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(54) **Equipment for cooling and heating spaces in building**

(57) Equipment for cooling and heating spaces in buildings, in whose housing (14), furnished with an entry for the intake of circulating air and an exhaust for conditioned air, there is a heat exchanger (1) unit with fan (4), where that fan (4) is positioned on the outlet side of the heat exchanger (1), whilst under the heat transfer surface of the heat exchanger (1) there is a condensate tank (2). The heat transfer surface of the heat exchanger (1) is tightly closed at both ends by the housing (14), which is furnished with a tightly fitting service lid (7). The heat transfer surface of the heat exchanger (1) consists of a

cylindrical annular segment with axis perpendicular to the direction of the horizontal flow of the incoming circulating air, and the unclosed part of the cylinder fits tightly for its whole height against the vertical closing wall of the housing (14). Inside that cylindrical heat transfer surface there is a suction fan (4) whose exhaust passes sealingly through the vertical closing wall of the housing (14) in the location of the unclosed part of the cylinder of the heat transfer surface of the heat exchanger (1), and is connected by a distribution duct (9), through a diffuser (8), to an air distribution element (10).

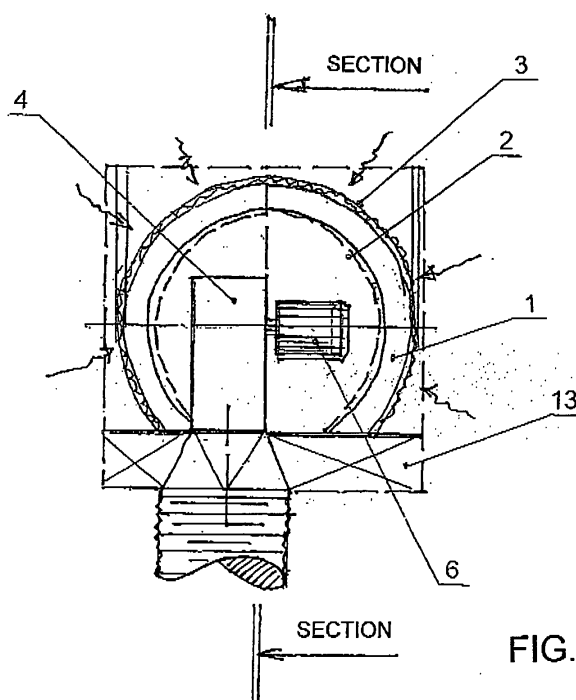


FIG. 2

Description

Field of the invention

[0001] The invention involves equipment for cooling and heating spaces in buildings.

Description of the prior art

[0002] To ensure a comfortable atmosphere in administrative buildings, the fan coil has long been known and used as the end element of the air-conditioning system, to ensure thermal well-being without the need for a primary supply of fresh air. At the same time it was introduced as a balance to the induction units, in an attempt to substitute for this final air conditioning element a sufficiently powerful and flexible unit which would not be dependent upon a principal air flow. A further purpose for its introduction was to simplify the regulating system for heating and cooling water, as an auxiliary fan was inserted into the system, permitting a greater performance range by circulating air across a heat transfer surface. The heating and cooling capacity was thus determined without direct dependence upon a primary supply of air, which also meant that the diameters of the central vertical air distribution pipes in tall buildings could be reduced. Fan coils are mainly used at the present time as the final element for comfortable air-conditioning of hotel rooms, meeting rooms, administrative areas, commercial surfaces etc., and also in the off-take of thermal load from some technological operations. The structural arrangements of these fan coils are described for example in USA Patents Nos. 4527762, 4548050, 4856672, 4986087, 5042269, 5071027, 5113667, 5131560, 5152154, 5174467, 5195332, 5199276, 5205472, 6109044.

[0003] From the point of view of the overall structural solution, there has been no significant change in the execution and concept of fan coils, their development concentrating primarily on the use of modern production techniques involving serial production, the possibility of improved regulation, reduced dimensions and also, in part, greater effectiveness of the individual components, and reduced noise levels in those units resulting from the reduction in their size and an increase in the number of revolutions of the fan. The original effect of the design of the air-conditioning systems was that the noise was not consistently reduced in the areas where they were used. The noise of the fan coil is the most problematic attendant factor. Primarily caused by the running of the fan, it is influenced both by the execution of the fan coil, its heating and cooling performance and by the area of use. The noise is generally caused by an improperly executed structural embodiment of the unit, when a turbulent motion is produced by an incorrect design of the runner blades of the fan, by sharp edges in the direction of the air flow etc. It is further caused by an inappropriate technical execution of the unit and its accessories, putting

