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(54) Multi-user refrigeration plant

(57) A multi-user refrigeration plant comprises portions (2, 3, 44) assigned to serve at least two different type of users selected among first normal cooling users TN, second environmental conditioning users AC and third cooling users BT. The multi-user refrigeration plant (1) is equipped with at least a first compressors set (4) whose outlet are mutually interconnected (8), and it (1) is also equipped with at least switch means first (11) and second (12), a condenser means (5), a liquid receiver means (9), a plurality of valve means and a plurality of connecting means wherein said elements and means cooperate to compose the circuit of the plant for the in it circulating cooling fluid state change. Said first user plant portion (2) includes a first evaporator means (6), said second user plant portion (3) includes a heat exchanger (7), said third user plant portion (44) includes a evaporator means (42), this latter (42) is connected to the remaining part of the circuit by means of a second cooling stage (40). Said plant (1) comprises a balancing means (13), controlled by control means that controls also the switch means (11, 12), and it comprises a fluid flow regulation valve (35) interconnected between a bleed connector connected immediately downstream of the outlet interconnection (8) of the compressor set (4) and a mixing means (15) inlet and it comprises a controlled expanding valve (36) interposed between a receivers means (9) outlet and an additional mixing means (15) inlet having an outlet (32) connected at the compressor set (4) common suction inlet (17).

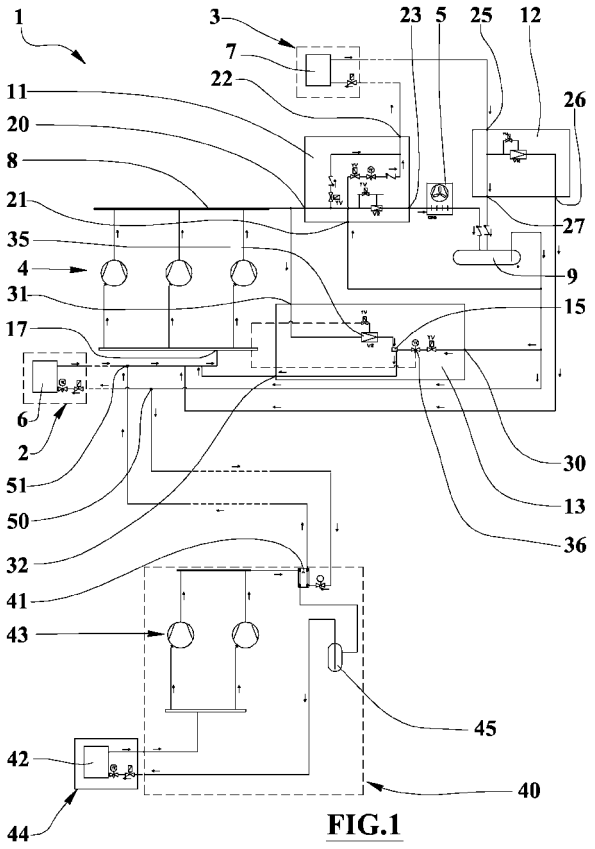

FIG.1

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Description

[0001] The present invention refers to the field concerning the cooling and the environmental conditioning and in particular it refers to a multi-user refrigeration plant able to ensure simultaneously respective and different temperature levels for two or three users, for example maintaining them at normal cooling temperature (TN) indicatively between -10°C and +5°C, low-temperature (BT) indicatively between -40°C and -15°C and at environmental conditioning temperature (AC) suitable for commercial environments and indicatively between +10°C and +30°C.

[0002] There are known systems able to supply different cooling or conditionings to respective users. Such known systems consist of many refrigeration plants as the users with different needs.

[0003] A disadvantage of these known systems consists in the fact that they are not very efficient and consume high energetic.

[0004] Another disadvantage consists in that they are very cumbersome and require therefore a lot of expensive surface.

[0005] Further disadvantage of the known systems consists in that they comprise a very big quantity of expensive components and are very complex requiring a lot of expensive maintenance.

[0006] An aim of the present invention is to propose a multi-user refrigeration plant provided with a single or double sets of compressors and able to serve independently more users.

[0007] Another aim is to propose a plant economical to be bought, to be conducted and to be maintained.

[0008] Further aim is to propose a relatively simple plant and provided with a small quantity of components for a better reliability.

