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(54) COOLING SYSTEM FOR AIRCRAFT ELECTRIC OR ELECTRONIC DEVICES

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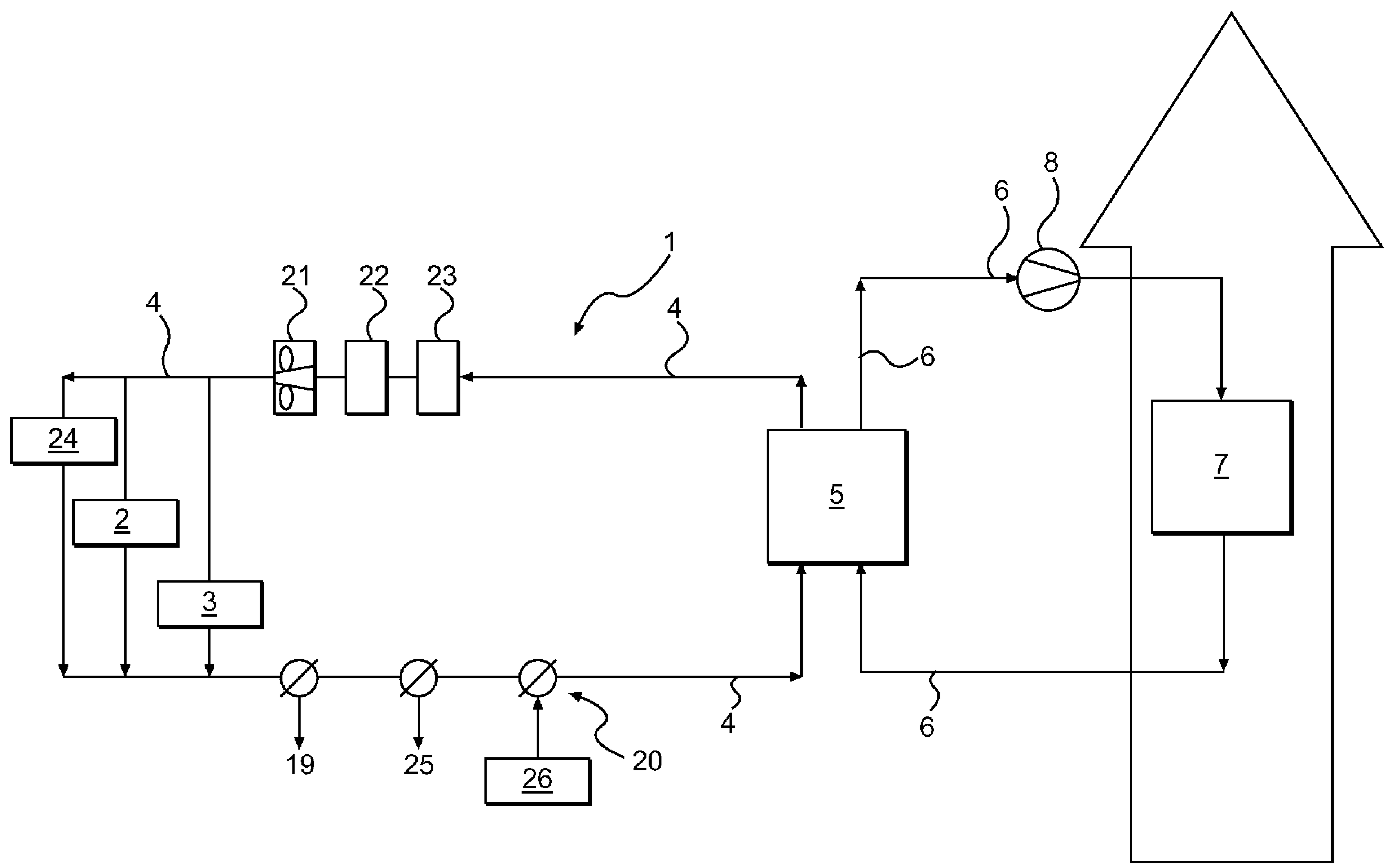
(57) **ABSTRACT**

In a cooling system for the electrical or electronic equipment on board an aircraft, a heat transfer medium circulates through a main closed cooling circuit. A liquid coolant circulates through a secondary closed cooling circuit. A first heat exchanger makes it possible to transfer the heat from the heat transfer medium circulating through the main closed cooling circuit to the liquid coolant circulating through the secondary closed cooling circuit, by evaporation of the liquid coolant circulating through the secondary closed cooling circuit. A second heat exchanger makes possible the condensation of the liquid coolant circulating through the secondary closed cooling circuit. The second heat exchanger cools the liquid coolant by thermal coupling to the outside ambient air.



