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FIRE EXTINGUISHING APPARATUS

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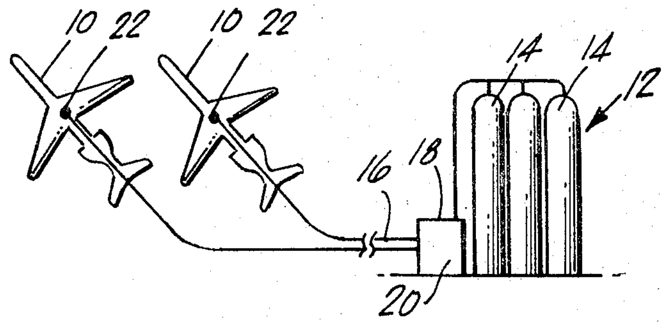

Fig. 1

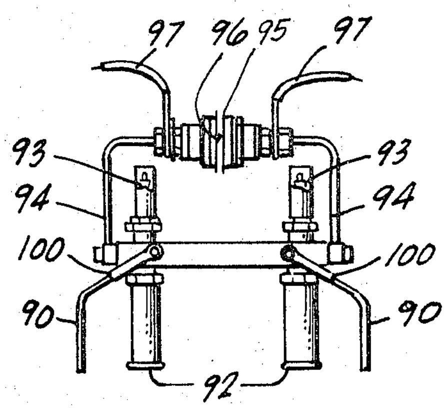

Fig. 5

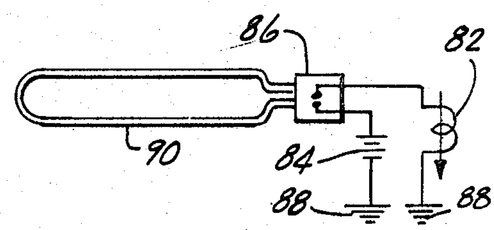

Fig. 4

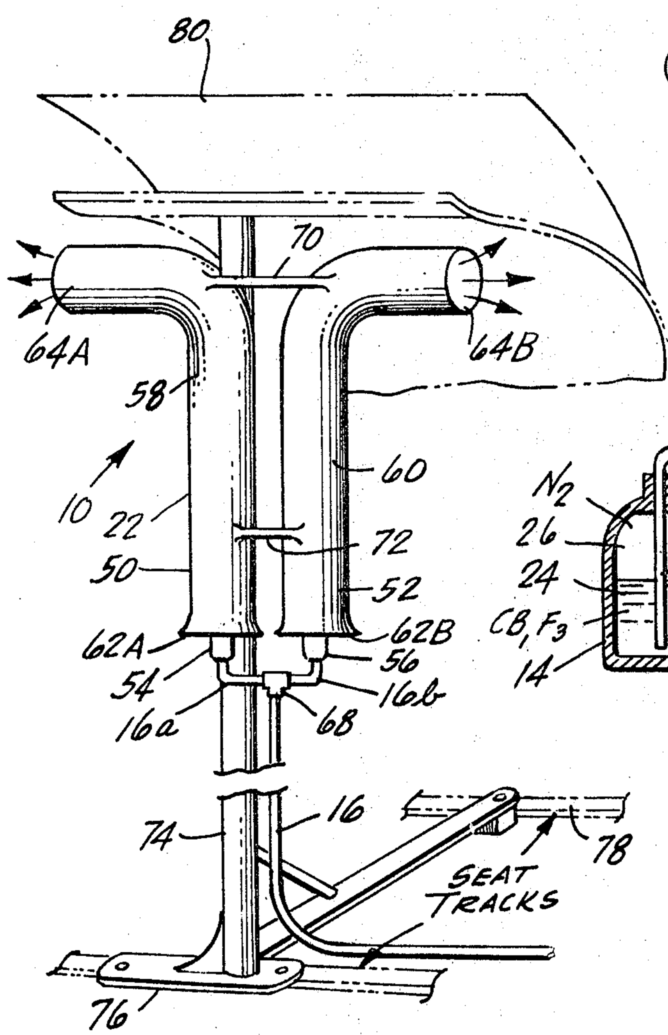

Fig. 3

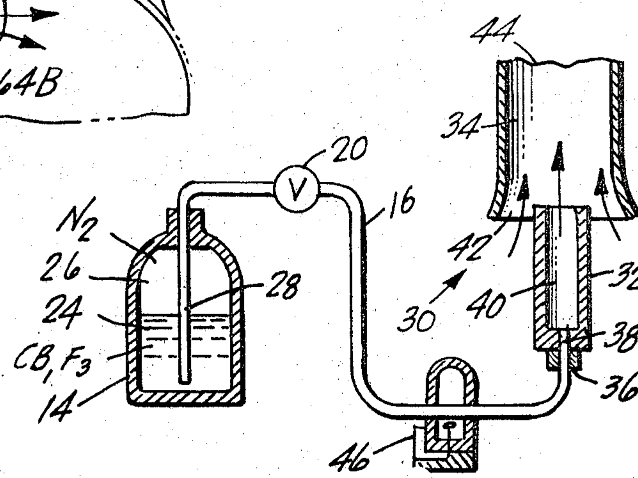

Fig. 2

INVENTOR.
CARL A. WEISE
BY
Ming Y. Moy
- ATTORNEY -

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FIRE EXTINGUISHING APPARATUS

Carl A. Weise, San Pedro, Calif., assignor to McDonnell Douglas Corporation, a corporation of Maryland

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U.S. Cl. 169—2 3 Claims

ABSTRACT OF THE DISCLOSURE

A fire extinguishing system including a supply system for an extinguishing agent such as bromotrifluoromethane, a control system, and a diffuser assembly. The diffuser assembly is adapted for placement in a space to be protected from fire and includes a nozzle connected to the supply assembly by suitable conduit means, and an aspirator positioned to receive the output of the nozzle. The construction of the diffuser assembly is such as, upon energization, to provide a rapid, diffused and blanketing discharge of the extinguishing agent in an appropriate concentration with air or other gases. The control system may be controlled by a detector unit placed in the protected space.

BACKGROUND OF THE INVENTION

Bromotrifluoromethane has long been employed as a fire extinguishing agent. Its high efficiency, low toxicity and light weight are significant factors when used in aircraft. On a weight-of-agent basis, this agent is more effective than carbon tetrachloride, carbon dioxide and chemicals of the bicarbonate of soda type. It is particularly advantageous for use against fires in delicate electrical, mechanical or electronic equipment as unlike dry powder types, it leaves no residue which in itself might be troublesome to remove in the post extinguishment stage, or which might damage equipment beyond salvage or operation.

Bromotrifluoromethane, like carbon dioxide, is normally supplied as a liquified, compressed gas. It is especially useful as a fire extinguishing agent in total flooding types of fire extinguishing systems. A three to five percent concentration in air or other gases is sufficient to extinguish fires on contact or to eliminate any possibility of explosions of flammable atmospheres.

