Dec. 22, 1959 R. SPEAROW 2,918,124

METHOD OF CEMENTING UNUSABLE BOREHOLES

Filed Oct. 11, 1956 3 Sheets-Sheet 1

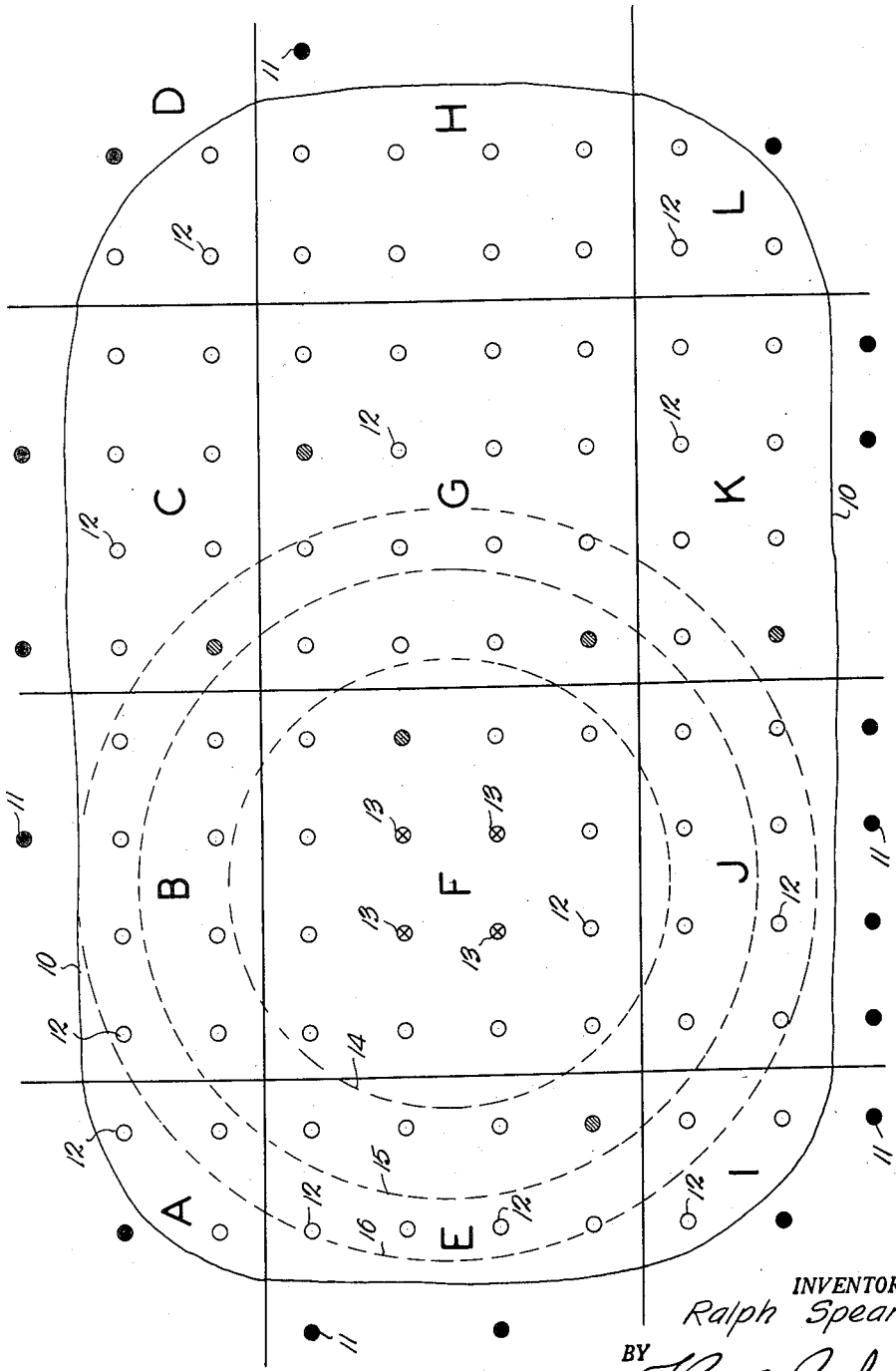


Fig. 1.

INVENTOR.
Ralph Spearow
BY
Thos E Scofield
ATTORNEY.

