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(54) **COOLING AN APPARATUS CABINET**

(57)

ABSTRACT

(76) Inventors: **Timo Heikkila**, Oulu (FI); **Arto Hietala**, Oulu (FI); **Jouko HirvasKari**, Oulu (FI)

Correspondence Address:
PILLSBURY WINTHROP, LLP
P.O. BOX 10500
MCLEAN, VA 22102 (US)

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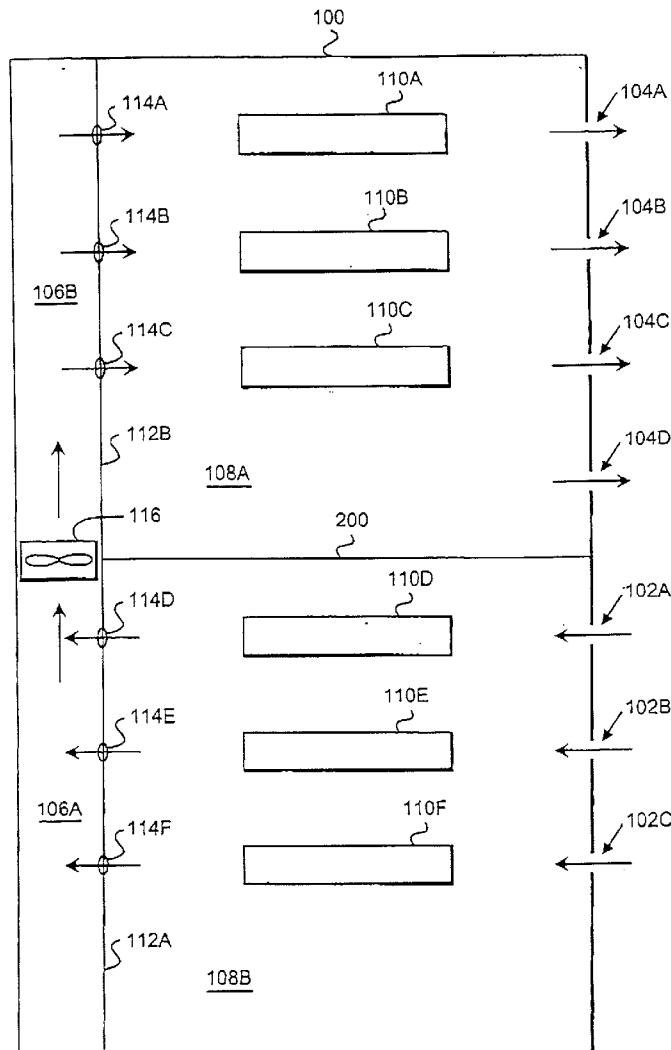
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An apparatus cabinet comprising one or more equipment bays, and at least one apparatus unit emitting heat in the equipment bay, the apparatus cabinet further comprising one or more inlets for drawing cooling air into the apparatus cabinet for cooling said apparatus unit, and one or more outlets for dissipating the air used for cooling from the apparatus cabinet, and the apparatus cabinet comprising a pressurization space and one or more fans interconnected to the pressurization space for changing the air pressure in the pressurization space to be different from the air pressure in the equipment bay, and a partition for separating the equipment bay and the pressurization space at least partly from one another, the partition comprising one or more air nozzles for conveying the air between the pressurization space and the equipment bay.



