

Feb. 6, 1940.

C. E. BURT ET AL

2,189,703

WELL PRODUCTION APPARATUS

Filed July 25, 1939

3 Sheets-Sheet 1

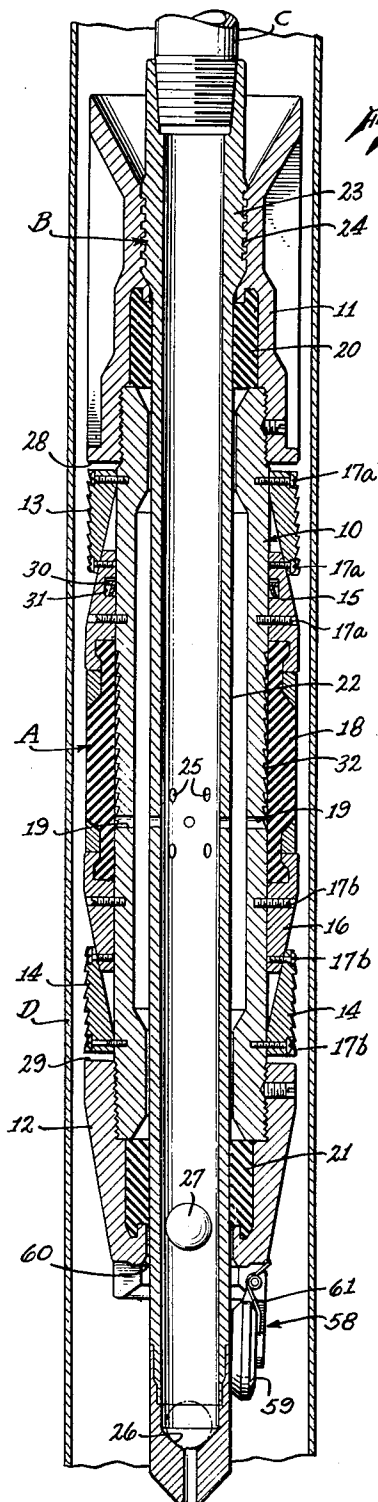


Fig. 1.

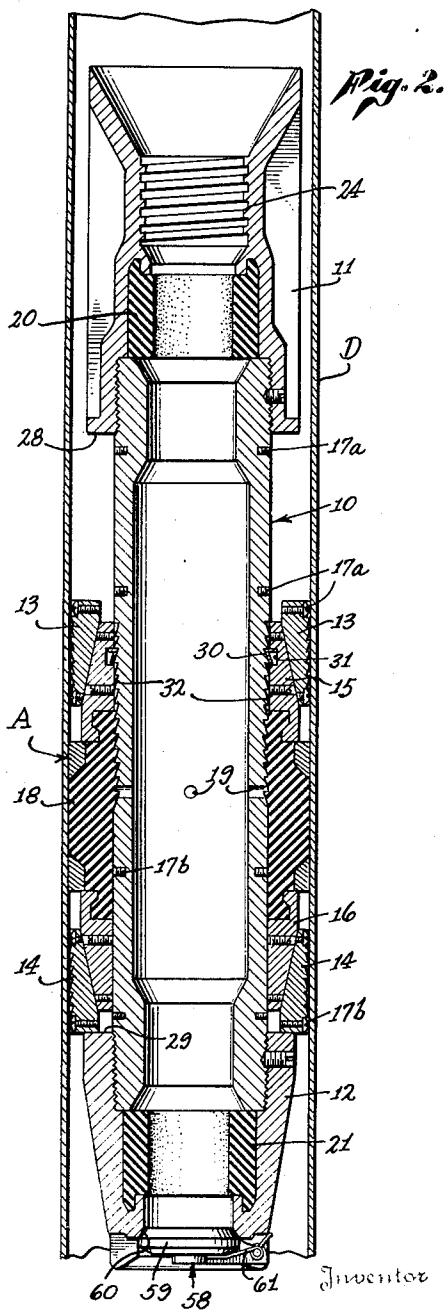


Fig. 2.

