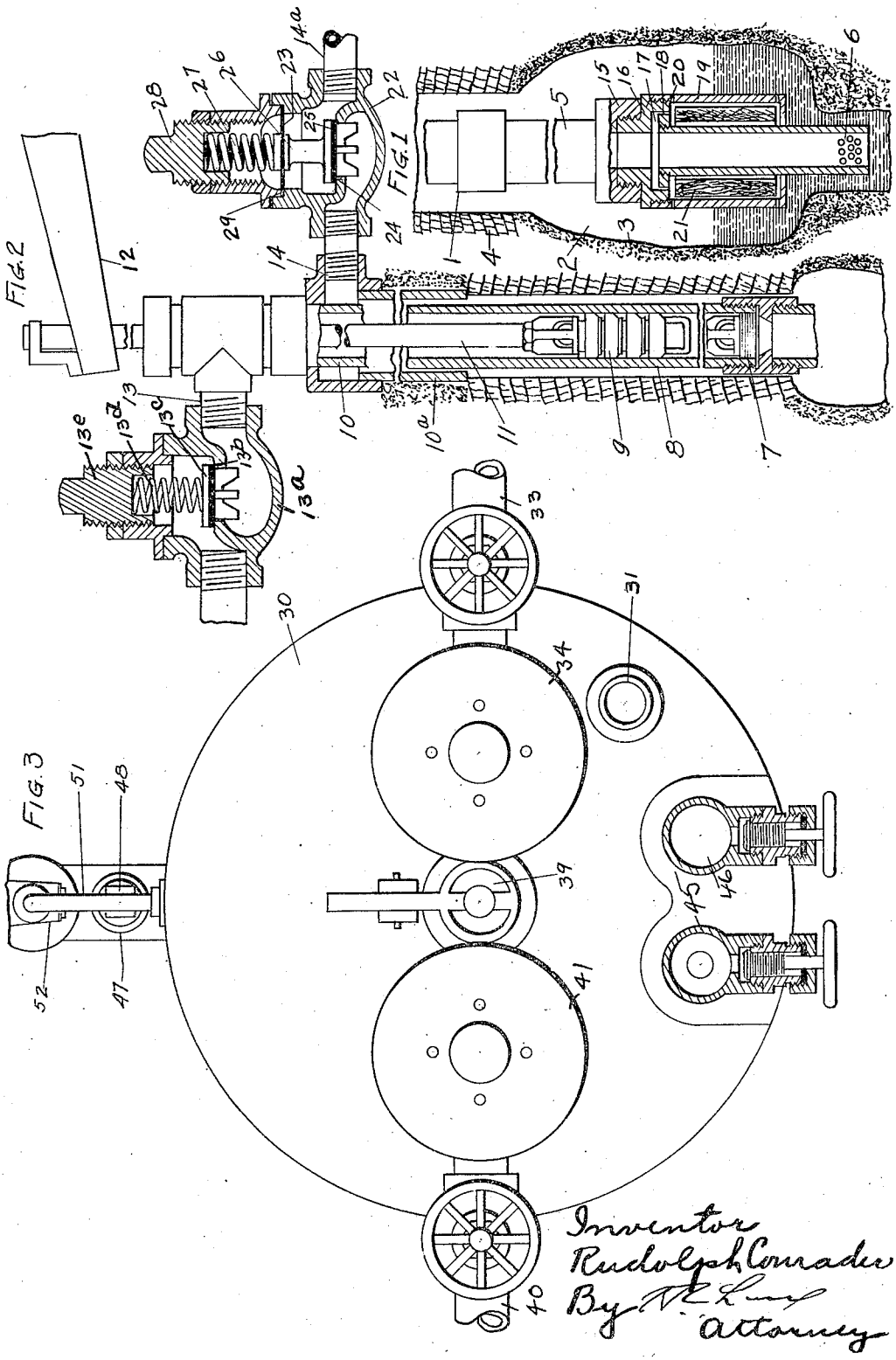
Dec. 23, 1924. 1,520,052

R. CONRADER

METHOD OF OPERATING OIL WELLS AND TREATING THE PRODUCTS THEREFROM AND APPARATUS THEREFOR

Filed Nov. 15, 1920 3 Sheets-Sheet 1