Effectiveness of the chemical agent alone, however, is only one key to an effective fire extinguisher. The agent must be properly applied, and the problem is not as simple as taking an extinguisher designed for carbon tetrachloride or carbon dioxide, for example, and simply replacing the agent with bromotrifluoromethane. Experiments have shown that to be effective in fixed fire extinguishing systems, bromotrifluoromethane must be distributed thoroughly throughout the space to be protected in no less than a three to five percent concentration, and preferably within twenty seconds after detection of fire. Since bromotrifluoromethane is about five times as heavy as air, vigorous mixing is required to achieve this disbursion in such a short time duration. Prior fire extinguishers have failed to solve this significant problem; it is a direct improvement upon the state-of-the-art to provide a fire extinguishing system which incorporates a diffuser arranged to mix a fire extinguishing agent such as bromotrifluoromethane and air or other gaseous elements in the protected space, so that the agent is thoroughly distributed,

utilizing, to the full, the energy readily available from the expansion of bromotrifluoromethane as well as pressure in the supply system to achieve the mixing and distribution.

SUMMARY OF THE INVENTION

In carrying out the principles of this invention according to one embodiment thereof, there is provided a diffuser which includes a nozzle having an attachment at one end for connection to a container of a pressurized fire extinguishing agent such as liquid bromotrifluoromethane. The nozzle includes an orifice having a diameter adequate to regulate flow of the pressurized agent therethrough, and an expansion chamber, having a sufficient length and a diameter substantially greater than the diameter of the orifice, for expanding substantially all the fire extinguishing agent output of the orifice into a gaseous form and for accelerating the gaseous agent to near sonic velocity. The diffuser further includes an elongated tubular member having two open ends and a diameter substantially greater than the diameter of the expansion chamber. The tubular member is in axial alignment and positioned to receive the output of the expansion chamber whereby the extinguishing agent emitted from the expansion chamber may pass into and mix with air or other gaseous elements in the tubular member.

