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(54) **Multi-functioning air conditioning system**

(57) Multi-functioning air-conditioning system able to provide hot or cold air and sanitary hot water, wherein a first circuit comprises at least a heat regenerator (1), a condenser/evaporator (2), a "lap" refrigerating battery (3), a four outputs flux adjusting valve (11, 11'), flux adjusting solenoid valves (12, 12', 13, 13', 14, 14', 10, 10'), a compressor (15, 15'), a throttling valve (16); a second circuit comprises at least a heat regenerator (1), a condenser/evaporator (2), a "lap" refrigerating battery (3),

flux distributing pumps (4, 7), accumulation tanks (5, 6), a four outputs flux adjusting valve (11, 11'), flux adjusting solenoid valves (12, 12', 13, 13', 14, 14', 10, 10'), a compressor (15, 15'), a throttling valve (16), characterized in that: the regenerator (1) and a condenser/evaporator (2) function as two machines in series and they are shared by the first and the second circuit; at least a lap refrigerating battery (3) is introduced in the two circuits systems which is apt to carry out the defrosting without producing negative energy on the evaporator.

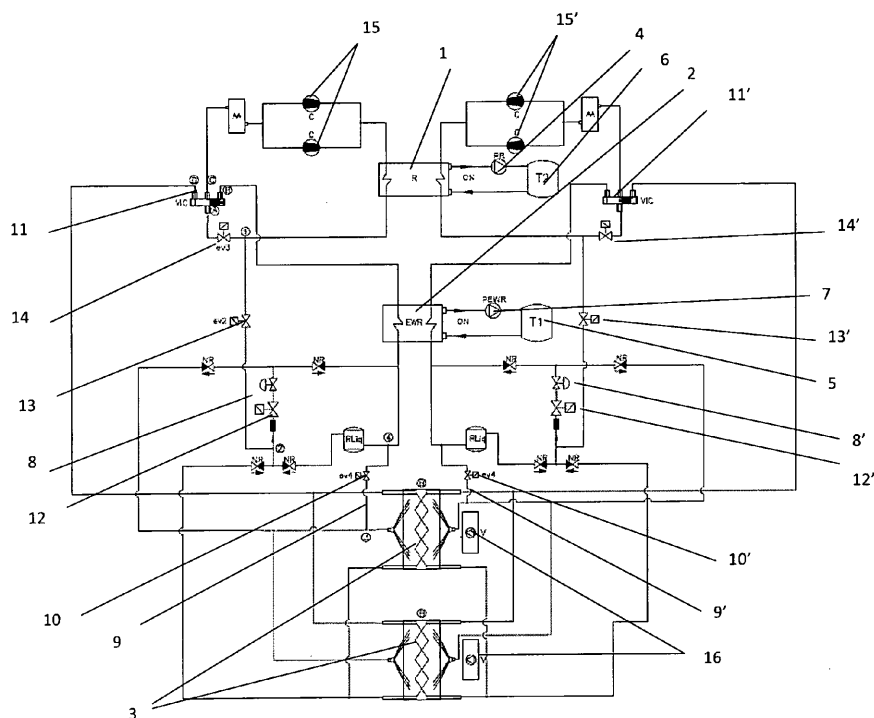


Fig. 1

Description

[0001] Object of the present invention is a multi-functioning air-conditioning system apt to heat or cool ambients in every season of the year and to regenerate energy for the production of sanitary hot water.

[0002] In particular, the inventive system uses polyvalent refrigerating assemblies with four pipes and two pipes.

[0003] Said polyvalent refrigerating assemblies represent the ideal solution when it is needed to serve instant charges required by the system, these being both hot or cold.

[0004] The typical application of the systems occurs during half seasons, when the required ratio between heat energy and refrigerating energy can be equal to 1. In fact, in these cases the machine produces both heat and refrigerating energy and at the same time it regenerates energy of opposite sign from a suitable exchanger or tube bundle, thus obtaining a remarkable energy saving.

