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(54) **AIR-CONDITIONING SYSTEM FOR A ROOM**

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(76) **Inventor: Gilles Serinet, Rueil Malmaison (FR)**

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Correspondence Address:
FAEGRE & BENSON LLP
PATENT DOCKETING
2200 WELLS FARGO CENTER, 90 SOUTH SEVENTH STREET
MINNEAPOLIS, MN 55402-3901 (US)

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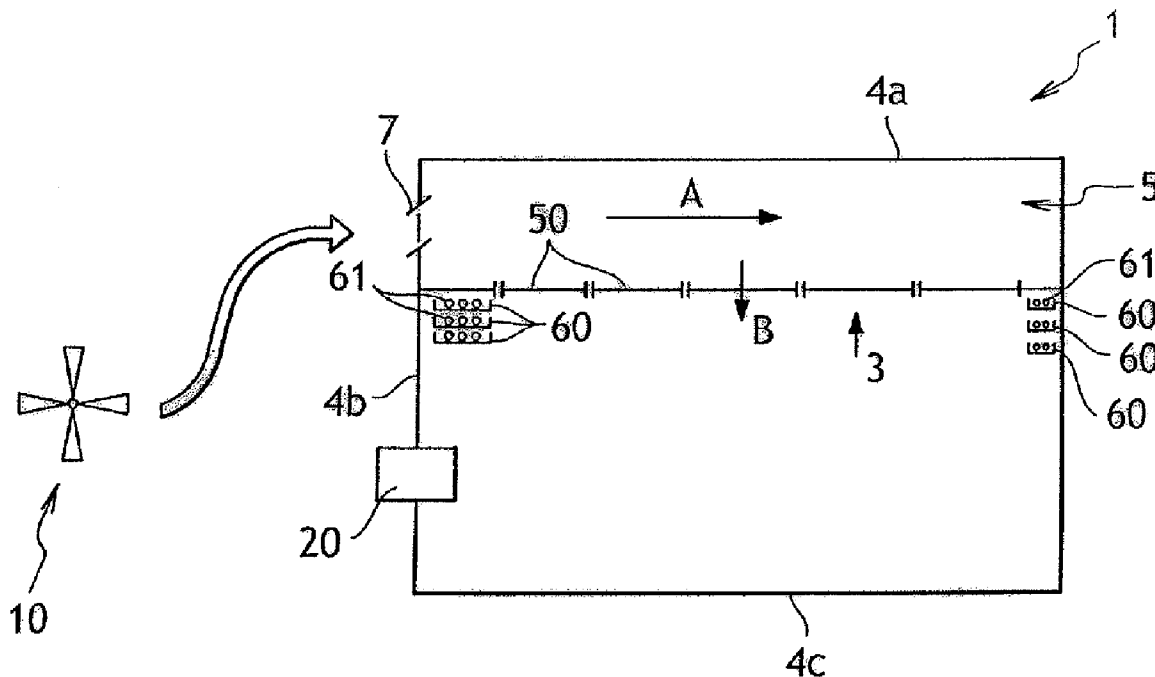
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(57) **ABSTRACT**

Air-conditioning system for a room, comprising means for diffusing air in the room and regulating means for diffusion of the blown air, characterised in that said means are intended to be placed at the level of the ceiling of the room, and in that the regulating means are suitable for spatially modulating diffusion of the air in the room.

