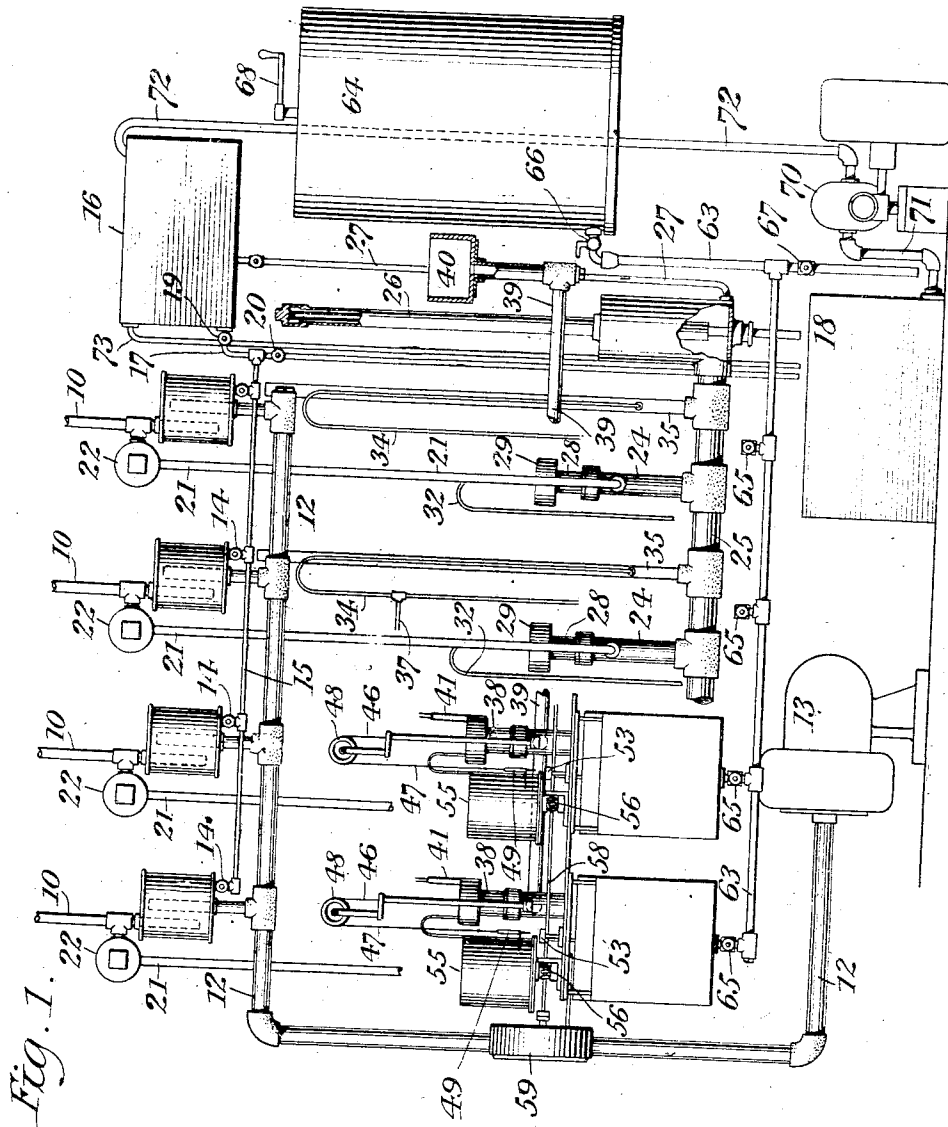


L. SANDERS.
GAS ANALYZING APPARATUS.
APPLICATION FILED NOV. 28, 1910.

1,055,420.

Patented Mar. 11, 1913.

2 SHEETS-SHEET 1.

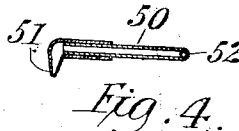


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1,055,420.

2 SHEETS—SHEET 2.



UNITED STATES PATENT OFFICE.

LEWIS SANDERS, OF NEW YORK, N. Y., ASSIGNOR TO SARCO FUEL SAVING & ENGINEERING CO., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

GAS-ANALYZING APPARATUS.

1,055,420.

Specification of Letters Patent.

Patented Mar. 11, 1913.

Application filed November 28, 1910. Serial No. 594 277.

