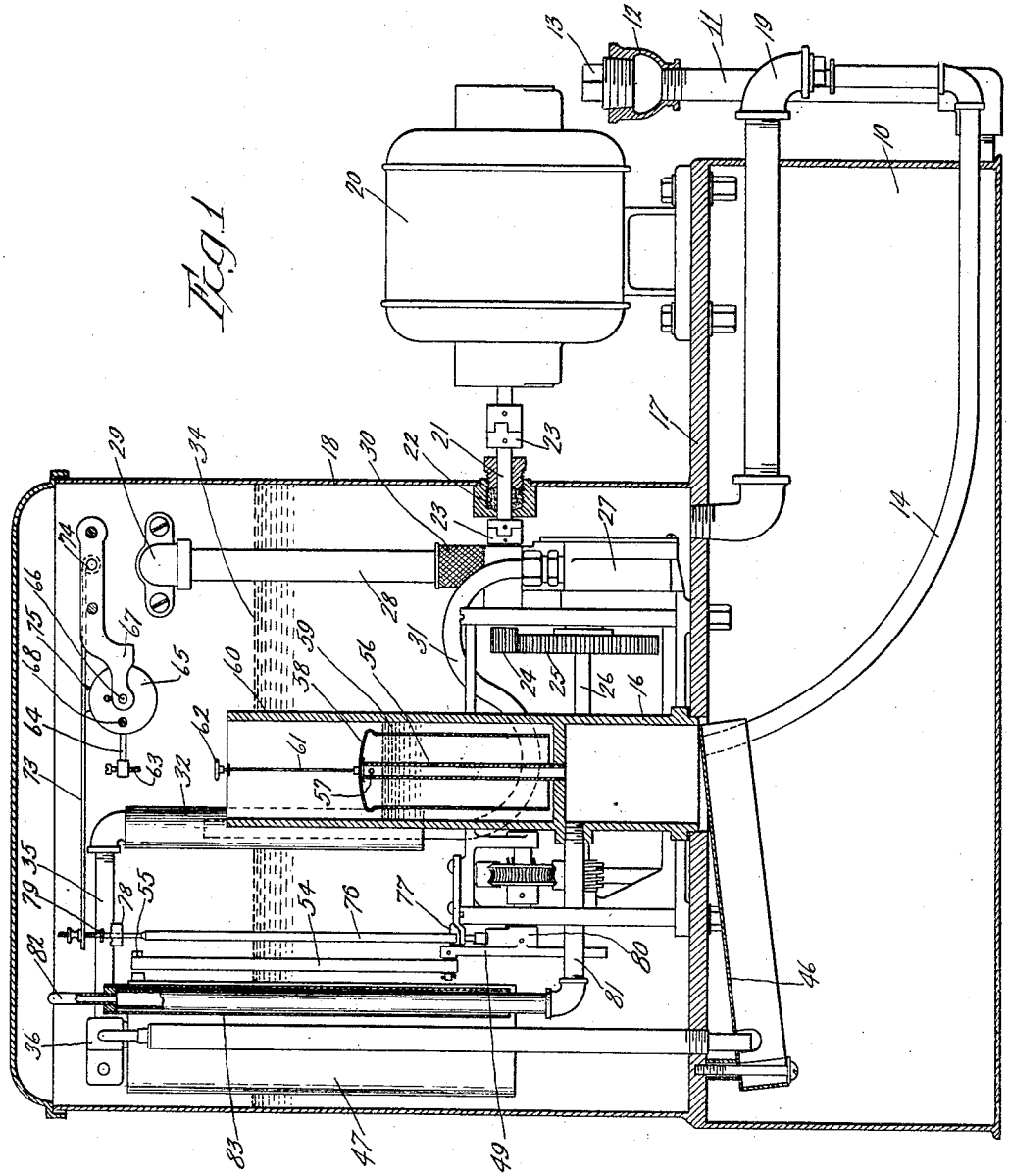
Feb. 14, 1933. A. B. CUNNINGHAM 1,897,721

MECHANICALLY OPERATED GAS ANALYZER

Filed June 18, 1926 4 Sheets-Sheet 1

Fig. 1.



Inventor:
Arthur B. Cunningham
By: Wisen & Grant Attys.

