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APPARATUS FOR COMMINGLING MULTIPLE ZONE WELL PRODUCTION

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FIG. 1

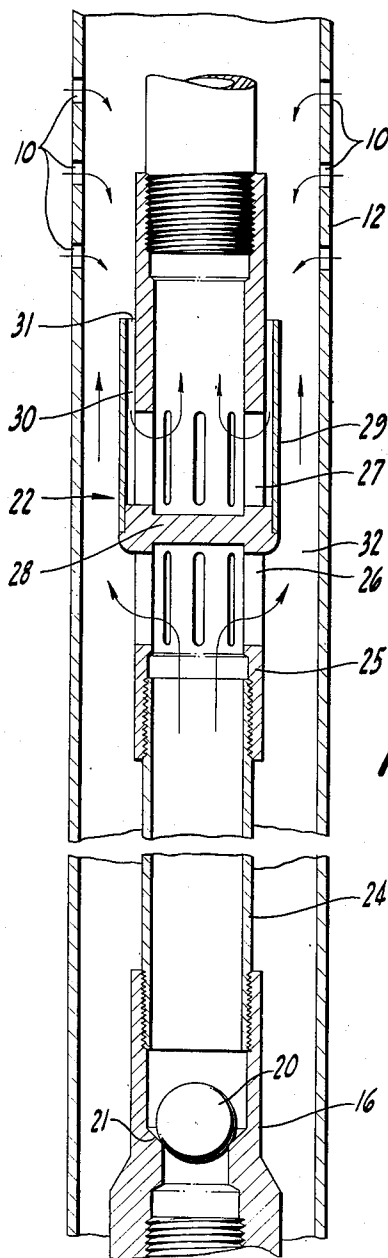
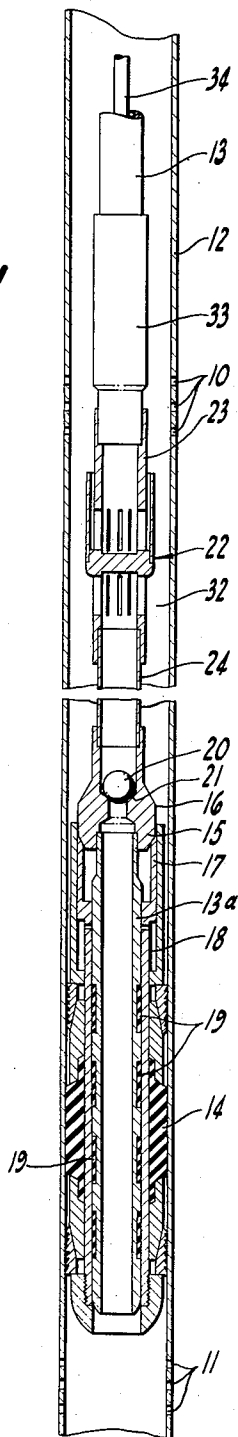


FIG. 2

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APPARATUS FOR COMMINGLING MULTIPLE
ZONE WELL PRODUCTIONRobert C. Glover, Tulsa, Okla., assignor to Baker
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5 Claims. (Cl. 166—2)

1

The present invention relates to well production apparatus, and more particularly to apparatus for obtaining production from a plurality of zones in a well bore.

An object of the present invention is to provide an apparatus capable of obtaining production through a single tubular string simultaneously from a plurality of producing zones in a well bore and of preventing flow of production from an upper zone into a lower zone.

Another object of the invention is to provide an apparatus for comingling or mixing the production from upper and lower zones in a well bore prior to its elevation to the top of a well bore in such manner as to prevent gas locking.

A further object of the invention is to provide an apparatus for simultaneously producing well production from a plurality of zones through a single tubing string, which apparatus acts as a gas anchor and maintains the gas-oil ratio at a relatively low value.

One form which the invention may assume is exemplified in the following description and illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a longitudinal section through a well production apparatus disposed in a well casing.

Fig. 2 is a view on an enlarged scale, similar to Fig. 1, of the apparatus for comingling the production from upper and lower zones, and for preventing the upper zone production from flowing into the lower zone.

In the form of the invention disclosed in the drawings, it is desired to obtain production from a pair of spaced zones or horizons in a well bore, the production flowing through upper and lower ports or perforations 10, 11 in a well casing 12, or similar conduit, and through the casing into a string of production tubing 13 extending to the top of the well bore.

