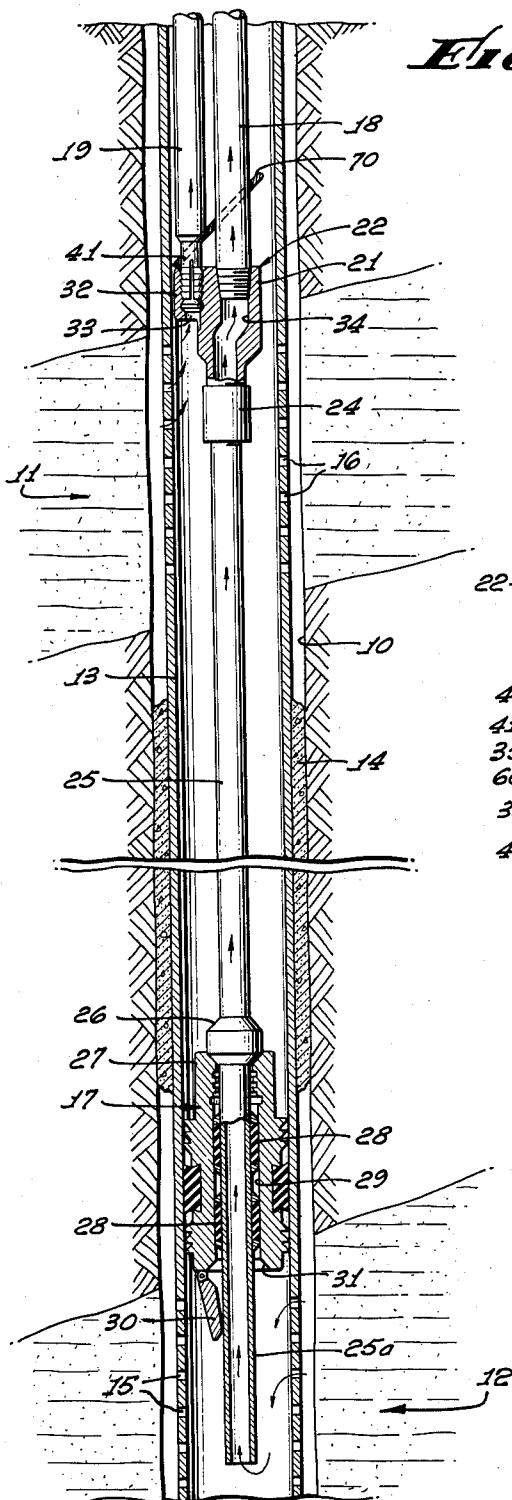


Fig. 1.

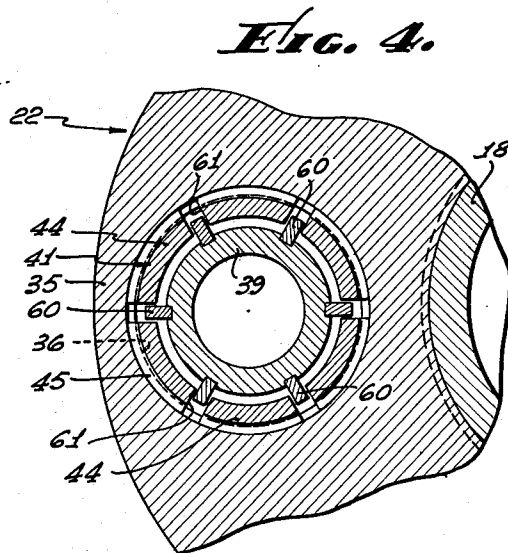


Fig. 4.

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Fig. 2.

