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(71) Applicant: **Daikin Industries, Ltd.**
Osaka 530-8323 (JP)

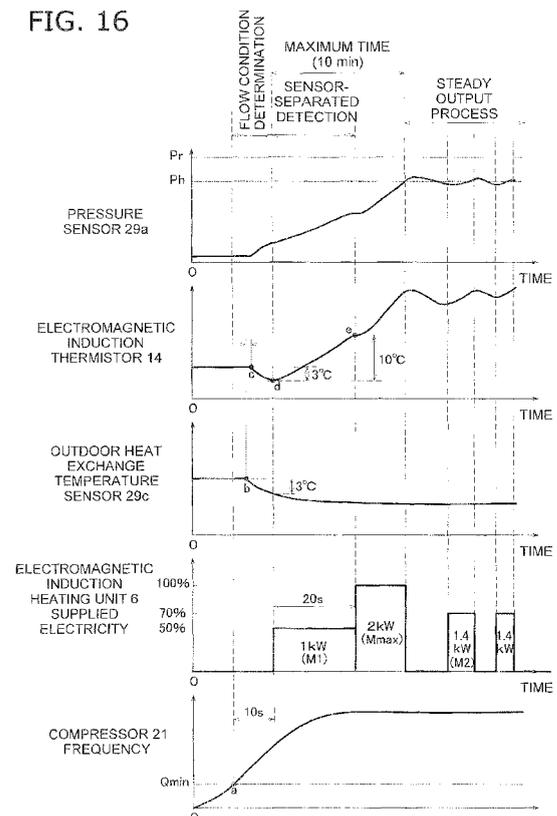
(72) Inventors:
• **KINOSHITA, Hidehiko**
Sakai-shi
Osaka 591-8511 (JP)
• **YAMADA, Tsuyoshi**
Sakai-shi
Osaka 591-8511 (JP)

(74) Representative: **HOFFMANN EITL**
Patent- und Rechtsanwälte
Arabellastraße 4
81925 München (DE)

(54) **AIR CONDITIONER**

(57) To provide an air conditioning apparatus capable of quickly ensuring performance during startup and keeping post-startup overshooting to a minimum. An air conditioning apparatus (1) uses a refrigeration cycle which has a compressor (21) and a refrigerant tube (F) whose external periphery is composed of a magnetic tube (F2), the air conditioning apparatus (1) comprising a coil (68), a pressure sensor (29a), and a control part (11). The coil (68) generates a magnetic field for induction-heating the magnetic tube (F2). The pressure sensor (29a) detects refrigerant pressure in a high-pressure side of at least part of the refrigeration cycle. When the refrigeration cycle is performing an air-warming operation, the control part (11) initiates a state in which magnetic field generation by the coil (68) is at a maximum supplied electricity (Mmax) from the time the frequency of the compressor (21) is equal to or greater than a predetermined minimum frequency (Qmin), and the control part (11) performs this state until the pressure detected by the pressure sensor (29a) reaches a target high pressure (Ph). Onward from the time the target high pressure is reached, operation is performed under the restriction that a steady supplied electricity (M2) lower than the maximum supplied electricity (Mmax) is the upper output limit.

FIG. 16



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Description**TECHNICAL FIELD**

[0001] The present invention relates to an air conditioning apparatus.

BACKGROUND ART

[0002] Among air conditioning apparatuses capable of an air-warming operation, there have been those proposed which include a refrigerant heating function intended to increase air-warming capability.

[0003] For example, in the air conditioning apparatus disclosed in Patent Literature 1 shown below (Japanese Laid-open Patent Application Publication No. 2000-97510), the air-warming capability is increased due to the refrigerant flowing into a refrigerant heating device and being heated by a gas burner.

[0004] In the air conditioning apparatus disclosed in Patent Literature 1 (Japanese Laid-open Patent Application Publication No. 2000-97510), a technique is proposed in which the combustion rate of the gas burner is adjusted based on the detection value of a thermistor, in order to prevent the refrigerant temperature from rising too high and protective action from being taken too frequently during the air-warming operation.

SUMMARY OF THE INVENTION

<Technical Problem>

[0005] In the technique disclosed in the aforementioned Patent Literature 1, only the frequency of the protective action is suppressed, and no control is proposed to address the difference in loads between during startup and after startup.

[0006] For example, in some cases, there is a large difference between the surrounding temperature and the set temperature at the startup of the air conditioning apparatus and the set temperature is desired to be quickly reached, while there is also a difference in loads between during startup and after startup, in which case there is a risk of overshooting in which the target value is far exceeded.

[0007] When the system for heating the refrigerant is an electromagnetic induction heating system, the aforementioned overshooting in particular is likely to be a problem because of the high heating rate.

[0008] The present invention was devised in view of the circumstances described above, and an object thereof is to provide an air conditioning apparatus capable of quickly ensuring performance at startup and keeping post-startup overshooting to a minimum.

<Solution to Problem>

[0009] An air conditioning apparatus according to a

first aspect is an air conditioning apparatus which uses a refrigeration cycle having a compression mechanism for circulating refrigerant, a refrigeration tube that makes thermal contact with the refrigerant flowing through the refrigerant tube and/or a heat-generating member that makes thermal contact with the refrigerant flowing through the refrigerant tube; the air conditioning apparatus comprising a magnetic field generator, a refrigerant state quantity detector, and a control part. The magnetic field generator generates a magnetic field for induction-heating a portion to be heated by induction heating. The refrigerant state quantity detector detects a state quantity relating to refrigerant flowing through a predetermined state quantity detected portion which is at least part of the refrigeration cycle. The state quantity in this instance includes at least one of, e.g., the temperature and the pressure. The control part performs startup magnetic field generation control and post-startup magnetic field generation control. In startup magnetic field generation control, during startup involving performing an air-warming operation in the refrigeration cycle, the control part initiates a state in which the output of the magnetic field generator is a predetermined maximum output from the time the compression mechanism has assumed a drive state, and ends this state when the state quantity detected by the refrigerant state quantity detector reaches a first predetermined target state quantity. In post-startup magnetic field generation control, after the startup magnetic field generation control has ended, the control part performs a state of applying a restriction that a first magnetic field limit reference value lower than the predetermined maximum output be an upper limit of the output of the magnetic field generator. The phase "when the refrigeration cycle is performing the air-warming operation" herein does not include operations such as a defrosting operation. The heating by the electromagnetic induction heating unit herein includes at least, e.g., electromagnetic induction heating of a heat-generating member in thermal contact with the refrigerant tube, electromagnetic induction heating of a heat-generating member in thermal contact with the refrigerant flowing through the refrigerant tube, and electromagnetic induction heating of a heat-generating member constituting at least part of the refrigerant tube.

[0010] In the air conditioning apparatus according to the aspect described above, by performing startup magnetic field generation control so that the output of the magnetic field generator during startup reaches a maximum, the time needed for warm air to be provided to the user after initiating the air-warming operation startup can be shortened. It is also possible to minimize control overshooting caused by the output of the magnetic field generator being raised too high during post-startup magnetic field generation control. It is thereby possible for control overshooting to be minimized, while the supply of warm air to the user is quickly started.

[0011] An air conditioning apparatus according to a second aspect is the air conditioning apparatus of the

first aspect, wherein the portion to be heated by induction heating includes a magnetic material.

[0012] In the air conditioning apparatus according to the aspect described above, since the magnetic field generator generates a magnetic field using the portion containing the magnetic material as a target, heat generation by electromagnetic induction can be performed efficiently.

[0013] An air conditioning apparatus according to a third aspect is the air conditioning apparatus according to the first or second aspect, wherein the predetermined state quantity detection portion is a portion in which a magnetic field is generated by the magnetic field generator.

[0014] In the air conditioning apparatus according to the aspect described above, since rapid temperature changes caused by electromagnetic induction heating can be perceived, control responsiveness can be improved.

[0015] An air conditioning apparatus according to a fourth aspect is the air conditioning apparatus according to any of the first through third aspects, wherein the state quantity detected by the refrigerant state quantity detector includes at least one of either the temperature or pressure relating to the refrigerant flowing through the predetermined state quantity detection portion.

[0016] In the air conditioning apparatus according to the aspect described above, various sensors used in order to control the state of the refrigeration cycle can be used to perform the detections herein.

[0017] An air conditioning apparatus according to a fifth aspect is the air conditioning apparatus according to any of the first through fourth aspects, wherein the refrigerant state quantity detector is a temperature detector for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion. In the post-startup magnetic field generation control, the control part performs post-startup magnetic field generation PI control for performing PI control of the value or frequency relating to the output of the magnetic field generator so that the temperature detected by the temperature detector is maintained at a target maintenance temperature. The target maintenance temperature herein may be the same temperature as the first predetermined target temperature.

[0018] In the air conditioning apparatus according to the aspect described above, temperature changes caused by electromagnetic induction heating are commonly more sudden than temperature changes resulting from changes in the state of the refrigerant passing through the predetermined state quantity detection portion. Even when the temperature suddenly changes due to electromagnetic induction heating in this manner, the temperature detected by the temperature detector can be stabilized at the second predetermined target temperature by PI-controlling the size of the magnetic field generated by the magnetic field generator and/or the frequency with which the magnetic field generator gener-

ates a magnetic field.

[0019] An air conditioning apparatus according to a sixth aspect is the air conditioning apparatus according to any of the first through fifth aspects, wherein the refrigerant state quantity detector is a temperature detector for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion. The control part executes the startup magnetic field generation control after a magnetic field level increase condition has been fulfilled. This magnetic field level increase condition is that there be a change in the detected temperature of the temperature detector or that the temperature detector detect a temperature change, due to a magnetic field level change process being performed for raising or lowering the level of the magnetic field generated by the magnetic field generator within a range below the predetermined maximum output.

[0020] When the temperature detector is unable to detect a temperature change even though electromagnetic induction heating has been performed, there is a risk of the state of attachment of the temperature detector becoming unstable or coming apart.

[0021] As a countermeasure to this, in the air conditioning apparatus according to the aspect described above, when the state of attachment of the temperature detector becomes unstable or comes apart in this manner, the temperature change is insufficient and the magnetic field level increase condition is not fulfilled. Therefore, the control part limits magnetic field generation to a level lower than the predetermined maximum output and does not perform magnetic field generation at a high level, and the reliability of the device can therefore be improved. When the magnetic field level increase condition has been fulfilled, it is possible to perceive that the portion to be heated by induction heating is generating heat due to the generation of a magnetic field by the magnetic field generator, the installed state of the temperature detector is satisfactory, and the temperature of the heating target portion of induction heating is successfully and accurately confirmed. It is thereby possible to suppress damage to the devices caused by abnormal temperature increases from electromagnetic induction heating, and to improve the reliability of the devices.

[0022] An air conditioning apparatus according to a seventh aspect is the air conditioning apparatus of the sixth aspect, wherein a maximum magnetic field level outputted in the magnetic field level change process is a value less than the first magnetic field limit reference value.

[0023] In the air conditioning apparatus according to the aspect described above, it is possible to prevent electromagnetic induction heating caused by a magnetic field of a size approximately equivalent to the first magnetic field limit reference value in stages in which the state of attachment of the temperature detector has not yet been confirmed to be satisfactory.

[0024] An air conditioning apparatus according to an eighth aspect is the air conditioning apparatus according

to any of the first through seventh aspects, wherein the refrigerant state quantity detector is a temperature detector for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion. The control part executes determining of the magnetic field level increase condition after a flow condition has been fulfilled. The flow condition is that there be a change in the detected temperature of the temperature detector between a first compression mechanism state and a second compression mechanism state, when the compression mechanism is caused to realize two compression mechanism states of different compression mechanism outputs, one being the first compression mechanism state and the other being the second compression mechanism state having a higher output level than the first compression mechanism state. A state in which the compression mechanism is stopped is included in the first compression mechanism state.

[0025] In the air conditioning apparatus according to the aspect described above, there is a risk of the flow of refrigerant being insufficient when the flow condition is not fulfilled, and there is a risk of causing an abnormal temperature increase even with a magnetic field generator output at the level for determining the magnetic field level increase condition. As a countermeasure to this, in the air conditioning apparatus according to the aspect described above, since the magnetic field level increase condition can be determined while ensuring a flow of refrigerant passing through the predetermined state quantity detection portion, a determination of the magnetic field level increase condition can be performed while maintaining the reliability of the devices.

[0026] An air conditioning apparatus according to a ninth aspect is the air conditioning apparatus according to any of the first through eighth aspects, wherein the refrigerant state quantity detector is a temperature detector for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion. The control part performs a defrosting operation output control for controlling the output of the magnetic field generator on the basis of the detected temperature of the temperature detector, the upper limit of the output of the magnetic field generator being the predetermined maximum output, when the refrigeration cycle executes a defrosting operation different from the air-warming operation after the post-startup magnetic field generation control has been initiated.

[0027] In the air conditioning apparatus according to the aspect described above, since the output of the magnetic field generator can be increased similarly with respect to the startup magnetic field generation control, the defrosting process can be quickened.

[0028] An air conditioning apparatus according to a tenth aspect is the air conditioning apparatus of the ninth aspect, wherein during the defrosting operation output control, the control part performs defrosting PI control in which PI control is performed so that the temperature detected by the temperature detector is maintained at a

second predetermined target temperature that is lower than the first predetermined target temperature.

[0029] In the air conditioning apparatus according to the aspect described above, since abnormal increases in temperature do not occur readily during the defrosting operation compared to when startup magnetic field generation control is performed, overshooting during the defrosting operation can be reduced by using the detected temperature of the temperature detector as the second predetermined target temperature below the first predetermined target temperature of the startup magnetic field generation control.

[0030] An air conditioning apparatus according to an eleventh aspect is the air conditioning apparatus of any of the first through tenth aspects, wherein the refrigerant state quantity detector is a temperature detector for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion. The air conditioning apparatus further comprises an elastic member for applying elastic force to the temperature detector. The temperature detector is pressed against the predetermined state quantity detection portion by the elastic force of the elastic member.

[0031] In the air conditioning apparatus according to the aspect described above, it is common for sudden temperature increases to occur more readily when electromagnetic induction heating is performed than temperature increases caused by changes in the refrigerant circulating condition in the refrigeration cycle.

[0032] As a countermeasure to this, in the air conditioning apparatus according to the aspect described above, since the temperature detector is kept pressed against the predetermined state quantity detecting portion by the elastic member, the responsiveness of the temperature detector can be improved. Thereby, control with improved responsiveness can be performed.

<Advantageous Effects of Invention>

[0033] In the air conditioning apparatus according to the first aspect, control overshooting can be kept to a minimum while the supply of warm air to the user is quickly initiated.

[0034] In the air conditioning apparatus according to the second aspect, heat generation by electromagnetic induction can be performed efficiently.

[0035] In the air conditioning apparatus according to the third aspect, control responsiveness can be improved.

[0036] In the air conditioning apparatus according to the fourth aspect, various sensors used in order to control the state of the refrigeration cycle can be used to perform the detections herein.

[0037] In the air conditioning apparatus according to the fifth aspect, the temperature detected by the temperature detector can be stabilized at the second predetermined target temperature.

[0038] In the air conditioning apparatus according to

the sixth aspect, it is possible to suppress damage to the devices caused by abnormal temperature increases from electromagnetic induction heating, and the reliability of the devices can be improved.

[0039] In the air conditioning apparatus according to the seventh aspect, it is possible to prevent electromagnetic induction heating caused by a magnetic field at approximately the size of the first magnetic field limit reference value in stages in which the state of attachment of the temperature detector has not yet been confirmed to be satisfactory.

[0040] In the air conditioning apparatus according to the eighth aspect, a determination of the magnetic field level increase condition can be performed while the reliability of the devices is preserved.

[0041] In the air conditioning apparatus according to the ninth aspect, the defrosting process can be quickened.

[0042] In the air conditioning apparatus according to the tenth aspect, overshooting during the defrosting operation can be reduced.

[0043] In the air conditioning apparatus according to the eleventh aspect, control with improved responsiveness can be performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044]

FIG 1 is a refrigerant circuit diagram of an air conditioning apparatus according to an embodiment of the present invention.

FIG. 2 is an external perspective view including the front side of an outdoor unit.

FIG. 3 is a perspective view of the internal arrangement and configuration of the outdoor unit.

FIG. 4 is an external perspective view including the rear side of the internal arrangement and configuration of the outdoor unit.

FIG. 5 is an overall front perspective view showing the internal structure of a machine chamber of the outdoor unit.

FIG. 6 is a perspective view showing the internal structure of the machine chamber of the outdoor unit.

FIG. 7 is a perspective view of a bottom plate and an outdoor heat exchanger of the outdoor unit.

FIG. 8 is a plan view in which an air-blowing mechanism of the outdoor unit has been removed.

FIG. 9 is a plan view showing the arrangement relationship between the bottom plate of the outdoor unit and the hot gas bypass circuit.

FIG. 10 is an external perspective view of an electromagnetic induction heating unit.

FIG. 11 is an external perspective view showing a state in which a shielding cover has been removed from the electromagnetic induction heating unit.

FIG. 12 is an external perspective view of an electromagnetic induction thermistor.

FIG. 13 is an external perspective view of a fuse.

FIG. 14 is a schematic cross-sectional view showing the state of attachment of the electromagnetic induction thermistor and the fuse.

FIG. 15 is a cross-sectional structural view of the electromagnetic induction heating unit.

FIG. 16 is a view showing a time chart of electromagnetic induction heating control.

FIG. 17 is a view showing a flowchart of a flow condition judgment process.

FIG. 18 is a view showing a flowchart of a sensor-separation detection process.

FIG. 19 is a view showing a flowchart of a rapid pressure-increasing process.

FIG. 20 is a view showing a flowchart of a steady output process.

FIG. 21 is a view showing a flowchart of a defrosting process.

FIG. 22 is a view showing the attached position of an electromagnetic induction thermistor according to another embodiment (A).

FIG. 23 is an illustrative view of a refrigerant tube of another embodiment (F).

FIG. 24 is an illustrative view of a refrigerant tube of another embodiment (G).

FIG. 25 is a view showing an example of arranging coils and a refrigerant tube of another embodiment (H).

FIG. 26 is a view showing an example of arranging bobbin covers of another embodiment (H).

FIG. 27 is a view showing an example of arranging ferrite cases of another embodiment (H).

DESCRIPTION OF EMBODIMENTS

[0045] An air conditioning apparatus 1 comprising an electromagnetic induction heating unit 6 in one embodiment of the present invention is described in an example hereinbelow with reference to the drawings.

<1-1> Air Conditioning Apparatus 1

[0046] FIG. 1 shows a refrigerant circuit diagram showing a refrigerant circuit 10 of the air conditioning apparatus 1.

[0047] In the air conditioning apparatus 1, an outdoor unit 2 as a heat source-side apparatus and an indoor unit 4 as a usage-side apparatus are connected by refrigerant tubes, and air conditioning is performed in the space where the usage-side apparatus is located; the air conditioning apparatus 1 comprising a compressor 21, a four-way switching valve 22, an outdoor heat exchanger 23, an outdoor electric expansion valve 24, an accumulator 25, outdoor fans 26, an indoor heat exchanger 41, an indoor fan 42, a hot gas bypass valve 27, a capillary tube 28, an electromagnetic induction heating unit 6, and other components.

[0048] The compressor 21, the four-way switching

valve 22, the outdoor heat exchanger 23, the outdoor electric expansion valve 24, the accumulator 25, the outdoor fans 26, the hot gas bypass valve 27, the capillary tube 28, and the electromagnetic induction heating unit 6 are housed within the outdoor unit 2. The indoor heat exchanger 41 and the indoor fan 42 are housed within the indoor unit 4.

[0049] The refrigerant circuit 10 has a discharge tube A, an indoor-side gas tube B, an indoor-side liquid tube C, an outdoor-side liquid tube D, an outdoor-side gas tube E, an accumulation tube F, an intake tube G, a hot gas bypass circuit H, a branched tube K, and a converging tube J. Large quantities of gas-state refrigerant pass through the indoor-side gas tube B and the outdoor-side gas tube E, but the refrigerant passing through is not limited to a gas refrigerant. Large quantities of liquid-state refrigerant pass through the indoor-side liquid tube C and the outdoor-side liquid tube D, but the refrigerant passing through is not limited to a liquid refrigerant.

[0050] The discharge tube A is connected with the compressor 21 and the four-way switching valve 22.

[0051] The indoor-side gas tube B connects the four-way switching valve 22 and the indoor heat exchanger 41. A pressure sensor 29a for sensing the pressure of the refrigerant passing through is provided at some point along the indoor-side gas tube B.

[0052] The indoor-side liquid tube C connects the indoor heat exchanger 41 and the outdoor electric expansion valve 24.

[0053] The outdoor-side liquid tube D connects the outdoor electric expansion valve 24 and the outdoor heat exchanger 23.

[0054] The outdoor-side gas tube E connects the outdoor heat exchanger 23 and the four-way switching valve 22.

