March 31, 1931. L. N. YATES 1,798,774

METHOD AND APPARATUS FOR RECOVERING PRESSURE GAS FROM OIL WELLS

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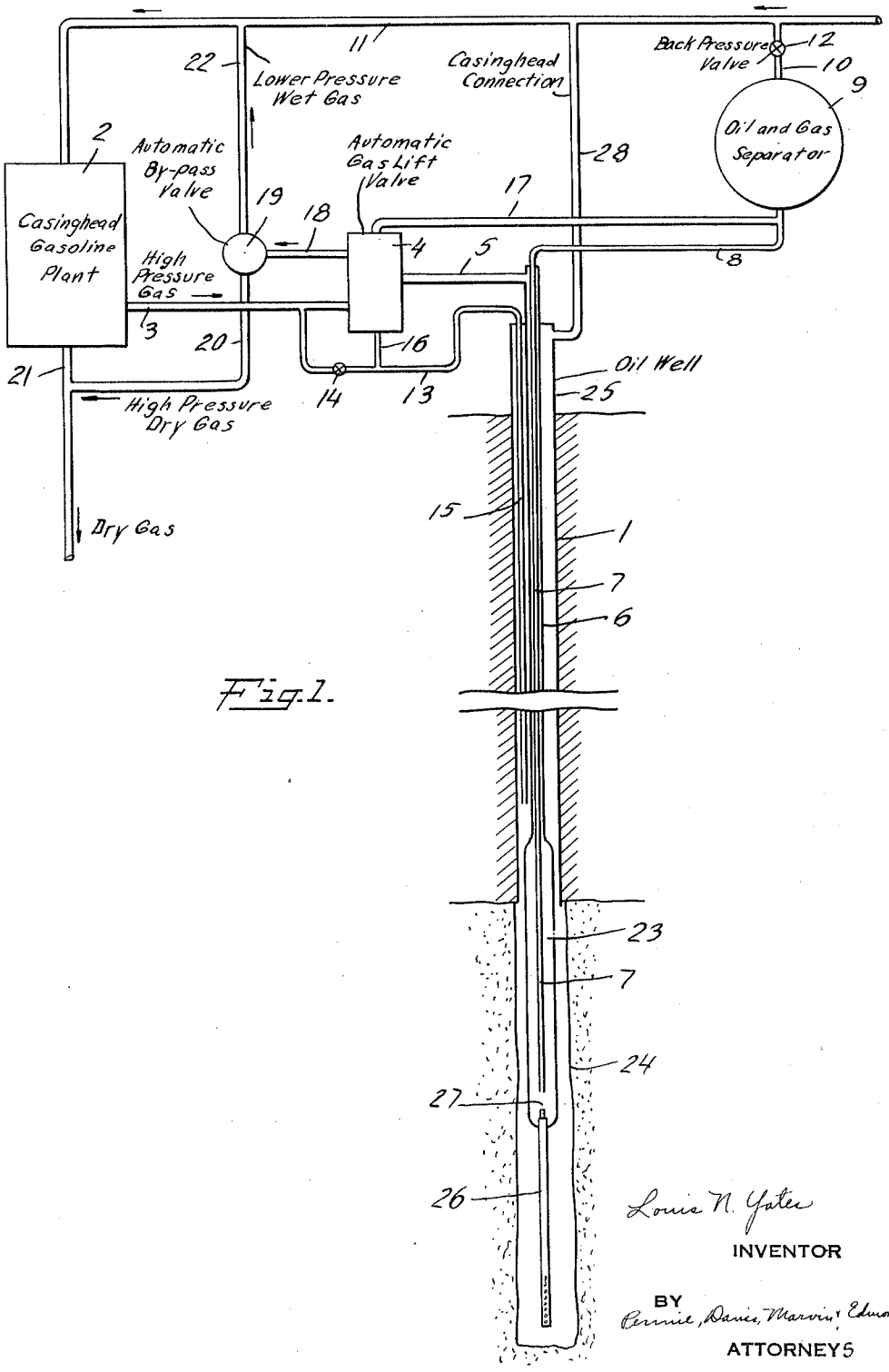


Fig. 1.

Louis N. Yates

INVENTOR

BY Pennie, Davis, Marvin & Edmonds

ATTORNEYS

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Fig. 2.

