(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 722 689 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.10.2020 Bulletin 2020/42

(21) Application number: **19185986.7**

(22) Date of filing: **12.07.2019**

(51) Int Cl.:
F24F 11/46 *(2018.01)* ***F24F 11/83*** *(2018.01)*
F24F 110/10 *(2018.01)* *F24F 110/20* *(2018.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **09.04.2019 HK 19122058**

(71) Applicant: **Sustainable Energy Limited**
Hong Kong 999077 (HK)

(72) Inventors:
- **TUNG, Siu Lok**
  999077 Hong Kong (HK)
- **LUN, Yuen Ha**
  999077 Hong Kong (HK)

(74) Representative: **Casalonga**
Casalonga & Partners
Bayerstraße 71/73
80335 München (DE)

(54) CONTROL SYSTEM FOR ADJUSTING AIR TEMPERATURE, HUMIDITY AND WATER TEMPERATURE BY AN OUTDOOR AIR HEAT EXCHANGER

(57) The present invention relates to a control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger, comprising an air conditioning apparatus, a heat exchange apparatus and an outdoor air heat exchanger. The air conditioning apparatus comprises: a gas recovery apparatus, a gas refrigerating and dehumidifying apparatus, a gas supply apparatus and a compressor unit; the gas refrigerating and dehumidifying apparatus and the compressor unit are connected in series to a first heat exchange apparatus to form a refrigerant system; the outdoor air heat exchanger is connected in parallel to the refrigerant system; the control system is enabled based on different set values of indoor humidity, water temperature and/or room temperature, and particularly makes use of the heat absorption and heat dissipation functions of the outdoor air heat exchanger to control water temperature and/or room temperature.

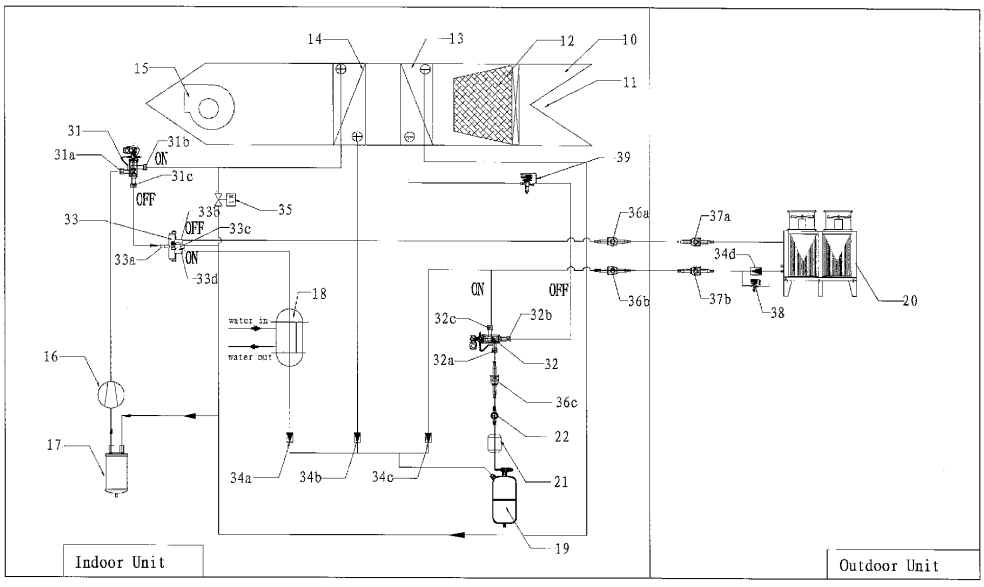

Fig. 1

EP 3 722 689 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to the field of air conditioning and energy utilization, particularly to a two-way circulation control system with an outdoor air heat exchanger.

BACKGROUND ART

[0002] The indoor air conditioning mostly uses an evaporator. The refrigerating coil in the evaporator dehumidifies and cools indoor gas in high humidity or indoor gas mixed with outdoor gas, and transfers the heat absorbed at the refrigerating coil to a heating coil to reheat the cooled air, which returns to the indoor space as dehumidified air. In a dehumidifying process, refrigerant cyclically recovers latent heat and reheats cold air, which is then supplied to the indoor space. The heat absorbed at the refrigerating coil in the evaporator may also be led to a water heat exchange apparatus to heat water in a building or water in a swimming pool. When the air temperature and water temperature in the building both meet requirements, an outdoor air heat exchanger may be used to reject heat and release surplus heat recovered in a dehumidifying process.

[0003] However, in winter, particularly when humidity meets requirements and is lower than an expected value, the foregoing dehumidifying process cannot be used to generate latent heat, and auxiliary electric heating devices are needed to raise indoor gas temperature and water temperature.

SUMMARY OF THE INVENTION

[0004] The present invention intends to provide to a control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger.

[0005] A technical means adopted by the present invention is as follows.

[0006] Firstly, the present invention provides a control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger, comprising an air conditioning apparatus, a heat exchange apparatus and an outdoor air heat exchanger; the air conditioning apparatus comprises in turn: a gas recovery apparatus, a gas refrigerating and dehumidifying apparatus, a gas supply apparatus and a compressor unit; the gas refrigerating and dehumidifying apparatus and the compressor unit are connected in series to a first heat exchange apparatus to form a refrigerant system; the outdoor air heat exchanger is connected in parallel to the refrigerant system; the control system is enabled when indoor humidity is lower than a set value, i.e.: when indoor humidity is lower than a set value and water temperature and/or room temperature is lower than a set value, a heat absorption mode of the outdoor air heat exchanger will be enabled, refrigerant in the outdoor air heat exchanger will be inputted to the compressor unit via the outdoor air heat exchanger, the refrigerant in the compressor unit will be converted into a heating medium, and the heating medium will be inputted to the heat exchange apparatus and raise water temperature and/or room temperature through the first heat exchange apparatus.

[0007] When indoor humidity is lower than a set value and water temperature and/or room temperature is higher than a set value, a heat dissipation mode of the outdoor air heat exchanger will be enabled, the refrigerant in the outdoor air heat exchanger will perform heat dissipation by outdoor air, and the refrigerant after heat dissipation will be inputted to the heat exchange apparatus and reduce water temperature and/or room temperature via the first heat exchange apparatus.

[0008] When indoor humidity is higher than a set value and water temperature and/or room temperature is lower than a set value, a mode of dehumidifying heat pump will be enabled, the refrigerant will absorb heat via the gas refrigerating and dehumidifying apparatus and then be inputted to the compressor unit and converted into a heating medium in the compressor unit, and the heating medium will be inputted to the heat exchange apparatus and raise water temperature and/or room temperature via the first heat exchange apparatus.

[0009] When indoor humidity is higher than a set value, water temperature and/or room temperature is higher than a set value, a mode of dehumidifying heat pump will be enabled, the refrigerant will reduce water temperature and/or room temperature via the first heat exchange apparatus and/or the gas refrigerating and dehumidifying apparatus, the refrigerant after heat absorption will be inputted to the compressor unit, the refrigerant in the compressor unit will be converted into a heating medium, and the heating medium will be inputted to the outdoor air heat exchanger for heat dissipation by outdoor air.

[0010] The first heat exchange apparatus is a gas reheating apparatus arranged inside an air conditioning apparatus; the refrigerant system is connected in parallel to a second heat exchanger, which is connected to a water system or a water tower.

[0011] Based on the foregoing solution, the control system further comprises a first three-way valve, a second three-

way valve, a four-way valve and a liquid storage tank;

The compressor unit is connected to an inlet of the first three-way valve, and an outlet 1 of the first three-way valve is connected to an inlet of the gas reheating apparatus; an outlet 2 of the first three-way valve is connected to an inlet of the four-way valve, and the four-way valve comprises a first outlet, a second outlet and a third outlet in turn;

The first outlet of the four-way valve is connected to an outdoor air heat exchanger, the second outlet of the four-way valve is connected to a compressor, and the third outlet of the four-way valve is connected to a water heat exchange apparatus;

The other ends of the outdoor air heat exchanger, the gas reheating apparatus and the second heat exchanger are connected to the liquid storage tank respectively;

The liquid storage tank is connected to an inlet of a second three-way valve, an outlet 1 of the second three-way valve is connected to a second expansion valve, the second expansion valve is connected to an inlet of a gas refrigerating and dehumidifying apparatus, an outlet of the gas refrigerating and dehumidifying apparatus is connected to a compressor unit, or the gas refrigerating and dehumidifying apparatus is connected to a gas reheating apparatus via a valve; and an outlet 2 of the second three-way valve is connected to a first expansion valve, and the first expansion valve is connected to an outdoor air heat exchanger;

A heat absorption mode of the outdoor air heat exchanger is enabled, refrigerant in the outdoor air heat exchanger is inputted to the four-way valve via the outdoor air heat exchanger, then to the compressor unit via the four-way valve, and converted into a heating medium in the compressor unit, and the heating medium is inputted to an inlet of the first three-way valve, and to the gas reheating apparatus via the first three-way valve and/or to the second heat exchanger connected to the four-way valve; the heating medium after heat exchange flows back to the liquid storage tank via the gas reheating apparatus and/or the second heat exchanger, and then flows to the outdoor air heat exchanger via the second three-way valve.

[0012] Further, on the basis of the foregoing solution, a refrigerant filter is arranged between the liquid storage tank and the second three-way valve.

[0013] Further, on the basis of the foregoing solution, an inlet-end outdoor exhaust fan is arranged at the gas recovery apparatus.