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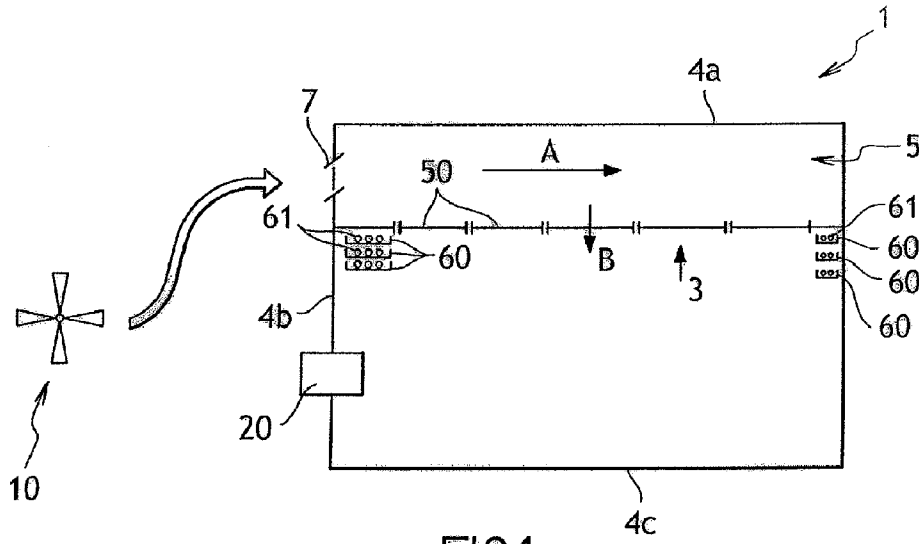


FIG. 1

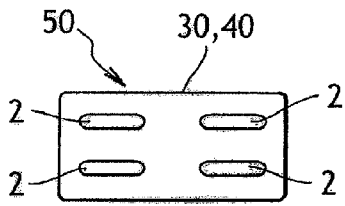


FIG. 2a

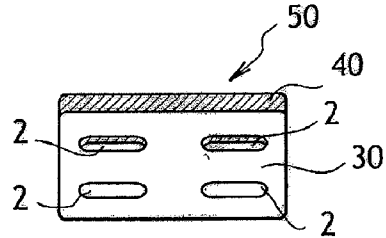


FIG. 2b

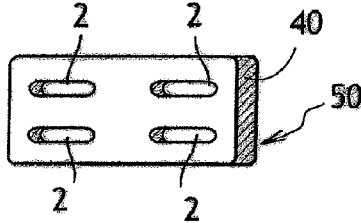


FIG. 2c

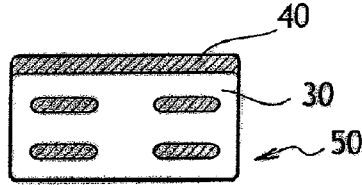


FIG. 2d

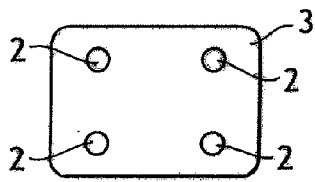


FIG. 3a

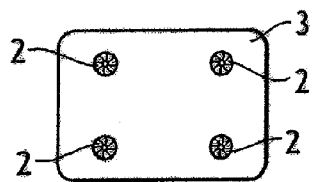


FIG. 3b

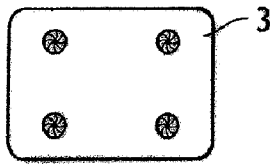


FIG. 3c

AIR-CONDITIONING SYSTEM FOR A ROOM

[0001] The invention relates to air-conditioning systems, and their supports and terminal element.

[0002] The invention relates more particularly to ceiling air-conditioning systems intended to adjust the temperature of a room to a given set temperature, by sending cold or hot air into the room.

[0003] The invention can be applied particularly to cooling rooms containing computer means, such as computer rooms of data-processing centres (also known as «data centres»). In fact, they generally need to be kept at a temperature not exceeding a determined threshold temperature, so as not to risk damage to computer equipment or networks stored there. This computer equipment or these networks, which function continuously, heat up and inevitably boost the temperature of the room.

[0004] Air-conditioning systems are thus necessary. The most popular system used in this situation is an air-conditioning system placed under a false floor composed of perforated tiles or tiles equipped with grilles, which projects cold air through the perforations of the tiles in the direction of the ceiling. The projected air thus keeps the temperature of the room at a given set temperature, by accompanying the rising hot air.

