



- (51) International Patent Classification: *H05K 7/20* (2006.01) *G06F 1/20* (2006.01)
- (21) International Application Number: PCT/US2012/048387
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- (22) International Filing Date: 26 July 2012 (26.07.2012)
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 61/511,816 26 July 2011 (26.07.2011) US
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
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(54) Title: METHODS AND APPARATUS FOR HOT AISLE/COLD AISLE DATA CENTER FIRE SUPPRESSION

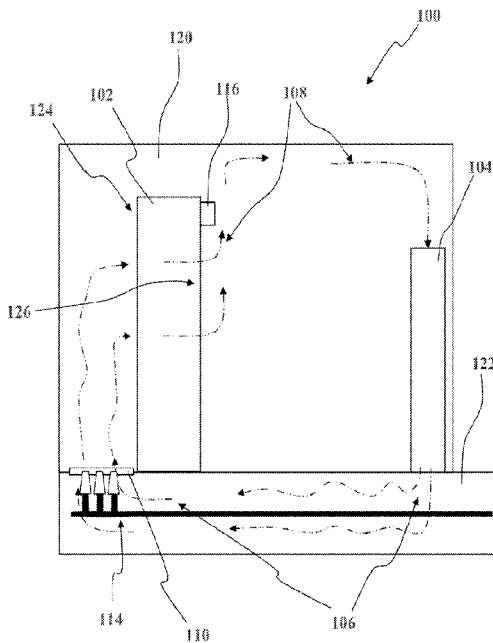


FIGURE 1

(57) Abstract: Methods and apparatus for hot aisle/cold aisle data center fire suppression according to various aspects of the present invention include a detection system that is configured to be located proximate to a side of a computer cabinet facing a hot aisle and a discharge system that is configured to be located within a subfloor having a cooling airflow that is directed upwards from the subfloor through one or more vents in the subfloor and into a cold aisle. The detection system may be configured to detect a fire condition such as smoke exiting the cabinet and in response generate a signal that activates the discharge system. The discharge system may be configured to inject a fire suppressant into the cooling airflow, whereby the cooling airflow may facilitate delivery of the fire suppressant into the cold aisle and the computer cabinet.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). **Published:**

— with international search report (Art. 21(3))

TITLE: Methods and Apparatus for Hot Aisle/Cold Aisle Data Center
Fire Suppression

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/511,816, filed July 26, 2011, and incorporates the disclosure of the application by reference.

BACKGROUND OF INVENTION

[0002] Computer server racks and/or cabinets positioned within a data center are commonly cooled via hot aisle/cold aisle containment systems to sustain high processing capacity while reducing total cooling utility costs. In these systems, cooling air is routed from an air handling unit through a subfloor where it is introduced into the data center through one or more vents in the subfloor positioned along a side of the cabinets. This side is referred to as the cold aisle. The cooling air then travels through the cabinet, collects heat from components located within the cabinet, and exits from the other side of the cabinet into a hot aisle where the then heated air returns to the air handling unit and is re-circulated forming a closed-loop system. To further aid cooling, computer cabinets may be arranged in an enclosed and/or partitioned area within the data center to better

isolate the cold aisle from the hot aisle and to direct cooling capability to the inside of the computer cabinets. Alternatively, rather than fully enclose the computer server cabinets, a partition wall such as a plastic or vinyl screen may be placed between cabinets to facilitate air flow through each cabinet.

[0003] Fire suppression systems in these closed-loop cooling systems often utilize clean agents in place of water based sprinkler systems to prevent damage to the electronic components. These clean agents are commonly liquefied gasses that also act as refrigerants when discharged thereby creating a cooling effect on the environment within the data center. Upon discharge, a total flooding concept is followed that typically seeks to obtain a uniform distribution of the clean agent throughout the entire environment of the room where the computer cabinets are located. However, due to the possibility of human exposure, standards have been developed to establish acceptable concentration levels of clean agent that provide extinguishing capability below a maximum human exposure level. Obtaining a uniform distribution level within the acceptable standards is difficult due to the enclosures and partitions used to separate the hot and cold aisles. For example, a partition may inhibit the distribution of the clean agent throughout the environment or the natural flow of air caused by the cooling system itself may impede the clean agent from entering a cabinet in sufficient quantity to suppress a fire condition.

SUMMARY OF THE INVENTION

[0004] Methods and apparatus for hot aisle/cold aisle data center fire suppression according to various aspects of the present invention comprise a detection system

that is configured to be located proximate to a side of a computer cabinet facing a hot aisle and a discharge system that is configured to be located within a subfloor having a cooling airflow that is directed upwards from the subfloor through one or more vents in the subfloor and into a cold aisle. The detection system may be configured to detect a fire condition such as smoke exiting the cabinet and in response generate a signal that activates the discharge system. The discharge system may be configured to inject a fire suppressant into the cooling airflow, whereby the cooling airflow may facilitate delivery of the fire suppressant into the cold aisle and the computer cabinet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] A more complete understanding of the present invention may be derived by referring to the detailed description when considered in connection with the following illustrative figures. In the following figures, like reference numbers refer to similar elements and steps throughout the figures.

[0006] Figure 1 representatively illustrates a hot aisle/cold aisle fire suppression system in accordance with an exemplary embodiment of the present invention;

[0007] Figure 2 representatively illustrates a control system coupled to the hot aisle/cold aisle fire suppression system in accordance with an exemplary embodiment of the present invention;

[0008] Figure 3 representatively illustrates a multi-zone fire suppression system in accordance with an exemplary embodiment of the present invention;

[0009] Figure 4 representatively illustrates a multi-zone fire suppression system with individual delivery systems for each zone in accordance with an exemplary embodiment of the present invention; and

[0010] Figure 5 is a block diagram of a hot aisle/cold aisle fire suppression system in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0011] The present invention may be described in terms of functional block components and various processing steps. Such functional blocks may be realized by any number of components configured to perform the specified functions and achieve the various results. For example, the present invention may employ various types of sensors, dispersant equipment, ducting, storage equipment for various types of fire suppression materials, and the like, which may carry out a variety of functions. In addition, the present invention may be practiced in conjunction with any number of processes such as fire detection and suppression, hazard condition detection and control, ambient air temperature control, and total room flooding, and the system described is merely one exemplary application for the invention. Further, the present invention may employ any number of conventional techniques or control systems for dispersing fire suppressants, circulating air, detecting potential fire and/or hazardous conditions, and/or sensing concentrations of particulates in air within an enclosed environment.