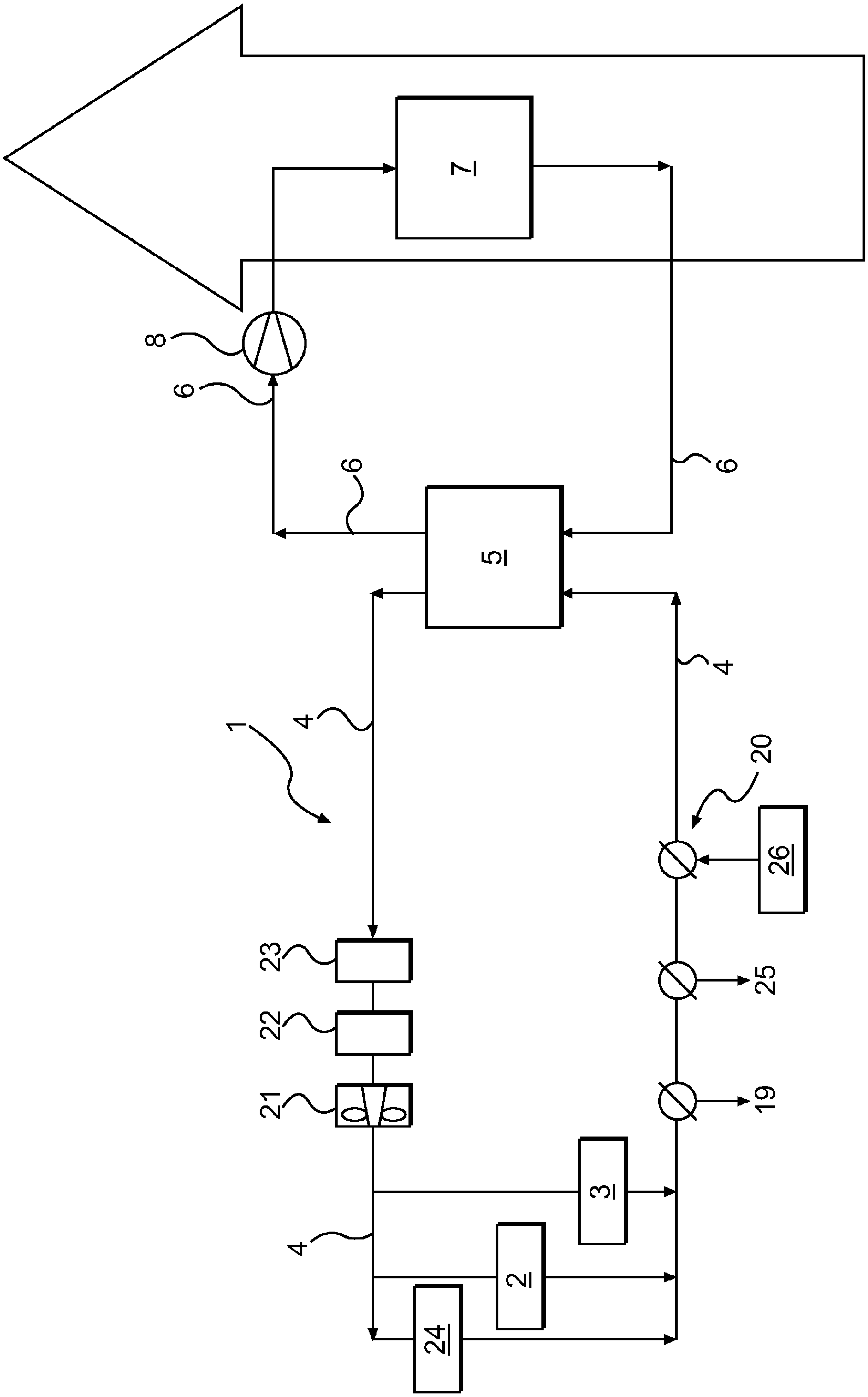


FIG. 1

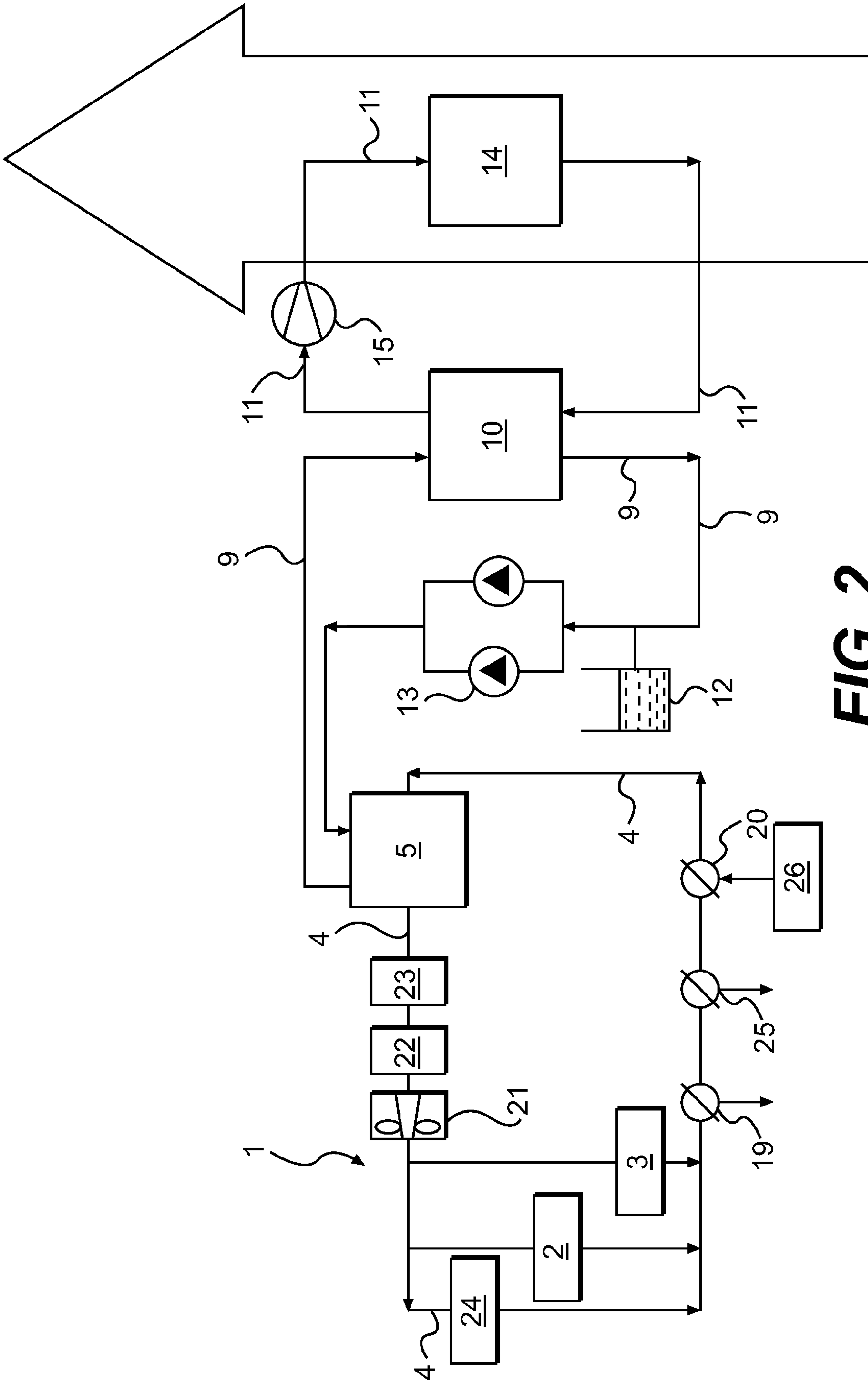


FIG. 2

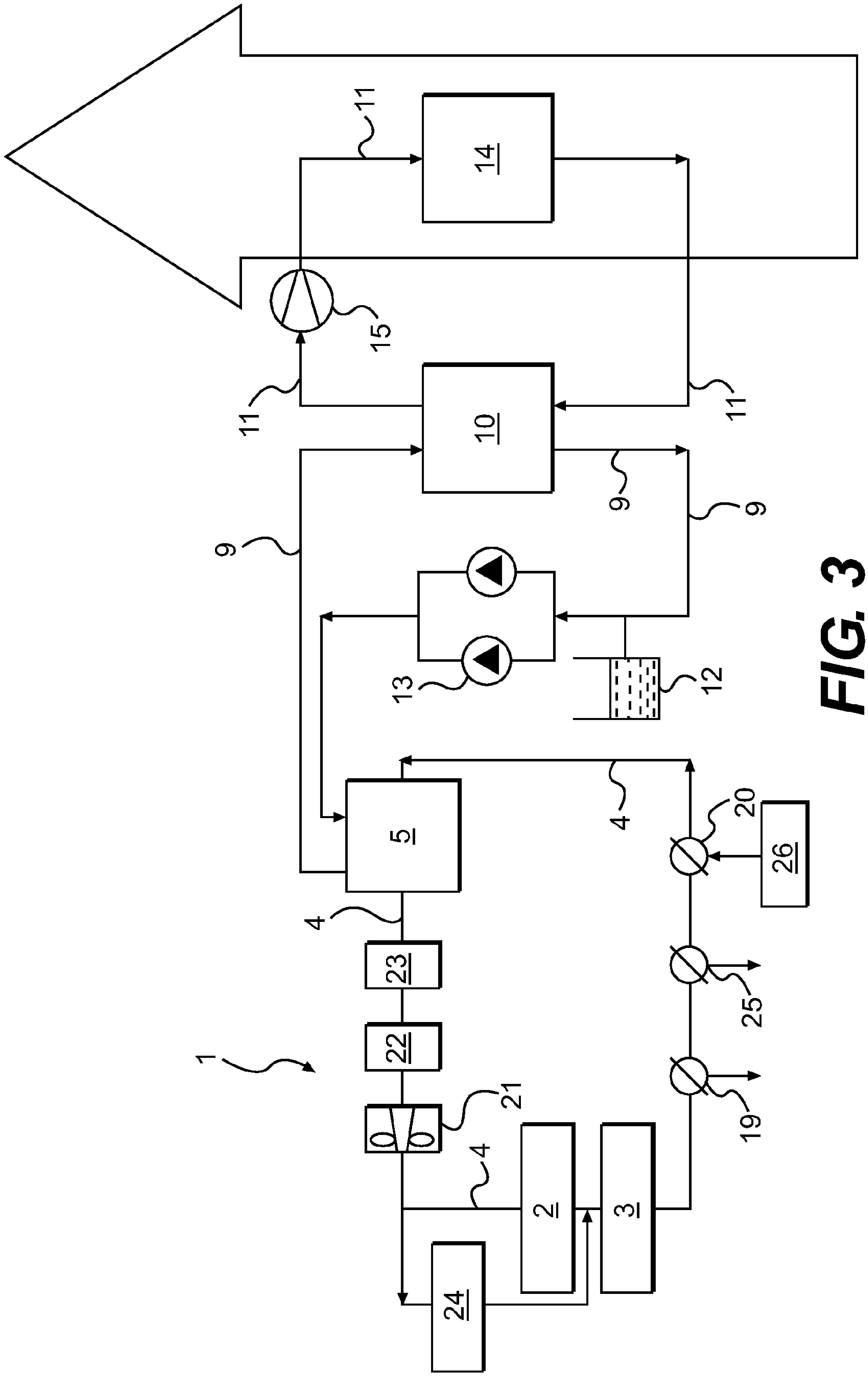


FIG. 3

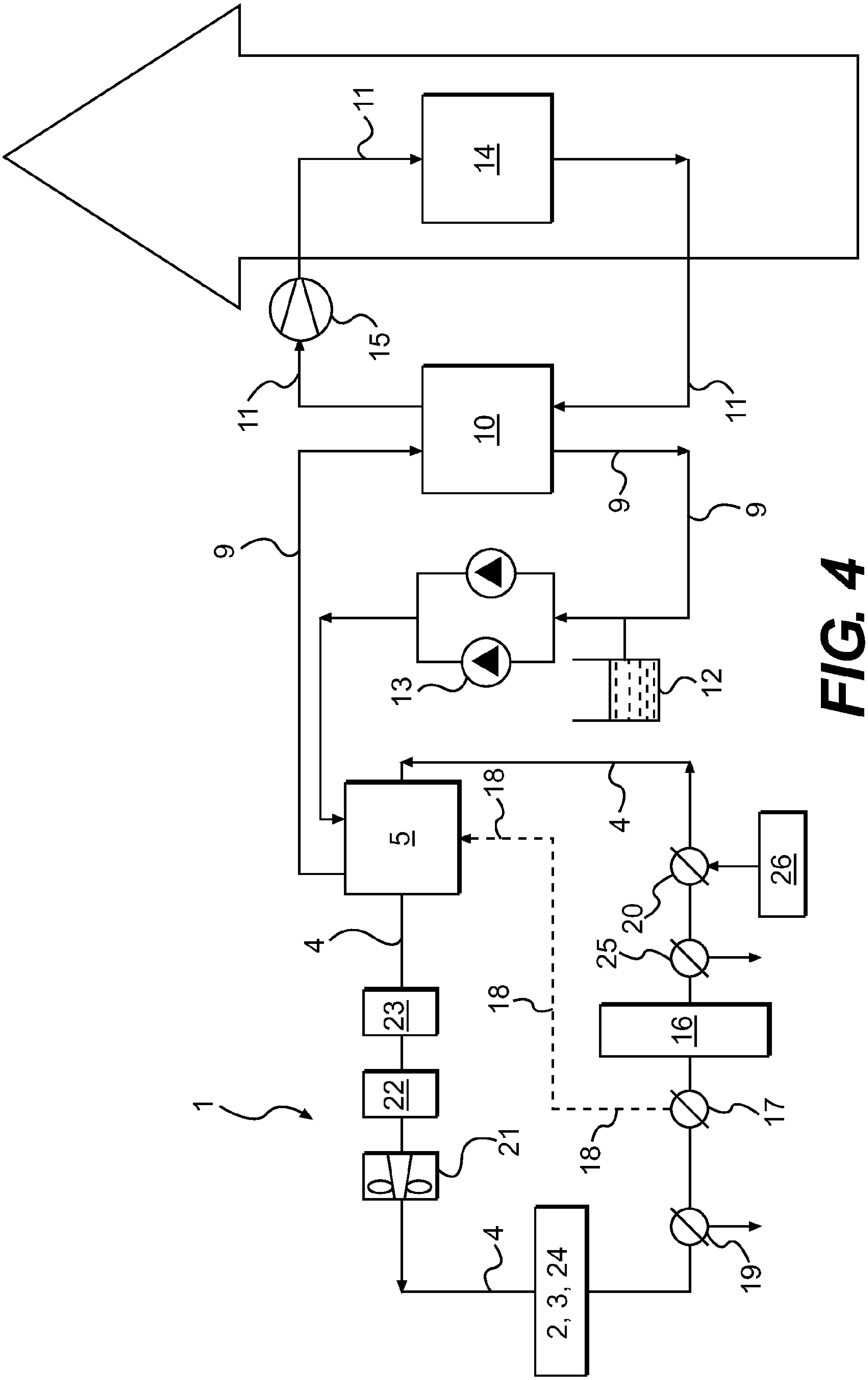


FIG. 4

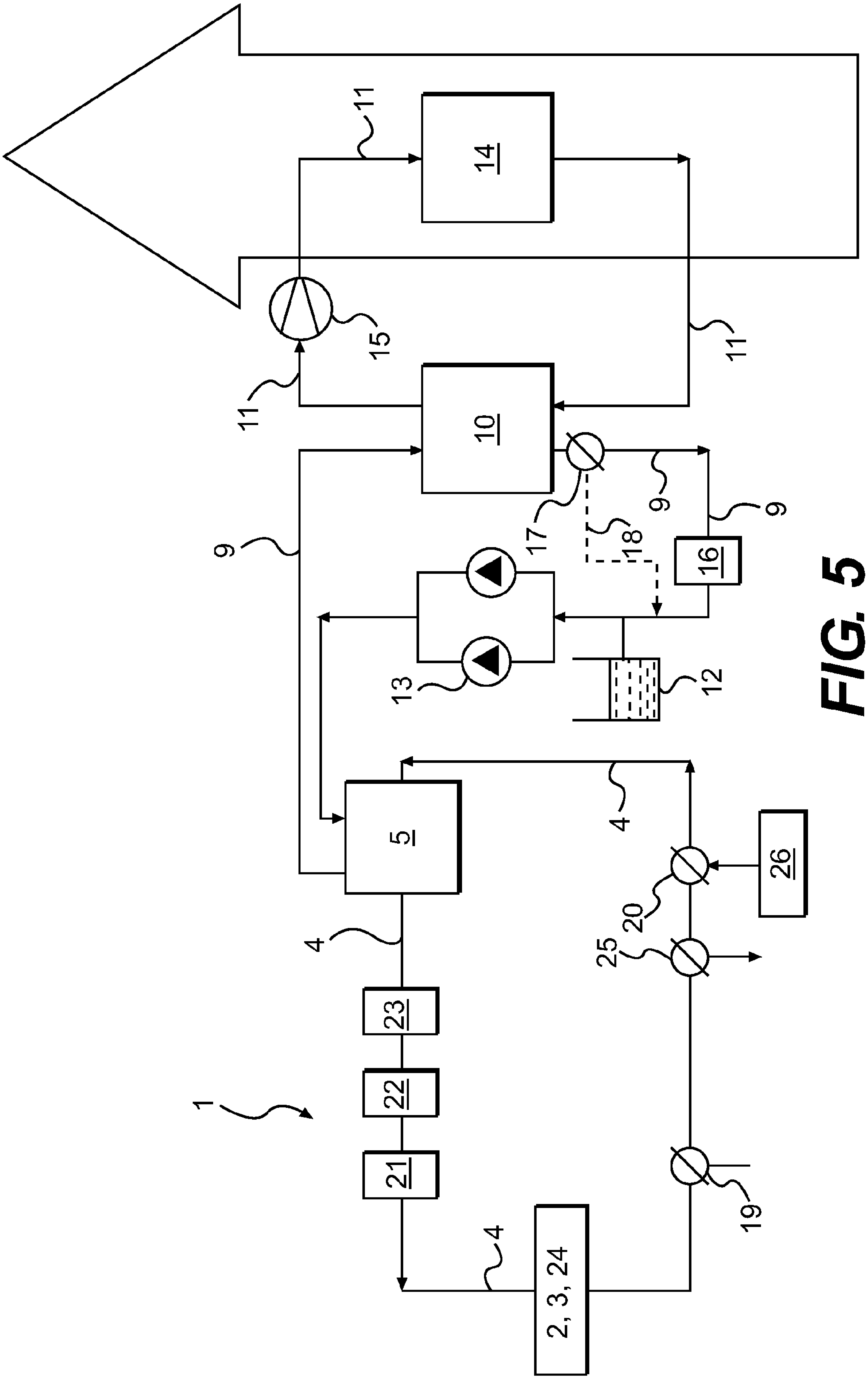


FIG. 5

COOLING SYSTEM FOR AIRCRAFT ELECTRIC OR ELECTRONIC DEVICES

CROSSED REFERENCE

[0001] This application claims priority over the French application FR 08 55669, filed on Aug. 21, 2008, and over the French application FR 08 55670, filed on Aug. 21, 2008, since those two applications are entirely included by reference into this application.

TECHNICAL AREA OF THE INVENTION

[0002] This invention relates to a cooling system for the electrical or electronic equipment on board an aircraft. The invention also relates to an aircraft equipped with such a system.

PRIOR STATE OF THE ART

[0003] An aircraft, such as a modern commercial transport aircraft, has various electrical and electronic equipments intended for its operation, in particular electronic equipment used in the avionic systems, general electrical equipment, and flight instruments from the cockpit. This equipment is usually contained in holds and cabinets located in various places in the structure of the aircraft. These holds and cabinets are usually equipped with cooling systems, in particular forced air cooling systems, that make it possible to control their inside temperature, in order to prevent the electrical and electronic equipment contained in them from overheating.