Feb. 14, 1933. A. B. CUNNINGHAM 1,897,721

MECHANICALLY OPERATED GAS ANALYZER

Filed June 18, 1926 4 Sheets-Sheet 2

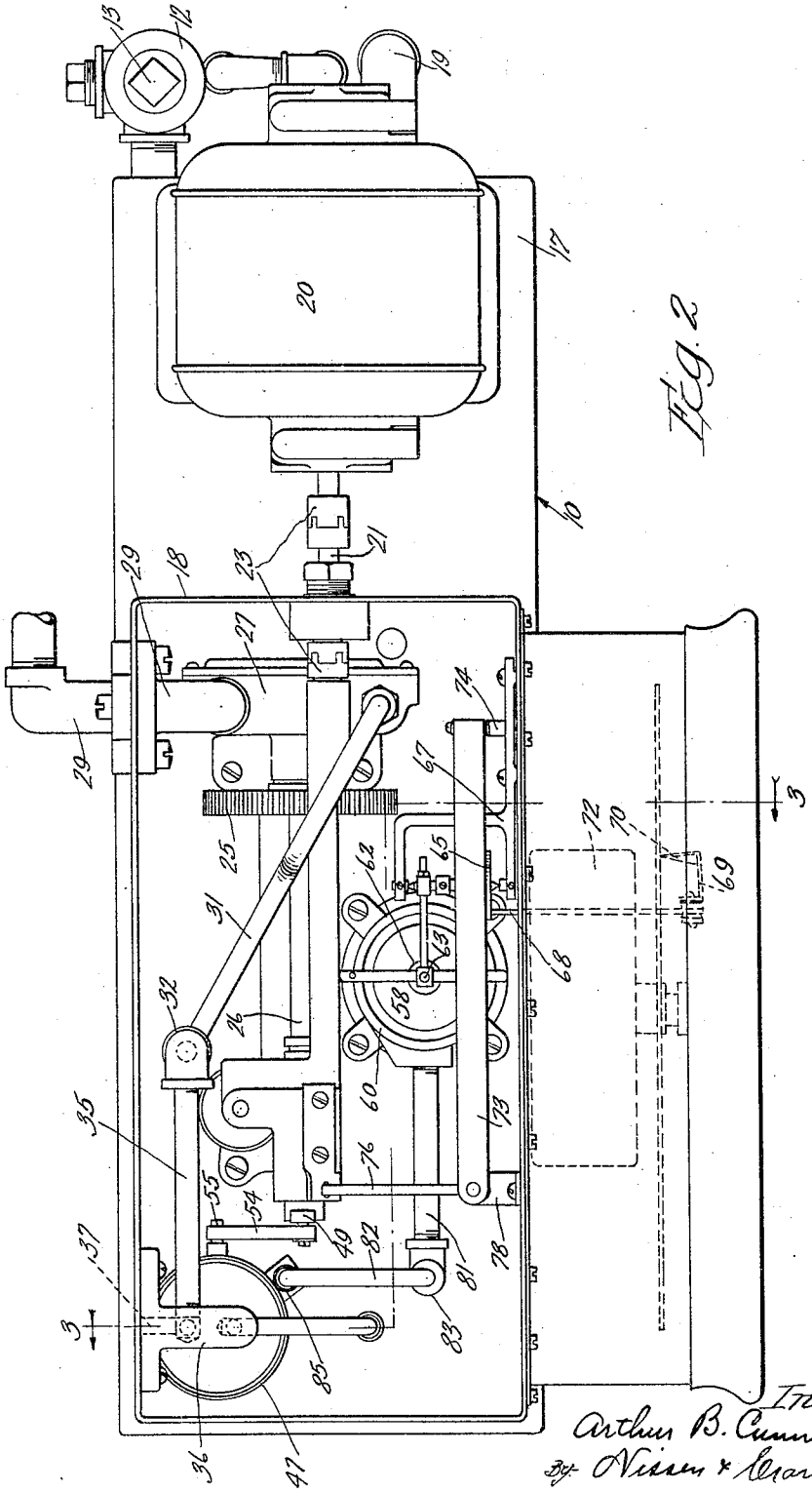


Fig. 2

Inventor:
Arthur B. Cunningham
By Nissen & Grant Attys.

