I. L. DUNN.

METHOD OF PRODUCING HYDROCARBON FROM HYDROCARBON BEARING EARTH STRATA.

APPLICATION FILED SEPT. 21, 1911.

1,190,267. Patented July 11, 1916.

Fig. 1

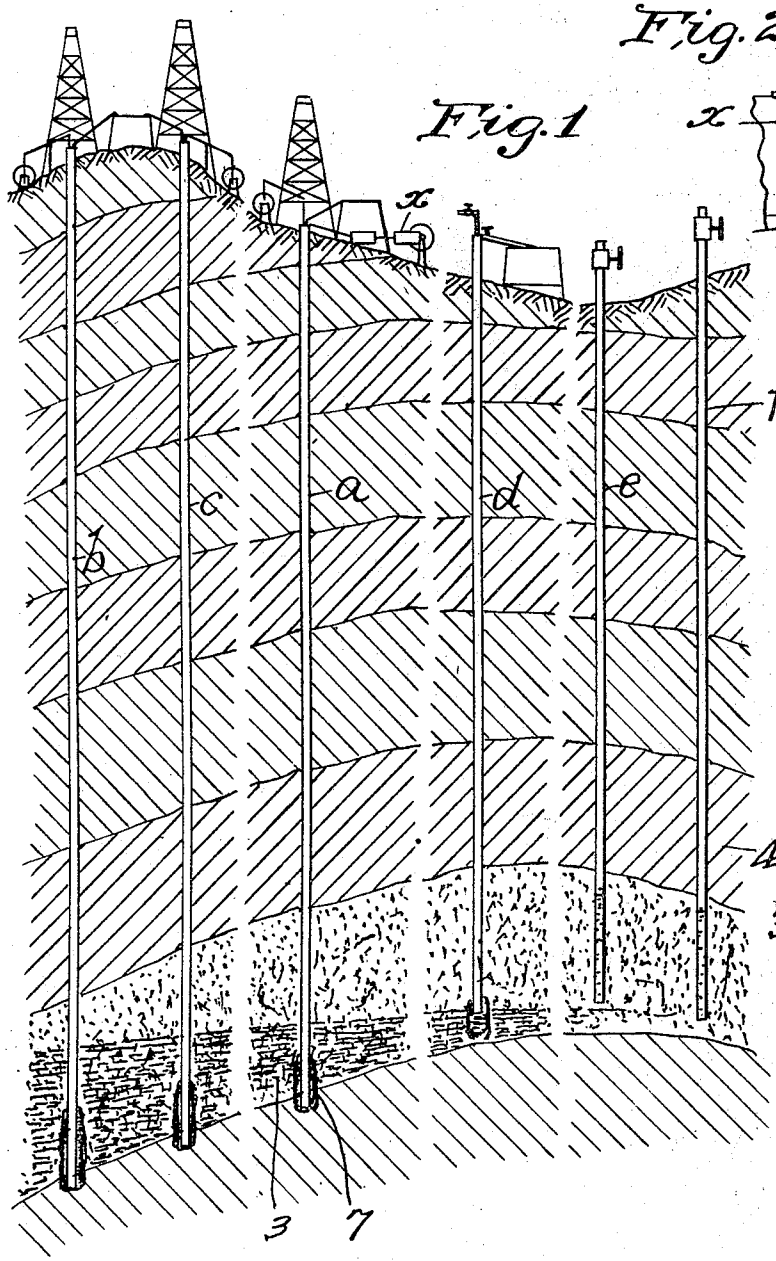
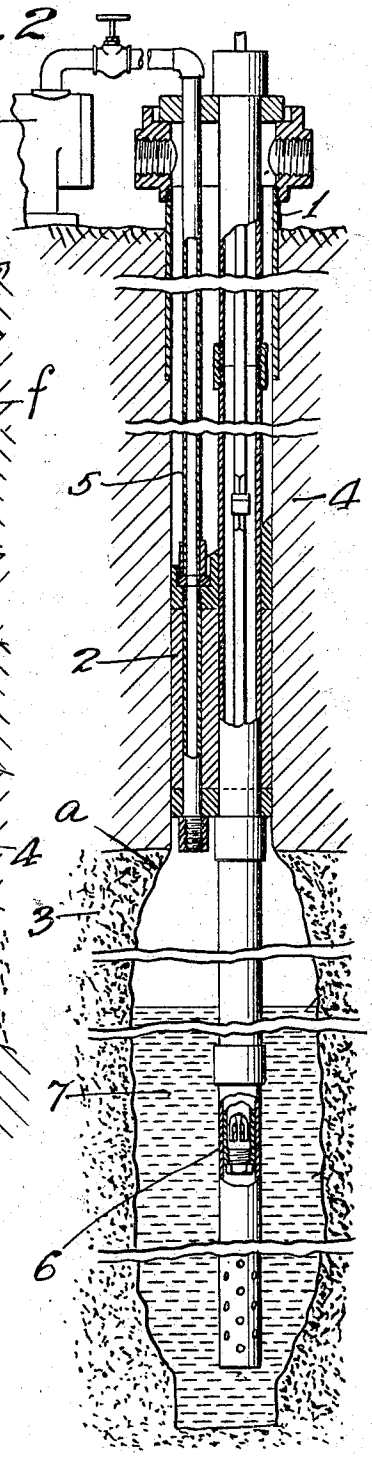


