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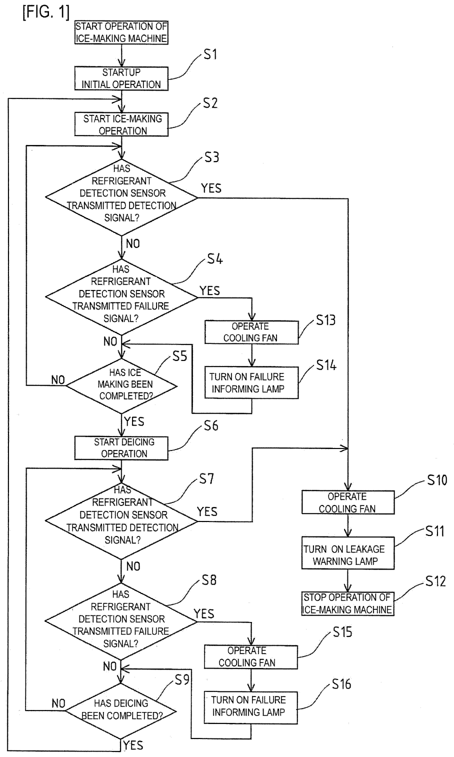
(54) METHOD FOR OPERATING ICE-MAKING MACHINE

(57) Safety and reliability are enhanced when the leakage of a refrigerant occurs, and ice-making efficiency is prevented from being lowered when a failure occurs in refrigerant detecting means.

A refrigerant detection sensor S that can detect a refrigerant leaking from a refrigerating mechanism E transmits a detection signal to controlling means C when the refrigerant has been detected, and transmits a failure signal to the controlling means C when a failure has occurred in the refrigerant detection sensor itself. The controlling means C controls a cooling fan 34, which forcedly air-cools a condenser 31, to continuously operate and also controls an ice-making mechanism D to stop an ice-making operation and a deicing operation upon receiving the detection signal from the refrigerant detection sensor S. Further, the controlling means C controls the cooling fan 34 to continuously operate and also controls the ice-making mechanism D to continue the ice-making operation and the deicing operation upon receiving the failure signal from the refrigerant detection sensor S.

[FIG. 1]



EP 2 618 079 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a method for operating an ice-making machine comprising a refrigerating mechanism that circulates a refrigerant which is a combustible gas and performs an ice-making operation and a deicing operation of the ice-making mechanism, and refrigerant detecting means capable of detecting the refrigerant leaking from the refrigerating mechanism.

BACKGROUND ART

[0002] FIG. 19 is a side cross-sectional view schematically showing a jet ice-making machine M that continuously produces many cubic ice blocks. In this ice-making machine M, the inside of a substantially box-like housing 10 is vertically partitioned, an upper part is configured as an ice storage chamber 11, a lower part is configured as a machine chamber 12, an ice-making mechanism D comprising an ice-making unit 20 that produces ice blocks is arranged on the upper side in the ice storage chamber 11, and a refrigerating mechanism E and others are arranged in the machine chamber 12. Further, as shown in FIG. 20, ice blocks 1 are generated by the ice-making unit 20 when the ice-making unit 20 of the ice-making mechanism D is cooled by the refrigerating mechanism E, and the generated ice blocks 20 are dropped and stored in the ice storage chamber 11 when the ice-making unit 20 is heated by the refrigerating mechanism E. As schematically shown in FIG. 20, the ice-making mechanism D is constituted of the ice-making unit 20 in which many ice-making small chambers 20A that are opened toward the lower side are formed, a water plate which can open or close each ice-making small chamber 20A, an ice-making water tank 22 arranged below the water plate 21, a water plate opening/closing mechanism 23 that integrally tilts the water plate 21 and the ice-making water tank 22, and others.

[0003] In the refrigerating mechanism E, as shown in FIG. 19 and FIG. 20, a refrigerant is circuited in a closed circuit having a compressor 30, a condenser 31 forcedly air-cooled by a cooling fan 34, an expansion valve 32, and an evaporator 33 coupled through a coupling tube 35 (a first coupling tube 35A, a second coupling tube 35B, a third coupling tube 35C, and a fourth coupling tube 35D), the compressor 30, the condenser 31, and the expansion valve 32 are arranged in the machine chamber 12, and the evaporator 33 is arranged to form a meandering pattern on an upper surface of the ice-making unit 20 in the ice storage chamber 11. In such a refrigerating mechanism E, the refrigerant is turned to a high-pressure gas by the compressor 30, the refrigerant is cooled and turned to a high-pressure liquid by the condenser 31, and the refrigerant is turned to an adiabatically-expanded liquid by the expansion valve 32, the refrigerant is gasified by the evaporator 33, and the evaporator 33 is cooled by vaporization heat. Further, as shown in FIG. 20, the refrigerating mechanism E comprises a fifth coupling tube 35E that couples the compressor 30 with the evaporator 33 and has a hot gas valve 36 arranged therein, a heated refrigerant (a hot gas) having a high temperature/high pressure is supplied from the compressor 30 to the evaporator 33 when the hot gas valve 36 is opened, and the evaporator 33 can be heated. That is, in the refrigerating mechanism E, the evaporator 33 can be cooled and heated, the ice-making mechanism D can perform an ice-making operation by cooling the evaporator 33, and the ice-making mechanism D can perform a deicing operation by heating the evaporator 33.

[0004] In conventional examples, the refrigerating mechanism E uses a noncombustible gas such as chlorofluorocarbon as the refrigerant, but use of the noncombustible gas is banned because it may possibly decompose ozone in the stratosphere, and a combustible gas such as propane or butane is adopted at the present. This combustible gas may leak into the ice-making machine M from appropriate portions of the compressor 30, the condenser 31, the expansion valve 32, the evaporator 33, and the coupling tube 35 in the refrigerating mechanism E. Therefore, in the ice-making machine M shown in FIG. 19, a refrigerant detection sensor S is arranged in each of the partitioned machine chamber 12 and ice storage chamber 11 so that the refrigerant detection sensor S can detect the refrigerant leaking from the refrigerating mechanism E. It is to be noted that a refrigerator provided with the refrigerant detection sensors is disclosed in Patent Document 1.

CITATION LIST

PATENT DOCUMENT

[0005] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2003-207244

DISCLOSURE OF INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006] Meanwhile, when leakage of the refrigerant has actually occurred and at least one of the two refrigerant detection sensors S has detected the leakage of the refrigerant, the conventional ice-making machine M that uses the combustible gas as the refrigerant is controlled so as to deactivate the refrigerating mechanism E and stop the ice-making operation and the deicing operation of the ice-making mechanism D. However, when the operation of the ice-making machine M is stopped while the refrigerant is leaking, the leaking refrigerant stays in the ice storage chamber 11 or the machine chamber 12, the highly-charged refrigerant may catch fire in the machine chamber 12 containing electrical parts or hot parts in particular, and hence there is a problem in safety and reliability.

[0007] Therefore, in view of the problem inherent in the conventional technology, the present invention is suggested so as to preferably solve this problem, and an object of the present invention is to provide a method for operating an ice-making machine that can prevent a refrigerant from staying in the ice-making machine when the refrigerant leaks and can enhance safety and reliability of the ice-making machine.

MEANS FOR SOLVING PROBLEM

[0008] To solve the problem and achieve the desired object, the invention according to claim 1 provides a method for operating an ice-making machine, the ice-making machine comprising: a refrigerating mechanism that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser forcedly air-cooled by a cooling fan, operates the cooling fan, performs an ice-making operation of an ice-making mechanism, and carries out a deicing operation of the ice-making mechanism after the ice-making operation; and refrigerant detecting means configured to detect the refrigerant leaking from the refrigerating mechanism,
wherein the refrigerate detecting means transmits a detection signal to controlling means when the refrigerant is detected, and
the controlling means controls the cooling fan to continuously operate upon receiving the detection signal from the refrigerant detecting means.
Therefore, according to the invention defined in claim 1, when the refrigerant detecting means has detected the refrigerant leaking from the refrigerating mechanism, since the controlling means continuously operates the cooling fan of the condenser, the leaking refrigerant can be discharged to the outside of the ice-making machine by the cooling fan, and the ice-making machine can be held in the safe state.

[0009] Likewise, to solve the problem and achieve the desired object, the invention according to claim 2 provides a method for operating an ice-making machine, the ice-making machine comprising: a refrigerating mechanism that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser forcedly air-cooled by a cooling fan, operates the cooling fan, performs an ice-making operation of an ice-making mechanism, and carries out a deicing operation of the ice-making mechanism after the ice-making operation; and refrigerant detecting means configured to detect the refrigerant leaking from the refrigerating mechanism,
wherein the refrigerant detecting means transmits a detecting signal to controlling means when the refrigerant is detected, and transmits a failure signal to the controlling means when a failure occurs in the refrigerant detecting means, and
the controlling means controls the cooling fan to continuously operate upon receiving at least one of the detection signal and the failure signal from the refrigerant detecting means.
Therefore, according to the invention defined in claim 2, when the refrigerant detecting means has detected the refrigerant leaking from the refrigerating mechanism, since the controlling means continuously operates the cooling fan of the condenser, the leaking refrigerant can be discharged to the outside of the ice-making machine by the cooling fan, the refrigerant does not stay in the ice-making machine, and hence the ice-making machine can be held in the safe state. Furthermore, when a failure has occurred in the refrigerant detecting means, since the controlling means continuously operates the cooling fan of the condenser, the refrigerant can be discharged to the outside of the ice-making machine by the cooling fan even if the refrigerant leaks during the failure of the refrigerant detecting means, the refrigerant does not stay in the ice-making machine, and hence the ice-making machine can be held in the safe state.

[0010] Likewise, to solve the problem and achieve the desired object, the invention according to claim 5 provides a method for operating an ice-making machine, the ice-making machine comprising a refrigerating mechanism that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser forcedly air-cooled by a cooling fan, operates the cooling fan, performs an ice-making operation of an ice-making mechanism, and carries out a deicing operation of the ice-making mechanism after the ice-making operation,
wherein refrigerant detecting means for transmitting a detection signal to controlling means is used while the refrigerant is detected, and
the controlling means controls the cooling fan to continuously operate when the detection signal from the refrigerant

detecting means is received even though a waiting time has elapsed from a time point at which reception of the detection signal from the refrigerant detecting means was started.

Therefore, according to the invention defined in claim 5, when the controlling means has not received the detection signal from the refrigerant detecting means at the time point that a waiting time elapsed after reception of the detection signal from the refrigerant detecting means was started, it can be determined that the refrigerant detecting means has detected a gas other than the refrigerant. Moreover, if the controlling means has received the detection signal from the refrigerant detecting means at the time point that the waiting time elapsed, it can be determined that the refrigerant detecting means has detected the refrigerant leaking from the refrigerating mechanism. Therefore, whether the refrigerant is leaking from the refrigerating mechanism can be assuredly and appropriately recognized.

[0011] Likewise, to solve the problem and achieve the desired object, the invention according to claim 6 provides a method for operating an ice-making machine, the ice-making machine comprising a refrigerating mechanism that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser forcedly air-cooled by a cooling fan, operates the cooling fan, performs an ice-making operation of an ice-making mechanism, and carries out a deicing operation of the ice-making mechanism after the ice-making operation,

wherein refrigerant detecting means for transmitting a detection signal to controlling means is used while the refrigerant is detected,

the controlling means operates the cooling fan for a predetermined operating time at a time point that reception of the detection signal from the refrigerant detecting means was started, and

the controlling means controls the cooling fan to continuously operate when the detection signal from the refrigerant detecting means has been received before a judging time elapses from a time point at which the cooling fan was stopped after elapse of the operating time.

Therefore, according to the invention defined in claim 6, in a case that reception of the detection signal from the refrigerant detecting means has started, if the gas or the refrigerant has been temporarily spread by the cooling fan over the operating time and then the controlling means does not receive the detection signal from the refrigerant detecting means a judging time elapses, it can be determined that the refrigerant detecting means has detected a gas other than the refrigerant. Additionally, when the controlling means has received the detection signal from the refrigerant detecting means before the judging time elapses, it can be determined that the refrigerant detecting means has detected the refrigerant leaking from the refrigerating mechanism. Therefore, whether the refrigerant is leaking from the refrigerating mechanism can be assuredly and appropriately recognized.

