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1,880,941

APPARATUS FOR DETECTING AND ESTIMATING INFLAMMABLE GASES IN AIR

Filed April 5, 1927

2 Sheets-Sheet 1

FIG. 2.

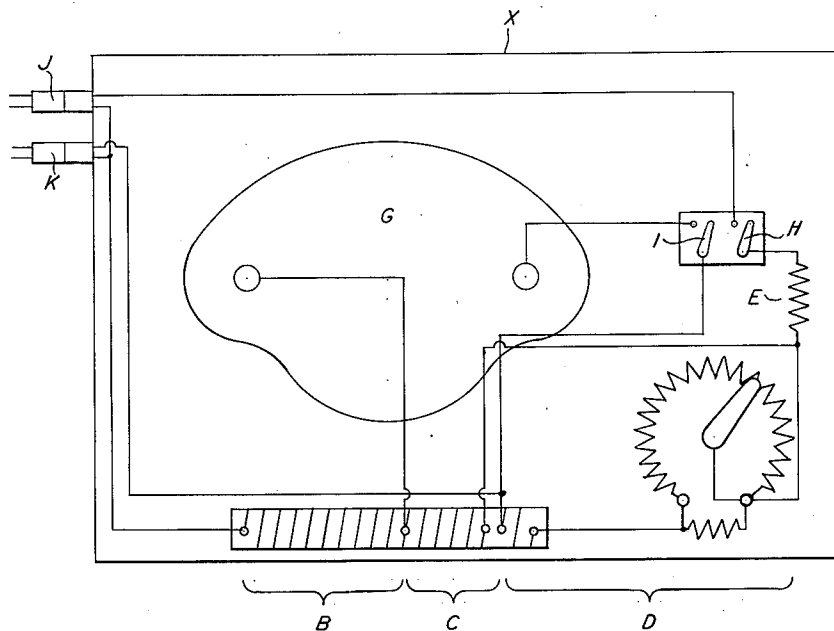
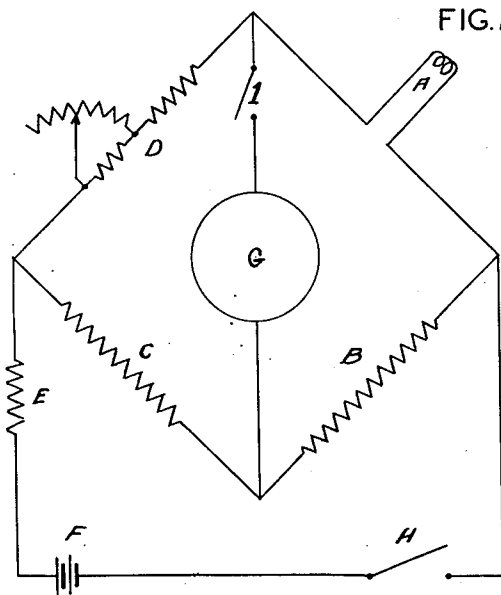


FIG. 1.



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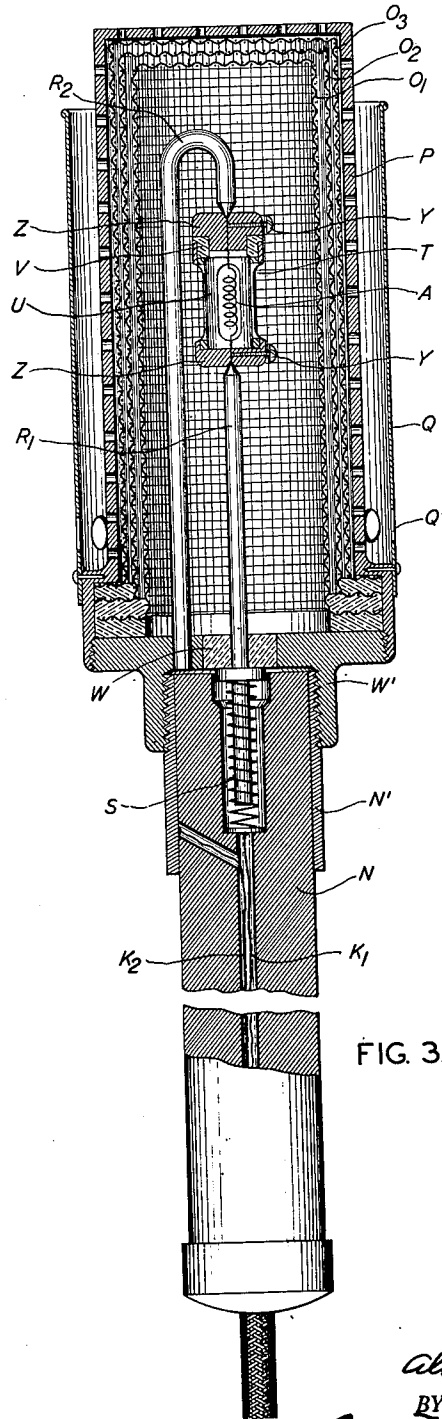


