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REARRANGEMENT OF OIL AND GAS DEPOSITS IN SEALED DOMES AND LIKE NATURAL FORMATIONS

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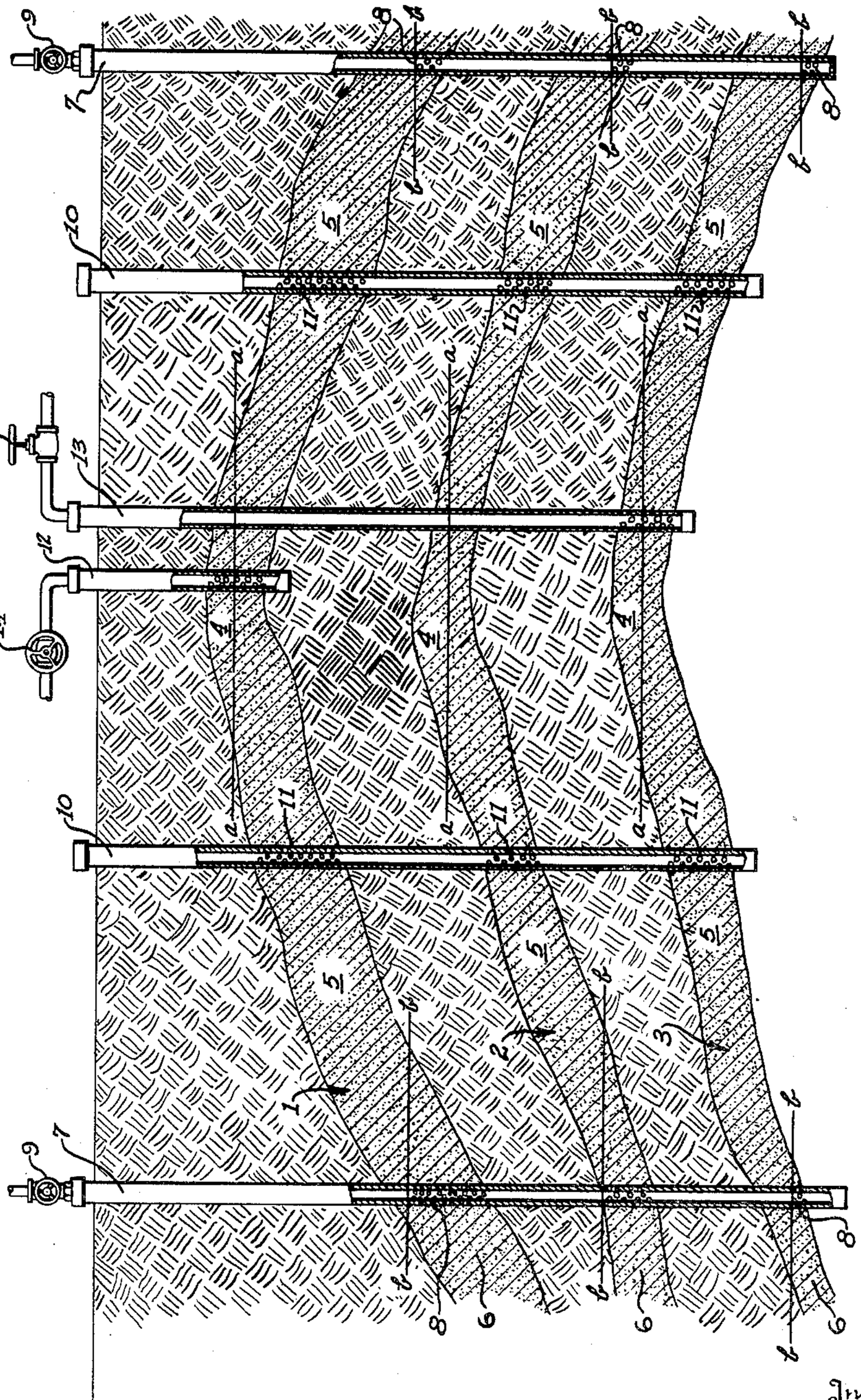

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REARRANGEMENT OF OIL AND GAS DEPOSITS IN SEALED DOMES AND LIKE NATURAL FORMATIONS

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2 Claims. (Cl. 166—21)

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This invention relates to the re-arrangement of oil and gas in sealed natural formations, and has for its object to provide a method for effecting the natural re-arrangement of gas, oil and water in such domes, anticlines or similar formations in which a plurality of superposed sand strata occur, separated by impervious earth structure, each stratum containing gas, oil and water or any two of these fluids, so that in the re-arrangement the gas occupies the uppermost, while the oil occupies the lowermost of such strata as are within the zone affected by the re-arrangement.

Other objects of the invention will appear as the following description of an illustrative embodiment thereof proceeds.

In the drawing which accompanies and forms a part of the following specification, the sole figure is a diagrammatic sectional view in vertical plane through a plunging anticline, illustrating the nature of the stratification to which the method is applicable, and means for carrying out the method.

Referring now in detail to the drawing, the numerals 1, 2 and 3 represent strata of pervious sands separated by impervious layers, so that each stratum may be regarded as an independent reservoir. The strata follow the contours of a plunging anticline or dome, each having a pocket of gas 4 in the apex, a body of oil 5 at an intermediate level, and a body of water 6, usually salt, at a level below the oil body, sealing the respective sand strata. The lines *a*—*a* indicate the interfaces between the gas and oil bodies, and the lines *b*—*b* the interfaces between the oil and water.

