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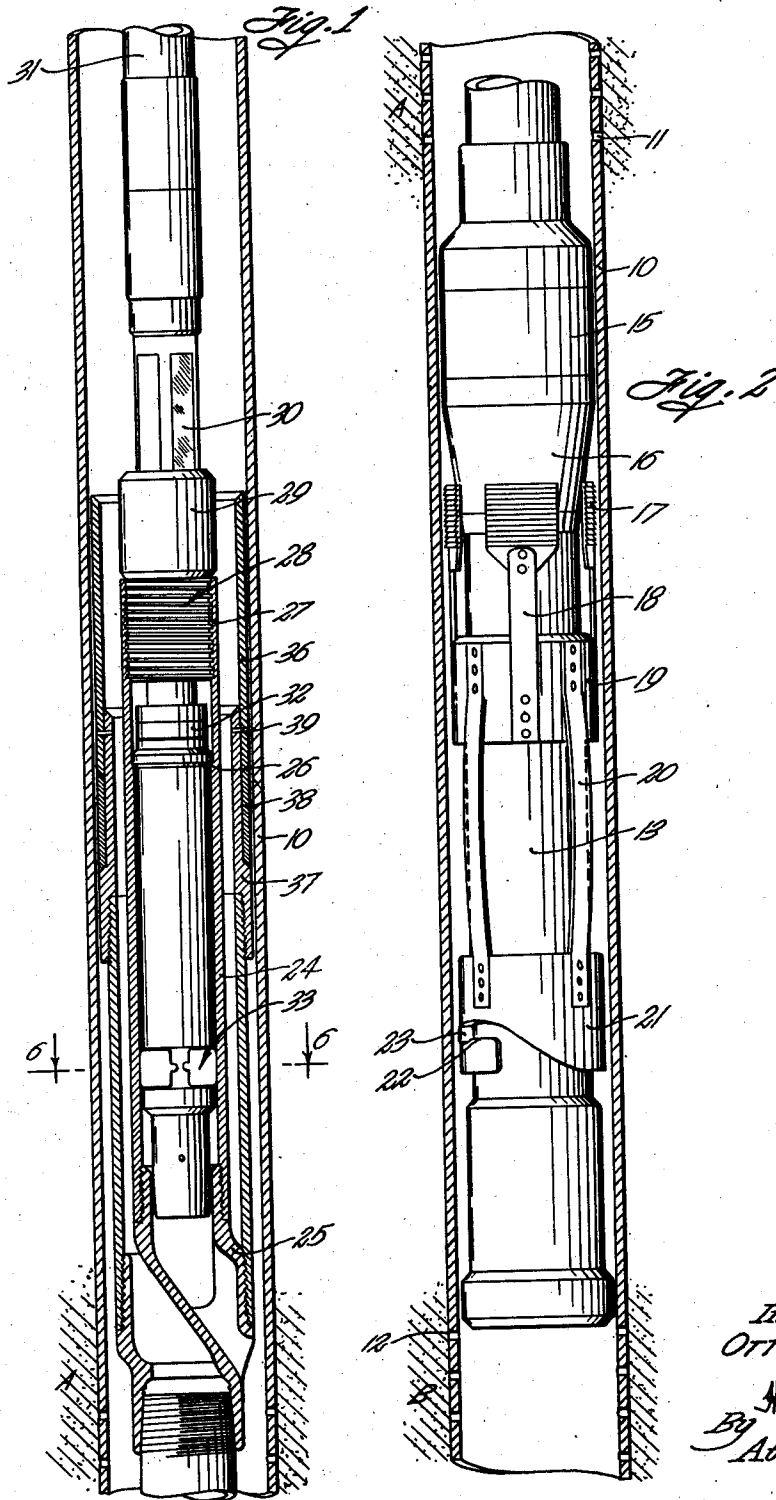
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MEANS FOR PRODUCING FROM SPACED OIL SANDS ONE OF WHICH REQUIRES PUMPING