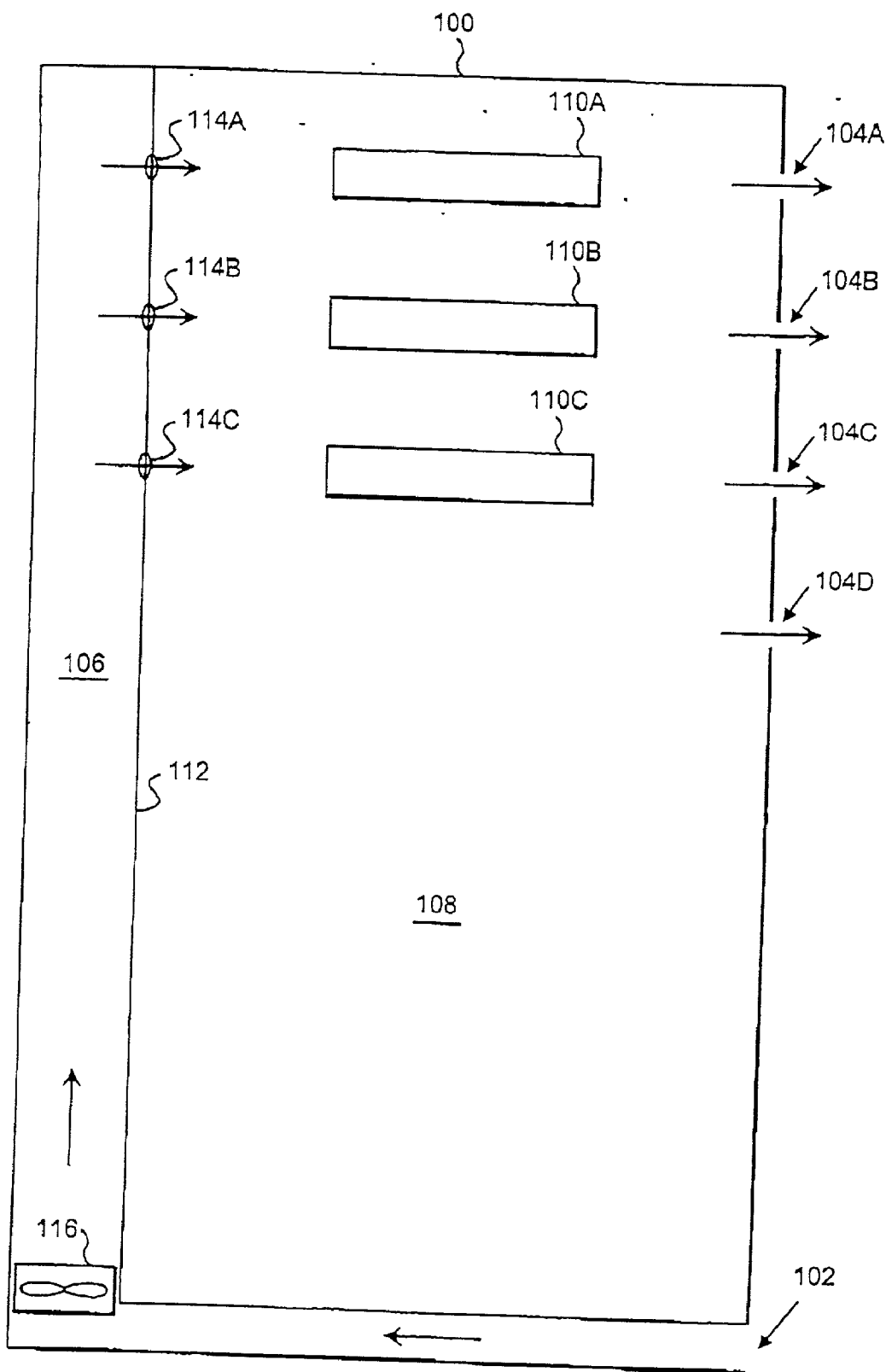


Fig. 1

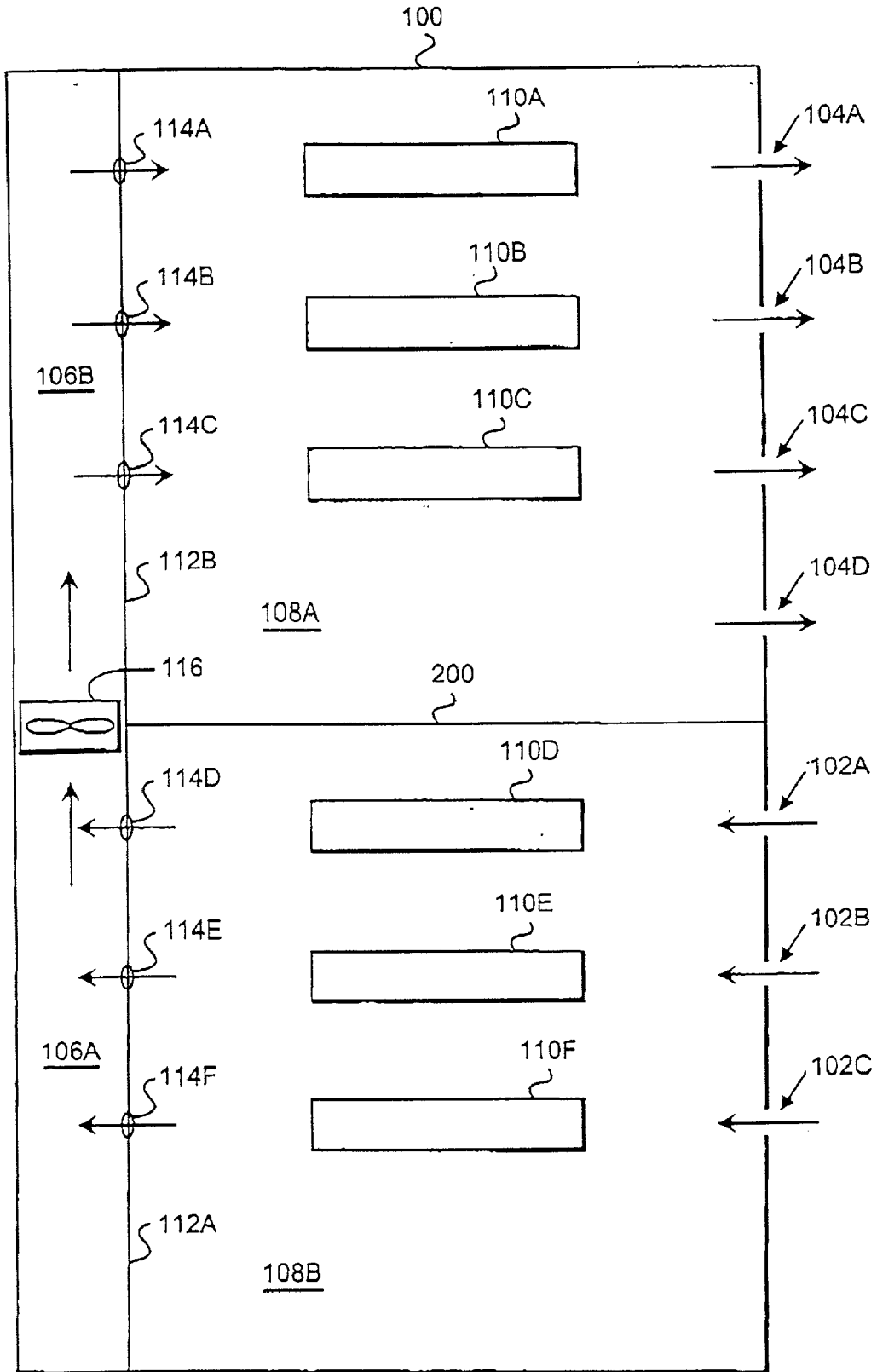


Fig. 2

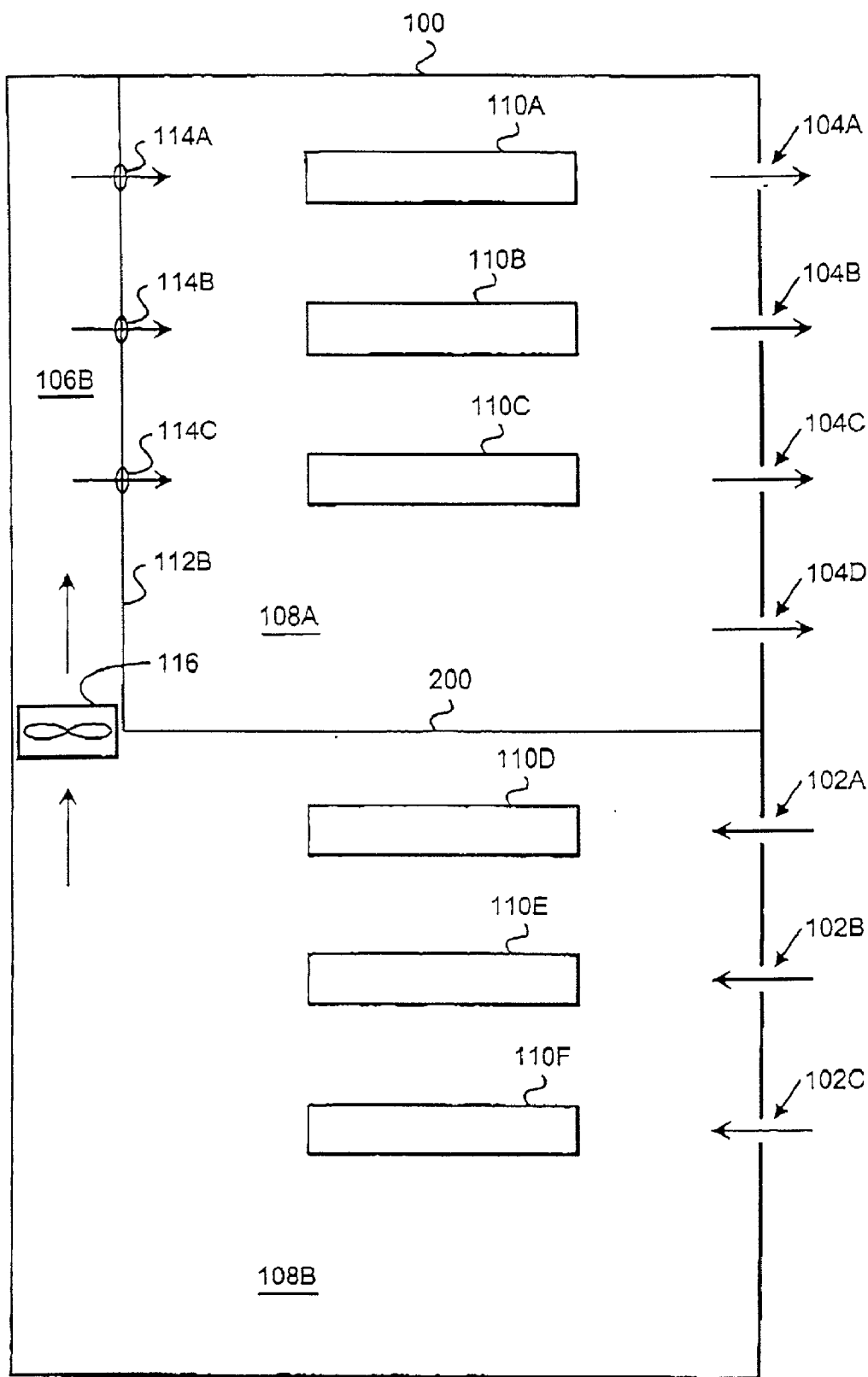


Fig. 3

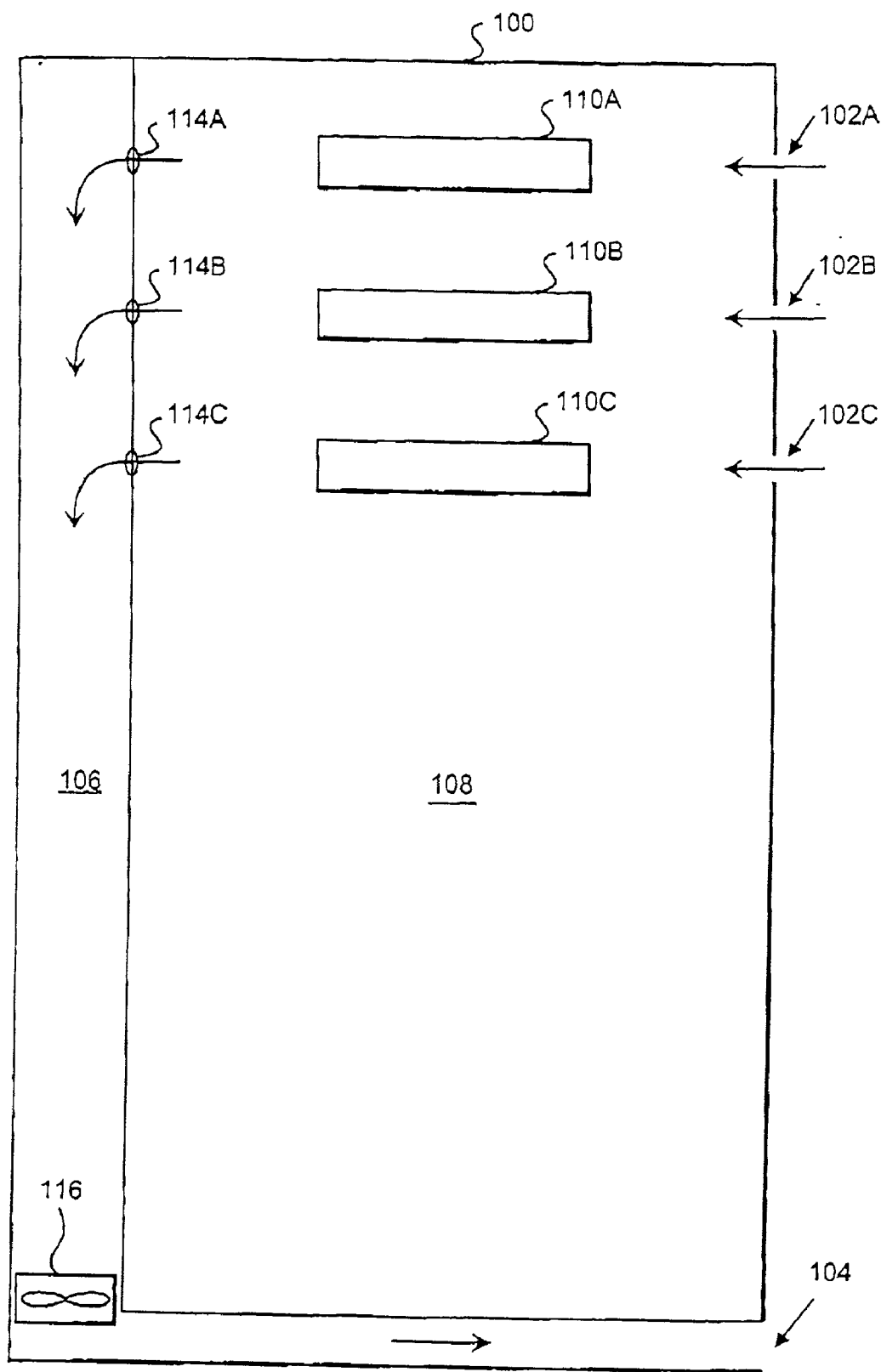


Fig. 4

COOLING AN APPARATUS CABINET

FIELD OF THE INVENTION

[0001] The invention relates to cooling apparatus cabinets including electronic apparatus units.

BACKGROUND OF THE INVENTION

[0002] An apparatus cabinet, such as a base station cabinet in a mobile system, comprises several electronic apparatus units emitting heat. In order to avoid the heat from damaging the apparatus units, cooling must be thoroughly planned in the apparatus cabinet. Cooling implemented by means