March 11, 1952 W. G. NOLCKEN 2,589,116

LEAK DETECTING LAMP

Filed June 14, 1945

2 SHEETS—SHEET 1

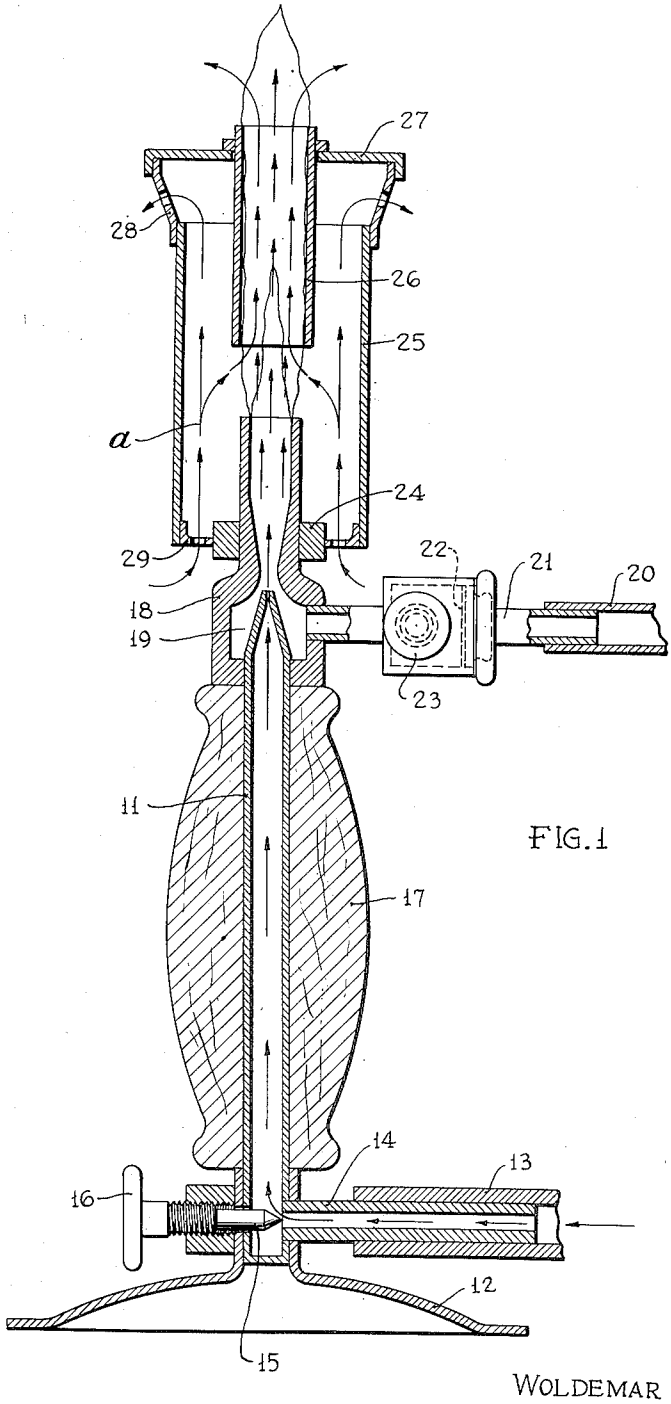

FIG. 1

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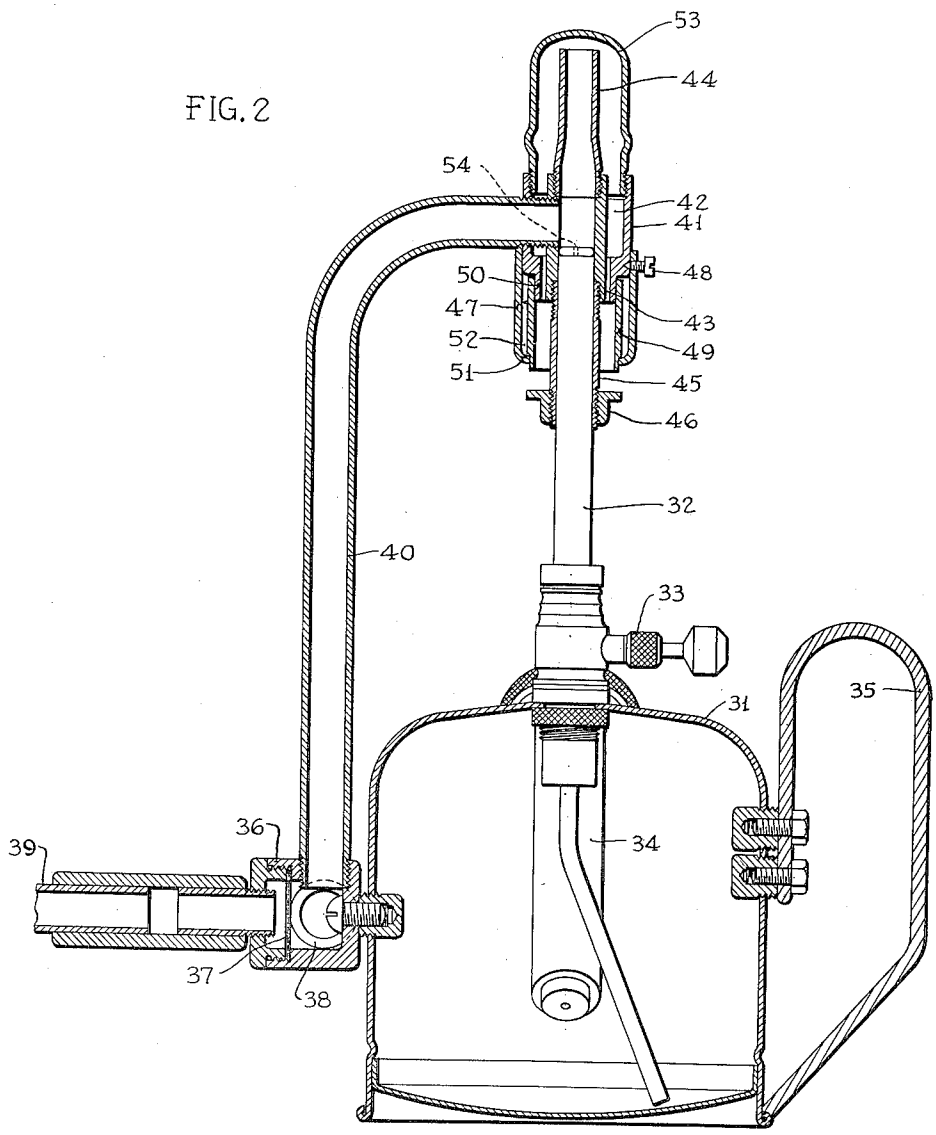
2 SHEETS—SHEET 2

FIG. 2



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LEAK DETECTING LAMP

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This invention relates to a device for the detection of leaks from apparatus or containers in which is a gas held under pressure and which gas may be recognised by the well known Beilstein test. Examples of such gases are the chlorinated hydrocarbon group and in fact, all halogen compounds which, in contact with copper (or a copper alloy) placed in a flame and heated by it to a high temperature, dissociate to form a volatile chloride or other halide of copper, which may in turn be wholly or partially oxidised to copper oxide in contact with the atmosphere of said flame or alternatively reduced to metallic copper, thereby providing a stream of incandescent vapour or minute solid particles of copper and/or copper compound within the flame imparting to it the characteristic colours appropriate to these substances. For example, copper chloride colours the flame pale blue, copper oxide emerald green and metallic copper pale orange-red. Solid copper or alloy is not volatile at the temperature of the flame and therefore can impart no colour to it but when there is formed a volatile compound of copper such as copper chloride a characteristic flame colouration results. Hence a piece of copper in a flame will give visual indication of the presence in that flame of gases which form volatile compounds with copper such as chlorine, other halogens or dissociable compounds thereof. This is the Beilstein reaction, hereinafter referred to as the primary reaction.