Dec. 22, 1959 R. SPEAROW 2,918,124

METHOD OF CEMENTING UNUSABLE BOREHOLES

Filed Oct. 11, 1956 3 Sheets-Sheet 2

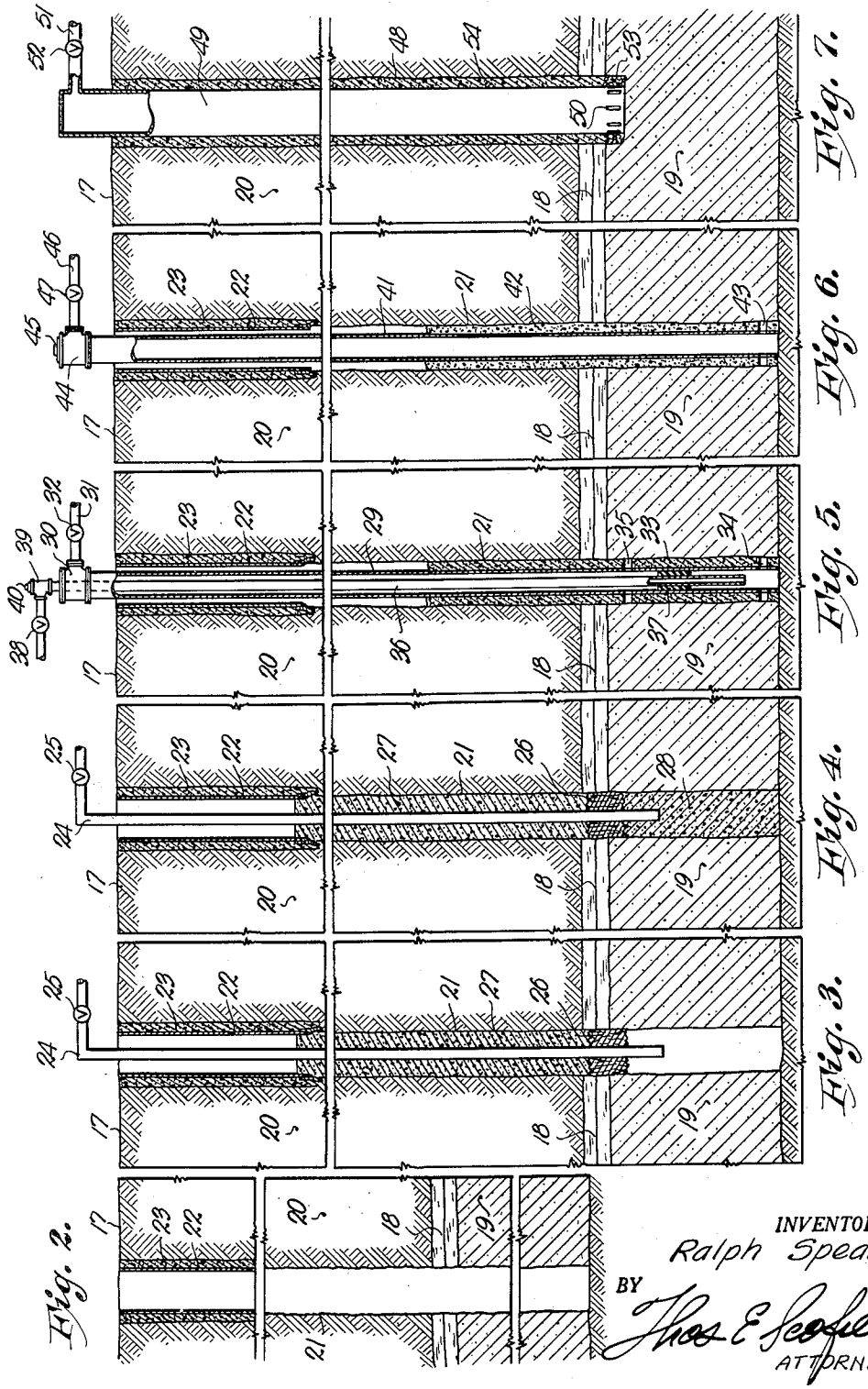


Fig. 7.

Fig. 6.

Fig. 5.

Fig. 4.

Fig. 3.

Fig. 2.

INVENTOR.
Ralph Spearow
BY
Thos E. Scofield
ATTORNEY.