of airflow openings and fans tends to provide an optimal cooling power and also a solution in which the amount of noise is insignificant.

[0003] A prior art cooling solution for cooling an apparatus cabinet is disclosed in U.S. Pat. No. 5,484,012. The publication describes a cooling solution of a microcomputer, in which the apparatus cabinet comprises several apparatus units emitting heat. One or more fans circulate the cooling air between an intake port and an exhaust port. In this publication, fans are placed for example in the exhaust port and near the apparatus unit.

[0004] The prior art solution includes significant drawbacks. In the presented solution, if the cabinet comprises a limited number of fans, the blowing capacity to the apparatus units is easily unevenly divided and may cause shadow areas in the apparatus cabinet as regards airflow. An increase in the number fans is in turn incompatible with the low noise level, which is a desirable property in a cooling solution.

BRIEF DESCRIPTION OF THE INVENTION

[0005] It is an object of the invention to implement an improved solution for cooling an apparatus cabinet. This is achieved with the apparatus cabinet of the invention comprising one or more equipment bays, and at least one apparatus unit emitting heat in the equipment bay, the apparatus cabinet further comprising one or more inlets for drawing cooling air into the apparatus cabinet for cooling said apparatus unit, and one or more outlets for dissipating the air used for cooling from the apparatus cabinet, and the apparatus cabinet comprising a pressurization space and one or more fans interconnected to the pressurization space for changing the air pressure in the pressurization space to be different from the air pressure in the equipment bay, and a partition for separating the equipment bay and the pressurization space at least partly from one another, the partition comprising one or more air nozzles for conveying the air between the pressurization space and the equipment bay.