[0014] Meanwhile, the present invention further provides the following few advanced solutions:

On the basis of the foregoing solution, the air conditioning apparatus is provided with a water cooling system before or after air treatment of the refrigerant system.

[0015] Alternatively, on the basis of the foregoing solution, the air conditioning apparatus is provided with a water heating system before or after air treatment of the refrigerant system.

[0016] Alternatively, on the basis of the foregoing solution, the air conditioning apparatus is provided with a water cooling system before air treatment of the refrigerant system, and is provided with a water heating system after air treatment of the refrigerant system.

[0017] Alternatively, the second heat exchanger is connected in series to a third heat exchanger, and the third heat exchanger is connected to chilled water. The air conditioning apparatus is provided with a water cooling system before air treatment of the refrigerant system, a third three-way valve is arranged at an inlet of the water cooling system, and an outlet 2 of the third three-way valve is connected to an inlet of the third heat exchanger; a fourth three-way valve is arranged at the inlet of the third heat exchanger, the outlet 2 of the third three-way valve is connected to an inlet of the fourth three-way valve, and an outlet 2 of the fourth three-way valve is connected to chilled water.

[0018] Technical effect generated by the present invention: The present invention discloses various types of indoor refrigerant systems connected in parallel to an outdoor air heat exchanger. When humidity is high in summer, the indoor refrigerant system will perform dehumidification and cooling and use absorbed heat to adjust indoor air and indoor water systems (e.g., swimming pool or bath water). When indoor humidity, temperature and pool water temperature all meet requirements, surplus heat recovered in a dehumidifying process will be removed through an outdoor air heat exchanger. In winter, following the decrease of demand for dehumidification, recovered latent heat is restricted. A "reverse circulation" system runs a refrigerant loop as an air source heat pump, providing enough heat for reheating of air and reheating of pool water. Under the reverse circulation system, the outdoor air heat exchanger acts as a "heat pump" and absorbs outdoor heat to heat indoor air and water. The generated latent heat (from the reverse circulation system) subsequently is transferred to an air reheater and used to heat the hall and water of the swimming pool. The use of a reverse circulation system saves operating cost in winter by more than 60% than an auxiliary electric heating device does.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a schematic view of the overall structure of a control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger according to the present invention.

FIG. 2 ~ FIG. 1 0 show embodiments of the control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger according to the present invention.

DETAILED DESCRIPTION

[0020] Below the specific embodiments, structure, features and effects of the control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger according to the present invention will be illustrated by referring to accompanying drawings.

[0021] The present invention provides a control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger, comprising an air conditioning apparatus, a heat exchange apparatus and an outdoor air heat exchanger, wherein the air conditioning apparatus comprises in turn: a gas recovery apparatus, a gas refrigerating and dehumidifying apparatus, a gas supply apparatus and a compressor unit; the gas refrigerating and dehumidifying apparatus and the compressor unit are connected in series to a first heat exchange apparatus to form a refrigerant system; the outdoor air heat exchanger is connected in parallel to the refrigerant system. The control system is enabled when indoor humidity is lower than a set value, i.e.: when indoor humidity is lower than a set value and water temperature and/or room temperature is lower than a set value, a heat absorption mode of the outdoor air heat exchanger will be enabled, refrigerant in the outdoor air heat exchanger will be inputted to the compressor unit via the outdoor air heat exchanger, the refrigerant in the compressor unit will be converted into a heating medium, and the heating medium will be inputted to the heat exchange apparatus and raise water temperature and/or room temperature through the first heat exchange apparatus.

[0022] FIG. 1 is a schematic view of the overall structure of a control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger according to the present invention, which comprises an indoor unit and an outdoor unit. The indoor unit comprises an air conditioning apparatus 10, which comprises a gas recovery apparatus 11, a gas filter 12, a gas refrigerating and dehumidifying apparatus 13, a gas reheating apparatus 14, a gas supply apparatus 15 and a compressor unit. The compressor unit comprises a compressor 16 and a gas-liquid separator 17 connected to the compressor 16. The indoor unit further comprises a water heat exchange apparatus 18 and a liquid storage tank 19. The outdoor unit comprises an outdoor air heat exchanger 20.

[0023] The indoor unit further comprises a first three-way valve 31, a second three-way valve 32 and a four-way valve 33, the compressor 16 is connected to an inlet 31a of the first three-way valve, and an outlet 31b of the first three-way valve is connected to an inlet of the gas reheating apparatus 14; an outlet 2 31c of the first three-way valve is connected to an inlet 33a of the four-way valve, and the four-way valve 33 comprises a first outlet 33b, a second outlet 33c and a third outlet 33d in turn. The first outlet 33b of the four-way valve is connected to a first indoor ball valve 36a. The first indoor ball valve 36a is connected to a first outdoor ball valve 37a, and the first outdoor ball valve 37a is connected to an outdoor air heat exchanger 20. The second outlet 33c of the four-way valve is connected to a gas-liquid separator 17. The gas-liquid separator 17 is connected to a compressor 16. The compressor 16 is connected to the inlet 31a of the first three-way valve. The third outlet 33d of the four-way valve is connected to a water heat exchange apparatus 18.

[0024] The other end of the water heat exchange apparatus 18 is connected to a liquid storage tank 19 via a first check valve 34a. The other end of the gas reheating apparatus 14 is connected to the liquid storage tank 19 via a second check valve 34b. The other end of the outdoor air heat exchanger is connected to a first expansion valve 38 and a fourth check valve 34d, which are connected to each other in parallel and then is connected to a second outdoor ball valve 37b. The second outdoor ball valve 37b is connected to a second indoor ball valve 36b. The second indoor ball valve 36b is connected to a third check valve 34c. The third check valve 34c is connected to a liquid storage tank 19.

[0025] The liquid storage tank 19 is connected to an inlet 32a of a second three-way valve 32a. An outlet 1 32b of the second three-way valve is connected to a second expansion valve 39. The second expansion valve 39 is connected to an inlet of a gas refrigerating and dehumidifying apparatus 13. An outlet of the gas refrigerating and dehumidifying apparatus 13 is connected to a gas-liquid separator 17. The gas-liquid separator 17 is connected to a compressor 16. The gas refrigerating and dehumidifying apparatus 13 may further be connected to an inlet of a gas reheating apparatus 14 via a valve 35. An outlet 2 32c of the second three-way valve is connected to a second indoor ball valve 36b. The second indoor ball valve 36b is connected to a second outdoor ball valve 37b. The second outdoor ball valve 37b is connected to a first expansion valve 38 and a fourth check valve 34d, which are connected to each other in parallel. The first expansion valve 38 and the fourth check valve 34d in parallel are connected to an outdoor air heat exchanger 20. A refrigerant filter 21, a sight glass 22 and a third indoor ball valve 36c are arranged between the liquid storage tank 19 and the second three-way valve 32.

[0026] The control system is enabled when indoor humidity is lower than a set value, i.e.: when indoor humidity is lower than a set value, and air temperature and/or room temperature is lower than a set value, a heat absorption mode of the outdoor air heat exchanger will be enabled, refrigerant in an outdoor air heat exchanger is inputted to a four-way valve via an outdoor air heat exchanger and then to a compressor via the four-way valve, and converted into a heating medium inside the compressor. The heating medium is inputted to an inlet of a first three-way valve and to a gas reheating

apparatus via the first three-way valve and/or to a water heat exchange apparatus connected to a four-way valve; after heat exchange the heating medium flows back to a liquid storage tank via the gas reheating apparatus and/or the water heat exchange apparatus, and then flows to the outdoor air heat exchanger via a second three-way valve.

[0027] When indoor humidity is lower than a set value, and water temperature and/or room temperature is higher than a set value, a heat dissipation mode of the outdoor air heat exchanger 20 will be enabled, the refrigerant in the outdoor air heat exchanger will circulate clockwise into an air heat exchanger 20, for heat dissipation by outdoor air. The refrigerant liquid after heat dissipation is collected to a liquid storage tank 19, and then reduces room temperature and/or water temperature through a gas refrigerating and dehumidifying apparatus 13 and/or a water heat exchange apparatus 18.

[0028] The control system is enabled when indoor humidity is higher than a set value, i.e.: when indoor humidity is higher than a set value and water temperature and/or room temperature is lower than a set value, a mode of dehumidifying heat pump will be enabled, refrigerant liquid will be collected to a liquid storage tank 19 and then perform refrigeration and dehumidification through an expansion valve 39 and a gas refrigerating and dehumidifying apparatus 13. The refrigerant gas after heat absorption is inputted to a compressor unit. After compression, the refrigerant gas inside the compressor 16 is converted into a heating medium. The heating medium is inputted to a heat exchange apparatus and raises room temperature and/or water temperature through a gas reheating apparatus 14 and/or a water heat exchange apparatus 18.

[0029] When indoor humidity is higher than a set value, and water temperature and/or room temperature is higher than a set value, a mode of dehumidifying heat pump will be enabled, refrigerant liquid will be collected to a liquid storage tank 19 and then perform refrigeration and dehumidification through an expansion valve 39 and a gas refrigerating and dehumidifying apparatus 13. The refrigerant gas after heat absorption is inputted to a compressor unit. After compression, the refrigerant gas inside the compressor 16 is converted into a heating medium. A heat dissipation mode of the outdoor air heat exchanger is enabled, and the refrigerant in the outdoor air heat exchanger circulates clockwise into an air heat exchanger 20, for heat dissipation by outdoor air.

