Oct. 29, 1957 R. SPEAROW 2,811,205

WATER BASED OIL FORMATION PRODUCTION METHOD

Filed March 26, 1956 3 Sheets-Sheet 1

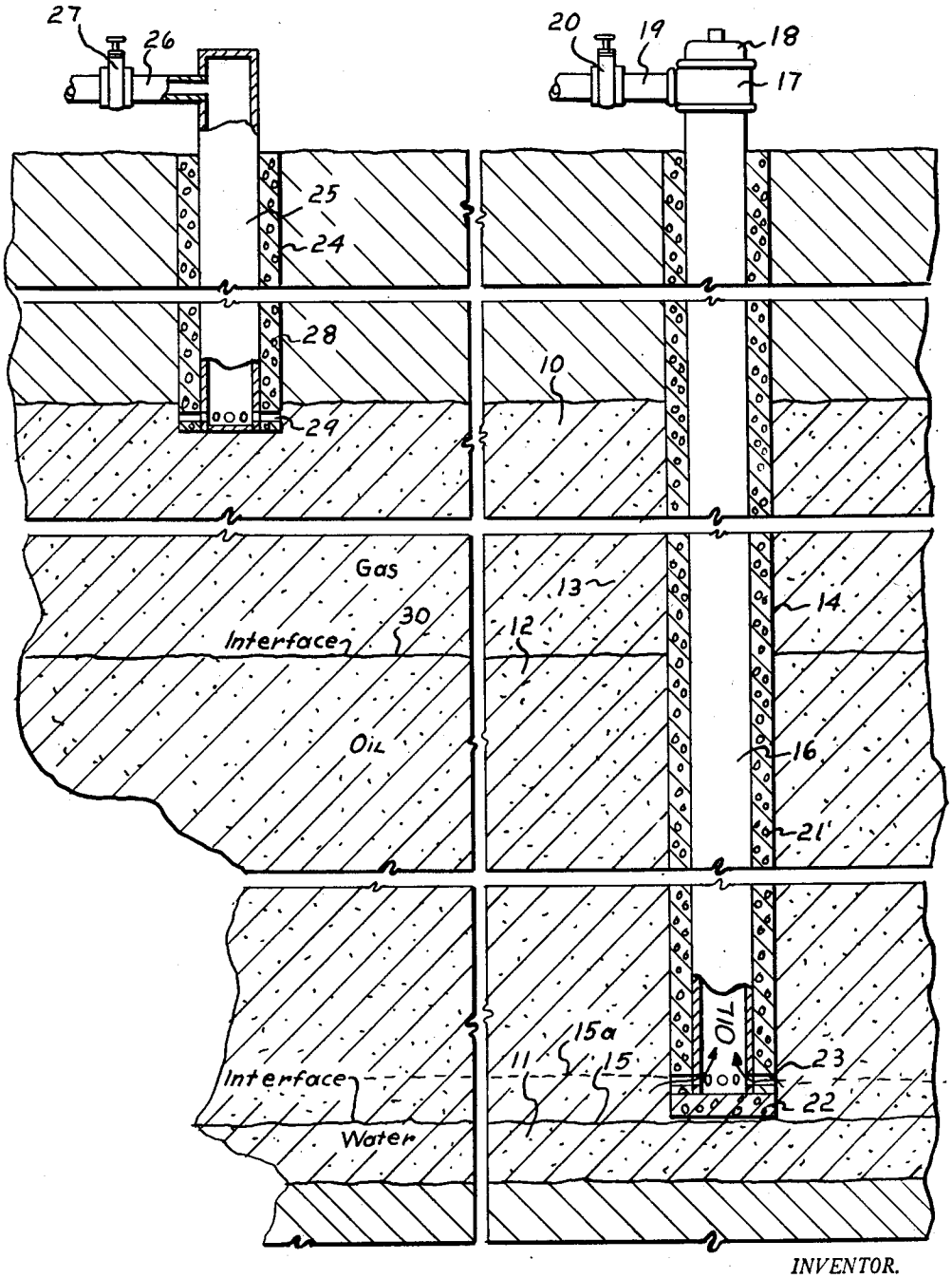


Fig. 1.

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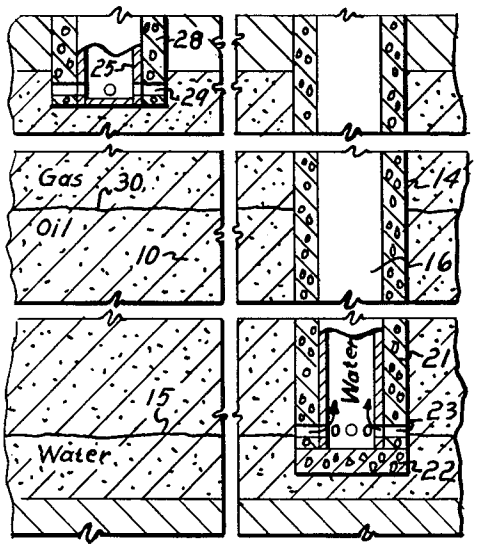


Fig. 2.

