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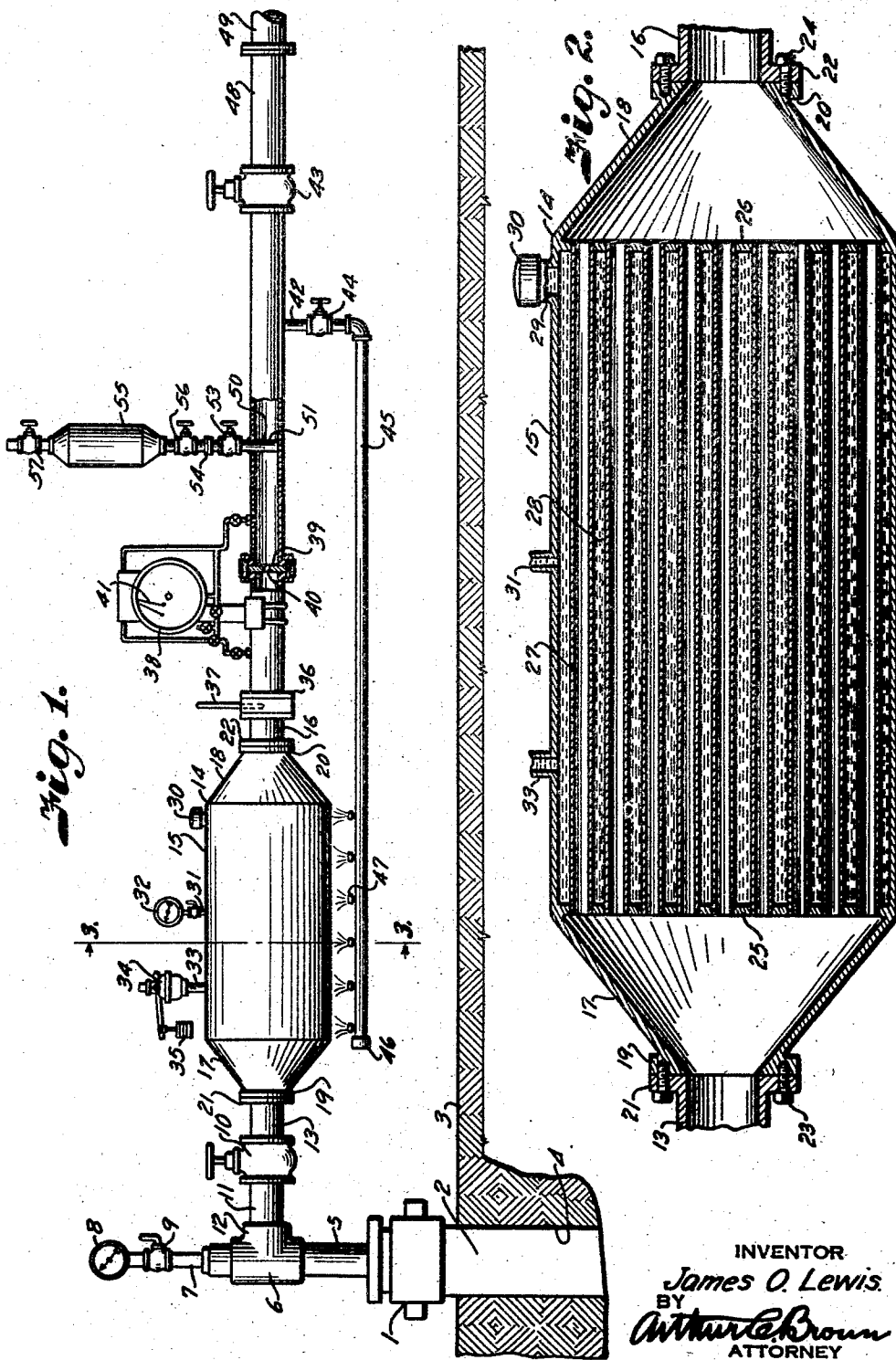
J. O. LEWIS

