

953,482.

Fig. 2. This diagram shows a cross-section of a mechanical assembly. On the left, a vertical shaft (10) is connected to a crank (11) and a piston (12) within a cylinder (13). A valve (14) is positioned at the bottom of the cylinder. A connecting rod (15) links the piston to a lever (16) pivoted on a point (17). The lever is connected to a control mechanism (18) which includes a spring (19) and a valve (20). A pipe (21) leads from the control mechanism to a larger chamber (22) containing a piston (23) and a valve (24). A shaft (25) is connected to the piston (23) and a crank (26) at the bottom. A pipe (27) leads from the chamber (22) to a vertical pipe (28) on the right. A control lever (29) is connected to the vertical pipe (28) and a valve (30) at the bottom. A spring (31) is connected to the lever (29) and a fixed point (32). A pipe (33) leads from the vertical pipe (28) to a chamber (34) containing a piston (35) and a valve (36). A shaft (37) is connected to the piston (35) and a crank (38) at the bottom. A pipe (39) leads from the chamber (34) to a vertical pipe (40) on the right. A control lever (41) is connected to the vertical pipe (40) and a valve (42) at the bottom. A spring (43) is connected to the lever (41) and a fixed point (44). A pipe (45) leads from the vertical pipe (40) to a chamber (46) containing a piston (47) and a valve (48). A shaft (49) is connected to the piston (47) and a crank (50) at the bottom. A pipe (51) leads from the chamber (46) to a vertical pipe (52) on the right. A control lever (53) is connected to the vertical pipe (52) and a valve (54) at the bottom. A spring (55) is connected to the lever (53) and a fixed point (56). A pipe (57) leads from the vertical pipe (52) to a chamber (58) containing a piston (59) and a valve (60). A shaft (61) is connected to the piston (59) and a crank (62) at the bottom. A pipe (63) leads from the chamber (58) to a vertical pipe (64) on the right. A control lever (65) is connected to the vertical pipe (64) and a valve (66) at the bottom. A spring (67) is connected to the lever (65) and a fixed point (68). A pipe (69) leads from the vertical pipe (64) to a chamber (70) containing a piston (71) and a valve (72). A shaft (73) is connected to the piston (71) and a crank (74) at the bottom. A pipe (75) leads from the chamber (70) to a vertical pipe (76) on the right. A control lever (77) is connected to the vertical pipe (76) and a valve (78) at the bottom. A spring (79) is connected to the lever (77) and a fixed point (80). A pipe (81) leads from the vertical pipe (76) to a chamber (82) containing a piston (83) and a valve (84). A shaft (85) is connected to the piston (83) and a crank (86) at the bottom. A pipe (87) leads from the chamber (82) to a vertical pipe (88) on the right. A control lever (89) is connected to the vertical pipe (88) and a valve (90) at the bottom. A spring (91) is connected to the lever (89) and a fixed point (92). A pipe (93) leads from the vertical pipe (88) to a chamber (94) containing a piston (95) and a valve (96). A shaft (97) is connected to the piston (95) and a crank (98) at the bottom. A pipe (99) leads from the chamber (94) to a vertical pipe (100) on the right. A control lever (101) is connected to the vertical pipe (100) and a valve (102) at the bottom. A spring (103) is connected to the lever (101) and a fixed point (104). A pipe (105) leads from the vertical pipe (100) to a chamber (106) containing a piston (107) and a valve (108). A shaft (109) is connected to the piston (107) and a crank (110) at the bottom. A pipe (111) leads from the chamber (106) to a vertical pipe (112) on the right. A control lever (113) is connected to the vertical pipe (112) and a valve (114) at the bottom. A spring (115) is connected to the lever (113) and a fixed point (116). A pipe (117) leads from the vertical pipe (112) to a chamber (118) containing a piston (119) and a valve (120). A shaft (121) is connected to the piston (119) and a crank (122) at the bottom. A pipe (123) leads from the chamber (118) to a vertical pipe (124) on the right. A control lever (125) is connected to the vertical pipe (124) and a valve (126) at the bottom. A spring (127) is connected to the lever (125) and a fixed point (128). A pipe (129) leads from the vertical pipe (124) to a chamber (130) containing a piston (131) and a valve (132). A shaft (133) is connected to the piston (131) and a crank (134) at the bottom. A pipe (135) leads from the chamber (130) to a vertical pipe (136) on the right. A control lever (137) is connected to the vertical pipe (136) and a valve (138) at the bottom. A spring (139) is connected to the lever (137) and a fixed point (140). A pipe (141) leads from the vertical pipe (136) to a chamber (142) containing a piston (143) and a valve (144). A shaft (145) is connected to the piston (143) and a crank (146) at the bottom. A pipe (147) leads from the chamber (142) to a vertical pipe (148) on the right. A control lever (149) is connected to the vertical pipe (148) and a valve (150) at the bottom. A spring (151) is connected to the lever (149) and a fixed point (152). A pipe (153) leads from the vertical pipe (148) to a chamber (154) containing a piston (155) and a valve (156). A shaft (157) is connected to the piston (155) and a crank (158) at the bottom. A pipe (159) leads from the chamber (154) to a vertical pipe (160) on the right. A control lever (161) is connected to the vertical pipe (160) and a valve (162) at the bottom. A spring (163) is connected to the lever (161) and a fixed point (164). A pipe (165) leads from the vertical pipe (160) to a chamber (166) containing a piston (167) and a valve (168). A shaft (169) is connected to the piston (167) and a crank (170) at the bottom. A pipe (171) leads from the chamber (166) to a vertical pipe (172) on the right. A control