Fig. 2



Witnesses
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UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING HYDROCARBON FROM HYDROCARBON-BEARING EARTH-STRATA.

1,190,267. Specification of Letters Patent. Patented July 11, 1916.

Application filed September 21, 1911. Serial No. 650,640½.

To all whom it may concern:

Be it known that I, IRWIN L. DUNN, a citizen of the United States, residing at Long Beach, in the county of Los Angeles and State of California, have invented a new and useful Method of Producing Hydrocarbon from Hydrocarbon-Bearing Earth-Strata, of which the following is a specification.

This application is intended to cover subject-matter divided out of my application Serial No. 620854, filed April 13, 1911, on which Patent No. 1,067,868 was granted July 22, 1913, for method of increasing the productiveness of oil and gas wells.

This invention also includes certain further improvements as will hereinafter more clearly appear.

It is well known; that hydrocarbon-bearing earth strata may simultaneously contain water, hydrocarbon liquid and hydrocarbon gas; that by the force of gravity the water seeks the lowest level, the liquid a higher level and the gas the highest level; that a well entering said strata may supply gas, oil or water depending upon where it taps the strata, and also that such well may simultaneously supply oil, gas and water, or oil and gas, or oil and water, or gas alone as the conditions determine. It is also well known that the production of hydrocarbon from such strata diminishes as the gas pressure decreases.

It is a well-known fact that in order that any oil sand may be productive, it must be covered with a tight roof and tight bottom; otherwise, gas, together with other hydrocarbon, escapes, and we find the reservoir sand exhausted. In drilling into a virgin territory we find the rock pressure approximately equal to one-half the average depth of the producing strata. From time to time, if the rock pressure be tested as the wells decrease in production, such pressure is found to be continuously reducing. In other words, an oil territory continues to produce until the gas held in the interstices of the rock has expanded to atmospheric pressure. After this, gas pumps are employed to create a vacuum, and thus increase the flow of oil. After all known methods have been used there still remains large quantities of hydrocarbons held in the interstices of the rock by capillary attraction. I have found by renewing this pressure by artificial means—either through the producing wells, or abandoned wells in the same strata—that great quantities of oil can be produced from the old and unproductive oil fields: in fact, my experiments lead me to believe that not over twenty-five per cent. of the oil has been taken out of the rock, and that most of what remains may be recovered and used.

An object of this invention is to recover from the hydrocarbon-bearing earth strata as large a percentage as possible of the hydrocarbon contained therein and to produce such product in a manner entirely at the control of the producer and in such form, also at the control of the producer, as may be most desirable for transportation and use.