2,380,977

METHOD AND APPARATUS FOR OBTAINING SAMPLES

Filed Feb. 28, 1941

2 Sheets-Sheet 1



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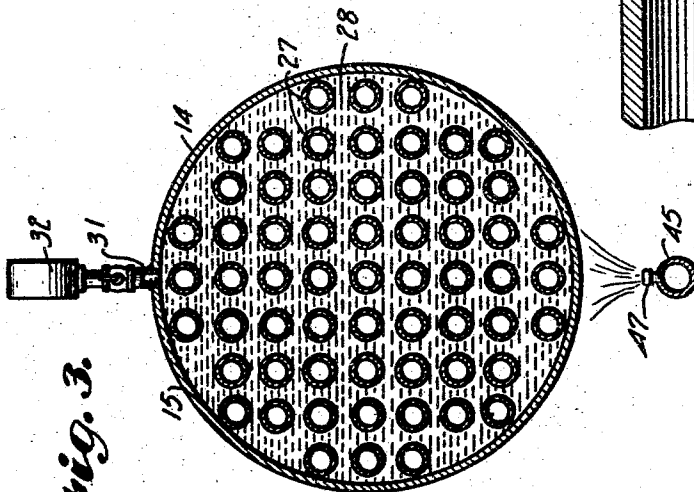
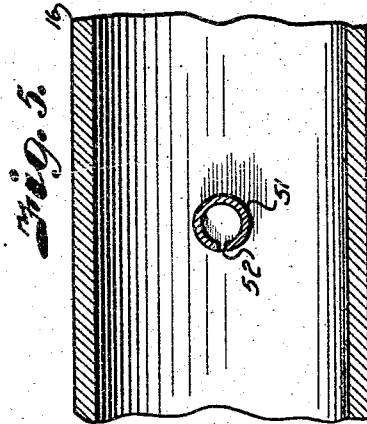
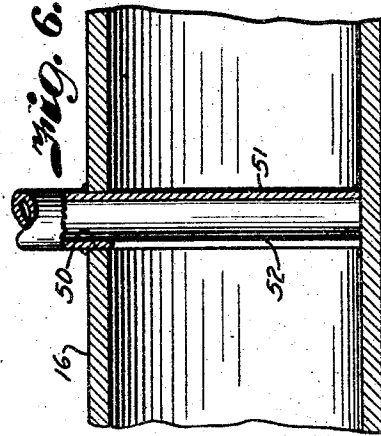
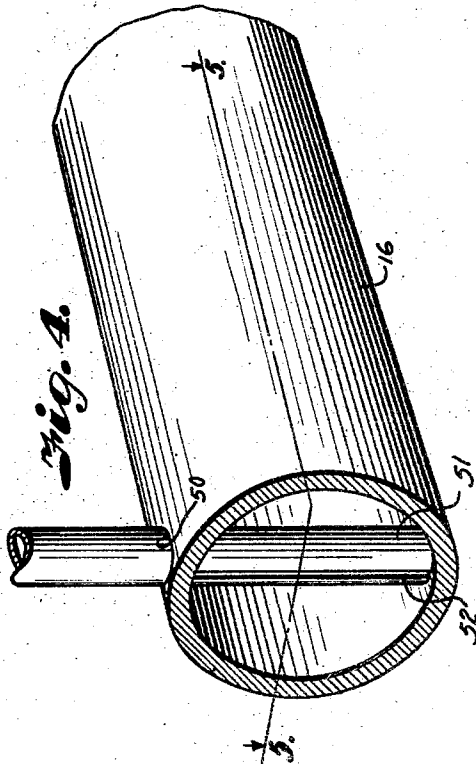
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METHOD AND APPARATUS FOR OBTAINING SAMPLES

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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR OBTAINING SAMPLES

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13 Claims. (Cl. 73-422)

This invention relates to a method and apparatus for obtaining samples, and more particularly a method and apparatus for obtaining representative samples of gas and its liquefiable constituents from natural gas wells, especially from wells wherein the gas and its constituents have been subjected to conditions conducive to retrograde condensation.

It has been found that natural gas flowing from wells sometimes contains entrained hydrocarbon liquids and water, which gas and constituents existed in their strata of origin in vapor phase. Through reduction in pressure and/or temperatures resulting from transfer of the gas from the producing strata to the surface of the earth, part of the vapors become condensed because of the physical phenomena known as retrograde condensation occurring as a result of such transfer. Accurate sampling and/or metering of the two-phase liquid and vapor flow, produced because of the noted retrograde condensation, are difficult for the reason that the liquids are sometimes produced irregularly and tend to follow the bottom of horizontal flow pipes leading from the well. It has been attempted to overcome the difficulties in sampling and metering such two-phase flows by installing gas and oil separators at the well, together with other expensive equipment, and to flow the wells at different operating rates closely simulating actual production operations. Such attempted expedients are expensive and time consuming.