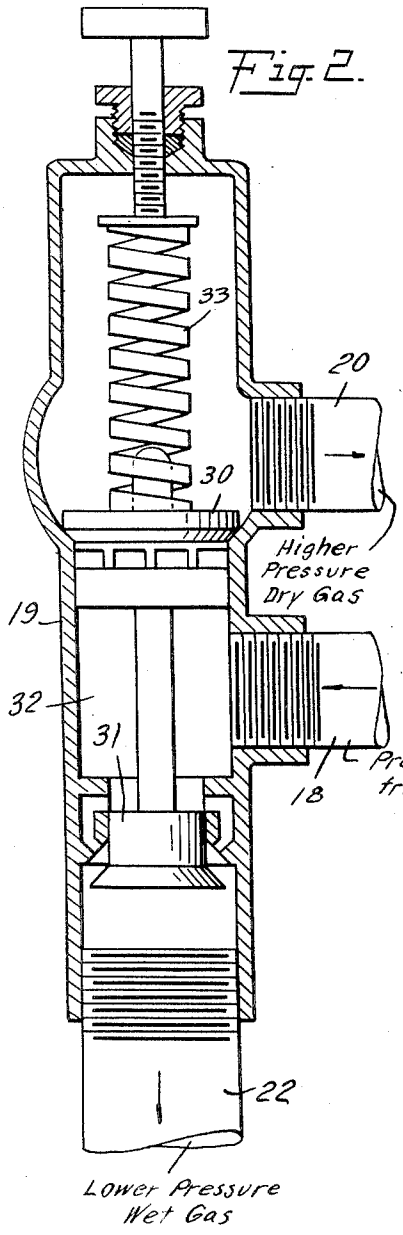
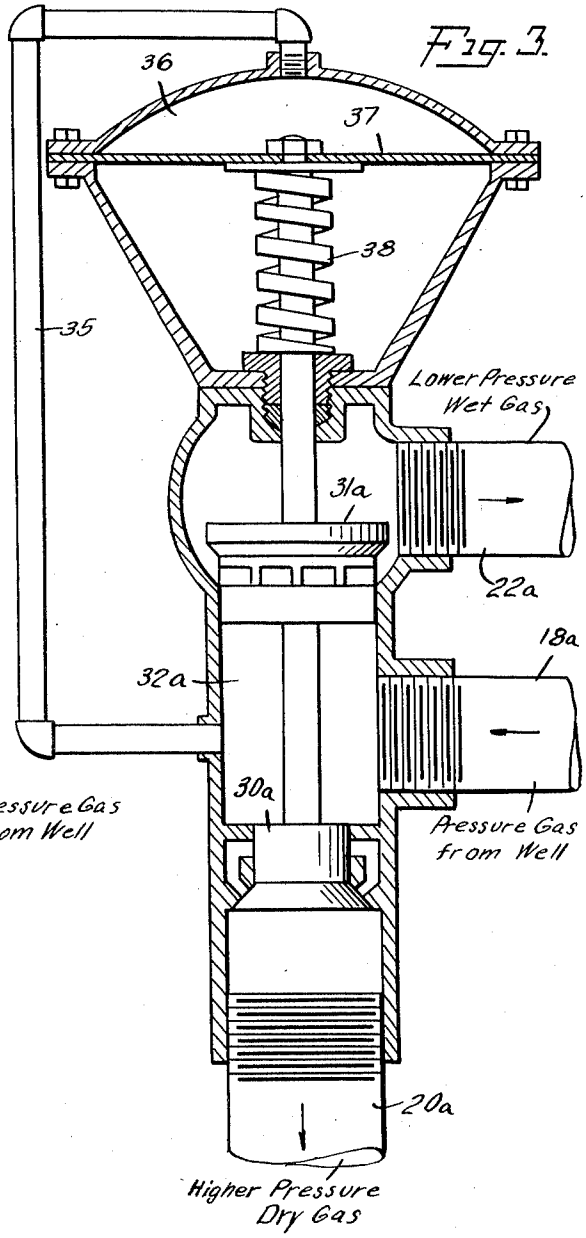


Fig. 3.



