May 18, 1937. W. F. McMAHON 2,080,622

APPARATUS FOR ENTRAINING OIL AND GAS FROM OIL WELLS

Filed March 23, 1935 2 Sheets-Sheet 1

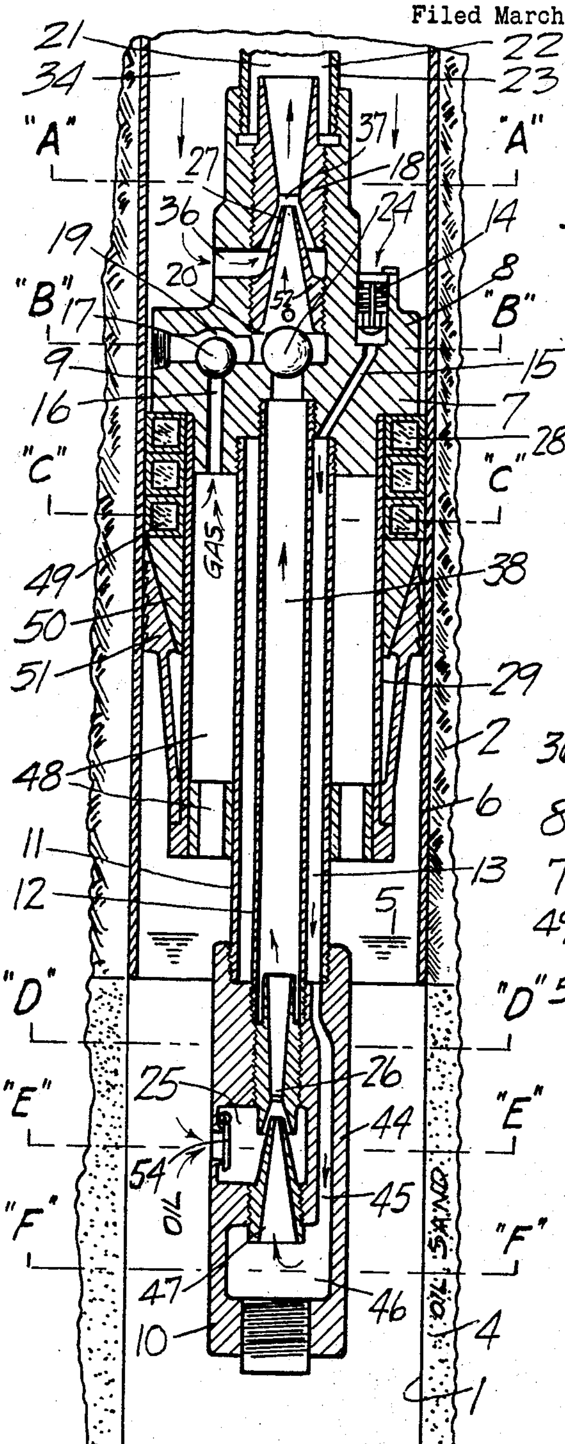

Fig. 1.

