

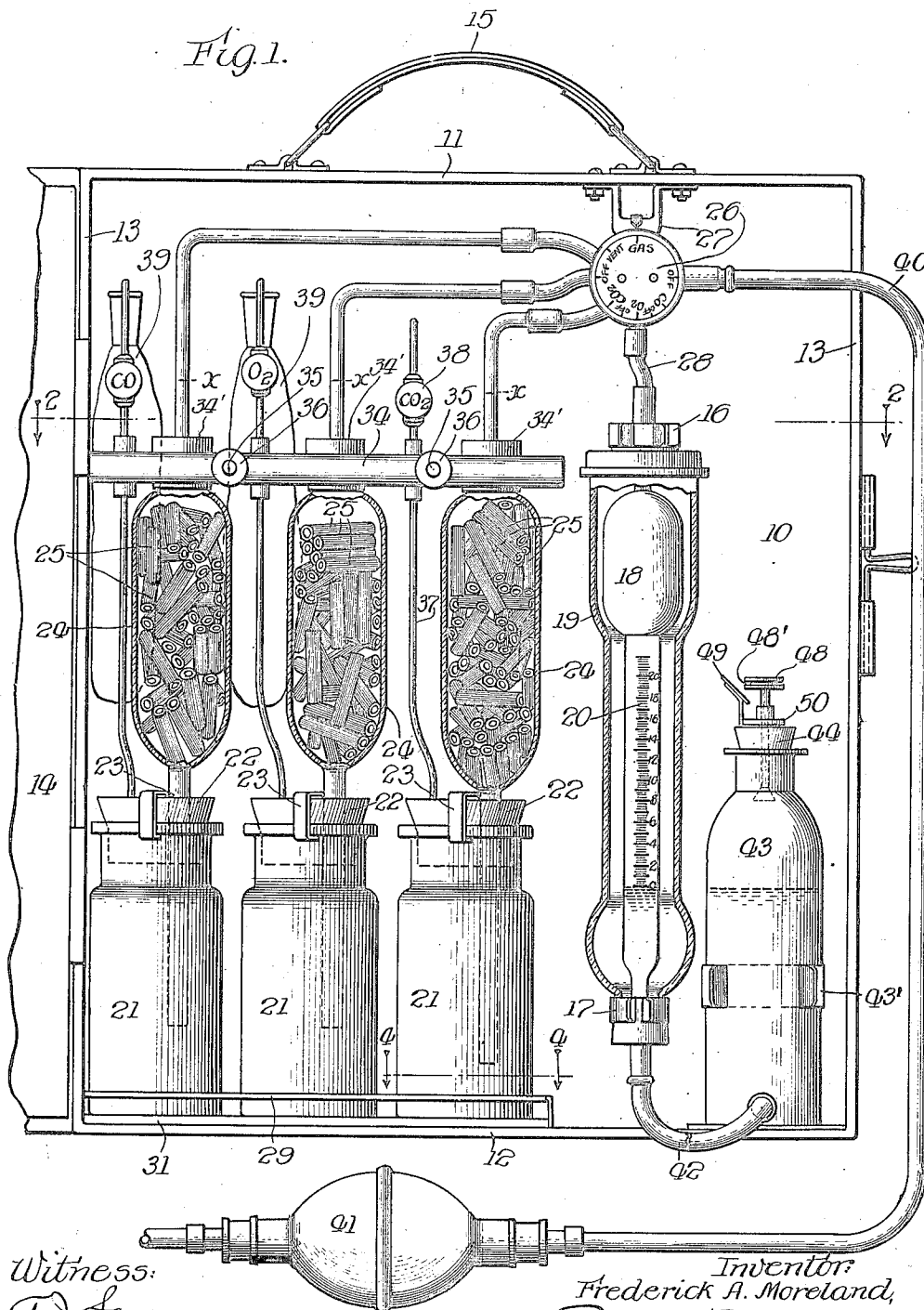
Mar. 20, 1923.

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F. A. MORELAND  
GAS ANALYSIS MACHINE

Filed June 9, 1919

2 sheets-sheet 1



Witness:

A. J. Sauer;

Inventor:

Frederick A. Moreland,

By Pond & Wilson, Attys.