lever (173) is connected to the vertical pipe (172) and a valve (174) at the bottom. A spring (175) is connected to the lever (173) and a fixed point (176). A pipe (177) leads from the vertical pipe (172) to a chamber (178) containing a piston (179) and a valve (180). A shaft (181) is connected to the piston (179) and a crank (182) at the bottom. A pipe (183) leads from the chamber (178) to a vertical pipe (184) on the right. A control lever (185) is connected to the vertical pipe (184) and a valve (186) at the bottom. A spring (187) is connected to the lever (185) and a fixed point (188). A pipe (189) leads from the vertical pipe (184) to a chamber (190) containing a piston (191) and a valve (192). A shaft (193) is connected to the piston (191) and a crank (194) at the bottom. A pipe (195) leads from the chamber (190) to a vertical pipe (196) on the right. A control lever (197) is connected to the vertical pipe (196) and a valve (198) at the bottom. A spring (199) is connected to the lever (197) and a fixed point (200). A pipe (201) leads from the vertical pipe (196) to a chamber (202) containing a piston (203) and a valve (204). A shaft (205) is connected to the piston (203) and a crank (206) at the bottom. A pipe (207) leads from the chamber (202) to a vertical pipe (208) on the right. A control lever (209) is connected to the vertical pipe (208) and a valve (210) at the bottom. A spring (211) is connected to the lever (209) and a fixed point (212). A pipe (213) leads from the vertical pipe (208) to a chamber (214) containing a piston (215) and a valve (216). A shaft (217) is connected to the piston (215) and a crank (218) at the bottom. A pipe (219) leads from the chamber (214) to a vertical pipe (220) on the right. A control lever (221) is connected to the vertical pipe (220) and a valve (222) at the bottom. A spring (223) is connected to the lever (221) and a fixed point (224). A pipe (225) leads from the vertical pipe (220) to a chamber (226) containing a piston (227) and a valve (228). A shaft (229) is connected to the piston (227) and a crank (230) at the bottom. A pipe (231) leads from the chamber (226) to a vertical pipe (232) on the right. A control lever (233) is connected to the vertical pipe (232) and a valve (234) at the bottom. A spring (235) is connected to the lever (233) and a fixed point (236). A pipe (237) leads from the vertical pipe (232) to a chamber (238) containing a piston (239) and a valve (240). A shaft (241) is connected to the piston (239) and a crank (242) at the bottom. A pipe (243) leads from the chamber (238) to a vertical pipe (244) on the right. A control lever (245) is connected to the vertical pipe (244) and a valve (246) at the bottom. A spring (247) is connected to the lever (245) and a fixed point (248). A pipe (249) leads from the vertical pipe (244) to a chamber (250) containing a piston (251) and a valve (252). A shaft (253) is connected to the piston (251) and a crank (254) at the bottom. A pipe (255) leads from the chamber (250) to a vertical pipe (256) on the right. A control lever (257) is connected to the vertical pipe (256) and a valve (258) at the bottom. A spring (259) is connected to the lever (257) and a fixed point (260). A pipe (261) leads from the vertical pipe (256) to a chamber (262) containing a piston (263) and a valve (264). A shaft (265) is connected to the piston (263) and a crank (266) at the bottom. A pipe (267) leads from the chamber (262) to a vertical pipe (268) on the right. A control lever (269) is connected to the vertical pipe (268) and a valve (270) at the bottom. A spring (271) is connected to the lever (269) and a fixed point (272). A pipe (273) leads from the vertical pipe (268) to a chamber (274) containing a piston (275) and a valve (276). A shaft (277) is connected to the piston (275) and a crank (278) at the bottom. A pipe (279) leads from the chamber (274) to a vertical pipe (280) on the right. A control lever (281) is connected to the vertical pipe (280) and a valve (282) at the bottom. A spring (283) is connected to the lever (281) and a fixed point (284). A pipe (285) leads from the vertical pipe (280) to a chamber (286) containing a piston (287) and a valve (288). A shaft (289) is connected to the piston (287) and a crank (290) at the bottom. A pipe (291) leads from the chamber (286) to a vertical pipe (292) on the right. A control lever (293) is connected to the vertical pipe (292) and a valve (294) at the bottom. A spring (295) is connected to the lever (293) and a fixed point (296). A pipe (297) leads from the vertical pipe (292) to a chamber (298) containing a piston (299) and a valve (300). A shaft (301) is connected to the piston (299) and a crank (302) at the bottom. A pipe (303) leads from the chamber (298) to a vertical pipe (304) on the right. A control lever (305) is connected to the vertical pipe (304) and a valve (306) at the bottom. A spring (307) is connected to the lever (305) and a fixed point (308). A pipe (309) leads from the vertical pipe (304) to a chamber (310) containing a piston (311) and a valve (312). A shaft (313) is connected to the piston (311) and a crank (314) at the bottom. A pipe (315) leads from the chamber (310) to a vertical pipe (316) on the right. A control lever (317) is connected to the vertical pipe (316) and a valve (318) at the bottom. A spring (319) is connected to the lever (317) and a fixed point (320). A pipe (321) leads from the vertical pipe (316) to a chamber (322) containing a piston (323) and a valve (324). A shaft (325) is connected to the piston (323) and a crank (326) at the bottom. A pipe (327) leads from the chamber (322) to a vertical pipe (328) on the right. A control lever (329) is connected to the vertical pipe (328) and a valve (330) at the bottom. A spring (331) is connected to the lever (329) and a fixed point (332). A