[0030] Without electric heating of air or reheating and without electric heating of boiler pool water, heat can be absorbed outdoors in winter. The use of reverse circulation may save energy cost by more than 60%.

[0031] The operational logic is to open (open/close) valves for reverse circulation and turn an outdoor air heat exchanger into a "heat pump" to absorb outdoor heat to heat indoor air and water. The control logic of "heat pump" operation is shown in the table below:

Table 1: Summer mode:

Summer mode: ↓= lower than a set value ↑= higher than a set value													
Indoor heat pump unit											Outdoor air heat exchanger		
Humidity	Air temperature	water temperature	Supply fan	Compressor	Refrigerating coil	Heating coil	Water heat exchange apparatus	Four-way valve	First three-way valve	Second three-way valve	Heat rejection	Heat absorption	Fan
↑	↓	↑	On	On	On	On	Off	Off	On	Off	Off	NA	Off
↑	↑	↓	On	On	On	Off	On	On	Off	Off	Off	NA	Off
↓	↑	↑	On	On	On	Off	Off	Off	Off	Off	On	NA	On
↑	↓	↓	On	On	On	Off	On	On	Off	Off	Off	NA	Off
↓	↑	↓	On	On	On	Off	On	On	Off	Off	Off	NA	Off
↓	↓	↑	On	Off	Off	Off	Off	Off	Off	Off	Off	NA	Off
↓	↓	↓	On	Off	Off	Off	Off	Off	Off	Off	Off	NA	Off

Table 2: Winter mode:

Winter mode: ↓= lower than a set value ↑= higher than a set value													
Indoor heat pump unit											Outdoor air heat exchanger		
Humidity	Air temperature	water temperature	Supply fan	Compressor	Refrigerating coil	Heating coil	Water heat exchange apparatus	Four-way valve	First three-way valve	Second three-way valve	Heat rejection	Heat absorption	Fan
↑	↑	↑	On	On	On	Off	Off	Off	Off	Off	On	NA	On
↑	↓	↑	On	On	On	On	Off	On	On	Off	Off	NA	Off
↑	↑	↓	On	On	On	Off	On	On	Off	Off	Off	NA	Off

↓	↑	↑	On	Off	Off	Off	Off	On	Off	Off	Off	NA	Off
↑	↓	↓	On	On	On	Off	On	On	Off	Off	Off	NA	Off
↓	↑	↓	On	On	Off	Off	On	On	Off	On	NA	On	On
↓	↓	↑	On	On	Off	On	Off	On	On	On	NA	On	On
↓	↓	↓	On	On	Off	On	On	On	On	On	NA	On	On

[0032] Please refer to FIG. 2, which shows an embodiment of the present invention, comprising an air conditioning apparatus 10 and an outdoor air heat exchanger 20. The air conditioning apparatus 10 comprises a gas recovery apparatus 11, a gas filter 12, a gas refrigerating and dehumidifying apparatus 13, a gas reheating apparatus 14, a gas supply apparatus 15 and an inlet-end outdoor exhaust fan 15-1. The gas refrigerating and dehumidifying apparatus 13 and the gas reheating apparatus 14 are connected to a compressor 16 in series to form a refrigerant system 100. In this solution, an outdoor air heat exchanger 20 serves as a heat reject and heat absorption component. When indoor humidity is lower than a set value, refrigerant in the outdoor air heat exchanger will be inputted to a compressor unit via the outdoor air heat exchanger, and converted into a heating medium inside the compressor unit, and the heating medium will be inputted to a heat exchange apparatus, and adjust temperature through the gas reheating apparatus 14.

[0033] Please refer to FIG. 3, which shows another embodiment of the present invention. Different from the embodiment disclosed in FIG. 2, in this embodiment a second heat exchanger 40 is connected to the refrigerant system in parallel, which may be a condenser, and exchanges heat with indoor water systems, such as swimming pool water and bath water.

[0034] Please refer to FIG. 4, which shows another embodiment of the present invention. Different from the embodiment disclosed in FIG. 3, in this embodiment a second heat exchanger 40 is connected to the refrigerant system in parallel and connected to a water tower 50, for energy storage and heat dissipation.

[0035] Please refer to FIG. 5 and FIG. 6, which show another two embodiments of the present invention. Different from the embodiment disclosed in FIG. 3, in this embodiment the air conditioning apparatus is provided with a water cooling system 13-1 before air treatment of the refrigerant system, as shown in FIG. 5, or a water cooling system 13-1 is added after air treatment of the refrigerant system and before air supply, and the water cooling system 13-1 is a refrigerating coil, and chilled water is delivered into the refrigerating coil to cool the air.

[0036] Please refer to FIG. 7, which shows another embodiment of the present invention. Different from the embodiment disclosed in FIG. 3, in this embodiment the air conditioning apparatus is provided with a water cooling system 13-1 before air treatment of the refrigerant system, and is provided with a water heating system 14-1 after air treatment of the refrigerant system and before air supply. The water heating system 14-1 is a hot water coil and may be communicable to hot water for heating to raise temperature of the air.

[0037] Please refer to FIG. 8, which shows another embodiment of the present invention. Different from the embodiment disclosed in FIG. 7, in this embodiment the air conditioning apparatus is provided with a water heating system 14-1 after air treatment of the refrigerant system and before air supply.

[0038] Please refer to FIG. 9, which shows another embodiment of the present invention. The second heat exchanger 40 is connected in series to a third heat exchanger 60 and used to heat swimming pool water. The third heat exchanger 60 is communicable to chilled water. The air conditioning apparatus is provided with a water cooling system 13-1 before air treatment of the refrigerant system. A third three-way valve 23 is arranged at an inlet of the water cooling system 13-1. An inlet 23a of the third three-way valve 23 is communicable to chilled water. An outlet 1 23b of the third three-way valve is connected to a refrigerating coil of the water cooling system 13-1. An outlet 2 23c of the third three-way valve is connected to an inlet of a third heat exchanger 60. A fourth three-way valve 24 is arranged at the inlet of the third heat exchanger 60, the outlet 2 23c of the third three-way valve is connected to an inlet 24a of the fourth three-way valve, or an outlet of the refrigerating coil of the water cooling system 13-1 is connected to the inlet 24a of the fourth three-way valve, an outlet 1 24b of the fourth three-way valve is connected to the inlet of the third heat exchanger 60, and an outlet 2 24c of the fourth three-way valve is communicable to chilled water.

[0039] Please refer to FIG. 10, which shows another embodiment of the present invention. Here, a first heat exchanger in a refrigerant system 100 is not the gas reheating apparatus 14 in the air conditioning apparatus in the foregoing embodiments, but a separate condenser. When indoor air meets the conditions for dehumidification and cooling, the condenser will reject heat to a gas reheating apparatus 14 connected to the condenser. When indoor air does not meet the conditions for dehumidification and cooling, for example, the indoor humidity is lower than a set value in winter, a

heat absorption mode of an outdoor air heat exchanger 20 will be enabled, refrigerant in the outdoor air heat exchanger will be inputted to a compressor unit via the outdoor air heat exchanger, and converted into a heating medium in the compressor unit, the heating medium will be inputted to a first heat exchanger 40, and the first heat exchanger 40 will exchange heat with a gas reheating apparatus 14 or a water heat exchange apparatus 18 to adjust room temperature and water temperature.

[0040] Above a plurality of embodiments and various kinds of indoor refrigerant systems connected in parallel to an outdoor air heat exchanger have been disclosed. When humidity is high in summer, the indoor refrigerant system will perform dehumidification and cooling and use absorbed heat to adjust indoor air and indoor water systems (e.g., swimming pool or bath water), and when indoor humidity, temperature and pool water temperature all meet requirements, surplus heat recovered in a dehumidifying process will be removed through an outdoor air heat exchanger. In winter, following the decrease of demand for dehumidification, recovered latent heat is restricted. A "reverse circulation" system runs a refrigerant loop as an air source heat pump, providing enough heat for reheating of air and reheating of pool water. Under the reverse circulation system, the outdoor air heat exchanger acts as a "heat pump" and absorbs outdoor heat to heat indoor air and water. The generated latent heat (from the reverse circulation system) subsequently is transferred to an air reheater and used to heat the hall and water of the swimming pool. The use of a reverse circulation system saves operating cost in winter by more than 60% in winter than an auxiliary electric heating device does.

Claims

1. A control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger, comprising an air conditioning apparatus, a heat exchange apparatus and an outdoor air heat exchanger, wherein the air conditioning apparatus comprises in turn: a gas recovery apparatus, a gas refrigerating and dehumidifying apparatus, a gas supply apparatus and a compressor unit;
   the gas refrigerating and dehumidifying apparatus and the compressor unit are connected in series to a first heat exchange apparatus to form a refrigerant system;
   the outdoor air heat exchanger is connected in parallel to the refrigerant system;
   the control system is enabled when indoor humidity is lower than a set value, i.e.:

   when indoor humidity is lower than a set value and water temperature and/or room temperature is lower than a set value, a heat absorption mode of the outdoor air heat exchanger will be enabled, refrigerant in the outdoor air heat exchanger will be inputted to the compressor unit via the outdoor air heat exchanger, the refrigerant in the compressor unit will be converted into a heating medium, and the heating medium will be inputted to the heat exchange apparatus and raise water temperature and/or room temperature through the first heat exchange apparatus; and
   when indoor humidity is lower than a set value and water temperature and/or room temperature is higher than a set value, a heat dissipation mode of the outdoor air heat exchanger will be enabled, refrigerant in the outdoor air heat exchanger will perform heat dissipation by outdoor air, and the refrigerant after heat dissipation will be inputted to the heat exchange apparatus and reduce water temperature and/or room temperature via the first heat exchange apparatus.

2. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in claim 1, wherein
   when indoor humidity is higher than a set value and water temperature and/or room temperature is lower than a set value, a mode of dehumidifying heat pump will be enabled, the refrigerant will absorb heat via the gas refrigerating and dehumidifying apparatus and then be inputted to a compressor unit and converted into a heating medium in the compressor unit, and the heating medium will be inputted to a heat exchange apparatus and raise water temperature and/or room temperature via a first heat exchange apparatus;
   When indoor humidity is higher than a set value and water temperature and/or room temperature is higher than a set value, a mode of dehumidifying heat pump will be enabled, the refrigerant will reduce water temperature and/or room temperature via the first heat exchange apparatus and/or the gas refrigerating and dehumidifying apparatus, the refrigerant after heat absorption will be inputted to a compressor unit, the refrigerant in the compressor unit will be converted into a heating medium, and the heating medium will be inputted to the outdoor air heat exchanger for heat dissipation by outdoor air.

3. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in claim 1, wherein
   the first heat exchange apparatus is a gas reheating apparatus arranged inside an air conditioning apparatus; and

the refrigerant system is connected in parallel to a second heat exchanger, which is connected to a water system or a water tower.

4. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in claim 3, wherein
the control system further comprises a first three-way valve, a second three-way valve, a four-way valve and a liquid storage tank;
the compressor unit is connected to an inlet of the first three-way valve, and an outlet 1 of the first three-way valve is connected to an inlet of the gas reheating apparatus; an outlet 2 of the first three-way valve is connected to an inlet of the four-way valve, and the four-way valve comprises a first outlet, a second outlet and a third outlet in turn; the first outlet of the four-way valve is connected to an outdoor air heat exchanger, the second outlet of the four-way valve is connected to a compressor, and the third outlet of the four-way valve is connected to a water heat exchange apparatus;
the other ends of the outdoor air heat exchanger, the gas reheating apparatus and the second heat exchanger are connected to the liquid storage tank respectively;
the liquid storage tank is connected to an inlet of the second three-way valve, an outlet 1 of the second three-way valve is connected to a second expansion valve, the second expansion valve is connected to an inlet of a gas refrigerating and dehumidifying apparatus, an outlet of the gas refrigerating and dehumidifying apparatus is connected to a compressor unit, or the gas refrigerating and dehumidifying apparatus is connected to a gas reheating apparatus via a valve; and an outlet 2 of the second three-way valve is connected to a first expansion valve, and the first expansion valve is connected to an outdoor air heat exchanger;
a heat absorption mode of the outdoor air heat exchanger is enabled, refrigerant in the outdoor air heat exchanger is inputted to the four-way valve via the outdoor air heat exchanger, then to the compressor unit via the four-way valve, and converted into a heating medium in the compressor unit, and the heating medium is inputted to an inlet of the first three-way valve, and to the gas reheating apparatus via the first three-way valve and/or to the second heat exchanger connected to the four-way valve; the heating medium after heat exchange flows back to the liquid storage tank via the gas reheating apparatus and/or the second heat exchanger, and then flows to the outdoor air heat exchanger via the second three-way valve.

5. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in any of claims 1~4, wherein the air conditioning apparatus is provided with a water cooling system before or after air treatment of the refrigerant system.

6. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in any of claims 1~4, wherein the air conditioning apparatus is provided with a water heating system before or after air treatment of the refrigerant system.

7. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in any of claims 1~4, wherein the air conditioning apparatus is provided with a water cooling system before air treatment of the refrigerant system, and is provided with a water heating system after air treatment of the refrigerant system.

8. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in any of claims 1~4, wherein the second heat exchanger is connected in series to a third heat exchanger, and the third heat exchanger is connected to chilled water.

9. The control system for adjusting air temperature, humidity and water temperature by an outdoor air heat exchanger as described in claim 8, wherein the air conditioning apparatus is provided with a water cooling system before air treatment of the refrigerant system, a third three-way valve is arranged at an inlet of the water cooling system, and an outlet 2 of the third three-way valve is connected to an inlet of a third heat exchanger; a fourth three-way valve is arranged at the inlet of the third heat exchanger, the outlet 2 of the third three-way valve is connected to an inlet of the fourth three-way valve, and an outlet 2 of the fourth three-way valve is connected to chilled water.

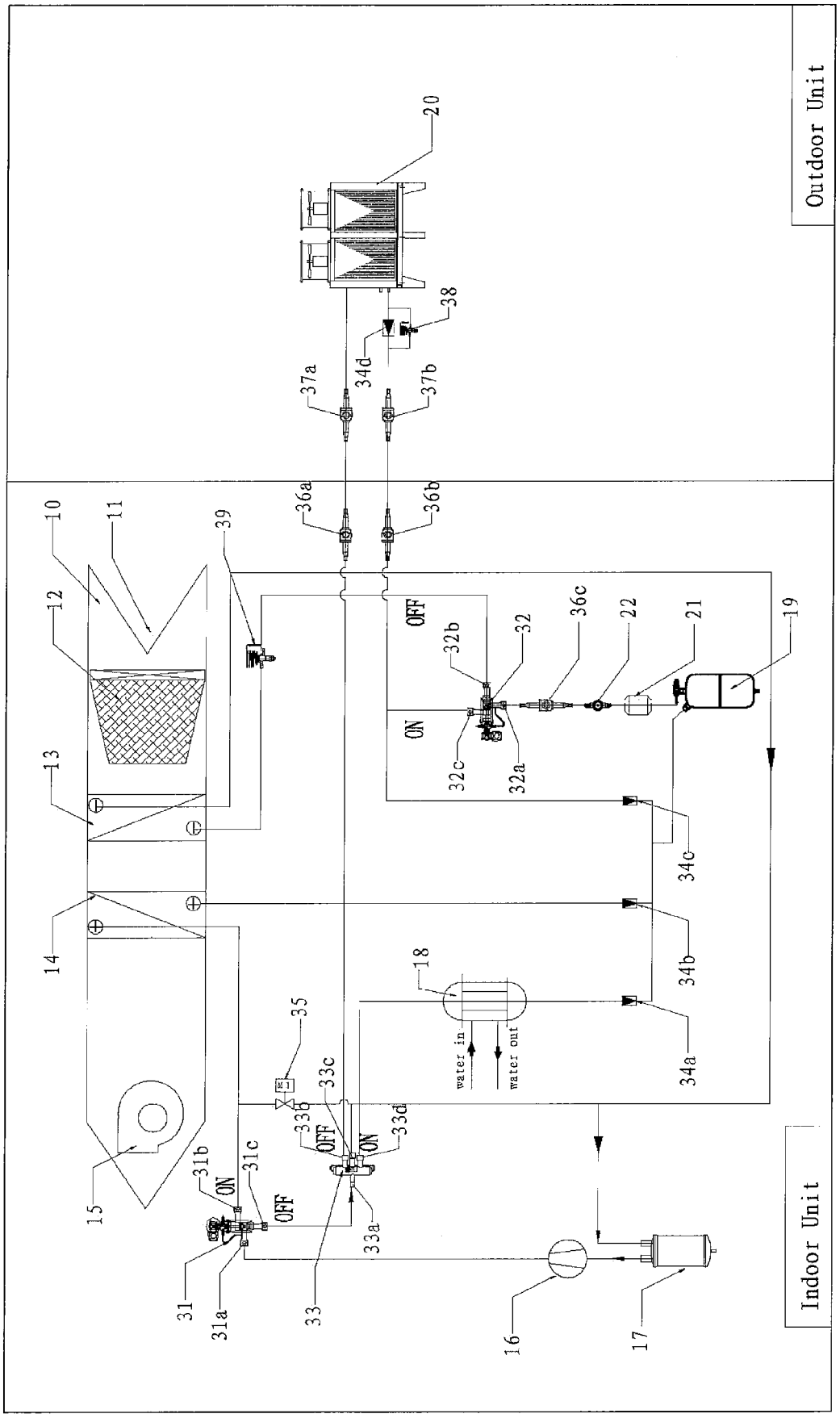
Outdoor Unit
Indoor Unit
20
38
37a
34d
37b
36a
36b
10
11
39
12
OFF
32b
32
36c
22
21
19
ON
32c
32a
13
34c
14
34b
18
35
water in
water out
34a
33c
33b
OFF
ON
33d
15
31b
ON
31c
OFF
33a
31
31a
33
16
17

