Aug. 23, 1932. H. L. DOHERTY 1,872,906

METHOD OF DEVELOPING OIL FIELDS

Filed Aug. 8, 1925 2 Sheets-Sheet 1

Fig. 1.

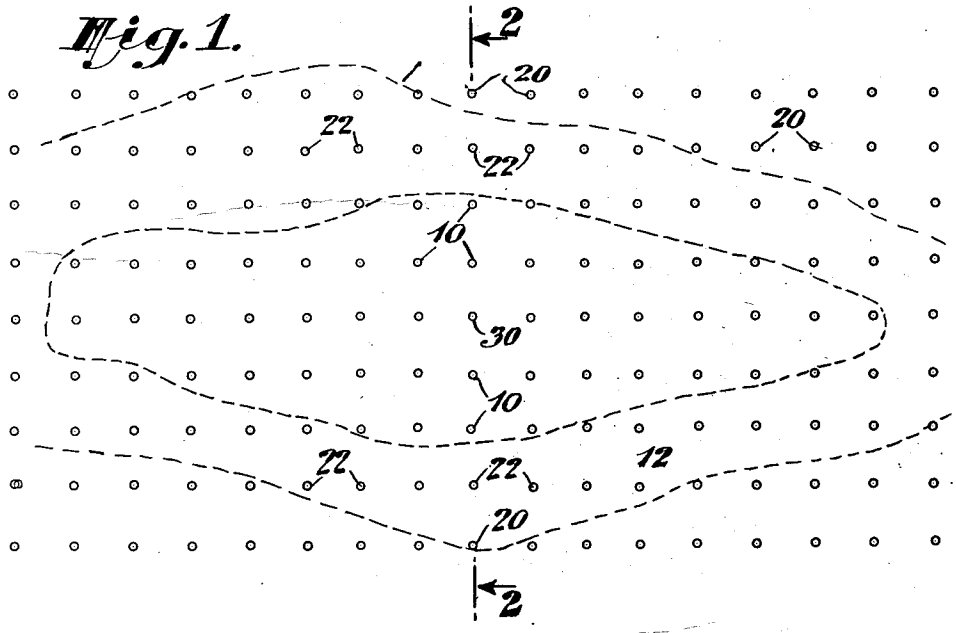
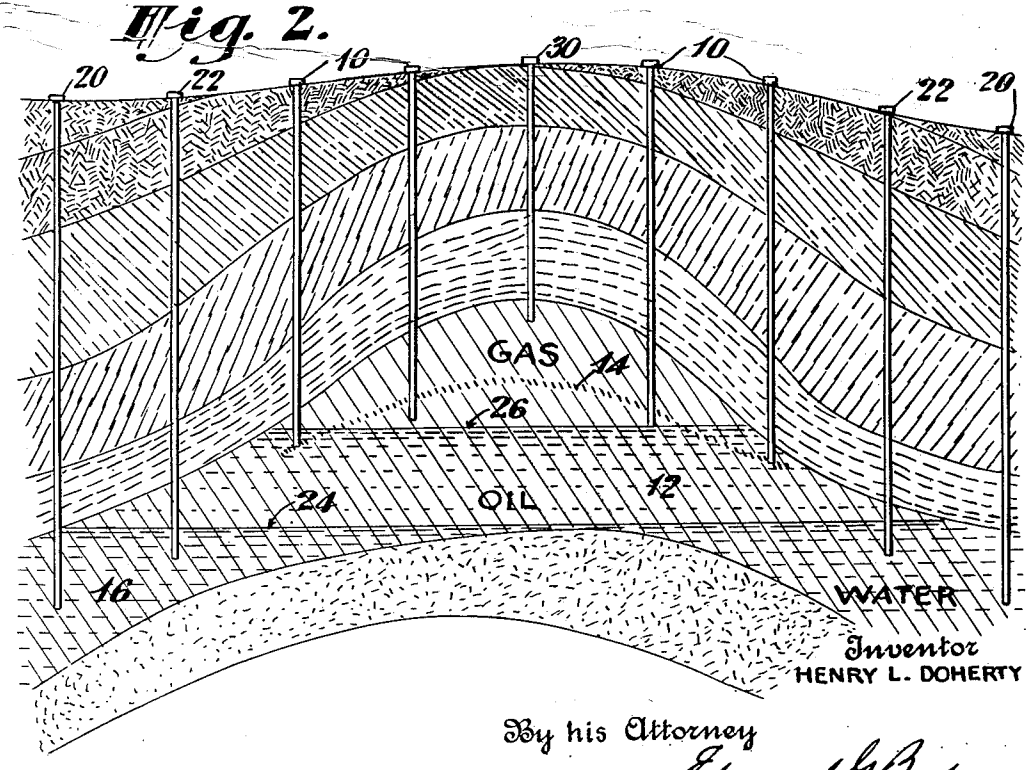