Dec. 22, 1959 R. SPEAROW 2,918,124

METHOD OF CEMENTING UNUSABLE BOREHOLES

Filed Oct. 11, 1956 3 Sheets-Sheet 3

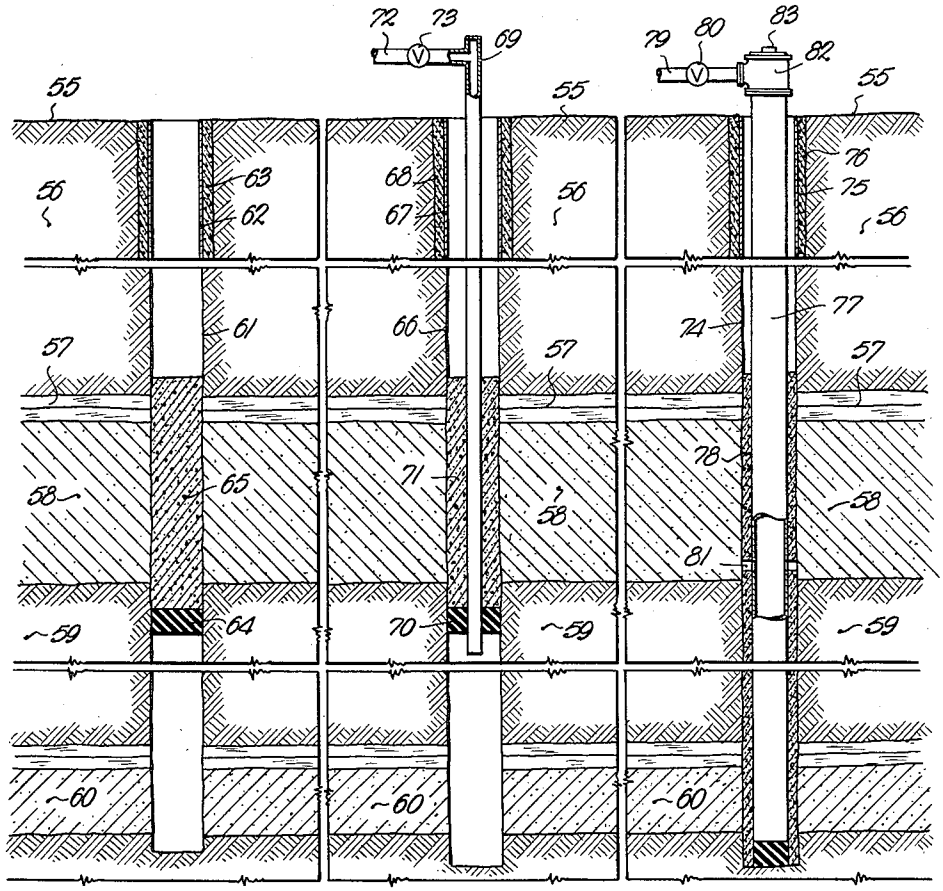


Fig. 8. Fig. 9. Fig. 10.

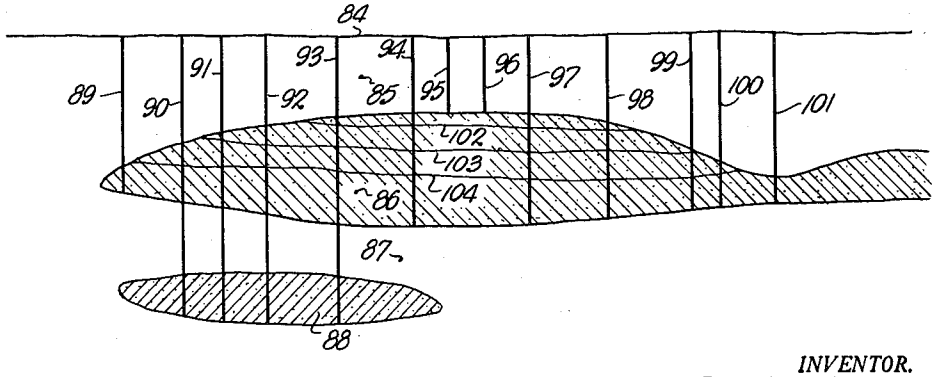


Fig. 11.

INVENTOR.
Ralph Spearow
BY
Thos E. Scofield
ATTORNEY.

United States Patent Office 2,918,124
Patented Dec. 22, 1959

2,918,124

METHOD OF CEMENTING UNUSABLE BOREHOLES

Ralph Spearow, Paola, Kans.

Application October 11, 1956, Serial No. 617,677

1 Claim. (Cl. 166—21)

This invention relates to a vertical drive gaseous pressurization method of producing oil from oil wells and refers more particularly to a method of preparing an oil field or a portion thereof for the application of the vertical drive pressurization method thereto when the oil field already has a plurality of old wells or well boreholes drilled into or through the sand to be produced with the pressurization method.

Previously, in my U.S. Patents Numbers 2,593,497 and 2,725,106, as well as in co-pending applications, I have provided methods of producing oil from oil formations or horizons by applying gaseous pressurization to the top portion of the oil horizon and recovering oil from the lower portion of the horizon under impetus of the pressurization.