[0009] Another aim is to propose a plant of reduced encumbrance.

[0010] Normally, it is quite easy to warm a room or user using the heat brought to the condenser of a known running cooling system. It is more complicate to obtain heat when the system is operating at a preset controlled temperature or it doesn't refrigerate.

[0011] A particularity of the multi-user refrigeration plant of the present invention consists in that it is possible to obtain heat, for example to heat commercial environments, also without request for refrigeration by the users such as refrigerated shop windows and frigorific cells.

[0012] The multi-user refrigeration plant object of the present invention is able to supply heat or refrigeration independently from the requests of the users TN and BT; therefore, for three different users, the plant works exactly as three independent plants without limit due to bounds between the three cycles.

[0013] The characteristics of the invention are evidenced in the following with particular reference to the joined drawings, in which:

- figure 1 shows a schematic view of the multi-user refrigeration plant object of the present invention;
- figure 2 shows a schematic view of the plant of figure 1 in which are evidenced the flows of the cooling fluid in an inactivity condition of a first user plant portion and during the heating operation of a second user plant portion;
- figure 3 shows a schematic view of the plant of figure 1 in which are evidenced the flows of the cooling fluid in an inactivity condition of a first user plant portion and during the refrigeration operation of a second user plant portion.

[0014] With reference to figures from 1 to 3, the numeral 1 indicates the multi-user refrigeration plant, object of the present invention, comprising at least:

- a plant portion 2 for a first user,
- a plant portion 3 for a second user,
- a first compressors set 4 whose outlet 8 are mutually interconnected and equipped with an afferent common inlet 17 to all the suctions inlets of these compressors,
- first 11 and second 12 switch means,
- a balancing means 13,
- connections between the elements over mentioned to feed them with a cooling fluid and including ducts sets, liquid receivers means 9, valve means, connecting means, and at least a condenser means 5.

[0015] The plant can be equipped also with a plant portion 44 for a third user. In the followed, by synthesis, in place of the locution "nth user plant portion" can be used the expression "nth user".

[0016] The plant also includes control means, preferably of microprocessor programmable type, linked to the different controlled and/or remote operated valves, means and other circuit elements, to control and/or to drive them in a remote manner, carrying out the various independent users operating conditions.

[0017] The first user plant portion 2 and the second user plant portion 3 include respectively a first evaporator means 6 and a heat exchanger 7 connected to said connections and assigned to the adjustment of the temperatures of the respective users compartments or rooms.

[0018] The outlet 8 of the first compressors set 4 is connected to a first inlet 20 of the first switch means 11 and, through a bleed connector and a bleed duct, to a second incoming inlet 31 of the balancing means 13.

[0019] The first switch means 11 is further equipped with a second inlet 21 connected to an outlet for the fluid at the liquid state of the receivers means 9, with a first outlet 22 connected to an inlet of the heat exchanger 7 of the second user plant portion 3 and with a second outlet 23 connected to an inlet of the condenser means 5; the outlet of the latter condenser means 5 flows into the receivers means 9.

[0020] The second switch means 12 is equipped with

an inlet door 25 connected to the outlet of said heat exchanger 7, with a first outlet door 26 connected in the inlet 17 of the compressors set 4 and with a second outlet door 27 flowing into the receivers means 9.

[0021] The balancing means 13 includes a first incoming inlet 30 connected to the liquid state fluid outlet of the receivers means 9, a second incoming inlet 31 connected through a bleed connector and duct to the outlet 8 of the compressors set 4 and an outgoing outlet 32 connected to the inlet 17 of the compressors set 4. Said incoming inlets 30, 31 and said outgoing outlet 32 are mutually connected through the three-way mixing means 15 of the same balancing means.

[0022] The first user plant portion 2 is provided with two doors 50, 51 or connections for the fluid. The first door 50 of the first user plant portion 2 is directly connected to the liquid state fluid outlet of the receiver means 9 and the second 51 is directly connected to the inlet 17 of the compressors set 4.

[0023] The first inlet 20 of the first switch means 11 is connected, through a spool valve controlled by the control means and a check valve, to the first outlet 22 and is connected through an adjusting valve controlled by control means to the second outlet 23.

