

Sept. 25, 1934.

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1,974,498

GAS DETECTOR

Filed June 17, 1932

2 Sheets-Sheet 1

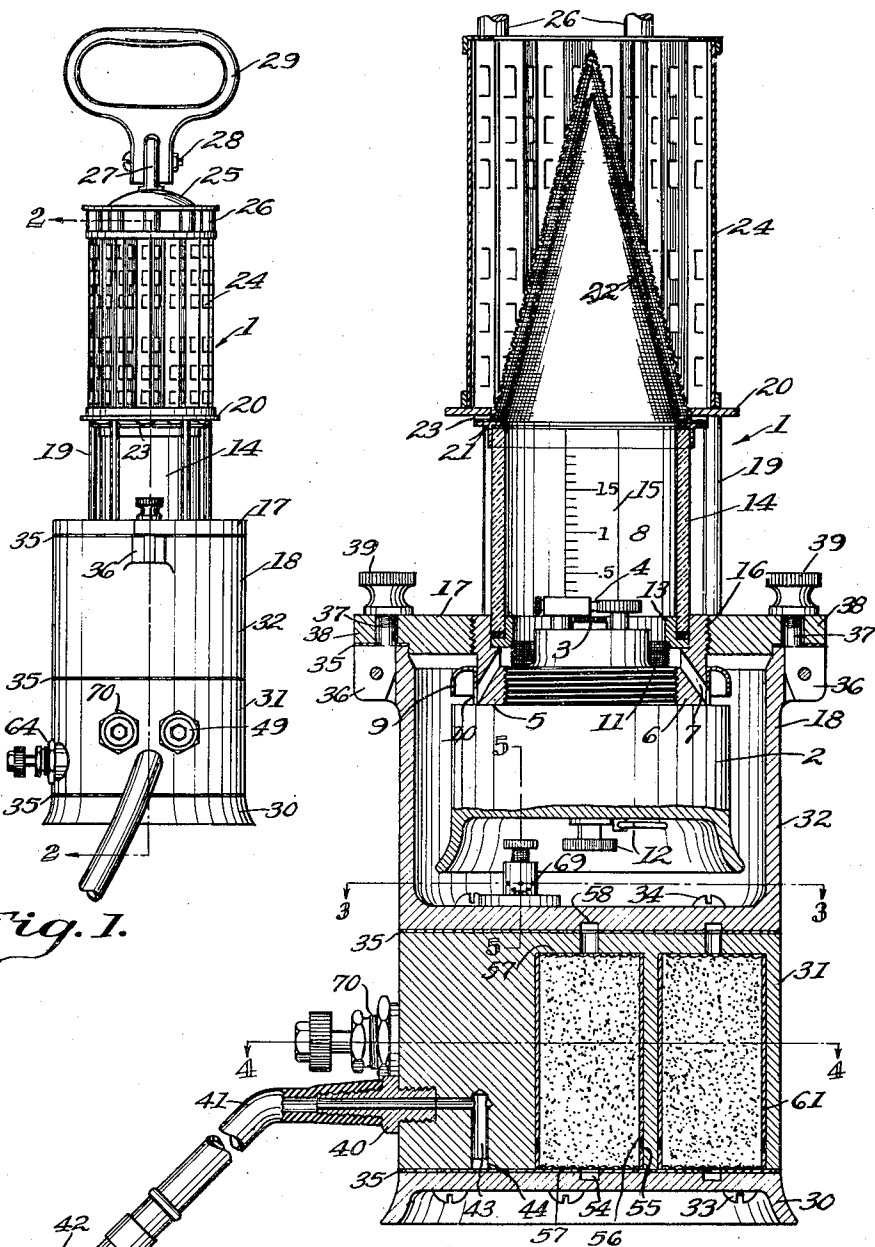


Fig. 1.

Fig. 2.

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2 Sheets-Sheet 2

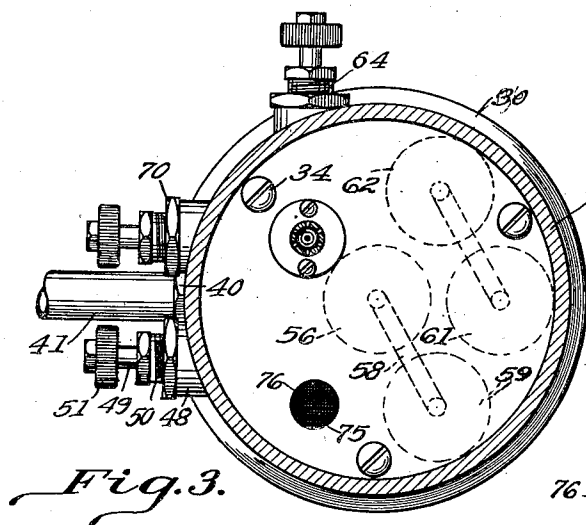


Fig. 5.

