Sept. 28, 1937. W. J. HUFF 2,094.357

APPARATUS FOR ANALYZING GASES

Filed July 22, 1931

Fig. 2.

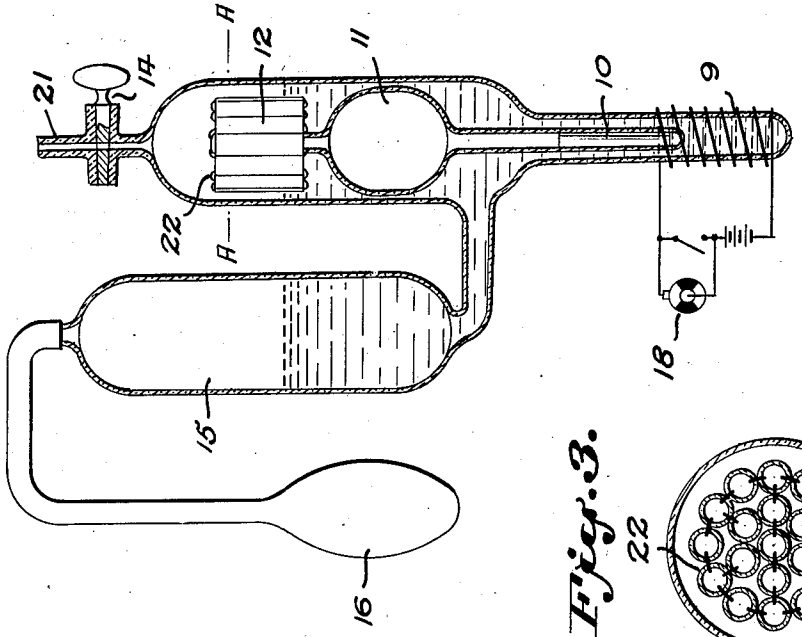
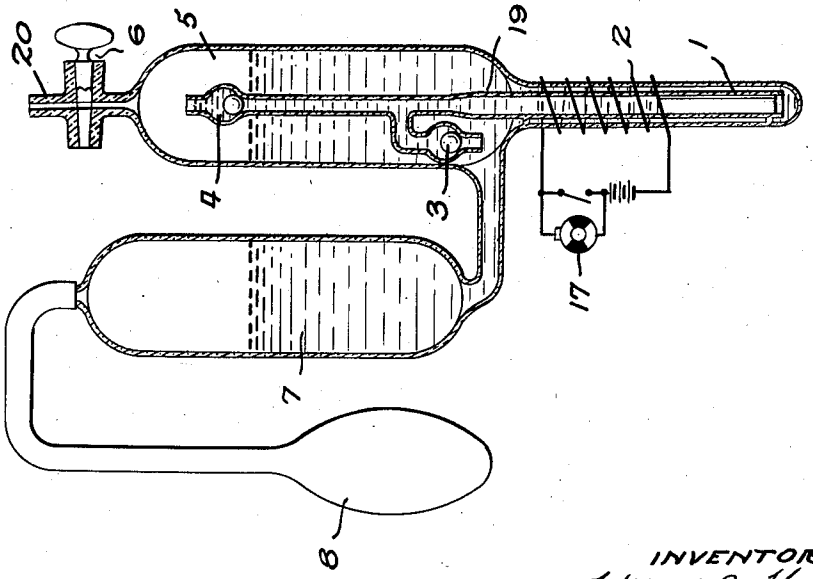



Fig. 3.




Fig. 1.




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## APPARATUS FOR ANALYZING GASES

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5 Claims. (Cl. 23—254)

This invention relates to the interaction of gases with liquid media by means of which a constituent is removed from the gas, and the composition of the gas is thereby ascertained. It has for its object the promotion of that interaction whereby the process is rendered more simple, less laborious, and more expeditious and the wear upon vital portions of the apparatus is minimized.

