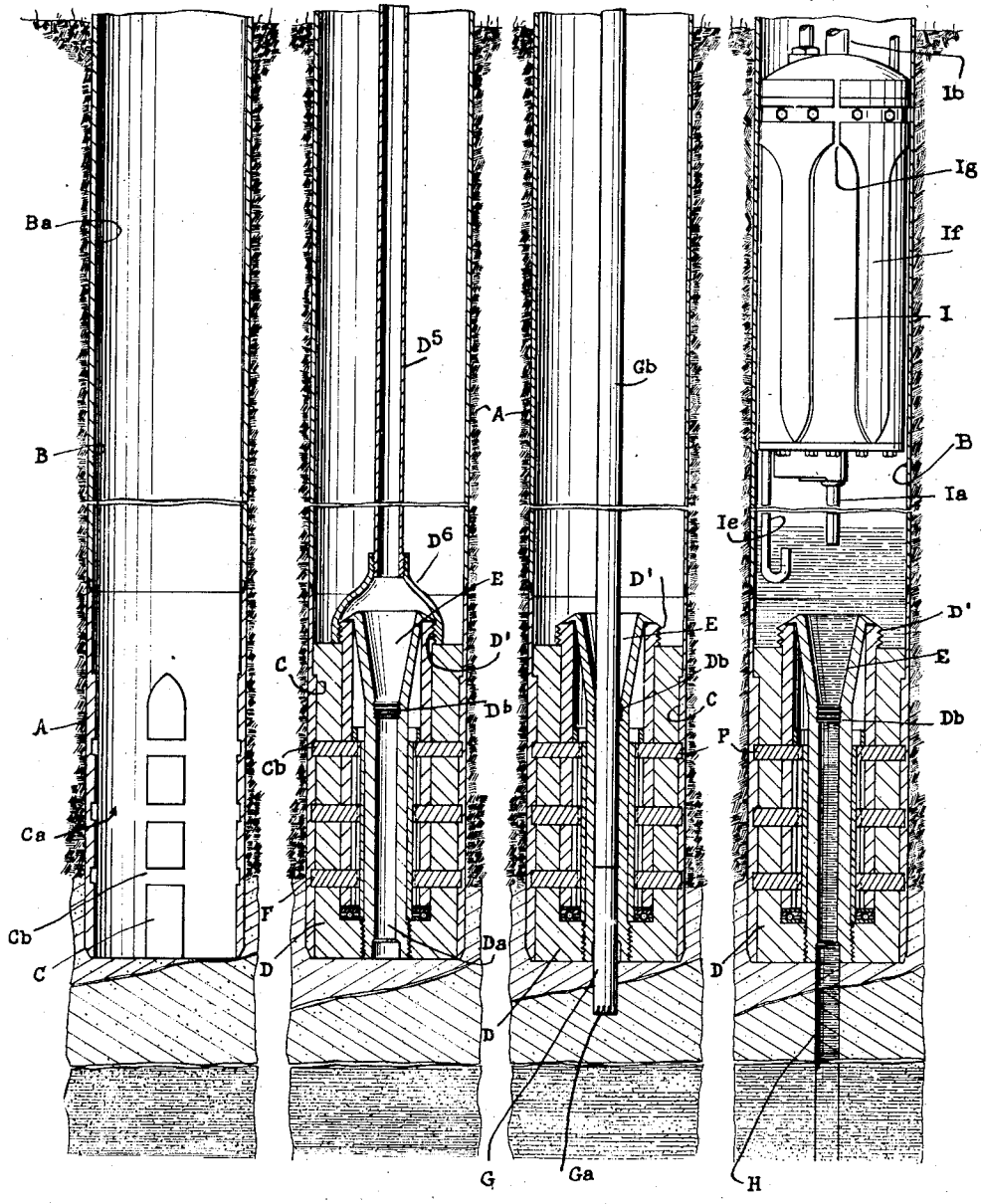
Feb. 7, 1933. R. P. SIMMONS 1,896,110

METHOD OF MAKING WELLS

Filed Aug. 27, 1930 4 Sheets-Sheet 1

Fig. 1 Fig. 2 Fig. 3 Fig. 4