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UNITED STATES PATENT OFFICE.

SETH D. MERTON, OF ST. LOUIS, MISSOURI.

GAS-ANALYSIS APPARATUS.

953,482.

Specification of Letters Patent. Patented Mar. 29, 1910.

Application filed October 8, 1909. Serial No. 521,733.

To all whom it may concern:

Be it known that I, SETH D. MERTON, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Gas-Analysis Apparatus, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a device for gas analysis, such as is used, for example, for determining the percentage of carbon dioxide (CO_2) in the products of combustion in kilns, furnaces, gas producers, etc.

Briefly described, the device herein shown consists of a movable receptacle that contains an absorbing medium, means for trapping a sample of gas of known volume and forcing it into said receptacle so that the absorbing medium therein will extract one of the constituents of the gas and thus cause the receptacle to change its position, the percentage of the constituent that has been absorbed being recorded or indicated by suitable mechanism controlled by the movement of the receptacle.

The apparatus herein shown for trapping off the sample of gas and forcing it into the receptacle which contains the absorbing medium is well-known and is used in the "Sarco" automatic CO_2 recorder, but any other suitable apparatus could be used for this purpose and therefore I do not wish it to be understood that my broad idea is limited to any particular means or apparatus for trapping off the sample of gas and forcing it into the receptacle which contains the absorbing medium.

Figure 1 of the drawings is a vertical sectional view of a device embodying my invention; and Fig. 2 is a detail vertical sectional view taken on approximately the line 2-2 of Fig. 1.