[0024] The second inlet 21 of the first switch means 11 is connected to the first outlet 22 through a spool valve, controlled by the control means, and an electronic thermostatic valve and a check valve connected in series between them.

[0025] The inlet door 25 of the second switch means 12 is connected, through an adjusting valve controlled by the control means, to the first outlet door 26 and it is also connected to the second outlet door 27. Downstream the second outlet door 27, into the feeding duct flowing into the receivers means 9, a check valve precludes the flow when this inlet door 25 is in communication with the first outlet door 26.

[0026] The first incoming inlet 30 of the balancing means 13 is connected through a spool valve controlled by the control means and a controlled valve 36, of thermostatic electronic type feedback controlled on the basis of the temperature and pressure on the inlet 17 of the compressors set 4, to the first inlet of the mixing means 15. The second incoming inlet 31 is connected, through a regulation valve 35 operated by the pressure at the inlet 17 of the compressors set 4, to the second inlet of the mixing means 15 The outgoing outlet 32 of the balancing means 13 is directly connected to the outlet of the mixing means 15 from which receives the fluid coming from the receivers means 9 mixed with the fluid coming from the bleed connector in the correct proportions to reach the suitable physical state to supply the inlet 17 of the compressors set 4, that is connected to said outlet 32 of the balancing means 13, at least during the second user plant portion 3 heating operation.

This first switch means 11 components configuration is actuated by the control means at least to connect the first inlet 20 at least to the first outlet 22 and to close the second inlet 21 during the second user plant portion 3 heating operation, and to connect the first inlet 20 to the second outlet 23 and the second inlet 21 to the first outlet 22 during the plant portion 3 for the second user refrigeration operation.

[0027] Said second switch means 12 components configuration is actuated by the control means at least to connect the inlet door 25 to the second outlet door 27 during the second user plant portion 3 heating operation and to connect the inlet door 25 to the first outlet door 26 during the second user plant portion 3 refrigerating operation. The first door 50 of the first user plant portion 2 is connected, through spool and electronic thermostatic valves connected in series, to the inlet of the first evaporator means 6 of the first user plant portion 2; the second door 51 of the first user plant portion 2 is directly connected to the outlet of the first evaporator means 6.

[0028] Said first 50 and second 51 doors of the first user plant portion 2 are also connected to first connections, in mutual flow communication, of an exchanger for refrigerating fluids 41 of a second cooling stage 40, for the low temperature, of the circuit.

[0029] The second connections of said exchanger for refrigerating fluids 41 are mutually connected in flow communication and they are separated by the first connections, furthermore said second connections are part of the cooling circuit of the plant portion 44 assigned to serve the third user. The third user plant portion 44 furthermore comprises at least a second evaporator means 42 and a second compressors set 43 of the second stage. One of the second connections of the exchanger 41 for refrigerating fluids receives a cooling fluid from the common outlet of the second compressors set 43 to which is connected; the other second connection of the refrigerating fluids exchanger 41 is connected in series to a liquid receiver means 45 and through the inlet and the outlet of the evaporator 42 to the second compressors set 43 common outlet closing down the cooling circuit for the third user plant portion 44.

[0030] Said second stage allows, for example, to refrigerate a cell or low-temperature environment of the third user with very low consumption and very high efficiency.

[0031] In the operation of the plant, in an inactivity condition of the first user plant portion 2 to carry out the second user plant portion 3 heating operation, said switch means 11, 12 connect the outlet 8 of the compressors set 4 in cascade to the second user plant portion 3 heat exchanger 7, to the receivers means 9 and to the balancing means 13, which, through the mixing means 15 leads into the cold cooling fluid flow, coming from the receivers means 9, a quantity of fluid immediately tapped downstream of the outlet 8 of the compressors set 4 where said quantity is controlled to increase the enthalpy of the fluid which, by the balancing means 13, is abducted in the inlet 17 of the compressors set 4 in the correct physical state for the compression; to carry out the second user plant portion 3 refrigeration operation of the

switch means 11, 12 connect the outlet 8 of the compressors set 4 in cascade to said condenser means 5, receivers means 9, heat exchanger 7 of the second user plant portion 3 and compressors set 4 suction inlet 17 wherein the first user plant portion 2 operates at least in refrigeration or is inactive and the second user plant portion 3 operates at least in refrigeration or in heating independently from first user plant portion 2.