Richard P. Simmons

INVENTOR

BY Kon. Fetterstonhaugh

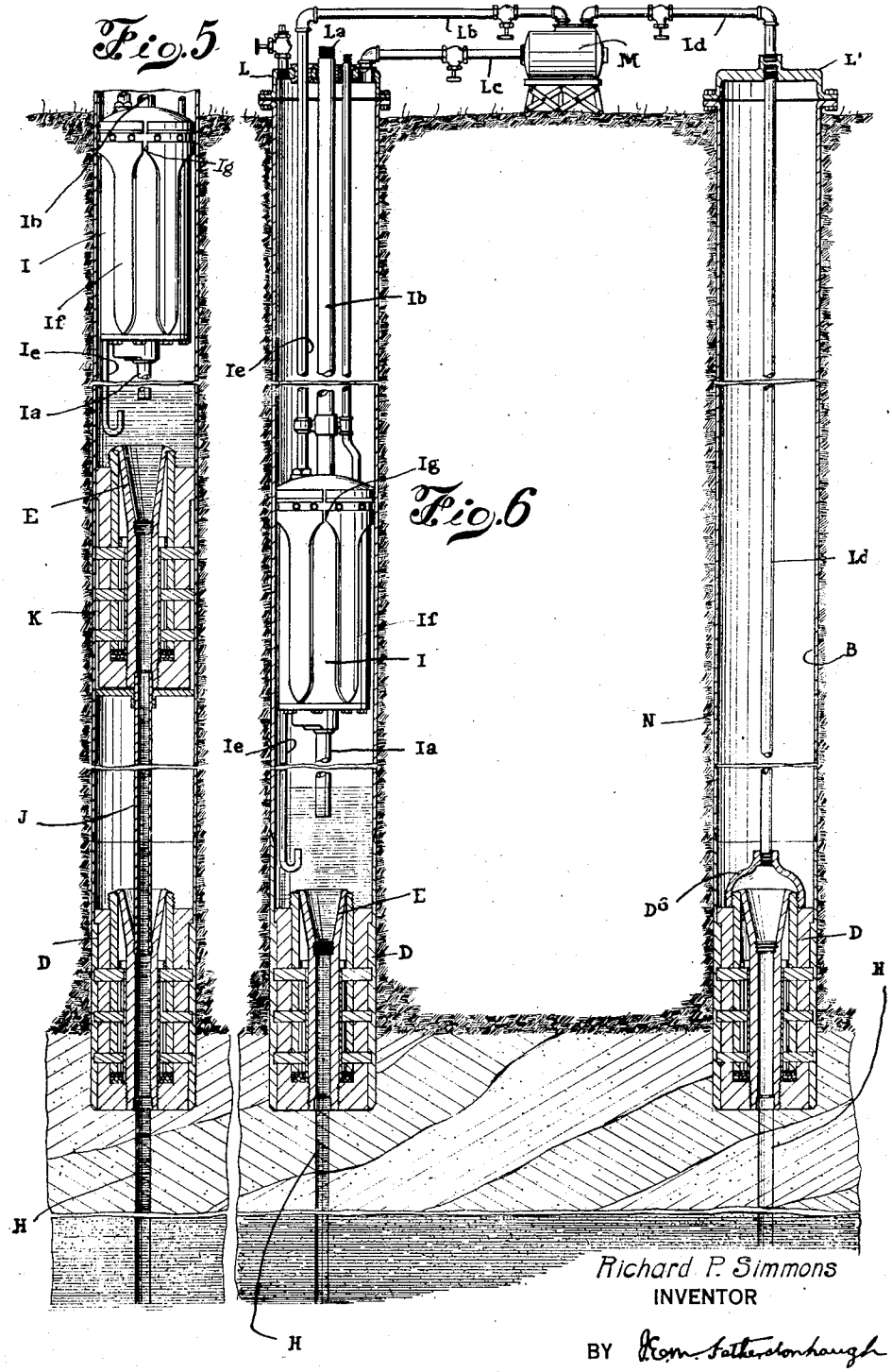
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METHOD OF MAKING WELLS