[0012] Methods and apparatus for hot aisle/cold aisle data center fire suppression according to various aspects of the present invention may operate in conjunction

with any suitable fire detection system and/or fire suppression material or agent. Various representative implementations of the present invention may be applied to any system for sensing and/or suppressing hazardous conditions.

[0013] Referring now to Figures 1 and 2, in one embodiment, methods and apparatus for a hot aisle/cold aisle data center fire suppression system 100 may comprise a detection system 116 configured to generate a detection signal upon detection of a fire condition and a discharge system 114 configured to release a fire suppressant material into a cooling airflow 106. The fire suppression system 100 may further comprise a control system 202 communicatively linked to the detection system 116 and the discharge system 114.

[0014] Referring now to Figure 1, the fire suppression system 100 may be adapted to suppress a fire condition that occurs within a computer cabinet 102 disposed within an enclosed environment 120 utilizing a hot aisle/cold aisle cooling system. The hot aisle/cold aisle cooling system may utilize an air handling unit 104 configured to receive a hot air flow 108 from the enclosed environment 120, remove heat from the hot air flow 108 to form a cooling airflow 106, and direct the cooling airflow 106 into a subfloor 122 located under the enclosed environment 120. The cooling airflow 106 may be routed through the subfloor 122 by any suitable method and may enter the enclosed environment 120 through a vent 110 connecting the subfloor 122 to the enclosed environment 120. The cooling airflow 106 may be directed to one side of the computer cabinet 102 to form a cold aisle. The cooling airflow 106 may then be drawn through an intake side 124 of the computer cabinet 102 by any suitable method to provide cooling to components

such as computer servers, memory devices, routers, and the like positioned within the computer cabinet 102. The cooling airflow 106 absorbs heat from the components to form the heated airflow 108, which exits the computer cabinet 102 from an exhaust side 126, where the heated airflow 108 then flows to the air handling unit 104 to be cooled and recirculated.

[0015] The enclosed environment 120 may be any area that may experience a fire condition to be controlled by the fire suppression system 100. For example, the enclosed environment 120 may comprise the interior of a data center, server room, and/or other similar area. In the present embodiment, the enclosed environment 120 comprises a room housing one or more computer cabinets 102 having a subfloor 122. The enclosed environment 120 may be separated from the subfloor 122 by a floor having one or more vents 110 that allow for the passage of the cooling airflow 106 between the subfloor 122 and the enclosed environment 120. In an alternative embodiment, the cooling airflow 106 may be routed through a cooling system located in a wall or ceiling. For example, a similar closed-loop cooling system may direct the cooling airflow 106 from the air handler 104 through a ducting system positioned in a ceiling or one or more walls such that the vent 110 is located along a wall or ceiling.

[0016] The computer cabinet 102 houses one or more heat generating components and provides an airflow path between the intake side 124 and the exhaust side 126 of the computer cabinet 102 allowing for the thermal transfer of heat away from the heat generating components. The computer cabinet 102 may comprise any suitable system or device for housing components. For example, in one

embodiment, the computer cabinet 102 may comprise a server rack measuring approximately twenty inches wide by seventy-two inches high. In another embodiment, the computer cabinet 102 may comprise a shelving system configured to store various types of electronic components.

[0017] The computer cabinet 102 may have one or more openings facing the cold aisle and the hot aisle to allow for the passage of air between the intake side 124 and the exhaust side 126 of the computer cabinet 102. The computer cabinet 102 may also have internal channels or ducts suitably configured to direct the cooling airflow 106 in a desired direction. The computer cabinet 102 may also comprise one or more fans suitably configured to facilitate the movement of air between the intake side 124 and the exhaust side 126 of the computer cabinet 102.

[0018] Multiple computer cabinets and vents may be arranged within the enclosed environment 120 to form multiple zones. For example, referring now to Figure 3, in one embodiment a first computer cabinet 304 may be located proximate to a first vent 310 and a second computer cabinet 314 may be located proximate to a second vent 320. A partition 322 may be located between the first and second computer cabinets 304, 314 to form a first zone 302 and a second zone 312 such that each zone may comprise a cold aisle and a hot aisle.

[0019] In addition multiple computer cabinets may be positioned adjacent to each other within a given zone forming a row of cabinets in each zone. Similarly, multiple vents may be located along the floor of the enclosed environment such that each cabinet in a zone is located proximate to a single vent. Alternatively, a bank of vents may be disposed along the floor of each cold aisle such that the

number of vents making up the bank of vents is independent of the number of computer cabinets in a given zone.

[0020] Referring again to Figure 1, the air handling unit 104 generates the cooling airflow 106. The air handling unit 104 may comprise any suitable system for creating a flow of air between the cold aisle and the hot aisle. For example, in the present embodiment, the air handling unit 104 comprises one or more units that cool a heated airflow 108 received from the enclosed environment 120 to generate a cooling airflow 106. The air handling unit 104 may then direct the cooling airflow 106 into the subfloor 122. Alternatively, the air handling unit 104 may direct the cooling airflow 106 into a ducting system positioned in a wall and/or a ceiling. The air handling unit 104 may be configured to provide any suitable predetermined level of cooling airflow 106.

[0021] The detection system 116 may be configured to couple to the exhaust side 126 of the computer cabinet 102 such that the detection system 116 is exposed to the heated airflow 108 exiting the computer cabinet 102. Alternatively, the detection system 116 may be positioned at any desirable location within the enclosed environment 120. For example, in one embodiment, the detection system 116 may comprise multiple sensors positioned throughout the enclosed environment 120 and communicatively linked to the control system 202. In another embodiment, the detection system 116 may comprise one or more detectors located within each zone.

[0022] The detection system 116 may generate a detection signal in response to a detected fire condition. The detection system 116 may comprise any suitable

system or device for detecting one or more specific fire conditions and generating a corresponding signal, such as a smoke detector, an air ionization sensor, a temperature sensing device, a temperature sensitive device, obscuration and air sampling detection, fusible link, infrared detector, radiation detector, and/or the like. For example, in one embodiment, the detection system 116 is adapted to detect a fire and provide a corresponding detection signal to the control system 202.