[0032] The operation of the plant including the third user plant portion 44 is controlled and operated by the control means by respective programs providing, in a state of contemporary inactivity of the first 2 and third 44 user plant portions and of contemporary heating operation of the second user plant portion 3, that the first switch means 11 connects the compressors set 4 outlet interconnection 8 to the heat exchanger 7 inlets of the second user plant portion 3.

[0033] The cooling fluid coming from the compressors set 4 produces the environmental heating wanted effect releasing heat to the second user.

[0034] In the same condition, the second switch means 12 connects the second user plant portion 3 heat exchanger 7 outlet to the receiver means 9, moreover the regulation valve 35 of the balancing means 13 connects the bleed connector immediately connected downstream of the compressors set 4 outlets interconnection 8 to the corresponding mixing means 15 inlet feeding it with a flow of predetermined fluid amount coming from the compressors 4 outlet and the controlled expanding valve 36 connects the receivers means 9 outlet to the respective mixing means 15 inlet feeding them with the expanded fluid from the controlled expanding valve 36 and coming from the receivers means 9.

[0035] In the same operative state, the mixing means 15 mix the predetermined fluid flow supplied by the regulation valve 35 with the expanded cooling fluid flow to the controlled expanding valve 36 and supply this fluid mixture to the compressors set 4 common suction inlet 17 at the correct physical state for the compression without that this has carried out no thermal exchange with the outside and therefore in absence of exchangers.

[0036] In the first user plant portion 2 and third user plant portion 44 inactivity state and in the second user plant portion 3 cooling operating, the first switch means 11 connects the compressors set 4 outlets interconnection 8 to said condenser means 5 and, in series, to a receivers means 9 inlet and connected these receivers means 9 outlet to the heat exchanger 7 inlet of the second user plant portion 3 where the cooling fluid can produce the wanted effect of environmental cooling absorbing heat, and the second switch means 12 connects the heat exchanger 7 outlet to the compressors set 4 suction common inlet 17.

[0037] In conditions wherein the plant portion 2 for the first user and/or the plant portion 44 for the third user operate in refrigeration or are inactive, the plant portion 3 for the second user operates in conditioning with heating effect or environmental cooling independently.

[0038] An advantage of the present invention is to supply a very efficient multi-user refrigeration plant, able to reduce necessary energetic consumption to supply different users respective cooling or conditioning value.

[0039] Other advantage consists in the supplying a multi-user refrigeration plant having very small encumbrances.

[0040] Further advantage is to provide a simple multi-user refrigeration plant and with a relatively small number of components and that either it is economical to acquire, to conduct and to maintain.

[0041] Other advantage is to supply a refrigeration plant suitable for two or three or more users.

Claims

1. Multi-user refrigeration plant comprising portions (2, 3, 44) assigned to serve at least two different type of users selected among first normal cooling users TN, second environmental conditioning users AC and third cooling users BT; the multi-user refrigeration plant (1) is equipped with at least a first compressors set (4) whose outlet are mutually interconnected (8), and it (1) is also equipped with at least switch means first (11) and second (12), a condenser means (5), a liquid receiver means (9), a plurality of valve means and a plurality of connecting means wherein said elements and means cooperate to compose the circuit of the plant for the in it circulating cooling fluid state change; said first user plant portion (2) includes a first evaporator means (6), said second user plant portion (3) includes a heat exchanger (7), said third user plant portion (44) includes a evaporator means (42), this latter (42) is connected to the remaining part of the circuit by means of a second cooling stage (40); said plant (1) being **characterised in that**it comprises a balancing means (13), controlled by control means that controls also the switch means (11, 12), and it comprises a fluid flow regulation valve (35) interconnected between a bleed connector connected immediately downstream of the outlet interconnection (8) of the compressor set (4) and a mixing means (15) inlet and it comprises a controlled expanding valve (36) interposed between a receivers means (9) outlet and an additional mixing means (15) inlet having an outlet (32) connected at the compressor set (4) common suction inlet (17); in a contemporary inactivity state of the first (2) and third (44) users plant portions and an operating heating state of the second user plant portion (3), the first switch means (11) connects the compressors set (4) outlet interconnection (8) in the heat exchanger (7) inlet of the second user plant portion (3), wherein the cooling fluid produces the environmental heating wanted effect releasing heat, and the second switch means (12) connects the heat exchanger (7) outlet of the second user plant portion