FIG. 3.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR DETECTING AND ESTIMATING INFLAMMABLE GASES IN AIR

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My invention relates to a process and apparatus for determining the content of combustible gas in gaseous mixtures and is especially adapted for use in coal or other mines, although it is equally well adapted for detecting the presence of inflammable vapors in receptacles which have contained oils, or for use in any other situation in which it is desirable to determine the presence of combustible or inflammable constituents in an atmosphere.

Combustible gases when mixed with air or other gases containing oxygen and brought into contact with a heated surface, will begin to oxidize at a temperature below the ignition point of the mixture. Furthermore, when in contact with a heated surface oxidation of the inflammable or combustible gases will occur, even though the latter is present in a proportion too small to support free combustion. Oxidation of the inflammable gas even below its ignition temperature is accompanied by the generation of heat, part of which will act to raise the temperature of the surface in contact with which the oxidation is proceeding. If the proportion of combustible gases in the mixture be great enough it will generate enough heat to maintain the temperature of the surface, but more dilute mixtures require the supply of extraneous heat. In either case the surface will assume a higher temperature in air containing a combustible gas.

These well-known properties have been utilized in the construction of devices for detecting the presence or estimating the proportion of inflammable gases in mixtures. In most of such devices a filament of platinum wire heated by the passage of electrical current has been the means for providing the oxidizing surface although such substances as clays have been used. In the devices hitherto known it has been the practice to rely upon a catalytic effect, the temperature of the heating surface being only sufficient to bring about catalysis. To permit a lower temperature to be used the normal catalytic property of wrought platinum has been augmented by applying a coating of finely divided platinum or other catalytic substances. The in-

crease in temperature in the presence of combustible gas has been measured by a thermocouple having its junction in close proximity to the filament, by the use of a resistance element, or by visual inspection.

In my device, I take advantage of the diminishing electrical conductivity of a metallic filament as its temperature rises, and ascertain its increased resistance, and thereby the increased temperature, by the principle of the Wheatstone bridge. Furthermore, I do not employ a separate resistance element for this purpose but use the same element which is heated to cause the oxidation. This element is heated to such a temperature that catalytic action becomes superfluous, thereby avoiding the inaccuracies due to "poisoning" of a catalytic heating element. I have found platinum wire to be very satisfactory as the testing filament by reason of its fairly high electrical resistance, its large temperature-resistance coefficient, its high melting point and its resistance to oxidation at high temperatures.

An object of my invention is to produce a portable device for testing for the presence of inflammable gases in air, which shall be sensitive to the presence of one half of one percent of methane, in an atmosphere, which shall be rapid in operation, and shall permit of an exploration of pockets into which the operator cannot enter.

These and other objects of my invention will be apparent from the following description of one embodiment thereof taken in connection with the accompanying drawings in which

Figure 1 is a diagram of the electrical connections;

Figure 2 is a schematic representation of the testing box; and

Figure 3 is a vertical cross-section of the testing element and its protective enclosure.

A platinum filament A with its connecting leads forms one leg of the Wheatstone bridge, fixed resistances B and C forming two other legs of the bridge, the latter resistances preferably being formed of a wire having a small temperature-resistance coefficient such as nichrome. The fourth leg is formed of a

