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(54) **COOLING SYSTEM FOR AN ENGINE DISPOSED WITHIN AN ENGINE ROOM**

(57) A cooling system (200) for an engine (106) disposed within an engine room (104) includes a first cooling circuit (202) associated with an intercooler (206) of the engine (106), and a second cooling circuit (208) associated with a cooling jacket (214) of the engine (106). The cooling system (200) further includes a first connecting conduit (222) fluidly connecting the first cooling circuit (202) and the second cooling circuit (208), and a diverter valve (224) disposed in the first connecting conduit (222). The diverter valve (224) is configured to control a flow of cooling fluid from the second cooling circuit (208) to the first cooling circuit (202). The cooling system (200) further includes a controller (226) communicably coupled to the diverter valve (224). The controller (226) is configured to regulate the diverter valve (224) to allow a flow of cooling fluid from the second cooling circuit (208) to the first cooling circuit (202) based on at least one of air temperature (T1) in the engine room (104) and ambient air temperature (T).

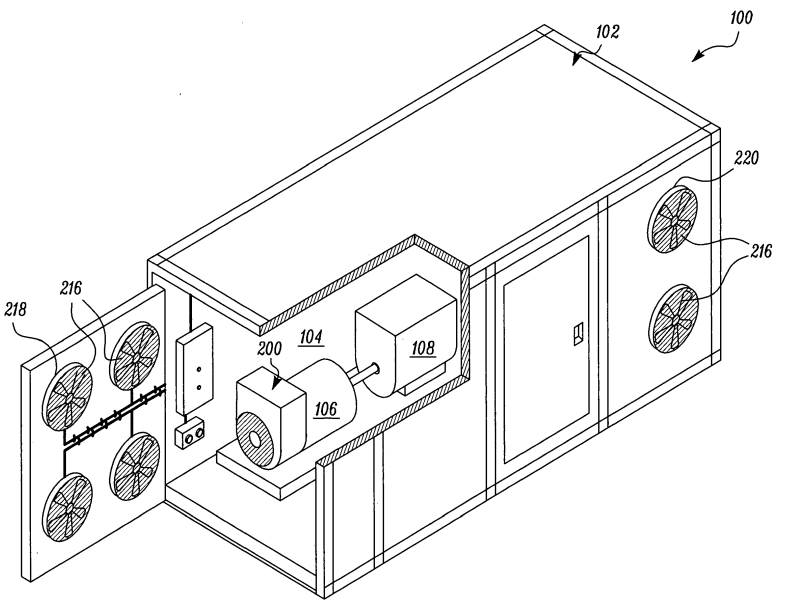


*FIG.1*

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## Description

### Technical Field

**[0001]** The present disclosure relates to a power generating system, and more particularly, to a cooling system for an engine disposed within an engine room of the power generating system.

### Background

**[0002]** Power generating systems such as for *e.g.*, Gas-engine gensets have been known to employ containers or enclosures to house various heat sources and heat exchangers therein. These systems typically contain an engine and a generator coupled thereto. Moreover, these systems may include cooling fluid circuits to cool down components such as the engine. For instance, engines may have cooling circuits for at least the following three waste heat streams associated therewith for *e.g.*, an intercooler cooling circuit, an engine jacket cooling circuit, and heat radiation that may possibly occur from components of the system present within the container. However, conventional containers or enclosures lack room to treat such waste heat streams separately.

**[0003]** U.S Patent 7,472,771 (hereinafter referred to as "the ’771 patent") discloses a snowmobile that includes an engine unit disposed in an engine room covered by an engine hood. The engine unit includes an engine body, a turbocharger, an intercooler for cooling an intake-air, which is pressurized and heated up by the turbocharger, and an electric motor-driven cooling fan provided for the intercooler for introducing outside air to the intercooler through which the air after cooling the intercooler is discharged toward the inside of the engine room.

**[0004]** Although, the ’771 patent discloses that heated air, obtained from cooling the intercooler, is discharged toward the inside of the engine room, the ’771 patent does not account for changes in ambient temperature or temperature of air present within the engine room.

### Summary of the Disclosure

**[0005]** In one aspect of the present disclosure, a cooling system is provided for an engine disposed within an engine room. The cooling system includes a first cooling circuit. The first cooling circuit includes a first heat exchanger, and a first cooling conduit disposed in fluid communication with the first heat exchanger. The first heat exchanger is configured to receive cooling fluid. The first cooling conduit is configured to transport the cooling fluid to an intercooler associated with the engine.