[0012] Likewise, to solve the problem and achieve the desired object, the invention according to claim 7 provides a method for operating an ice-making machine, the ice-making machine comprising: an ice-making unit that is opened toward the lower side and generates ice blocks; a water plate that is arranged below the ice-making unit and configured to change its posture to an ice-making position where the ice-making unit is closed and a deicing position that is inclined downward from the ice-making unit and where the ice-making unit is opened; an ice-making water tank that is fixed below the water plate, opened to the water plate side, and configured to change its posture integrally with the water plate; and a refrigerating mechanism configured to circulate a refrigerant that is a combustible gas and cool and heat the ice-making unit,

wherein a detection signal is transmitted to controlling means when refrigerant detecting means detects that the refrigerant leaks from the refrigerating mechanism,

the controlling means changes a posture of the water plate to the deicing position and stops an operation of the refrigerating mechanism when the water plate is present at the ice-making position or between the ice-making position and the deicing position, and

the controlling means stops the operation of the refrigerating mechanism while holding the water plate at the deicing position when the water plate is present at the deicing position.

Therefore, according to the invention defined in claim 7, when the refrigerant has leaked from the refrigerating mechanism, since the operation of the refrigerating mechanism stops while holding the water plate at the deicing position during either the ice-making operation or the deicing operation, a situation that the water plate and the ice-making water tank are opened and the leaking refrigerant permeates the ice-making water tank until hazardous concentration is reached can be avoided, and hence safety of the ice-making machine can be assured.

EFFECT OF THE INVENTION

[0013] According to the method for operating the ice-making machine of the present invention, since the refrigerant can be prevented from staying in the ice-making machine when the refrigerant is leaking, and hence safety and reliability of the ice-making machine can be enhanced.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

[FIG. 1] FIG. 1 is a flowchart schematically showing a method for operating an ice-making machine according to a first example.

[FIG. 2] FIG. 2 is a timing chart of a normal mode that is executed when the ice-making machine is normal in the method for operating the ice-making machine according to the first example.

[FIG. 3] FIG. 3 is a timing chart showing a state that the normal mode changes to a safe hold mode when a refrigerant leaking from a refrigerating mechanism is detected in the method for operating the ice-making machine according to the first example.

[FIG. 4] FIG. 4 is a timing chart showing a state that the normal mode changes to a safe mode when a failure in a refrigerant detection sensor occurs in the method for operating the ice-making machine according to the first example.

[FIG. 5] FIG. 5 is a flowchart schematically showing a method for operating an ice-making machine according to a second example.

[FIG. 6] FIG. 6 is a timing chart when a refrigerant detection sensor has detected a gas other than a refrigerant in the method for operating the ice-making machine according to the second example.

[FIG. 7] FIG. 7 is a timing chart showing a state that a normal mode changes to a safe hold mode when the refrigerant detection sensor has detected the refrigerant in the method for operating the ice-making machine according to the second example.

[FIG. 8] (a) is an explanatory view showing a detection signal when the refrigerant detection sensor has detected a gas other than the refrigerant, and (b) is an explanatory view showing a detection signal when the refrigerant detection sensor has detected the refrigerant.

[FIG. 9] FIG. 9 is a flowchart schematically showing a method for operating an ice-making machine according to a third example.

[FIG. 10] FIG. 10 is a timing chart when a refrigerant detection sensor has detected a gas other than a refrigerant in the method for operating the ice-making machine according to the third example.

[FIG. 11] FIG. 11 is a timing chart showing a state that a normal mode changes to a safe hold mode when the refrigerant detection senor has detected the refrigerant in the method for operating the ice-making machine according to the third example.

[FIG. 12] (a) is an explanatory view showing a detection signal when the refrigerant detection sensor has detected a gas other than the refrigerant, and (b) is an explanatory view showing a detection signal when the refrigerant detection sensor has detected the refrigerant.

[FIG. 13] FIG. 13 is a flowchart schematically showing a method for operating an ice-making machine according to a fourth example.

[FIG. 14] FIG. 14 is a timing chart showing a state that a normal mode changes to a safe hold mode when a refrigerant leaking from a refrigerating mechanism has been detected in the method for operating the ice-making machine according to the fourth example.

[FIG. 15] FIG. 15 is a block diagram of a control system in an ice-making machine to which the operating method according to each of the first to fourth examples is carried out.

[FIG. 16] FIG. 16 is a side cross-sectional view schematically showing a configuration of the ice-making machine to which the operating method according to each of the first to fourth examples is carried out.

[FIG. 17] FIG. 17 is a partially cutaway exploded perspective view showing the ice-making machine depicted in FIG. 16 with some members being removed.

[FIG. 18] FIG. 18 is a partially cutaway front view showing an ice-making mechanism in the ice-making machine depicted in FIG. 16.

[FIG. 19] FIG. 19 is a side cross-sectional view schematically showing a configuration of a conventional ice-making machine that continuously generates cubic ice blocks.

[FIG. 20] FIG. 20 is a schematic block diagram of an ice-making mechanism and a refrigerating mechanism in the conventional ice-making machine.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0015] Preferred examples of a method for operating an ice-making machine according to the present invention will now be described hereinafter with reference to the accompanying drawings. In each example, there is illustrated an ice-making machine M in which a basic configuration of a housing or configurations of a refrigerating mechanism E and an ice-making mechanism D are equal to those in the conventional ice-making machine M shown in FIG. 19 and FIG. 20. Therefore, like reference numerals denote members and portions equal to the members and the portions shown in FIG.

19 and FIG. 20, and FIG. 20 will be used in a description of the refrigerating mechanism E and the ice-making mechanism D. It is to be noted that, in each example, a side where an opening/closing door 18 is arranged (a left side in FIG. 16) is a front side of the ice-making machine M, a left-and-right direction seen from the front side is a left-and-right direction of the ice-making machine M, and an up-and-down direction is an up-and-down direction of the ice-making machine M.

EXAMPLES

[0016] First, the ice-making machine M to which a later-described operating method according to each example is carried out will be explained with reference to FIG. 15 to FIG. 18 and FIG. 20. As shown in FIG. 16 and FIG. 17, in the ice-making machine M, the inside of a substantially box-like housing 10 is vertically partitioned, an ice storage chamber 11 having a heat-insulated structure is defined on the upper side, and a machine chamber 12 is defined below the ice storage chamber 11. The ice storage chamber 11 can be opened or closed based on a change in posture of the opening/closing door 18 arranged on the front side of the housing 10, and an ice-making mechanism D and an evaporator 33 of a refrigerating mechanism E are arranged on an inner upper side. A compressor 30, a condenser 31, an expansion valve 32, and others constituting the refrigerating mechanism E, and other various mechanisms and components are arranged in the machine chamber 12. Additionally, a refrigerant detection sensor S as refrigerant detecting means is arranged on a bottom portion of the machine chamber 12. Further, an ice storage switch 19 that detects that generated ice blocks 1 have reached a predetermined ice storage amount is arranged on a wall portion of the ice storage chamber 11 (see FIG. 15 and FIG. 20).

[0017] As shown in FIG. 16 to FIG. 18 and FIG. 20, the ice-making mechanism D is constituted of the ice-making unit 20 in which many ice-making small chambers 20A that are opened toward the lower side are formed, a water plate 21 which can open or close each ice-making small chamber 20A from the lower side, an ice-making water tank 22 arranged below the water plate 21, a water plate opening/closing mechanism 23 that integrally tilts the water plate 21 and the ice-making water tank 22, and others. Further, a fitting member 13 is installed above the ice-making unit 20 in the housing 10 so as to be horizontal in the left-and-right direction, and the ice-making mechanism D is arranged so as to be suspended from the fitting member 13 (see FIG. 16 to FIG. 18). The ice-making unit 20 is fixed to the fitting member 13 in a horizontal state that the respective ice-making small chambers 20A face the lower side. A support arm 24 disposed to a left end portion of the water plate 21 is pivoted on a bracket 14 of the fitting member 13 through a spindle 15, and a portion near a right end portion of the water plate 21 is connected through a coil spring 26 to a cam arm 25 constituting the water plate opening/closing mechanism 23 arranged on the fitting member 13. Therefore, when the cam arm 25 is rotated in a forward or reverse direction by an opening/closing motor 27, the water plate 21 can change its posture to an ice-making position (indicated by a solid line in each of FIG. 18 and FIG. 20) at which the cam arm 25 moves up and becomes horizontal so as to close the ice-making portion 20, and a deicing position inclined to bottom right (indicated by an alternate long and short dashes line in FIG. 20) at which the cam arm 25 moves down to open the ice-producing portion 20. It is to be noted that, in the ice-making mechanism D, a first water plate detection switch 40 which detects that that the water plate 21 has reached the ice-making position and a second water plate detection switch 41 which detects that the water plate 21 has reached the deicing position are arranged (see FIG. 15). Further, the ice-making mechanism D comprises an ice-making unit temperature sensor 42 that detects a temperature of the ice-making unit 20 at a necessary position of the ice-making unit 20 (see FIG. 15 and FIG. 20). Therefore, the ice-making mechanism D is controlled so as to change from the ice-making operation to the deicing operation when the ice-making unit temperature sensor 42 has detected a preset ice-making completion temperature during the ice-making operation, and the ice-making mechanism D is controlled so as to change from the deicing operation to the ice-making operation when the ice-making unit temperature sensor 42 has detected a preset deicing completion temperature during the deicing operation.

[0018] As shown in FIG. 16 to FIG. 18 and FIG. 20, the ice-making water tank 22 is a bucket-like member that is upwardly opened, and it is fixed to the water plate 21 by an appropriate fixing member and configured to tilt with a change in tilt of the water plate 21. The ice-making water tank 22 can store a predetermined amount of ice-making water supplied from an external water supply source by opening of a feed-water valve 29 in a posture that the water plate 21 is engaged with a closing position, or it is configured to discharge the stored ice-making water to a drain pan 16 in a posture that the water plate 21 is engaged with an opening position. Furthermore, on a left-side front wall which is the deepest portion of the ice-making water tank 22, an ice-making water pump 28 that jets and supplies the ice-making water stored in the ice-making water tank 22 into each ice-making small chamber 20A of the ice-making unit 20 through an injection hole provided in the water plate 21. It is to be noted that the ice-making water tank 22 is opened in the ice storage chamber 11 in a state that the right bottom portion of the ice-making water tank 22 is inclined toward the bottom right when the water plate 21 tilts to the deicing position and moves away from the ice-making unit 20 toward the lower side (see FIG. 20).

[0019] As shown in FIG. 16, FIG. 17, and FIG. 20, the refrigerating mechanism E comprises the compressor 30 arranged in the machine chamber 12, the condenser 31 that is provided with a cooling fan 34 and forcedly air-cooled, the expansion valve 32, and an evaporator 33 arranged to form a meandering pattern on an upper surface of the ice-making unit 20 of the ice-making mechanism D in the ice storage chamber 11. The compressor 30, the condenser 31, the expansion valve 32, and the evaporator 33 are coupled in series through the coupling tube 35, whereby a refrigerating circuit in which the refrigerant constituted of a combustible gas is circuited is formed. That is, an outlet portion of the compressor 30 is coupled with an inlet portion of the condenser 31 through the first coupling tube 35A, an outlet portion of the condenser 31 is coupled with an inlet portion of the expansion valve 32 through the second coupling tube 35B, an outlet portion of the expansion valve 32 is coupled with an inlet portion of the evaporator 33 through the third coupling tube 35C, and an outlet portion of the evaporator 33 is coupled with an inlet portion of the compressor 30 through the fourth coupling tube 35D. Further, the fifth coupling tube 35E that is connected to a midpoint of the first coupling tube 35A and also connected to a midpoint of the third coupling tube 35C is provided (see FIG. 20), and the heated refrigerant (a hot gas) compressed by the compressor 30 can be directly supplied to the evaporator 33 through the fifth coupling tube 35E by controlling the hot gas valve 36 arranged on a midpoint of the fifth coupling tube 35E to be opened.

[0020] The refrigerant is an HC (hydrocarbon) refrigerant which has been extensively used in refrigerators or ice-making machines, and it is made of a combustible gas such as propane (R290) or isobutene (R600a). This refrigerant has specific gravity higher than air. Therefore, if the refrigerant leaks from the compressor 30, the condenser 31, the expansion valve 32, or the evaporator 33 constituting the refrigerating mechanism E, the coupling tube 35 (the first coupling tube 35A to the fifth coupling tube 35E), a coupling portion between each of these devices and the coupling tube 35, or the like, the refrigerant moves to the machine chamber 12 placed below the ice-making machine M. It is to be noted that a description of various physical properties and others of the refrigerant will be omitted.

