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SELECTIVE PRODUCTION MEANS FOR WELLS

Charles H. Barnes, Glendale, Calif., assignor to Lane-Wells Company, Los Angeles, Calif., a corporation of Delaware

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My invention relates to selective production means for wells, and among the objects of my invention are:

First, to provide a means of this character which, when used in conjunction with a well packer, permits production through a single tubing string from either one or the other of two producing zones located on opposite sides of the packer;

Second, to provide a means of this character whereby production may be readily and quickly changed from one production zone to the other;

Third, to provide a means of this character wherein the upper zone may be produced between the tubing and casing simultaneously with production from the lower zone; and

Fourth, to provide a novelly constructed valve and surface-operated control means, said means being adapted to be lowered or dropped through the tubing and readily retrieved therefrom.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawing, in which:

Figure 1 is a longitudinal sectional view of a well with my selective production means shown in elevation therein and in association with a packer set within the well casing;

Figure 2 is a longitudinal sectional view through my selective production means showing the parts in the positions assumed when ready for production from the uppermost of two zones;

Figure 3 is a longitudinal sectional view of a valve-operating go-devil with the parts in the positions assumed when the go-devil is lowered or raised in the tubing; and

Figure 4 is a longitudinal sectional view of my selective production means similar to Figure 2, but showing the parts in the positions assumed when producing from the lowermost of two zones.

My selective production means is adapted to be used in wells having an upper producing zone designated A and a lower producing zone designated B. The well bore is provided with the usual casing C having perforations D communicating with the upper zone. The casing may terminate short of the lower zone or be provided with perforations E communicating therewith.

A conventional packer 1 is set in the casing between the zones A and B. Said packer is provided with a tubular passage therethrough connected with a tubing string 2 from which the packer is suspended. My selective production means, designated 11, is interposed between the packer 1 and the tubing string 2.

My selective production means comprises a

tubular case 12 which is internally threaded at its upper end for connection to an adaptor 13 which in turn is internally threaded for connection to the tubing 2. The lower end of the case 12 is likewise internally threaded and is joined to an adaptor 14 which is secured to the upper end of the packer 1. At its lower end, above the adaptor 14, the bore of the case 12 is constricted, as indicated by 15, forming shoulders 16 and 17 at the lower and upper ends, respectively, thereof.

Between the constriction 15 and the upper end of the case there is fitted a sleeve valve 18 which controls intake ports 19 provided in the case 12 near its upper end. Between the lower end of the sleeve valve 18 and the constriction 15 there is interposed a spring 20 which normally holds the sleeve valve in its upper or port-closing position, as shown best in Figure 4. The sleeve valve 18 is provided with a bore therethrough equal to the nominal inside diameter of the adaptor 13 and the tubing thereabove, except that at the lower end of the sleeve valve 18 there is provided a slight constriction which forms a shoulder 21. The sleeve valve constriction is slightly less than the constriction 15 so that a member clearing the shoulder 21 may engage the shoulder 17 for purposes to be brought out hereinafter.

The sleeve valve is adapted to be held in an open position by means of a valve-holding go-devil designated generally by 31. The go-devil comprises a head member 32 provided with a shoulder 33 adapted to coact with shoulder 21 of the sleeve valve, and preferably form a fluid-tight connection therewith. The lower end of the head member, which is generally cylindrical in form, is connected to a tube 34, in the lower end of which are provided lateral openings adapted to receive key balls 35.

The tube 34 is small enough to pass through the constriction 15 and the key balls 35 are adapted to coact with the shoulder 16 at the lower end of the constriction 15. Normally the key balls occupy an inner position, as shown best in Figure 3, and are held in such position by a retainer sleeve 36 which fits over the tube 34. The retainer sleeve is adapted to fit within the constriction 15 except for its upper end, which is provided with a flange 37 adapted to engage the shoulder 17 but clear the shoulder 21. A spring 38 is interposed between the retainer sleeve 36 and the head member 32 so as to urge the sleeve downwardly. However, when the flange 37 engages the shoulder 17 the sleeve is moved upwardly so as to permit

the key balls 35 to move outwardly for engagement with the shoulder 16.

