

(19)



(11)

EP 2 891 849 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.07.2015 Bulletin 2015/28

(51) Int Cl.:
F25B 13/00 (2006.01)

(21) Application number: **14160810.9**

(22) Date of filing: **20.03.2014**

(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

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(54) **Heat reclaim for a multifunction heat pump and a multifunction air conditioner**

(57) The present invention relates to heat reclaim arrangement for a multifunction heat pump and a multifunction air conditioner which performs multiple operating modes such as cooling mode, cooling with water heating

mode, heating mode, heating with water heating, water heating mode, and defrost function that is suitable for cold climate application. Refrigerant circuits with simple arrangements are provided to form the above operations.

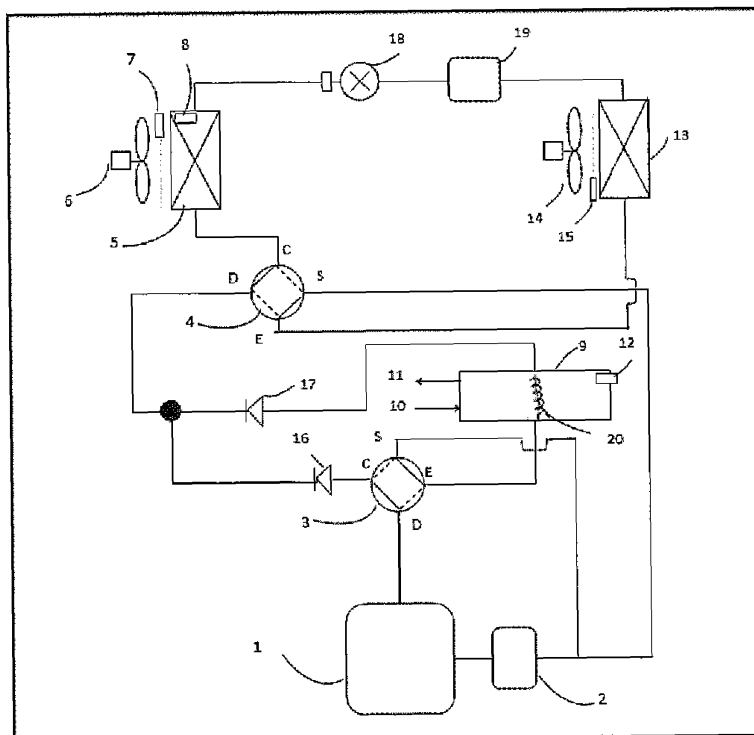


Figure 1

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Description

Field of invention

[0001] The present invention relates generally to a multifunction heat pump and a multifunction air-conditioner that are operable with multiple operating modes which include defrost function.

Background of the Invention

[0002] The primary difference between air conditioners and heat pumps is heat pumps can provide both cooling and heating whereas air conditioner can provide cooling but not heating. A straightforward workshop modification can turn an air conditioner into a heat pump, or vice versa.

[0003] Multifunction heat pumps and multifunction air-conditioners are typically configured with components such as a compressor, heat-exchangers and valves such as solenoid valves, check valves, four way valves, and expansion valves. The components are interconnected to one another via tubes forming a refrigerant circuit. A refrigerant circuit may adopt different number of components and routes.

[0004] In low ambient temperature or cold climate, an outdoor heat exchanger may subject to frost. The frost may form on the surface of the heat exchanger. The formation of frost may decrease the performance of the heat pumps or air-conditioners.

[0005] Reclaiming heat from a condenser of an air conditioner or heat pump to provide hot water is known. Conventionally, the multifunction air conditioners and multifunction heat pumps combine the multiple operating modes into a single refrigerant circuit system.

[0006] Several multifunction heat pump systems are disclosed in CN101231053 (A), CN101504211 (A), CN101504212 (A), and CN201043824 (Y). The disclosures teach that in order to perform multiple operating modes, multiple solenoid valves are used. The use of solenoid valves would increase the cost for manufacturing multifunction heat pump units.

[0007] CN201028886 (Y) and CN101231053 (A) disclose a multifunction heat pump system in which the heat reclaim heat exchanger at the compressor discharges without any valves in between. This type of system would only be able to reclaim partial of the condenser heat and therefore it requires a longer time to provide hot water as compared to the system of the present invention.

[0008] CN101231053 (A) teaches that the fan speed of the outdoor condenser be reduced. While hot water is not consumed during cooling demand is continued, hot water in the heat reclaim heat exchanger will cause the system efficiency to drops even fan speed of additional condenser is proposed to increased due to the hot water produce by the heat reclaim heat exchanger becomes additional load to the system. This problem can be solved by bypass heat reclaim heat exchanger as adopted in the present invention.

[0009] The above disclosures do not teach how defrost function can be performed to overcome frost problem of the outdoor heat exchanger in cold climate or low temperature condition. The refrigerant circuits disclosed in the disclosures do not allow defrost function to be performed during water heating and/or heating with water heating modes. It appears that the above systems are not suitable for country with low ambient temperature or cold climate where the requirement for hot water and defrost function and equally important and essential.

[0010] The present invention provides a defrost function during water heating mode and/or heating with water heating mode by incorporating a refrigerant circuit that is arranged in a manner that a simple refrigerant circuit can be attained and operable with defrost function that is suitable for cold climate application.

Summary of the Invention

[0011] According to the present invention, a heat reclaim of a multifunction heat pump which operates with multiple operating modes which are

- a) cooling
- b) heating
- c) water heating
- d) cooling with water heating (full heat reclaim)
- e) cooling with water heating (partial heat reclaim)
- f) heating with water heating
- g) defrost function

[0012] The refrigerant circuit of the multifunction heat pump is configured without the use of solenoid valve in order to provide simple and economical solution to the manufacture of multifunction heat pumps. Furthermore, without solenoid valve, low noise operation can be attained.

[0013] The refrigerant circuit comprises an outdoor heat exchanger which functions as evaporator during water heating mode and heating with water heating mode to defrost any frost formed over the surface of the heat exchanger. The four-way valve is switched to allow the refrigerant to flow toward the outdoor heat exchanger to perform the defrost function.

[0014] A heat exchanger with a water tank is arranged to be connected in series to an air-cooled condenser to reclaim waste heat for heating water. The heat exchanger acts as an additional condenser. This configuration allows cooling with water heating mode with higher energy efficiency compared to conventional air conditioner (i.e. without heat reclaim system). During cooling with water heating mode, the duration for providing hot water can be expedited by switching off the outdoor fan equipped with the outdoor heat exchanger to allow more heat to be transferred to the water.

[0015] When hot water is needed, the multifunction heat pump will be operated in water heating mode in which during this mode the system does not provide cool-

ing and defrost function will be performed at the outdoor heat exchanger. This is performed by switching two four-way valves in the system. Both heating mode and heating with water heating mode provide indoor heating.

[0016] According to the present invention, a heat reclaim of a multifunction air conditioner which operates with multiple operating modes which are

- a) cooling
- b) cooling with water heating
- c) water heating
- d) defrost function

[0017] A heat exchanger with a water tank is arranged to be connected in parallel to an air-cooled condenser to reclaim waste heat for heating water. The heat exchanger with water tank acts as an alternative condenser when ambient temperature of the air cooled condenser is high in order to achieve better energy efficiency. This configuration allows cooling with water heating mode. During cooling with water heating mode, the duration for providing hot water can be expedited since full condenser heat is being reclaimed. This is performed by switching off the outdoor fan equipped with the outdoor heat exchanger to allow more heat to be transferred to the water.

[0018] When hot water is needed, the multifunction air-conditioner will be operated in water heating mode in which during this mode the system does not provide cooling and defrost function will be performed at the outdoor heat exchanger. This is performed by switching the four-way valve in the system.

Brief Description of the Drawings

[0019] The present invention will be further described by way example only with reference to the accompanying drawings, in which:

FIG. 1 shows a schematic diagram of a refrigerant circuit of a multifunction heat pump according to present invention.

FIG. 2 shows a refrigerant flow direction in the refrigerant circuit as shown in Fig. 1 during cooling only. (The indoor heat exchanger acts as an evaporator while the outdoor heat exchanger acts as a condenser)

FIG. 3 shows a refrigerant flow direction to operate in cooling with heat reclaim mode, which means indoor heat exchanger acts as evaporator for space cooling while heat rejected to the water in a water tank through heat reclaim heat exchanger and outdoor heat exchanger acts as a condenser.

FIG. 4 shows a refrigerant flow direction to operate in heating mode, which means indoor heat exchanger function as condenser for space heating while out-

door heat exchanger function as evaporator.

FIG. 5 shows a refrigerant flow direction in heat with water heating mode or water heating mode only to heat up water in the water tank meanwhile outdoor heat exchanger perform as evaporator and indoor heat exchanger perform as condenser during heating capacity requirement for indoor space. When no space heating is required, heat is fully rejected through water tank.

Fig. 6 shows a schematic diagram of a refrigerant circuit of a multifunction air conditioner according to the present invention.