It is necessary for the successful operation of the vertical drive gaseous pressurization method to seal the pressurization and/or production well casings to the well bore wall at selected positions above and through the oil horizon to be produced to prevent leakage of gaseous pressurization medium either above the oil horizon or through the oil horizon, thus preventing the production of oil therefrom. However, in such oil production methods, when the top portion of the oil formation is pressurized with gaseous pressurization medium, a gas cap is formed or the existing gas cap is added to and these gas caps expand both outwardly and downwardly, especially outwardly. In vertical drive production of fields where the original pressure found in the formation has descreased to a level making additional pressurization desirable or where the pressure has essentially been exhausted in the field, the migration of the pressurization gas cap laterally along the top of the oil horizon being pressurized eventually reaches any other old wells or boreholes in the horizon whether they are being employed in the process or not. Once the gas cap has penetrated to one of these old boreholes, if the hole is open above the sand and there is access to the borehole from the sand, the pressurization medium can completely escape into the formations above the oil horizon being pressurized or out of the borehole. Even if the borehole is sealed or blocked from the top of the sand to be pressurized to a level thereabove which is not usually the case, the expansion of the gas cap to include the old borehole will permit the pressurization medium to fill the hole bore within the oil horizon and then by-pass to any area of least resistance within the horizon, thus defeating the desired gradual and unitary moving of the gas cap down through the formation. If the borehole goes below the sand, the pressurization medium or liquid driven thereby can be lost to lower formations or horizons. Just a few of these unsealed well bores in a field can seriously bleed off the applied pressurization to the field and greatly reduce the productive potential thereof as well as add to the expense of pressurization.

The extent of lateral migration of the gas cap under application of gaseous pressurization to the top of an oil sand is amazing to those who have not actually been

in contact with the method. When the pressurizaiton wells are sealed above the horizon so there can be no escape of pressurization medium above the horizon through the pressurization wells, the gas cap will spread circumferentially miles from the pressurization input under relatively low pressurization levels. This fact makes the vertical drive gaseous pressurization method one readily adaptable to the production of very large areas from a limited pressurization zone. Indeed, the application of such pressurization in any given field cuts across leasing zones and land rights indiscriminately and requires individuals producing wells conventionally under the pump or the like to complete their wells or seal them, as will be described, to avoid ruining their own wells. In many instances also, old forgotten wells may presently be positioned in city limits, farm yards, or even residential areas which may be affected by the migration of the gas cap and contaminate the surface of the ground with old well fluids, gas and perhaps even some oil carried up with the expelling gas.

Therefore, an object of the present invention is to provide a method of preparing previously produced oil fields for the application thereto of a vertical drive gaseous pressurization method, which method will conserve the maximum amount of pressurization within the formation to produce the oil and avoid all difficulties accompanying the leaving of open well bores in a field under vertical drive gaseous pressurization.

Another object of the invention is to provide a method of preparing an oil field for gaseous pressurization wherein the oil horizon to be produced has old wells or boreholes extending into or through the horizon, the location and number of the old wells being unknown.

Another object of the invention is to provide a method of preparing a field for gaseous drive vertical pressurization thereof, the field having boreholes extending through or into the horizon to be produced, the method avoiding any loss of gaseous pressurization medium into any of the earth formations or at the surface and, as well, avoiding any possibility of channeling of the gaseous pressurization medium through the formation at points of lower resistance below the top portion of the oil horizon.

Another object of the invention is to provide a method of preparing an oil field for vertical drive gaseous pressurization wherein the horizon to be produced has boreholes or old wells extending into or below it, the method conserving the maximum amount of pressurization medium and avoiding difficulties due to loss of pressurization medium into the earth formations or at the surface and, as well, permitting the exploitation of the field in the most efficient manner possible by using the old boreholes for pressurization or production wells or pressurization and production wells or merely sealing off the old wells.

Another object of the invention is to provide a method of preparing an oil field for application of vertical drive gaseous pressurization, the method giving as complete control of the expanding gas cap produced by the gaseous pressurization to the operator as possible.

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

Fig. 1 is a plan view schematically indicated of an oil field, a grid being superimposed upon the outline of the field to indicate the leasing rights, and producing wells, dry holes and pressurization input points being indicated in the field.

The figures on the second sheet of drawings are in-

tended to be taken through the same earth formation having a single oil horizon to be produced therein. Therefore, the earth formation structures will be numbered alike.

Fig. 2 is a cross-sectional view through the earth formation showing an old borehole extending through the oil horizon, the borehole merely having surface casing set therein.

Fig. 3 is a cross-sectional view through the same earth formation showing the well of Fig. 2 at an intermediate stage of sealing the borehole off.

Fig. 4 is a view of the well of Figs. 2 and 3 at a later stage in the process of sealing off the borehole.

Fig. 5 is a cross-sectional view through the same earth formation showing an old borehole extending through the oil horizon having been recompleted as a combined pressurization and production well.

Fig. 6 is a cross section through the same earth formation showing an old borehole penetrating the oil horizon to be produced, the borehole having been recompleted as a production well.

Fig. 7 is a cross-sectional view through the same earth formation showing a new pressurization well completed into the top portion of the oil horizon to be produced.

The upper three figures on the third sheet of drawings are intended to be taken through the same earth formation having a single oil horizon to be produced therein and a permeable formation below this oil horizon. Therefore, the earth formations will be numbered alike in the various figures.