Filed Aug. 9, 1939

3 Sheets-Sheet 1



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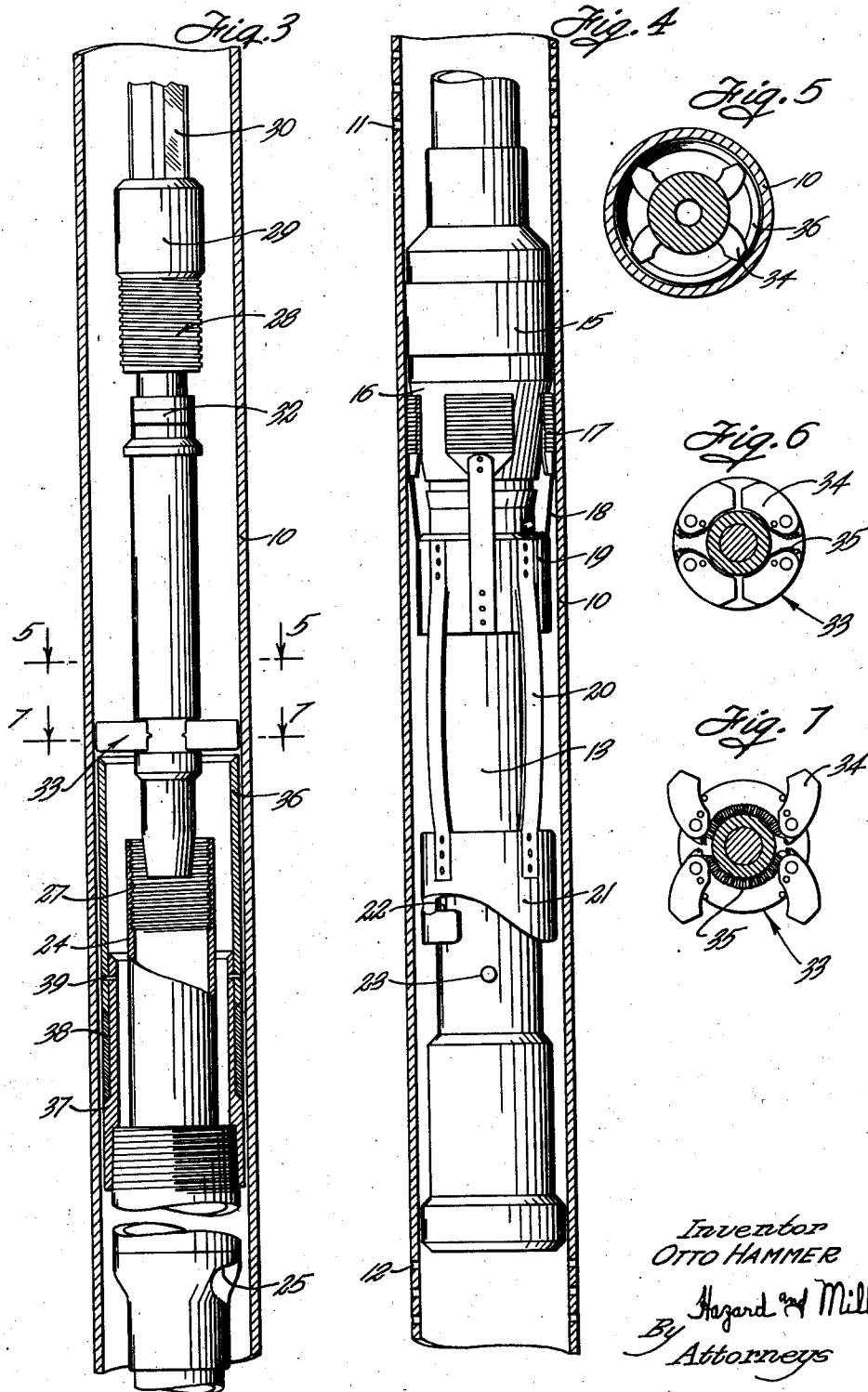
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Fig. 8