To all whom it may concern:

Be it known that I, LEWIS SANDERS, a citizen of the United States, residing at New York, county and State of New York, have invented certain new and useful Improvements in Gas-Analyzing Apparatus, of which the following is a full, clear, and exact description.

This invention relates to apparatus for analyzing gases to determine their composition quantitatively with respect to one or more constituents, for example sulfur dioxide, oxygen, carbon dioxide, and other gaseous compounds and elements.

More particularly the invention, while capable, with suitable modification well within its spirit, of use for the analysis of other gaseous mixtures, is designed more especially for the determination of the carbon dioxide content of furnace gases.

As is well known, carbon dioxide (CO_2) is formed by the chemical combination of the carbon of the fuel with the oxygen of the air in the proportion of one atom of carbon to two of oxygen. As this represents complete combustion it is evident that a record of the CO_2 content of the furnace gases is a direct indication of the degree of perfection to which the carbonaceous fuel has been burned, and is therefore a reliable guide to efficiency and economy in firing. Thus a high percentage of carbon dioxide in the furnace or flue gases without evidence of carbon monoxide shows high efficiency in fuel consumption, and, conversely, low efficiency is indicated by low carbon dioxide content. Knowing this, and having before him an accurate record of the CO_2 content, the fireman can proceed intelligently to maintain the proper proportion of fuel to air supply so necessary to the most efficient performance of the furnace. Various types of apparatus for making such a record have been proposed, and some of them have proved successful in practice.

As a result of long familiarity with such instruments I have been led to devise my present invention, which has for its chief object to provide improved instrumentalities for the purpose, especially in the direction of greater accuracy and of less sensitivity to disturbing influences both internal and external.

A further object is to simplify the appa-

ratus, both as to construction and operation, to the end of minimizing liability of derangement in the course of ordinary usage.

A still further object is to provide an apparatus which can be built up of "units," whereby what is in effect a single machine can produce separate and independent records of the combustion in the several furnaces of a battery of furnaces.

A further object is to so construct and organize and so associate such "units" that they may all operate with the same degree of accuracy.

To these and other ends the invention consists in the novel features of construction, arrangements of parts, and combinations of elements hereinafter described, and more particularly set forth in the appended claims.

It may be here stated that the invention can be embodied in a considerable variety of forms, and that these may also differ widely in details of construction and operation. Of these various embodiments I have selected for illustration and specific description herein the one which at the present time I consider to exemplify the various features of the invention in their most convenient and effective form. This construction is shown in the accompanying drawings and will now be described in detail, but the reader should keep in mind the fact, stated above, that the apparatus specifically described is merely the preferred and by no means the only embodiment of the invention.

Referring now to the drawings, Figure 1 is a side view of the apparatus comprising four "units," with portions of two omitted. Fig. 2 is a cross section of a unit, somewhat diagrammatic in character. Figs. 3 and 4 are detail sectional views of the recording pen or marker.

The gases which are to be analyzed are led from the several furnaces through individual pipe-lines to the respective analyzing units of the recorder. Each of these pipe lines includes a perforated sampling tube (not shown) extending into the path of the gases at a convenient and suitable point, for example the last pass of a boiler, and the pipe-lines deliver their gases to individual filtering and drying devices (not shown) in which the gases are filtered and dried. From these devices extend pipes 10, one for

each unit, connected through liquid seals 11 to a bus-pipe or main 12 which is in turn connected to a motor and exhaust fan combination 13.

5 From the foregoing it will be seen that when the fan is in operation gas from the different furnaces will be drawn from the several furnaces through the pipes 10 and seals 11. The latter are connected through
10 individual valves 14 to a pipe 15 conveying a suitable inert liquid, preferably paraffin oil, from a supply reservoir 16 with which said pipe is in communication through a pipe 17 extending downwardly into position
15 to discharge into a waste receptacle 18 and having valves 19, 20, above and below the point of juncture with the pipe 15. By manipulating these valves the quantity of oil 11^a in the several seals can be nicely
20 regulated, to afford such resistance to the flow of gas as to make the rate of flow the same in all the sampling lines. From this function the seals may be aptly termed equalizing devices. For the purpose of ob-
25 serving the operation, so that the desired regulation can be more conveniently effected, the vessels 11 are made wholly or in part of glass.