[0021] As shown in FIG. 16 and FIG. 17, the third coupling tube 35C that couples the expansion valve 32 arranged in the machine chamber 12 with the evaporator 33 arranged in the ice storage chamber 11 and the fourth coupling tube 35D that couples the evaporator 33 with the compressor 30 arranged in the machine chamber 12 are arranged along the inside of a piping space (a communication space) defined on a back surface of the housing 10. As shown in FIG. 17, the piping space 45 is vertically defined on the back surface of the housing 10 by disposing a half-gutter-like cover member 46 that is vertically elongated and opened on the housing 10 side to the back surface of the housing 10. Moreover, as shown in FIG. 16, the piping space 45 spatially communicates with the inside of the ice storage chamber 11 through a first communicating portion 47 formed at an upper portion (a rear wall upper portion of the ice storage chamber 11) of the housing 10, and it also spatially communicates with the inside of the machine chamber 12 through a second inserting portion 48 formed from the center of the housing 10 in the vertical direction toward the lower side. Additionally, each of the first coupling portion 47, the piping space 45, and the second inserting portion 48 is formed with a shape and a size that enable a gap G, which allows the refrigerant to flow therethrough, to be formed between itself and a heat insulating material 37 wound around the third coupling tube 35C and the fourth coupling tube 35D.

[0022] It is to be noted that the first coupling portion 47 is provided at the rear wall upper portion of the ice storage chamber 11 for the following reasons. As a reason 1, when the ice blocks 1 generated by the ice-making mechanism D are fully stored in the ice storage chamber 11 as shown in FIG. 20, in a situation where the first communicating portion 47 is provided at the bottom portion of the ice storage chamber 11, the ice blocks 1 may close the first communicating portion 47 and the refrigerant may not be appropriately discharged. As a reason 2, since molten water is always generated in the ice storage chamber 11, if the first communicating portion 47 is provided at the bottom portion of the ice storage chamber 11, the molten water may flow into the first communicating portion 47. As a reason 3, since the refrigerating mechanism E arranged in the ice-making machine M has a higher refrigerant filling amount than that of a household refrigerator or air conditioner and an internal volume of the ice storage chamber 11 is smaller than that of a household refrigerator or air conditioner, the entire inside of the ice storage chamber 11 is filled with the leaking refrigerant in a relatively short time, and the leaking refrigerant can be also sufficiently discharged from the first communicating portion 47 provided at the rear wall upper portion of the ice storage chamber 11. In particular, as shown in FIG. 16, the drain pan 16 is arranged on the lower side of the ice-making mechanism D, the refrigerant that has leaked into the ice storage chamber 11 from the refrigerating mechanism E hardly flows down because of the drain pan 16 and is apt to stay on the upper side of the drain pan 16, and hence the refrigerant can be easily discharged from the first communicating portion 47. Further, since the rear wall upper portion of the ice storage chamber 11 is close to the evaporator 33, the refrigerant leaking from the evaporator 33 can easily flows into the first communicating portion 47 provided at the rear wall upper portion.

[0023] That is, the ice-making machine M is configured in such a manner that, for example, when a crack or a hole is formed at a halfway point of the third coupling tube 35C or the fourth coupling tube 35D and the refrigerant leaks from the crack or the hole, the refrigerant can move downward in the piping space 45 and move to the inside of the machine chamber 12 through the second inserting portion 48. Furthermore, the ice-making machine M is configured in such a manner that, when a crack or a hole is formed at a halfway point of the evaporator 33 and the refrigerant leaks into the ice storage chamber 11 from the crack or the hole, or when the refrigerant leaks into the ice storage chamber 11 from the coupling portion between the evaporator 33 and the third coupling tube 35C or the coupling portion between the evaporator 33 and the fourth coupling tube 35D, the refrigerant can move into the machine chamber 12 through the first communicating portion 47, the piping space 45, and the second inserting portion 48.

[0024] Moreover, in the ice-making machine M, as described above, since the ice storage chamber 11 is configured to communicate with the machine chamber 12 through the piping space 45, one refrigerant detection sensor S alone, which can detect the refrigerant, is arranged substantially immediately below the second inserting portion 48 in the machine chamber 12 as shown in FIG. 16 and FIG. 17. This refrigerant detection sensor S is of a tin oxide semiconductor type having a heater coil or an electrode leak wire buried in a material mainly containing stannic oxide (SnO_2) as a gas sensing element, and it can appropriately detect the refrigerant made of propane or isobutene. Moreover, the refrigerant detection sensor S is electrically connected to controlling means C (see FIG. 15) for controlling the ice-making machine M and keeps supplying detection signals to the controlling means C while the refrigerant is being detected. Therefore, the refrigerant detection sensor S can appropriately detect the refrigerant that has directly leaked into the machine chamber 12 from the compressor 30, the condenser 31, the expansion valve 32, the first coupling tube 35A, and the second coupling tube 35B, and it can also appropriately detect the refrigerant that has leaked from the condenser 31, the third coupling tube 35C, and the fourth coupling tube 35D and moved into the machine chamber 12 as described above. It is to be noted that the refrigerant detection sensor S is configured to supply a detection signal when concentration of the refrigerant is, e.g., not smaller than 0.15% and configured to cancel supply of the detection signal when the concentration of the refrigerant is lower than 0.15%.

[0025] Additionally, the refrigerant detection sensor S has a self-diagnostic function and can always judge a failure in its own, and it is configured to supply a failure signal to the controlling means C when a failure occurs due to, e.g., degradation or damage arising from long-term use. Therefore, the controlling means C of the ice-making machine M can immediately recognize a failure in the refrigerant detection sensor S even during the ice-making operation or the deicing operation of the ice-making mechanism D. It is to be noted that, when the failure is temporary and the machine is normally restored, the refrigerant detection sensor S can be automatically restored and can automatically stop supply of the failure signal to the controlling means C.

[0026] As shown in FIG. 15, the ice-making machine M comprises leakage warning lamp (warning means) 50 that informs (warns) of occurrence of leakage of the refrigerant, and it can rapidly detect occurrence of leakage of the refrigerant by using the controlling means C when the leakage occurs. Further, the ice-making machine M comprises a failure informing lamp (informing means) 51 that informs of occurrence of a failure in the refrigerant detection sensor S, and it can rapidly inform of occurrence of a failure in the refrigerant detection sensor S by using the controlling means C when the failure occurs. It is to be noted that the leakage warning lamp 50 and the failure informing lamp 51 are arranged on, e.g., a front surface of the housing 10 of the ice-making machine M.

[0027] As shown in FIG. 15, the controlling means C comprehensively controls the ice-making machine M, receives a detection signal or a failure signal from the refrigerant detection sensor S, receives a detection signal from the ice-making unit temperature sensor 42, the first water plate detection switch 40, the second water plate detection switch 41, the ice storage switch 19, or the like, and also receives a detection signal and others from various measuring means, detecting means, or the like which are omitted in the drawings. Furthermore, the controlling means C comprehensively controls the compressor 30, the cooling fan 34, and the hot gas valve 36 in the refrigerating mechanism E, the opening/closing motor 27, the feed-water valve 29, and the ice-making water pump 28 in the ice-making mechanism D, the leakage warning lamp 50, the failure informing lamp 51, and others based on various input signals and various settings and the like input from a non-illustrated control panel.

[0028] A method for operating the thus configured ice-making machine M will now be described in conjunction with first to fourth examples.

(First Example)

[0029] In a method for operating the ice-making machine according to a first example, as shown in the following Table 1, as operation modes during running, a "normal mode", a "safe hold mode", and a "safe mode" are set, and the operation modes are automatically changed over in accordance with a state of the ice-making machine M.

[0030]

[Table 1]

Operation mode	Regular	Safe	Safe hold
Ice-making state	Normal	Sensor failure	Leakage of refrigerant
Operation	Normal Ice-making operation	Ice-making operation enabled	Ice-making operation stopped
Condenser fan	ON-OFF control	Continuous ON control	Continuous ON control
Indication	-	Failure informing lamp ON	Leakage warning lamp ON

[0031] The "normal mode" is an operation mode that is executed when the ice-making machine M is normal on the premise that the refrigerant detection sensor S is normally operating, and the normal ice-making operation and deicing operation are executed in accordance with a predetermined operation program. In this normal mode, as shown in FIG. 2, the cooling fan 34 of the condenser 31 is controlled to be turned on and operated during the ice-making operation, and the cooling fan 34 is controlled to be turned off and stopped only while the hot gas valve 36 is opened during the deicing operation. It is to be noted that the ice-making machine M can operate in such a manner that the cooling fan 34 is controlled to be turned on and operated even during the deicing operation in the normal mode, a predetermined ice storage amount of the ice blocks 1 is stored in the ice storage chamber 11, and the cooling fan 34 is controlled to be turned off and stopped only while the ice storage switch 19 is detecting the ice blocks 1.

[0032] The "safe hold mode" is an operation mode that is executed at the time of abnormality that the refrigerant detection sensor S has detected the refrigerant leaking from the refrigerating mechanism E and a detection signal from the refrigerant detection sensor S has been supplied to the controlling means C. In this safe hold mode, as shown in FIG. 3, the ice-making operation and the deicing operation of the ice-making mechanism D are stopped, and the cooling fan 34 of the condenser 31 is subjected to continuous ON control and continuously operated. Therefore, when the cooling fan 34 of the condenser 31 is continuously operated, air in the machine chamber 12 is stirred, the refrigerant that has flowed into the machine chamber 12 is diffused and discharged to the outside of the machine through venting holes 17 providing in the housing 10, and hence the refrigerant can be prevented from permeating the machine chamber 12 so as to increase concentration. It is to be noted that the refrigerant that has leaked into the ice storage chamber 11 moves to the machine chamber 12 through the piping space 45 and is then discharged to the outside of the machine through the venting holes 17, but it can be also discharged to the outside of the machine by opening the opening/closing door 18.

[0033] The "safe mode" is an operation mode that is executed at the time of abnormality that a failure has occurred in a refrigerant detecting function or the like in the refrigerant detection sensor S and a failure signal from the faulty refrigerant detection sensor S has been supplied to the controlling means C. In this safe mode, as shown in FIG. 4, the cooling fan 34 of the condenser 31 is subjected to the continuous ON control and continuously operated, and the ice-making operation and the deicing operation of the ice-making mechanism D continue. As a result, generation of the ice blocks 1 continues even though the refrigerant detection sensor S has a failure and, if the refrigerant has leaked from the refrigerating mechanism E and the refrigerant has flowed into the machine chamber 12, the refrigerant is diffused by the continuous operation of the cooling fan 35, the refrigerant is discharged to the outside of the machine through the venting holes 17 provided in the housing 10, and the refrigerant can be prevented from permeating the machine chamber 12 so as to increase concentration. That is, in the operating method according to the first example, even if a failure has occurred in the refrigerant detection sensor S, the ice-making operation and the deicing operation of the ice-making mechanism D continue on the premise that the refrigerating mechanism E is normal, thereby suppressing a decrease in ice-making efficiency of the ice blocks.

[0034] It is to be noted that, in the safe hold mode and the safe mode, the number of revolutions of the cooling fan 34 when the cooling fan 34 is continuously operated is set to be higher than the number of revolutions in the ice-making operation in the normal mode. As a result, in the safe hold mode and the safe mode, since the cooling fan 34 rotates at a high speed and energetically stirs air in the machine chamber 12, the refrigerant that has leaked from the refrigerant mechanism E to the inside of the machine chamber 12 can be efficiently diffused.

(Operation of First Example)

[0035] In the method for operating the ice-making machine according to the first example, as shown in FIG. 1 and FIG. 2, when a main power supply is turned on and the operation of the ice-making machine is started, a startup initial operation is first executed, whereby a predetermined initial operation concerning the ice-making mechanism D and the refrigerating mechanism E is carried out (a step S1). When the startup initial operation is completed, the ice-making operation in the normal mode is started (a step S2), and the ice-making mechanism D and the refrigerating mechanism E are operated.

[0036] Further, during the ice-making operation in the normal mode, the controlling means C confirms whether the refrigerant detection sensor S has supplied the refrigerant detection signal (a step S3), and the control C confirms whether the refrigerant detection sensor S has supplied the failure signal when the detection signal is yet to be supplied (a step S4). If the refrigerant detection sensor S has not supplied both the detection signal and the failure signal, whether the ice making in the ice-making mechanism D has been completed is confirmed (a step S5), the processing returns to the step S3 if the ice making has not been completed, and the step S3 and the step S4 are again executed. That is, during the ice-making operation, supply of the detection signal and supply of the failure signal from the refrigerant detection sensor S are constantly confirmed. It is to be noted that completion of ice making is determined by the ice-making unit temperature sensor 42 when a temperature of the ice-making unit 20 has been lowered to a preset ice-making completion temperature.