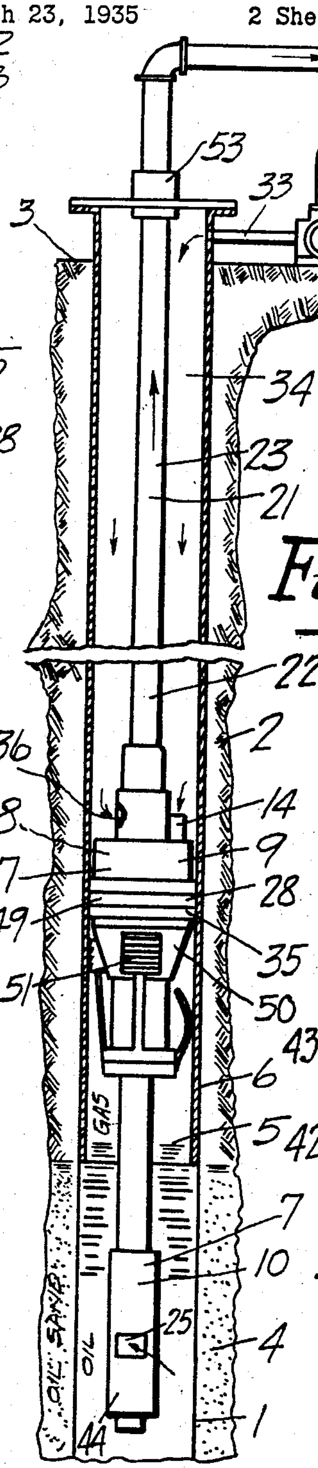

Fig. 9.

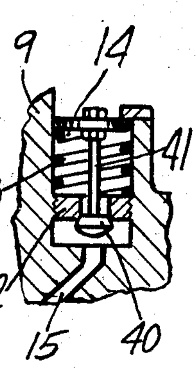

Fig. 2.

INVENTOR:

William Frederick McMahon.

APPARATUS FOR ENTRAINING OIL AND GAS FROM OIL WELLS

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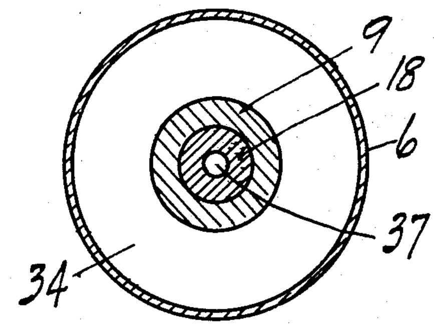

Fig. 3.

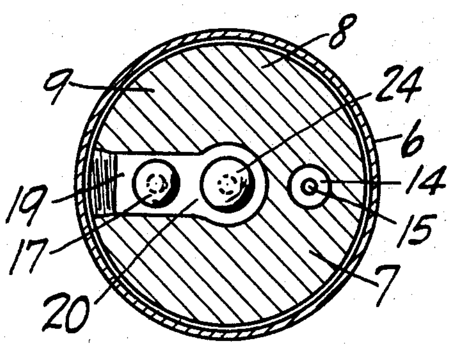

Fig. 4.

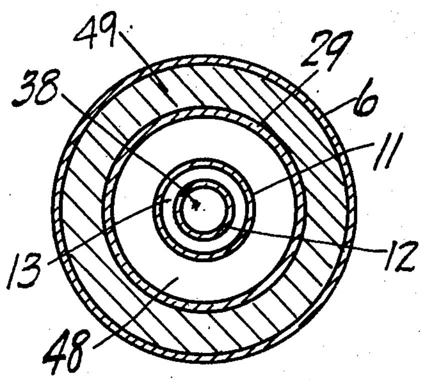

Fig. 5.

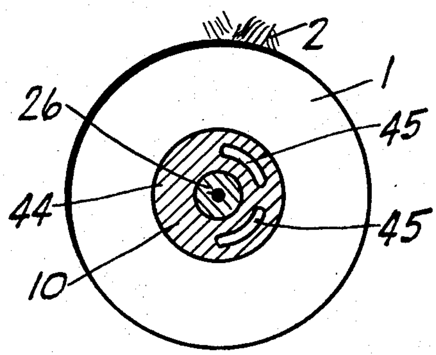

Fig. 6.

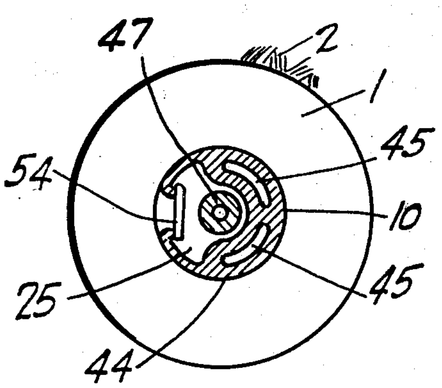

Fig. 7.