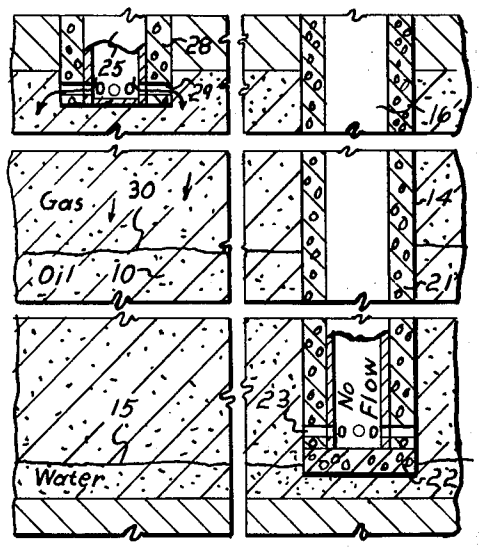


Fig. 3.

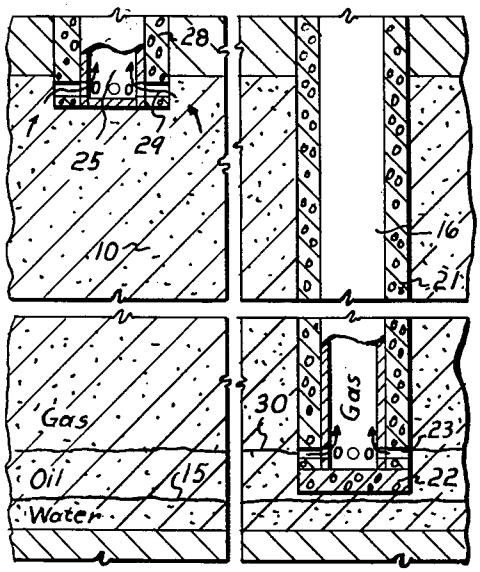


Fig. 4.

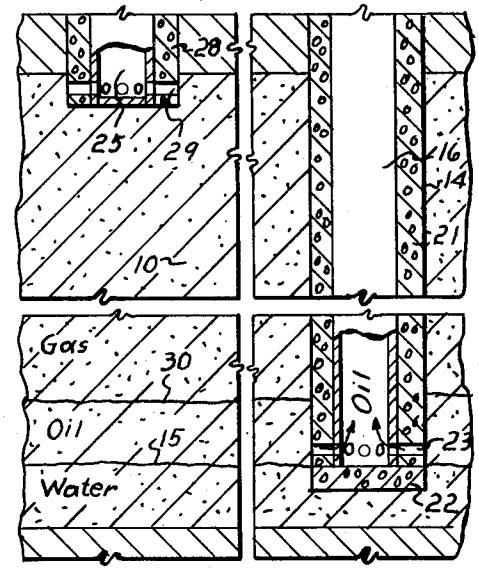


Fig. 5.

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WATER BASED OIL FORMATION PRODUCTION METHOD

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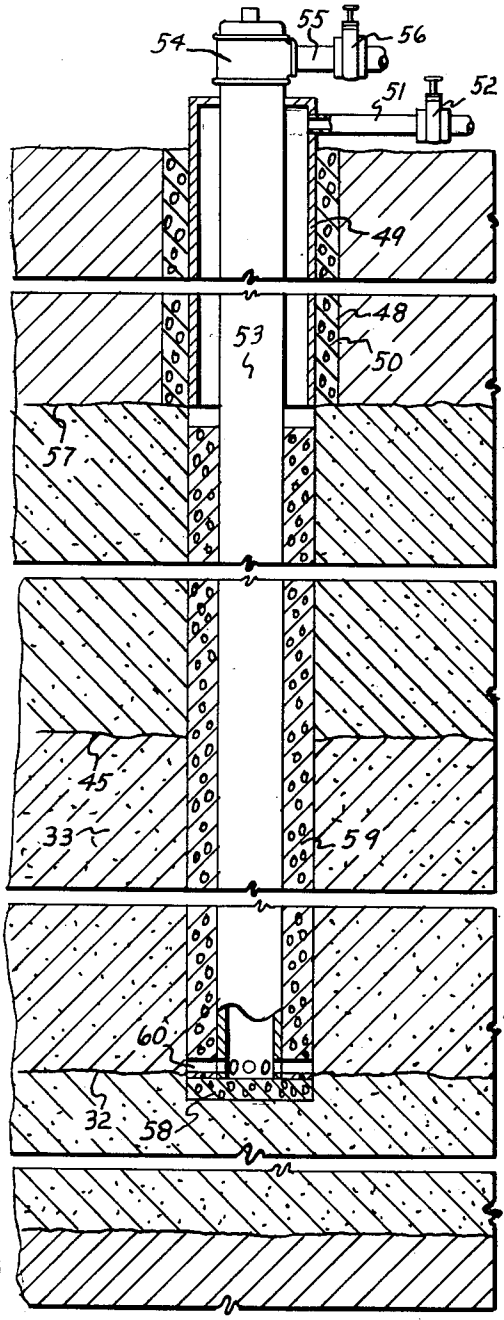