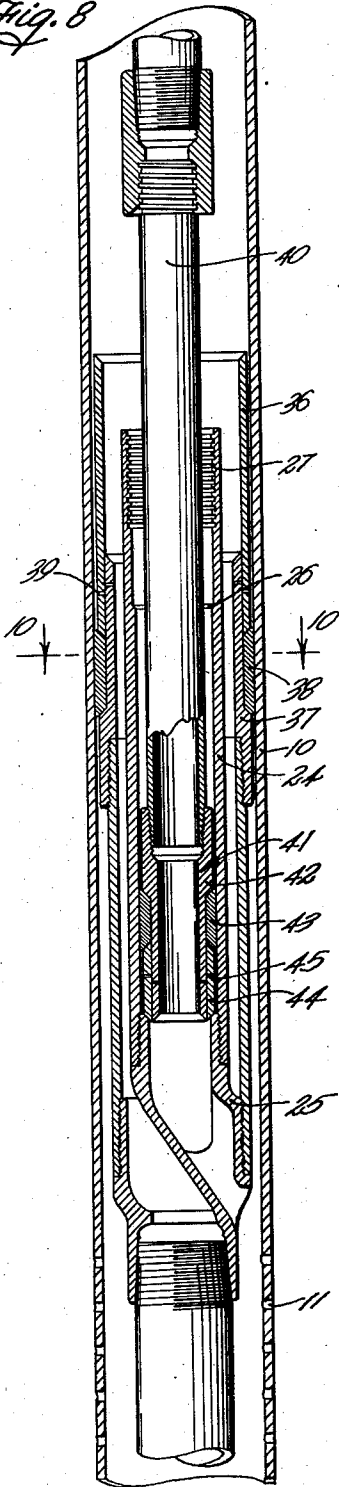


Fig. 9

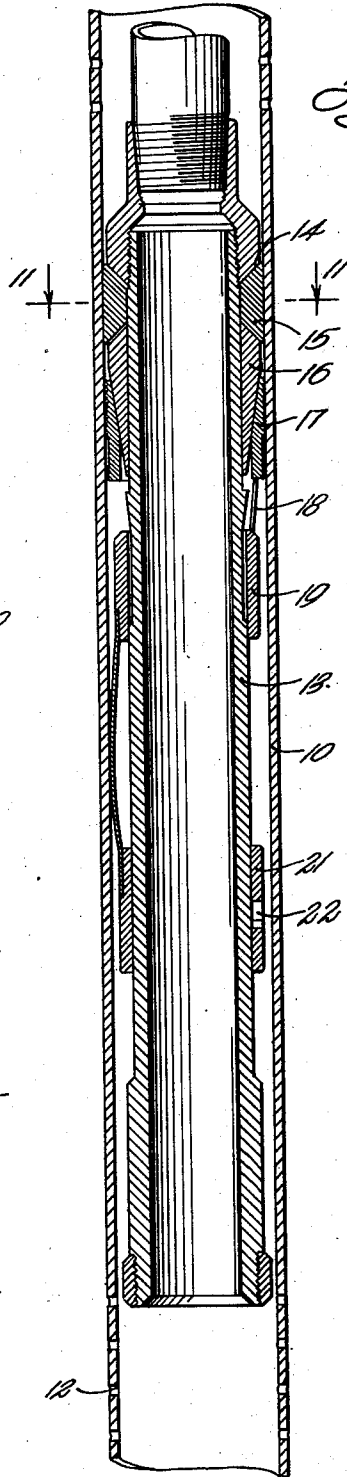


Fig. 10

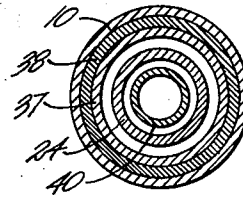
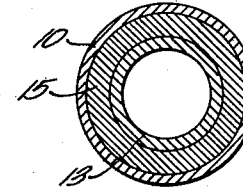


Fig. 11



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UNITED STATES PATENT OFFICE

2,274,407

MEANS FOR PRODUCING FROM SPACED OIL SANDS ONE OF WHICH REQUIRES PUMPING

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Application August 9, 1939, Serial No. 289,164

2 Claims. (Cl. 166—2)

This invention relates to a means for producing from spaced oil sands or zones.

In the drilling of oil wells it not infrequently occurs that two spaced oil sands or zones are penetrated from which it is desired to produce simultaneously. It is a relatively simple matter to produce from two spaced oil zones having the same formation pressure as these zones may be treated as one large producing zone. It is also a relatively simple matter to produce simultaneously from two spaced oil zones where the formation pressure in the upper zone is sufficient to cause the well to flow, but the formation pressure of the lower zone is so weak as to require pumping. In this event, the tubing and pump may be lowered into the well to the lower zone and the lower zone packed off from the upper zone. The pumping of the lower zone may take place through the tubing while the upper zone is allowed to flow around the tubing or through the space between the tubing and the casing.