**[0006]** The cooling system further includes a second cooling circuit. The second cooling circuit includes a second heat exchanger, and a second cooling conduit disposed in fluid communication with the second heat exchanger. The second heat exchanger configured to receive cooling fluid. The second cooling conduit is configured to transport cooling fluid to a cooling jacket associated with the engine.

**[0007]** The cooling system further includes a fan configured to draw air over the first heat exchanger, through the engine room, and over the second heat exchanger. Moreover, the cooling system further includes a first connecting conduit fluidly connecting the first cooling conduit and the second cooling conduit. Additionally, the cooling system includes a diverter valve disposed in the first connecting conduit. The diverter valve is configured to control a flow of cooling fluid from the second cooling conduit to the first cooling conduit. The cooling system further includes a controller that is communicably coupled to the diverter valve. The controller is configured to regulate the diverter valve to allow flow of cooling fluid from the second cooling conduit to the first cooling conduit based on at least one of: air temperature in the engine room and ambient air temperature so as to regulate temperature of air within the engine room.

**[0008]** In another aspect of the present disclosure, a power generating system includes a container defining an engine room therein; an engine disposed within the engine room; and a generator drivably coupled to the engine and disposed within the container. The power generating system also includes the cooling system of the present disclosure. The cooling system is disposed within the container and is configured to execute functions that are in accordance with embodiments of present disclosure.

**[0009]** Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

### Brief Description of the Drawings

**[0010]**

FIG. 1 is a perspective view of a power generating system showing a container, in accordance with embodiments of the present disclosure;

FIG. 2 is a schematic view of the power generating system showing the engine and the cooling system, in accordance with an embodiment of the present disclosure; and

FIG. 3 is a schematic view of the power generating system showing the engine and the cooling system, in accordance with another embodiment of the present disclosure.

### Detailed Description

**[0011]** Wherever possible, the same reference numbers will be used throughout the drawings to refer to same or like parts. Moreover, references to various elements described herein are made collectively or individually when there may be more than one element of the same type. However, such references are merely exemplary in nature. It may be noted that any reference to elements in the singular is also to be construed to relate to the plural and vice-versa without limiting the scope of the disclosure to the exact number or type of such elements unless set forth explicitly in the appended claims.

**[0012]** FIG. 1 shows a perspective view of a power generating system 100. The power generating system 100 includes a container 102 such as that shown in FIG. 1. The container 102 may be of any type *i.e.,* shape, size, and/or configuration known to persons skilled in the art. As such, a type of container disclosed herein may be exemplary in nature and hence, non-limiting of this disclosure. Any type of container known in the art may be used to implement the embodiments disclosed herein without deviating from the spirit of the present disclosure.

**[0013]** The container 102 defines an engine room 104 therein. The power generating system 100 further includes an engine 106 and a generator 108 disposed within the engine room 104. Moreover, the generator 108 is coupled to the engine 106 so as to be driven by the engine 106 during operation of the power generating system 100. The generator 108 is configured to produce electric power when driven by the engine 106.

**[0014]** The engine 106 disclosed herein may be for *e.g.*, a diesel engine, a gas engine, a dual-fuel engine, or any other type of engine known to one skilled in the art. A type or configuration of the engine disclosed herein is merely exemplary in nature and hence, non-limiting of this disclosure. Any type or configuration of engine known in the art may be used to implement the embodiments disclosed herein without deviating from the spirit of the present disclosure.

**[0015]** Referring to FIG. 2, a schematic view of the power generating system 100 is illustrated. As shown in FIG. 2, the power generating system 100 further includes a cooling system 200 that is disposed within the container 102. The cooling system 200 includes a first cooling circuit 202. The first cooling circuit 202 includes a first heat exchanger 204, and a first cooling conduit 205 disposed in fluid communication with the first heat exchanger 204. The first heat exchanger 204 is configured to receive cooling fluid for e.g., water, oil, and/or coolant fluid of a specific grade. The first cooling conduit 205 is configured to transport the cooling fluid to an intercooler 206 associated with the engine 106.