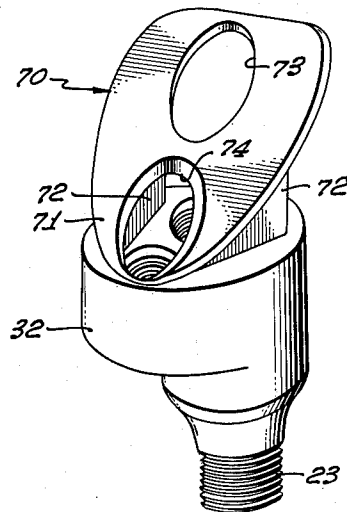
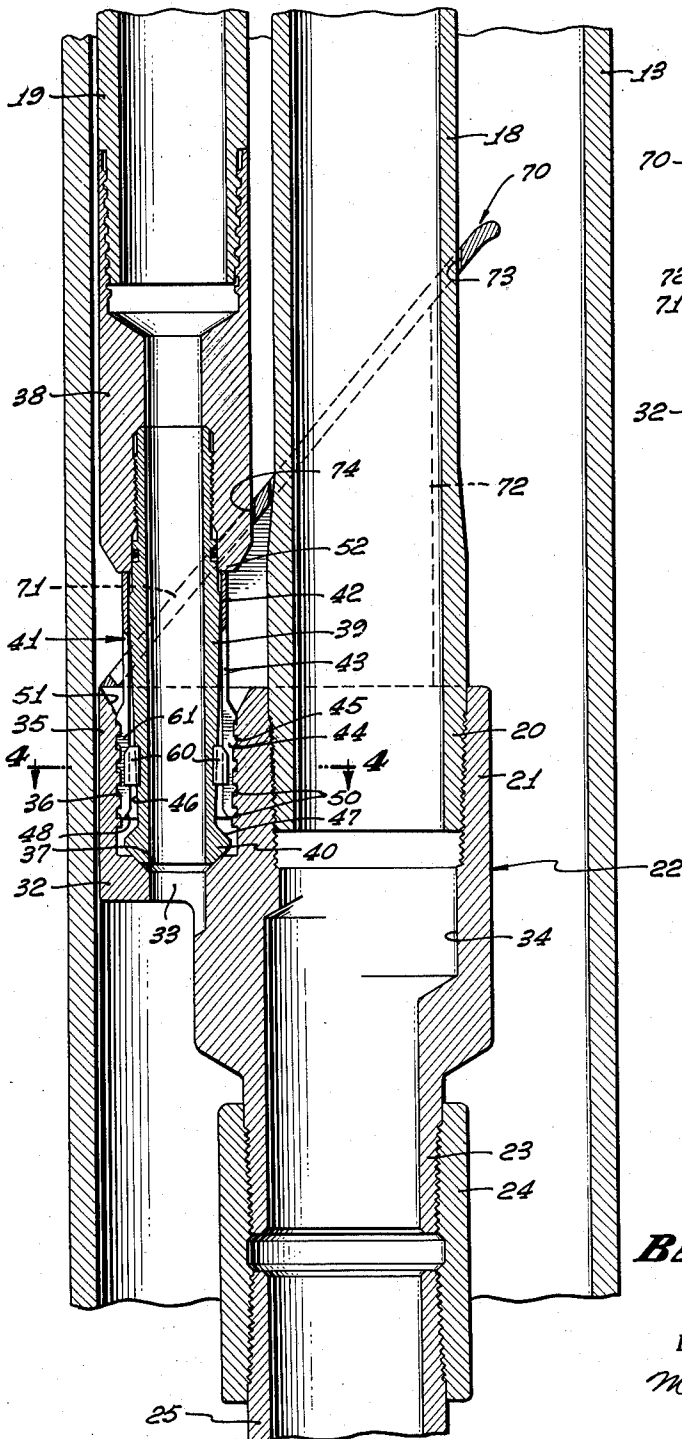


Fig. 3.

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MULTIPLE ZONE WELL PRODUCTION APPARATUS

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The present invention relates to apparatus for conducting production from a plurality of separate zones in a well bore to the top of the hole.

A single well bore may extend through longitudinally spaced producing zones. It is desirable to prevent commingling between the production in the several zones and to conduct the production from each zone separately to the top of the hole.

Accordingly, it is an object of the present invention to provide improved subsurface apparatus for conducting multiple zone production in a cased well bore through a plurality of tubular strings disposed in the well casing, the production from one zone being prevented from commingling with the production from another zone.

Another object of the invention is to provide multiple zone production apparatus adapted to be run in a well bore on a first tubular string and appropriately related to a packer in the bore set between producing zones therein, in order that production from one of the zones will flow through the first tubular string to the top of the hole, a second tubular string then being run in the well bore alongside the first tubular string and related to the apparatus in such manner as to enable production from another zone to be conducted through the second tubular string to the top of the hole.

A further object of the invention is to provide subsurface multiple zone apparatus of the character indicated, in which the apparatus is capable of guiding the second string into its appropriate flow conducting position with respect to the apparatus.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a somewhat diagrammatic longitudinal section through an apparatus disposed in a cased well bore;

FIG. 2 is an enlarged longitudinal section through the upper portion of the apparatus disclosed in FIG. 1;

FIG. 3 is an isometric projection of the upper portion of the apparatus to which a plurality of individual tubular strings are connectible;

FIG. 4 is a cross-section taken along the line 4-4 on FIG. 2.