Fig. 7

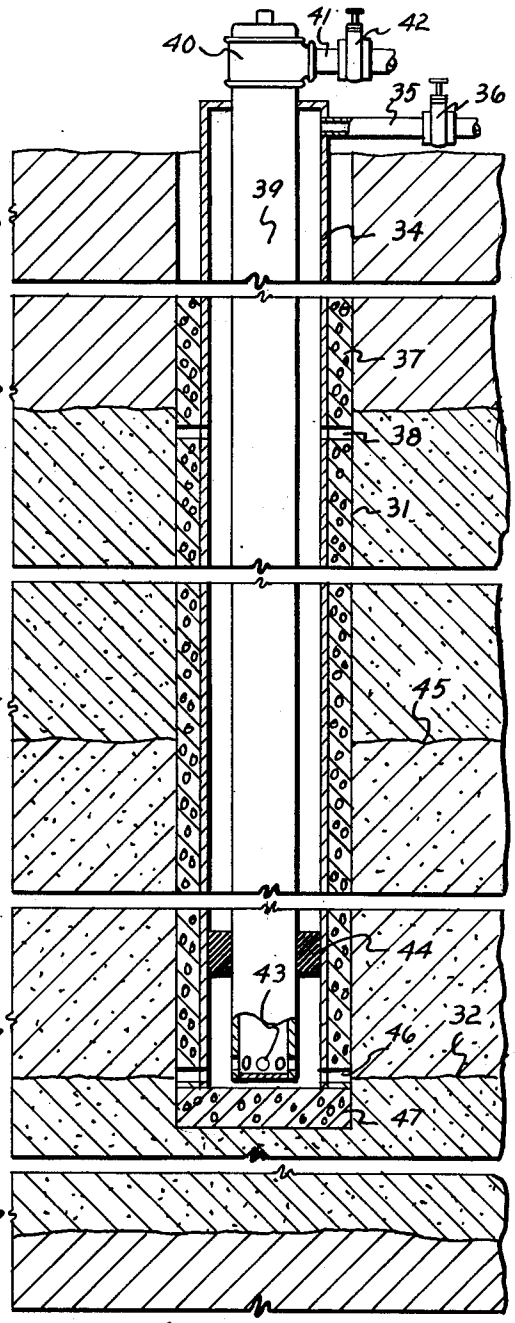


Fig. 6

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WATER BASED OIL FORMATION PRODUCTION METHOD

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Application March 26, 1956, Serial No. 573,907

7 Claims. (Cl. 166—10)

This invention relates to a method of producing oil from oil horizons or sands having a water layer in the lower portion thereof or aquifer and refers more particularly to such a production method employing vertical drive gaseous pressurization wherein substantially all of the oil in the horizon may be produced therefrom with total absence or the minimum accompaniment of water.

Production of oil from an oil sand or horizon having a water sand in the lower level thereof (aquifer) has always created problems. In original production with conventional well completion methods, any production of water with the oil requires expensive separation processes and equipment at the surface due to mixing from borehole turbulence. Great care is thus exercised in such oil completions to seal off water sands and layers in the oil horizon from the production areas in the well.

The term "aquifer" is herewith so defined so as to mean in this specification a water layer or water sand in the lower portion of an oil sand or oil horizon.

In a vertical gaseous pressurization method such as is shown in my United States Patent No. 2,593,497, entitled "Method and Apparatus for Producing Oil Wells," issued April 22, 1952, and my later United States Patent No. 2,725,106, entitled "Oil Production," issued November 29, 1955, an oil production method is disclosed wherein gaseous pressure is applied to the top of an oil horizon and fluid oil recovered from the bottom level thereof. It is desirable in such a method to complete the pressurization area in the top portion of the horizon as close to said top portion as possible and the oil production area in the lower portion of the horizon as close to the bottom portion thereof as possible to obtain essentially all of the oil from the oil sand or horizon.

It is most desirable to apply such a vertical drive gaseous pressurization method to oil production from water based oil sands in both original and secondary production. However, in seeking to apply such a method so as to obtain substantially all of the oil from the formation, a number of problems arise.

It is well known that water in very great volume is somewhat compressible. Additionally, in many oil sands or horizons, the aquifer is not shut off and is free to migrate through the oil sand against its oil formation hydrostatic head upon disturbance of the pressure equiliriums in the horizon. These and other considerations make it very difficult to define the position of the water-oil interface at the top of the aquifer after vertical drive gaseous pressurization has been put into effect. Furthermore, it is obvious that production of oil from the oil horizon above the aquifer will permit the water-oil interface to rise in the horizon. Thus, the key problem in the application of such a vertical drive gaseous pressurization method to water based oil sands is where to locate the oil production area in the oil formation to avoid water production and yet produce essentially all of the oil from the horizon.