A more difficult situation arises where the formation pressure of the lower zone is sufficient to cause the well to flow but the formation pressure of the upper zone is so weak as to require pumping.

An object of the present invention is to provide for apparatus which will enable the simultaneous production from two spaced oil sands or zones, the lower zone of which has sufficient formation pressure for flowing but the upper formation pressure is so weak as to require pumping.

More specifically, an object of the invention is to provide an apparatus that may be lowered into the well which will isolate the path of flow from the lower zone of high formation pressure from the path of flow from the upper zone of low formation pressure and which requires pumping, thus enabling both zones to be produced simultaneously without danger of contamination of oil from one zone with oil from the other, and without danger of the pressure in the lower zone forcing oil therefrom into the formation of the upper zone.

More specifically, an object of the invention is to provide an apparatus for producing from spaced oil zones which is of relatively simple yet durable construction and which may be set or installed in a well with a single "run-in" of the "run-in" string of pipe by having the apparatus so designed as to permit its installation with a single "run-in." A great saving in time and labor is accomplished.

Still another object of the invention is to provide an apparatus having the above-mentioned

characteristics and which is so designed and constructed as to enable its ready removal in the event that conditions of the well change or it otherwise becomes desirable to remove or replace the apparatus.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a vertical section through the upper portion of the apparatus illustrating it in its initial condition wherein it is about to be set in the well;

Fig. 2 is a vertical section of the lower portion of the apparatus in its initial condition wherein it is about to be set in the well, it being understood that the top of Fig. 2 is a continuation of the bottom of Fig. 1;

Figs. 3 and 4 are views similar to Figs. 1 and 2 respectively illustrating the condition of the apparatus after it has been partially set in the well;

Fig. 5 is a horizontal section taken substantially upon the line 5—5 upon Fig. 3;

Fig. 6 is a horizontal section taken substantially upon the line 6—6 upon Fig. 1 through the delayed action setting means illustrating the delayed action setting means in collapsed or contracted condition;

Fig. 7 is a view taken substantially upon the line 7—7 upon Fig. 3 through the delayed action setting means illustrating the delayed action setting means in expanded condition;

Figs. 8 and 9 are vertical sections through the apparatus somewhat similar to Figs. 1 and 2 but illustrating the apparatus as having been completely set in the well and the connection with the tubing having been established;

Fig. 10 is a horizontal section taken upon the line 10—10 upon Fig. 8; and

Fig. 11 is a horizontal section taken substantially upon the line 11—11 upon Fig. 9.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the apparatus forming the present invention is designed to be used where two spaced producing oil sands or zones are encountered. In the drawings the upper oil sand or zone is indicated at A while the lower zone is indicated at B. The location of these zones is determined during the drilling procedure or may be determined from production tests. The well may be assumed to have installed therein a casing indicated at 10 or in some instances,

a long liner may be installed which would occupy the position of casing 10 so as to extend through both zones A and B. The casing or liner 10 is cemented in place so that the space between the exterior of the casing and the well walls is filled to isolate zone A from zone B. Perforations are formed in the casing or liner as the case may be opposite each zone, the perforations opposite zone A being indicated by the reference character 11 and those opposite zone B by the reference character 12. These perforations may be formed in the casing or liner prior to installation or may be formed after installation by means of gun perforators or the like.

The apparatus embodying the present invention comprises an outer conduit 13 on the lower end of which there is provided a packing means set by means of slips. Slip-set packers are conventional in the art but for completeness of description the lower packing means may be described as follows. On the conduit 13 there is formed a shoulder 14 (see Fig. 9) against the underside of which there is a deformable packing ring 15 preferably formed of lead. This ring may be formed of rubber composition or other deformable material if desired. Below this packing ring a slip cone 16 is slidable on the conduit which slip cone is designed to expand slips 17 into engagement with the interior of the liner or casing 10. The slips are connected by springs 18 to a slip ring 19. The slip ring 19 has connected thereto friction springs 20 which in turn are connected to a lower ring 21. The lower ring 21 is provided with one or more bayonet slots 22 designed to receive studs 23 formed on the bottom of conduit 13 so that when the lower ring 21 is in the position shown in Fig. 2 the slip ring 19 and slips 17 will be held in their lowermost or contracted positions while the device is being lowered into the well. It will be understood that the above-described construction having reference to the packing ring 15 and the expanding mechanism therefor constitutes a lower packer or packing means on conduit 13 and that while the type of packing means illustrated is preferred, any other suitable packer or packing means may be substituted therefor if desired, the sole requirement being that the packing means be held against release until the desired level in the well is reached, after which release and setting of the packer may be accomplished by turning and lowering conduit 13.

