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COMBUSTIBLE GAS INDICATOR AND FILAMENT THEREFOR

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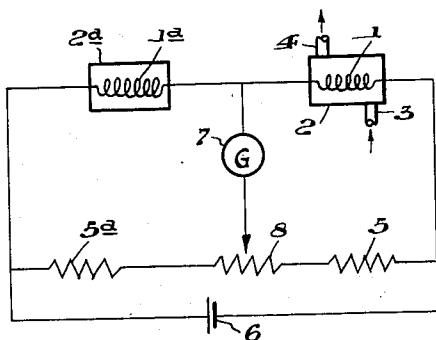


Fig. 1.

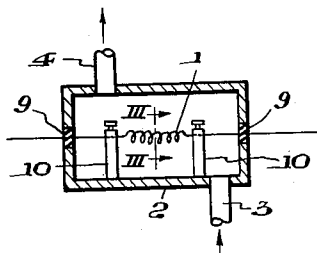


Fig. 2.

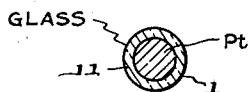


Fig. 3.

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COMBUSTIBLE GAS INDICATOR AND FILAMENT THEREFOR

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4 Claims. (Cl. 23—255)

This invention relates to combustible gas indicators of the hot wire type. Such devices usually embody two filaments in an electrical circuit which heats them to a temperature such as to cause combustion of a combustible constituent of a gas passed over one of the filaments, commonly known as the detector filament. The other filament is exposed to air free from combustible constituents or to an inert atmosphere, such as nitrogen, and this filament is commonly referred to as the compensator filament. The two filaments are associated in an initially balanced electrical circuit. When a gas is to be tested for the presence of combustible constituent it is passed over the heated detector element and the resultant burning of the combustible constituent at the surface of the filament causes its temperature to increase with concurrent increase of its electrical resistance. That in turn results in unbalance of the circuit, which indicates the presence of a combustible constituent, and by appropriate calibration of the recording instrument the amount of the combustible constituent is indicated directly.

To provide sufficient mechanical strength and stability for these filaments, the end supports must be constructed of relatively large size, possibly ten to fifteen times the diameter of the filament wire. Heat is conducted away from the ends of the filament to the relatively large mass of such supports. In good filament design some advantage is taken of the mutual exchange of heat between individual turns of a coiled filament but even in the best designs the center turns of the helix are much hotter than those near the ends, with the mid-section at the highest temperature.

The rate of evaporation of the filament metal, commonly platinum, increases very rapidly with temperature, and in order to provide sufficient sensitivity when detecting combustibles of high ignition temperature or to prevent poisoning by such contaminants as tetraethyl lead or silicones it is necessary to have the major portion of the filament operate at a relatively high temperature. This automatically brings the center portion of the filament to a temperature which is sufficiently high as to make the life of the filament short and to cause premature burnout. Furthermore, when operated at such high temperatures burnout of the filament almost invariably follows exposure to high concentrations of combustible gas or vapor. Such difficulties are particularly true of filaments for portable instruments where power for the circuit must be supplied by batteries and hence minimum power consumption is required which in turn necessitates the use of very fine wire for the filament.

An object of the invention is to provide combustible gas indicators of the hot wire type of any conventional or desired construction but which embody a novel form of filament characterized by longer useful life than the filaments used heretofore.

A particular object is to provide filaments for hot wire combustible gas indicators that operate over longer periods of time under comparable conditions than the filaments used before while possessing satisfactory sensitivity,

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that may be prepared easily and inexpensively, and that form a desirable substitute, or replacement, for the previously used filaments in existing apparatus of the type contemplated.

Still another object is to provide a simple, easily performed and inexpensive method of preparing filaments in accordance with the immediately preceding object.

Other objects will appear from the following specification.

The invention will be described in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of one common form of combustible gas indicator of the hot wire type;

Fig. 2 is a longitudinal somewhat schematic sectional view on an enlarged scale through a detector element of an instrument of this type; and

Fig. 3 is a cross-sectional view taken on line III—III, Fig. 2, but on a still larger scale, showing a filament in accordance with this invention but with portions exaggerated for readiness of understanding.

Combustible gas indicators of the hot wire type take a variety of forms. A common form is that shown in Fig. 1. It comprises a coiled filament 1 mounted within a housing 2 provided with an inlet 3 and an outlet 4 for circulation over the filament of a gas to be tested. A similar filament 1a is mounted within a closed housing 2a containing air or an inert gas. Filaments 1 and 1a constitute, respectively, the detector and compensator elements and they are connected, as shown, as the arms of one branch of a Wheatstone bridge, the other branch of which comprises resistances 5 and 5a, as known in the art. Power is supplied to the circuit from a battery 6. The branches are bridged by a null instrument 7, such as a galvanometer, and a variable resistance 8 is provided for bringing the circuit into balance. In another well known type of hot wire instrument the filaments are connected in a potentiometer circuit instead of in a Wheatstone bridge, as is so well known in the art as not to require illustration. Typical forms of such combustible gas indicators are represented by Patents Nos. 2,114,383, 2,149,441, 2,219,391, 2,244,366, 2,279,397, 2,378,019, and 2,393,220, although various other modifications and refinements appear in numerous other patents.

As shown in Fig. 2 leads to the filaments pass through insulated bushings 9 disposed in opposed ends of the housing, and the coiled portion of the filament is secured in the binding posts 10.

The present invention is predicated upon my discovery that filaments of improved life, i. e., reduced tendency toward burning out, under the conditions described above, are provided by coating the mid-section of the filament, most suitably in the form of a helix, with a thin, adherent coating of glass. Thus, as seen in Fig. 3, the filament 1 of platinum is coated with glass 11.

