E. J. BILLINGS.

GAS ANALYSIS APPARATUS.

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1,089,390. **Patented Mar. 10, 1914.**

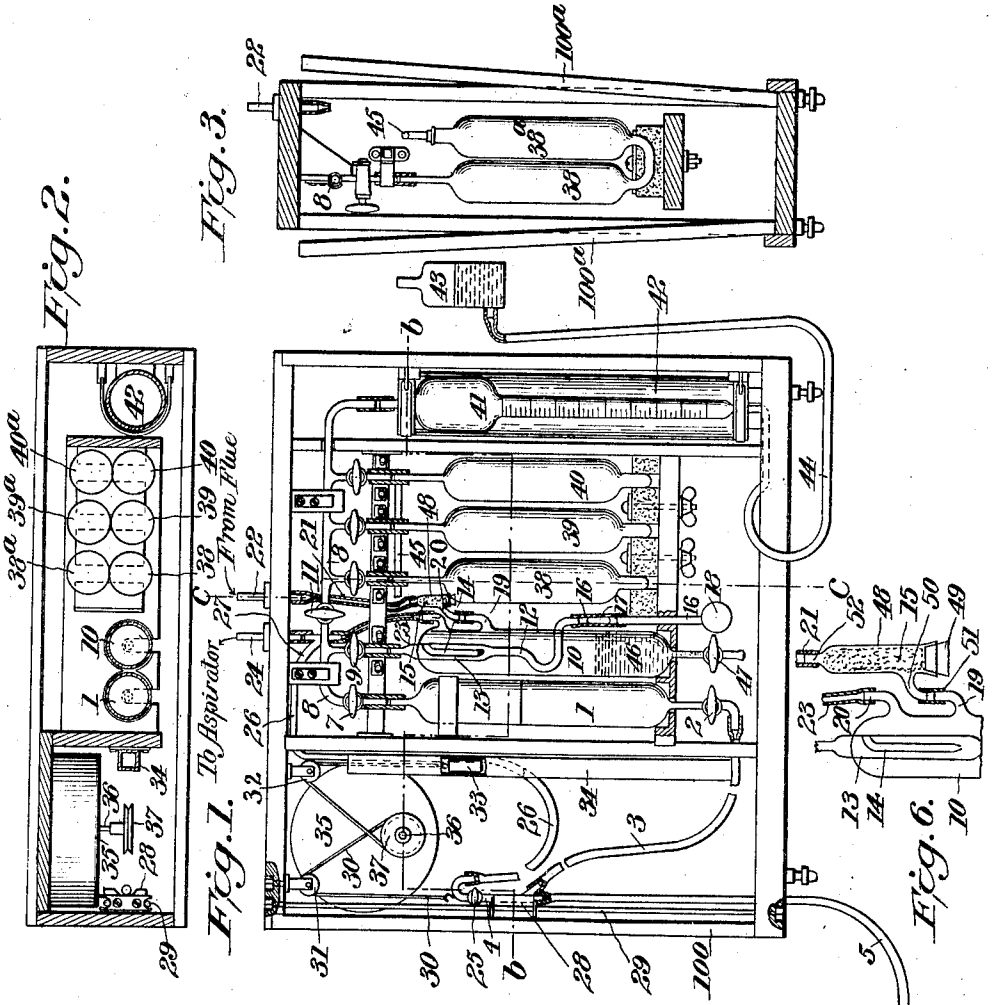


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 6.

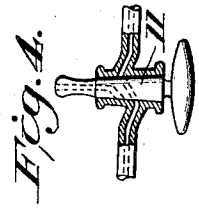


Fig. 4.

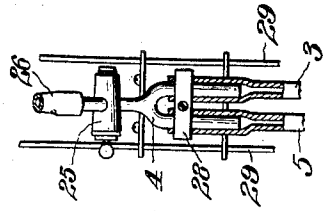


Fig. 5.

WITNESSES

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GAS-ANALYSIS APPARATUS.

1,089,390. Specification of Letters Patent. **Patented Mar. 10, 1914.**

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To all whom it may concern:

Be it known that I, EDWARD J. BILLINGS, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Gas-Analysis Apparatus, of which the following is a specification.

My invention relates to a gas-analysis apparatus, and consists of means for automatically collecting a sample of gas during a predetermined length of time, and for analyzing the same.

The object of my invention is to provide an automatic apparatus that will continuously and uniformly collect a sample of gas to be analyzed, during a definite time, which may be varied at will, and to provide means for its measurement and analysis, in a compact and portable form.