Fig. 2.



Inventor
HENRY L. DOHERTY

By his Attorney
Edmund G. Borden

Aug. 23, 1932. H. L. DOHERTY 1,872,906

METHOD OF DEVELOPING OIL FIELDS

Filed Aug. 8, 1925 2 Sheets-Sheet 2

Fig. 3.

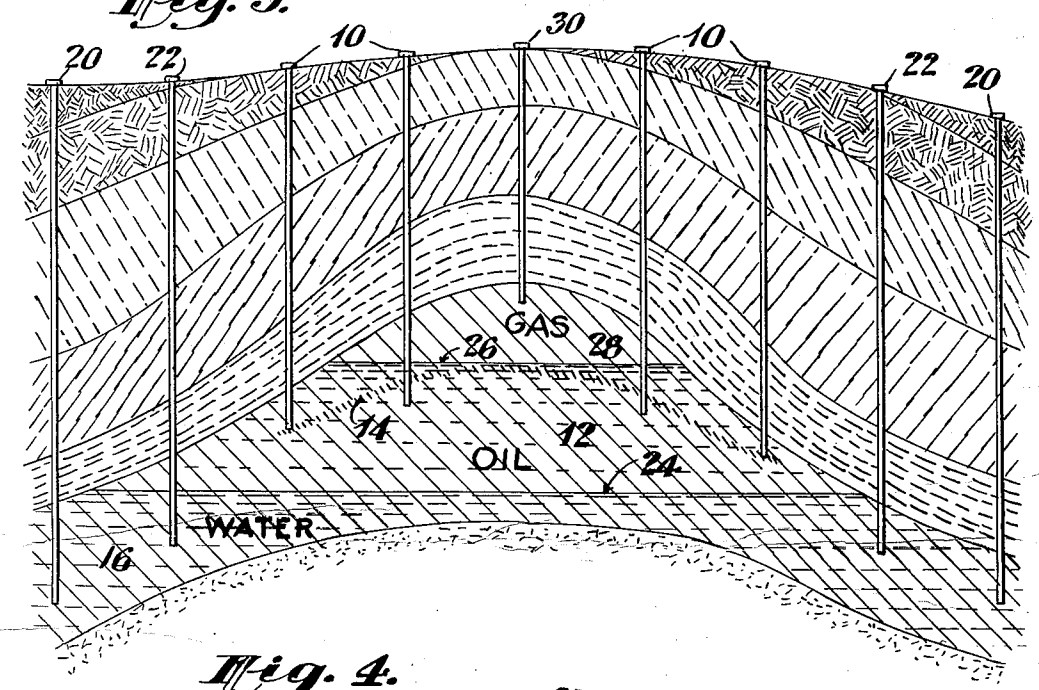
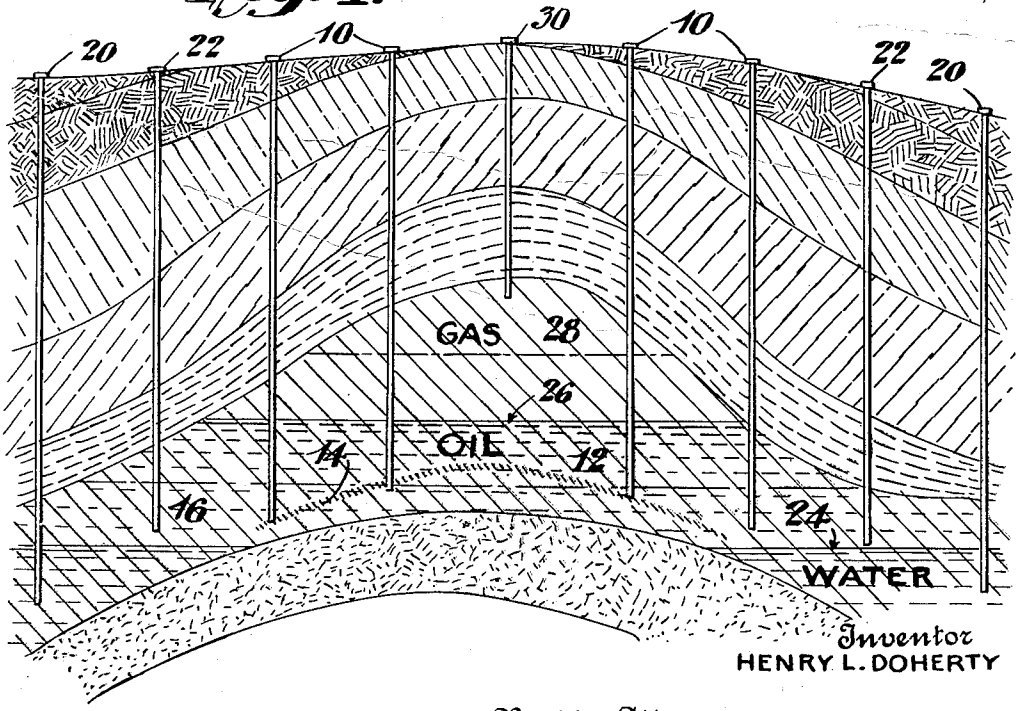