[0023] The detection signal may comprise any appropriate signal for transmitting relevant information, such as an electrical pulse or signal, acoustic signal, mechanical signal, wireless signal, pneumatic signal, and the like. The detection system 116 may also trigger or activate the discharge system 114 by any suitable method. For example, in one embodiment, the detection system 116 may be electrically or mechanically coupled to a valve (not shown) of a container 204 of the discharge system 114 which is responsive to the detection signal and opens to release a fire suppressant material contained within the container 204. Referring now to Figure 2, in an alternative embodiment, the detection signal may comprise an electronic signal generated in response to detection of the fire condition and communicated to the control system 202, which is suitably adapted to activate the discharge system 114 to disperse the fire suppressant into the cooling airflow 106.

[0024] As shown in Figure 1, the discharge system 114 delivers the fire suppressant into the cooling airflow 106. The discharge system 114 may comprise any suitable method, component, or device for dispersing the fire suppressant into the cooling airflow 106 and/or computer cabinet 102. For example, referring now

to Figure 2, in one embodiment, the discharge system 114 may comprise the container 204, a dispersal device 206, and a delivery system 208 linking the container 204 to the dispersal device 206.

[0025] The discharge system 114 may also be configured to operate with multiple zones, wherein a particular zone or zones respond independently to a detected fire condition within a zone rather than flood the entire enclosed environment 120 with the fire suppressant. For example, referring now to Figure 3, in an alternative embodiment, the discharge system 114 may comprise a set of dispersal devices 308, 318 for each zone.

[0026] Referring now to Figure 4, in yet another embodiment, the discharge system 114 may be configured to function independently for the first and second zones 402, 412. For example, in the first zone 402, the discharge system 114 may comprise a first container 402, a first dispersal device 406, and a first delivery system 404. The first container 402 may be connected to the first dispersal device 406 via the first delivery system 404 to provide fire suppression capability to the first zone 402. In addition, the discharge system 114 may comprise a second container 412, a second dispersal device 416, and a second delivery system 414. The second container 412 may be connected to the second dispersal device 416 via the second delivery system 414 to provide fire suppression capability to the second zone 412.

[0027] The discharge system 114 may be further configured to discharge the fire suppressant into the cold aisle without the aid of the cooling airflow 106. For example, the discharge system 114 may be configured to maintain the fire

suppressant under pressure such that the pressure differential between the system pressure of the discharge system 114 and the ambient environment will facilitate discharge of the fire suppressant into the computer cabinet 102. Alternatively, the discharge system 114 may be configured to self-pressurize in the event that the air handling unit 104 becomes inoperable during the fire condition and cannot supply sufficient cooling airflow 106 to aid distribution of the fire suppressant.

[0028] Referring again to Figure 2, the dispersal device 206 may be configured to disperse the fire suppressant into the cooling airflow 106. The dispersal device 206 may comprise any suitable system or device for directing the fire suppressant into an ambient airflow moving past the dispersal device 206. For example, the dispersal device 206 may comprise one or more nozzles, atomizers, misters, ejectors, sprayers, and/or the like. The dispersal device 206 may be positioned substantially within the subfloor 122 or extend at least partially into the cold aisle of the enclosed environment 120. The dispersal device 206 may also be arranged within the subfloor 122 by any suitable method, such as single units evenly dispersed throughout the subfloor 122 or grouped together at predetermined locations.

[0029] For example, in one embodiment, the dispersal device 206 may comprise a plurality of nozzles individually coupled to the delivery system 208 and positioned just below the surface of the subfloor 122 at equidistant spaces along the vent 110 to the cold aisle, wherein each nozzle is configured to eject the suppressant substantially upwards and into the cooling airflow 106 moving into the cold aisle. Alternatively, the dispersal device 206 may be arranged in groups positioned just

below the surface of the subfloor 122 and be configured to eject the fire suppressant into the cold aisle at multiple angles so that the cooling airflow 106 may assist in delivering the suppressant to the computer cabinet 102. In yet another embodiment, the dispersal device 206 may be positioned proximate to a vent located in a wall or ceiling.

[0030] The delivery system 208 may comprise any suitable system for supplying the fire suppressant to the dispersal device 206. The delivery system 208 may comprise a tube, a pipe, a duct, or a perforated hose. For example, in one embodiment, the delivery system 208 may comprise a piping system configured to provide a conduit path for the fire suppressant from the container 204 to the dispersal device 206. The delivery system 208 may comprise any suitable material such as metal, plastic, or polymer and may be suitably adapted to withstand elevated temperatures associated with fires, reduced temperatures associated with various fire suppressant materials, and/or exposure to caustic chemicals.

[0031] The container 204, which contains the fire suppressant, may comprise any suitable system for holding the fire suppressant such as a pressurized vessel, tank, bladder, drum, and the like. The container 204 may be suitably configured to contain a mass or volume of any material such as a liquid, gas, or solid material. The container 204 may also comprise any suitable material for a given application such as metal, plastic, or composite material. The fire suppressant may comprise any suitable material for suppressing an existing or imminent fire condition. For example, the fire suppressant may comprise a liquefied gas or combination of gasses that do not harm electronic devices such as hydrofluorocarbons,

hydrochlorofluorocarbons, and/or hydrofluoroketones. Alternatively, the fire suppressant may comprise halon, a dry powder material, a liquid fire suppressant, an inert gas, or other refrigerant material.

[0032] The container 204 may comprise a pneumatic bottle configured to be pressurized to any suitable predetermined level. In one embodiment, the container 204 may hold the fire suppressant at a pressure of up to about 360 pounds per square inch (psi). In another embodiment, the container 204 may be configured to house the fire suppressant at a pressure of up to about 800-850 psi.

[0033] The container 204 may also comprise a valve connecting the delivery system 208. The valve may also control the release of, or rate of release of, the fire suppressant. The valve may comprise any suitable system for maintaining the pressurized volume of fire suppressant and for releasing that volume upon demand. For example, the valve may comprise a seal between the fire suppressant and the delivery system 208. The valve may be responsive to an activation signal from the detection system 116 and/or the control system 202 and be suitably adapted to break, open, or otherwise remove the seal in response to the activation signal from the control system 202. Once the seal has been broken the entire volume of the fire suppressant may be released to the delivery system 208.