[0004] The Aerospace Information Report titled "*Electrical and Electronic Equipment Cooling in Commercial Transports,*" issued by the Society of Automotive Engineers Inc. organization (SAE) on Dec. 15, 1956, as revised on Sep. 1, 1992 (hereinafter the "SAE Report"), contains a summary of the systems and methods for cooling the electrical and electronic equipment by forced air, that can be used in commercial aviation. Such systems usually consist of a forced air device and one or several air ducts intended to transport the forced air to the desired location. The electrical and electronic equipment to be cooled is arranged so as to allow maximum thermal coupling with the air. The systems may be open (use of ambient air and recirculation of this air in other compartments of the aircraft) or closed (recirculation of the same air in a circuit in an independent cooling system).

[0005] However, due (i) to the increase in power density of the new electrical and electronic equipment used in modern commercial aircraft or in those intended to equip the commercial aircraft under development, (ii) to the increase in the number of components of electrical and electronic equipment to be cooled, and (iii) to the fact that this equipment is more and more tightly consolidated, the electrical and electronic equipment of commercial aircraft releases more and more heat and the air temperature of the holds and cabinets in which it is consolidated tends to increase significantly. And vice-versa, the new electrical and electronic equipment developed for commercial aviation, and in particular the electronic equipment of avionic systems, requires more and more to be operated at well controlled temperatures.

[0006] Without an appropriate cooling system, the ambient temperature of the holds and cabinets in which is located the electrical or electronic equipment can increase above the maximum temperature at which this can be operated. This can lead to the following results: malfunction of the equipment, a decrease in its useful life, breakdown or final damage. Such a situation is critical for the electrical and electronic equipment used in the operation of an aircraft, such as a commercial transportation airplane.

[0007] However, the systems generally known in the prior art and those suggested in the SAE Report do not bring a satisfactory solution to this new problem. The simple increase in the quantity and flow of the air forced over the electrical or electronic components to be cooled has some significant disadvantages: (i) low thermal efficiency, (ii) decrease in the commercial space available on the aircraft, (iii) noise increase, (iv) increased energy consumption, and (v) risk of damage to the equipment cooled.