Fig. 1

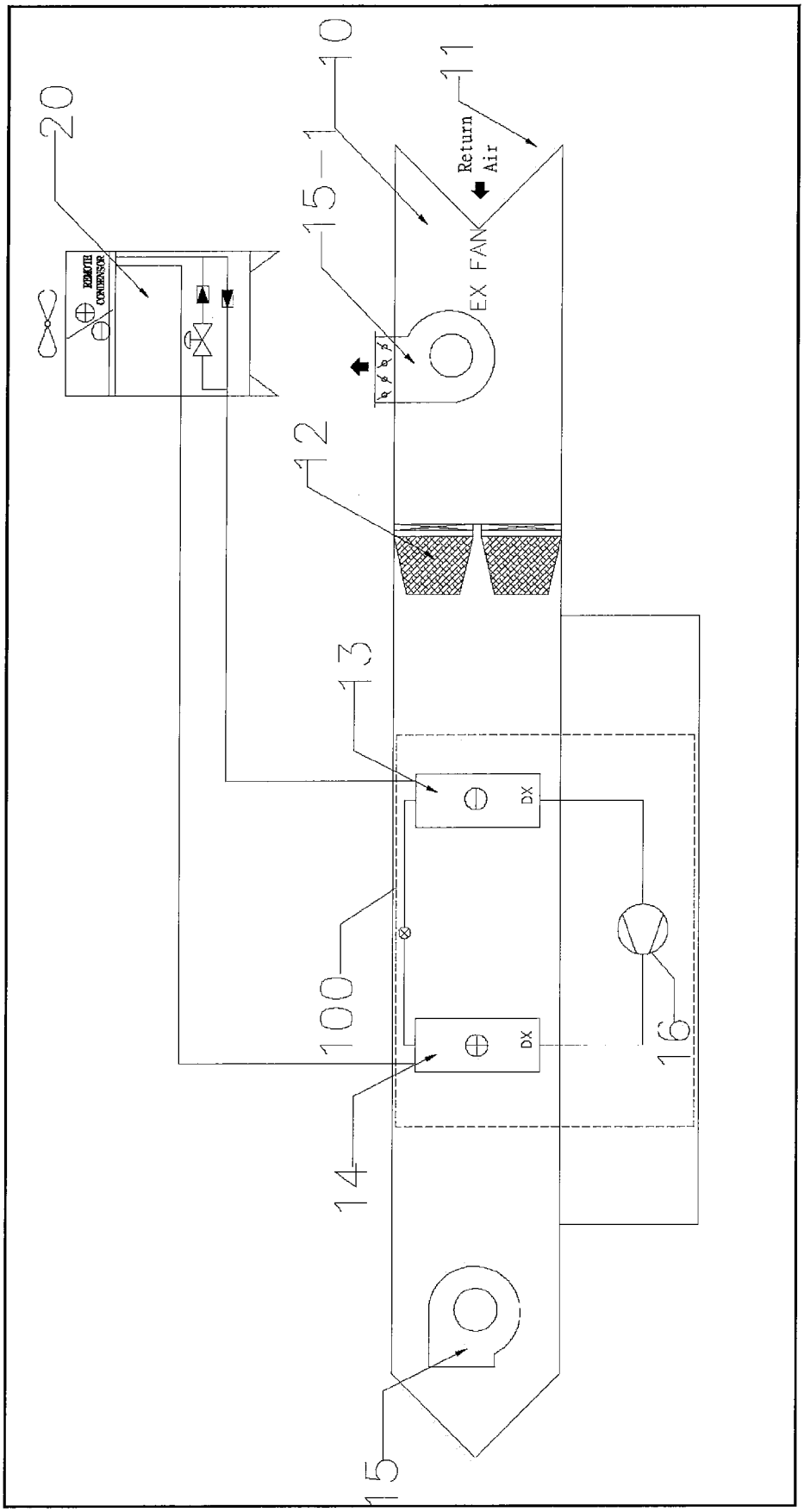

Fig. 2

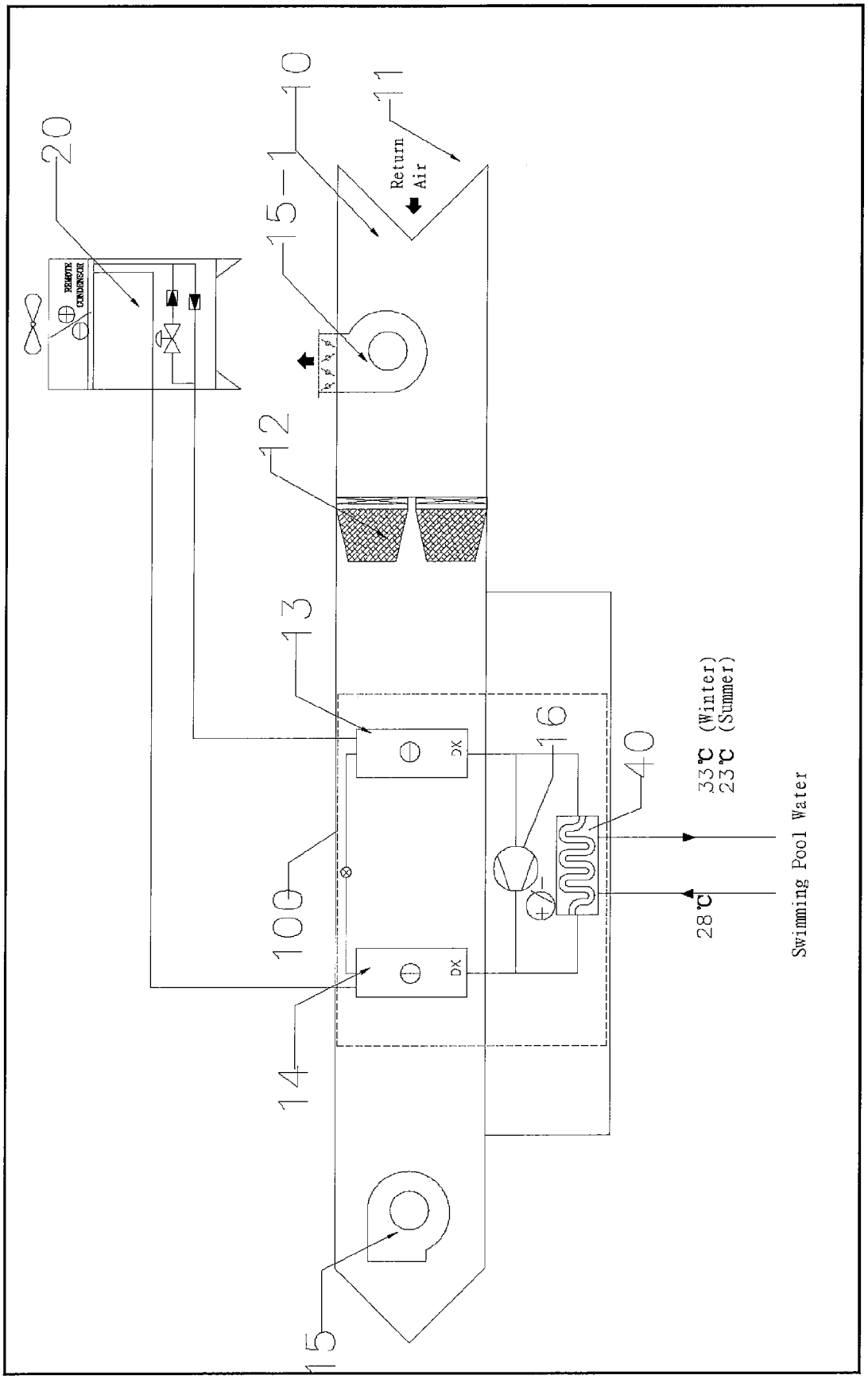
20
10
11
Return Air
15
12
13
16
40
100
14
15
DX
DX
33℃ (Winter)
23℃ (Summer)
28℃
Swimming Pool Water

Fig. 3

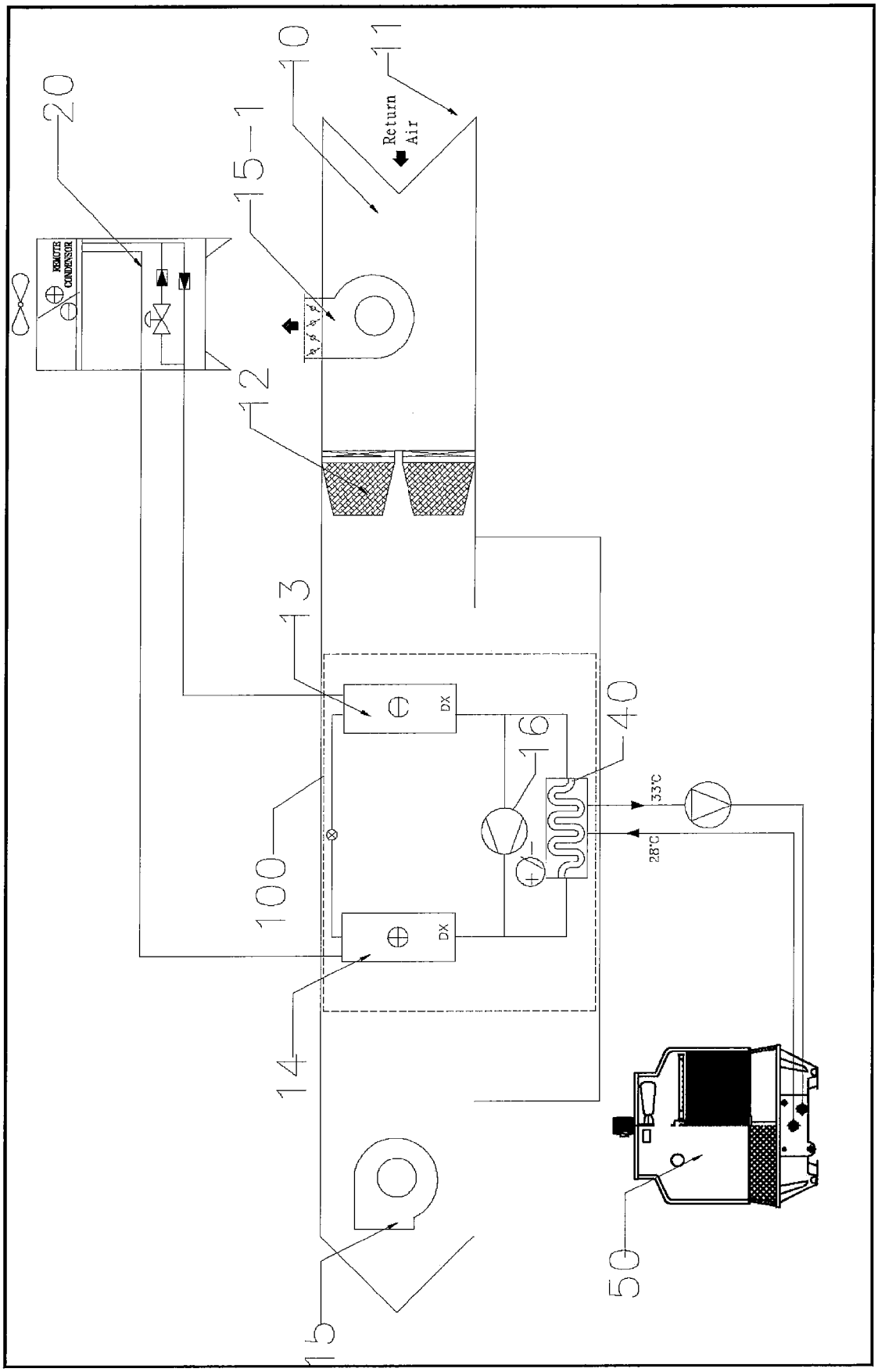
20
10
11
Return Air
15-1
12
13
DX
16
40
33°C
28°C
100
DX
14
50
15
REMOTE CONDENSER