[0055] The accumulation tube F connects the four-way switching valve 22 and the accumulator 25, and extends in a vertical direction when the outdoor unit 2 has been installed. The electromagnetic induction heating unit 6 is attached to a part of the accumulation tube F. A heat-generating portion of the accumulation tube F, whose periphery is covered at least by a coil 68 described hereinafter, is composed of a copper tube F1 through which refrigerant flows and a magnetic tube F2 provided so as to cover the periphery of the copper tube F1 (see FIG. 15). This magnetic tube F2 is composed of SUS (stainless used steel) 430. This SUS 430 is a ferromagnetic material, which creates eddy currents when placed in a magnetic field and which generates heat by Joule heat created by its own electrical resistance. Aside from the magnetic tube F2, the tubes constituting the refrigerant circuit 10 are composed of copper tubes, the same material as the copper tube F1. The material of the tubes covering the peripheries of these copper tubes is not limited to SUS 430; it can be, for example, iron, copper, aluminum, chrome, nickel, other conductors, and alloys containing at least two or more metals selected from these listed. Possible examples of the magnetic material

include ferrite, martensite, or a combination thereof, but it is preferable to use a ferromagnetic substance which has a comparatively high electrical resistance and which has a higher Curie temperature than its service temperature range. The accumulation tube F here requires more electricity, but may not comprise a magnetic substance and a material containing a magnetic substance, or may include a material that will be the target of induction heating. The magnetic material may constitute the entire accumulation tube F, it may be formed only in the inside surface of the accumulation tube F, or it may be present due to being included in the material constituting the accumulation tube F, for example. By performing electromagnetic induction heating in this manner, the accumulation tube F can be heated by electromagnetic induction, and the refrigerant drawn into the compressor 21 via the accumulator 25 can be warmed. The warming capability of the air conditioning apparatus 1 can thereby be improved. Even in cases in which the compressor 21 is not sufficiently warmed at the startup of the air-warming operation, for example, the lack of capability at startup can be compensated for by the quick heating by the electromagnetic induction heating unit 6. Furthermore, when the four-way switching valve 22 is switched to the air-cooling operation state and a defrosting operation is performed for removing frost deposited on the outdoor heat exchanger 23 or other components, the compressor 21 can quickly compress the warmed refrigerant due to the electromagnetic induction heating unit 6 quickly heating the accumulation tube F. Therefore, the temperature of the hot gas discharged from the compressor 21 can be quickly increased. The time required to thaw the frost through the defrosting operation can thereby be shortened. Thereby, even when the defrosting operation must be performed at the right time during the air-warming operation, a return to the air-warming operation can be made as quickly as possible, and user comfort can be improved.

[0056] The intake tube G connects the accumulator 25 and the intake side of the compressor 21.

[0057] The hot gas bypass circuit H connects a branching point A1 provided at some point along the discharge tube A and a branching point D1 provided at some point along the outdoor-side liquid tube D. Disposed at some point in the hot gas bypass circuit H is the hot gas bypass valve 27, which can switch between a state of permitting the passage of refrigerant and a state of not permitting the passage of refrigerant. Between the hot gas bypass valve 27 and the branching point D1, the hot gas bypass circuit H is provided with a capillary tube 28 for lowering the pressure of refrigerant passing through. This capillary tube 28 makes it possible to approach the pressure that follows the refrigerant pressure decrease by the outdoor electric expansion valve 24 during the air-warming operation, and therefore makes it possible to suppress the rise in refrigerant pressure in the outdoor-side liquid tube D caused by the supply of hot gas through the hot gas bypass circuit H to the outdoor-side liquid tube D.

[0058] The branched tube K, which constitutes part of the outdoor heat exchanger 23, consists of a refrigerant tube extending from a gas-side inlet/outlet 23e of the outdoor heat exchanger 23 and branching into a plurality of tubes at a branching/converging point 23k described hereinafter, in order to increase the effective surface area for heat exchange. The branched tube K has a first branched tube K1, a second branched tube K2, and a third branched tube K3 which extend independently from the branching/converging point 23k to a converging/branching point 23j, and these branching tubes K1, K2, K3 converge at the converging/branching point 23j. Seen from the side with the converging tube J, the branched tube K branches at and extends from the converging/branching point 23j.

[0059] The converging tube J, which constitutes a part of the outdoor heat exchanger 23, is a tube extending from the converging/branching point 23j to a liquid-side inlet/outlet 23d of the outdoor heat exchanger 23. The converging tube J is capable of equalizing the subcooling degree of the refrigerant flowing out from the outdoor heat exchanger 23 during the air-cooling operation, and is also capable of thawing ice deposited in the vicinity of the lower end of the outdoor heat exchanger 23 during the air-warming operation. The converging tube J has a cross-sectional area approximately three times each of those of the branching tubes K1, K2, K3, and the amount of refrigerant passing through is approximately three times greater than in each of the branching tubes K1, K2, K3.

[0060] The four-way switching valve 22 is capable of switching between an air-cooling operation cycle and an air-warming operation cycle. In FIG. 1, the connection state during the air-warming operation is shown by solid lines, and the connection state during the air-cooling operation is shown by dotted lines. During the air-warming operation, the indoor heat exchanger 41 functions as a cooler of refrigerant and the outdoor heat exchanger 23 functions as a heater of refrigerant. During the air-cooling operation, the outdoor heat exchanger 23 functions as a cooler of refrigerant and the indoor heat exchanger 41 functions as a heater of refrigerant.

[0061] The outdoor heat exchanger 23 has the gas-side inlet/outlet 23e, the liquid-side inlet/outlet 23d, the branching/converging point 23k, the converging/branching point 23j, the branched tube K, the converging tube J, and heat exchange fins 23z. The gas-side inlet/outlet 23e is positioned in the end of the outdoor heat exchanger 23 next to the outdoor-side gas tube E, and is connected to the outdoor-side gas tube E. The liquid-side inlet/outlet 23d is positioned in the end of the outdoor heat exchanger 23 next to the outdoor-side liquid tube D, and is connected to the outdoor-side liquid tube D. The branching/converging point 23k is where the tube extending from the gas-side inlet/outlet 23e branches, and the refrigerant can branch or converge depending on the direction in which the refrigerant is flowing. The branched tube K extends as a plurality of tubes from each of the branched

portions in the branching/converging point 23k. The converging/branching point 23j is where the branched tube K converges, and the refrigerant can converge or branch depending on the direction in which the refrigerant is flowing. The converging tube J extends from the converging/branching point 23j to the liquid-side inlet/outlet 23d. The heat exchange fins 23z are composed of a plurality of plate-shaped aluminum fins aligned in their plate-thickness direction and arranged at predetermined intervals. The branched tube K and the converging tube J both pass through the heat exchange fins 23z. Specifically, the branched tube K and the converging tube J are arranged so as to penetrate in the plate-thickness direction through different parts of the same heat exchange fins 23z. Upwind side of the outdoor fans 26 in the direction of air flow, the outdoor heat exchanger 23 is provided with an outdoor air temperature sensor 29b for sensing the temperature of the outdoor air. The outdoor heat exchanger 23 is also provided with an outdoor heat exchange temperature sensor 29c for sensing the temperature of the refrigerant flowing through the branched tube air conditioning apparatus.

[0062] An indoor temperature sensor 43 for sensing the indoor temperature is provided inside the indoor unit 4. The indoor heat exchanger 41 is also provided with an indoor heat exchange temperature sensor 44 for sensing the refrigerant temperature of the side next to the indoor-side liquid tube C where the outdoor electric expansion valve 24 is connected.

[0063] An outdoor control part 12 for controlling the devices disposed in the outdoor unit 2 and an indoor control part 13 for controlling the devices disposed in the indoor unit 4 are connected by a communication line 11a, thereby constituting a control part 11. This control part 11 performs various controls on the air conditioning apparatus 1.

[0064] The outdoor control part 12 is also provided with a timer 95 for counting the elapsed time when the various controls are performed.

[0065] A controller 90 for receiving a setting input from the user is connected to the control part 11.

<1-2> Outdoor Unit 2

[0066] FIG. 2 shows an external perspective view of the front side of the outdoor unit 2. FIG. 3 shows a perspective view depicting the positional relationship between the outdoor heat exchanger 23 and the outdoor fans 26. FIG. 4 shows a perspective view of the rear side of the outdoor heat exchanger 23.

[0067] The outside surfaces of the outdoor unit 2 are configured from a substantially rectangular parallelepiped outdoor unit casing, which is configured from a ceiling plate 2a, a bottom plate 2b, a front panel 2c, a left side panel 2d, a right side panel 2f, and a rear side panel 2e.

[0068] The outdoor unit 2 is sectioned via a partitioning plate 2H into an air-blower chamber next to the left side panel 2d, in which the outdoor heat exchanger 23, the

outdoor fans 26, and other components are placed; and a machine chamber next to the right side panel 2f, where the compressor 21 and/or the electromagnetic induction heating unit 6 are placed. The outdoor unit 2 is fixed in place by being screwed onto the bottom plate 2b, and the outdoor unit 2 has an outdoor unit support stand 2G constituting the left and right sides of the lowest end of the outdoor unit 2. The electromagnetic induction heating unit 6 is disposed in the machine chamber, in an upper position in proximity to the right side panel 2f and the ceiling plate 2a. The heat exchange fins 23z of the outdoor heat exchanger 23 described above are arranged so as to be aligned in the plate-thickness direction while the plate-thickness direction runs generally horizontally. The converging tube J is placed in the lowest parts of the heat exchange fins 23z of the outdoor heat exchanger 23, by passing through the heat exchange fins 23z in the thickness direction. The hot gas bypass circuit H is disposed so as to extend below the outdoor fans 26 and the outdoor heat exchanger 23.

<1-3> Internal Configuration of Outdoor Unit 2

[0069] FIG. 5 shows an overall front perspective view showing the internal structure of the machine chamber of the outdoor unit 2. FIG. 6 shows a perspective view showing the internal structure of the machine chamber of the outdoor unit 2. FIG. 7 shows a perspective view depicting the arrangement relationship between the outdoor heat exchanger 23 and the bottom plate 2b.

[0070] The partitioning plate 2H partitions the outdoor unit 2 frontward to rearward from the top end to the bottom end, so as to section the outdoor unit 2 into an air-blower chamber in which the outdoor heat exchanger 23, the outdoor fans 26, and other components are placed, and a machine chamber in which the electromagnetic induction heating unit 6, the compressor 21, the accumulator 25, and other components are placed. The compressor 21 and the accumulator 25 are placed in a space below the machine chamber of the outdoor unit 2. The electromagnetic induction heating unit 6, the four-way switching valve 22, and the outdoor control part 12 are placed in an upper space of the machine chamber of the outdoor unit 2, which is also a space at the top of the compressor 21, the accumulator 25, and other components. The functional elements constituting the outdoor unit 2 and placed in the machine chamber, which are the compressor 21, the four-way switching valve 22, the outdoor heat exchanger 23, the outdoor electric expansion valve 24, the accumulator 25, the hot gas bypass valve 27, the capillary tube 28, and the electromagnetic induction heating unit 6, are connected via the discharge tube A, the indoor-side gas tube B, the outdoor-side liquid tube D, the outdoor-side gas tube E, the accumulation tube F, the hot gas bypass circuit H, and other components so that the refrigeration cycle is performed by the refrigerant circuit 10 shown in FIG. 1. The hot gas bypass circuit H is configured from nine portions linked, which are a first bypass

portion H1 through to a ninth bypass portion H9 as described hereinafter, and when refrigerant flows through the hot gas bypass circuit H, the refrigerant flows sequentially from the first bypass portion H1 to the ninth bypass portion H9.

<1-4> Converging Tube J and Branched Tube K

[0071] The converging tube J shown in FIG. 7 has a cross-sectional area equivalent to the cross-sectional areas of the first branched tube K1, the second branched tube K2, and the third branched tube K3 as described above, and within the outdoor heat exchanger 23, the portion containing the first branched tube K1, the second branched tube K2, and the third branched tube K3 can be increased in terms of its heat exchange effective surface area relative to that of the converging tube J. In the portion of the converging tube J, a large amount of refrigerant collects and flows more intensively than in the portion of the first branched tube K1, the second branched tube K2, and the third branched tube K3; and the growth of ice below the outdoor heat exchanger 23 can therefore be suppressed more effectively. The converging tube J herein is composed of a first converging tube portion J1, a second converging tube portion J2, a third converging tube portion J3, and a fourth converging tube portion J4 connected to each other, as shown in FIG. 7. Refrigerant that has flowed into the outdoor heat exchanger 23 through the branched tube K converges at the converging/branching point 23j, in which state the refrigerant in the refrigerant circuit 10 can make a pass through the lowest end portion of the outdoor heat exchanger 23 after having collected into one flow. The first converging tube portion J1 extends from the converging/branching point 23j to the heat exchange fins 23z disposed in the outermost edge of the outdoor heat exchanger 23. The second converging tube portion J2 extends from the end of the first converging tube portion J1 so as to pass through the plurality of heat exchange fins 23z. As with the second converging tube portion J2, the fourth converging tube portion J4 also extends so as to pass through the plurality of heat exchange fins 23z. The third converging tube portion J3 is a U-shaped tube which connects the second converging tube portion J2 and the fourth converging tube portion J4 in the end of the outdoor heat exchanger 23. During the air-cooling operation, since the flow of refrigerant in the refrigerant circuit 10 collects from a multiple-split flow in the branched tube K into a single flow in the converging tube J, the refrigerant can collect into a single flow in the converging tube J even if the degree of subcooling of the refrigerant flowing through the branched tube K in the portion immediately before the converging/branching point 23j differs with each set of refrigerant flowing through the individual tubes constituting the branched tube K, and the degree of subcooling of the outlet of the outdoor heat exchanger 23 can therefore be adjusted. When the defrosting operation is performed during the air-warming operation, the hot gas by-

pass valve 27 is opened and high-temperature refrigerant discharged from the compressor 21 can be supplied to the converging tube J provided at the bottom end of the outdoor heat exchanger 23 before being supplied to the other portions of the outdoor heat exchanger 23. Therefore, ice deposited in the lower vicinity of the outdoor heat exchanger 23 can be effectively thawed.

<1-5> Hot Gas Bypass Circuit H

[0072] FIG. 8 shows a plan view in which the air-blowing mechanism of the outdoor unit 2 has been removed. FIG. 9 shows a plan view of the placement relationship between the bottom plate of the outdoor unit 2 and the hot gas bypass circuit H.

[0073] The hot gas bypass circuit H has a first bypass portion H1 through to an eighth bypass portion H8 as shown in FIGS. 8 and 9, and also a ninth bypass portion H9 which is not shown. In the hot gas bypass circuit H, the portion that branches at the branching point A1 from the discharge tube A, extends to the hot gas bypass valve 27, and further extends from this hot gas bypass valve 27 is the first bypass portion H1. The second bypass portion H2 extends from the end of the first bypass portion H1 toward the air-blower chamber near the rear side. The third bypass portion H3 extends toward the front side from the end of the second bypass portion H2. The fourth bypass portion H4 extends in the opposite direction of the machine chamber, toward the left, from the end of the third bypass portion H3. The fifth bypass portion H5 extends toward the rear side from the end of the fourth bypass portion H4, up to a portion where a gap can be ensured from the rear side panel 2e of the outdoor unit casing. The sixth bypass portion H6 extends from the end of the fifth bypass portion H5 toward the machine chamber at the right and toward the rear side. The seventh bypass portion H7 extends from the end of the sixth bypass portion H6 toward the machine chamber at the right and through the inside of the air-blower chamber. The eighth bypass portion H8 extends through the inside of the machine chamber from the end of the seventh bypass portion H7. The ninth bypass portion H9 extends from the end of the eighth bypass portion H8 until it reaches the capillary tube 28. When the hot gas bypass valve 27 has been opened, refrigerant flows through the hot gas bypass circuit H in sequence from the first bypass portion H1 to the ninth bypass portion H9 as described above. Therefore, the refrigerant that branches at the branching point A1 of the discharged tube A extending from the compressor 21 flows to the first bypass portion H1 before the refrigerant flowing through the ninth bypass portion H9. Therefore, viewing the refrigerant flowing through the hot gas bypass circuit H as a whole, the refrigerant that has flowed through the fourth bypass portion H4 then continues to flow to the fifth through eighth bypass portions H8, the temperature of the refrigerant flowing through the fourth bypass portion H4 readily becomes higher than the temperature of the refrigerant

flowing through the fifth through eighth bypass portions H8.

[0074] Thus, the hot gas bypass circuit H is placed in the bottom plate 2b of the outdoor unit casing so as to pass near the portion below the outdoor fans 26 and below the outdoor heat exchanger 23. Therefore, the vicinity of the portion where the hot gas bypass circuit H passes can be warmed by the high-temperature refrigerant branched and supplied from the discharge tube A of the compressor 21 without the use of a heater or another separate heat source. Consequently, even if the top side of the bottom plate 2b is wetted by rainwater or by drain water produced in the outdoor heat exchanger 23, the formation of ice can be suppressed in the bottom plate 2b below the outdoor fans 26 and below the outdoor heat exchanger 23. It is thereby possible to avoid situations in which the driving of the outdoor fans 26 is hindered by ice and situations in which the surface of the outdoor heat exchanger 23 is covered by ice, reducing heat exchange efficiency. The hot gas bypass circuit H is arranged so as to pass below the outdoor fans 26 after branching at the branching point A1 of the discharge tube A and before passing below the outdoor heat exchanger 23. Therefore, the formation of ice below the outdoor fans 26 can be prevented with greater priority.

<1-6> Electromagnetic Induction Heating Unit 6

[0075] FIG. 10 shows a schematic perspective view of the electromagnetic induction heating unit 6 attached to the accumulation tube F. FIG. 11 shows an external perspective view in which a shielding cover 75 has been removed from the electromagnetic induction heating unit 6. FIG. 12 shows a cross-sectional view of the electromagnetic induction heating unit 6 attached to the accumulation tube F.

[0076] The electromagnetic induction heating unit 6 is placed so as to cover the magnetic tube F2 from the radially outer side, the magnetic tube F2 being the heat-generating portion of the accumulation tube F, and the magnetic tube F2 is made to generate heat by electromagnetic induction heating. This heat-generating portion of the accumulation tube F has a double-layered tube structure having the copper tube F1 on the inner side and the magnetic tube F2 on the outer side.

[0077] The electromagnetic induction heating unit 6 comprises a first hexagonal nut 61, a second hexagonal nut 66, a first bobbin cover 63, a second bobbin cover 64, a bobbin main body 65, a first ferrite case 71, a second ferrite case 72, a third ferrite case 73, a fourth ferrite case 74, a first ferrite 98, a second ferrite 99, a coil 68, the shielding cover 75, an electromagnetic induction thermistor 14, a fuse 15, and other components.

[0078] The first hexagonal nut 61 and the second hexagonal nut 66 are made of a resin, and are used to stabilize the fixed state between the electromagnetic induction heating unit 6 and the accumulation tube F with the aid of a C ring (not shown). The first bobbin cover 63 and

the second bobbin cover 64 are made of a resin and are used to cover the accumulation tube F from the radially outer side in the top end position and bottom end position, respectively. The first bobbin cover 63 and the second bobbin cover 64 have four screw holes for screws 69, whereby the first through fourth ferrite cases 71 to 74 described hereinafter are screwed in via the screws 69. Furthermore, the second bobbin cover 64 has an electromagnetic induction thermistor insertion opening 64f for inserting the electromagnetic induction thermistor 14 shown in FIG. 12 and attaching it to the outer surface of the magnetic tube F2. The second bobbin cover 64 has a fuse insertion opening 64e (see FIG. 14) for inserting the fuse 15 shown in FIG. 13 and attaching it to the outer surface of the magnetic tube F2. The electromagnetic induction thermistor 14 has an electromagnetic induction thermistor detector 14a, an outer projection 14b, a side projection 14c, and electromagnetic induction thermistor wires 14d for converting the detection result of the electromagnetic induction thermistor detector 14a to a signal and sending it to the control part 11, as shown in FIG. 12. The electromagnetic induction thermistor detector 14a has a shape that conforms to the curved shape of the outer surface of the accumulation tube F, and has a substantial contact surface area. The fuse 15 has a fuse detector 15a, an asymmetrical shape 15b, and fuse wires 15d for converting the detection result of the fuse detector 15a to a signal and sending it to the control part 11, as shown in FIG. 13. Having received from the fuse 15 a notification that a temperature exceeding a predetermined limit temperature has been detected, the control part 11 performs a control for stopping the supply of electricity to the coil 68, avoiding heat damage to the equipment. The bobbin main body 65 is made of a resin and the coil 68 is wound over the bobbin main body 65. The coil 68 is wound in a helical shape over the outer side of the bobbin main body 65, the axial direction being the direction in which the accumulation tube F extends. The coil 68 is connected to a control print board (not shown), and the coil receives a supply of high-frequency electric current. The output of the control print board is controlled by the control part 11. The electromagnetic induction thermistor 14 and the fuse 15 are attached in a state in which the bobbin main body 65 and the second bobbin cover 64 have been joined together, as shown in FIG. 14. When the electromagnetic induction thermistor 14 has been attached, a satisfactory state of pressurized contact with the outer surface of the magnetic tube F2 is maintained by a plate spring 16 pushing radially inward on the magnetic tube F2. Similarly, in the attachment of the fuse 15, a satisfactory state of pressurized contact with the outer surface of the magnetic tube F2 is maintained by a plate spring 17 pushing radially inward on the magnetic tube F2. Thus, since the electromagnetic induction thermistor 14 and the fuse 15 stay satisfactorily in firm contact with the outer surface of the accumulation tube F, responsiveness is improved and sudden temperature changes caused by electromagnetic induction

heating can be quickly detected. The first bobbin cover 63 and the second bobbin cover 64 are held in by the first ferrite case 71 from the direction in which the accumulation tube F extends and are screwed in place by the screws 69. The first ferrite case 71 through the fourth ferrite case 74 house the first ferrite 98 and the second ferrite 99, which are configured from the highly magnetically permeable material ferrite. The first ferrite 98 and the second ferrite 99 absorb the magnetic field created by the coil 68 and form a magnetic flux pathway, thereby impeding the magnetic field from leaking out to the exterior, as shown in the cross-sectional view of the accumulation tube F and electromagnetic induction heating unit 6 of FIG. 15. The shielding cover 75 is placed around the outermost periphery of the electromagnetic induction heating unit 6, and collects a magnetic flux that cannot be contained with the first ferrite 98 and the second ferrite 99 alone. The magnetic flux mostly does not leak out past the shielding cover 75, and the locations where the magnetic flux is created can be determined arbitrarily.