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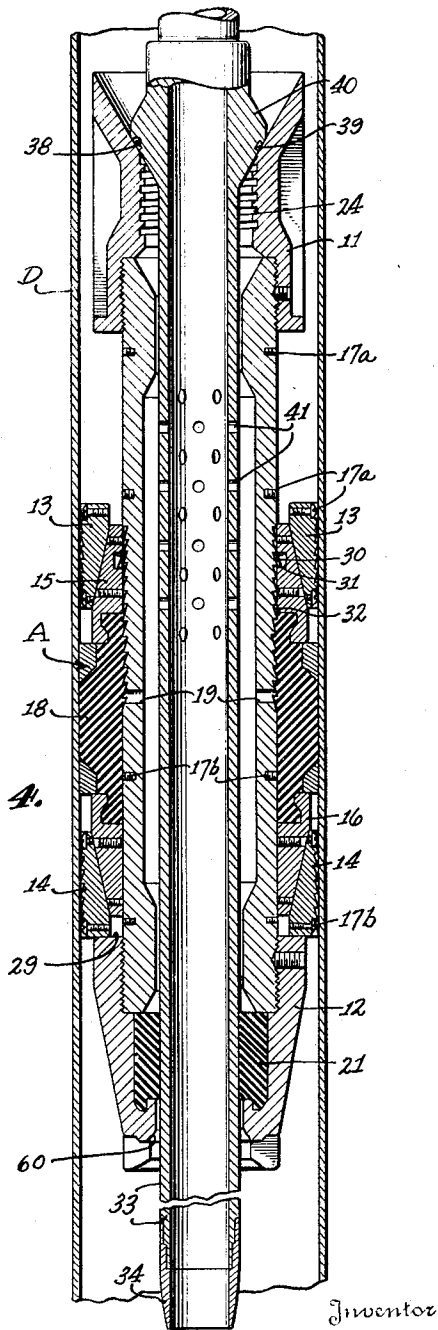
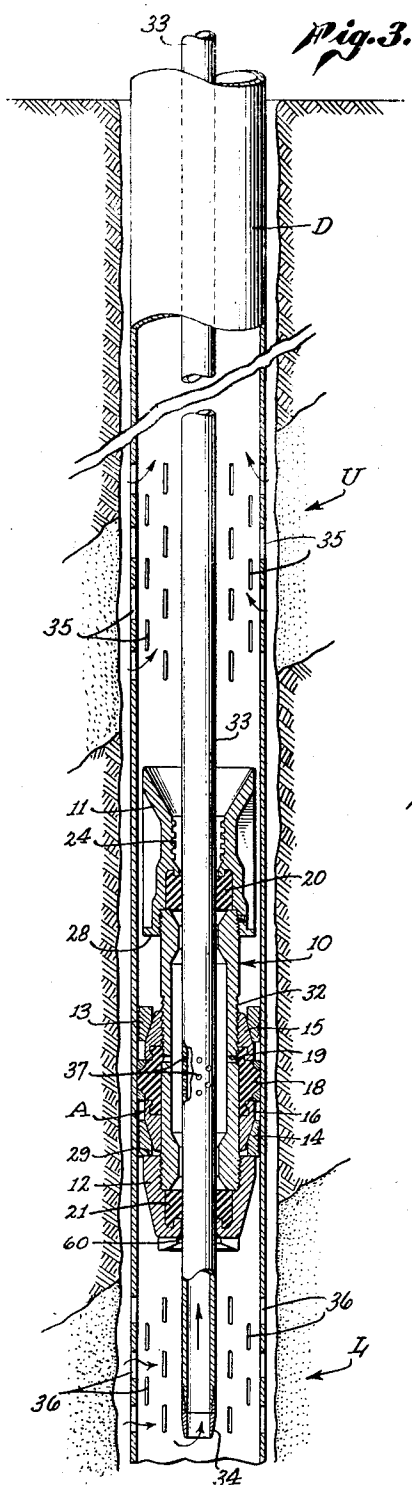
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3 Sheets-Sheet 3