[0008] One solution to this problem is to use a cooling system with pre-cooled forced air circulating continuously in a closed loop. The SAE Report describes in particular such a system, the re-circulated air of which can be pre-cooled by means of a heat exchanger that makes possible the thermal coupling with the outer atmosphere of the aircraft, which is supposedly cold enough to cool the re-circulated air to an acceptable level. The SAE Report also describes that when the aircraft is on the ground in warm weather, an auxiliary refrigeration system makes it possible to cool the re-circulated air in the loop at an acceptable level. However, this system presents certain problems:

[0009] (i) using the outer atmosphere of the aircraft as the main source for dissipating the heat released by the electrical and electronic equipment does not make it possible to guarantee a constant level of cooling under all operating conditions of this equipment, and under certain operating conditions, it may be harmful to the cooling of this equipment; and

[0010] (ii) using an auxiliary refrigeration system may involve an additional energy demand and a significant increase in the total mass of the forced air cooling system.

DISCLOSURE OF THE INVENTION

[0011] In one embodiment of this invention, a cooling system for the electrical or electronic equipment on board an aircraft consists of:

[0012] a main closed cooling circuit adapted to circulate a heat transfer medium through the main closed cooling circuit;

[0013] a secondary closed cooling circuit adapted to circulate a liquid coolant through the secondary closed cooling circuit;

[0014] a first heat exchanger (**5**) that makes it possible to transfer the heat from the heat transfer medium circulating through the main closed cooling circuit (**4**) to the liquid coolant circulating through the secondary closed cooling circuit (**6**), by evaporation of the liquid coolant circulating through the secondary closed cooling circuit (**6**);

[0015] a second heat exchanger (**7**) that makes possible the condensation of the liquid coolant circulating through the secondary closed cooling circuit (**6**); and

[0016] the second heat exchanger (**7**) being adapted to cool the liquid coolant by thermal coupling to the outside ambient air.

[0017] Such a system may contribute to a sufficiently effective cooling of the electrical or electronic equipment, in particular the high power density equipment, while contributing, among other things, to a reduction in the size of the air ducts in the circuit and a reduction in the noise generated by the circulation of the heat transfer medium through the circuit.

[0018] In one form of embodiment, the main closed cooling circuit is adapted to cool:

[0019] a first compartment containing avionic systems of the aircraft; and

[0020] a second compartment containing electrical systems of the aircraft;

[0021] In one form of embodiment, the first compartment and the second compartment are placed in series in the main closed cooling circuit.

[0022] Such a form of embodiment may contribute, among other things, to the achievement of a good energy efficiency ratio, for example when the operating temperature of the equipment from the first compartment is lower than the operating temperature of the equipment in the second compartment.

[0023] In one form of embodiment, the first compartment (**2**) and the second compartment (**3**) are placed in parallel in the main closed cooling circuit (**4**).

[0024] Such a form of embodiment may contribute, among other things, to the achievement of a good energy efficiency ratio, for example when the equipment from the first compartment and the equipment in the second compartment have approximately the same the operating temperature.

[0025] In one form of embodiment, the main closed cooling circuit is adapted to cool a third compartment containing flight instruments from the aircraft's cockpit.

[0026] Such a form of embodiment may contribute, among other things, to the achievement of a good energy efficiency ratio.

[0027] In one form of embodiment, the system also includes an inlet valve and at least one exhaust valve, adapted to open the main closed circuit.

[0028] In one form of embodiment, the system consists of:

[0029] a tertiary closed cooling circuit consisting of a liquid coolant and at least one compressor adapted to make the liquid coolant circulate in the tertiary closed cooling circuit, where the tertiary closed cooling circuit is fluidically independent from the main closed cooling circuit and from the secondary closed cooling circuit; and

[0030] a third heat exchanger adapted for cooling the liquid coolant of the tertiary cooling circuit by means of the outside ambient air by condensation of the liquid coolant circulating through the third closed cooling circuit; and

[0031] the second heat exchanger is adapted to couple thermally the liquid coolant of the secondary closed cooling circuit with the liquid coolant of the tertiary closed cooling circuit, and make possible the evaporation of the liquid coolant that circulates through the tertiary closed cooling circuit.

[0032] Such a form of embodiment may contribute, among other things, to the achievement of a more flexible integration of the cooling system by making the location of the tertiary closed cooling circuit independent from the location of the main closed circuit.

[0033] In one form of embodiment, the secondary closed cooling circuit consists of:

[0034] an additional heat exchanger to thermally couple the liquid coolant that circulates through the secondary closed cooling circuit directly to the outside ambient air;

[0035] a bypass valve located upstream from the additional heat exchanger, that makes it possible to block, at least in part, the circulation of the liquid coolant towards the secondary heat exchanger; and

[0036] a bypass duct connecting the bypass valve to a point on the secondary closed cooling circuit downstream from the additional heat exchanger, to allow the liquid coolant to bypass at least in part the additional heat exchanger as a function of a control setting of the bypass valve.

[0037] Such a form of embodiment may contribute, among other things, to the provision of appropriate cooling in case of a malfunction of the secondary heat exchanger, and also to the improvement of the energy efficiency ratio by using the outside ambient air to cool the liquid coolant that circulates through the secondary closed cooling circuit.

[0038] In one form of embodiment, the main closed cooling circuit consists of:

[0039] an additional heat exchanger adapted to thermally couple the heat transfer medium that circulates through the main closed cooling circuit directly to the outside ambient air;

[0040] a bypass valve located upstream from the additional heat exchanger, that makes it possible to block, at least in part, the circulation of the heat transfer medium towards the additional heat exchanger; and

[0041] a bypass duct connecting the bypass valve to a point on the main closed cooling circuit downstream from the additional heat exchanger, to allow the heat transfer medium to bypass at least in part the additional heat exchanger as a function of a control setting of the bypass valve.

[0042] Such a form of embodiment may contribute, among other things, to the provision of appropriate cooling in case of a malfunction of the main heat exchanger, and it can also contribute to the improvement of the energy efficiency ratio by using the outside ambient air to cool the liquid coolant that circulates through the main closed cooling circuit.

[0043] Another embodiment of the invention concerns an aircraft with a cooling system as described above.