<1-7> Electromagnetic Induction Heating Control

[0079] The electromagnetic induction heating unit 6 described above performs a control for causing the magnetic tube F2 of the accumulation tube F to generate heat, during startup in which the air-warming operation is initiated when the refrigeration cycle is caused to perform the air-warming operation, during air-warming capability assistance, and during performing of the defrosting operation.

[0080] The description hereinbelow pertains to the time of startup.

[0081] When an air-warming operation command is inputted to the controller 90 from the user, the control part 11 initiates the air-warming operation. When the air-warming operation is initiated, the control part 11 waits until the compressor 21 has started up and the pressure detected by the pressure sensor 29a has risen to 39 kg/cm², and then causes the indoor fan 42 to be driven. This prevents discomfort for the user due to unwarmed air flowing into the room in the stage at which the refrigerant passing through the indoor heat exchanger 41 has not yet been warmed. Electromagnetic induction heating using the electromagnetic induction heating unit 6 is performed here in order to shorten the time for the compressor 21 to start up and the pressure detected by the pressure sensor 29a to reach 39 kg/cm². During this electromagnetic induction heating, since the temperature of the accumulation tube F rises rapidly, prior to initiating electromagnetic induction heating, the control part 11 performs a control for determining whether or not conditions are suitable for initiating electromagnetic induction heating. Examples of such a determination include a flow condition judgment process, a sensor-separation detection process, a rapid pressure-increasing process, and the like, as shown in the time chart of FIG. 16.

<1-8> Flow condition judgment process

[0082] When electromagnetic induction heating is performed, the heating load is only the refrigerant accumulated in the portion of the accumulation tube F where the electromagnetic induction heating unit 6 is attached while refrigerant is not flowing to the accumulation tube F. Thus, when electromagnetic induction heating by the electromagnetic induction heating unit 6 is performed while refrigerant is not flowing to the accumulation tube F, the temperature of the accumulation tube F rises abnormally to an extent such that the refrigerator oil deteriorates. The temperature of the electromagnetic induction heating unit 6 itself also rises, and the reliability of the equipment is reduced. Therefore, a flow condition judgment process is performed herein which ensures that refrigerant flows to the accumulation tube F during a stage prior to initiating electromagnetic induction heating, so that electromagnetic induction heating by the electromagnetic induction heating unit 6 is not performed while refrigerant is not flowing to the accumulation tube F.

[0083] In the flow condition judgment process, the following processes are performed as shown in the flowchart of FIG. 17.

[0084] In step S11, the control part 11 determines whether or not the controller 90 has received a command from the user for the air-warming operation and not for the air-cooling operation. Such a determination is made because the refrigerant must be heated by the electromagnetic induction heating unit 6 under the conditions in which the air-warming operation is performed.

[0085] In step S12, the control part 11 initiates startup of the compressor 21, and the frequency of the compressor 21 gradually increases.

[0086] In step S13, the control part 11 determines whether or not the frequency of the compressor 21 has reached a predetermined minimum frequency Q_{min} , and proceeds to step S14 when it has determined that the minimum frequency has been reached.

[0087] In step S14, the control part 11 initiates the flow condition judgment process, stores detected temperature data of the electromagnetic induction thermistor 14 and detected temperature data of the outdoor heat exchange temperature sensor 29c at the time the frequency of the compressor 21 reached the predetermined minimum frequency Q_{min} (see point a in FIG. 16), and initiates a count of the flow detection time by the timer 95. If the frequency of the compressor 21 has not yet reached the predetermined minimum frequency Q_{min} , the refrigerant flowing through the accumulation tube F and the outdoor heat exchanger 23 is in a gas-liquid double phase and maintains a constant temperature at the saturation temperature, and the temperatures detected by the electromagnetic induction thermistor 14 and the outdoor heat exchange temperature sensor 29c are therefore constant and unchanging at the saturation temperature. However, the frequency of the compressor 21 continues to increase after some time, the refrigerant pressures in the outdoor

heat exchanger 23 and in the accumulation tube F continue to decrease further, and the saturation temperature begins to decrease, whereby the temperatures detected by the electromagnetic induction thermistor 14 and the outdoor heat exchange temperature sensor 29c begin to decrease. Since the outdoor heat exchanger 23 herein is positioned farther downstream than the accumulation tube F in relation to the intake side of the compressor 21, the timing at which the temperature of refrigerant passing through the outdoor heat exchanger 23 begins to decrease is earlier than the timing at which the temperature of refrigerant passing through the accumulation tube F begins to decrease (see points b and c in FIG. 16).

[0088] In step S15, the control part 11 determines whether or not the flow detection time of 10 seconds has elapsed since the timer 95 began counting, and the process transitions to step S16 when the flow detection time has elapsed. When the flow detection time has not yet elapsed, step S15 is repeated.

[0089] In step S16, the control part 11 acquires detected temperature data of the electromagnetic induction thermistor 14 and detected temperature data of the outdoor heat exchange temperature sensor 29c at the time that the flow detection time has elapsed and the refrigerant temperatures in the outdoor heat exchanger 23 and in the accumulation tube F have decreased, and the process then transitions to step S17.

[0090] In step S17, the control part 11 determines whether or not the detected temperature of the electromagnetic induction thermistor 14 acquired in step S16 has fallen 3°C or more below the detected temperature data of the electromagnetic induction thermistor 14 stored in step S14, and also determines whether or not the detected temperature of the outdoor heat exchange temperature sensor 29c acquired in step S16 has fallen 3°C or more below the detected temperature data of the outdoor heat exchange temperature sensor 29c stored in step S14. Specifically, it is determined whether or not a decrease in the refrigerant temperature was successfully detected during the flow detection time. When either the detected temperature of the electromagnetic induction thermistor 14 or the detected temperature of the outdoor heat exchange temperature sensor 29c has fallen by 3°C or more, it is determined that refrigerant is flowing through the accumulation tube F and a refrigerant flow has been ensured, the flow condition judgment process is ended, and a transition is made either to the rapid pressure-increasing process during startup in which the output of the electromagnetic induction heating unit 6 is used at its maximum limit, to the sensor-separation detection process, or to another process.

[0091] On the other hand, when neither the detected temperature of the electromagnetic induction thermistor 14 nor the detected temperature of the outdoor heat exchange temperature sensor 29c has fallen by 3°C or more, the process transitions to step S18.

[0092] In step S18, the control part 11 assumes that the quantity of refrigerant flowing through the accumula-

tion tube F is insufficient for induction heating by the electromagnetic induction heating unit 6, and the control part 11 outputs a flow abnormality display on the display screen of the controller 90.

<1-9> Sensor-separation detection process

[0093] The sensor-separation detection process is a process for confirming the state of attachment of the electromagnetic induction thermistor 14, and is performed after the electromagnetic induction thermistor 14 is attached to the accumulation tube F and the air conditioning apparatus 1 is finished being installed (after installation is finished, including after the breaker supplying electricity to the electromagnetic induction heating unit 6 has tripped), when the air-warming operation is first initiated. Specifically, the control part 11 performs the sensor-separation detection process after it has been determined in the above-described flow condition judgment process that the flow quantity of refrigerant in the accumulation tube F has been ensured, and prior to the performing of the rapid pressure-increasing process during startup in which the output of the electromagnetic induction heating unit 6 is used at its maximum limit.

[0094] When the air conditioning apparatus 1 is being transported, unanticipated vibrations or other factors can cause the electromagnetic induction thermistor 14 to be in an unstably attached state or a detached state, and when a newly transported electromagnetic induction heating unit 6 is operated for the first time, its reliability in particular is required, and when a newly transported electromagnetic induction heating unit 6 operates for the first time in the proper manner, it can be forecast, to a certain extent, that subsequent operations will be stable. Therefore, the sensor-separation detection process is performed with the timing described above.

[0095] In the sensor-separation detection process, the following processes are performed as shown in the flowchart of FIG. 18.

[0096] In step S21, the control part 11 initiates the supply of electricity to the coil 68 of the electromagnetic induction heating unit 6, while ensuring the refrigerant flow quantity in the accumulation tube F that was confirmed by the flow condition judgment process, or a greater refrigerant flow quantity, and while storing detected temperature data of the electromagnetic induction thermistor 14 (see point d in FIG. 16) at the time the flow detection time has ended (i.e., the starting time point of the sensor-separation detection time). Electricity is supplied to the coil 68 of the electromagnetic induction heating unit 6 here for the sensor-separation detection time of 20 seconds, at a separation detection supply of electricity M1 (1 kW) of an output 50% less than a predetermined maximum supplied electricity Mmax (2 kW). In this stage, since the state of attachment of the electromagnetic induction thermistor 14 is not yet confirmed to be satisfactory, the output is reduced to 50%, so that the fuse 15 will not be damaged and the resin members of the elec-

tromagnetic induction heating unit 6 will not melt due to the electromagnetic induction thermistor 14 being unable to detect this abnormal rise in temperature regardless of any abnormal rise in temperature in the accumulation tube F. At the same time, the continuous heating time duration of the electromagnetic induction heating unit 6 is set in advance so as not to exceed the maximum continuous output time of 10 minutes, and the control part 11 therefore causes the timer 95 to begin counting the elapsed time in which the electromagnetic induction heating unit 6 continues to output. The supply of electricity to the coil 68 of the electromagnetic induction heating unit 6 and the size of the magnetic field generated by the coil 68 around itself are correlated values.

[0097] In step S22, the control part 11 determines whether or not the sensor-separation detection time has ended. If the sensor-separation detection time has ended, the process transitions to step S23. If the sensor-separation detection time has not yet ended, step S22 is repeated.

[0098] In step S23, the control part 11 acquires the detected temperature of the electromagnetic induction thermistor 14 at the point in time when the sensor-separation detection time ended (point e of FIG. 16), and the process transitions to step S24.

[0099] In step S24, the control part 11 determines whether or not the detected temperature of the electromagnetic induction thermistor 14 at the end of the sensor-separation detection time acquired in step S23 has risen 10°C or more above the detected temperature data of the electromagnetic induction thermistor 14 at the start of the sensor-separation detection time stored in step S21. Specifically, a determination is made as to whether or not the refrigerant temperature has risen by 10°C or more due to the induction heating by the electromagnetic induction heating unit 6 during the sensor-separation detection time. When the detected temperature of the electromagnetic induction thermistor 14 has risen by 10°C or more, it is determined that confirmation could be made that the state of attachment of the electromagnetic induction thermistor 14 to the accumulation tube F is satisfactory and that the accumulation tube F has been appropriately warmed by the induction heating of the electromagnetic induction heating unit 6, the sensor-separation detection process is ended, and the process transitions to the rapid pressure-increasing process at startup in which the output of the electromagnetic induction heating unit 6 is used to its maximum limit. On the other hand, if the detected temperature of the electromagnetic induction thermistor 14 has not risen by 10°C or more, the process transitions to step S25.

[0100] In step S25, the control part 11 counts the number of times a sensor-separation retry process was performed. When the number of retries is less than ten, the process transitions to step S26, and when the number of retries exceeds ten, the process transitions to step S27 without transitioning to step S26.

[0101] In step S26, the control part 11 executes the

sensor-separation retry process. Herein the detected temperature data of the electromagnetic induction thermistor 14 at the elapse of 30 more seconds (not shown in FIG. 16) is stored, electricity is supplied at a separation detection supply of electricity M1 to the coil 68 of the electromagnetic induction heating unit 6 for 20 seconds, the same processes of steps S22 and S23 are performed, the sensor-separation detection process is ended when the detected temperature of the electromagnetic induction thermistor 14 has risen by 10°C or more, and the process transitions to the rapid pressure-increasing process at startup in which the output of the electromagnetic induction heating unit 6 is used to its maximum limit. On the other hand, if the detected temperature of the electromagnetic induction thermistor 14 has not risen by 10°C or more, the process returns to step S25.

[0102] In step S27, the control part 11 determines that the state of attachment of the electromagnetic induction thermistor 14 to the accumulation tube F is unstable or unsatisfactory, and outputs a sensor-separated abnormality display on the display screen of the controller 90.

<1-10> Rapid Pressure-Increasing Process

[0103] The control part 11 initiates the rapid pressure-increasing process in a state in which the flow condition judgment process and the sensor-separation detection process have ended, confirmation has been made that sufficient refrigerant flow in the accumulation tube F has been ensured, the state of attachment of the electromagnetic induction thermistor 14 to the accumulation tube F is satisfactory, and the accumulation tube F has been appropriately warmed by induction heating by the electromagnetic induction heating unit 6.

[0104] Even if induction heating by the electromagnetic induction heating unit 6 is performed here at high output, the reliability of the air conditioning apparatus 1 is successfully improved because it is confirmed that there is no abnormal rise in temperature in the accumulation tube F.

[0105] In the rapid pressure-increasing process, the following processes are performed as shown in the flowchart of FIG. 19.

[0106] In step S31, the control part 11 sets the supply of electricity to the coil 68 of the electromagnetic induction heating unit 6 not to the separation detection supply of electricity M1 limited to 50% output as it was during the sensor-separation detection process described above, but rather to the predetermined maximum supplied electricity Mmax (2 kW). This output by the electromagnetic induction heating unit 6 is continued until the pressure sensor 29a reaches a predetermined target high pressure Ph.

[0107] To prevent abnormal high-pressure increases in the refrigeration cycle of the air conditioning apparatus 1, the control part 11 forces the compressor 21 to stop when the pressure sensor 29a detects an abnormally high pressure Pr. The target high pressure Ph during this

rapid pressure-increasing process is provided as a separate threshold that is a pressure value smaller than the abnormally high pressure Pr.

[0108] In step S32, the control part 11 determines whether or not the maximum continuous output time of 10 minutes of the electromagnetic induction heating unit 6 has elapsed since the start of the count in step S21 of the sensor-separation detection process. If the maximum continuous output time has not elapsed, the process advances to step S33. If the maximum continuous output time has elapsed, the process advances to step S34.

[0109] In step S33, the control part 11 determines whether or not the detected pressure of the pressure sensor 29a has reached the target high pressure Ph. If the target high pressure Ph has been reached, the process transitions to step S34. If the target high pressure Ph has not been reached, step S32 is repeated.

[0110] In step S34, the control part 11 initiates driving of the indoor fan 42, ends the rapid pressure-increasing process, and transitions to a steady output process.

[0111] When the process advances herein from step S33 to step S34, the indoor fan 42 begins to operate under conditions in which sufficiently warm conditioned air is successfully being provided to the user. When the process advances from step S32 to step S34, a state of successfully providing the user with sufficiently warm conditioned air has not been reached, but conditioned air that is somewhat warm can be supplied and the supply of warm air can be initiated in a range wherein the elapsed time since the start of the air-warming operation is not too long.

<1-11> Steady Output Process

[0112] In the steady output process, a steadily supplied electricity M2 (1.4 kW), which is equal to or greater than the separated-detection supply of electricity M1 (1 kW) and equal to or less than the maximum supplied electricity Mmax (2 kW), is designated as a fixed output value, and the frequency at which electricity is supplied to the electromagnetic induction heating unit 6 is PI controlled so that the detected temperature of the electromagnetic induction thermistor 14 is maintained at the startup target accumulation tube temperature of 80°C.

[0113] In the steady output process, the following processes are performed as shown in the flowchart of FIG. 20.

[0114] In step S41, the control part 11 stores the detected temperature of the electromagnetic induction thermistor 14 and the process transitions to step S42.

[0115] In step S42, the control part 11 compares the detected temperature of the electromagnetic induction thermistor 14 stored in step S41 with the startup target accumulation tube temperature of 80°C, and determines whether or not the detected temperature of the electromagnetic induction thermistor 14 is equal to or less than a predetermined maintained temperature that is lower than the startup target accumulation tube temperature of 80°C by a predetermined temperature. If the detected

temperature is equal to or less than the predetermined maintained temperature, the process transitions to step S43. If the detected temperature is not equal to or less than the predetermined maintained temperature, the process stands by until the detected temperature is equal to or less than the predetermined maintained temperature.

[0116] In step S43, the control part 11 perceives the time elapsed since the end of the most recent supply of electricity to the electromagnetic induction heating unit 6.

[0117] In step S44, the control part 11 designates, as one set, the continuous supply of electricity to the electromagnetic induction heating unit 6 fixed at the steadily supplied electricity M2 (1.4 kW) for 30 seconds, and performs PI control in which the frequency of this set is increased in response to a longer elapsed time ascertained in step S43.

<1-12> Defrosting Process

[0118] When the steady output process described above is continued and the detected temperature of the outdoor heat exchange temperature sensor 29c of the outdoor heat exchanger 23 is a predetermined value or lower, the defrosting process, which is an operation for melting frost adhering to the outdoor heat exchanger 23, is performed. Specifically, similar to setting the connection state of the four-way switching valve 22 to the air-cooling operation (the connection state shown by the dashed lines of FIG. 1), high-pressure, high-temperature gas refrigerant discharged from the compressor 21 is supplied to the outdoor heat exchanger 23 before passing through the indoor heat exchanger 41, and the heat of condensation of the refrigerant is used to melt the frost adhering to the outdoor heat exchanger 23.

[0119] In the defrosting process, the following processes are performed as shown in the flowchart of FIG. 21.

[0120] In step S51, the control part 11 confirms that the frequency of the compressor 21 is equal to or greater than the predetermined minimum frequency Q_{min} , which ensures a predetermined refrigerant circulating quantity; that a refrigerant flow quantity is ensured by the flow condition judgment process to an extent such that electromagnetic induction heating can be performed; and that the state of attachment of the electromagnetic induction thermistor 14 is proper according to the sensor-separation detection process; and transitions to step S52.

[0121] In step S52, the control part 11 determines whether or not the detected temperature of the outdoor heat exchange temperature sensor 29c is less than 10°C. If it is less than 10°C, the process transitions to step S53. If it is not less than 10°C, step S52 is repeated.

[0122] In step S53, the control part 11 brings induction heating by the electromagnetic induction heating unit 6 to a halt and transmits a defrost signal.

[0123] In step S54, after transmitting a defrost signal, the control part 11 sets the connection state of the four-way switching valve 22 to the connection state of the air-

cooling operation, and also performs a count, using the timer 95, of the time elapsed after defrosting is initiated, once the connection state of the four-way switching valve 22 has become the connection state of the air-cooling operation.

[0124] In step S55, the control part 11 determines whether or not 30 seconds has elapsed since defrosting was initiated. If 30 seconds has elapsed, the process transitions to step S56. If 30 seconds has not elapsed, step S55 is repeated.

[0125] In step S56, the control part 11 brings the electricity supplied to the coil 68 of the electromagnetic induction heating unit 6 to a predetermined maximum supplied electricity M_{max} (2 kW), and PI controls the frequency of induction heating by the electromagnetic induction heating unit 6 so that the detected temperature of the electromagnetic induction thermistor 14 reaches the target defrosting temperature, which is 40°C (different from the startup target accumulation tube temperature during the steady output process). When the detected temperature of the outdoor heat exchange temperature sensor 29c falls below 0°C, the hot gas bypass valve 27 of the hot gas bypass circuit H then opens, high-temperature, high-pressure gas refrigerant is supplied to the area below the outdoor fans 26 and below the outdoor heat exchanger 23 on the top surface of the bottom plate 2b of the outdoor unit 2, and the ice formed on the top surface of the bottom plate 2b is removed. Since the connection state of the four-way switching valve 22 is switched to the state of the air-cooling operation, the high-temperature, high-pressure gas refrigerant discharged from the compressor 21 flows from the branching/converging point 23k to the converging/branching point 23j of the outdoor heat exchanger 23 and converges into a single flow in the converging/branching point 23j, whereby refrigerant three times greater in quantity than that of the branched tube K flows collectively through the converging tube J. Since the converging tube J is positioned in the vicinity of the bottom end of the outdoor heat exchanger 23, much heat of condensation can be collectively supplied to the bottom end vicinity of the outdoor heat exchanger 23. Defrosting can thereby be further quickened.

