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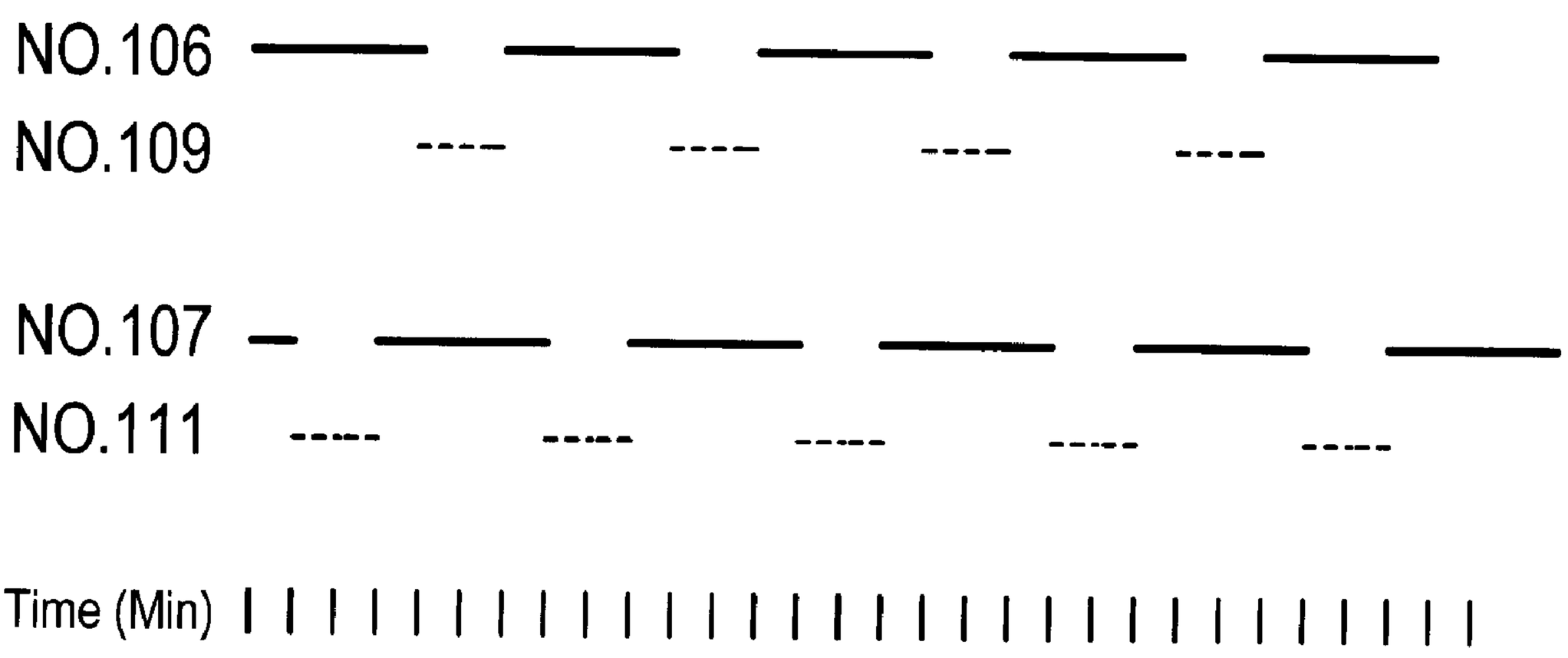
(54) Titre : THERMOPOMPE DE CONDITIONNEMENT D'AIR AVEC COMPRESSEUR SECONDAIRE
(54) Title: AN AIR CONDITIONING HEAT PUMP WITH SECONDARY COMPRESSOR



Heating operation

Defrosting operation

(57) Abrégé/Abstract:
The present invention is the divisional application of an air conditioning heat pump with cross-defrosting system. Said air conditioning heat pump consists of a main-heating-refrigeration-circuit, a defrost-refrigeration-circuit; said main-heating-