[0005] This air-conditioning system does have however a number of disadvantages, including the impossibility of evenly regulating the temperature within the room, which proves particularly annoying. In fact, the air blown through the tiles of the floor is intended to be distributed uniformly in the room, but its passage is blocked by connecting cables, generally placed under the floor for convenience. Therefore, not only is cooling of the room not performed optimally, but it is also done independently of the thermal gradients present in the volume to be cooled. It is known that a computer room of a data-processing centre has a significant thermal gradient, due especially to the different computer equipment operating.

[0006] Also, replacement or changing connections of one or more cables, including access to defective elements of the air-conditioning system (hampered by the presence of cables), requires the false floor to be dismantled. Maintenance operations are thus cumbersome to carry out and costly, especially when the room is occupied by computer equipment which has to be shifted.

[0007] In addition, this system is very sensitive to the accumulation of dust, difficult to avoid given the localisation of the system and cables hampering cleaning efforts. Now, dust partly hinders the passage of air and thus even further reduces the efficacy of the air-conditioning system, which can in turn harm computer installations.

[0008] Finally, the false floor must support the weight of the equipment sitting in the room, constituting a strict requirement for its size and requiring a high manufacturing cost.

[0009] Novel air-conditioning systems have thus been developed in an effort to eliminate disadvantages of the prior art. The document WO 99/0411, for example, proposes placing air-conditioning means in a false ceiling comprising porous acoustic tiles, the false ceiling being located at a distance from the ceiling of the room to be temperature-adjusted. The air sent by a fan circulates between the ceiling and the false ceiling, and is pushed through the porous gaps in the tiles by application of pressure. However, this system does not adapt the air-conditioning to the thermal gradients of the

room, and fails to propose solutions to the problems of maintenance and upkeep posed by the presence of cables under a false floor. Furthermore, it cannot be implemented for cooling a computer room of a data-processing centre: the air distributed by the pores does not actually suffice to compensate the increase in temperature due to the operating of the processors.

[0010] An aim of the invention is thus to eliminate these disadvantages of the prior art by proposing an air-conditioning system for cooling a computer room of a data-processing centre.

[0011] Another object of the invention is to propose an air-conditioning system for regulating diffusion of air as a function of thermal gradients of the room in which it is installed.

[0012] Another object of the invention is to propose an air-conditioning system ensuring the temperature of the room is maintained according to a set temperature under all circumstances.

[0013] Another object of the invention is to propose an air-conditioning system whereof the maintenance is facilitated relative to conventional systems.

[0014] Another object of the invention is to propose an air-conditioning system whereof the upkeep operations are facilitated relative to conventional systems.

[0015] Finally, an aim is to propose a room housing computer means, fitted with an air-conditioning system according to the invention, in which the cables do not hamper general upkeep and maintenance.

[0016] For this, the invention proposes an air-conditioning system of a room, comprising means for diffusing air in the room and regulating means for diffusion of the blown air, characterised in that said means are intended to be placed at the level of the ceiling of the room, and in that the regulating means are suitable for spatially modulating the diffusion of air in the room.

[0017] Preferentially said means are intended to be placed in a false ceiling, at a distance from the ceiling of the room.

[0018] Certain preferred though non-limiting aspects are as follows:

[0019] the means for diffusing air are openings made in the false ceiling,

[0020] the openings have oblong, circular or rectangular geometry,

[0021] spatial modulation, by the regulating means of the diffused air flow is done by modification of the size of the openings,

[0022] the regulating means comprise at least two superposed grilles which form the false ceiling, and in which the openings are made,

[0023] modification of the size of the openings is done by shifting one grille relative to the other,

[0024] the size of the openings is made using a diaphragm,

[0025] modification of the size of the openings is done selectively,

[0026] modification of the size of the openings is done by grouping the openings,