Fig. 7 shows a refrigerant flow direction in the refrigerant circuit shown in Fig. 6 during cooling only mode. (The indoor heat exchanger acts as an evaporator while the outdoor heat exchanger acts as a condenser)

Fig. 8 shows a refrigerant flow direction in the refrigerant circuit shown in Fig. 6 during cooling with water heating. (The indoor heat exchanger acts as an evaporator and the heat exchanger with tank acts as a condenser that releases heat to water in tank.)

Fig. 9 shows a refrigerant flow direction in the refrigerant circuit shown in Fig. 6 during water heating mode (The outdoor heat exchanger acts as evaporator)

Fig. 10 shows a refrigerant flow direction in the refrigerant circuit shown in Fig. 6 during defrost function. (Refrigerant flows in reverse direction of water heating mode).

Detailed Description of the Embodiments of the Invention

[0020] FIG. 1 is a schematic diagram of a refrigerant circuit of a multifunction heat pump according to the present invention. The circuit comprises:

- a) an indoor air-cooled heat exchanger (13),
 - b) an outdoor air-cooled heat exchanger (5),
 - c) a water-cooled heat exchanger (20) with a water tank (9),
 - d) a compressor (1),
 - e) an expansion valve. (18),
 - f) a first (3) and a second (4) four-way valves, and
 - g) a first and a second check valves (16, 17)
- wherein the components are interconnected to form the refrigerant circuit

[0021] According to the present invention, the refrigerant circuit as shown in Fig. 1 is operable to perform multiple operating modes which are

- a) cooling
- b) heating
- c) water heating
- d) cooling with water heating (full heat reclaim)
- e) cooling with water heating (partial heat reclaim)
- f) heating with water heating
- g) defrost function

[0022] The compressor (1) for compressing and circulating the refrigerant in the refrigerant circuit is connected to an accumulator (2) via a suction side of the compressor (1). A discharge pipe of the compressor (1) is connected to a "D" port of the first four-way valve (3). A "C" port of the first four-way valve (3) is connected to the "D" port of the second four-way valve (4). A "C" port of the second four-way valve (4) is connected to the outdoor air-cooled heat exchanger (5).

[0023] The outdoor heat exchanger (5) is cooled by air blown by an outdoor fan (6). An outdoor air sensor (7) is provided at the upstream of outdoor air flow for measuring outdoor ambient temperature. A sensor that can be referred to as outdoor heat exchanger sensor (8) is provided at the outdoor heat exchanger (5) to determine frost condition on the outdoor heat exchanger (5). Based on the outdoor heat exchanger sensor (8), the system will determine whether defrost function need to be performed.

[0024] A "E" port of the first four-way valve (3) is connected to a heat reclaim heat exchanger (20). The heat reclaim heat exchanger (20) is cooled by water. The heat exchanger (20) includes but not limited to a heat exchanger with a water tank. It can be a plate heat exchanger, a tube heat exchanger or any water cooled heat exchanger.

[0025] A cold water inlet pipe (10) and a hot water outlet pipe (11) are connected to a water tank (9) wherein the pipes are connected to a water supply circuit of a building. A water tank sensor (12) is provided in the water tank (9) to measure the water temperature and the ambient temperature of the heat reclaim heat exchanger (20). Based on the measurement, a controller will determine operation of system to achieve desired pre-set temperature.

[0026] An indoor heat exchanger (13) is provided with an indoor fan (14) and an indoor air sensor (15) for measuring a room temperature. Preferably, the indoor air sensor (15) is installed adjacent to an indoor return air.

[0027] At least a first (16) and a second (17) check valves are provided on the refrigerant circuit of the system. An inlet port of the first check valve (16) is connected to the "C" port of the first four-way valve (3). An outlet port of the first check valve (16) is connected with an outlet port of the second check valve (17). An inlet port of the second check valve (17) is connected to the heat reclaim heat exchanger (20).

[0028] A connecting pipe from outdoor heat exchanger (5) is connected to an electronic expansion device (18). A balance port of the electronic expansion valve (18) is connected to liquid receiver (19). The liquid receiver (19)

is then connected to the indoor heat exchanger (13). A connecting pipe from the indoor heat exchanger (13) is connected to a "S" port of the second four-way valve (4) to allow the refrigerant to flow back to the accumulator (2).

Cooling Mode

[0029] FIG. 2 shows the refrigerant flow direction during cooling only mode for the multifunction heat pump. During cooling only mode, a pressurized hot refrigerant will flow from the compressor (1) to the first four-way valve (3) and to the second four-way valve (4), and then to the outdoor heat exchanger (5) where heat from the refrigerant will be rejected wherein both first and second four-way valves (3) and (4) are de-energized to allow refrigerant to flow from port "D" to port "C".

[0030] The condensed liquid refrigerant then will flow to an electronic expansion device (18) resulting a cold refrigerant. The cold refrigerant will flow via the liquid receiver (19) and flow to the indoor heat exchanger (13) for cooling a space or room. The refrigerant will flow back to the accumulator (2) and compressor (1). This cycle continues to provide cooling.

Cooling with Water Heating Mode (Partial and Full Heat Reclaim)

[0031] FIG. 3 describes a refrigerant flow direction in cooling with water heating mode for multifunction heat pump. During cooling with water heating mode, the first four-way valve (3) is energized (i.e. power is supplied) to allow the refrigerant to flow from the compressor (1) to the heat reclaim heat exchanger (20) with the water tank (9) where partial condenser heat is rejected to the water. The water tank (9) is provided with an outlet pipe (11) for channelling out hot water from the water tank (9) and an inlet pipe (10) for refilling the water tank (9) with water. The refrigerant will flow via the second check valve (17) to the second four-way valve (4). The second four-way valve (4) is de-energized (i.e. power is not supplied) to allow the refrigerant to flow from the heat reclaim heat exchanger (20) to the outdoor heat exchanger (5). Remaining heat in the refrigerant is rejected at the outdoor heat exchanger (5). The condensed liquid refrigerant then will flow via the expansion valve (18) and expanded to a low pressure cold refrigerant. The cold refrigerant will flow via the liquid receiver (19) and then will flow to the indoor heat exchanger (13) for cooling the space according to the desired pre-set temperature. This cooling with partial heat reclaim mode uses both heat reclaim heat exchanger (20) and the outdoor heat exchanger (5) as condensers to maximize system efficiency.

[0032] If hot water with a higher temperature is required, a control system of the multifunction heat pump will switch off the outdoor fan (6) so that heat from the refrigerant will not be rejected at the outdoor heat exchanger (5). Therefore the heat reclaim heat exchanger (20) will reject more heat to the water. This cycle is per-

formed for cooling with full heat reclaim mode.

Heating Mode

[0033] FIG. 4 shows a refrigerant flow direction during heating only mode for multifunction heat pump. During heating only mode, a pressurized hot refrigerant will flow from the compressor (1) to the first (3) and second (4) four-way valves, and then to the indoor heat exchanger (13) to provide heating to the room. The first four-way valve (3) is de-energized to allow refrigerant to flow from port "D" to "C" and the second four-way valve (4) is energized to allow the refrigerant to flow from port "D" to "E". The cold refrigerant will flow via the liquid receiver (19) to the electronic expansion device (18) where the condensed liquid refrigerant will be expanded. The refrigerant then will flow to the outdoor heat exchanger (5) to absorb heat from the surrounding. Then, the refrigerant will flow back to the accumulator (2) and compressor (1). The cycle continues to provide heating.

Water Heating Mode

[0034] During cold ambient temperature or cold condition, cooling may not be required. If hot water is required, the water heating mode can be operated by the system. FIG. 5 shows a refrigerant flow direction during water heating mode for multifunction heat pump in which the outdoor heat exchanger (5) acts as an evaporator. The first (3) and second (4) four-way valve are energized in this operating mode. The refrigerant will flow from the compressor (1) to the heat reclaim heat exchanger (20) to reject heat to the water. The refrigerant will flow through a check valve (17) to the second four-way valve (4), and then to the indoor heat exchanger (13). The indoor fan (14) will stop operate during this mode. The condensed liquid refrigerant will flow via a liquid receiver (19) to the expansion valve (18). The cold refrigerant then will flow to the outdoor heat exchanger (5) and acts as an evaporator. The water tank sensor (12) provided at the water tank (9) will provide feedback to the controller to allow the compressor (1) to operate if the water temperature in the tank is lower than the set temperature.

Heating with Water Heating Mode

[0035] If hot water and space heating are required, the system will operate in heating with water heating mode. During this mode, indoor fan (14) will operate to reject heat from indoor heat exchanger (13) for space heating.

Defrost Function

[0036] Some country may experience low ambient temperature. Frost may be formed on the surface of the outdoor heat exchanger (5) while water heating mode or heating with water heating mode operation in low ambient. When the outdoor heat exchanger sensor (8) meas-

ures a temperature below a certain temperature, signal will be sent to the controller to allow the system to perform defrost function.