The tube 34 contains a spreader member 39 having a major diametered portion adapted to pass between the key balls 35 when they are in their extended position shown in Figure 2, and a minor diametered portion adapted to allow the key balls to occupy the retracted position shown in Figure 3. Between these two portions the spreader member 39 is tapered. A stem 40 is connected to the spreader 39 and extends upwardly through the tube into the head member 32 and is there connected to a valve 41 which coacts with a sealing block 42 secured between the head member and the tube. The stem 40 is relatively small in diameter so that the hydrostatic pressure that may exist below the selective production means can exert only a nominal upward force. This force is counteracted by a spring 43 interposed between the sealing block 42 and the spreader member 39.

The valve 41 is connected to a handle 44 which extends upwardly through the head member 32 and terminates in a knob designed for engagement with a conventional fishing tool such as used on wire lines for the purpose of retrieving removable core barrels. Inasmuch as such fishing tools are conventional, none are here disclosed.

A second or valve-opening go-devil, designated generally by 51, is employed to move the sleeve valve from the position shown in Figure 4 to that shown in Figure 2. The valve-opening go-devil comprises a tubular body 52, the lower end of which is adapted to engage the head member 32 of the valve-holding go-devil. The upper end of the body 52 is provided with a piston 53 adapted to fill the opening in the tubing 2 so that fluid pressure may be applied. A suitable mandrel is provided at the upper end of the body 52 for engagement with a fishing tool.

Operation of my selective production means is as follows: When it is desired to produce from the lower zone B the selective production sub is in its normal position shown in Figure 4, that is, a passageway is provided through the packer and through the production sub, which passageway is isolated from the exterior of the case 12 by the sleeve valve 18.

When it is desired to produce from the upper zone A the valve-holding go-devil 31 is dropped or lowered to position and the valve-opening go-devil 51 is dropped or lowered thereon. Fluid pressure is then applied to the top of the valve-opening go-devil 51, which forces the valve-holding go-devil downward and by reason of the coacting shoulders 21 and 33 the sleeve valve 18 is urged downwardly against the tension of the spring 20. The downward movement continues until the key balls 35 are below the shoulder 16 and the retainer sleeve 36 has been held stationary by reason of engagement of its flange 37 with the shoulder 17. The spring 43 thereupon urges the spreader member 39 downwardly, facing the key balls outwardly so that they may engage the shoulder 16.

The valve-holding go-devil 31 does not seal the constriction 15, so that the pressure of the zone B acts in conjunction with the spring 20 to urge the sleeve valve upwardly to maintain a tight fit between the shoulders 21 and 33. The sleeve valve is closely fitted within the case 12 so that there is no leakage between these two members.

After the sleeve valve has been moved to its open position the valve-opening go-devil 51 is retrieved and production may then be had

through the port 19, communicating with the upper zone A. If for any reason it is desired to again produce from the lower zone B it is merely necessary to lower a fishing tool to engage the handle 44 of the valve-holding go-devil 31. Upon pulling upwardly on the handle 44 the spreader member 39 is moved from between the key balls 35, and by reason of the fact that the shoulder 16 is tapered the key balls move inwardly to their original position, thereby freeing the go-devil. The retainer sleeve thereupon returns to its original position so that the parts of the go-devil are in the position shown in Figure 3 and the go-devil may be readily retrieved. As soon as the sleeve valve is released the spring 20 returns it to its upper position, closing port 19.

Various changes and alternate arrangements may be made within the scope of the appended claims, in which it is my intention to claim all novelty inherent in the invention as broadly as the prior art permits.

I claim:

1. In a well apparatus adapted to be interposed in a tubing string: a case interposed in said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders, and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; and a go-devil unit adapted to be lowered through said tubing string, said go-devil including means engageable with said sleeve valve to urge said sleeve valve against the spring, and means engageable with the other shoulder of said constriction to secure said sleeve in an open position.