**[0016]** The cooling system 200 further includes a second cooling circuit 208. The second cooling circuit 208 includes a second heat exchanger 210, and a second cooling conduit 212 disposed in fluid communication with the second heat exchanger 210. The second heat exchanger 210 is configured to receive cooling fluid. The second cooling conduit 212 is configured to transport cooling fluid to a cooling jacket 214 associated with the engine 106.

**[0017]** The cooling system 200 further includes a fan 216 configured to draw air over the first heat exchanger 204, through the engine room 104, and over the second heat exchanger 210. Two fans 216 are shown in the schematic illustration of FIG. 2. Moreover, as shown schematically in FIG. 2, the container 102 defines an inlet opening 218 and an outlet opening 220. The inlet opening 218 may be configured to allow a draft of air to flow towards the first heat exchanger 204 while the outlet opening 220 may be configured to help discharge air from across the second heat exchanger 210 to the atmosphere.

**[0018]** The cooling system 200 further includes a first connecting conduit 222 fluidly connecting the first cooling conduit 205 and the second cooling conduit 212. Additionally, as exemplarily shown in FIG. 2, the cooling system 200 includes a diverter valve 224 disposed in the first connecting conduit 222. The diverter valve 224 is configured to control a flow of cooling fluid from the second cooling conduit 212 to the first cooling conduit 205. The cooling system 200 further includes a controller 226 that is communicably coupled to the diverter valve 224. The controller 226 is configured to regulate the diverter valve 224 to allow flow of cooling fluid from the second cooling conduit 212 to the first cooling conduit 205 based on at least one of: temperature T1 of air in the engine room 104 and ambient air temperature T so as to regulate temperature T1 of air within the engine room 104.

**[0019]** In an embodiment as exemplarily shown in FIG. 2, the cooling system 200 further includes a second connecting conduit 228 fluidly connecting the first cooling conduit 205 with the second cooling conduit 212. A control valve 230 is disposed in the second connecting conduit 228 to control flow of cooling fluid from the first cooling conduit 205 to the second cooling conduit 212. In the illustrated embodiment of FIG. 2, the controller 226 is communicably coupled to the control valve 230. The controller 226 is configured to regulate the control valve 230 so as to allow a flow of cooling fluid from the first cooling conduit 205 to the second cooling conduit 212 based on a regulation of the diverter valve 224.

**[0020]** In the illustrated embodiment of FIG. 2, the first cooling circuit 202 further includes a first pump 232 that is disposed in the first cooling conduit 205. Moreover, as shown in FIG. 2, the first cooling circuit 202 can further include a first bypass conduit 234 fluidly communicating a portion 236 of the first cooling conduit 205 located downstream of the intercooler 206 to a portion 238 of the first cooling conduit 205 located upstream of the intercooler 206. The first bypass conduit 234 and the first cooling conduit 205 therefore form a closed loop circuit with a first bypass valve 240 that is configured to control flow of cooling fluid from the first cooling conduit 205 through the first bypass conduit 234.

**[0021]** As shown in the illustrated embodiment of FIG. 2, the second cooling circuit 208 may, additionally or optionally, include a second pump 242 that is disposed in the second cooling conduit 212. The second cooling circuit 208 may further include a second bypass conduit 244 fluidly communicating a portion 246 of the second cooling conduit 212 located downstream of the cooling jacket 214 to a portion 248 of the second cooling conduit

212 located upstream of the cooling jacket 214. The second bypass conduit 244 and the second cooling conduit 212 therefore form a closed loop circuit with a second bypass valve 250 that is configured to control a flow of cooling fluid from the second cooling conduit 212 through the second bypass conduit 244.

**[0022]** Various embodiments disclosed herein are to be taken in the illustrative and explanatory sense, and should in no way be construed as limiting of the present disclosure. All joinder references (*e.g*., attached, affixed, coupled, engaged, connected, and the like) are only used to aid the reader's understanding of the present disclosure, and may not create limitations, particularly as to the position, orientation, or use of the modules/ devices and/or methods disclosed herein. Such joinder references are to be construed broadly. Moreover, such joinder references can infer that two elements or modules are not directly connected to each other.