great overall strain on the fan. The pressure losses from the fan are so great that a high peripheral speed in the runner and an increased input from the fan are required to overcome them. The noise of the fan generally has a specific mathematical relationship to its input and efficiency. The principle generally applies that, given good technical execution, the greater the number of revolutions of the fan, the noisier it is. The pressure loss by the elements in the fan coil and its accessories, to be compensated by the fan pressure, equals the square of the air flow speed in through that segment. In practice that means that if the air flow speed can be cut by half in the key components experiencing significant pressure loss, the pressure loss will be reduced by a quarter and the necessary input from the fan will be reduced to 25% of the original energy requirement. It is true that the noise level will not be reduced in this proportion because the reduction in noise will have a logarithmic relationship, but nevertheless the reduction will be significant. The aim of the invention as filed is to create equipment for cooling and heating spaces in buildings with a reduction in the noise level, simplified logistics, that is with a reduction in the number of parts and supplies in stock, with simplified dispatching and service and increased serial production.

Summary of the invention

[0004] The invention involves equipment for cooling and heating spaces in buildings, in whose housing, furnished with an entry for the intake of circulating air and an exhaust for conditioned air, there is a heat exchanger unit with fan, where that fan is positioned on the outlet side of the heat exchanger, whilst under the heat transfer surface of the heat exchanger there is a condensate tank, and where the heat transfer surface of the heat exchanger is tightly closed at both ends by the housing, which is furnished with a tightly fitting service lid. The basis of the invention lies in the fact that the heat transfer surface of the heat exchanger consists of a cylindrical annular segment with axis perpendicular to the direction of the horizontal flow of the incoming circulating air, and the unclosed part of the cylinder fits tightly for its whole height against the vertical closing wall of the housing, and where inside that cylindrical heat transfer surface there is a suction fan whose exhaust passes sealingly through the vertical closing wall of the housing in the location of the unclosed part of the cylinder of the heat transfer surface of the heat exchanger, and is connected by a distribution duct, through a diffuser, to an air distribution element.

[0005] At the entry to the heat exchanger of air to be heat conditioned, there can be a dirt filter whose shape corresponds to that entry part of the heat exchanger. The distribution element is selected from the group comprising anemostats, apertures, large-area ventilating outlets.

[0006] The equipment according to this invention is compact and has standardized outer dimensions which correspond to existing soffit or floor systems in buildings, for example 60 x 60 cm. The intent is to produce modular

equipment permitting serial production with simplification of logistics, that is with a reduction in the number of parts and supplies in stock, and with simplified dispatching and service. A further advantage lies in the reduction in noise level of the equipment.

[0007] The heat exchanger pipe is connected at its entry and outlet to a four-pipe distribution system for the operating medium, so that all the supply and offtake pipes for the cooling and heating operating medium are furnished with coupled shut-off valves to prevent simultaneous supply and offtake of the heating and cooling operating medium into the heat exchanger, for which, in the supply pipes for the heating and cooling operating medium in the direction of the heat exchanger, control valves are individually arranged, whose outlets are connected to the pipe at the entry to the heat exchanger, and at the same time the outlets of the shut-off valves in the direction of the heat exchanger are connected to the pipe at the outlet of the heat exchanger. The control valves for regulating the flow of the heating and cooling operating medium are individually connected through a regulator to a room temperature sensor in the air conditioned area. At least one further heat exchanger unit with fan, distribution duct and air distribution element can be connected parallel to the pipe at the entry and the pipe at the outlet of the heat exchanger. From the point of view of regulation, it is advantageous if more than one unit of the equipment are controlled by a single room temperature sensor in one place of larger dimensions or where there is greater heat loss or increase in temperature.

[0008] A duct for the supply of fresh air from a central treatment plant for outside air can be connected into the distribution duct from the heat exchanger unit with fan for circulating air in the air conditioned area, so that it is connected in the direction of the flow of the circulating air. An injection effect is thus created, assisting the flow of air, without thereby reducing the output of the equipment. Shut-off valves and control valves and further electrical installation elements can be arranged in the equipment housing, according to this invention. All of this contributes to the compactness of the equipment.

Brief description of the drawings

[0009] The invention is further explained by means of the attached drawings and the following description of a specific example of one possible embodiment. Fig. 1 shows a side view of a partial cross-section of a horizontal, soffit embodiment of an air-conditioning unit. Fig. 2 is a ground-plan view of the embodiment in Fig. 1. Fig. 3 is a schematic illustration of a set of air-conditioning units consisting of a master-type unit with a further slave-type unit connected to it, where the outlets of both these units are connected through individual distribution pipes to the corresponding distribution elements, which are anemostats in the given embodiment. A four-pipe distribution system for the operating medium is led into the master-type heat exchanger unit, to which it connects,

through the appropriate closing and control valves of the two-pipe connection, to the master-type unit A further, parallel slave-type air-conditioning unit is connected to this two-pipe connection by a two-pipe distribution system for the operating medium. The connection of the four-pipe distribution system for the operating medium to the master-type air-conditioning unit is illustrated in Fig. 4. Fig. 5 shows a side view in partial cross-section and a further ground plan view of the distribution element, consisting in this case of an anemostat.

