

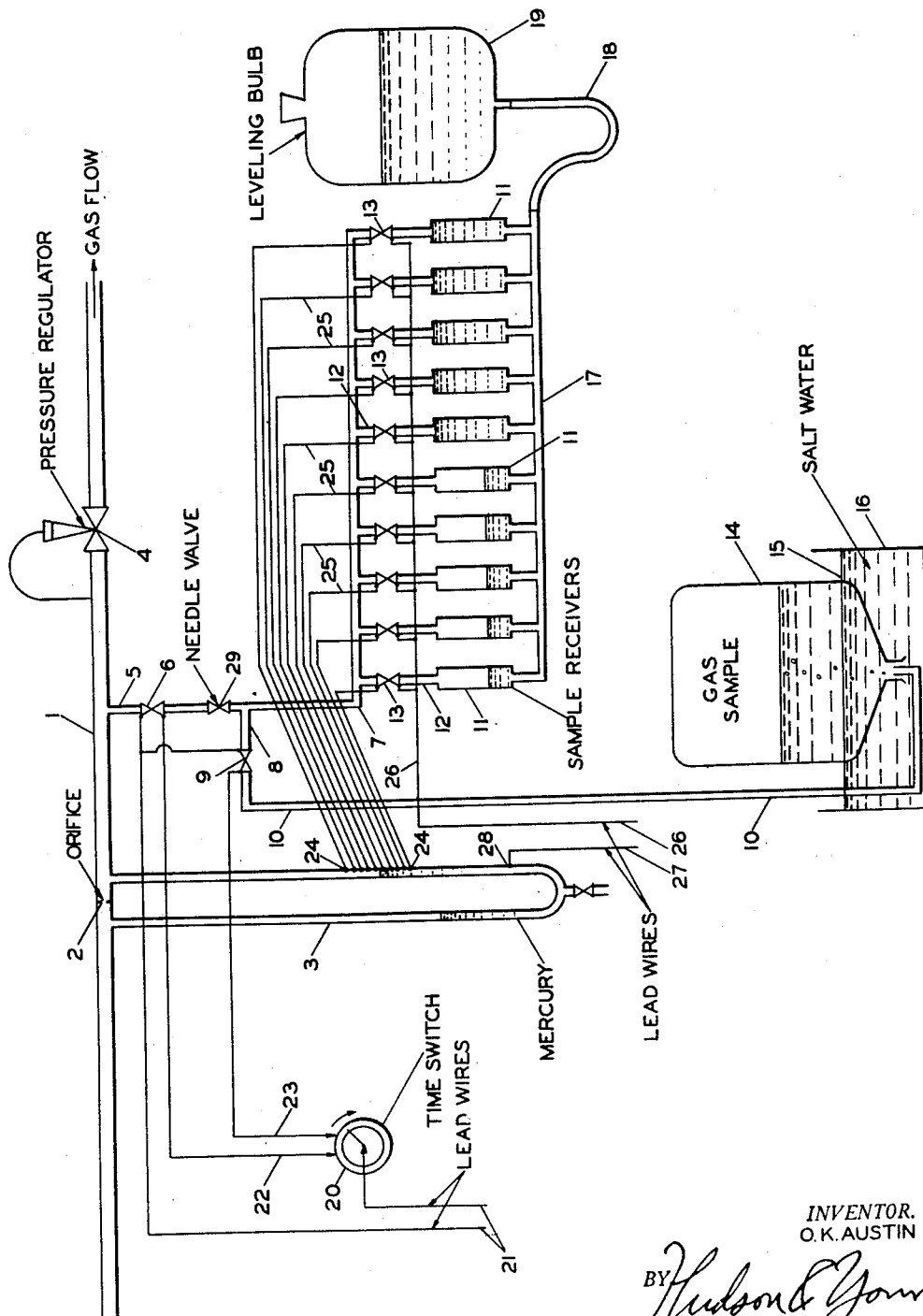
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O. K. AUSTIN

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VARIABLE FLOW GAS SAMPLING METHOD AND APPARATUS

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INVENTOR.
O. K. AUSTIN

BY *Hudson & Young*

ATTORNEYS

UNITED STATES PATENT OFFICE

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VARIABLE FLOW GAS SAMPLING METHOD
AND APPARATUSOliver K. Austin, Kansas City, Kans., assignor to
Phillips Petroleum Company, a corporation of
Delaware

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This invention relates to the sampling of gases. In one of its more specific aspects it relates to a gas sampling apparatus and a method for using the apparatus. In a specific application the apparatus described herein is adapted to the automatic sampling of gas streams whose rate of flow may be variable.