[0126] In step S57, the control part 11 determines whether or not the defrost initiation elapsed time has exceeded 10 minutes. If it has not exceeded 10 minutes, the process transitions to step S58. If it has exceeded 10 minutes, the process transitions to step S59. The connection state of the four-way switching valve 22 can thereby be prevented from remaining for 10 minutes or more in the air-cooling state, making it unlikely that the user will experience discomfort from a decrease in the indoor temperature.

[0127] In step S58, the control part 11 determines whether or not the detected temperature of the outdoor heat exchange temperature sensor 29c exceeds 10°C. If it exceeds 10°C, the process transitions to step S59. If it does not exceed 10°C, the process returns to and repeats step S56.

[0128] In step S59, the control part 11 stops the compressor 21 to equalize the high and low pressures in the refrigeration cycle, and ends induction heating by the electromagnetic induction heating unit 6.

[0129] In step S60, the control part 11 switches the connection state of the four-way switching valve 22 to the connection state of the air-warming operation.

[0130] The control part 11 then transmits a signal which ends defrosting. Furthermore, the control part 11 progressively raises the frequency of the compressor 21 to the predetermined minimum frequency Q_{min} or greater, and performs the steady output process until a condition is reached in which the defrosting process will be performed again. The hot gas bypass valve 27 of the hot gas bypass circuit H closes after 5 seconds following the transmission of the signal that ends defrosting.

<Characteristics of Air conditioning apparatus 1 of Present Embodiment>

[0131] In the air conditioning apparatus 1, performing the rapid pressure-increasing process causes a process to be performed in which the output of the electromagnetic induction heating unit 6 is brought to the maximum supplied electricity M_{max} (2 kW), and the refrigerant flowing toward the indoor heat exchanger 41 is quickly brought to a high temperature and high pressure. It is thereby possible to shorten the time needed for warm air to be supplied to the user after startup of the air-warming operation is initiated. Furthermore, by performing the steady output process in a state in which the room interior has been warmed to some extent, the steadily supplied electricity M_2 (1.4 kW), which is the output of the electromagnetic induction heating unit 6 limited below the maximum supplied electricity M_{max} (2 kW), is brought to a fixed output value. It is thereby possible to minimize control overshooting caused by excessively raising the output of the electromagnetic induction heating unit 6.

[0132] When electromagnetic induction heating is performed, sudden temperature increases typically occur more readily than temperature increases caused by changes in the refrigerant circulation conditions in the refrigeration cycle. As a countermeasure to this, in the electromagnetic induction heating unit 6 of the air conditioning apparatus 1, the electromagnetic induction thermistor 14, which is pressed against the magnetic tube F2 by the elastic force of the plate spring 16, maintains satisfactory responsiveness to rapid temperature changes caused by electromagnetic induction heating during the above-described steady output process achieved by electromagnetic induction heating. Therefore, the responsiveness of the steady output process is satisfactory, and control overshooting can be further minimized.

[0133] In the defrosting process, since induction heating by the electromagnetic induction heating unit 6 is performed at the maximum supplied electricity M_{max} (2 kW), the defrosting process can be quickened. Since the detected temperature of the electromagnetic induction ther-

mistor 14 is brought to the target defrosting temperature of 40°C and suppressed lower than the startup target accumulation tube temperature during the steady output process, overshooting caused by control is kept to a minimum.

<Other Embodiments>

[0134] Embodiments of the present invention were described above based on the drawings, but the specific configuration is not limited to these embodiments, and modifications can be made within a range that does not deviate from the scope of the invention.

(A)

[0135] In the embodiment described above, an example was described of a case in which the rapid pressure-increasing process of causing the electromagnetic induction heating unit 6 to output at the maximum supplied electricity M_{max} (2 kW) is ended at the point in time when the detected pressure of the pressure sensor 29a reaches the target high pressure P_h .

[0136] However, the present invention is not limited to this example.

[0137] The rapid pressure-increasing process of causing the electromagnetic induction heating unit 6 to output at the maximum supplied electricity M_{max} (2 kW) may, for example, be ended at the point in time when the electromagnetic induction thermistor 14 detects a temperature established based on the temperature corresponding to the refrigerant of the target high pressure P_h passing through the attached portion of the pressure sensor 29a.

[0138] In this case as well, since it is possible to confirm that the refrigerant supplied to the indoor heat exchanger 41 is sufficiently high in temperature, this confirmation can be used as a determination indicator for initiating the supply of warm conditioned air to the user at the start of the air-warming operation.

[0139] With this type of electromagnetic induction thermistor 14, detecting temperature changes when determining the time of ending the rapid pressure-increasing process may be done by detecting the temperature of an electromagnetic induction downstream-side thermistor 214 which detects temperature changes in the vicinity downstream in the refrigerant flow direction of the accumulation tube F having the magnetic tube F2, as shown in FIG. 22, for example; and detecting temperature changes is not limited to detecting the temperature of the accumulation tube F.

(B)

[0140] In the embodiment described above, an example was described of a case in which the state of attachment of the electromagnetic induction thermistor 14 is confirmed to be satisfactory by detecting a change in the

detected temperature of the electromagnetic induction thermistor 14 resulting from the electromagnetic induction heating unit 6 being changed from a stopped state to creating a magnetic field.

[0141] However, the present invention is not limited to this example.

[0142] For example, the state of attachment of the electromagnetic induction thermistor 14 may be confirmed by changing the electromagnetic induction heating unit 6 from a state of creating a magnetic field to a state of not creating a magnetic field. In this case, the state of attachment of the electromagnetic induction thermistor 14 can be confirmed to be satisfactory by detected temperature changes in which the detected temperature of the electromagnetic induction thermistor 14 decreases.

[0143] The state of attachment of the electromagnetic induction thermistor 14 may also be confirmed merely by changing the electricity supplied to the coil 68 of the electromagnetic induction heating unit 6, thereby varying the strength of the magnetic field being created, and by finding the resulting change in the detected temperature of the electromagnetic induction thermistor 14.

(C)

[0144] In the embodiment described above, an example was described of a case in which a determination is made as to whether or not the state of attachment of the electromagnetic induction thermistor 14 is satisfactory, focusing on changes in the detected temperature of the electromagnetic induction thermistor 14 which detects the temperature of the magnetic tube F2 constituting the outer side of the accumulation tube F.

[0145] However, the present invention is not limited to this example.

[0146] In another option, for example, temperature changes in the accumulation tube F may be detected by using a detection device of bimetal or the like for detecting if the temperature is greater than a predetermined temperature or less than a predetermined temperature, and setting the predetermined temperature of the detection device to a value between the temperature prior to the sensor-separation detection process and the subsequent temperature. In this case, even if it is not possible to detect the specific temperature when the sensor-separation detection process is performed, the state of attachment of the sensor can be confirmed by detecting the temperature changes.

(D)

[0147] In the embodiment described above, an example was described of a case in which the output of the electromagnetic induction heating unit 6 for electromagnetic induction heating is fixed at 70% in the steady output process while the output frequency thereof is controlled.

[0148] However, the present invention is not limited to

this example.

[0149] For example, in the steady output process, the output of the electromagnetic induction heating unit 6 may be controlled based on the detected temperature of the electromagnetic induction thermistor 14 while the frequency of performing electromagnetic induction heating remains fixed.

[0150] Another option is for both the frequency of performing electromagnetic induction heating and the output of the electromagnetic induction heating unit 6 to be controlled based on the detected temperature of the electromagnetic induction thermistor 14 in the steady output process.

(E)

[0151] In the embodiment described above, an example was described of a case in which the electromagnetic induction heating unit 6 is attached to the accumulation tube F within the refrigerant circuit 10.

[0152] However, the present invention is not limited to this example.

[0153] For example, the electromagnetic induction heating unit 6 may be provided to a refrigerant tube other than the accumulation tube F. In this case, the magnetic tube F2 or another magnetic component is provided to the refrigerant tube portion where the electromagnetic induction heating unit 6 is provided.

(F)

[0154] In the embodiment described above, an example was described of a case in which the accumulation tube F is configured as a double-layer pipe comprising the copper tube F1 and the magnetic tube F2.

[0155] However, the present invention is not limited to this example.

[0156] For example, a magnetic member F2a and two stoppers F1a, F1b may be disposed inside the accumulation tube F or a refrigerant tube as a heated object, as shown in FIG. 23. The magnetic member F2a is a member containing a magnetic material whereby heat is generated by electromagnetic induction heating in the embodiment described above. The stoppers F1a, F1b are placed in two locations inside the copper tube F1, constantly allowing refrigerant to pass through but not allowing the magnetic member F2a to pass through. The magnetic member F2a thereby does not move despite the flow of refrigerant. Therefore, the intended heating position in the accumulation tube F or the like can be heated. Furthermore, since the heat-generating magnetic member F2a and the refrigerant are in direct contact, heat transfer efficiency can be improved.

(G)

[0157] The magnetic member F2a described in the other embodiment (F) above may be positioned within the

tube without the use of the stoppers F1a, F1b.

[0158] For example, bent portions FW may be provided in two locations in the copper tube F1, and the magnetic member F2a may be disposed inside the copper tube F1 between these two bent portions FW, as shown in FIG. 24. The movement of the magnetic member F2a can be suppressed while refrigerant is allowed to pass through in this manner as well.

(H)

[0159] In the embodiment described above, an example was described of a case in which the coil 68 is wound around the accumulation tube F in a helical formation.

[0160] However, the present invention is not limited to this example.

[0161] For example, a coil 168 wound around a bobbin main body 165 may be disposed around the periphery of the accumulation tube F without being wound over the accumulation tube F, as shown in FIG. 25. The bobbin main body 165 is disposed so that its axial direction is substantially perpendicular to the axial direction of the accumulation tube F. The bobbin main body 165 and the coil 168 are disposed in two separate parts so as to sandwich the accumulation tube F.

[0162] In this case, for example, a first bobbin cover 163 and a second bobbin cover 164 which pass through the accumulation tube F may be arranged in a state of being fitted over the bobbin main body 165, as shown in FIG. 26.

[0163] Furthermore, the first bobbin cover 163 and the second bobbin cover 164 may be fixed in place by being sandwiched by a first ferrite case 171 and a second ferrite case 172, as shown in FIG. 27. In FIG. 27, an example is shown of a case in which two ferrite cases are arranged so as to sandwich the accumulation tube F, but they may be arranged in four directions similar to the embodiment described above. The ferrite may also be accommodated similar to the embodiment described above.

<Other>

[0164] Embodiments of the present invention were described above in several examples, but the present invention is not limited to these embodiments. For example, the present invention also includes combined embodiments obtained by suitably combining different portions of the above embodiments, within a range that can be carried out based on the above descriptions by those skilled in the art.

INDUSTRIAL APPLICABILITY

[0165] According to the present invention, performance during startup can be quickly ensured while overshooting after startup can be kept to a minimum; therefore, the present invention is particularly useful in an electromagnetic induction heating unit and an air conditioning

apparatus in which refrigerant is heated using electromagnetic induction.

REFERENCE SIGNS LIST

[0166]

1	Air conditioning apparatus
6	Electromagnetic induction heating unit
10	Refrigerant circuit
11	Control part
14	Electromagnetic induction thermistor (refrigerant state quantity detector, temperature detector)
15	Fuse
16	Plate spring (elastic member)
17	Plate spring (elastic member)
21	Compressor
22	Four-way switching valve
23	Outdoor heat exchanger
24	Electric expansion valve
25	Accumulator
29a	Pressure sensor (refrigerant state quantity detector)
29b	Outdoor air temperature sensor
29c	Outdoor heat exchange temperature sensor
41	Indoor heat exchanger
43	Indoor temperature sensor
44	Indoor heat exchange temperature sensor
65	Bobbin main body
68	Coil (magnetic field generator)
71-74	First ferrite case - fourth ferrite case
75	Shielding cover
90	Controller

95	Timer	
98, 99	First ferrite, second ferrite	
F	Accumulation tube, refrigerant tube (predetermined state quantity detected portion)	5
F2	Magnetic tube (heating target portion)	
M1	Separated-detection supply of electricity (magnetic field level)	10
M2	Steadily supplied electricity (first magnetic field limit reference value)	15
Mmax	Maximum supplied electricity (predetermined maximum output)	
Ph	Target high pressure (first predetermined target state quantity)	20

CITATION LIST

PATENT LITERATURE

[0167]

<Patent Literature 1> Japanese Laid-open Patent Application Publication No. 2000-97510

Claims

1. An air conditioning apparatus (1) which uses a refrigeration cycle having a compression mechanism (21) for circulating refrigerant, a refrigeration tube (F) that makes thermal contact with a refrigerant flowing through the refrigerant tube (F) and/or a heat-generating member (F2) that makes thermal contact with a refrigerant flowing through the refrigerant tube (F); the air conditioning apparatus (1) comprising:
 - a magnetic field generator (68) which generates a magnetic field for induction-heating a portion (F2) to be heated by the induction heating;
 - a refrigerant state quantity detector (14, 29a) for detecting a state quantity relating to refrigerant flowing through a predetermined state quantity detection portion (F) which is at least part of the refrigeration cycle; and
 - a control part (11) for performing at least:
 - startup magnetic field generation control during startup involving performing an air-warming operation in the refrigeration cycle, wherein a state in which the output of the magnetic field generator (68) is a predetermined maximum output (Mmax) is initiated

from the time the compression mechanism has assumed a drive state, and is ended when the state quantity detected by the refrigerant state quantity detector (14, 29a) reaches a first predetermined target state quantity (Ph); and post-startup magnetic field generation control wherein a state involving the applying of a restriction that a first magnetic field limit reference value (M2) lower than the predetermined maximum output (Mmax) be an upper limit of the output of the magnetic field generator (68) is performed after the startup magnetic field generation control has ended.

2. The air conditioning apparatus (1) according to claim 1; wherein the heating target portion (F2) of the induction heating contains a magnetic material.
3. The air conditioning apparatus (1) according to claim 1 or 2; wherein the predetermined state quantity detection portion (F) is a portion in which a magnetic field is generated by the magnetic field generator (68).
4. The air conditioning apparatus (1) according to any one of claims 1 through 3; wherein the state quantity detected by the refrigerant state quantity detector (14, 29a) includes at least one of either the temperature or pressure relating to the refrigerant flowing through the predetermined state quantity detection portion (F).
5. The air conditioning apparatus (1) according to any one of claims 1 through 4; wherein the refrigerant state quantity detector (14, 29a) is a temperature detector (14) for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion (F); and in the post-startup magnetic field generation control, the control part (11) performs post-startup magnetic field generation PI control for PI-controlling the size of the magnetic field generated by the magnetic field generator (68) and/or the frequency with which the magnetic field generator (68) generates a magnetic field so that the temperature detected by the temperature detector (14) is maintained at a target maintenance temperature.
6. The air conditioning apparatus (1) according to any one of claims 1 through 5; wherein the refrigerant state quantity detector (14, 29a) is a temperature detector (14) for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection

- portion (F); and
the control part (11) executes the startup magnetic field generation control after fulfilling of a magnetic field level increase condition that there be a change in the detected temperature of the temperature detector (14), or that the temperature detector (14) detect a temperature change, due to a magnetic field level change process being performed for raising or lowering the level of the magnetic field generated by the magnetic field generator (68) within a range below the predetermined maximum output (Mmax).
7. The air conditioning apparatus (1) according to claim 6;
wherein a maximum magnetic field level (M1) outputted in the magnetic field level change process is a value less than the first magnetic field limit reference value (M2).
8. The air conditioning apparatus (1) according to any one of claims 1 through 7;
wherein the refrigerant state quantity detector (14, 29a) is a temperature detector (14) for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion (F); and
the control part (11) executes determining of the magnetic field level increase condition after the fulfilling of a flow condition that there be a change in the detected temperature of the temperature detector (14) between a first compression mechanism state and a second compression mechanism state, when the compression mechanism is caused to realize two compression mechanism states of different compression mechanism outputs, one being the first compression mechanism state and the other being the second compression mechanism state having a higher output level than the first compression mechanism state.
9. The air conditioning apparatus (1) according to any one of claims 1 through 8;
wherein the refrigerant state quantity detector (14, 29a) is a temperature detector (14) for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion (F); and
the control part (11) performs a defrosting operation output control for controlling the output of the magnetic field generator (68) on the basis of the detected temperature of the temperature detector (14), the upper limit of the output of the magnetic field generator (68) being the predetermined maximum output (Mmax), when the refrigeration cycle executes a defrosting operation different from the air-warming operation after the post-startup magnetic field generation control has been initiated.
10. The air conditioning apparatus (1) according to claim 9;
wherein during the defrosting operation output control, the control part (11) performs defrosting PI control in which PI control is performed so that the temperature detected by the temperature detector (14) is maintained at a second predetermined target temperature that is lower than the first predetermined target temperature.
11. The air conditioning apparatus (1) according to any one of claims 1 through 10;
wherein the refrigerant state quantity detector (14, 29a) is a temperature detector (14) for detecting a temperature relating to the refrigerant flowing through the predetermined state quantity detection portion (F); and
the air conditioning apparatus (1) further comprises an elastic member (16, 17) for applying elastic force to the temperature detector (14); and
the temperature detector (14) is pressed against the predetermined state quantity detection portion (F) by the elastic force of the elastic member (16, 17).

