E. M. AND T. M. CHANCE.

METHOD AND APPARATUS FOR THE DETECTION OF COMBUSTIBLE AND VITIATED ATMOSPHERES.

APPLICATION FILED APR. 17, 1917.

1,390,497.

Patented Sept. 13, 1921.

2 SHEETS—SHEET 1.

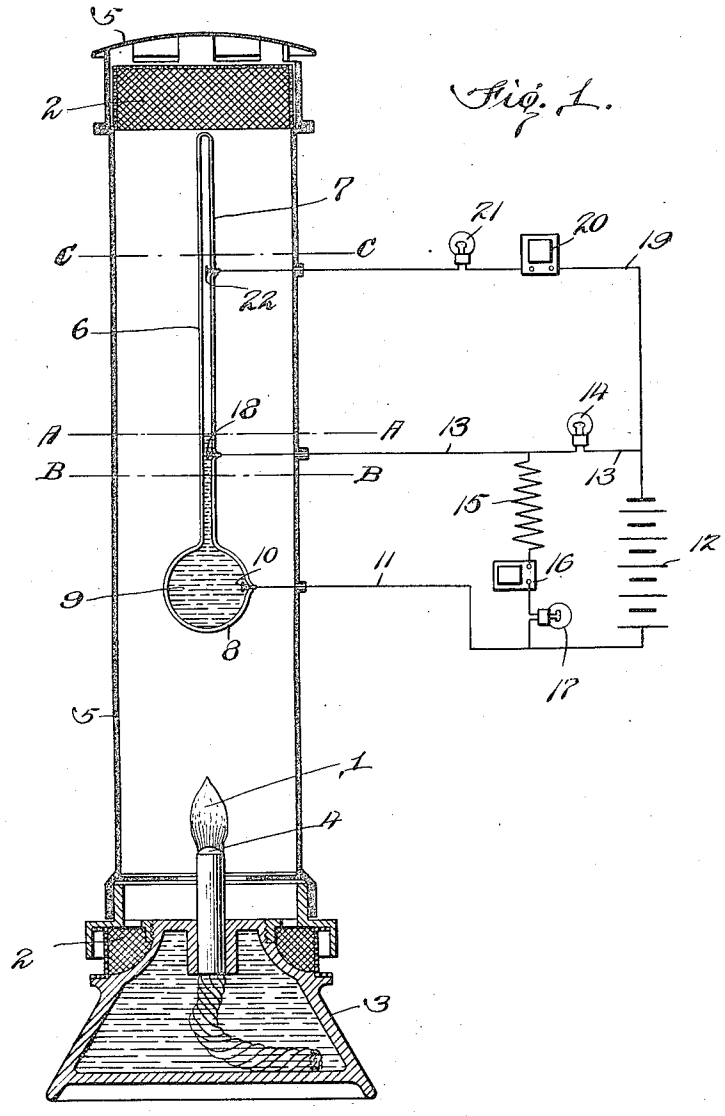

Fig. 1.

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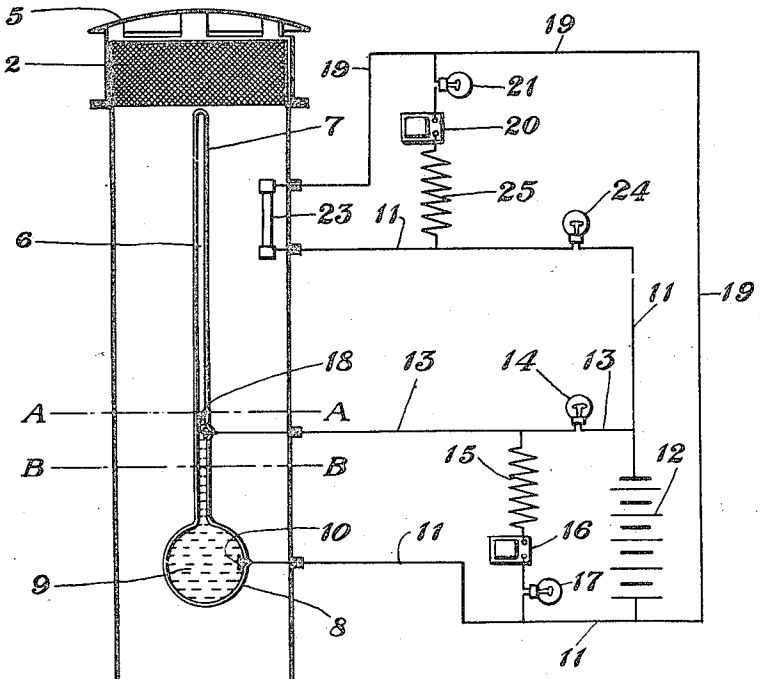