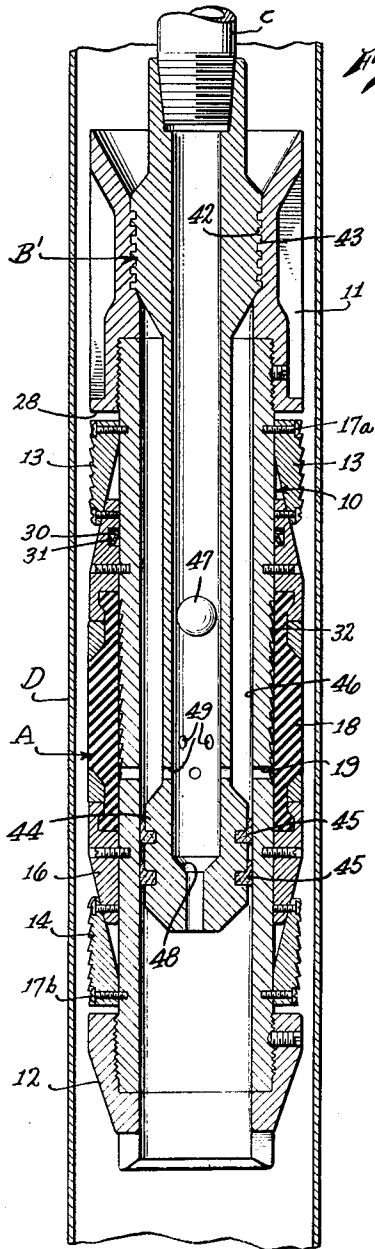


Fig. 5.

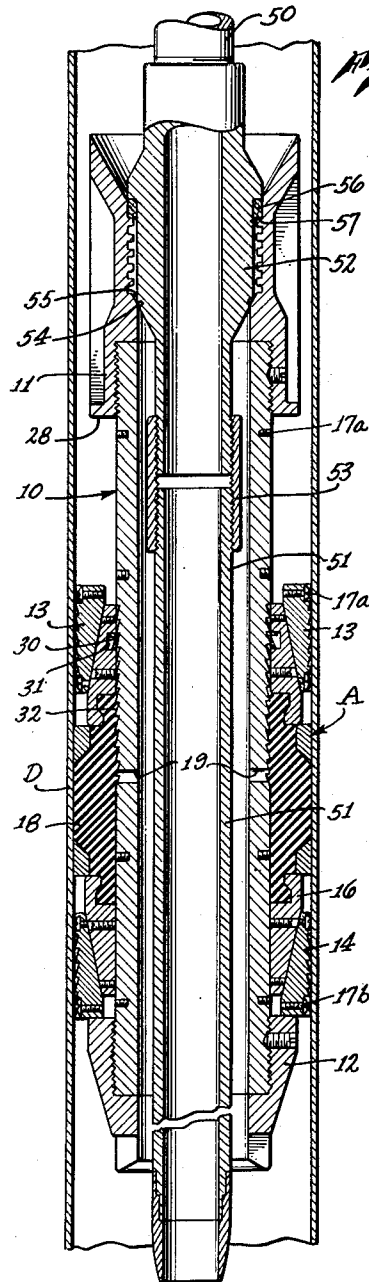


Fig. 6.

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WELL PRODUCTION APPARATUS

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Application July 25, 1939, Serial No. 286,324

6 Claims. (Cl. 166—12)

This invention relates to production equipment for oil wells and particularly to production packers and setting tools for anchoring them to well casings.

5 In areas where a plurality of producing zones are penetrated by a well it is desirable to segregate the zones and obtain production from them separately because of different gravities of oil, formation pressures, and types of sand accom-
10 panying the oil from each zone. Separate production through a single well is obtainable by cementing a perforated casing between the producing zones and setting one or more production packers in the casing between the perforations
15 which are positioned adjacent the oil sands. Production tubing or liners cooperate with the various packers to conduct the oil from each zone separately to the surface of the casing.

20 It is an object of the present invention to provide a production packer for use within a multiple zone well of a character capable of maintaining production from each zone separate and distinct or to allow simultaneous production through the associated tubing or casing.

25 Still a further object of the invention is to provide an improved production packer through which tubing or the like can be moved at will for the purpose of selectively changing the gas/oil ratio.

30 A further object of the invention is to provide an apparatus capable of altering the gas/oil ratio in a well without the necessity for removing the production packer from the casing.

35 Yet another object of the invention is to provide an improved sealing device between production packers and tubing cooperable therewith.

The invention further contemplates an improved production packer of the type having slips movable into engagement with the casing by
40 fluid under pressure, in which the packer preferably carries suitable seals for localizing the pressure at an intended region during the setting operation.