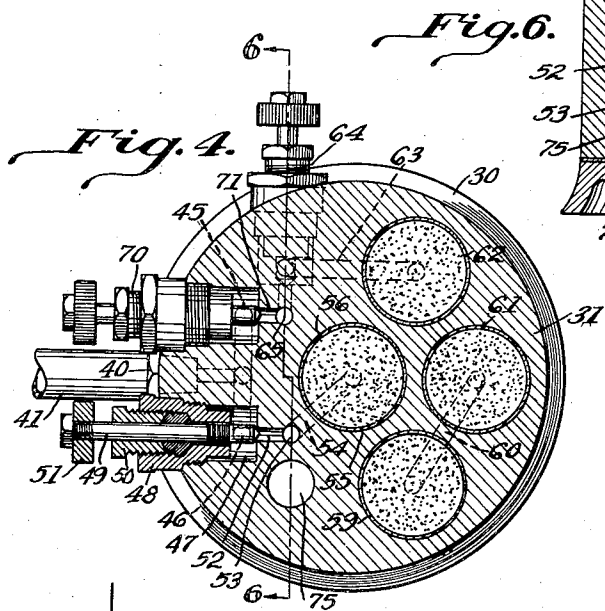
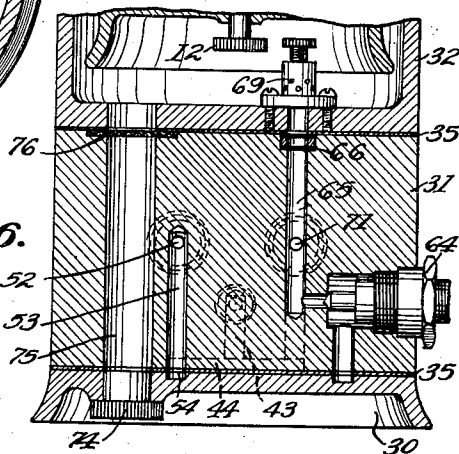
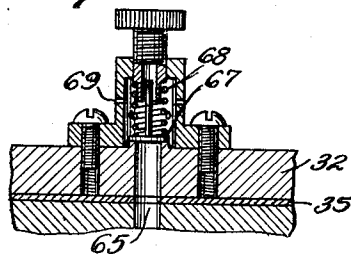


Fig. 7.

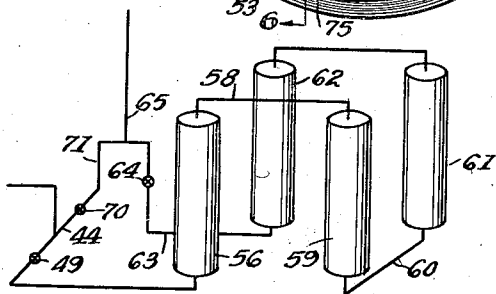


Fig. 8.

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UNITED STATES PATENT OFFICE

1,974,498

GAS DETECTOR

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3 Claims. (Cl. 23—254)

This invention relates to an improved gas detecting lamp and has for an object to provide a lamp which is particularly adapted for the use of men engaged in working in underground sewers, conduits, mains, manholes and the like where hydrocarbon gas, or like explosive gases, is often present and explosions likely to occur, whereby, through the use of the lamp, convenient and careful determinations to reveal the presence of such gases may be made to the end of assuring the safety of the workers and the preservation of property.

Very little has been done prior to the present invention to provide for the ready and careful ascertainment of the presence of natural gas in such underground atmospheres. In fact, the most often used method has been to submit samples of a given atmosphere to a laboratory equipped to make such determinations or gas analyses. This however, results in considerable loss of time and has not been satisfactory, since variations may take place in a given atmosphere between the time when the sample is taken and when the workers actually enter the underground location.