Feb. 14, 1933. A. B. CUNNINGHAM 1,897,721

MECHANICALLY OPERATED GAS ANALYZER

Filed June 18, 1926 4 Sheets-Sheet 3

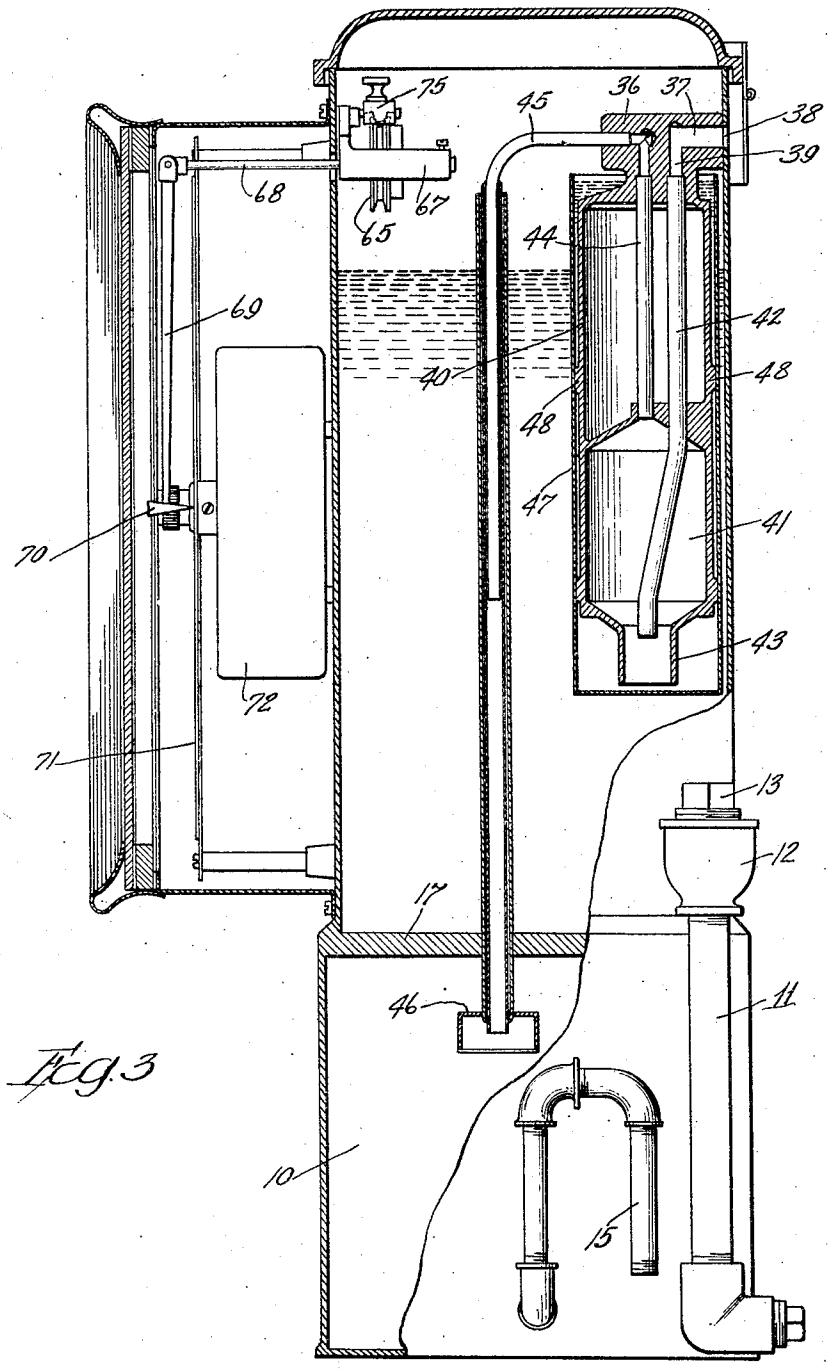


Fig. 3

Inventor:
Arthur B. Cunningham
By Wissen & Crane
Attys.

