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 accomplishment of water.

Production of oil from a 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 heretofore 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 equilibrium 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 utilisable 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 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 thereina 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.

The inventive method as applied in the well completion 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 oil sand 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 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 15a, 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 25 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 thereabout or, merely drilling into the top portion of the oil horizon running the casing thereinto and cementing to the top of the oil formation thereabout. 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 the thickness of the oil zone, (2) original reservoir pressure. (The oil-water interface will be lowered approximately 100 feet with each 45 pounds of established pressure in excess of the gassing 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 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 25. 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-water interface 15 within the horizon except that perhaps due to horizontal migration of the oil 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 the 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 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 gas-water pressure 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, a variation of the method came to the same stage in the process. At this point, sufficient gas from the 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 gas-oil 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 may then 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 control valve is set according to the horizon up to the first sets of drill points described in Fig. 5 which obtain 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 the oil-water interface is produced from the perforations 23 and, in such cases, pressure is applied and forced 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 oil-water interface.

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 described.

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 is left 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. Fluid 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 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 in the 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 that 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 water-oil 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 on a horizon through the perforations 38 or above the sealing column 43 in Fig. 2 as desired. 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 perforations 38, 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 to be understood 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 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 bore 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 thereaboe into the gas formations lying over the oil horizon. It should be noted that the invention also involves smaller casings 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 oil horizon, a gaseous 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 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 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 horizon fluids 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 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.

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