(3) to the receiver means (9), the balancing means (13) regulation valve (35) connects the bleed connector connected immediately downstream the compressors set (4) outlets interconnection (8) to the corresponding mixing means (15) inlet feeding them with a predetermined fluid flow coming from the compressors (4) outlet, the controlled expanding valve (36) connects the receivers means (9) outlets to the respective mixing means (15) inlet, feeding them with the fluid expanded by the controlled expanding valve (36) and coming from the receivers means (9), such mixing means (15) mix the predetermined fluid flow supplied by the regulation valve (35) with the expanded cooling fluid flow coming from the controlled expanding valve (36) and they supply this fluid mixture to the common suction inlet (17) of the compressors set (4) in the correct physical state for the compression without that this has carried out no one thermal exchange with the outside and therefore in absence of exchangers; in the first (2) and third (44) users plant portions inactivity state and cooling operating second user plant portion (3), the first switch means (11) connects the compressors set (4) outlets interconnection (8) to said condenser means (5) and, in series, to a receivers means (9) inlet and connects these receivers means (9) outlet to the heat exchanger (7) inlet of the second user plant portion (3) where the cooling fluid can produce the environmental cooling wanted effect by absorbing heat, and the second switch means (12) connects the heat exchanger (7) outlet to the compressors set (4) suction common inlets (17); in conditions wherein the first user plant portion (2) and/or the third user plant portion (44) operate in cooling or are inactive, the second user plant portion (3) operates in conditioning with heating effect or environmental cooling effect independently.

2. Plant according to claim 1 **characterised in that** the first switch means (11) is provided with a first inlet (20) connected to the compressors set (4) outlets interconnection (8), a second inlet (21) connected to receivers means (9) liquid state fluid outlet, a first outlet (22) connected to an heat exchanger (7) inlet of the second user plant portion (3) and a second outlet (23) connected to a condenser means (5) inlet; said first switch means (11) is provided with ducts and valves and/or regulators interconnected between said inlets (20, 21) and said outlets (22, 23) and controlled at least to connect the first inlet (20) at least to the first outlet (22) and to close the second inlet (21) during the second user plant portion (3) heating operation, and controlled at least to connect the first inlet (20) to the second outlet (23) and the second inlet (21) to the first outlet (22) during the second user plant portion (3) cooling operation; the second switch means (12) is provided with an inlet door (25) connected to the outlet of said heat exchanger (7), with a first outlet door (26) connected to the inlet (17) of the compressors set (4) and with a second outlet door (27) flowing into the receiver means (9); said second switch means (12) is provided with ducts and valves and/or regulators interconnected among this inlet (25) and said outlets (26, 27) said elements of the second switch means (12) are controlled at least to connect this inlet door (25) to the second outlet door (27) during the second user plant portion (3) heating operation and to connect the inlet door (25) to the first outlet door (26) during the second user plant portion (3) cooling operation.

3. Plant according to claim 1 or according to claim 2 **characterised in that** the balancing means (13) includes a first incoming inlet (30) connected to the outlet for the liquid state fluid of the receivers means (9), a second incoming inlet (31) connected, by means of bleed connector, to the compressors set (4) outlets interconnection (8) and an outgoing outlet (32) connected to the compressors set (4) inlet (17), wherein said incoming inlets and outgoing outlets are connected by means of the mixing means (15); the balancing means (13) also includes a controlled valve means, interposed between said first incoming inlet (30) and the respective mixing means (15) inlet and opening controlled at least when the first user plant portion (2) is in an inactive state at least during the second user plant portion (3) heating operation.

4. Plant according to claim 3 **characterised in that** the balancing means (13) comprises also at least a regulation valve (35) controlled by the inlet (17) pressure of the compressors set (4) and placed along said bleed connector between the second incoming inlet (31) and the respective mixing means (15) inlet and a controlled valve (36) feedback controlled on temperature and pressure at the compressors set (4) inlet (17) and on the energy amount required by the second user plant portion (3); the controlled valve (36) is interposed between the first incoming inlet (30) and the respective mixing means (15) inlet.