[0005] In the state of the art, there are known various embodiments of polyvalent refrigerating assemblies with four pipes and two pipes, in particular the same authors of said patent application have just protected part of their research activity concerning both refrigerating assemblies with four pipes with the patent n° 01287019 and the patent application BA200BA000042, and polyvalent assemblies with two pipes (also said totally regenerative assemblies) with the patent n° 01287020 and the patent application BA200SA000041. The patent application n° BA2005A000042 describes a four pipes air-conditioning system for residential, hotel or industrial use apt to serve a plurality of users of hot water and/or cooled water, and to accumulate heat or refrigerating energy in excess. In particular, the system comprises at least a compressor, a condenser, an evaporator, a throttling valve with a remarkable reduction of valves with respect to the known art.

[0006] In the same way, the patent application n° BA2005A000041 describes a totally regenerative air-conditioning system which is such optimized from a project point of view that the indispensable number of valves is reduced at minimum.

[0007] In particular, the technical optimizations are in that the machines have an exchanger connected to the system, which can function both as evaporator (summer) and condenser (winter), and an air refrigerating battery which can function indifferently as condenser or evaporator, as in a traditional heat pump.

[0008] Anyway, notwithstanding the above-described technical optimizations, it has never been possible to unify the performances of these two systems in a sole air-conditioning system in order to obtain all its functioning modes. Aim of the present invention is to design a sole air-conditioning system with both the functions of polyvalent refrigerating assemblies with four pipes and two pipes, according to claims 1 and 4.

[0009] These and other advantages will be clear in the following description, which refers to the drawing 1/1 in which figure 1 shows an absolutely non-limitative embodiment of the present invention. In particular figure 1 shows the circuit scheme of the air-conditioning system able to provide hot or cold air and sanitary hot water, comprising a first and a second circuit.

[0010] Said first circuit comprises at least a heat regenerator 1, a condenser/evaporator 2, a "lap" refrigerating battery 3, a four outputs flux adjusting valve 11, flux adjusting solenoid valves 12, 13, 14, 10, a compressor 15, a throttling valve 16.

[0011] A second circuit comprises at least a heat regenerator 1, a condenser/evaporator 2, a "lap" refrigerating battery 3, flux distributing pumps 4, 7, accumulation tanks 5, 6, a four outputs flux adjusting valve 11', flux adjusting solenoid valves 12', 13', 14', 10', a compressor 15', a throttling valve 16.

[0012] Said system is characterized in that the regenerator 1 and the condenser/evaporator 2 function as two machines in series and are shared by the first and the second circuit.

[0013] In addition, the at least one lap battery 3 introduced in the two circuits is apt to carry out the defrosting without producing negative energy on the evaporator.

[0014] In fact, when defrosting is required on one of the two circuits, the first circuit, the one interested by the defrosting, functions with the battery 3 as condenser on the interested circuit and 2 as evaporator and therefore has low pressure and cold fluid on the first circuit, instead on the the other circuit the battery 3 continues to function as evaporator and 2 is crossed by high pressure hot vapor, therefore on 3 the high pressure circuit defrosts the low pressure circuit, while 2 on a circuit has fluid which is condensing and on the other one has fluid which is evaporating.

[0015] The temperature balance is in favor of the first one, the water temperature in the cold tank 5 tends to increase avoiding that the temperature of the cold tank, owing to repeated defrosting and no demand of cold, can decrease up to approximately anti-freezing temperatures and so can block the system.

[0016] During the defrosting cycle, the pump 4 is stopped and therefore there is neither heat transfer to the heating cycle nor heat subtraction, a modest heat transfer for transmission being due to the fluid contact. Therefore said cycle provides defrosting without discharging negative energy in the hot tank 6 and anyway does not endanger the cold tank to reduce gradually its temperature due to repeated defrosting and to total absence of cold demand in the winter season.

[0017] The demand on sanitary hot water production is activated by means of the pump 4 when the sensed water temperature of the probe arranged in the accumulation tank 6 is lower than 40°C and the condensers 1 and 3 are on, the pumps 16 are on for a programmable time and for minimum condensation or evaporation pressure in order to store the maximum charge in 3. When the pumps 16 are stopped, the solenoid valve 14 is closed and the solenoid valve 13

is opened. Therefore, if the temperature (indicated with T_1) in the accumulation tank 5 is greater than 15°C and the overheating (indicated with S_1) is greater than 9°C, the solenoid valve 10 will be opened for a programmable time, as well as it will be opened if $T_1 < 15^\circ\text{C}$ and $S_1 > 6^\circ\text{C}$.