[0006] The preferred embodiments of the invention are disclosed in the dependent claims.

[0007] The invention relates to an apparatus cabinet, such as a base station cabinet in a mobile system, and more particularly to a cooling solution in said apparatus cabinet. The heat emitted by electronic apparatus units in an apparatus cabinet creates a need to cool the apparatus cabinet. The apparatus cabinet includes at least one cooling air inlet and at least one outlet for dissipating the heated air emitted by the apparatus units from the apparatus cabinet. The outer frames of the apparatus cabinet are preferably made of metal, and the inlets and outlets are openings made into the

metal framework. According to the cooling need the openings can be opened, closed or adjusted. The position of the openings is not relevant for the invention, and therefore the openings can be placed for example on the sides, on the door or in the ceiling of the apparatus cabinet. The space restricted by the apparatus cabinet is divided into two parts, for example with a metal partition, a pressurization space and one or more equipment bays, into which the apparatus units are placed. The pressurization space provides the apparatus cabinet with an air pressure that is different from the environment or the equipment bay. The different air pressure allows air to flow between the pressurization space and the equipment bay. Air pressure changes in the pressurization space are achieved with a fan placed into the pressurization space. One or more nozzles in the partition enable the airflow between the pressurization space and the equipment bay. The nozzles are preferably openings in the metal partition. It is obvious that the size of the nozzle may vary, and larger nozzles are used when a more powerful cooling power is required.

[0008] In a preferred embodiment of the invention the fan is placed in the air inlet, thereby creating excess pressure into the pressurization space. Another preferred embodiment comprises more than one equipment bays, which are separated from one another with a separation wall. In such a case, the fan is placed into the pressurization space preferably onto the separation wall, in which case one equipment bay is cooled using the inlet air of the fan and the other equipment bay is cooled using outlet air. In another preferred embodiment the fan is placed onto the separation wall, but so that the fan is directly interconnected to the equipment bay without the partition separating the pressurization space from the equipment bay. A similar structure can be implemented in reverse so that the inlet side between the pressurization space and the equipment bay comprises a partition, but the outlet side of the fan has no partition. Further according to a preferred embodiment the air inlets are interconnected to the equipment bay, and a low pressure is created in the pressurization space using the fan, the cooling thus being entirely implemented by means of the fan's inlet air. In the above embodiments, the fan used in pressurization is placed in the lower part of the apparatus cabinet, thus minimizing the noise caused by cooling.

[0009] The apparatus units are preferably placed on top of one another in the apparatus cabinet, and are consequently in an equivalent position regarding cooling. The nozzles can be placed on the sidewall in a number of ways, preferably for example in such a manner that the partition includes at least one nozzle for each apparatus unit. The embodiments describe cooling by means of a single fan, but it is obvious that the apparatus cabinet may include several fans, for example in the inlets for improving the inlet airflow. Additional fans may correspondingly be placed in the outlets.

[0010] The use of the pressurization space according to the invention provides the advantage that the airflow between the equipment bay and the pressurization space is even, since the strength of the airflow to all nozzles is substantially equal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the following the invention will be described in greater detail by means of the preferred embodiments with reference to the accompanying drawings, in which

[0012] FIG. 1 shows a cooling solution of an apparatus cabinet using the outlet air of a fan in accordance with a preferred embodiment of the invention,

[0013] FIG. 2 shows a cooling solution of an apparatus cabinet using the outlet and inlet air of a fan in accordance with a preferred embodiment of the invention,

[0014] FIG. 3 shows a cooling solution of an apparatus cabinet using the outlet and inlet air of a fan in accordance with a preferred embodiment of the invention, and