Examples of preferred embodiments

[0010] The cooling and heating equipment (hereinafter the air-conditioning unit) comprises a large-area multi-disc heat exchanger 1 for air flow of about 400 m³/hour and a frontal air-flow surface of about 0.2 m². The heat exchanger 1, about 220 to 250 mm in height, in a three-row embodiment (it can be two- to four-row), comprises three rows of copper pipes with a diameter of 0.8 to 1.2cm, on which are strung together staggered oblong vanes of aluminium alloy which fit closely against the surface of the copper pipes. One of these rows can be used for independent connection to the heating distribution system, the remaining rows can be connected to the cooling water distribution system. The heat exchanger is arranged, together with the fan 4, in the housing 14 of the air-conditioning unit, which is furnished with an entry for the intake of circulating air and an exhaust for conditioned air. The fan 4 is positioned on the outlet side of the heat exchanger 1, whilst under the heat transfer surface of the heat exchanger 1 there is a condensate tank 2. The heat transfer surface of the heat exchanger 1 is tightly closed at both ends by the housing 14, which is furnished with a tightly fitting service lid 7. The heat transfer surface of the heat exchanger 1 consists of a cylindrical annular segment with axis perpendicular to the direction of the horizontal flow of the incoming circulating air, and the unclosed part of the cylinder fits tightly for its whole height against the vertical closing wall of the housing 14. Inside that cylindrical heat transfer surface there is a suction fan 4 whose exhaust passes sealingly through the vertical closing wall of the housing 14 in the location of the unclosed part of the cylinder of the heat transfer surface of the heat exchanger 1, and is connected by a distribution duct 9, through a diffuser 8, to an air distribution element 10. An additional condensate tank, connected to the condenser outlet, can be connected to the condensate tank 2 in the shape of an annular segment, positioned under the correspondingly shaped heat transfer surface of the heat exchanger 1.

[0011] At the entry to the heat exchanger 1 of air to be heat conditioned, there is a dirt filter 3 whose shape corresponds to that entry part of the heat exchanger 1.

[0012] In the inner space defined by the heat exchanger 1 in the described embodiment, there is a radial fan 4 in a spiral housing 5, a so-called bilateral suction fan which can suck air from both sides of the spiral housing

5. Alternatively, a diagonal fan can be used (not illustrated). The runner of the fan 4 is driven by an asynchronous electrical motor 6 with the possibility of multi-stage or continuous regulation of the revolutions. This assembly (heat exchanger 1, fan 4) is positioned in the sealed housing 14, so that the air sucked in by the fan 4 does not flow outside the heat-exchanger surface. The lower part of the housing 14 is furnished with a tightly fitting service lid 7, allowing for maintenance and cleaning of the fan 4 and the heat exchanger 1 from the inside. On the upper plate of the housing 14 there are fixtures for fastening the whole device to the horizontal building structure (for example, to the ceiling of the room). Alternatively, the housing 14 is secured by lower fixtures to the floor of the building, in which case the service lid 7 is in the upper part of the housing 14.

[0013] The fan 4 blows air through the diffuser 8 into the distribution duct 9 which brings the air to the distribution element 10, for example an anemostat, aperture, large-area ventilating outlet. The purpose of the diffuser 8 is to reduce the speed of the air coming out of the fan 4 and thereby reduce the pressure loss in the connected distribution duct 9. Between the distribution duct 9 and the outlet of the diffuser 8 there can be a flexible element, for example a flexible pipe or a textile insert which limits the transfer of vibrations from the air-conditioning equipment or unit into a distribution duct 9 with a 250 mm diameter. Part of the diffuser 8 is a transitional collar permitting an easy connection to the flexible element, or to a distribution duct 9 of suitable diameter. The air-conditioning unit has standardized outer dimensions corresponding to the existing ceiling or floor systems, for example 60 x 60 cm. The intent is to produce a modular air-conditioning unit permitting serial production with simplification of logistics, that is with a reduction in the number of parts and supplies in stock, and with simplified dispatching and service