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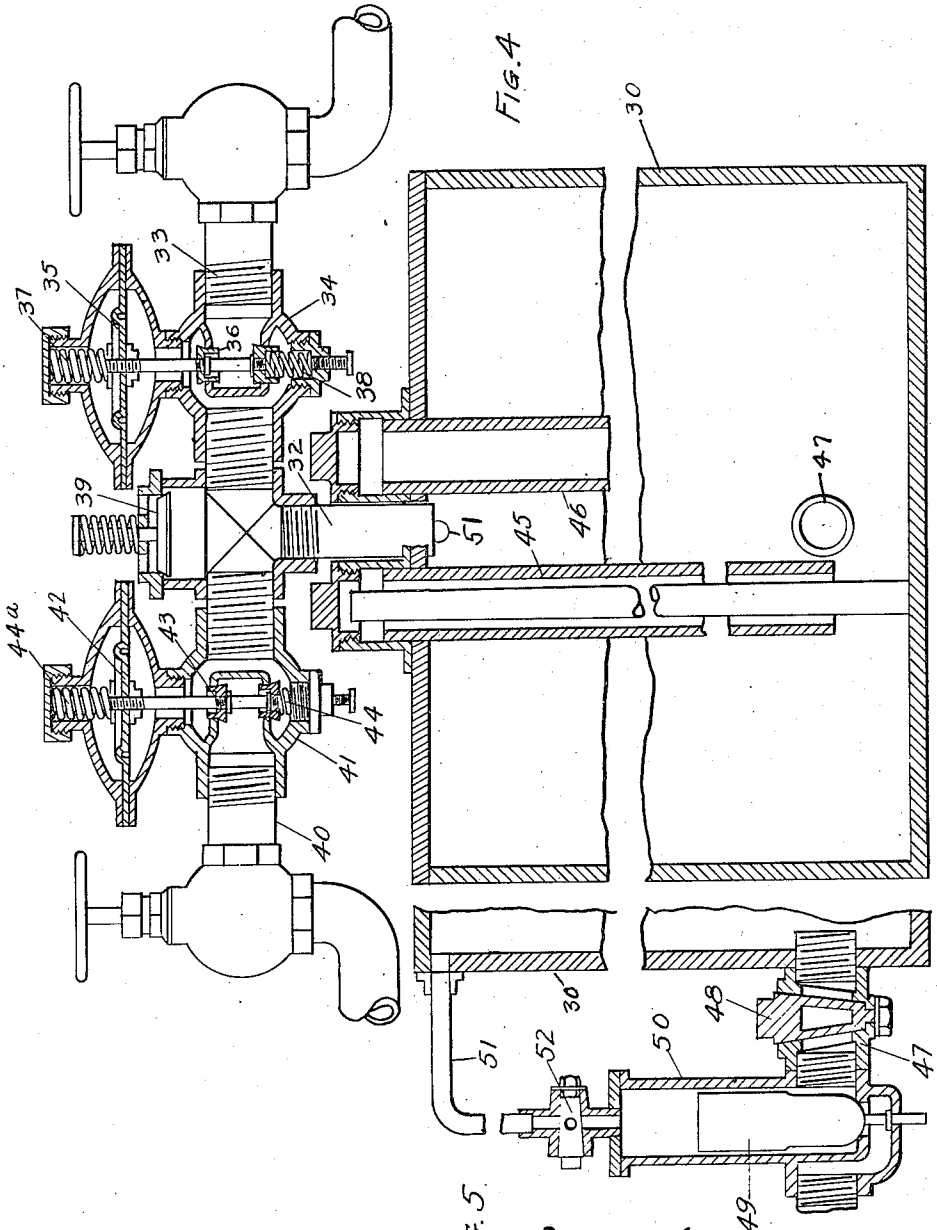


FIG. 4

FIG. 5

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Filed Nov. 15, 1920 3 Sheets-Sheet 3