Louis N. Yates

INVENTOR

BY Pennie, Davis, Marvin & Edmonds

ATTORNEYS

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UNITED STATES PATENT OFFICE

LOUIS N. YATES, OF GREENWOOD COUNTY, KANSAS, ASSIGNOR TO SINCLAIR OIL & GAS COMPANY, OF TULSA, OKLAHOMA, A CORPORATION OF MAINE

METHOD AND APPARATUS FOR RECOVERING PRESSURE GAS FROM OIL WELLS

Application filed June 19, 1930. Serial No. 462,177.

This invention relates to an improved method and apparatus for pumping oil from oil wells with high pressure gas, and more particularly to improvements in the recovery of pressure gas used in such operation.

The present invention provides an improved process and apparatus for pumping oil from oil wells automatically by means of high pressure gas with recovery of the pressure gas and automatic separation of the pressure gas into two parts, one free or practically so of oil vapors, and one containing oil vapors, so that the content of gasoline, etc., can be recovered from that part of the gas which contains oil vapors, without handling the entire amount of recovered pressure gas.

Automatic gas lift devices are known and used for pumping oil from wells which have ceased to flow by natural pressure. In such automatic gas lift devices a pocket or compartment is provided at the bottom of the well below the oil level so that the oil will flow into it when no pressure is applied. Pipe connections to such pocket or compartment permit forcing high pressure gas into the compartment and forcing of the oil from the compartment to the surface, a check valve preventing back flow of the oil from the compartment to the well. When the contents of the compartment are thus emptied, pressure is released, the compartment permitted to fill again, and the operation repeated. Automatic gas control valves are provided for admitting the high pressure gas when the compartment has been filled with oil and for releasing the pressure when the compartment has been emptied so that it may again fill. Various automatic gas lift valves are known and used for this automatic operation:

In such automatic operations the high pressure gas is alternately forced down into the well to expel the oil accumulated in the chamber and then permitted to flow back through the supply pipe when the pressure is released. As a result a large part of the high pressure gas employed for the pumping operations is released and recovered as low pressure gas.

I have found that when the high pressure gas employed for the automatic pumping of oil in the manner above described has its pressure released and returns from the well, that part of the high pressure gas which first returns as the pressure gradually falls is "dry" gas, that is, free, or practically so, from oil vapors, and that the gas which comes from the well later, at lower pressures, contains a valuable proportion of oil vapors and can advantageously be treated for the recovery of gasoline, etc., therefrom. In order to permit such recovery I provide an automatic bypass valve which can be set to a predetermined pressure and which will permit the dry gas first recovered from the well to pass to the atmosphere or to a place of use, and then permit the low pressure gas with its valuable content of gasoline or other oil vapors to pass to a recovery system.

In its broader aspects the invention includes the use of compressed air as the high pressure gas, and, in that case, when the pressure is released and the pressure gas recovered from the well, the high pressure air can be passed to the atmosphere while the low pressure air containing oil vapors can be passed to a recovery plant for recovering the oil vapors.

The present invention is of particular value, however, for operation in conjunction with casinghead gasoline plants where the high pressure dry gas from the casinghead plant is employed as the high pressure gas for the pumping operation. In such case, the pressure gas recovered from the well will be automatically divided into a higher pressure portion of dry gas and a lower pressure portion of "wet" gas which can advantageously be returned to the casinghead plant.

The subdivision of the recovered pressure gas into two portions, as provided for by the present invention, is important since it enables that part of the recovered gas which contains substantial amounts of oil vapors to be kept by itself and separately treated without admixture of a large amount of dry gas which would dilute the oil vapors and increase the difficulty and expense of their recovery. It is also important in enabling the dry gas to be kept separate so that it can be used as fuel without the necessity of return-

ing it to the casinghead plant and without loss of oil vapors in it when not so returned.