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Fig. 5



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METHOD OF MAKING WELLS

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Fig. 8

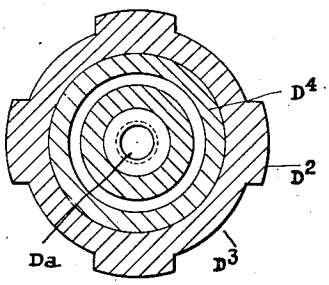


Fig. 7

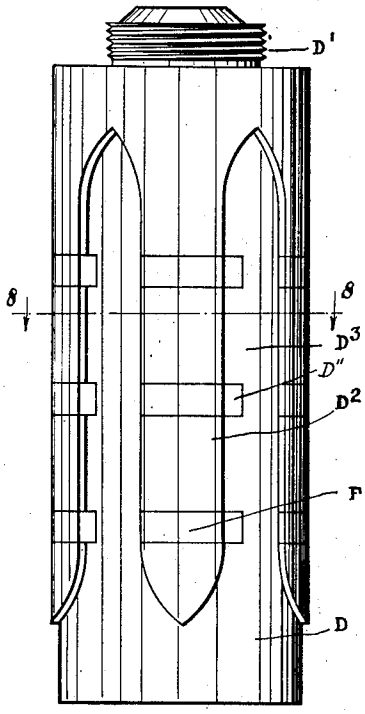
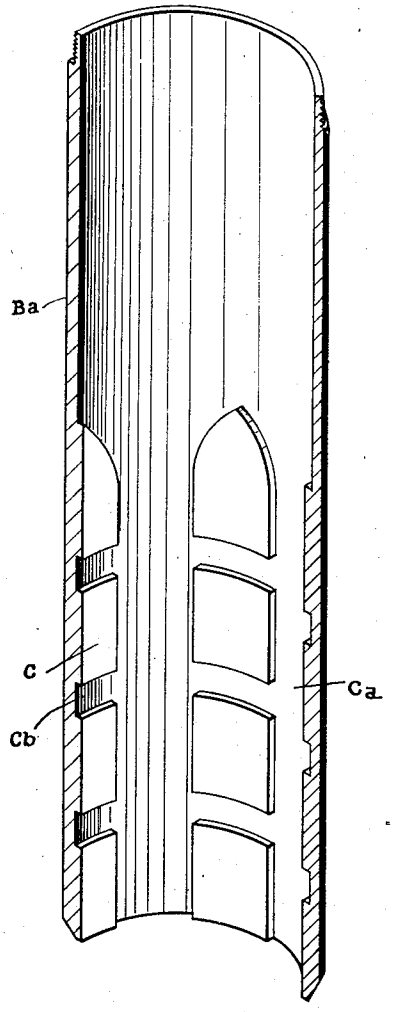


Fig. 11



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METHOD OF MAKING WELLS

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Fig. 10

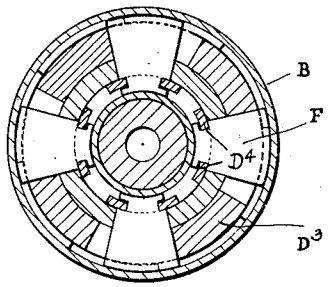


Fig. 9

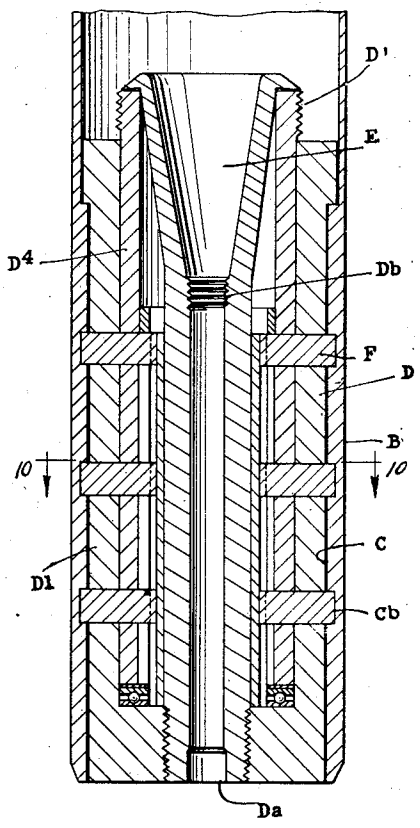
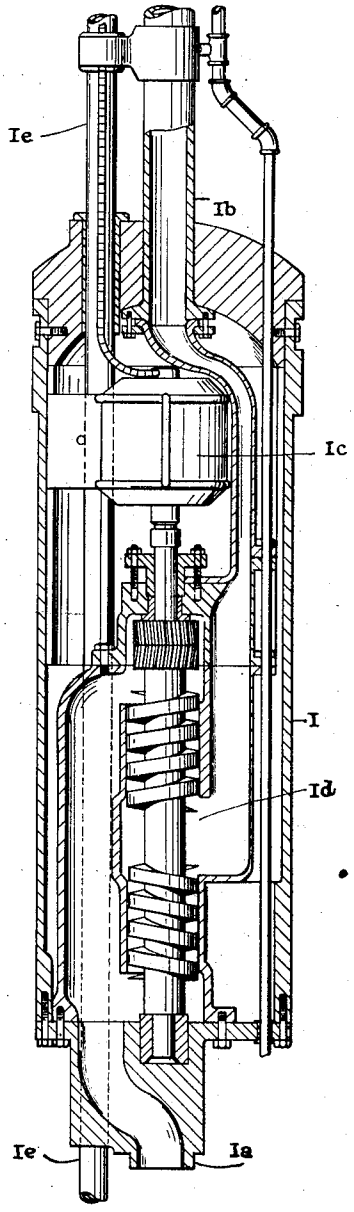


Fig. 12



Richard P. Simmons

INVENTOR

BY Thos. Fitzsimmons Hough

ATTORNEY

Patented Feb. 7, 1933 1,896,110

UNITED STATES PATENT OFFICE

RICHARD P. SIMMONS, OF NEW YORK, N. Y.