FIG. II

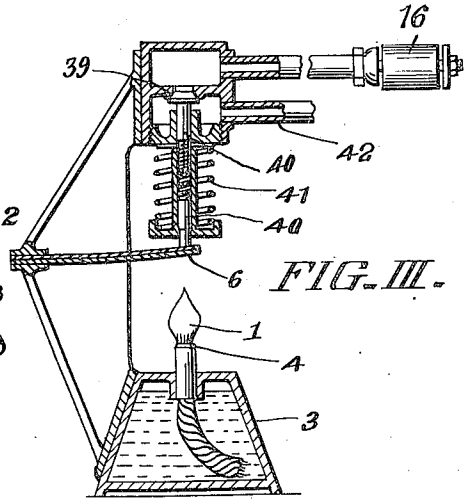

FIG. III.

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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR THE DETECTION OF COMBUSTIBLE AND VITIATED ATMOSPHERES.

1,390,497. Specification of Letters Patent. Patented Sept. 13, 1921.

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To all whom it may concern:

Be it known that we, EDWIN M. CHANCE and THOMAS M. CHANCE, of the city of Wilkes-Barre and of the city of Philadelphia, respectively, both in the State of Pennsylvania, have invented a certain new and Improved Method and Apparatus for the Detection of Combustible and Vitiated Atmospheres, of which the following is a specification.

The object of our invention is to provide means whereby the presence of combustible gases, or of a deficiency in oxygen, in the atmosphere may be made known to workmen or others where such conditions of the atmosphere may obtain. One of the principal difficulties attendant upon the use of electric lamps, whether stationary or portable, in mines or in places where dangerous atmospheric conditions may exist, is that such lamps give no indication whether the atmosphere is either respirable or inflammable, and this has caused accidents both from ignition of inflammable gas and from asphyxiation by irrespirable atmospheres, such accidents having occurred in coal mines where electric lights were used. The object of our invention is to provide means for overcoming this defect attendant upon the use of electric lamps under such conditions.

To attain these ends we provide a source of heat in operative relation to temperature responsive elements operatively connected to aural or visual signaling devices. If these connections be electrical they may preferably, but not necessarily, be inter-connected directly, or through resistance, with the electric circuit serving the lamps used for illumination.

The drawings Figures I, II, and III illustrate diagrammatically the general association of elements necessary to the operation of the invention. Like numbers in the several drawings indicate like parts.

In the drawing, Fig. I, which is a vertical cross-section, 1 indicates a flame, provided with foraminous means, shown as gauzes 2, for preventing exterior ignitions in inflammable atmospheres; a source of combustible, shown in the drawing as an oil vessel 3 and wick 4, but intended diagrammatically to represent any source of flame producing combustible; and a bonnet 5 for shielding the flame from currents of air moving at high velocity. A temperature responsive element, shown as a thermostat, is indicated diagrammatically by 6, and in the drawing is shown as composed of a tube 7 sealed at the top and provided with an expansion chamber 8 at its lower end, the whole being partly filled with mercury 9. An electric contact 10 connects circuit 11 and a source of electricity 12 with the mercury 9. Circuit 11 is connected through circuit 13, warning lamp 14 and contact 18 with mercury 9. Circuit 13 is also cross-connected through shunt resistance 15, electrical contactor diagrammatically indicated as a buzzer by 16 and warning lamp 17 with circuit 11. Circuit 11 is also connected through electrical contactor 20 diagrammatically shown as a buzzer and warning lamp 21 to contact 22, by means of circuit 19.

