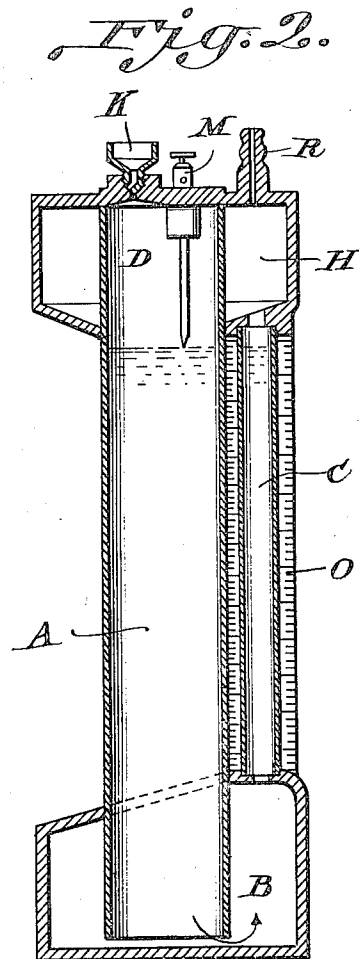
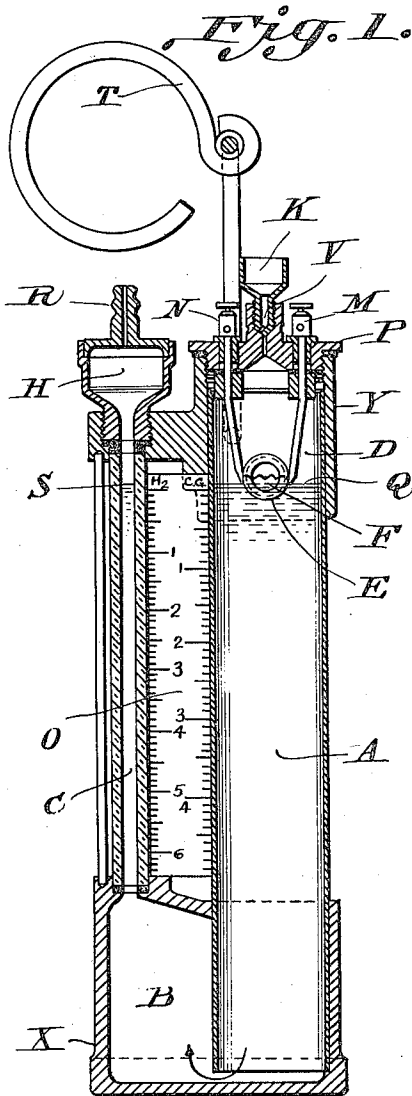


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GAS ANALYZING APPARATUS.
APPLICATION FILED FEB. 11, 1916.

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Patented Mar. 21, 1916.
2 SHEETS—SHEET 1.



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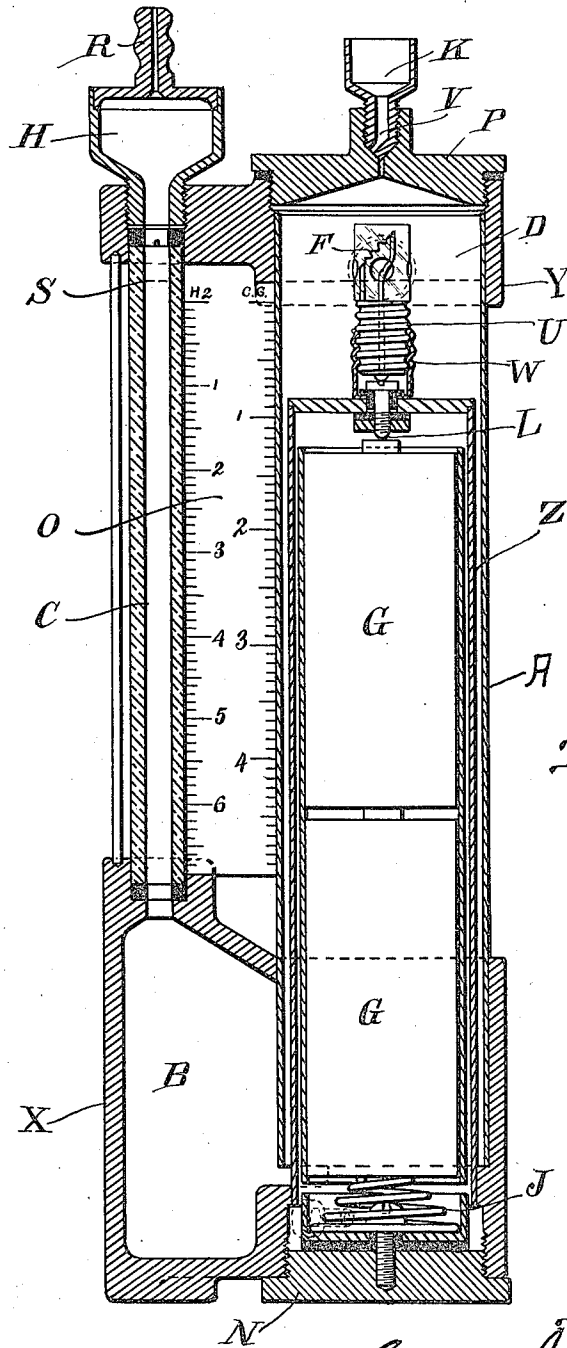


Fig. 3.