[0015] FIG. 4 shows a cooling solution of an apparatus cabinet using the inlet air of a fan in accordance with a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] In the following the invention will be explained in more detail by means of the preferred embodiments with reference to the accompanying drawings. The preferred embodiments to be presented are examples of the solution of the invention, and are not meant to restrict the invention. FIG. 1 describes a cooling solution in an apparatus cabinet 100, such as a base station cabinet in a mobile system. The apparatus cabinet 100 is provided with air inlets 102 for drawing in cooling air and with outlets 104 for dissipating the heated air used for cooling in the apparatus cabinet. The air used for cooling and drawn in from the inlet 102 can be pure indoor air or outdoor air purified using filtering. The inlet 102 is interconnected to a pressurization space 106 of the apparatus cabinet preferably so that the pressurization space 106 is a continuum of the inlet 102. In the pressurization space 106 the air is prepressurized, i.e. the air pressure is raised using a fan 116 to exceed the air pressure of the surrounding space. Here, the surrounding space refers to the air pressure outside the apparatus cabinet, for instance to the pressure of the air drawn in from the inlet 102 or to the pressure in an equipment bay 108 of the apparatus cabinet 100. The equipment bay 108 comprises one or more apparatus units 110A to 110C, which in the case of a base station cabinet are circuit board covers including circuit boards. The equipment bay 108 is interconnected to one or more outlets 104A to 104D, from where the heated air emitted by the apparatus units 110A to 110C is dissipated from the equipment bay 108. Even if FIG. 1 does not indicate that the equipment bay comprises a separate fan, it is obvious that such a fan can be placed in the outlet 104. Furthermore, the fan 116 in the pressurization space 106 can be placed into several other places than to the one shown in the Figure, for example immediately in the inlet port 102. The pressurization space 106 and the equipment bay 108 are separated from one another with a partition 112. The partition 112 comprises nozzles 114A to 114C in order to convey air from the pressurization space 106 to the equipment bay 108. The nozzles 114A to 114C are preferably placed at the apparatus units 110A to 110C, thus distributing cooling air evenly to the apparatus units. In the base station cabinet the partition 112 is made of metal, for example, and here the nozzle refers to an opening in the metal partition. The nozzle solution can be implemented for example so that the fabricated partition originally comprises openings functioning as nozzles. In practice the number of nozzles may vary from a few openings up to ten openings. The nozzles 114A to 114C can be closed or opened according to need, for example by

covering them with covering plates to be attached to the partition 112 or correspondingly by removing the covering plates. It is obvious that the nozzles to be employed may also be continuously adjustable nozzles, in which the size of the nozzle opening is adjusted with an adjustment system placed into the apparatus cabinet according to the cooling needs.

[0017] FIG. 2 shows a solution of another preferred embodiment, in which the equipment bay of the apparatus cabinet 100 is divided into two parts with a separation wall 200, into a first equipment bay 108A and a second equipment bay 108B. The first equipment bay 108A is interconnected to the cooling air inlets 102 to 102C. The first equipment bay 108A shows three heat emitting apparatus units 110D to 110F, which are cooled using the inlet air of the fan 116 in the pressurization space 106. The fan 116 creates a low pressure to the first pressurization space 106A in relation to the equipment bay 108A, and air flows from the nozzles 114D to 114F in the partition 112A from the equipment bay 108A to the pressurization space 106 as indicated by the arrows. The apparatus cabinet 100 also comprises another pressurization space 106B that is situated on the outlet side of the fan 116 in the pressurization space 106. An excess pressure is thus formed into the pressurization space 106B in relation to the second equipment bay 108B, and the cooling air flows from the nozzles 114A to 114C in the direction of the equipment bay 108B as indicated by the arrows. The air used for cooling the apparatus units 110A to 110F is dissipated from the apparatus cabinet through the air outlets 104A to 104D. The solution shown in FIG. 2 provides the advantage that less heat emitting apparatus units 110D to 110F are placed in the first equipment bay 108 for cooling with inlet air. Apparatus units 110A to 110C requiring more efficient cooling are placed into the equipment bay 108B employing a more efficient cooling carried out with excess pressure.