The present invention, therefore, provides a gas detecting lamp by which the atmosphere of an underground location of the character specified may be aspirated into the combustion zone of the lamp and the presence of explosive gases in such atmospheres noted by the changes which take place in the normal character of the flame produced by the lamp. By observing the changes in the physical properties of the flame, such as its elongation, extinguishment, etc., the percentages of natural gas present in the atmospheres undergoing such tests may be readily determined.

It is another object of the invention to provide the base of the lamp with a series of filters containing chemical reagents through which the atmospheres or gases to be tested under valve regulation are passed, the said filters functioning to remove from such atmospheres certain undesired gases which might detrimentally effect or mislead the observer in reading the character of the lamp flame, the filters further serving to permit of the passage therethrough of natural gas but to absorb or react with the other undesired gaseous compounds present in the mixture of gases undergoing such tests.

It is another object of the invention to provide means whereby gas determination tests may be made at various levels in an underground location. It is well known that gaseous atmospheres in such locations often stratify with the result

that determinations as to the gaseous content of the entire area are misleading if the sample is taken but from a restricted portion of the entire area. The present invention embodies an aspirating hose line connected with the filter chamber of the lamp, the hose line being of such length that its inlet end may be inserted to draw samples from different levels of the region undergoing testing so that by the provision of quickly made successive tests, the entire atmosphere of a given location as to its explosive gas content may be readily executed before the region is entered.

For a further understanding of the invention, reference is to be had to the following description and the accompanying drawings, wherein:

Fig. 1 is a view in side elevation of the improved gas detecting lamp comprising the present invention;

Fig. 2 is a vertical sectional view taken through the lamp on the plane indicated by the line 2—2 of Fig. 1;

Fig. 3 is a horizontal sectional view taken through the base of the lamp on the plane disclosed by the line 3—3 of Fig. 2;

Fig. 4 is a similar view on the line 4—4 of Fig. 2;

Fig. 5 is a detail vertical sectional view disclosing the valve and orifice casing used in admitting filtered gas into the base of the lamp and the view is taken on the line 5—5 of Fig. 2;

Fig. 6 is a vertical sectional view taken on the line 6—6 of Fig. 4;

Fig. 7 is a detail side elevation of a plug member which may be connected with the lamp in lieu of the flexible hose line;

Fig. 8 is a diagrammatic view disclosing the various filters and the paths of gas travel therethrough.

Referring more particularly to the drawings, the numeral 1 designates a gas detecting lamp of the so-called "Wolf" or Davy type, which comprises a fuel fount or oil receiving base 2, the top of which carries the usual wick 3 and ignitor 4. The upper portion of the base 2 is annularly shouldered as at 5 and is provided with a ring 6 which is formed with a plurality of ports 7 permitting of the passage of air into the combustion zone 8 of the lamp, the shoulder 5 of the ring 6 being provided with a loose annulus 9 also ported as at 10. The ports 7 are closed by means of a screen 11 to prevent explosions taking place in the zone 8 from transmitting flame backwardly into the base of the detector. Controls 12 for actuating the wick 3 and the ignitor 4 project through the lower portion of the base 2 where they may be conveniently actuated from a point

exteriorly of the lamp proper. The screen 11 is carried by a removable collar 13 which is positioned within the ring 6 and provides a seat for the lower circular edge of a heavy glass cylinder providing a chimney 14. This cylinder is coated so as to be substantially opaque except for transparent or translucent regions 15, which are graduated to permit of the ready determination of the height of the flame which obtains in the combustion zone 8. The ring 6 is exteriorly threaded as at 16 for engagement with similar threads formed in an annular securing plate 17 which is adapted to be secured to the detector base 18 of the lamp. Arising from the plate 17 are spaced vertical rods 19 which have their upper ends connected with a ring 20 arranged above the cylinder 14. The upper end of the cylinder 14 engages with a flanged annulus 21 formed on the lower end of a substantially conical foraminated flame arrester 22, which is formed from fine wire mesh and consists of inner and outer members, the construction thereof being such that explosions, which occur in the zone 8 will not transmit flame to the atmosphere surrounding the lamp. The upper portion of the annulus 21 is provided with a spring 23 which engages with the under side of the ring 20 and provides for the resilient clamping of the upper portion of the glass cylinder whereby to avoid breakage thereof and yet to maintain the cylinder firmly on its gasketed base provided by the annulus 13.