**[0023]** Additionally, all numerical terms, such as, but not limited to, "first", "second", "third", or any other ordinary and/or numerical terms, should also be taken only as identifiers, to assist the reader's understanding of the various modules, circuits, elements, embodiments, variations and/ or modifications of the present disclosure, and may not create any limitations, particularly as to the order, or preference, of any conduit, circuit, element, embodiment, variation and/or modification relative to, or over, another conduit, circuit, element, embodiment, variation and/or modification.

**[0024]** It is to be understood that individual features shown or described for one embodiment may be combined with individual features shown or described for another embodiment. The above-described implementation does not in any way limit the scope of the present disclosure. Therefore, it is to be understood although some features are shown or described to illustrate the use of the present disclosure in the context of functional segments, such features may be omitted from the scope of the present disclosure without departing from the spirit of the present disclosure as defined in the appended claims.

## Industrial Applicability

**[0025]** As known to persons skilled in the art, an intercooler 206 is typically configured to cool down heated high-pressure air supplied from a turbocharger while a cooling jacket 214 is configured to extract large amounts of heat from an engine 106 in order to cool down the engine 106. Therefore, it can be assumed that an operating temperature of an intercooler 206 is typically less than an operating temperature of the cooling jacket 214. Accordingly, with reference to the present disclosure, the first cooling circuit 202 (associated with the intercooler 206) may be regarded as a low temperature circuit; while the second cooling circuit 208 (associated with the cooling jacket 214) may be regarded as a high temperature circuit.

**[0026]** During operation of the power generating system 100 disclosed herein, fluid present in the first cooling circuit 202 can travel between the intercooler 206 and the first heat exchanger 204 so as to cool the intercooler 206. Similarly, fluid present in the second cooling circuit 208 can travel between the second heat exchanger 210 and the cooling jacket 214 associated with the engine 106 so as to cool the engine 106. In conditions where an ambient temperature T *i.e.,* temperature of atmospheric air taken from outside of the container 102, or a temperature T1 of air within the engine room 104 is lower than a pre-defined threshold value that is required at the intercooler 206, then a temperature of charge air supplied to the engine 106 would become low. Such low ambient temperature T or low temperature T1 of air within the engine room 104 can therefore, affect an overall performance and power output from the engine 106.

**[0027]** However, with implementation of embodiments disclosed herein, when a condition of low ambient temperature T or T1 occurs, the controller 226 may direct the diverter valve 224 to open thereby allowing some fluid from the second cooling conduit 212 (part of the second cooling circuit 208 *i.e.,* high temperature circuit) to enter the first cooling conduit 205 (part of the first cooling circuit 202 *i.e.,* the low temperature circuit). This allows heat transfer to occur at first cooling circuit 202 *i.e.,* at the first heat exchanger 204 until the temperature T1 of air within the engine room 104 at a charge air inlet of the engine 106 attains a value that is conducive for optimal combustion performance of the charge air-fuel mixture at the engine 106.

**[0028]** Moreover, as atmospheric air enters the inlet opening 218 of the container 102, the air comes in contact with the first heat exchanger 204 before entering the engine room 104. Upon contact with the first heat exchanger 204, the entering air gets heated to an elevated temperature as fluid present in the first heat exchanger 204 (part of first cooling circuit 202) is hotter than the ambient air entering the container 102 or the engine room 104. In this manner, temperature T or T1 of air that is entering the engine room 104 can be increased *i.e*., regulated to an optimal value so as to assist the combustion performance of the engine 106.

**[0029]** The fluid that flows from the second cooling circuit 208 into the first cooling circuit 202 via the first connecting conduit 222 returns back into the second cooling circuit 208 via the second connecting conduit 228, which may be selectively regulated by the control valve 230 depending on relative mass flow rates of the fluid from the first cooling circuit 208 to the second cooling circuit 202 and *vice-versa.* The fluid is portioned from the first cooling circuit 202 after the first heat exchanger 204 and may be interspersed back with the fluid in the second cooling circuit 208 for e.g., after the cooling jacket 214 (as shown in FIG. 2) or after the second heat exchanger 210 (as shown in FIG. 3).

**[0030]** Therefore, one skilled in the art will appreciate that with use of embodiments disclosed herein, the temperature T1 of air within the engine room 104 can be beneficially regulated by using a difference of temperatures of fluids present within the first cooling circuit 202 and the second cooling circuit 208 respectively. It is hereby envisioned that with use of embodiments disclosed herein, manufacturers of power generating systems can also do away with the use of conventional air ducts, baffles, and/or columns in the containers that are known to be tedious and expensive to install and/or operate. Moreover, in some cases, enclosures may typically offer tightly constrained spaces for installation and fitment of components. However, an implementation of embodiments disclosed herein can help manufacturers reclaim valuable space within such tightly constrained enclosures.

