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(54) **Cooling unit for air conditioning systems**

(57) The invention relates to a cooling unit installable into the air-conditioning systems of buildings for cooling/heating the indoor air thereof, the indoor spaces being cooled/heated by the supply air and liquid coolant-circulating cooling elements (7), The invention is implemented by way of complementing the intake air cooling/heating function of the cooling unit with a liquid-coolant cooler coupled to the same main circuit and passing the coolant to liquid-coolant circulating cooling devices (7) serving to cool the indoor spaces,

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Description

[0001] The present invention relates to a cooling unit installable into the air-conditioning systems of buildings for cooling/heating the indoor air thereof, the indoor spaces being cooled/heated by the supply air and liquid coolant circulating cooling elements.

[0002] Currently, the implementation of the cooling function in the air conditioning systems of buildings is generally based on cooling the indoor space by means of both a flow of chilled supply air as well as cooling devices such as cooling coils mounted in the indoor space. A coolant medium such as water is circulated in the cooling coils. For this purpose, a water cooler produces chilled water that is circulated via the cooling coil of the intake air unit and the cooling devices of the indoor space. In addition to the water cooler, a separate rooftop evaporator/condenser is necessary for transferring the heat exhausted from the indoor space to the outside air. Hence, a concurrent A/C system needs three different units: an intake air cooling unit, a cooler of the circulating refrigerant and a rooftop evaporator/condenser.

[0003] A prior-art cooling unit known by trademark "Cooler" in the applicant's product selection comprises an integrated functional unit that can be coupled with a building's air-conditioning machinery and serves to cool the intake air delivered into the building's indoor spaces. In more detail, this cooler is ready-to-use unit incorporating factory-mounted compressor machinery with an electrical/control system thereof. Heat removed from the intake air is transferred to a condenser coil located in the exhaust air flow and finally dissipated to the outdoor air about the building. The greatest shortcoming of a standard-type cooling unit is that the cooling effect is imposed only on the supply air. However, cooling the intake air alone does not provide a sufficiently high cooling effect unless very massive air flow rates are used.

[0004] It is an object of the present invention to provide a novel type of cooling unit installable into the A/C system of buildings, the cooling unit being able to overcome the problems of the prior-art system and to simplify the system construction in a significant fashion. The cooling unit according to the invention is characterized in that, in addition to the intake air cooling/heating function, the cooling unit comprises coupled with the same main circuit a coolant-circulating cooler coupled with the coolant-circulating cooling elements that cool the indoor space.

[0005] A preferred embodiment of the cooling unit according to the invention is characterized in that the cooling unit comprises three compressors and three heat exchangers, of which one compressor and one heat exchanger is employed for cooling the supply air and the two other compressors and heat exchangers are coupled with the coolant-circulating cooling elements of the indoor spaces.

[0006] An essential feature of the cooling unit is that the condensation heat released during cooling is removed with the help of an evaporator/condenser coil located in the cooling unit.

[0007] Another preferred embodiment of the cooling unit according to the invention is characterized in that the cooling unit comprises two compressors and two heat exchangers serving to cool the coolant-circulating cooling elements of the indoor spaces and that the coolant-circulating line has therewith coupled another line that with the help of a pump circulates the liquid coolant via the intake air cooling coil thus accomplishing the cooling of the supply air.

[0008] A still another preferred embodiment of the cooling unit according to the invention is characterized in that the cooling unit incorporates an integral function for heating the supply air.

[0009] The cooling unit according to the invention is installed as a unitary functional section into the air conditioning machinery. Complementing the intake air heating, the cooling unit according to the invention incorporates coupled with the same main circuit an evaporator (circulating cooling unit) that is coupled with the refrigerant circuit of the cooling coils. This arrangement permits a single factory-assembled unit to manage the entire cooling needs of a building. In normal applications, the water cooler can be omitted and a separate rooftop evaporator/condenser unit becomes redundant, too.

[0010] The invention is next described in more detail with the help of preferred exemplary embodiments by making reference to the appended drawings in which

FIG. 1 shows the circuit configuration of a preferred embodiment according to the invention;

FIG. 2 shows the circuit configuration of a second preferred embodiment according to the invention;

FIG. 3 shows the circuit configuration of a third preferred embodiment according to the invention; and

FIG. 4 shows the circuit configuration of a fourth preferred embodiment according to the invention.