Fig. 8 is a cross-sectional view through an earth formation showing a well bore extending through the oil horizon to be produced and the permeable formation therebelow, the well bore sealed completely across the oil horizon.

Fig. 9 is a cross-sectional view through the same earth formation as Fig. 8 showing a like well bore extending through the oil horizon and permeable formation, a different method of sealing the oil horizon through the entire depth thereof being shown.

Fig. 10 is a cross-sectional view through the same earth formation and the two preceding figures with a different method of sealing off the borehole across the entire oil horizon being shown, the well being completed as a production well.

Fig. 11 is a cross-sectional view through an earth formation showing two oil sands positioned therein with the smaller positioned below the larger. A plurality of wells are shown extending to and into the two oil sands within the earth formations, the showing being entirely schematic.

Referring to Fig. 1, therein is shown a schematic plan view of an oil field the peripheral boundary of which is indicated at **10**. Dry holes **11** surround the field and indicate its limits. Producing wells are indicated within the field by the numerals **12**. The grid lines show the lease arrangement with the different leaseholds indicated by the capital letters A—L. The operator of the leasehold "F" has decided to pressurize his lease to obtain greater production therefrom and to obtain the advantages of vertical drive gaseous pressurization. Such a decision is usually taken when the original pressure on the field is relatively low, the pressure of the field has been lowered below the desired production level or the pressurization medium naturally found in the horizon has been substantially exhausted. Sixteen wells are shown in the leasehold "F" and the operator has selected the four central wells **13** indicated by an X for input pressurization wells to the top of the sand. Circumferential to the four pressurization wells at **14**, **15** and **16**, are shown dotted circles indicating the spread of pressurization medium within the oil field **10**.

Referring to the second sheet of drawings, all of the wells shown on this sheet in Figs. 2–7, are intended to be shown in the same earth formation and, therefore, the various parts of the earth formation are numbered alike. Fig. 2 is shortened a little for the convenience of the drawing but represents the same earth formation. At **17** is shown the ground level, at **18** the rock formations above the producing horizon **19** which seal off the top portion of the horizon and at **20** the earth formations lying thereabove to the surface.

Referring to Fig. 2, therein is shown a well conventionally completed for production from the oil horizon **19**. Borehole **21** is drilled through the oil horizon **19** and surface casing **22** is set adjacent the surface and cemented as at **23**. It is understood that any conventional type of well completion is intended to be indicated here. Permeable sands may be encountered in the earth formation **20** above the oil horizon **19** and cemented or sealed off by casing and cement. The well may be produced by natural pressure within the horizon **19** as long as possible and then pumped as desired. If the well is still producing, there is generally a bradenhead on top of the surface casing **22** to control the flow of gas and liquid from the horizon **19**. If there are permeable sands in the earth formation **20**, the well bore may be sealed all the way to the top of the sand **19**. The completion shown in Fig. 2 is a very common completion found in old abandoned wells in depleted fields. Such a well bore may be partly filled with debris and the top end of the hole covered over.

Figs. 3–6 show three ways of recompleting the old well shown in Fig. 2 so the field may be adequately prepared for the application of a gaseous pressurization vertical drive method to the field. Figs. 3–4 show two stages in a process of sealing off the entire well bore through the sand whereby to prevent any migration of well fluids or pressurization medium either downwardly or upwardly along the borehole. Fig. 5 is the well bore of Fig. 2 recompleted as a combined pressurization and production well and Fig. 6 is the well bore of Fig. 2 recompleted as solely a production well. In all these figures, it is assumed that the same well bore is present and, therefore, the well bore and the original surface casing will be numbered the same. It should be pointed out that there are three eventualities that must be taken care of in preparing an old well borehole for use in a vertical drive gaseous pressurization oil field. The first is that the borehole above the oil horizon must be sealed so that gaseous pressurization medium or well fluids cannot escape into the earth formation above the horizon. The second is that the borehole must be sealed through the horizon to prevent migration of gaseous pressurization medium down the borehole when the expanding gas cap reaches the borehole. The third is that, if the borehole extends through the horizon and therebelow, the borehole must be sealed below the oil horizon to prevent loss of fluids or produced oil into the earth formations below the horizon.