2. In a well apparatus adapted to be interposed in a tubing string: a case interposed in said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders, and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; a go-devil unit adapted to be lowered through the tubing string, said go-devil including means engageable with said sleeve valve to urge said sleeve valve to a position uncovering said lateral ports; key elements engageable with the other shoulder of said constriction for securing said valve in its open position; and means operable from the upper end of said go-devil for releasing said key elements from engagement with said shoulder.

3. In a well apparatus adapted to be interposed in a tubing string: a case interposed in said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; a go-devil unit adapted to be lowered through the tubing string, said go-devil including a body engageable with said sleeve valve to urge said valve to an open position; key elements carried by said body and adapted to coact with the other shoulder of said constriction when said

valve is in an open position; and a retainer slidably mounted on said body and normally restraining said key elements, said retainer engageable with said constriction to release said key elements upon insertion of said body in said constriction.

4. In a well apparatus adapted to be interposed in a tubing string: a case interposed in said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; a go-devil unit adapted to be lowered through the tubing string, said go-devil including a body engageable with said sleeve valve to urge said valve to an open position; key elements carried by said body and adapted to coact with the other shoulder of said constriction when said valve is in an open position; a retainer slidably mounted on said body and normally restraining said key elements, said retainer engageable with said constriction to release said key elements upon insertion of said body in said constriction; means in said body including a yieldable element for urging said key elements into engagement with said shoulder; and a device operable from the upper end of said go-devil for retracting said means, thereby to permit retraction of said key elements.

5. In a well apparatus adapted to be interposed in a tubing string: a case interposed in said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders, and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; a go-devil unit adapted to be lowered through the tubing string, said go-devil including means engageable with said sleeve valve to urge said sleeve valve to a position uncovering said lateral ports; key elements engageable with the other shoulder of said constriction for securing said valve in its open position; means operable from the upper end of said go-devil for releasing said key elements from engagement with said shoulder; and a second go-devil including a piston element responsive to fluid pressure in said tubing string, and a stem engageable with said first go-devil for urging said first go-devil downwardly to engage and open said sleeve valve, said second go-devil being removable independently of said first go-devil.

6. In a well apparatus adapted to be interposed in a tubing string: a case interposed in

said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; a go-devil unit adapted to be lowered through the tubing string, said go-devil including a body engageable with said sleeve valve to urge said valve to an open position; key elements carried by said body and adapted to coact with the other shoulder of said constriction when said valve is in an open position; a retainer slidably mounted on said body and normally restraining said key elements, said retainer engageable with said constriction to release said key elements upon insertion of said body in said constriction; and a second go-devil including a piston element responsive to fluid pressure in said tubing string, and a stem engageable with said first go-devil for urging said first go-devil downwardly to engage and open said sleeve valve, said second go-devil being removable independently of said first go-devil.

7. In a well apparatus adapted to be interposed in a tubing string: a case interposed in said tubing string, said case having a longitudinal bore communicating with the interior of the tubing string, a constriction in said bore forming abutment shoulders and lateral ports in the walls of said case; a sleeve valve fitting the bore of said case and adapted to cover said lateral ports; a spring between said sleeve and one of said shoulders, normally urging said sleeve valve to cover said ports; a go-devil unit adapted to be lowered through the tubing string, said go-devil including a body engageable with said sleeve valve to urge said valve to an open position; key elements carried by said body and adapted to coact with the other shoulder of said constriction when said valve is in an open position; a retainer slidably mounted on said body and normally restraining said key elements, said retainer engageable with said constriction to release said key elements upon insertion of said body in said constriction; means in said body including a yieldable element for urging said key elements into engagement with said shoulder; a device operable from the upper end of said go-devil for retracting said means, thereby to permit retraction of said key elements; and a second go-devil including a piston element responsive to fluid pressure in said tubing string, and a stem engageable with said first go-devil for urging said first go-devil downwardly to engage and open said sleeve valve, said second go-devil being removable independently of said first go-devil.

CHARLES H. BARNES.