Jan. 28, 1958 R. SPEAROW 2,821,255

SUBFORMATION OIL PRODUCTION METHOD

Filed March 30, 1956

2 Sheets-Sheet 1

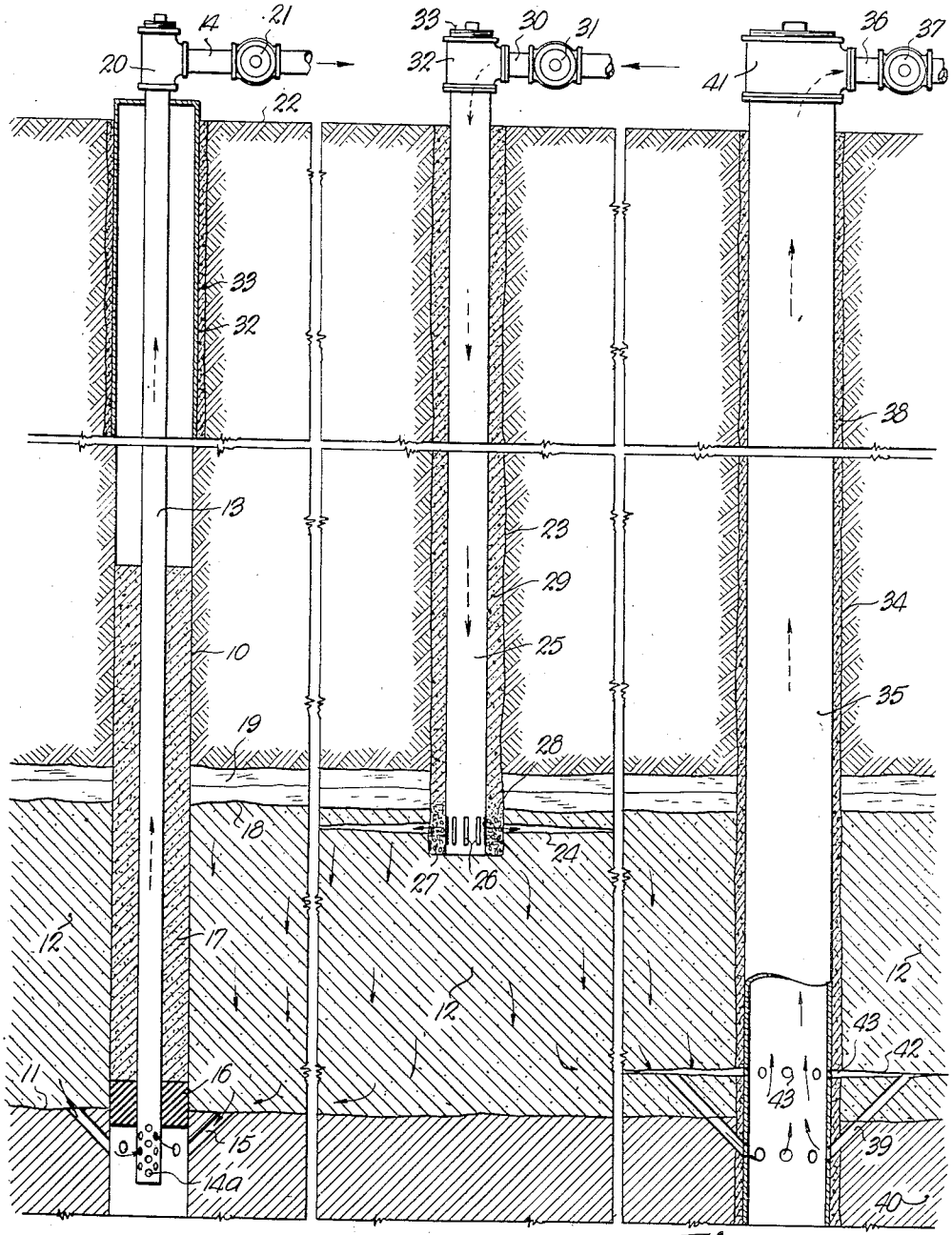


Fig. 1. Fig. 2. Fig. 3.