[0037] During the ice-making operation, when it is determined that ice making has been completed at the step S5 without transmitting the detection signal and the failure signal from the refrigerant detection sensor S, the ice-making operation is terminated, and the deicing operation is started (a step S6). During the deicing operation in the normal mode, the controlling means C confirms whether the refrigerant detection sensor S has transmitted the refrigerant detection signal (a step S7), and the controlling means C confirms whether the refrigerant detection sensor S has transmitted the failure signal when the detection signal has not been transmitted (a step S8). Furthermore, when the refrigerant detection sensor S has not transmitted both the detection signal and the failure signal, whether deicing in the ice-making mechanism D has been completed is confirmed (a step S9), the processing returns to the step S7 when deicing has not been completed, and the step S7 and the step S8 are again executed. That is, during the deicing operation, transmission of the detection signal and transmission of the failure signal from the refrigerant detection sensor S are constantly confirmed. It is to be noted that completion of deicing is determined by the ice-making unit temperature sensor 42 when a temperature of the ice-making unit 20 has reached a preset deicing completion temperature or a higher temperature.

[0038] That is, in the normal mode, the ice-making operation and the deicing operation are executed while constantly confirming transmission of the detection signal and transmission of the failure signal from the refrigerant detection sensor S. Furthermore, if the refrigerant detection sensor S has not transmitted the detection signal and the failure signal, the ice-making operation and the deicing operation are repeated until the ice storage switch 19 detects that a predetermined amount of ice blocks 1 has been stored in the ice storage chamber 11.

[0039] Moreover, in the operating method according to the first example, as shown in FIG. 1 and FIG. 3, during the ice-making operation that the step S2 to the step S5 are repeated in the normal mode, when the refrigerant detection sensor S has detected the leaking refrigerant and transmitted the detection signal to the controlling means C, the controlling means C switches the operation mode from the normal mode to the safe hold mode upon confirming transmission of the detection signal at the step S3. As a result, the controlling means C continuously operates the cooling fan 34 at a higher speed than that in a regular speed (a step S10), controls the leakage warning lamp 50 to be turned on (a step S11), and stops the operation of the refrigerating mechanism E and the ice-making mechanism D of the ice-making machine M.

[0040] Additionally, in the operating method according to the first example, during the deicing operation that the step S6 to the step S9 are repeated in the normal mode, when the refrigerant detection sensor S has detected the leaking refrigerant and transmitted the detection signal to the controlling means C, the controlling means C switches the operation mode from the normal mode to the safe hold mode upon confirming transmission of the detection signal at the step S7. As a result, the controlling means C continuously operates the cooling fan 34 at a higher speed than a regular speed (the step S10), controls the leakage warning lamp 50 to be turned on (the step S11), and stops the operation of the refrigerating mechanism E and the ice-making mechanism D of the ice-making machine M. That is, in the ice-making machine M, even if the mode is switched to the safe hold mode and the ice-making operation and the deicing operation in the ice-making mechanism D are stopped, the cooling fan 34 is continuously operated to prevent the refrigerant from staying in the machine chamber 12.

[0041] Therefore, in the method for operating the ice-making machine according to the first example, when the refrigerant has leaked from the refrigerating mechanism E into the machine chamber 12, since the refrigerant is diffused in the machine chamber 12 and discharged to the outside of the machine by the continuous operation of the cooling fan 34, the refrigerant can be appropriately prevented from permeating the machine chamber 12 and reaching hazardous concentration, and hence the ice-making machine M can be held in the safe state. Additionally, since the cooling fan 34 is operated at a higher speed than that in the regular ice-making operation, the leaking refrigerant can be appropriately diffused. Further, when the leakage warning lamp 5 is turned on, a manager of the ice-making machine M can recognize that the refrigerant has leaked in the ice-making machine M on the earlier stage, and hence the refrigerating mechanism E can be rapidly repaired or replaced.

[0042] On the other hand, in the operating method according to the first example, during the ice-making operation that the step S2 to the step S5 are repeated in the normal mode, when the refrigerant detection sensor S has failed to operate properly and transmitted to the failure signal to the controlling means C, the controlling means C switches the operation mode from the normal mode to the safe mode upon confirming transmission of the failure signal at the step S4. As a result, the controlling means C continuously operates the cooling fan 34 (a step S13), controls the failure informing lamp 51 to be turned on (a step S14), then returns to the step S5, and confirms whether ice making has been completed. Further, when ice making has not been completed, the step S3 to the step S5 are repeated, the ice-making operation is continued, the processing advances to the step S6 upon completion of ice making, the deicing operation is started, and thereafter the ice-making operation and the deicing operation are repeated while continuously operating the cooling fan 34 like the normal mode.

[0043] Furthermore, in the operating method according to the first example, during the deicing operation that the step S6 to the step S9 are repeated in the normal mode, when the refrigerant detection sensor S has failed to operate properly and transmitted the failure signal to the controlling means C, the controlling means C switches the operation mode from the normal mode to the safe mode upon confirming transmission of the failure signal at the step S8. As a result, the controlling means C continuously operates the cooling fan 34 (a step S 15), controls the failure informing lamp 51 to be turned on (a step S16), then returns to the step S9, confirms whether deicing has been completed, repeats the step S7 to the step S9 if deicing has not been completed, and continues the deicing operation. Further, if deicing has been completed, the processing advances to the step S2, the ice-making operation is started, and thereafter the ice-making operation and the deicing operation are repeated while continuously operating the cooling fan 34 like the normal mode.

[0044] Therefore, in the method for operating the ice-making machine according to the first example, when the refrigerant detection sensor S has failed to operate properly, since the ice-making operation and the deicing operation in the ice-making mechanism D can be continuously performed while continuously operating the cooling fan 34 of the condenser 31, a reduction in ice-making efficiency of the ice blocks 1 can be suppressed, and high safety and reliability required for business devices can be obtained. Furthermore, during a failure of the refrigerant detection sensor S, since the cooling fan 34 always continuously operates at the time of the ice-making operation and the deicing operation of the ice-making mechanism D, even if the refrigerant leaks from the refrigerating mechanism E during the ice-making operation and the deicing operation, the refrigerant can be appropriately diffused in the machine chamber 12 and discharged to the outside of the machine, and the ice-making machine M can be held in the safe state. Furthermore, since the cooling fan 34 is operated at a higher speed than a speed in the regular ice-making operation, the leaking refrigerant can be appropriately diffused. Moreover, when the failure informing lamp 51 is turned on, a manager of the ice-making machine M can recognize that a failure of the refrigerant detection sensor S has occurred in the ice-making machine M on the earlier stage, and the refrigerant detection sensor S can be rapidly repaired or replaced.

[0045] Additionally, in the method for operating the ice-making machine according to the first example, since the existing cooling fan 34 that forcedly cools the condenser 32 diffuses the refrigerant leaking from the refrigerating mechanism D, a dedicated fan for diffusing the refrigerant does not have to be separately added. Therefore, the design in the machine chamber 12 does not have to be changed, and a manufacturing cost is not increased.

(Second Example)

[0046] FIG. 5 is a flowchart showing a method for operating an ice-making machine according to a second example. In the method for operating an ice-making machine according to the second example, as operation modes during activation, a "normal mode" and a "safe hold mode" in Table 1 are set, and the operation modes are automatically switched in accordance with a state of the ice-making machine M. It is to be noted that the "normal mode" and the "safe hold mode" are as described above.

[0047] Further, in the method for operating an ice-making machine according to a second example, a situation where a refrigerant detection sensor S has detected a gas such as an insect killer diffused around the refrigerant detection sensor S and a situation where the refrigerant detection sensor S has detected a refrigerant actually leaking from the refrigerating mechanism E are appropriately judged, and the operation mode can be controlled to be switched from the normal mode to the safe hold mode only when the refrigerant leaks. That is, a diffusion time of an insect killer that is diffused around the refrigerant detection sensor S is approximately several seconds (1 to 2 seconds), whereas a leakage time of the refrigerant leaking from the refrigerating mechanism E continues for a fixed time (more than 30 seconds). Therefore, in the method for operating the ice-making machine according to the second example, when controlling means C has received a detection signal from the refrigerant detection sensor S in the normal mode, the operation mode is not immediately switched from the normal mode to the safe hold mode. That is, in the method for operating the ice-making machine according to the second example, when reception of the detection signal from the refrigerant detection sensor S is started and the detection signal from the refrigerant detection sensor S is being received even after elapse of a predetermined time from a time point of start of reception of the detection signal, the controlling means C determines that the refrigerant is actually leaking and controls the operation mode to be switched from the normal mode to the safe hold mode.

[0048] Specifically, as shown in FIG. 8(a) and FIG. 8(b), when the detection signal from the refrigerant detection sensor S is being received during a period from a time point at which reception of the detection signal from the refrigerant detection sensor S was started (which will be referred to as a "reference time point PT1" in the second example hereinafter) to a time point at which a predetermined waiting time WT that was set in advance elapsed (which will be referred to as an "elapsed time point PT2" in the second example hereinafter), the controlling means C switches the operation mode from the normal mode to the safe hold mode. The waiting time WT is set longer than a time required for the gas such as an insect killer diffused around the refrigerant detection sensor S to be diffused are reach concentration that cannot be detected by the refrigerant detection sensor. For example, since a spray type insect killer is applied generally for 1 to 2 seconds, it is desirable for the waiting time WT to be appropriately set in the range of 5 seconds to 30 seconds.

[0049] Therefore, when the gas, e.g., the insect killer diffused around the refrigerant detection sensor S has been detected by the refrigerant detection sensor S and the detection signal has been transmitted to the controlling means C, as shown in FIG. 6 and FIG. 8(a), since the gas, e.g., the insect killer is diffused before the waiting time WT elapses, the refrigerant detection sensor S enters a non-detection state. As a result, the detection signal is not transmitted from the refrigerant detection sensor S during the period from the reference time point PT1 to the elapsed time point PT2 at which the waiting time WT elapsed, and the controlling means C is yet to receive the detection signal at the elapsed time point PT2. Therefore, the controlling means C determines that the refrigerant is not leaking from the refrigerant mechanism E and controls the ice-making machine M so as to continue the ice-making operation and the deicing operation of the refrigerating mechanism E.

[0050] On the other hand, when the refrigerant actually leaking from the refrigerating mechanism E has been detected by the refrigerant detection sensor S and the detection signal has been transmitted to the controlling means C, as shown in FIG. 7 and FIG. 8(b), the refrigerant is continuously leaking even during the waiting time WT. That is, transmission of the detection signal from the refrigerant detection sensor S continues even during the period from the reference time point PT1 to the elapsed time point PT2 at which the waiting time WT elapsed, and the controlling means C receives the detection signal at the elapsed time point PT2. Therefore, the controlling means C determines that the refrigerant has leaked from the refrigerating mechanism E, continuously operates the cooling fan 34, and controls the ice-making machine M so as to stop the ice-making operation and deicing operation of the refrigerating mechanism E.

[0051] It is to be noted that, in the safe hold mode, the number of revolutions of the cooling fan 34 in case of continuously operating the cooling fan 34 is set higher than the number of revolutions at the time of the ice-making operation in the normal mode. As a result, in the safe hold mode, since the cooling fan 34 rotates at a high speed and energetically stirs air in the machine chamber 12, the refrigerant leaking from the refrigerating mechanism E into the machine chamber 12 can be efficiently diffused.

(Operation of Second Example)

[0052] In the method for operating the ice-making machine according to the second example, as shown in FIG. 5, when the main power supply is turned on and the operation of the ice-making machine is started, a predetermined initial operation concerning the ice-making mechanism D and the refrigerating mechanism E is first carried out by executing the startup initial operation (a step S21). When the startup initial operation is completed, the ice-making operation and the deicing operation in the normal mode are started (a step S22), and the ice-making mechanism D and the refrigerating mechanism E are normally operated.

[0053] Furthermore, during the ice-making operation and the deicing operation in the normal mode, the controlling means C confirms whether the refrigeration detection sensor S has transmitted the detection signal (a step S23), the processing returns to the step S22 if the detection signal has not been transmitted, and the step S22 and the step S23 are again executed. That is, in the normal mode, the ice-making operation and the deicing operation are executed while constantly confirming transmission of the detection signal from the refrigerant detection sensor S. Moreover, if the detection signal has not been transmitted from the refrigerant detection sensor S, the ice-making operation and the deicing operation are repeated until the ice storage switch 19 detects that a predetermined quantity of the ice blocks 1 has been stored in the ice storage chamber 11.