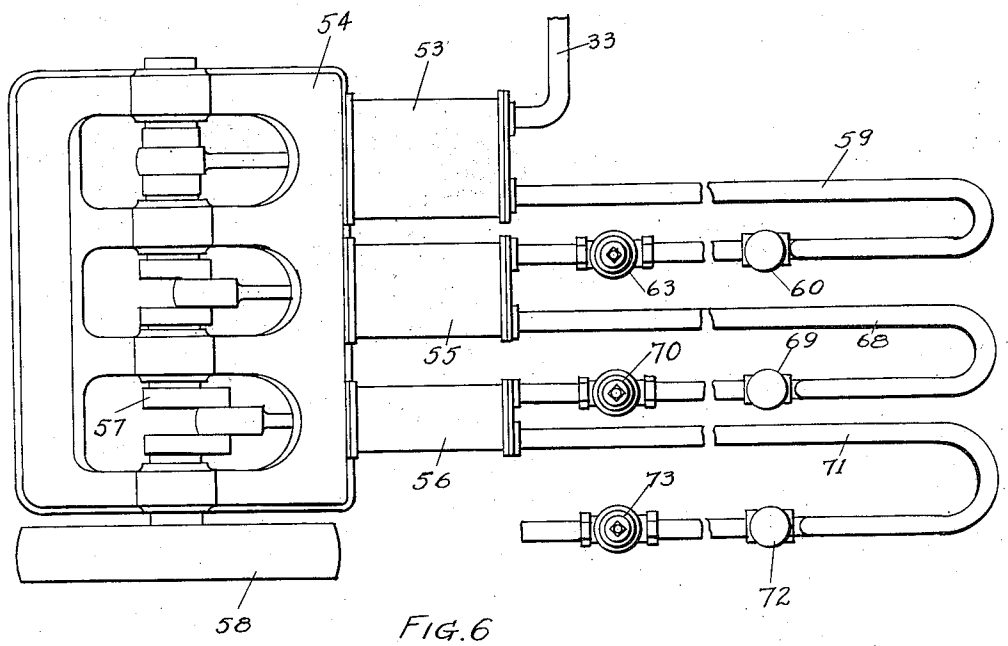


FIG. 6

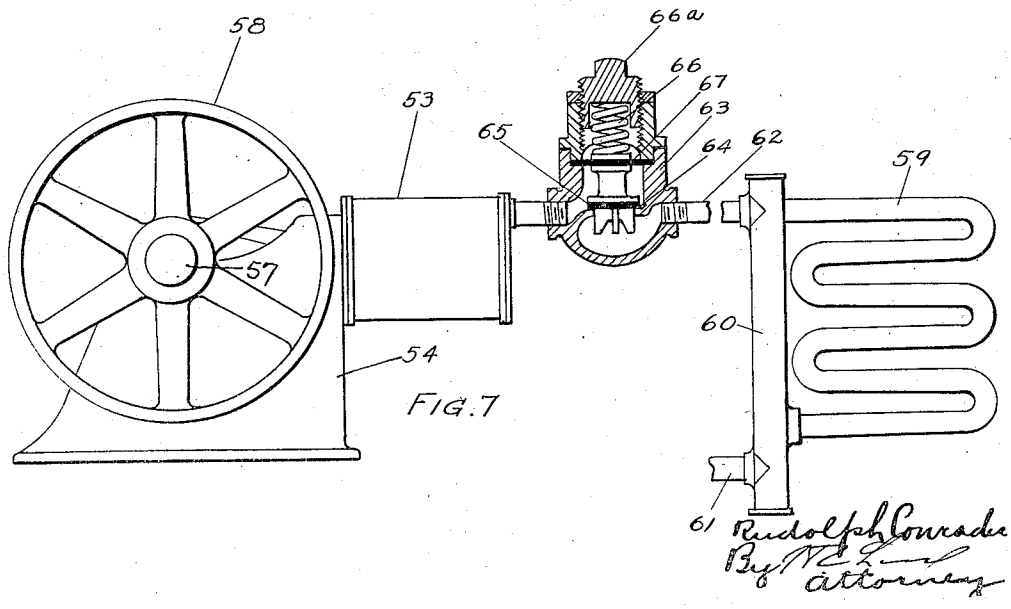


FIG. 7

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UNITED STATES PATENT OFFICE.

RUDOLPH CONRADER, OF ERIE, PENNSYLVANIA.

METHOD OF OPERATING OIL WELLS AND TREATING THE PRODUCTS THEREFROM AND APPARATUS THEREFOR.

Application filed November 15, 1920. Serial No. 424,179.

To all whom it may concern:

Be it known that I, RUDOLPH CONRADER, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented new and useful Improvements in the Method of Operating Oil Wells and Treating the Products Therefrom and Apparatus Therefor, of which the following is a specification.