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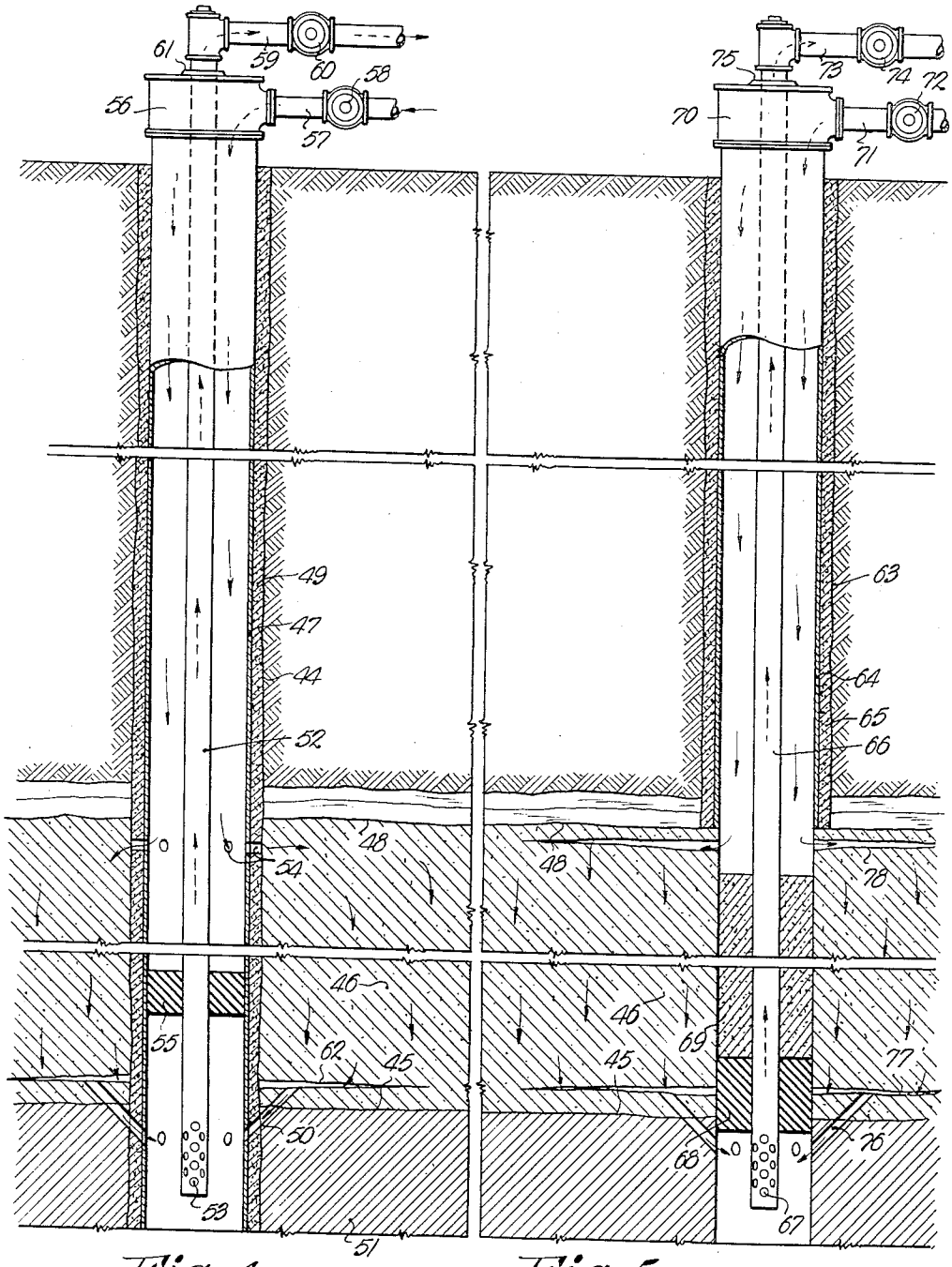


Fig. 4. Fig. 5.

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SUBFORMATION OIL PRODUCTION METHOD

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12 Claims. (Cl. 166—10)

This invention relates to methods of producing oil from oil sands by vertical drive gaseous pressurization and refers more particularly to such a method of producing oil wherein the oil is withdrawn from the earth formation from a level below the lowest level of the oil horizon whereby to permit production of all of the oil in the oil horizon.