This invention has other objects which will
45 become apparent from a consideration of the various forms in which it is embodied, shown in the drawings accompanying and forming part of the present specification. These forms will now
50 be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

55 Figure 1 is a longitudinal sectional view of a production packer shown in conjunction with

a setting tool prior to being anchored to the casing;

Figure 2 is a longitudinal sectional view of the packer in set position within the casing;

Figure 3 is a view similar to Figure 2, with
5 production tubing slidable through the packer to separate the paths of flow of oil from different zones of a multiple zone well.

Figure 4 is a view similar to Figure 3, illustrating a modified form of production packer and
10 tubing associated therewith;

Figure 5 is a view similar to Figure 1, showing a modified form of production packer and co-
operable setting tool;

Figure 6 is a view similar to Figure 3, showing
15 the production packer of Figure 5 in cooperation with a modified form of production tubing apparatus.

The production packer A disclosed in Figures 1 to 3, inclusive, is coupled to a setting tool B
20 attached to a string of tubing C employed for lowering the packer to the desired setting point in the casing D. The packer is similar in construction to the type disclosed in United States Letters Patent No. 2,121,051, issued June
25 31, 1938, to Thomas M. Ragan and Clarence E. Burt. It consists of a central body member 10 having a setting head 11 threadedly secured to its upper end and a guide 12 threadedly attached to its lower terminus. Individual sets 13, 14 of
30 upper and lower annular segmental slips are provided for anchoring the packer to the casing, these slips being moved radially into engagement with the casing by their cooperable expander
35 cones 15, 16, slidable longitudinally with respect to the body and slips. Initially, the slips are held in retracted position and the cones in ineffective position by anchoring them together and to the packer body by shear screws 17a, 17b.
40 The upper sets of screws 17a have a lower shear strength than the lower sets 17b to permit setting of the upper slips 13 in the casing before similar anchoring of the lower set 14.

A packing sleeve 18 of rubber or the like is secured to the cones, being capable of elongation
45 to set the upper slips 13 and of compression to effect a seal between the packer A and the casing D, and assist in setting the lower slips 14. Fluid
50 ports 19 are provided through the packer body 10 in order that fluid under pressure can enter the interior of the packing sleeve and cause its expansion and elongation for the purpose of setting the upper slips.

It will be noted that an upper seal 20 is provided between the setting head 11 and the top
55

of the packer body 10, and a similar lower seal 21 between the guide 12 and the body. These seals are cooperable with the tubular portion 22 of the setting tool B extending through the packer and depending from the setting tool head 23, coupled to the packer head by their left-hand threaded interconnection 24. The tubular portion 22 is provided with a plurality of ports 25 through which fluid can pass for action upon the packer sleeve. The lower end of the tube carries a tripping ball seat 26 adapted to receive a ball 27 which, when seated, enforces passage of fluid through the ports and the setting of the upper slips 13.

After lowering the packer on its cooperable setting tool and associated tubing string to the desired region within the casing, the tripping ball 27 is dropped through the tubing until it engages the tripping ball seat 26. Thereafter, the application of pressure to the fluid within the tubing will force it to pass outwardly through the setting tool ports 25 and the main body ports 19 into the packing 18, causing its upward elongation. Since the shear value of the upper screws 17a is less than that of the lower sets 17b, the force exerted by the fluid will shear them and move the upper cone 15 longitudinally along the body to expand the upper slips 13 radially into engagement with the casing. Upward movement of these slips is limited by their engagement with an abutment 28 provided by the lower end of the setting head. The taking of an upward strain on the tubing C will now move the main body 10, its lower guide 12, and lower cone 16 and slips 14 upwardly to compress the packing 18 into sealing engagement with both the casing and the packer body, whereupon continued strain in an upward direction will shear the lower screws 17b and cause an abutment 29 provided at the top of the guide to engage the lower slips 14 and force them longitudinally along the tapered face of the lower cone 16 and radially into engagement with the casing D.

The packer A is now securely anchored to the casing (see Figure 2), the upper slips resisting displacement of the packer in an upper direction and the lower slips preventing its displacement in the other direction. Separating movement between the cones is prevented and the packing sleeve maintained in compressed condition by the engagement of a split contractile pawl ring 30, carried within a groove 31 in the upper cone 15, with annular ratchet teeth 32 formed on the exterior of the packer body.

