

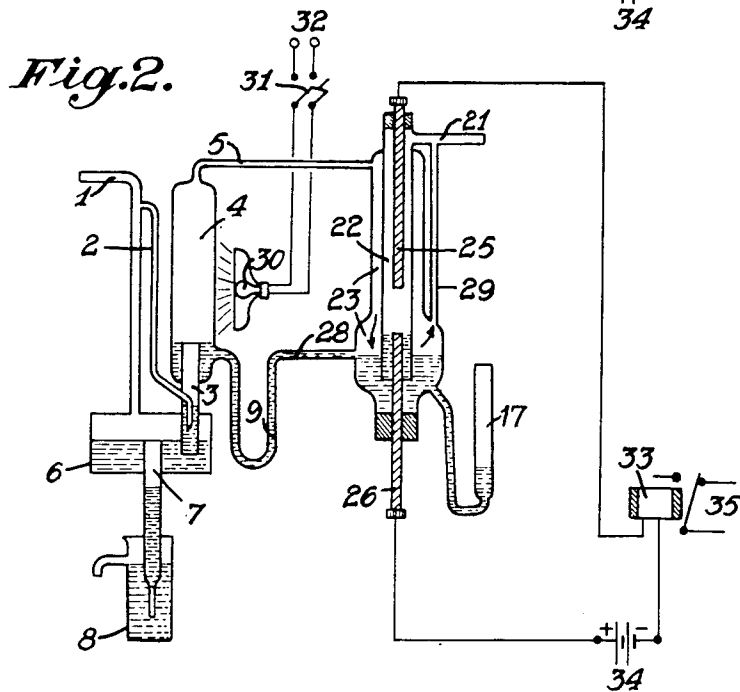
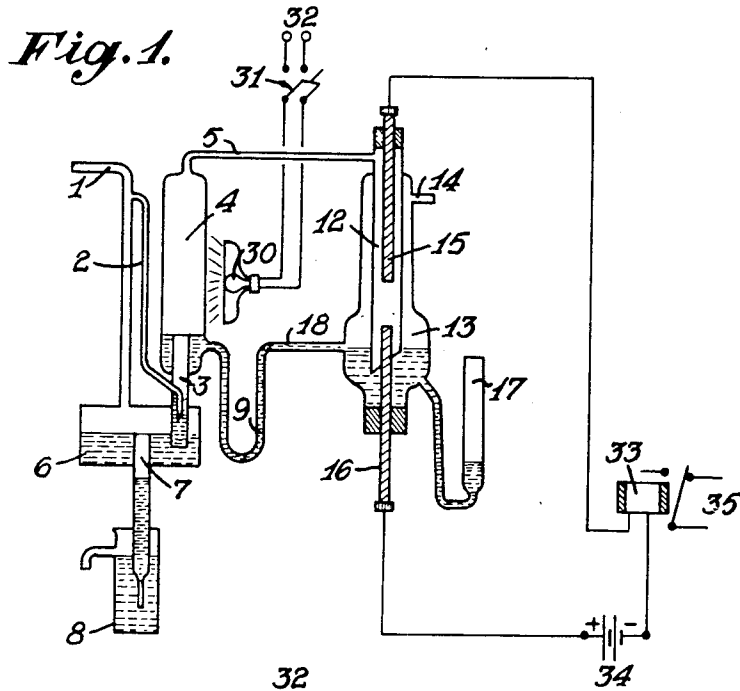
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TEST APPARATUS

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TEST APPARATUS

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This invention relates to a process and apparatus for automatically determining the presence of potentially explosive gaseous mixtures before the explosive limit of such mixtures is reached, and is more particularly concerned with a process and apparatus of the character indicated suitable for determining the presence of potentially explosive gaseous mixtures in electrolysis cells.