Previously, I have provided as in my Patent No. 2,593,497, entitled "Method and Apparatus for Producing Oil Wells," issued April 22, 1952, and my Patent No. 2,725,106, entitled "Oil Production" and issued November 29, 1955, methods of producing oil from oil horizons by vertical drive gaseous pressurization wherein gaseous pressure is applied to the uppermost portion of an oil horizon and liquid oil is produced from the lowermost portion of the oil horizon. As previously set forth in these patents, it is desirable both to pressurize as close to the top of the formation as possible and withdraw the oil from as close to the bottom formation as possible. In this way as much as possible of the oil may be produced from the horizon. Existing methods of completion of the production area in the lower portion of the oil horizon make it impossible to scavenge out the entire formation due to the nature of the completions themselves, such as perforation of casings and surrounding cement columns and packing off of casings against the oil formations themselves. Additionally, these production area completion methods which I have previously disclosed may fail to give complete sealing down to the top of the production area due to variations in the face of the well bore when a packer is set thereagainst and splitting or seaming of a cement column upon perforation. Such failures of sealing also tend to prevent 100% complete production of the oil from an oil horizon.

Therefore, an object of the present invention is to provide a method of producing oil from oil horizons utilizing a vertical drive gaseous pressurization method wherein oil is withdrawn only from below the horizon thereby permitting production of all of the oil in a formation by such a vertical drive gaseous pressurization method.

Another object of the invention is to provide such a subformation oil well production method utilizing vertical drive gaseous pressurization wherein either combined pressurization and production wells or separate pressurization and production wells may be employed.

Another object of the invention is to provide a subformation oil well production method utilizing vertical drive gaseous pressurization which in combination with my previously disclosed methods of completing production well areas in the lower portions of oil sands, permits differential distribution of the total oil amongst several wells in a vertical drive gaseous pressurization field with an oil horizon of varying depth.

Another object of the invention is to provide a subformation oil well production for use with vertical drive gaseous pressurization wherein the production area in the borehole of the oil well is completely sealed off from contact with the well bore face in the oil horizon and oil

is produced solely from the underside of the horizon, thereby getting vertical drainage of the liquid oil into the well.

Another object of the invention is to provide a subformation oil well production method utilizing vertical drive gaseous pressurization wherein a plurality of production well completion methods are provided for both combined and separate pressurization and production wells thereby to permit optimum adaptation to various well completion problems and horizon or sand types.

Yet another object of the present invention is to provide a subformation oil well production method utilizing vertical drive gaseous pressurization wherein the lower portion of the oil horizon may be fractured to improve the productivity thereof, yet oil is recovered only from the underside of the horizon and not from the well bore face opposite the fracture.

Other and further objects of the invention will appear in the course of the following description thereof.

In the drawings, which form a part of the instant specification and are to be read in conjunction therewith, there are shown several embodiments of the invention and, in the various views, like numerals are employed to indicate like parts.

Fig. 1 is a cross-sectional view through an earth formation containing an oil horizon, the well drilled into the horizon being solely a production well useable either alone in an original production application from a virgin sand or in conjunction with a pressurization well such as is shown in Fig. 2 in a secondary production application.

Fig. 2 is a cross-sectional view through an earth formation containing an oil producing horizon, the well drilled into the horizon being solely a pressurization well, this well useable only in conjunction with a separate production well such as is shown either in Fig. 1 or Fig. 3.

Fig. 3 is a cross-sectional view through an earth formation containing an oil producing horizon, the well drilled into the horizon being essentially the same as the well in Fig. 1, the only difference being in the method of completion of the well and the fact that the face of the well bore has been fractured at a predetermined position in the lower portion of the oil horizon.

Fig. 4 is a cross-sectional view through an earth formation containing an oil producing horizon, the well drilled into the horizon being a combined pressurization and production well, operable to produce oil from the horizon by itself, the lower portion of the horizon being shown fractured in this view.

Fig. 5 is a cross-sectional view through an earth formation containing an oil producing horizon, the well being drilled into the horizon being a combined pressurization and production well as in Fig. 4, the differences between the two lying in the method of completion of the well and the fact that the face of the oil horizon has been fractured both at the upper and lower positions thereof.