In order to prevent direct comingling between the upper and lower production, a well packer 14 is anchored in packed off position in the well casing between the upper and lower casing perforations 10, 11. Although any suitable packer may be used, the one exemplified in the drawings is of the general type described in United States Patent No. 2,189,703. This well packer has the lower end of the string of production tubing 13 extending into it in leakproof relation therewith. Specifically, this latter relationship may be obtained by the sealing engagement of a head 15 on an intermediate tubing string sub 16 with the head 17 of the packer body 18, or by the sealing engagement of one or more side seals 19 on the

2

tubing string with the inner wall of the packer body.

Production from the lower zone enters the casing through its lower perforations 11, and then passes upwardly through the packer 14 and tubing string 13. In order to prevent the production from the upper zone, which may be at a higher pressure than the production from the lower zone, from flowing downwardly into the latter zone, a one-way valve is provided in the tubing string at some convenient point between the upper and lower zones. As disclosed in the drawings, such valve is incorporated in the sub 16 resting upon the packer head 18 and includes a valve ball 20 adapted to seat downwardly against a valve seat 21 in the sub itself. It is readily apparent that upward flow of fluid from the lower zone through the tubing string unseats the ball 20, to open the valve, whereas any tendency of fluid to flow downwardly through the tubing string above the valve engages the valve ball 20 with its seat 21, thus precluding fluid flow from the upper zone, through the tubing string 13 and packer 18, to the lower zone.

It is desired to comingle or mix the upper and lower zone productions prior to their elevation through the production tubing 13 to the top of the well bore. Such mixing is accomplished in the present instance by providing an intermediate collar 22 in the production string threaded onto adjacent tubing sections 23, 24. This collar includes a tubular member 25 having lateral outlets or ports 26 and lateral inlets or ports 27 separated by a solid imperforate baffle or partition 28, which prevents direct fluid communication between the sets of ports 26, 27 through the tubular member 25. A shield or baffle sleeve 29 is secured to the member 25 in any suitable manner, as by welding, and extends upwardly around the inlet ports 27 and to a substantial extent thereabove. This shield 29 is spaced from the exterior of the member 25 to form an annular fluid passage 30 whose inlet 31 is materially above the upper ports 27.

Production from the lower zone flows upwardly through the lower portion 13a of the tubing string, unseating the ball 20, and flowing upwardly into the collar member 25, from which it exits through the outlet ports 25 into the annulus 32 between the tubing string 13 and casing 12. This production then passes upwardly around the baffle sleeve 29, where it meets and comingles with the production from the upper zone passing into the casing through the upper casing perforation 10. Such comingled production from

3

both zones then passes downwardly through the annular passage 30 between the sleeve 29 and tubular member 25, entering the tubing string 13 through the inlet ports 27 and then passing upwardly through the tubing string to the top of the well bore. A pump mechanism (not shown) within barrel 33 of a pump, operated by a string of sucker rods 34, may be used to elevate the well production in the tubing string.

It is to be noted that the well production from the lower zone, which is usually a mixture of both gas and oil, passes through the outlet ports 26 into the tubing-casing annulus 32 and mixes with similar well production from the upper zone within the annulus. Since the comingled and mixed fluid must pass downwardly through the annular passage 30 between the shield 28 and tubular member 25 before entering the inlet ports 27, a certain portion of the gas in the oil and gaseous mixture within the tubing-casing annulus 32 separates from the mixture, the gas tending to remain in the upper part of the annulus, and resulting in production passing downwardly through the annular passage 30 and into the inlet ports 27 of a comparatively lesser gas-oil ratio than the gas-oil ratio of the comingled production in the annulus above the collar 22. The collar thus effectively acts as a gas anchor and separator, the gas remaining in the oil production moving upwardly through the production tubing and into its pump portion having a lessened tendency to produce gas locking within the pump barrel 33.