As is well known, hydrogen may be formed and released at the surface of the cathode in electrolysis cells of the mercury cathode type as a result of local decomposition of the alkali metal amalgam which is formed during the operation of the cell. The formation of hydrogen at the surface of the cathode not only causes a decrease in electrolytic yield, but more seriously, the mixing of the hydrogen thus released with the gas normally evolved at the anodes, e. g. chlorine, may form an explosive mixture. It is thus of great practical importance to have available means whereby abnormal operation of the cell, which results in the liberation of hydrogen from the surface of the cathode, with concurrent formation of potentially explosive gaseous mixtures, can be automatically brought to the attention of the cell operator.

It is known that a reaction between two gases in a potentially explosive gaseous mixture can be brought about, e. g. by combustion of one gas in the other, before the concentration of one of the constituents has reached such proportions that the mixture becomes explosive. Methods have been heretofore proposed for the measurement of gaseous mixtures which are based on the absorption, combination, or combustion of the gases. However, devices suitable for operation in accordance with these known methods are relatively complicated, costly, and difficult to maintain.

It is an object of the present invention to provide a process for determining the presence of potentially explosive gas mixtures which is accurate and easily carried out and which does not require expensive and complicated or difficultly-maintainable apparatus for its use.

It is another object of the invention to provide an apparatus for carrying out this process which avoids the disadvantages and drawbacks of gas testing apparatus heretofore proposed.

The process according to the present invention is based on the principle of purposely bringing about the chemical combination of the gases in the mixture being tested and making use of the physical changes which result from such combination. In accordance with the invention, the combination of the gases in the mixture is effected periodically, and the variation in pressure resulting therefrom is caused to act on a manometric device which, when the variation reaches a predetermined limit value, causes the closing of an electric current to operate an alarm.

In carrying out the invention, the combination of the gases takes place in a reaction zone or chamber, preferably under the action of actinic rays, and the variation in pressure of the gases, as a result of the combination, causes a saline solution to enter into an electrode tube to provide a conductive path between two spaced-apart elec-

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trodes. The electric circuit which is made by this bridging of the gap between the electrodes actuates an alarm. The gas mixture to be tested is introduced into the reaction chamber through a tube which is of relatively small cross-sectional area, in order to prevent an overly rapid extinction of the pressure variation caused by the combination of the gases in the reaction chamber. The variation in the pressure of the gases in the reaction chamber is employed to cause either an increase or a decrease in pressure in the electrode tube, as will be explained more fully hereinafter.

While a quantity of the gaseous mixture to be subjected to the test is being introduced in the reaction chamber, the chamber is not exposed to the light. The gaseous mixture is then exposed to the actinic rays of a lamp for two or three seconds, during which the desired chemical combination takes place, then the lamp is turned off or masked, the products of the combination are evacuated by continuing the flow of the gaseous mixture through the apparatus, and a quantity of fresh gaseous mixture replaces the evacuated gas. Thus the reaction chamber is periodically exposed to the light rays for a few seconds at a time. The frequency of these exposures may be determined by any convenient means, e. g. manually or by a mechanical or hydraulic timing arrangement.

The invention will be more fully explained with reference to the illustrative embodiments of the apparatus of the invention which are shown in the accompanying drawing, wherein

Fig. 1 is an elevational view, partly in section, of a testing apparatus embodying features of the present invention showing the reaction chamber and the electrode chamber communicating therewith, and

Fig. 2 is a similar view of a modified form of apparatus.

Referring to the drawing, and more particularly to Fig. 1, reference numeral 1 designates the inlet tube for receiving the gas mixture to be tested. Inlet tube 1 communicates directly with a vessel 6 provided with an overflow tube 7 which empties into a receptacle 8. Communicating with the side of inlet tube 1 is a branch inlet 2 of relatively small diameter which has a free end extending into an enlarged tube 3 which extends downwardly into vessel 6 and at its upper end extends into reaction chamber 4. Associated with reaction chamber 4 is an electrode chamber 12 which extends into a larger gas chamber 13 having a gas outlet 14. The upper end of reaction chamber 4 communicates with the upper end of electrode chamber 12 by means of a gas conduit 5 and the lower portions of reaction chamber 4 and gas chamber 13 are connected by a liquid conduit 18 provided with a U-tube 9. The lower portions of the chambers 4 and 13 are adapted to contain an electrolyte solution, e. g. a sodium chloride brine, the solution flowing between the two chambers through conduit 18. From the lower portion of chamber 4, the electrolyte overflows into tube 3 and thence into vessel 6 from which it overflows through tube 7 into receptacle 8. A constant supply of electrolyte to chamber 13 is provided by a reservoir 17 which communicates at its lower end with the lower portion of chamber 13.

