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FLAMMABLE GAS DETECTOR

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FIG. 1.

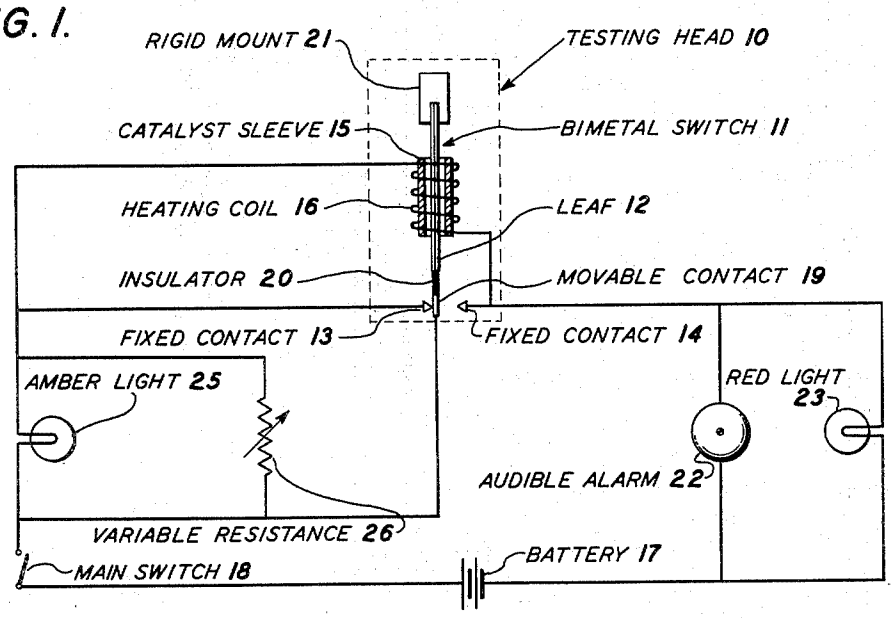


FIG. 2.

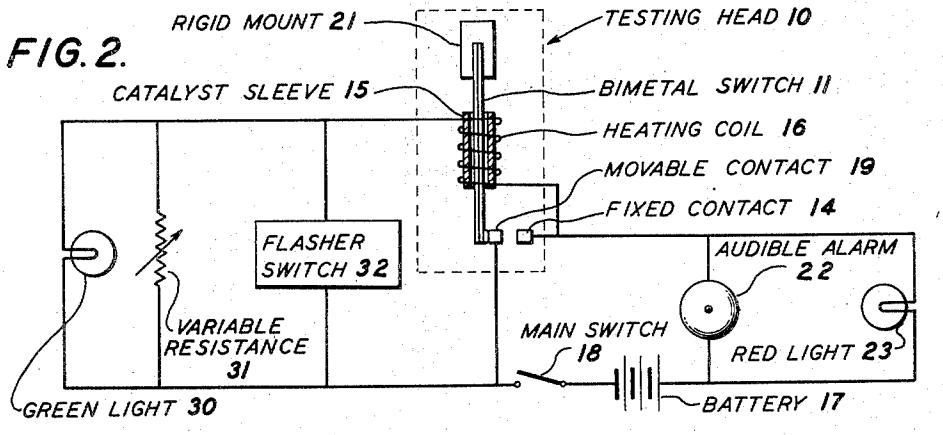
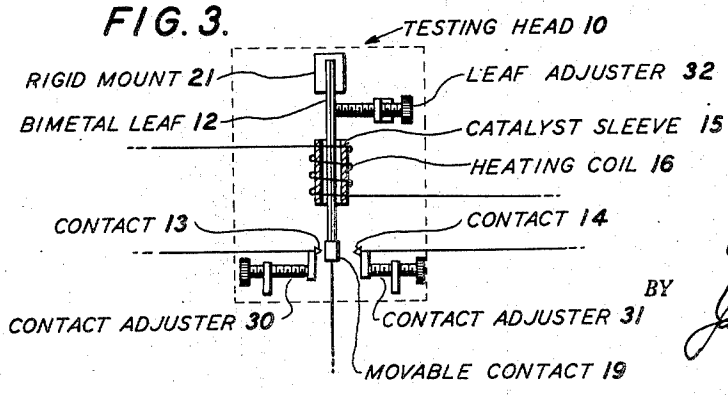


FIG. 3.



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FLAMMABLE GAS DETECTOR

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12 Claims. (Cl. 177—311)

1

This invention relates to the detection and indication of flammable gas mixtures and aims to provide improved apparatus for this purpose.