The principles of my invention will be understood by reference to one of the usual processes of analyzing gases. For this, I refer to the procedure described by the United States Bureau of Mines in Technical Paper #320, entitled "The Bureau of Mines orsat apparatus for gas analysis" but it will be understood that my invention is not limited to the apparatus and procedures therein described, but can be adapted generally to the analysis of a great variety of gases in any one of a large number of different types of apparatus, such as, for example, in apparatus similar to that used, the Hempel, or other types of selective absorption apparatus and other procedures for this purpose. I merely choose this illustration because it represents a well-known apparatus and procedure outlined by a Government bureau, and one whose details may therefore be readily referred to. Another and somewhat different apparatus and procedure is described in Bureau of Standards Journal of Research Volume 6, 1931, pages 121 and following. My improvements may be adapted to this apparatus and procedure if desired.

In these and in most of the ordinary procedures, a sample of gas is measured into the burette and then passed backwards and forwards from the burette to one or more pipettes containing suitable reagents such as potassium hydroxide solutions, alkaline pyrogallol solutions, cuprous chloride solutions, or other suitable materials. In each of such solutions the removal of a constituent is effected. The magnitude of the removal is ordinarily ascertained by noting the volume of the gas before it is passed through the solution and again after the interaction is complete.

With certain of these solutions, such as the alkaline gyrogallol, the interaction is slow, probably because of resistances encountered at the quiescent film interfaces between gas and solution. To shorten the delay experienced because of such resistances, it is customary to repeatedly bubble the gas through the solution or to pass the gas repeatedly backwards and forwards over surfaces provided by placing in the pipette a packing material such as glass tubes which become wetted with the rising and falling solution and thus give a more extensive transfer surface which is intermittently re-wetted. To repeatedly change the transfer interfaces by such methods involves the filling and emptying of the pipette and burette repeatedly. In this action the burette and its displacing liquid serve as a pump. With difficult absorptions it is not unusual, as the Bureau of Mines technical paper cited will show, to pass the gas through the solution as much as twelve times or more before constant volume is obtained. This repeated passing is laborious and tiresome. Moreover, it requires some considerable care to check and reverse the flows in order to avoid sending the burette confining liquid into the pipette or drawing the absorbent into the burette. Where bubbling pipettes are used, it is necessary to turn stopcocks backwards and forwards with each passage in order to properly direct the gas through the solution. This involves considerable wear upon the stopcocks, whose exact fit is very vital if the apparatus is to be maintained tight and satisfactory.

To overcome these disadvantages and delays, I have invented apparatus which does not require the multiplied passage of the gas backwards and forwards from burette to pipette and vice versa. In my process the gas undergoing analysis is first carefully measured in the burette in the usual manner. It is then carefully transferred to the absorbing pipette as usual and confined therein by any of the ordinary means, such as by closing a stopcock. I then effect a quick and complete removal of the constituent by violent and rapid agitation of the liquid while maintaining the pipette in place undisturbed. I effect this violent agitation of the liquid with attending movement of the confined gas particles by one of a number of mechanical means which pump or stir or displace the liquid without removing the gas from the pipette. The operation of one such a mechanical means will be understood from Figure 1. The gas, from which a constituent is to be absorbed, is passed into the space (5), displacing liquid which flows into another part of the apparatus (7), (15), which in turn displaces air or other gas into the bulb (8), (16), causing this to expand. Stopcock (6) is closed, sealing the gas in the pipette, and the contact in the electrical circuit shown is closed, thereby energizing solenoid (2) which causes a piston (1) to rise. This piston may be a soft iron core completely sealed within a tube of glass closed at top and bottom, the glass envelope and core constituting an easily moving element which rises with-