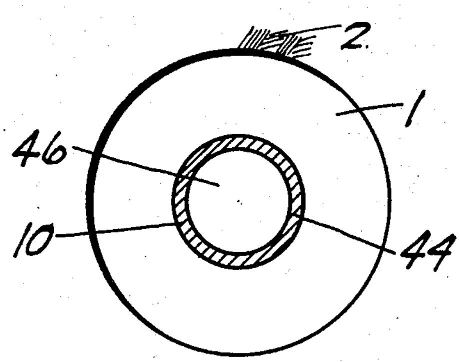

Fig. 8.

INVENTOR.

William Frederick McMahon.

Patented May 18, 1937

2,080,622

UNITED STATES PATENT OFFICE

2,080,622

APPARATUS FOR ENTRAINING OIL AND GAS FROM OIL WELLS

William Frederick McMahon, Riverside, Calif.

Application March 23, 1935, Serial No. 12,655

5 Claims. (Cl. 103—261)

This invention relates to the apparatus for entraining petroleum and/or gas from deposits in the earth wherein a circulating liquid acting as a motive medium and moving under a high velocity induced by a pressure pump is employed in cooperation with a new and novel means, and has for its object to render the method more expeditious, efficient and considerably cheaper.

In raising petroleum or fluid from oil wells by means of employing a circulating liquid in connection with any type of jetting apparatus construction and/or such as set forth and disclosed in my United States Letters Patent Number 1,779,483 issued April 23, 1928 entitled Oil well pumps; No. 1,801,503 issued April 23, 1931 entitled Oil well pumps; No. 1,992,436 issued February, 1935 entitled Oil well pump, the velocity of the circulating liquid is so high in passing through the jetting apparatus that unless the gas in the well is entrained through a unit substantially independent of the jetting apparatus adapted to entrain the petroleum, an emulsification of the petroleum is liable to take place especially where the water content in the said petroleum is high. Also the quantity of the circulating liquid in passing through a jetting apparatus is in the average case directly in an amount due to the static head at the depth the jetting apparatus is placed in the well and this quantity gets so large in a 6,000 foot well that unless some means is provided to reduce this quantity, then the throat of the venturi is liable to be choked and the amount of the fluid adapted to be entrained is reduced in many cases to almost nothing.

Also in direct connection with this large quantity of circulating liquid passing through the average jetting apparatus, due to the static head or depth at which a jetting apparatus must be placed in an oil well, the velocity set up thereby equals or is greater than three hundred feet per second and this speed of liquid is so high that a turbulent action, not alone due to the viscosity of the circulating liquid, is set up.

Now therefore, it is an object of this improvement to provide an apparatus and/or means, in the utilization of a circulating liquid to entrain fluid from oil wells, whereby any turbulent action is reduced to a minimum. Also the quantity of the circulating liquid passing through the jetting apparatus adapted to entrain oil from deposits in the earth, is also reduced to minimum quantity and made substantially different from that quantity that would be passed through due to the static head of the depth at which the said jetting apparatus is placed in an oil well.

It is a further object to provide a means for drawing off the gas from the oil well at a place different from that place at which the oil is entrained while at the same time proportions of the same circulating liquid, used as a motive medium, are utilized to perform the two functions namely, the entraining of the gas and the entraining of the oil from the same deposit and/or oil well.

It is a further object of this improvement to increase the efficiency of the kinetic and/or potential energy of the circulating liquid, being used as a motive medium, by preventing a large proportion thereof from being dissipated into heat. I am particularly concerned in these prime features and, of course, I do not wish to be limited to any details of construction of a desirable mechanical means for carrying the invention into practice. Therefore, the instrumentalities which characterize the apparatus herein disclosed are to be considered simply as a statutory prerequisite necessary to a disclosure of at least one known way of carrying the invention into practice.