[0037] During defrost function; the refrigerant will flow following the same direction as in cooling only mode where a pressurized hot refrigerant will flow from the compressor (1) to the first four-way valve (3) and to the second four-way valve (4), and then to the outdoor heat exchanger (5) where heat from the refrigerant will be rejected wherein both first and second four-way valves (3) and (4) are de-energized to allow refrigerant to flow from port "D" to port "C".

[0038] FIG. 6 is a schematic diagram of a refrigerant circuit of a multifunction air conditioner according to the present invention. The circuit comprises:

- a) an indoor air-cooled heat exchanger (105),
- b) an outdoor air-cooled heat exchanger (107),
- c) a water-cooled heat exchanger (104) with a water tank (122),
- d) a compressor (101),
- e) an expansion valve (109),
- f) a four-way valve (103),
- g) first, second, third and four solenoid valves (110, 111, 112, 113)
- h) temperature sensors (114, 115, 116, 117)

[0039] According to the present invention, the refrigerant circuit as shown in Fig. 6 is operable to perform multiple operating modes which are

- a) cooling
- b) cooling with water heating
- c) water heating
- d) defrost function

[0040] The compressor (101) for compressing and circulating the refrigerant in the refrigerant circuit is connected to an accumulator (102) at a suction side of the compressor (101). A discharge pipe of the compressor (1) is connected to a "D" port of a four-way valve (103). A "C" port of the first four-way valve (103) is connected to an outdoor air-cooled heat exchanger (107).

[0041] The outdoor heat exchanger (107) is cooled by air blown by an outdoor fan (108). A outdoor air sensor (114) is provided at the upstream of outdoor air flow for measuring outdoor ambient temperature. A sensor that can be referred to as outdoor heat exchanger sensor (115) is provided at the outdoor heat exchanger (107) to determine frost condition on the outdoor heat exchanger (107). Based on the outdoor heat exchanger sensor (115), the system will determine whether defrost function need to be performed.

[0042] A "E" port of the first four-way valve (103) is connected to a heat reclaim heat exchanger (104). The heat reclaim heat exchanger (104) is cooled by water. The heat exchanger (104) includes but not limited to a heat exchanger with a water tank (122). It can be a plate

heat exchanger, a tube heat exchanger or any water cooled heat exchanger.

[0043] A cold water inlet pipe (120) and a hot water outlet pipe (121) are connected to a water tank (122) wherein the pipes are connected to a water supply circuit of a building. A water tank sensor (116) is provided in the water tank (122) to measure the water temperature and the ambient temperature of the heat reclaim heat exchanger (107). Based on the measurements by the sensor, a controller will determine operation to achieve desired pre-set temperature.

[0044] An indoor heat exchanger (105) is provided with an indoor fan (114) and an indoor air sensor (117) for measuring a room temperature. Preferably, the indoor air sensor (117) is installed adjacent to an indoor return air.

[0045] At least four solenoid valves (110, 111, 112, 113) are provided on the refrigerant circuit. The first solenoid valve (110) is connected to the outdoor heat exchanger (107) at one side and the second solenoid valve (111) at the other side. One side of the second solenoid valve (111) is connected to an electronic expansion valve (109). A balance port of the electronic expansion valve (109) is connected to a junction that connects the expansion valve (109) to the third (112) and fourth (113) solenoid valve. The third solenoid valve (112) is connected to a heat reclaim heat exchanger (104). The balance port of the second (111) and fourth solenoid valve (113) are connected to the indoor heat exchanger (105). The indoor heat exchanger (105) is connected to a "S" port of the four way valve (103) and to the accumulator (102).

Cooling Mode

[0046] FIG. 7 shows a refrigerant flow direction during cooling only mode for multifunction air conditioner. During cooling only mode, a pressurized hot refrigerant will flow from the compressor (101) to the four-way valve (103) and then to the outdoor heat exchanger (107) where heat from the refrigerant will be rejected wherein the four-way valve (103) is de-energized to allow refrigerant to flow from port "D" to port "C".

[0047] The condensed liquid refrigerant then will flow to the first solenoid valve (110) and then to an electronic expansion device (109) in which the second and third solenoid valves (111, 112) are closed, and the fourth solenoid valve is opened to allow cold refrigerant to flow to indoor heat exchanger (105) to provide cooling to the room. The refrigerant will flow back the accumulator (102) and compressor (101). This cycle continues to provide cooling.

Cooling with Water Heating Mode

[0048] FIG. 8 shows a refrigerant flow direction during cooling with water heating mode for multifunction air conditioner. During cooling with water heating mode, the four-way valve (103) is energized to allow the refrigerant

to flow from the compressor (101) to the heat reclaim heat exchanger (104) with the water tank (122) where condenser heat is rejected to and absorbed by the water. The water tank (122) is provided with an outlet pipe (121) for channeling out hot water from the water tank (122) and an inlet pipe (120) for refilling the water tank (109) with water. The refrigerant will flow via the third solenoid valve (112) to the electronic expansion device (109) resulting low pressure refrigerant. The first solenoid valve (110) is closed to block flow to the outdoor heat exchanger (107) and the second solenoid valve (111) is opened to allow the cold refrigerant to flow to the indoor heat exchanger (105) for space cooling. The outdoor fan (108) is operated to blow the indoor heat exchanger.

[0049] Users have the option whether to choose to use heat rejected by the system to heat water and store hot water in the tank or reject the heat to the surrounding. Heat exchanger with colder ambient will allow the compressor to operate at lower discharge pressure and therefore lowering the power input to the system.

Water Heating Mode

[0050] If hot water with a higher temperature is required, the multifunction air conditioner will operate in water heating mode. Fig. 9 shows a refrigerant flow direction during water heating mode. The four-way valve (103) is energized to allow the refrigerant to flow from compressor (101) to heat reclaim heat exchanger (104) where heat will be rejected. The third and first solenoid valves (112, 110) are opened while the second and fourth solenoid valves (111, 113). Condensed liquid refrigerant will flow via the third solenoid valve (112) to the electronic expansion valve (109). The cold refrigerant is directed to the outdoor heat exchanger (107) to perform as an evaporator. This performs as a water heater with high efficiency compared to electric heating.

Defrost Function

[0051] Some country may experience low ambient temperature. Frost may be formed on the surface of the outdoor heat exchanger (107) while water heating mode or heating with water heating mode operation in low ambient. When an outdoor coil sensor measures a temperature below a certain temperature, signal will be sent to the controller to allow the system to perform defrost function.

[0052] FIG. 10 shows a refrigerant flow direction during defrost function which is in reverse direction of water heating mode as shown in Fig. 9. The third and first solenoid valves (112, 110) are opened while the second and fourth solenoid valves (111, 113) are closed. This four-way valve (103) is de-energized to reverse the flow direction as performed during water heating mode. Refrigerant from compressor (101) will flow to the outdoor heat exchanger (107), hence melting the frost on outdoor heat exchanger (107). Then, it flows to heat reclaim heat

exchanger (104) through first solenoid valve (110), expansion valve (109), and third solenoid valve (112). From the heat reclaim heat exchanger (104), the refrigerant flows to four way valve (103) entering port "E" to "S" and flows back to the accumulator (102) and compressor (101).

[0053] When frost is cleared, outdoor coil temperature will increase and this will be detected by the outdoor heat exchanger sensor (115) and consequently stop the defrost operation.