Therefore, an object of the instant invention is to provide a method of producing oil uncontaminated with water from oil horizons having an aquifer or water layer in the lower portions thereof in either original or secondary production.

Another object of the invention is to provide a method of producing oil uncontaminated with water from oil horizons having an aquifer or water layer in the lower portion thereof, said method utilizing vertical drive gaseous pressurization of the top portion of the formation to produce the oil from a lower level thereof in either original or secondary production.

Another object of the invention is to provide a method of producing oil from water based oil formations which is usable either in oil horizons where the water-oil interface at the top of the aquifer has been undisturbed by previous production from the horizon or those horizons in which displacement of such interface has taken place.

Another object of the invention is to provide a method of producing oil from water based oil formations which involves moving the water-oil interface at the top of the aquifer downwardly (and upwardly if necessary) under vertical drive gaseous pressurization, such method yet effective to permit a minimum amount of trapping of water in oil if the interface is moved downwardly or oil in water if the interface is moved upwardly.

Another object of the invention is to provide a method of producing oil from water based oil sands utilizing a vertical drive gaseous pressurization of the top portion of the formation, which method is utilizable either in separate or combined pressurization and production wells.

Another object of the invention is to provide a method of producing oil from water based oil sands or oil sands having an aquifer therein wherein essentially all of the oil may be produced from the oil horizon uncontaminated with water.

Still another object of the invention is to provide a method of producing oil from oil sands having an aquifer therein wherein fracturing of the oil horizon and well wall face may be employed to increase the productivity of oil therein yet without increasing water contamination of the oil produced therefrom.

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 invention and are to be read in conjunction therewith, embodiments of the invention are shown and, in the various views like numerals are employed to indicate like parts.

Fig. 1 is a cross-sectional view through an earth formation having an oil horizon therein with an aquifer or water layer in the lower portion thereof, two wells being shown in the figure, the left well being solely a pressurization well and the right well being solely a production well. The view in Fig. 1 shows an intermediate step in the inventive method wherein oil production is taking place from the production well.

Fig. 2 is a partial cross-sectional view through an earth formation having an oil horizon therein with an aquifer in the lower portion thereof. Two wells are shown in the figure, the left well being purely a pressurization well and the right well being purely a production well. Fig. 2 illustrates a stage in the operation of the method later than that of Fig. 1.

Fig. 3 is a view through the same oil horizon as that of Fig. 2 showing a later stage in the operation of the method than that shown in Fig. 2.

Fig. 4 is another cross-sectional view through the oil horizon of Fig. 2 showing yet a later stage in the operation of the method than that of Fig. 3.

Fig. 5 is still another cross-sectional view through the earth formation of Fig. 2 illustrating a later stage in the operation of the method than that shown in Fig. 4.

Fig. 6 is a cross-sectional view through an earth formation having an oil horizon therein with an aquifer or

water layer in the lower portion thereof, the single well being a combined pressurization and production well.

Fig. 7 is a view similar to that of Fig. 6 in a like water based oil horizon, the well being like that of Fig. 6 but completed differently.

The inventive method as applied in the well completions shown in Figs. 1 through 5, illustrating separate pressurization and production wells, is as follows:

In an earth formation having an oil horizon **10** therein and a water layer **11** in the lower level thereof topped by an oil layer **12** and possibly a gas layer **13**, the borehole **14** of an oil well is drilled to a level below the top of the water-oil interface **15** in the horizon **10**. If the oil horizon has been undisturbed by previous production, the well is drilled through the sand and the position of the oil-water interface is determined therein by coring and the borehole **14** drilled therebelow. If the oil sand or horizon has had previous production therefrom, then probably the water-oil interface will have risen in the horizon and the original interface level in the horizon will have to be determined from previously obtained well log data. In this latter instance, the well is drilled below the level of the original oil-water interface even though such may have risen in the sand due to previous production therefrom. Casing **16**, having conventional T **17** at the upper end thereof with plug **18** and flow line **19** with valve **20** therein is then run to the vicinity of the bottom of the hole bore **14** and below the oil-water interface as previously determined. Casing **16** is then sealed to the well from the bottom of the borehole to a level above the top of the oil horizon by an annular sealing column of cement or other sealing substance **21** whereby to seal off said casing from a level below the lower end thereof to a level above the horizon from access to the hole bore. Plug **22**, below said casing **16**, may be formed of cement or any conventional packing means provided that the lower end of the casing is also sealed off from access to the horizon. Gaseous pressure, such as air or inert gases is then applied to the top portion of the oil horizon whereby to lower said oil-water interface **15** in said horizon. After said oil-water interface has been lowered in said horizon an appreciable distance below the original position thereof, the casing and its surrounding annular seal **21** is perforated at a level adjacent the original position of the oil-water interface in the horizon and, of course, below the top of said oil horizon and oil is produced through said perforations **23** and casing. Fig. 1 shows this stage of the proceedings or process wherein the production casing **16** was run within borehole **14** below the original oil-water interface in the horizon **15***a*, the casing **16** sealed as described and then pressurization applied to the top portion of the oil horizon to lower the oil-water interface below its original level in the horizon and then the casing **16** and its surrounding annular seal **21** perforated at the original oil-water interface to permit the influx of oil thereinto for production at the surface through flow line **19**, the valve **20** being open.