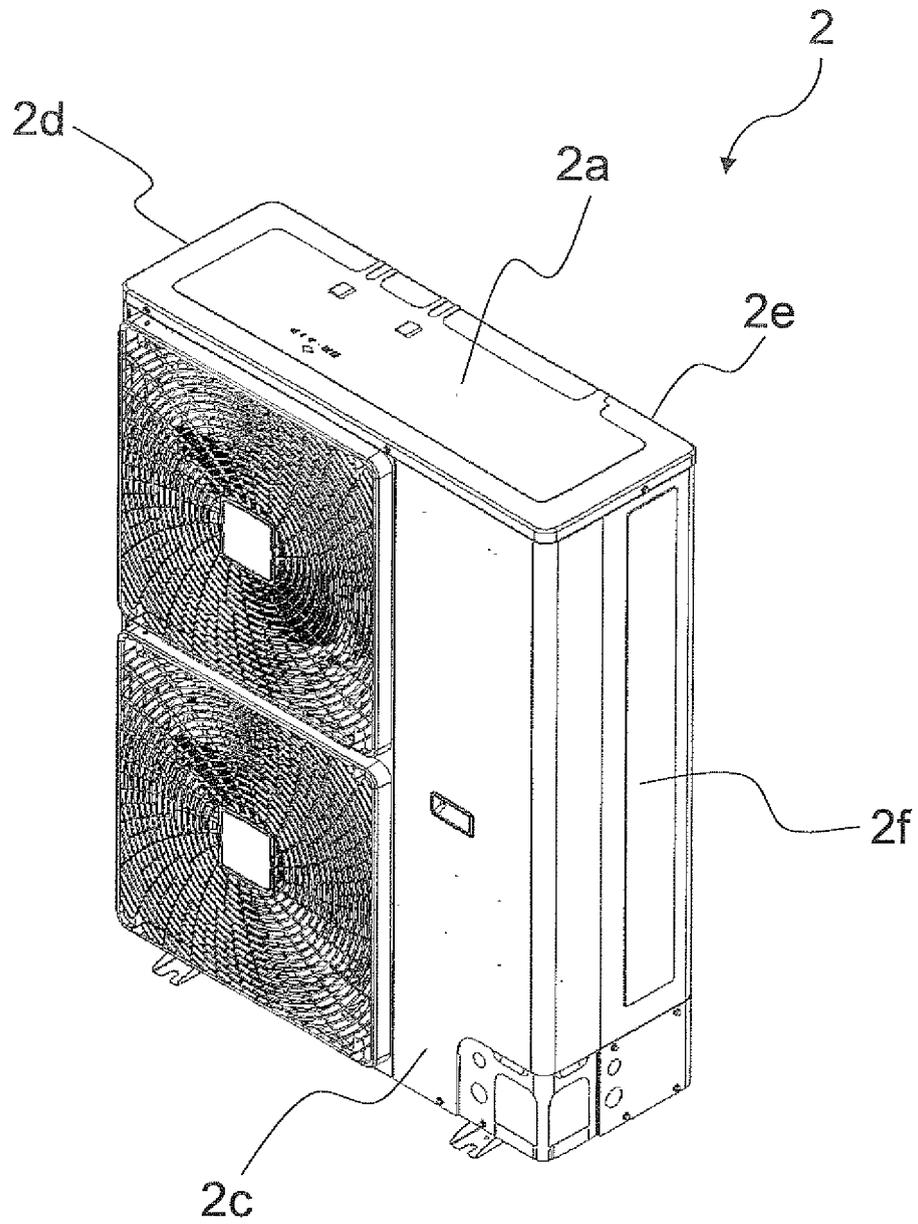


FIG. 2

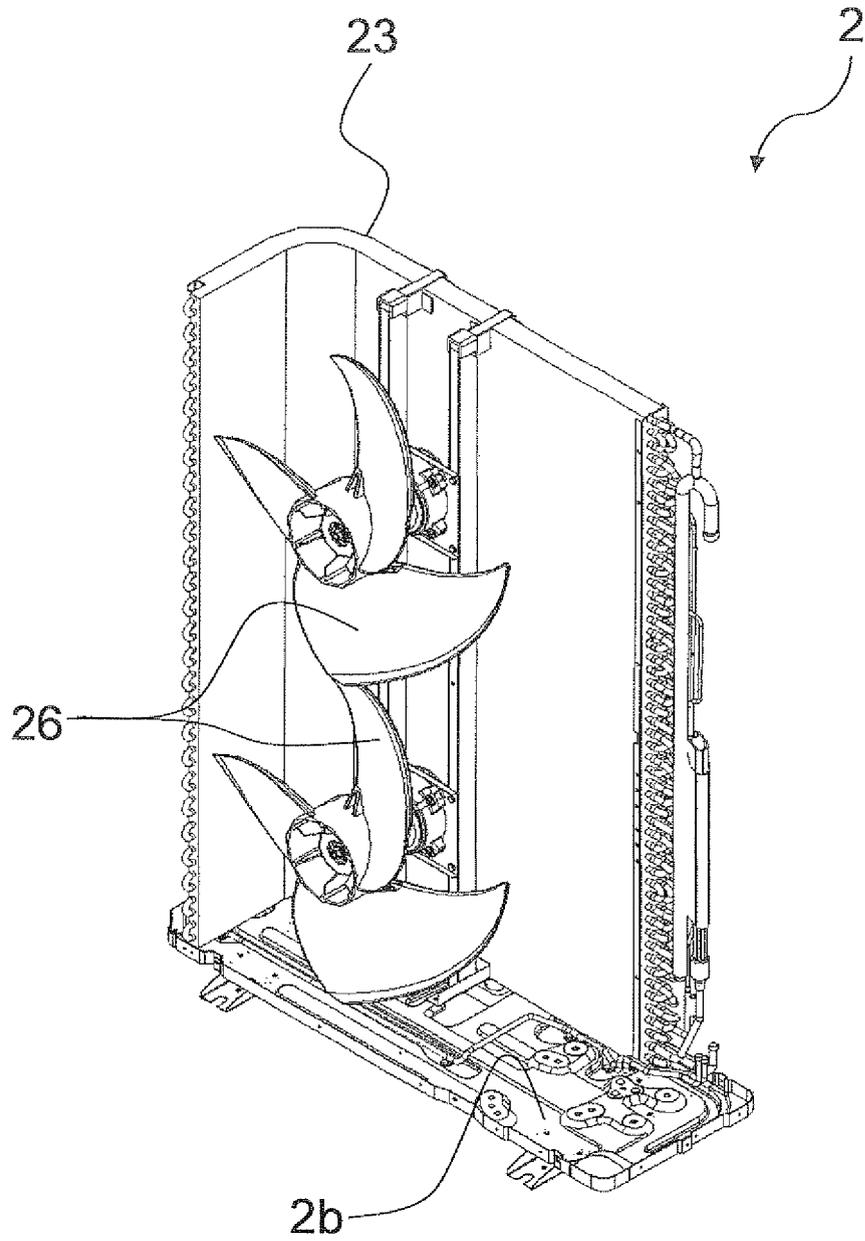


FIG. 3

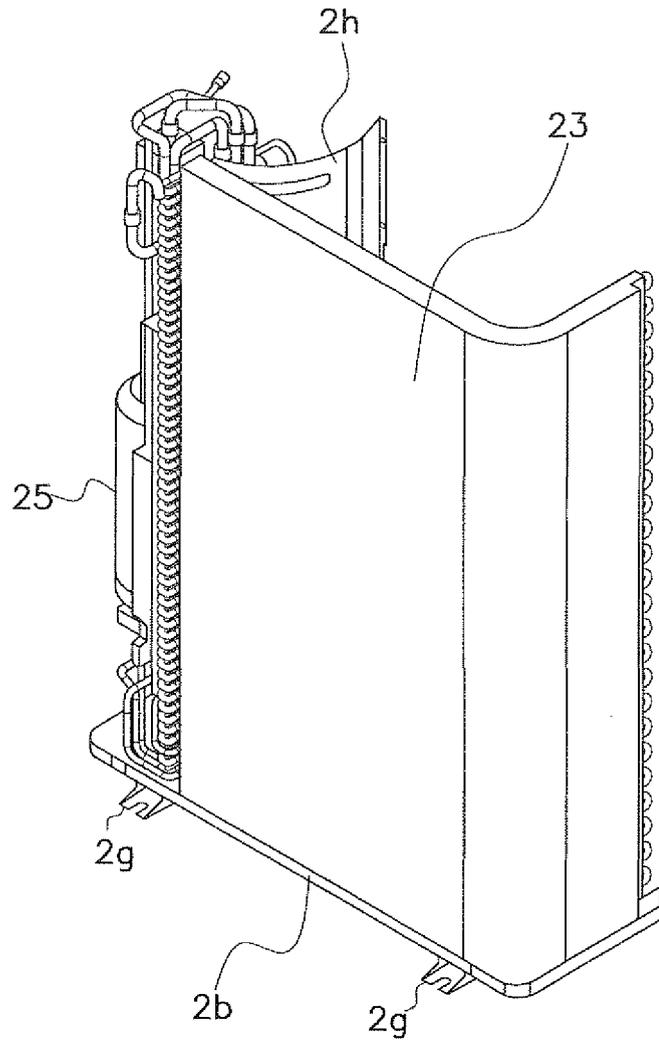


FIG. 4

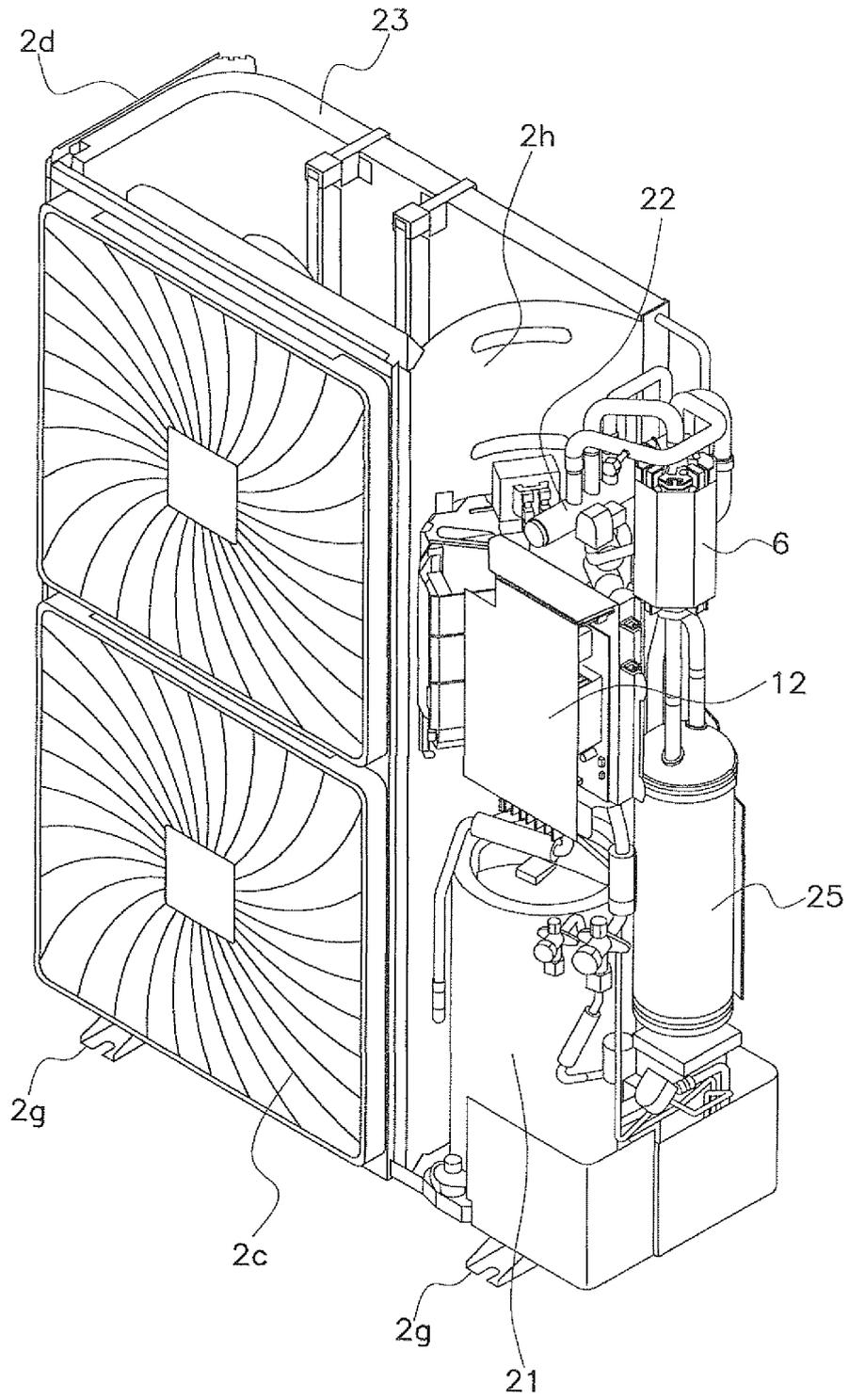


FIG. 5

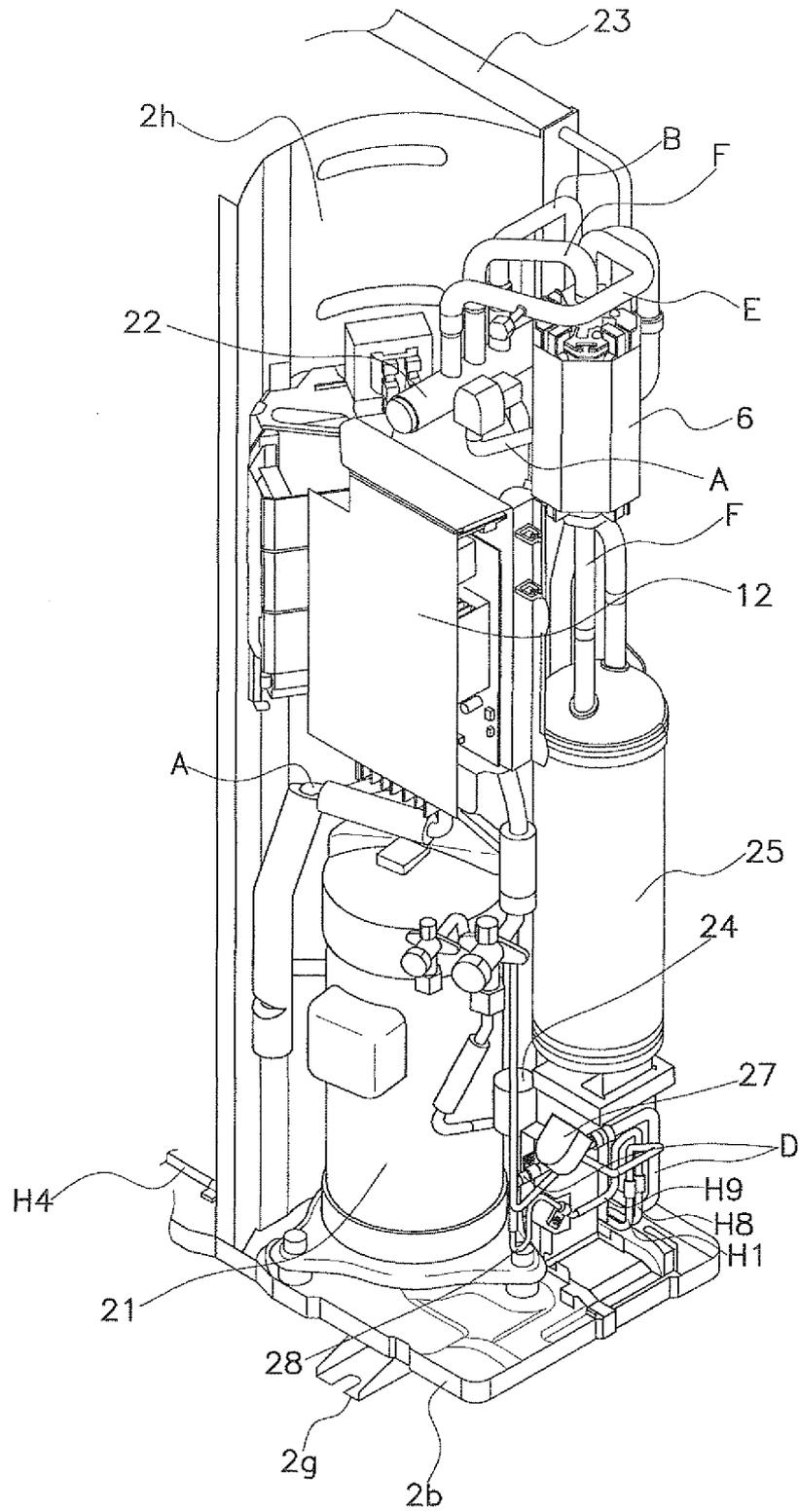


FIG. 6

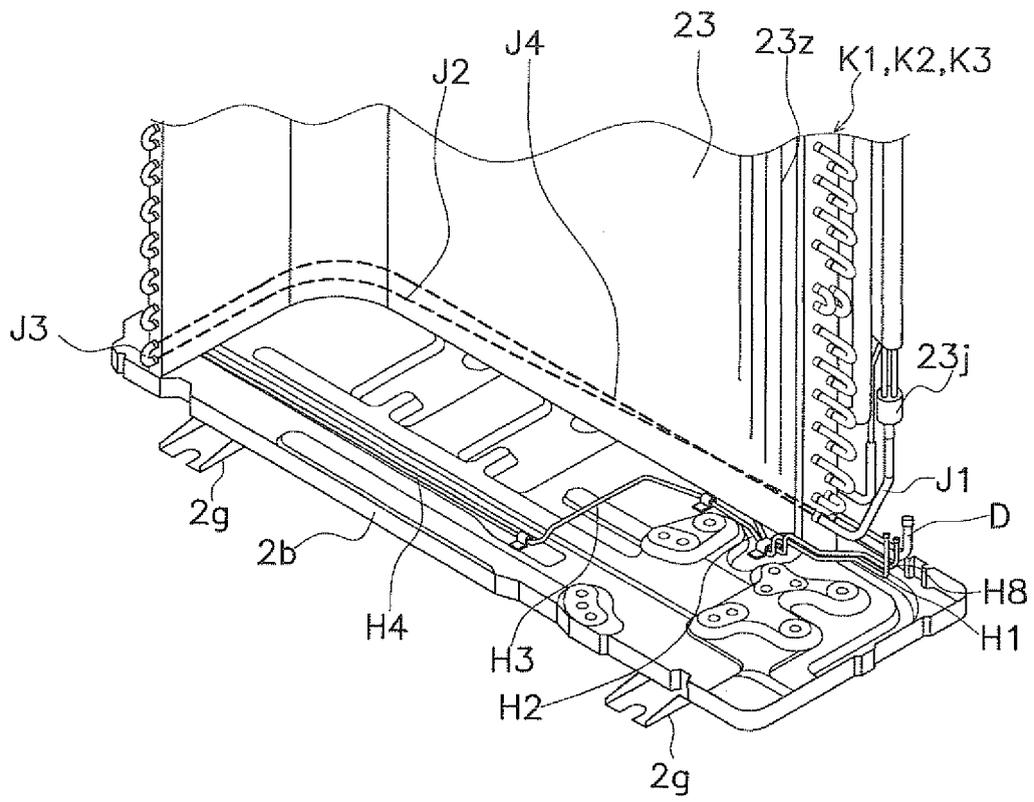


FIG. 7