In the accompanying drawing—Figure 1 is a front view of the complete apparatus, showing the connections between the several parts; Fig. 2 is a sectional view of the same along the line *b*—*b* in Fig. 1; Fig. 3 is an end view of the same, along the line *c*—*c* in Fig. 1, showing also the covers for the apparatus case; Fig. 4 is a view of the three-way stop-cock; Fig. 5 is a view of a mercury-overflow device; and Fig. 6 is a view of a filter, showing its location in the gas-circuit.

Similar reference characters indicate similar parts.

The apparatus consists of a casing 100, having lids 100ª, and provided with the usual Orsat apparatus combined with improved means for collecting the sample of gas. A sampling tube 1 is filled with mercury, and is connected, through stop-cock 2, rubber tube 3, mercury-overflow device 4, and rubber tube 5, to the movable mercury container 6. The upper end of the sampling tube 1 is connected through the stop-cock 7, and main conducting tube 8, through stop-cock 9, to the sampling pipette 10. A three-way stop-cock 11 in the main conducting tube connects the sampling tube and pipette with the measuring burette and the gas-absorption bulbs as in the well-known Orsat apparatus. This cock also connects the measuring burette and gas-absorption bulbs with the atmosphere.

Within the sampling pipette 10, is a tube 12 having an enlarged upper end 13, and containing a smaller tube 14 communicating with the space in the pipette at its upper end, as shown; the lower end of tube 14 being contracted to a small orifice. The enlarged part of tube 12 is sealed into the upper end of tube 10, and is connected by a rubber tube to the main conducting tube through stop-cock 9. The lower part of tube 12 passes through the wall of pipette 10, and connects to a supply of water in a collapsible rubber receptacle 18, through rubber tube 16, and valve 17; this valve is a short glass cylinder or rod within the rubber tube, closing it off, but affording a passage-way on pinching the surrounding tube. This valve is opened and receptacle 18 is squeezed to press the water up within tube 12 until it reaches the small orifice of tube 14, forming an adjustable seal through which the gas bubbles when passing into the sampling tube. On the side of pipette 10 are an inlet tube 19 and an outlet tube 20, the inlet connected to gas-supply tube 22, through the filtering tube 48 by means of the rubber nipple 51, glass extension 50, and rubber tube 21; and the outlet connected by rubber tube 23 and Y-tube 27 to exhaust-tube 24. Any water condensing from the gas to be analyzed collects at the bottom of tube 10, and may be removed by opening stop-cock 47.

The overflow device 4 is an inverted U-shaped tube, see Fig. 5, connected at its bend to a stop-cock 25, which is connected through a tube 26 and Y-tube 27 to the exhaust tube 24. The connection 25, 26 and 27 is called the "pressure equalizer," and establishes a uniform gas-pressure on both sides of the body of mercury in sampling tube 1, rubber tube 3 and overflow-device 4, thereby preventing the siphoning out of the mercury from the sampling tube, and serving to maintain a uniform back-flow of mercury from the sampling tube through the overflow-device, independent of the gas-pressure in the sampling tube.

The overflow-device 4 is supported in a bracket 28, slidable in vertical guides 29, and is suspended from a cord 30, which passes over pulleys 31, 32, to a counterbalancing weight 33, slidable in a vertical channel 34. From a clock-movement 35, suitably supported within the casing 100, there projects a spindle 36, which rotates at a fixed rate. Upon the spindle 36 may be

placed one of several different-sized pulleys, such as 37, around which passes the cord 30. The rotation of the pulley by the clock movement raises the weight 33 and lowers the overflow-device 4, the latter draining mercury from the sampling tube 1, on its descent, and drawing the gas to be analyzed from the sampling pipette 10 into the tube 1 through the connections 7, 8, 9, 15 and 14. The size of the pulley 37 determines the rate of descent of overflow-device 4, a large pulley lowering it rapidly and a small one slowly, predetermined sizes of pulleys giving predetermined rates of descent, thereby filling the sampling tube 1 with gas at a predetermined rate, as in one-half hour, one hour, four hours, twenty-four hours, etc.

The filtering tube 48, shown in Fig. 6, has an inlet extension 52 connected to rubber tube 21, and an outlet extension 50 connected by the nipple 51 to the inlet 19 of the sampling pipette 10. The tube 48 contains a suitable filter 15, such as glass wool, which removes any soot or other solids in the gas to be analyzed. The rubber stopper 49 in the end of tube 48 permits the removal of the filter when desired.

