

9900916-9
12/02/99

NETWORK EQUIPMENT CABINET WITH TEMPERATURE REGULATION AND FIRE PREVENTION MECHANISM

This invention relates to a temperature regulation and fire prevention apparatus, more particularly for controlling the temperature within a cabinet containing network servers, hub modules, router modules or other electrical equipment, and for detecting and extinguishing of fires in the event that the former fails.

BACKGROUND OF THE INVENTION

Nowadays, nearly all computers are linked to a network, be it a local area network or Internet. The advantage of networking is widely known. Different computer terminals can share resources such as software programs, files, printers and other peripherals through a network. The computer that allows other computers to share its resources is a server computer, while those other computers wanting to make use of the resources are client computers. A network hub or a router is required to link all the client computers to a server computer so that a request by a client computer can be routed to the correct server computer.

Information can also be shared, as in the case of World Wide Web. Internet allows all local area networks and individual computers in the whole world to be linked. A web page, containing certain information on a host computer, can be downloaded to another computer half way around the world. Electronic mails are also possible through the Internet. With millions of terminals connected to

the Internet, network hubs and routers have an important role to dispatch and route the data, based on the addresses, to the correct network, and ultimately to the correct computer terminal.

The network hub or router module, as well as the server computer, must always be switched on 24 hours a day, so that the server computer is able to share its resources at all times and client computers are able to access the resources at all times. Therefore, the server-hub-router system generates a lot of heat and requires effective cooling systems to prevent over-heating and fire. Apart from preventing fires, the lower temperature is able to extend the life of the equipment.

Normally, the network server, hub or router modules are placed in small rooms on server racks and the temperature within the whole room is cooled by compressor units (or air-condition units). Even at the end of the day, when there are no people working in the room, the compressor unit has to continue running. This results in inefficient use of energy. Other cooling methods currently present involves cooling fans or the like to promote air circulation so that excess heat is dissipated.

Typical cabinets include a rectangular internal frame structure, covered by removable metal panels on the outside. There are a number of racks to put the modules and computers on, leaving some space in between different modules. The front door is made of glass to expose the hub or router modules and server computer, so that indicator lights and monitor are visible without the necessity of opening the door. The front door is necessary for security reasons and also to prevent dust from contaminating the equipment.

The cabinets currently in used have very poor ventilation, which increases the risk of over-heating, equipment malfunctioning and fire. Even if ventilation is provided for, the direction of air-flow tends to be vertical, which is not very

effective in dissipating heat from the modules. Instead, horizontal flow of air is able to pass through the insides of the units and modules to dissipate heat more effectively.

OBJECTS OF THE INVENTION

The object of the network equipment cabinet with temperature regulation and fire prevention mechanism is to store server computers, hubs, router modules and other electrical equipment in it. At the same time, the temperature regulation unit controls and cools the internal temperature in the cabinet at all times, instead of keeping the whole room cool. In the event that a fire starts due to a short circuit, arcing or other reasons, the fire prevention mechanism will come into play to stop the fire from burning out of control. So, this invention promotes efficient use of energy and reduces risk of fires.

SUMMARY OF THE INVENTION

The network equipment cabinet with temperature regulation and fire prevention mechanism comprises of 3 main parts: outer casing, temperature regulation unit and fire prevention module.

The outer casing is basically a rectangular cabinet, with a number of racks whereby the network server computer, hub or router modules, and other equipment can be placed. The temperature regulation unit and fire prevention module are placed within the cabinet.

The temperature regulation unit includes a temperature sensor and a cooling mechanism. The temperature sensor checks the internal temperature at all times. When the temperature increases, it signals the cooling mechanism to

work harder to dissipate the extra heat so as to bring down the temperature. When the temperature is low, the sensor signals the cooling mechanism to slow down to conserve energy and also to extend the useful life of the mechanism. The cooling mechanism can either be compressor units, to cool the internal temperature in the cabinet, or a combination of exhaust fans and compressor units.