With these and other objects in view, the invention resides and consists in the construction and novel combination and arrangement of parts hereinafter more fully described and illustrated and pointed out in the claims hereto appended, it being understood that various changes in the construction, form, method, proportion, size and minor details of construction within the scope of the claims may be resorted to without departure from the spirit and intent or sacrificing any of the advantages of the invention.

Similar characters of reference denote like or corresponding parts throughout the several figures of the accompanying drawings forming a part of this specification and upon which:

Fig. 1 is a sectional longitudinal elevation through the jetting apparatus.

Fig. 2 is a sectional longitudinal elevation through the reducing valve, on a larger scale.

Fig. 3 is a transverse section through the jetting apparatus at A—A.

Fig. 4 is a transverse section through the jetting apparatus at B—B.

Fig. 5 is a transverse section through the jetting apparatus at C—C.

Fig. 6 is a transverse section through the jetting apparatus at D—D.

Fig. 7 is a transverse section through the jetting apparatus at E—E.

Fig. 8 is a transverse section through the jetting apparatus at F—F.

Fig. 9 is a diagrammatic view showing the complete operating assembly.

Referring in detail to the characters of reference marked upon the drawings, 1 represents the oil well, which is a hole bored into the earth 2 from the surface of the earth 3 to the oil deposits or oil sands 4. After the oil sands are penetrated the gas pressure, in the earth, raises the oil and/or fluid to some height 5, up into casing 6. It is into this casing 6 that my jetting apparatus 7 is lowered. Now, in particular, this preferred jetting apparatus 7 comprises an upper jetting device 8 forming a sealing unit head 9, while the lower portion, of the complete jetting apparatus 7, comprises the oil entraining jetting device 10.

Reference to Fig. 1 of the accompanying drawings will facilitate description as this specification proceeds.

The lower oil entraining jetting apparatus is directly connected to the upper gas entraining jetting apparatus by conduits 11 and 12 and an annular passageway 13 is formed between the inside diameter of the conduit 11 and the outside diameter of the inner conduit 12. This annular passageway 13 is adapted to convey that proportion of the circulating liquid that is permitted to pass through the reducing valve 14 into passageway 15 in the head 9.

Now this upper jetting apparatus device 8 is employed to entrain the gas from the oil well through passageway 16, past the check valve 17 into the passageway 19 when the circulating liquid has gained sufficient velocity in the venturi 18 so that the pressure in the chamber 20 is less than gas pressure or rock pressure in the oil sands 4. It is also employed to utilize that proportion of the circulating liquid sufficient in amount to offset the static head of the column of fluid in column 21 or the passageway 22 inside of the tubing 23, or in other words, the column of fluid in the passageway 22, which extends from the venturi 18 to the surface of the earth 3. To facilitate my description it may be remarked that when the throat diameter of the venturi 18 is made about $11/64$ of an inch in diameter and this jetting apparatus is used in a 4000 foot well, the required amount of circulating liquid necessary to be used to create a partial vacuum in the chamber 20 would be about thirty gallons per minute. This quantity is due to the velocity head or velocity through the venturi 18 induced by the pressure caused by the surface pump 31 plus the 4000 foot drop. About ten gallons per minute of this total circulating liquid is permitted to pass through the reducing valve 14 or an amount sufficient to create a velocity partial vacuum in chamber 25 of the lower jetting device 10 and to raise the oil from the oil sands 4 up to chamber 20 of the upper jetting device 8. Were it not for this reducing valve 14 the total amount of the circulating liquid would obviously pass through the lower jetting device and choke the Venturi throat 26 therein.

By this novel construction the gas from the oil sands 4 is first started up through nozzle 27, through venturi 18 and into the column 21, thereby lightening the specific gravity of said column of fluid 21 before the check valve 24 is opened permitting the oil from the passageway 38 and chamber 25 to enter into the suction nozzle 27. This method of operation facilitates the raising of the fluid from the oil sands 4, and at the same time permits the lower jetting apparatus 10 to remain in a substantial body of oil at all times, the gas from the oil sands 4 being taken off, as above mentioned, through means of the upper jetting apparatus 8.