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(57) Abrégé(suite)/Abstract(continued):
refrigeration-circuit consists of three sections, which are a refrigerant-compressing section, a refrigerant-condensing section, and a refrigerant-evaporating section; said defrost-refrigeration-circuit consists of three sections, which are a defrost-refrigerant-compressing section, a defrost-refrigerant-condensing section, and a defrost-refrigerant-evaporating section; said refrigerant-evaporating section consists of at least two evaporator units, said two evaporator units will operate in the cross-defrosting mode in the outdoor temperature range of 10 degree to negative 40 degree Celsius; during said cross-defrosting mode, a secondary compressor of the defrost-refrigerant will operate to provide a flow of pressurized refrigerant into a defrost-condenser corresponded to the evaporator unit in defrosting process, while the other evaporator unit will operate the refrigerant evaporation process to maintain the indoor-heating operation of said main-heating-refrigeration-circuit.

AN AIR CONDITIONING HEAT PUMP WITH SECONDARY COMPRESSOR

ABSTRACT OF THE DISCLOSURE

The present invention is the divisional application of an air conditioning heat pump with cross-defrosting system. Said air conditioning heat pump consists of a main-heating-refrigeration-circuit, a defrost-refrigeration-circuit; said main-heating-refrigeration-circuit consists of three sections, which are a refrigerant-compressing section, a refrigerant-condensing section, and a refrigerant-evaporating section; said defrost-refrigeration-circuit consists of three sections, which are a defrost-refrigerant-compressing section, a defrost-refrigerant-condensing section, and a defrost-refrigerant-evaporating section; said refrigerant-evaporating section consists of at least two evaporator units, said two evaporator units will operate in the cross-defrosting mode in the outdoor temperature range of 10 degree to negative 40 degree Celsius; during said cross-defrosting mode, a secondary compressor of the defrost-refrigerant will operate to provide a flow of pressurized refrigerant into a defrost-condenser corresponded to the evaporator unit in defrosting process, while the other evaporator unit will operate the refrigerant evaporation process to maintain the indoor-heating operation of said main-heating-refrigeration-circuit.

SPECIFICATION OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a wide-range air-condition heat pump, more particularly to a wide-range air-condition heat pump capable of uninterrupted operation. The present invention can be applied on residential, agriculture , commercial transportation, and industrial purposes. More particularly, the present invention can be used for air-conditioning, refrigeration.

BACKGROUND OF THE INVENTION

Current available heat pump requires different types of compressors for different range of working environment temperature, therefore, the user may need to install multiple air-conditioning systems such as a combination of a heat pump and a gas heater for different range of working temperature. One for the reason is the low efficiency of the heat pump under low working temperature, another reason is the need for interrupting operation due to defrosting.

The current defrosting methods such as electrical defrost system and reverse-circulation defrost system require the heat pump to stop operation while defrosting. Therefore, it is one objective of the present invention to provide an air-condition heat pump capable of uninterrupted operation during defrosting.

In general, current heat pump has very limited range of working temperatures due to the limitation and the operation efficiency of the compressor; however, in many circumstances, working environment temperature may vary from negative 40 degree Celsius to 10 degree Celsius, therefore it is main objective of the present invention to provide a wide range air-condition heat pump capable of operating under wide range of working environment temperature at high efficiency.

The present invention is a divisional application of an air condition heat pump with cross-defrosting system of Canadian application no.2,526,194

SUMMARY OF THE INVENTION

1. It is a primary object of the present invention to provide a wide range air-condition heat pump capable of operating under various range of temperature.

2. It is a second object of the present invention to provide an air-condition heat pump capable of uninterrupted operation while defrosting.

3. It is yet another object of the present invention to provide an air-condition heat pump capable of defrosting without additional energy and heating equipment.

BREIF DESCRIPTION OF THE DRAWINGS

FIG.1 is illustrative diagram of the present invention with secondary compressor and two defrost condensers.