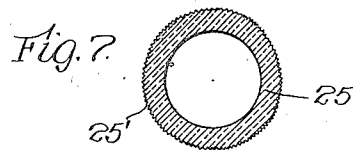
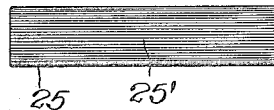
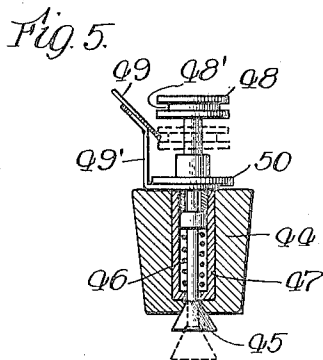
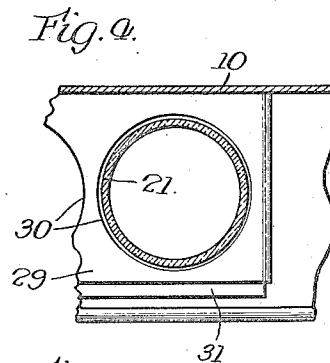
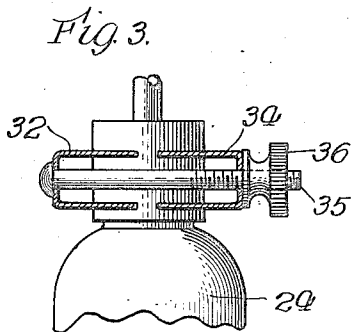
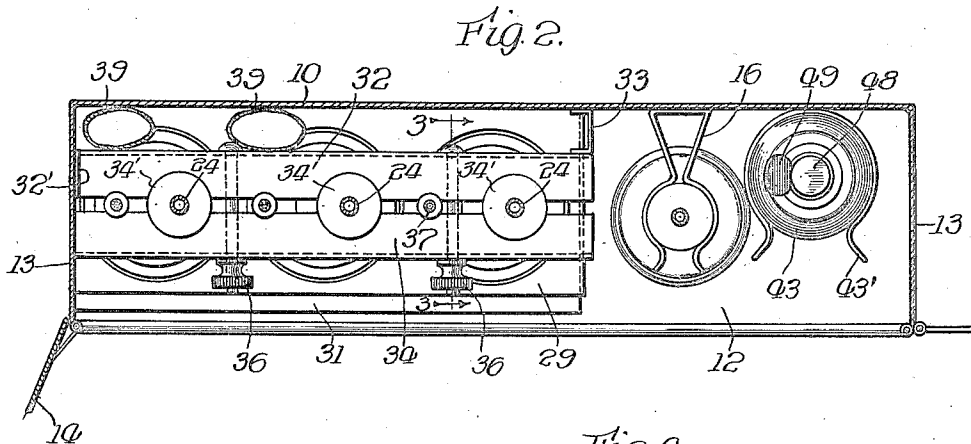
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attys.

## UNITED STATES PATENT OFFICE.

FREDERICK A. MORELAND, OF CHICAGO, ILLINOIS.

## GAS-ANALYSIS MACHINE.

Application filed June 9, 1919. Serial No. 302,685.

*To all whom it may concern:*

Be it known that I, FREDERICK A. MORELAND, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Gas-Analysis Machines, of which the following is a specification.

This invention relates to machines for analyzing gas, and has reference more particularly to machines of the well known Orsat type which are designed to determine several or all of the constituents of a gaseous mixture such as furnace gas, illuminating gas, producer gas, etc., and the relative amounts of such constituents in any given sample; the constituent gases being successively eliminated from the mixture by chemical absorption.

The principal objects of the invention are, to provide an improved construction of gas absorber; to provide means for preventing deterioration of the oxygen and carbon monoxide absorbers by the oxygen of the atmosphere; and to provide an improved thumb valve and lock on the filling bottle for controlling the flow of gas and air through the latter.

Other objects and advantages of the invention will be apparent to those skilled in the art, as the same becomes better understood by reference to the following detailed description, taken in connection with the accompanying drawing wherein I have illustrated an approved embodiment of the invention which has been found in practice to satisfactorily fulfill the stated objects, and in which—

Fig. 1 is a front elevation of the complete apparatus, with the hinged front door of the housing or casing in open position;

Fig. 2 is a horizontal section, taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional detail through the upper rack, taken on the line 3—3 of Fig. 2;

Fig. 4 is a sectional detail, taken on the line 4—4 of Fig. 1;

Fig. 5 is a vertical section, taken through the stopper and valve of the leveling bottle;

Figs. 6 and 7 are enlarged views in side elevation and cross-section respectively of one of the glass beads employed as chemical distributing material in the pipettes of the gas-absorption devices.