I apprehend that for manufacturing and domestic purposes and for ready and convenient transportation within certain limits from the producing well to the burner where used the best form in which hydrocarbon may be produced from earth strata, is the gaseous form; and by the method herein described and claimed it is made possible at low cost and inexpensive mechanism, to supply from hydrocarbon-bearing strata, combustible gas as required, and under any desired pressure within practical limits.

In the parent application Serial No. 620,854, I have claimed the newly-discovered art generically and have specifically claimed the process of reproducing hydrocarbons from earth strata by introducing into such strata natural gas under pressure from other earth strata, thus more or less fully restoring the rock pressure; and allowing said rock pressure to displace the hydrocarbons from the pores and interstices of the strata to a place where they may be recovered.

The subject-matter of the present invention is broadly novel and of a pioneer nature in that it treats the hydrocarbon bearing earth strata and the roof and floor thereof as constituting an immense fully charged carbureter into which atmospheric air may be pumped for the purpose of removing the hydrocarbons. The atmospheric air thus pumped into the hydrocarbon bearing strata serves two purposes, one being to displace from the pores and interstices of the oil bearing sand, rock, shale or other formation, to an available position, hydrocarbon in

liquid form available at a well that reaches the proper level in the earth strata; and second, to displace the hydrocarbon by absorption into the air, so that the air recovered from the strata will be highly carbureted and suitable as fuel for power, for domestic use and for manufacturing and other purposes. The lighter hydrocarbons may thus be taken up from the earth strata and carried off to an available place and there be condensed to produce gasolene and other refined products. The heavier hydrocarbons must be pumped unless sufficient air pressure is applied to produce a flowing well. It is thus seen that by introducing atmospheric air under pressure to hydrocarbon bearing strata, the highly volatile hydrocarbons may be recovered as combustible gas suited to immediate use for power, light and heat; that refined liquid hydrocarbon may be produced from such gas; and that heavier liquid hydrocarbon may be recovered either by pumping the liquid from a well or by applying the air pressure so forcibly on top of the liquid as to produce a flowing well. Said air pressure may be introduced into the strata at the top thereof or at any other point or points and will eventually produce a gaseous pressure down on top of any liquid body that may be or may accumulate in the stratum or strata closed in by the impervious floor and roof, care being taken, of course against undue emission or escape of the contents of the strata by closing all outlets except those from which the hydrocarbons are to be taken.

By this invention substantially all of the hydrocarbons within the area designed to be worked by the apparatus can be drawn from the earth, and to effect this there is first created an artificial pressure upon the liquid hydrocarbons within a given zone, and said zone is tapped at different levels so as to draw off both liquid and gaseous hydrocarbons. I employ compressed air to produce the artificial pressure and such compressed air acting upon the more volatile constituents of the liquid hydrocarbons produces an inflammable gas which is drawn off from the stratum that lies immediately above the liquid hydrocarbons so that said gas is not lost. It is clear that liquid hydrocarbons are not only expelled or lifted, or at least partially raised, from the hydrocarbon-bearing stratum by the pressure of the compressed air but that said compressed air gasifies a large percentage of the liquid hydrocarbon which is subsequently drawn off above said stratum, thus minimizing the expense of obtaining the hydrocarbons.

The herein claimed method will be understood by reference to the accompanying drawings.

Figure 1 represents in a conventional way a portion of a hydrocarbon bearing field in vertical section with apparatus for carrying out the invention and for recovering the hydrocarbon from the earth strata in several ways. Fig. 2 is a conventional representation in fragmental vertical section of a hydrocarbon-bearing field and apparatus by which the method may be employed to recover liquid hydrocarbon by pumping the same from the same well into which the air pressure is pumped.

The lower part of the well *a* is hermetically sealed from the interior of the well casing 1 by packing 2, so that the gaseous medium introduced into the hydrocarbon bearing strata 3 will not escape above the impervious formation 4. The pipe 5 packed by the packing 2 in the casing is connected with the air compressor *x*, and delivers the compressed air to the strata 3.