Referring first to Fig. 1, the inventive method comprises drilling of the borehole **10** of an oil well below the bottom level **11** of the oil horizon **12** to be produced, forming an open passageway **15** through the adjacent earth formations extending from a level below the horizon into the bottom of the oil horizon, running a casing or tubing **13** having a flow line **14** at the upper end thereof to the vicinity of the bottom of the hole bore and below the bottom of the oil horizon to be produced, said casing having at least one inlet opening **14***a* adjacent the lower end thereof, sealing said casing to the well wall from a level below the bottom of the oil horizon to a level above the top thereof, and producing oil through said passageway **15** into said casing and thence to the surface. In Fig. 1, the method of sealing the casing to the well wall comprises packing off as at **16** at a level below the bottom

portion of the oil horizon and filling the annulus above the packer between the casing or tubing **13** and the borehole wall with an annular sealing column of cement or other sealing substance **17**. This sealing column extends to above the topmost level of the oil horizon **18** at least into the impermeable layers **19** thereabove. Tubing or casing **13** preferably has conventional T **20** at the upper end thereof to permit insertion of a pumping string (not shown) so that oil may be pumped from the tubing if desired. Flow line **14** preferably has valve **21** therein to permit withdrawal of the fluid oil from the casing **13**. Ground level is indicated at **22**. Once the borehole **10** has been drilled below the lower level **11** of the oil horizon **12**, the open passageways **15** may be formed either before or after the casing **13** is run and sealed. Such open passageways may be formed by angled perforation of the earth formation into the lower part of the oil horizon. Should there be cracking or sloughing of the formations below the oil horizon due to the perforation, it will not hinder the oil production but, in fact, usually aid it in offering a greater cross-sectional area of oil production so long as access is given to the borehole below the packer or other sealing means **16**.

The inventive method as applied to original oil production under the original formation pressures within the oil sand is the same as set forth above without a step of applying gaseous pressure to the top of the oil horizon. In this case, once the casing **13** has been set in the well bore, the passageways **15** formed and the sealing column **17** and packer **16** set to a level above the top of the horizon, oil may be flowed from the inlet openings **14** in the tubing **13** out of the flow line **14** merely by opening the valve **21**, provided the original formation pressure is sufficient to raise the fluid column to the surface. If it is not, a pumping string inserted in T **20** serves to raise the oil to the surface. Whether or not a gas cap exists originally in the oil horizon **12**, the subformation production means shown permit complete production of the oil from the vicinity of the borehole **10** until the gas-oil interface at the bottom of the gas cap formed in the process of production reaches the passageways **15** where they enter the oil horizon **12**. It is, of course, not possible to completely produce all of the oil within the horizon, even with the subject completion method, under the original formation pressures. Thus, any residue of oil left in the horizon will have to be produced therefrom by a vertical drive gaseous pressurization method in secondary production as will now be described.

Referring now to the use of the production well in Fig. 1 in secondary production, it is necessary to provide means for applying gaseous pressure to the top of the oil horizon. Such means are shown in Fig. 2 wherein is shown a pressurization well providing a gaseous pressure flow line channel to the top of the oil horizon. This aspect of the method comprises the steps of drilling the borehole **23** of the pressurization well to or into the top of the oil horizon **12**. If it is desired to have the top of the oil horizon fractured as shown at **24**, the borehole of the pressurization well should be drilled into the top of the oil horizon **21** a sufficient distance for a fracturing packer assembly to be set in the well bore to fracture the oil horizon at the top or very close to the top thereof. A preferred fracturing packer assembly for fracturing localized areas of oil horizons is shown in my application Serial No. 563,089, filed February 2, 1956, entitled "Fracturing Packer and Method of Application Thereof." The top level of the horizon may also be cracked by a method as hereinafter set forth. Pressurization casing **25** having output openings **26** at the lower end thereof is then run to or into the top of the oil horizon, preferably gravel packed as shown at **27** with a layer of sealing substance (gelatinous or finely grained material) **28** placed on top of the gravel and sealed by an annular column **29** of sealing substance or cement from the top of the oil horizon to a level thereabove. Pressurization casing **25** has pressure flow line **30** connected into the sealed upper end thereof with valve **31** thereon. After gravel packing and cementing as described, the horizon may be cracked by running liquid into the casing **25** to fill it and then applying fracturing pressure thereto. The pressure is thus applied to the well bore face below the sealing column **27**. After fracturing, the fluid is removed from the tubing **25** for the input of air therein. T **32** having sealing plug **33** in the top portion thereof permits such a fluid removal pumping operation or the fracturing fluid may be forced into fracture **24** by gaseous pressure.