It may be remarked, at this time, that the function inherent in my patented device to-wit; McMahon, 1,801,520, April 21, 1931 is not the function or new and useful result accomplished by this method of operation and/or construction, because in the above mentioned patent both the gas from the oil sands and the oil from the oil sands must enter into and be entrained through the same suction entrance therein. This sets up practically the same condition as having any suction pipe, of any kind of pump, out of the liquid adapted to be pumped; and the detrimental suction action of permitting air or gas to have access to the suction pipe of any pump is well known, especially in the case of an oil well wherein a packer seal is used in connection with a casing 6, this packer seal shutting off any escape of the gas except through the suction entrance to the pump suction. Now the construction covered by this specification is the direct opposite in method of operation from the above mentioned method of operation because the gas from the oil sands 4 is entrained through the upper jetting apparatus 8, while the oil from the oil sands is entrained through the lower jetting apparatus 10.

One of the most important features of this new and useful method of operation is the using of certain proportions of the circulating liquid as a motive medium, in both the upper jetting apparatus 8 and the lower jetting apparatus 10, to entrain gas and oil respectively.

It is further thought that this construction of jetting apparatus formed and adapted to function as a packer unit 28 is also a new and useful physical embodiment to carry out the above mentioned method of operation, in an efficient manner.

A novel feature being that the entire upper jetting apparatus 8, the gas passageway 16 and the reducing valve 14 which segregates a proportion of the total volume of circulating liquid to the lower jetting apparatus 10 is formed in a packer head 9. While a nozzle and a venturi used as a jetting apparatus is well known in view of the art, it is obvious that the use herein of an upper jetting apparatus 8 and a lower jetting apparatus 10 is not a mere mechanical grouping of independent features because gas and oil are independent fluids in the same oil well and this new and useful combination of elements, as herein set forth, are employed to entrain these segregated fluids in an efficient segregated manner from the same oil well by use of segregated proportions of the same circulating liquid used as a motive medium. This is believed absolutely new in the art wherein a liquid is used as a motive medium. In other words, the function of the combination of elements is to raise fluid from the oil well and this fluid is both gas and oil and this function is to raise this oil and gas in the most efficient manner, which as set forth, results in a new and useful method of operation.

My construction resides principally in the upper jetting apparatus 8 and the lower jetting apparatus 10 formed as a packer unit 28 in which the elements thereof 9 and 29 together with the other elements thereof, form passageways and the like to permit this unit to function as a whole to obtain the results set forth.

The mode of operation is as follows: A surface pump 31, which may be any kind of a pump adapted to create a pressure on a fluid, performs the work of drawing liquid from a tank 30 through pipe line 32 and discharging the same through pipe line 33 into the annular passageway 34 formed between the inside diameter of casing 6 and the outside diameter of tubing 23. As the packer unit 28 sealing off the casing 6 at some point just above the oil sands 4 prevents this circulating liquid from passing by that point 35 into the oil sands 4, a certain proportion of this circulating liquid enters entrance 36, of the upper jetting apparatus 8, and is forced by the surface pressure of the pump 31 up through the throat 37 of the venturi 18. The velocity of and quantity of this circulating liquid passing through the throat 37 will be such as to create a partial vacuum in chamber 20 of head 9. Now even before a partial vacuum is created in chamber 20, the gas from the oil well will start flowing into chamber 20 when and at the time the pressure of the said gas exceeds the pressure reduced in chamber 20 by the flow of the circulating liquid through the venturi 18. At this point, the gas entering into the column of fluid 21 will lighten the specific gravity of that column 21 in tubing 23 and this condition will obviously further cooperate with the circulating liquid in creating vacuum in said chamber 20. When partial vacuum is created in chamber 20, the pressure of the column of liquid 38 in tubing 12, which connects the flow of the oil entrained by lower jetting apparatus 10 with chamber 20, is relieved and amounts merely to that pressure caused by the head of liquid extending between chamber 20 and chamber 25. Now during the time of the creation of vacuum in chamber 20 a certain proportion of the total circulating liquid in passageway 34, about thirty percent in volume, is permitted to bypass the reducing valve 14 in head 9, through passageway 15 hence into passageway 13 downward through jetting apparatus 10 thence upward through chamber 25 and venturi 26 thereof.