The gas-absorption bulbs 38, 39 and 40, are connected through stop-cocks to the main conducting tube 8, and through this tube to the measuring burette 41, which is suitably water-jacketed by the tube 42. The burette is connected to the hand-leveling bottle 43 by the tube 44. Respectively connected to the absorption-bulbs 38, 39, 40, are liquid-reservoir-bulbs 38^a, 39^a, 40^a, see Figs. 2 and 3, the upper ends of the reservoir-bulbs being connected through tube 45 to a bellows or gas-bag, not shown.

The apparatus is operated as follows:— The sampling tube 1 is filled with mercury by raising the mercury container 6 in the usual manner. The overflow-device 4 is now raised to the upper part of the case, a suitable sized pulley is placed on the spindle 36, and all stop-cocks are closed. A suitable aspirator, such as a water-filter pump or other suction means, is connected to the exhaust tube 24, and supply-tube 22 is connected to the source of gas to be analyzed. The gas passes through supply-tube 22, rubber tube 21, filtering tube 48 containing the glass wool filter 15, glass extension 50, rubber nipple 51, and inlet 19 into sampling pipette 10, wherein any moisture in the gas condenses and collects at 46. The gas thence passes through outlet 20, rubber tube 23, the vertical branch of Y-tube 27, and exhaust 24 to the aspirator. After the gas has been flowing long enough to remove any air in the apparatus, stop-cocks 2, 7, 9 and 25 are opened and the overflow-device is caused to descend at a regulated rate by means of the clock-movement 35 and pulley 37. The descent of the overflow-device will slowly drain the mercury from the sampling tube 1, thereby drawing in gas from the sampling pipette 10 through passages 14, 13, 9, 8 and 7. The gas in passing through the tube 14 will bubble through the water seal, which latter may be adjusted as explained above. The glass-wool filter 15 removes any soot, etc., from the gas before it passes to the sampling pipette 10. When a sufficient quantity of gas has been collected, stop-cock 9 is closed and mercury container 6 elevated slowly until the mercury columns join at the overflow point 4. Stop-cock 25 is then closed and the mercury container 6 raised still further and set on top of the case 100. The gas in the sampling tube 1 is now under pressure and it may be drawn through the three-way cock 11 into the measuring burette of the Orsat apparatus in the usual manner, after which it is transferred to the absorption-bulbs 38, 39 and 40.

In order to take instantaneous or grab samples while a continuous sample is being collected, stop-cock 7 is closed and the gas drawn through stop-cock 9 and three-way cock 11 into the measuring burette 41 of the Orsat apparatus by means of the hand-leveling bottle 43 in the usual manner. After the proper volume of gas has been obtained in the measuring burette 41, the three-way cock 11 is closed and stop-cock 7 opened; thereby resuming the continuous sampling operation.

I claim:

1. In a gas-analysis apparatus, a sampling tube, a draining conduit comprising a Y-overflow tube connected thereto, and means for lowering said Y-overflow tube and collecting a sample of gas during a predetermined time.

2. In a gas-analysis apparatus, a sampling pipette, an exhaust tube connected thereto, a sampling tube connected to said pipette, a conduit leading from said sampling tube, and a gas connection between said conduit and exhaust tube.

3. In a gas-analysis apparatus, a sampling pipette, an exhaust tube connected thereto, a sampling tube connected to said pipette, a conduit leading from said sampling tube, said conduit having a valved connection to said exhaust tube, and means for draining said sampling tube through said conduit.

4. In a gas-analysis apparatus, a sampling tube, a conduit leading therefrom, a clock-movement, and means operated by said clock-movement for lowering a part of said conduit at a predetermined rate.

5. In a gas-analysis apparatus, a sampling tube, a conduit comprising a Y-overflow tube leading therefrom, a clock-movement, and changeable means for imparting predetermined velocities attachable to said

clock-movement to lower said Y-overflow tube at different predetermined rates.

6. In a gas-analysis apparatus, a sampling pipette, an exhaust tube connected thereto, a sampling tube, a valved passage between said pipette and said sampling tube, a conduit including an overflow device communicating with said sampling tube, means for draining said sampling tube through said conduit and overflow device, and means for establishing a connection between said overflow device and said exhaust tube.

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

EDWARD J. BILLINGS.

Witnesses:
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