Fig. 4

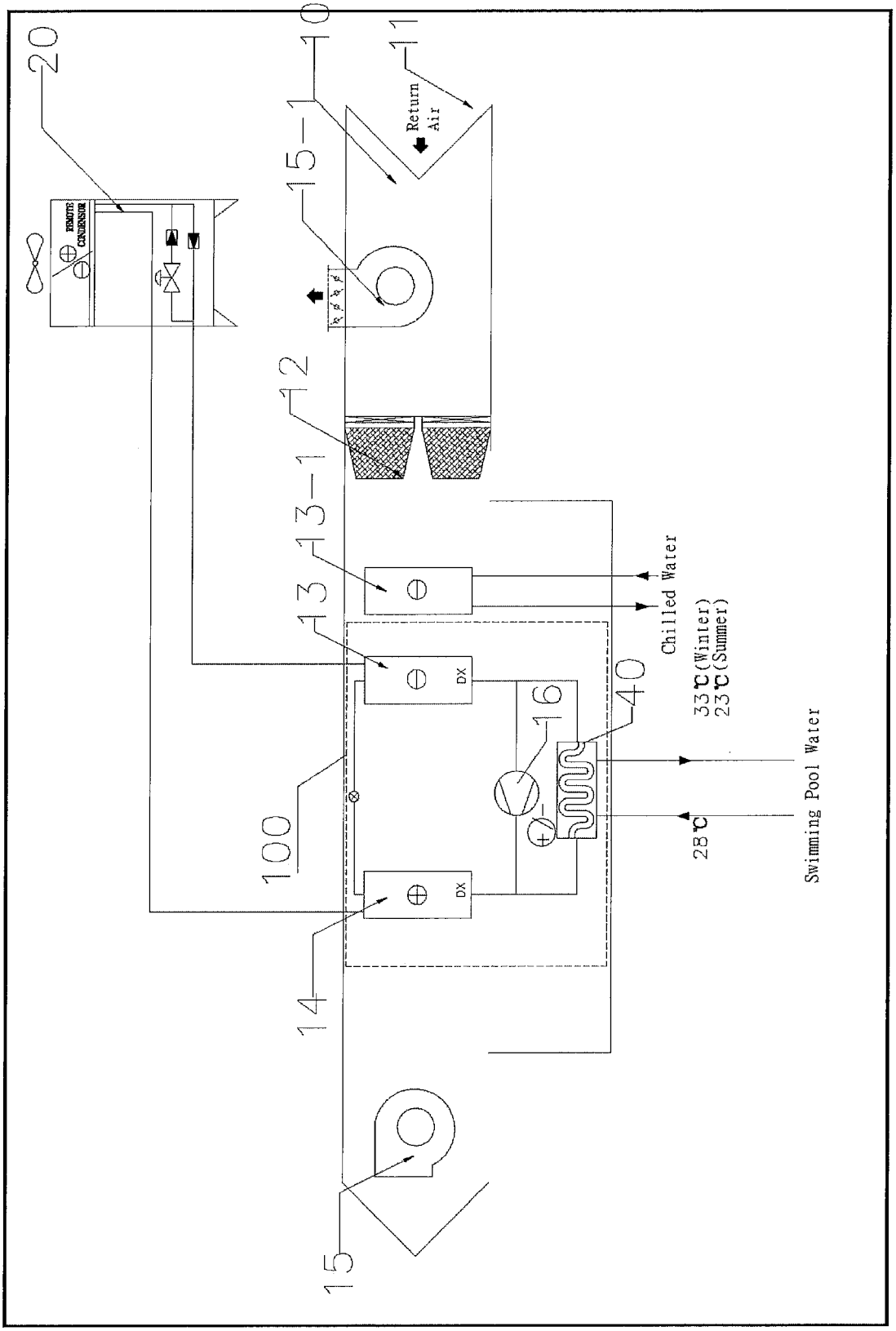
20
10
11
Return Air
15-1
12
13-1
13
Chilled Water
33℃(Winter)
23℃(Summer)
DX
16
40
100
28℃
Swimming Pool Water
14
15

Fig. 5

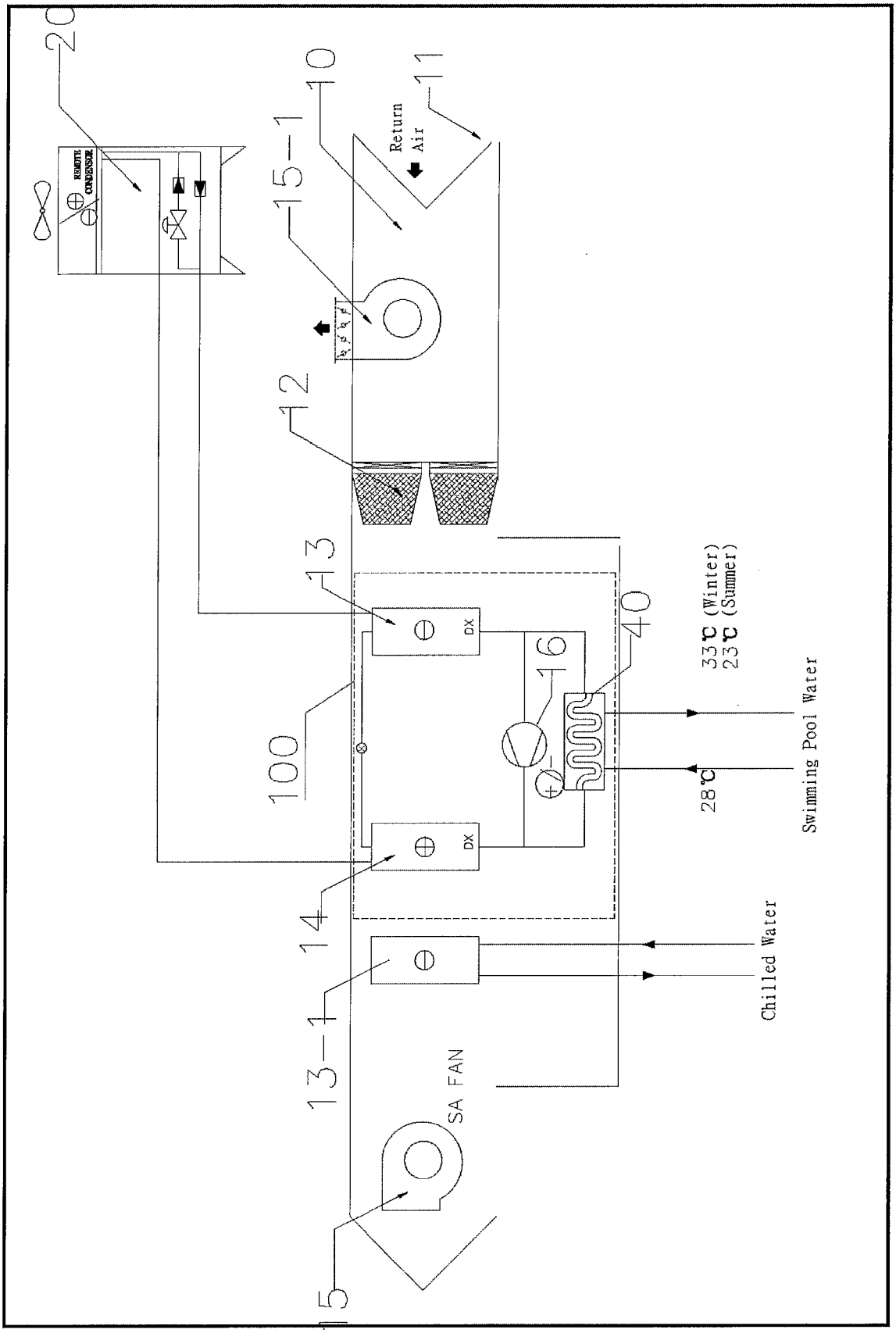
20
REMOTE CONDENSOR
15-1
10
11
Return Air
12
13
DX
DX
16
40
100
33℃ (Winter)
23℃ (Summer)
28℃
Swimming Pool Water
14
Chilled Water
13-1
SA FAN
15