To operate the combined apparatus of Fig. 1 and Fig. 2 in a pressure exhausted oil sand or very low pressure oil sand, gaseous pressurization media such as air or inert gases, is forced into the flow line **30** and out of the open or perforated lower end of the pressurization casing **25**. The gaseous pressurization media flows into the top of the horizon and forms a gas cap which expands both outwardly and downwardly driving the liquid oil before it. A gas-oil interface is formed by the periphery of this expanding gas cap and oil may be recovered from the open passageways **15** below the oil horizon until the gas-oil interface reaches and actually passes into the passageways **15**. When this occurs, the production well of Fig. 1 is finished as a producer in the particular oil field. The purpose of the fracture **24** at the pressurization well is to increase the rate of input of the gaseous pressurization media to reduce to a minimum the horsepower requisite thereto. It is also contemplated that the secondary recovery method be practiced in a plurality of pressurization and/or production wells analogous to production from a plurality of production wells in original production.

In Fig. 1, surface casing **32** has been set and cemented as shown in **33**. Such surface casing **32** permits proper installation and positioning of tubing **13**. It is also contemplated that the cement or sealing column **17** be extended up to the vicinity of the surface thereby obviating the necessity of surface casing.

Fig. 3 illustrates a variation of the Fig. 1 production well illustrating a different completion method and also a method wherein the lower portion of the oil horizon is fractured to increase the oil production therefrom. It is also contemplated that the Fig. 1 construction be employed with such a lower horizon fracture and the fracturing step as described relative Fig. 3 will also apply to Fig. 1. As in the Fig. 1 well, the well shown in Fig. 3 may be used either alone in original production or in combination with a pressurization well such as is shown in Fig. 2 in secondary production.

The method as practiced in the Fig. 3 well in secondary production comprises the steps of drilling the borehole **34** of an oil well below the bottom level of the oil horizon **12**, running a casing **35** having a flow line **36** with valve **37** attached to the upper end thereof to the vicinity of the bottom of the hole bore and below the bottom of the oil horizon, sealing said casing to the well wall from a level below the bottom of the oil horizon to a level at least above the top thereof by an annular column **38** of cement or other sealing substance, forming an open passageway **39** through the casing, its surrounding annular seal and the adjacent earth formations **40** extending from a level below the oil horizon into the bottom of the oil horizon, applying fluid under pressure to the top portion of the oil horizon and producing oil from the casing at the surface. Casing **35** preferably has conventional T **41** at the upper end thereof to permit insertion of a pumping string (not shown) to permit pumping oil from the tubing if such is desired.

As to the provision of a fracture in the lower portion of the horizon, either a suitable fracturing assembly may be run to the vicinity of the bottom of the oil horizon before running the casing **35** therein and the horizon fracture **42** at or slightly above the bottom of the horizon or, after the casing has been run and sealed at **38**, the

casing and its surrounding annular seal may be perforated as shown at 43, the area below the perforations packed off and sufficient gaseous or fluid pressure applied within the casing 35 to fracture the horizon as shown at 42. The open passageways 39 may be formed by perforation or other method upwardly at an angle into the bottom of the horizon and into the fracture 42 to obtain optimum oil production from the lower portion of the oil horizon. It is evident that if the fracturing of the oil horizon is done by perforation of the casing and its surrounding annular seal, these perforations must be closed off in the oil production method whereby oil is produced only through the passageways 39 and not through the perforations 43. This may be done by putting a secondary tubing (not shown) within the primary tubing 35 and packing off at the level of the perforations and then draining oil only through the tubing below said packer. It is obvious that such a perforation method would not be as feasible in the completion method of Fig. 1 with the packer 16 positioned in the fracturing area. Thus it is preferred that the horizon be fractured before the setting of the casings 35 and 13 in both the Fig. 3 and Fig. 1 modifications.