**[0031]** In various embodiments of the present disclosure, it should be noted that the temperature T1 of air initially entering the engine room 104 may be substantially equal to the ambient temperature T of air *i.e.,* T1 = T. However, upon implementation of embodiments disclosed herein, the temperature T1 of air within the engine room 104 can become greater than the ambient temperature T of air *i.e.,* T1 > T. Therefore, for purposes of the present disclosure, the temperature T1 of air entering the engine room 104 can be regarded as being substantially equal to the ambient temperature T of air *i.e.,* T1~T initially, and thereafter, with the help of embodiments disclosed herein, become greater than the ambient temperature T of air *i.e.*, T1 > T. The temperature T1 of air within the engine room 104 is increased until the temperature T1 reaches an optimum value corresponding to optimal combustion performance parameters at the engine 106 and/or facilitates maximum heat rejection efficiency to occur at the first and second cooling circuits 202, 208 when the circuits 202, 208 finally reject heat into the air present within the engine room 104.

**[0032]** Moreover, with reference to various embodiments disclosed herein, it should also be noted that the controller 226 is capable of regulating the diverter valve 224 and the control valve 230 in a simultaneous manner or a tandem manner. However, in order to regulate the temperature T1 of air within the engine room 104, the controller 226 may also be configured to perform the regulation of the diverter valve 224 and the control valve 230 independently of each other without deviating from the scope of the present disclosure.

**[0033]** While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.

**Claims**

1. A cooling system (200) for an engine (106) disposed within an engine room (104), the cooling system (200) comprising:

    a first cooling circuit (202) comprising:

        a first heat exchanger (204) configured to receive cooling fluid; and
        a first cooling conduit (205) disposed in fluid communication with the first heat exchanger (204), the first cooling conduit (205) configured to transport the cooling fluid to an intercooler (206) associated with the engine (106);

    a second cooling circuit (208) comprising:

        a second heat exchanger (210) configured to receive cooling fluid; and
        a second cooling conduit (212) disposed in fluid communication with the second heat exchanger (210), the second cooling conduit (212) configured to transport cooling fluid to a cooling jacket (214) associated with the engine (106);

    a fan (216) configured to draw air over the first heat exchanger (204), through the engine room (104), and over the second heat exchanger (210);
    a first connecting conduit (222) fluidly connecting the first cooling conduit (205) and the second cooling conduit (212);
    a diverter valve (224) disposed in the first connecting conduit (222), the diverter valve (224) configured to control flow of cooling fluid from the second cooling conduit (212) to the first cooling conduit (205); and
    a controller (226) communicably coupled to the diverter valve (224), the controller (226) configured to regulate the diverter valve (224) to allow flow of cooling fluid from the second cooling conduit (212) to the first cooling conduit (205) based on at least one of air temperature (T1) in the engine room (104) and ambient air temperature (T) so as to regulate temperature (T1) of air within the engine room (104).

2. The cooling system (200) of claim 1 further comprising a second connecting conduit (228) fluidly connecting the first cooling conduit (205) with the second cooling conduit (212).

3. The cooling system (200) of claim 2 further comprising a control valve (230) disposed in the second connecting conduit (228) and configured to control flow

of cooling fluid from the first cooling conduit (205) to the second cooling conduit (212).

**4.** The cooling system (200) of claim 3, wherein the controller (226) is communicably coupled to the control valve (230), and wherein the controller (226) is further configured to regulate the control valve (230) to allow flow of cooling fluid from the first cooling conduit (205) to the second cooling conduit (212) based on a regulation of the diverter valve (224).

**5.** The cooling system (200) of claim 1, wherein the first cooling circuit (202) further comprises a first pump (232) disposed in the first cooling conduit (205).

**6.** The cooling system (200) of claim 1, wherein the second cooling circuit (208) further comprises a second pump (242) disposed in the second cooling conduit (212).