It has been proposed heretofore to construct flammable gas detectors and alarms which include a catalyst for the combustion of the gas, electric signalling means, and means such as a bimetal switch associated with the catalyst for actuating the signalling means when the catalyst encounters gas containing a minimum concentration of combustible. Apparatus of this type which is reliable and satisfactory has been constructed. However, in its preferred form it employs a somewhat complicated electrical circuit, and it is the purpose of the instant invention to provide a simpler type of apparatus which is less expensive to build but which is entirely satisfactory for a number of applications, including that of continuous sampling fully automatic duty.

The apparatus of the invention has a catalyst capable of catalyzing the combustion of the gaseous mixture to be detected. It may take the form of a porous ceramic sleeve containing finely divided platinum or palladium. An electrical resistance element is provided and preferably disposed in good heat conductive relationship with the catalyst. The resistance may be a coil of high resistance wire wound around the sleeve. A bimetal switch is disposed adjacent the catalyst in good heat conductive relationship. It has a bimetal member which flexes with changes in temperature, so that the switch is thrown as the bimetal is heated as a result of combustion occurring at the catalyst. The bimetal member, say a leaf, may be disposed within the catalyst sleeve.

Preferably the resistance or heating element, the catalyst and the bimetal switch are all included in a portable probe or testing head, the outside of which is formed of one or more layers of metal gauze or the like, as in the old fashioned miner's safety lamps. The gas to be tested enters the head through the gauze but the combustion which results at the catalyst is prevented from spreading by the gauze, so that explosions, etc., cannot be propagated by the testing head.

The rest of the apparatus may be and preferably is disposed remote from the testing head and connected thereto by a cable containing electrical conductors. It comprises a power source which may be A. C. or D. C. capable of delivering about 6 volts, together with an electrical signal device, say an audible signalling means such as a buzzer or siren or a visual signaller, such as a

2

red lamp. A circuit connects the signalling means to the power source and to the bimetal switch. A shunt around this switch contains the resistance element and when the switch is cold the current runs from the power source through the resistance element to the signalling means. The latter is so constructed that it is not energized sufficiently to operate when the resistance is in the circuit, but as the bimetal heats due to combustion at the catalyst it is thrown to by-pass the shunt and cut out the resistance, thus permitting a larger current flow and the actuation of the alarm. However, there is a continuous flow of current through the electrical signal device or alarm when the device is in operation, actuation being due to reduction of resistance by throwing the bimetal switch.

A main switch may be included to interrupt the circuit completely when the apparatus is not in use and thus prevent waste of power. However, for continuous monitoring installations such a switch is generally eliminated to preclude inadvertent shut down.

In one form of the device of my invention the bimetal switch has a single fixed contact and a single movable contact. These remain open until the concentration of flammable gas at the catalyst is high enough to generate the heat required to flex the switch to closed position whereupon the resistance, which also serves as a heating element to keep the catalyst active, is cut out of the circuit and permits the flow of current in amount sufficient to actuate the signalling means. In this form of the device it is desirable to provide means for bringing about intermittent increases in the flow of current through the resistance or heater coil, thus assuring that the catalyst is periodically heated to reactivation temperature. A preferred means is a flasher switch, a variable resistance, and a lamp (say a green light) connected in parallel with each other in the shunt between the power source and the resistance. The flasher switch may be of any conventional type, say one employing a bimetal member which snaps open as it is heated by current passage, then cools off and snaps closed, this action being repeated as long as the heating current is applied.

In the structure just described a small amount of current flows continuously through the variable resistance to the heating coil, the amount being adjusted to prevent the catalyst from cooling to a certain minimum temperature, say 300° F., below which it cannot promote the combustion of certain dilute gaseous mixtures, for example

a very dilute mixture of gasoline in air. This minimum current flow is augmented periodically by the flasher switch, which is of low resistance, and supplies a surge of current that momentarily heats the catalyst, or at least a portion of it, very highly, thus overcoming the effects of accumulated catalyst poisons, etc. When the flasher switch is closed, the lamp does not receive sufficient power to light it, but when the switch is open the light goes on. Hence the light flashes on and off and indicates that the equipment is in operating condition during the time that the concentration of flammable gas is below the "alarm" level.

Other means may be employed for causing intermittent current flow in the resistance or heater coil and thus heat and reactivate the catalyst during periods when, due to the low concentration of flammable gas being sensed, this is desirable. They are exemplified in the following detailed description, taken in conjunction with the accompanying drawings in which:

Figs. 1 and 2 are, respectively, wiring diagrams of two different types of the apparatus of the invention; and

Fig. 3 is a diagram of a testing head provided with means for adjusting the action of the bimetal switch.