[0054] Additionally, in the method for operating the ice-making machine according to the second example, as shown in FIG. 5, at the time of repeating the step S22 and the step S23 in the normal mode, when the refrigerant detection sensor S has transmitted the detection signal to the controlling means C at the step S23, the controlling means C that has received the detection signal confirms whether the refrigerant detection sensor S has transmitted the detection signal (a step S25) after measurement of the waiting time WT was started by using a timer or the like (a step S24). Further, when the refrigerant detection sensor S has transmitted the detection signal, whether the waiting time WT has elapsed is confirmed (a step S26), and the processing returns to the step S25 if the waiting time WT has not elapsed. Furthermore, the controlling means C repeats the step S25 and the step S26 and determines that the refrigerant has not leaked from the refrigerating means E when the detection signal from the refrigerant detection sensor S is not received at the step S25 before the waiting time WT elapses, the processing returns to the step S22, and the ice-making/deicing operations are continued in the normal mode.

[0055] On the other hand, when the step S25 and the step S26 have been repeated and the waiting time WT has elapsed, the controlling means C reconfirms whether the refrigerant detection sensor S has transmitted the detection signal (a step S27). Further, if the detection signal from the refrigerant detection sensor S has not been received after elapse of the waiting time WT, it is determined that the refrigerant has not leaked from the refrigerating mechanism E, the processing returns to the step S22, and the ice-making/deicing operations in the normal mode are continued. Furthermore, if the detection signal from the refrigerant detection sensor S has been received even after elapse of the waiting time WT, it is determined that the refrigerant has leaked from the refrigerating mechanism E, and the operation mode is switched from the normal mode to the safe hold mode. As a result, the controlling means C continuously operates the cooling fan 34 (a step S28), controls a leakage warning lamp 50 to be turned on (a step S29), and stops the operations of the refrigerating mechanism E and the ice-making mechanism D in the ice-making machine M (a step S30). That is, in the ice-making machine M, even if the mode is changed to the safe hold mode and the ice-making operation and the deicing operation in the ice-making mechanism D are stopped, the cooling fan 34 continuously operates, and the refrigerant is prevented from staying in the machine chamber 12.

[0056] Therefore, in the method for operating the ice-making machine according to the second example, in relation to transmission of the detection signal of the refrigerant detection sensor S, it is possible to assuredly and appropriately determine whether transmission of the detection signal is based on detection of a gas, e.g., an insect kilter other than the refrigerant or based on detection of the refrigerant that has actually leaked. As a result, the operation of the ice-making machine M can be continued and reduction in the ice-making efficiency can be avoided when the detection effected by the refrigerant detection sensor S is determined as detection of a gas other than the refrigerant, and the ice-making operation and the deicing operation of the ice-making machine M can be stopped and safety and reliability of the ice-making machine M can be improved when the detection effected by the refrigerant detection sensor S is determined as detection of the refrigerant that has actually leaked from the refrigerating mechanism E. Moreover, when the refrigerant has leaked from the refrigerating mechanism E to the machine chamber 12, since the refrigerant is diffused in the machine chamber 12 and discharged to the outside of the machine by the continuous operation of the cooling fan 34, the refrigerant does not permeate the machine chamber 12 and reach hazardous concentration, and hence the ice-making machine M can be held in the safe state. Additionally, since the waiting time WT in the second example is set longer than a time required for a gas, e.g., an insect killer applied around the refrigerant detection sensor S to be diffused and reach concentration that cannot be detected by the refrigerant detection sensor, it is possible to assuredly and appropriately determine which one of the refrigerant and a gas other than the refrigerant the refrigerant detection sensor S has detected. Further, since the cooling fan 34 is operated at a higher speed than a speed in the regular ice-making operation, the leaking refrigerant can be appropriately diffused and discharged to the outside of the machine. Furthermore, when the leakage warning lamp 50 is turned on, a manager of the ice-making machine M can confirm that leakage of the refrigerant has occurred in the ice-making machine M on the earlier stage, and the refrigerating mechanism E can be rapidly repaired or replaced.

(Third Example)

[0057] FIG. 9 is a flowchart showing a method for operating an ice-making machine according to a third example. In the operating method according to the third example, like the operating method according to the second example, the "normal mode" and the "safe hold mode" in Table 1 are set as the operation modes, and these modes can be automatically switched in accordance with a state of the ice-making machine M. Moreover, in the third example, likewise, it is possible to assuredly and appropriately determine a situation where a gas such as an insect killer applied around a refrigerant detection sensor S has been detected by the refrigerant detection sensor S and a situation where a refrigerant that has actually leaked from a refrigerating mechanism E has been actually detected by the refrigerant detection sensor S, the operation modes can be controlled in such a manner that the normal mode can be switched to the safe hold mode only when the refrigerant has leaked.

[0058] Specifically, as shown in FIG. 12(a) and FIG. 12(c), upon confirming reception of a detection signal from the refrigerant detection sensor S, controlling means C first operates the cooling fan 34 for a predetermined operating time RT. Additionally, if the controlling means C has confirmed reception of the detection signal from the refrigerant detection sensor S after a time point at which the operating time RT elapsed and the cooling fan 34 was stopped (which will be referred to as a "reference time point PT1" in the third example hereinafter) and before a time point at which a predetermined judging time JT elapsed (which will be referred to as an "elapsed time point PT2" in the third example hereinafter), it switches the operation mode from the normal mode to the safe hold model. The operating time RT is set longer than a time required for a gas or the refrigerant present around the refrigerant detection sensor S to be diffused by the operation of the cooling fan 34 and reach concentration that cannot be detected by the refrigerant detection sensor S. Further, the judging time JT is set longer than a time required from the refrigerant that has moved to the periphery of the refrigerant detection sensors to reach the concentration that cannot be detected by the refrigerant detection sensor S, and it is desirable to appropriately set the judging time within a range of, e.g., three to 10 minutes.

[0059] Therefore, if the refrigerant detection sensor S has detected a small amount of gas other than the refrigerant, e.g., an insect killer applied around the refrigerant detection sensor S and the refrigerant detection sensor S has supplied a detection signal to the controlling means C, as shown in FIG. 10 and FIG. 12(a), since the gas is diffused while the cooling face 34 is operated for the operating time RT, the refrigerant detection sensor S enters a non-detection state. Furthermore, since the gas is diffused before the judging time JT elapses from the reference time point PT1, the detection signal is not supplied from the refrigerant detection sensor S, and the controlling means C does not receive the detection signal at the elapsed time point PT2. Therefore, the controlling means C determines that the refrigerant has not leaked from the refrigerating mechanism E, and it controls the ice-making machine M so as to continue the ice-making operation and the deicing operation of the refrigerating mechanism E.

[0060] On the other hand, if the refrigerant detection sensor S has detected the refrigerant that has actually leaked from the refrigerating mechanism E and transmitted the detection signal to the controlling means C, as shown in FIG. 11 and FIG. 12(b), the refrigerant is temporarily diffused while the cooling fan 34 is operated for the operating time RT, and hence the refrigerant detection sensor S enters the non-detection state. However, since the refrigerant that has continuously leaked from the refrigerating mechanism E again stays in the periphery of the refrigerant detection sensor S and reaches concentration that cannot be detected by the refrigerant detection sensor S during the waiting time WT from the reference time point PT1, when the refrigerant detection sensor S detects the refrigerant and transmits a detection signal, the controlling means C receives the detection signal before the elapsed time point PT2. Therefore, the controlling means C determines that the refrigerant has leaked from the refrigerating mechanism E and controls the ice-making machine M so as to stop the ice-making operation and the deicing operation of the refrigerating mechanism E. It is to be noted that, in the safe hold mode, like the second example, the number of revolutions of the cooling fan 34 is set higher than the number of revolutions at the time of the ice-making operation in the normal mode, and a leakage warning lamp (warning means) 50 that informs of occurrence of leakage of the refrigerant is operated.

(Operation of Third Example)

[0061] In the method for operating the ice-making machine according to the third example, as shown in FIG. 9, when the main power supply is turned on and the operation of the ice-making machine is started, a predetermined initial operation concerning the ice-making mechanism D and the refrigerating mechanism E is first carried out by executing a startup initial operation (a step S31). When the startup initial operation is completed, the ice-making operation and the deicing operation in the normal mode are started (a step S32), and the ice-making mechanism D and the refrigerating mechanism E normally operate.

[0062] Further, during the ice-making operation and the deicing operation in the normal mode, the controlling means C confirms whether the refrigerant detection sensor S has transmitted the refrigerant detection signal (a step S33), the processing returns to the step S32 if the detection signal has not been transmitted, and the step S32 and the step S33 are again executed. That is, in the normal mode, the ice-making operation and the deicing operation are executed while constantly confirming transmission of the detection signal from the refrigerant detection sensor S. Furthermore, if the detection signal from the refrigerant detection sensor S is not transmitted, the ice-making operation and the deicing operation are repeated until the ice storage switch 19 detects that a predetermined amount of ice blocks 1 is stored in the ice storage chamber 11.

[0063] Moreover, in the method for operating the ice-making machine according to the third example, as shown in FIG. 9, at the time of repeating the step S32 and the step S33 in the normal mode, if the refrigerant detection sensor S has transmitted the detection signal to the controlling means C at the step S33, the controlling means C operates the cooling fan 34 for the operating time RT (a step S34). Additionally, the controlling means C confirms whether the refrigerating detection sensor S transmits the detection signal after stop of the operation of the cooling fan 34 and before elapse of the judging time JT from the reference time PT1 (a step S35). Further, when the controlling means C cannot confirm reception of the detection signal from the refrigerant detection sensor S at the step S35, it determines that the refrigerant has not leaked from the refrigerating mechanism E, returns to the step S32, and continues the operation in the normal mode. On the other hand, when the controlling means C has confirmed reception of the detection signal from the refrigerant detection sensor S at the step S35, it determines that the refrigerant has leaked from the refrigerating mechanism E, and switches the operation mode from the normal mode to the safe hold mode. As a result, the controlling means C continuously operates the cooling fan 34 (a step S36), controls the leakage warning lamp 50 to be turned on (a step S37), and stops the operations of the refrigerating mechanism E and the ice-making mechanism D in the ice-making machine M (a step S38). That is, in the ice-making machine M, even if the mode is switched to the safe hold mode and the ice-making operation and the deicing operation in the ice-making mechanism D are stopped, the cooling fan 34 continuously operates, and the refrigerant is prevented from staying in the machine chamber 12.

[0064] Therefore, in the method for operating the ice-making machine according to the third example, in relation to transmission of the detection signal from the refrigerant detection sensor S, it is possible to assuredly and appropriately determine whether transmission of the detection signal is based on detection of a gas, e.g., an insect killer other than the refrigerant or based on detection of the refrigerant that has actually leaked. As a result, the operation of the ice-making machine M can be continued and the ice-making efficiency can be prevented from being lowered when the detection effected by the refrigerant detection sensor S is determined as the detection of a gas other than the refrigerant, and the ice-making operation and the deicing operation of the ice-making machine M are stopped and safety and reliability of the ice-making machine M can be improved when the detection effected by the refrigerant detection sensor S is determined as the detection of the refrigerant that has actually leaked from the refrigerating mechanism E. Further, when the refrigerant has leaked from the refrigerating mechanism E to the machine chamber 12, since the refrigerant is diffused in the machine chamber 12 by the continuous operation of the cooling fan 34 and discharged to the outside of the machine, the refrigerant does not permeate the machine chamber 12 to reach hazardous concentration, and hence the ice-making machine M can be held in the safe state. Furthermore, since the judging time JT in the third example is set longer than a time required for the refrigerant that has moved to the periphery of the refrigerant detection sensor S to reach concentration that can be detected by the refrigerant detector sensor S, it is possible to assuredly and appropriately determine which one of the refrigerant and a gas other than the refrigerant the refrigerant detection sensor S has detected. Moreover, since the cooling fan 34 is operated at a higher speed than a speed in the regular ice-making operation, the leaking refrigerant can be appropriately diffused and discharged to the outside of the machine. Additionally, when the leakage warning lamp 50 is turned on, a manager of the ice-making machine M can precociously confirm that the leakage of the refrigerant has occurred in the ice-making machine M and can rapidly repair or replace the refrigerating mechanism E.

(Fourth Example)

[0065] FIG. 13 is a flowchart showing a method for operating an ice-making machine according to a fourth example. In the operating method according to the fourth example, as operation modes, a "normal mode" and a "safe hold mode" in Table 1 are set, and these modes are automatically switched in accordance with a state of the ice-making machine M.