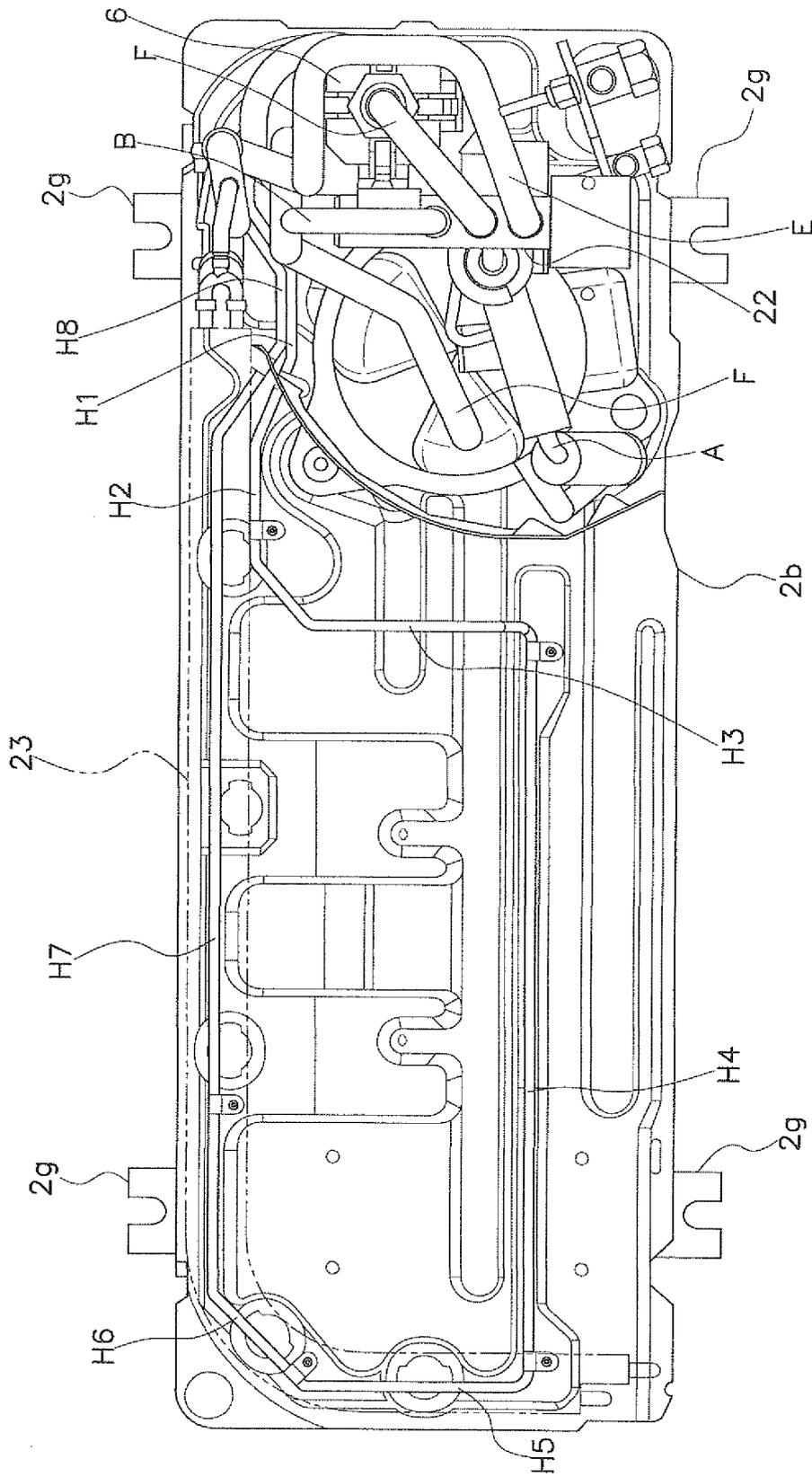


FIG. 8

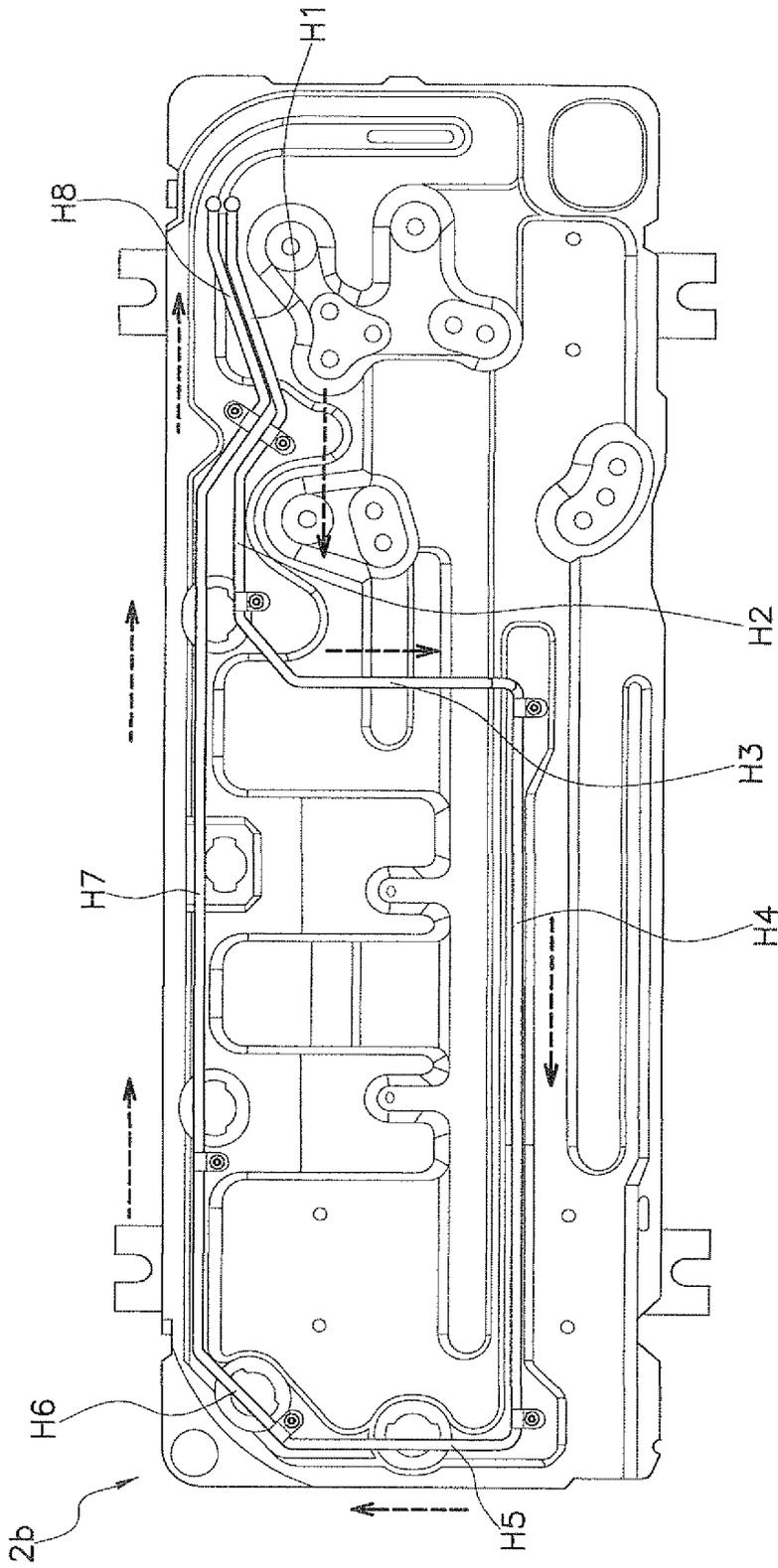


FIG. 9

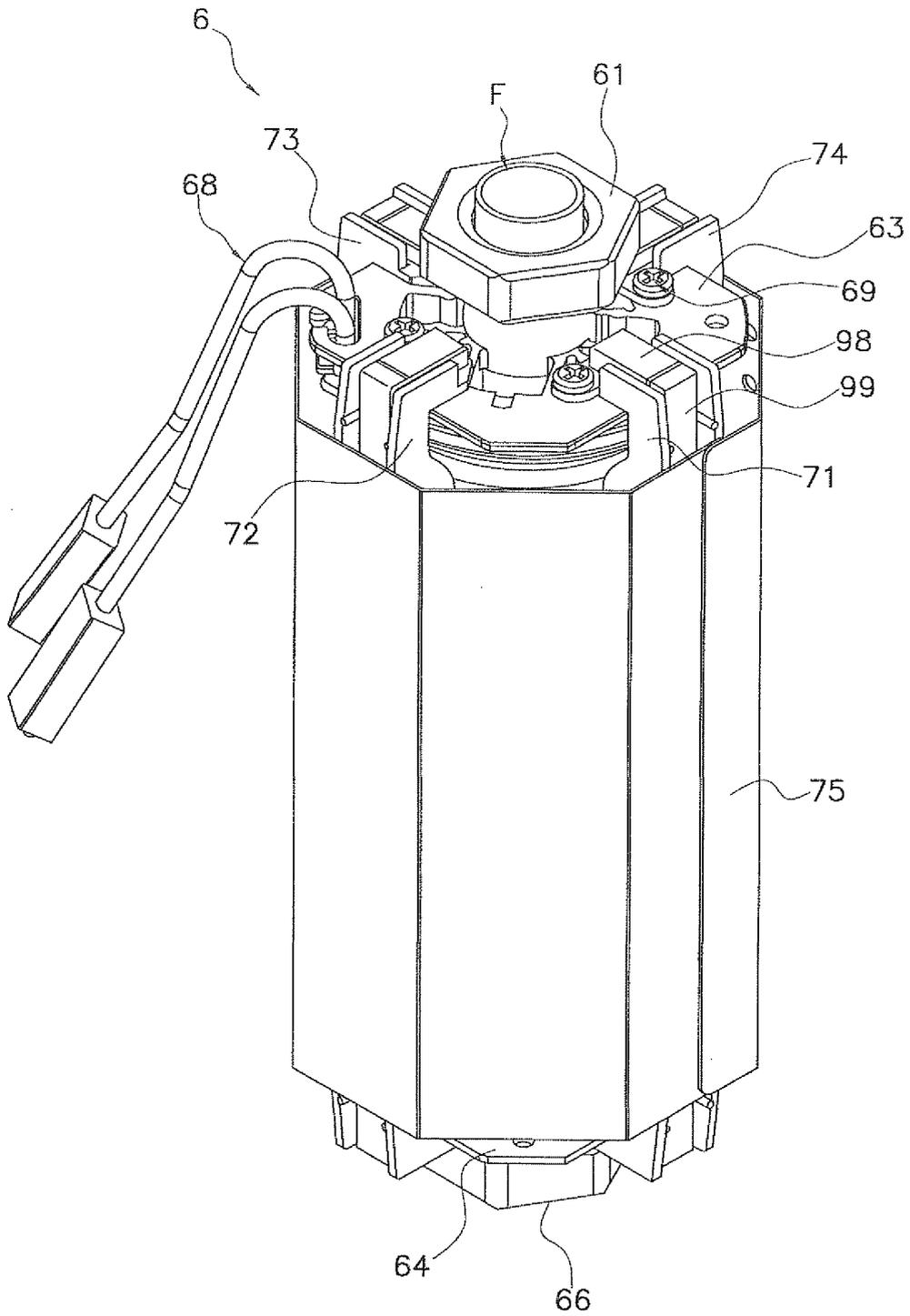


FIG. 10

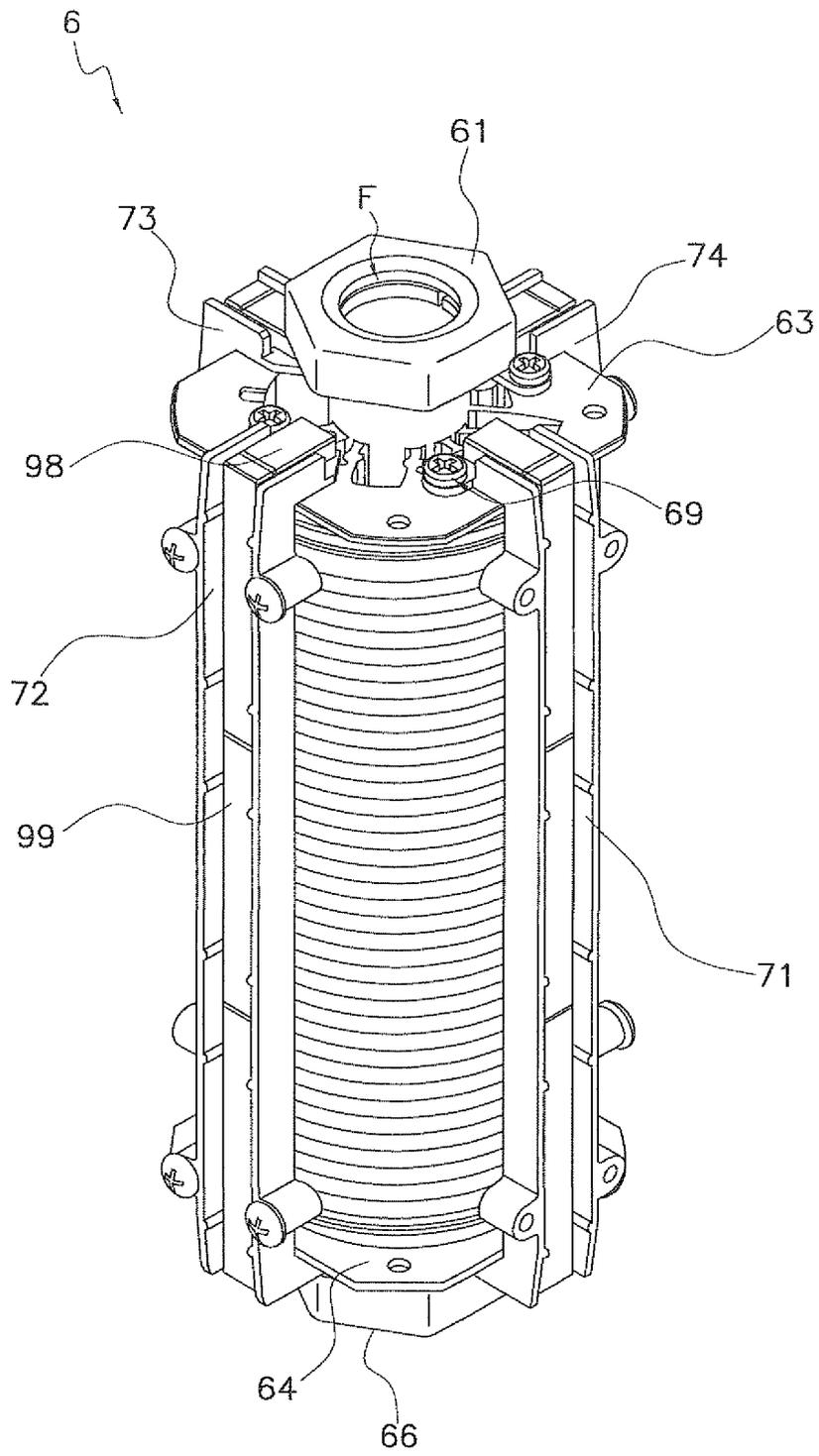


FIG. 11

FIG. 12

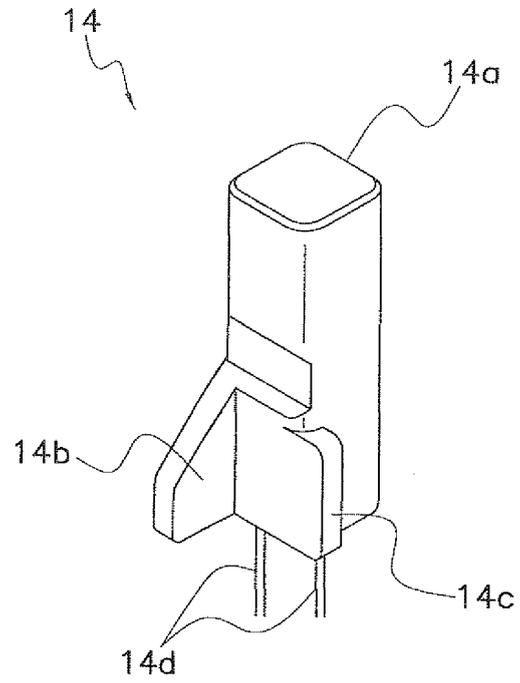
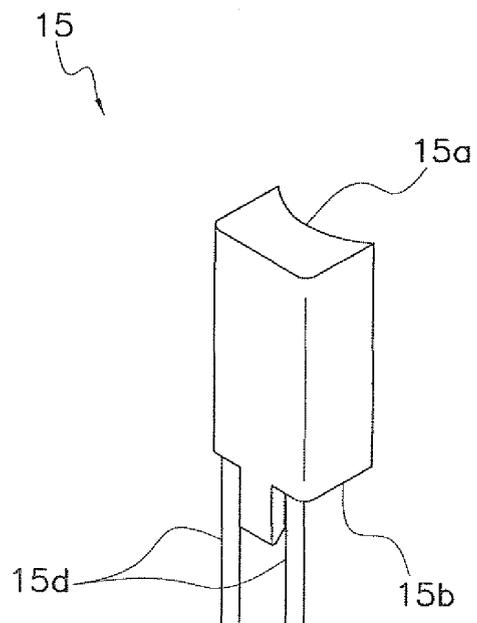