5. Plant according to any of the previous claims **characterised in that** the first evaporator means (6) inlet of the first user plant portion (2) is connected to the outlet for the fluid at the liquid state of the receivers means (9) through a respective controlled valve for the flow stop in the first evaporator means (6) at least in said inactivity state, the first evaporator means (6) outlet is connected to the compressors set (4) inlet (17).

6. Plant according to claim 1 **characterised in that** the third cooling user BT plant portion (44), comprising the evaporator (42) and connection and control means, is managed by the second cooling stage (40) provided with a respective heat exchanger (41); this

latter (41) is assigned to condense the second cooling stage (40) cooling fluid by the evaporation of the cooling fluid of the compressors set (4) circuit, said second cooling stage (40) also includes a compressors set (43) and a liquid receiver means (45).

7. Plant according to any of the previous claims **characterised in that** said control means are preferably microprocessor programmable type and they control and drive the different controlled valve and controlled means to carry out the independent users plant portions operating states.

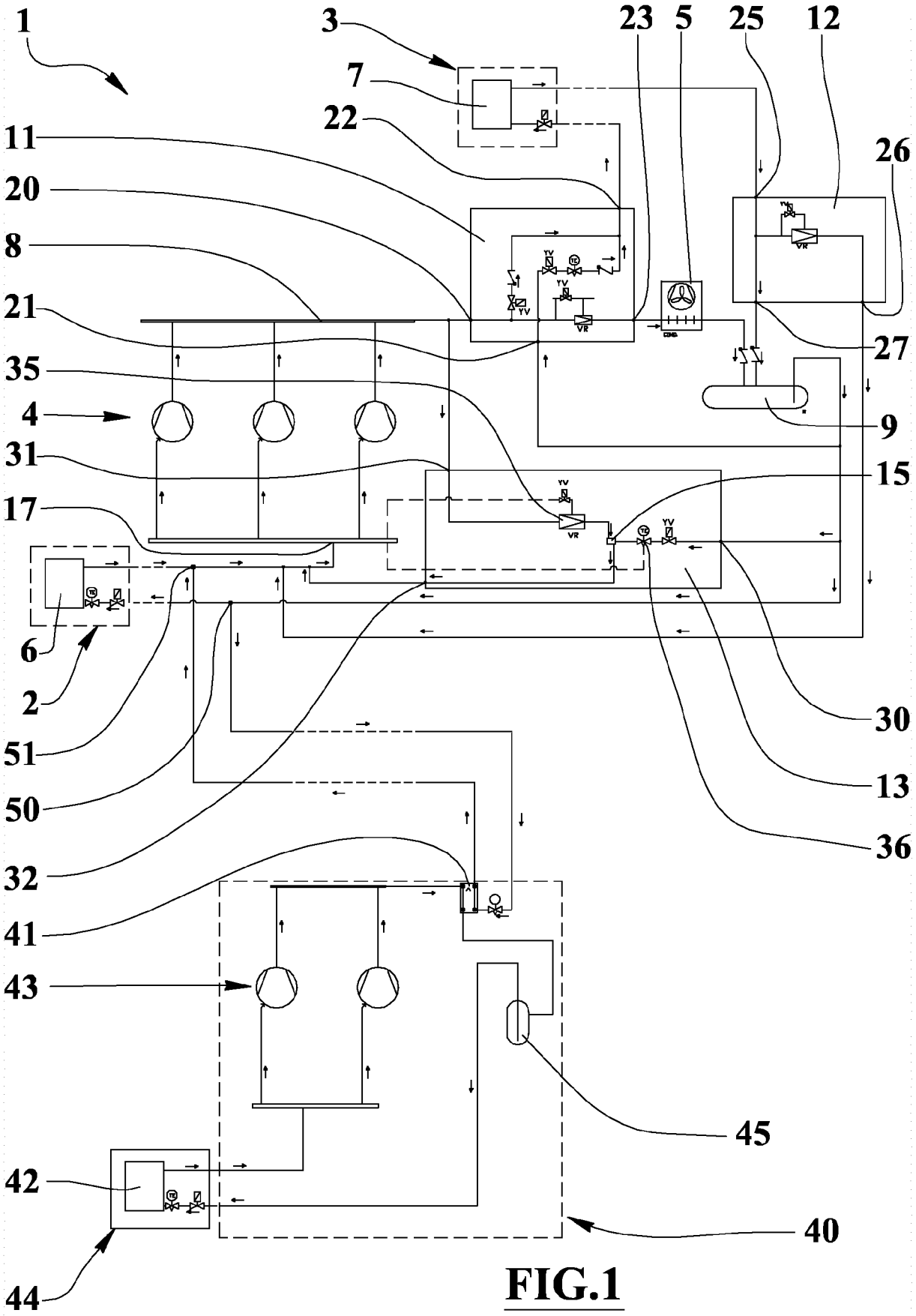
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FIG.1