Referring to Fig. 3, therein is shown a conventional well bore **21** having originally been completed with surface casing **22** and cemented as shown at **23**. The well bore is first cleaned out and then tubing **24** having valve **25** in the upper end thereof is run within the well bore to a level below the top of the oil horizon **19**. The tubing **24** is packed off at the top of horizon **19** by suitable packing means such as conventional rag packer **26**. The hole bore or annulus between the tubing **24** and well bore wall **21** is filled with an annular column of cement or other sealing substance as shown at **27** from the top of the packer **26** to a level above the top thereof, preferably to a level at least slightly above the lower end of the casing **22**. If there is any existing pressure on the sand, either from the original pressure inherent therein, the original pressure inherent therein plus applied artificial pressurization thereto or from the artificial pressurization alone, the valve **25** is opened on tubing **24** while the cement column **27** sets whereby to permit escape of pressure below the packer **26**. Fig. 4 shows

the second stage of the recompletion of the old borehole 21 after the cement column 27 has set. When the column 27 has set, the packer 26 and the column 27 serve as an anchor against any pressure within the formation and additional cement 28 may be forced through the tubing 25 to fill the well bore below the packer 26 from the bottom of the borehole to the bottom of the packer 26. When the borehole below the packer 26 has been filled with cement, the valve 25 is closed to prevent any pressurization medium within the formation bubbling through the cement into the tubing 24 and the cement column 28 is allowed to set. Once it is set, it is immaterial whether or not the valve 25 is open or closed. In this manner, the entire horizon is sealed off to prevent any escape of the pressurization medium which may be applied to the top of the formation 19. This well completion method is applicable in boreholes which extend below the oil horizon 19 but a little way. If the borehole extends very far below the horizon 19, an excess amount of cement below the packer 26 would be required.

Fig. 5 shows the recompletion of the borehole 21 as a combined pressurization and production well. As in Figs. 3-4, the borehole 21 is cleaned out and permeability tests may be made to determine whether or not the borehole should be employed in the production of the field if it can be adequately cleaned out and prepared. If it is ascertained that the latter is the case, primary casing 29 is run to the bottom of the borehole 21 which in this instance runs to the bottom of the horizon 19. The type of completion shown in this figure is not feasible in an old well if the borehole does not extend at least closely to the vicinity of the bottom of the oil horizon. Casing 29 has conventional T 30 at the upper end thereof with flow line 31 having valve 32 therein extending out of one side thereof. Casing 29 is cemented from the bottom of the casing and the borehole to a level above the top of the oil horizon by an annular column of cement or other sealing substance as shown at 33. The casing and the surrounding annular seal are perforated adjacent the bottom of the oil horizon 19 as shown at 34 and adjacent the top of the oil horizon as shown at 35. Tubing 36 is then run within casing 29 to a level below the perforation 35 and sealed to the inside surface of casing 29 below the upper perforations and above the lower perforations by sealing means such as packer 37. The tubing 36 is sealed into the T 30 to prevent any escape of fluids at the top of the T 30. Tubing 36 has valve 38 in the upper end thereof. To apply gaseous pressurization medium to the top portion of the oil horizon 19, valve 32 is opened and the gas forced into flow line 31 passing into the annulus between casing 29 and tubing 36 and out perforations 35 into the top portion of the oil horizon. Oil driven downwardly within the formation by application of gaseous pressurization thereto may be produced through the perforations 34 into tubing 36 and out of the top thereof if valve 38 is open. Oil may be pumped from the tubing 36 if desired by insertion of a pumping string in T 39 at the upper end thereof presently sealed by plug 40. It is evident that oil may be only produced from the well by sealing valve 32 in flow line 31 or the horizon may only be pressurized if desired through perforations 35 by sealing valve 38 in flow line 36. A completion as shown in Fig. 5 would be operable in the well shown at 13 in Fig. 1. In such a completion, the formation may be both pressurized and produced at the same point in the field, thus obtaining the maximum amount of oil therefrom.

In Fig. 6 is shown the well bore 21 completed solely as a production well which may be the case if the well bore 21 is not centrally or strategically located in the field for presseurization or if it is not needed for pressurization of the field. In this case, after the well bore 21 has been cleaned out, permeability tests may be run on the sand to determine whether it is worth completing for either pressurization or production. Another reason for not completing such a well as the pressurization well would be if extremely low permeability were found adjacent the top portion of the sand. Casing 41 is run within the borehole to the bottom thereof and sealed from the bottom of the casing and well bore to a level above the top of the oil horizon 19 by an annular column 42 of cement or other sealing substance. For a well to be completed as a production well, it is necessary that the borehole thereof extend closely adjacent the bottom of the horizon 19 to be pressurized. The casing 41 and the surrounding annular seal 42 are then perforated as at 43. In the completions of Fig. 5 and Fig. 6, if desired, the casings 29 or 41 may be run merely adjacent the bottom of the oil horizon and hole bore 21 and then sealed from the bottom of the casing to a level above the top of the oil horizon leaving a small unsealed space adjacent the bottom of the horizon. This is practicable only if the well bore does not extend below the horizon into permeable formations. The completion previously described is preferable. Casing 41 has conventional T 44 at the upper end thereof with plug 45 sealing the top thereof and flow line 46 having valve 47 extending from one side thereof. With the well completed as in Fig. 6, application of gaseous pressurization medium to the top portion of the oil horizon 19 will force the oil therein to migrate downwardly therein and some of the oil may be produced through the perforations 43. The annular column of cement 42 prevents escape of gaseous pressurization medium above the formation 19 along the well bore wall and the sealing of the column down to the perforations 43 prevents migration of the pressurization medium down the well bore wall. A pumping string may be inserted in the T 44 to pump oil from the casing 41 if desired.