FIG. 13



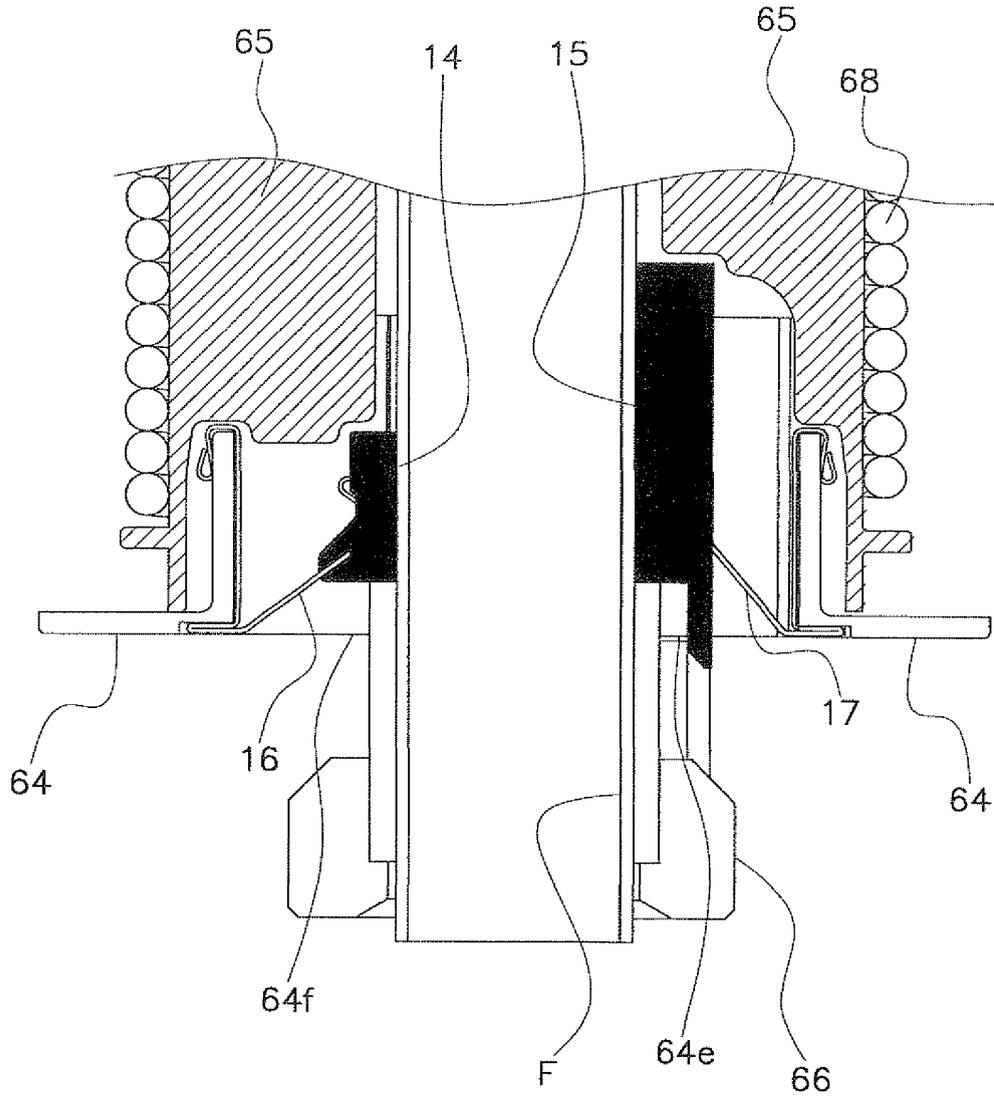


FIG. 14

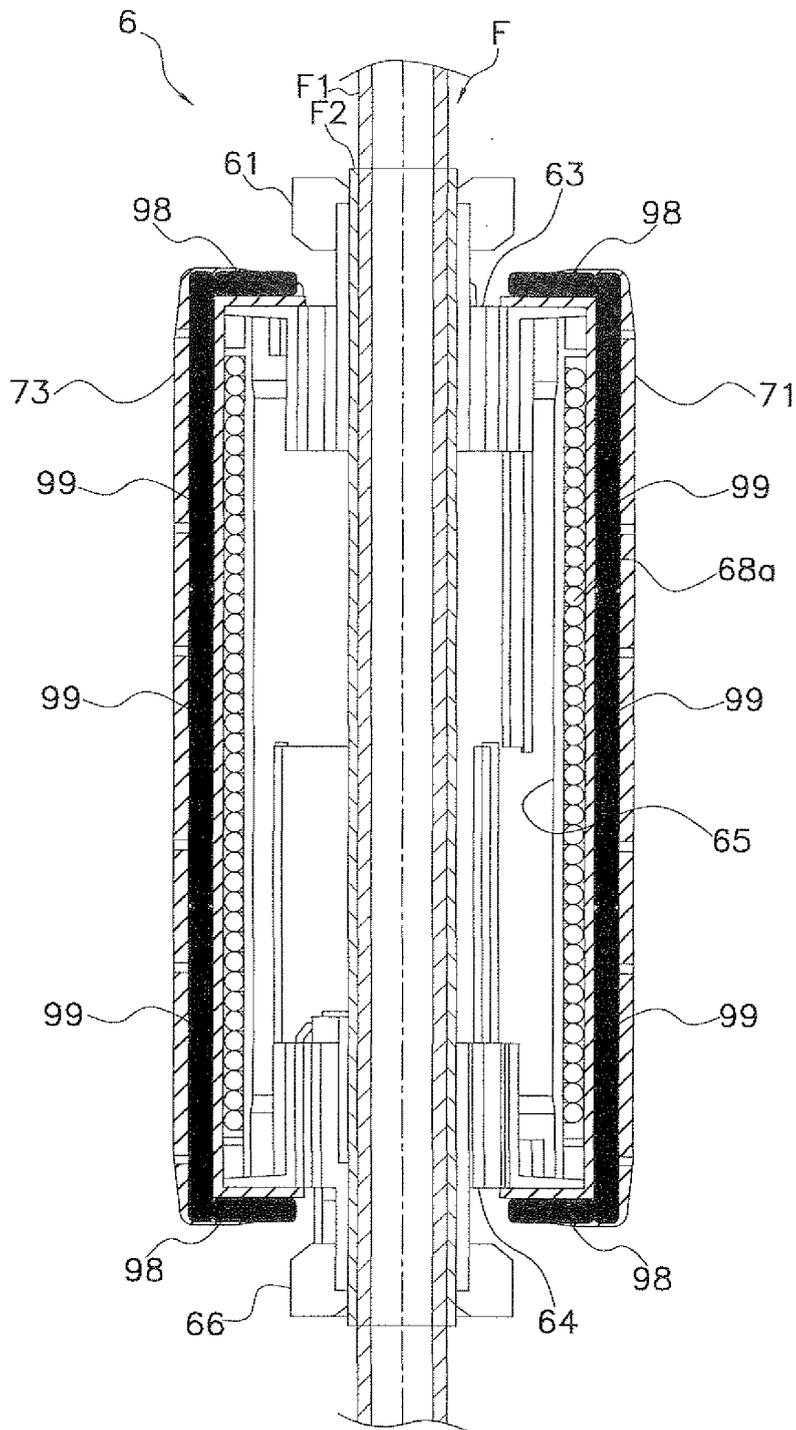


FIG. 15

FIG. 16

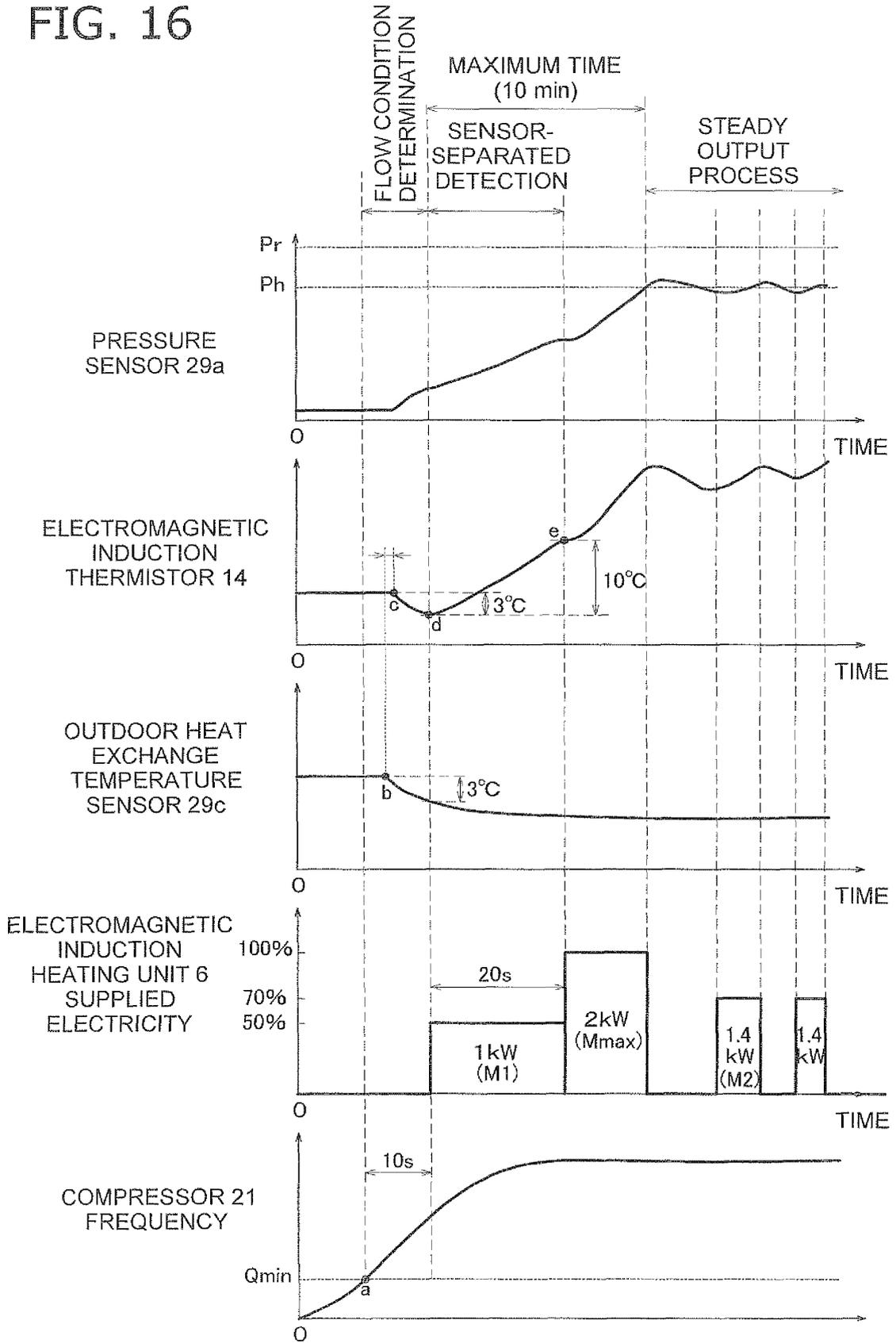
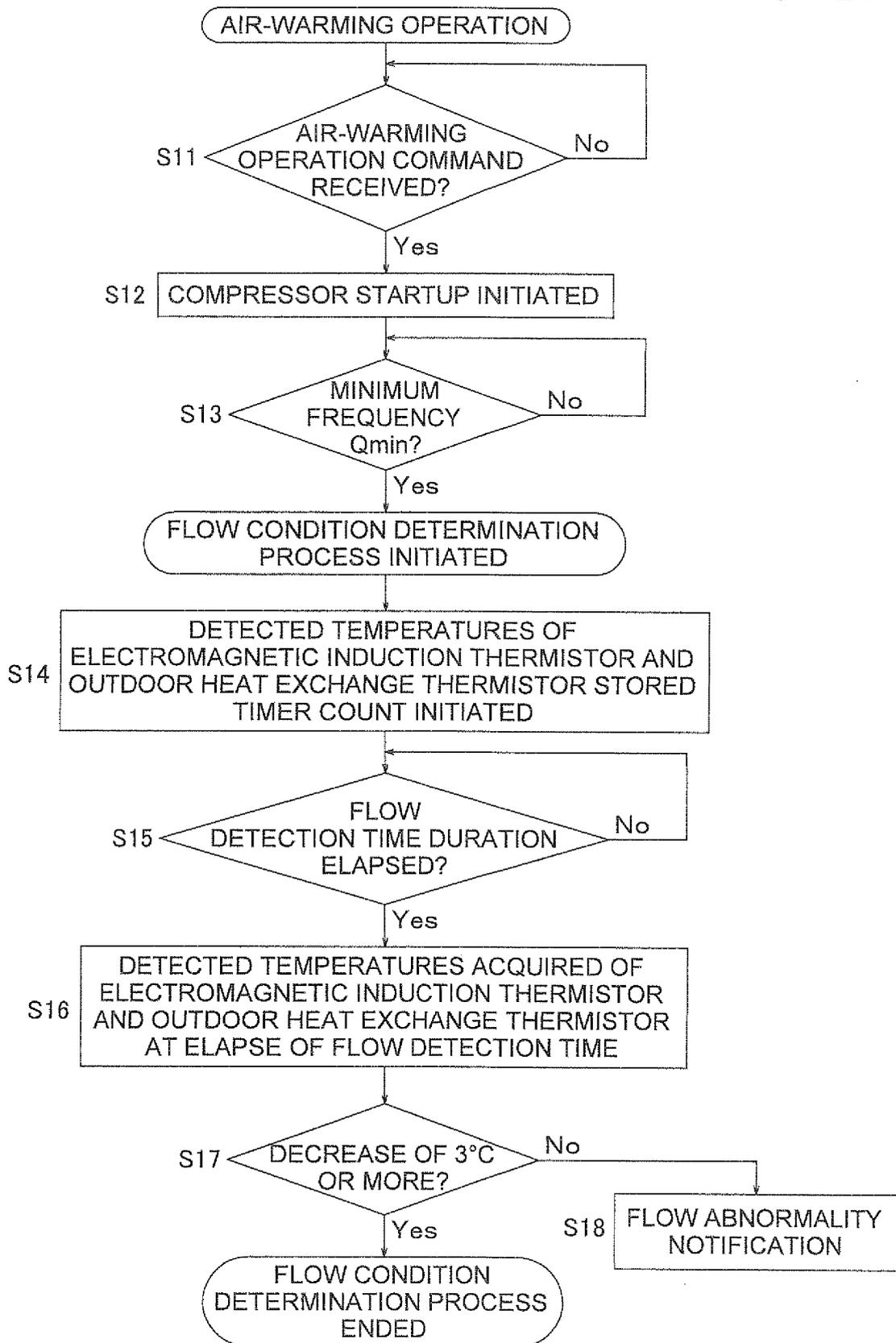