The present invention is applicable to automatic gas lift devices of various kinds which operate automatically and intermittently with the use of high pressure gas. In such systems, the supply and release of the high pressure gas is automatic and intermittent. I provide, in conjunction with such a system, an automatic by-pass valve or pressure control valve and connect it with the release line through which the pressure gas is released so that, during the first portion of the release and until the pressure falls to a predetermined point, the high pressure dry gas will be passed to one place, and, after the pressure has fallen to the predetermined point, the low pressure wet gas will be passed to a separate place. The present invention requires merely the addition of an automatic by-pass or pressure control valve in addition to the usual automatic gas lift valve and equipment of a high pressure pumping system, together with connecting pipes for conveying the dry gas and the wet gas to their respective places of storage, treatment or use. When the invention is applied at a location adjacent a casinghead gasoline plant in which the gasoline is recovered from casinghead gases by compression and absorption methods, the high pressure gas from the gasoline plant is advantageously employed for the automatic pumping operations, the dry pressure gas released from the operation can be combined with the dry gas from the casinghead plant, and the low pressure wet gas from the operation can advantageously be returned to the casinghead plant for recovery of oil vapors therefrom. Thereby, the valuable gasoline and other oil vapor content of that portion of the recovered pressure gas can be recovered while that portion of the pressure gas which is recovered as dry gas can be passed to the dry gas handling system without further treatment.

The automatic by-pass valve or pressure valve which is added to the automatic gas lift system to accomplish the result above mentioned may vary in its construction and operation. In general, it will be an automatic by-pass valve which can be adjusted and set to operate at a predetermined pressure and which has connections so that the high pressure gas will be automatically kept separate from the low pressure wet gas.

The invention will be further described in connection with the accompanying drawings which are of a more or less conventional and diagrammatic character, but it will be understood that the invention is not limited thereto.

In the accompanying drawings

Fig. 1 shows a conventional and diagrammatic arrangement of apparatus embodying the invention and adapted for the practice of the process of the invention;

Fig. 2 shows one form of automatic by-pass valve; and

Fig. 3 shows a modified form of automatic by-pass valve.

In the diagrammatic arrangement of Fig. 1, the oil well 1 has a casing and various pipes extending down to the oil level in the bottom of the well. High pressure dry gas from the casinghead gasoline plant 2 is supplied through the high pressure gas pipe 3 to the automatic gas lift valve 4 and thence through the high pressure line 5 to the pipe 6 extending down into the well. The oil pumped from the well, together with such gas as accompanies it, passes upwardly from the well through the pipe 7 and the pipe 8 to the oil and gas separator 9 from which the gas, which is wet gas, i. e., gas containing oil vapors, passes through the lines 10 and 11 to the casinghead gasoline plant 2. The pipe 11 may lead from several wells and may convey wet casinghead gas to the casinghead gasoline recovery plant. A back pressure regulating valve 12 is provided in the pipe 10. The automatic gas lift controlling valve 4 may vary in its construction, and various automatic valves are known and in use. Operating connections are shown in the form of a small connecting pipe 13 having a needle valve or throttle valve 14 therein, this pipe leading to a starting pipe 15 extending down into the well and having a branch connection 16 leading to the automatic gas lift valve. Another connection 17 leads from the discharge pipe 8 to the automatic gas lift valve. It is unnecessary to describe in detail the operation of such automatic gas lift valves except to explain that the starting pipe 15 and the pipe connection 17 so act automatically and intermittently as to admit high pressure gas to the well to pump accumulated oil therefrom, and then to release the pressure gas back through the automatic valve in order that the oil may again accumulate.

The pressure gas released from the well through the pipe 5 is conveyed through a release line 18 to the automatic by-pass valve 19. This valve, of a construction hereinafter explained, divides the recovered pressure gas into two portions, one a higher pressure dry gas that passes through the pipe 20 and the other a lower pressure gas that passes through the pipe 22. The pipe 20 is shown as leading to the discharge pipe 21 for dry stripped gas from the casinghead plant. The pipe 22 conveys the low pressure wet gas to a place of treatment for recovery of oil vapors therefrom, for example, to the pipe 11 and thence to the casinghead plant 2.