The method and means for applying gaseous pressurization to the top portion of the oil horizon 12 has been previously described relative Fig. 2 and will not be described again. It is also contemplated that the method as shown in Figs. 2 and 3 be practiced in a plurality of pressurization and/or production wells.

In employment of the Fig. 3 method in original production, the Fig. 3 well is drilled as described above and finished as previously described but the step of applying gaseous pressurization to the top of the oil horizon is omitted. Again, pumping means may be employed to pump oil from the tubing or casing 35 if such is desired or necessary. The fracture 42 at the bottom of the horizon increases the access to the oil sand in the vicinity of the passageways 29 for improved oil production. When the gas-oil interface in the horizon passes into the passageways 39 below the lowest level of the oil horizon, the Fig. 3 well is through as a producer and all of the oil has been produced in the vicinity of this production well, whether the gas-oil interface was produced by original or secondary production methods. As set forth relative the Fig. 1 modification, however, it is not contemplated that original pressures in the formation will produce all of the oil within the horizon and that at a late stage in such a production method, secondary pressurization with a pressurization well as shown in Fig. 2 will be necessary to completely scavenge the horizon of oil.

Fig. 4 illustrates a combined pressurization and production well. The method as practiced in Fig. 4 comprises the steps of drilling the borehole 44 of an oil well to a level below the lowest level 45 of an oil horizon 46, running a primary casing 47 into said borehole to a level below the bottom of said oil horizon and adjacent the bottom of the borehole, sealing said primary casing to the well wall from a level below the bottom of the oil horizon to a level above the top 48 thereof with an annular column of cement or other sealing substance 49, forming an open passageway 50 through the primary casing 47 and its surrounding annular seal and the adjacent earth formations 51 extending from a level below said oil horizon into the bottom 45 of said oil horizon, running a secondary tubing 52 having an inlet opening at the lower end thereof 53 to a level at least below the topmost perforations in said primary tubing, said primary casing having been perforated 54 with its surrounding annular seal to provide access to the topmost portion of the oil horizon, packing off as at 55 the secondary tubing against the inner face of the primary tubing to prevent fluid flow through the annulus between the two casings therebelow, and producing oil from the secondary tubing through the passageways 50 below the packer 55. Primary casing 47 has conventional T 56 at the upper end thereof with pressurization flow line 57 attached thereto with valve 58 therein. Secondary tubing 52 has flow line 59 with valve 60 therein attached to the upper end thereof. Sealing gland 61 seals the secondary tubing into the T 56 of the primary tubing 47.

Should the well shown in Fig. 4 be desired to be produced under the original formation pressures, the valve 58 on flow line 57 to the primary casing 47 is kept closed so no oil sand fluid will pass into the annulus between the two casings through the perforations 54. With the valve 60 on flow line 59 on secondary casing 52 open any original formation pressure existing in the sand may produce oil through the open passageways 50 at the bottom of the oil horizon until such pressure is so depleted that secondary pressurization is desired. When such secondary pressurization is desired, valve 58 on flow line 57 is opened and gaseous pressurization media forced into the annulus between the two casings 47 and 52 and out the perforations 54 in the primary casing. Thus all of the oil may be driven from the formation. The formation of a gas cap and a gas-oil interface under such original production or secondary production is the same as has been previously described. If it is desired to fracture either or both the top or bottom portion of the oil horizon to increase the productivity and pressurization input into the horizon, such may be done. The fracture as shown at 62 in the lower portion of the oil horizon is preferably made before the setting of the primary casing and its cementing by a fracturing packer assemoly as previously described. The passageways 50 which may be formed after the casing 47 is set and cemented running into the fracture thus collect more oil per unit time. If it is desired to fracture the top portion of the oil horizon to increase the secondary pressurization into the oil horizon, the horizon may first be fractured as in the fracture 62 and then the perforations 54 made opposite the fracture or the casing 47 set and sealed as at 49, perforations 54 made through the casing 47 and the seal 49 and then sufficient fluid or gaseous pressure applied through the perforations after the packer 55 has been set to fracture the upper portion of the horizon. Such a fracture is not shown in Fig. 4. It is, of course, contemplated that a plurality of combined pressurization and production wells may be employed in the given oil horizon 46 or, the combination of combined pressurization and production wells as in Fig. 4 and separate pressurization and production wells as in Figs. 1, 2 and 3. The arrangement of such wells would depend upon the thickness of the sand, the permeability of the various areas of the sand, etc.