DESCRIPTION OF FIGURES

[0044] This invention is illustrated by non restrictive examples of the figures attached, where identical references show similar elements:

[0045] FIG. **1** is a schematic illustration of the first possible embodiment of the invention;

[0046] FIG. **2** is a schematic illustration of the second possible embodiment of the invention;

[0047] FIG. **3** is a schematic illustration of the third possible embodiment of the invention;

[0048] FIG. **4** is a schematic illustration of the fourth possible embodiment of the invention; and

[0049] FIG. **5** is a schematic illustration of the fifth possible embodiment of the invention.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0050] One possible embodiment of the invention, as well as certain variations that can be made to it, are described below with reference to FIGS. **1** à **5**. These embodiments of the invention and certain possible variations are given as an illustration and should not limit in any way the extent of the scope of the invention. Other possible embodiments and variations of the invention will be apparent to the average technician skilled in the art.

[0051] The cooling system for electrical or electronic equipment (**1**) makes it possible to cool at least a first group of electrical or electronic equipment (**2**), a second group of electrical or electronic equipment (**3**) and a third group of electrical or electronic equipment (**24**). In this illustrative embodiment of the invention, the first group of electrical or electronic equipment (**2**) consists of electronic equipment of the avionic systems of a commercial transportation aircraft that can be, for example, mounted together depending on similar thermal needs in a first portion of the aircraft such as, for example, on a rack or in a compartment. In general, among them there is electronic equipment associated with aeronautics instrumentation and aircraft communications systems, among which there are, as an example, on-board computers, microprocessors and evaluators, controllers, display units and screens, probes and antennas, etc.

[0052] On the other hand, the second group of electrical or electronic equipment (**3**) consists of electrical or electromechanical components generally associated with the operation of the aircraft, and in particular, also as an example, electric distribution centers, converters, rectifying installations, circuit breakers, actuators, electric pumps, etc. The equipment in the second group of electrical or electronic equipment (**3**) can be, for example, mounted together depending on similar thermal needs in a second portion of the aircraft, for example, in a compartment. In addition, the third group or electrical or electronic equipment (**24**) consists of flight instruments from the aircraft's cockpit. The equipment in the third group of electrical or electronic equipment (**24**) can be, for example, mounted together depending on similar thermal needs in a third portion of the aircraft, for example, on a rack, in a compartment or behind an instrument panel.

[0053] The cooling system (**1**) consists of a set of ducts forming a main closed circuit (**4**) through which circulates a heat transfer medium. The heat transfer medium can be any element or mixture of elements, in gaseous or fluid state, able to transfer heat. In the illustrative embodiments represented in FIGS. **1** through **5**, the air is the heat transfer medium given as an example. The air circulates in the direction indicated by the arrows. These ducts connect various elements of the cooling system (**1**). The entire circuit (**4**) can be leaktight or semi leaktight, i.e., during the operation, it can leak an acceptable volume of air from the circuit and allow an acceptable volume of air from the outside to enter the circuit.

[0054] The equipment from the first, second and third group of electrical or electronic equipment (**2**, **3**, **24**) can be cooled directly or indirectly. When cooled directly, the cooled air circulating through the closed circuit (**4**) is transported to the inlet of a leaktight or semi-leaktight compartment (not shown) containing certain electrical or electronic equipment to be cooled. The heat from the electrical or electronic equipment is transported directly to the air that circulates freely in the compartment and to which it is directly coupled thermally. The air containing the heat released by the electrical or electronic equipment is then evacuated through the compartment outlet and continues its flow through the main closed circuit (**4**). Each leaktight compartment is equipped with a device (not shown) in order to prevent the pressure from rising too high within the compartment. This device can be a release valve, for example.

[0055] Alternately, when the electrical or electronic equipment is cooled indirectly, it is thermally coupled to a heat exchanger that is in turn thermally coupled to the air circulating through the closed circuit (**4**).

[0056] FIG. **1** shows a first embodiment of the invention consisting of a main heat exchanger (**5**) that can cool by itself the air circulating through the main closed circuit (**4**). In this embodiment, the main heat exchanger (**5**) is an evaporator that makes it possible to thermally couple the air circulating through the main closed circuit (**4**) to a liquid coolant circulating through a second closed cooling circuit (**6**), fluidically independent from the main closed circuit (**4**).

[0057] A second heat exchanger (**7**) is also thermally coupled to the liquid coolant circulating through the second independent closed cooling circuit (**6**); This second heat exchanger (**7**) is a condenser cooled by a conventional forced air system well known to the average technician skilled in the art, for example a "ram air" in English ("système à air dynamique", in French). The air used to cool the second heat exchanger (**7**) may come, in particular, from outside the aircraft, and be directed to the second heat exchanger (**7**) via an appropriate ventilation system.

[0058] The cooling cycle of the second independent closed cooling circuit (**6**) is basically as follows: the main heat exchanger (**5**) makes it possible to send the heat accumulated by the air circulating through the main closed circuit (**4**) to the liquid coolant of the second independent closed cooling circuit (**6**), and then it is evaporated in gaseous state. This liquid coolant is transported to the second heat exchanger (**7**), in this case a condenser, that makes it possible to transfer the heat accumulated by the liquid coolant to the air used to cool this second heat exchanger (**7**). The cooled liquid coolant is then condensed to its liquid state and transported towards the main heat exchanger (**5**) in order to store heat again.

[0059] A thrust system (**8**), such as a compressor, allows the liquid coolant in gaseous state to circulate from the main heat exchanger (**5**) towards the second heat exchanger (**7**).

[0060] Some elements that make possible the optimal use of the main closed circuit (**4**) are also shown on FIG. **1**, and they are described below.

[0061] A fan (**21**) makes it possible to circulate the air in the main closed circuit (**4**). This fan (**21**) is equipped with a control system that makes it possible to adjust the outburst as a function of the level of cooling desired for the electrical or electronic equipment (**2**, **3**, **24**). The higher the fan (**21**) outburst, the higher the velocity of the air circulating through the main closed circuit (**4**), and more heat could be extracted from the electrical or electronic equipment (**2**, **3**, **24**). This control system is computerized. It is connected to one or several sensors (not shown) that measure the air temperature at various locations in the main closed circuit (**4**), in particular before the first group of electrical or electronic equipment (**2**), before the second group of electrical or electronic equipment (**3**), and after the main heat exchanger (**5**).

[0062] In order to avoid dust accumulation on the cooled electrical or electronic equipment (**2**, **3**, **24**) or damage caused by the particles in the air, the main closed circuit (**4**) is also equipped with a filter (**22**), located before the fan (**20**) in the air circulation cycle.

[0063] Sensors located in various places in the circuit (**4**), and which make it possible to determine the pressure and velocity of the air circulating through the main closed circuit (**4**), also make it possible to detect any obstruction or opening in the circuit. Such sensors located before and after the filter (**22**) will be able to indicate when the filter is clogged.

[0064] Since air temperature fluctuations across the entire main closed circuit (**4**) are likely to cause condensation and water particles that might damage the electrical or electronic equipment to be cooled (**2**, **3**, **24**) when they are cooled directly, the main closed circuit (**4**) also includes a water separator (**23**).