Just outside the equalizing devices the in-
30 let pipes 10 are connected with sampling tubes 21, through filters 22 each comprising a cylindrical chamber containing a brush 23 (Fig. 2) surrounding the orifice of the sampling tube, so that any gas entering the lat-
35 ter must pass through the brush and thus be freed from the last trace of solid or liquid impurities.

The sampling tubes 21 extend down into connection with vertical pipes 24 on a hori-
40 zontal conduit 25 connected to a siphon 26 and also, through a tube 27, to the oil reservoirs 16. These vertical pipes support the inlet or measuring burettes 28, each of which has its upper portion in the form of
45 an enlargement or chamber 29 terminating in an upwardly extending neck 30 of small diameter. Assume now that the measuring burettes are full of oil and that the siphon is operating. As the oil level falls in the
50 pipes 24 below the orifices 31 of the sampling tubes the suction produced by the descent of the oil draws samples of gas from the filtering devices 22, the force of the suction being of course dependent on the "head"
55 due to the siphon 26, which head is uniform throughout the system. The measuring burettes are thus filled with gas from the respective furnaces, and as soon as the siphon ceases to flow the inflow of oil from
60 the reservoir 16 through the pipe 27 begins to fill the system again. As the oil rises in the pipes 24 it eventually closes the inlet orifices of the sampling tubes, thereby preventing ingress or egress of gas thereat and
65 entrapping in each burette the same volume

of gas. Continuing to rise in the burettes the oil forces the gas out through the capillary tubes 32 which deliver the gas into absorbing vessels 33 at the bottom thereof.

70 These vessels are filled with a solution capable of rapidly absorbing carbon dioxide, for example a solution of caustic potash (KOH). Bubbling up through this solution the gas is deprived of its carbon dioxide, and being thereby diminished in volume by
75 an amount proportional to the quantity of CO₂ originally contained. From the absorption vessels the gases pass into the ascending legs of the inverted U-shaped tubes 34, whose descending legs are connected to
80 open-topped risers 35 on the conduit 25. The points of juncture, 36, of the tubes 34 with the risers are below the sampling tube orifices 31, and hence are closed before the gas begins to enter the tubes 34 from the
85 absorption vessels. Being thus prevented from entering the risers, the gas flows from the outlet tubes 34 through tubes 37 into the recording vessels or burettes 38. These latter, similar in form and size to the measur-
90 ing or inlet burettes 28, are connected by a conduit 39 to a common displacement vessel 40, open to the atmosphere; the system containing such quantity of paraffin oil that when the recording burettes are also in communi-
95 cation with the atmosphere (through the tubes 34 and risers 35) the oil, or other liquid employed, will stand in the narrow necks 41 of the recording burettes and above the bottom of the displacement vessel.

100 Flowing into the recording burettes the gas, under pressure, displaces the liquid therein, forcing it out of the burettes and into the displacement vessel, the amount of oil displaced being of course proportional
105 to the volume of gas remaining after the carbon dioxide is absorbed in the vessels 33. Inasmuch as the quantity of CO₂ in the original gas can never greatly exceed
110 twenty per cent. of the original volume, and in practice is, at most, considerably less, it is unnecessary to make any record if the volume remaining after removal of the CO₂ does not exceed eighty per cent. of the initial volume, and accordingly the recording
115 devices are constructed and arranged to be inactive until a volume of gas equal to at least eighty per cent. of the original volume has entered the recording burette. For this
120 purpose a float 42 is provided in each recording burette, with means for keeping the float stationary until the descending oil level has reached the eighty per cent. point; that
125 is, the point indicating substantially perfect combustion. The float is of annular form, encircling a slender tube 43 and connected by fine rods 44 to a cross piece 45
130 below the lower end of said tube, the connecting rods being of such length that the float will stand at the eighty per cent. level,

submerged in the liquid, until the latter is displaced to such point. Attached by its lower end to the cross piece and extending upwardly through the guide tube 43 is a slender rod or stem 46, connected at the top to a thin cord or thread 47 passing over a delicately journaled wheel 48 and supporting by its depending end a body 49 of sufficient weight, with the marking pen, to counterbalance the float 42. Carried by the counterweight 49 is a marking pen 50 having a laterally turned marking point 51 and a depending leg 52 adapted to dip into an open vessel 53 containing ink at each descent of the pen. It will therefore be seen that the pen receives at each cycle a fresh supply of ink, to compensate for the amount consumed in making the record, so that its weight does not vary from cycle to cycle; and inasmuch as the amount of ink consumed in making the record is exceedingly minute the change in the weight of the pen during any cycle is too minute to disturb the balance of the float. The weight of the marking device is therefore in effect constant. The counterweight 49 is connected to the cord 47 by means of a threaded stem 49^a, so that by simply turning the latter the pen may be raised or lowered, as may be necessary to bring it accurately to zero when the machine is put into operation.