The diffuser in combination with a pressurized fire extinguishing agent source, a discharge valve for regulating the flow of the agent to the diffuser, and a fire detector for sensing the existence of a fire and for closing an electrical circuit to energize and open the discharge valve, form an efficient automatic flooding type fire extinguishing apparatus which is useful for protection of a substantially enclosed space such as an interior compartment of an aircraft.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic illustration of an automatic fire extinguishing system shown in use with aircraft;

FIG. 2 is a partially schematic diagram illustrating details of the present invention;

FIG. 3 is an enlarged fragmentary, partially pictorial illustration of the diffuser assembly used in the system shown in FIG. 1, and including a pair of diffusers;

FIG. 4 is a schematic diagram of a control system which may be used with the system shown in FIG. 1; and

FIG. 5 illustrates a fire detector which may be used with the system shown in FIG. 4.

DESCRIPTION OF THE PRESENT EMBODIMENT

There is shown in FIG. 1 an automatic, total flooding fire extinguishing system employed to protect aircraft interior compartments **10**. There is shown a pressurized fire extinguishing agent supply assembly **12**, a diffuser assembly **22**, and a control system **18**. The diffuser assembly **22** is placed in the aircraft interior compartment **10** and connected to the supply assembly **12** by a conduit **16**. The control system **18** includes an electrically operated solenoid valve **20**, which is positioned in the conduit **16**, for controlling the delivery of the fire extinguishing agent from a casing **14** of the supply assembly **12** to the diffuser assembly **22**. The diffuser assembly **22** distributes the fire extinguishing agent throughout the protected enclosures **10** by mixing the agent with air or other gaseous elements in the compartment **10**.

Referring to FIG. 2, there is shown a fire extinguishing agent casing **14** adapted to contain, under pressure, a fire extinguishing agent liquid bromotrifluoromethane **24**, and a discharge agent such as gaseous nitrogen **26**. By virtue of being lighter than the liquid bromotrifluoromethane, the discharge agent, gaseous nitrogen, occupies the uppermost position within the container **14**. A tube **28** extends down to the bottom of the container so that the gaseous nitrogen can force the liquid bromotrifluoromethane through a conduit or hose **16** which includes inlet and outlet portions, the inlet portion being connected to the tube **28**. A conventional discharge valve **20**, which may be manually or electrically operated, positioned in the conduit controls the delivery of bromotrifluoromethane therethrough.

In accordance with this invention, there is provided a diffuser **30** adapted to be connected to the discharge outlet of the hose **16**. The diffuser **30** comprises a vaporizing nozzle **32** and an aspirator **34**. The nozzle or expanding means **32** includes an end fitting **36** adapted to be connected to the outlet of the hose **16**, and an orifice **38** having a diameter adequate to regulate the flow of bromotrifluoromethane therethrough. The nozzle **32** further includes an expansion chamber **40**, having a sufficient length and a diameter substantially greater than that of the orifice **38**, for expanding the bromotrifluoromethane output of the orifice into gaseous form and for accelerating the bromotrifluoromethane to near sonic velocity. The expansion chamber **40** is arranged to discharge into the aspirator or mixing means **34** which is a hollow tube-like member having a diameter greater than the diameter of the expansion chamber **40**. The aspirator includes open ends **42** and **44** with the open end **42** positioned to receive the output of the nozzle **32**. Since the diameter of the aspirator **34** is greater than that of the expansion chamber **40**, the open end **42** functions as an inlet for atmospheric air to enter the aspirator tube **34** for mixing with the extinguishing agent bromotrifluoromethane. The aspirator **34** is of sufficient length to cause thorough mixing of the extinguishing agent with incoming air.

Thus, in operation, the pressurized liquid bromotrifluoromethane is directed to the nozzle **32**, at which location, at least a major portion of the liquid bromotrifluoromethane vaporizes and accelerates to near sonic velocity as it expands, carrying the unvaporized portion of the bromotrifluoromethane with it. This output mixture of the nozzle **32** is directed to mix with air in the aspirator **34** and the mixture emitted therefrom is directed to a fire.