METHOD OF MAKING WELLS

Application filed August 27, 1930. Serial No. 478,112.

This invention relates to improvements in methods of removing mineral oil from the earth, and its leading object is to provide a method by means of which the native gas pressure of a natural oil and gas reservoir of any given geological area, may be conserved against free, wasteful, discharge to the atmosphere, and utilized over a prolonged period of time to maintain the lifting energy of the natural gas supply, so that oil will be conveyed to a preferred point of withdrawal, for final removal by the aid of pumping means or otherwise.

The prevailing practice of extracting mineral oil from the earth or ground involves the usual operation of drilling the well to penetrate the natural oil and gas zone or reservoir, which lies beneath a rock cap or covering, over which lies various strata of geological materials. After the well is completed the oil and gas are conducted, according to prevailing practice, to the ground level, by a casing of uniform diameter, in which the gas pressure from the natural reservoir is concentrated to produce a concentrated flow of mixed oil and gas, and a very wasteful discharge of both, in the preliminary stages of operation of the average oil and gas well.

It is the current practice to drill an oil well so that the wall of the well bore is supported by a casing, consisting of sections joined together at their meeting ends, by suitable coupling means. When the well has been completed through the rock to vent the natural reservoir another casing, of uniform diameter from its head section to its lowermost section, is progressively extended from the head of the well, through the outer casing, to the entrance to the natural oil and gas reservoir, until the source of the oil and gas is tapped. The oil and gas, under their own natural pressure, then discharge through this inner conduit, which is, as stated before, of uniform diameter from its lower end to its upper end through the well.

In many new oil wells the natural pressure of the gas is very high, and recent experience in one very large producing well graphically demonstrated the enormous waste of oil and gas which results from the uncontrolled discharge of both to the surface, resulting in the spraying of surrounding buildings and places with oil, and endangering valuable property and the lives of many people. This wasting of oil increases the fire hazard and naturally raises the cost of insurance and of property and life protecting systems employed.

The discharge of large volumes of gas and oil during the initial stages of the operation of a newly constructed oil well, furthermore, results in the early reduction of the gas pressure of the well, with the consequent reduction of the output of the oil from the well, and leading to its possible early abandonment, due to the fact that the residuent gas pressure has dropped below the stage necessary to provide sufficient energy to propel the oil into the well, so that it may be conveyed to the surface by pump pressure.

The present method aims to conserve the gas supply in the natural oil and gas reservoir of the ground, and to utilize the capacity of the well for local storage of oil which may be readily removed when wanted, by providing a well having flow chambers of different diameters, one of large capacity to receive and hold the oil and provide an expansion of the compressed natural gas, and therefore a reduction of its pressure, and the other chamber or passage being of relatively small diameter, which forms the intake for the larger chamber or means of communication between this large chamber and the natural oil and gas reservoir, through the natural covering or cap rock which normally seals the oil and gas in its natural reservoir in the ground. By my method the natural gas flows through this cap rock or natural covering in a passage or well intake opening of approximately normal diameter, considering current oil well practice, entering the large capacity well chamber above this intake passage, so that it must fill a larger cubical area and thus expand to do so, thereby reducing its own pressure per cubic inch. This reduction of pressure of the natural gas after it has entered the large capacity chamber of the oil well, necessarily reduces the lifting energy

of the expanded gas, and if the level of the expansion of the natural gas is properly located with reference to the depth of the well, or the distance the oil must be conveyed or lifted to the surface, the level of the oil delivered into the well may be accordingly controlled, so that wasting of both oil and gas through uncontrolled discharge will be avoided.

The practical object of the invention is to provide an oil well and method of operation thereof, for piercing a natural gas and oil reservoir and withdrawing both oil and natural gas under flow control, both as to pressure and delivery, whereby the natural pressure of the gas in its natural reservoir may be maintained at the highest point of propulsive energy or lifting force over a period of time greatly prolonged beyond what is now possible with current methods and oil well practices, to secure increased and controllable production of the oil for the longest possible period of time, and to eliminate waste of both oil and gas.

With the above and other objects in view the invention consists in certain new and useful constructions, steps and operations, and combinations thereof, examples of which are illustrated in the accompanying drawings, in which:—

Fig. 1 is a vertical sectional view through the large capacity chamber of an oil well, partly completed, showing the well casing in place.