FIG.2 is an exemplary defrosting procedure of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG.1, an air-condition heat pump with secondary compressor is provided. When the primary heat pump starts operating, compressor **101** pumps refrigerant into condenser **102**. After refrigerant has condensed, refrigerant flows through expansion valve **103** to solenoid valve **104** and solenoid valve **105**. At this time, both solenoid valve **104** and solenoid valve **105** are open. The refrigerant flows through solenoid valve **104** and solenoid valve **105** to evaporator **106** and evaporator **107** respectively. Then refrigerant in evaporator **106** and evaporator **107** return to compressor **101**.

During defrosting process of evaporator **106**, solenoid valve **104** is closed. ,solenoid valve **108** is open to provide passage for refrigerant. Then secondary compressor **114** starts operating and sending heated refrigerant to defrost condenser **109** through solenoid valve **108**. Then the heat from defrost condenser **109** is used to heat up evaporator **106** by heat conducting means such as fan or direct contact. The refrigerant in defrost condenser **109** flows through expansion valve **116**. Then the refrigerant from expansion valve **116** enters heat exchanger **115** to absorb heat from the refrigerant in primary heat pump. Then the refrigerant returns to secondary compressor **114**.

During defrosting process of evaporator **107**, solenoid valve **105** is closed. Solenoid valve **110** is open to provide passage for refrigerant. Then secondary compressor **114** starts operating and sending heated refrigerant to defrost condenser **111** through solenoid valve **110**. Then the heat from defrost condenser **111** is used to heat up evaporator **107** by heat conducting means such as fan or direct contact. The refrigerant in defrost condenser **111** flows through expansion valve **116**. Then the refrigerant from expansion valve **116** enters heat exchanger **115** to absorb heat from the refrigerant in primary heat pump. Then the refrigerant returns to secondary compressor **114**.

FIG.2 is an exemplary working procedure table of the present invention as explained in FIG.1 when defrosting is required. When evaporator **107** requires defrosting, evaporator **107** stops operating, and evaporator **106** continues operating to provide heat energy that defrost condenser **111** required to defrost evaporator **107**. After a preset time has reached or if sensor (not shown) has detected no further defrosting is necessary, defrost condenser **111** stops defrosting and evaporator **107** starts working. When evaporator **106** requires defrosting, evaporator **106** stops operating, and evaporator **107** continues operating to provide heat energy that defrost condenser **109** required to defrost

evaporator **106**. After a preset time has reached or if sensor has detected no further defrosting is necessary, defrost condenser **109** stops defrosting and evaporator **106** starts working. When both of evaporator **106** and evaporator **107** can operate without frosting, both of them can uninterruptedly operate.

Under severe working condition, the working procedure could follow the exemplary working procedure table as in FIG.2. Each of the evaporator operates for approximately 20 minutes and defrosts for 10 minutes. Same concept and working procedure can be applied on all other embodiments of the present invention.

CLAIMS

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1). An air-condition heat pump with secondary compressor comprising:

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a) a main-heating-refrigeration-circuit, and a defrost-refrigeration-circuit; said main-heating-
6 refrigeration-circuit consists of three sections, which are a refrigerant-compressing section, a refrigerant-condensing section, and a refrigerant-evaporating section; said defrost-refrigeration-
8 circuit consists of three sections, which are a defrost-refrigerant-compressing section, a defrost-refrigerant-condensing section, and a defrost-refrigerant-evaporating section;

10

b) said refrigerant-compressing section of said main-heating-refrigeration-circuit comprises at least
12 one main compressor **(101)** for pressurizing the refrigerant in said main-heating-refrigeration-circuit;

14 c) said refrigerant-condensing section of said main-heating-refrigeration-circuit comprises at least one dual-circulation heat exchanger **(115)** and one main condenser **(102)**; said dual-circulation heat
16 exchanger **(115)** consists of two separate refrigerant coils, which are the main-heating-refrigerant-coil and the defrost-refrigerant-coil; the refrigerant of said main-heating-refrigeration-circuit flows
18 through said main-heating-refrigerant coil of said dual-circulation heat exchanger **(115)**, while the refrigerant of said defrost-refrigeration-circuit flows through said defrost-refrigerant-coil of said
20 dual-circulation heat exchanger **(115)**;the heat energy from said main-heating-refrigerant-coil can be transferred to said defrost-refrigerant-coil; said main condenser **(102)** will operate with refrigerant
22 condensation process for indoor-heating;