It is, accordingly, apparent that a well production apparatus has been provided which prevents the downward flowing of fluids from the upper zone into the lower zone, despite the presence of a formation pressure in the lower zone substantially less than the formation pressure in the upper zone. The operating stroke of the pump can still draw production from both zones into the tubing-casing annulus 32 above the packer 14 separating the two zones within the casing. The collar arrangement reduces the quantity of gas entering the inlet ports 27 in the collar, not only functioning as a device for mixing the production from the upper and lower zones, but as a gas anchor as well.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, what I claim and desire to obtain by Letters Patent is:

1. Well production apparatus, including a well conduit disposed in a well bore having upper and lower producing zones, said well conduit having upper and lower openings communicating with said upper and lower zones, respectively, a well packer set in and sealing off said well conduit between said upper and lower openings, said packer having a passage extending therethrough, a tubing string engaging said packer and having an outlet for discharging production flowing through said packer from said lower zone into the annulus around said tubing string above said packer, said tubing string also having an inlet above said outlet, means for closing the central passage through said tubing string between said inlet and outlet, and baffle means secured to said tubing string and closed at its lower portion below said inlet and above said outlet, said baffle means being disposed around said inlet and having an

4

opening at its upper end substantially above said inlet in order to convey fluid from said annulus downwardly and thence through said inlet into said tubing string.

2. Well production apparatus, including a well conduit disposed in a well bore having upper and lower producing zones, said well conduit having upper and lower openings communicating with said upper and lower zones, respectively, a well packer set in and sealing off said well conduit between said upper and lower openings, said packer having a passage extending therethrough, a tubing string engaging said packer and having an outlet for discharging production flowing through said packer from said lower zone into the annulus around said tubing string above said packer, said tubing string also having an inlet above said outlet, means for closing the central passage through said tubing string between said inlet and outlet, baffle means secured to said tubing string and closed at its lower portion below said inlet and above said outlet, said baffle means being disposed around said inlet and having an opening at its upper end substantially above said inlet in order to convey fluid from said annulus downwardly and thence through said inlet into said tubing string, and a downwardly closing valve in said tubing string below said outlet.

3. Well production apparatus, including a well conduit disposed in a well bore having upper and lower producing zones, said well conduit having upper and lower openings communicating with said upper and lower zones, respectively, a well packer set in and sealing off said well conduit between said upper and lower openings, said packer having a passage extending therethrough, a tubing string engaging said packer and having a first port establishing fluid communication between the well conduit below said packer and the annulus around said tubing string above said packer, said tubing string also having a second port above said first port establishing fluid communication between said annulus and the interior of said tubing string, an imperforate baffle extending across the interior of said tubing string between said ports to prevent direct passage of fluid therebetween through said tubing string, a sleeve disposed around said second port in lateral spaced relation to said tubing string to form an annular passage therewith, said sleeve being closed at its lower portion below said second port and above said first port, said sleeve having an open upper end substantially above said second port to direct fluid from said annulus around said tubing string downwardly through said annular passage and thence through said second port into said tubing string above said imperforate baffle.

4. Well production apparatus, including a well conduit disposed in a well bore having upper and lower producing zones, said well conduit having upper and lower openings communicating with said upper and lower zones, respectively, a well packer set in and sealing off said well conduit between said upper and lower openings, said packer having a passage extending therethrough, a tubing string engaging said packer and having a first port establishing fluid communication between the well conduit below said packer and the annulus around said tubing string above said packer, said tubing string also having a second port above said first port establishing fluid communication between said annulus and the interior of said tubing string, an imperforate baffle extending across the interior of said tubing string

5

between said ports to prevent direct passage of fluid therebetween through said tubing string, a sleeve disposed around said second port in lateral spaced relation to said tubing string to form an annular passage therewith, said sleeve being closed at its lower portion below said second port and above said first port, said sleeve having an open upper end substantially above said second port to direct fluid from said annulus around said tubing string downwardly through said annular passage and thence through said second port into said tubing string above said imperforate baffle, and a downwardly closing valve in said tubing string below said first port.

5. Well production apparatus, including a well conduit having upper and lower inlets through which well production can flow into said conduit, a well packer set in and sealing off said conduit between said upper and lower inlets, said packer having a passage extending therethrough, a tubing string engaging said packer and adapted to be released from said packer without disturbing the set condition of said packer in said conduit, said tubing string having a first port establishing fluid communication between said lower inlet and the annulus around said tubing string above said packer, said annulus being in communication with said upper inlet, said tubing string also having a second port above said first port establishing fluid communication between said annulus and the interior of said tubing string, an imperforate baffle extending across the interior of said tubing string between said ports

6

to prevent direct passage of fluid therebetween through said tubing string, a sleeve disposed around said second port in lateral spaced relation to said tubing string to form an annular passage therewith, said sleeve being closed at its lower portion below said second port, said sleeve having an open upper end substantially above said second port to direct fluid from said annulus around said tubing string downwardly through said annular passage and thence through said second port into said tubing string above said imperforate baffle, and a downwardly closing valve in said tubing string below said first port.

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