Fig. 2 is a similar view showing the expansion plug at the bottom of the large well chamber locked in place.

Fig. 3 is another similar view, showing the use of one form of drilling means, for forming the small diameter well chamber or well intake passage, showing the expansion plug in place.

Fig. 4 is another similar view showing the completed plural diameter oil well, and a pumping unit installed therein.

Fig. 5 is a vertical sectional view through an oil well, showing an elevated expansion plug therein.

Fig. 6 is a vertical sectional view through an oil well constructed and equipped to carry out my improved method of oil and gas withdrawal and separation in the well, and through a companion well, equipped to provide an independent path for the return of the natural gas to the natural gas and oil reservoir.

Fig. 7 is a side elevation of the expansion plug on an enlarged scale.

Fig. 8 is a cross sectional view, taken on line 8 of Fig. 7, looking in the direction of the arrows.

Fig. 9 is a vertical sectional view through the expansion plug, showing the well casing broken away.

Fig. 10 is a cross sectional view taken on line 9 of Fig. 9, looking in the direction of the arrows.

Fig. 11 is a sectional perspective of one section of the well casing.

Fig. 12 is a sectional longitudinal view through one form of a pumping unit, illustrating the method of continuing the gas conduit through the casing of the pumping unit.

The method is carried out by first forming an oil well chamber A down to the rock covering or cap, which forms the natural seal for the oil and gas supply, through the material which overlies this rock covering or cap. This oil well chamber A is of abnormal diameter, considering current oil well drilling practice, and may be twenty inches in diameter, twenty-four inches in diameter, or more or less.

This large diameter oil well chamber A is formed by the aid of large diameter well casing B, which consists of companion sections B*a*, coupled together at their meeting ends and extending down into the well bore formed. This well casing is of uniform diameter from the top to the bottom thereof, and the well chamber A is also of approximately uniform diameter from the top to its lower end.

The oil well chamber A is formed by the use of drilling equipment capable of successfully drilling an oil well of abnormal size or diameter.

The well casing B is formed with one or more sections having internal longitudinal keys C and keyways C*a* therebetween. Internal radial keyways C*b* are cut through the longitudinal keys C. These sets of keys and keyways are preferably spaced vertically from each other in the casing when the same is practicably installed.

The longitudinal keys form means for maintaining any well units employed in a vertical plane, either against relative rotative or relative longitudinal movement, as may be required.

The longitudinal and radial keyways also form means for holding the expansion plug D in selected position, against displacement, at the bottom of the well chamber A, when this chamber has been driven to the rock covering or cap, which seals the oil and gas supply in the earth.

This expansion plug consists of a body of metal or other material suitable for the purpose, and is provided with a central passage or opening D*a*, the wall of which is formed with coupling means D*b*. From this central opening a flared or conical chamber E extends upward. This chamber provides means for a gradual expansion of the natural gas, during its upward flow from the natural oil and gas pocket or pool in the earth, so that the gas enters the chamber A at a greatly reduced velocity.

The expansion plug D is positivelv coupled

to the lowermost section of the well casing B by means of locking lugs F, which may be mounted in the plug for sliding movement, or rigidly formed thereon or secured thereto. These lugs F are designed to pass freely through the longitudinal keyways of the well casing B, and then be locked in the radial or transverse keyways thereof, by a slight turning movement of the expansion plug, affected through the medium of an operating casing coupled to the upper end of the expansion plug D, through the external coupling means D′ formed thereon. To this well casing B the expansion plug D is thus positively locked against displacement under the pressure of the gas and oil.

After the expansion plug D has been placed in position it is possible to start the work of drilling the smaller diameter oil and gas intake, to establish a means for inducing the oil and gas to discharge from the pocket or pool chamber usually located below the rock cap or covering.

Any system of drilling may be employed, as the present method is not limited to any particular means or method of removing the rock below the chamber A, to provide the smaller diameter oil and gas intake passage for the oil well. As an example of a drilling equipment which can be used to excavate the rock, I show a drilling barrel or casing G, the lower end of which is equipped with a suitable excavating or cutting tool G*a*. This barrel or casing G is rotated by means of a sectional casing or piping G*b*, which extends to the ground surface.

The drilling head or casing G is lowered, with its supporting casing or piping to the level of the expansion plug D, when the cutting tool G*a* of this drilling head or casing rides on the conical wall of the expansion chamber of this plug D, and is thus centered relative the axis of the well. The operating casing or piping G*b* may then be rotated in either or both directions of turning and the rock progressively excavated to form an intake passage H through which the oil and gas may flow from the natural deposit or supply.