**7.** The cooling system (200) of claim 1, wherein the first cooling circuit (202) further comprises a first bypass conduit (234) fluidly communicating a portion (236) of the first cooling conduit (205) located downstream of the intercooler (206) to a portion (238) of the first cooling conduit (205) located upstream of the intercooler (206).

**8.** The cooling system (200) of claim 7, wherein the first cooling circuit (202) further comprises a first bypass valve (240) configured to control flow of cooling fluid through the first bypass conduit (234).

**9.** The cooling system (200) of claim 1, wherein the second cooling circuit (208) further comprises a second bypass conduit (244) fluidly communicating a portion (246) of the second cooling conduit (212) located downstream of the cooling jacket (214) to a portion (248) of the second cooling conduit (212) located upstream of the cooling jacket (214).

**10.** The cooling system (200) of claim 9, wherein the second cooling circuit (208) further comprises a second bypass valve (250) configured to control flow of cooling fluid through the second bypass conduit (244).

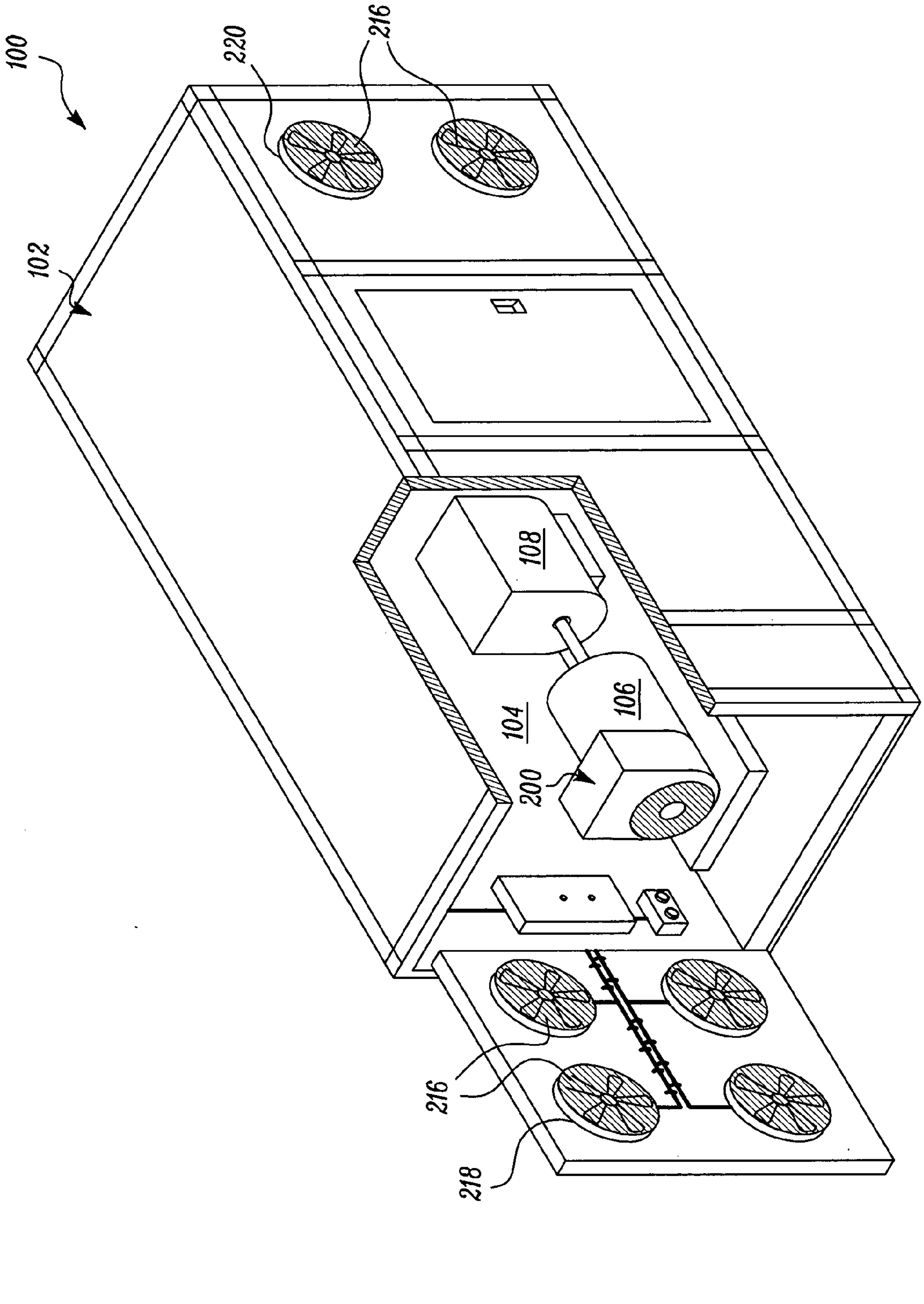


FIG.1

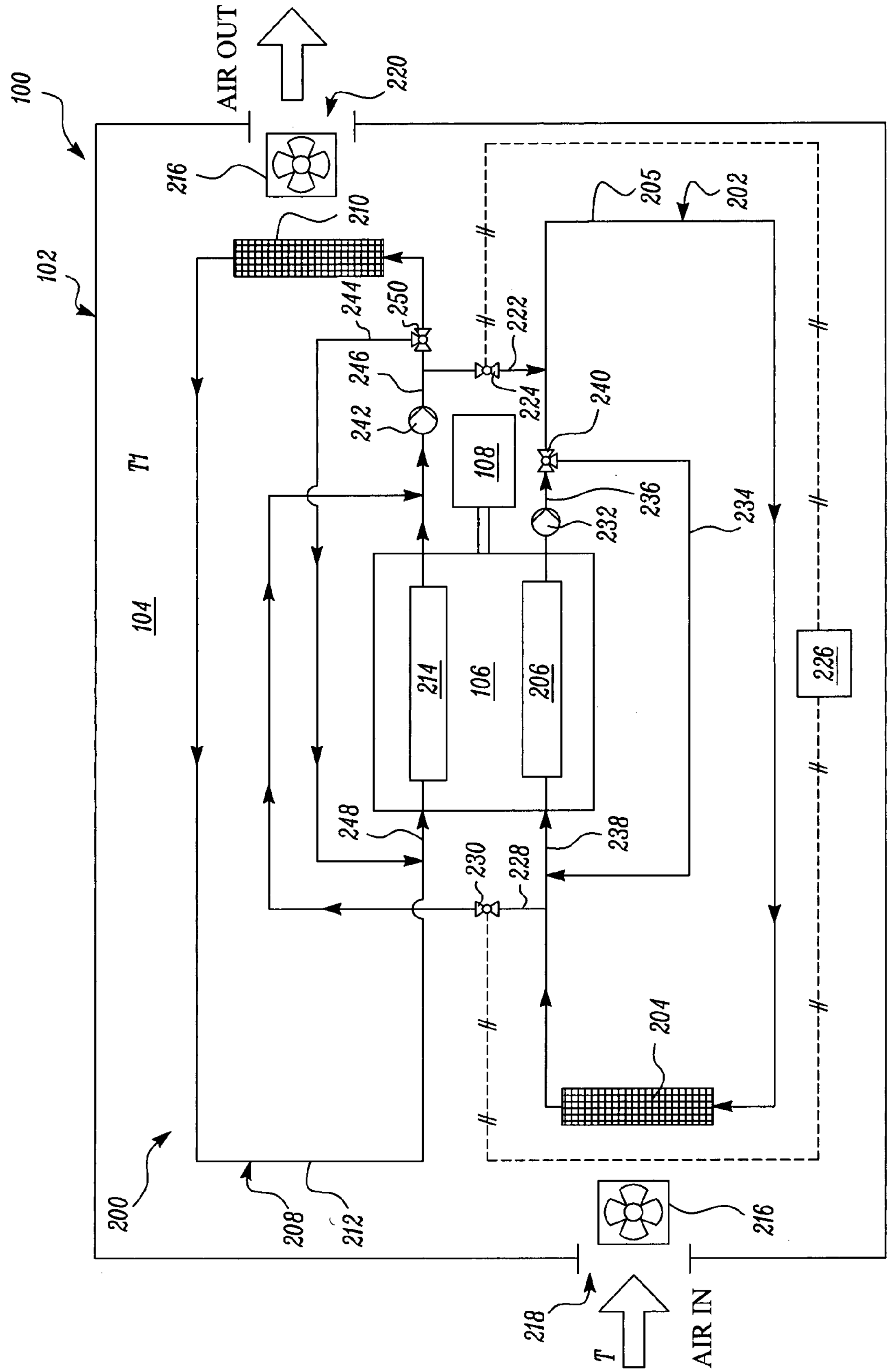
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FIG.2