The principal objects of my invention are, therefore, to provide a convenient, economical and efficient method and apparatus for obtaining representative samples of gases and their liquefiable constituents from natural gas wells.

Other objects of my invention are to provide a method and apparatus for correctly sampling well products in a relatively rapid and simple manner.

Other objects of the invention are to provide improved steps in a method and improved elements in an apparatus, together with improved arrangements of such steps and elements in a method and apparatus of the character and for the purpose specified.

In accomplishing these and other objects of the present invention, I have provided improved details in a method and apparatus, the preferred form of apparatus for carrying the method into effect being shown in the accompanying drawings, wherein:

Fig. 1 is a side elevational view of a gas sampling apparatus embodying the present invention

shown operatively applied to a well, parts thereof being broken away to better illustrate its construction.

Fig. 2 is a vertical substantially central cross section through a regulated heater forming a part of the apparatus for acting on gas and its constituents to be sampled.

Fig. 3 is a detail vertical transverse section through the apparatus substantially on the line 3-3, Fig. 1.

Fig. 4 is a detail perspective view of a portion of the sampling device showing its relation to the gas flow line.

Fig. 5 is a horizontal section through the gas sampling device substantially on the line 5-5, Fig. 4.

Fig. 6 is a detail vertical longitudinal section through a portion of the gas flow line showing the relation of the sampling device thereto.

Referring more in detail to the drawings and to the method steps:

1 designates the head of a gas well casing 2 that is suitably extended to a producing stratum below the surface of the earth 3, the casing being mounted in a suitable bore hole 4 and being provided with tubing 5 leading from the well. The tubing 5 preferably terminates in a fitting 6 such as a T, the T having a suitable connection 7 with a pressure gauge 8 controlled by a valve 9.

A control valve 10 is preferably mounted in a nipple or the like 11 leading from the lateral outlet 12 of the T 6, the valve 10 being connected by a suitable nipple or the like 13 with a regulated heater 14, the details of which are clearly shown in Figs. 2 and 3.

The heater 14 preferably consists of a section of pipe 15 enlarged in relation to the flow line 16 extending from the discharge or downstream end of the heater and to the nipples 11 and 13 which form part of the flow line well end of the heater. Opposite ends of the heater are provided with suitable reducers 17 and 18, the outer extremities of which are provided with annular flanges 19 and 20 that are secured to mating flanges 21 and 22 on the nipple 13 and the flow line 16 respectively as by fastening devices 23 and 24. The heater 14 is also provided with spaced headers 25 and 26 between which spaced tubes 27 extend for connecting the interiors of the reducers 17 and 18. The space or spaces between the headers of the heater and its tubes is preferably filled with water 28 that may be applied to the interior of the heater, and particularly its reservoir surrounding the tubes, as by a fill opening 29 that is normally closed by a cap 30.

An outlet 31 from the interior of the heater is controlled as by a valve and leads to a pressure gauge 32 for selectively measuring the pressure in the water space reservoir. A temperature and pressure control outlet 33 is also preferably provided for the heater. The outlet 33 leads to a relief valve 34 that may be regulated in a suitable manner as by devices 35.

Mounted in the flow line 16 in spaced relation to the heater 14 and downstream relative thereto is a temperature well 36 provided with a thermometer 37.

Also mounted in the flow line 16, in downstream relation to the temperature well 36, is a metering device 38, preferably of orifice type and consisting of a plate 39 arranged transversely of the flow line and provided with an orifice 40. The metering device 38 is also preferably provided with a recording element 41 for measuring pressures in the flow line adjacent the metering device.

An outlet 42 from the flow line is preferably arranged downstream relative to the metering device 38 and on the well side of a flow line control valve 43, which outlet 42 is controlled by a valve 44 and leads through a connection 45 to a point adjacent and below the heater 14. The connection 45 is preferably capped, as at 46, and is provided with suitable heating elements 47 to provide for ignition of gases and constituents thereof in the outlet to heat the contents of the heater to desirable temperatures.

From the control valve 43 the flow line leads, as by sections 48 and 49, to suitable points of disposal for the products of the well passing through the line.