The pump 6 is located below the surface of the accumulated oil 7 at the bottom of the well *a* and is sealed from the compressed air by the oil body. So long as the output of the well is not sufficient to unbalance the seal 7, the rock pressure will remain in the strata to assist in producing oil at the pump; and so long as these conditions prevail, oil alone will be pumped and gas may be taken off from other parts of the field either through flowing wells *d* or through gas wells *e*, *f*, as shown in Fig. 1.

Any suitable well-known air compressor, as a bellows, an air pump, three phase compressor, or the like, may be employed for forcing compressed air into the hydrocarbon bearing strata.

In Fig. 1 the air compressor *x* is connected with a well *a* which is hermetically sealed in any well-known way as detailed in Fig. 2, and is arranged to conduct the air into the hydrocarbon bearing formation 3. Other wells, *b*, *c*, *d*, *e*, *f*, enter the same strata at other stations. The air from the air compressor permeates the earth strata to a greater or less extent producing what is called rock pressure. I have found in actual practice that where the wells have been pumped in a vacuum the air flows in to the exhausted hydrocarbon strata with great readiness, thus showing that a vaccum is being filled, and that when the rock pressure reaches an appreciable amount, say three or four pounds, valuable increase in production is noted at the wells. The amount of production in the field may be regulated by regulating the rock pressure which is thus produced. The air flowing into the strata 3 from the well *a* will displace the liquid hydrocarbon from the interstices and pores of the rock or other formation where it is held by capillary attraction or other forces, and will be caused to

flow to a lower level; the natural tendency of the air being to seek the highest level.

In wells *b* and *c* it may be assumed that the oil does not rise to the surface of the ground, and must be pumped, while in well *d* the surface of the ground is at a lower level and the rock pressure may be sufficient to cause the well to flow. Furthermore the bottom of the well *d* is shown at a higher level, so that gas and oil may both be discharged from such well, thus tending to produce a flowing well, while practically no air escapes from the wells *b* and *c*.

Wells *e* and *f* tap the strata 3 at a level above or outside the oil deposit and consequently are only gas producers. The gas issuing therefrom, however, may be carbureted atmospheric air and natural gas displaced by the atmospheric air and the carbureted atmospheric air may sink to a lower level than the natural gas and may be discharged through the flowing well *d*.

It is understood that in some instances sufficient air may be introduced at one well for an entire field or for a large portion of a field, or for a large number of wells; and that the recovery of the hydrocarbons from all of the wells may proceed simultaneously with the air pumping operation, the air in effect filling the upper portion of the hydrocarbon-bearing strata and the liquid hydrocarbon being removed from the wells respectively by pumps having their inlets entirely below the surface of the accumulated liquid hydrocarbon bodies. In any event all of the wells in the formation where the rock pressure is restored will produce hydrocarbons and the same may be drawn off by pumps or otherwise as required.

When the hydrocarbons have been produced at the top of the well they may be handled in any appropriate manner as for instance, the heavy hydrocarbons may be refined and the lighter hydrocarbons coming off as gas may be condensed or synthetically reduced to the required product. Such of the lighter hydrocarbons as are liquid at about the ordinary temperatures and pressures may be readily condensed from the air in ordinary condensers by cooling with or without the application of pressure. And the hydrocarbons which are gaseous at normal temperatures may likewise be condensed by known methods of extracting the heat therefrom and applying pressure thereto, the cooling and compression, however, being necessarily of higher degree, as will be readily understood by those skilled in the art.

I claim:—

A method of obtaining the lighter liquid hydrocarbons from the earth which consists in forcing atmospheric air into hydrocarbon bearing strata thereby carbureting the same, drawing off the carbureted air so produced, and condensing the hydrocarbons from said air to a liquid form.

In testimony whereof, I have hereunto set my hand at Marietta Ohio this 19th day of September, 1911.

IRWIN L. DUNN.

In presence of—
T. J. SUMMERS,
RUTH E. RITTER.