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Method and installation for fighting fire

The present invention relates to a method and an installation for fighting fire, in particular for spaces involving any risk of fire under a floor structure or in cabinets for electrical apparatuses, and which comprises at least one spray head or sprinkler for spraying liquid fog.

Spaces in question are e.g. computer rooms with cable channels running under the floor and possibly communicating with different kinds of apparatus cabinets, or ship engine rooms with objects liable to catch fire under the floor in the so-called bilge space.

A serious problem with such spaces is that cable channels, apparatus cabinets etc. are usually narrow and, in addition, have cables, frameworks, pipes etc., whereby difficultly accessible corners are formed. It is very difficult to position spray heads or sprinklers in such a way that the liquid fog has access to all corners; an unproportionally large number of spray heads is required, resulting in an expensive installation, and because of the general narrowness, the liquid fog does not come into its own but turns into large water drops which just run down the structures.

It is the object of the invention to provide a new method and a new installation for fighting fire in order to solve the above problems.

According to the method of the invention, liquid fog is sprayed in the major part of the space, which major part can be considered as a normal room, while a non-combustible gas, preferably heavier than air, is sprayed into the narrow partial spaces for cables etc. The gas in question can preferably be argon gas, but a suitable mixture of argon gas and nitrogen gas can also be contemplated, or in some cases even nitrogen gas only,



which is lighter than air. In principle, any gas having some kind of extinguishing effect can be utilized.

The gas is capable of efficiently penetrating into and filling up all narrow spaces, thereby smothering any fires occurring therein. Because the spaces into which gas is sprayed are of small volume in relation to the so-called normal room, into which liquid fog is sprayed, the total concentration of gas is prevented from rising to non-allowed high values which may present health hazard. If, e.g. in a telephone exchange office, argon in combination with liquid fog is used, the gas is only about 5 % of the total volume, whereat the oxygen content in the room decreases from about 20% to about 19%, which is quite harmless.

If argon gas is used as extinguishing gas, the gas gathers into a layer down in the space, remaining under the floor and in apparatus cabinets and the like. If a spray of liquid fog is sprayed in a room with gas at the floor level, the gas is pushed away towards the walls and the corners of the room and is pushed upwards, in particular along the corners right up to the upper corner parts of the room, which the liquid fog has certain difficulties to reach by itself. The liquid fog hereby also tends to push the gas into cabinets standing on the floor and into similar structures into which the liquid fog does not penetrate very easily. The concentration of e.g. argon gas can be chosen to be about 10% of the total volume, which lowers the oxygen content from about 20% to about 18%, likewise quite harmless. In order to achieve extinguishing by pushing away (replacing) air oxygen, an approximate general rule is that the concentration of argon gas within the partial space in question should be 40-50% of the volume. With this as a basis, the partial space in question may well be about 30% of the total volume of the action space, whereat the hazard limit applied for human



beings, 15 % oxygen of the total volume, is cleared by a safe margin.

Cable fires often generate PVC smoke gases, which damage e.g. computer apparatuses. E.g. in computer rooms, the combination of extinguishing gas and liquid fog spray according to the invention, which creates a suction along the ceiling of the room inwards to the liquid fog spray, causes the gas to push the smoke gases, including harmful PVC gases, up towards the ceiling, whereafter the smoke gases are sucked into the fog and on one hand are washed and cooled and on the other hand are sprayed to the floor level, so that damage to computers and other sensitive apparatuses is avoided at least essentially. The liquid fog also has a good general cooling effect.

The use of gases like Halon and carbon dioxide for fire extinguishing purposes has as such been known for a long time but this has concerned what can be called total use. As distinct from such total use, the present invention is directed, in relation to the total action space volume involved in each case, merely to a local and controlled concentration of gas in certain partial spaces or partial areas in combination with liquid fog for the rest of the space. The use of Halon will apparently cease within the near future. Replacement gases are under development but are so far unproportionally expensive. The present invention, which makes it possible to manage with small amounts of gas, can make even the use of expensive gases economically worth contemplating. For the part of partial spaces relevant to the present invention, existing installations intended for Halon can be used with minor modifications only. In general, there may be a need to add pressure reducing valves at suitable places, because installations according to the invention preferably employ a higher operating pressure than existing Halon installations.