Surrounding the conical flame arrester 22 is a corrugated and perforated casing 24, which protects the flame arresters from injury. Above the casing 24 is a top plate 25, which is secured in place by means of tie rods 26 extending upwardly from the ring 20, heat dissipating outlets being provided between the upper portions of the casing 24 and the plate 25. The center of the plate 25 is provided with a swiveled eye 27 to which is pivotally connected as at 28 a handle member 29 by which the lamp may be conveniently carried from place to place.

With the exception of the plate 17, the construction so far described, has been in considerable use heretofore as a gas detecting lamp for use in underground mines and other similar locations. Its use, however, in underground sewers, mains, conduits, manholes and the like, of the type found in connection with the properties of public utility companies engaged in distributing gas and electricity in urban districts, has not been successful, due to the fact that such underground locations of the character last mentioned often contain complex gaseous atmospheres composed of so many or such widely different gases that the flame determinations of the "Wolf" lamp are without meaning, especially in so far as the natural hydrocarbon gas content of such atmospheres is concerned and it is this natural gas content which must be evaluated in determining whether a given atmosphere may be entered with safety.

Therefore, in adapting the "Wolf" lamp to this peculiar service and the practical conditions which exist therein, I provide in conjunction therewith the detector base 18. This base is made up of three separable sections consisting of a bottom plate or section 30, a filter section 31 and a chambered top section 32. The bottom section is secured to the lower portion of the filter section by means of a plurality of screws 33, having their headed ends disposed downwardly. Likewise the top section 32 is secured to the upper

portion of the filter section 31 by means of a plurality of screws 34 having their headed ends disposed upwardly. Preferably, thinned gaskets 35 are disposed between the planer meeting surfaces of the sections 30, 31 and 32. The upper portion of the top section 32 is provided with laterally directed enlargements 36 in which are pivoted upstanding screws 37, the latter being received within opposed recesses formed in connection with hook like extensions 38 formed with and projecting laterally from the plate 17. The upper ends of the screws 37 receive knurled hand operated nuts 39 by which the "Wolf" lamp may be securely clamped in connection with the upper portion of the detector base.

In order to control the admission of gases into the detector, the filter section 31 is provided with a threaded nipple 40 to which is attached one end of a suitable length of flexible tubing, as indicated at 41, usually about thirty feet in length. Adjacent to the nipple, the tubing is provided with a hand operated bulb 42 provided with suitable check valves (not shown) by which gases may be aspirated into the detector lamp.

The nipple 40 communicates with an L-shaped passage 43, formed in the section 31. The bottom of the passage 43 terminates in the center of a laterally directed horizontally disposed passage 44, and the ends of this latter passage communicate with a pair of vertical passages 45 and 46 formed in the section 31. The upper end of the passage 46 terminates in a socket 47 in which is threaded a bushing 48 provided with a threaded valve stem 49, the bushing surrounding said stem being fluid-tight by the provision of a packing nut 50 which engages with a suitable compressible packing surrounding the stem 49. The outer end of said stem is equipped with an operating knob 51. The inner end of the stem engages with a horizontal port 52 which terminates in a downwardly extending passage 53 communicating with a groove 54 formed in the upper part of the base section 30. The opposite end of the groove 54 terminates in registration with a vertical socket 55, formed in the section 31, in which is positioned a cartridge 56 provided with removable foraminated end caps 57, which cartridges are adapted to receive a suitable chemical reagent used in the selective treatment and absorption of conduit or main atmospheres. Usually, the cartridge 56 contains calcium chloride or other equivalent deliquescent materials.

After the gases aspirated into the detector pass through the valve 49 and the calcium chloride contained in the cartridge 56, the calcium chloride serving to remove entrained liquids or water vapor, the gases are conducted from the top of the socket 55 by way of a port 58, formed in the bottom of the top section 32 to a second cartridge 59 identical in construction to the cartridge 56 but containing, between the foraminated ends thereof soda lime, and from the cartridge, the gases, following reaction with the soda lime, are conducted by way of a passage 60, formed in the top surface of the plate 30, to third and fourth cartridges 61 and 62 containing activated charcoal, or the equivalent thereof, such as fuller's earth or other chemical reagents having the ability to selectively remove extraneous compounds from a mixture of gases containing natural hydrocarbon gas but permitting the latter to pass through unaffected, except for the removal of impurities therefrom. Following the passage of the gases through all four of the cartridges, the said gases travel through a passage-