Associated with the above-described apparatus is an alarm circuit including an electrode 15 extending downwardly into electrode chamber 12, an electrode 16 extending upwardly through the bottom of chamber 13 into the lower end of electrode chamber 12, a source of current, e. g. a battery 34, and a relay 33, the relay 33 being arranged to close a circuit 35. The electrodes are advantageously formed from graphite and the source of current may, if desired, be the electrolysis cell with which the apparatus is associated. Radiation to which the gas mixture is exposed in the reaction chamber is, in the embodiment illustrated, provided by an incandescent

lamp 30 connected through a switch 31 to a current source 32.

When the apparatus shown in Fig. 1 is operated in accordance with the invention, the gas inlet tube 1 is connected by any suitable means to the source of the gas to be tested, e. g. a mercury cathode electrolyte cell. The gas, under a positive pressure, thus enters the apparatus through tube 1 and flows through branch tube 2. The gas pressure in tube 1 causes some of the liquid in vessel 6 to rise in tube 3 to a point above the free end of tube 2 so that the gas bubbles through this liquid and flows upwardly into reaction chamber 4. The arrangement comprising tubes 3 and 7, vessel 6, and receptacle 8 operates to maintain the flow of gas into reaction chamber 4 substantially constant. If for some reason the pressure decreases in conduit 1, the level of the liquid in tube 3 will fall and reduce the extent of immersion of branch tube 2, thereby permitting the desired volume of gas to pass into chamber 4, notwithstanding the reduced pressure. Conversely, if the pressure in tube 1 increases, the level of the liquid in tube 3 will rise with corresponding control of the volume of gas flowing from tube 2. The gas thus flows into chamber 4 at a substantially uniform rate. When a test is to be made, switch 31, which, as mentioned, may be manually operated or may be connected to any convenient mechanical, hydraulic or similar timing device, is closed for a few seconds, thereby causing the lamp 30 to be energized and the resultant exposure of the gases in chamber 4 to the radiation from lamp 30 causes the gases to combine chemically.

The resulting instantaneous rise in temperature causes a pressure increase which drives the gas through line 5 into electrode chamber 12 for a few seconds, e. g. 2 or 3 seconds, the gas flows through the electrode chamber 12 and escapes by bubbling through the liquid into chamber 13 from which it is removed through gas outlet 14. As soon as the temperature in the reaction chamber 4 drops, following this expansion of the gases, a vacuum is produced in the electrode chamber and the liquid in chamber 13 rises in the electrode chamber 12 toward electrode 15. When the level of the brine reaches the lower end of upper electrode 15, the circuit between electrode 15 and electrode 16 is completed. This occurs when the gas mixture reaches dangerous proportions, the electrodes 15 and 16 being arranged to be vertically adjustable so that they may be positioned at any desired position relative to one another and relative to the overflow line 18 in accordance with the nature of the gas being tested. The arrangement shown in the drawings is particularly suitable for testing chlorine-hydrogen mixtures which may be formed in a mercury cathode electrolysis cell. The completion of the circuit between electrodes 15 and 16 energizes relay 33 which in turn makes the alarm circuit and sounds the alarm to the cell operator.