[0066] In the method for operating an ice-making machine according to the fourth example, as shown in FIG. 14, controlling means C is configured to perform control, e.g., (1) stopping an ice-making operation of an ice-making mechanism D, (2) effecting continuous ON control over a cooling fan 34 of the condenser 31 and continuously operating this fan, (3) changing a posture of the water plate 21 to the deicing position, (4) turning on a leakage warning lamp (warning means) 50 that warns about leakage of a refrigerant after elapse of a predetermined delay time T from reception of a detection signal, or the like. In such a method for operating the ice-making machine according to the fourth example, when a refrigerant detection sensor S has detected the refrigerant, the posture of the water plate 21 is changed to the deicing position, an ice-making water tank 22 is stopped in a posture inclined to bottom right (indicated by an alternate long and two short dashes line in FIG. 20), whereby the operation of the ice-making machine M is stopped in a state that the refrigerant that has leaked into an ice storage chamber 11 and entered the ice-making water tank 22 is stored in the ice-making water tank 22. That is, since the ice-making water tank 22 taking the posture inclined to bottom right is opened in the ice storage chamber 11 with a bottom portion of this tank being inclined to bottom right, the refrigerant that has entered the ice-making water tank 22 is allowed to move into the ice storage chamber 11 without staying in the ice-making water tank 22. Further, since the cooling fan 34 continuously operates, part of the refrigerant that has leaked into the water storage chamber 11 moves to a machine chamber 12 through the piping space 45 and is then discharged to the outside of the machine through venting holes 17. Furthermore, the refrigerant that has stayed in the ice storage chamber 11 without flowing into the piping space 45 is discharged to the outside of the machine when the leakage warning lamp 50 is turned on and then the ice storage chamber 11 is opened by opening an opening/closing door 18 or removing a top panel of a housing 10 in a repairing operation. It is to be noted that the refrigerant that has flowed down to the upper side of a drain pan 16 flows down from a drain outlet of the drain pan 16 to the vicinity of a bottom surface of the ice storage chamber 11, and the refrigerant can be also prevented from staying in the drain pan 16.

[0067] The delay time T is set longer than a time required for the posture of the water plate 21 to change to the deicing position from an ice-making position by an operation of the water plate opening/closing mechanism 23. As a result, even if the controlling means C has received the detection signal from the refrigerant detection sensor S during the ice-making operation of the ice-making mechanism D, the water plate 21 changes its posture from the ice-making position to the deicing position and stops, and then the leakage warning lamp 50 is turned on to warn a manager about the leakage of the refrigerant. Therefore, even if the manager turns off the main power supply immediately after the leakage warning lamp 50 is turned on, the water plate 21 is prevented from stopping at the ice-making position or between the ice-making position and the deicing position, and the refrigerant that has leaked into the ice-making water tank 22 can be prevented from staying in the ice-making water tank 22.

[0068] Further, in the safe hold mode, the number of revolutions of the cooling fan 34 when the cooling fan 34 is continuously operated is set higher than the number of revolutions in the ice-making operation in the normal mode. As a result, in the safe hold mode, since the cooling fan 34 rotates at a high speed to energetically stir air in the machine chamber 12, the refrigerant that has leaked from the refrigerating mechanism E into the machine chamber 12 can be efficiently diffused.

(Operation of Fourth Example)

[0069] In the method for operating the ice-making machine according to the fourth example, as shown in FIG. 13, when the main power supply is turned on and the operation of the ice-making machine M is started, a predetermined initial operation concerning the ice-making mechanism D and the refrigerating mechanism E is first carried out by executing the startup initial operation (a step S41). When the startup initial operation is completed, the ice-making operation in the normal mode is started (a step S42), and the ice-making mechanism D and the refrigerating mechanism E are normally operated.

[0070] Further, during the ice-making operation in the normal mode, the controlling means C confirms whether the refrigerant detection sensor S has transmitted the detection signal of the refrigerant (a step S43), confirms whether ice making effected by the ice-making mechanism D has been completed if the detection signal has not been transmitted (a step S44), or returns to the step S43 and again executes the step S43 and the step S44 if ice making has not been completed. That is, during the ice-making operation, transmission of the detection signal from the refrigerant detection sensor S is constantly confirmed. It is to be noted that the completion of ice making is determined by the ice-making unit temperature sensor 42 when a temperature of an ice-making unit 20 has been reduced to a preset ice-making completion temperature.

[0071] When it is determined that ice making has been terminated at the step S44 without transmitting the detection signal from the refrigerant detection sensor S during the ice-making operation, the ice-making operation is completed, and the deicing operation is started (a step S45). During the deicing operation in the normal mode, the controlling means C confirms whether the refrigerant detection sensor S has transmitted the detection signal of the refrigerant (a step S46), confirms whether deicing in the deicing mechanism D has been completed if the detection signal has not been transmitted (a step S47), or returns to the step S46 and again executes the step S46 and the step S47 if deicing has not been completed. That is, during the deicing operation, transmission of the detection signal from the refrigerant detection sensor S is constantly confirmed. It is to be noted that the completion of the deicing operation is determined by the ice-making unit temperature sensor 42 when a temperature of the ice-making unit 20 has been increased to a preset deicing completion temperature.

[0072] That is, in the normal mode, the ice-making operation and the deicing operation are executed while constantly confirming transmission of the detection signal from the refrigerant detection sensor S. Furthermore, if the detection signal has not been transmitted from the refrigerant detection sensor S, the ice-making operation and the deicing operation are repeated until the ice storage switch 19 detects that a predetermined amount of ice blocks 1 is stored in the ice storage chamber 11.

[0073] Furthermore, in the method for operating the ice-making machine according to the fourth example, as shown in FIG. 13 and FIG. 14, during the ice-making operation that the step S43 and the step S44 are repeated in the normal mode, when the refrigerant detection sensor S has detected the leaking refrigerant and transmitted the detection signal to the controlling means C, the controlling means C receives the detection signal and thereby switches the operation mode from the normal mode to the safe hold mode. As a result, the controlling means C stops the ice-making operation of the ice-making mechanism D (a step S48), continuously operates the cooling fan 34 (a step S49), and controls the water plate 21 to change its posture from the ice-making position to the deicing position (a step S50). Moreover, when the controlling means C has confirmed that the delay time T elapsed (a step S51), turns on the leakage warning lamp 50 (a step S52), and then stops the operation of the ice-making machine M while continuously operating the cooling fan 34 (a step S53). That is, even if the mode is switched to the safe hold mode and the ice-making operation in the ice-making mechanism D is stopped, the ice-making machine M can move the refrigerant that has leaked in the ice-making water tank 22 to the inside of the ice storage chamber 11, and can move part of the refrigerant that has moved into the ice storage chamber 11 to the machine chamber 12 via the first communicating portion 47, a piping space 45, and a second inserting portion 48. Additionally, the refrigerant that has moved into the machine chamber 12 is discharged to the outside of the machine when the cooling fan 34 continuously operates, and the refrigerant is prevented from staying in the machine chamber 12.

[0074] Further, in the operating method according to the fourth example, as shown in FIG. 13, during the deicing operation that the step S46 and the step S47 are repeated in the normal mode, when the refrigerant detection sensor S has detected the leaking refrigerant and transmitted the detection signal to the controlling means C, the controlling means C receives the detection signal and thereby switches the operation mode from the normal mode to the safe hold mode. As a result, the controlling means C stops the deicing operation of the ice-making mechanism D (a step S54), continuously operates the cooling fan 34 (a step S49), and controls the water plate 21 to change its posture to the deicing position (a step S50). Therefore, in the deicing operation, even if the water plate 21 is placed at the deicing position and even if the water plate 21 is moving from the ice-making position to the deicing position and the water plate 21 is moving from the deicing position to the ice-making position, the water plate 21 changes its posture to the deicing position. Further, when the controlling means C has confirmed that the delay time T elapsed (a step S51), it turns on the leakage warning lamp 50 (a step S52), and stops the operation of the ice-making machine M while continuously operating the cooling fan 34 (a step S53). That is, even if the mode is switched to the safe hold mode and the deicing operation in the ice-making mechanism D is stopped, the ice-making machine M can move the refrigerant that has leaked into the ice-making water tank 22 to the inside of the ice storage chamber 11 and can move part of the refrigerant that has moved into the ice storage chamber 11 to the machine chamber 12 via the first communicating portion 47, the piping space 45, and the second inserting portion 48. Furthermore, the refrigerant that has moved to the inside of the machine chamber 12 is discharged to the outside of the machine when the cooling fan 34 continuously operates, and the refrigerant is prevented from staying in the machine chamber 12.

[0075] Therefore, in the method for operating the ice-making machine according to the fourth example, when the refrigerant leaks from the refrigerating mechanism E to the machine chamber 12 and the operation mode is switched from the normal mode to the safe hold mode, since the operation of the ice-making machine M is stopped while holding the water plate 21 held at the deicing position during both the ice-making operation and the deicing operation, the refrigerant can be prevented from permeating the ice-making water tank 22 to reach hazardous concentration, and safety of the ice-making machine M can be assured. Moreover, when the mode is switched to the safe hold mode, since the cooling fan 34 continuously operates and the refrigerant is diffused in the machine chamber 12 and discharged to the outside of the machine, the refrigerant can be prevented from permeating the machine chamber 12 to reach hazardous concentration, and safety of the ice-making machine M can be assured.

[0076] Additionally, in the method for operating the ice-making machine according to the fourth example, since the cooling fan 34 is operated at a higher speed than a speed in the regular ice-making operation, the refrigerant that has moved to the machine chamber 12 can be appropriately diffused and discharged to the outside of the machine. Further, when the leakage warning lamp 50 is turned on, a manager of the ice-making machine M can precociously confirm that leakage of the refrigerant has occurred in the ice-making machine M and can rapidly repair or replace the refrigerating mechanism E. Furthermore, when the leakage warning lamp 50 is turned on and then a top panel of a housing 10 is removed or an opening/closing door 18 is opened, the refrigerant staying in the ice storage chamber 11 is appropriately discharged to the outside of the machine. Moreover, since the leakage warning lamp 50 is turned on after the waiting time T elapses from reception of the detection signal from the refrigerant detection sensor S and after the water plate 21 is stopped at the deicing position, even if a manager turns off the main power supply of the ice-making machine M immediately after turning off the leakage warning lamp 50, the water plate 21 is stopped at the deicing position, and hence the refrigerant can be prevented from staying in the ice-making water tank 22.

(Modification)

[0077] The method for operating the ice-making machine according to this application is not restricted to the operating method illustrated in each of the examples, and it can be modified and embodied in many ways.

(1) In each example, although the method for operating the ice-making machine M comprising one refrigerant detection sensor S has been described, the method for operating the ice-making machine according to the present invention can be preferably embodied with respect to the ice-making machine M comprising the two refrigerant detection sensors S shown in FIG. 19 or an ice-making machine comprising three or more refrigerant detection sensor S. In the ice-making machine M comprising the plurality of refrigerant detection sensors S, when at least one refrigerant detection sensor S has detected a refrigerant and transmitted a detection signal to controlling means C, the operating methods according to the first to fourth examples can be carried out. It is to be noted that, in the first example, the mode can be switched to the safe hold mode when at least one refrigerant detection sensor S has detected the refrigerant and transmitted the detection signal, and the mode can be switched to the safe mode when a failure has occurred in at least one refrigerant detection sensor S and a failure signal has been transmitted.

(2) In the first example, if different lighting conformations or different display colors are adopted in the leakage warning lamp 50 and the failure informing lamp 51, a single lamp can be shared.

(3) In the first example, informing means for informing of a failure in the refrigerant detection sensor 3 or warning means for warning about leakage of the refrigerant is not restricted to each lamp in the example, and it may be a buzzer, an alarm, an electronic mail transmitted to a personal computer or a mobile terminal, and others.

(4) It is needless to say that settings of the waiting time WT explained in the second example and the operating time RT and the judging time JT described in the third example can be appropriately changed based on an arrangement position of the refrigerant detection sensor S in the machine chamber 12 of the ice-making machine M, an arrangement position relationship between the refrigerant detection sensor S and the cooling fan 34 in the machine chamber 12, an installing position of the ice-making machine M, and others.

(5) In the fourth example, the refrigerant detection sensor S as refrigerant detecting means may be arranged at a necessary position in the ice storage chamber 11 so that and the refrigerant that has leaked into the ice storage chamber 11 can be directly detected by the refrigerant detection sensor S arranged in the ice storage chamber 11.

(6) The refrigerant detecting means S is not restricted to the tin oxide semiconductor type described in each example, and any type that can appropriately detect a combustible gas used as the refrigerant can suffice.

(7) In each example, although the cell type ice-making machine having the machine chamber arranged in the lower portion has been exemplified, an ice-making machine having the machine chamber arranged in an upper portion of an ice storage chamber or an ice-making machine having the machine chamber arranged on a left or right side or a rear side of the ice storage chamber can be a target.

(8) In each example, although the cell type ice-making machine has been exemplified, the ice-making machine that is a target of the present invention includes all ice-making machines each having a refrigerating mechanism using a refrigerant made of a combustible gas.