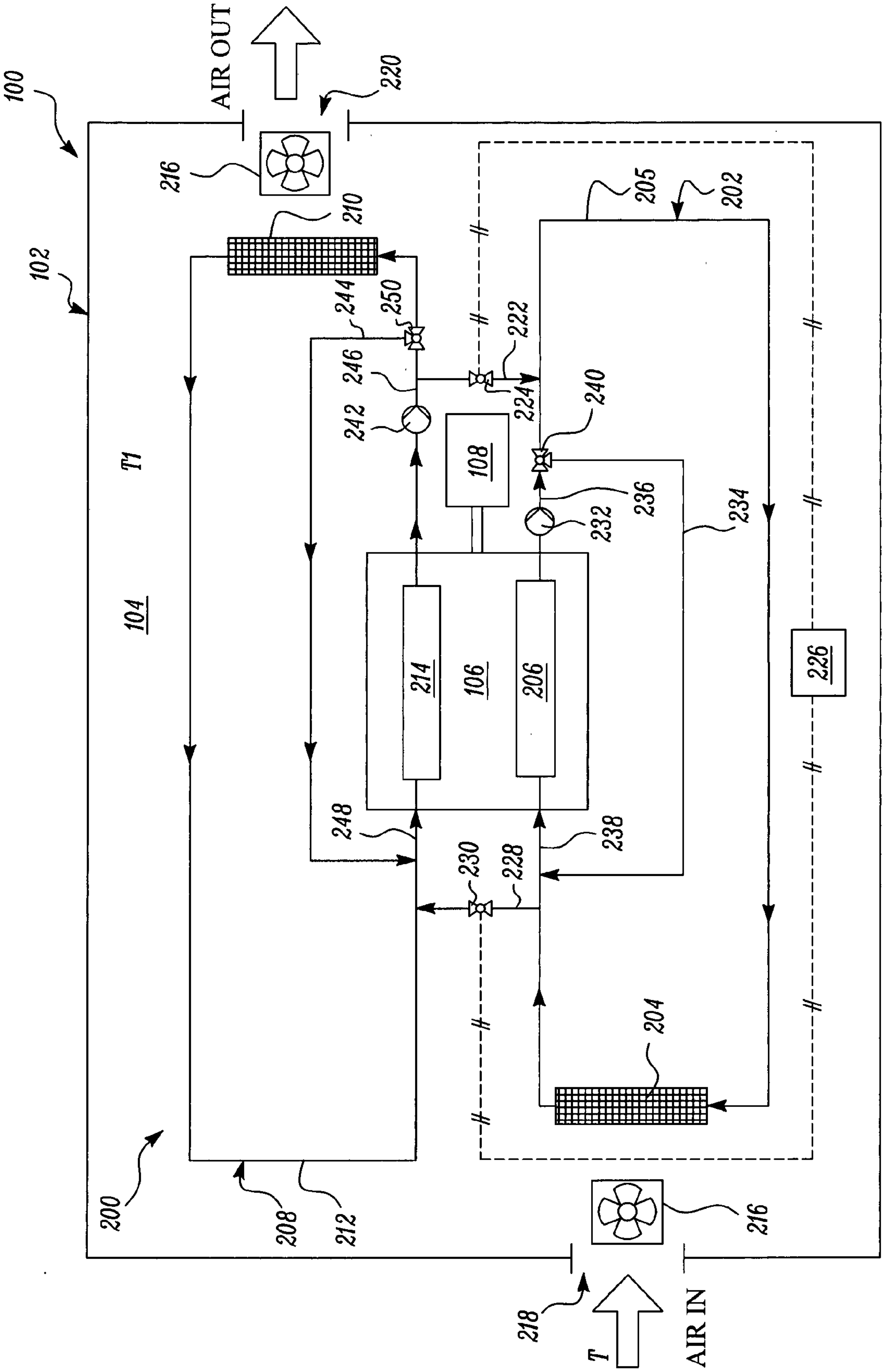
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FIG.3

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# EUROPEAN SEARCH REPORT

Application Number
EP 15 00 2381

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 20 January 2016 | Luta, Dragos |

CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 00 2381

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