As disclosed in the drawings, a well bore 10 has been drilled through a plurality of separate producing zones 11, 12, and a string of well casing 13 has been disposed in the well bore, the casing passing through both of the producing zones. Cement 14 has been deposited in the well bore around the casing 13 between the producing zones to maintain the production therefrom separate. The well production from the lower zone can flow through a lower set of casing perforations 15 into the interior of the casing, whereas the production from the upper zone 11 can flow through upper casing perforations 16 into the interior of the well casing. The production within the casing is

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prevented from commingling by a suitable barrier, such as a production packer 17, set in packed-off condition in the well casing between the two sets of perforations 15, 16 at a desired distance above the lower set 15 of casing perforations. The packer 17 may be of any suitable type, such as the one disclosed in United States Patent 2,189,703.

As disclosed in the drawings, it is desired to conduct the production from the lower zone 12 through a first string of tubing 18 extending to the top of the well bore. The production from the upper zone 11 is to be conducted through a separate or second string of tubing 19 extending alongside the first string of tubing to the top of the well bore.

The first-mentioned string of tubing 18 has a lower threaded pin 20 threadedly secured within a threaded box 21 in a main head 22, the lower end of which is constituted as a threaded pin 23 secured within the upper threaded box 24 of a string of tubing 25 extending downwardly in the well casing 13. This last-mentioned string of tubing has a head 26 adapted to seat upon the upper end 27 of the well packer 17. The tubing 25 depends from this head 26 through the well packer 17, there being suitable seal rings 28 on the tubing engaging the inner wall 29 of the packer body, to prevent fluid from flowing upwardly through the annulus between the tubing 25 and the inner wall of the packer body. The lower portion 25a of the tubing may hold a flapper valve 30 pivotally mounted on the packer to one side. In the event the tubing 25 were to be elevated above the packer 17, then the flapper valve 30 would move upwardly into engagement with a companion seat 31 at the lower end of the well packer, to prevent the production from the lower zone from passing upwardly through the packer.

The main head 22 has an offset portion 32 provided with a longitudinal passage 33 offset from the longitudinal passage 34 through the head that conducts the fluid to the first tubular string 18 extending to the top of the hole. The offset portion 32 has a box 35 surrounding its passage provided with left-hand threads 36, the box portion terminating in a tapered seat 37, from which the offset passage 33 opens in a downward direction externally of the head. The second tubular string 19 has its lower portion constituted by a tubular sub 38 threadedly secured to the upper end of a tubular mandrel 39 having a lower tapered guide 40 adapted to engage the tapered seat 37. Disposed around the mandrel 39 is a latch sleeve 41, the upper end 42 of which is circumferentially continuous and the lower portion of which is constituted by legs 43 terminating in latch dogs 44 that collectively have a left-hand male thread 45 formed therein companion to the female thread 36 in the box. The latch legs 43 tend to spring outwardly to the extent at which they tend to engage their threads 45 fully with the female threads 36 in the box 35. However, the legs can be sprung inwardly to the extent at which their threads are out of engagement with the box threads. Such inward springing is permitted in view of the relief 46 provided on the tubular mandrel 39 behind the threaded portions of the latch legs. This relief portion 46 terminates at the guide 40 of the mandrel, the upper portion 47 of the guide being inclined in an upward and inward direction to engage companion inclined portions 48 at the lower ends of the latch legs 43.

The over-all length of the latch sleeve 41 is less than the distance between the lower end of the sub 38 and the tapered surface 47 on the mandrel, to permit a small amount of relative longitudinal movement to take place between the mandrel 39 and the latch sleeve 41. It is also to be noted that the lower ends 50 of the latch threads 45 are inclined in a downward and inward direction. When the mandrel 39 is stabbed into the offset threaded box 35, the lower ends of the latch legs will first engage the upper flaring end 51 of the box, which will

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at first prevent the latch sleeve 41 from moving downwardly until the guide surface 47 is shifted below the legs 43 and the lower shoulder 52 on the sub comes in contact with the upper end of the latch sleeve. Continuation of the downward effort then forces the latch sleeve 41 into the threaded box 35, the inclined thread surfaces 50 on the latch legs camming the legs inwardly and allowing them to ratchet in a downward direction along the box threads 36, as permitted by the inward springing of the legs into the relief portion 46 of the mandrel. The latch sleeve 41 will shift downwardly until the guide 40 engages the seat 37 on the head, at which time the latch threads 45 can spring outwardly into full threaded engagement with the box threads 36. An upward pull can now be taken on the second tubular string 19, which will shift the retainer surface 47 into engagement with the lower tapered surfaces 50 on the latch legs, to hold the latter in threaded engagement with the left-hand thread 36 of the box 35.