In the upper end of conduit 13 there is formed an inner conduit 24 which is arranged centrally thereof and which has its inlet provided by a special coupling or fitting 25 through the walls of the tubing or pipe sections that form conduit 13. This inlet is intended to receive oil from the upper oil sand or zone A exclusively inasmuch as packing ring 15 prevents oil from the lower sand or zone B from mingling therewith inside of the casing or liner 10. The internal conduit 24 is equipped with an internal shoulder 26 and has its upper end internally threaded as at 27 so as to provide for attachment of a left-hand floating nut-type setting tool generally designated at 28. The thread 27 is a left-hand thread and the nut 29 has a complementary thread. A non-circular mandrel 30 is attached to the "run-in" string of pipe 31 and slidably extends through nut 29 so as to be slidably keyed thereto. The mandrel preferably carries a thrust bearing 32 the bottom race of which is carried by shoulder 26. The lower end of the mandrel

is equipped with a delayed action setting tool generally designated at 33.

This delayed action setting tool comprises a plurality of pivoted dogs indicated at 34 which are urged outwardly from their collapsed positions as shown in Fig. 1 into expanded positions as shown in Fig. 3 by means of springs 35. The dogs when expanded will project beyond the top edge of a packer sleeve 36 which is telescoped over a packing ring carrier 37 mounted on the upper end of conduit 13. A packing ring in the form of a lead, rubber, or composition sealing ring 38 fits between a shoulder on the packing ring carrier 37 and the bottom of the sleeve 36. The sleeve is held in uppermost position during lowering of the device into the well by means of shear pins 39. When the delayed action setting tool is pulled out of the inner conduit 24 the dogs 34 are automatically expanded over the top edge of sleeve 36 assuming a position as shown in Fig. 3. When the "run-in" string of pipe 31 is then lowered the sleeve 36 is forced downwardly shearing off the shear pins 39 and expanding the seal ring 38 into engagement with the interior of the liner or casing 10. This forms an upper packing means packing off above the upper zone A.

The operation and advantages of the above-described construction are as follows: Assuming that the liner or casing has been set and is equipped with perforations 11 and 12 opposite the respective oil sands or zones A and B, the device is run into the well on the "run-in" string of pipe 31 with the parts in the position as shown in Figs. 1 and 2. The "run-in" string of pipe 31 is then reversely rotated so as to back the stud 23 out of slot 22 and the "run-in" string of pipe is then lowered so as to set the slips 17 and the lower packer. "Run-in" string of pipe 31 is then rotated toward the right so as to unscrew the left-hand floating nut 29 and thus disconnect the "run-in" string of pipe from the inner conduit 24. The "run-in" string of pipe is then lifted so as to draw the delayed action setting tool 33 out of the inner conduit 24 and enable it to be expanded over the top of sleeve 36. The "run-in" string of pipe is then lowered to cause sleeve 36 to shear off its pin 39 and expand the upper packing ring 38. In this manner the lower packer 15 will be set above the perforations opposite oil sand or zone B and the upper packer 38 will be set above the upper sand or zone A. The "run-in" string of pipe is then withdrawn from the well leaving the apparatus in set condition therein. Thereafter a string of tubing 40 is lowered into the well which string carries a suitable packer at its lower end generally indicated at 41 designed to form a packed connection between the bottom of the tubing and the interior of the inner conduit. In the preferred form of construction the tubing is provided with a packing ring carrier 42 on which there is a deformable packing ring 43 formed of lead, or other suitable material and which is designed to be compressed by a sleeve 44 held in extended position by means of shear pins 45. The top of fitting 25 forms a seat limiting downward movement of sleeve 44 so that when weight is imposed by means of the tubing 40 the sleeve 44 will compress the ring 43 into good sealing engagement with the inner conduit 24. The tubing 40 may contain or have embodied therein any conventional or preferred form of pumping mechanism for elevating the oil therethrough that is received from the upper zone A. With