[0027] each group comprises a set of at least one opening,

[0028] the openings of the same group are adjacent,

[0029] each group defines a zone of the ceiling,

[0030] it also comprises blocking means in position of the regulating means,

[0031] the blocking means are thumbwheels,

[0032] it also comprises recovery means of the force air,

- [0033] the recovery means are intended to be placed in the lower part of the room,
- [0034] the recovery means are intended to be placed in a side wall of the room,
- [0035] the recovery means of the air comprise air filters for filtering recycled air,
- [0036] fire detection means are placed at the level of the air recovery means,
- [0037] it also comprises means for controlling the humidity of the room,
- [0038] the regulating means are controlled manually,
- [0039] the regulating means are controlled by control means as a function of a set temperature,
- [0040] the diffused air is pressurised between the ceiling and the sub-ceiling,
- [0041] it also comprises at least one central air-conditioning unit,
- [0042] the central air-conditioning unit is connected upstream to cold groups,
- [0043] the central air-conditioning unit is connected downstream to a fan,
- [0044] the fan sends air between the false ceiling and the ceiling,
- [0045] it also comprises at least one radiator grille,
- [0046] the air sent by the fan is deflected by the radiator grille, such that the air is distributed evenly between the ceiling and the false ceiling, and sweeps the entire surface of the false ceiling.
- [0047] According to a second aspect of the invention a room housing computer equipment is proposed, characterised in that it comprises an air-conditioning system as claimed in any one of the preceding claims.
- [0048] Certain preferred though non-limiting aspects are as follows:
- [0049] the cable paths are placed at the level of the ceiling,
- [0050] the cable paths are placed under the false ceiling,
- [0051] each cable path is dedicated to a network,
- [0052] it comprises a cable path dedicated to each element of the following group: strong currents, weak currents, and fiberoptic networks.
- [0053] Other characteristics, aims and advantages of the present invention will emerge from the following detailed description, with respect to the attached drawings, given by way of non-limiting examples, in which:
- [0054] FIG. 1 illustrates a room in section fitted with an air-conditioning system according to the invention,
- [0055] FIG. 2a shows diffusion means of the air-conditioning system according to a first embodiment, in a first diffusion position,
- [0056] FIG. 2b shows diffusion means of the air-conditioning system according to the first embodiment, in a second diffusion position,
- [0057] FIG. 2c shows diffusion means of the air-conditioning system according to the first embodiment, in a third diffusion position,
- [0058] FIG. 2d shows diffusion means of the air-conditioning system according to the first embodiment, in a fourth diffusion position,
- [0059] FIG. 3a shows diffusion means of the air-conditioning system according to a second embodiment, in a first diffusion position,
- [0060] FIG. 3b shows diffusion means of the air-conditioning system according to the second embodiment, in a second diffusion position,
- [0061] FIG. 3c presents diffusion means of the air-conditioning system according to the second embodiment, in a third diffusion position.
- [0062] The air-conditioning system according to the invention comprises diffusion means 2, as well as means for regulating the air flow sent into the room 1 by the diffusion means 2.
- [0063] The diffusion means are preferably openings 2 made in a false ceiling 3. The false ceiling 3 is intended to be placed at a distance from the ceiling 4a of the room 1, so as to leave a free space 5 for passage of air.
- [0064] The air flow 6 is sent by a fan, located upstream of the diffusion means 2, towards the space 5. To ensure even distribution of the air in this space 5, at least one radiator grille 7 is placed at the entry of the space 5, and deflects air flow 6. The flow then follows a direction A parallel to the ceiling 4a and the false ceiling 3, and is thus spread out so that it can evenly sweep the entire surface of the false ceiling 3 in the space 5.
- [0065] Pressurising of the air by the fan forces the air through the openings 2 made in the false ceiling 3, according to the direction B, towards the interior of the room 1.
- [0066] The air is then aspirated by recovery means 20, preferably placed near the floor 4c, in a side wall 4b of the room 1, for optimal cooling of the room 1 favouring circulation of the force air. These recovery means 20 aspirate force air, whereof the temperature has increased during its circulation in the room 1, and heat it outside the room 1. The displaced air is then rejected to the exterior, or recycled then reutilised by the air-conditioning system if the latter is operating in closed or semi-closed system.
- [0067] The recovery means 20 can also comprise means for filtering recycled air. Conventional fire detection means placed in front of the recovery means 20, which detect the presence of smoke in the when it is aspirated, and means for managing the humidity of the room can also be provided.
- [0068] The regulating means of the air force flow in the room 1 are suitable for spatially modulating diffusion of the air flow in the room 1, by selectively modifying the size of the openings 2.
- [0069] The openings 2 are preferably perforations made in the false ceiling 3. The regulating means are partial blocking means (as shown in FIGS. 2b, 2c and 3b) or total blocking means (as shown in FIGS. 2d and 3c) of the free cross-sections of the perforations 2, controlled individually at the level of each perforation, or by group of perforations.
- [0070] The groups of perforations are for example a set of adjacent perforations 2, the number of perforations 2 making up such a group depending on the scale of spatial modulation preferred for temperature regulation. The groups comprise a lesser number of perforations if the aim is to finely modulate regulation of the flow, if the aim is simply to adapt diffusion to a weak temperature gradient in the room.
- [0071] Regulating the free sections can be done manually, or due to electric control means, as a function of a set temperature. If needed, temperature sensors are placed in the room 1 and output a signal representative of the thermal gradient of the room 1, such that the control means control the free section of the perforations 2 as a function of the information transmitted by said sensors, and of the recorded set temperature.