In the event it is desired to disconnect the second tubular string 19 from the head 22, the second tubular string need merely be rotated to the right. The mandrel 39 has one or a plurality of keys 60 thereon extending into the slots 61 between the latch legs 43, to transmit the right-hand rotation of the mandrel 39 to the latch sleeve 41, threading it in an upward direction relative to the box 35 until a complete disconnection has occurred. The second tubular string 19 can now be elevated in the well casing 13 and withdrawn completely therefrom, if desired.

In the use of the apparatus, the well packer 17 has been anchored in packed-off condition in the well casing 10 at the desired distance above the lower set of perforations 15. Thereafter, the first tubular running-in string 18 is threadedly secured to the main head 22, onto which the lower section of tubing 25 of the desired length (which, for example, may be from about 20 ft. to 1000 ft. in length) has been secured. This combination is run down through the well casing 13 until the lower end 25a of the tubing passes into and through the packer 17, displacing its flapper valve 30 to one side and coming to rest with the head 26 engaging the upper end 27 of the packer. Accordingly, the production from the lower zone 12 can now be conducted through the tubing members 25, 18 to the top of the hole.

It is also desired to conduct the production from the upper zone 11 through the other string of tubing 19 to the top of the hole. This string of tubing is then run in the well casing, and is to be inserted in the box 35 that is offset from the other threaded box 21 and passage 34. The present invention contemplates guiding or steering the second tubular string 19 into the threaded box 35. For this purpose, a guide member 70, which is specifically disclosed as being in the form of a plate, is provided, which is disposed in an inclined position, its lower portion 71 being above and closely adjacent the offset threaded box 35 and inclining from such offset threaded box in an upward direction. This plate is secured to the head 22 at the desired inclination (which, for example, may be of the order of about 45 degrees to the axis of the well casing) by a pair of plates 72 suitably secured, as by welding, to the upper end of the head 22 and to the lower face of the inclined plate 70, and on opposite sides of the threaded boxes 35, 21.

The inclined plate 70 has a hole 73 therethrough in alignment with the first threaded box 21 and of a size sufficient to permit the tubular running-in string 18 to pass therethrough, in order that it can be threaded into the box 21. The plate has another hole 74 therethrough offset with respect to the first-mentioned hole 73 and in alignment with the second threaded box 35. This hole is likewise of a sufficient size as to permit the mandrel 39, latch sleeve 41 and sub 38 to pass therethrough. The perimeter of the plate 70 itself will not have too great a clearance with the wall of the well casing 13. The

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clearance, however, can be quite substantial, but it is much less than the diameters across the latch sleeve 41 and mandrel 39, to prevent the lower end of the mandrel from being caught between the edge of the plate and the wall of the well casing at any point around these members.

When the second tubular string 19 is run in the well casing, it will move downwardly along the previously installed first tubular string 18, until the guide 40 of the mandrel 39 engages the plate 70, being guided by the inclined plate in a downward direction until it enters the offset hole 74 in the plate. The mandrel 39 and latch sleeve 41 will move through this hole and enter the offset threaded box 35, the latch sleeve 41 being threadedly connected to the box to secure the second tubular string 19 thereto. If it is desired to maintain the second tubular string 19 in tension, then an upward pull can be taken thereon to engage the retainer surface 47 with the companion tapered surfaces 48 on the latch legs 43, to hold the latter in firm threaded engagement with the threaded box 35.

Production can now pass from the upper zone 11, through the casing perforations 16, and into the second tubular string 19, to be conducted to the top of the hole. As stated before, the production from the lower zone 12 passes through the lower perforations 15 into the other tubular string 18 to the top of the hole. Accordingly, two separate flow paths are provided for the production from the different zones, such flow paths being separate and distinct from one another. Such production may flow to the top of the hole when the formation pressure is sufficient, or, if insufficient, suitable pumping equipment (not shown) can be used in each tubular string 18, 19 to elevate the production to the top of the hole.

The running-in tubular string 18 is disclosed in the drawings as being substantially coaxial of the well casing 13. However, it need not be disposed in this position. If arranged in an eccentric position, proper sealing engagement between the tubing 24 and the well packer 17 can still take place, inasmuch as there is ordinarily a sufficient length of tubing 24 between the head 22 and the well packer 17 to permit the tubing to deflect and still be disposed in a coaxial position within the well packer itself.