The operation of the device illustrated in Fig. I is as follows: Assuming the flame 1 to be burning in a normal atmosphere, the mercury 9 as it becomes heated by flame 1 will rise to the level of normal operation, indicated diagrammatically by the line A—A and cover contact 18. Current will then be free to flow through circuit 13 and light warning lamp 14 to its normal brilliancy. As the resistance of shunt 15 is far greater than that of the mercury 9 the electrical contactor 16 will not operate nor will warning lamp 17 be lighted to normal brilliancy. Curcuit 19 will still be broken as contact 22 will not be covered and warning devices 20 and 21 will be inoperative.

If an atmosphere deficient in oxygen now reaches the flame 1, the extinction or the lowered rate of combustion and reduced quantity of head generated by the flame will permit the mercury 9 to contract. If this chilling of the mercury proceeds far enough it will drop to line B—B, the contact 18 will become uncovered and the circuit 13 will only be connected with circuit 11 through the shunt resistance 15. Warning light 14 will now be operating at greatly reduced voltage and will hence be dimmed, giving the warning for deficient oxygen. At the same time lamp 17 will increase in brilliancy and electrical contactor 16 will be brought into operation, due to the flow of current passing through resistance 15, both of which operate as warning signals to indicate a vitiated condition of the atmosphere.

If on the other hand the flame 1 burns in an atmosphere containing inflammable gas, the increased heat generated from the combustion of said gas will cause the mercury 9 to expand above the line A—A until it eventually may reach line C—C, or above, covering contact 22. Circuit 19 will now be energized and the electrical contactor 20 and warning light 21 will both be placed in operation, providing a warning of the presence of inflammable gas in the atmosphere.

It will be understood that if both deficient oxygen and inflammable gas be present, the element having the preponderating influence on flame 1 will actuate the warning signal, although in general the presence of both conditions will result in a warning signal being given for deficient oxygen.

In certain cases it may be advisable to operate the inflammable atmosphere warning by the melting of a fusible member when the combustion, inaugurated by flame 1 of Fig. I, reaches a certain rate. This may be accomplished by apparatus such as is illustrated diagrammatically in Fig. II. It will of course be understood that the portion of the apparatus for warning against deficient oxygen, if any be used, and for providing a source of flame, may be constructed as shown in Fig. I, just described.

In the drawing Fig. II, 12 indicates a source of electric current connected through circuits 11 and 19 and fusible element 23 with a lamp 24. Circuits 11 and 19 are also cross-connected through resistance 25, electrical contactor 20, and warning light 21. The rest of the apparatus is identical with that shown in Fig. I and need not be further described.

The operation of the apparatus is as follows: If the flame 1 burns in an atmosphere containing inflammable gas, the fusible member 23 will be heated, until, if the rate of combustion increase be sufficient, said member 23 is fused, breaking circuit with 11 and 19. The only connection between 11 and 19 will then be through resistance 25, warning light 21 and electrical contactor 20. Warning light 24 will now operate at greatly decreased voltage, giving the warning for inflammable gas. At the same time electrical contactor 20 will be brought into operation and warning light 21 will increase in brilliancy (due to the flow of current through resistance 25) both of which operate as warning signals to indicate an inflammable atmosphere.

In the operation of certain classes of mines, such as metalliferous mines, where no combustible gases are likely to be met, it may be desirable to operate the method for the detection of vitiated atmospheres only, and Fig. III is a diagrammatic vertical cross-section of apparatus adapted to such use.

In the drawing Fig. III, 1 indicates a source of heat, in this case a flame, burning from a wick 4 receiving oil from supply vessel 3. 6 indicates a heat responsive element, in this case a bi-metallic thermostatic device, in operative relation to a valve stem 40 carrying valve 39 at its upper end. Valve 39 is held to its seat by said thermostatic device 6 and is adapted to be lifted therefrom by spring 41 when thermostatic device 6 is cooled. A warning device, in this case shown as a whistle 16, actuated by compressed air or other elastic fluid, is placed in operation when said thermostatic device 6 cools, permitting valve 39 to open and said elastic fluid to flow from supply pipe 42 through said valve 39 and into whistle 16.