Fig. 4.



Inventor
HENRY L. DOHERTY

By his Attorney
Edmund G. Bordea

Patented Aug. 23, 1932 1,872,906

UNITED STATES PATENT OFFICE

HENRY L. DOHERTY, OF NEW YORK, N. Y.

METHOD OF DEVELOPING OIL FIELDS

Application filed August 8, 1925. Serial No. 49,128.

This invention relates to the development of oil fields and more particularly to a method of treating an oil body in the oil sands so that a maximum recovery of oil may be recovered from the sands.

The sand or formation in which the oil is found is seldom of the same degree of porosity throughout its thickness. Sometimes the upper portions of the sands are more porous than the lower portions, or vice versa, or there may be fissures or crevices in the sands which extend in lateral directions. Unless the oil body occupies the more porous parts of the sand the amount of oil recovered will be but a very small percentage of what might be recovered if the oil saturated sands were those sands of greatest porosity. Furthermore, if the more porous stratum of the sands are above the general level of the oil saturated sands, the free gas which usually accompanies an oil body will find its way through the upper sands to the wells without carrying or forcing any oil from the oil body or from the oil saturated sands to the wells. Moreover, even if the oil saturated sands comprise the more porous portions of the sands, the drainage of the oil, which occurs from the top of the sands, will leave an upper stratum of porous sands through which the free gas may readily find its way toward the wells. As a consequence, the gas-oil ratio will gradually increase as the life of the well increases. To put the matter in another way, the more oil that is drained from the top of the oil sands the greater the thickness of the channel or path through which the free gas may flow on its way toward the wells.

It is a well known fact that oil under pressure contains a very considerable volume of dissolved gas and that it is the expansion of the gases in the oil that is primarily responsible for the movement of the oil through the sands, the gas expanding and coming out of solution as the pressure decreases. If the free gas which is usually found above the oil body in cavities or domes, is allowed to escape through the sands which have been drained of their oil or through other paths such as channels, crevices or fissures in the sands above the oil body, the pressure on the field will fall very rapidly and thus seriously interfere with the drainage of the oil sands. As the pressure falls the gas which is dissolved in the oil will naturally seek the nearest point of low pressure. The upper portions of the sands from which the oil has been drained and through which the free gas is finding its way toward the wells will obviously be the nearest region of reduced pressure, and consequently the dissolved gas, in expanding, will flow toward this region. Some of the oil will be carried up by the expanding gas into this region of reduced pressure and be carried along by the gas which is flowing therethrough toward the wells. However, the top portion of the drained sands will continue to offer a comparatively free path to the flow of gas and consequently the production of oil will gradually decrease while the production of gas will increase.