Feb. 14, 1933. A. B. CUNNINGHAM 1,897,721

MECHANICALLY OPERATED GAS ANALYZER

Filed June 18, 1926 4 Sheets-Sheet 4

Fig. 4

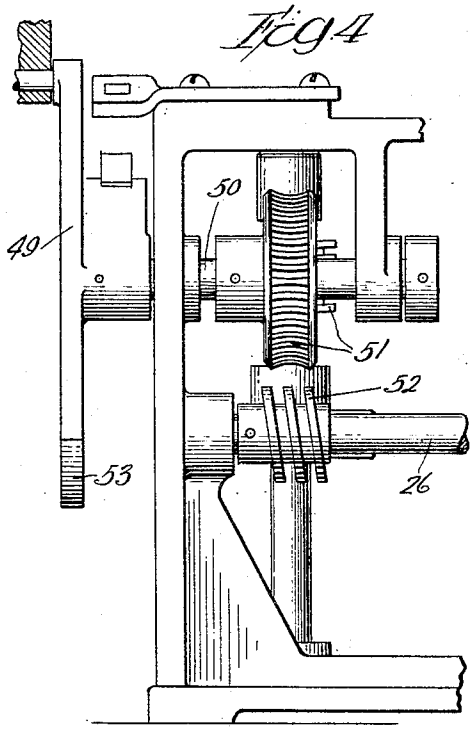
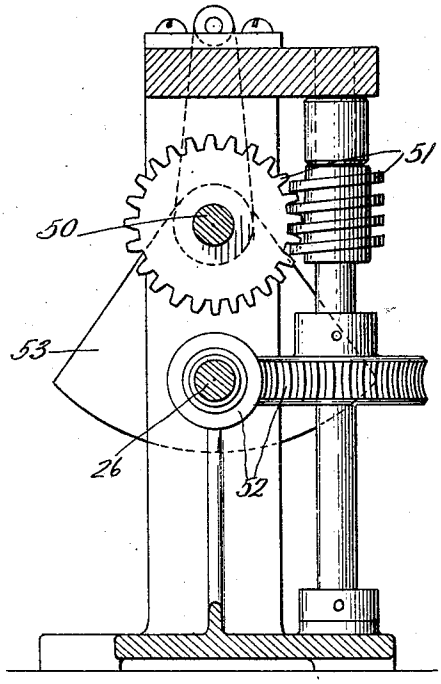


Fig. 5



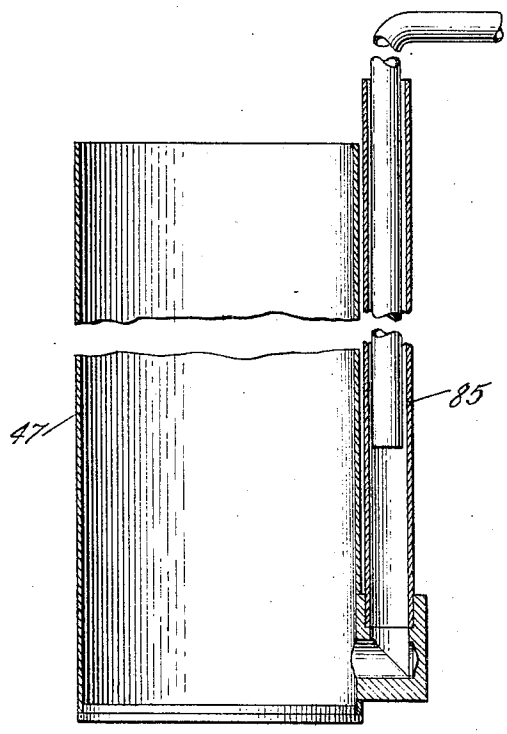


Fig. 6

Inventor:
Arthur B. Cunningham
By: Nissen & Evans
Attys.

Patented Feb. 14, 1933 1,897,721

UNITED STATES PATENT OFFICE

ARTHUR B. CUNNINGHAM, OF CHICAGO, ILLINOIS, ASSIGNOR TO REPUBLIC FLOW METERS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

MECHANICALLY OPERATED GAS ANALYZER

Application filed June 18, 1926. Serial No. 116,777.

This invention relates to a device for analyzing the percentage of carbon dioxide in flue gases and maintaining a record of the analysis.