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UNITED STATES PATENT OFFICE.

GEORGE A. BURRELL, OF PITTSBURGH, PENNSYLVANIA.

GAS-ANALYZING APPARATUS.

1,176,199.

Specification of Letters Patent.

Patented Mar. 21, 1916.

Application filed February 11, 1916. Serial No. 77,785.

(DEDICATED TO THE PUBLIC.)

To all whom it may concern:

Be it known that I, GEORGE A. BURRELL, a citizen of the United States, and a resident of the city of Pittsburgh, county of Allegheny, State of Pennsylvania, and an employee of the United States Bureau of Mines at Pittsburgh, Pennsylvania, have invented certain new and useful Improvements in Gas-Analyzing Apparatus, of which the following is a specification.

This application is made under the act of March 3, 1883, chapter 143 (22 Stat., 625) and the invention herein described and claimed may be used by the Government of the United States or any of its officers or employees in the prosecution of work for the United States, or by any other person in the United States, without the payment of any royalty thereon.

My invention relates to means for detecting the presence and quantitatively determining the proportion of inflammable gas in mixtures comprising such gas, and belongs to that class of apparatus in which the inflammable gas if present is burned by the oxygen in the mixture to form products of less volume than the original constituents, the combustion being initiated by means of a metallic filament which is heated by the passage of an electric current therethrough.

The object of my invention is to construct a strong, cheap, and compact apparatus which can be readily carried about and operated without the exercise of special skill, and used for the detection of methane (fire-damp) in mines, hydrogen around storage batteries, carbon monoxid in flue gases, or the above named inflammable gases as well as benzol, gasolene vapor, or acetylene wherever they may occur in mixtures containing oxygen, such as mixtures with air. This object is attained by the apparatus illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation, partly in section, of my apparatus, Fig. 2 is a similar view of a modification of the apparatus designed to promote the more rapid cooling of the gases after the combustion as will be more fully described, and Fig. 3 is another modification in which the battery used to produce the electric current necessary to operate the instrument is contained within the same.

Referring particularly to Fig. 1, the ap-

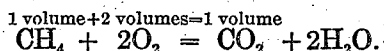
paratus comprises primarily a modified U-tube consisting of the stout gage glass C and the metallic tube A joined at their bottoms by the chamber B formed in the lower casing X, and supported at their tops by the upper casing Y. The limb C terminates in a small chamber H in the upper portion of which is the nipple R, adapted to receive a soft rubber tube (not shown) for convenience in applying air pressure by the mouth or otherwise. Parallel and close to the gage glass C is a scale-bearing member O, graduated in a plurality of scales and so arranged that the scale desired can be placed next to the gage glass C. The limb A of the U-tube terminates in the combustion chamber D which is provided with a plug P containing an aperture closed by the valve V having the cup K, the construction of which valve and cup is clearly shown on the drawings. Mounted within the combustion chamber D is a filament F, which I prefer to construct of platinum wire although other suitable materials will readily suggest themselves. Leads from the end of the filament pass through plugs of insulating material to the outside of the chamber D, where they are connected to binding posts M N. In the casing Y which forms the upper portion of the frame of the instrument is mounted a small glass window E, placed opposite the filament F so that the latter can be viewed from outside. The window E is so set into the wall Y as to be free from any danger of breakage. The joints between the various parts of the apparatus are packed or cemented so as to be tight. The whole apparatus may be conveniently lifted and carried by means of the bail T.

The operation of the apparatus is as follows:—To prepare the apparatus for use, the plug P is removed and water is poured into D until it stands at S and Q in the tubes C and A, the point S coinciding with the zero points of the scales on the tube O. The plug P is then replaced. When it is desired to test a sample of air for the presence of inflammable gas, the instrument is carried to the region where the suspected air is found, and pressure is applied at R, for example by blowing into R through a rubber tube, until water appears in the cup K. During this operation, the valve V is of course open. If for any reason the cup K is not visible to the operator, a slight click of

the valve will notify him that the water has reached it. Communication between the nipple R and the exterior of the instrument is then cut off, as by pinching the rubber tube between the fingers, and the valve V is placed at the exact point where the sample is to be taken. Air is then allowed to escape from R until the levels of the water in the two limbs of the U-tube are equalized, whereupon the chamber D will become filled with a certain volume of the gas under examination. The valve V is then closed.

In order to cause the combustion of the inflammable constituent, the terminals of a battery are connected to the binding posts M N, the battery being of sufficient capacity to heat the filament F to a bright red heat. By means of the window E, the heating of the filament may be observed, showing that the electrical connections are properly made. The combustion of the sample is complete in two minutes or less. During the combustion, the gas in the chamber D expands owing to its increase in temperature and the liquid rises in the other limb of the U-tube, into the chamber H. Before the indication of the instrument is read off, the gases must be cooled to their original temperature and this cooling is hastened by shaking the instrument so that the liquid in the tub A commingles with the gas and absorbs heat therefrom.