Claims

1. Heat reclaim arrangement for a multifunction heat pump comprising
 - a water-cooled heat exchanger (20);
 - an indoor air-cooled heat exchanger (13);
 - an outdoor air-cooled heat exchanger (5);
 - an expansion valve (18) with a liquid receiver (19) connecting the indoor and outdoor heat exchangers;
 - a compressor (1) comprising a suction side and a discharge pipe for circulating a refrigerant;
 - a first four-way valve (3) comprising D, C, S and E ports;
 - a second four-way valve (4) comprising D, C, S and E ports;
 - a first (16) and second (17) check valves
 wherein the suction side of the compressor (1) is connected to an accumulator (2) and the discharge pipe is connected to the D port of the first four-way (3) and its C port is connected to the D port of the second four-way valve (4) and its C port is connected to the outdoor heat exchanger (5);
 - wherein the E port of the first four-way valve (3) is connected to the water-cooler heat exchanger (20) to allow the water to absorb heat rejected by the exchanger; wherein the indoor heat-exchanger (13) is connected to E port of the second four-way valve (4) to allow refrigerant to flow back to the accumulator (2);
 - wherein the connection between the components forming a refrigerant circuit that is operable for cooling, heating, water heating and defrost functions.
2. A heat reclaim arrangement according to claim 1 wherein the first check valve (16) is disposed within the connect between the first four-way valve (3) and second four-way valve (4); and the second check valve (17) is connected to the water-cooled heat exchanger (20) and to the connection between first four-way valve (3) and second four-way valve (4) at a junction.
3. A heat reclaim arrangement according to claim 1 wherein the refrigerant circuit includes
 - an outdoor heat exchanger sensor (8) disposed at the outdoor heat exchanger (5) to determine frost
- condition on the outdoor heat exchanger (5);
- an outdoor air sensor (7) disposed at the upstream of air flow of the outdoor heat exchanger (5) for measuring outdoor ambient temperature;
- an outdoor air sensor (15) disposed at the upstream of air flow of the indoor heat exchanger (13) for measuring room temperature; and
4. A heat reclaim arrangement according to claim 1 wherein the water-cooled heat exchanger includes a water tank and a water tank sensor (12) is disposed in the water tank for measuring water temperatures.
5. A heat reclaim arrangement according to claim 1 wherein defrost function is operable by de-energizing first four-way valve (3) and second four-ways valve (4) to allow hot refrigerant to flow from the compressor to the outdoor heat exchanger (5) that subject to frost in cold climate.
6. A heat reclaim arrangement according to claim 1 cooling and water heating function is operable by energizing the first four-way valve (3), de-energizing four-ways valve (4), and switching off a fan (6) provided at the outdoor heat exchanger (5) for full heat reclaim function.
7. A heat reclaim arrangement according to claim 1 wherein cooling and water heating is operable by energizing the first four-way (3), de-energizing the second four-ways valve (4), and switching on a fan (6) provided at the outdoor heat exchanger (5) for partial heat reclaim function.
8. A heat reclaim arrangement according to claim 1 wherein heating is operable by de-energizing a first four-way valve (3) and energizing a second four-way valve (4).
9. A heat reclaim arrangement according to claim 1 wherein heating and water heating function is operable by energizing a first four-ways valve (3) and a second four-way valve (4), and operating a fan (14) provided at the indoor heat exchanger (13).
10. A heat reclaim arrangement according to claim 1 wherein water heating function is operable by energizing a first four-ways valve (3) and a second four-way valve (4), and switching off a fan (14) provided at the indoor heat exchanger (13).
11. Heat reclaim arrangement for a multifunction air conditioner comprising
 - an indoor air-cooled heat exchanger (105),
 - an outdoor air-cooled heat exchanger (107),
 - a water-cooled heat exchanger (104) with a water tank,
 - a compressor (101) comprising a suction side and a

discharge pipe for circulating a refrigerant;
 an expansion valve (109),
 a four-way valve (103),
 first, second, third and fourth solenoid valves (110, 111, 112, 113)
 wherein the suction side of the compressor (101) is connected to an accumulator (102) and the discharge pipe is connected to the D port of the four-way (103) and its C port is connected to the outdoor heat exchanger (107);
 wherein the water-cooled heat exchanger (104) is connected to E port and the third solenoid valve (112);
 wherein the outdoor heat exchanger (107) is connected to the first solenoid valve (110) and the second solenoid valve (111)
 wherein the second solenoid valve (111) is connected to an electronic expansion valve (10) having a balance port that is connected to a junction that connected the expansion valve to the third (112) and fourth (113) solenoid valve;
 wherein a balance part of the second (111) and fourth solenoid valve (113) are connected to the indoor heat exchanger (105) and the indoor heat exchanger (105) is connected to a "S" port of the four way valve (103) and to the accumulator (102). wherein the connection between the components forming a refrigerant circuit that is operable for cooling, water heating and defrost functions.

12. Heat reclaim arrangement according to claim 11 wherein

an outdoor heat exchanger sensor (115) is provided at the outdoor heat exchanger (107) to determine frost condition on the outdoor heat exchanger (107).
 an outdoor air sensor (114) disposed at the upstream of air flow of the outdoor heat exchanger (107) for measuring ambient temperature;
 an indoor air sensor (117) disposed at the upstream of air flow of the indoor heat exchanger (105) for measuring room temperature.

13. A heat reclaim arrangement according to claim 1 wherein the water-cooled heat exchanger includes a water tank (122) and a water tank sensor (116) is disposed in the water tank for measuring water temperature.

14. A heat reclaim arrangement according to claim 11 wherein water heating mode is operation by energizing the four-way valve (103) and by opening the third and first solenoid valves (112, 110) and by closing the second and fourth solenoid valves (111, 113); and wherein defrost function during water heating mode is operable by de-energizing the four-way valve (103) and by opening the third and first solenoid valves (112, 110) and by closing the second and fourth solenoid valves (111, 113).

15. A heat reclaim arrangement according to claim 11 wherein cooling and water heating is operable by energizing the four-way valve (103), open the third and second (112, 111) solenoid valves and close first and fourth (110, 113) solenoid valves; or wherein cooling is operable by de-energizing the four-way valve (103), open the first and the fourth (110, 113) solenoid valves and close second and third (111, 112) solenoid valves.