24 d) said refrigerant-evaporating section of said main-heating-refrigeration-circuit comprises at least two evaporator units, which are a first evaporator **(106)** and a second evaporator **(107)**; said first
26 evaporator and said second evaporator receive the refrigerant from said main condenser **(102)**, and absorb the heat energy from the outdoor air to perform refrigerant-evaporating process; each
28 evaporator unit can perform refrigerant-evaporating process individually; a first evaporator control valve **(104)** is used to control the refrigerant flow of said first evaporator **(106)**; a second evaporator
30 control valve **(105)** is used to control the refrigerant flow of said second evaporator **(107)**;

32 e) said defrost-refrigerant-compressing section of said defrost-refrigeration-circuit comprises at least one secondary compressor **(114)** for pressurizing the refrigerant in said defrost-refrigeration-circuit;

f) said defrost-refrigerant-condensing section of said defrost-refrigeration-circuit comprises at least two defrost condenser units, which are a first defrost condenser **(109)** and a second defrost condenser **(111)**; said first defrost condenser **(109)** and said second defrost condenser **(111)** receive the pressurized refrigerant from said secondary compressor **(114)** and generate heat energy to defrost said first evaporator and said second evaporator respectively; a first defrost control valve **(108)** is used to control the refrigerant flow of said first defrost condenser **(109)**; a second defrost control valve **(110)** is used to control the refrigerant flow of said second defrost condenser **(111)**;

g) said defrost-refrigerant-evaporating section of said defrost-refrigeration-circuit consists of said defrost-refrigerant-coil of said dual-circulation heat exchanger **(115)**; the heat energy from said refrigerant-condensing section of said main-heating-refrigerant-circuit is used to evaporate the refrigerant inside said defrost-refrigerant-coil; the evaporated refrigerant from said defrost-refrigerant-coil of said dual-circulation heat exchanger **(115)** is delivered to said secondary compressor **(114)**;

h) a logic control circuit for determining the operation modes; the operating modes includes full-capacity heating mode and cross-defrosting mode;

wherein:

- when said main-heating-refrigeration-circuit operates in full-capacity heating mode, said secondary compressor **(114)** is disabled, so that said defrost-refrigeration-circuit is not conducting, while said main-heating-refrigeration-circuit is conducting at full capacity with both first evaporator **(106)** and second evaporator **(107)**;
- when said refrigeration circuit is operating in cross-defrosting mode, said first evaporator **(106)** and said second evaporator **(107)** alternately operates with defrosting process and refrigerant-evaporating process;
- during the defrosting process of said first evaporator **(106)**, said first evaporator control valve **(104)** stops the refrigerant flow of said first evaporator **(106)**, said first defrost control valve **(108)** enables the refrigerant flow of said first defrost condenser **(109)**, the frost on said first evaporator **(106)** is melt by the heat transferred from said first defrost condenser **(109)**, said second evaporator **(107)** operates in refrigerant-evaporating process to provide the heat energy for air-conditioning and the defrosting process of said first evaporator **(106)**;

- during the defrosting process of said second evaporator **(107)**, said second evaporator control valve **(105)** stops the refrigerant flow of said second evaporator **(107)**, said second defrost control valve **(110)** enables the refrigerant flow of said second defrost condenser **(111)**, the frost on said second evaporator **(107)** is melt by the heat transferred from said second defrost condenser **(111)**, said first evaporator **(106)** operates in refrigerant-evaporating process to provide the heat energy for air-conditioning and the defrosting process of said second evaporator **(107)**.