The apparatus of Fig. 1 has a testing head 10 which contains a bimetal switch 11 with its leaf 12 held rigidly at one end but free to flex at the other end under the influence of heat between two contact points 13, 14. A catalyst sleeve 15 of, for example, porous ceramic impregnated with finely divided platinum, is disposed around the bimetal leaf in good heat conductive relationship. A heating coil 16 of high resistance wire is wrapped around the sleeve. All of the foregoing elements are enclosed in a small portable housing, say one composed of several telescoped thimbles of metal gauze (not shown).

A battery 17 is disposed in series with a main switch 18. This switch is connected by a low resistance lead to the movable switch member 19 of the bimetal switch, which may be a separate conductor fastened to the leaf by an insulator 20 or merely the end of the leaf itself, the other end of the leaf being held in a rigid mount 21 of insulating material. The leaf is fastened so that it touches the contact 13 when no current is flowing in the circuit. The other contact 14 is connected to the other side of the battery through an audible electrical alarm 22, say a buzzer or horn, in parallel with a visual electrical signal, say a red electric lamp 23.

The heating coil is connected between the two contact points around the bimetal switch. A visual electrical signal means 25, say an amber lamp, is connected in parallel with a variable resistance 26 between the main switch and the end of the resistance coil that is connected to the fixed contact 13.

The energy requirements of the audible alarm and the red lamp are such that they do not operate when the current flow through them is also through the heater coil. The energy requirement of the amber lamp is such that it does not operate when the current flow is through the fixed contact 13, in parallel with that through the amber lamp.

The operation of the apparatus of Fig. 1 is as follows:

When the main switch 18 is closed and there is no combustible mixture to be burned in the testing head, current follows the path of least resistance through the contact 13 of the bimetal switch, the heating coil, and the audible alarm and red light back to the battery. Some current also flows through the adjustable resistance and the amber light, but the circuit is adjusted so that the amount through the amber light is insufficient to cause it to glow.

The flow of current through the heating coil heats the bimetal leaf and causes it to flex the movable contact 19 away from the fixed contact 13, thus cutting off the low resistance path and putting a heavier current flow through the variable resistance and the amber lamp, this being sufficient to cause the lamp to glow. The total current flow through the circuit is, however, reduced so that the heating coil cools, permitting the movable contact to flex back to the fixed contact, i. e. to the original state of the circuit. The amber light then goes out. This operation is repeated as long as the environment remains constant, and the flashing amber light indicates that the apparatus is in operation.

Assume now that a combustible gas mixture enters the head at a concentration sufficiently high that, upon being burned through the influence of the catalyst, it heats the bimetal leaf so much that it flexes the movable contact clear over to the other fixed contact 14. Now there is a low resistance path directly from the battery to the audible alarm and the red light, and the current flow through the latter two indicating or alarm devices is high enough to actuate them. At the same time the current flow through the amber light is diminished to the point where it is no longer illuminated.

Intermediate concentrations of flammables which displace the movable contact between the two fixed contacts are evidenced by a continuous burning of the amber light.

The apparatus may be adjusted so that the alarm system triggers and lights the red light, etc., for any predetermined concentration of combustible gas. Ordinarily the apparatus will be set to go off at a concentration well below the explosive limit, to give ample warning of the approach of a dangerous condition. This adjustment may be made by any of several means discussed later in reference to Fig. 3. Thus the contact 14 may be moved to the right with an adjusting screw or the like.

The heating coil always receives some current when the main switch is closed, the amount being adjusted so that the temperature of the catalyst is maintained above a certain minimum, say 300° F., which is necessary if the catalyst is to promote the combustion of certain very dilute mixtures of hydrocarbons, etc., in air. The adjustment is made conveniently with the adjustable resistance. However, since there is some flow of current through the amber light to the heater coil, the presence of the adjustable resistance is not absolutely essential, providing that the resistance of the light is such that the required minimum heater current can always pass.

When the apparatus is sensing very dilute mixtures of combustible gas, i. e. well below the alarm level, it is desirable that the catalyst be heated highly at intervals to assure that it is reactivated. This is accomplished automatically in the apparatus of Fig. 1, for the continued make and break of the contacts 13, 19, periodically sends surges of current to the heater coil, the heat surges thus generated being conducted to the catalyst.