The flow line 16 is preferably provided with an opening 50 in the upper surface thereof arranged between the metering device and the outlet 42 from the flow line. A sampler tube 51 is mounted in the flow line through the opening 50 and is preferably secured in position. The sampler tube is provided with a longitudinally arranged slot 52, Figs. 4 to 6, of a length substantially equal to the inner diameter of the flow line for allowing a cross-sectional sample of the contents of the flow line on the downstream side of the metering device to be received in the sampler tube. The sampler tube is preferably provided at its upper end with a control valve 53 that is connected by suitable devices 54 with a sampler receptacle or container 55 provided with control valves 56 and 57 at its opposite ends.

The method of the present invention may be conveniently carried out with an apparatus, constructed as above described, in the following manner:

Flow from the gas well through the tubing 5 is admitted to the flow line 16 in two phase condition by manipulation of the valves 10 and 43. Such flow of the gas, inclusive of its liquefiable constituents, passes through the cylinder 15 by means of the tubes therein and is metered by the recording metering device 38. Some of the gas and its constituents may be admitted to the heater line 45 by manipulation of the valve 44 which gas is suitably ignited to heat the water or other suitable liquid in the cylinder.

Sufficient heat is applied to the cylinder to re-vaporize all the condensates in the gas, i. e. to convert the two-phase flow to single phase. The heat as well as the pressure produced in the cylinder is regulated by the control 34-35, the pressure being indicated by the gauge 32 and the temperature by the thermometer 37.

It is then desirable to regulate the flow of the gas through the flow line by manipulation of the valve 43 to create desirable back pressures between the valve 43 and the well, such pressures being recorded by the recorder of the metering device 38. The temperature of the gas in the flow line is also indicated by the thermometer in the temperature well 36.

When the temperatures and the pressures of the single-phase flow have been regulated to the desired values, the sampler container 55 is preferably first purged and then applied to its connections with the slotted sampler tube 51. The sampler container 55 is preferably filled slowly under the control of the valves 53 and 56 in order that a sample may be obtained over a considerable period of time, thus avoiding errors due to fluctuations in the rate of flow and in the constituents of the flux. Upon filling of the sampler container, the valves 53, 56 and 57 are closed and the sampler container is removed from the line, after which it may be taken to a laboratory for analysis of its contents.

The method above described may be repeated at suitable intervals to determine variations in the quality of production from the well and/or the apparatus may be removed and applied to other wells for carrying out the method in connection with such other wells.

It is apparent, therefore, that the present method and apparatus conveniently, economically and efficiently samples gas and its liquefiable constituents throughout the cross-section of flow thereof in a rapid and simple manner. It is to be understood that the method and apparatus are applicable to sampling any gas liquid flow whether caused by retrograde condensation or otherwise.

What I claim and desire to secure by Letters Patent is:

1. The method of obtaining truly representative samples of gas and its liquefiable constituents from a gas well so as to permit of accurate sampling and analysis consisting of converting fluids flowing from said well in two-phase liquid and vapor flow to single-phase vapor flow, and collecting a sample of said single-phase flow for removal and analysis.

2. The method of obtaining representative samples of gas and its liquefiable constituents from a gas well consisting of heating fluids flowing from said well in two-phase liquid and vapor flow to effect conversion to a single-phase vapor flow, and collecting a sample of said single-phase flow for removal and analysis.

3. The method of obtaining representative samples of gas and its liquefiable constituents from a gas well consisting of converting fluids flowing from said well in two-phase liquid and vapor flow to single-phase vapor flow by applying regulated heat and pressure thereto, and collecting a sample of said single-phase flow for removal and analysis.

4. The method of treating the gas and liquefiable constituents as produced from a well in two-phase flow so as to permit of an accurate analysis which includes, heating the two-phase flow to convert the same to single-phase vapor flow so as to permit of accurate measurement thereof in such single-phase, metering said flow, applying a back pressure to said flow, and collecting a sample of said single-phase flow for removal, and analysis thereof.

5. The method of producing an accurate sample of a well fluid for analysis consisting of

withdrawing gas and liquefiable constituents thereof from a well in two-phase flow, diverting a portion of the flow for ignition and for heating the two-phase flow to convert the same to single-phase vapor flow so as to permit of accurate measurement thereof in such single-phase, metering said flow, applying a back pressure to said flow, and collecting a sample of said single-phase flow thereof for removal, and analysis thereof.