To the left in Fig. 1 is shown the means for applying gaseous pressurization to the top level of the oil horizon comprising drilling the borehole **24** of a pressurization well into the top portion of the oil horizon **10**, running a casing **25** having a pressure flow line **26** with valve **27** therein to at least the top of the oil horizon and sealing the casing **25** to the well wall with an annular sealing column of cement or other sealing substance **28** at least from the top of the oil horizon to a level above the top of the oil horizon. The entry point of the pressurization casing into the top of the formation may be completed in a number of different ways, a single one of such ways being shown in Fig. 1 wherein the pressurization well was drilled into the top of the formation, the sealing column **28** sealed the length of the casing from a level slightly below the top of the formation to a level thereabove and the casing and its surrounding annular seal were perforated **29** to permit access into the top portion of the formation. Many other completion methods are available such as gravel packing the lower end of the pressurization casing and then sealing the top of the gravel pack and cementing thereabove or, merely drilling into the top portion of the oil horizon, running the casing thereinto and cementing to the top of the oil formation thereabove. At any rate, once the pressurization well is completed so as to have access to the top portion of the oil horizon with its well bore annulus sealed above the oil horizon, gaseous pressure may be applied to the top portion of the oil horizon through the casing and flow line **26** to move the oil-water interface in the horizon downwardly from its original position or from its present position to a level below its original determined position. The amount of pressure to be imprisoned in the gas cap is determined by the pressure required to establish reservoir equilibrium at a point greater than the reservoir pressure at date of original discovery well. The exact required pressure will be determined by (1) thickness of the oil zone, (2) original reservoir pressure. (The water-oil interface will be lowered approximately 100 feet with each 45 pounds of established pressure in excess to the original reservoir pressure.) It is obvious that the input of the gaseous pressure into the top portion of the oil horizon will form, if one does not already exist, a gas cap within the horizon which will expand outwardly and downwardly within the horizon driving the liquids therein before it. Thus, a gas-oil interface **30** will be formed which, as the pressurization continues (unless it is interrupted) and oil is produced will move downwardly through the horizon and outwardly therein until eventually it reaches the bottom of the oil horizon. However, before this stage is reached, the operation of the method in such a water based sand as is illustrated here demands certain manipulatory steps which will now be described.

It is evident, that so long as there is sufficient pressure within the oil horizon to force the oil in through the perforations **23** in the production casing **16** that oil may be produced therefrom either by permitting the horizon pressure to flow the oil to the surface or by inserting a pumping string (not shown) into the T **17** and pumping oil from the casing **16**. Having begun production of oil from the production casing **16**, the operator has two options at this stage in the process. The first is to stop the pressurization in the pressurization well or casing **25** and produce oil from the production well under the impetus of the pressure in the formation both natural (if in original production) and those applied previously to the formation. The second option is to continue the pressurization of the top portion of the formation while producing the oil through the perforations **23**.

In the first choice or option, the operator will sooner or later be forced to meet the situation which is shown in Fig. 2, wherein the water-oil interface **15** has risen in the oil horizon due to the production of fluid oil therefrom. Since there is no lead off of gas or oil from the top portion of the formation, there is little or no fluctuation of the gas-oil interface **30** within the horizon except that perhaps due to horizontal migration of the gas cap itself. Therefore, the removal of the oil in appreciable quantities from the oil horizon permits the oil-water interface to rise to a level where water is produced through the perforations **23** in the production casing **16**. When this occurs, the operator immediately closes the valve **20** in the flow line **19** or stops his pumping operation. Gaseous pressurization, then, of the top portion of the oil horizon must once more be resumed through the pressurization casing **25** to move the oil-water interface **15** once again below the perforations in the production casing **23**. Naturally, in this situation, the gas-oil interface is forced further downwardly in the horizon as may be seen in Fig. 3. When the oil-water interface **15** has been once again forced appreciably below the perforations **23**, oil production may be again resumed with the

operator having once again the option of either continuing the pressurization or stopping it until once again needed.

If the operator has originally chosen the second alternative, it is desirable for him to regulate the amount of pressurization applied to the top portion of the formation so as to maintain the interface **15** at a more or less fixed distance below the perforations **23** in the production casing **16**. If any water is produced through the production casing **16**, he knows that he is applying the gaseous pressurization at too slow a rate and, after sealing off the production casing a sufficiently long period to make sure he has moved the interface back down, production may be resumed with a readjusted pressurization rate. Some idea of what the receptivity of an oil horizon is to gaseous pressurization and the productivity of an oil horizon at certain given formation pressures may be determined by methods as shown in my application Serial No. 563,090, entitled "Method of Determining Oil Horizon Permeability, etc." filed February 2, 1956.