I have found that the principle involved according to my invention may be applied to sampling devices for use in the spot or in the composite sampling of gaseous streams. My invention has special application in the petroleum industry, but may be used as well in chemical, or gas or other industries where gases are to be sampled.

One object of my invention is to provide apparatus and a method for sampling streams of gases while in transit.

Another object of my invention is to provide apparatus and a method for operating the apparatus wherein composite samples of gases may be taken over periods of time.

Still another object of my invention is to provide an apparatus for the composite sampling of gas streams of variable flow. Still another object is to provide an automatically operated gas sampling apparatus.

These and other objects and advantages of my apparatus and method of operation of this apparatus will be apparent to those skilled in the art by reference to the following detailed description and annexed drawing which respectively describes and illustrates a preferred embodiment of my invention.

The figure illustrates a form of apparatus adapted to the sampling of gas in transit.

Referring to the drawing a gas to be sampled is passed through a process or transfer line 1 in the direction indicated by the arrows. An orifice 2 is positioned in the line in combination with a manometer 3 for producing a pressure differential proportional to the flow of gas through the transfer line 1. Downstream from the orifice is a pressure regulator 4 adapted to maintain a constant gas pressure on the downstream side of the orifice.

Intermediate the orifice and pressure regulator is a gas sample take-off line 5 carrying a valve 6. To the discharge end of the valve 6 is connected a manifold header tube 7 which is adapted to carry gas passing through the valve 6 into a part or all of gas sample bottles 11. Each sampling bottle 11 has a gas inlet tube 12 carrying a valve 13, and said gas inlet tubes 12 are connected with

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the header tube 7 as shown to form a manifold assembly.

On the downstream side of the main gas sampling valve 6 is a side tube 8 carrying a second main valve 9. From this latter valve is a gas sample line 10 leading to a large sample collecting bottle 14. This latter bottle is placed in an inverted position, as illustrated, and is adapted to retain sampled gas by liquid displacement. A liquid, 15, such as a salt water brine is well adapted for use in collecting hydrocarbon gases since such gases are only very slightly soluble in brine. The sample container 14 may be inverted over such a container as a tank 16 in such a manner that the neck of the bottle is at all times submerged in the brine solution. The discharge end of the line 10 is bent in such a manner as to extend into the open neck of the bottle for at least a short distance.

The sample measuring bottles 11, at their bottom ends, are manifolded into a common header line 17, which in turn is connected by a tubing 18 to a main reservoir vessel 19. A displacement liquid such as mercury, may be used in the measuring bottles 11-manifold tube 17-reservoir bulb 19 assembly.

A time switch assembly mechanism 20 is employed to operate automatically the main valves 6 and 9. Lead wires 21 bring electrical current from a source, not shown, to my apparatus. One of the wires is connected directly with the timing switch mechanism 20 while the other is connected in parallel to the mechanisms operating valves 6 and 9. Return wires 22 and 23 complete the circuits from the valves 6 and 9 operating mechanisms.

The manometer tube contains a plurality of electrical connections 24 sealed through the walls of the tube as shown. Each of this plurality of connections or contacts 24 is connected by leads 25 with an operating mechanism attached to each of the gas flow valves 13. Return connections from these individual valve mechanisms are through a line 26, the open end of which is termed on the drawing as a "lead wire, 26". Another lead wire 27 conducts electrical current to a contact point 28 in the lower portion of the manometer tube, as shown. The lead wires 26 and 27 bring electrical current from a source not shown, to the manometer—individual valve operating mechanisms as shown on the drawing.

The manometer tube is filled with such an electrical conducting liquid as mercury for gas pressure differential indicating purposes and for electrical circuit closing purposes.

A needle valve 29 is provided in tube 7 to assist in controlling gas flow into the bottles 11.