The operation of the device is as follows: Assuming flame 1 to be burning in normal atmosphere, thermostatic device 6 is heated and valve 39 raised to its seat, preventing the operation of whistle 16. If now a vitiated atmosphere deficient in oxygen reaches flame 1, the rate of combustion of said flame will be lowered and thermostatic device 6 will cool. When the rate of combustion has decreased to the desired degree at which the warning is to be operated, the thermostatic device 6 will have cooled sufficiently to permit valve 39 to open, under the pressure of spring 41. The elastic fluid for the operation of whistle 16 will now flow past valve 39 and operate said whistle 16, providing a warning of the vitiated condition of the atmosphere.

While in the drawing Fig. III a mechanical connection is shown between the heat responsive element 6 and warning device 16, it will of course be understood that electrical means for the operation of said warning device may be applied as heretofore described.

It will be clear that warning lights 14 in Fig. I and 24 in Fig. II may also be used as lights for ordinary illumination and that a plurality of such lights may be used. It will also be clear that mechanical or visual signals alone may be employed, or that they may be used together as shown in the drawings. It will be understood that whether mechanical or visual signals, or both, be employed, a plurality of such signals may be placed in circuit with one or more sources of flame, and that a plurality of flame sources may be used to operate one or more sets of signals.

The term electrical contactor used in the description of the several drawings is intended to include any type of electromagnetic buzzer, gong, switch or circuit-breaker in common use. It may operate a signal such as a semaphore or colored glass moved over a lighted lamp, and it will of course be understood that if a circuit breaking type be employed, it will be possible to arrange

the system so that the signals will stand at warning until reset, after they have once been brought to the warning position.

It will be understood that the invention may be employed with either stationary or portable electric lighting systems, and that in certain cases it may profitably be used for operating a signaling system in coal mines, gas works, etc., where no electrical illumination is used, without departing from the spirit thereof.

It will be clear that the source of flame may be widely varied, any permissible liquid or gaseous fuel being available for use.

It will be understood that the combined use of a detector for inflammable atmosphere and a detector for deficient oxygen is not essential and that use of either detector may be dispensed with in locations where there is no necessity for its use, without departing from the spirit of this invention.

Any type of flame safety lamp employing foraminous or other means for preventing exterior ignitions may be used in the operation of this invention without departing from the spirit thereof, and in certain cases the use of a flame safety lamp burning a gaseous fuel under pressure, such is dissolved acetylene, may be advantageously employed, especially where stationary detectors are to be used at remote points. The employment of "long-time" burners using liquid fuel, such as those used in railway signal lighting, will in certain cases prove desirable.

The type of temperature responsive element may be widely varied, and is not confined to the use of an expanding liquid or of a fusible member, as shown in the drawings hereof, as any type of temperature responsive element, such as thermostatic devices employing the differential expansion of metals, the expansion of a gaseous medium under pressure, etc., may be employed provided it possesses the necessary operating characteristics.

It will be understood that the particular arrangement of circuits, shown in the drawings Figs. I and II is not essential to the operation of the invention and that these arrangements may be widely varied within the scope thereof. In many cases it may be desirable to use stationary detectors wired to signaling apparatus at a central point, or to a plurality of signaling apparatus at distant points where it may be desirable to provide danger warnings, and such remote control of said signaling devices is entirely within the scope of the invention.

It will of course be understood that the use of foraminous or other means for the preventing of propagation of combustion from the source of heat to the exterior atmosphere will not be necessary in cases where this method and apparatus are used for the detection of vitiated atmospheres alone.