In the operation of oil wells difficulty is experienced in maintaining the production of the well, or in other words, exhausting the oil from the oil bearing sands. But a comparatively small fraction of the total oil carried in oil bearing sands is extracted. Petroleum is made up of different constituents, some very heavy and some very light and the fluidity of the oil depends very largely on retaining the more volatile constituents so as to carry the less volatile constituents. The more volatile constituents will carry only a certain proportion of the heavier constituents and when the volatile constituents are removed these heavier constituents are precipitated forming paraffin, or other practically non-fluid materials depending on the nature of the petroleum. The constituents of the petroleum vaporize at a given pressure and temperature and this vaporizing pressure and temperature is constantly the same whether the constituents are separated from the other portions of the oil or whether they are carried in the body of the oil. In order to overcome the capillary action of the oil in the sands it is necessary to utilize the pressures inherent in the oil. Some of the more volatile constituents contained in the oil when the oil is subjected to rock pressure must, therefore, be released in order to obtain such a movement of the oil. I prefer, therefore, to maintain the well under pressure and to have that pressure approximately the vaporizing pressure of the constituent of the oil which is the next less volatile constituent than will vaporize at normal well pressure. For instance in a well where the rock pressure is from thirty-three to forty pounds the butane has a vapor pressure of thirty-three pounds at 65° Fahrenheit and is, therefore, in liquid form in the rock but if the full thirty-three pounds were maintained there would be practically no expelling pressure on the fluid in the sand. I prefer, therefore, to drop down to the next constituent as pentane which under a temperature of 65° Fahrenheit has a vapor pressure of seven and a half pounds. Under these conditions by retaining a pressure at seven and one half pounds the pentane is maintained in liquid form and forms a solvent for the heavier constituents such as paraffin and if this is maintained in the oil and these constituents kept together the precipitation of the heavier constituents can be very much prevented and consequently the clogging of the well prevented so that the production may remain approximately uniform for a long period.

In carrying out my invention, therefore, I maintain the pressure on the well as before stated and in removing the oil from the well I prefer to remove it from the lower level because of the tendency of the constituents to stratify. If, therefore, the oil is pumped from the lower level in each instance it will leave in the well at the completion of each pumping action a body of oil containing an excess of the more volatile constituents and these will act in the surrounding sands upon the less volatile constituents that have been precipitated so that in time these non-fluid substances will be dissolved and removed.

By retaining these substances in the oil and removing them from the well in the oil and then reducing the pressure on the oil so as to vaporize these volatile constituents the gasoline content may be condensed with but a small part of the energy that is required to separate the gasoline from the gases when the gases are permitted to separate from the oil in the well and co-mingle with the more volatile gases because in condensing the gasoline from the gases they have been mixed with the more volatile gases all the gas must be compressed whereas with the less volatile gases separated as in the case where they are taken from a well with the oil only these less volatile gases need be compressed. I therefore, prefer to deliver the oil into large tanks, reduce the pressure to approximately atmospheric pressure or slightly below atmosphere, and condense the gasoline from the gas so evolved excluding the air from the oil or gases.

In carrying out the method I utilize an

apparatus herein illustrated, such apparatus forming a part of my invention as follows:—

Fig. 1 shows a well cavity.

Fig. 2 a well extending to the surface.

Fig. 3 a plan view of the storage tank, the connections therein being partly in section.

Fig. 4 a section through the storage tank with the controlling devices.

Fig. 5 a section of the liquid discharge valves.

Fig. 6 a plan view of the condensing apparatus.

Fig. 7 a side elevation of the same, a part being in section to better show construction.