[0011] Referring to FIG. 1, therein is shown the circuit configuration of a cooling unit wherein a compressor 1 cools the intake air with the help of a heat exchanger 3. Compressors 2 serve to cool with the help of refrigerant/coolant heat exchangers 4 the liquid coolant circulating in the piping network of indoor space A/C devices 7. A pump 6 circulates the cooled liquid coolant in the indoor space A/C devices 7 that render the cooling of the indoor air. The heat dissipation of the compressors is passed to an evaporator/condenser coil 5 of the cooling unit, where the heat dissipated from the cooling process is transferred via the cooling unit to the exhaust air passing out of the A/C system. The power output of compressors 1, 2 can be controlled stagewise and mutually distributed such that a desired cooling effect is selectively delivered to any point needing cooling, while the exhaust air temperature is simultaneously prevented from rising exces-

sively high.

[0012] In FIG. 2 is shown the circuit configuration of a second embodiment of the invention. Its layout is basically similar to that of FIG. 1, while this layout has two compressors in lieu of the three in the embodiment described above, whereby herein the compressors 1 via the refrigerant/coolant heat exchangers 4 cool the coolant circulating in the piping network 8. Respectively, pump 9 circulates the coolant in the intake air cooling coil that serves to cool the supply air. Pump 6 circulates the cooled liquid coolant in the indoor space A/C devices 7 that accomplish the cooling of the indoor air. The heat dissipation of the compressors is passed to an evaporator/condenser coil 3 of the cooling unit..

[0013] Under certain outdoor air temperature conditions, the intake air must be heated even when the indoor air of the building requires cooling. FIG. 3 shows a circuit configuration according to another embodiment of the inventtion offering the possibility of using the intake air cooling coil alternatively for heating the intake air while the water circulating as coolant in the piping network 8 serves to cool the indoor space A/C devices. The integration of the heating function into the cooling unit gives the benefit of allowing the omission of a separate intake air heating coil from the A/C machinery. By the same token are eliminated the pressure losses of the intake air heater coil and the input power of blowers is reduced. The omission of the heating coil also reduces the space required by the A/C machinery length in the rooftop machinery room by about 700 mm, which is a significant benefit.

[0014] Referring again in greater detail to FIG. 3, the circuit diagram of the present embodiment functions as follows: compressors 1 cool via heat exchangers 4 the coolant circulating in the piping network 8. Pump 6 circulates the cooled coolant in the indoor space A/C devices 7 that accomplish the cooling of the indoor air. The indoor-mounted pump 9 circulates the coolant of the same piping network system via the supply air heat exchanger 3 (liquid coolant/air heat exchanger). This cooling circuit 12 is diverted apart from liquid coolant circulation of the indoor air cooling devices by a valve 11. The thermal energy required for heating the supply air is introduced into the auxiliary circuit 12 via a liquid/liquid heat exchanger 10. By virtue of having the circuits 8, 12 running separately from each other, it is possible to operate these two circuits at different temperature levels. Thence the indoor space A/C cooling devices can be fed with a liquid coolant cooled in the evaporator 4 and at the same time warm water may be fed to the supply air heat exchanger 3, while simultaneously the intake air is being heated to the desired set temperature of supply air.

[0015] The invention also makes it possible to implement the utilization of a low temperature of the outdoor air for cooling the liquid coolant circulating in the indoor space A/C devices, whereby this "free circulation" is run having the compressors stopped. As the water coolant circulating in the piping network of indoor space A/C devices herein also passes through the inlet air cooling coil of the cooling unit, it becomes possible to employ this "free-circulation" cooling facility when the building needs cooling and the outdoor air is sufficiently low, i.e., about 10-15 °C, to achieve a cooling effect. Cooling by "free circulation" also allows the cooling effect offered by passing the cold outdoor air through the intake air cooling coil to be transferred to the piping network of the indoor space A/C devices and therefrom to a desired indoor space. Cooling by means of "free circulation" permits the electrical energy budget of a building to be reduced significantly.