The inventor claims:

1. In multiple zone well production apparatus: a well casing passing through upper and lower producing zones in a well bore, said casing having upper and lower openings through which production from said upper and lower zones can flow into the well casing; barrier means in said casing between said upper and lower openings; a head having a plurality of longitudinal passages; said head having threaded means in one of said passages for securing a first tubular string to said head extending to the top of the casing; tubular means connected to said head engaging said barrier means and communicating with said one passage for conducting fluid in the lower zone to said first tubular string; said head having means in another of said passages receiving a second tubular string extending to the top of the casing for conducting fluid from the upper zone to the top of the well bore; said head having a guide surface inclined downwardly from said one passage to said another passage to guide the second tubular string into said another passage after said head has been lowered in the well bore on the first tubular string.

2. In multiple zone well production apparatus: a well casing passing through upper and lower producing zones in a well bore, said casing having upper and lower openings through which production from said upper and lower zones can flow into the well casing; barrier means in said casing between said upper and lower openings, said barrier means having a central opening; a head having a plurality of longitudinal passages therethrough; said head having means in one of said passages for securing a first tubular

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string to said head that extends to the top of the casing; tubular means connected to said head and engaging said barrier means within said opening and communicating with said one passage for conducting fluid from the lower zone into said first tubular string; said head having means in another of said passages for threadedly receiving a second tubular string extending to the top of the casing for conducting fluid from the upper zone to the top of the well bore while said second tubular string is held in tension; said head having a guide surface inclined downwardly from said one passage to said another passage to guide the second tubular string into said another passage after said head has been lowered in the well bore on the first tubular string.

3. In multiple zone well production apparatus: a well casing passing through upper and lower producing zones in a well bore, said casing having upper and lower openings through which production from said upper and lower zones can flow into the well casing; barrier means in said casing between said upper and lower openings, said barrier means having a central opening; a head having a plurality of longitudinal passages therethrough; said head having means in one of said passages for securing a first tubular string to said head that extends to the top of the casing; tubular means connected to said head and engaging said barrier means within said opening and communicating with said one passage for conducting fluid from the lower zone into said first tubular string; said head having means in another of said passages for receiving a second tubular string extending to the top of the casing for conducting fluid from the upper zone to the top of the well bore; said head having a guide surface inclined downwardly from said one passage to said another passage to guide the second tubular string into said another passage after said head has been lowered in the well bore on the first tubular string; and releasable latch means for securing the second tubular string in said another passage.

4. In multiple zone well production apparatus: a well casing passing through upper and lower producing zones in a well bore, said casing having upper and lower openings through which production from said upper and lower zones can flow into the well casing; barrier means in said casing between said upper and lower openings, said barrier means having a central opening; a head having a plurality of longitudinal passages therethrough; said head

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having means in one of said passages for securing a first tubular string to said head that extends to the top of the casing; tubular means connected to said head and engaging said barrier means within said opening and communicating with said one passage for conducting fluid from the lower zone into said first tubular string; said head having means in another of said passages for receiving a second tubular string extending to the top of the well bore; said head having a guide surface inclined downwardly from said one passage to said another passage to guide the second tubular means into said another passage after said head has been lowered in the well bore on the first tubular string; said head having a left-hand thread in said another passage; and means including a retractable and expansible left-hand threaded latch carried by the second tubular string for releasably securing the second tubular string in said another passage.

5. In multiple zone well production apparatus: a well casing passing through upper and lower producing zones in a well bore, said casing having upper and lower openings through which production from said upper and lower zones can flow into the well casing; barrier means in said casing between said upper and lower openings; a head having a plurality of longitudinal passages; said head having means in one of said passages for securing a first tubular string to said head extending to the top of the casing; tubular means connected to said head engaging said barrier means and communicating with said one passage for conducting fluid in the lower zone to said first tubular string; said head having means in another of said passages receiving a second tubular string extending to the top of the casing for conducting fluid from the upper zone to the top of the well bore; said head having a guide surface inclined downwardly from said one passage to said another passage to guide the second tubular string into said another passage after said head has been lowered in the well bore on the first tubular string.

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Dedication

3,080,922.—*Bernardus E. Mater*, Woodland Hills, Calif. MULTIPLE ZONE
WELL PRODUCTION APPARATUS. Patent dated Mar. 12, 1963.
Dedication filed Feb. 27, 1970, by the assignee, *Baker Oil Tools, Inc.*
Hereby dedicates the remainder of the term of the patent to the Public.
[*Official Gazette June 2, 1970.*]