way 63 in which is located a hand operated valve 64 corresponding in construction and operation to the valve 49, and when the valve 64 is open, the purified gases pass through a vertically extending port 65 in which is located a fire screen 66. The gases after traveling through the screen 66 elevate a valve 67 against pressure of a spring 68, permitting said gases to flow under the pressure imparted by the bulb 42 past the valve 67 and thence through a plurality of small orifices 69 into the chambered area of the top section 32, the gases then passing through the port 7 of the ring 6 into the combustion zone of the lamp proper. If desired, the valves 49 and 64 may be closed and a valve 70, corresponding in construction to the valves 49 and 64 opened whereby to allow the direct passage of an atmosphere undergoing testing to the base of the lamp, thereby shunting the cartridges in which the chemical reagents are contained. Normally, however, in the use of the detector, the valve 70 remains closed, thereby stopping gas flow through its associated passage 71 and compelling the atmosphere undergoing testing to pass serially through said cartridges. It is of course within the range of the invention to employ any suitable number of cartridges and to use various chemical reagents, depending upon conditions and the particular gases to be analyzed and for sake of description, it may be said that the detector contains one or more of the sockets or chambers in which chemical reagents are positioned.

If natural or illuminating gas is present in a given atmosphere, the result of the addition of the gas to the combustion zone usually tends to elongate or extinguish the flame of the "Wolf" lamp, and this elongation or variation in flame propagation from normal may be noted by comparison of the flame determinations with the graduated surfaces appearing on the chimney cylinder 14. Combustible compounds present in the atmosphere undergoing testing, other than hydrocarbon gas used for illuminating or heating purposes, are absorbed by the chemicals in said cartridges, but as previously stated, these chemicals do not affect the hydrocarbon gas.

In the testing of certain types of underground chambers, the hose line is not employed but in lieu thereof a plug 72, as shown in Fig. 7, is placed into an opening leading into the chamber. This plug is of tapered hollow form and is provided with a reduced upper end 73, which by the removal of a closure cap 74, may be positioned in the lower end of a vertical passage 75 leading directly into the chambered area of the top section 32, the passage 75 being provided with a fire screen 76.

In the operation of the detector, the wick 3 of the lamp is adjusted to produce a flame height equivalent to the graduation .5 appearing on the graduated chimney surface, following which, the operator may aspirate an atmosphere sample directly into the detector chamber opening the valve 70 and allowing the valves 49 and 64 to remain closed. Approximately 5 bulbs full, (250 cubic centimeters) of an atmosphere under test should be sufficient to give immediate results. Should an elongation occur, or should the flame be extinguished, accompanied by an elongation or a smothering effect, the next operation is to close the valve 70 and open the valves 49 and 64, repeating the test at the same level, and if the flame is elongated or extinguished with the valves in this latter position, the operator is informed that the sample under test contains natural gas.

If no elongation occurs or if the flame is not extinguished with the valve 70 closed, a sample is aspirated with valves 49 and 64 open, the sample under test should be considered free from natural gas, and the next series of tests should be made at various depths by lowering the inlet end of the flexible tubing 41 to different levels in, for instance, the manhole or sewer.

If tests made at the top of sewers, conduits, etc., as well as at the various depths, show no combustibles or effects thereof when samples are discharged into the detector, it is not necessary to use the absorbers, thereby prolonging the life of the several reagents, and using the absorbers only when indications of combustibles are evident as a result of the initial tests.

When the detector is to be used for testing so-called bar holes, curb boxes, etc., valves 49, 64 and 70 are closed, and the closure 74 removed from the bottom of the detector, permitting the upper end of the plug 72 to be connected with the passage 75 for the purpose of conducting a sample to the detector. This is a direct connection to the detector chamber and does not result in the passage of the samples through the absorbers. If, at any time, doubt as to contents so secured is entertained, samples may be aspirated through the absorbers by connecting the sampling line to the reduced end 73 of the plug 72.