When a volume of gas equal to eighty per cent. of the initial volume has entered the recording burette the oil level reaches the float. If, now, more gas enters, that is, if the amount of CO₂ in the original volume was less than twenty per cent. of the whole, the oil level in the burette will continue to fall, thereby allowing the float to descend and the marking device to rise, making a vertical mark on a graduated record sheet wrapped around a horizontally revolving record drum 55. The vertical shafts on which the drums are mounted carry worm gears 56, meshing with worms or endless screws 57 on a horizontal shaft 58 driven by a powerful clock 59, the gear ratio being in the present form such that each drum makes one revolution in twenty-four hours. If the machine is making—say, twenty records per hour, the motion of the drum is relatively so slow that the mark traced by the pen, through theoretically a curve, is in reality simply a vertical line. Since the descent of the float and consequently the ascent of the marking device are dependent in extent upon the volume lost by the gas by removal of its contained carbon dioxide, it will be seen that the height of the line traced on the record sheet indicates inversely, so to speak, the percentage of CO₂ in the original sample of gas. Thus, no mark at all indicates twenty per cent. carbon dioxide, and a line of maximum height indicates no carbon dioxide. By suitable graduation and calibra-

tion the percentage of carbon dioxide in the original gas can be read directly from the record.

The guide tubes 43 are sealed in the tops of the recording burettes, and extend not only well above zero level of the oil in the necks 41 but also well below the level in the recording burettes at maximum displacement, so as to prevent any possible escape of gas. The liquid stuffing box thus provided is practically frictionless, since the stem 46 rises and falls in a column of oil.

While the record is being made, as above described, paraffin oil from the reservoir 16 is flowing into the conduit 25, and rising in the siphon 26 and risers 35. At the instant the floats 42 in the recording burettes reach their lowermost positions, that is, when the record is completed, the siphon begins to flow and the oil in the measuring or inlet burettes to sink, thereby relieving the pressure on the gas in the recording burettes. As soon as the orifices 31 are uncovered gas again enters the measuring burettes, and shortly thereafter the descending oil in the risers 35 uncovers the orifices 36, thereby permitting the head of displaced oil in the displacement vessel 40 to expel the gas from the recording burettes through the tubes 37 and 34 to the risers and thence into the atmosphere. Thus the surface of the displacement liquid in each burette is at the end of each cycle put in free communication with the atmosphere through the respective riser. When the siphon ceases to flow oil again begins to ascend in the measuring burettes and the risers, and the cycle described is repeated.

It will be observed that when the oil in the recording burettes is at zero position, and therefore standing in the narrow necks 41, with a small surface of the oil exposed, the oil level in the measuring burettes is below the necks 30, with a large surface exposed. On the other hand, by the time the oil rising in the last-mentioned burettes has reached the necks and the oil surfaces have become small, the oil levels in the recording burettes have fallen far below the necks 41 and hence have large surfaces exposed. Thus the ascent of the oil in the measuring burettes is relatively slow at first, but is rapid during the last portion of its rise; whereas the accompanying movement (downward) of the oil in the recording burettes is at first rapid but becomes relatively slow during the making of the record. The advantage of this is that any effect which change of temperature may have on the volume of the oil in the measuring burette will, in the course of the cycle, be compensated in the recording burette. For example, an increase of heat which would cause a slight but abnormally high oil level in the neck 30 will have no appreciable effect on the level

in the recording burette, since at such time the oil level therein is falling at a much slower rate than that at which the oil is rising in the neck 30. Moreover, the use of the narrow necks or tubes 30 and 41 insures that the expulsion of the gas by the rise of liquids in these tubes will be rapid and hence will be more effective in carrying along bubbles of gas than would be the case if such rise were slow. It will also be observed that the records do not depend upon any displacement of the absorbing liquid by which the carbon dioxide is removed. This is a highly advantageous feature, for the reason that it is unnecessary to have a constant and accurately known volume of absorbing liquid, it being sufficient to keep the absorption vessels filled, whatever their size. Moreover, the gas can be allowed to bubble through the liquid instead of depending on surface absorption, thereby securing more rapid and efficient action. The absorbing vessels are connected by a supply pipe 63 to a supply tank 64 containing caustic potash solution, valves 65, 66, and 67 being provided so that any absorbing vessel can be drained or filled independently of the others. The tank 64 is charged by placing therein suitable quantities of water and caustic potash, a suitable stirrer actuated by a handle 68 being provided to accelerate the dissolving of the caustic.