1 marks the well, 2 the cavity ordinarily formed in the oil sand 3, and 4 the overlying rock, 5 a strainer connection, 6 the strainer, 7 a standing valve from which the connection 5 extends, 8 the pump barrel, 9 the pump plunger, 10 a tubing extending to the top of the well, 11 the sucker rods, 10ª a casing, 12 the walking beam operating the pump, 13 the oil discharge from the tubing, and 14 the gas discharge from the casing. These parts in the main are of ordinary construction. I prefer to provide, however, between the pump and the strainer 6 a device for automatically cutting off the pumping action with a level of liquid above the intake formed at the strainer. This has been accomplished heretofore by placing a vent through the connection 5 at the level to which it is desired to pump. The difficulty with this vent has been that the more volatile constituents of the oil having the greater fluidity flowed through this vent in the operation of the pump and consequently that part of the oil having the greatest capability of acting as a solvent for the less volatile constituents was usually removed in the pumping action so that the residue which was left in the well being devoid of this lighter constituent would gradually precipitate some of the less volatile constituents, such as paraffin, thus clogging the well and this clogging action gradually operating in the walls of the sand closed the flow area to the well to a very small portion of the well cavity near the top of the oil bearing sands. With this invention I provide a float device which prevents the liquid from entering the vent so that all the oil that is pumped is pumped from the lower level, thus retaining in the well the more volatile constituents of the oil and assuring the gradual dissolving of the paraffin or other constituents that are precipitated. A fitting 15 is secured to the connection 5. A vent coupling 16 is screwed into the fitting 15, the vent coupling having a vent opening 17 leading through a seat 18. A receptacle 19 is secured to the coupling 17 and this is provided with openings 20 at its top and bottom permitting the free entrance of liquid and gas to the receptacle. An annular float 21 is placed in the receptacle, the upper end of the float forming a valve operating on the seat 18 to open and close the vent 17. It will readily be seen that as the liquid fills into the well the float is carried upwardly with it closing the vent 17 and this closure is more positive as the liquid level rises and increases the pressure on the float. When the pumping takes place all the liquid leading to the pump passes through the strainer at a level below the vent, this distance being varied depending on the depth of the sands and the desirable level to maintain the liquid in the well. As soon as the liquid in well reaches a point somewhat below the top of the float the float drops away from the seat 18 and opening the vent immediately stops the pumping action. It will readily be seen that the liquid left in the well is the more volatile liquid so far as any stratification has taken place and consequently is capable of dissolving a quantity of the less volatile constituents of the oil such as paraffin that may have been accumulated in the lower portions of the well cavity and the sands adjacent. It will readily be seen that as these non-fluid substances are dissolved out of the walls of the cavity and the immediate sands that the flow of oil if the volatile constituents are retained in the oil to the cavity will be from all the oil bearing sand rather than from the upper portions of it so that the production in this way may be very much increased and a greater portion of the oil sands recovered.

In order to retain the desired pressure on the well I provide a valve having a body 22, a diaphragm 23, a valve seat 24, and a valve disc 25, the valve body being secured to the pipe or discharge 14. A stem 26 extends from the disc 25 and a spring 27 operates on the stem. The spring pressure may be varied by a screw 28 and a diaphragm is provided to prevent the back pressure of gas in the discharge pipe 14ª disturbing the pressure at which the valve operates. This particular valve and the method of retaining the pressure on the well broadly is contained in an application filed by me on July 20th, 1920, Serial Number 397,664 patented Oct. 10, 1922, No. 1,431,777. By adjusting this valve the pressure may be maintained on the well approximating the vaporizing pressure of the most volatile constituent which has a vaporizing pressure distinctly below that of the well pressure. Using this pressure a maximum flow of oil may be obtained because the greatest possible volatile constituents are retained in liquid form so as to add fluidity to the oil as a whole and act as a

solvent for the non-volatile constituents which may have been precipitated.

The oil is delivered from the pipe 13 to a tank 30 through an inlet 31. The tank 30 has a gas discharge pipe 32 leading from the tank. A pipe 33 leads from the pipe 32. A controlling valve 34 is arranged in the pipe 33. It is provided with a diaphragm 35 subjected to the pressure of the tank, the diaphragm being connected to the valve 36 and the pressure at which the diaphragm acts being adjustable through the adjustment of the springs 37 and 38. It will readily be seen that this may be set at a pressure so as to accomplish the opening of the valve 36 with any desired pressure within the tank—preferably slightly below atmosphere. In order to avoid a reduction of pressure below the safety point a valve 39 is provided which admits air for this purpose. It will be understood, however, that this is simply a safety device and does not operate under normal conditions.

In order to exclude the air from the tank particularly as the oil is discharged therefrom it is desirable to deliver gas from some source as through a pipe 40 leading to the pipe 32. The pipe 40 is provided with a controlling valve 41 having a diaphragm 42 subjected to the tank pressure and operating on the valve 43. The diaphragm action is opposed by the springs 44 and 44[a] so that the gas will enter at any pressure desired preferably approximately atmospheric pressure. Testing and gauging tubes 45 and 46 are provided which are arranged to be opened and closed without the introduction of excess air or discharge of gas. These features are fully described in an application filed by me on May 20th, 1920, Serial Number 382,759.