Many lamps have been devised and are in current use for the detection of leaks all of which require the heating of a piece of copper or high melting point copper alloy by means of a flame to which flame is led the atmosphere contaminated by the leakage gas which, on coming into contact with the hot copper or copper alloy is dissociated to form copper chloride (or other halogen salt) and/or copper oxide to produce the characteristic flame colouration.

Lamps of this kind whilst performing their function satisfactorily to a certain extent have some disadvantages, the principal of which is the persistence of the characteristic flame colour after the flame is free from contamination by the leakage gas. Many lamps do not have this disadvantage when new but appear steadily to deteriorate with the passage of time until it is found frequently that the lamps burn with the characteristic flame colour at all times. These lamps also are found to be generally insensitive.

The main object of the present invention is to provide a leak detecting lamp which avoids all the

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disadvantages of the known types of lamp, which is extremely sensitive and which responds with great rapidity when brought back into the vicinity of a leak and in which the flame colouration disappears substantially immediately the lamp is removed from the leak. In other words there is no "after effect," either when the lamp is new or even after it has been in use for any length of time.

Further objects of the invention will be apparent as the description proceeds.

Numerous experiments have shown that the "after effect" in leak detecting lamps is due to the condensation of volatile copper compounds on the cooler parts of the lamp. This condensation may persist in the form of a deposit for some time but will be volatilised with, of course, the characteristic flame colouration, when those parts of the lamp on which it is deposited are raised again to the requisite high temperature. For example, copper chloride vapour condenses at temperatures below 1000° C. and any solid surface in or near the flame which is below that temperature is liable to become coated with copper chloride while the supply of chlorine into the flame lasts, said supply of chlorine lowering the temperature of the flame and its surroundings. When this is cut off and pure air admitted the temperature of the flame rises again and the coated surface colours the flame. Such colouration depends upon the composition of this coating which may be partially or wholly oxidised. The oxide being less volatile than the chloride but dissociating at much lower temperatures, its presence results in a protracted after effect. Hereinafter this reaction caused by the deposition of volatile copper compounds and the re-emission thereof will be referred to as the secondary reaction.

The relationship of the primary and secondary reactions is as follows: An active surface responsive to the primary reaction e. g. metallic copper is turned into chloride and vapourises this into the flame and surroundings. A secondary surface e. g. responsive to the secondary reaction re-evaporates previously deposited copper chloride some of which may reach the flame and cause after effects. In order that the secondary surface may do this there must be present the following conditions:

(1) The surface must be below 1000° C. at a time when there is copper chloride vapour near it for this vapour to condense on this surface.

(2) The surface must be above 1000° C. at a time when the supply of chlorine into the flame

is cut off for the condensed chloride to re-evaporate with some of the vapour being able to reach the flame.

Altogether there must be an alternate rise and fall of temperature of the secondary surface coinciding with the intermittent supply and cutting off of chlorine to the primary surface. Since the presence of chlorine lowers the temperature of the flame (e. g. by displacing the oxygen which if carried too far i. e. excess of chlorine will extinguish the flame altogether) and with it the temperature of the surroundings including the secondary surface, conditions 1 and 2 automatically take place together.

According to the present invention a sensitive lamp with no objectionable after effect, for detecting the leakage of halogenated gases from apparatus or containers in which said gases are retained under pressure embodies a well defined surface of copper or copper alloy, responsive to the primary reaction, maintained at all times whilst the lamp is in operation at a temperature above that at which the secondary reaction can take place, whilst every secondary reaction which might take place on all other surfaces of the lamp are wholly screened from view, and cannot at any time affect the colour of the detecting flame.