[0014] Part of the electrical connection of the unit, or even its regulation, the so-called electrical housing, and also the space for positioning the vents of the heat exchanger 1 can advantageously be part of the air-conditioning unit according to this invention. These parts fit tightly against the diffuser 8 at the outlet of the unit. The heat exchanger 1 pipe is connected to the entry and outlet of the operating medium, for example water, anti-freeze mixture etc. The connection of the heat exchanger pipe 1 to the four-pipe distribution system for the operating medium is executed so that the supply and offtake pipes for the cooling and heating medium (the operating medium) are individually furnished with shut-off valves 11 to prevent simultaneous supply and offtake of the heating and cooling operating medium in the heat exchanger 1. They can be mutually connected electrically with independent controlling elements, or they can be mechanically coupled. In the heating operational mode, first the two-position closing valve on the hot water circuit opens. This two-position closing valve is coupled with the closing valve 11 on the cooling water circuit and simultaneously

closes in the heating operational mode. It is similar to the opposite sequence of two shut-off valves 11 in the cooling operational mode.

[0015] The actual regulation of the heating and cooling performance of the heat exchanger 1 is carried out by means of direct or two-way control valves 12, furnished for example with thermal-heads or actuating mechanisms which are connected through a regulator to a room temperature sensor 13 in the air-conditioned area. The control valves 12 regulate the flow of the heating and cooling medium in accordance with the required temperature in the air-conditioned area.

[0016] If the cooling medium has temperature parameters of 14° C / 18° C (input/output) and the heating water 35° C / 30° C (input/output), then given interior parameters of 22° C in the winter and 24.5° C in the summer for the air-conditioned area, the air-conditioning unit will have a cooling or heating capacity of about 1.2 kW under standard office conditions, for example 10 to 15 m² of usable surface area. For offices with greater surface area, more air-conditioning units will have to be added. It will then be convenient, from the point of view of regulation, if more units are controlled by a single room temperature sensor 13. According to this invention, a single room temperature sensor 13 can control a pilot air-conditioning unit, the so-called master unit, which is then equipped with the set of valves described above (shut-off valves 11 and direct control valves 12) so that, beyond the direct control valves 12 in the direction of the air-conditioning unit, branches at the supply and offtake from the heat exchanger 1 are individually taken to the two-pipe connection, and they then go in the direction of the other (slave) air-conditioning units, connected parallel to the master-type unit. If a single distributing element 10 is used for the supply of fresh air from the central treatment plant for outside air and for the supply of circulating air from the air-conditioning unit, the supply of outside air must be provided in such a way that the output from the air-conditioning unit is not reduced and it must be brought in the direction of the flow of circulating air, thus creating an injection effect, assisting the flow of air.

[0017] The solution according to this invention in no way reduces the floor surface available to the renter or user of the space. It is very flexible and, from an architectural standpoint, allows for the creation of a variety of interior solutions by an appropriate selection of the distribution element. The advantages lie in the reduced need to limit the flow of air through the fan coil, as a result of which a reduction in the heating and cooling performance through clogging of the filter is to a considerable extent avoided. A further advantage lies in the fact that the supply of fresh air and of circulating air from the fan coil can be put into a single element. With the appropriate connection of the fresh air supply, increased air flow (and thereby an increased heating and cooling output) can be achieved by use of the induction effect. By placing more units next to one another, the desired area inputs of heat and coolness for the whole surface can be achieved in

spaces with large interior depth.

Industrial use

[0018] The invention can be used for cooling and heating spaces in buildings.

List of reference numerals

[0019]