A discharge connection 47 leads from the tank. This has a manually operated valve 48 and an automatic valve 49, the automatic valve being in the form of a float which cuts off the discharge prior to the uncovering of the discharge pipe to the tank gas. The float valve is carried in a chamber 50 connected by a pipe 51 with the tank, the connection 51 being controlled by a valve 52. By operating the valve 52 the movement of oil in the chamber may be permitted so as to assure a movement of the float valve as the tank is discharged. In a general way this construction is described in my application filed April 9, 1919, Serial Number 288,867.

Where the oil is delivered carrying the more volatile constituents it is desirable to reduce the pressure on the oil to atmosphere or slightly below so that those constituents which will not remain in the oil when it is exposed to the atmosphere may be saved. In the present method and apparatus this is accomplished by drawing off the gas as the pressure is reduced through the pipe 33, and passing it through a condensing apparatus which takes out the gasoline delivering the gas for use. The condensing apparatus is of common construction except that the compression is stepped and the gasoline condensed at each compression is extracted separately as they have a greater commercial value in most instances when separated than when co-mingled. The compressor as shown comprises the three cylinders 53, 55 and 56 which are mounted on the one frame 54 and driven from a common crank shaft 57, the crank shaft being driven from a pulley 58. The gases as they are compressed in the cylinder 53 are delivered to the coil 59 and from the cooling coil 59 to the separating column 60, the gasoline being withdrawn through the pipe 61 and the gases passed forward through the pipe 62. The gases then pass through a valve 63 which maintains the pre-determined pressure to the second cylinder 55 and are delivered from that to a condensing coil 68 similar to the coil 59 and from the coil 68 to a condensing column 69 having a gasoline discharge at 61 and a gas discharge as 62 and are delivered through a valve 70 to the third pressure cylinder 56, the gases being further compressed and delivered to a third coil 71 from which they pass to a separating column 72 from which the gasoline is drawn and the gases delivered through a valve 73 to the gas line. The valve 63 has a seat 64 on which a disc 65 operates and the disc is subjected to the pressure of the spring 66 which may be adjusted by a screw 66[a] to any pressure desired. The diaphragm 67 is subjected to the pressure and neutralizes variations in pressure at the discharge side of the valve. In this way it will be understood that the valves 70 and 73 are of similar construction to the valve 63 so that the pressure in the coils 59, 68 and 71 may be adjusted so as to extract one of the constituents of the oil, as for instance, heptane and hexane the principal constituents of good gasoline may be condensed in the first stage, and the pentane which is of too high a gravity for commercial gasoline except where it is mixed with distillate may be taken in the second stage, this having a higher value in its separated state, however, than with ordinary gasoline. It will readily be seen that only the gases which carry oil constituents capable of being condensed into commercial gasoline are compressed, that is to say, the gases which do not carry such gasoline are not present. Consequently there is a tremendous saving in the collection of gasoline by this method over that of the method usually employed with what is commonly known as casing head gas. With this method the wells are placed under a vacuum so that not only are all the disadvantages of sepa-

rating the more volatile substances from the well brought about but there is carried into the gas from which the gasoline is to be separated all the constituents which by reason of their low vaporizing quality preclude their being practically utilized for the production of gasoline. Nevertheless all these extra gases must be compressed to the same extent as the gasoline producing gases.

As the oil is pumped and reaches the upper part of the tubing it is subjected to the violent agitation due to the reciprocation of the sucker rod and this agitation with the reduction in pressure on the oil as it reaches the surface by reason of the reduction in static head tends to liberate the gases or lighter constitutents of the oil. This separation of these lighter constituents results in the precipitation of the heavier constituents forming paraffin and this paraffin accumulating in the tubing interferes with the free pumping of the oil. I obviate this by arranging a pressure valve on the oil discharge tube pipe 13. As shown a valve 13^a has the valve seat 13^b controlled by a disc 13^c. A spring 13^d operates on the disc and the pressure of the spring may be regulated by the screw 13^e. The pressure on this disc should approximate the vaporizing pressure of the most volatile constituent of the oil. This added pressure will be very slight as compared to the load in lifting the oil from wells of the ordinary depth.

What I claim as new is:—

1. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of the most volatile constituent of the oil vaporizing at well temperature at a pressure below the rock pressure.