It will be apparent that changes may be made in the embodiment shown in Fig. 1 to obtain the desired result without departing from the scope of the invention. One such modified form of apparatus is illustrated in Fig. 2. In this embodiment, the relationships of the gas chamber 13 and the electrode chamber 12 have been changed somewhat. In Fig. 2 the electrode chamber 22 extends into the gas chamber 23 but is not connected to line 5 from reaction chamber 4. Instead, line 5 communicates with the upper end of gas chamber 23. Gas outlet 29 from gas chamber 23 joins a gas outlet 21 which communicates with the upper end of electrode chamber 22. In other respects, the apparatus of Fig. 2 is substantially identical with the apparatus of Fig. 1. In the operation of the apparatus of Fig. 2, the expanding gas from reaction chamber 4 passes through line 5 into gas chamber 23 and exerts a pressure upon the liquid contained in this chamber, the gas outlet line 29 being of relatively small diameter so as to prevent rapid diminution of the pressure. The pressure on the

liquid forces it upwardly into electrode chamber 22 and eventually the liquid bridges the gap between the ends of electrodes 25 and 26 and closes the circuit which operates the alarm, as described above in connection with the embodiment of Fig. 1. As in Fig. 1, the electrodes are vertically adjustable so that the distance between the lower end of the upper electrode 25 with respect to the level of the liquid overflow 28 can be varied.

In accordance with the invention, it is possible to detect in a chlorine-hydrogen mixture a quantity of less than 2% by volume of hydrogen. The apparatus has no parts which are required to move during operation and the apparatus remains clean at all times, hence minimum maintenance is required. While the invention is primarily applicable to mercury cathode electrolysis cells, it may also be used in testing any gaseous mixture having constituents which will react with one another and while an incandescent lamp has been shown as the means for bringing about the desired chemical combination in the reaction zone, it will be apparent that other reaction-initiating means may be employed within the scope of the invention.

It will be obvious that various changes and modifications other than those discussed above may be made without departing from the scope of the invention, as defined in the appended claims, and it is intended therefore that all matter contained in the foregoing description and in the drawing shall be interpreted as illustrative only.

What we claim and desire to secure by Letters Patent is:

1. Apparatus for determining the presence of an explosive gaseous mixture which comprises, in combination, means defining a reaction chamber, means for supplying the gas to be tested to said chamber, contacts in end spaced-apart relationship in an electrical circuit including means for sounding an alarm when the circuit is made between said contacts, means defining a first confined chamber enclosing the spaced-apart ends of said contacts, means defining a second confined chamber for containing an electrolyte in fluid-communicating relationship with said first confined chamber, first conduit means connecting the lower end of said reaction chamber with the lower end of said second confined chamber and second conduit means connecting the upper end of said reaction chamber with one of said confined chambers to bring the gases produced in said reaction chamber to act upon said electrolyte to vary the level of said electrolyte in said first confined zone enclosing the ends of said contacts, and a gas flow control means communicating with said reaction chamber for regulating the volume of gaseous mixture supplied to said chamber, said first conduit means including a U-tube and said flow control means including a liquid container disposed below said reaction chamber, means providing a constant liquid level in said container, tube means extending into said container below the liquid level therein and extending upwardly into said reaction zone, conduit means for carrying the gas to be tested, said last-named conduit means communicating with said container, and said means for supplying gas to be tested to said reaction chamber comprising a conduit of reduced diameter branching from said last-named conduit means and extending into said tube means.

2. Apparatus as defined in claim 1, wherein said contacts are electrodes and said means defining said first confined chamber containing said electrodes extends into said second confined chamber for containing the electrolyte.

3. Apparatus as defined in claim 1, wherein said second conduit means connects said reaction chamber with said first confined zone.

4. Apparatus as defined in claim 1, wherein said second conduit means connects said reaction chamber with said second confined chamber.

5. Apparatus as defined in claim 1, further comprising

means defining an electrolyte circuit including a source of electrolyte communicating with said second confined chamber, and an overflow in said container and said tube means extending into said container below the liquid level therein and extending upwardly into said reaction chamber providing an overflow therefrom.

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