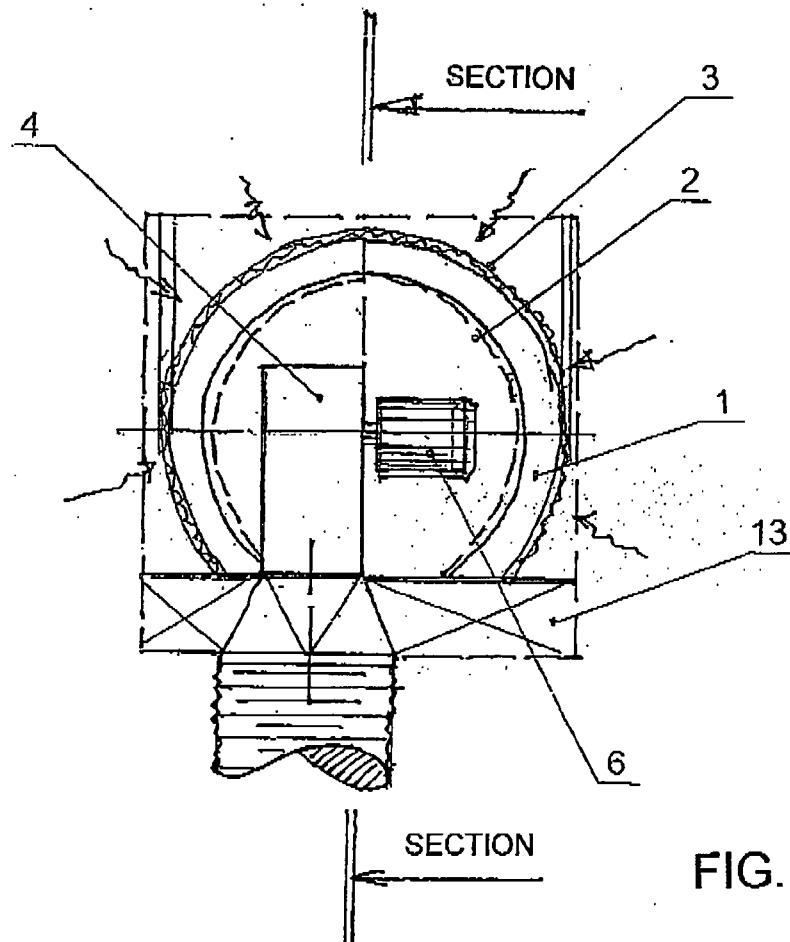
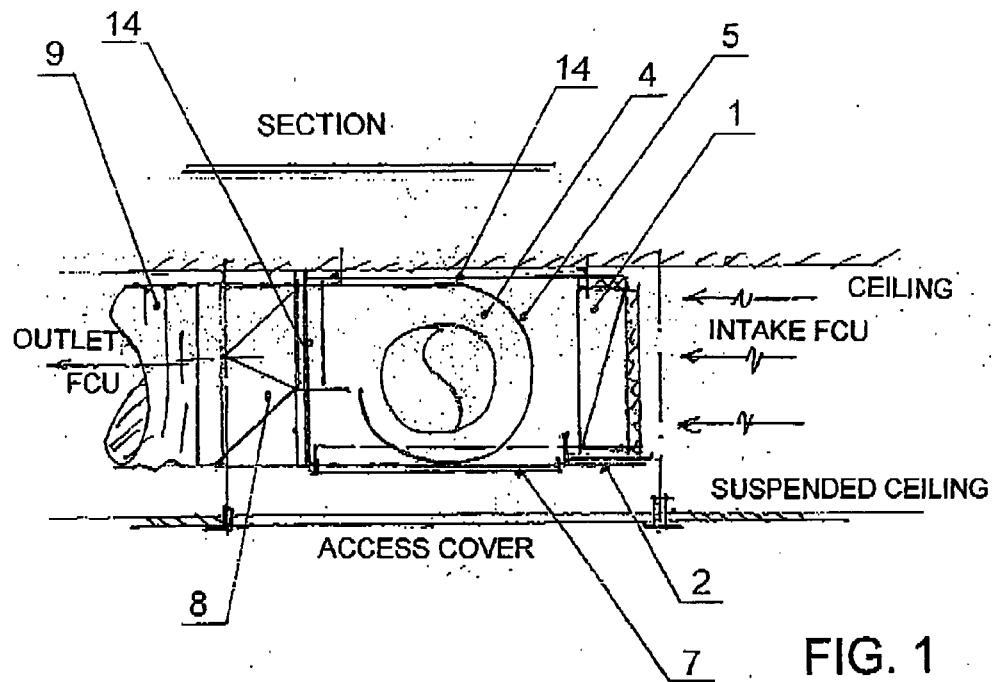
- | | | |
|------|--------------------------------------|----|
| 1... | heat exchanger | |
| 2... | condensate tank | |
| 3... | filter | |
| 4... | fan | |
| 5... | spiral fan housing | 15 |
| 6... | electrical fan motor | |
| 7... | service lid of the equipment housing | |
| 8... | diffuser | |
| 9... | distribution duct | 20 |
| 10.. | distribution element | |
| 11.. | shut-off valves | |
| 12.. | control valves | |
| 13.. | room temperature sensor | |
| 14.. | housing | 25 |

Claims

1. Equipment for cooling and heating spaces in buildings, in whose housing (14), furnished with an entry for the intake of circulating air and an exhaust for conditioned air, there is a heat exchanger (1) unit with fan (4), where that fan (4) is positioned on the outlet side of the heat exchanger (1), whilst under the heat transfer surface of the heat exchanger (1) there is a condensate tank (2), and where the heat transfer surface of the heat exchanger (1) is tightly closed at both ends by the housing (14), which is furnished with a tightly fitting service lid (7), **characterised in that** the heat transfer surface of the heat exchanger (1) consists of a cylindrical annular segment with axis perpendicular to the direction of the horizontal flow of the incoming circulating air, and the unclosed part of the cylinder fits tightly for its whole height against the vertical closing wall of the housing (14), and where inside that cylindrical heat transfer surface there is a suction fan (4) whose exhaust passes sealingly through the vertical closing wall of the housing (14) in the location of the unclosed part of the cylinder of the heat transfer surface of the heat exchanger (1), and is connected by a distribution duct (9), through a diffuser (8), to an air distribution element (10). 30 35 40 45 50 55
2. Equipment according to claim 1, **characterised in that**, at the entry to the heat exchanger (1) of air to be heat conditioned, there is a dirt filter (3) whose

shape corresponds to that entry part of the heat exchanger (1).