The well defined surface, of copper or copper alloy, is hereinafter referred to as the primary active surface, that is to say, the surface of the lamp which inter-acts directly with the flame to produce the characteristic flame colouration caused by the volatile halogen compounds of copper, whilst any other surfaces of the lamp where deposition on and re-emission from, of said copper compounds, may take place are hereinafter referred to as secondary surfaces. Preferably the well defined primary active surface of the lamp is a cylinder of pure copper suspended above the flame and so arranged that its entire inner surface is heated to a temperature of not less than 1000° C. The copper cylinder is suspended by means never in direct contact with the flame in such manner that no portion of the primary active surface can at any time whilst the lamp is in operation, be at a temperature below that at which condensation of volatile copper compounds can take place. In other words no conduction of heat from the active surface to the suspension can take place to a degree sufficient to create relatively cold spots or areas in said primary active surface, which might result in condensation of the copper compounds with a consequent after effect.

The suspension of the copper cylinder is such that normally the volatile copper compounds cannot be deposited thereon, but should they be so, they cannot normally be re-evaporated therefrom to give a flame colouration but should they so re-evaporate, they cannot affect the visible portion of the detecting flame. As the melting point of pure copper is 1083° C. it is essential to ensure that the copper is in sufficient bulk so that heat is conducted away to prevent its melting and collapse. Preferably, the source of heat is a Bunsen type flame provided by a fuel such, for example, as coal gas where a source of coal gas is available, or a liquid or gaseous fuel capable of being contained under pressure in a container formed as one with the lamp or separately therefrom. The primary active portion of the lamp consists of the inner surface of a copper cylinder or tube supported concentrically of the axis of the flame by a metal ring which rests on a metal cylinder forming a screen to the lamp (both said ring and screen being secondary surfaces), the contaminated atmosphere being brought to the flame by means, for example, of a flexible hose. Air passages for cooling the lamp are provided. The metal ring supporting the copper cylinder serves to conduct heat away from the copper and may be of steel as also may be the cylindrical screen. The primary active surface of the copper cylinder is maintained above the condensation temperature of volatile copper compounds, e. g. about 1000° C. for copper chloride, but outside the copper cylinder in the cooler parts of the lamp i. e. on the secondary surfaces, volatile compounds of copper may be deposited but this deposit cannot again come into contact with the flame and can therefore be disregarded. Should for any reason, the flame reach this deposit the resulting flame colouration will be screened from view or emerge from an opening in the lamp quite distinct from the copper cylinder and cannot therefore be confused with the detecting flame. Furthermore, the screen to the lamp also serves as a windscreen for the flame, which function is useful when testing for leaks in a draught which would tend to make the flame unsteady and lower the temperature of the active surface.

It has been found that in order to ensure maximum sensitivity of the lamp the primary active surface should preferably be of pure copper as distinct from its high melting point alloys and maintained at or just above 1000° C. and the gas velocity in the suction tube to the lamp should be as hight as possible. When pure copper is used, it will be apparent that in the course of time, it will burn away and provision must be made for its quick and easy replacement. To prevent the ingress of foreign particles to the lamp through the suction tube a suitable filter may be provided therein.

It may be found that the lamp of this invention is so sensitive that it fails to locate large leaks, i. e. to identify the exact spot where leakage occurs, when the suction tube is brought near, in that it responds with the characteristic flame colouration at some distance from the source of the leak. In this case, provision is made for dulling the sensitivity by by-passing some of the air drawn to the suction tube. It should be understood that when referring to sensitivity of lamps, the comparison is between lamps of substantially equal capacity.

The invention is illustrated in the accompanying drawings of which Figure 1 is a longitudinal section through one form of lamp whilst Figure 2 is a similar section through an alternative arrangement. The lamp of Figure 1 is designed essentially to be used with an extraneous source of fuel supply such, for example, as coal gas supply whilst the lamp of Figure 2 is self-contained in that it carries its own fuel supply.