Claims

1. A method for operating an ice-making machine, the ice-making machine comprising: a refrigerating mechanism (E) that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser (31) forcedly air-cooled by a cooling fan (34), operates the cooling fan (34), performs an ice-making operation of an ice-making mechanism (D), and carries out a deicing operation of the ice-making mechanism (D) after the ice-making operation; and refrigerant detecting means (S) configured to detect the refrigerant leaking from the refrigerating mechanism (E),
wherein the refrigerate detecting means (S) transmits a detection signal to controlling means (C) when the refrigerant is detected, and
the controlling means (C) controls the cooling fan (34) to continuously operate upon receiving the detection signal from the refrigerant detecting means (S).

2. A method for operating an ice-making machine, the ice-making machine comprising: a refrigerating mechanism (E) that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser (31) forcedly air-cooled by a cooling fan (34), operates the cooling fan (34), performs an ice-making operation of an ice-making mechanism (D), and carries out a deicing operation of the ice-making mechanism (D) after the ice-making operation; and refrigerant detecting means (S) configured to detect the refrigerant leaking from the refrigerating mechanism (E),
wherein the refrigerant detecting means (S) transmits a detecting signal to controlling means (C) when the refrigerant is detected, and transmits a failure signal to the controlling means (C) when a failure occurs in the refrigerant detecting means (S), and
the controlling means (C) controls the cooling fan (34) to continuously operate upon receiving at least one of the detection signal and the failure signal from the refrigerant detecting means (S).

3. The method for operating an ice-making machine according to claim 2,
wherein the controlling means (C) controls the ice-making mechanism (D) to stop the ice-making operation and the deicing operation upon receiving the detection signal from the refrigerant detecting means (S), and controls the ice-making mechanism (D) to continue the ice-making operation and the deicing operation upon receiving the failure signal from the refrigerant detecting means (S).

4. The method for operating an ice-making machine according to claim 2 or 3,
wherein the controlling means (C) operates warning means (50) for warning about occurrence of leakage of the refrigerant upon receiving the detection signal from the refrigerant detecting means (S), and operates informing means (51) for informing of occurrence of a failure in the refrigerant detecting means (S) upon receiving the failure signal from the refrigerant detecting means (S).

5. A method for operating an ice-making machine, the ice-making machine comprising a refrigerating mechanism (E) that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser (31) forcedly air-cooled by a cooling fan (34), operates the cooling fan (34), performs an ice-making operation of an ice-making mechanism (D), and carries out a deicing operation of the ice-making mechanism (D) after the ice-making operation,
wherein refrigerant detecting means (S) for transmitting a detection signal to controlling means (C) is used while the refrigerant is detected, and
the controlling means (C) controls the cooling fan (34) to continuously operate when the detection signal from the refrigerant detecting means (S) is received even though a waiting time (WT) has elapsed from a time point (PT1) at which reception of the detection signal from the refrigerant detecting means (S) was started.

6. A method for operating an ice-making machine, the ice-making machine comprising a refrigerating mechanism (E) that circulates a refrigerant which is a combustible gas in a circuit comprising a condenser (31) forcedly air-cooled by a cooling fan (34), operates the cooling fan (34), performs an ice-making operation of an ice-making mechanism (D), and carries out a deicing operation of the ice-making mechanism (D) after the ice-making operation,
wherein refrigerant detecting means (S) for transmitting a detection signal to controlling means (C) is used while the refrigerant is detected,
the controlling means (C) operates the cooling fan (34) for a predetermined operating time (RT) at a time point that reception of the detection signal from the refrigerant detecting means (S) was started, and
the controlling means (C) controls the cooling fan (34) to continuously operate when the detection signal from the refrigerant detecting means (S) has been received before a judging time (JT) elapses from a time point (PT1) at which the cooling fan (34) was stopped after elapse of the operating time (RT).

7. A method for operating an ice-making machine, the ice-making machine comprising: an ice-making unit (20) that is

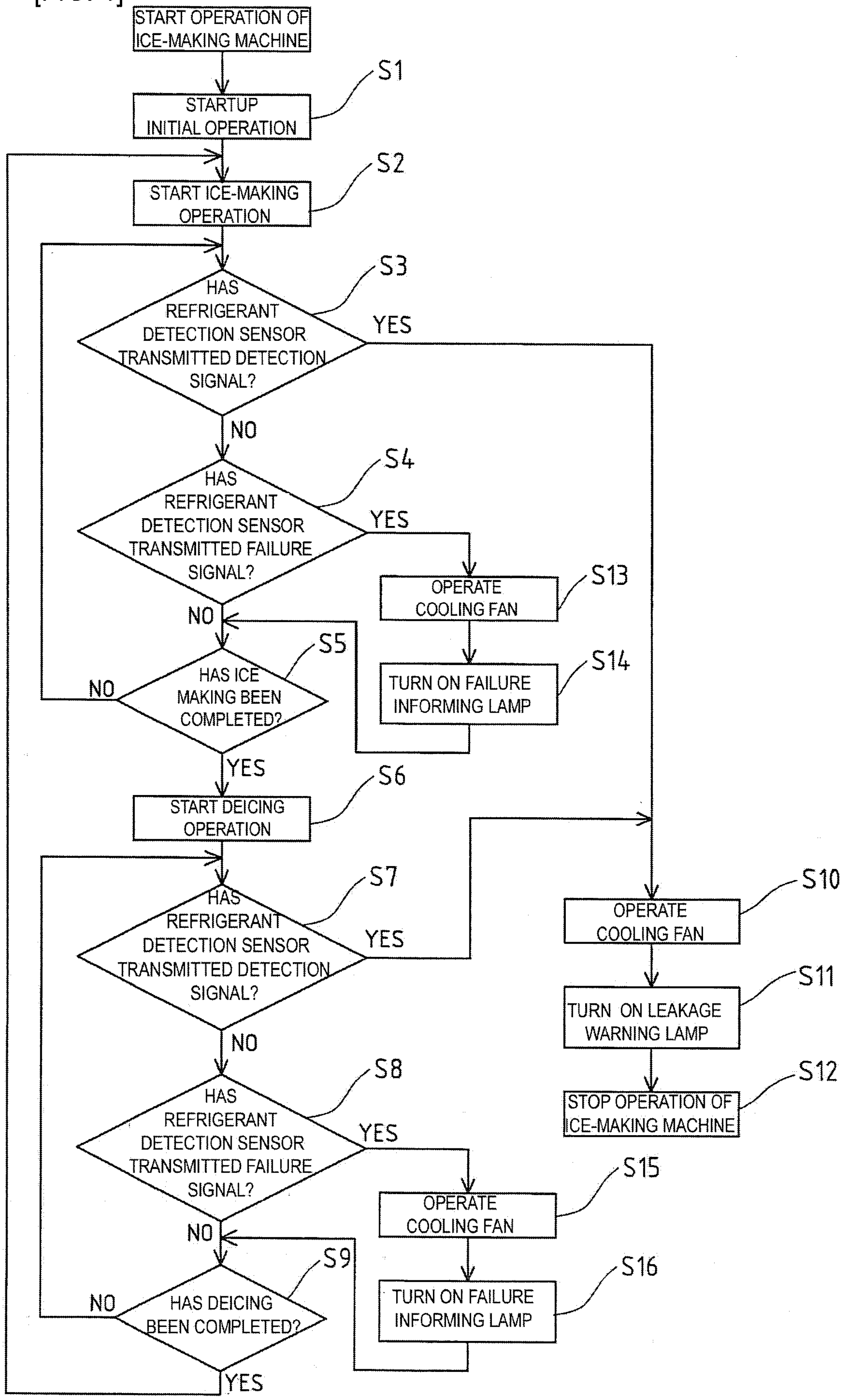
opened toward the lower side and generates ice blocks (I); a water plate (21) that is arranged below the ice-making unit (20) and configured to change its posture to an ice-making position where the ice-making unit (20) is closed and a deicing position that is inclined downward from the ice-making unit (20) and where the ice-making unit (20) is opened; an ice-making water tank (22) that is fixed below the water plate (21), opened to the water plate (21) side, and configured to change its posture integrally with the water plate (21); and a refrigerating mechanism (E) configured to circulate a refrigerant that is a combustible gas and cool and heat the ice-making unit (20),
wherein a detection signal is transmitted to controlling means (C) when refrigerant detecting means (S) detects that the refrigerant has leaked from the refrigerating mechanism (E),
the controlling means (C) changes a posture of the water plate (21) to the deicing position and stops an operation of the refrigerating mechanism (E) when the water plate (21) is present at the ice-making position or between the ice-making position and the deicing position, and
the controlling means (C) stops the operation of the refrigerating mechanism (E) while holding the water plate (21) at the deicing position when the water plate (21) is present at the deicing position.

8. The method for operating an ice-making machine according to claim 7,
wherein, after elapse of a delay time (T) that is set longer than a time required for the water plate (21) to change its posture from the ice-making position to the deicing position from detection of leakage of the refrigerant by the refrigerant detecting means (S), the controlling means (C) warns about occurrence of the leakage of the refrigerant by using warning means (50).

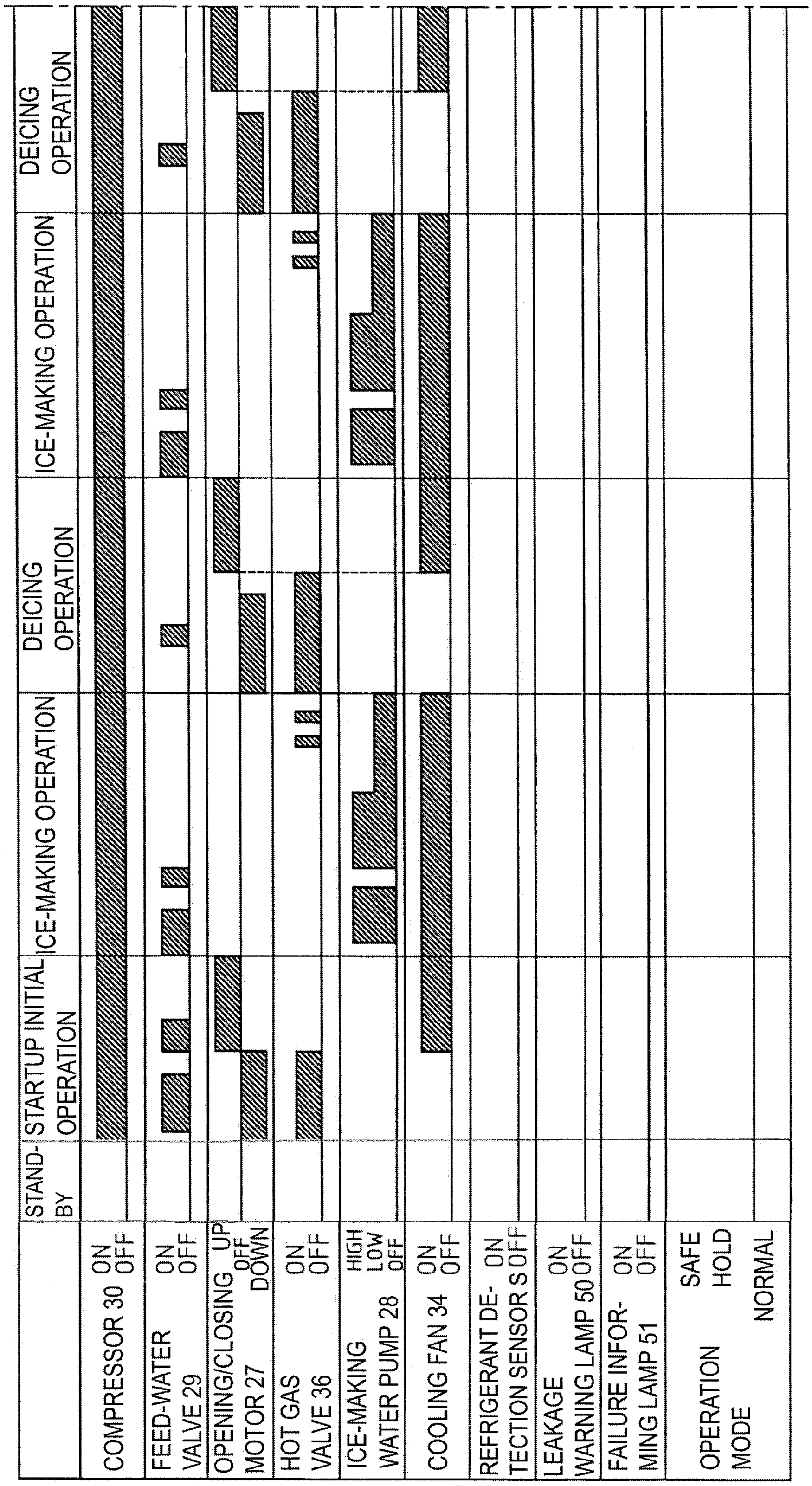
9. The method for operating an ice-making machine according to claim 7 or 8,
wherein the controlling means (C) controls a cooling fan (34), which forcedly air-cools a condenser (31) in the refrigerating mechanism (E), to continuously operate upon receiving the detection signal from the refrigerant detecting means (S).