As one can manage with small amounts of gas, it is also possible, if so desired, to use carbon dioxide in cases where carbon dioxide previously has meant a serious health hazard; the carbon dioxide content must not exceed 5% by volume in occupied rooms.

In the following the invention will be described in more detail with reference to preferred exemplifying embodiments shown in the attached drawing.

Figures 1-5 show different embodiments in connection with a computer room or the like.

Figure 6 shows a first embodiment in connection with a ship engine room or the like.

Figures 7-9 show a valve preferable for use in the embodiments of figures 4 and 6.

Figure 10 shows a second embodiment in connection with a ship engine room or the like.

Figures 11-14 show a preferred exemplifying embodiment of a spray head mountable in the floor of an engine room.

Figures 15-17 show a preferred embodiment of a gas nozzle mountable under the floor of an engine room.

Figures 18-21 show a preferred embodiment of a spray head mountable at the ceiling of an engine room.

Figures 22-24 show an application of the spray head of figures 11-14 that can be mounted advantageously in the floor of a car deck in a ship, or another space comparable to that.

In figures 1-4 the reference numeral 1 indicates a computer room, the floor of which is indicated by 2. Under the floor there is a cable channel 3, which communicates with apparatus cabinets 6 and 7 via openings 4 and 5 in the floor. At the ceiling of the room 1 a suitable number of spray heads or sprinklers 8 are positioned, and a number of gas nozzles 9 are arranged in the cable channel 3.



Liquid is delivered to the spray heads 8 from one or a plurality of hydraulic accumulators, in figures 1 and 2 a liquid container 10, a so-called pressure water bottle, wherefrom the liquid is driven out by means of drive gas, e.g. argon, from a high-pressure gas container 11.

In figure 1, part of the drive gas is led from the very beginning to the gas nozzles 9 via a throttle 12; in figure 2, delivery of gas to the nozzles 9 takes place via an e.g. electrically operated valve 13, which can be arranged to open when the pressure in the container 11 has fallen to a predetermined value.

In figures 3 and 4 the drive gas is compressed in the upper part of a hydraulic accumulator container 14. In figure 3, drive gas is delivered to the nozzles 9 in principle in the same way as in figure 2 via an e.g. electrically operated valve 15, and in figure 4 drive gas is delivered to the nozzles 9 by utilizing a combination of valves 16 and 17 adapted in such a way that when the bottle 14 has been emptied of liquid and the pressure of the drive gas has fallen to a predeterminable value after expansion, the valve 16 in the liquid line to the spray head 8 closes while the valve 17 in a branch line to the gas nozzles 9 opens. The embodiment of figure 4 has the advantage that the desired operation can be achieved without access to electric current. A preferred embodiment of the valve 17 will be described later in more detail with reference to figures 7-9.

The embodiment of figure 5 works in principle in the same way as the embodiment of figure 1. In figure 5 the computer room 1 or the like has, in addition to the cable channel 3 under the floor 2, an upper cable channel 3a above the ceiling of the room 1, with gas nozzles 9a. Gas nozzles 9b are arranged to open directly into the apparatus cabinets 6 and 7. Delivery of drive gas to the



nozzles 9a takes place in the same way as to the nozzles 9 and 9b, via a throttle 12a.

If the room 1 has no cable channels or similar spaces liable to catching fire under the floor but has apparatus cabinets liable to catching fire, the embodiment of figure 5 can be modified so as to comprise only gas nozzles directed into the cabinets, possibly from above instead of from below as in figure 5. The liquid fog sprayed down from the ceiling level contributes considerably to keeping the gas in the cabinets.