The object of the invention is to provide a device of the class named which shall be of improved construction and operation and which is actuated by a motor rather than by flowing water.

Other objects of the invention will appear from the following description.

The invention is exemplified in the combination and arrangement of parts shown in the accompanying drawings and described in the following specification, and it is more particularly pointed out in the appended claims.

In the drawings;—

Fig. 1 is a vertical sectional view of an instrument embodying one form of the present invention;

Fig. 2 is a top plan view of the instrument with the cover removed;

Fig. 3 is a transverse section of the instrument substantially on line 3—3 of Fig. 2, with parts omitted;

Fig. 4 is a fragmentary elevation of a part of the mechanical operating mechanism;

Fig. 5 is a view looking from the right in Fig. 4; and

Fig. 6 is a vertical sectional view of the reciprocating cylinder showing its connection with the exhaust pipe for the measured gas.

The present invention is in some respects similar to my prior application, Serial No. 501,077, filed September 16, 1921, but differs from the device of that application in that the present invention provides means for actuating the instrument from a power drive instead of by water from a pressure main.

In the drawings, the numeral 10 designates a tank for containing caustic potash through which measured charges of the flue gases are passed to absorb the carbon dioxide therefrom. The tank 10 is provided with a pipe 11 having a funnel 12 closed by a plug 13 by means of which the tank may be charged with a suitable caustic potash solution. The tank is also provided with an overflow pipe 14 having a discharge outlet pipe 15 for fixing the surface level of the potash in the tank 10. It will be noted that the inner end of the pipe 14 opens within a dome 16 connected with the cover 17 of the tank 10 so that the potash level is fixed at a height such that the tank is completely filled with the solution.

A casing 18 is mounted on the cover plate 17 and forms a liquid-tight joint therewith. The casing 18 is partially filled with a light lubricating oil and a drain pipe 19 is provided for draining the oil from the casing when necessary. An electric motor 20 is mounted on the cover plate 17 outside of the casing 18 and is provided with a shaft 21 which extends through a stuffing box 22 into the casing. Universal couplings 23 are provided to compensate for any inaccuracy in the alinement of the portion of the shaft passing through the stuffing box 22. A pinion 24 is secured to the shaft 21 within the casing 18 and drives a gear 25 secured to a shaft 26. The shaft 26 operates a pump 27 adapted for pumping flue gases. The gases enter the pump 27 through a pipe 28 which passes through the wall of the housing 18 at 29 and is connected in any suitable way with the source of gas to be analyzed. It has been found that a gear pump may be used for pumping the gases, provided a limited supply of oil is permitted to enter the pump with the gases. For this purpose a small perforation is made in the pipe 28 and the portion of the pipe thus perforated is surrounded by a screen 30 to prevent the entrance of any dirt or foreign matter in the lubricating oil. The gas is discharged from

the pump 27 through a pipe 31 into a larger pipe 32 having its lower end opening below the surface level of the oil in the casing 18. The surface level of the oil is indicated by the line 34. The discharge pipe 31 opens into the pipe 32 above the oil level so that the gas may pass upwardly and any oil may return to the tank. The pipe 32 is connected by a pipe 35 with a manifold 36 and connects with a passage 37 therein. The passage 37 in the manifold 36 is open to atmosphere at 38 through the rear wall and provides means for discharge of gas from the pipe 35 into the surrounding atmosphere. It is the purpose of the pump 27 to provide a continuous stream of gas from the source to be tested through the passage 37 in the manifold 36. Measured quantities of this gas are drawn off as required through a passage 39 leading downwardly from the passage 37.