[0016] Next, the "free circulation" discussed above is elucidated in more detail by making reference to FIG. 4. The liquid coolant returning from the cooling devices 7 is routed via a valve 11 to the intake air cooling coil 3 of the cooling unit. At this instant, the coolant temperature is about 19 °C. The liquid coolant is cooled in the intake air cooling coil to a temperature of, e.g., 17 °C. The cooled coolant is passed forward to the evaporator 4 of the cooling unit, wherein it is cooled further so that the liquid coolant finally is cooled down to the temperature of, e.g., about 15 °C, necessary for operating the piping network of the indoor space A/C devices. Cooling the liquid coolant in the intake air cooling coil becomes possible when the outdoor air temperature is below 19°C.

[0017] To a person skilled in the art it is obvious that the invention is not limited by the above-described exemplary embodiments, but rather may be varied within the inventive spirit and scope of the appended claims. The coolant medium of the liquid-coolant-circulating indoor space A/C devices may be any type of liquid employed in this kind of application as required to comply with the local constraints. Furthermore, the number of compressors and heat exchangers mentioned in the claims and description above are exemplary by definition and may be varied as desired.

Claims

1. A cooling unit installable into the air-conditioning systems of buildings for cooling/heating the indoor air thereof, the indoor spaces being cooled/heated by the supply air and liquid coolant-circulating cooling elements (7), **characterized in that**, in addition to the intake air cooling/heating function, the cooling unit comprises coupled with the same main circuit a coolant-circulating cooler coupled with the coolant-circulating cooling elements (7) that cool the indoor space.

2. The cooling unit of claim 1, **characterized in that** the cooling unit comprises three compressors (1, 2) and three heat exchangers (3, 4), of which one compressor (1) and one heat exchanger (3) is employed for cooling the supply air and the two other compressors (2) and heat exchangers (4) are coupled with

the coolant-circulating cooling elements (7) of the indoor spaces.

3. The cooling unit of claim 1, **characterized in that** the cooling unit comprises two compressors (1) and two heat exchangers (4) serving to cool the coolant-circulating cooling elements (7) of the indoor spaces and that the coolant-circulating line has therewith coupled another line that with the help of a pump (9) circulates the coolant via the intake air cooling coil (7) thus accomplishing the cooling of the supply air.

4. The cooling unit of any one of claims 1-3, **characterized in that** the cooling unit incorporates an integral function for heating the supply air.

5. The cooling unit of claim 1, **characterized in that** a low temperature of the outdoor air is utilized for cooling the liquid coolant circulating in the indoor space A/C devices (7).

6. The cooling unit of claim 5, **characterized in that** the liquid coolant returning from the liquid-coolant-circulating indoor space A/C devices (7) is routed via a valve (11) to the inlet air cooling coil (3) of the cooling unit, wherein the liquid coolant is cooled whereupon the coolant is passed to the evaporator (4) for further cooling.