The nature of the operations which take place during the automatic pumping of oil with high pressure gas will be understood by reference to the construction shown at the

bottom of the well in Fig. 1. The well extends down to the oil sand 24. Within the outer casing 25 are arranged various pipes. The pipe 6 has an enlargement 23 at its lower end forming a chamber into which the oil flows, through a perforated pipe 26 at the bottom. A check valve 27 prevents back flow of oil out of the chamber when pressure is applied. The discharge pipe 7 extends downwardly to near the bottom of the chamber. The starting pipe 15 terminates somewhat above the chamber 23. The oil level in the oil sand is such that it will flow into the chamber 23 and fill it when no pressure is applied to this chamber. When pressure is applied through the pipe 6 it forces the oil upwardly through the pipe 7 and out through the pipe 8 to the separator 9, some gas being forced out with the oil. Separation of oil and gas takes place in the separator 9 and the gas then passes through the pipes 10 and 11 to the casinghead plant. When the chamber 23 has been emptied pressure is automatically released and the high pressure gas passes back up through the pipe 6 and the pipe 5 to the automatic valve 4 and is then conveyed through the pipe 18 to the automatical by-pass valve 19, the high pressure dry gas passing through the line 20 and the low pressure wet gas through the line 22.

When the pressure has fallen again to atmospheric the oil again flows into the chamber 23 until it is filled, when pressure is again applied and the oil pumped out, this application of pressure and the subsequent release of pressure being automatically controlled by the valve 4.

The automatic control of the valve 4 may be by means of the starting pipe 15 and the pipe connection 17. Gas is continuously supplied through the pipe 13 to the starter pipe 15 and is discharged from the lower end of this pipe into the well, this gas rising in the well and passing through the casinghead gas connection 28 from the casing to the line 11 leading to the casinghead plant. As the oil rises in the well and seals the end of the pipe 15 pressure is built up in this line and this pressure acting through the connection 15 causes the automatic valve to open and connect the high pressure gas line 3 with the pipes 5 and 7, thereby applying pressure to the chamber 23 for pumping the oil upwardly therefrom. The connecting pipe 17 is so arranged that when the oil has been discharged into the gas separator the pressure built up by the back pressure valve 12 and exerted through the line 17 will cause the automatic valve 4 to operate and connect the pipes 7 and 5 with the line 18, thereby permitting the pressure gas to escape from the well to the automatic by-pass valve 19 where the pressure gas is automatically divided into a high pressure dry gas and a low pressure wet gas, as above described.

The pressure required for the operation of an automatic gas lift pump will vary with the depth of the well, and the pressure at which the automatic by-pass valve 19 is set to divide the high pressure dry gas from the low pressure wet gas can be adjusted to a predetermined pressure which will accomplish that purpose. In systems having high pressure gas supplied at about 260 pounds and with a flowing pressure of 180 pounds, the automatic by-pass valve 19 can be set to operate at a predetermined lower pressure, for example, around 25 pounds, although this pressure can be increased or decreased to obtain the desired separation of higher pressure dry gas from lower pressure wet gas. The particular pressure at which the valve is set can be adjusted to a pressure which will approximate that at which the gas escaping from the well ceases to be dry gas and begins to contain sufficient amounts of oil vapors to make their recovery desirable or profitable.

In general, the greater part of the pressure gas released from the well will be higher pressure dry gas, and a relatively smaller proportion will be lower pressure wet gas. The high pressure gas which has not been forced down to the bottom of the well during the pressure period, and which has not come in contact with oil in the well, returns, when pressure is released, as dry gas. The gas which has been forced into the chamber at the bottom of the well and has come into contact with oil will take up appreciable quantities of oil vapors, and, as the pressure is released, and the lower pressures tend to promote vaporization of oil, the lower pressure gases which escape last from the well will be those containing appreciable amounts of oil vapors. By providing for the automatic control of these released gases it is possible, as above pointed out, to keep the high pressure dry gas separate and combine it with the dry gas from the casinghead plant, and, at the same time, to keep the low pressure wet gas separate and return it to the casinghead plant for the recovery of its valuable gasoline, etc., content therefrom.

In Figs. 2 and 3 I have shown two forms of automatic pressure control by-pass valves, but the invention is not limited to the particular constructions illustrated.