When the temperature exceeds a certain pre-determined value for some duration and the cooling mechanism is unable to bring down the temperature even though it is operating at full capacity, then an alarm is activated to warn of the possibility of over-heating and fire. When the temperature reaches yet another higher value, signifying a high possibility of fire, the fire prevention unit comes into play to kill the fire and prevent it from spreading beyond the cabinet.

The fire prevention unit comprises a smoke detector and an inert gas fire extinguisher system. The smoke detector is able to detect the presence of smoke and indirectly, the existence of fire or sparks. The fire prevention unit serves to protect the server computers and the modules in the cabinet from catching fire. When activated, the fire prevention unit releases inert gases such as helium or argon, which flushes out oxygen from within the cabinet, to kill the fire upon detection. At the same time, the power supply is shut down until the fault is repaired.

The embodiment of the network equipment cabinet with temperature regulation and fire prevention mechanism is as follows:

Figure 1 shows an example of the cabinet, including the temperature regulation unit and fire prevention module wherein

- 10 Outer casing,
- 20 Stand,

- 30 Bracket holder,
- 40 Racks,
- 50 Rack supports,
- 60 Glass door,
- 70 Hinge,
- 80 Lock,
- 90 Temperature regulation unit,
- 100 Fire prevention module,
- 110 Ventilation slits,
- 120 Cable interface unit, and
- 130 Cable openings.

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figure 1, an example of the outer casing **10** is shown here. Apart from being vertically elongated, the cabinet can also be horizontally elongated. The size of the cabinet is variable and there may be different sizes to suit different user needs. The cabinet can either be placed on the floor or be mounted on the wall to economise the floor space. The cabinet stands **20** raise the cabinet to allow movement of air below the cabinet. For the possibility of wall mounting, the sides of the outer case **10** can be built with bracket holders **30**. The sides or panels of the outer casing **10** can also be dismantled, leaving only a structural frame.

The outer casing **10** is made of strong and durable material, so as to support the heavy modules and server computers, and also increase its life span. The inner regulated environmental temperature needs to be insulated from the outside room temperature. So, the outer case is made of insulating material to prevent external heat from affecting the cool environment in the cabinet.

The racks **40** can be of any number, depending on the number of modules and the size of the cabinet. The positions of the racks in the cabinet are adjustable by changing the positions of the rack supports **50** to accommodate the different heights and sizes of the network server computers, hubs and router modules. The racks are also made of strong materials to take the weight of the equipment.

The glass door **60** is hinged **70** securely to the front side of the outer casing **10**, to allow for horizontally swinging action. At the centre of the glass door **60** is a lock **80**. A key is required to open the door and access the modules kept in the cabinet. As network equipment and computers are expensive items, it is necessary to keep them behind lock and key.

The temperature regulation unit **90** is placed at the top of the cabinet. The unit comprises two parts: temperature sensor and cooling mechanism. The temperature sensors can be placed at virtually anywhere in the cabinet. It is the cooling mechanism that is best put at the top of the cabinet. This exploits the fact that hot air rises and cool air descends. The cooling mechanism can be compressor units, or a combination of compressor units and exhaust fans. Both are able to dissipate excess heat and maintain the internal temperature, by lowering the temperature or by promoting air circulation.

For a compressor unit, the cool air produced descends to the bottom of the cabinet while the warmer air rises to the top to be cooled in turn. On the other hand, an exhaust fan draws out hot air at the top, allowing cooler air from the outside nearer the floor to be drawn in from the ventilation slits **110** in the front and the sides of the cabinet. The structure of the cabinet can be made in such a way as to promote horizontal airflow. The ventilation slits **110** are openings that promote air circulation and these slits can be closed in the event of fire to kill the fire.

To increase the life of the cooling mechanism, redundancy is introduced. For example, there are two exhaust fans in use. Fan A operates from 12 midnight to 12 noon and fan B operates from 12 noon to 12 midnight. Similarly, there can be two compressor units operating in turn. This allows part of the cooling mechanism to take a break, thus increasing the life of the exhaust fans or compressor units.