[0034] In another embodiment, the valve may be suitably configured to control the rate of release of the fire suppressant. For example, the valve may comprise a ball or gate valve that is configured to be selectively activated to release a predetermined mass flow rate of fire suppressant. The rate of release may be dependent on a given application or location and may be related to the pressure

within the container 204 relative to the ambient pressure in the enclosed environment 120 and/or subfloor 122.

[0035] The valve may also be configured to release the fire suppressant over a specific period of time. For example, the valve may be sized such that a total release of the fire suppressant occurs over a period of about sixty seconds. Alternatively, the valve may be suitably adapted to release the fire suppressant over a relatively short period of time such as 0.1 seconds. The valve may also be configured to sustain a constant level of the fire suppressant in a given volume based on signals from the control system 202.

[0036] The control system 202 monitors the detection system 116 and activates the discharge system 114 in the event of a detected fire condition. The control system 202 may comprise any suitable system or device for sending and receiving signals. The control system 202 may be configured to send and/or receive signals by any suitable method such as wirelessly or by a wired connection. Referring now to Figure 2, the control system 202 may be communicatively linked to the detection system 116 and the discharge system 114. In one embodiment, the control system 202 may comprise a control panel suitably adapted to receive a detection signal from the detection system 116, process the detection signal, and send an activation signal to the discharge system 114 to initiate the release of fire suppressant.

[0037] The control system 202 may also be suitably adapted to direct the release of fire suppressant into multiple zones. For example, referring now to Figures 4 and 5, in one embodiment, the control system 202 may be communicatively linked to a first sensor 306 in the first zone 402 and a second sensor 316 in the second

zone 412. In the event of a detected fire in the first zone 402, the first sensor 306 may send the detection signal to the control system 202. The control system 202 may then process the detection signal and send a corresponding activation signal to the discharge system 114 initiating the release of fire suppressant into the first zone 402.

[0038] The control system 202 may also be linked to an external system such as a general building alarm system and be suitably adapted to send an appropriate signal to the external system indicating the detection and/or successful suppression of a fire condition. The control system 202 may also be configured to function from a supplied source of power or operate off of a local power source such as a battery.

[0039] In addition, the control system 202 may be adapted to control the discharge of the fire suppressant by the discharge system 114. In one embodiment, the control system 202 may receive multiple signals from the detection system 116 and direct the activation of the discharge system 114 accordingly. For example, control system 202 may signal the discharge system 114 to deliver a onetime immediate discharge, a onetime discharge over a predetermined period of time, multiple discharges at calculated and/or predetermined intervals, and/or multiple discharges triggered by multiple detections of the fire or a re-ignition of the fire condition.

[0040] In operation, a detection system 116 may be coupled to a computer cabinet 102 located within an enclosed environment 120 such as a data center. An air handling unit 104 may also be located within the enclosed environment 120 and be

suitably configured to receive a heated airflow 108 and direct a cooling airflow 106 into a subfloor 122 located beneath the enclosed environment 120. The cooling airflow 106 may be introduced back into the enclosed environment 120 through a cold aisle disposed along one side of the computer cabinet 102 through a vent 110 separating the enclosed environment 120 from the subfloor 122. The cooling airflow 106 is then drawn through an intake side 124 of the computer cabinet 102 and exhausted through an exhaust side 126 of the computer cabinet 102 into a hot aisle.

[0041] A discharge system 114 may be at least partially positioned within the subfloor 122 and be linked to the detection system 116 directly or through a control system 202. In the event that the detection system 116 detects a fire condition, a detection signal is generated by the detection system 116 which directly or indirectly causes the activation of the discharge system 114. Upon activation, the discharge system 114 disperses the fire suppressant into the flow of the cooling airflow 106 which then carries the fire suppressant into the cold aisle of the enclosed environment and subsequently into the computer cabinet 102.

[0042] The particular implementations shown and described are illustrative of the invention and its best mode and are not intended to otherwise limit the scope of the present invention in any way. Indeed, for the sake of brevity, conventional manufacturing, connection, preparation, and other functional aspects of the system may not be described in detail. Furthermore, the connecting lines shown in the various figures are intended to represent exemplary functional relationships and/or

steps between the various elements. Many alternative or additional functional relationships or physical connections may be present in a practical system.

[0043] In the foregoing specification, the invention has been described with reference to specific exemplary embodiments. Various modifications and changes may be made, however, without departing from the scope of the present invention as set forth in the claims. The specification and figures are illustrative, rather than restrictive, and modifications are intended to be included within the scope of the present invention. Accordingly, the scope of the invention should be determined by the claims and their legal equivalents rather than by merely the examples described.

[0044] For example, the steps recited in any method or process claims may be executed in any order and are not limited to the specific order presented in the claims. Additionally, the components and/or elements recited in any apparatus claims may be assembled or otherwise operationally configured in a variety of permutations and are accordingly not limited to the specific configuration recited in the claims.

[0045] Benefits, other advantages and solutions to problems have been described above with regard to particular embodiments; however, any benefit, advantage, solution to problem or any element that may cause any particular benefit, advantage or solution to occur or to become more pronounced are not to be construed as critical, required or essential features or components of any or all the claims.

[0046] As used herein, the terms “comprise”, “comprises”, “comprising”, “having”, “including”, “includes” or any variation thereof, are intended to reference a non-exclusive inclusion, such that a process, method, article, composition or apparatus that comprises a list of elements does not include only those elements recited, but may also include other elements not expressly listed or inherent to such process, method, article, composition or apparatus. Other combinations and/or modifications of the above-described structures, arrangements, applications, proportions, elements, materials or components used in the practice of the present invention, in addition to those not specifically recited, may be varied or otherwise particularly adapted to specific environments, manufacturing specifications, design parameters or other operating requirements without departing from the general principles of the same.