In figure 6 a ship engine room is indicated by 21; the floor of the engine room is indicated by 22; and the bilge space under the floor is indicated by 23. An engine, e.g. a diesel engine, is indicated by 24. At the ceiling of the engine room there are positioned a number of spray heads or sprinklers 25, and close to the engine 24, there are also a number of spray heads or sprinklers 26. In the bilge space 23 a number of gas nozzles 27 are provided.

The fire fighting installation of figure 6 comprises a high-pressure drive unit 28 and a low-pressure drive unit 29. The high-pressure unit 28 includes a number of liquid bottles 30, the walls of the out-going rising tubes 31 of which preferably have a number of apertures at different levels, as shown e.g. in Finnish Patent Application 924752, for successively mixing drive gas with the outgoing liquid, and drive gas bottles 32, which are arranged in two groups or batteries indicated by A and B. Outgoing liquid is directed to the concerned fire zone, in figure 6 to the fire zone D, by means of a valve 33, which is preferably made as presented in Finnish Patent Application 925836.

The installation works in the following way.

To begin with, the liquid bottles 30 are emptied a first time by means of one of the drive gas batteries, e.g. the battery A. When the bottles 30 and 31 are empty,



the low-pressure unit 29 is switched in, on one hand to fill the bottles 30 again with liquid and on the other hand to feed liquid to the spray heads 25 and 26, primarily for the purpose of cooling. When the bottles 30 are full again they can be emptied another time by means of the other drive gas battery B. In this way the capacity of the liquid bottles can be doubled.

A branch 35 is connected to the outgoing liquid line 34, leading to the gas nozzles 27. In the line 35, there is mounted a valve 36 of such a construction that it is closed at line pressures less than e.g. 20 bar and more than e.g. 100 bar but is open within the pressure range of 20-100 bar. The drive gas bottles 31 are hereby adapted in such a way that they have a gas pressure somewhat less than 100 bar after the liquid bottles 30 have been emptied; the gas of the bottles 32 is delivered to the gas nozzles 27.

The drive unit shown in figure 6 can of course also be used advantageously in fire fighting installations where liquid fog only is sprayed, i.e. without gas nozzles 27 and gas line 35 with valve 36.

A preferred structure of the valve 36 is shown in figures 7-9. Inside the valve housing 36a, 36b, a valve head 37 is positioned movably between a first position in closing abutment, pressed by a spring 38, against an opening in one valve housing part 36a, as shown in figure 9, and a second position in closing abutment, compressed with the spring 38, against an opening in the other valve housing part 36b, as shown in figure 7. The spring 38 can, as desired in each case, be easily adapted e.g. in such a way that it keeps the valve head 37 in the position of figure 9 against a pressure of up to about 20 bar and yields at a pressure of about 100 bar so that the valve head takes the position of figure 7 due to the liquid pressure fall in an annular passage 39 arranged for this



purpose between the valve head 37 and the valve housing part 36a. In both cases the valve 36 is closed. Within the pressure range of 20-100 bar, the spring 38 yields only partly, as shown in figure 8, the valve being open and allowing gas to flow to the gas nozzles 27, as mentioned earlier. The pressure fall for gas in the passage 39 is considerably smaller than for liquid at the same pressure. In this way, high-pressure liquid and liquid delivered by the low-pressure unit 29 are prevented from entering the gas nozzles. As mentioned earlier, a similar valve structure can likewise be used in the embodiment of figure 4, the valve 17.

A second preferred embodiment for engine rooms and the like is shown in figure 10. The drive unit of the installation is in figure 10 similar to that shown in figure 6, while the arrangement in the engine room 21 itself is somewhat different.