the apparatus thus set oil from the lower or high pressure zone B may enter the open bottom of the conduit 13 and flow upwardly therethrough between the packing ring carrier 37 and the inner conduit 24. Oil from the upper or lower pressure zone A may enter the inlet forming fitting 25 and pass upwardly through the inner conduit 24 and into the tubing 40. In this way oil from the lower or high pressure zone B may flow by formation pressure through the space between tubing 40 and the casing 10 while oil is simultaneously being pumped through the tubing 40 from the low pressure zone A. Thus, both zones may be simultaneously produced without danger of oil from one zone becoming contaminated with or commingling with oil from the other. Also the pressure from the high pressure zone B will be kept from dissipating itself through perforations 11 into the lower pressure zone A.

It will be appreciated that with the above-described apparatus that both packers may be set and that the apparatus may be installed with but a single run-in of the "run-in" string of pipe 31. In other words, the entire apparatus is run into the well, set, and left in position with a single run-in of the "run-in" string 31. The "run-in" string is then withdrawn and the tubing 40 introduced. The connection is made by setting the packer 41 and the well is then in condition to produce from both zones simultaneously.

It will be appreciated that the design is not only simple in operation, but durable in construction having relatively few moving parts so that there is little danger of any part of the construction failing to operate properly or to get out of order.

The invention has been described as being used in a continuous casing or liner which extends through both productive zones A and B. However, the use of the invention is in no way restricted thereto. In some fields, such as for example in the State of Illinois, the formation at the productive zone or zones is such that production may take place without the installation of a liner or a screen, or to use a popular terminology, the well is produced "barefooted." In these instances, where it is not necessary to use a perforated liner or a screen, I contemplate the introduction into the well of a casing, the shoe of which is set at the top of the lower oil sand or productive zone B. At the location of the upper productive zone A the casing may be formed of readily drillable material, such as for example the aluminum alloy now sold on the market under the trade-name of "Securaloy." The entire casing is then cemented in place and after the cement has set, the readily drillable or Securaloy portion of the casing is drilled out or otherwise removed and the cement surround-

ing the same is also removed, thus exposing the walls of the well at the upper zone A. This leaves the well with an upper string of cemented casing extending from the top of the upper zone A to the surface and a lower string of cemented casing extending from the bottom of the upper zone A to the top of the lower zone B. The two strings of casing are unconnected. With the well in this condition the apparatus embodying the present invention may be introduced and the lower packer set in the lower casing string between zones A and B. The upper packer is set in the upper casing string above the upper zone A. The operation and the advantages of the construction are, of course, the same when thus used as in the case where it is used in a continuous liner or casing.

It is also apparent that if a liner is set so as to extend through the upper zone A only, and a smaller liner is set therein so as to extend into the lower zone B, that the apparatus may be readily installed therein by selecting the proper size of packers, one to fit the smaller liner and the other to fit the upper liner if occasion should so require.

Various changes may be made in the details of construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. An apparatus for producing from spaced oil sands comprising vertically spaced packers, means providing a passage through the upper packer leading from the space between the packers through the upper packer to a tubing, means providing a second passage leading from below the lower packer through both packers to the space above the upper packer surrounding the tubing, the lower packer being a slip-set packer, the upper packer being equipped for releasably connecting it to a "run-in" pipe, and a delayed action setting means by which the "run-in" pipe may set the upper packer following release.

2. A device for producing spaced oil sands in wells comprising upper and lower packers, means defining an outer passage connecting the packers leading from below the lower packer through the upper packer, means defining an inner passage leading from the exterior of said passage-defining means into the outer passage, and a tubing connectable to the inner passage-defining means and forming a continuation thereof whereby fluids from below each packer may ascend through the outer and inner passages isolated from each other, the lower packer being a slip-set packer and the upper packer being designed to be set by compression after the lower packer has been set.

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