[0018] Another peculiarity of the present invention is the application of the portion 8, 8' of the fluid line which avoids to cross the condenser/evaporator 2 at the same time, when hot water is produced in the regenerator with evaporation in 3. In fact, if the fluid is allowed to cross 2, in case the pump 7 is on, there is a double condensation with danger of excessive low condensation pressure and so low evaporation pressure with possible system blocking. In case the pump 7 is stopped, the danger is not to sense the possible need of demand by the accumulation 5.

[0019] Moreover, another characterizing aspect is the portion 9, 9' of fluid line, which, when the charge differences are not only compensable by the fluid receiver but is necessary to use the fluid accumulated in 3, allows to drain it in a calibrated way by opening the solenoid valve 10 according to an overheating and under-cooling value.

[0020] Said system is a machine with two refrigerating circuits, each of which is able to function independently with respect to each other.

[0021] In a particular embodiment, the inventive air-conditioning system is configured with two functioning modes: the first one as two pipes electric boiler, also called totally regenerative system (two user pipes and 2 sanitary water pipes), while the second one as four pipes machine for hot-cold production. For each kind there are different controlled operation modes of the system according to the needs of the user. The first kind of system is characterized by six functioning modes with two pipes circuit for production of sanitary hot water to the users on the regenerative exchanger and of hot-cold water for users on evaporation/condenser exchanger, the modes being:

1. production of only cold air and water to users
2. production of cold water to the users and hot water for sanitary use (obtained by using the regenerator)
3. production of air and cold water and also hot water for sanitary use to the users
4. production of hot air/water to the users
5. production of hot air and sanitary hot water
6. defrosting

[0022] As referring to table 1, the lines indicate the six functioning modes of the system while the columns define the adjusting status of the means useful in order to adjust one of the modes 1 to 6 of the whole system, these ones being the four outputs flux adjusting valves 11/11', the adjusting solenoid valves 12/12', 13/13', 14/14', the solenoid valve 10, compressors 15, flux distributing pumps 4, 7 and finally the throttling valve 16 apt to adjust the evaporation/condensation.

Table 1

table 1										
system references										
functioning modes		11/11'	12/12'	13/13'	14/14'	10	15	4	7	16
	1	A-D ON	ON	OFF	ON	OFF	ON	ON OFF	ON	REG
	2	A-D ON	ON	REG OFF	REG ON	REG OFF	ON	ON	ON	REG OFF
	3	A-B OFF	ON	ON	OFF	REG OFF	ON	ON	ON	REG
	4	A-B OFF	ON	OFF	ON	REG OFF	ON	OFF	ON	REG ON
	5	A-B OFF	ON	ON	OFF	REG OFF	ON	ON	ON	REG
	6	A-D ON	ON	OFF	ON	OFF	ON	OFF	ON	OFF

[0023] In mode 1 for the production of only cold air and water to the users, the throttling valve 16 can be adjusted and

is apt to control the condensation, and in the same way the flux distributing pump 4 can be adjusted in the states ON or OFF as well; the pump 4 is in the state ON if it is produced sanitary hot water, otherwise it is in the state OFF. The mode 2 is apt to produce cold water to the users and to produce freely sanitary hot water on the regenerator 1. Said functioning cycle is activated when the sensed water temperature of the probe arranged in the accumulation tank 6 is lower than 40°C; this implies the sanitary water demand and activates the pumps 4, the condensers 1 and 3 being on; the pumps 16 will remain active for a programmable time and for minimum condensation or evaporation pressure in order to store the maximum charge in 3. When the pumps 16 are stopped, the solenoid valves 14' will be closed and the solenoid valve 13' will be opened. Therefore, if the temperature in the accumulation tank 5 (indicated with T_1) is greater than 15°C and the overheating (indicated with S_1) is greater than 9°C, the solenoid valve 10' will be opened for a programmable time, as well as it will be opened if $T_1 < 15^\circ\text{C}$ and $S_1 > 6^\circ\text{C}$ for a programmable time.