in the pump cylinder (19) as shown, driving ahead of it the absorbent solution to close valve (3) and to open valve (4). The pump body (19) and valves may be of glass, although other non-corrosive material may be used, and the pump (19) must be attached securely to the main body of the pipette, as by sealing or welding at various points which will not prevent the ready fluctuation of the absorbent solution with the rise and fall of the piston. Such seals are well understood by those skilled in the art of working suitable materials, as, for instance, a glass blower. The absorbent solution is thus pumped up through valve (4) and is discharged through the gas space (5), thus presenting fresh absorbent films and facilitating the interaction between the gas and solution. While the discharge opening above (4) has been shown in its simplest form for clarity, it will be understood that this opening may be subdivided and reduced in size to throw out several fine streams or sprays, thereby presenting even more extensive fresh film surfaces and so further assist in promoting the interaction. When piston (1) has reached the center of solenoid (2), the flow of absorbent into gas space (5) substantially ceases. The electrical contact is then broken, after which the piston falls under the influence of gravity and the movement of the solution in the pump closes valve (4) and opens valve (3). When piston (1) reaches the bottom of its stroke, the solenoid is again energized, and the pumping is continued until the desired interaction is completed, after which the gas, if any, lodging in the header beyond and including (20), (21), may be brought into the pipette and the analysis continued as described above. Since the opening and closing of the circuit carrying the power which energizes solenoid (2) may be effected by a convenient automatic means such as a switch which is slowly opened and closed by clockwork (17 and 18), it will readily be understood that the apparatus shown in Figure 1 presents a means for rapidly and simply securing automatic absorption without any attention on the operator's part save the placing of the sample in the pipette and its removal at the completion of the absorption.

Not only does this present the advantage of simplicity in operation but it also presents the advantage that it may greatly promote the rapidity of interaction. Thus in comparative tests with the older procedure of removing oxygen from air by means of alkaline pyrogallol in the manner described in Bureau of Mines Technical Paper #320, a test using the above apparatus showed that only about a quarter of the time formerly required was necessary.

In Figure 2, I have shown another means for use in carrying out my invention. The gas sample is drawn through the header (21) and, by turning stopcock (14), sealed in (13) is repeatedly exposed to fresh absorbent films by the alternate rising and falling of the float (11) which responds to alternate energizing of solenoid (9) by virtue of the soft iron core sealed in (10). As the closed hollow float (11) sinks, the open end glass tubes (12) attached to and above it are immersed, displacing old liquid films with which they may be wetted, bringing fresh liquid to the surface of the tubes. When the power energizing the solenoid is released, the float rises, carrying fresh liquid films up into the gas. By alternately energizing and releasing the solenoid the interaction between the gas and absorbent may be rapidly promoted. One method of attaching the tubes to the float is indicated at sections AA, the wire (22) shown being composed of platinum or other non-corrosive material.

It will be understood that this operation may be made automatic and may be applied to the further analysis of the gas as already indicated above.

While I have completely disclosed the principles of my invention in the illustrations presented above, it will be understood that the application of these principles is not limited to the specific embodiments disclosed, but that one skilled in the art may use the principles in a variety of ways.

I therefore claim:

1. In an analytical gas pipette of glass, a first chamber adapted to hold fluid and gas, a second chamber adapted to receive liquid displaced by a gas sample from the first chamber, means for conducting liquid between the two chambers at a point below the normal liquid level within the chambers, a magnetically actuated glass surfaced agitator within the first chamber, and means external to the chamber and agitator for exerting magnetic attraction upon the agitator.

2. In an analytical gas pipette, a chamber adapted to hold liquid and gas, a magnetically sensitive reciprocating agitator within the chamber, and magnetic means including a solenoid external to the chamber and agitator for exerting magnetic attraction to reciprocate said agitator.

3. In an analytical gas pipette of transparent material, a first chamber adapted to hold liquid and gas, a second chamber adapted to receive liquid displaced by a gas sample from the first chamber, means for conducting liquid between the two chambers at a point below the normal liquid levels within the chambers, a magnetically actuated agitator within the pipette, means external to the chamber and agitator for exerting magnetic attraction upon the agitator, and means for applying and releasing the magnetic attraction.

4. A gas pipette comprising at least one chamber for enclosing liquid and gas, an agitator, sensitive to magnetic force, contained wholly within said chamber and free to assume different depths of immersion in said liquid, in combination with means outside the chamber capable of exerting and releasing an effective magnetic force upon said agitator whereby in response to said exertion and release the agitator may be caused to alter its depth of immersion.

5. In a gas pipette, a first chamber adapted to hold liquid and gas, a second chamber adapted to hold liquid and gas, means for conducting liquid between the two chambers at a point below the normal liquid levels within the chambers, a magnetically actuated glass surfaced agitator within the chamber, means external to the chamber and agitator for exerting magnetic attraction upon the agitator and automatic means for exerting and releasing the effective magnetic attraction.

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