Supported below the manifold 36 is a hollow piston 40 having a measuring chamber 41 in the lower portion thereof. A pipe 42 connects the passage 39 to the lower portion of the measuring chamber 41. The measuring chamber 41 is provided with a downwardly projecting neck 43 which extends below the open end of the pipe 42. A second pipe 44 communicates with the top of the measuring chamber 41 and is connected through the manifold 36 with a pipe 45 which extends downwardly through the top plate 17 where it forms a tight joint therewith and opens beneath a baffle 46 within the caustic potash chamber 10. A cylinder 47 surrounds the piston 40 and is spaced a slight distance from the outer surface of the piston 40 by spacing lugs 48 which leave room for the flow of liquid between the outer wall of the piston 40 and the inner wall of the cylinder 47. The cylinder 47 is supplied with a sealing liquid which completely covers the piston 40 when the cylinder is in its uppermost position shown in Fig. 3. A non-evaporating oil of specific gravity of about 1.25 is preferably used for this sealing liquid. The cylinder 47 is periodically raised and lowered by means of a crank 49 carried on a shaft 50 and operated by worm reduction gears 51 and 52 driven from the shaft 26. The crank 49 may be provided with a counterbalance 53, as shown in Figs. 4 and 5. The cylinder 47 is connected to the crank 49 by a connecting rod 54 pivoted to the upper end of the cylinder 47 by the pivot pin 55.

When the cylinder 47 is in its uppermost position, as shown in Fig. 3, the sealing liquid will completely fill the measuring chamber 41. When the cylinder is lowered the liquid will all drain from the chamber 41 into the lower end of the measuring cylinder. As the liquid drains out gas will enter through the pipe 42 and fill the chamber 41. In this way the measuring chamber is charged with gas fresh from the source of supply each time the cylinder 47 is lowered. As the cylinder again rises a measured quantity of gas will be sealed off in the chamber 41 when the liquid level reaches the lower end of the tube 42 and seals this tube. Further rise of the cylinder will force the gas in the chamber 41 out through the pipes 44 and 45 and discharge the gas into the caustic potash chamber below the baffle 46. It will be noted that at the time the gas is sealed off in the chamber 41 it is subject to atmospheric pressure for the reason that the pipe 42 is open to atmosphere at 38. The vertical reciprocation of the cylinder 47 therefore periodically discharges a measured quantity of gas into the caustic potash chamber below the baffle 46. The baffle 46 is preferably provided with longitudinally extending partitions to insure complete contact of the gas as it rises along the baffle and escapes at the upper end thereof. During this movement of the gas in contact with the caustic potash solution the carbon dioxide will be absorbed therefrom and the remaining gas will escape into the dome 16. From the dome 16 the gas rises through a pipe 56 and discharges through a perforation 57 at the top of the pipe into a bell 58 which is inverted in a sealing liquid 59 contained in a standpipe 60 open at its upper end. A rod 61 extends upwardly from the bell 58 and is provided with a tappet 62 for engaging a contact screw 63 carried on an arm 64 secured to a disc 65 mounted on a shaft 66 which is journaled in a bracket 67. A rod 68 projects forwardly from the disc 65 and carries an indicator arm 69 at its forward end. A tracing pen 70 is secured to the lower end of the indicator arm 69 and engages a chart 71 which is rotated by means of clockwork contained in a case 72.

A brake lever 73 is pivoted at 74 on the bracket 67 and carries a brake shoe 75 which engages the disc 65. A push rod 76 is mounted in guides 77 and 78 and is arranged to engage an adjustable contact 79 secured to the end of the brake lever 73. The lower end of the push rod 76 bears upon a cam 80 connected to the crank arm 49. The upper end of the push rod 76 engages the contact member 79 at the time that the cylinder 47 is in its uppermost position and thus releases the brake shoe 75 from the disc 65. Since the gas is discharged from the measuring chamber 41 at the time that the cylinder 47 is in its uppermost position the brake shoe 75 will be released at the time that the bell 58 is raised to its uppermost position by the gas which escapes from the measuring chamber 41. This will free the spindle 66 and its connected parts so that it may be rotated by the tappet 62

when it engages the adjustable contact screw 63 at the upper extreme position of the bell 58. This permits the indicator 69 to be rotated under the action of the bell 58 and swung to a position to indicate the extreme position of the bell 58 which will, of course, be a measure of the quantity of gas contained in the bell. Since a definite quantity of gas is discharged from the measuring chamber 41 at each stroke of the cylinder 47 the height of the bell 58 and consequently the position of the indicator 69 will be an indication of the quantity of gas remaining in the charger after the carbon dioxide has been absorbed therefrom. The instrument may be calibrated to read directly in percentage of CO_2 contained in the gas. Before the gas is discharged from the bell 58 and the bell permitted to return, the downward movement of the cylinder 47 releases the brake arm 73 and permits the brake to re-engage the disc 65 and retain the indicator 69 in its indicating position until the operation of the instrument again returns the cylinder 47 to its uppermost position. In this way the only variation in the position of the needle is produced by differences in quantity of carbon dioxide in the different charges and the needle is not permitted to swing back to zero position each time the bell 58 is lowered.