The several oil bodies actualy consist of oil containing a large proportion of gas held in saturation through the normal high pressure imposed by the gas in the pockets 4 and the surrounding water. If a production well were sunk to tap one of the oil bodies, the pressure in that body would be reduced and some of the dissolved gas would be freed. If the pressure reduction were gradual, this gas would come out of the oil in an orderly fashion and is a major factor in forcing the oil toward the production well. If the pressure reduction were rapid, due to more copious removal of oil from the production well, then the evolution of dissolved gas would be so rapid as to cause foaming in the sands, and foam clogs the interstices in the sand stratum and inhibits flow toward the production well, so that the rate of production would be unduly curtailed on this account.

If, with the oil and gas bodies in their natural arrangement as shown, a production well is sunk

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to tap all of the oil bodies, the pressure on each becomes at once proportional to their depth below the surface of the ground, so that for a given rate of production, the dissolved gas may come off relatively slowly from the oil in the lowermost stratum, promoting flow in this stratum toward the well, while it may be foaming in the uppermost stratum. Thus optimum production cannot be obtained from all of the strata. If the production well is sunk through all three strata in the region of the gas pockets, then the gas content from all three will be depleted before there is any oil production, after which the conditions attending the oil production will be the same as those last described. This is a particularly bad method of production, for the elimination of the gas pressure removes one of the factors relied upon for promoting the flow of oil to production wells outside of the bounds of the gas pockets.

The present invention seeks to produce a gravitational re-arrangement of the fluids permeating the several strata, so that substantially all the free gas in the several strata being light, will flow upwardly, and substantially all the oil will gravitate downward, to the end that the uppermost stratum will contain nothing but gas, and the lowermost stratum nothing but oil (including dissolved gas). By this method the dome may be prepared for re-arrangement and left for years, if desired, before it is tapped for production.

Referring to the drawings, previous exploration of the field having been made, cased wells 7 are sunk at the peripheries of the oil bodies in the strata, with perforations 8 communicating with the surrounding water. These wells are closed at the top, the closures being preferably provided with cut-off valves 9 which are normally shut. Thus, the pressure of the sealing water is equalized upon all of the strata.

Another set of cased wells 10 is sunk through all the strata in the region of the oil bodies therein, having perforations 11 communicating with each of the oil bodies. The wells 10 are permanently closed at the top.

Now, all of the sand strata are in communication, and under the same pressure, so that the gas from the lower strata ascends the wells 10 into the upper strata, while the oil being heavier, descends the wells 10 into the lower strata. In time, the gas pocket 4 at the top strata will have enlarged so as to occupy the entire upper stratum, while the lowermost stratum will contain nothing but oil. Excess gas and oil beyond that which the upper and lower strata can contain, will be found in the intermediate stratum.

In working the re-arranged dome, a gas producing well 12 is sunk, penetrating only the topmost excessively gas containing stratum and an oil producing well 13 is sunk, penetrating through all of the sand strata, but communicating only with the lowermost, that is, the exclusively oil bearing stratum. These wells are provided with the respective cut-off valves 14 and 15 at the top, so that gas and oil can be independently produced and the rate of production of the well 13 so controlled as to maintain the optimum oil, gas ratio with respect to the evolution of the dissolved gas in the oil.

When, through partial depletion of the oil or gas reserves, it is desired to increase the flow of oil, this can be done, on the one hand by pumping gas into the well 12, or on the other, by pumping water into the wells 9, in either case increasing pressure on the oil and driving it toward the production well 13. As depletion of gas and oil in the respective top and bottom strata progresses, replenishment takes place gravitationally by the gas in the middle stratum 2, rising through the wells 10 into the top stratum, and the oil in said middle stratum gravitating into the bottom stratum 3.

While I have in the above description disclosed what I believe to be a practical embodiment of the invention, it will be understood by those skilled in the art that such variations in the technique of carrying out the method, and in the means employed as do not depart from the inventive principle, are to be regarded as within the scope of the invention.

What I claim as my invention is:

1. Method of effecting re-arrangement of the oil and gas reservoirs in natural domes and similar formations in which the bearing sands exist in superposed independent strata, gas occupying the higher levels of each and oil the lower levels, with surrounding water sealing said strata at independent pressures, comprising providing closed wells extending through all the strata adjacent the peripheral boundary of the oil body in each, communicating with the water body in each, whereby the water pressure becomes equalized in all of said strata, and providing closed wells extending through all of said oil bodies, communicating with each, whereby an interchange of the gas and oil in the several strata takes place, the gas rising in said second mentioned wells while the oil gravitates downward therein, resulting in the top stratum containing substantially solely gas while the bottom stratum contains substantially solely oil.

2. Method of effecting re-arrangement of the oil and gas in reservoirs in natural domes and similar formations in which the bearing sands exist in superposed independent strata, gas occupying the higher levels of each and oil the lower levels, with surrounding water sealing said strata at independent pressures, comprising providing closed wells extending through all the strata adjacent the peripheral boundary of the oil body in each, communicating with the water body in each, whereby the water pressure becomes equalized in all of said strata, and providing closed wells extending through all of said oil bodies, communicating with each, whereby an interchange of the gas and oil in the several strata takes place, the gas rising in said second mentioned wells while the oil gravitates downward therein, resulting in the top stratum containing substantially solely gas while the bottom stratum contains substantially solely oil, and providing a gas injection well tapping solely the top stratum and an oil production well tapping solely said bottom stratum.

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