The oil discharged from the siphon 26 and received by the receptacle 18 is conveyed from the latter to the reservoir 16 by means of a pump 70, connected to the two vessels by pipes 71, 72. An overflow pipe 73 may be provided to carry any excess oil from the reservoir back to the waste receptacle.

From the foregoing description it will be seen that while the several units are supplied with fresh gas by the same agency, namely, the suction through the pipe line 12, and the operation is carried out in all the units by another single agency, namely, the fluid pressure in the tank 16, the units are independent of each other in operation, each making its record without affecting the rest. At the same time, the records made by the several units are made simultaneously and not successively so that it is not necessary to await the registering of all the furnaces in turn before another record can be made. The "time lag," that is, the time between the withdrawal of a sample of gas from the flue and the making of the record, is reduced to a minimum chiefly by means of the powerful suction produced by the fan 13. The only adjustments required in putting the machine in operation are setting the marking pens to zero by turning the threaded stems 49^a, and regulating the quantities of liquid in the equalizing devices to produce the same degree of suc-

tion for each unit. Instead of mixing the caustic outside the machine and then pouring the solution into the absorbing vessels, a procedure which usually results in spilling more or less of the mixture on the recorder, the solution is mixed in the tank 64, which forms part of the machine, and is conveyed to the absorbing vessels through valved pipes. The apparatus is independent of temperature, by reason of the compensating action of the measuring and recording burettes; in addition, the same paraffin oil is used over and over again in the successive cycles, thus keeping the parts at constant temperature.

As previously stated, the apparatus herein specifically illustrated and described is merely the preferred embodiment of the invention, which may be embodied in other forms without departure from its proper spirit and scope.

I claim:

1. In a gas analyzing apparatus, the combination of a plurality of analyzing units each including a recording vessel adapted to contain a liquid, a common displacement receptacle into which the liquid in the recording vessels is displaced by volumes of gas delivered into said vessels, and recording devices for the several units dependent for operation upon descent of the liquid levels in the respective recording vessels as the liquid is displaced therefrom.

2. In a gas analyzing apparatus, the combination with a plurality of analyzing units each including a recording vessel adapted to contain a liquid, of a common displacement vessel in communication with the several recording devices, and independent recording devices associated with the respective recording vessels and dependent for operation upon displacement of liquid therein.

3. In a gas analyzing apparatus, the combination of a recording vessel adapted to contain a liquid, a displacement vessel in constant communication with the recording vessel and constantly open to the atmosphere, intermittently operating recording devices associated with the recording vessel and dependent for operation upon variation of the level of the liquid therein, and means for putting the interior of the recording vessel into free communication with the atmosphere at the end of each recording operation.

4. In a gas analyzing apparatus, in combination, a measuring vessel adapted to contain liquid to be displaced by gas admitted to the vessel, a recording vessel adapted to contain a liquid to be displaced by the gas admitted thereto, means to convey the gas from the measuring vessel to the recording vessel, intermittently operable recording mechanism dependent for operation upon

the displacement of the liquid in the recording vessel and means connected with the measuring vessel dependent upon the displacement of the liquid therein for putting the interior of the recording vessel into free communication with the atmosphere.

5. In a gas analyzing apparatus, the combination of a measuring vessel, a recording vessel having a contracted upper portion, means for conveying gas from the first to the second-named vessel, a displaceable body of liquid in the recording vessel, standing in the contracted upper portion of the vessel when at zero position, and recording mechanism associated with the recording vessel and dependent for operation on displacement of the liquid in the recording vessel.