Laboratory experiments have shown that the time duration required for mixing and distributing the fire extinguishing agent bromotrifluoromethane throughout an enclosure is directly related to the velocity of the bromotrifluoromethane as it leaves the nozzle **32**, the relationship being that the higher the bromotrifluoromethane velocity, the shorter the required distribution time duration. Experiments have further indicated that the velocity of the bromotrifluoromethane as it leaves the nozzle **32** can be substantially increased by heating the liquid bromotrifluoromethane prior to its entrance to the nozzle **32**. Generally indicated in FIG. 2 is a heater **46**, provided to heat the liquid bromotrifluoromethane in the conduit **16** to a suitable temperature to achieve the desired bromotrifluoromethane velocity at the exit of the nozzle **32**. The heater **46**, the details of which are not part of this invention, is of conventional construction well known in the art, such as, for example, the type disclosed in U.S. Pat. No. 2,450,537, or preferably, the commercially available electric heating units which can be inserted into the conduit **16**.

Referring to FIG. 3, which shows details of the diffuser assembly **22** employed in the system shown in FIG. 1, there is shown identical diffusers **50** and **52** arranged to discharge in a direction opposite to each other so the discharge reaction forces would substantially cancel. The diffusers **50** and **52**, constructed and operated substantially similar to the corresponding parts shown in FIG. 2 and

described above, each comprises a vaporizing nozzle **54–56**. Each diffuser further includes an inverted L-shaped tubular member or aspirator **58–60**. The aspirator **58** includes open ends **62**A and **64**A and the aspirator **60** includes open ends **62**B and **64**B. The fire extinguishing agent is delivered to the diffusers through the common conduit **16** which includes a divider or T **68**. The identical aspirators are held to discharge in opposite directions by relatively rigid connecting members **70** and **72**, while the nozzles **54** and **56** are mounted in proper relation to the aspirators by rigid conduit portions **16A** and **16B**. The entire diffuser assembly **22** is supported by a structural member **74** which is fixed to and vertically extended from a base **76**. The base is a flat, rigid T shape member fixedly secured to seat tracks **78** of the aircraft interior compartment **10**. It has been found that if the aspirator **58–60** is mounted in proper relation to one of the surfaces of the space to be protected, for example, near a surface **80** of the aircraft interior compartment **10** as shown in FIG. 3, the effectiveness of the mixing of the agent bromotrifluoromethane and air or other gaseous element is enhanced by an aspirator-like action in the protected enclosure. The air or other gaseous element in the enclosure and the bromotrifluoromethane tend to violently circulate within the protected space, thus the agent, bromotrifluoromethane, can reach a fire anywhere in the protected enclosure.

Referring to FIG. 4, which is a schematic diagram of the control system **18** employed in the system shown in FIG. 1, there is shown an electrically operated, conventional solenoid discharge valve **82** used to control the flow of extinguishing agent through the conduit **16**, a battery **84** for supplying the power to energize the valve **82**, and a fire detector **86** which functions as a switch and is located in the aircraft interior compartment **10**. The solenoid valve **82** is connected at one terminal to a ground **88** and its other end to the detector or switch **86**. The detector **86** is connected to the power source **84** which, in turn, is connected to the ground **88** to complete the circuit when the switch **86** is closed. In operation, when a fire is detected by the detector **86**, it functions as a switch to close the electrical circuit to energize and open the discharge valve **82**, thereby allowing the pressurized fire extinguishing agent bromotrifluoromethane to pass through the condiut **16** to the diffuser assembly **22** for mixing with air in the compartment **10**.

Referring now to FIG. 5, which shows additional details of the fire detector **86** which may be used in the system shown in FIG. 1, there is shown a detector having a detector tube **90**, which is located in the aircraft interior compartment **10**. When heated, the air in the tube **90** expands and the resultant pressure, via a copper tube **94**, causes two bellows type diaphragms **95** to make contact, thus closing the circuit shown in FIG. 4.

More specifically, the pressure created by heat in the protected area travels in opposite directions from the source of heat to the diaphrgams **95** through the detector tube **90**. Each end of the tube **90** terminates at a compensator **92** through terminals **100**. The compensator is a hollow closed cylinder of predetermined capacity used to compensate or cushion any sudden but momentary expansion of the air in the detector tube **90**. From the compensators **92** the expanded air travels through the breathers **93**, which are the devices that permit the expanded air in the detector tube and the compensators to be released to the outside atmosphere at a predetermined rate.