The maximum cutting diameter of the drilling head G determines the final diameter of the intake passage H. The core produced by the operating of the drilling head G is progressively lifted to the surface, as it enters and is frictionally locked in the barrel or casing G, and removed, until the rock cap or covering is pierced, when the pressure of the gas and oil will then seek discharge or release. The drilling head is forcibly held downward against this pressure and then gradually lifted until the drilling head passes entirely above the expansion plug, when the pressure will have been greatly reduced.

Since each time the ratio between the intake passage H and the main well chamber A is doubled, the area of the latter is increased four times, it follows that the reduction of the pressure of gas and oil in the intake passage H is correspondingly reduced. It follows therefore, that if the area of the main well chamber A is increased four times that of the intake passage H, the pressure of the gas when it reaches the main well chamber A will be reduced to one-fourth the pressure of the gas in the intake passage H. If this ratio be further increased so that the main well chamber A is approximately twenty-four inches and the intake passage H is approximately six inches in diameter then the area of the main well chamber will be approximately sixteen times that of the area of the intake passage, and the pressure of the main well chamber A will be but one-sixteenth of the pressure in the intake passage H.

The number of vertical feet the oil is propelled or lifted by the pressure of the gas will then be determined by the pressure of gas in the main well chamber A. Natural gas under great presure is the only means for imparting flow to the oil stream, so that it can be induced to enter the oil well and then elevated to the surface, either by utilizing the pressure of the natural gas, or by combining this pressure with that which can be supplied by means of a pumping unit installed in the well.

After the drilling unit G is removed and the pressure of the gas supply has been determined, it is then possible to calculate the approximate level to which the oil will rise under the reduced pressure of the natural gas, resulting from its expansion during its upward flow in the large well chamber A.

A pumping unit, comprising a casing I, is then lowered into the well chamber A, by means of its eduction or outlet pipe I*b*, so that its inlet pipe I*a* will be immersed in the oil supply which settles and accumulates in the well chamber A at the level where expansion of the gas takes place. This eduction pipe I*b* also serves to hold the pump unit against relative rotation in the well, and to hold it downwardly against any upward pressure which the gas may exert upon it. The casing I encloses an electrical motor I*c*, the pumping means I*d*, and the gas conduit I*e*, which extends through the casing I, from end to end.

The casing I is provided with external keys I*f*, which are designed to provide restricted gas channels I*g*, so that a limited upward gas flow may take place in the well from the separating chamber below the pump unit. This serves, together with the external control provided at the head of the well, to regulate the gas pressure of the separating chamber.

Due to the lifting force exerted in the relatively small intake passage by the gas, the oil is conveyed into the chamber A, where the gas expands, resulting in a separation of the

gas and oil. Owing to the viscosity of the oil and the flow conditions of the well, the oil will offer considerable resistance to the upward flow of the gas, and will thus act to restrain the gas from excessive discharge, with the result that the supply of gas may be conserved in its natural reservoir and its pressure maintained against rapid reduction within the natural reservoir. The effect of this is to prolong the period of time in which the gas pressure of the natural reservoir as exerted through the well chamber A communicating therewith, will exert effective lifting force upon the oil to cause it to flow into and through the well, so that its withdrawal can be accomplished. My method thus creates a pool of oil above the reservoir of gas. which is confined by the natural rock cap or covering, which causes a reverse pressure upon the gas under certain conditions of hydrostatic balance, and assists in maintaining that adequate control over gas pressure and delivery of both gas and oil, which is essential to economical operation, sound conservation of gas and oil, and elimination of wastage of both.

When the gas pressure of a well of present type drops very low oil cannot be taken from the well, since none is delivered into the well, and this may take place though the supply of oil in the natural reservoir below the well is far from being exhausted.

Due to the inability of operating crews to control the outflow of both gas and oil during the initial period of operation of a new oil well, because of unrestricted discharge through a conduit of uniform diameter from its intake to its head, the pressure of the gas of the natural reservoir acting through the oil well, is rapidly lowered, and soon reaches a point where insufficient propulsive energy is supplied to convey the oil.

By holding oil in the well losses from fire and lightning, and the cost of conserving it for disposal may be materially reduced, and, in fact many costs eliminated, since the use of large storage tanks at the location of the oil wells is now made necessary by the forcible expulsion of the oil by the high pressure natural gas, and the complete lack of efficient and reliable means for preventing discharge of oil and gas during the period when a well is flowing at its maximum.

Effective control of the natural gas pressure therefore makes possible the adequate control of the discharge of both oil and gas.