As will be readily understood by those skilled in the art, the combustion of methane, gasolene, carbon monoxid, acetylene, benzol, and fuel gases produces carbon dioxid and water vapor, while the combustion of hydrogen gives only water vapor. This vapor condenses on the cooling of the gases and does not occupy appreciable space. Only the carbon dioxid will be left, and this will always have a volume less than the combined volumes of the inflammable gas and oxygen from which it is formed. Thus, taking methane as a typical example, the reaction is as follows:



It will be seen that three volumes of gas before combustion produce only one volume after combustion, which will cause the liquid to rise in the limb A of the U-tube and to be correspondingly depressed in the limb B. The magnitude of the depression produced will be a function of the percentage of inflammable gas present.

If it is desired to absorb the carbon dioxid formed, and thus to render the diminution in volume still greater, I may substitute for the water in the instrument a suitable solvent for carbon dioxid, such as a solution of potassium hydroxid. However, I do not find this to be necessary to secure accurate results. By the use of the instrument as

little as 0.1% of inflammable gas may be detected.

After the cooling of the gases is complete, which will be indicated by the liquid level in the gage glass C becoming stationary, the liquid level is read off on the appropriate scale on O. One scale is provided for each of the inflammable gases for the detection of which the instrument is to be used, and the scales are calibrated to read directly in percentages of inflammable gas by the results obtained on mixtures of known composition determined according to the usual methods.

If desired, the filament F may be surrounded by a small chimney to promote the circulation of the gas mixture when the filament is heated, thereby somewhat reducing the time required for combustion.

In the modification of the apparatus shown in Fig. 2, the chamber H is so constructed as to surround the combustion chamber, whereby the cooling of the gases after a combustion is further hastened. This modification of the apparatus is otherwise similar to that shown in Fig. 1, except that the shape of chamber B is somewhat modified to adapt the apparatus to be conveniently packed in a case for transportation.

Either of the above forms of the apparatus is intended to employ current from a battery which is separate from the apparatus, and this battery may be either that of a miner's electric cap lamp, or a special battery carried in the hand or on the back of the operator.

In Fig. 3, I have shown a form of the apparatus in which the battery is contained within the instrument. The battery is shown as consisting of two small dry cells G G which are inserted in the liquid-tight tube Z contained within the tube A, the batteries being accessible by removing the plug N. The cells of the battery are held in contact with each other and with the contact screw L by means of the coiled spring J. The circuit is opened or closed through the filament F by means of a suitable switch on the outside of the instrument, which is not shown in the drawings.

In Fig. 3, I have shown a convenient form of readily replaceable ignition filament, though it will be seen that this arrangement can be as readily adapted to either of the other modifications of apparatus shown. The filament as shown is mounted on a plug U which screws into a socket W similar to those used for miniature electric lamps. When one filament is burned out, the plug on which it is mounted can be removed and another inserted without loss of time. The operation of this form of the instrument is the same as that of the other modifications.

It will be understood that various other modifications of the apparatus may be found desirable and I do not wish to be understood as being limited to any of the details specifically described herein.

What I claim as new and desire to secure by Letters Patent is:—

1. In a gas analyzing apparatus two tubes having a connection between their lower extremities, a liquid seal in said connection, a closure for the upper extremity of one of said tubes comprising a valve, and an ignition member in said closed tube.

2. In a gas analyzing apparatus two vertical tubes having a connection between their lower extremities, a liquid seal in said connection, a portion of enlarged cross-section at the upper end of one of said tubes, a closure for said tube, and a filament in said enlarged portion adapted to be heated.

3. In a gas analyzing apparatus a U-tube having a liquid seal in the lower portion thereof, a scale arranged parallel to one limb of said U-tube, means for closing the upper end of the other limb of said U-tube, comprising a valve, a filament mounted in the closed limb, and a source of electrical energy adapted to be connected with said filament.

4. In a gas analyzing apparatus a modified U-tube, a liquid seal in the lower por-

tion thereof, means for closing the upper extremity of one limb of said U-tube to form a chamber above said liquid seal, a metallic filament within said chamber and adapted to be heated from outside the chamber, and a graduated scale adjacent the other limb of said U-tube.

5. In a gas analyzing apparatus a vertical transparent tube, a movable member adjacent said transparent tube graduated in a plurality of different scales, a second vertical tube, a connection between said tubes at their lower ends, a liquid seal in the junction of said tubes, a cap closing the upper end of said second tube, and a metallic filament within said cap adapted to be heated by the passage of an electric current therethrough.

6. In a gas analyzing apparatus a U-tube having a liquid seal therein, a graduated scale on which to read the liquid level in one limb of said U-tube, a closure for the second limb of said U-tube, an ignition member within said closed limb and above the normal level of said liquid seal, a tube projecting into said second limb of said U-tube, and a source of electrical energy within said tube and connected to said ignition member.

In testimony whereof I affix my signature.

GEORGE A. BURRELL.