The exact width of the coating band is determined by the protection desired and the decrease in filament sensitivity that can be tolerated. For most purposes, however, only a very narrow band at the mid-section need be coated. As an example, but not by way of limitation, I have found that for a filament of platinum wire of 0.002-inch diameter wound in the form of a helix with 15 turns and an internal diameter of 0.005 inch, covering the center two turns prevents burnout for as many as 50 exposures to the maximum explosive concentration of natural gas or petroleum vapor in air. The decrease in sensitivity of such a coated filament when treated in the manner described below is only a few per cent from the sensitivity of an untreated filament.

Such filaments coated at the mid-section with a narrow band of glass are utilizable not only in new instruments but also as replacements for the filaments of all existing forms of combustion gas indicators. Likewise, although

especially suited for use as the detector element, they may likewise be applied with advantage as the compensator element.

The mechanism by which the glass coating represses burning out is not fully understood but without limiting myself to this explanation I now believe that it may be due to any or all of the following factors. Since the burning of gas or vapor is promoted by the catalytic action of the metal, such as platinum, the glass prevents contact of the metal and the combustible constituent in the area that is normally hottest and so inhibits burning in that area and keeps that section at a lower temperature than would be attained with an unprotected filament. The glass possibly acts also to prevent escape of vapor of the filament metal and so decreases the rate of evaporation at the normally hottest center section. Even though glass is a relatively poor conductor of heat it probably aids in the transfer of heat from the center to the adjacent turns in the case of a coiled filament and so reduces the temperature of the normally hottest center turns. A further factor is that the glass gives physical support, or strengthens, the center section and helps to prevent separation of the wire in that point as the melting point of the metal is approached.

It has been found that with the small amount of glass used to give the desired protection, no measurable increase in power is required to maintain the filament at the same average temperature as the normal operating temperature of an untreated filament. This indicates that the rate of total heat loss is unchanged in the filaments of this invention in comparison with untreated filaments. The decrease in heat loss by radiation, conduction and convection at the center is compensated for by greater conduction to the ends and greater surface area.

Experience has shown that only a very thin layer of glass coating is necessary to provide the protection and increased life that characterizes filaments in accordance with this invention. The glass coating may be applied in a variety of ways although I now prefer to do so with the aid of a low power microscope in the following manner. The filament is heated so that the mid-section temperature is above the melting point of the glass used. Soft glasses have been used successfully but whatever glass is used must, of course, have a melting point above the maximum temperature to which it will be exposed in the use of the filament. Most suitably the glass is in the form of a fine filament or bundle of fibers, with a cross section of about 0.005 inch. It may be strung across a bow of suitable wire, such as No. 28 brass, for convenience of manipulation, and it is touched to the center of the heated wire helix to cover the desired band width and apply the desired thickness.

Another convenient way is to use a micro-manipulator adjustable in three dimensions to feed the glass fiber into the heated helix. One end of the fiber is attached to the manipulator by suitable adhesive material, such as cement or modeling clay, and the fiber is fed at a right angle to the axis of the helix into the center turn. As it touches the heated wire the glass melts and forms a small bead attached to the wire, and by means of the manipulator the glass of the bead can be moved and positioned as desired.

Most suitably, filaments prepared in accordance with the invention are given a conditioning treatment to restore most of the sensitivity which results from the decrease of metal surface. This is accomplished by exposing the glass while molten to a mixture of a combustible gas or vapor in air. One or two exposures to a maximum explosive concentration of natural gas in air has been found effective although other gas mixtures containing combustible constituents may be used likewise. This treatment gives the glass coating a fritted or sintered appearance. The sensitivity of the filament is restored in this way almost to its untreated value while still maintaining protection against burnout. The glass apparently takes on the fritted appearance due to the presence of combustion products of the combustible gas or vapor burning on its

surface while it is in the molten state. Heating the filament to the same temperature by passing an electrical current through it but in the absence of a combustible gas or vapor does not give the glass the same appearance and in fact will restore it to the glassy state if done after the gas conditioning treatment.

As indicated above, in the case of instruments having both detector and compensator filaments it is desirable to coat both filaments in accordance with the invention. This is desirable in order that the compensator shall operate at the same temperature as the detector to achieve maximum compensation for bridge voltage variations, ambient temperature changes, and the like. Also, the effects of aging would thus be more nearly the same for both arms of the bridge, thereby minimizing zero drift with use.

Although the invention has been described with particular reference to two-filament instruments, it will be understood that it is applicable equally to single filament indicators such, for example, as that described in the R. E. Hartline Patent No. 2,279,397.

Although the invention has been described with specific reference to coating with glass, it will be understood that other glassy or glass-like materials may be used likewise, an example being sodium silicates.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In a combustible gas indicator comprising a detector filament, means for passing gas to be tested over said filament, a source of electric current associated with said filament for heating it to a predetermined temperature, and electrical means responsive to increase of temperature of said filament due to the presence of a combustible constituent in said gas, the improvement consisting in providing said detector filament as a metallic wire having a narrow band at the mid-section surrounded by a thin and adherent coating of glass the melting point of which is above the temperature at which the detector filament is operated.

2. An indicator according to claim 1, said detector filament being a platinum coil, and said glass being soft glass.

3. In a combustible gas indicator comprising a detector filament, a compensator filament, means for passing gas to be tested over said detector filament, a source of electric current associated with said filaments for heating them to a predetermined temperature, and electrical means responsive to increase of temperature of said detector filament due to the presence of a combustible constituent in said gas, the improvement consisting in providing said filaments as metallic wires each having a narrow band at the mid-section surrounded by a thin and adherent coating of glass the melting point of which is above the temperature at which the detector filament is operated.

4. An indicator according to claim 3, said filaments being platinum coils, and said glass being soft glass.

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