Fig. 5 illustrates a modification of the combined pressurization and production well in Fig. 4 with a different method of well completion and wherein, as before, either both the top and bottom portions of the oil horizon are fractured or merely one of these locations is fractured to aid both the input of pressurization media (gaseous) into the top of the oil horizon and withdrawal of the liquid oil from the bottom of the oil horizon.

The method as practiced in Fig. 5 consists in the steps of drilling the borehole 63 of an oil well below the bottom level of an oil horizon, fracturing adjacent the bottom or top portions of the oil horizon as desired, running a primary casing 64 at least to the top level of the oil horizon, sealing said casing 64 to the well wall from the top of the oil horizon to a level above the top thereof, running a secondary casing 66 having an inlet opening 67 at the lower end thereof, to the vicinity of the bottom of the hole bore and below the bottom 45 of the oil horizon, packing off as at 68 the annulus between the secondary casing and the well wall face, the lower face of said packer being below the lower level of the oil horizon, filling the annulus between the secondary casing and the

well bore face above the packer 68 with an annular column 69 of cement or other sealing substance from the top surface of the packer to a level adjacent to but below the upper level 48 of the oil horizon 46, forming an open passageway through the adjacent earth formations extending from a level below the oil horizon into the bottom of the oil horizon and communicating with the borehole of the well 63 below the oil horizon, either before or after the tubing 66 is run and sealed and producing fluid oil at the surface through said secondary tubing 66. Primary tubing or casing 64 preferably has conventional T 70 at the upper end thereof with flow line 61 having valve 72 connected therewith. Secondary tubing 66 has flow line 73 with valve 74 therein attached to the upper end thereof and sealing gland 75 in the top of T 70 seals the secondary casing within the primary casing at the top thereof.

It should be noted relative Figs. 4 and 5 that T's may be inserted in the top of the secondary tubings 52 and 66 to permit the insertion of pumping strings therein if it is desired to pump oil from the secondary tubings.

The open passageways 76 from below the oil horizon preferably penetrate any fractures 77 which may have been made in the lower portion of the oil horizon to permit greater oil production. The fracture 77 in the lower portion of the oil horizon is preferably made before the secondary casing 66 is run and sealed to the well wall. The fracture 78 at the top portion of the oil horizon, if made, may be made before the secondary tubing 66 is run or thereafter as desired. If made thereafter, once the sealing column 69 has set, liquid or gaseous pressure may be applied to flow line 71 into the primary casing at fracturing pressures to create the fracture above the sealing column 69.

As set forth relative Fig. 4, the well shown in Fig. 5 may be produced under original formation pressure by shutting off valve 72 in flow line 71 on the primary casing. After all the feasible production under this method, gaseous pressure may be applied to the top portion of the oil horizon through flow line 71 after valve 72 has been opened whereby to drive any remaining fluid oil downwardly in the oil horizon to be recovered through the passageways 76 below the oil horizon. Again, all of the oil in the vicinity of the well bore 64 may be recovered.

In the completion of the well shown in Fig. 5, it is also contemplated that the well bore 64 be drilled to the top of the oil sand, the casing 64 be set and cemented as shown at 65 and then the well bore be completed to the vicinity of the bottom and necessarily below the bottom of the oil horizon by drilling or "ratholing" a well bore of lesser diameter downwardly from the bottom of the casing 64. This is conventional practice and is only set forth as a more convenient method of completing the well of the type shown in Fig. 5. Fig. 5 actually shows this modification of completion.

Referring to all of the wells shown in the five figures, it is necessary that all seals therein both above and within the oil horizon of casings and tubings be of such strength and cross-sectional area as to withstand any pressures exerted upon the sand either in original or secondary vertical drive gaseous pressurization production. The well bore seals must adhere to the well wall in the borehole to prevent any by-passing or flow of fluid or gas along the well bore face. If the seals are not properly completed, the method will fail due to the pressurization leakage.