The discharge of gas from the bell 58 is effected through a pipe 81 which enters the dome 16 near the top thereof and extends upwardly to a position somewhat above the uppermost position of the cylinder 47. A U-tube 82 is telescoped over the open end of the pipe 81 and the oil in the casing forms a sealed joint between the pipe 81 and the enlarged end 83 of the U-tube 82. The other leg of the U-tube 82 telescopes into an upwardly extending tube 85 secured to the cylinder 47, as shown in Fig. 6. It will be apparent that the surface level of the sealing liquid in the cylinder 47 and the tube 85 would be the same so that as the cylinder 47 is lowered the liquid in the tube 85 will be lowered until the end of the U-tube 82 is uncovered. This takes place after the cylinder 47 has been lowered sufficiently to release the brake arm 73. When the end of the U-tube 82 is uncovered the gas remaining in the bell 58 will be forced outwardly therefrom by the weight of the bell and escape through the pipe 81, U-tube 82 and the upper end of the pipe 85 into the atmosphere.

When the cylinder 47 is lowered a decrease in pressure will be produced in the chamber 41 measured by the head of liquid in this chamber. This, of course, will be transmitted to the pipe 45 and will cause the liquid in the chamber 10 to rise in the pipe 45 to a sufficient height to counterbalance the head of liquid in the chamber 10. As soon as the liquid level in the chamber 41 reaches the lower end of the pipe 42, gas will rush in from the passage 37 to fill the chamber 41 and the reduced pressure will be relieved and atmospheric pressure restored. This will permit the liquid in the pipe 45 to return to the chamber 10.

It will be seen from Figs. 1 and 3 of the drawings that the oil in the chamber 18 surrounds the pump and conduits by which the gas is supplied to the apparatus and also surrounds both measuring chambers. This oil not only seals the pump and gas passages, but also acts as a temperature regulating medium which insures measurement of the gas before and after removal of the carbon dioxide therefrom at the same temperatures, since both measuring receptacles are submerged in the same body of oil.

I claim:—

1. In combination, a motor driven pump for drawing gas from a source to be tested, a conduit for conducting the gas from said pump to atmosphere, a measuring vessel closed at its top and opened at its bottom, a discharge pipe opening into said vessel at the top thereof, a pipe connected with said conduit and opening into said measuring vessel below the top thereof, a motor operated device for causing liquid to rise in said vessel to seal said pipe and discharge the gas sealed in said vessel therefrom, means for absorbing from said gas a constituent thereof, and means for ascertaining the proportion of said constituent.

2. In combination, a member having a measuring chamber therein open at its lower end, a vessel in which said chamber is disposed, a reciprocating member connected with said vessel for raising and lowering said vessel, a motor, reduction gearing for operating said reciprocating member from said motor, liquid in said vessel for alternately filling and emptying said measuring chamber as said vessel is raised and lowered, means for supplying gas to said chamber from a source to be tested when said chamber is emptied of liquid, means for receiving the gas from said chamber when said chamber is filled with liquid, said receiving means having an absorbent therein, and means for measuring the remainder of gas from each charge after it has passed through said absorbent.

3. In combination, a casing, a pump positioned in said casing, a conduit leading to said pump for supplying gas to said pump, lubricating oil in said casing covering said pump, a conduit leading from said pump having the discharge end thereof above the surface level of said oil, and means sealed by the oil in said casing for receiving gas from the discharge end of said conduit, the supply conduit for said pump having a re-

stricted perforation therein to admit a limited quantity of oil to said pump.

4. In combination, a housing, a pump disposed in said housing, a discharge conduit leading from said pump, means for supplying gas to be tested to said pump, lubricating oil in said housing, said discharge conduit having a sealed connection with said lubricating oil to permit return of oil from said conduit to the body of oil in said housing, mechanism for measuring off definite quantities of gas from said conduit, gearing immersed in the lubricating oil for operating said measuring mechanism, and a motor mounted outside of said housing for driving said pump and gearing.