Referring now to Figure 1 which embodies a heater of the gas Bunsen type the central gas supply tube **11** is secured in a suitable base **12**, the fuel being admitted from a flexible tube **13** to a connecting pipe **14** giving admission to the central tube **11**. A screwed control needle **15** operated by the handle **16** controls the ingress of fuel to the central tube. A convenient handle **17** of wood, plastic or the like is shown surrounding the central tube **11**. Mounted at the upper end of the central tube **11** is a Venturi type nozzle member **18** to the chamber **19** of which is admitted the contaminated atmosphere undergoing test from the flexible detector tube **20**, the free

end of which can readily be moved to any location where it is thought a leak occurs, its other end being attached to the inlet pipe 21 on which is mounted a strainer 22 and an air by-pass adjustor 23. The provision of the Venturi-type nozzle or injector ensures the required high gas velocity. A collar 24 secured on the nozzle 18 supports a horizontal spider 29 which in turn supports a cylindrical steel or like casing 25 serving as a screen and as a support for the indicating copper tube 26 constituting the primary active surface, which is secured in an upper plate or ring 27 arranged on a vertical spider 28 secured to the screen 25. The arrows *a* indicate the path followed by the inflowing air and heating gas. In use the fuel supply from the tube 13 is turned on by movement of the control 16 and a light applied to the issuing gas at the top of the copper tube 26. Additional air is drawn in by the chimney effect of screen 25 through the horizontal spider 29 to augment the air supply to the heating flame which passes through the centre of the copper tube which is consequently heated up to, or just above, a temperature of 1000° C. Part of this additional air provides the required cooling of the outer surface of the tube 26. When a leak is now suspected the detector tube is moved to the region of the leak and the air which, if a leak be present, will be contaminated with the leakage gas, is sucked through the detector tube by the action of the gas from the central tube 11 passing through the Venturi type nozzle 18. Before reaching the space 19 however it is caused to pass through the strainer 22 to trap all foreign bodies, which if entering the lamp itself would ultimately cause it to fail. The contaminated gas mixing with the heating gas in contact with the copper tube very rapidly, in fact almost instantaneously, acts on the copper to form copper chloride (or other copper halogen) which may in turn be oxidised to copper oxide and in both cases the characteristic flame colouration appears at the outlet of the copper tube. The by-pass adjustor 23 is designed to dilute the contaminated gas in the event of testing for a large leak, so that the detector tube can be moved to the precise spot of the occurrence of the leak. In other words this provision makes the sensitivity of the lamp controllable at will.

The steel casing serves to screen the flame from draughts, whilst it will be clear that the only visible flame issuing from the lamp is the detecting flame at the top of the copper tube 26.

Referring now to Figure 2 the lamp embodies an integral liquid fuel container 31 into the upper surface of which is screwed a control valve 33 of any well known type into which in turn is screwed the upstanding pipe 32 formed at its upper end with a restricted orifice 54, the vapourisation of the liquid fuel being caused when the lamp is in operation by the detecting flame as will be apparent as the description proceeds. A fuel filler opening and a pump of well known kind is shown at 34. A handle 35 is shown attached to the fuel container 31 and diametrically opposite thereto is attached a chamber 36 which includes a strainer 37 and a by-pass valve 38 similar to that described in connection with Figure 1 to which chamber is led the contaminated air via the flexible detector tube 39. Upstanding from the chamber 36 is the air and contaminated atmosphere inlet pipe 40 which at its upper end is bent inwardly towards the axis of the fuel container 31 and has screwed on its end a burner 41 formed with an annular recess 42 and a series

of holes 43. An upstanding pipe 44 is screwed into the top of the burner 41 and a depending pipe 45 carrying a baffle 46 is screwed into the bottom of the burner to surround the upstanding pipe 32. A screen 47 is secured to the burner 41 by means of grub screws 48 passing into a recess formed in the lower end of said burner. The copper tube or cylinder 49 at its upper end embraces the lower neck portion 50 of the burner 41 and is retained in position by the inturned flange 51 of the screen 47. Screwed into the upper end of the burner 41 so as totally to enclose the upstanding pipe 44 is a dome 53. The action is as follows: By pre-heating the pipe 32 and operating the pump 34 an initial vapourisation of the liquid fuel is obtained which vapourised fuel issues at high velocity from the orifice 54 and in known manner entrains and mixes with air entering via the pipe 40, which mixture passes through the upstanding pipe 44 and downwardly through the annulus between said pipe and the dome 53 through the annulus 42, the holes 43 of the burner where it is ignited, the flame passing through the copper cylinder to erupt below said copper cylinder 49 and above the baffle 46 being deflected outwardly thereby. It will be clear that after the lamp has been in operation a short time automatic vapourisation is ensured. When contaminated atmosphere is admitted via the pipe 40 to the upstanding pipe 44 just above the orifice 54 at the top of the tube 32 it mixes with the fuel and causes the characteristic flame colouration in the flame issuing from the bottom of the copper cylinder 49.