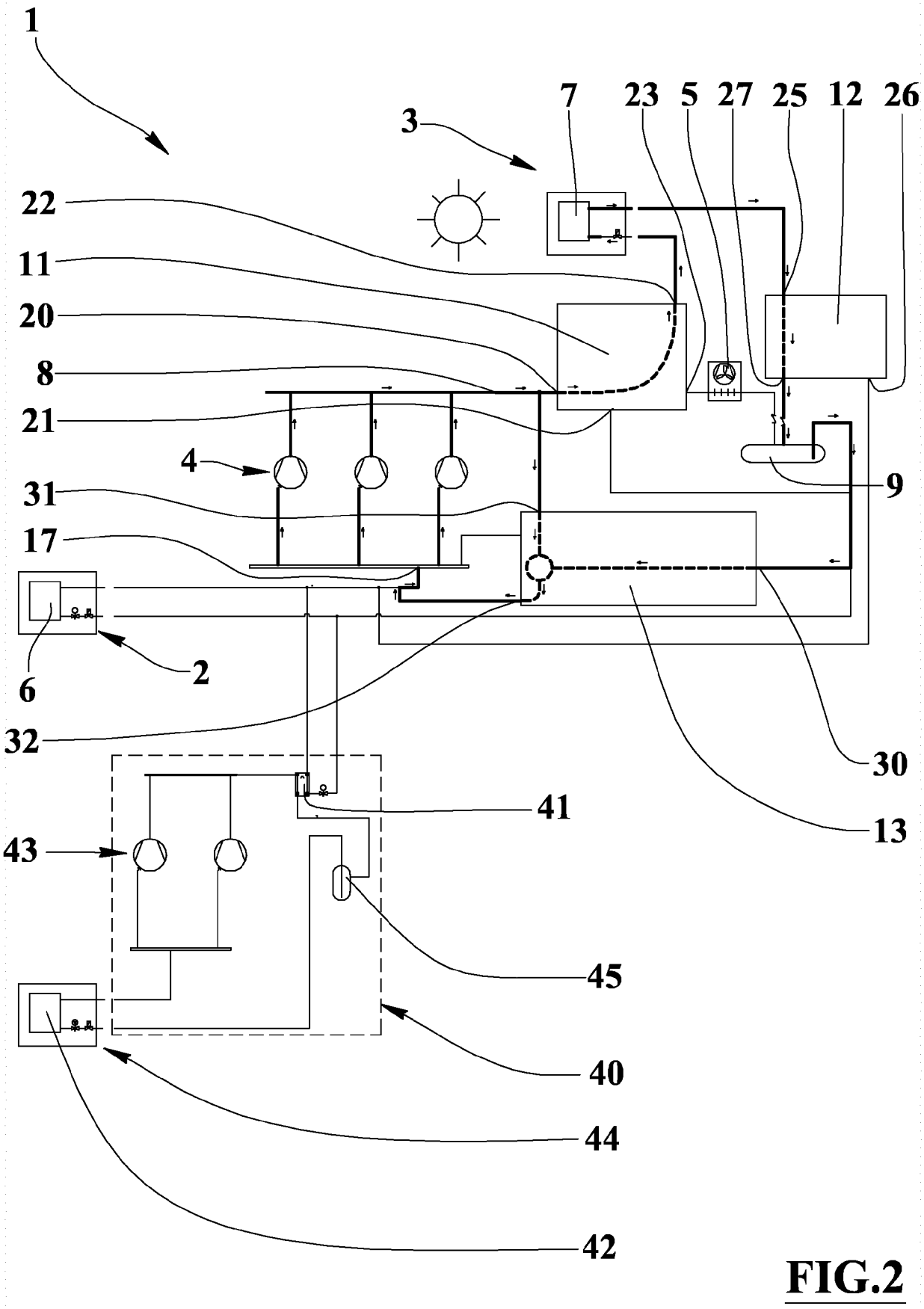

FIG.2