3. Equipment according to claim 1 or 2, **characterised in that** the heat exchanger (1) pipe is connected at its entry and outlet to a four-pipe distribution system for the operating medium, so that all the supply and offtake pipes for the cooling and heating operating medium are furnished with coupled shut-off valves (11) to prevent simultaneous supply and offtake of heating and cooling operating medium into the heat exchanger (1), for which, in the supply pipes for the heating and cooling operating medium in the direction of the heat exchanger (1), control valves (12) are individually arranged, whose outlets are connected to the pipe at the entry to the heat exchanger (1), and at the same time the outlets of the shut-off valves (11) in the direction of the heat exchanger (1) are connected to the pipe at the outlet of the heat exchanger (1).
4. Equipment according to claim 3, **characterised in that** the control valves (12) for regulating the flow of the heating and cooling operating medium are individually connected through a regulator to a room temperature sensor (13) in the air conditioned area.
5. Equipment according to any of claims 1 to 4, **characterised in that** the distribution element (10) is selected from the group comprising anemostats, apertures, large-area ventilating outlets.
6. Equipment according to any of claims 3 to 5, **characterised in that** at least one further heat exchanger (1) unit with fan (4), distribution duct (9) and air distribution element (10) is connected parallel to the pipe at the entry and the pipe at the outlet of the heat exchanger (1).
7. Equipment according to any of claims 1 to 6, **characterised in that** a duct for the supply of fresh air from a central treatment plant for outside air is connected into the distribution duct (9) from the heat exchanger (1) unit with fan (4) for circulating air in the air conditioned area, so that it is connected in the direction of the flow of the circulating air.
8. Equipment according to any of claims 3 to 7, **characterised in that** shut-off valves (11) and control valves (12) and further electrical installation elements are arranged in the housing.