After the setting of the packer, rotation of the tubing string C and the setting tool B coupled thereto in a right hand direction will effect disconnection between the left hand threads 24 and permit the withdrawal of the setting tool and tubing from the casing. Suitable production tubing 33, preferably of the flush joint type, having a lower terminal guide shoe 34 can be lowered through the casing D and through the packer A, a double slidable seal being effected between the tubing and packer by the engagement of the upper and lower packing seals 20, 21 with the exterior of the tubing 33 (see Figure 3).

When employed in multiple zone wells, the packer is set between separated casing perforations 35, 36 which face the oil sands (see Figure 3). Production can be had from the lower zone L through the tubing and also from an upper zone U around the tubing and through the casing, the flow from the two zones being maintained separate and distinct by being caused to

pursue separate flow paths to the surface of the bore. Accordingly, the production from several zones is not commingled, so that the characteristics of the flow from one zone is prevented from having any effect upon the production passing from another zone.

Because of the type of seal provided between the production packer A and the tubing 33, the latter can be raised or lowered through the packer to variously position its lower end 34 and thus regulate the ratio between the gas and oil flowing from the lower zone L. The two seals in effect are in continuous sealing contact with the tubing, permitting its repositioning or entire removal, if desired, without the necessity for withdrawing the production packer, which remains anchored in the casing.

In the event that it is desired to produce through the tubing or the casing simultaneously from zones both below and above the packer, the tubing 33 can be formed with perforations 37 at a sufficient distance above its shoe to permit the tubing to be raised and its interior placed in communication with both the upper and lower zones. Should production through the tubing from the lower zone only be desired, it can be lowered until its perforations 37 are positioned below the upper packing seal 20. However, the perforations can be omitted should simultaneous production in the manner described be unnecessary.

With the arrangement described, it is apparent that not only has a production apparatus been provided which permits control of the gas/oil ratio of the lower zone L, but selective production through the tubing or casing from a single zone or a plurality of zones, as desired, can be obtained. In this connection it is to be noted that the packer is employable in a single zone well to permit ease of variation in the gas/oil ratio simply by the expedient of repositioning the tubing with respect to the packer.

The production packer and associated equipment disclosed in Figure 4 is similar to that disclosed in Figures 1 to 3, inclusive. The same type of setting tool B is employed for anchoring its slips to the casing. The main distinction resides in the employment of only a single sliding seal 21 between the lower end of the packer and the production tubing 33. A seal at the upper end of the packer is effected between the inclined seat 38 on the setting head 11 and a packing ring 39 contained in a groove formed in the packing sub 40 to which the lower end of the tubing C is suitably secured.

With the arrangement shown in Figure 4, the gas/oil ratio from a lower zone can also be varied by raising the tubing 33. However, the tubing can only be lowered to an extent determined by the abutting of the packing sub 40 with the setting head 11. The provision of circulation holes 41 through that part of the tubing positioned within the packing body 10, when the packing sub 40 is in sealing contact with the setting head 11, provides a selective arrangement for producing through the tubing from the lower zone only or obtaining simultaneous production through the tubing or casing from both lower and upper zones, by elevating the tubing to move the packing sub from sealing contact with the setting head and allowing flow to pass between the upper zone and interior of the tubing through the circulation holes 41. By this arrangement, not only can simultaneous production be had from the two zones, but the higher

pressure zone can be utilized for repressuring the lower zone. This is also true of the embodiment shown in Figures 1 to 3, inclusive.

In the form of invention shown in Figures 5 and 6, slidable seals are omitted from the packer body, necessitating its setting with a different form of setting tool B¹. As disclosed in Figure 5, the setting tool has left hand threads 42 cooperable with corresponding threads 43 on the packer head 11. The lower end of the tool includes a piston body 4 carrying packing rings 45 engageable with the interior cylindrical bore 46 of the main packer body 10 below the radial ports 19.

Upon lowering of the packer to the desired point in the casing, a tripping ball 47 is passed through the string of tubing until it engages a seat 48 at the lower end of the setting tool or mandrel B¹. Fluid under pressure can thereafter pass through the lateral ports 49 provided in the setting tool to set the upper slips 13, as described in connection with the other embodiments, and thereafter enable the setting of the lower slips 14 and the sealing of the packing sleeve 18 with the casing D. Righthand rotation of the setting tool B¹ will disconnect it from the set packer and permit withdrawal of the former member from the casing.