[0065] An inlet valve (**20**), connected to a mixer (**26**) can allow the intake of air from a source outside the main closed circuit (**4**), in particular if the fan (**21**) stops operating. In this case, a relief valve (**25**) opens to evacuate from the cockpit the air from a source outside the main closed circuit (**4**).

[0066] A relief valve (**19**) can be used to allow the evacuation of air circulating through the main closed circuit (**4**) outside the aircraft, in particular if this air becomes contaminated, for example, by the smoke released by an electrical or electronic equipment from the first, second or third group (**2**, **3**, **24**).

[0067] FIG. **2** shows an embodiment of the invention where the first group of electrical or electronic equipment (**2**), the second group of electrical or electronic equipment (**3**) and the third group of electrical or electronic equipment (**24**) are placed in parallel in the main closed circuit (**4**), and a single main heat exchanger (**5**) makes it possible to cool the air circulating through the main closed circuit (**4**). In this embodiment, two independent closed cooling circuits (**9**, **11**), placed in series, are used to cool the air circulating in the main closed circuit (**4**) through the main heat exchanger (**5**).

[0068] In this embodiment, the main heat exchanger (**50**) makes it possible to thermally couple the air circulating through the main closed circuit (**4**) and a liquid coolant circulating through a second independent closed cooling circuit (**9**). A second heat exchanger (**10**) makes it possible to thermally couple this liquid coolant to a liquid coolant circulating through a third independent closed cooling circuit (**11**). A third heat exchanger (**14**) is thermally coupled to the liquid coolant circulating through the third independent closed cooling circuit (**11**);

[0069] The second independent closed cooling circuit (**9**) contains a liquid coolant tank (**12**) that makes it possible to compensate the volume variations of the liquid coolant in the second independent closed cooling circuit (**9**) because of a change in temperature or a leak. A forced air system (**13**), in this case a main pump and an auxiliary pump intended to take over in case of failure of the main pump, makes it possible to circulate the liquid coolant through the circuit (**9**).

[0070] The cooling cycle of the second independent closed cooling circuit (**9**) is basically as follows: the main heat exchanger (**5**) makes it possible to send the heat accumulated by the air circulating through the main closed circuit (**4**) to the liquid coolant circulating through the second independent closed cooling circuit (**9**). This liquid coolant is fed to the second heat exchanger (**10**) which makes it possible to send the heat accumulated by the liquid coolant to the liquid coolant circulating through the third independent closed cooling circuit (**11**). The cooled liquid coolant circulating through the second independent closed cooling circuit (**9**) is then transported towards the main heat exchanger (**5**) in order to store heat again.

[0071] The second heat exchanger (**10**) is an evaporator, the third heat exchanger (**14**) is a condenser cooled by a conventional forced air system, the liquid coolant circulating through the third independent closed cooling circuit (**11**) is in gaseous state between the second heat exchanger (**10**) and the third heat exchanger (**14**), and in liquid state between the third heat exchanger (**14**) and the second heat exchanger (**10**). The third independent closed cooling circuit (**11**) is similar to the second independent closed cooling circuit (**6**) in the first embodiment of the invention shown in FIG. **1**. The third independent closed cooling circuit (**11**) also contains a compressor (**5**).

[0072] FIG. **3** shows an embodiment of the invention where the first group of electrical or electronic equipment (**2**), and the second group of electrical or electronic equipment (**3**) are placed in series in the main closed circuit (**4**), and the third group of electrical or electronic equipment (**24**) is placed in parallel with the first group of electrical or electronic equipment (**2**). Such an arrangement in series allows optimum yield of the system, since the equipment in the first and third groups (**2**, **24**) must be kept at a temperature lower than those in the second group (**3**). The temperature of the air used to cool the equipment in the first and third groups (**2**, **24**) may be between approximately 10° C. and 15° C. Once loaded with the heat released from the first group (**2**), this air can be transported directly towards the equipment in the second group (**3**), which it will reach at a temperature of approximately 40° C.

[0073] FIG. **4** shows another embodiment of the invention where a secondary heat exchanger (**16**) is present in the main closed circuit (**4**). This secondary heat exchanger (**16**) may be in the form of a skin heat exchanger that makes it possible to thermally couple the air circulating through the main closed circuit (**4**) with the air on the outside of the aircraft. This variation of the invention makes it possible to cool the air circulating through the main closed circuit (**4**) without requiring auxiliary energy and it allows an appropriate cooling yield for the purpose of this invention, for example, when the aircraft is at altitude or when it is operated on the ground in cold weather.

[0074] However, under certain operating conditions, for example when the aircraft is on the ground in warm weather, a heat exchange between the air outside the aircraft and the air circulating through the main closed circuit (**4**) may not be desired, since it might force a work overload on the main heat exchanger (**5**). A valve (**17**) located before the secondary heat exchanger (**16**) makes it possible to divert the air circulating through the main closed circuit (**4**) directly towards the main heat exchanger (**5**) by means of a bypass duct (**18**). The quantity of bypassed air may vary as a function of the temperature outside the aircraft and of the temperature at which the groups of electrical or electronic equipment (**2**, **3**, **24**) must be maintained.

[0075] FIG. **5** shows another embodiment of the invention where a secondary heat exchanger (**16**) is present in the second independent closed cooling circuit (**9**). This secondary heat exchanger (**16**) may be in the form of a skin heat exchanger that makes it possible to thermally couple the fluid circulating through the second independent closed cooling circuit (**9**) with the air on the outside of the aircraft. This variation of the invention makes it possible to cool the fluid circulating through the second independent closed cooling circuit (**9**) without requiring auxiliary energy and it allows an appropriate cooling yield for the purpose of this invention, for example, when the aircraft is at altitude or when it is operated on the ground in cold weather.

[0076] However, under certain operating conditions, for example when the aircraft is on the ground in warm weather, a heat exchange between the air outside the aircraft and the fluid circulating through the second independent closed cooling circuit (**9**) may not be desired, since it might force a work overload on the second heat exchanger (**10**). A valve (**17**) located between the second heat exchanger (**10**) and the secondary heat exchanger (**16**) makes it possible to divert the fluid circulating through the second independent closed cooling circuit (**9**) directly towards the main heat exchanger (**5**) by means of a bypass duct (**18**). The quantity of bypassed fluid may vary as a function of the temperature outside the aircraft and of the temperature at which the groups of electrical or electronic equipment (**2**, **3**, **24**) must be maintained.

[0077] These figures of the invention should not be interpreted as limitations to said invention. The reference signs in the claims are not restrictive by any means. The verbs "to contain" and "to consist of" do not exclude the presence of other elements besides those listed in the claims. The word "a/an" preceding an element does not exclude the presence of several such elements.