composite resistance D partly fixed and partly variable which serves as means for maintaining the bridge in balance so long as the platinum filament A is not in contact with any inflammable gas. I may use this resistance for bringing the bridge back into balance after the filament A has come into contact with the inflammable gases, but I prefer to measure the change in resistance by noting the amount of unbalance. For this purpose an instrument for indicating the flow of small currents is connected across the bridge in the usual manner, the connection being provided with a switch I. Instrument G may be either a galvanometer, a millivoltmeter, or a milliammeter. The current for the operation of the bridge is furnished by any convenient source F. Such a source may conveniently be a storage battery of the type used for supplying current to miners' cap lights. A switch H is provided for controlling this current and a resistance E having a high temperature coefficient is also inserted in the circuit to maintain a constant current flow. I may employ various resistances in the bridge but the following have given satisfactory results. The resistance A consists of 1½" of No. 36 platinum wire having a resistance of 0.375 ohm at 25° C., and 1.647 ohms at 1035° C. The resistance B has a value of 14.236 ohms; the resistance C a value of 3.321 ohms; the fixed portion of resistance D has a value of 0.375 ohm and the variable portion has an average resistance of 0.01 ohm. With these resistances I have found that the current drain will be 1.85 amperes at 3.65 volts from a miner's lamp storage battery, which batteries are usually capable of supplying a current of 2 amperes at 4 volts for at least three hours. Using such a current and a millivoltmeter at G, I have observed the following potential differences between the opposite sides of the bridge with the stated percentages of methane mixed with air.

Methane	Millivolts
Per cent	
1 ½	7
2	13
3	25
4	35
5	42.5
	49

For convenience I prefer to embody all of the apparatus except the battery F and the resistance A in a box X as shown in Figure 2 in which the resistances B and C and the fixed part of the resistance D may conveniently be wound in a single coil, the leads being taken off from suitable points as shown. The battery F is connected to the resistances in the case X in any suitable manner such as by a plug J; and the resistance A, which will be mounted in a container

to be described hereafter, is connected in any suitable manner such as by a plug K.

The resistance A of platinum wire is mounted in a testing element shown in Figure 3. The resistance itself consists of a piece of platinum wire and may be either straight or coiled. The latter allows a higher initial temperature to be obtained with the same flow of current. I have found that using 1½" of No. 36 platinum wire good results are obtained when the wire is wound into a coil ¼" in diameter and ⅝" long. In order to permit of the replacement of filaments I find it convenient to mount the wire in a holder, thus permitting greater facility in the replacement of a destroyed filament and insuring that all filaments shall have as near the same resistance as possible. However, it should be noted that a precise equivalence in resistance is not essential since the variable resistance D affords a means for maintaining the bridge in balance in spite of variation in filament resistance due to the use of different filaments or changes which may take place during the life of a single filament. The filament is held by screws Y in end caps Z. These end caps are spaced apart by a member U which may be of metal or may be made of any non-conductive substance capable of resisting heat such, for example, as transite. In case the wall is made of metal an insulating plug V is provided to prevent the short-circuiting of the filament by the spacing member U. In either case the wall U is slotted in such manner as to permit free ingress of the surrounding atmosphere. This also serves to reduce the mass of material in close proximity to the filament to the smallest amount necessary to provide the mechanical strength necessary to reduce breakage. The end members Z are provided with depressions to receive the supporting posts R₁ and R₂ to be described below.

The testing element comprises a handle preferably made of wood which may be of any length required for the operator to reach the place to be tested. This handle may be hollow to provide a space for the leads K₁ and K₂, which are connected to the plug K at the resistance box. One end of the handle N is provided with a ferrule N' which is threaded to receive a collar W', one of the leads K₂ being connected with the metallic ferrule N'. Concentric wire gauze jackets O₁, O₂, and O₃ are mounted on the collar W' by flame-tight joints. These joints may be formed by flanging the jackets outwardly at the base and providing resilient washers between the flanges. A perforated metallic bonnet P is mounted outside the gauze jacket and engages the collar W', compressing the washers between the flanges of the jackets. This bonnet serves to protect the gauze and supplies a heat-absorbing capacity and a heat-radiating surface to assist in keeping the apparatus cool

in case an inflammable mixture should be allowed to burn momentarily inside the inner gauze O_1 . A metallic shield Q may be secured to the bottom of the metallic bonnet P to protect the apparatus from strong drafts which might have an objectionable cooling effect on the hot filament. The metallic shield Q is provided with a row of large perforations Q' to permit the atmosphere to enter. A supporting post R_2 having a U-shaped bend at the top and a pointed end is provided inside the innermost gauze jacket O_1 . This is electrically connected with the collar W' and through the ferrule N' to the lead K_2 . Another supporting post R' is mounted at or near the center of the testing element and slides through an insulating member W , being urged upwardly by a spring S which engages a collar thereon below the insulating member W . The spring S is electrically connected to the lead K_1 but is insulated from the lead K_2 by the wooden handle and the insulating member W . In inserting the holder T the supporting post R_1 is forced downwardly against the spring S , the cartridge is then inserted with its upper depression engaging the point of the post R_2 , and the post R_1 is then allowed to move upward to engage the lower depression of the holder. After this has been done the gauze jackets are placed in position and firmly held by screwing the metallic bonnet onto the collar W' . The electrical circuit through the device is from the lead K_1 , through spring S , supporting post R_1 , lower end piece Z , filament A , upper end piece Z supporting post R_2 , collar W' ferrule N' back to the lead K_2 .