2. The method of operating oil wells which consists in maintaining a pre-determined pressure on the well; removing the oil from the well beginning with the less volatile constituents; and retaining in the well a portion of the more volatile constituents.

3. The method of operating oil wells which consists in maintaining a pre-determined pressure on the well; removing the oil from the well entirely from a low level in the well cavity; and preventing the exhaustion of the well to said low level.

4. The method of operating oil wells and treating the products therefrom which consists in maintaining the well under pressure; removing the oil; confining the oil and gas therefrom; and reducing the pressure to expel the gases.

5. The method of operating oil wells and treating the products therefrom which consists in maintaining the well under pressure; removing the oil; confining the oil and gas therefrom; and reducing the pressure to approximately atmospheric pressure to expel the gases.

6. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of the most volatile constituents of the oil; vaporizing at well temperature at a pressure below the rock pressure; removing the oil; confining the oil and gas therefrom; and reducing the pressure to expel the gases.

7. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of the most volatile constituent of the oil vaporizing at well temperature at a pressure below the rock pressure; removing the oil; confining the oil and gas therefrom; and reducing the pressure to approximately atmospheric pressure to expel the gases.

8. The method of operating oil wells and treating the products therefrom which consists in maintaining the well under pressure; removing the oil; excluding the air; reducing the pressure to expel the gases; and condensing the gases.

9. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of the most volatile constituent of the oil vaporizing at well temperature at a pressure below the rock pressure; removing the oil; excluding the air; reducing the pressure to expel the gases; and condensing the gases.

10. In an apparatus for operating oil wells and treating the products therefrom, the combination of means for removing the oil; means for maintaining a pressure on the well; a tank excluding the air into which the oil is delivered; and an apparatus condensing the gases.

11. In an apparatus for operating oil wells, the combination of a pump; an intake through which the entire flow to the pump passes; and a valve mechanism automatically stopping the flow to the pump with a level of oil above the intake.

12. In an apparatus for operating oil wells, the combination of a pump; an intake leading to the pump; a vent above the intake; and means automatically closing the vent to liquid.

13. In an apparatus for operating oil wells, the combination of a pump; an intake leading to the pump; a vent above the intake; and a float closing the vent under the action of the liquid.

14. In an apparatus for operating oil wells, the combination of a pump; an intake to the pump; a vent coupling in the intake; a receptacle secured to the coupling; and a float in the receptacle, said float being adapted to close the vent coupling when acted upon by the liquid.

15. The method of operating oil wells which consists in maintaining a constant pressure on the well approximating the vapor pressure of the most volatile con-

stituent of the oil vaporizing at well temperature at a pressure below the rock pressure.

16. The method of operating oil wells which consists in elevating the oil; and maintaining a pressure on the oil at the discharge equal to the pressure of the most volatile constituent of the oil at the discharge.

17. The method of operating oil wells which consists in maintaining a pressure on the well; elevating the oil; and maintaining a pressure on the discharged oil.

18. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of the most volatile constituent of the oil vaporizing at well temperature at a pressure below the rock pressure, elevating the oil; and maintaining a pressure on the oil at the discharge.

19. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of the most volatile constituent of the oil vaporizing at well temperature at a pressure below the rock pressure; elevating the oil; and maintaining a pressure on the oil at the discharge approximating the pressure of the most volatile constituent of the oil at the discharge.

20. In an apparatus for operating oil wells, the combination of a tubing; a pump on the tubing; a sucker rod operating in the tubing; and means for putting back pressure on the tubing.

21. In an apparatus for operating oil wells, the combination of a tubing; a pump on the tubing; a sucker rod operating in the tubing; and means for putting back pressure on the tubing comprising a pressure valve at the discharge; and means for adjusting the pressure valve.

22. The method of operating oil wells which consists in maintaining a pressure on the well below rock pressure equal to the vapor pressure of one of the more volatile constituents of the oil.

23. The method of operating oil wells which consists in maintaining a pressure on the well approximating the vapor pressure of one of the more volatile constituents of the oil.

24. The method of operating oil wells which consists in maintaining a constant pressure on the well below rock pressure equal to the vapor pressure of one of the more volatile constituents of the oil.

25. The method of operating oil wells which consists in maintaining a constant pressure on the well approximating the vapor pressure of one of the more volatile constituents of the oil.

In testimony whereof I have hereunto set my hand.

RUDOLPH CONRADER.