Eventually, whether the operator continues his pressurization or pressurizes only periodically as set forth above, both variations of the method come to the same stage in the process. At this point, sufficient gaseous pressurization medium has been forced into the oil horizon to drive the gas-oil interface **30** down to a level below the top of the perforations **23** in the production casing **16** and its surrounding annular seal **21**. At this juncture, gas will be produced in the production well and the operator must stop his pumping operation or close the valve **30** in the flow line **19**. The operator knows that there is no more fluid oil above the gas-oil interface as it has been entirely scoured from the formation by the gaseous pressurization medium. (Cross-sectional cores of oil sands operated under the vertical drive gaseous pressurization method indicate that this complete removal is a fact.) However, it was assumed that the oil-water interface **15** had been forced or was maintained substantially below the perforations **23** by the gaseous pressurization. Therefore, there should still be an appreciable quantity of oil still in the horizon between the interfaces **30** and **15**. The operator must thus manipulate the fluid oil layer within the horizon so that the perforations **23** are between the interfaces **30** and **15**. Thus, pressurization is ceased at the pressurization well and the valve **27** on flow line **26** on casing **25** is opened to permit release of gaseous pressurization medium from the top portion of the oil horizon. Upon such release, the oil layer will migrate once again upwardly through the horizon until the situation as illustrated in Fig. 5 obtains wherein the interfaces **30** and **15** lie above and below the perforations **23**, respectively. The operator may either release pressure from the pressurization casing **25** testing periodically until oil may be flowed from the production casing **16** upon which production is resumed until once again gas is produced or he may continue the release of pressure testing until water is flowed from the perforations **23**, then resume pressurization for a limited period until oil production may be resumed, the oil-water interface **15** having been driven again below the perforations **23**. It should be appreciated that appreciable time intervals are required to move the layers of gas and liquid through the horizon but, allowing for the permeability factors, the process may be accomplished. Production having been resumed after either of the suggested procedures, oil again is produced until either gas or water is produced from the perforations **23** and, in such case, pressure is applied or released from the top portion of the oil horizon to move the offending interface away from the perforations. It is evident that eventually all of the oil will have been produced and the gas-oil interface **30** and the oil-water interface will become essentially one gas-water interface. At this point, the production well **14** is through as an oil producer. All of the oil in the horizon in the substantial vicinity of this well will have been removed from the horizon. The method of my application Serial No. 432,734, filed May 27, 1954, entitled, "Water Contaminated Oil Well Production Method" might be applied at this point.

It can now be explained why it is so important to perforate the production casing **16** and its surrounding annular seal **21** at a level very closely adjacent or precisely at such level of the original water-oil interface level in the horizon. The point is that the oil-water interface was formed under fluid pressure conditions which reached an equilibrium. Over the many years the fluid migration in the horizon will have essentially reached a fairly static level, at least on human time scales. Thus, essentially all of the oil in the horizon will be in the oil level and essentially all of the water in the water level. The manipulation of the water-oil interface around its original level by the vertical gaseous pressurization creates a minimum of trapping of water in oil and oil in water, respectively, as the layers fluctuate under the pressurization. Thus, what production there is from the perforations **23** will be fluid having a minimum of contamination by the other fluid.

Pressurization values and production values must be determined for each field and may best be determined by my method as set forth in my application Serial No. 563,090 above. It is, of course, contemplated that a plurality of either pressurization or production wells or both be employed in a given field to obtain the optimum production therefrom. In such a case, the relative quantities of pressurization in the various parts of the field and production therefrom should be regulated relative the pattern of wells therein.

Figs. 5 and 6 illustrate the application of the inventive method in combined pressurization and production wells. The showings differ only in the method of well completion. The mechanics of the application of the method are the same with these wells as in the separate pressurization and production wells as described relative Figs. 1 through 5.

Referring first to Fig. 6, the inventive method as practiced in such a modification comprises the steps of drilling the borehole **31** of an oil well below the top of the original position of the water-oil interface **32** in the oil horizon **33**. A primary casing **34** having a flow line **35** with a valve **36** therein at the upper end thereof is run to the vicinity of the bottom of the hole bore and below the water-oil interface position, as above characterized. Casing **34** is then sealed to the well wall from the bottom of the hole bore and below the bottom of the casing to a level above the top of the oil horizon by an annular column of sealing substance or cement **37** whereby to seal off the casing from any access to the oil horizon. Casing **34** is then perforated **38** with its surrounding annular seal adjacent the top of the oil horizon. A secondary tubing **39** having conventional T **40** and flow line **41** with valve **42** therein attached to the upper end thereof is then run within said primary casing **34** below said perforations **38** and preferably adjacent the sealed lower end of the casing **34**. Secondary tubing **39** has at least one inlet opening **43** adjacent the lower end thereof. Secondary tubing **39** is then sealed as at **44** to the inner face of the casing **34** below the perforations **38** preferably by a packer. Fliud under pressure or a gaseous pressurization medium is then applied to the top portion of the oil horizon to lower the oil-water interface therein and, of course, any gas-oil interface **45** that may exist or be created by the pressurization therein. After the pressurization has driven the oil-water interface appreciably downwardly in the horizon below the original position of the water-oil interface in the oil horizon, the primary casing and its surrounding annular seal are perforated as at **46** above the plug **47** at a level adjacent to and preferably precisely at the original level of the oil-water inter-