Although there has been described two forms of lamp, each with the copper or copper alloy cylinder arranged with its axis vertically, it must be understood that in accordance with the invention, this axis can be arranged in any desired position.

I claim:

1. A device for detecting the presence of halogens in gases which comprises in combination a Bunsen-type burner including a first inlet for admitting a combustible gaseous mixture, a mixing chamber surrounding said first inlet, a second inlet for admitting a gas to be detected, said second inlet being connected with said mixing chamber, and a Venturi-type burner nozzle mounted coaxially with and spaced above said first inlet; an elongated copper reactor tube mounted coaxially with and in spaced relationship above said Venturi nozzle, means holding such tube in said coaxial relationship to said Venturi nozzle, and means, including said first mentioned means, enclosing said reactor tube and Venturi nozzle in a predetermined, fixed space.

2. In a device for detecting gases, a nozzle substantially symmetrical about a straight axis, said nozzle having an inner end adapted for connection to a source of a combustible gaseous mixture and to a source of a gas to be detected and having an outer end adapted for ejecting a flame fed by said mixture, a reactor member in the form of an elognated tube arranged in coaxial relation to and at a distance from said outer end of said nozzle and exposing its interior surface over its entire length to a flame erupting from said outer end of said nozzle, and shielding means cooperating with said tube to circumferentially engage the same near its outer open end in the aforesaid arrangement and to form an enclosed annular space about the adjoining portion thereof, said means having a portion thereof radially

arranged with respect to said axis to close the annular space around said tube at the outer end of said space, said means shielding from view and blocking passage of flame or other gases, moving over the outside of said tube, from reaching the outer end of said tube.

3. In a device for detecting gases, a nozzle having an inner end adapted for communication with a source of a combustible gaseous mixture and a possible source of a gas to be detected and having an outer end adapted for ejecting an annular flame, an elongated tubular reactor member, means engaging the outside of said tubular member to circumferentially hold it in coaxial relation to said nozzle on the outside of the path of such annular flame, said means including a member extending coaxially through the interior of said tubular member, said reactor member having an interior exposed surface arranged exclusively in front of said outer end of said nozzle, and shielding means cooperating with said tubular member to circumferentially engage the same near its outer open end in the aforesaid arrangement and to form an enclosed annular space about the adjoining portion thereof, said means having a portion thereof radially arranged to close the annular space around said tubular member at the outer end of said space, said means shielding from view and blocking passage of flame or other gases, moving over the outside of said tubular member, from reaching the outer end of said tube.

4. In a device for detecting gases, a vertically arranged nozzle having its one end adapted for communication with a source of combustible gaseous mixture and a possible source of the gas

to be detected and its second end adapted for ejecting a flame, an elongated tubular reactor member arranged in coaxial relation to said nozzle and with an interior exposed surface exclusively in front of said second end of said nozzle, supporting and shielding means cooperating with said tubular reactor to circumferentially engage and support the same near its upper open end in the aforesaid arangement and to form an enclosed annular space about the lower portion thereof, said means having a portion thereof horizontally arranged to close the annular space around said tubular reactor at the upper end of said space, said means shielding the lower portion of the outer surface from view and blocking passage of flame and other gases, moving over the outside of said reactor member, from reaching the end of said reactor tube remote from said nozzle.

WOLDEMAR GEORGE NOLCKEN.

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