It is an object of the invention to provide a method of treating the oil body which will prevent the free escape of gas through the more porous portions of the sands and thus to increase the amount of oil which may be recovered from the sands.

Another object is to provide a method of adjusting the position of the oil body within the sands so that the oil may flow through the more porous portions of the sands.

Oil bodies are usually found associated with underlying bodies of water. If the body of water happens to occupy the more porous portions of the sands, the production of oil is very materially retarded or interfered with.

It is therefore a still further object of the invention to provide a method of adjusting the oil body downwardly so as to allow the oil to flow through the more porous stratum therebelow.

The features of the invention will be more fully described in connection with the accompanying drawings in which:—

Fig. 1 is a plan view of an oil field in which the oil wells are represented by small circles and the approximate upper and lower boundaries of the oil pool underlying the field are respectively the inner and outer dotted contour lines;

Fig. 2 is a vertical sectional view taken on

the line 2—2 of Fig. 1 and which shows a typical strata formation and oil pool;

Fig. 3 is a view similar to that of Fig. 2 showing the oil pool after elevation in accordance with the process of the invention;

Fig. 4 is a view similar to Fig. 3 showing a modified strata formation with the oil pool lowered.

In practicing the present invention oil wells shown as small circles in Fig. 1 are to be projected into the oil sands according to a more or less geometric pattern. While the wells are being drilled, cores will be taken from the oil sands and a careful study made to ascertain the relative degrees of porosity of the sands at different levels. A study of the cores will also reveal the relative position of the oil body 12 with respect to the more porous parts 14 of the sands 16.

When conditions indicate that the more porous portions of the sands are above the main body of the oil saturated sands as shown in Fig. 2, the oil body will be elevated so as to bring the level of the oil body above the upper portion or level of the more porous stratum of sand. The elevation of the oil body will be accomplished by pumping water into the sands 16 below the oil body. The water will be pumped through water wells 20 located around the edge-water line and also preferably through wells 22 which project through the oil sands into the water sands therebelow. It is preferred to pump water into the water sands by way of wells extending through the oil sands as well as through wells located at the edge-water line, so that the water level 24 may be raised as rapidly as possible and as uniformly as possible beneath the entire oil body.

By raising the level of the oil body in the manner indicated and until the upper level 26 of the oil body is on a level with or above the more porous stratum 14 (as shown in Fig. 3), the free gas 28 in the upper portion of the sands will not be able to escape without doing useful work, namely, in forcing or carrying the oil toward the wells. By elevating the body of oil until the upper part of the porous stratum is completely saturated, it is obvious that the gas pressure on the oil body may be maintained more or less nearly approximating the original rock pressure and, in any event, will not be enabled to fall below the pressure in the region of the wells. As a consequence, the gas, in coming out of solution in the oil, will be obliged to move laterally toward the wells or, in other words, towards the region of reduced pressure. The ratio of gas to oil will therefore approximate more or less closely the ideal ratio, which is that the volume of gas produced per barrel of oil should not materially exceed the amount of gas which is dissolved in the oil at the pressure existing on the field.

In order to maintain the upper level 26 of the oil body substantially constant, it is contemplated in accordance with the invention that water will be supplied continuously to the water sands below the oil body in about the same volume that the oil is drained from the sands. If there is no leakage or migration of the water to remote points or to the surface, the volume of water supplied through wells 20 and 22 should equal the amount of oil recovered from the sands through wells 10 after the oil body has once been raised to the proper level.

If conditions indicate that the more porous portions 14 of the sands are below the oil saturated portions of the sands, the invention contemplates that water shall be pumped from below the oil body through wells 20 sufficiently to enable the oil to sink or be forced by the gas pressure thereabove into the more porous stratum 14 therebelow as shown in Fig. 4. If the gas pressure on the field is comparatively high, the oil will sink more or less readily through the water-wetted sands and gradually find its way toward the wells 10. However, if the pressure on the field is not very high, the pressure should be increased by pumping gas from an extraneous source or by pumping air into the field through wells 30 to assist the oil in penetrating through the water-wetted sands. Once a channel has been established by the oil through the water-wetted sands, the drainage of oil will proceed very rapidly and the efficiency of the oil recovery will be unusually high.