[0024] In the mode 3, the solenoid valve 10 can be adjusted as in the mode 2, if needed, the pump 16 will be adjusted for the evaporation temperature. The flux adjusting valve 11/11', even if "AB" OFF is preprogrammed, is not crossed by the fluid in delivery because owing to the condensation in 1 (regenerator), it is possible that by crossing 2 (condenser/evaporator) with pump ON, the condensation decreases further and lowers the system pressure, therefore it is deviated on the branch of the solenoid valve 13/13' while the position of the flux adjusting valve 11/11' allows the return of the gas evaporated from the batteries 3 through outputs "D-C" of the fluid adjusting valve 11/11'.

[0025] Mode 4 is apt to the production of hot water for the users on the evaporator/condenser 2, therefore the pump 4 has to be OFF and the possible heat transfer for hot fluid contact for water to sanitary fittings is positive since it will delay the demand start for sanitary use which is prior to every other cycle. The solenoid valve 10 can intervene if needed according to mode 2. The pump 16 in ON at the maximum speed but if needed it will be adjusted by controlling the evaporation.

[0026] In mode 5, there is the priority of production of sanitary water for the regenerator 1: in this case it is not possible to produce at the same time hot water to the users with 2. The cycle to be carried out is as for mode 2, but being in winter it is possible to activate the defrosting cycle as well. The defrosting mode 6 is apt to the production of cold water on the accumulation tank 5 with the battery 3 in condensation mode. For double circuit machines with lap batteries, the first circuit will defrost and the other circuit will be forced in mode 4. In this case, it will never be produced negative energy, therefore on 2 it will be produced hot water on a circuit and cold water on the other one. Since the condensation heat is greater than the cold produced, the temperature in the accumulation tank 5 never tends to decrease but it tends to increase slightly, while maintaining the system active also in case of continuous defrosting and sanitary hot water production, without demand on heating to the users.

[0027] In the same way as the first kind of system, in the second kind of system with four pipes circuit for the production of hot water to users on the regenerative exchanger and cold water to users on evaporator there exist other seven modes, which are:

1. production of only cold air and water to users (it corresponds to mode 1 of the totally regenerative cycle);
2. production of cold water to the users and hot water for sanitary use (it corresponds to mode 2 of the totally regenerative cycle);
3. production for air and cold water and also hot water for sanitary use to the users (it corresponds to mode 3 of the totally regenerative cycle);
4. production of only hot air water (it corresponds to the mode 5 of the totally regenerative cycle for mono-circuit system while for bi-circuit system when there is no production of cold, the defrosting occurs with lap battery 3 according to the mode 6 of the totally regenerative cycle);
5. production of only cold air water: (it corresponds to mode 1 of the totally regenerative cycle, with condensation adjusting for low air temperatures);
6. production water-water hot-cold (it corresponds to mode 2 of the totally regenerative cycle);
7. defrosting (it corresponds to mode 6 of the totally regenerative cycle).

[0028] The advantages of the inventive system are clear: it increases the system functioning during the year with the combination of different configurations so that it is perfectly adapted to heat and refrigerating charges required by the system, besides the energy regeneration thanks to the fact that the machine produces both heat and refrigerating energy and at the same time the regeneration of energy of opposite sign on the exchanger.

CLAIMS

Claims

1. Multi-functioning air-conditioning system able to provide hot or cold air and sanitary hot water, wherein

- a first circuit comprises at least a heat regenerator (1), a condenser/evaporator (2), a "lap" refrigerating battery (3), a four outputs flux adjusting valve (11), flux adjusting solenoid valves (12, 13, 14, 10), a compressor (15), a throttling valve (16),
- a second circuit comprises at least a heat regenerator (1), a condenser/evaporator (2), a "lap" refrigerating battery (3), flux distributing pumps (4, 7), accumulation tanks (5, 6), a four outputs flux adjusting valve (11'), flux adjusting solenoid valves (12', 13', 14', 10'), a compressor (15'), a throttling valve (16),

characterized in that:

- the regenerator (1) and a condenser/evaporator (2) function as two machines in series
 - the regenerator (1) and a condenser/evaporator (2) are shared by the first and the second circuit
 - at least a lap battery (3) is introduced in the two circuits systems which is apt to carry out the defrosting without producing negative energy on the evaporator.
2. System according to claim 1, **characterized in that** the demand on sanitary hot water production to the user is activated by means of the pump (4) when the sensed water temperature of the probe arranged in the accumulation tank 6 is lower than 40°C.
 3. System according to any one of the preceding claims, **characterized in that** the portion (8, 8') of the fluid line avoids, when it is produced hot water in the regenerator (1) with evaporation in (3), to cross the condenser/evaporator (2) at the same time.
 4. System according to any one of the preceding claims, **characterized in that** the portion (9, 9') of the fluid line allows the calibrated draining of the same, by opening the solenoid valve (10, 10') according to an overheating and under-cooling value.