Now as I above mentioned that the pressure head of the column of liquid 38 is merely that head pressure set up by the distance between chamber 20 and chamber 25, the pressure of the column of circulating liquid released by reducing valve 14 will be substantially the total pressure in pounds per square inch equivalent to the total head from the surface of the earth 3 to the lower jetting apparatus 10. This great difference of pressures in columns 13 and 38 and passing through the lower jetting apparatus 10 will result in a large amount of oil being entrained by the said jetting apparatus 10 and discharged therefrom into chamber 20 of the upper jetting apparatus from which point it is raised to the surface of the earth 3 by the flow of the other seventy percent proportion of the circulating liquid flowing under pressure through venturi 18. Check valve 28 in chamber 20 prevents the said seventy percent proportion of the total volume of said circulating liquid from entering into column 38. Check valve 17 in the gas passageway chamber 18 prevents any liquid in column 21 from passing into passageway 16 hence to the oil deposits 4. Reducing valve 14, may be any kind of construction to perform the necessary requirements and in this preferred construction it comprises a valve 40 and a valve stem 41. This valve has a seat 42 connected with the head 9. A spring 43 will be set to suit the static pressure head of the column of liquid above it to such a degree that the pressure developed by the surface pump 31 will move valve 40 in a longitudinal direction off its seat 42 and create the necessary area that will permit about thirty percent of the total volume of the circulating liquid in column 34 to pass through said reducing valve 14 into the passageway 15 in head 9 thence into passageway 13 leading to the lower jetting apparatus 10 of this complete unit 7. The lower jetting apparatus 10 is similar in construction to that shown in my United States Letters Patent No. 1,801,520, April 21, 1931, with the exception of a check valve 54 in chamber 25, which will permit liquid to enter into the chamber 25 of the apparatus 10 but will not permit any liquid to leave it. This lower jetting apparatus 10, which is but one element in this combination of elements adapted to form the whole unit, is a cast body 44, comprising cored passageways 45 adapted to form a passageway for the flow of liquid from the passageway 13 formed between the two conduits 11 and 12 which are directly connected in concentric formation with said body 44. A lower chamber 46 in the body 44 serves to reverse the flow of liquid therein 180 degrees or from a downward direction to an upward direction so that the flow of liquid passes through nozzle 47 up through venturi 26 into passageway 38 formed by conduit 12. The liquid passing through nozzle 47 and venturi 26 will have such a velocity or kinetic energy as to create a partial vacuum in chamber 25 of the body 44, and this partial vacuum will permit oil from the oil sands 4 to be entrained into the system. Further proof of this lower jetting apparatus 10 being but one element in this combination of elements that serve to make up this complete unit 7, may be had by reason of the fact that a gas passageway 48 is created by the outside diameter of conduit 11, that connects the upper jetting apparatus 8 or head 9 with the body 44, and the inside diameter of the tubular cylinder 29. This cylinder 29 which is connected to and formed a part of head 9 and/or upper jetting apparatus 8, serves not only as a means for forming gas passageway 48 but also as a mandrel upon which the packing rings 49, tubular wedge 50, and slips 51 are mounted and permitted to move in a longitudinal direction toward the head 9 to shift the said packing rings 49 as and when the slips 51 are sufficiently embedded into casing 6 and the weight of the tubing 23 rests on said slips 51. Head 9 comprises a nozzle 52 and a venturi 18, and a chamber 36 for the entrance thereto of the circulating liquid, together with the other chambers, valves, etc. above mentioned. It serves also as a packer head and permits tubing 23 to be directly connected thereto. This tubing 23, which is connected to head 9, extends therefrom to the casing head 53 at the surface of the earth 3, and is adapted to convey the liquid and/or fluid raised or entrained from the oil sands 4, plus the circulating liquid used as a motive medium, to the surface of the earth 3 or casing head 53. From casing head 53 this tubing will convey the said liquid into the tank 30. The circulating liquid used in this method of operation may be any kind of liquid or combinations of liquids either nonblending with the fluid raised from the oil deposits or otherwise and used to equally good advantage. Due to the high velocity of the circulating liquid through a venturi used in a jetting apparatus placed at such depths in the earth as six thousand feet etc., the velocity of such circulating liquid is directly dependent upon the said depths and it is obvious that a turbulent action is set up in the majority of the cases, especially where a large quantity of circulating liquid is permitted to pass through a small throated venturi. By this construction of only permitting a small proportion of the total circulating liquid to pass through the lower jetting apparatus 10, I reduce any turbulent action of the circulating liquid or fluid to a minimum and prevent thereby a high percentage of its kinetic and/or potential energy from being dissipated into heat, while at the same time, the ratio of the volume of the oil entrained, from the oil sands, to the volume of the liquid or fluid circulated is considerably increased resulting thereby not only in a higher production but in a more efficient operating result.