The operation of the devices is as follows:

The battery is connected to the testing box at J and the testing member is connected at K , the switches H and I are closed and resistance D is adjusted so that the instrument G shows no current flowing thereby indicating that the bridge is in balance. The switches H and I are then opened and the device is taken into the atmosphere to be tested. The switch H is first closed to heat the filament A to such a temperature that any inflammable gases will be oxidized without catalytic action. A temperature of $1,000^\circ \text{C}$. is satisfactory. Should any such gases be present the filament A will assume a temperature above that which it would take in normal atmosphere and the resistance of the filament will be increased. This will be evident by a deflection of the needle of G upon closing the switch I . The instrument may be graduated so that the amount of gas present may be read directly or, if graduated as a millivoltmeter or a milliammeter, the amount of inflammable gas present may be determined from a table obtained by previous tests.

Should I so desire, I may construct various other embodiments of my invention.

Thus, instead of using a portable instrument drawing current from a portable battery, the gas testing member may be installed permanently at any desired location in a mine and with any suitable source of current, such as the lighting circuit, in which case suitable means for reducing the voltage should be provided. In this case the testing box may be installed at a distance from the testing member, as on the outside of the mine, and I may, if I so desire, install a recording millivoltmeter or milliammeter at G .

The testing filament instead of being mounted on a handle and connected electrically to the testing box by leads, may be installed in a combustion chamber formed in the testing box, in which case means must be provided for introducing a sample of the atmosphere to be tested into the combustion chamber as, for example, a flexible tube terminating in a pump, as a hand operated bulb pump. Moreover, the device, without change from the embodiment shown, may be operated by adjusting the variable resistance D to bring the needle of G to zero, the content of combustible gas being calculated from the resistance change required.

From the above description it will be evident that I have obtained a device which has numerous advantages over the means heretofore used in testing for inflammable gases in atmospheres. Notwithstanding the numerous methane detectors which have been proposed the only means at present widely employed for this use is the miner's safety lamp. One of the advantages of my device is greater sensitiveness in that it plainly indicates $\frac{1}{2}\%$ of methane while with the flame safety lamps experts can rarely detect less than 2% , and never less than 1% .

My device also has the advantage that by employing a handle of suitable length it is possible to test the atmosphere in places such as in high rooms or under caved areas, which it would be unsafe to explore with a lamp. My device lends itself well to permanent installation as a recording or alarm instrument, provision being made for the closing of a contact to an alarm device when the needle attains a predetermined deflection.

I claim:

1. In a testing system for determining the presence of combustible gas in gaseous mixtures by noting the change in temperature of a surface heated to a temperature such that the combustible gases will oxidize without catalytic action, a testing element comprising a non-conducting skeleton holder having conducting end pieces provided with recesses in the ends thereof, a metallic filament between said end pieces, a supporting post engaging one of said recesses, and another supporting post movably mounted to engage the other recess and resilient means for urging said

other supporting post against said other recess.

2. In a testing element the combination of a base, a supporting post on said base having
5 a U-shaped pointed end, an insulating member in said base, a pointed supporting post slidably mounted in said insulating member, a skeleton holder containing a metallic filament engaged between said supporting posts,
10 and resilient means urging said slidably mounted supporting piece against said holder.

3. In a testing element the combination of a base, a U-shaped supporting post, a slidably mounted supporting post insulated from
15 said base, a holder containing a metallic filament held between said supporting posts, a plurality of gauze jackets having flanged ends surrounding said holder, annular resilient members between said flanges and between the flange of the innermost jacket and the base, a perforated bonnet having a shoulder thereon, said bonnet cooperating with
20 said base to compress the resilient annular members between said shoulder and said base.

In testimony whereof, I affix my signature.

ALBERT N. ERICKSON.

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