In the operation of my apparatus as herein described for the sampling of gases, the following procedure may be used:

The gas to be sampled, which may merely be a gas in transit from one point to another or may be a gas passing from one process point to another, passes through the orifice 2 for pressure differential producing purposes. The pressure regulator 4 operates to hold a constant pressure on the gas on the downstream side of the orifice 2. Thus, the greater the flow of gas through the orifice 2, the greater will be the pressure drop through the orifice. Such a pressure differential is indicated by the difference in mercury levels in the manometer tube, and the greater the pressure differential the higher will be the mercury level among the electrical contacts 24. These latter and the quantity of mercury in the manometer are so inter-adjusted that the flow of a small quantity of gas in the main transfer line 1 will raise the mercury level to make electrical contact with at least one of the connections 24. In like manner, the upper or highest of these several connections is so placed as to just make contact when the rate of flow of gas through the line 1 is the highest anticipated flow of gas desired to be sampled. The intermediate contacts 24 may then be spaced between the lower and the upper contacts.

When the mercury in the manometer tube makes contact with one or more connections 24, the corresponding valves 13 open. As illustrated in the drawing the mercury level is of such height that five of the contacts 24 have closed their respective electrical circuits and the corresponding five valves 13 are open to the flow of gas. These valves remain open until such time as the mercury level in the manometer tube drops to open the circuits, under which conditions such open valves close.

Assuming again, the first five valves are open, then at a predetermined time as indicated by a setting on the time switch 20, the main gas valve 6 opens (valve 9 being closed). Gas from line 1 then flows through tube 5, valve 6, manifold header tube 7, valve 29 and through the first five valves 13 into the corresponding gas measuring bottles 11. The mercury from these five bottles passes through the manifold line 17 and tube 18 into the reservoir 19. This reservoir is open at its top so that as mercury enters the reservoir at the bottom the upper gas phase remains at atmospheric pressure. Under these conditions the gas being sampled flows into the measuring bottles until such time as the time switch operates to close the valve 6. The manually operated valve 29, which may be a needle valve, or other valve adapted for rather fine adjustment of the flow of small volumes of gas, is so adjusted as to permit a maximum flow of at least ten measuring bottles (11) of gas to be sampled during the time interval valve 6 remains open. By this adjustment then with only one valve (13) open and one sample bottle (11) of gas to be taken, the excess of gas passing through the needle valve 29 and ultimately through the sample bottles backs the mercury up through tube 17 into the mercury reservoir 19. Further gas flow will then merely be vented through the mercury reservoir to be dissipated in the atmosphere. It is at this point that the utility of the needle valve 29 becomes apparent. If the valve 6, needle valve 29, lines 5 and 7 and valve 13 were fully open, there would be an

excessive flow of gas through these members and tubes 17 and 18 and the mercury reservoir 19. Thus, the needle valve 29 is so adjusted manually as to permit sufficient flow of gas as to make certain that all the sampling bottles 11 are filled in case of maximum gas flow in pipe 1 with a slight excess flow which excess can be vented to the atmosphere as hereinbefore stated.

When the sampling bottles 11 are filled and the sampling time at an end as determined by the setting of the time switch 20, the switch operates to close the valve 6 and to open the valve 9. With valve 9 open the head of mercury in the reservoir 19 forces the gas from the sample bottles through tubes 12, valves 13, lines 7 and 8, valve 9 and line 10 into the sample collecting bottle 14 to displace an equivalent volume of brine. The height of the mercury reservoir above the top of the sampling bottles should be so adjusted that upon passage of sample from the bottles 11 to the container 14 mercury will not enter valves 13 nor pass through lines 12, 7, 8, etc. The mercury reservoir should be sufficiently large that it can conveniently hold all the mercury from the plurality of sampling bottles 11 when gas flow is high and all bottles are in active use.

The volumes of the sampling bottles 11 should preferably be small, as for example, about 100 cubic centimeters, or $\frac{1}{4}$ pint. If each be $\frac{1}{4}$ pint in volume, ten such bottles will have a combined capacity of $1\frac{1}{4}$ quarts. At a high sampling rate with 10 bottles in use and sampling at 1 hour intervals over a 24 hour period 30 quarts of gas will have been transferred to the container 14. Half hour intervals may be used, or any time intervals as desired by merely setting the time switch mechanism. Hand wound time clocks or electrically controlled instruments may be used, all of which are standard equipment and commercially available. The valves 6, 9 and the plurality of valves 13 may well be electrically operated for both opening and closing, and such valves are also available.

The sample bottle 14 may be a 5-gallon or a 10-gallon glass bottle or any other type of container desired. It should of course, be of proper size to hold the volume of sample taken over a predetermined time period.