face in the oil horizon. Liquid oil may be then produced through the lower perforations **46** and secondary tubing **39** to the surface. Oil may be pumped from the secondary tubing **39** if it is necessary or desired to raise the oil to the surface. The pressurization at the top portion of the oil horizon is, of course, preferably applied through flow line **35**, valve **36**, casing **34** and perforations **38**. However, if a separate pressurization well such as is shown to the left in Fig. 1 is desired to be employed, such may be used either alone or in conjunction with the combined pressurization and production well of Fig. 6 itself.

Additionally, before secondary casing or tubing **39** is run within the primary casing **34** and packed off as at **44**, the oil horizon may be pressurized through the top perforations **38** so the oil-water interface is moved downwardly as far as desired, the lower perforations **46** then made and then the secondary tubing **39** run and packed off as previously described. This is merely a question of order in the completion method.

The inventive method as applied in the modification of Fig. 7 involves first drilling the borehole of an oil well **48** into the oil horizon below the top of the original position of the water-oil interface **32** in the oil horizon **33**. A primary casing **49** is run at least to the top of the oil horizon and sealed to the well wall by an annular column **50** of sealing substance or cement from the top of the oil horizon to a level above the top thereof. Casing **49** has flow line **51** with valve **52** therein attached to the upper end thereof. Secondary casing **53** having conventional T **54** with flow line **55** and valve **56** at the upper end thereof, is then run within the primary casing **49** to the vicinity of the bottom of the hole bore and below the original position of the water-oil interface in the oil horizon. Secondary casing or tubing **53** is then sealed to the well wall from the bottom of the borehole and below the bottom of the casing to a level adjacent the top **57** of the oil horizon but below the top thereof whereby to fill the annulus between the casing **53** and the well wall from below the bottom thereof to the designated level. Thus plug **58** is formed either by packing off below the secondary casing **53** or sealing with the annular column **59** of cement or other sealing substance. Fluid under pressure is then applied to the top portion of the oil horizon to lower the oil-water interface **32** therein to a level below the original position of the water-oil interface in the oil horizon. After said interface **32** has been lowered to the desired level, the secondary casing **53** and its surrounding annular seal **59** is perforated as shown at **60** at a level adjacent the original level of the oil-water interface in the oil horizon **33**. Oil may then proceed through said lower perforations **60** and the secondary tubing **53** to the surface. Oil may be pumped from the secondary tubing **53** if desired. A plurality of wells such as are shown in Fig. 7 may be employed in a given field or wells completed as in Figs. 6 and 7 or Figs. 6, 7 and 1 in combination.

Preferably the pressure applied to the top portion of the oil horizon in the Fig. 7 modification is applied through flow line **51** in the primary casing **49** and below the cement seal **50** and above the cement seal **59**. However, a separate pressurization well as is shown to the left in Fig. 1 could be used either alone or in combination with the Fig. 7 modification. If the Fig. 7 modification is not being used for actual pressurization, the valve **52** must be kept closed.

The operation of the method in the two Figures 6 and 7 is essentially the same as described relative the Figs. 1 through 5 showings and the only difference is that the pressurization may be applied to the top of the oil formation or horizon through the perforations **38** or above the sealing column in Fig. 7 numbered **59**. Thus, the pressure may be applied intermittently or continuously as previously described. Also, when the oil-water interface rises to the perforations **46** or **60**, further pressurization must be applied to move the interface downwardly to prevent the production of water. Should the gas-oil interface **45** reach the perforations **46** or **60**, pressure must be released from the top of the formation through the flow lines **35** or **51**, thus permitting the rising of the gas-oil interface in the oil horizon. The oil layer is thus moved upwardly and downwardly relative the perforations **46** and **60**, as previously described in the modification of Figs. 1 through 5 to produce essentially all of the oil within the oil horizon.

It is obvious that this method may be applied without any modification in either original or secondary production, that is, in fields having some of the original pressure still remaining within the field or in fields in which the original pressures have been essentially exhausted. If in secondary production sufficient gaseous pressurization must be applied to the top of the sand to not only move the oil-water interface downwardly as described but to cause the oil to flow into the perforated lower portions of the production casings. In original production, the pressure already existing in the oil sand would serve to move the oil into the perforations but the additional pressurization at the top portion of the horizon serves to move the oil-water interface upwardly and downwardly as desired.