It may be remarked along this line that, a circulating liquid that will be non-blending with the oil entrained could be used or a circulating liquid that will also cooperate to prevent emulsification of the oil entrained, especially where there is a high water content in said oil.

Suitable vents, relief valves, air chambers and/or accumulators that are used in good piping practice may be installed at any place in the system to suit the work.

The arrows in the several figures of the accompanying drawings indicate the direction of the flow of the circulating fluid and the flow of the circulating fluid and gas and/or oil raised.

What I claim as my invention is:—

1. In an apparatus for pumping an oil well comprising an oil well casing, a tubing located within and concentric with the said casing and a surface pressure device operated by energy derived from some external source for continuously moving and imparting a pressure on a fluid adapted for use as a circulating motive medium; said motive fluid being circulated through the said casing and tubing; a packer adapted to seal off said casing relative to said tubing and form thereby two concentric conduits leading from the oil deposit to the surface of the earth; said packer, being connected to the tubing, an upper jetting device connected to said packer and having a suction entrance or inlet from the oil deposit and a nozzle and an opened end Venturi tube connected with said inlet and adapted to entrain gas from below the packer and a lower jetting device connected to said packer and also comprising a suction entrance or inlet from the oil deposit and a nozzle and an opened end Venturi tube connected with said inlet and adapted to entrain the said petroleum; means for introducing the continuous circulating motive fluid around said tubing and under a pressure created by the surface pressure device and the static head of the column itself above said packer and leading respective portions of the total volume of the said circulating motive fluid under said pressure through the respective upper and lower jetting devices wherein the velocity of the movement of the circulating motive fluid therethrough creates a vacuum in the suction entrances or inlets in the respective jetting devices thereby entraining gas and petroleum respectively from their respective fluid levels in the deposit, and finally causing the circulating motive fluid to ascend in the tubing with the entrained gas and oil and to intermingle therewith, and means for taking off the entrained fluid from the circulating motive fluid as the circulating motive fluid increases in volume.