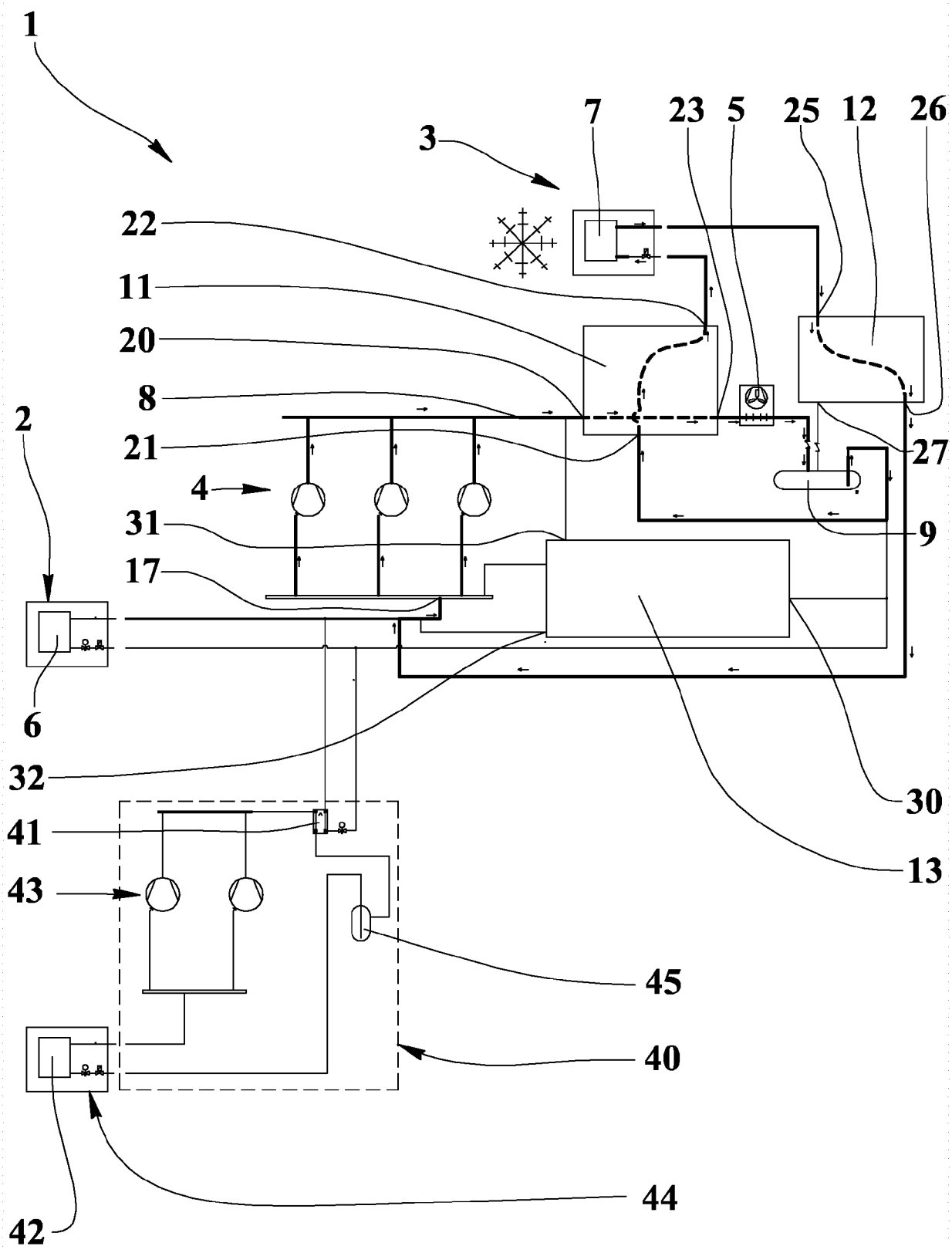

FIG.3