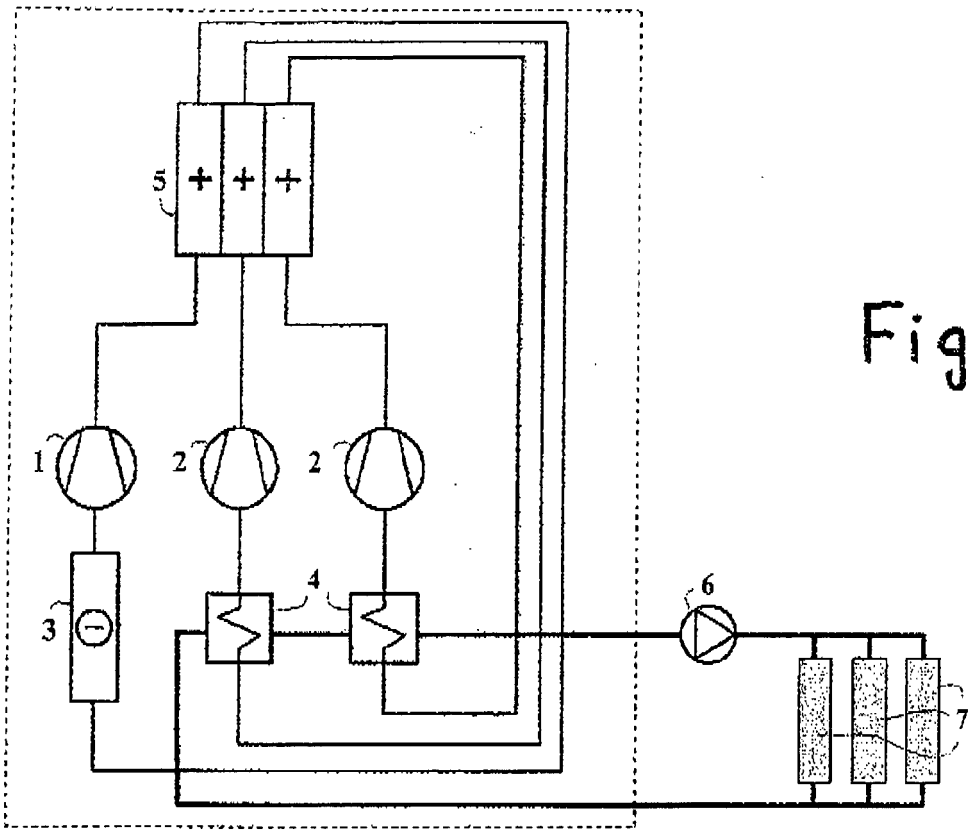

Fig. 1

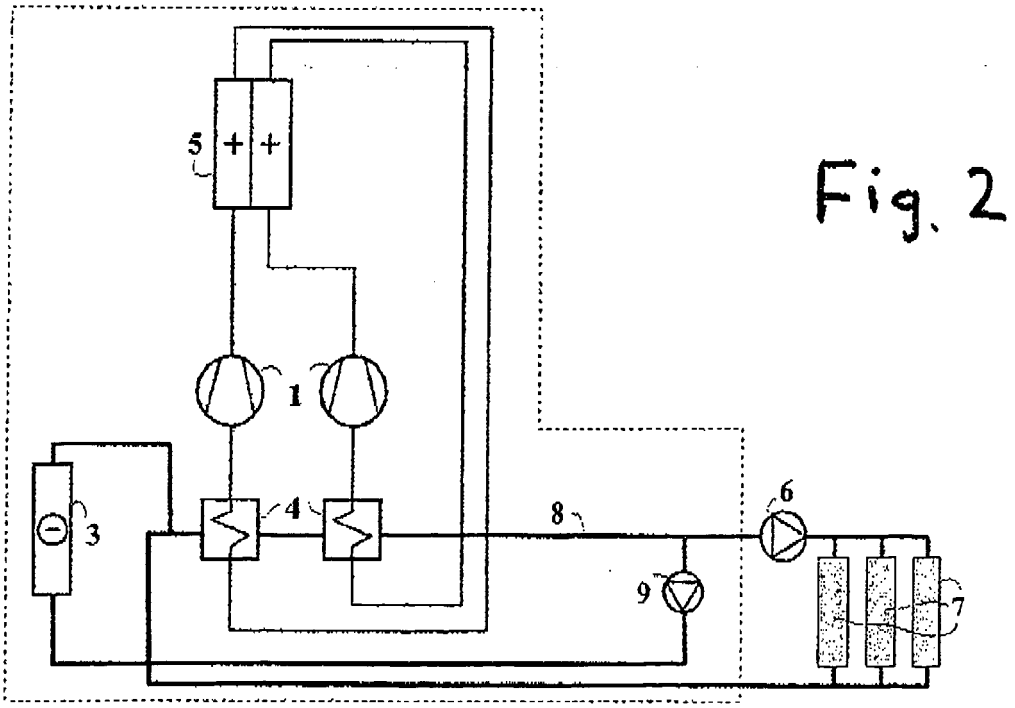

Fig. 2

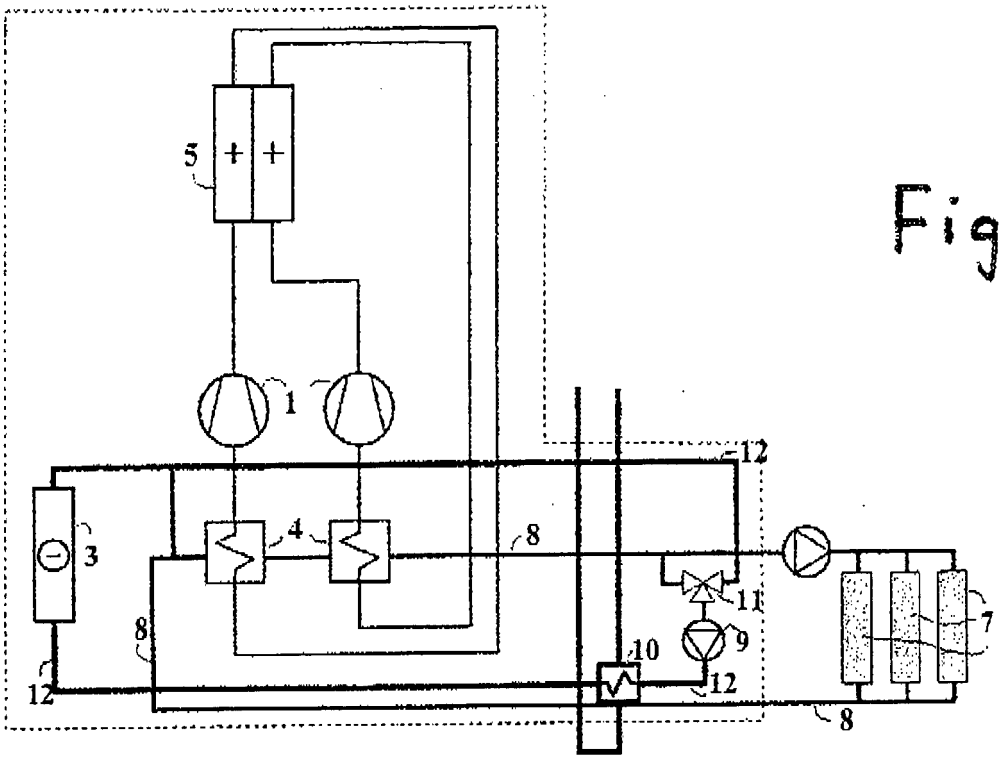

Fig. 3

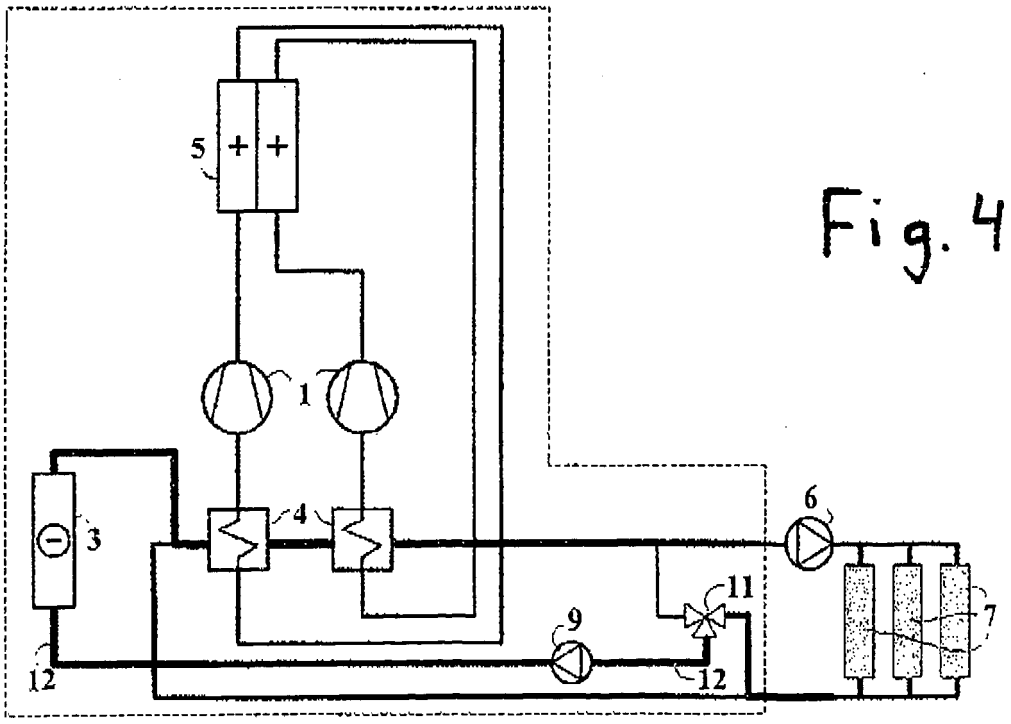

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 07 00 3618

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 June 2007	Valenza, Davide

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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