[0072] According to a preferred embodiment, illustrated in FIGS. 2a to 2d, the false ceiling is made up of at least two grilles 30 and 40, superposed on one another, in which the perforations are made. The perforations are preferably of identical size and form, and distributed evenly in the plane of each grille 30, 40 of the false ceiling 3, such that it is possible to place each perforation of a grille 30 opposite a perforation made in the other grille 40 to form openings 2 connecting the space 5 above the false ceiling 3 and the room 1.

[0073] Each grille 30, 40 can be any size and form. Two grilles 30, 40 superposed on one another are preferably identical.

[0074] In the rest of the description, we will qualify the ensemble formed by two perforated grilles 30, 40 and superposed by a panel. We will also designate this panel by reference numeral 50 in the attached diagrams.

[0075] The false ceiling 3 preferably comprises a plurality of adjacent panels 50 of the above-mentioned type, covering the entire surface of the ceiling 4a, or at least the majority.

[0076] When the perforations 2 of the grilles 30 and 40, which form each panel 50, are opposite, as illustrated in FIG. 2a, the part of the false ceiling 3 covered by the panel 50 has a series of openings 2 via which the air can pass freely, and when the grilles 30 and 40 are offset transversally or longitudinally relative to one another the openings 2 are of a lesser size, as shown in FIGS. 2b and 2c, or even zero, as shown in FIG. 2d, where the air flow able to pass through is thus reduced.

[0077] Diffusion of the air flow sent into the room 1 can thus be modulated spatially by zones, by adding to the free section of the openings 2 at the level of each panel 50 according to the desired temperature in the subjacent part of the room 1. The surface of the regulated zones is then equal to the surface of the panels 50 constituting the false ceiling 3.

[0078] In this embodiment, the perforations 2 can have any geometry, for example rectangular or circular.

[0079] The perforations preferably have an oblong geometry to avoid any problem singularity (due to the presence of angles, as can be the case with rectangular openings), and can regulate the diffused air more precisely and more easily. In fact, in the case of circular perforations, shifting one grille 30 relative to the other 40 would cause irregular variation of the free section of the perforations, and thus of the quantity of flow sent into the room, whereas oblong geometry enables more linear modification.

[0080] The respective positioning of the grilles 30 and 40 can be done manually. In this case, the grilles 30 and 40 of a panel 50 are shifted relative to one another until the openings 2 have the right size. The grilles 30 and 40 can then be kept superposed in position to avoid any undesirable variation in their free sections, which would change the regulating of the air diffusion by blocking them by means of thumbwheels.

[0081] The grilles 30 and 40 can also be positioned using electric control means, which shift the grilles 30 and 40 relative to one another, as a function of the thermal gradient of the room 1, and of the set temperature.