Referring to the drawing, 10 designates

the back wall, 11 the top wall, 12 the bottom wall, and 13 the side walls of a rectangular portable holder or case in which the several working parts of the apparatus are all mounted, and in which they may be completely enclosed upon shutting a front door 14 which is hinged to one of the side walls 13, as indicated in Fig. 1. A handle strap 15 is secured to the top wall for convenience in transporting the apparatus by hand from place to place, and insuring the upright position of the chemical containers during transportation.

Secured to the back wall 10 and projecting forwardly therefrom are a pair of upper and lower spring clips 16 and 17, in which is removably mounted and supported an ordinary gas measuring burette 18 surrounded by the usual glass water jacket 19 and provided with the reading scale 20.

At one side of the burette are mounted a plurality (herein shown as 3) of gas absorption devices. Each of these comprises a chemical bottle or flask 21 having a rubber stopper 22 and a stopper clamp 23, and a superposed pipette 24 containing chemical-distributing material in the bulbs thereof consisting, preferably, of glass beads 25, a special form of which is shown in the enlarged detailed views, Figs. 6 and 7, and will be hereinafter more particularly described. The lower reduced ends of the pipettes 24 pass through the stoppers 22 and into the chemical bottles 21, while their upper ends lead into a distribution or master valve 26 that is suspended from the top wall 11 of the case by a hanger bracket 27. The upper end of the burette 18 also communicates directly through a short section of tube 28 with the distribution valve 26. The gas absorption devices are removably supported and held within the case by a pair of racks. 29 designates the lower rack which conveniently consists simply of a sheet metal plate mounted a slight distance above the bottom wall 12 and formed with holes 30 forming seats for the bottles 21, the bottoms of the latter resting on the bottom wall 12, or preferably upon a rubber or other mat 31 between the bottom wall 12 and the rack plate 29. This rack prevents accidental lateral displacement of the lower ends of the gas absorption devices.

The upper rack comprises, as herein shown, a stationary rack bar 32 (Figs. 2 and 3) secured at one end by integral flanges 32'

to one of the side walls 13 and at its other end by a bracket 33 to the rear wall 10, the parts being united either by solder or by riveting. 34 designates the co-operating member of the upper rack and consists of a clamp bar which is detachably mounted in place through the agency of screw bolts 35 mounted in the stationary or permanent rack bar 32, and knurled nuts 36 engaged with the outer ends of the screw bolts 35. The opposed inner edges of the bars 32 and 34 are properly notched, as shown in Fig. 2, to embrace the several pipettes 24, at the upper ends of the bulbs thereof; rubber gaskets 34' being preferably employed between the pipettes and the rack as cushions to prevent breakage.

Extending through each bottle stopper 22 of the gas absorption devices is a small vent pipe 37, the upper portion of which is clamped and held in the upper rack in the same way that the pipettes are clamped and held by the latter. In each vent pipe 37 is a valve 38, the outer face of which is appropriately marked, as shown in Fig. 1, with symbols indicating the particular gas withdrawn or absorbed by each of the gas absorption devices.

To the upper free ends of the vent pipes of the CO and O<sub>2</sub> absorbers are secured rubber bags 39 which permit venting of the chemical bottled, when required, without subsequent introduction of free oxygen which would oxidize and deteriorate the chemicals employed in said absorbers.

To the master valve 26 is also connected a pipe or hose 40 containing a hand bulb pump 41 for forcing the gas to be analyzed into the apparatus; the other end of the pipe 40 being connected to a source or sample of such gas.