Sprinklers or spray heads 25 positioned at the ceiling of the engine room can be similar to those in figure 6 as well as spray heads 26 near the engine 24. In addition, in the floor 22 of the engine room, a number of spray heads 40 are mounted, preferably near to the engine 24. The spray heads 40 are arranged to rise upon activation a distance above the floor 22, while pushing off a cover 41, essentially as is presented in International Patent Application PCT/FI92/00213;, and at a first stage to produce a liquid fog spray directed upwards and producing a strong upward suction out of the bilge space 23, and at a later stage to spray gas into the bilge space, generally by applying the general solution shown in figures 7-9. In order to ensure that there is a sufficient amount of gas in the bilge space 23, the spray heads 40 can be further provided with a number of gas nozzles 42, which also apply the valve solution of figures 7-9. All sprinklers and spray heads as well as gas nozzles can



thereby be fed by one and the same line 43 extending from the drive unit of the installation. The way of operation of the floor spray heads 40, which are essential in the embodiment of figure 10, will be described more fully in the following with reference to figures 11-14.

Figure 11 shows a spray head 40 in the stand-by state; figures 12 and 13 show the spray head at the first activated stage producing liquid fog; and figure 14 shows the later activated stage spraying gas into the bilge space.

The spray head 40 comprises a primary housing or holder 44, which is firmly fastened to the floor 22 of the engine room by means of a flange 45. The primary housing 44 has an inlet 43a for liquid and gas, respectively, and, in its lower portion, a number of liquid nozzles 46 directed obliquely to the sides and a central gas nozzle 47 with orifices 48 preferably directed to the sides. The connection from the inlet 43a to the nozzles 46 and 47 is regulated by means of a valve head 49 being under the influence of a spring 50, in principle in the same way as in the valve according to figures 7-9.

In the upper portion of the primary housing 44, a secondary housing 51 is arranged slideably, having a number of liquid spray nozzles 52 directed obliquely upwards to the sides. The connection from the inlet 43a to the spray nozzles 52 is regulated by means of a spindle 53, a spring 54 trying to press the spindle to the end position closing the connection, as shown in figure 11. The spring 54 is positioned in an annular space between the housing 51 and the spindle 53, which annular space communicates with the inlet via a central channel formed in the spindle. By dimensioning said annular space suitably, the pressure in the inlet can be partly balanced e.g. in such a way that even a relatively weak spring 54 is capable of keeping the spindle in the closed position



shown in figure 11 against a pressure of e.g. up to 100 bar.

When the installation is activated after a fire has broken out, liquid is delivered to the spray head 40 at a pressure higher than 100 bar, e.g. 280 bar, which state is shown in figures 12 and 13. The secondary housing 51 has been lifted up with a great force to the upper end position against a retainer ring 55 and has thereby pushed off the cover 41. The high pressure has also driven up the spindle 53, the upper protruding end of which ensures that the cover 41 will not remain lying in front of the nozzles 52, which now are in communication with the inlet 43a. The nozzles 52 produce a forceful upward liquid fog spray which in turn produces a forceful upward suction out of the bilge space via frame apertures 56 adjacent the flange 45, said suction being indicated by arrows 57. As an example can be mentioned that a liquid fog spray of about 5 liters water per minute sucks along with it up to 5,000 liters of smoke gases and air. In practice, the bilge space is a sea of fire, large flames being sucked out through the frame apertures 56. These flames as well as smoke gases which as such are hot bring about a very powerful generation of steam in the sprayed liquid fog already almost immediately at floor level. The steam contributes very effectively to extinguishing the fire.

At the same time the high pressure in the inlet 43a has hit the valve head 49 down against the gas nozzle 47, so that the connection thereto is closed while liquid can be sprayed out of the nozzles 46.

After the liquid bottles 30 have been emptied and the pressure of the drive gas in the bottles 31 has fallen somewhat below 100 bar, the spray head 40 takes a position in principle such as shown in figure 14. The secondary housing 51 is still in the lifted position but the spindle 53 has been pressed back by the spring 54, so that the



connection from the inlet 43a to the nozzles 52 is again closed. The spring 50 has lifted the valve head 49 off the gas nozzle 47, which now communicates with the inlet 43a. Most of the gas flows out through the orifices 48 of the nozzle 47, a small proportion of the gas flowing out through the nozzles 46. This state continues until the gas pressure has fallen so low, e.g. to 20 bar, that the spring 50 presses the valve head 49 back to the position shown in figure 11. The powerful generation of steam during the stage according to figures 12 and 13 is in many cases alone sufficient for finally extinguishing a fire, but final fighting with gas is still recommendable as a safety measure.