In Fig. 7 is shown a pressurization well applicable to apply gaseous pressurization medium to the top portion of the oil sand 19. This pressurization well may be a new well drilled into the top of the oil sand 19 or it may be a recompletion of an old well which merely penetrated the topmost portion of the horizon 19. At any rate, well bore 48 extends at least to the top of the oil horizon 19 and preferably slightly thereinto. Pressurization casing 49 having an open lower end or perforations 50 therein extends at least to the top of the oil horizon 19 and preferably slightly thereinto. Casing 49 has flow line 50 at the upper end thereof having valve 51 therein. The casing 49 in the region of the perforations 50 may be gravel packed as at 53 with an annular column 54 of cement or other sealing substance extending from the top of the gravel packed layer and the top of the oil formation 19 to a level above the top thereof. Gaseous pressurization medium forced into flow line 51 with valve 52 open will be applied to the topmost portion of the oil horizon 19. The pressurization area should be limited to as close to the top of the oil horizon 19 as possible to avoid channeling through areas of low permeability, thus trapping some of the oil above the pressurization medium gas cap.

Figs. 8–10 are shown as old well bores completed within the same earth formation and therefore the parts of the earth formation will be numbered alike in the various views. At 55 is the ground level, 56 indicates the earth formations above the oil horizon, 57 the cap formations above the oil horizon, and 58 the oil horizon itself. 59 indicates the earth formations below the oil horizon to be produced or pressurized and 60 indicates a permeable strata below the oil horizon 58. In Fig. 8, borehole 61 extends below the oil horizon 58 and the permeable strata 60. The borehole may extend to lower oil horizons or any other depth below the strata 60. It is desired to pressurize horizon 58. Surface casing 62 has been run and cemented as at 63. On cleaning out the well bore, it is determined that it is not desirable to complete the well bore 61 either as a pressurization or production well. Therefore, a bridge 64 is run to a

level below the oil horizon 58 and set. A column of cement or other suitable sealing substance is filled in above the bridge 64 to a level above the top of the oil horizon 58. The column is shown at 65. When any pressurization medium moving across the top part of the formation 58 reaches the borehole 61, it can move neither upwardly nor downwardly due to the sealing column 65. Any liquid within the formation moving downwardly therein cannot move below the horizon 58 in the well bore 61 because of the column 65 extending therebelow and the bridge 64.

Fig. 9 shows a well bore 66 extending below the earth formation 58 to be pressurized and the permeable strata 60. Surface casing 67 has been run and cemented as at 68. Tubing 69, on determination that it is not desirable to produce the oil horizon 58 or pressurize it in the well bore 66, is run below the horizon 58 and sealed to the well wall as at 70 by a packer. A column of cement is filled in the annulus between the tubing 69 and the well bore wall 66 from a level on top of the packer 70 to a level above the top of the oil horizon as shown at 71. Tubing 69 has flow line 72 with valve 73 therein. While the annular column 71 of cement seals any pressurization medium or well liquids from escaping either upwardly or downwardly in the well bore 66, the tubing 69 permits withdrawal of anything from below the formation 58, either liquids or gas such as gas from a gas sand below the oil sand 58.

In Fig. 10, borehole 74 extends through and below the oil sand 58 and the permeable strata 60. Surface casing 75 has been run and sealed to the well bore wall as at 76. Casing 77 is run to a level below the permeable strata 60 and cemented to the well wall from a level below the permeable strata 60 to a level above the oil horizon 58 by annular column 78 of cement or other sealing substance. Flow line 79 on casing 77 has valve 80 therein. The lower end of the casing 77 is open or sealed as desired, depending upon whether or not any gas or other fluid from a level below the permeable strata 60 is desired within the casing 77. The casing 77 and its surrounding annular seal may be perforated as at 81 to produce oil from the bottom of horizon 58 if desired and in this instance, the lower end of casing 77 must be sealed. Conventional T 82 atop casing 77 is sealed by plug 83 which may be removed to permit insertion of a pumping string if desired. The casing 77 and its surrounding annular seal may be perforated at any level opposite permeable strata 60 should such be desired as well. Should the distance between horizon 58 and strata 60 be excessive, the casing 77 should be sealed off below the perforations 81 to avoid the oil passing into the sump below the perforations.

Thus, the well completions of Figs. 8–10 illustrate the method as applied in completing wells which extend below the horizon to be pressurized, thus preventing flow of liquid from the horizon below the horizon as well as movement of fluid above the horizon due to the pressurization. All cement and casing seals in both completely sealed wells, pressurization wells, production wells or pressurization and production wells must be of sufficient strength to secure whatever pressures are employed in driving the fluid and gaseous hydrocarbons down through the sand body and must offer no means of escape for those pressures except at the points designated within the oil sand.