FIG. 17



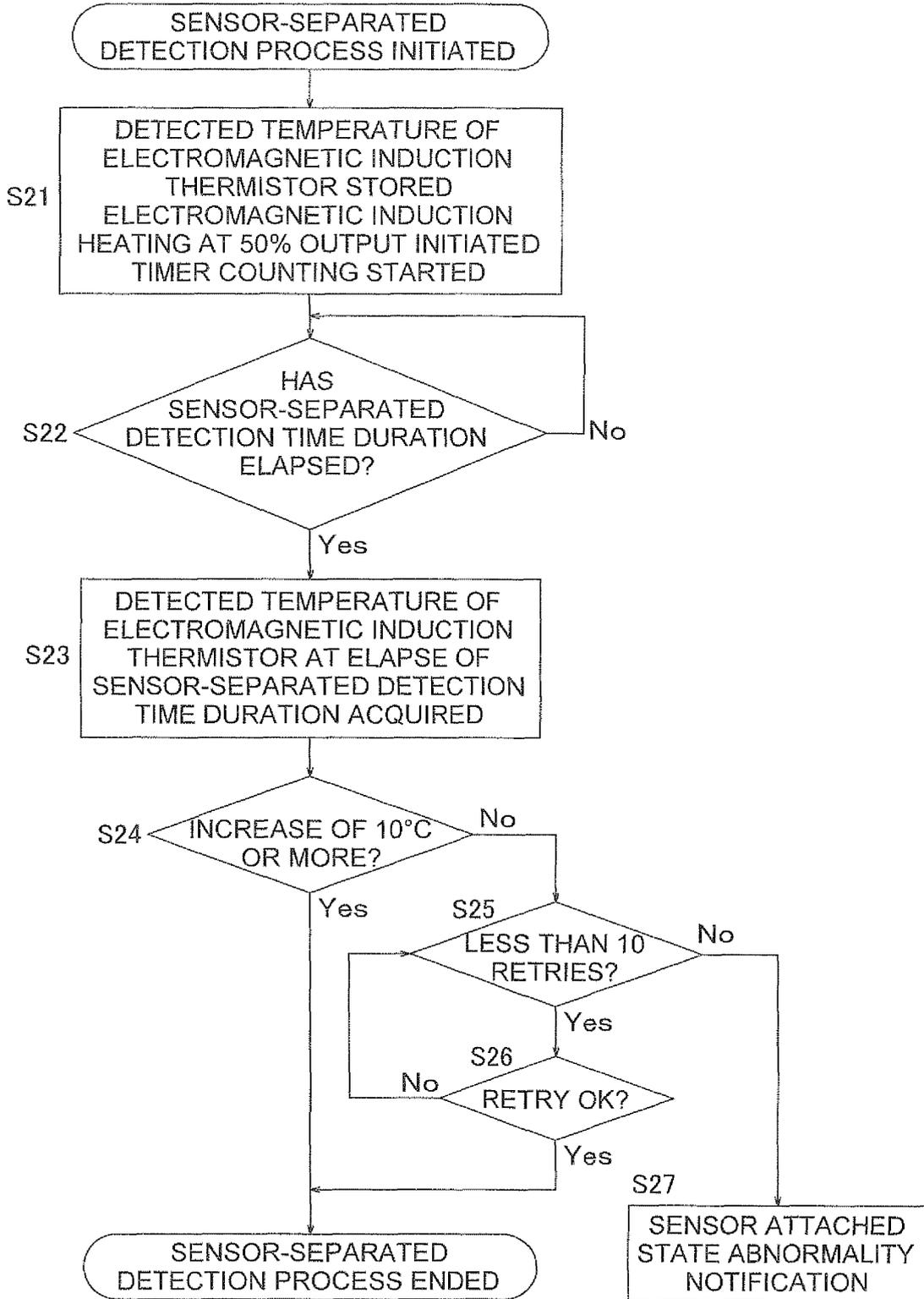


FIG. 18

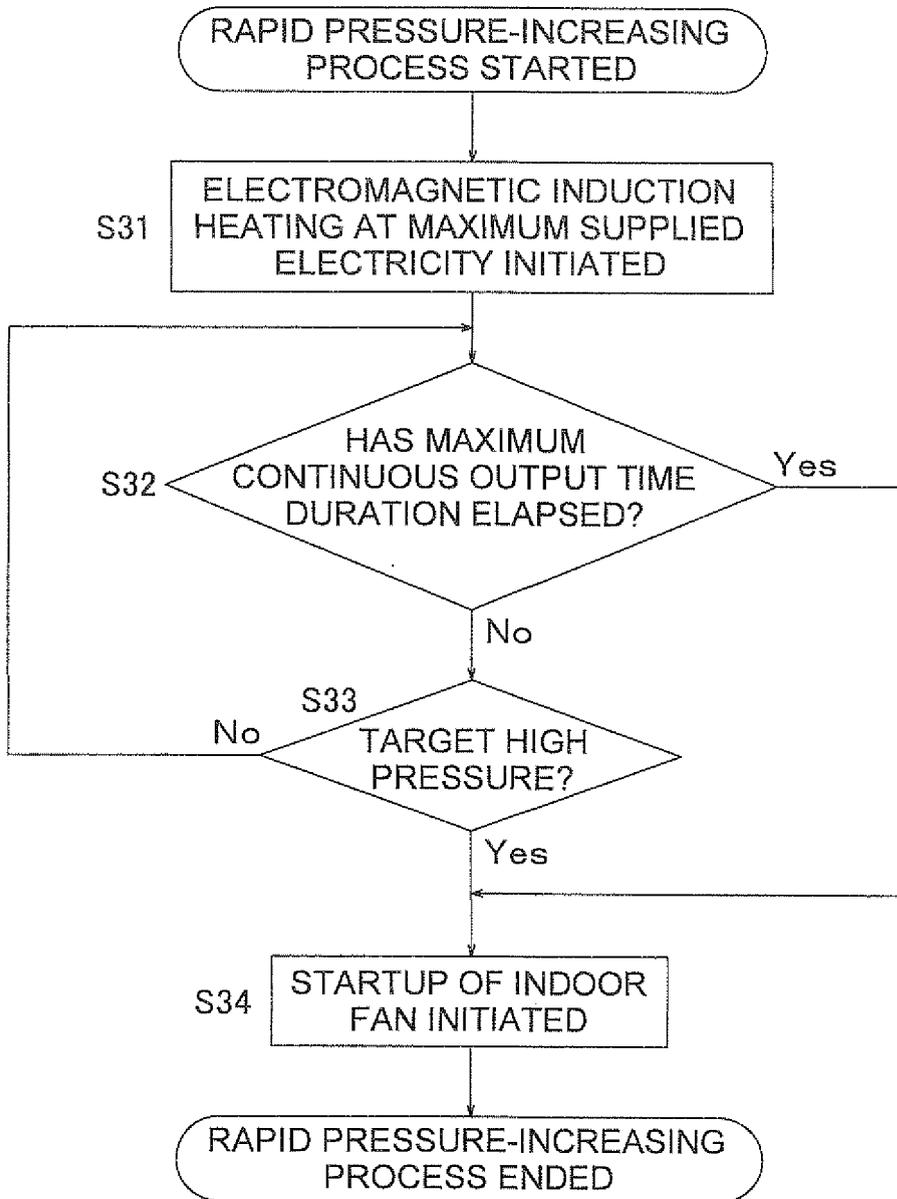


FIG. 19

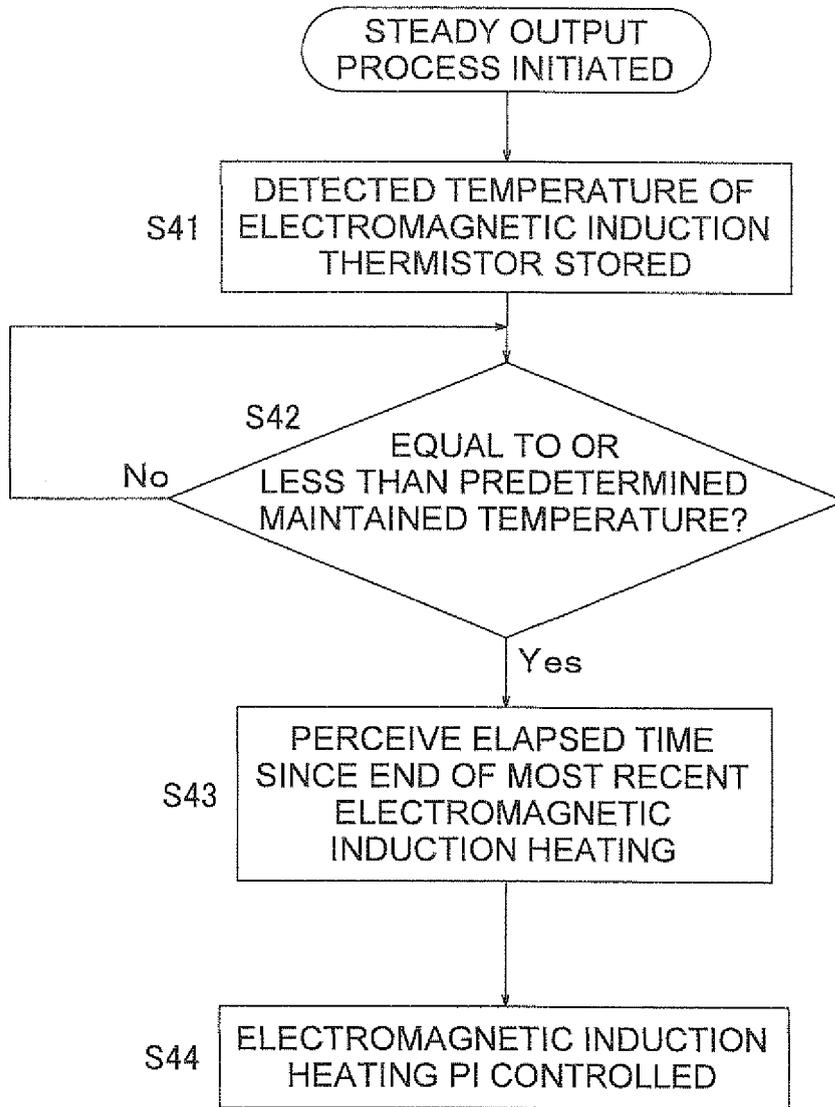


FIG. 20

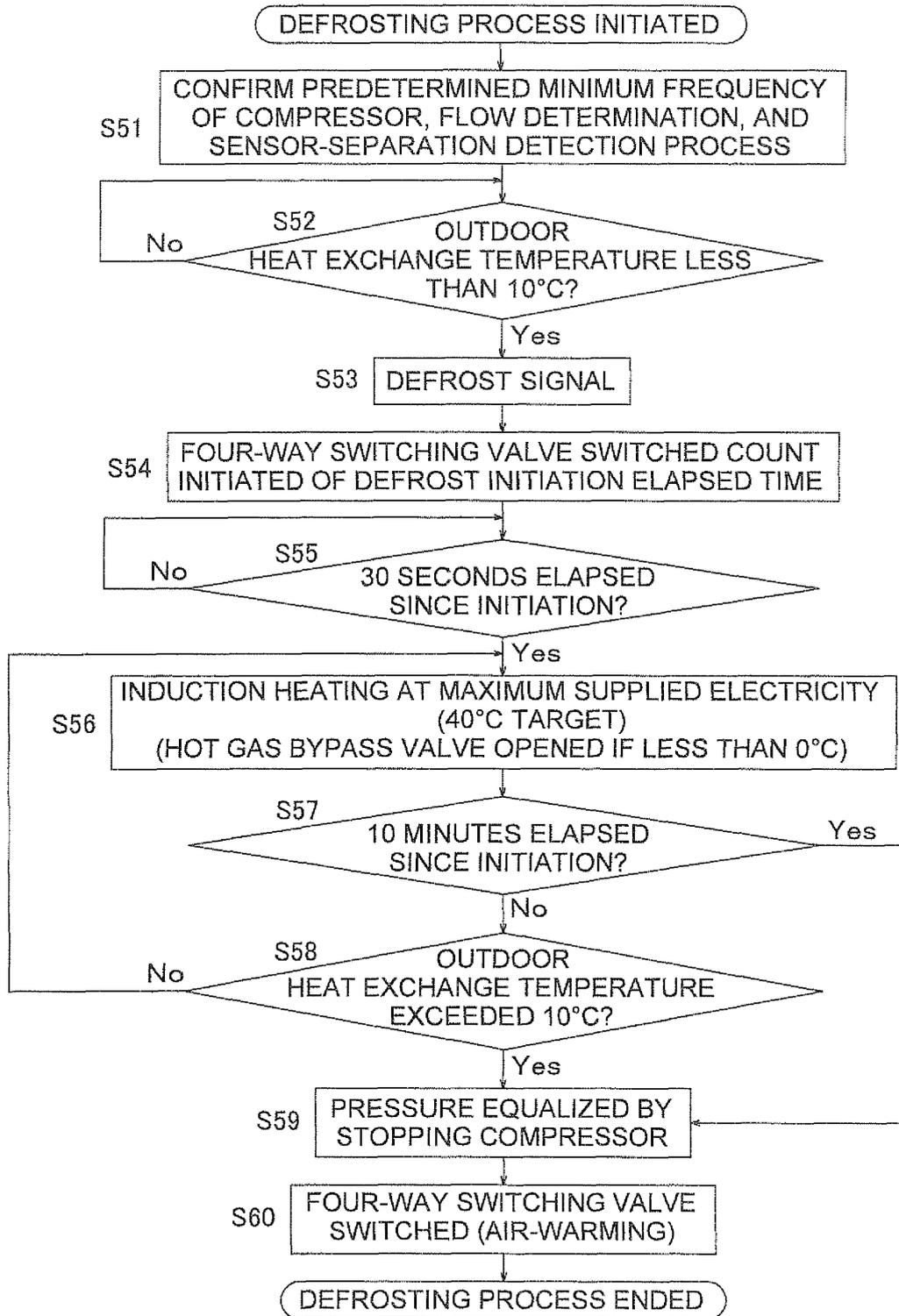


FIG. 21

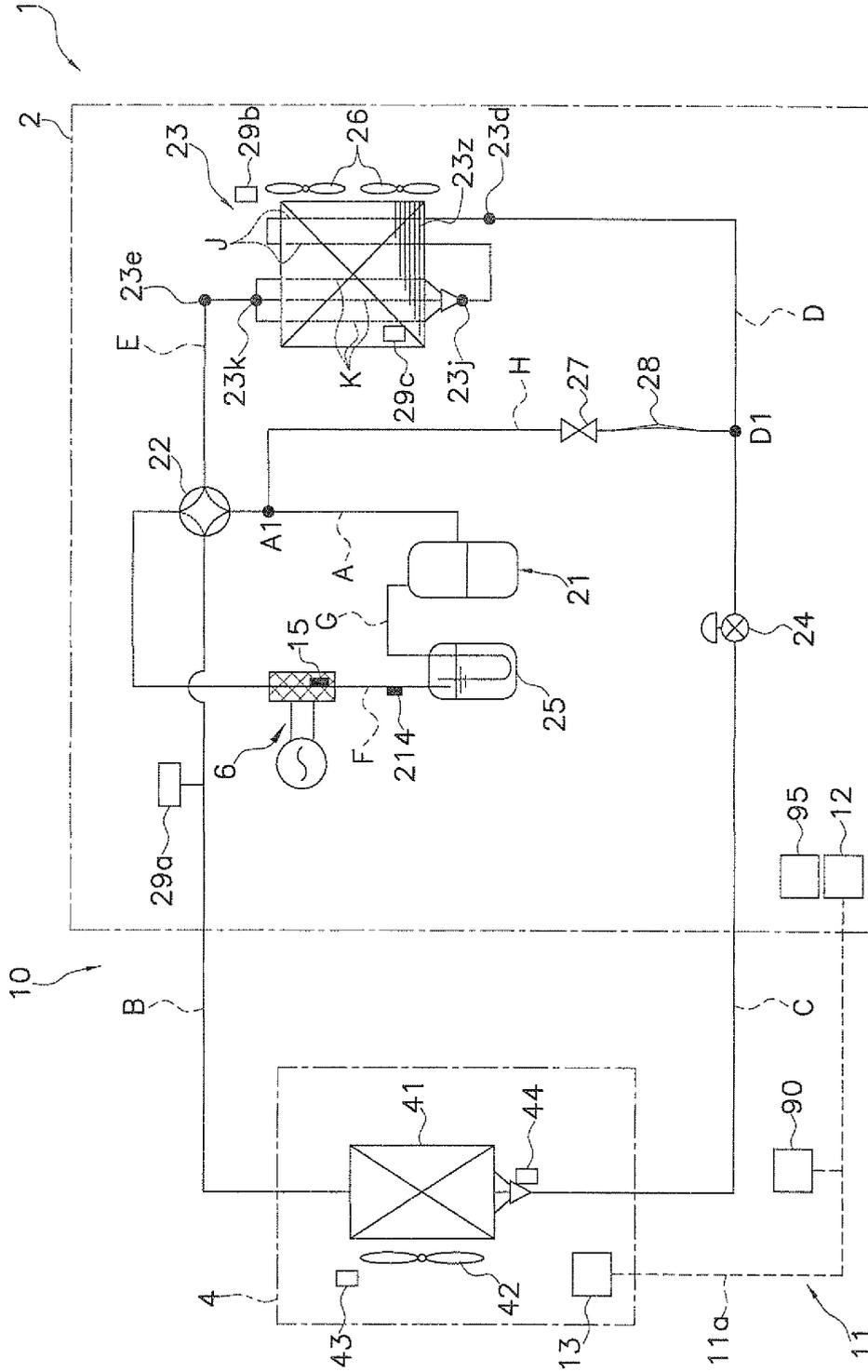


FIG. 22

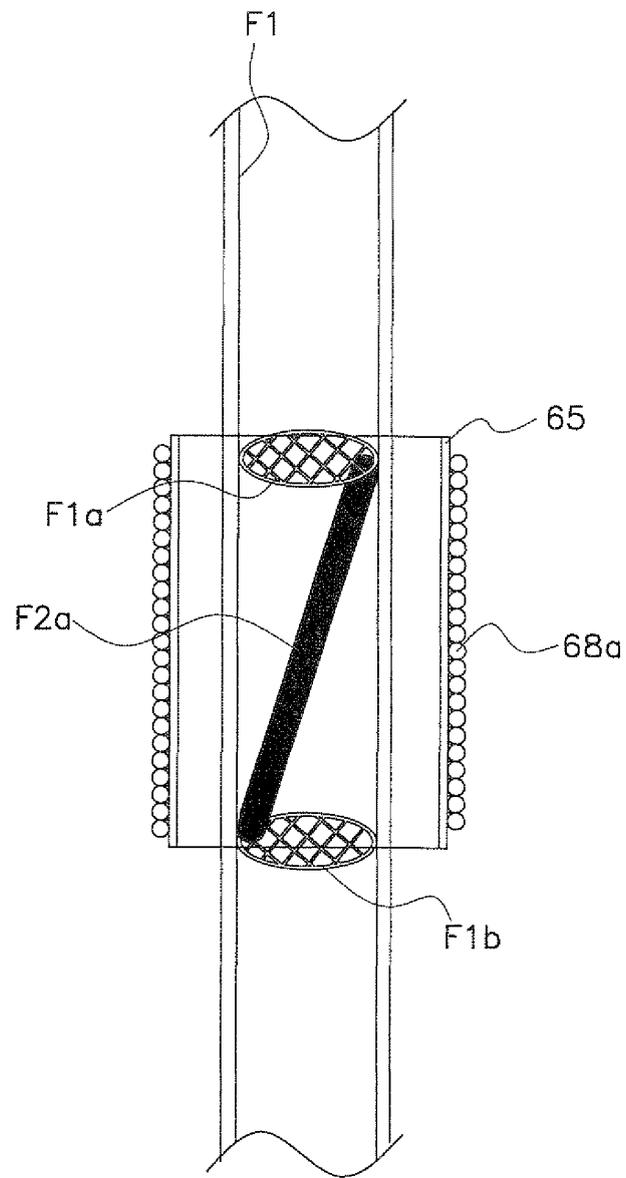


FIG. 23

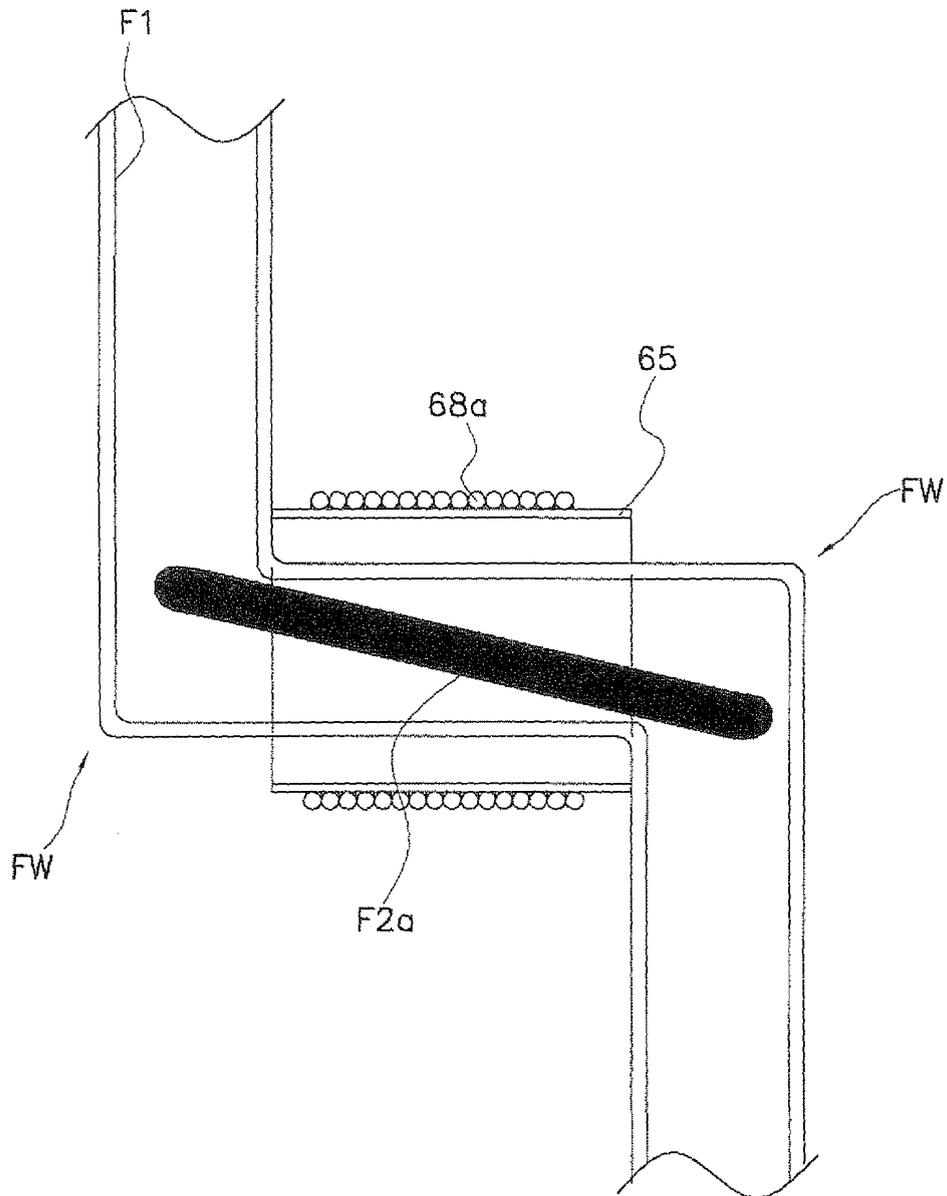


FIG. 24

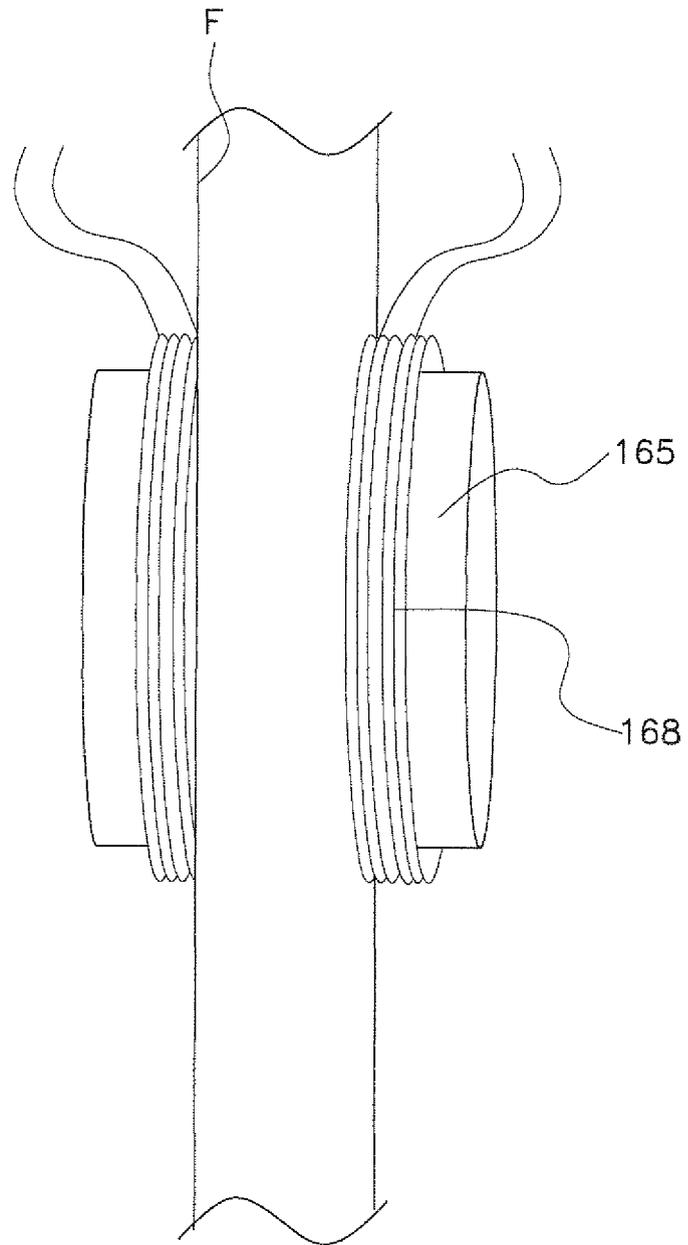


FIG. 25

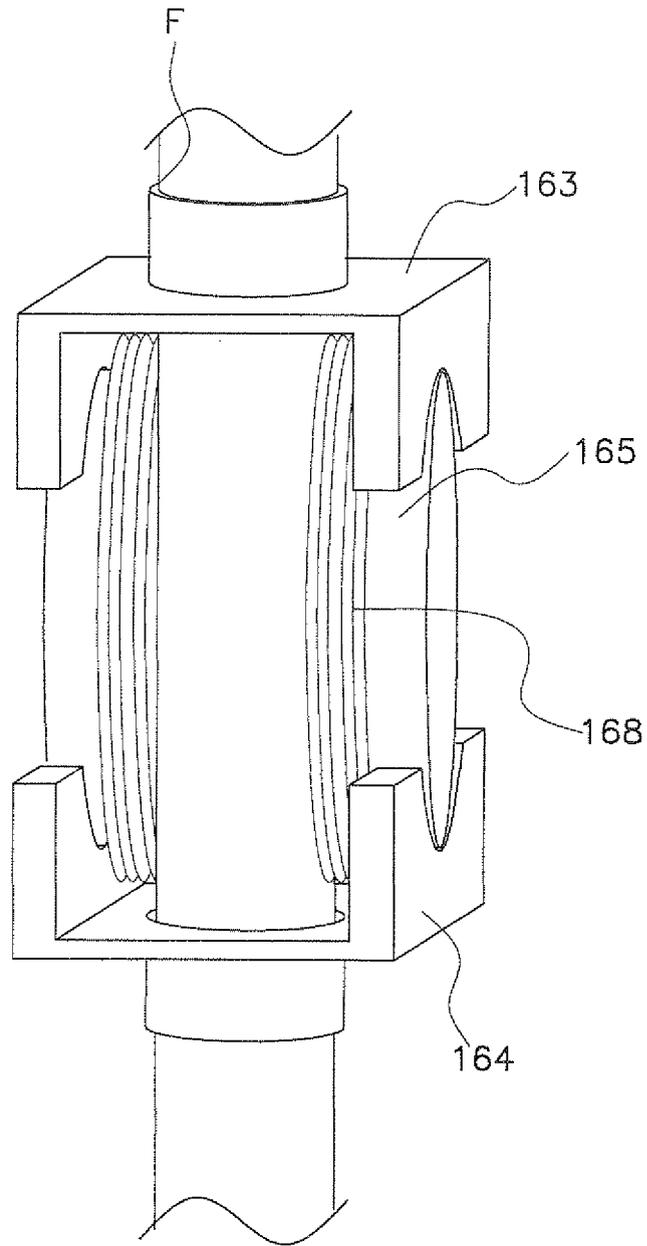


FIG. 26

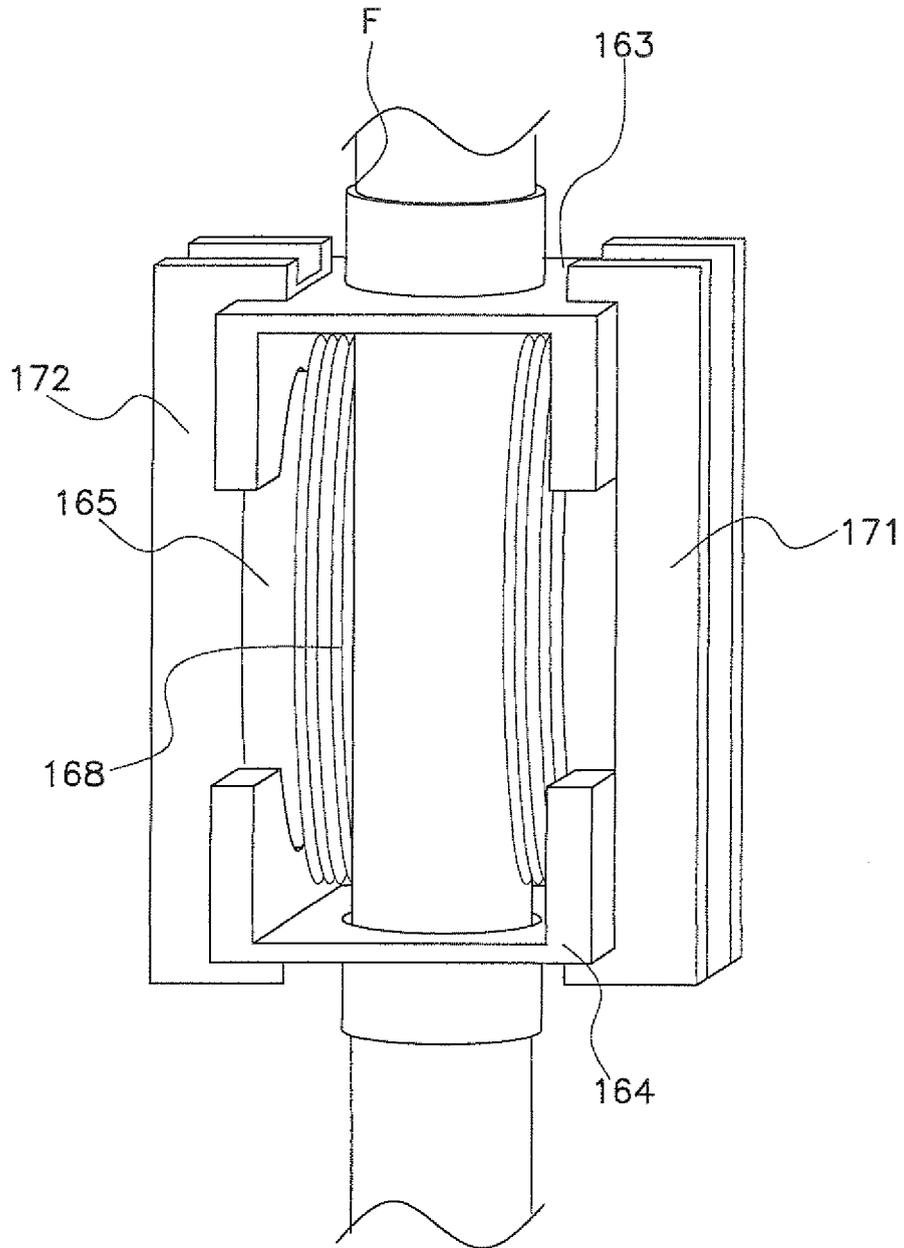


FIG. 27

EP 2 410 262 A1

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2010/001942
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A. CLASSIFICATION OF SUBJECT MATTER <i>F25B1/00</i> (2006.01) i, <i>F24F1/00</i> (2006.01) i, <i>F24F11/02</i> (2006.01) i, <i>F25B13/00</i> (2006.01) i, <i>F25B47/02</i> (2006.01) i According to International Patent Classification (IPC) or to both national classification and IPC													
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) <i>F25B1/00</i> , <i>F24F1/00</i> , <i>F24F11/02</i> , <i>F25B13/00</i> , <i>F25B47/02</i> Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010 Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)													
C. DOCUMENTS CONSIDERED TO BE RELEVANT													
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>JP 2000-97510 A (Sanyo Electric Co., Ltd.), 04 April 2000 (04.04.2000), entire text; all drawings (Family: none)</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>JP 62-77574 A (Toshiba Corp.), 09 April 1987 (09.04.1987), entire text; all drawings (Family: none)</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>JP 2001-255025 A (Daikin Industries, Ltd.), 21 September 2001 (21.09.2001), entire text; all drawings (Family: none)</td> <td>1-11</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	JP 2000-97510 A (Sanyo Electric Co., Ltd.), 04 April 2000 (04.04.2000), entire text; all drawings (Family: none)	1-11	A	JP 62-77574 A (Toshiba Corp.), 09 April 1987 (09.04.1987), entire text; all drawings (Family: none)	1-11	A	JP 2001-255025 A (Daikin Industries, Ltd.), 21 September 2001 (21.09.2001), entire text; all drawings (Family: none)	1-11	
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.													
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Date of the actual completion of the international search 16 June, 2010 (16.06.10)	Date of mailing of the international search report 29 June, 2010 (29.06.10)												
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/001942

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 4-15446 A (Matsushita Electric Industrial Co., Ltd.), 20 January 1992 (20.01.1992), entire text; all drawings (Family: none)	1-11
A	JP 2007-212036 A (Daikin Industries, Ltd.), 23 August 2007 (23.08.2007), entire text; all drawings & WO 2007/091553 A1	1-11
A	JP 2007-178114 A (Daikin Industries, Ltd.), 12 July 2007 (12.07.2007), entire text; all drawings & WO 2007/063916 A1	1-11

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000097510 A [0003] [0004] [0167]