To the lower end of the burette 18 is connected by a length of flexible tubing 42 a leveling bottle 43, which normally rests on the bottom wall 12 of the case on the opposite side of the burette from the gas absorption devices, and is removably held in place by a spring clip 43' secured to the back wall of the case, this spring clip being similar to the clips 16 and 17 which support the burette. This bottle contains a body of liquid which may be mercury, light oil or water, preferably in amount such that the level in the bottle and burette will stand at the zero scale mark of the latter when the bottle is at rest, as shown in Fig. 1. This leveling bottle 43 is provided with a rubber cork 44 (see Fig. 5) in which is mounted a valve 45 by which the flow of air and gas therethrough is manually controlled. The valve is normally closed by a spring 46 surrounding the stem thereof, said spring being housed within a metal socket piece 47 set into the cork from its upper end. The valve stem extends some distance above the

top of the cork and at its upper end is provided with a button or thumb piece 48 by which the valve may be opened, as shown in dotted lines in Fig. 5, and when so opened it is automatically locked in open position by a spring detent 49 snapping into a groove 48' in the periphery of the button 48. The stem or shank 49' of the detent 49 is held in place by a clamp screw 50 that screws into the threaded upper end of the socket piece 47 and is apertured for the passage therethrough of the valve stem.

The gas absorption devices may, of course, be equipped to handle any particular gases that it may be desired to extract from the sample; but I have herein indicated one of them as designed to absorb the carbon dioxide and preferably employing as the absorbent chemical a strong solution of caustic potash; another as designed to extract oxygen, and preferably employing for this purpose an alkaline solution of pyrogalllic acid; and the third as designed to extract carbon monoxide, and employing a solution, preferably ammoniacal, of cuprous chlorid.

As a distribution material for the bulbs of the pipettes, I preferably employ glass beads; but I have discovered that the efficiency of such material may be greatly enhanced by roughening the exterior surfaces of the beads. This roughening preferably takes the form of fine longitudinal corrugations 25' on the cylindrical surface of the bead, as shown in Figs. 6 and 7. When the material is bathed by the chemical solution, a greater amount of the latter adheres to and remains on the material than where smooth glass beads are used, with a consequently greatly increased capacity for absorbing by chemical affinity the particular gas that is to be extracted from the sample. The beads also have the effect of breaking up the inflowing gas into small volumes, thus securing a more thorough and intimate contact of the gas with the chemical.

In the manipulation of the apparatus, assuming that the several chemical containers 21 are properly charged with their respective solutions and that the leveling bottle is charged with clean water or other liquid until, when the bottle is at rest on its seat, the liquid stands at zero in the burette, the gas-absorption devices are primed as follows. The CO vent-valve is opened, and the master valve is turned to "Vent." The leveling bottle is then removed and raised, with its thumb-valve open, allowing the liquid to rise in the burette. When the burette is full, the thumb-valve is released, the master valve is turned to CO and the bottle slowly lowered, the thumb-valve being gradually opened to regulate the flow. As the liquid descends in the burette, the air is sucked out of the CO pipette, drawing the cuprous so-

lution from the bottle 21 up into the pipette 24 to the point on the latter marked X (Fig. 1), wetting the beads 25. If the solution does not rise to the full height, this operation is repeated. The thumb-valve is then released and allowed to close, and the master-valve is turned to "Off."

The pyro and caustic solutions for the  $O_2$  and  $CO_2$  determinations are raised in the same way, except that the master valve is turned to  $O_2$  and  $CO_2$ , respectively. As the content of the pipette must necessarily be greater than that of the burette, necessitating the filling of burette more than once in order to raise the chemical to full height required, the  $CO$  pipette should be primed first, in order to avoid passing the other ports of the valve after the chemical or chemicals controlled by said other ports have been raised.

The leveling bottle is then placed on its seat and the thumb-valve pressed down and locked by the detent. The master-valve is turned to "Gas," and gas is pumped into and through the burette and leveling bottle until all air is expelled and they are filled with gas except for the liquid. The master-valve is then turned to "Vent," and the liquid in the burette and bottle will both automatically level at zero, without the necessity of manipulating the bottle, thus insuring an accurate measurement of the gas sample. The master-valve is next turned to  $CO_2$ , the leveling bottle is again raised, and as soon as the water in the burette, driving the gas before it over into the  $CO_2$  absorber, reaches the top of the burette, the thumb control is released, closing the bottle valve, and the master-valve is turned to the next "Off" or blank point. Preferably the gas is left in the  $CO_2$  pipette a few seconds to insure complete absorption of the  $CO_2$ . The gas residue is then returned to the burette to measure the amount of  $CO_2$  absorption. To do this, the bottle is lowered, the master-valve is again turned to  $CO_2$ , the thumb-valve is pressed down, and the caustic solution is raised to the top of the pipette, exactly as before. As soon as the caustic solution reaches the top of the pipette, the master-valve is turned to the "Off" point at the right of the  $CO_2$  mark if it is intended to analyze only for  $CO_2$ . If it is intended to analyze for other gases from the same sample, then the master-valve should be turned to the "Off" point at the left of the  $CO_2$  mark, or between the  $O_2$  and  $CO_2$  marks. With the thumb-control pressed down, the leveling bottle is then placed beside the burette, with the liquid levels in the two exactly opposite each other, and the level in the burette is then read off on the scale of the latter, and will be at some point above zero. This will represent the percentage of  $CO_2$  in the sample analyzed, each line divi-