From the foregoing it will be seen that this invention is well adapted to attain all of the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the method.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter hereinabove set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. A method of producing oil from oil horizons having at least some of the original formation pressure still resident therein comprising the steps of drilling the borehole of a production well below the bottom level of the oil horizon to be produced, running a production channel to the vicinity of the bottom of the hole bore and below the bottom of the oil horizon to be produced, sealing said production channel to the well wall to produce an annular seal from a level below the bottom of the oil horizon to a level above the top thereof, forming at least one open passageway through the earth formations extending from a level below the horizon and within the well bore upwardly into the bottom of the oil horizon, producing oil through said passageway into said well bore below the bottom of the oil horizon under the impetus of the pressure inherent in the oil horizon, and thence to the surface in said production channel.

2. A method as in claim 1 wherein the open passageway extends upwardly into the bottom of the oil horizon from the open well bore below the bottom of the production channel.

3. A method as in claim 1 wherein the open passageway extends into the bottom of the oil horizon from therebelow and penetrates the production channel and its annular seal below the bottom of the oil horizon.

4. A method as in claim 3 including the step of fracturing the oil horizon closely adjacent the bottom thereto before running the production channel therein and wherein the passageway from below the oil horizon runs into the fracture.

5. In a method of producing oil from oil horizons by vertical drive gaseous pressurization wherein gaseous pressure is applied to the top portion of an oil horizon through a pressurization channel extending at least to the top of the oil horizon in a well bore and sealed to the well bore wall at least from the top of the oil horizon to a level thereabove whereby to prevent leakage of gaseous pressurization medium thereabove, the improvement which comprises running a production channel in a well bore at least below the bottom of the oil horizon to be produced, sealing said production channel to the well wall to produce an annular seal from a level below the bottom of the oil horizon to a level at least adjacent the top thereof to prevent migration of pressurization medium through the annulus between the production channel and the well bore wall, forming at least one secondary production channel extending from the production channel well bore below the oil horizon outwardly therefrom and upwardly into the bottom of the oil horizon and producing oil from the oil horizon at least partially under the impetus of gaseous pressurization applied through a pressurization channel through said secondary channel into the well bore of the production channel below the oil horizon and then through the production channel to the surface.

6. A method as in claim 5 wherein the production channel is in a separate well bore from the pressurization channel, the production channel being sealed to its well bore wall to a level above the top of the oil horizon to be produced whereby to prevent any leakage of gaseous pressurization medium above the oil horizon as well as through it.

7. A method as in claim 5 wherein the production channel is in the same well bore as the pressurization channel and the production channel is sealed to the pressurization channel at some level along the length thereof whereby to prevent any leakage of gaseous pressurization medium above the top of the oil horizon.

8. A method as in claim 5 wherein the secondary channel extends from the open well bore of the production channel well bore into the bottom of the oil horizon.

9. A method as in claim 5 wherein the secondary channel penetrates the production channel and its annular seal below the bottom of the oil horizon to be produced.

10. A method as in claim 5 wherein the bottom portion of the oil horizon is fractured before the production channel is sealed to the well bore wall and the secondary channel extends upwardly within the oil formation to contact the fracture.

11. A method of producing oil from oil horizons having at least some fluid pressure existent within the horizon comprising the steps of drilling the borehole of a production well below the bottom level of the oil horizon to be produced, running a production channel to the vicinity of the bottom of the hole bore and below the bottom of the oil horizon to be produced, sealing said production channel to the well wall throughout the earth formations including the oil horizon to prevent any leakage of fluid pressure along the annulus between the production channel and the well bore wall either through, above or below the oil horizon to be produced, forming at least one open passageway through the earth formations extending from a level below the horizon and within the well bore upwardly into the bottom of the oil horizon, producing oil through said passageway into said well bore under the impetus of the fluid pressure within the formation and thence to the surface in said production channel.

12. A method as in claim 11 including pumping oil from said production channel when the pressure within the oil horizon being produced is not sufficient to flow oil to the surface.

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