The setting of the packer in the manner described in a multiple zone well permits its use in obtaining segregated production from the oil sands of each zone. Production tubing 50 is lowered within the casing, and includes a tail piece 51 coupled to a packing sub 52 by means of a collar 53 or the like. The sub carries a lower ring 54 adapted to seat upon the tapered face 55 on the packer head 11 to effect a seal therebetween and prevent communication between the two zones through the packer. A second, sediment seal can also be provided by securing an annulus 56 to the packing sub, which is engageable with a seat 57 formed on the packer head.

The tubing 50 cooperates with the packer by being supported on its head 11 to effect the double sealing between the sub and head described. The tail piece 51 extends from the packer to permit production to enter from the lower zone for passage to the surface of the bore. By attaching different lengths of tail pieces 51 to the packing sub 52, the entrance of the tubing can be positioned at various points below the packer to effect alteration in the gas/oil ratio. However, this form of the invention does not permit the raising or lowering of the tubing at will to alter the gas/oil ratio, as in the other embodiments, but it does enable alteration in the entrance position of the tubing without the need for removing the packer from the casing.

As disclosed in Figures 1 and 2, a one-way valve 58 can be provided at the lower ends of the packers to shut off production from the lower zone, provided that its formation pressure is higher than that of the upper zone. In the specific form of valve shown, a flapper head 59 is pivotally mounted at the lower end of the packer, being urged toward engagement with a valve seat 60 by a coil spring 61. So long as tubing extends through the packer, the valve head 59 is displaced and held to one side, as shown in Figure 1, but upon removal of the tubing, the spring 61 will seat it at the lower end of the packer opening, the action of the spring being supplemented by the higher fluid pressure of the lower zone.

We claim:

1. A well packer, including a main body having an upper head and a guide below said head, said body having a passage extending through it, means carried by said body for securing it to a casing, a packing carried by said guide within said passage for peripheral slidable sealing contact with a device adapted to extend therethrough, said head having a seat upon which said device is adapted to rest and effect a second seal.

2. In production apparatus for multiple zone wells, a packer adapted to be set in sealed off condition in a casing between zones, said packer having a passage therethrough, a tubular production device extending through said passage, a packing seal between said device and the upper portion of the packer, a second packing effecting a slidable seal between said device and the lower portion of the packer, said device being provided with means establishing a flow path between its interior and exterior, and said device being shiftable selectively through said passage while said packer remains set in sealed off condition to place its means in communication with a zone above said packer or to confine said means between said packing seals to obtain production through said tubing only from a zone below said packer.

3. In production apparatus for multiple zone wells, a packer adapted to be set in sealed off condition in a casing between zones, said packer having a longitudinal passage therethrough, a tubular production device extending through said passage, a packing effecting a slidable seal between said device and the upper portion of the packer, a second packing effecting a slidable seal between said device and the lower portion of the packer, said device being provided with means establishing a flow path between its interior and exterior, and said tubular device being shiftable selectively through said passage while said packer remains in set and sealed off condition to place its means above said upper packing in communication with a zone above said packer or to place said means below said upper packing to obtain production through said tubing only from a zone below said packer.

4. In production apparatus for multiple zone wells, a packer adapted to be set in sealed off condition in a casing between zones, said packer having a longitudinal passage therethrough, a tubular production device extending through said passage, means for effecting a seal between said device and the upper portion of said packer due to the weight of said device on said packer, a packing effecting a slidable seal between said device and the lower portion of the packer, said device being provided with one or more openings establishing communication between its interior and exterior, and said tubular device being shiftable longitudinally in said passage to disrupt the upper seal and place its openings in communication with a zone above said packer, said upper seal permitting production through said tubing only from a zone below said packer when said tubing rests on said packer.

5. In apparatus for wells, a packer adapted to be set in sealed off condition in a casing and having a passage therethrough, a tubular device extending through said passage, a packing carried by said packer at the lower portion of said passage for slidable sealing contact with said device, and a packing ring between said device and upper part of said packer for effecting a

seal therebetween due to the weight of said device on said packer.

6. In production apparatus for wells, a packer adapted to be set in sealed off condition in a casing and having a passage therethrough, said
5 packer having a head at its upper end, a tubular production device comprising a sub in said pas-

sage adjacent said head and a tail piece extending through said passage and detachably coupled to said sub, and a packing ring between said sub and head for effecting a seal therebetween due to the weight of said device on said packer.

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