When the pressure of the natural gas supply in an oil well is insufficient to lift the oil to a level preferred for conveyance to the surface by pumping, by allowing expansion of the gas to take place at the bottom of the chamber A, then the oil level may be raised in the chamber A, by connecting a small conduit or casing J with the passage H, and providing an additional expansion plug K at the head of this casing J. The casing J would have a diameter approximately that of the passage H, so that no expansion of the gas supply would take place in this casing or conduit J, the expansion taking place as the gas flows upward through the second expansion plug K. The pumping unit is located in the chamber A, above this second expansion plug, at a level sufficient to insure flow by pump pressure of the oil discharged above the second expansion plug K. By varying the level of the final expansion of the gas the pocketing of the oil in the chamber A may be controlled to accommodate the decreasing pressure of the natural gas supply, and to continue discharge of the oil into the well under conditions calculated to insure maximum productive life to the oil well, and to further insure the fullest practicable conservation of both oil and gas.

The upper end of the well casing B is equipped with a cap L, tightly secured thereto, through which the oil conduit or outlet pipe from the pumping unit is extended at L*a*. The natural gas which rises in the well is conducted by the conduit L*c* to a power gas compressor M, whereby the gas may be placed under additional pressure and returned to the oil well chamber A, by means of the conduit L*b*, which extends downwardly past the pumping unit and is connected at its lower end to the lowermost expansion plug D, through which the natural gas is discharged into the well chamber A.

By this return conduit system the supply of natural gas for a given oil well may be maintained fairly constant, so that the pressure exerted by the natural gas to propel the oil into the well will be maintained throughout the productive life of the well, with the least losses.

The use of the cap L at the head of the well casing establishes approximately equal pressures above and below the pumping unit and the expansion plug. The oil is squeezed or forced into the well by the high pressure of the gas against the sand deposit, and the gas and oil separate in the chamber A, the gas which penetrates the oil rising above its level, flowing past the pumping unit and then being withdrawn by the gas compressor, which returns it to the natural reservoir zone, as extended by the oil well chamber A.

By this separation of the gas and oil in the well chamber A it is possible to withdraw either alone, or both at the same time. The gas may be conducted to any external source if so desired, or returned to the natural gas reservoir as herein indicated, so that an effective working gas volume may be maintained in the oil and gas reservoir, to insure sufficient gas pressure to propel the oil into the well chamber A.

Since the natural gas forms the elemental means of causing the oil to flow into and

through the well, it is essential that the gas be maintained in the well with the least loss of volume and of pressure. As the oil is extracted or withdrawn the gas pressure can be built up by pressure created upon it through the external compressing unit.

The system provides for the confinement of the gas in the well under conditions promoting effective control thereof, with the least geological change of the fundamental flow conditions of the well.

Any desired drop in pressure may be maintained in the chamber A, by regulating the rate of withdrawal of the excess gas from the gas conduit system.

Under existing practices only a minor percentage of the available oil supply of a natural reservoir, as tapped by an oil well, can be withdrawn. Expert opinion indicates that this percentage is about one-quarter of the total available supply, due to the difficulties inherent to the present system of using gas or allowing it to freely waste, with rapid reduction of the propulsive energy of the gas supply. Other expert opinion indicates that the percentage of oil extracted from the natural oil deposit is even less than one-quarter of the whole available supply.

When oil is withdrawn from the natural reservoir it is subject to losses through evaporation, when stored in ground tanks, which alters the basic chemical balance of the oil. The storage of oil at the well location, or near it, is now made necessary by the rapid expulsion of the oil, because of the high natural pressure of the natural gas, and the lack of any method at present for effectively controlling it. This practice increases the cost of delivering the oil, in its original condition or in its refined forms, to the public, but is unavoidable with present methods.

By my method of withdrawal from the natural reservoir of either the oil or gas, extraction is accomplished under conditions calculated to meet current market needs, without requiring expensive and hazardous external storage.

The expansion plug D includes an outer cylinder or casing D^1, which is formed with longitudinal keys D^2 and keyways D^3, located between said keys. The locking lugs or members F have a circumferential movement in the slots D^{11} formed in the casing D^1, so that these lugs or members F may be forced into the vertical planes of the keyways D^3, from their positions in normal registration with the keys D^2. The shifting of the lugs or locking members F is accomplished by means of the inner casing D^4, which is enclosed by the outer casing D^1. The upper end of this inner casing D^4 is provided with screw threads or coupling means D^7, which are engaged by bellshaped member D^6, which is coupled to the operating casing D^5.