In Fig. 2 the valve 19 is shown as having an upper valve member 30 and a lower valve member 31, the valve 30 having a greater area exposed to the chamber 32 than the valve 31. A spring 33 is set at a predetermined pressure, which can be adjusted, and holds the valve 30 seated when the pressure in the line 18 is below a predetermined amount. When the pressure is above this predetermined amount, as is the case when the high pressure gas is first released from the well, this pressure exerts enough force to force

the valve 30 off its seat and close the valve 31, owing to the different areas of these valves exposed to the pressure. When the pressure falls below the predetermined amount, determined by the spring 33, the valve 30 is forced to its seat and the valve 31 is forced open when the gas escapes from the chamber 32 to the pipe 22. The spring 33 will have a range of adjustment which permits the pressure at which the valves 30 and 31 will open and close to be adjusted at approximately that pressure which will separate the higher pressure dry gas from the lower pressure wet gas, so that the higher pressure dry gas will be automatically conveyed past the valve 30 to the pipe 20 while the valve 30 is open, and the lower pressure wet gas will be automatically passed through the valve 31 to the line 22 when the pressure falls below the predetermined amount.

The valve shown in Fig. 3 is a diaphragm acting by-pass valve, in which the corresponding parts to those of Fig. 2 are indicated by the same reference numerals with the letter "a" appended thereto. The chamber 32*a* is connected through the small by-pass line 35 with a diaphragm chamber 36 having a diaphragm 37 connected to the spring 38. At lower pressures the tension of the spring holds the valve 30*a* closed and the valve 31*a* open, thereby permitting the gas entering from the line 18 to pass out through the line 22*a*. When the pressure is above the predetermined amount it will act through the pipe 35*a* on the top of the diaphragm and will overcome the spring tension and close the valve 31*a* and open the valve 30*a*, thereby permitting the high pressure gas to pass into the line 20*a*. The tension of the spring and the size of the diaphragm can be adjusted so that automatic operation of the valves will take place at a predetermined pressure which can be so chosen as to approximate that at which the higher pressure dry gas can be separated from the low pressure wet gas.

In the operation of the present invention it has been found that an important increase in gasoline recovery can be obtained by the use of the present invention; and that this recovery can moreover be obtained without retreating all of the pressure gas recovered from the well. As a result, the high pressure dry gas can be kept separate and only the low pressure wet gas treated, thereby eliminating the handling of the total recovered pressure gas to recover its small gasoline content, and eliminating the loss of gasoline which would result from not returning the recovered gas to the casinghead plant. The present invention enables that portion of the recovered pressure gas which contains the valuable gasoline content to be treated for gasoline recovery without treating the remainder of the gas, and enables the dry gas recovered from the operation to be kept separate.

From the apparatus standpoint, the present invention requires a minimum of change from existing plants having automatic gas lift apparatus for pumping oil from oil wells. Existing plants can be changed to embody the invention by providing the automatic by-pass valve, operating at a regulated and predetermined pressure, and by providing separate connections for the higher pressure dry gas and the low pressure wet gas. So also, from the apparatus standpoint, the connecting of the low pressure wet gas line with the casinghead plant enables the valuable gasoline content of such gas to be recovered in existing recovery equipment of the casinghead plant.

From the process standpoint it will be seen that the present invention provides an improved process of operating automatic gas lift pumping equipment in which the pressure gas recovered from the well, during the operation, is automatically separated into a higher pressure dry gas and a lower pressure wet gas, which wet gas can be advantageously treated in a casinghead plant for the recovery of its gasoline content.

In referring to "dry" gas I refer generally to the gas containing little or no content of recoverable vapors, such as escapes from the well during the first portion of the release of the pressure gases, and while these gases are at a higher range of pressures; and in referring to "wet" gas I refer to the gas containing oil vapors in appreciable amount such as is obtained at lower pressures during the later portion of the escape of the pressure gas from the well. Where dry gas from a casinghead plant, in which compression processes of gasoline recovery are employed, is the pressure gas used for the automatic pumping of oil from the well, this gas will contain little or no recoverable gasoline, and the high pressure dry gas recovered from the well according to the present invention will similarly contain little or no gasoline content; while the lower pressure gases recovered according to the present invention will contain appreciable quantities of recoverable gasoline. When compressed air is employed for operating the automatic gas lift pumping apparatus, the high pressure air released from the well will contain little or no oil vapors, while the low pressure air released from the well will contain appreciable amounts of recoverable gasoline, and such lower pressure air can be treated for the recovery of its gasoline content.