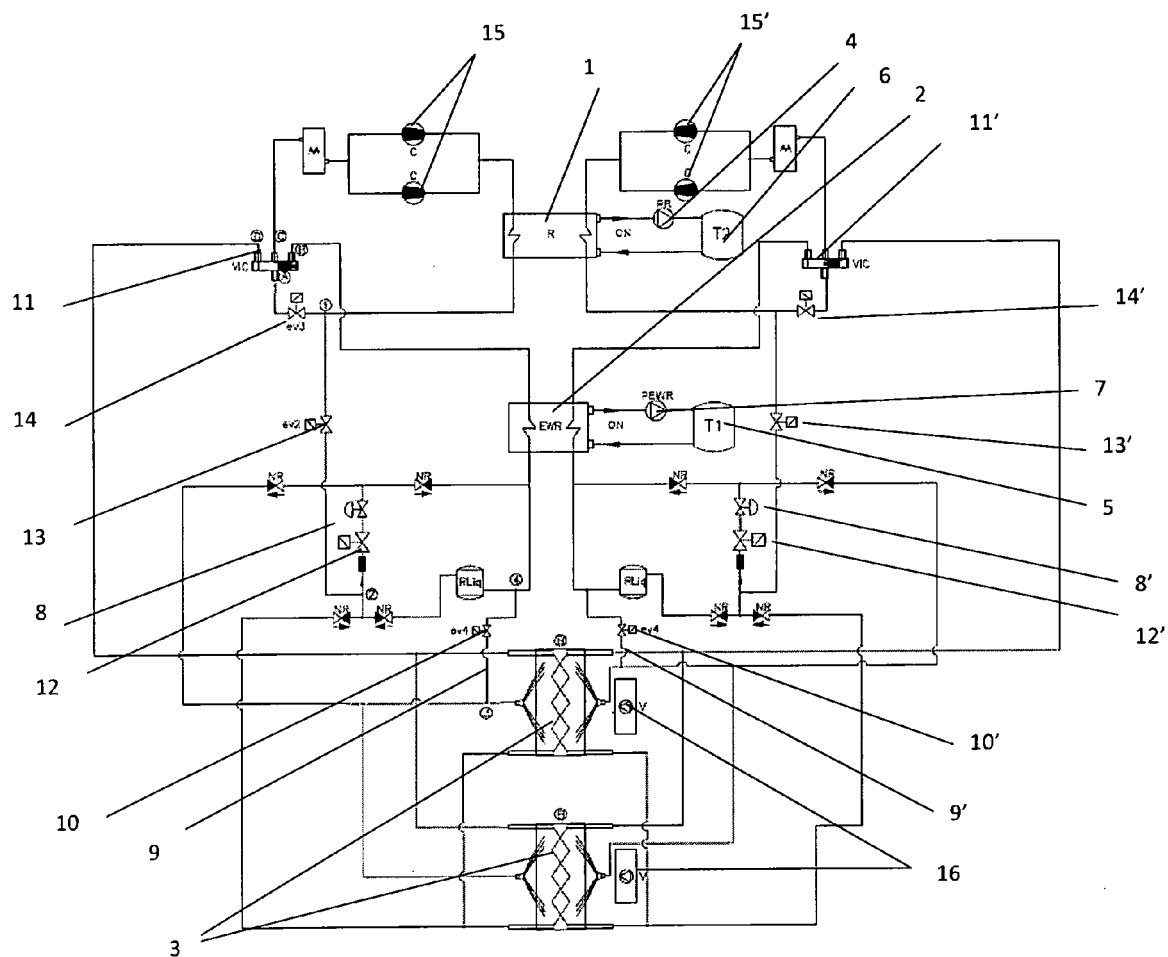


Fig. 1



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Application Number
EP 10 42 5393

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