1. A cooling system for the electrical or electronic equipment on board an aircraft, consisting of:

a main closed cooling circuit adapted to circulate a heat transfer medium through the main closed cooling circuit;

a secondary closed cooling circuit adapted to circulate a liquid coolant through the secondary closed cooling circuit;

a first heat exchanger that makes it possible to transfer the heat from the heat transfer medium circulating through the main closed cooling circuit to the liquid coolant circulating through the secondary closed cooling circuit, by evaporation of the liquid coolant circulating through the secondary closed cooling circuit;

a second heat exchanger that makes possible the condensation of the liquid coolant circulating through the secondary closed cooling circuit; and

the second heat exchanger being adapted to cool the liquid coolant by thermal coupling to the outside ambient air.

2. A cooling system according to claim **1**, where the main closed cooling circuit is adapted to cool:

a first compartment containing avionic systems of the aircraft; and

a second compartment containing electrical systems of the aircraft;

3. A cooling system according to claim **2**, where:

the first compartment and the second compartment are placed in series in the main closed cooling circuit.

4. A cooling system according to claim **2**, where:

the first compartment and the second compartment are placed in parallel in the main closed cooling circuit.

5. A cooling system according to claim **2**, where the main closed cooling circuit is adapted to cool a third compartment containing flight instruments from the aircraft's cockpit.

6. A cooling system according to claim **1**, where the system consists of:

an inlet valve and at least one exhaust valve, adapted to open the main closed cooling circuit.

7. A cooling system according to claim **1**, consisting of:

a tertiary closed cooling circuit consisting of a liquid coolant and at least one compressor adapted to make the liquid coolant circulate in the tertiary closed cooling circuit, where the tertiary closed cooling circuit is fluidically independent from the main closed cooling circuit and from the secondary closed cooling circuit;

a third heat exchanger adapted for cooling the liquid coolant of the tertiary cooling circuit by means of the outside ambient air by condensation of the liquid coolant circulating through the third closed cooling circuit; and

the second heat exchanger is adapted to couple thermally the liquid coolant of the secondary closed cooling circuit with the liquid coolant of the tertiary closed cooling circuit, and makes possible the evaporation of the liquid coolant that circulates through the tertiary closed cooling circuit.

8. A cooling system according to claim **7**, where the secondary closed cooling circuit consists of:

an additional heat exchanger to thermally couple the liquid coolant that circulates through the secondary closed cooling circuit directly to the outside ambient air;

a bypass valve located upstream from the additional heat exchanger, that makes it possible to block, at least in part, the circulation of the liquid coolant towards the secondary heat exchanger; and

a bypass duct connecting the bypass valve to a point on the secondary closed cooling circuit downstream from the additional heat exchanger to allow the liquid coolant to bypass at least in part the additional heat exchanger as a function of a control setting of the bypass valve.

9. A cooling system according to claim **1**, where the main closed cooling circuit consists of:

an additional heat exchanger adapted to thermally couple the heat transfer medium that circulates through the main closed cooling circuit directly to the outside ambient air;

a bypass valve located upstream from the additional heat exchanger, that makes it possible to block, at least in part, the circulation of the heat transfer medium towards the additional heat exchanger; and

a bypass duct connecting the bypass valve to a point on the main closed cooling circuit downstream from the additional heat exchanger to allow the heat transfer medium to bypass at least in part the additional heat exchanger as a function of a control setting of the bypass valve.

10. An aircraft containing a cooling system for electrical or electronic equipment on board an aircraft, the system consisting of:

a main closed cooling circuit adapted to circulate a heat transfer medium through the main closed cooling circuit;

a secondary closed cooling circuit adapted to circulate a liquid coolant through the secondary closed cooling circuit;

a first heat exchanger that makes it possible to transfer the heat from the heat transfer medium circulating through the main closed cooling circuit to the liquid coolant circulating through the secondary closed cooling circuit, by evaporation of the liquid coolant circulating through the secondary closed cooling circuit;

a second heat exchanger that makes possible the condensation of the liquid coolant circulating through the secondary closed cooling circuit; and

the second heat exchanger being adapted to cool the liquid coolant by thermal coupling to the outside ambient air.

11. An aircraft containing a cooling system according to claim **10**, where the main closed cooling circuit is adapted to cool:

a first compartment containing avionic systems of the aircraft; and

a second compartment containing electrical systems of the aircraft;

12. An aircraft containing a cooling system according to claim **11**, where:

the first compartment and the second compartment are placed in series in the main closed cooling circuit.

13. An aircraft containing a cooling system according to claim **11**, where:

the first compartment and the second compartment are placed in parallel in the main closed cooling circuit.

14. An aircraft containing a cooling system according to claim **11**, where the main closed cooling circuit is adapted to cool a third compartment containing flight instruments from the aircraft's cockpit.

15. A cooling system according to claim **10**, where the system consists of:

an inlet valve and at least one exhaust valve, adapted to open the main closed cooling circuit.

16. An aircraft containing a cooling system according to claim **10**, consisting of:

a tertiary closed cooling circuit consisting of a liquid coolant and at least one compressor adapted to make the liquid coolant circulate in the tertiary closed cooling circuit, where the tertiary closed cooling circuit is fluidically independent from the main closed cooling circuit and from the secondary closed cooling circuit;

a third heat exchanger adapted for cooling the liquid coolant of the tertiary cooling circuit by means of the outside ambient air by condensation of the liquid coolant circulating through the third closed cooling circuit; and

the second heat exchanger is adapted to couple thermally the liquid coolant of the secondary closed cooling circuit with the liquid coolant of the tertiary closed cooling circuit, and makes possible the evaporation of the liquid coolant that circulates through the tertiary closed cooling circuit.

17. An aircraft containing a cooling system according to claim **16**, where the secondary closed cooling circuit consists of:

an additional heat exchanger to thermally couple the liquid coolant that circulates through the secondary closed cooling circuit directly to the outside ambient air;

a bypass valve located upstream from the additional heat exchanger, that makes it possible to block, at least in part, the circulation of the liquid coolant towards the secondary heat exchanger; and

a bypass duct connecting the bypass valve to a point on the secondary closed cooling circuit downstream from the additional heat exchanger to allow the liquid coolant to bypass at least in part the additional heat exchanger as a function of a control setting of the bypass valve.

18. An aircraft containing a cooling system according to claim **10**, where the main closed cooling circuit consists of:

an additional heat exchanger adapted to thermally couple the heat transfer medium that circulates through the main closed cooling circuit directly to the outside ambient air;

a bypass valve located upstream from the additional heat exchanger, that makes it possible to block, at least in part, the circulation of the heat transfer medium towards the additional heat exchanger; and

a bypass duct connecting the bypass valve to a point on the main closed cooling circuit downstream from the additional heat exchanger to allow the heat transfer medium to bypass at least in part the additional heat exchanger as a function of a control setting of the bypass valve.

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