2). An air condition heat pump with cross-defrosting system as defined in Claim 1, wherein said heat transferring means is an air-fan;

a) during defrosting process of said first evaporator **(106)**, said first defrost condenser **(109)** will heat up its surrounding air, and the air-fan associated with said first defrost condenser **(109)** will blow the heated air onto said first evaporator **(106)** to melt the frost on the surface of said first evaporator **(106)**;

b) during defrosting process of said second evaporator **(107)**, said second defrost condenser **(111)** will heat up its surrounding air, and the air-fan associated with said second defrost condenser **(111)** will blow the heated air onto said second evaporator **(107)** to melt the frost on the surface of said second evaporator **(107)**.

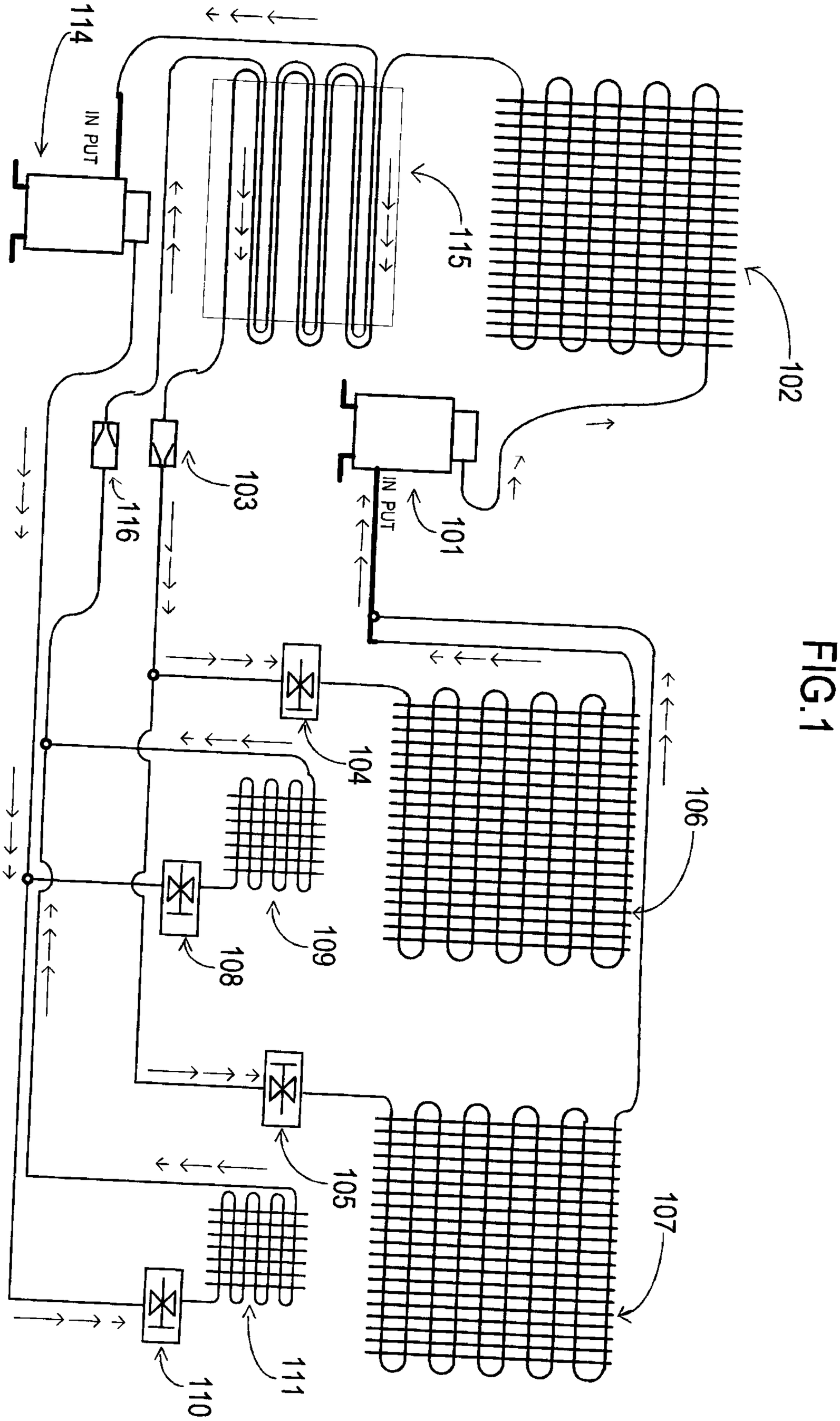
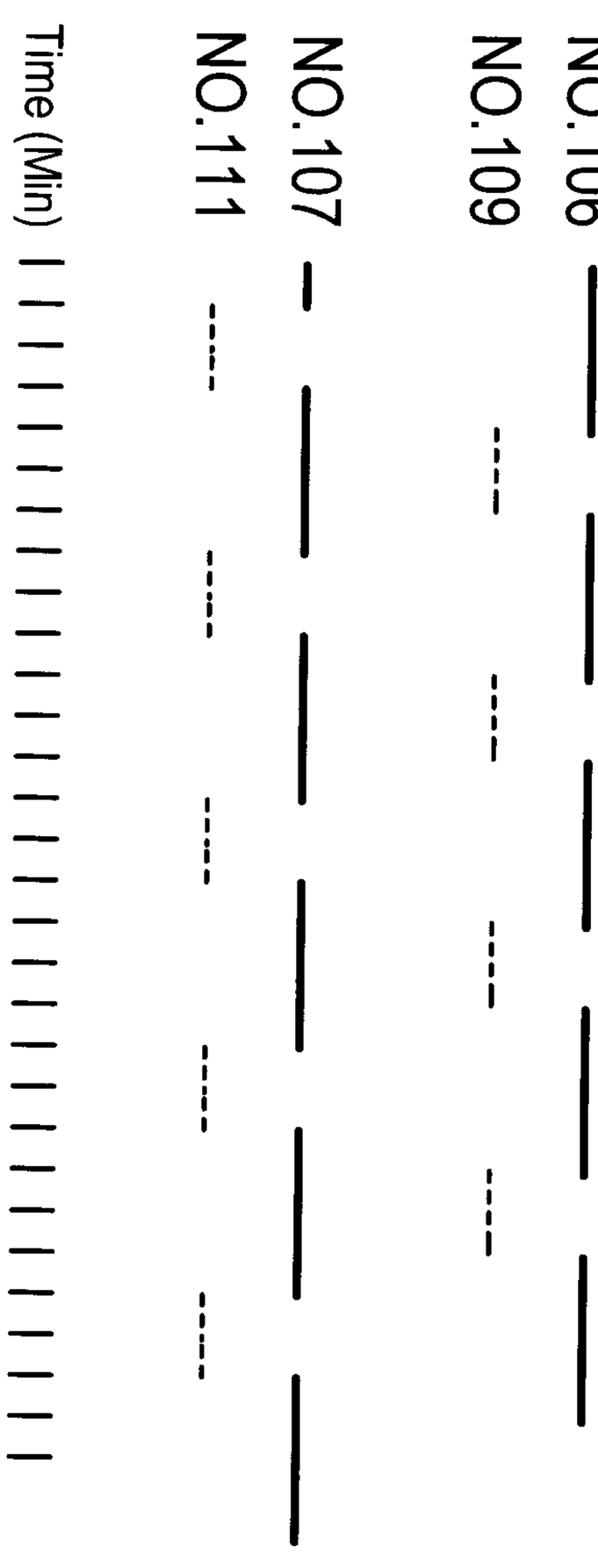

114
IN PUT
115
102
116
103
IN PUT
101
104
106
108
109
105
107
110
111

FIG. 1

FIG.2


NO.106
NO.109
NO.107
NO.111
Time (Min)
Heating operation
Defrosting operation

NO.106 ——— ——— ——— ——— ———

NO.109 ---- ---- ---- ----

NO.107 — ——— ——— ——— ——— ———

NO.111 ---- ---- ---- ---- ----

Time (Min) | | | | | | | | | | | | | | | | | | | | | | | | |

Heating operation ———

Defrosting operation ----