CLAIMS

1. A fire suppression system for a computer cabinet positioned in an enclosed environment having a subfloor with a cooling airflow, comprising:
 - a discharge system responsive to a detection signal comprising a dispersal device disposed proximate to a vent in the subfloor, wherein:
 - the dispersal device is configured to release a fire suppressant into an area proximate to the vent; and
 - the released fire suppressant is delivered to an intake side of the computer cabinet by the cooling airflow flowing upward from the vent towards the intake side of the computer cabinet.
2. A fire suppression system according to claim 1, further comprising a detection system configured to couple to an exhaust side of the computer cabinet, wherein the detection system is:
 - exposed to a heated airflow exiting from the exhaust side the computer cabinet; and
 - adapted to generate the detection signal in response to a detected fire condition.
3. A fire suppression system according to claim 2, further comprising a control system communicatively linked to the detection system and the discharge system, wherein the control system is responsive to the detection signal and configured to activate the discharge system in response to the detection signal.
4. A fire suppression system according to claim 3, wherein the control system is adapted to control the release of the fire suppressant by the discharge system.

5. A fire suppression system according to claim 4, wherein:
- the detection system is further adapted to generate a second detection signal in response to at least one of a continued fire condition and a reignition condition;
 - and
 - the control system is responsive to the second detection signal and further adapted to activate the discharge system to release an additional amount of the fire suppressant.
6. A fire suppression system according to claim 3, wherein:
- the discharge system further comprises a second dispersal device disposed proximate to a second vent in the subfloor, wherein:
 - the second vent is disposed proximate to a second computer cabinet in the enclosed environment;
 - the second dispersal device is configured to release a fire suppressant into an area proximate to the second vent; and
 - the released fire suppressant is delivered to an intake side of the second computer cabinet by the cooling airflow flowing upward from the second vent towards the intake side of the second computer cabinet; and wherein:
 - the first dispersal device, the first vent, and the first computer cabinet define a first zone within the enclosed environment;
 - the second dispersal device, the second vent, and a second computer cabinet define a second zone within the enclosed environment;
 - the detection system is further exposed to a heated airflow exiting from an exhaust side the second computer cabinet and adapted to:
 - generate the first detection signal in response to a detected fire condition within the first zone; and
 - generate a second detection signal in response to a detected fire condition within the second zone; and
 - the control system is responsive to the first and second detection signal and configured to cause the discharge system to:

release the fire suppressant through the first dispersal device in response to the first detection signal; and
release the fire suppressant through the second dispersal device in response to the second detection signal.

7. A fire suppression system according to claim 1, wherein the discharge system further comprises:
 - a container configured to contain the fire suppressant; and
 - a delivery system coupled between the container and the dispersal device, wherein the delivery system is configured to provide a conduit for the fire suppressant from the container to the dispersal device.
8. A fire suppression system according to claim 7, wherein the container comprises:
 - a pressure vessel configured to contain the fire suppressant at a predetermined pressure; and
 - a deployment valve coupled between the pressure vessel and the delivery system, wherein the deployment valve is adapted to control a rate of release of the fire suppressant to the delivery system.
9. A fire suppression system according to claim 1, wherein the dispersal device comprises a nozzle disposed in the subfloor and proximate to the vent.
10. A fire suppression system for a computer cabinet positioned in an enclosed environment having a cooling airflow directed into the enclosed environment through a vent, comprising:
 - a discharge system responsive to a detection signal comprising a dispersal device disposed proximate to the vent, wherein:
 - the dispersal device is configured to release a fire suppressant into an area proximate to the vent; and
 - the released fire suppressant is delivered to an intake side of the computer cabinet by the cooling airflow flowing through the vent towards the intake side of the computer cabinet.

11. A fire suppression system according to claim 10, further comprising a detection system configured to couple to an exhaust side of the computer cabinet, wherein the detection system is:
 - exposed to a heated airflow exiting from the exhaust side the computer cabinet; and
 - adapted to generate the detection signal in response to a detected fire condition.
12. A fire suppression system according to claim 11, wherein the discharge system further comprises:
 - a container configured to contain the fire suppressant; and
 - a delivery system coupled between the container and the dispersal device, wherein the delivery system is configured to provide a conduit for the fire suppressant from the container to the dispersal device.
13. A fire suppression system according to claim 12 wherein the container comprises:
 - a pressure vessel configured to contain the fire suppressant at a predetermined pressure; and
 - a deployment valve coupled to the pressure vessel, wherein the deployment valve is adapted to control a rate of release of the fire suppressant to the delivery system.
14. A fire suppression system according to claim 11, further comprising a control system communicatively linked to the detection system and the discharge system, wherein the control system is responsive to the detection signal and configured to activate the discharge system in response to the detection signal.
15. A fire suppression system according to claim 10, wherein the dispersal device comprises a nozzle proximate to the vent.

16. A method of providing fire suppression to a computer cabinet positioned in an enclosed environment having a subfloor with a cooling airflow, comprising:
 - positioning a dispersing device adjacent to a vent in the subfloor proximate the computer cabinet, wherein:
 - the dispersing device is configured to release a fire suppressant into an area proximate to the vent; and
 - the released fire suppressant is delivered to an intake side of the computer cabinet by the cooling airflow flowing upward from the subfloor through the vent towards the intake side of the computer cabinet.
17. A method of providing fire suppression to a computer cabinet according to claim 16, further comprising positioning a sensing device adjacent to an exhaust side of the computer cabinet, wherein the sensing device is adapted to generate a detection signal in response to a sensed fire condition within the computer cabinet.
18. A method of providing fire suppression to a computer cabinet according to claim 17, further comprising processing the detection signal with a control system coupled to the sensing device and the dispersing device, wherein the control system is adapted to activate the dispersing device in response to the processed detection signal.
19. A method of providing fire suppression to a computer cabinet according to claim 18, further comprising controlling an amount of fire suppressant released from the dispersing device with the control system.
20. A method of providing fire suppression to a computer cabinet according to claim 16, wherein releasing the fire suppressant into the area proximate to the vent comprises:
 - routing the fire suppressant from a storage container through a delivery system disposed within the subfloor to the dispersing device; and
 - dispersing the fire suppressant into the airflow in the area proximate to the vent.