6. The method of obtaining a sample of a well fluid which is susceptible of accurate analysis consisting of producing gas and liquefiable constituents thereof from a well in two-phase flow and the treatment thereof to admit of accurate metering and analysis which comprises, recording pressures incident to such production, controlling flow of the gas adjacent its point of available production, heating the gas and liquefiable constituents in said two-phase flow to convert the same to single-phase vapor flow, recording pressures incident to heating said flow, regulating pressures incident to heating said flow, recording temperatures of said flow, metering said flow, applying a back pressure on said flow, and collecting and removing a sample of said single-phase flow substantially throughout the cross sectional area thereof for analysis thereof.

7. In an apparatus for obtaining representative samples of gas and its liquefiable constituents from a gas well, means for converting the output from said well in two-phase liquid and vapor flow to single-phase vapor flow, and means for collecting and removing a sample of said single-phase flow for analysis thereof.

8. In an apparatus for obtaining accurate representative samples of gas and its liquefiable constituents from a gas producing well for analysis to determine the composition thereof, means for converting fluids flowing from said well in two-phase liquid and vapor flow to single-phase vapor flow, means for metering the single-phase flow, and means for collecting and removing a sample of said single-phase flow for removal and analysis thereof.

9. In an apparatus of the character described, the combination of means for producing gas inclusive of its liquefiable constituents in two-phase liquid and vapor flow, a flow line for said gas, means for applying regulated heat and pressure to said gas to convert said two-phase flow to single-phase vapor flow, means for collecting and removing a sample of said single-phase flow area of said flow line so as to permit of an accurate analysis, and means for controlling flow through said line.

10. In an apparatus of the character described, the combination of means for producing gas inclusive of its liquefiable constituents in two-phase liquid and vapor flow, a flow line for said gas, means for applying regulated heat and pressure to said gas to convert said two-phase flow to single-phase vapor flow, a temperature well in said flow line downstream relative to said heat and pressure applying means having a thermometer, means in said flow line for metering said single-phase flow, detachable

means for collecting a sample of said single-phase flow from said flow line, and means for controlling flow through said line.

11. In an apparatus of the character described, a sampling device for collecting a single-phase-flow gas sample from a horizontal flow line comprising means to convert any liquid phase in the flow to the gaseous phase, a tube mounted vertically in said line beyond said means and having a slot extending throughout the interior cross-sectional area of said line from top to bottom thereof, and means detachably connected with said tube for receiving and retaining the gas sample admitted to said tube by said slot whereby an accurate analysis thereof may be obtained.

12. In an apparatus of the character described, a flow line, means for selectively admitting gas in two-phase vapor and liquefiable constituent flow to said flow line, a heater mounted in said flow line consisting of a cylinder enlarged relative to the flow line having a liquid reservoir and having tubes allowing passage therethrough of said two-phase flow, means for diverting a portion of the flow from the flow line to a point adjacent the heater for ignition to heat the contents of the heater to convert the same to single-phase flow, means for creating a back pressure in the flow line, a metering device connected to the flow line, a tube in the flow line arranged between the back pressure producing means and the metering device having a vertical slot extending substantially throughout the cross-sectional area of the flow line, a sampler container connected with the tube, and means for selectively admitting and excluding samples of the flow from the tube and sampler container.

13. In an apparatus of the character described, a flow line, means for selectively admitting gas in two-phase vapor and liquefiable constituent flow to said flow line, a heater mounted in said flow line consisting of a cylinder enlarged relative to the flow line having a liquid reservoir and having tubes allowing passage therethrough of said two-phase flow, means on the heater for recording pressures therein, means on the heater for regulating temperatures and pressures therein, means for diverting a portion of the flow from the flow line to a point adjacent the heater for ignition to heat the contents of the heater to convert the same to single-phase flow, a temperature well in the flow line, a metering device in the flow line, means on the metering device to record pressures in the flow line adjacent the metering device, means for creating a back pressure in the flow line, a tube in the flow line arranged between the back pressure producing means and the metering device having a vertical slot extending substantially throughout the cross-sectional area of the flow line, a sampler container connected with the tube, and means for selectively admitting and excluding samples of the flow from the tube and sampler container.

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