5. In combination, a tank for caustic potash, a housing mounted on said tank, a motor mounted on said tank outside of said housing, a pump mounted within said housing and driven by said motor for supplying gas to said pump from a source to be tested, lubricating oil within said housing, a conduit for discharging gas from said pump into atmosphere above the surface level of said lubricating oil, a member having a measuring chamber open at its bottom, a vessel disposed in said housing and surrounding said member, said vessel being closed at its bottom and having a liquid therein separate from the lubricating oil in said housing, mechanism disposed in said housing for raising and lowering said vessel to alternately fill and empty said measuring chamber with the liquid from said vessel, means for conducting gas from said measuring chamber to said tank, means for receiving gas from said tank, and means for indicating the volume of gas received from said tank.

6. In combination, a member having a measuring chamber therein, a vessel surrounding said member and having liquid contained therein, means for raising and lowering said vessel to alternately fill and empty said measuring chamber with said liquid, means for supplying gas to be tested to said chamber, means for receiving the gas discharged from said chamber and for absorbing therefrom a constituent thereof, a bell float for receiving the gas after the absorption of said constituent, a liquid sealed outlet conduit communicating with the interior of said float, a liquid seal for said float, and means operating by the movement of said vessel for breaking the seal of said outlet conduit subsequent to the measurement of a charge of gas by said bell float.

7. A gas analyzer comprising a receptacle containing a body of liquid, a pump submerged in said liquid, means for connecting said pump with a gas supply, said pump having a restricted passage for admitting a limited quantity of liquid from said receptacle into the interior of said pump, a conduit for conducting a stream of gas from said pump, a trap for permitting return of liquid from said conduit to the body of liquid in said receptacle, means for withdrawing gas from said conduit and for separating off measured quantities of the gas withdrawn, said separating means being submerged in the liquid in said receptacle, means for discharging the gas from said separating means to a measuring vessel also submerged in the liquid in said receptacle, and means for removing a constituent of said gas before it enters said measuring vessel.

8. A gas analyzing apparatus comprising a measuring receptacle having an inlet adjacent the lower end thereof and an outlet adjacent the top, a vessel surrounding said measuring receptacle and having a liquid therein, means or causing the liquid in said vessel to fill and empty said measuring receptacle, a tank having an absorbent or a constituent of the gas measured, a conduit communicating with the outlet of said measuring receptacle and terminating in said tank, a second measuring vessel for receiving the unabsorbed gas from said tank, an outlet conduit from said second measuring vessel and sealed at its remote end by the liquid of said vessel whereby the second measuring chamber is vented to the atmosphere when the liquid in the measuring vessel is lowered and sealed when the liquid is raised.

9. A gas analyzing apparatus comprising a member having a measuring chamber therein, a vessel surrounding said member and having liquid contained therein, means for raising and lowering said vessel to alternately fill and empty said measuring chamber with said liquid, means for supplying gas to be tested to said chamber, means for receiving the gas discharged from said chamber and for absorbing a constituent thereof, a bell float for receiving the unabsorbed gas, a conduit communicating with the interior of such float and having its distal end sealed by the liquid of such vessel whereby the interior of the said bell float is alternately sealed from and exposed to the atmosphere as the measuring vesssel is raised and lowered.

10. A gas analyzing apparatus comprising a measuring chamber open at its lower end and having inlet and outlet conduits communicating with said chamber adjacent the top and bottom thereof, a vessel surrounding said measuring chamber and having an auxiliary compartment, a sealing liquid in said vessel and compartment, means for alternately raising and lowering the liquid in said vessel, a receptacle containing an absorbent liquid, a conduit communicating with the outlet of said measuring chamber and terminating within said absorbent medium, a second measuring cham-

ber adapted to receive the unabsorbed gas from said medium, an outlet conduit for said second measuring chamber having its distal end disposed in said auxiliary compartment whereby the outlet conduit is alternately sealed and unsealed by the rise and fall of the sealing liquid in said compartment.

In testimony whereof I have signed my name to this specification on this 16th day of June, A. D. 1926.

ARTHUR B. CUNNINGHAM.