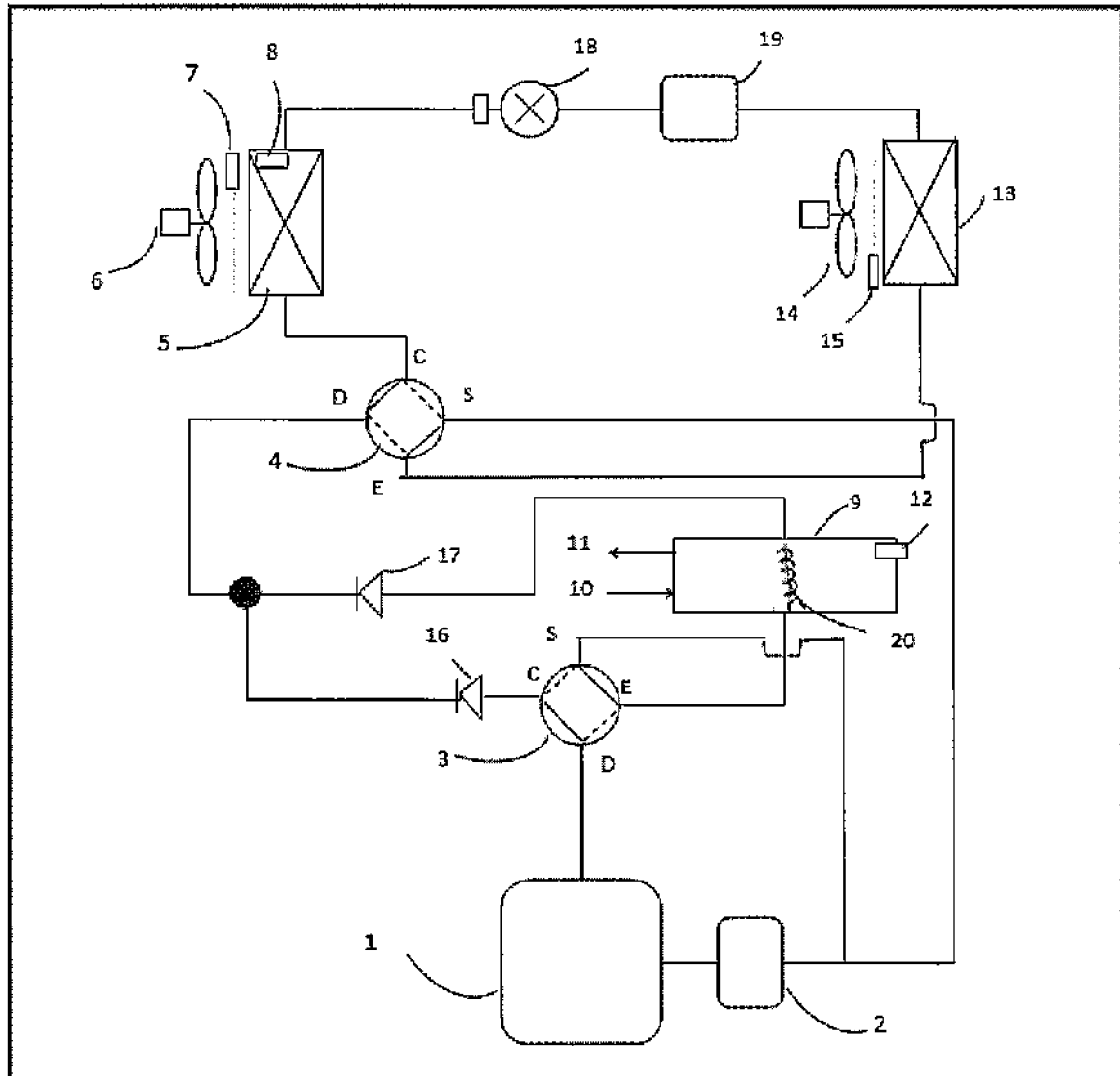


Figure 1

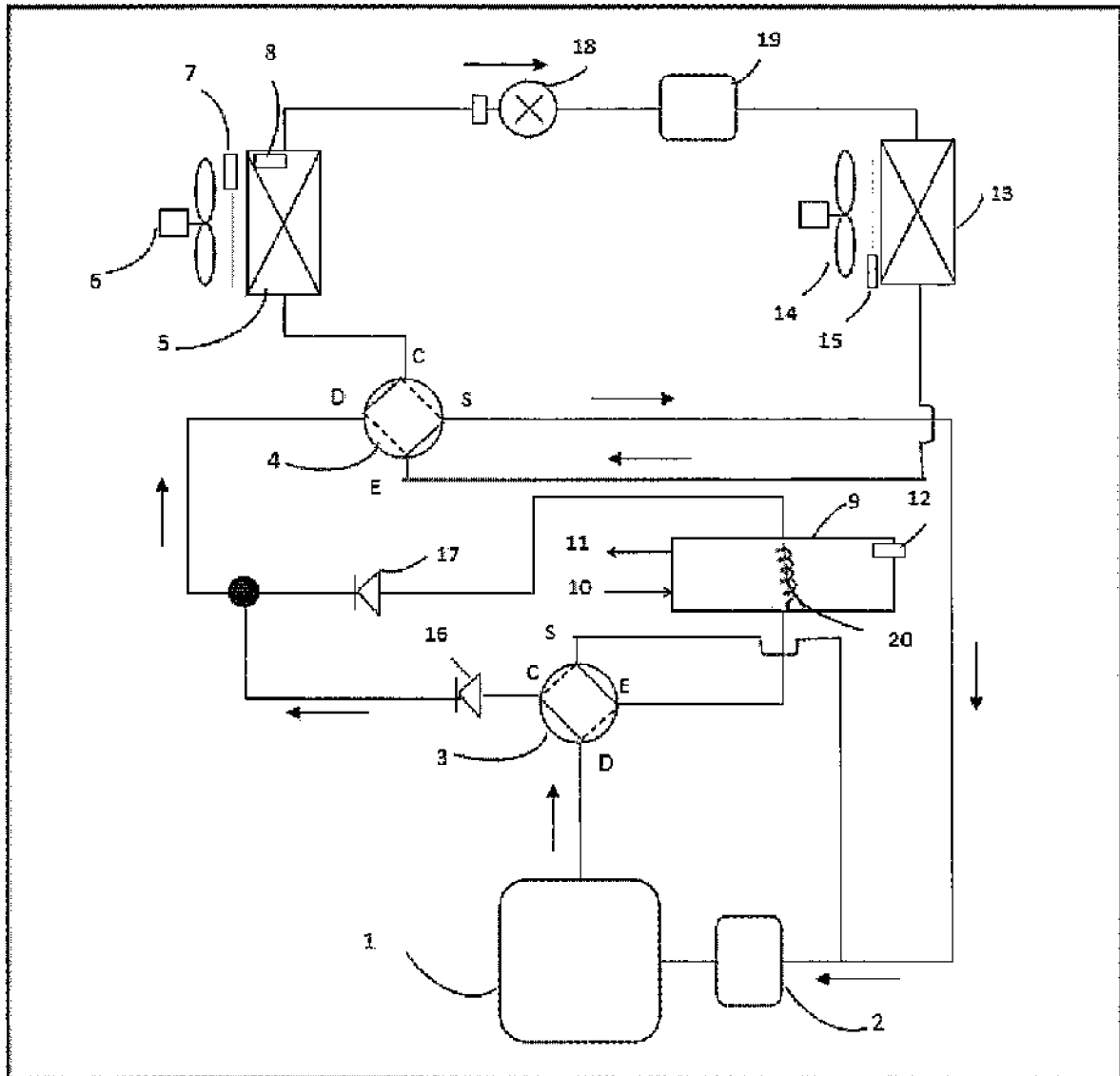


Figure 2

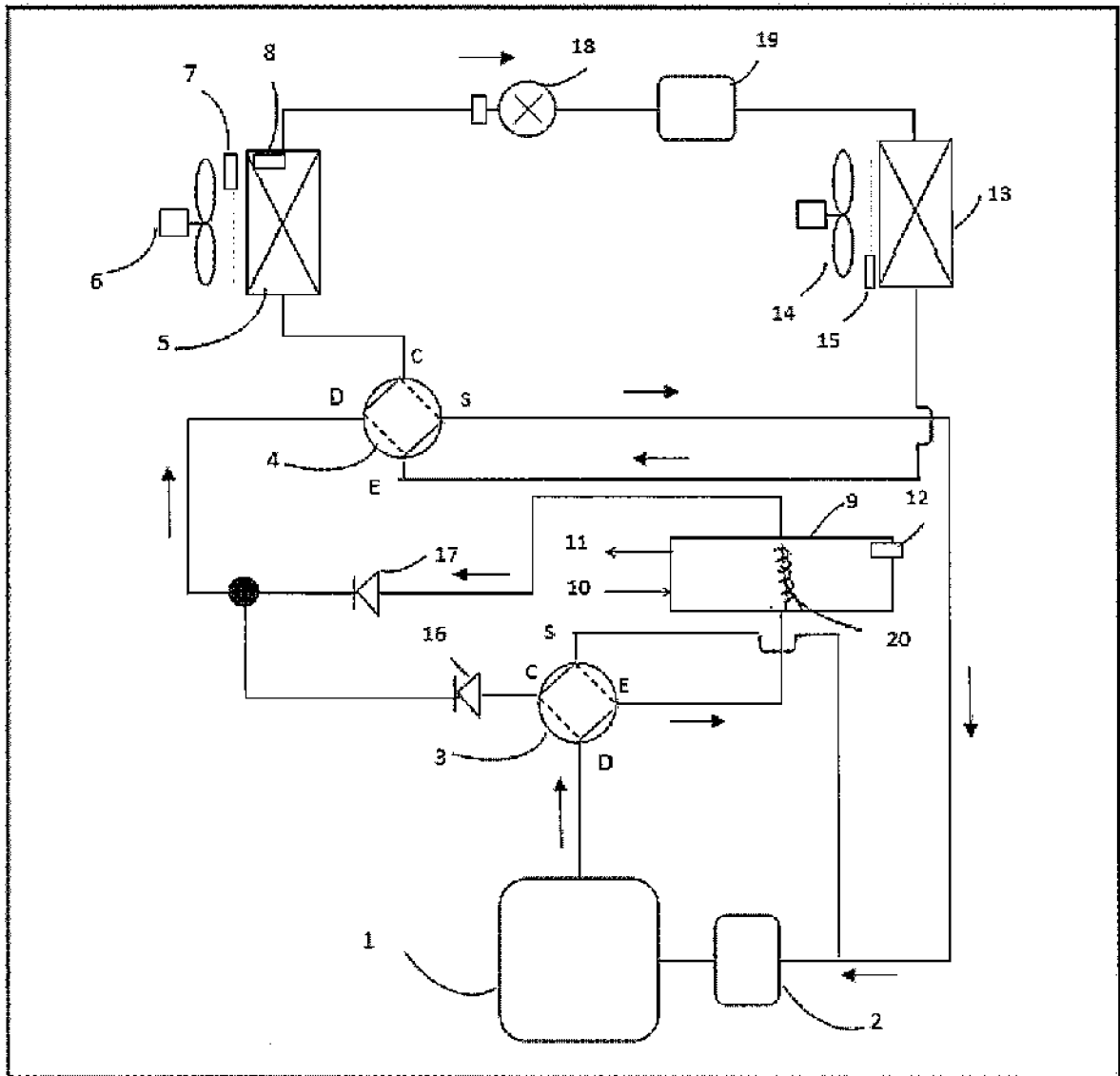


Figure 3

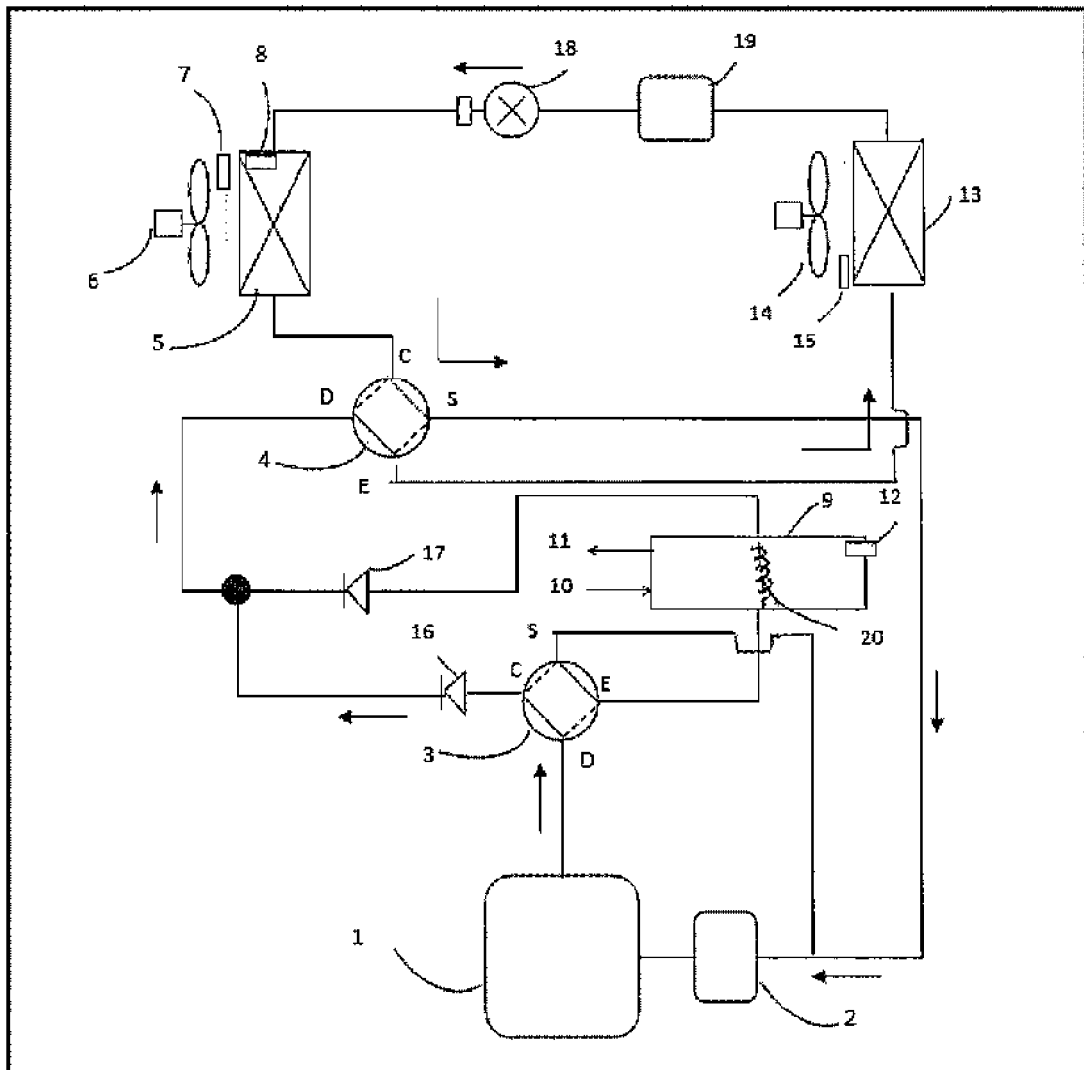


Figure 4

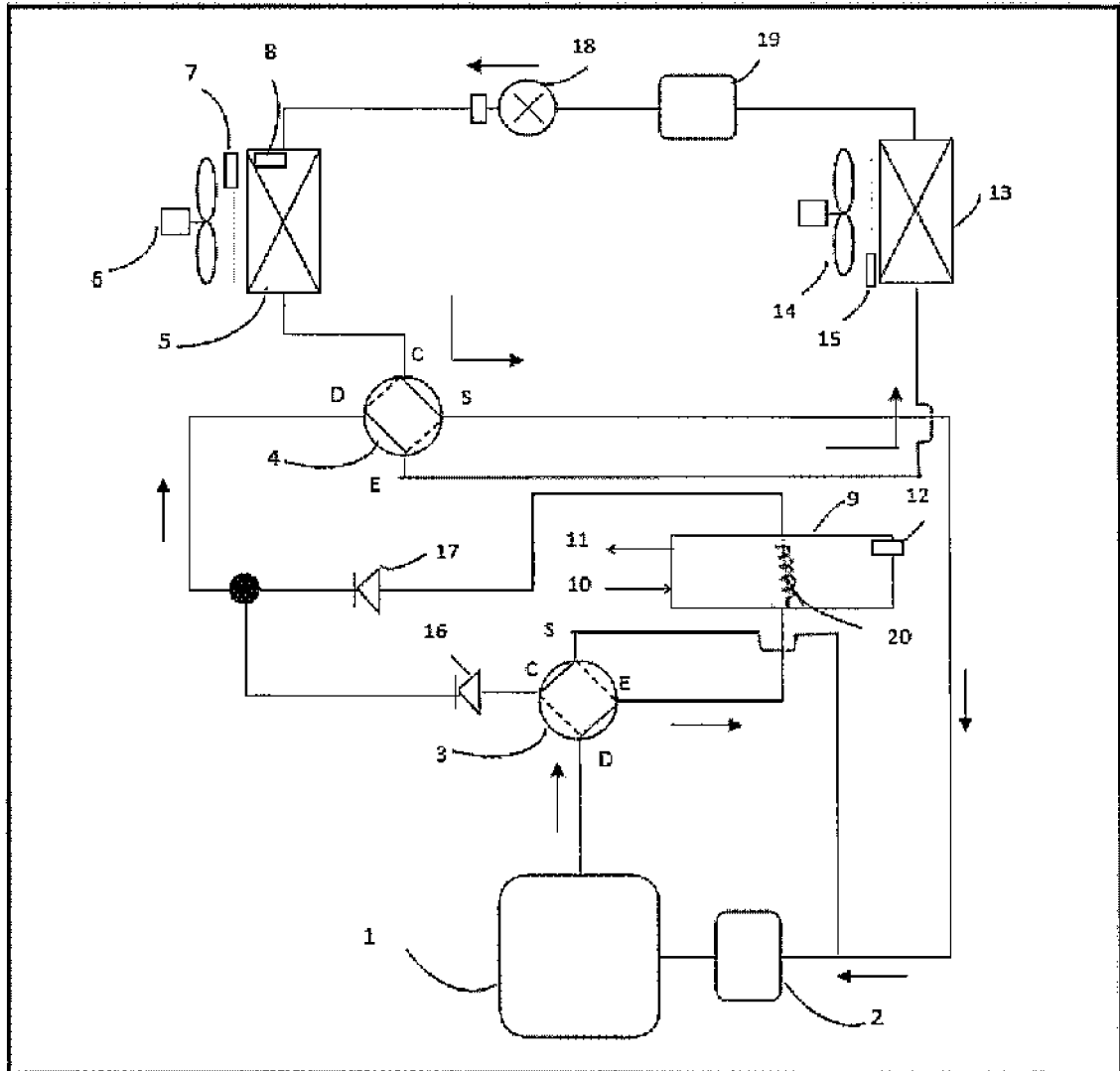


Figure 5

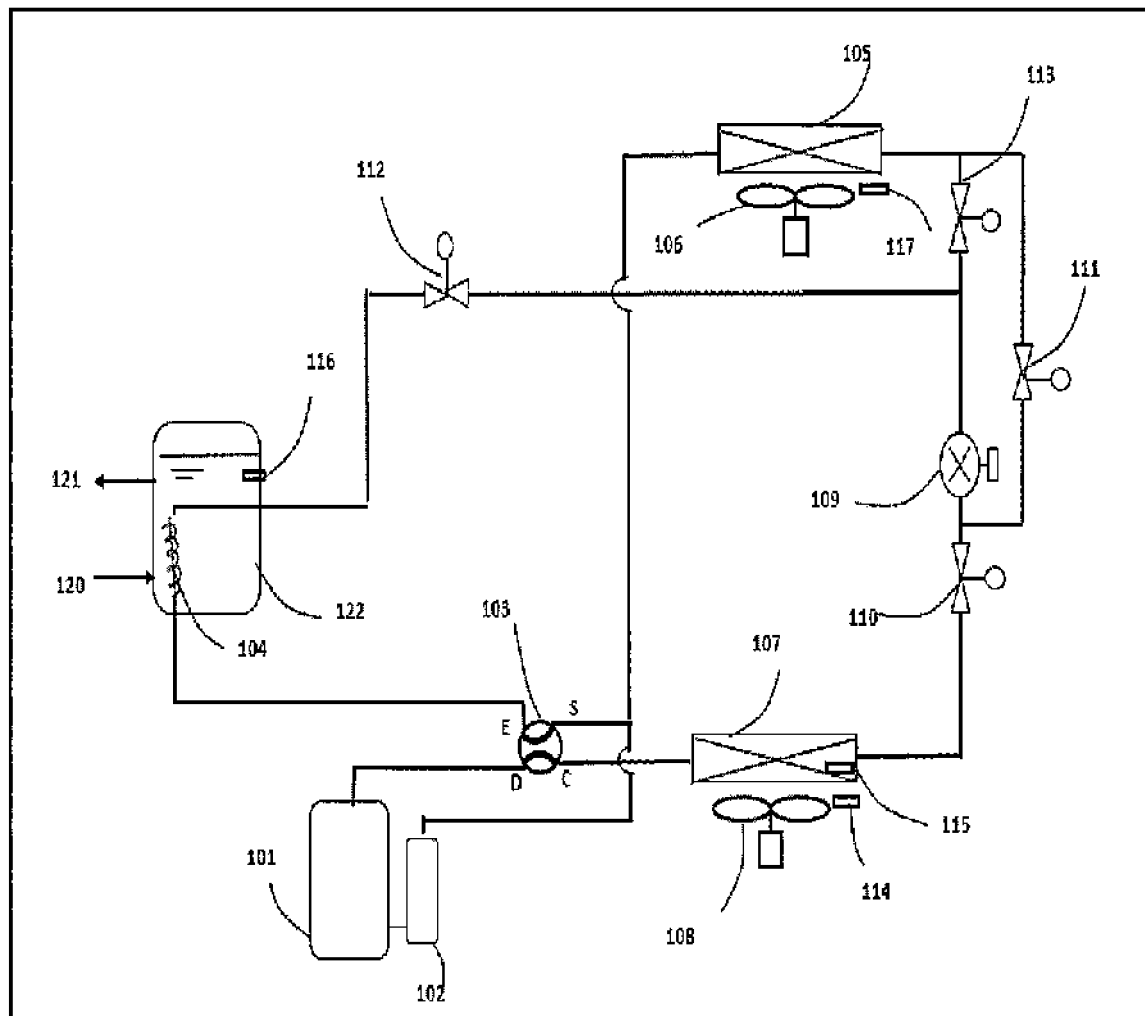


Figure 6

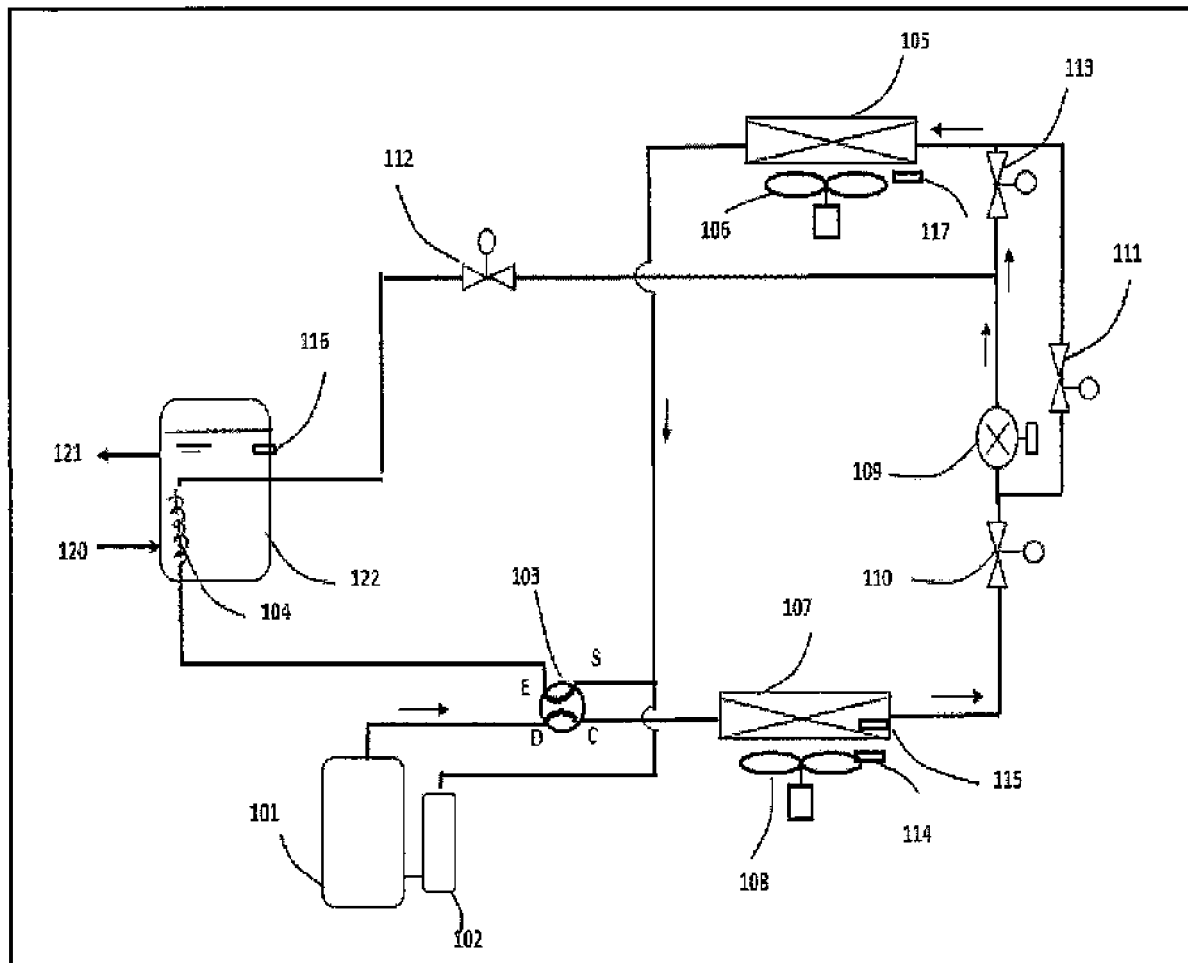


Figure 7

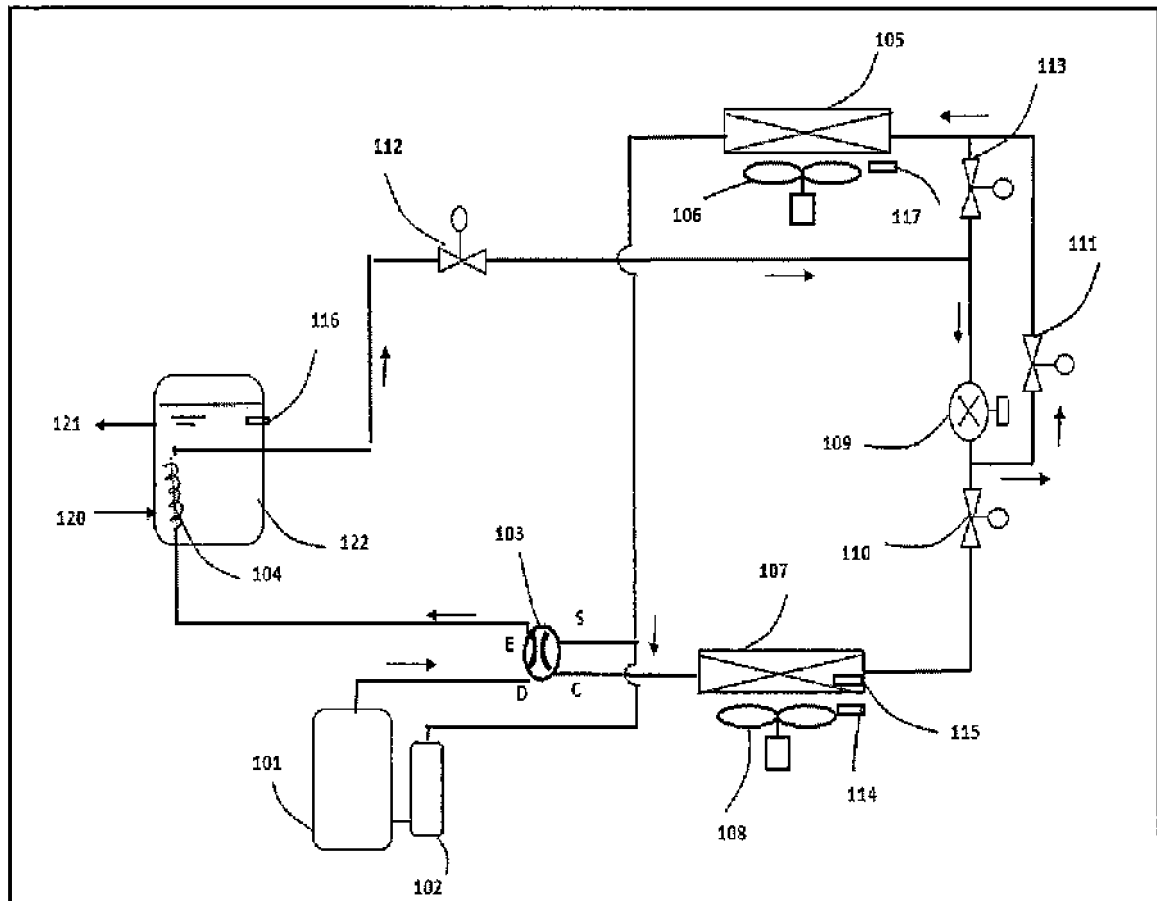


Figure 8

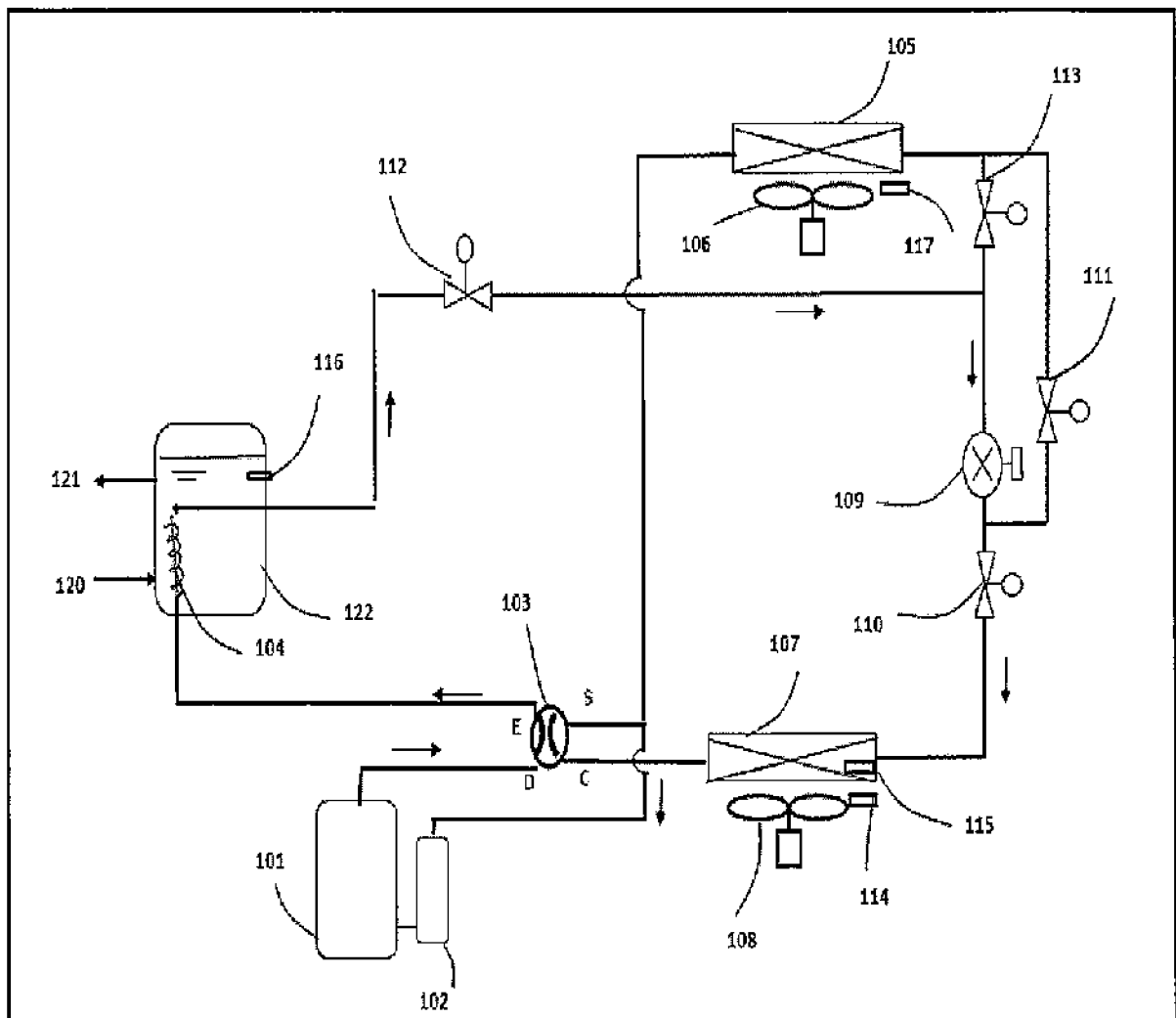


Figure 9

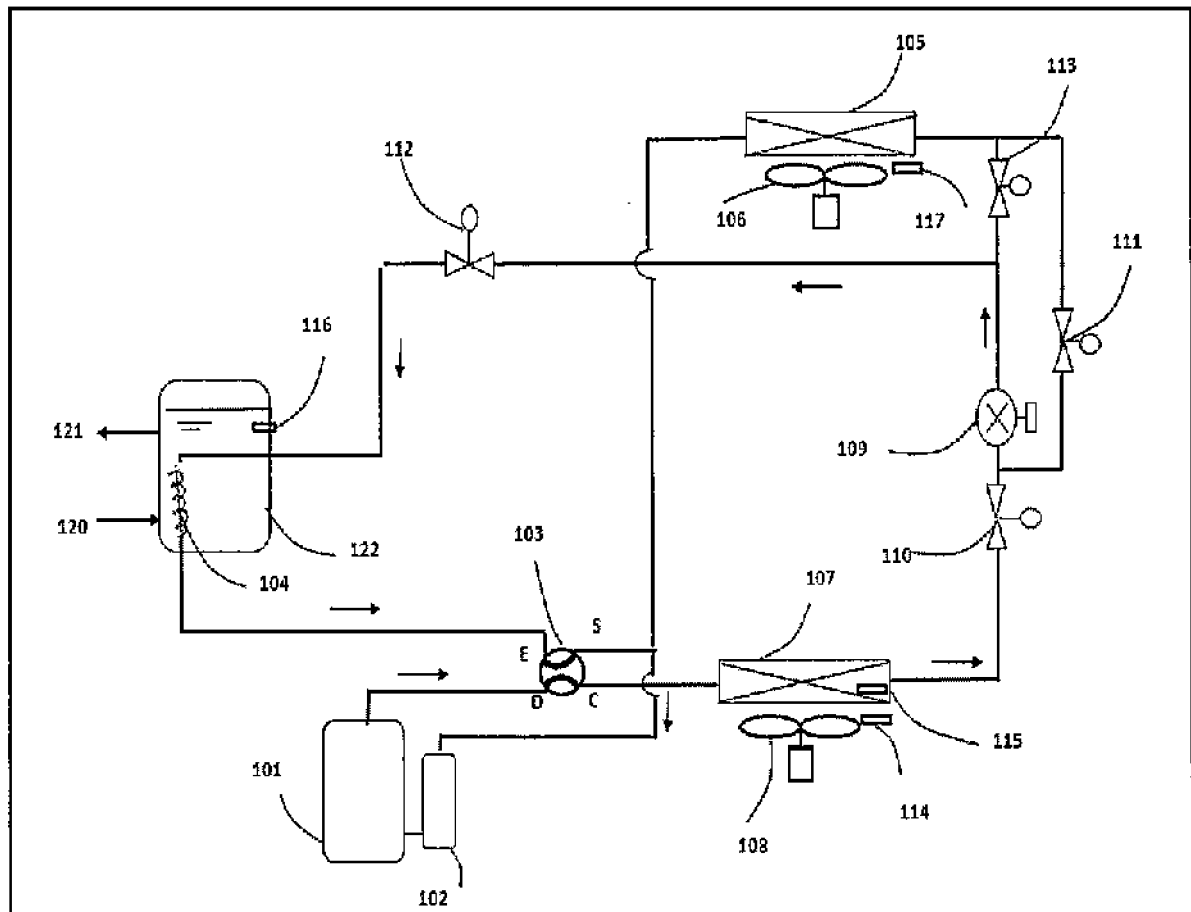


Figure 10

**PARTIAL EUROPEAN SEARCH REPORT**

Application Number

under Rule 62a and/or 63 of the European Patent Convention.
This report shall be considered, for the purposes of
subsequent proceedings, as the European search report