The aspiration of samples of various contents of sewers, conduits, etc. through the herein described detector effectively removes the following gaseous chemical compounds from samples tested giving direct results and percentages of natural gas contained in the sample:—

Acetic acid, acetaldehyde, acetone, acrolein, alcohol (ethyl and wood), aldehydes, amylacetate (banana oil), aniline, benzene, benzyl chloride, benzyl bromide, bromine, butyl alcohol, butyl acetate, camphor, carbon bisulphide, carbon dioxide, carbon tetrachloride, chloracetone, chloracetophenone, chloracetyl chloride, chlorine, chloroform, chloropierin, collodion, creosote, cyanogen chloride, dimethyl sulphate, esters, ether, ethyl acetate, ethyl chloride, ethyl gasoline, ethylene dichloride, ethylene, fluorine, formaldehyde, furfural, hexane, hydrogen bromide, hydrogen chloride, hydrogen cyanide, hydrogen sulphide, japan, kerosene, lacquer, naphtha, natural gasoline, nitric acid, nitric oxide, nitrobenzene, nitrogen peroxide, pentane, phenol, phosgene, phosphorous pentachloride, phosphorus trichloride, propane, silicon tetrachloride, sulphur chloride, sulphur dichloride, sulphur dioxide, sulphuric acid, sulphur trioxide, straight run gasoline, tar, thiophosgene, tin tetrachloride, titanium tetrachloride, toluidine, toluene, turpentine.

In view of the foregoing, it will be seen that apparatus is provided in which the objects of the invention and other advantages are obtained. In the detector, readings are direct and results obtained are immediate in terms of percentages of natural gas, mixed gas, coke oven gas and blast furnace gas present in all samples tested. The calibration of the scale on the chimney 14 is preferably in tenths of inches, permitting readings to be made to the nearest hundredth of an inch. This scale is etched on the front and rear of the chimney to avoid parallax. The detector eliminates the necessity of taking and analyzing gas samples with remotely disposed apparatus and also the necessity of lowering the detector into sewers, conduits, etc., which is an added safety factor and a time saver. The aspiration of sam-

ples permits the latter to be taken from any desired depth, eliminating the possibility of errors in reporting existing conditions due to stratified atmospheres of manholes, sewers and the like.

- 5 The aspiration of samples permits the detector to be used when openings are too small to allow a detector to be introduced directly into the suspected area, as samples may be aspirated into the detector or the detector set immediately over the suspected area. All of the passages of the detector are protected by means of thirty-two mesh wire gauge preventing flash-back of flame should an explosion occur in the detector chamber, which would never permit flame propagation into the sampling line. These safety features permit this detector to be used where gaseous samples may contain high percentages of hydrogen. Among other advantages, the detector provides for simplicity in construction, convenience in maintenance and use and also low initial cost.

The following table sets forth the results of tests made in connection with various types of gases and/or fluids encountered in sewer and conduit atmospheres:

Re-agents	Samples aspirated directly into detector chamber	Samples aspirated thru absorbers—20 bulbs (approx. 1000 cc.)
Benzine.....	Flame extinguished; 3 bulbs (approx. 150 cc.).	No effect.
Straight run gasoline....	Flame extinguished; 12 bulbs (approx. 600 cc.).	No effect.
35 Wood alcohol.....	Flame elongated .05"; 20 bulbs (approx. 1000 cc.).	No effect.
Toluene.....	Flame elongated .1"; 20 bulbs (approx. 1000 cc.).	No effect.
Ethylene dichloride.....	Flame elongated 1.3" and remains at this height; 20 bulbs (approx. 1000 cc.).	No effect.
40 Natural gasoline.....	Flame extinguished; 20 bulbs (flame wavers); 25 bulbs (flame extinguished); (approx. 1250 cc.).	No effect.
Ethyl gasoline.....	Flame elongated .35"; 20 bulbs (approx. 1000 cc.).	No effect.
Naphtha.....	Flame elongated .13"; 20 bulbs (approx. 1000 cc.).	No effect.
45 Ethyl alcohol.....	Flame elongated .1"; 20 bulbs (approx. 1000 cc.).	No effect.
Creosote.....	Flame elongated .1"; 40 bulbs (approx. 2000 cc.).	No effect.
Carbon tetrachloride.....	Flame elongated .5" and remains at this height and smoking.	No effect.

The following table discloses observed actions of gaseous mixtures following passage through the absorbers of the detector:

Atmospheres deficient in oxygen

Observed flame action:

1. Flame recedes from tip to wick,
2. Flame smothered out slowly at mixtures of approximately 16 per cent oxygen.

Note: Results the same when aspirated directly into detector.