Referring to the drawings which illustrate the preferred form of my invention, A designates a receptacle that is adapted to contain an absorbing medium 1, such, for example, as a solution of caustic potash, and 2 designates a stationary support on which said receptacle is fulcrumed or pivotally mounted. In the construction herein shown a strap 3 on the upper side of the receptacle A passes over the support 2 so as to sustain the receptacle in position but it will be obvious that various other means could be em-

ployed for sustaining the receptacle in such a position that it will tilt or swing under certain conditions. The receptacle A preferably has a comparatively large central portion and two reduced end portions 4 and 5 which curve upwardly from said body portion and thus produce a receptacle which is substantially U-shaped. The long neck or reduced portion 4 at one end of the receptacle is open to the atmosphere, and the neck or reduced portion 5 at the opposite end of the receptacle merges into a hollow elliptical-shaped portion 6 which is of sufficient size to hold quite a quantity of the absorbing solution. A flexible conduit 7 communicates with the enlarged portion 6 on the neck 5 of the receptacle A so as to introduce the sample of gas into said receptacle and thus cause the receptacle to shift or move from its normal position, as herein- after more clearly described.

In view of the fact that the apparatus for trapping off the sample of gas and forcing it into the receptacle A is well-known I will not describe the specific details of construction of said apparatus but will merely describe it in general terms so that the operation of same can be understood. Said apparatus comprises a gas-inlet pipe 8 that leads from the flue or combustion chamber of a furnace or other source of gas supply, not shown, a burette formed by an approximately oblong-shaped tube 9 that communicates with said inlet pipe, a water aspirator 10, and a pipe 11 leading from said aspirator to the burette or tube 9. A by-pass or liquid seal B is arranged between the inlet pipe 8 and the pipe 11 so that the main stream of gas can pass directly from said inlet pipe to the aspirator after the sample of gas has been trapped off in the burette, as hereinafter described. A pipe 12 leads from the aspirator into a box 13 so as to supply water thereto, and said box is provided with a discharge nozzle 14 which permits the water to escape into a pipe 15 that leads to a tank C having an upper compartment 16 for receiving the water from the pipe 15, and a lower compartment 17 which contains a solution of water and glycerin or some other similar substance, said lower compartment being connected with the burette 9 by means of a pipe 17^a. A siphon pipe 18 leads from the upper compartment of the tank C, and at a certain

period of the cycle of operations of the apparatus the water in the upper compartment is sucked up through the siphon pipe 18 and down through the pipe 18^a which communicates with the upper end of the siphon pipe. An air pipe 19 leads from the lower compartment of the tank C into the upper compartment of said tank, as shown in Fig. 2, so as to permit the air in said upper compartment to pass downwardly into the lower compartment and exert pressure on the glycerin solution in said lower compartment, said air pressure causing the glycerin solution in the lower end of the burette 9 to rise far enough to cut off the ingress and egress of gas from the burette. The apparatus also comprises a flexible air chamber 20 which communicates with the pipe 21 that enters the burette 9 so as to maintain atmospheric pressure inside of said burette. I have herein illustrated the gas-trapping apparatus on a much smaller scale than the receptacle A which contains the absorbing medium, and consequently the relative positions of said apparatus and receptacle A are different from what they would be in actual practice. It will be understood, of course, that in a commercial device the apparatus for trapping off the sample of gas and forcing it into the receptacle A will be so proportioned that it will perform the function for which it is designed.

When the recorder is first set in operation the gas will be drawn through the pipe 8, burette 9 and pipe 11 by the aspirator, and the water that escapes from the aspirator will gradually fill the upper compartment 16 of the tank C and thus compress the air in said compartment, the pressure of said air causing the glycerin solution to rise in the burette 9. When said solution rises far enough to close the pipes 8 and 11 the ingress and egress of gas to and from the burette will be cut off and the gas in the upper portion of the burette will be trapped off so that it can be utilized as a sample to be tested. As the glycerin solution continues to rise in the burette the sample of gas therein will be forced through the conduit 7 into the receptacle, the pressure of the gas in said conduit causing it to tend to straighten out and thus rock the receptacle A upwardly or in the direction indicated by the arrow in Fig. 1. The gas which enters the receptacle A also tends to rock the receptacle owing to the fact that the pressure which said gas exerts on the absorbing solution causes said solution to rise in the neck 4 of the receptacle A. The solution in the receptacle A absorbs the CO₂ in the gas and consequently reduces the volume of the sample so that the movement of the receptacle will vary in accordance with the percentage of CO₂ in the gas. If the sample contains no CO₂ the receptacle A will

move the maximum distance, and if the sample contains 10% of CO₂ the receptacle will move less than the maximum distance.