In the completion of the well shown in Fig. 7, it is also contemplated that the well bore **48** be drilled to the top of the oil sand, the casing **49** be set and cemented as shown at **50** and then the well bore be completed to the level below the original oil-water interface in the horizon by drilling or "rat-holing" a well bore of lesser diameter downwardly from the bottom of the casing **49**. This is conventional practice and is only set forth as a more convenient method of completing the well of the type shown in Fig. 7. Fig. 7 actually shows this type of completion.

Referring to all of the wells shown in the seven 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 bypassing 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 either across the face of the oil horizon or thereabove into the earth formations lying over the oil horizon. It should be noted that the invention also contemplates drilling the wells completely through the aquifer layer and the casings run therethrough and cemented as described if completions are too difficult in the aquifer. The perforations and other operations, however, would be as previously described.

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. In a method of producing oil from oil horizons having a water layer in the lower portion thereof wherein a gaseous pressurization channel communicates from the surface of the top portion of the oil horizon, the pressurization channel so sealed as to prevent any escape of gas from the pressurization input area of the oil horizon and an oil production channel communicates from the

surface to a level in the oil horizon below the top of the water layer and water-oil interface therein, the production channel sealed so as to isolate the lower portion thereof in the vicinity of the water-oil interface from any migration of horizon fluids thereto including gas input to the horizon through the pressurization channel except through the oil horizon, the improvement which comprises applying gaseous pressurization to the top portion of the oil horizon at least partially through said pressurization channel until the water-oil interface is lowered below its original position before applying said pressurization, establishing at least one communicating passageway between the production channel and the oil horizon closely adjacent the level of the water-oil interface before pressurization, producing oil through the producing channel from the lower portion of said channel whereby the oil-water interface tends to rise upwardly in the horizon, and so regulating the pressurization of the top portion of the oil horizon as to maintain the water-oil interface below the communicating passageway between the horizon and production channel.

2. A method as in claim 1 wherein the production channel is at least partly contained within the pressurization channel and the portion thereof not contained therein comprises an extension of the pressurization channel.

3. A method as in claim 1 wherein the communicating passageway is established at precisely the original oil-water interface level before pressurization.

4. A method as in claim 1 including the additional step of releasing pressure from the top portion of the formation at least partially through said pressurization channel should the gas-oil interface in the horizon pass below the level of the water-oil interface before pressurization whereby to raise said gas-oil interface above said level.

5. A method as in claim 1 applied in relatively shallow oil horizons wherein the gaseous pressurization is applied to the top portion of the oil horizon until the water-oil interface is substantially below the level thereof before pressurization but the gas-oil interface in the horizon remains above said level before pressurization.

6. In a method of producing oil from an oil horizon having a water layer in the lower portion thereof wherein a gaseous pressurization channel communicates from the surface to the top portion of the oil horizon, the pressurization channel so sealed as to prevent any escape of gas from the pressurization input area of the oil horizon and an oil production channel communicates from the surface to a level in the oil horizon below the top of the water layer and water-oil interface therein, the production channel sealed so as to isolate the lower portion thereof in the vicinity of the water-oil interface from any migration of horizon fluids thereto including gas input to the horizon through the pressurization channel, except through the oil horizon, the improvement which comprises applying gaseous pressurization to the top portion of the oil horizon at least partially through said pressurization channel until the water-oil interface is lowered below its original position before the application of said pressurization, establishing at least one communicating passageway between the production channel and the oil horizon closely adjacent the level of the water-oil interface before said pressurization, producing oil through the producing channel from the lower portion of said horizon whereby the oil-water interface tends to rise upwardly in the horizon until the water-oil interface again rises at least closely adjacent the communicating passageway, stopping production of oil through the producing channel while applying gaseous pressurization to the top of the horizon until the water-oil interface is again below the communicating passageway and then again producing oil through said producing channel.

7. In a method of producing oil from oil horizons having a water layer in the lower portion thereof, the water-oil interface in said horizon having migrated vertically within the horizon due to disturbance of the fluid equilibrium therein due to production therefrom, wherein a gaseous pressurization channel communicates from the surface to the top portion of the oil horizon, the pressurization channel so sealed as to prevent any escape of gas from the pressurization input area of the oil horizon and an oil production channel communicates from the surface to a level in the oil horizon below the original top of the water layer and water-oil interface therein as they were before any production from the horizon, the production channel sealed so as to isolate the lower portion thereof in the vicinity of the original water-oil interface from any migration of horizon fluids thereto including gas input to the horizon through the pressurization channel except through the oil horizon, the improvement which comprises applying gaseous pressurization to the top portion of the oil horizon at least partially through said pressurization channel until the water-oil interface is lowered below its original position before any production from said oil horizon and before the application of gaseous pressurization thereto, establishing at least one communicating passageway between the production channel and the oil horizon closely adjacent the level of the water-oil interface before the gaseous pressurization and any production from the oil horizon, producing oil through the producing channel from the lower portion of said horizon whereby the oil-water interface tends to rise upwardly in the horizon and so regulating the pressurization of the top portion of the oil horizon as to maintain the water-oil interface below the communicating passageway between the horizon and producing channel.

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