EP 14 16 0810

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	AU 2010 100 284 A4 (VAST VISION LTD) 29 April 2010 (2010-04-29) * the whole document *	1-10	INV. F25B13/00
A	US 2011/214437 A1 (JEONG DONG WOON [KR] ET AL) 8 September 2011 (2011-09-08) * the whole document *	1-10	
A,D	CN 101 504 212 A (BRIGHT AIR CONDITIONING CO LTD [CN]) 12 August 2009 (2009-08-12) * figure 1 *	1-10	
A	US 6 378 318 B1 (JIN KEUM SU [KR]) 30 April 2002 (2002-04-30) * the whole document *	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
INCOMPLETE SEARCH			
The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out. Claims searched completely : Claims searched incompletely : Claims not searched : Reason for the limitation of the search: see sheet C			
Place of search		Date of completion of the search	Examiner
Munich		29 May 2015	Lucic, Anita
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			

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INCOMPLETE SEARCH
SHEET C

Application Number

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Claim(s) completely searchable:
1-10

Claim(s) not searched:
11-15

Reason for the limitation of the search:

The search has been restricted to the subject-matter indicated by the applicant in his letter of 11.03.2015 filed in reply to the invitation pursuant to Rule 62a(1) EPC. Thus, the search report has been drawn up on the basis of independent claim 1 and its associated dependent claims 2-10.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 16 0810

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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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29-05-2015

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
AU 2010100284 A4	29-04-2010	NONE	
US 2011214437 A1	08-09-2011	EP 2363667 A2 KR 20110099558 A US 2011214437 A1	07-09-2011 08-09-2011 08-09-2011
CN 101504212 A	12-08-2009	NONE	
US 6378318 B1	30-04-2002	CN 1322929 A JP 2002031432 A KR 20010102808 A US 6378318 B1	21-11-2001 31-01-2002 16-11-2001 30-04-2002

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Patent documents cited in the description

- CN 101231053 A [0006] [0007] [0008]
- CN 101504211 A [0006]
- CN 101504212 A [0006]
- CN 201043824 Y [0006]
- CN 201028886 Y [0007]