Fig. 6

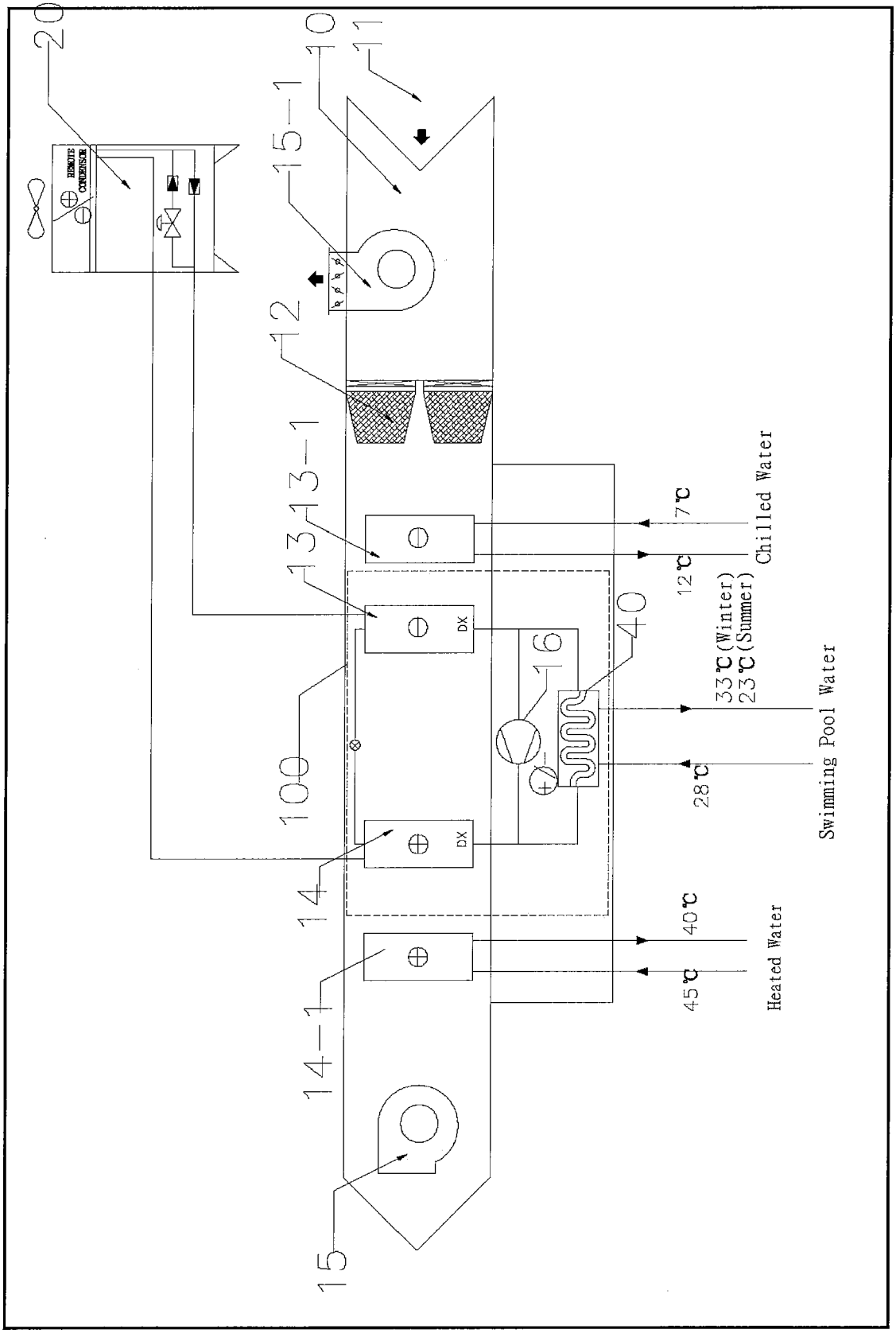
20
10
11
15-1
12
13-1
13
40
16
100
14
14-1
15
REMOTE CONDENSOR
DX
DX
7℃
12℃
Chilled Water
33℃(Winter)
23℃(Summer)
28℃
Swimming Pool Water
40℃
45℃
Heated Water

Fig. 7

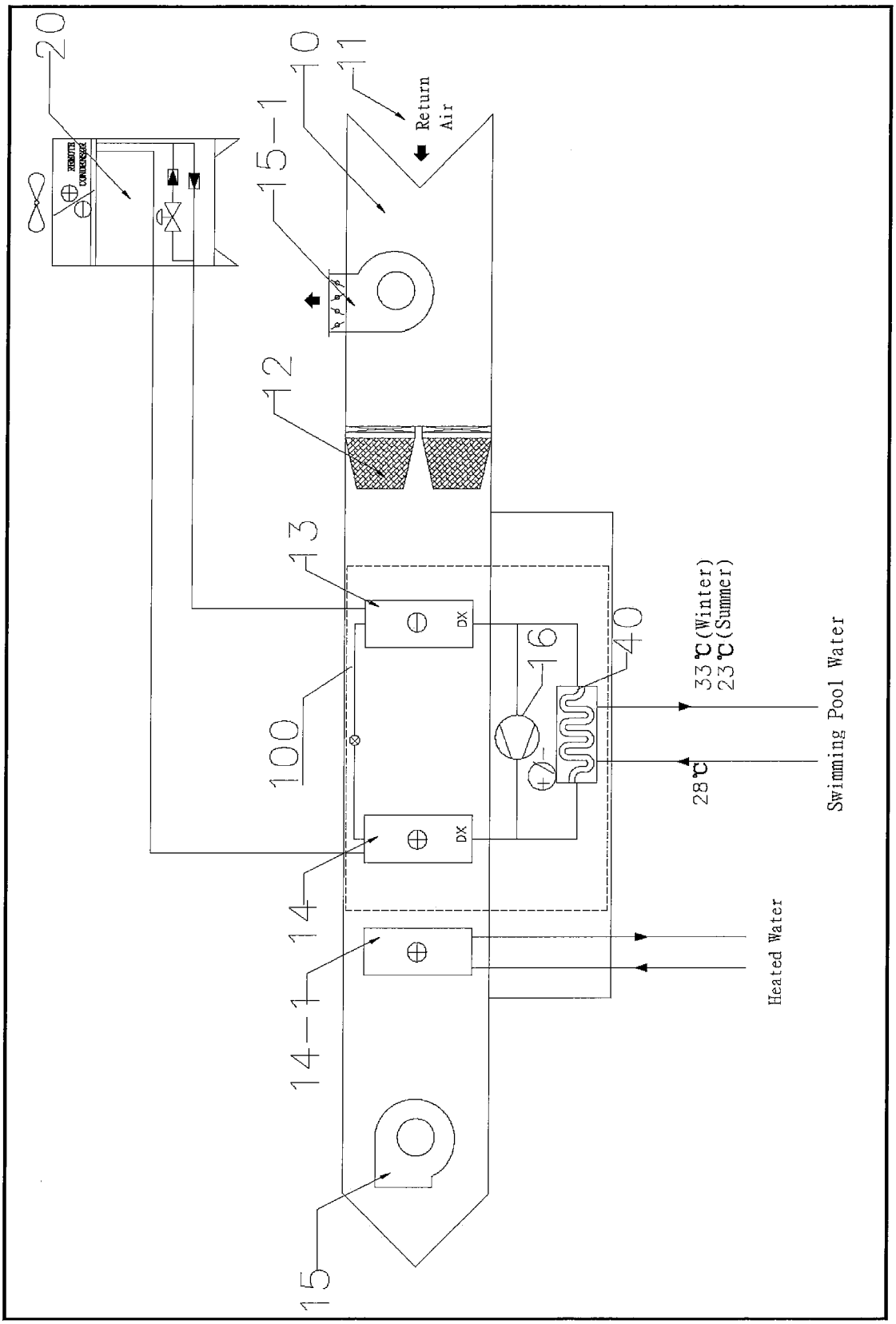
20
10
11
Return Air
15-1
12
13
DX
DX
16
40
100
14
14-1
15
33℃(Winter)
23℃(Summer)
28℃
Swimming Pool Water
Heated Water