Small percentages of natural gas and air—Deficient in oxygen

Observed flame action:

1. Slight elongation of flame.
2. Yellow tip of flame disappeared accompanied by a recession of the "blue inner cone" and "yellow outer cone" from tip to wick.
3. Flame lifted off wick.

Note: Results the same when aspirated directly into detector.

Small percentages of natural gas and air

Observed flame action:

1. Flame elongated up to a point where the mixtures became explosive, then the flame was snapped out accompanied by a swirl or a wavering back and forth before being extinguished.

Note: Results the same when aspirated directly into detector.

Atmospheres deficient in oxygen and carbon dioxide pressure

Observed flame action:

1. Flame recedes from tip to wick.
2. Flame smothered out slowly at mixtures of approximately 16 per cent oxygen.
3. Results same as atmospheres deficient in oxygen, as CO₂ is removed by the soda lime absorbers.

Note: When samples are aspirated directly into the detector (not thru the absorbers), the flame is smothered out quickly.

Small percentage of natural gas, atmosphere deficient in oxygen and carbon dioxide present

Observed flame action:

1. Slight elongation.
2. Yellow tip of flame disappeared accompanied by a recession of the "blue inner cone" and "yellow outer cone" from tip to wick.
3. Flame lifted off wick.

Note: Results the same as samples containing a small percentage of natural gas and atmospheres deficient in oxygen, due to CO₂ being removed by soda lime.

4. When sample is aspirated directly into detector chamber, (not thru the absorbers) the lifting off effect is more pronounced and more rapid.

Atmospheres deficient in oxygen—carbon monoxide, carbon dioxide and natural gas present

Observed flame action:

1. Slight elongation, or no elongation (dependent upon proportions of various gases in the mixture)
2. Yellow tip of flame disappeared accompanied by a recession of the "blue inner cone" and "yellow outer cone" from tip to wick.
3. Flame lifted off wick.
4. When sample is aspirated directly into detector chamber (not thru absorbers) the lifting off effect is more pronounced and more rapid.

Note: Results the same as samples containing a small percentage of natural gas and atmosphere deficient in oxygen, due to CO₂ being removed by soda lime, and the carbon monoxide being present in small percentages does not change results of flame action.

When the flame of the detector is elongated and is not extinguished, a plotted curve may be provided with each detector for the purpose of determining the approximate percentage of natural or mixed gas present in any sample aspirated through the absorbers.

Where the flame of the detector is elongated and extinguished, accompanied by a swirl, or the flame is snapped out, and the sample has been aspirated through the absorbers, the sample is above six per cent, gas when working in natural, coke oven, blast furnace or mixed gases.

Also, in gases where the flame of the detector is slightly elongated, and the inner and outer

cone of the flame recedes slowly from the tip to the wick, accompanied by a lifting-off effect of the blue inner cone and a disappearing effect of the yellow outer cone, the sample under test contains natural or mixed gas.

What is claimed is:

1. Apparatus for detecting the presence of explosive hydrocarbon gases in underground sewers, conduits and the like, comprising a lamp structure including a fuel fount, a wick, a graduated flame measuring chimney and a screened outlet for said chimney, in combination with a base receptacle detachably connected with the fount of said lamp and provided with a chamber in which said fount is positioned, said chamber being in communication with the combustion zone of the lamp, said receptacle being provided with a gas inlet having a pair of branched passages leading to said chamber, one of said passages being provided with a multiplicity of serially connected compartments adapted for the reception of chemical reagents capable of selectively extracting from the gases passing through the apparatus undesired gaseous compounds, and manually operated valve means for governing selectively the travel of gases through said passages.

2. The structure as specified in claim 1 in combination with a flexible aspirating hose line connected at one end with said inlet and adapted to have its other end positioned in an atmosphere to be tested.

3. Apparatus for detecting the presence of combustible matter in a gaseous fluid comprising a safety lamp provided with a screened combustion zone having means for burning fuel therein with a controlled visible flame, a base receptacle in which the lower portion of said lamp is detachably connected, the upper portion of said receptacle being provided with a chamber communicating with the combustion zone of the lamp, an atmospheric inlet formed with said base receptacle, a duct leading from said inlet directly to the chamber of said base receptacle, a valve for controlling gas flow through said duct, a second duct leading from said inlet to said chamber, a plurality of serially related chemical containers disposed in said second-named duct for selectively absorbing a constituent gas from fluids passed through said second-named duct, and valve means for regulating the passage of gases through said second-named duct.

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