In referring to the high pressure or higher pressure gas recovered from the well or to the low pressure or lower pressure gas so recovered, I refer to the pressure of the gases as they escape from the well and pass through the apparatus illustrated and described, since it will be evident that the pressure of the gases may subsequently be re-

leased to atmospheric pressure, or the pressure may be increased in case the dry gases are to be conveyed under pressure to a place of storage or use, or in case the wet gases are to be compressed to a high pressure for recovery of their gasoline content.

I claim:

1. The method of recovering pressure gases from the automatic and intermittent pumping of oil from oil wells by pressure gases which comprises automatically separating the higher pressure dry gas recovered from the well from the lower pressure wet gas, whereby the dry gas can be kept substantially free from oil vapors, and whereby the gas containing appreciable amounts of oil vapors can be kept relatively free from admixture with dry gas.

2. The method of pumping oil from oil wells by intermittent application and release of gas pressure which comprises applying gases under pressure which are substantially free from oil vapors, releasing the pressure gradually and separately collecting the higher pressure released gases having little or no vapor content and the lower pressure released gases containing an appreciable vapor content.

3. The method of recovering gasoline from the pressure gases employed in the automatic and intermittent pumping of oil from oil wells by the application and release of pressure gas, which comprises separately collecting the higher pressure released gases and the lower pressure released gases, and treating the lower pressure released gases for recovery of their gasoline content.

4. The method of pumping oil from oil wells by the automatic and intermittent application of high pressure gas which comprises automatically and intermittently supplying to the oil well compressed natural gas freed from gasoline by a casinghead gasoline recovery treatment, releasing the pressure gases automatically and intermittently and subdividing the released gases into a higher pressure portion relatively free from gasoline vapors and a lower pressure portion containing appreciable gasoline vapors, and returning the lower pressure gases to the casinghead gasoline plant for the recovery of gasoline therefrom.

5. The method of recovering pressure gases from the automatic and intermittent pumping of oil from oil wells by high pressure gas, which comprises releasing the high pressure gas intermittently, collecting the higher pressure gas separately until the pressure falls to a predetermined amount and then separately collecting the lower pressure gases containing appreciable quantities of oil vapors and recovering oil vapors therefrom.

6. An apparatus for the recovery of pressure gases used for pumping oil from oil wells by the use of high pressure gas comprising an automatic pressure controlled by-pass valve connected to the pressure gas release line and adapted to separate higher pressure gases from lower pressure gases, and means for keeping separate the gases so separated.

7. An apparatus for pumping oil from oil wells and for recovering pressure gases employed therein comprising an automatic gas lift valve and pipe connections for automatically and intermittently appying high pressure gas to the well and releasing the gas after being so applied, a release line for the gases so released, and another automatic valve for automatically separating the higher pressure released gases from the lower pressure released gases, together with means for keeping separate the gases so separated.

8. An apparatus for pumping oil from oil wells comprising a compression casinghead gasoline plant producing dry gas under pressure, means for automatically and intermittently applying such compressed gas to an oil well to pump oil therefrom, means for intermittently releasing the pressure gases, automatic means for separating the higher pressure released gases from the lower pressure released gases, and means for returning the lower pressure released gases to the casinghead gasoline plant for the recovery of oil vapors contained therein.

9. An apparatus for recovering gasoline from the pressure gases employed in the automatic and intermittent pumping of oil from oil wells by the use of high pressure gas, comprising an automatic pressure controlled by-pass valve connected to the release line for the release of the pressure gases, said valve being adjusted to automatically separate the higher pressure dry gases from the lower pressure wet gases containing appreciable quantities of gasoline vapors, and means for separately conveying the latter gases to a gasoline recovery plant.

10. An apparatus for the pumping of oil from oil wells and for the recovery of gasoline from natural gas comprising a compression gasoline plant for recovering gasoline from natural gas in which high pressure dry gas is produced, means for utilizing high pressure dry gas from said plant, in an automatic and intermittent manner, to pump oil from oil wells, an automatic pressure controlled by-pass valve connected with the release line from the well to automatically separate the higher pressure released gases from the lower pressure gases, means for conveying the higher pressure gases for admixture with the dry gases from the casinghead plant, and means for returning the lower pressure gases to the casinghead plant.

In testimony whereof I affix my signature.

LOUIS N. YATES.