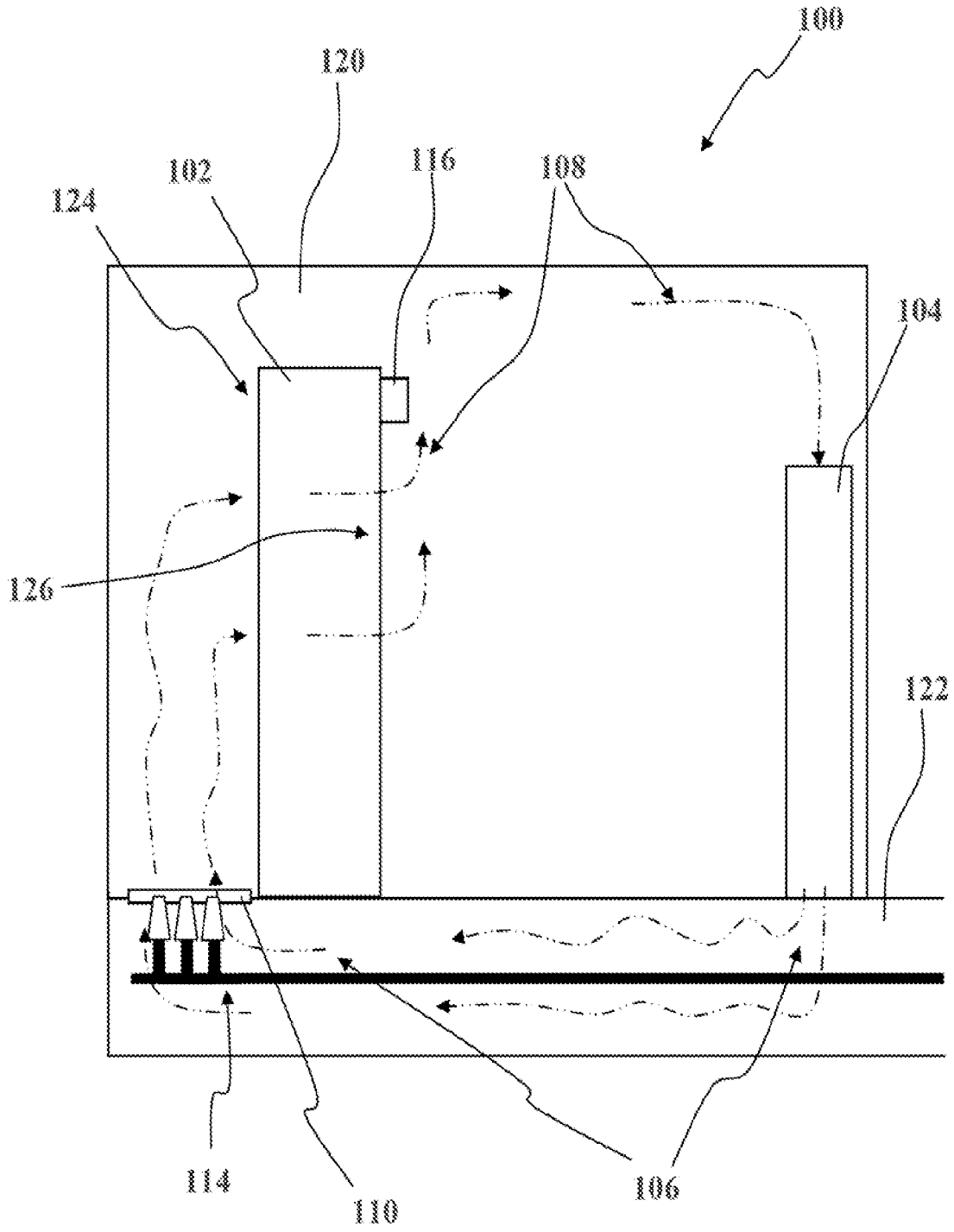


FIGURE 1

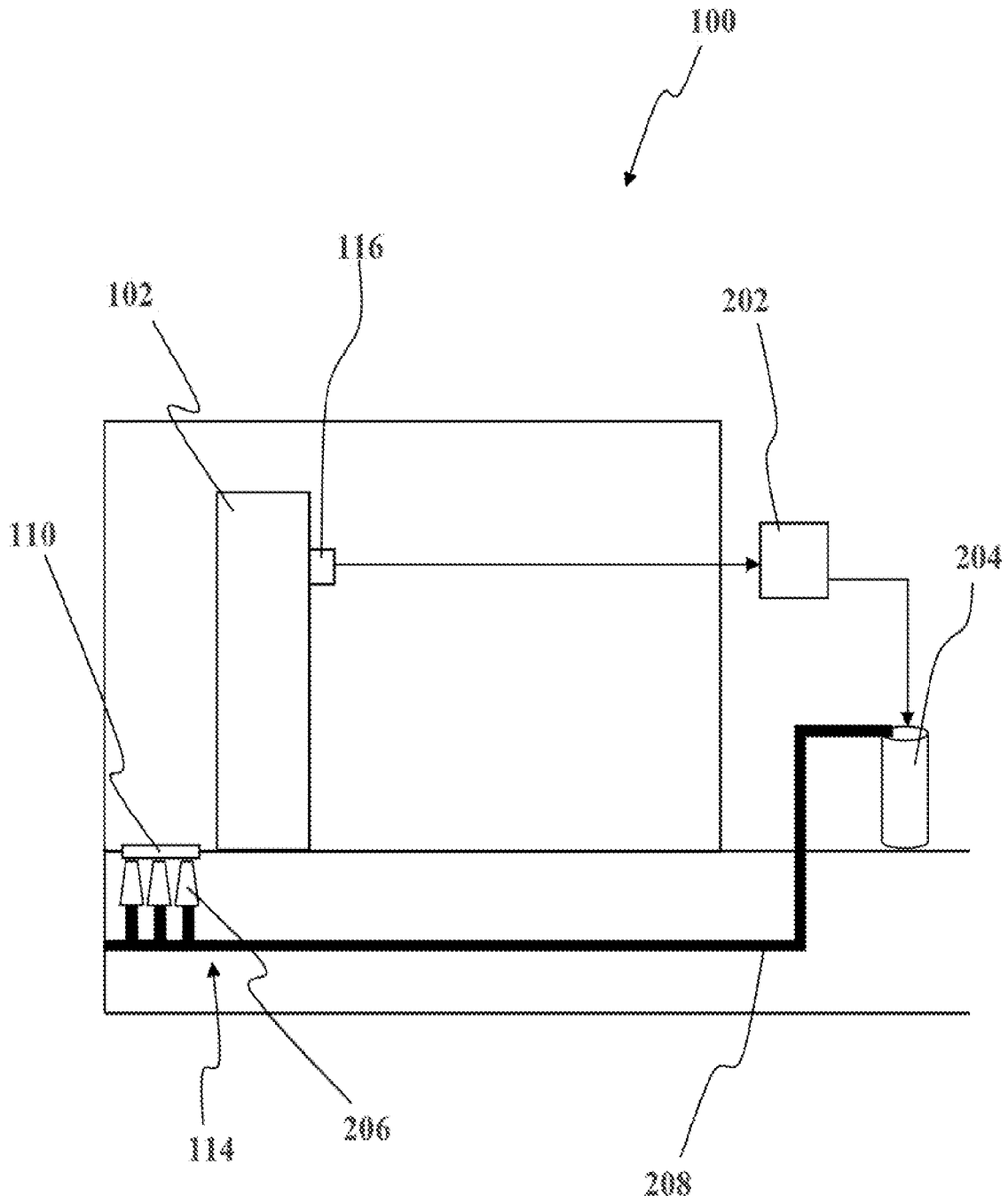


FIGURE 2

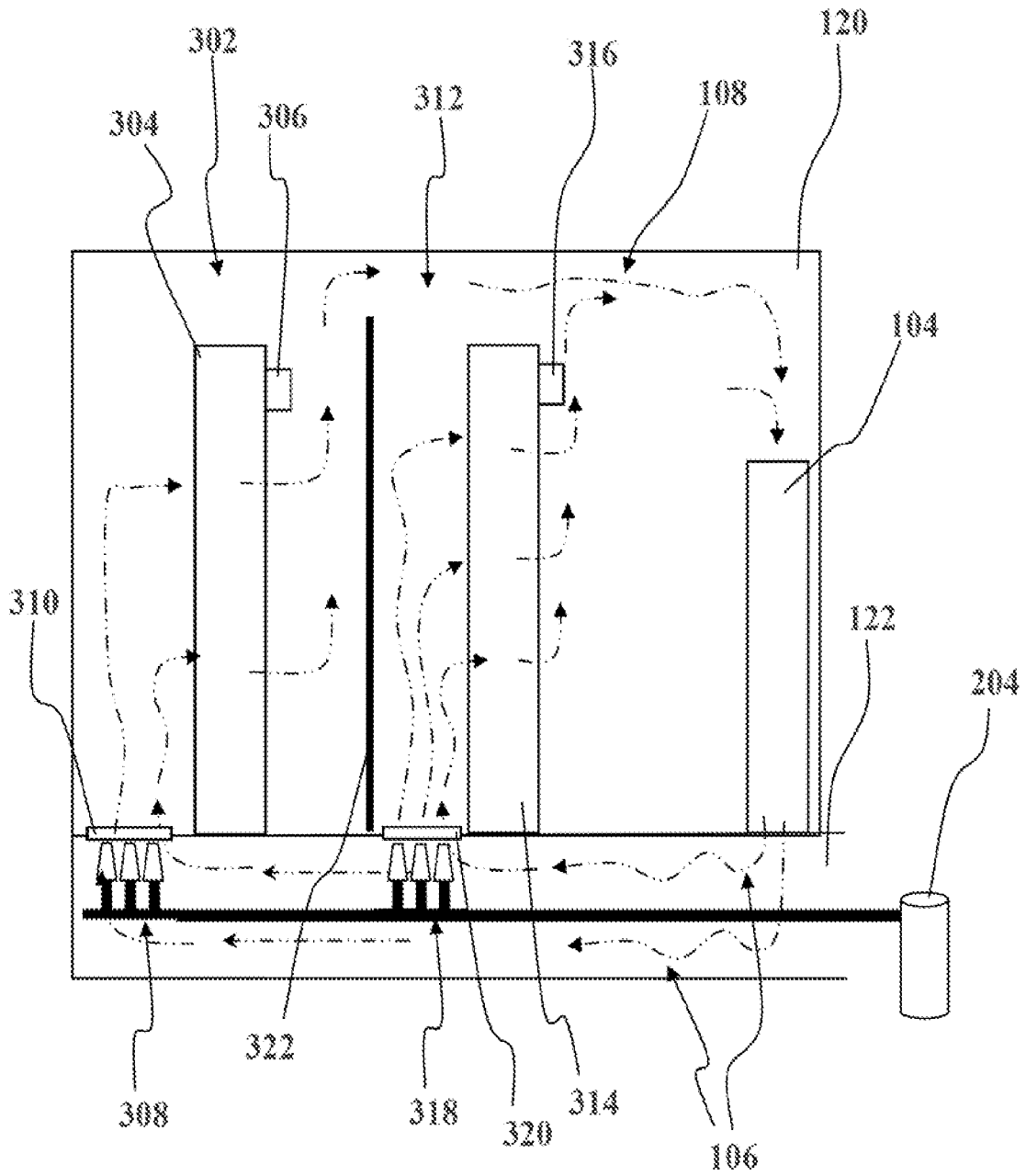


FIGURE 3

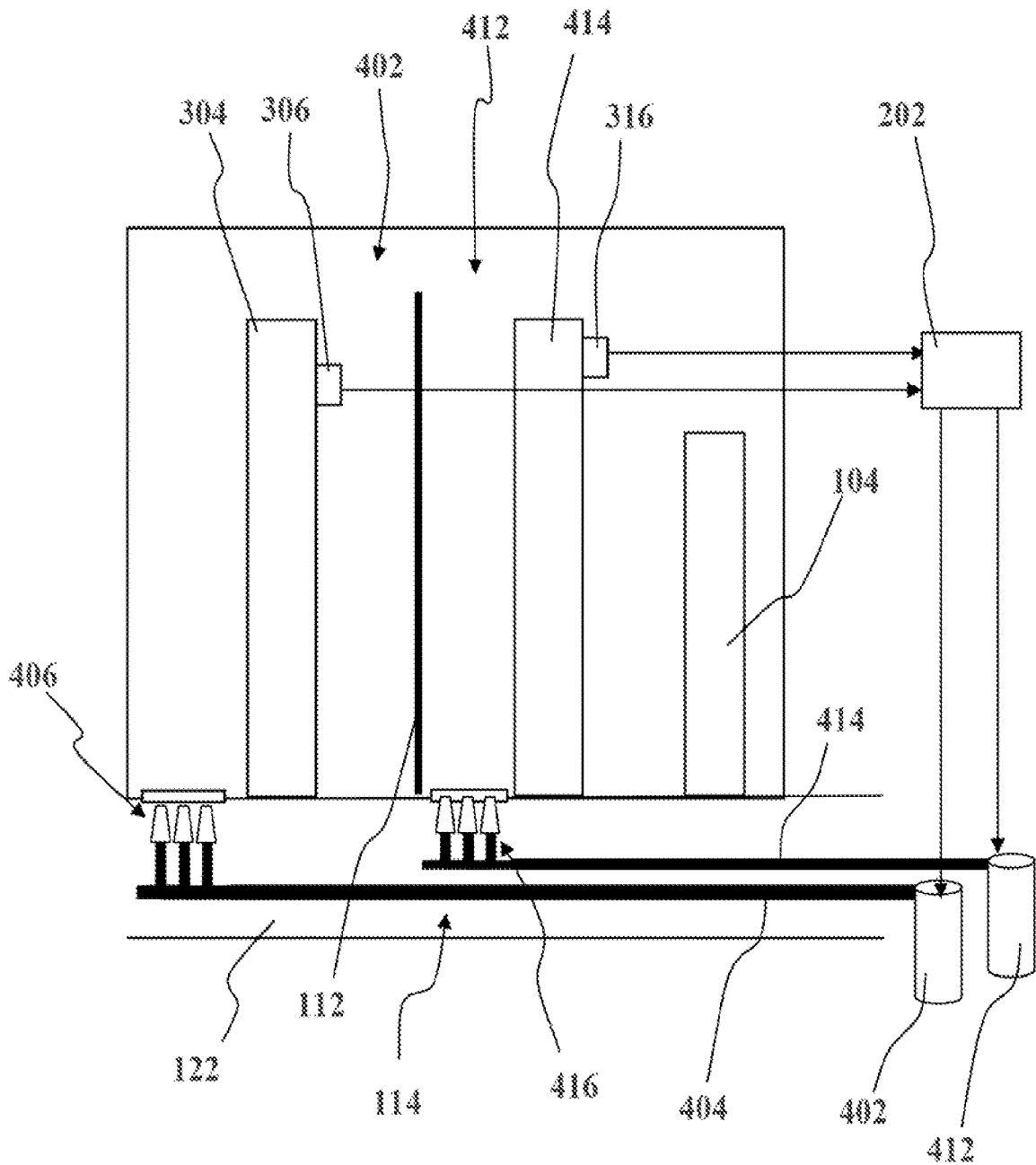


FIGURE 4

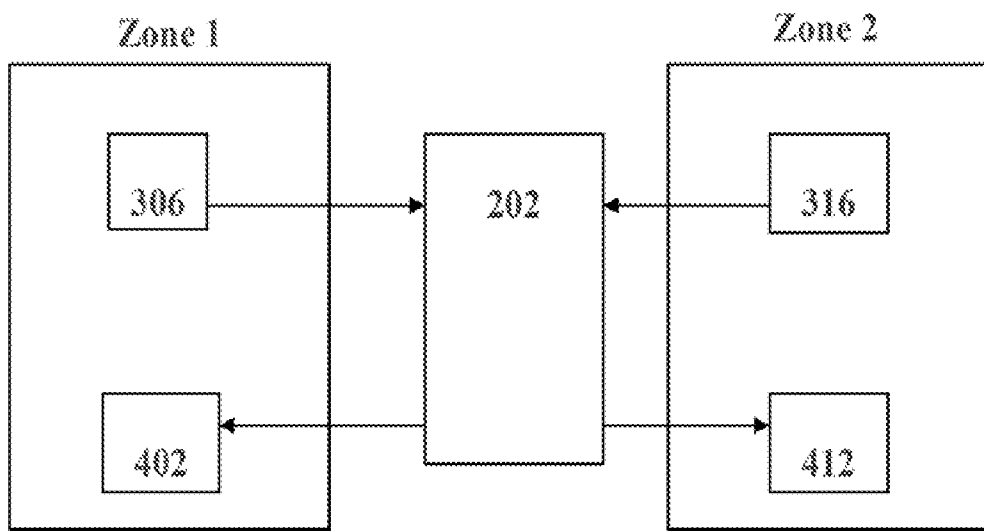


FIGURE 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/48387

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - H05K 7/20 (2012.01); G06F 1/20 (2012.01)
 USPC - 340/628
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 USPC: 340/628