While it is preferred to obtain cores from the oil sands while the wells are being drilled so that the operator may be in a position to adjust the position of the oil both with respect to the more porous stratum or portions of the oil sands, nevertheless the invention may be practiced without this preliminary study of the oil sands. The wells may be opened to the flow of oil and gas in the usual manner, the ratio of gas to oil being carefully noted. If the wells flow an excessive amount of gas the operator may justifiably assume that free gas is finding its way through an upper stratum. The operator will then proceed to elevate the oil body until the upper level of the latter is sufficiently high to prevent the free gas from freely flowing through such stratum. On the other hand, if the ratio of gas to oil is comparatively low but the wells tend to flow a mixture of oil and water, the operator may justifiably assume that this stratum of the sands from which the mixture is drawn is occupied at least in part by the body of water and he may therefore proceed to pump out sufficient water to enable the oil body to sink or penetrate into said stratum.

It is preferable that the wells be operated under a back-pressure in order to prevent as far as possible the tendency of the free gas

from channeling through the oil body. The maintenance of a back-pressure on the wells is particularly desirable where the gas pressure on the field is high. Due to the fact that gas will flow through the sands more readily than oil, it will tend to channel its way through the oil sands toward the wells when the pressure is high.

The invention is particularly adapted to the treatment of an oil body or field as a whole. It also offers a method of recovering oil from oil sands which cannot be satisfactorily drained of their oil by ordinary methods of production. In addition, it offers a method which will enable a more complete extraction of oil from any given oil bearing sands.

What is claimed is:—

1. The method of developing oil fields which consists in ascertaining the location of the most porous stratum of the sands in which the oil body is found, bringing the oil body into such position with respect to said stratum that the oil will flow through the same toward oil wells projected into the sands, and maintaining said oil body in line with said porous stratum while removing oil through said wells.

2. The method of developing oil fields which consists in projecting wells into the field in accordance with a given geometric pattern, obtaining cores of the oil sands as the wells are being drilled, ascertaining from a study of the cores the relative degrees of porosity of the oil sands at different levels and the relative position of the oil body with respect to the more porous strata of the oil sands, changing the relative position of the oil body in the sands to bring the oil body in line with the more porous strata of the sands, and maintaining said oil body in line with said porous strata while recovering oil from said body.

3. The method of reducing flow of fluids other than oil along paths in oil sands which are more porous than the main body of the sands which consists in adjusting the position of the oil body into line with the more porous paths in preference to said other fluids and holding the oil body in said new position while flowing oil along said paths.

4. The method of reducing flow of fluids other than oil from a region of high pressure toward a region of low pressure through paths in oil sands offering relatively low resistance to the flow of fluids in the sands which consists in shifting the oil body into a position which will permit the oil to flow along the paths of least resistance in preference to the other fluids, and holding said oil body in said position while removing oil therefrom.

5. The method of preventing gas from flowing from a region of high pressure toward a region of low pressure along paths in oil sands offering less resistance to the flow of fluids than the main portion of the sands which consists in elevating the oil body into such position that oil will tend to flow along said paths in preference to the gas, and maintaining the oil body in line with said paths while recovering oil therefrom.

6. The method of developing an oil body contained within sands in the earth which consists in so adjusting the position of the oil body as a whole that oil may flow along the most permeable sand stratum toward the oil wells in preference to water and gas, the position of the oil body being adjusted by varying the pressure from beneath the same, and flowing oil from said body along said permeable stratum.

7. The method of developing an oil field which consists in projecting wells into the oil sands, flowing oil and gas from the wells as long as a predetermined ratio of gas to oil is maintained, elevating the oil body in the sands when more gas flows than should flow according to said ratio, and maintaining the oil body at that level which will cause the predetermined ratio of gas to oil to be maintained.

8. The method of reducing the water-oil production ratio of an oil well draining porous sands, which consists in removing the water from said porous sands and in shifting the underground oil body as a unit downwardly into line with said porous sands through which the underlying water tends to flow toward the oil well to thereby cut off such water flow and substitute a flow of oil therefor.

9. The method of developing an oil body contained within sub-surface earth strata which consists in shifting the position of the oil body as a unit into line with the most permeable stratum directly communicating with the oil well to thereby increase the flow of oil and proportionately reduce the flow of water and gas.

In testimony whereof I affix my signature.

HENRY L. DOHERTY.