[0018] FIG. 3 further shows a preferred embodiment. What distinguishes this solution from the one shown in FIG. 2 is that there is no partition 112A and no nozzles 114D to 114F placed therein between the first equipment bay 108A and the fan 116. Then the cooling carried out using inlet air in the first equipment bay 108A is not very efficient, thus enabling to position the heat emitting apparatus units 110D to 110F into said space. On account of the excess pressure created in the pressurization space 106 the cooling of the apparatus units 110A to 110C in the second equipment bay 108B is nevertheless efficient. The solution in FIG. 3 provides the advantage that the cooling solution is applicable to be used for cooling modularly assembled base station cabinets 100. In such a case, the structure of a module of the base station cabinet 100 including the first equipment bay 108A may differ from the module including the second equipment bay 108B. This may improve the use of base station cabinets in different environments.

[0019] According to a preferred embodiment illustrated in FIG. 4 the fan 116 is placed into the lower part of the apparatus cabinet 100 and is directly interconnected to the air outlet 104. The fan 116 creates a low pressure to the pressurization space 106 in comparison to the equipment bay 108, which is interconnected to the air outside the apparatus cabinet 100 through the inlets 102A to 102C. In the preferred embodiment shown in FIG. 4 cooling air flows from the equipment bay 108 to the pressurization space 106 as indicated by the arrows, meaning that cooling is imple-

mented utilizing the inlet power of the fan 116. The preferred embodiment in **FIG. 4** provides a significant advantage as regards noise reduction at the upper part level of the apparatus cabinet 100, i.e. on the standard listening height of human beings.

[0020] The solution of the invention is above presented by means of the preferred embodiments with reference to FIGS. 1 to 4. In the Figures the solution is described with reference to base station cabinets, but it is obvious that the solution is also applicable for cooling other apparatus cabinets including electronic apparatus units and/or components. The Figures do not show all base station cabinet parts, as the description thereof is not relevant for this invention. It is obvious that the invention is not restricted to the above embodiments but the solution of the invention can be modified in various ways within the scope of the appended claims.

1. An apparatus cabinet comprising one or more equipment bays, and at least one apparatus unit emitting heat in the equipment bay, the apparatus cabinet further comprising one or more inlets for drawing cooling air into the apparatus cabinet for cooling said apparatus unit, and one or more outlets for dissipating the air used for cooling from the apparatus cabinet, and the apparatus cabinet comprising a pressurization space and one or more fans interconnected to the pressurization space for changing the air pressure in the pressurization space to be different from the air pressure in the equipment bay, and a partition for separating the equipment bay and the pressurization space at least partly from one another, the partition comprising one or more air nozzles for conveying the air between the pressurization space and the equipment bay.

2. An apparatus cabinet as claimed in claim 1, wherein said one or more outlets are interconnected to the equipment bay including one or more apparatus units to be cooled.

3. An apparatus cabinet as claimed in claim 1, wherein the pressurization space is interconnected to said one or more inlets.

4. An apparatus cabinet as claimed in claim 1, wherein the pressurization space is interconnected to one or more outlets.

5. An apparatus cabinet as claimed in claim 1, wherein the equipment bay is interconnected to said one or more inlets.

6. An apparatus cabinet as claimed in claim 1, wherein the fan is placed into the pressurization space.

7. An apparatus cabinet as claimed in claim 1, wherein the fan creates excess pressure to the pressurization space for conveying cooling air from the pressurization space to said one or more equipment bays.

8. An apparatus cabinet as claimed in claim 1, wherein the fan creates low pressure to the pressurization space in comparison with the air used for cooling to be conveyed from the equipment bay to the pressurization space.

9. An apparatus cabinet as claimed in claim 1, wherein the fan is placed into the lower part of the apparatus cabinet for minimizing the noise at the listening height of human beings.

10. An apparatus cabinet as claimed in claim 1 comprising a first equipment bay and a second equipment bay and a separation wall separating said equipment bays from one another, the first equipment bay being cooled using the inlet air of the fan and the second equipment bay using the outlet air of the fan.

11. An apparatus cabinet as claimed in claim 1, wherein a partition separates the pressurization space and the equipment bay entirely from one another, thus restricting the air between the pressurization space and the equipment bay to be conveyed through nozzles.

12. An apparatus cabinet as claimed in claim 1, wherein the nozzles can be adjusted in relation to the penetrating capacity of air.

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