Fig. 11 is a schematic view of an earth formation containing an oil horizon with wells drilled into the horizon showing the problems encountered in the vertical drive pressurization method which this invention is designed to solve. In Fig. 11, 84 indicates the ground level, 85 the earth formations above the first oil formation, 86 the upper oil formation, 87 the earth formations between the upper oil horizon and the lower horizon and 88 the lower oil horizon. A plurality of wells are shown drilled to, into or through the two horizons. It is well known that oil sands differ in their cross-sectional form. The oil horizon 86 is shown as essentially a lens-shaped horizon with a central dip at the right side thereof which enlarges again into a formation of the original thickness. The second oil formation 88 is shown as a simple lens-shaped sand body. Wells 89, 94, 97, 98, 99 and 101 are shown as drilled through the top oil sand to the bottom thereof. Wells 90, 91, 92 and 93 are drilled through the top sand and through the lower sand 88 to the bottom thereof. Wells 95 and 96 are pressurization wells to apply gaseous pressurization to the top of the oil horizon 86. At 102 is shown either the original gas cap in the formation or a first level of the gas cap produced by applied gaseous pressurization medium to the top of formation 86. 103 indicates a second level of the gas cap after prolonged pressurization of the formation and 104 indicates a third level.

Referring to Fig. 11, it will be observed that only wells 93, 94, 97 and 98 either contact the original gas cap or are reached by the initial level of pressurization shown at 102. Therefore, only these wells would need to be sealed off as in Figs 4–6 or 8–10 to avoid leakage of gaseous pressurization medium into the well bores. Wells 94, 97 and 98 could be completed as Figs. 4–6 because they do not extend below the horizon 86. It would be necessary to complete well 93 as in Figs. 8–10 to prevent the movement of liquid into the borehole 93 below the horizon 86. It should also be noted, that if new pressurization creates the gas cap level as shown at 102, oil may be driven into the boreholes of the wells not contacted by the gas cap so wells extending below the horizon such as 90—93 may have to be sealed as in Figs. 8–10 to avoid loss of oil into the lower formations. Further pressurization through the pressurization wells 95 and 96 lowers the level to 103. This level includes new wells 92 and 99 as well as those previously listed. Peripheral wells not yet reached by the gas cap may require sealing below the formation if they extend therebelow as previously noted. Further pressurization as shown at 104 includes wells 90, 91 and 100. Further pressurization will eventually include wells 89 and 101. It should also be obvious that any wells in the right hand portion of horizon 86 will not be reached by the gas cap until it passes below the dip of the formations.

Referring to Fig. 1, therein is shown graphically the effects of pressuring the top portion of a limited portion of an oil field. Whether or not the wells in leaseholds "A," "B," "C," "E," "G," "I," "J," and "K" are producing wells or abandoned wells, the extension of the pressurization medium gas cap to a given well will result in leakage of pressurization medium up the bore hole into the overlying formation or out at the surface. If oil is being produced conventionally from a given well, it will be necessary to seal the well bore off with inlets to the borehole below the gas cap or the gas will infiltrate the oil and perhaps cause turbulence and frothing therein. The problem of the expanding gas cap works both ways. If the wells are not sealed, the operator who is pressurizing will lose pressure through the unsealed holes and the land owner or lease owner onto whose land the gas cap expands may have existing wells fouled up. The expansion of the gas cap is not selective.

From the foregoing it will be seen that this invention is one 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 claim.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein 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:

In a method of conditioning an oil horizon for a production of oil therefrom under vertical drive gaseous pressurization, wherein the horizon has boreholes of wells drilled into and through the horizon which are not able to be reconditioned and used in said vertical drive gaseous pressurization process, the improvement which comprises seeking out each said old, unusable borehole and sealing any such borehole which extends completely through the horizon entirely across the face of said horizon from at least the bottom thereof to at least the top thereof in such manner as to prevent any fluid leakage in the well bore above, below and through said horizon, and any such well bore which extends only into the horizon from the bottom of each said well bore to at least the top of the horizon whereby to prevent any fluid leakage in said well bore above and through said horizon, said sealed boreholes each sealed by running a tubing below the top of the oil horizon, packing off the tubing adjacent the top of the oil horizon, filling the annulus between the well bore wall and the tubing above the packer with an annular column of sealing substance which extends at least slightly above the top of the oil horizon and, after said sealing column above the packer has set, filling the borehole below the packer with other sealing substance through the tubing.

References Cited in the file of this patent

UNITED STATES PATENTS

2,548,059	Ramsey	Apr. 10, 1951
2,725,106	Spearow	Nov. 29, 1955