The apparatus of Fig. 2 is similar to that of

Fig. 1 in several respects. It has the same testing head 10 enclosing the heating coil 16, the catalyst sleeve 15 and the bimetal switch 11 with its rigid mount 21. However, the fixed contact 13 is eliminated. The movable contact 19 is flexed to the right under the influence of heat and if flexed sufficiently far will touch the fixed contact 14.

Current flows from the battery 17 through the main switch 18 via a low resistance lead to the movable contact 19 which may or may not be insulated from the leaf of the bimetal switch. When the concentration of gas being burned in the testing head is high enough to close the contact 14, 19 the battery is connected directly through a low resistance path to the audible alarm 22 and the red light 23 in parallel with each other. One side of the heater coil is connected to a shunt consisting of a green lamp 30, a variable resistance 31 and a flasher switch 32 in parallel with each other. The other side of the heater coil is connected to the circuit adjacent the fixed contact 14, i. e. between this contact and the audible alarm and the red light.

The flasher switch should have a low resistance and may be of any type which automatically opens and closes at intervals. Flasher switches such as those employed in electric signs and controlled by a bimetal element are suitable.

When the main switch is closed and there is no combustible mixture in the testing head, the current flow is through the flasher switch, variable resistance and the green light in parallel, thence through the heating coil and thence through the audible alarm and red light in parallel with each other. The audible alarm, say an electric horn, and the red lamp are such that the low current which flows through them under these conditions is insufficient for actuation, i. e. the red light does not illuminate and the alarm makes no noise. The energy requirements of the green light are such that it is not illuminated when the flasher switch is closed. However, when the flasher switch is open the current flow through the green light is sufficient to illuminate it. Consequently, the flasher switch induces a flashing of the green light indicating that the apparatus is in operation. If a sufficient concentration of combustible gas enters the testing head it will burn under the influence of the catalyst and heat the leaf of the bimetal switch sufficiently to throw the movable contact 19 to the right so that it touches the fixed contact 14. When this occurs, the green light, variable resistance and flasher switch and heating coil are effectively shorted out and the current flow through the low resistance circuit established via the contacts 14, 19 is sufficient to actuate the audible alarm and the red light.

As in the case of the apparatus of Fig. 1, the variable resistance may be employed to insure minimum heating current requirements continuously at the heating coil, these minimum heating requirements being augmented periodically by the closing of the flasher switch so that there is a periodic increase in current to periodically heat the catalyst sleeve for reactivation as described previously.

The adjustment of the bimetal switch to the particular condition of operation is illustrated in Fig. 3. This shows a testing head identical to that of Fig. 1 with the addition of an adjuster 30 for the contact 13, a second adjuster 31 for the contact 14 and a leaf adjuster 32. The testing head of Fig. 3 may be substituted for that of Fig. 1 to permit such adjustment. Assuming that such substitution is made, the movable contact 19 will be pressed against the contact 13 when the apparatus is not in operation. The pressure exerted may be adjusted by moving the contact 13 from right to left or vice versa by the contact adjuster 30, which is a screw threaded through a mount with the contact mounted on its inner end. The pressure may also be adjusted with the leaf adjuster 32, which is a screw threaded through a mount with its inner end bearing against the bimetal leaf. By employing either or both of these adjustments the make and break period as well as the duration of the contact 13, 19 may be varied at will, thus adjusting the flashing.

If the system is set so that its alarm triggers when the testing head encounters a relatively rich combustible gas mixture, the contact 14 is moved to the right by the contact adjuster 31, which like the contact adjuster 30 is a screw threaded through a mount and with the contact on its inner end. Moving the contact 14 to the left makes the system sensitive to triggering with a weaker mixture.

The adjusting system of Fig. 3 is applicable to the testing head of Fig. 2, except that the contact adjuster 30 is eliminated along with its contact 13.

The apparatus of the invention is relatively inexpensive to build. It is rugged and reliable. In its preferred form a flashing light indicates that the instrument is in operation up to the time that a dangerous concentration of flammable gas is encountered, when the alarm is actuated.

The apparatus has numerous applications. It may be used to examine the atmosphere in dry cleaning establishments, paint spray booths, oil refineries, mines, sewers, ship's holds, etc., and in fact, wherever there is the possibility that flammable or explosive mixtures of gas may be encountered. The examination is made continuously and operators are warned by the alarm system whenever a dangerous condition approaches or exists.

Adjustment of the apparatus to sense any predetermined concentration of gas is simple, and the apparatus may be set to give alarm at concentrations well below the point where danger exists.