6. In a gas analyzing apparatus, the combination of a recording vessel having a contracted upper portion, a body of liquid in said vessel and displaceable by gas admitted through the contracted upper portion of the vessel, said liquid when at zero position standing in the contracted upper portion, a measuring vessel having a contracted upper portion, means for conveying gas from the measuring vessel through the contracted upper portion thereof to the contracted upper portion of the recording vessel, and means for introducing a liquid into the measuring vessel at a position of relatively large diameter below the contracted upper portion to force gas out through such contracted portion and into the recording vessel through the contracted portion thereof, whereby the liquid in the last mentioned vessel will be displaced downwardly out of its contracted portion.

7. In a gas analyzing apparatus, a measuring vessel having its lower portion of large diameter relatively to its upper portion, a recording vessel having its upper portion of small diameter relatively to its lower portion, gas-conveying means connecting the upper portions of the vessels, a displaceable body of liquid in the recording vessel and having its initial level in the said upper portion of the vessel, intermittently operable recording mechanism dependent for operation upon displacement of the liquid in the recording vessel downwardly out of the upper portion and into the lower portion, and means for supplying liquid to the measuring vessel through the lower portion thereof to expel gas therefrom through the upper portion and into the recording vessel to displace the liquid in the latter.

8. In a gas analyzing apparatus, the combination of a recording vessel containing a displaceable body of liquid and having an upper portion of small diameter in which the liquid stands when at zero position, a gas measuring vessel having a lower portion of large diameter, gas-conveying means con-

necting the upper portions of the vessels, and means for supplying a liquid to the measuring vessel through its lower portion to expel gas through its upper portion and into the recording vessel through the upper portion thereof to displace the liquid in said recording vessel.

9. In a gas analyzing apparatus, the combination of a recording vessel having an upper portion of small diameter, a displacement vessel of large diameter, open to the atmosphere and communicating with the lower portion of the recording vessel, means for putting the recording vessel into communication with the atmosphere through the upper portion of the vessel, and a body of liquid displaceable from the recording vessel by gaseous pressure and standing in the upper portion of the recording vessel when the same is in communication with the atmosphere.

10. In a gas analyzing apparatus, the combination of a recording vessel having an upper portion of small diameter, a body of liquid in the vessel and displaceable through the lower portion thereof, said liquid at its initial position standing in the said upper portion of small diameter, and means for delivering gas to the vessel through its said upper portion to displace the liquid.

11. In a gas analyzing apparatus, the combination of a recording vessel adapted to contain a displaceable body of liquid, a guide tube extending downwardly into the vessel from outside the same, said tube having both ends open and having its lower orifice below the lowest level of the liquid, a float in the vessel having a stem extending upwardly through the guide tube, and recording devices operatively connected with said stem.

12. In a gas analyzing apparatus, the combination of a recording vessel adapted to contain a displaceable body of liquid, a float inside the vessel, a stem connected to the float and extending upwardly outside of the vessel, and a frictionless liquid stuffing box for said stem.

13. In a gas analyzing apparatus, the combination of a recording vessel adapted to contain a displaceable body of liquid, recording mechanism dependent for operation upon displacement of such liquid and having a stem extending into the vessel, and a frictionless liquid stuffing box for said stem.

14. In a gas analyzing apparatus, the combination of a recording vessel adapted to contain a downwardly displaceable body of liquid, a float inside the vessel, means for holding the float submerged until the liquid level has fallen to a predetermined point, and recording devices operatively connected with the float.

15. In a gas analyzing apparatus, the combination of a recording vessel adapted

to contain a downwardly displaceable body of liquid, a float inside the vessel, means for preventing rise of the float to the surface of the liquid when the latter is at its initial position, whereby descent of the liquid will cause no movement of the float until the liquid has fallen to a predetermined level, and recording mechanism operatively connected with the float.

16. In a gas analyzing apparatus, the combination of a recording vessel adapted to contain a downwardly displaceable body of liquid, a counterbalanced float inside the vessel, adapted to be submerged until the liquid is displaced to a predetermined point and to float on the surface of the liquid thereafter, and recording devices operatively associated with the float.

17. In a gas analyzing apparatus, in combination, gas sampling tubes, measuring burettes, absorbing vessels and recording vessels and a common siphon, said siphon adapted to draw a sample of gas into said measuring burettes and to force said sample through the absorbing vessels and into the recording vessels substantially as described.