Fig. 8

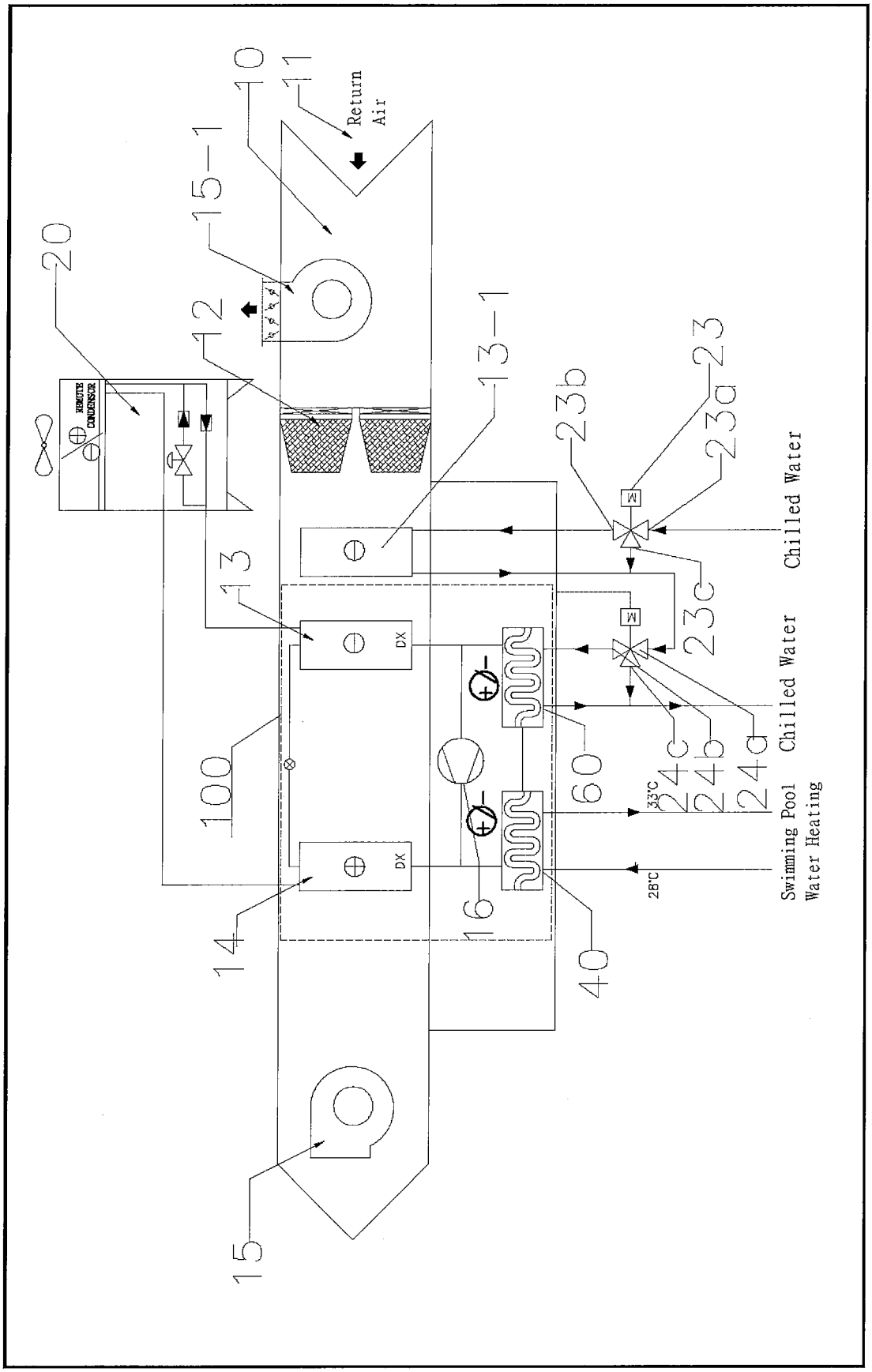
10
11
Return Air
15-1
20
12
13-1
23b
23
23a
Chilled Water
13
23c
Chilled Water
100
60
24c
24b
24a
33°C
28°C
Swimming Pool Water Heating
14
16
40
15
DX
DX

Fig. 9

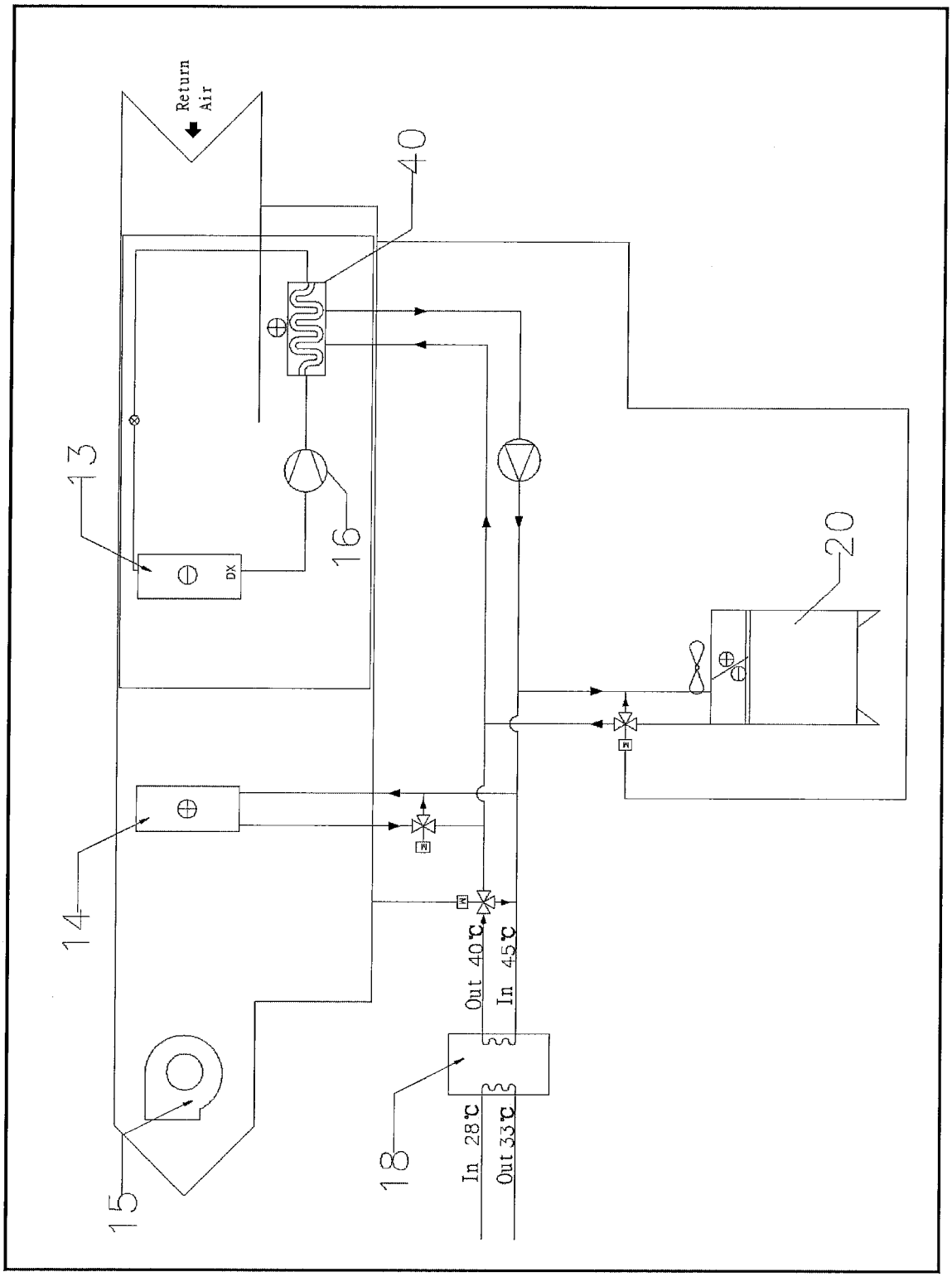

Fig. 10

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 18 5986

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 415 839 A1 (MITSUBISHI ELECTRIC CORP [JP]) 19 December 2018 (2018-12-19)	1,3,5-8	INV. F24F11/46
A	* paragraph [0009] - paragraph [0032]; figures 1-7 *	2,4,9	F24F11/83
	-----		ADD.
X	EP 3 299 734 A1 (DAIKIN IND LTD [JP]; DAIKIN EUROPE NV [BE]) 28 March 2018 (2018-03-28)	1,3,5-8	F24F110/10 F24F110/20
A	* paragraph [0021] - paragraph [0049]; figures 1-7 *	2,4,9	

X	EP 3 205 955 A1 (MITSUBISHI HEAVY IND THERMAL SYSTEMS LTD [JP]) 16 August 2017 (2017-08-16)	1,3,5-8	
A	* paragraph [0016] - paragraph [0034]; figure 1 *	2,4,9	

X	EP 2 733 441 A2 (MITSUBISHI HEAVY IND LTD [JP]) 21 May 2014 (2014-05-21)	1,3,5-8	
A	* paragraph [0029] - paragraph [0051]; figure 1 *	2,4,9	
	-----		TECHNICAL FIELDS SEARCHED (IPC)
A	CN 2 457 532 Y (SENBOYUAN SCIENCE AND TECHNOLO [CN]) 31 October 2001 (2001-10-31) * page 4 - page 6; figures 1-5 *	1-9	F24F F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 August 2020	Anconetani, Mirco

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 18 5986

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-08-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3415839 A1	19-12-2018	EP 3415839 A1	19-12-2018
		JP 6602403 B2	06-11-2019
		JP WO2017138107 A1	13-09-2018
		US 2019011148 A1	10-01-2019
		WO 2017138107 A1	17-08-2017
EP 3299734 A1	28-03-2018	CN 109716033 A	03-05-2019
		EP 3299734 A1	28-03-2018
		JP 2019534437 A	28-11-2019
		US 2019309989 A1	10-10-2019
		WO 2018056177 A1	29-03-2018
EP 3205955 A1	16-08-2017	EP 3205955 A1	16-08-2017
		JP 2017142039 A	17-08-2017
EP 2733441 A2	21-05-2014	EP 2733441 A2	21-05-2014
		JP 6129520 B2	17-05-2017
		JP 2014102011 A	05-06-2014
CN 2457532 Y	31-10-2001	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82