The temperature sensors regularly sense the internal temperature. When one of the sensors detect an increase in the temperature, the micro-controller instructs the cooling mechanism to work harder. The exhaust fan may be instructed to increase the fan speed to draw hot air out faster, or the compressor unit may lower the temperature of the air produced. In either case, the temperature within will be lowered back to a safe operating region. When this happens, the micro-controller instructs the cooling mechanism once again, but this time to slow down to conserve energy.

If a fault really happens and one of the modules begins to heat up, the cooling mechanism will try very hard to cool down the affected module. In the end, if it is still unsuccessful and the temperature has gone beyond the safe limit for far too long, an alarm is sounded to alert the user. The temperature sensor continues to monitor the situation and when a critical high temperature has been reached, the fire prevention module 100 at the bottom of the cabinet releases inert gases into the cabinet through a nozzle. At the same time, the ventilation slits are shut and power to all modules in the cabinet is cut-off. The only opening is through the exhaust fans. As the inert gases displace the air in the cabinet, the internal of the cabinet is beginning to be filled with inert gases, which do not aid in combustion. After a reasonable time, the exhaust fans are closed up to contain the inert gases. Hence, the fire dies down due to a lack of oxygen. This example relates to a network equipment cabinet with both types of cooling mechanisms.

Lastly, there is a cable interface unit **120** on the back part of the outer casing **10**, which have sockets on both the inside and the outside. This allows network cables, power cables, wires and others from the external, to be connected to the modules in the cabinet, without running through the cabinet. For example, power is supplied to the cable interface unit **120** by plugging in the mains in the socket on the outside face of the cable interface unit **120**. Then, the network equipment, computers and modules get their supply via power supply cords plugged into the sockets on the inside face of the cable interface unit **120**. The same explanation goes for network links and other connections. This limits the number of openings so that inert gases are prevented from escaping to the outside environment when a fire is detected.

Cable openings **130** are allowed in small numbers to allow for other non-conventional type of connections. They are fitted with elastic materials to minimise the amount of openings.

The foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the present invention being limited solely by the appended claims.



CLAIMS

1. A network equipment cabinet with temperature regulation and fire prevention mechanism comprising:
 - outer casing **10** with glass door as well as openings for ventilation and cables,
 - temperature regulation unit **90** with a temperature sensor and a cooling module, and
 - fire prevention module **100** utilising inert gases to kill any occurrence of fire.
2. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, wherein the outer casing is made of durable and insulating material, to contain the cool atmosphere within.
3. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, wherein the temperature regulation unit contains a temperature sensor and a cooling mechanism.
4. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1 and Claim 3, wherein the cooling mechanism is best put at the top of the cabinet.
5. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, Claim 3 and Claim 4, wherein the cooling mechanism can be compressor units, or a combination of compressor units and exhaust fans.



6. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, wherein the structure of the cabinet can be made in such a way as to promote horizontal airflow, which is more effective in cooling the modules in the cabinet.
7. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1 and Claim 6, wherein ventilation slits are required on the outer casing when exhaust fan is in operation to promote horizontal airflow.
8. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1 and Claim 7, wherein the ventilation slits can be covered up when the compressor units are in operation or in the event of fire.
9. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, wherein redundancy in the exhaust fans and compressor units are introduced to extend the useful life and the effectiveness of the cooling mechanism.
10. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1 and Claim 3, wherein the temperature sensor continually checks for an increase in temperature of the internal environment.
11. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, Claim 3 and Claim 10, wherein the temperature sensor sends a signal to the cooling mechanism when the temperature increases, so that the cooling mechanism is able to bring down the temperature to a safe value.



12. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, wherein the fire prevention mechanism employs inert gases, such as argon or helium, to kill any fire which may have started.
13. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1 and Claim 12, wherein the fire prevention mechanism is activated when the temperature sensor detects an increase in temperature beyond a critical value or when the smoke detector detects smoke in the cabinet.
14. A network equipment cabinet with temperature regulation and fire prevention mechanism as claimed in Claim 1, wherein the cable interface unit provides the power connections, network connections and others from inside to outside.