The particular means used for indicating or recording the percentage of CO₂ in the gas is immaterial so far as my broad idea is concerned as any suitable means could be used for this purpose. I have herein shown a recording device for indicating the percentage of CO₂ in the gas but it will, of course, be obvious that a visual indicating device could be used if desired. The recording device herein shown consists of a pen 22 connected by a flexible device 23 to the long neck 4 of the receptacle A and adapted to make a mark or impression on a chart 24 which is driven continuously by some suitable mechanical means.

The receptacle A can be provided with an adjustable weight 25 so as to retain said receptacle in a certain normal position, and if desired, a dashpot D can be arranged between the receptacle and a stationary support so as to prevent the receptacle from vibrating. I prefer to arrange the receptacle A and the trapping apparatus inside of a case or cabinet E so as to protect said parts.

When the water in the upper compartment 16 of the tank C and in pipes 15 and 18 reaches a certain level a siphon will be created in the pipes 18 and 18^a and thus cause the water to be sucked out of said upper compartment, thereby reducing the pressure of air in the lower compartment 17 and permitting the liquid solution in the burette 9 to drop back to its normal level, completing the cycle of one analysis and restoring the conditions for the beginning of a new cycle.

My device for gas analysis, and for automatically drawing and measuring the gas sample to be analyzed for any given element, and for automatically recording the result of such analysis, is mechanically simpler than most of those devices for a similar purpose which have hitherto come into extensive use, in that the absorption of the given element in the gas directly alters the position of the absorbent vessel itself in proportion to the percentage of the gas absorbed by the contained absorbing medium. This movement of the absorbent vessel is directly and simply recorded without the necessity of delicate mechanism between the absorbent vessel and the recording apparatus. In most successful devices of this character, hitherto, the absorbent vessel has been motionless; it has been essentially a U tube; the rise of absorbing liquid in the far leg of this U has been in proportion to the volume of the gas sample remaining after absorption of the element to be measured has taken place, and the degree of rise has been contributed to the recording pen through mechanism necessarily of great delicacy. My invention aims at an increased usefulness of such devices through simplification.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A device for the purpose described, comprising a hollow member that is mounted in such a manner that it can rock, an absorbing medium in said member, means for trapping off a sample of gas of known volume and introducing it into said hollow member, and means for recording the degree of movement of said member so as to determine the percentage of the constituent that has been removed from the gas.

2. A device for the purpose described, comprising a hollow member that is mounted in such a manner that it can rock, an absorbing medium in said member, means for trapping off a sample of gas of known volume and forcing it into contact with said absorbing medium, and means for registering the degree of movement of said hollow member.

3. In a device of the character described, a receptacle that is mounted in such a manner that it can rock, said receptacle being provided at one end with a contracted portion which is open to the atmosphere, and at its opposite end with an enlarged portion that is approximately flat and hollow, an absorbing medium in said receptacle, and means for supplying gas to the hollow flat portion at one end of said receptacle.

4. A device of the character described, having means for drawing gas from a source of supply, means for trapping off a sample of gas of known volume, a hollow member adapted to receive said sample and being mounted in such a manner that it can rock, and a medium in said receptacle for absorbing one of the constituents of said gas.

5. A device of the character described, comprising means for drawing gas from a

source of supply, means for trapping off a sample of gas of known volume, a hollow member adapted to receive said sample and being mounted in such a manner that it can rock, a medium in said receptacle for absorbing one of the constituents of said gas, and means for registering the degree of movement of said receptacle.

6. A device for the purpose described, comprising means for drawing gas from a source of supply, means for trapping off a sample of gas of known volume, an approximately U-shaped member for receiving said sample of gas and being mounted in such a manner that it can rock, said receptacle being open to the atmosphere, means in said receptacle for absorbing one of the constituents of said sample of gas, a recording mechanism, and means operated by the movement of said receptacle for actuating said recording mechanism.

7. A device for the purpose described, comprising means for drawing gas from a source of supply, means for trapping off a sample of gas of known volume, an approximately U-shaped member for receiving said sample of gas and being mounted in such a manner that it can rock, said receptacle being open to the atmosphere, means in said receptacle for absorbing one of the constituents of said sample of gas, a recording mechanism, means operated by the movement of said receptacle for actuating said recording mechanism, and means for preventing said receptacle from vibrating.

In testimony whereof I hereunto affix my signature in the presence of two witnesses, this sixth day of October 1909.

SETH D. MERTON.

Witnesses:

WELLS L. CHURCH,
GEORGE BAKEWELL.