18. In a gas analyzing apparatus, in combination, gas sampling tubes, measuring burettes, absorbing vessels, recording vessels, means comprising a siphon adapted to draw a sample of gas into the measuring burettes, said means adapted to force a measured quantity of said gas from the measuring burettes through the absorbing vessels, and the means also adapted to place the recording vessel into communication with the atmosphere after each recording operation.

19. In a gas analyzing apparatus in combination, gas sampling tubes, equalizing devices, measuring burettes, absorbing vessels and means to supply liquid from a common supply to said equalizing devices whereby the gases in the measuring vessels are maintained under equal conditions of pressure.

20. In a gas analyzing apparatus, in combination sampling tubes, measuring vessels, means adapted to supply gases from said tubes to said measuring vessels, absorbing vessels containing a substance adapted to remove a constituent from the gas, recording vessels normally filled with liquid, and a common means to pass the aforesaid gas from the measuring vessels through the said absorbing vessels into said recording vessels whereby the liquid in said recording vessels is displaced and a record made.

21. In a gas analyzing apparatus, the combination of a plurality of analyzing units each including measuring and recording vessels, independent gas-sampling pipe-lines for the several units, a common suction main for the pipe-lines for drawing samples of gas through all simultaneously, equalizing devices associated with the pipe-lines for equalizing the suction therein, means for

conveying gas samples from the pipe-lines to the respective measuring vessels, means for delivering gas from the measuring vessels to the respective recording vessels and removing a gaseous constituent in transit, and recording devices associated with the respective recording vessels.

22. In a gas analyzing apparatus, the combination of a plurality of analyzing units, gas-sampling pipe-lines for the respective units, a common suction main for the several pipe-lines, liquid seals between the pipe-lines and the suction main, and means for varying the quantity of liquid in the seals independently of each other whereby to equalize the suction on the pipe-lines.

23. In a gas analyzing apparatus, the combination of a plurality of analyzing units, gas-sampling pipe lines for the respective units, a common suction main for the several pipe-lines, liquid seals between the pipe-lines and the suction main, a reservoir adapted to contain liquid for the seals, a system of piping for conveying liquid from the reservoir to the seals, and valves in said system enabling the quantity of liquid in any seal to be varied independently of the others, whereby to equalize the suction on the pipe-lines.

24. In a gas analyzing apparatus, the combination with a plurality of analyzing units each including a measuring vessel, a recording vessel, and an absorbing vessel adapted to contain a liquid capable of absorbing a constituent of the gas as the same passes through the absorbing vessel in transit from the measuring vessel to the recording vessel; of a tank adapted to contain a supply of absorbing liquid; a system of piping connecting the absorbing vessels with the tank; and valves in said system enabling the absorbing vessels to be filled and emptied independently of each other.

25. In a gas analyzing apparatus, the combination with a plurality of analyzing units, each including a measuring vessel, a gas-sampling pipe-line connected with the vessel for supplying samples of gas thereto, a recording vessel, and means for conveying gas from the measuring vessel to the recording vessel and removing a constituent of the gas in transit; of a pipe-line common to the several measuring vessels; means for supplying a liquid through said pipe-line to the measuring vessels to expel gas therefrom and into the respective recording vessels; and automatic intermittently operating means associated with the pipe-line to empty the measuring vessels when predetermined volumes of gas have been expelled therefrom, the outflow of liquid from the measuring vessels producing suction to draw fresh samples of gas into such vessels from the gas sampling pipe-lines.

26. In a gas analyzing apparatus, the

combination with a plurality of analyzing
units each having a measuring vessel, means
connected with the top of the vessel for con-
veying gas therefrom, and a gas-sampling
5 pipe-line connected to the lower portion of
the measuring vessel to supply samples of
gas thereto; of a pipe-line common to the
several measuring vessels and connected to
the lower portions thereof; means for sup-
10 plying a liquid to the measuring vessels
through the common pipe-line, whereby the
liquid rising in the measuring vessels will
serve to expel gas therefrom; and a siphon
associated with the pipe line to empty the

measuring vessels periodically, the siphon 15
operating when the liquid has risen to a
predetermined height in each measuring
vessel, the outflow of liquid from the measur-
ing vessels producing a suction to draw fresh
samples of gas into the measuring vessels 20
from the gas-sampling pipe-lines.

In testimony whereof I affix my signature
in the presence of two subscribing witnesses.

LEWIS SANDERS.

Witnesses:

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S. S. DUNHAM.