By constructing an auxiliary well N in the same territory as the main well A, by the drilling of a large capacity well chamber and a reduced oil and gas intake, or duplicating the well A, and by using a return gas conduit L*d*, suitably connected with the compressor M, and extending through the cap L′ at the head of the casing B of the well N, the natural gas which is not returned directly to the reservoir immediately below the well A, or conducted to an outside source, may be returned to the natural reservoir under the pressure supplied by the compressor. By suitable valves located on the gas conduit the direction of flow of the gas discharged from the well A may be controlled at will. The conduit L*d* is shown coupled to the threaded upper end of the expansion plug D, which is locked at the bottom of the auxiliary well N, by means of an inverted bell-shaped or conical coupling element D^6.

The full control and conservation of the natural gas supply in the ground reservoir is thus made possible, by providing means for controlling the flow of the gas that leaves the well, so that it may be either returned to the well under higher pressure, or returned to the natural oil and gas reservoir, through an auxiliary communication with the natural ground reservoir, as by the auxiliary well N, or by communication through any associated oil well tapping a common oil and gas supply.

My method therefore provides for the maximum return of the gas to the ground reservoir, so that the original pressure of the gas upon the oil supply may be continued, with the least avoidable reduction, for as great a length of time as possible. It further provides for the natural separation of the oil and gas in the well, by a separator formed by the oil well, and which operates from the time the initial flow of gas or gas and oil starts, and is not dependent upon any equipment introduced into the well subsequent to the starting of flow upwardly through the well.

This separating action results, as previously explained, from the expansion of the gas stream, caused by the increased area of the main chamber of the well, over the area of the intake, which results in a great reduction of pressure per square inch of well surface, and a great loss of lifting energy of the gas supply admitted to the well, due to this dissipation of pressure.

The expansion plug D employed at the bottom of the well is not primarily necessary to this expansion and consequential separating action between the gas and oil, and is used largely to provide a more complete control of the expansion and separation, and to reduce the erosion at the intake of the well, due to the high velocity which results from the initial flow of the oil and gas into the well.

The present application is a development

and a continuation of the disclosure set forth in the application for patent filed by me on April 25th, 1928, Serial 272,799. In this application I disclosed a two diameter oil and gas well, wherein the main chamber of the well is of relatively large capacity and the intake is of greatly reduced capacity, so that an expansion of the gas takes place after its flow from the intake passage, or as it leaves this intake passage and fills the main chamber of the well.

The details of this coupling head are more fully disclosed in my copending application for patent Serial 386,354, filed August 16th, 1929, the references made herein being largely for illustrative purposes.

In my copending application for patent, Serial 401,446, filed October 22nd, 1929, I show means for drilling large diameter oil wells, by one method of operation, and in my copending application for patent Serial 401,445, filed October 22nd, 1929, I show a motor operated means for drilling oil wells of large diameter. In other copending applications for patent I have disclosed various forms and types of mechanism for drilling. In my application for patent Serial 401,447, filed October 22nd, 1929, I show a core barrel drilling apparatus, whereby the core may be removed as the material is drilled through. In my copending application for Letters Patent Serial 401,926, filed October 23rd, 1929, I show an oil well pumping apparatus, by means of which the oil can be efficiently removed in carrying out the present disclosed method.

I reserve the right to use any equipment in carrying out my improved method, or to apply the mechanism shown in my copending applications for patent, which I may more fully illustrate in this case if required to do so.

I claim as new:—

1. The method of mineral oil production which comprises drilling a well of comparatively large diameter from the surface to the cap rock of an oil deposit to provide a gas expansion chamber of sufficient volume to substantially dissipate the natural gas pressure and preclude gushing when the oil flows, then disposing at the bottom of the well a filler having an opening therethrough, and then breaking through the cap rock into the oil deposit with a tool of comparatively small diameter operated through the filler opening to provide a channel of comparatively small cross section effecting communication between said chamber and the oil deposit.

2. The method of constructing an oil well consisting of drilling the well to a point just above the natural oil deposit, disposing a flow reducer at the bottom of the well thus drilled, and then piercing the intervening wall between the bottom of the well and the oil deposit to effect a relatively small intake between such deposit and the interior of the well.

3. The method of constructing an oil well which consists of first drilling the well to a point just above the oil deposit, then inserting in the bottom of the well a filler having a relatively small channel therethrough, and then piercing the wall between the oil deposit and the bottom of the well with a tool operated through said channel.

4. The method of constructing an oil well which consists of first drilling the well to a point just above the oil deposit, then inserting in the bottom of the well a filler having a relatively small channel therethrough, and then piercing the intervening wall between the bottom of the well and the oil deposit by using the filler channel as a guide for the cutting tool, so that the opening in said wall will correspond in size to the channel in said filler.

In testimony whereof I affix my signature.

RICHARD P. SIMMONS.