The materials of construction of the sampling bottles, tubes, etc. may be glass, or metal or any material desired. Transparency makes use of glass advantageous. Tube 18 may be a thick wall rubber tube if desired or a rigid metal or glass tube may be used in fixed position if desired. When using metal or glass for this tube then the position of the mercury reservoir 19 is fixed and the maximum mercury level therein will need to be adjusted by addition or removal of mercury.

It will be obvious to those skilled in the art that many modifications of my hereinabove described apparatus and procedure of operation may be made and yet remain within the intended scope and spirit of my invention.

Having disclosed my invention, I claim:

1. A proportional sample collecting system which comprises a supply conduit; a plurality of measuring vessels communicating at their lower extremities with a liquid reservoir; a header conduit communicating between said supply conduit and the upper extremities of said measuring vessels; a cut-off valve closing the upper end of each measuring vessel from said header conduit; a time switch means; a first control valve

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in said header conduit intermediate said supply conduit and said measuring vessels, in communication with and adapted so as to be operated in accordance with settings of said time switch means; a sample container; conduit means communicating between said sample container and said header conduit, at a point intermediate said first control valve and said measuring vessels; a second control valve in said conduit means intermediate said sample container and said header conduit, said second control valve being in communication with said time switch means and adapted so as to be opened and closed alternately with said first control valve in accordance with settings of said time switch means; pressure differential indicator means communicating with said supply conduit upstream of said header conduit; and valve operating means in communication with said pressure differential indicator and adapted so as to successively open one of said cut-off valves in accordance with each unit increase indicated by said pressure differential indicator means and so as to successively close one of said cut-off valves in accordance with each unit decrease indicated by said pressure differential indicator means.

2. The system of claim 1, wherein a volume throttle valve is provided in said header conduit intermediate said first control valve and said conduit means.

3. A proportional gas sample collecting system which comprises a gas supply conduit; a plurality of gaseous volume measuring vessels communicating at their lower extremities through a manifold tube; a liquid reservoir flexibly connected to said manifold tube; a header conduit communicating between said supply conduit and the upper extremities of said measuring vessels; a cut-off valve closing the upper end of each measuring vessel from said header conduit; a time switch means; a first control valve in said header conduit intermediate said supply conduit and said measuring vessels, in communication with and adapted so as to be operated in accordance with settings of said time switch means; a sample container; conduit means communicating between said sample container and said header conduit, at a point intermediate said first control valve and said measuring vessels; a second control valve in said conduit means intermediate said sample container and said header conduit, said second control valve being in communication with said time switch means and adapted so as to be opened and closed alternately with said first control valve in accordance with settings of said time switch means; a pressure differential orifice in said gas supply conduit at a point upstream of said header conduit; pressure differential indicating manometer communicating with said supply conduit on each side of said orifice; a power inlet in the lower part of said manometer; a plurality of power outlets, corresponding in number to said measuring vessels, vertically disposed in the downstream leg of said manometer; and circuit clo-

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sure means within said manometer, individual said cut-off valves communicating with individual said power outlets in said manometer and adapted so as to be opened upon the closure of each respective electric circuit in said manometer and closed upon the breaking of each respective electric circuit in said manometer.

4. A method for taking a gas sample which is directly proportional in volume to the volume of gas to be sampled, which comprises the steps of passing said gas to be sampled through a constriction zone in a gas supply conduit; measuring the pressure differential in said gas supply conduit at said constriction zone; opening a section of a gas measuring zone for each unit of pressure differential measured for a constant period of time; passing sample gas from said supply conduit into said measuring zone in a volume sufficient to fill all opened sections of said measuring zone so as to displace a liquid from said opened measuring zone sections; venting that portion of gas in excess of said opened measuring zone sections through a liquid reservoir zone; periodically closing said measuring zone from said gas supply conduit; displacing said measured gas sample portions with liquid from said liquid reservoir zone; and passing said measured sample portions from said measuring zone sections to a sample storage.

5. A method for taking a gas sample which is directly proportional in volume to the volume of gas to be sampled, which comprises the steps of passing said gas to be sampled through a constriction zone in a gas supply conduit; measuring the pressure differential in said gas supply conduit at said constriction zone; opening a section of a gas measuring zone for each unit of pressure differential measured for a constant period of time; filling said opened measuring zone sections with sample gas from said supply conduit; periodically closing said measuring zone from said gas supply conduit; and passing said measured sample portions from said measuring zone sections to a sample storage.

OLIVER K. AUSTIN.

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