sion of the scale representing two-tenths of one per cent.

If it is desired to analyze for  $O_2$  and  $CO$ , the method of procedure is the same as that above described, except that the starting point on the burette scale, instead of being zero, is the point at which the liquid stands at the conclusion of the immediately preceding analysis, and the percentage of the gas is determined by the difference, as shown on the scale, between the present scale reading and the immediately preceding scale reading. The apparatus may, of course, be equipped with any desired number and characters of gas-absorption devices, those herein shown being only such as are most commonly employed in gas analysis machines of this type.

The volume of liquid employed being constant, the practical value and importance in the apparatus, aside from convenient portability, of the housing or case in which all of the parts are mounted in a fixed relation to each other and in which the liquid levels in the burette will exactly and accurately show the percentages of the several constituent gases analyzed for, will be readily apparent to those skilled in the art. Moreover, the described construction permits the quick removal of all the parts for cleaning, loading and repairs, the absorption devices being removable by simply removing the clamp-bar and disconnecting the upper ends of the pipettes and the burette and leveling bottle being readily removable from their spring holding clips. The rubber bags 39 on the free ends of the vent-pipes prevent the introduction of atmospheric oxygen to the pyro and cuprous solutions which would otherwise be quickly oxidized and rendered useless for  $O_2$  and  $CO$  absorption.

It is evident that the apparatus shown and described as one practical and workable embodiment of the invention may be modified in respect of detail structural features without departing from the principle and substantial character of the invention or sacrificing any of the advantages thereof. Hence, I reserve all such variations and modifications as fairly fall within the spirit and purview of the appended claims.

I claim:

1. In a gas analysis machine, a gas-absorption device comprising, in combination, a chemical bottle, a stopper therefor, a clamp for holding said stopper in said bottle, a pipette mounted on said stopper and extending through the latter into said bottle, and a vent-pipe mounted on said stopper.

2. In a gas analysis machine, a gas-absorption device comprising, in combination, a chemical bottle, a stopper therefor, a clamp for holding said stopper in said bottle, a pipette mounted on said stopper and extending through the latter into said bottle, a

vent-pipe mounted on said stopper, a vent-valve in said vent-pipe, and an expansion bag attached to the upper end of said vent-pipe.

5 3. In a gas analysis machine, the combination of a chemical bottle, a vent pipe communicating with the interior of said bottle, and an expansion bag attached to the upper end of said vent pipe.

10 4. In a gas analysis machine, the combination of a chemical bottle, a stopper therefor, a vent pipe mounted on said stopper, a vent valve in said vent pipe, and an expansion bag attached to the upper end of said vent pipe.

15 5. In a gas analysis machine, the combination with a burette, of a leveling bottle, a hose connection between the lower end of said bottle and the lower end of said burette, 20 a stopper for said bottle, and a thumb-controlled valve in said stopper.

6. In a gas analysis machine, the combination with a burette, of a leveling bottle, a hose connection between the lower end of said bottle and the lower end of said burette, 25 a stopper for said bottle, a valve in said stopper, a spring urging said valve to closed position, and a thumb-piece on the stem of said valve for opening the latter.

7. In a gas analysis machine, the combination with a burette, of a leveling bottle, a hose connection between the lower end of said bottle and the lower end of said burette, a stopper for said bottle, a valve in said stopper, a spring urging said valve to closed 30 position, a thumb-piece on the stem of said valve for opening the latter, and a detent mounted on said stopper to engage with said thumb-piece and lock said valve in open 35 position.

FREDERICK A. MORELAND.