2. In an oil well having an oil deposit and a conduit and a tubing located within and concentric with the said conduit; a surface pressure device operated by energy derived from some external source for continuously moving and imparting a pressure on a fluid adapted for use as a circulating motive medium; said circulating motive fluid being circulated through the said conduit and tubing; a sealing means adapted to seal off said conduit relative to said tubing and form thereby two concentric tubes leading from the oil deposit to the surface of the earth, the said sealing means being connected to the said concentric tubes and comprising an upper jetting device and a lower jetting device, both said devices having access with the said oil deposit; means for introducing the circulating motive fluid around said tubing and under a pressure created by the surface pressure device plus the static head of the column of itself above said jetting devices and segregating and leading respective proportions of the total volume of the said circulating motive fluid through the respective upper and lower jetting devices wherein the kinetic energy of the respective proportions of the circulating motive fluid creates vacuum in each respective jetting device thereby entraining gas and petroleum respectively from their respective fluid levels in the oil well and finally causing the circulating motive fluid to ascend in the tubing with the entrained gas and petroleum and to intermingle therewith.

3. In an oil well having an oil deposit and an oil well casing and a tubing located within and concentric with the said casing; a surface pressure device operated by energy derived from some external source for continuously moving and imparting a pressure on a fluid used as a circulating motive medium; said circulating motive medium or fluid being circulated through the said casing and tubing; a packer adapted to seal off said casing relative to said tubing and form thereby two conduits leading from the oil deposit to the surface of the earth, the said packer being connected to the tubing and located at the lower end portion of the casing in the oil well and comprising an upper ejecting means for entraining gas from the deposit and a lower ejecting means for entraining petroleum from the deposit, the said lower ejecting means adapted to discharge through the said upper ejecting means; means for introducing the total volume of circulating motive fluid around said tubing and under a pressure created by the surface pressure device; means connected with the packer and adapted to segregate and lead respective proportions of the total volume of the circulating motive fluid under said pressure through the respective upper and lower jetting means; means connected with the said packer for reducing the pressure head of the downstream column of fluid between the upper and lower ejecting means by creating vacuum with one portion of the total volume of the circulating motive fluid in the upper ejecting means and further comprising of means permitting the full pressure head from the surface of the earth to the lower ejecting means to act on the other portion of the circulating motive fluid passing through the said lower ejecting means; means wherein each portion of the total volume of the circulating motive fluid creates sufficient kinetic energy in the respective upper and lower ejecting means to entrain gas and petroleum from their respective fluid levels in the oil well and finally causing the circulating motive fluid to ascend in the tubing with the entrained gas and petroleum and to intermingle therewith.

4. In an oil well containing a column of gas and an accumulation of petroleum below said column of gas; a pumping apparatus adapted to be located in said oil well and comprising of a surface pressure device operated by energy derived from some external source for continuously moving and imparting a pressure on a fluid used as a motive medium; two concentric conduits connected to said surface pressure device; an upper and lower ejecting means in said conduits, said motive fluid being circulated through said conduits, the upper ejecting means adapted to entrain the gas in the well and the lower ejecting means adapted to entrain the petroleum; means for introducing the total volume of the circulating motive fluid into the outer of said concentric conduits; means for segregating and leading respective portions of the total volume of the flow of circulating motive fluid through the respective upper and lower ejecting means to create kinetic energy and vacuum in each of said ejecting means; means for reducing the static head of that portion of the flow which goes to the lower ejecting means, while the portion of the flow going to the upper ejecting means has a pressure equal to the static head of the column of fluid between the surface of the earth and said upper ejecting means plus the pressure induced by the surface pressure device.

5. In an oil well containing a column of gas and an accumulation of petroleum below said column of gas; a pumping apparatus adapted to be located in said oil well and comprising a surface pressure device operated by energy derived from some external source for continuously moving and imparting a pressure on a fluid used as a motive medium; two concentric conduits connected to said surface pressure device; an upper and lower ejecting means in said conduits, said motive fluid being circulated through said conduits, the upper ejecting means adapted to entrain the gas in the well and the lower ejecting means adapted to entrain petroleum; means for introducing the total volume of the circulating motive fluid into one of the said concentric conduits; means for segregating and leading respective portions of the total volume of the flow of circulating motive fluid through the respective upper and lower ejecting means to create vacuum in each of said ejecting means.

WILLIAM FREDERICK McMAHON.