[0082] According to a second embodiment, illustrated in FIGS. 3a to 3c, each opening 2 made in the false ceiling is associated with a diaphragm 60, allowing its size to be modified.

[0083] So, in the case of circular openings, the diaphragm is particularly adapted for modulating diffused air flow in the room, the latter simply modifying the diameter of the circular opening. Regulating can thus be easily controlled.

[0084] Blocking the openings 2 by means of the diaphragm is preferably controlled by control means attached to a given set temperature. It can also be done by a group openings in the false ceiling 3, these groups defining regulating zones, or individually, at the level of each opening.

[0085] When the air-conditioning system is installed in a place 1 housing computer means, such as a computer room of a data-processing centre, the fan 10 is connected to at least one central air-conditioning unit, preferably several, and sends cold air towards the radiator grilles 7 at a flow rate of the order of $27 \text{ km}^3 \cdot \text{h}^{3/4}$. The air is thus projected rapidly into the space 5, formed between the ceiling 4a and the false ceiling 3, ensuring both proper distribution in the space 5 prior to diffusion in the room 1, and also boosting the pressure applied by the air to the false ceiling 3, and thus the diffusion force of the air flow via the openings 2.

[0086] By way of indication, for a computer room of a conventional data-processing centre having a floor surface of around 400 m^2 , cooled by means of six conventional central air-conditioning units by the air-conditioning system according to the invention:

[0087] breakdown of a central air-conditioning unit does not substantially modify the temperature of the room 1,

[0088] simultaneous breakdown of two central air-conditioning units causes a 2° C. rise in the temperature of the room 1 relative to the set temperature,

[0089] simultaneous breakdown of three central air-conditioning units causes a 4° C. rise in the temperature of the room 1 relative to the set temperature.

[0090] Beyond this any the rise is not acceptable, as it would damage the computer equipment. However, such a situation where more than half of the central air-conditioning units are not operational has little risk of surviving these days.

[0091] Upstream of the central air-conditioning units cold groups produce cold water sent to the central air-conditioning units.

[0092] Finally, for convenience, the connecting cables 71 can be laid in cable paths 70 placed at height in the room 1, preferably under the false ceiling 3, each cable path 71 being specific to the type of cable laid. Strong currents, weak currents and fiberoptic networks can thus be laid separately in three separate cable paths for example. The installations are then apparent and thus better controlled.

[0093] As the air-conditioning system is placed high up, in the false ceiling 3 (of a size to support stresses applied by air blown in the room 1, as well as the weight of the false ceiling 3 and, if required, of the device for controlling and shifting the panels 50 which make it up), the problems associated with the false floor, now useless, are resolved by making maintenance and upkeep (cleaning) operations easier, without any heavy operation, such as disassembling tiles, being necessary.

[0094] Obviously, the air-conditioning system according to the invention is not limited to the cooling of rooms housing computer means, such as computer rooms of data-processing centres. It can also be adapted to cooling and/or heating of more conventional rooms.

[0095] Furthermore, because of the air-conditioning system, air in the room fitted with the system can be diffused adjustably by varying the size of the openings made in the false ceiling:

[0096] or so that the room temperature remains even, despite localised sources of heat (computer rooms of

data-processing centres). The set temperature is thus a constant temperature in the room,

[0097] so as to create a thermal gradient within the same room (for example in an «open space» office—that is, in open space—in which the aim is to maintain different temperatures according to the places in the room, for the comfort of personnel, so as to adapt individual work conditions as needed). The set temperature is thus a temperature gradient.

1. An air-conditioning system for a room (1), comprising means (2) for diffusing air in the room (1) and means (30, 40, 60) for regulating the diffusion blown air, characterised in that said means (2; 30, 40, 60) are intended to be placed at the level of the ceiling (4a) of the room (1), and in that the regulating means are suitable for spatially modulating diffusion of the air in the room.

2. The air-conditioning system according to claim 1, characterised in that said means are intended to be placed in a false ceiling (3), at a distance from the ceiling (4a) of the room (1).