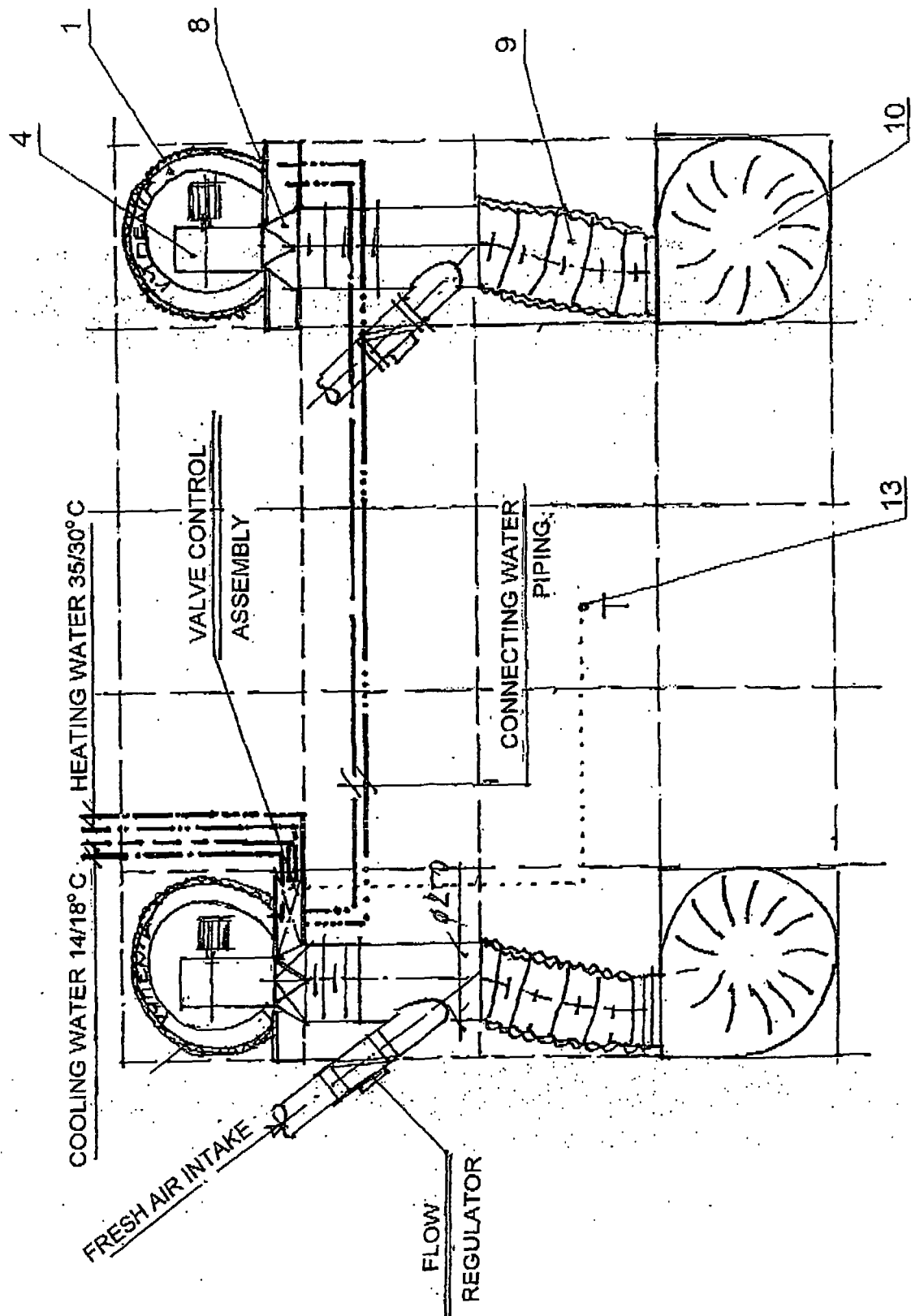


FIG. 3

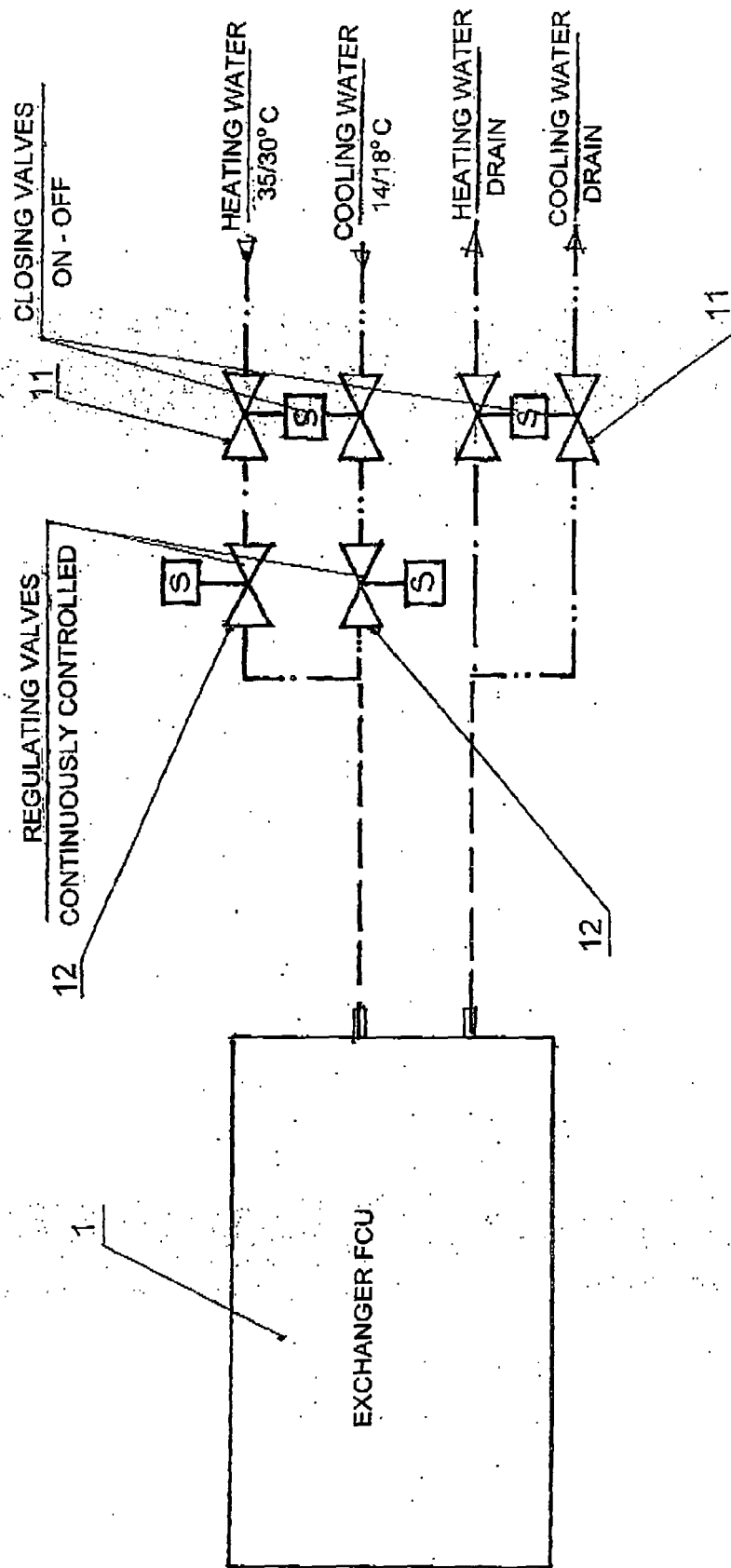
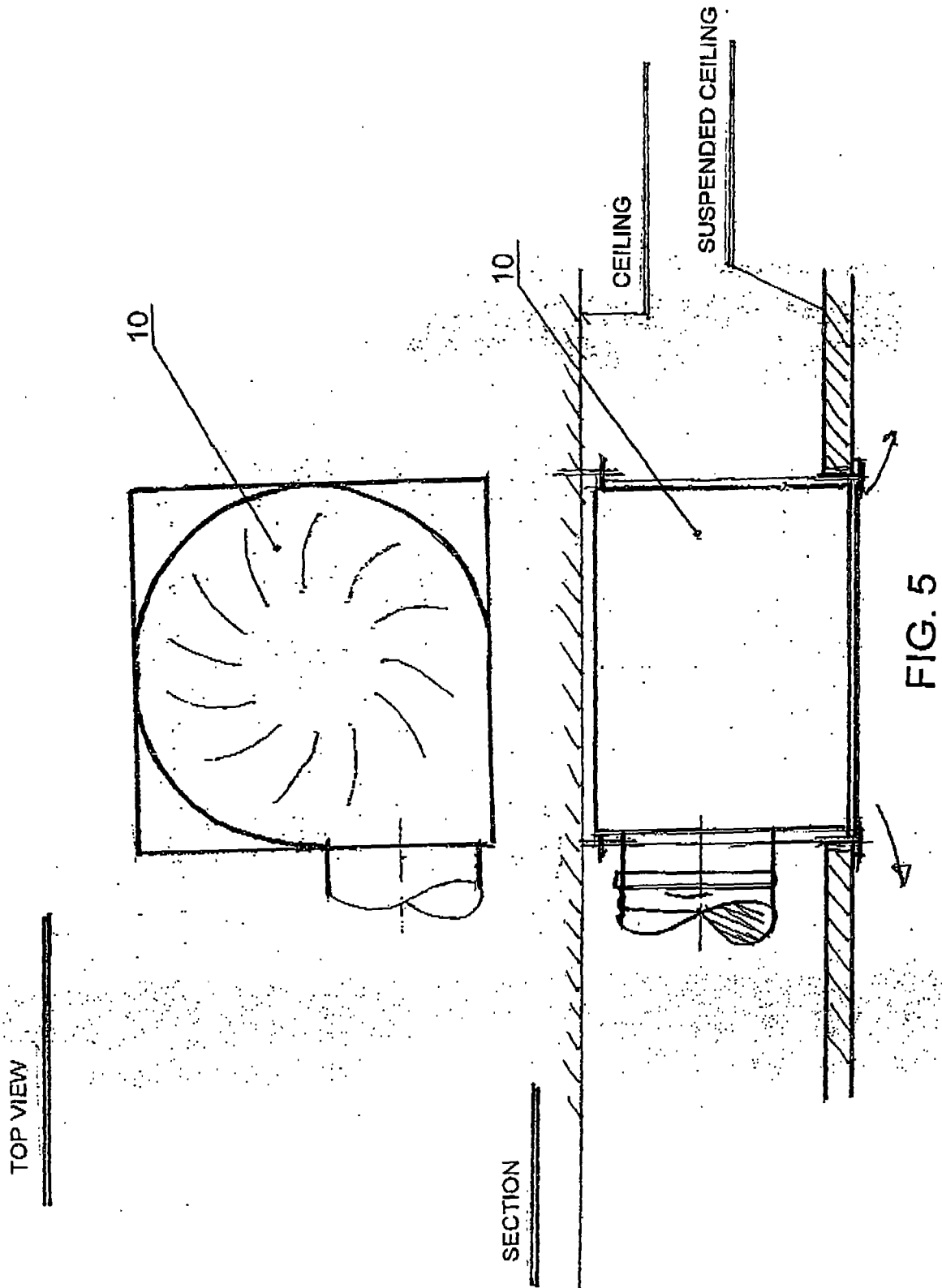


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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