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 USPC: 62/259.2,419; 454/184; 361/688; 340/628 (text search - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 PubWEST(USPT,PGPB,EPAB,JPAB); Google
 Search Terms: fire, suppressant, computer, cabinet, subfloor, sub floor, vent, air conditioning, data center, inject, additional, amount, nozzle, reignite, reflash, detect, sense

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 2009/0211773 A1 (GOOCH) 27 August 2009 (27.08.2009), entire document especially Figs 4, 10; paras [0031]-[0032], [0069][0072], [0075]	10-12, 14 ----- 1-9, 13, 15-20
Y	US 2011/0105010 A1 (DAY) 05 May 2011 (05.05.2011), entire document especially Figs 1, 5d; paras [0026], [0124]	1-9, 16-20
Y	US 6,518,574 B1 (CASTLEMAN) 11 February 2003 (11.02.2003), entire document especially col 29, lns 25-35	5, 19
Y	US 6,491,254 B1 (WALKINSHAW et al.) 10 December 2002 (10.12.2002), entire document especially Fig 3; col 13, lns 36-44	8-9, 13, 15
A	US 2009/0168345 A1 (MARTINI) 02 July 2009 (02.07.2009), entire document	1-20

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
 24 September 2012 (24.09.2012)

Date of mailing of the international search report
15 OCT 2012

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