The general solution described above can also well be applied to the complementary gas nozzles 42; figure 15 shows such a nozzle when the pressure is less than 20 bar; figure 16 shows the state of the nozzle within the pressure range of 20-100 bar; and figure 17 shows the state of the nozzle when the pressure is over 100 bar.

With floor spray heads and gas nozzles made according to figures 11-17, and preferably with apertures in the wall of the riser tubes 31 of the liquid bottles 30, it can be said that optimal utilization of the drive gas is achieved without wasteful spending of the liquid delivered by the low-pressure drive unit 29 of the installation.

With respect to the spray heads 25 and 26 positioned at the ceiling and near the engine, the situation is different, i.e. they should be open at a pressure over 100 bar and below 20 bar but be closed within the pressure range of 20-100 bar. A preferred structure for this purpose is shown in figures 18-21.

The spray head 25 has a number of nozzles 61 mounted in a housing 60 and directed obliquely downwards, and a central through-flow nozzle 62. The connection



between the inlet 43b and the nozzles 61 as well as the nozzle 62 is regulated by means of a spindle structure in two co-operating parts 63 and 64 which both are acted upon by a spring 65 and 66, respectively, supported against the nozzle 62. If the spring 65 acting on the spindle part 63 is adapted to withstand a pressure of 100 bar in the inlet 43b, and the spring 66 acting on the spindle part 54 is adapted to overcome 20 bar only, the function will be as follows.

In the stand-by state, according to figure 18, the pressure in the inlet 43b being substantially zero, the spindle part 63 is pressed by the spring 65 into close abutment against the inlet opening, and the spindle part 64 is in turn pressed by the spring 66 against the spindle part 63, thereby closing an axial, suitably throttled channel 67 running through the spindle part 63. The connections from the inlet 43b to all nozzles are closed.

When the installation is activated, liquid with a pressure of e.g. 280 bar is connected, whereat the whole spindle structure 63, 64 is driven to the bottom with the spindle part 64 in close abutment against the inlet of the nozzle 62, as shown in figure 19. The inlet 43b communicates with the nozzles 61 but not with the nozzle 62.

When the pressure in the inlet 43b has fallen below 100 bar but is greater than 20 bar, which is assumed to be the case in figure 20, the spring 65 presses the spindle part 63 back to the position of figure 18, but the spindle part 64 is still held in the position of figure 19. The connections from the inlet 43b to all nozzles are again closed.

When the pressure in the inlet 43b falls below 20 bar, which happens when the low-pressure unit 29 of the installation is connected, the spindle part 64 rises up from the position of figure 20 to a "floating" inter-



mediate position according to figure 21, whereat the connection from the inlet 43b to the nozzles 61 is still closed but the connection to the nozzle 62 is open through the axial channel 67 of the spindle part 63 and past the floating spindle part 64.

Figures 22-24 finally show an application of the invention that can be used advantageously in action spaces which do not comprise difficultly accessible partial spaces liable to fire under the floor but where the floor level itself generally can be assumed to constitute a particular fire risk zone. As an example can be mentioned a car deck in a ship.

A car deck floor is indicated by 70 and a spray head mounted in the floor is generally indicated by 71. The housing 72 of the spray head, with a number of nozzles 72 directed obliquely upwards to the sides, is arranged slideably in a holder 74, which is firmly fastened to the floor 70 by means of a flange 75. The connection from an inlet 76 for liquid and gas, respectively, to the nozzles 73 and to an upper central gas nozzle 77 is regulated in the same way as in figures 11-14, by means of a valve head 78, which under the influence of a spring 79 is held in the position according to figure 22 for closing the connection, e.g. in the stand-by state with a low pressure in the inlet 76 and with a cover 80 on. The installation can be operated in the same way as shown in figures 6 and 10.