The detector head and the signal or alarm devices may be widely separated. For example, the detector head may be in the hold of a ship and the alarm on the bridge, the two being connected by a cable. Or there may be a detector head in each gallery of a coal mine, with a central indicating and alarm system at the surface and individual ones in each gallery, so that a superintendent or foreman, at the surface, as well as the miners on the job, are warned immediately if there should be an accumulation of fire damp, i. e. methane.

I claim:

1. In a flammable gas detector, the combination which comprises a catalyst for the combustion of the gas, a resistance element, a bimetal switch disposed adjacent the resistance element in heat conductive relationship, an electrical signal device requiring a relatively high current to operate but which is conductive at lower current, a power source, a circuit connecting the power source to the signal device through the resistance element, the value of which is so high that the electrical signal device does not operate to indicate a flammable gas when thus connected, and a low resistance shunt in the circuit

around the resistance element through the bimetal switch and which is closed by the bimetal switch when the latter is heated by the catalyst.

2. Apparatus according to claim 1 provided with an additional switch in the circuit in series with the power source to interrupt completely the flow of current in the circuit.

3. In a flammable gas detector, the combination which comprises a catalyst for the combustion of the gas, a resistance element disposed adjacent the catalyst in heat conductive relationship, a bimetal switch disposed adjacent the catalyst and the resistance element in heat conductive relationship, an electrical signal device requiring a relatively high current to operate but which is conductive at lower current, a power source, a circuit connecting the power source to the signal device through the resistance element, the value of which is so high that the electrical signal device does not operate to indicate a flammable gas when thus connected, and a low resistance shunt in the circuit around the resistance element through the bimetal switch which is closed by the bimetal switch when the latter is heated by the catalyst.

4. In a flammable gas detector, the combination which comprises a catalyst for the combustion of the gas, a resistance element, a bimetal switch disposed adjacent the catalyst in heat conductive relationship, an electrical signal device requiring a relatively high current to operate but which is conductive at lower current, a power source, a circuit connecting the power source to the electrical signal device through the resistance element, the value of which is so high that the electrical signal device does not operate to indicate a flammable gas when thus connnected, a low resistance shunt in the circuit around the resistance element through the bimetal switch and which is closed by the bimetal switch when the latter is heated by the catalyst, a flasher switch which opens and closes automatically and of relatively low resistance, an auxiliary electrical signal device, a second shunt in the circuit from the power supply to the resistance element with the flasher switch and the auxiliary signal device connected in parallel therein, the auxiliary signal device being conductive but having energy requirements such that it does not operate when the flasher switch is closed but does when the flasher switch is open.

5. Apparatus according to claim 4 provided with a variable resistance in the second shunt in parallel with the flasher switch and the auxiliary signal device.

6. Apparatus according to claim 4 in which the resistance element is disposed in heat conductive relationship with the catalyst.

7. Apparatus according to claim 4 provided with a variable resistance in the second shunt in parallel with the flasher switch and the auxiliary signal device and in which the resistance element is disposed in heat conductive relationship with the catalyst.

8. In a flammable gas detector, the combination which comprises a catalyst for the combustion of the gas, a resistance element, a double-pole bimetal switch disposed in good heat conductive relationship with the resistance element, a power source, an electrical signal device, a circuit connecting the power source to the electrical signal device through one pole of the switch and the resistance element, and a shunt in the circuit connected through the second pole of the switch and by-passing the resistance element and the first pole, the switch being closed through the first pole when the bimetal is cold and through the second pole when the bimetal rises above a predetermined temperature, and the signal device having current requirements such that it does not signal the presence of a flammable gas when the current flows is reduced by passage through the resistance element.

9. In a flammable gas detector, the combination which comprises a catalyst for the combustion of the gas, a resistance element disposed in good heat conductive relationship with the catalyst, a double-pole bimetal switch disposed in good heat conductive relationship with the catalyst, a power source, an electrical signal device, a circuit connecting the power source to the electrical signal device through the resistance element and one pole of the switch, and a shunt in the circuit connected through the second pole of the switch around the resistance element and the first pole, the switch being closed through the first pole when the bimetal is cold and through the second pole when the bimetal rises above a predetermined temperature, and the signal device being such that it does not signal the presence of a flammable gas when the current flows through the resistance element, and a second electrical signal device connected between the power source and the resistance element in parallel with the first pole of the switch and having power requirements such that it passes current but does not operate when the switch is closed through the first pole.

10. Apparatus according to claim 9 in which the second electrical signal means is a lamp.

11. Apparatus according to claim 9 provided with a variable resistance connected in parallel with the second electrical signal.

12. Apparatus according to claim 9 in which the catalyst, the resistance and the bimetal switch are mounted remote from the signal devices.

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