The operation of the method and apparatus of our invention provides a means for automatically measuring any diminution in the quantity or percentage of oxygen in the atmosphere from the normal quantity of oxygen down to that at which extinction of the flame occurs. One of the advantages of using an acetylene flame, or flame that will continue to burn in atmospheres in which the quantity of oxygen is reduced nearly 40 per cent. below normal is that the use of such flame enables us to set the apparatus to give notice of a lowering of the oxygen percentage to any predetermined point above this limit at which such warning is desired. The apparatus may of course be used, by noting the degree of expansion or contraction of the temperature responsive element, to instantly determine the percentage of oxygen present in the atmosphere. In other words, the reduction in heat due to reduced oxygen will be registered by a lowering of the mercury (9) in the thermostat (6) of Figs. I and II or by a change in position of the thermostat 6 of Fig. III and this may, if desired, be used to determine the reduction in oxygen before the reduction becomes great enough to operate the warning signals. It is therefore possible by use of our invention to give warning of a reduction in the oxygen content of a mine or other atmosphere before this reduction is great enough to render the atmosphere dangerous to life and before the reduction is sufficient to extinguish a flame.

Having described the invention we claim:

1. A method of detecting changes in the constituent gases of the atmosphere and measuring the oxygen content thereof, which consists in maintaining a temperature responsive element in operative relation to a source of heat maintained at a predetermined constant value whereby the temperature of said element will be a function of the composition of said constituent gases, said element being operatively connected to signaling means adapted to give warning of such changes; bringing said gases in contact with said source of heat; in causing said element to operate said signaling means when the temperature of said element reaches a predetermined lower limit; and in permitting reductions in the heat received from said source of heat, due to changes in said constituent gases, to cause the temperature of said element to reach said limit; whereby said signaling means are operated and a warning of said changes given.

2. A method of detecting changes in the constituent gases of the atmosphere and measuring the oxygen content thereof, which consists in maintaining a temperature responsive element in operative relation to a source of heat maintained at a predeter-

mined constant value whereby the temperature of said element will be a function of the composition of said constituent gases, said element being operatively connected to signaling means adapted to give warning of such changes; in bringing said gases in contact with said source of heat; in causing said element to operate said signaling means when the temperature of said element reaches predetermined upper and lower limits; and in permitting variations in the heat received from said source of heat, due to changes in said constituent gases, to cause the temperature of said element to reach said limits; whereby said signaling means are operated and a warning of said changes given.

3. A method of detecting changes in the constituent gases of the atmosphere and measuring reductions in the oxygen content thereof which consists in bringing said atmosphere in operative relation to a source of heat maintained by combustion, whereby if combustible gases be present in said atmosphere, the temperature produced by said source of heat is, by the combustion of said gases, increased and whereby if the oxygen content of said atmosphere is reduced the temperature produced by said source of heat is decreased, in causing said changes in temperature so produced to act upon a temperature responsive element adapted to indicate such change in temperature by movement to a position indicating such change and to maintain said position during the continuance of said change in said constituent gases, said element being in operative relation to means adapted to give warning when said changes in temperature reach predetermined limits, and in causing said temperature responsive element to operate signaling means adapted to give warning when said changes in temperature reach predetermined limits at which such warning is desired.

4. Apparatus for the detection of changes in the constituent gases of the atmosphere and measuring the oxygen content thereof comprising in combination a source of heat in operative relation to a closed thermostat, said source of heat being adapted to be maintained at a predetermined constant value whereby the temperature of said thermostat will be a function of the composition of said constituent gases; electric contacts sealed within the envelop of said thermostat; a source of electric energy in operative relation to said contacts, and signaling means adapted to give warning of such changes in operative relation to said contacts and to said source of electric energy.

5. Apparatus for the detection of changes in the constituent gases of the atmosphere and measuring the oxygen content thereof, comprising in combination a source of heat in operative relation to a heat responsive element, said source of heat being adapted to be maintained at a predetermined constant value whereby the temperature of said element will be a function of the composition of said constituent gases, and signaling means in operative relation to said element and adapted to be actuated thereby when the temperature of said element falls to a predetermined lower limit.

In testimony whereof we have hereunto signed our names at Wilkes-Barre, Pennsylvania, this 14th day of April, 1917.

EDWIN M. CHANCE.
THOMAS M. CHANCE.

Witnesses:
G. W. REYNOLDS,
JOSEPH FLUEGEL.