In figure 23 the spray head has been activated by connecting liquid under high pressure, which can be nearly 300 bar, whereat the housing 72 has been lifted up to the upper end position against a retainer ring 81, and the cover 80 has been pushed off by the gas nozzle 77 and fallen to the side. The valve head 78 has been driven up against the gas nozzle 77 by the liquid pressure, and closes connection thereto but has opened connection to the



nozzles 73, which produce forceful liquid fog as described earlier.

In figure 24 the drive gas pressure has fallen to a value below e.g. 100 bar, whereat the spring 79 has pushed the valve head off the position of figure 23, so that most of the gas available at this stage, preferably argon or another inert gas heavier than air, can flow out through the orifices 82 of the gas nozzle 77, preferably essentially horizontally directed, and form a gas layer along the floor 70, said gas layer pushing away oxygen, thus smothering the fire.

The invention can also be applied to isolated objects or objects in a small group, e.g. a separate computer or a separate diesel engine in a larger room or hall, in such a way that the object is screened off the surrounding area by means of liquid fog, using at least one but preferably a plurality of spray heads or sprinklers positioned appropriately above and/or around the object, and gas is sprayed on, into or under the object. The liquid fog then acts as a kind of external protection while the gas acts as an internal protection.

The liquid droplets in the liquid fog can be of a size typically about 10 - 200 microns, as distinct from conventional sprinkler installations which spray extinguishing liquid comparable to rain. Sprinklers and spray heads included in the installation are preferably constructed in accordance to what is presented in International Patent Applications PCT/FI92/00060 and PCT/FI92/00155. However, it is, of course, also possible to apply the basic idea of the invention to low-pressure operation, utilizing local, controlled concentration of gas to a partial area or a partial space of the total action space volume in each case.



Claims:

1. Method for fighting fire, wherein liquid fog is produced by means of at least one spray head or sprinkler, characterized in that in combination with the liquid fog, a concentration of extinguishing gas or inert gas is produced locally within a partial space (3; 3a; 23) small in relation to the volume of the total action space (1; 21).

2. Method according to claim 1, characterized in that a gas heavier than air is used in order to produce a layer of gas in the low part of the action space.

3. Method according to claim 2, characterized in that a liquid fog spray is sprayed on the gas layer in order to drive the gas to the sides and up along the walls and, in particular, up along the corners of the space.

4. Method according to claim 2, characterized in that argon gas or a gas mixture with argon gas as a component is used.

5. Method according to claim 1, characterized in that the gas is also used as drive gas for at least one hydraulic accumulator (10 14; 30) for producing liquid fog.

6. Method according to claim 5, characterized in that producing a concentration of gas is initiated at least essentially simultaneously with producing liquid fog.

7. Method according to claim 5, characterized in that producing a concentration of gas is initiated after the drive gas pressure, in a container (11; 32) for the purpose, has fallen to a predeterminable value.

8. Method according to claim 7, characterized in that producing a concentration of gas is initiated after the drive gas has emptied said at least one hydraulic accumulator (30) of liquid.



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9. Installation for fighting fire, with at least one sprinkler or spray head for producing a liquid fog and with a drive unit preferably comprising at least one gas-driven hydraulic accumulator, characterized in that at least part of the drive gas is arranged to be fed to gas nozzles (9; 27; 40) positioned within at least one locally restricted partial space (3; 23) of the action space (1; 21) of the installation.

10. Installation according to claim 9, in particular for engine rooms and the like, characterized in that the connections to the gas nozzles are arranged to be opened after the hydraulic accumulators (30) have been emptied of liquid at a correspondingly decreased gas pressure.

11. Installation according to claim 10, characterized in that said at least one spray head or sprinkler (25) is arranged to be closed at the pressure of connection for the gas nozzles.

12. Installation according to claim 10, characterized by at least one combined gas nozzle (47) and liquid fog spray head (40) mounted in the floor of the space, the spray head (40) being arranged to produce a powerful suction from below the floor (22) upwards in order to produce a powerful generation of steam in the liquid fog.

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