3. The air-conditioning system according to claim 2, characterised in that the means (2) for diffusing air are openings made in the false ceiling (3).

4. The air-conditioning system according to claim 3, characterised in that the openings (2) have oblong, circular or rectangular geometry.

5. The air-conditioning system according to claim 3, characterised in that spatial modulation, by the means (30, 40, 60) for regulating diffused air flow is done by modification of the size of the openings (2).

6. The air-conditioning system according to claim 3, characterised in that the regulating means comprise at least two superposed grilles (30, 40), which form the false ceiling (3), and in which the openings (2) are made.

7. The air-conditioning system according to claim 6, characterised in that modification of the size of the openings (2) is done by shifting one grille (30) relative to the other (40).

8. The air-conditioning system according to claim 5, characterised in that modification of the size of the openings (2) is done by means a diaphragm (60).

9. The air-conditioning system according to claim 5, characterised in that modification of the size of the openings (2) is done selectively.

10. The air-conditioning system according to claim 5, characterised in that modification of the size of the openings (2) is done by groups of openings.

11. The air-conditioning system according to claim 10, characterised in that each group comprises a set of at least one opening (2).

12. The air-conditioning system according to claim 10, characterised in that the openings (2) of the same group are adjacent.

13. The air-conditioning system according to claim 1, characterised in that each group defines a zone (50) of the ceiling (4a).

14. The air-conditioning system according to claim 1, characterised in that it also comprises blocking means in position of the regulating means (30, 40).

15. The air-conditioning system according to claim 14, characterised in that the blocking means are thumbwheels.

16. The air-conditioning system according to claim 1, characterised in that it also comprises recovery means (20) of the force air.

17. The air-conditioning system according to claim 16, characterised in that the recovery means (20) are intended to be placed in the lower part of the room (1).

18. The air-conditioning system according to claim 16, characterised in that the recovery means (20) are intended to be placed in a side wall (4b) of the room (1).

19. The air-conditioning system according to claim 16, characterised in that the recovery means (20) of the air comprise air filters for filtering the recycled air.

20. The air-conditioning system according to claim 16, characterised in that fire detection means are placed at the level of the air recovery means (20).

21. The air-conditioning system according to claim 1, characterised in that it also comprises means for managing the humidity of the room.

22. The air-conditioning system according to claim 1, characterised in that the regulating means (30, 40) are controlled manually.

23. The air-conditioning system according to claim 1, characterised in that the regulating means (30, 40, 60) are controlled by control means as a function of a set temperature.

24. The air-conditioning system according to claim 1, characterised in that the diffused air is pressurised between the ceiling (4a) and the sub-ceiling (3).

25. The air-conditioning system according to claim 1, characterised in that it also comprises at least one central air-conditioning unit.

26. The air-conditioning system according to claim 25, characterised in that the central air-conditioning unit is connected upstream of the cold groups.

27. The air-conditioning system according to claim 25, characterised in that the central air-conditioning unit is connected downstream of a fan (10).

28. The air-conditioning system according to claim 27, characterised in that the fan (10) sends air between the false ceiling (3) and the ceiling (4a).

29. The air-conditioning system according to claim 1, characterised in that it also comprises at least one radiator grille (7).

30. The air-conditioning system according to claim 27 characterised in that the air sent by the fan (10) is deflected by a radiator grille (7), such that the air is distributed evenly between the ceiling (4a) and the false ceiling (3), and sweeps the entire surface of the false ceiling (3).

31. A room (1) housing computer equipment, characterised in that it comprises an air-conditioning system according to claim 1.

32. The room (1) according to claim 31 characterised in that the cable paths (60) are placed at the level of the ceiling (4a).

33. The room (1) according to claim 31, characterised in that the cable paths (70) are placed under the false ceiling (3).

34. The room according to claim 31, characterised in that it comprises a cable path dedicated to each element of the following group: strong currents, weak currents, and fiberoptic networks.

* * * * *