A slow gradual rise, or a sudden but momentary rise in temperature in the protected area, and the resulting expansion of air in the detector tube **90**, will not cause the diaphragms **95** to make contact, since any moderate excess volume of air can be absorbed by the compensators **92** and gradually breathed out into the atmosphere. If an abnormal, continued rise in temperature, such as a fire would produce, causes the air to expand in the detector tube **90** faster than the compensators **92** can absorb it, and faster than the breathers **93** can exhaust it, the built-up pressure travels through the insulator tubes **94**, which lead from the compensator **92** and the breather **93** to each bellows type diaphragm **95**. The pressure behind the two opposing diaphragms **95** forces them toward each other. Two platinum-faced contact points **96** are provided to facilitate contact and when the points **96** meet, the electrical circuit shown in FIG. 4 is closed, through connections **97**, to energize and open valve **82** to allow the pressurized extinguishing agent to reach the diffuser assembly **22** for distribution.

While it is preferred to use the extinguishing agent bromotrifluoromethane and discharge agent nitrogen as the two components of the present extinguisher, nevertheless, if desired, other agents having equivalent characteristics may be used.

I claim:

1. An apparatus comprising:
- a first diffuser and a second diffuser, each of said diffusers including:
  - a nozzle having an attachment at one end for connection to a container of a liquefied, pressurized fire extinguishing agent, said nozzle having an orifice of a diameter adequate to regulate flow of said pressurized agent therethrough;
  - an expansion chamber forming a portion of said nozzle and having a length sufficient to permit desired expansion of said agent and having a diameter substantially greater than the diameter of said orifice, said agent being substantially wholly converted to a gaseous form as emitted from said nozle and accelerated to near sonic velocity; and
  - an elongated tubular member having two open ends and a diameter substantially greater than the diameter of said expansion chamber, in axial alignment and positioned to receive the output of said expansion chamber whereby the high velocity output of said expansion chamber may pass into and mix with gaseous elements in said tubular member;
- said first diffuser is positioned and arranged to discharge in a direction opposite to said second diffuser so that substantially all reaction forces will cancel upon a simultaneous discharge;
- mounting means for maintaining the relative positions of said diffusers; and
- common delivery means for delivering a liquified, pressurized fire extinguishing agent to said diffusers.

2. A fire extinguishing apparatus for protection of a substantially enclosed space, comprising:
- a container for storing a fire extinguishing agent, such as liquified bromotrifluoromethane, and a discharging agent, such as gaseous nitrogen, under pressure;
- a conduit, having inlet and outlet portions and said inlet being connected to said container, for delivering the fire extinguishing agent from said container to a place of use;

- a control unit having a discharge valve positioned in said conduit for controlling the passage of the fire extinguishing agent therethrough, and a fire detector, positioned in the substantially enclosed space, for providing an electrical output signal to open said discharge valve when fire is detected, thereby allowing the fire extinguishing agent to pass through said conduit;
- heating means, connected to said conduit, for heating the fire extinguishing agent in said conduit to increase the energy available in the fire extinguishing agent resulting in higher agent velocity as it emits from said expansion chamber; and
- a diffuser, connected to the outlet of said conduit, for mixing the fire extinguishing agent with gaseous elements in the protected space, said diffuser includes:
  - a nozzle having an attachment at one end for connection to a container of a liquified, pressurized fire extinguishing agent, said nozzle having an orifice of a diameter adequate to regulate flow of said pressurized agent therethrough;
  - an expansion chamber forming a portion of said nozzle and having a length sufficient to permit desired expansion of said agent and having a diameter substantially greater than the diameter of said orifice, said agent being substantially wholly converted to a gaseous form as emitted from said nozzle and accelerated to near sonic velocity; and
  - an elongated tubular member having two open ends and a diameter substantially greater than the diameter of said expansion chamber, in axial alignment and positioned to receive the output of said expansion chamber whereby the high velocity output of said expansion chamber may pass into and mix with gaseous elements in said tubular member.

3. The apparatus of claim **2** wherein said diffuser is positioned and arranged to discharge in a direction opposite to a second diffuser of claim **2**, so that substantially all reaction forces will cancel upon a simultaneous discharge;
- mounting means for maintaining the relative positions of said diffusers; and
- common delivery means for delivering the liquified, pressurized fire extinguishing agent to said diffusers.

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G. A. CHURCH, Assistant Examiner

U.S. Cl. X.R.

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