10. The method for operating an ice-making machine according to any one of claims 1 to 6 and 9,
wherein the continuous operation of the cooling fan (34) is set to a higher number of revolutions than a number of revolutions in a regular ice-making operation of the ice-making mechanism (E).

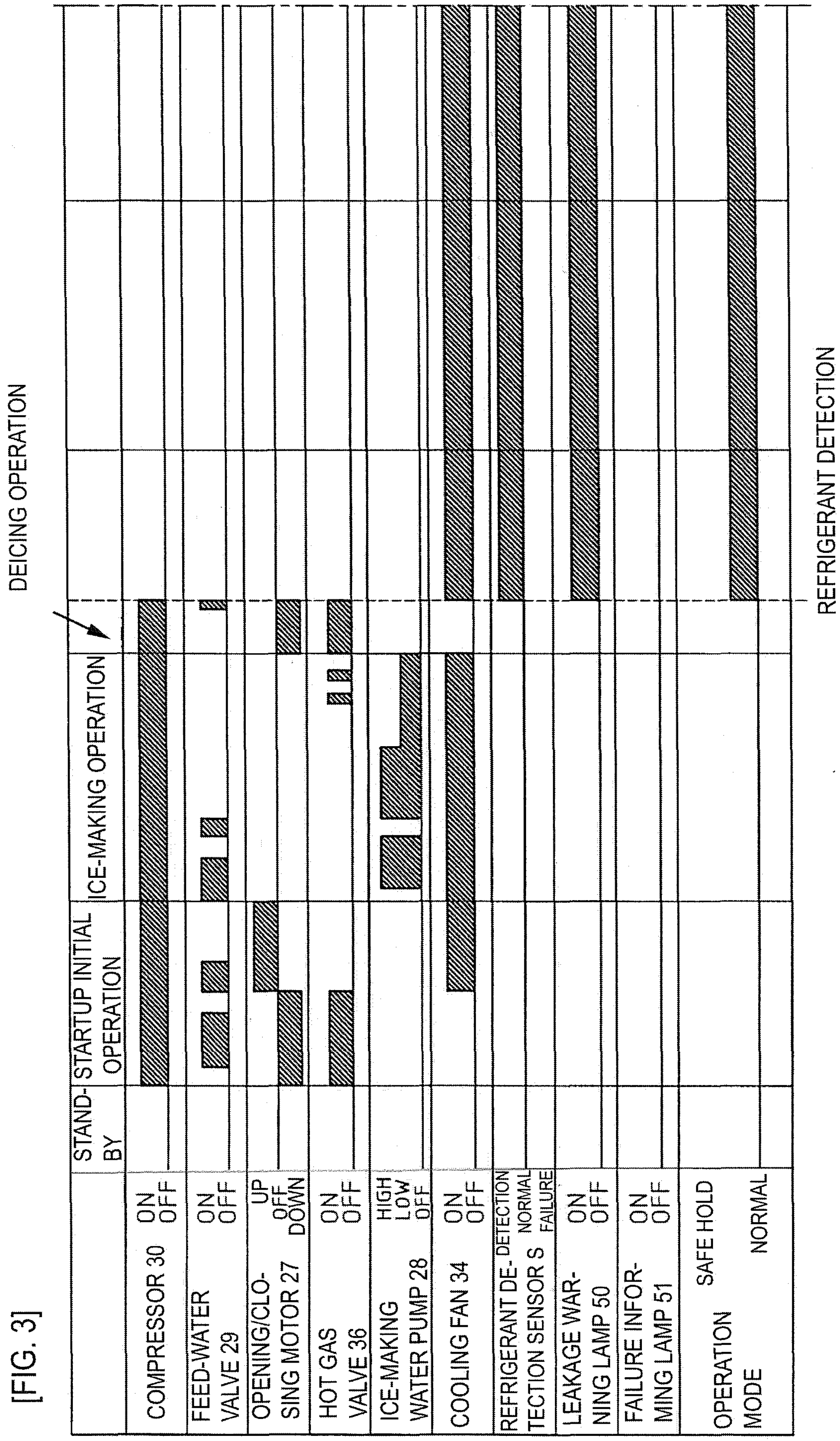
[FIG. 1]


START OPERATION OF ICE-MAKING MACHINE
S1
STARTUP INITIAL OPERATION
S2
START ICE-MAKING OPERATION
S3
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTION SIGNAL?
YES
NO
S4
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED FAILURE SIGNAL?
YES
NO
S13
OPERATE COOLING FAN
S14
TURN ON FAILURE INFORMING LAMP
S5
HAS ICE MAKING BEEN COMPLETED?
NO
YES
S6
START DEICING OPERATION
S7
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTION SIGNAL?
YES
NO
S10
OPERATE COOLING FAN
S11
TURN ON LEAKAGE WARNING LAMP
S12
STOP OPERATION OF ICE-MAKING MACHINE
S8
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED FAILURE SIGNAL?
YES
NO
S15
OPERATE COOLING FAN
S16
TURN ON FAILURE INFORMING LAMP
S9
HAS DEICING BEEN COMPLETED?
NO
YES

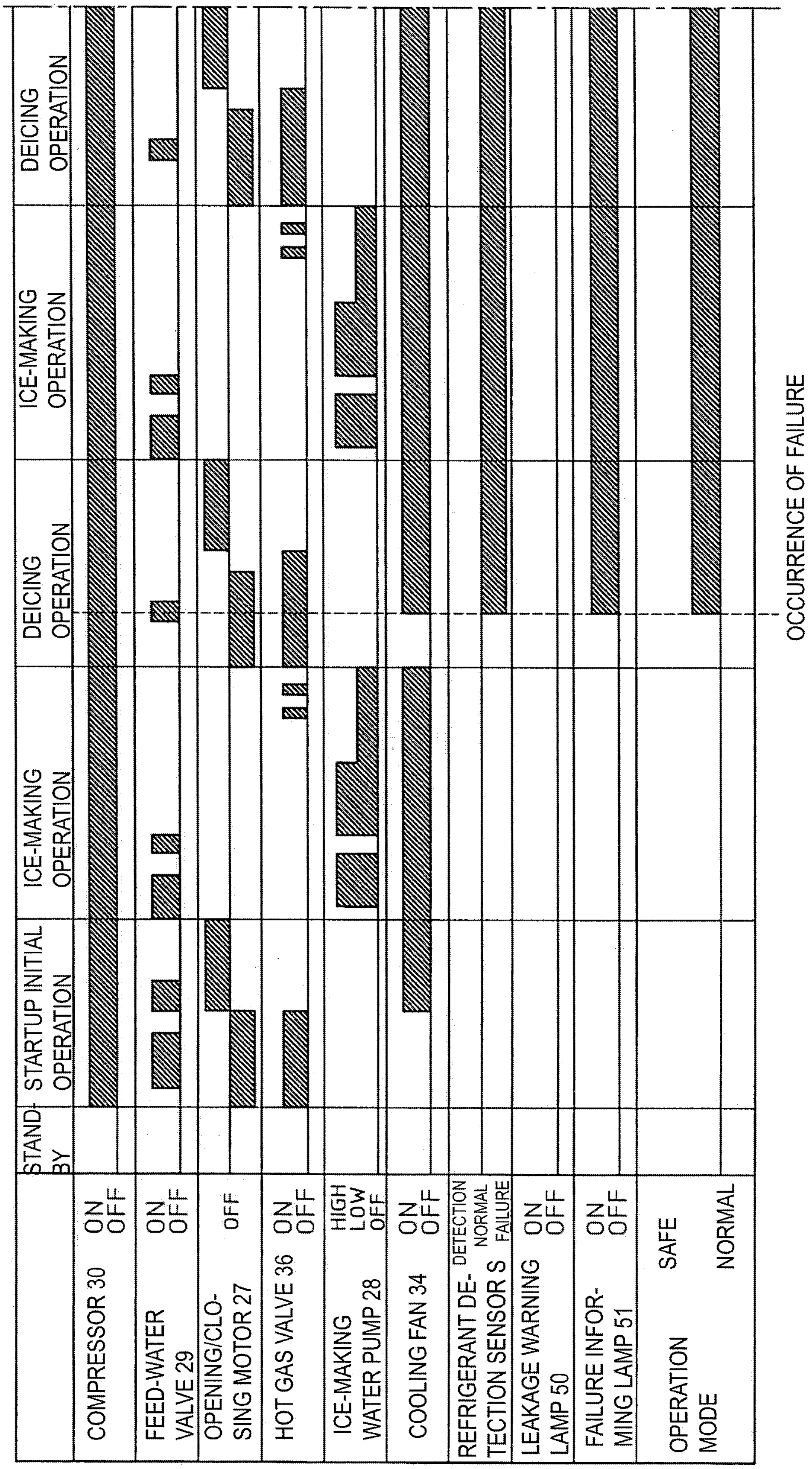
[FIG. 2]


STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSING MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
ON
OFF
LEAKAGE WARNING LAMP 50
ON
OFF
FAILURE INFORMING LAMP 51
ON
OFF
OPERATION MODE
SAFE
HOLD
NORMAL

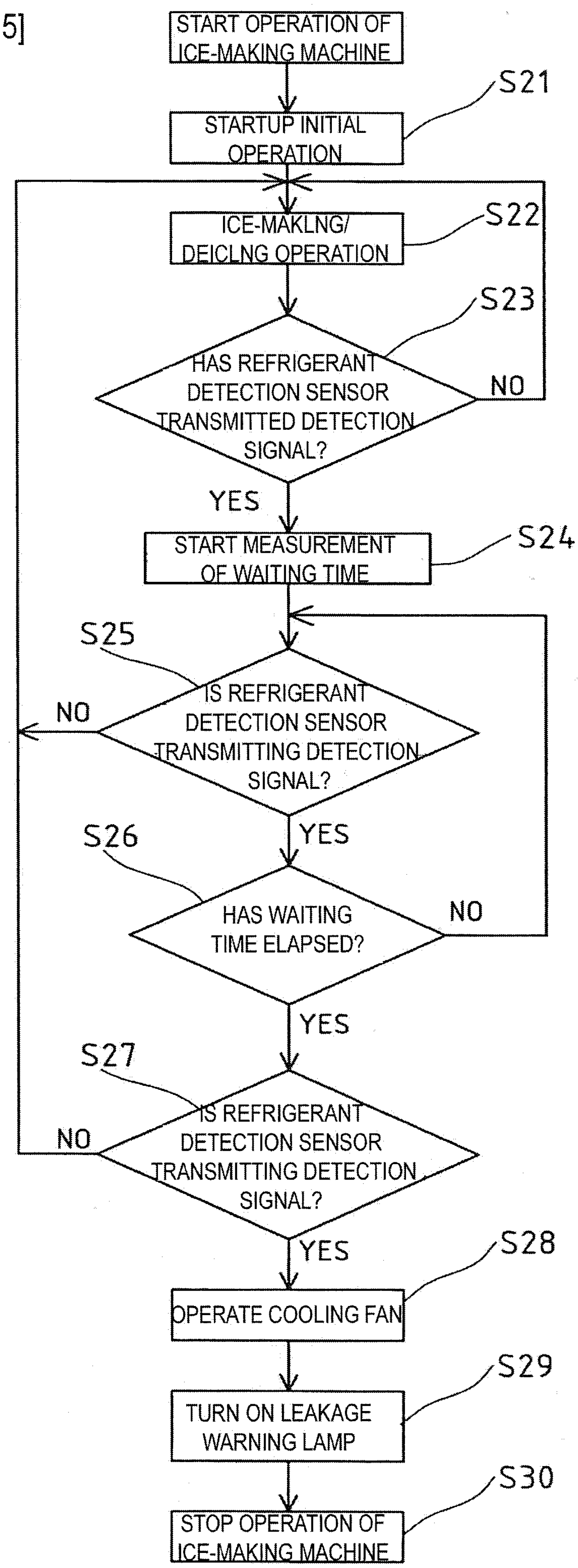
[FIG. 3]


DEICING OPERATION
STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSING MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
DETECTION
NORMAL
FAILURE
LEAKAGE WARNING LAMP 50
ON
OFF
FAILURE INFORMING LAMP 51
ON
OFF
OPERATION MODE
SAFE HOLD
NORMAL
REFRIGERANT DETECTION

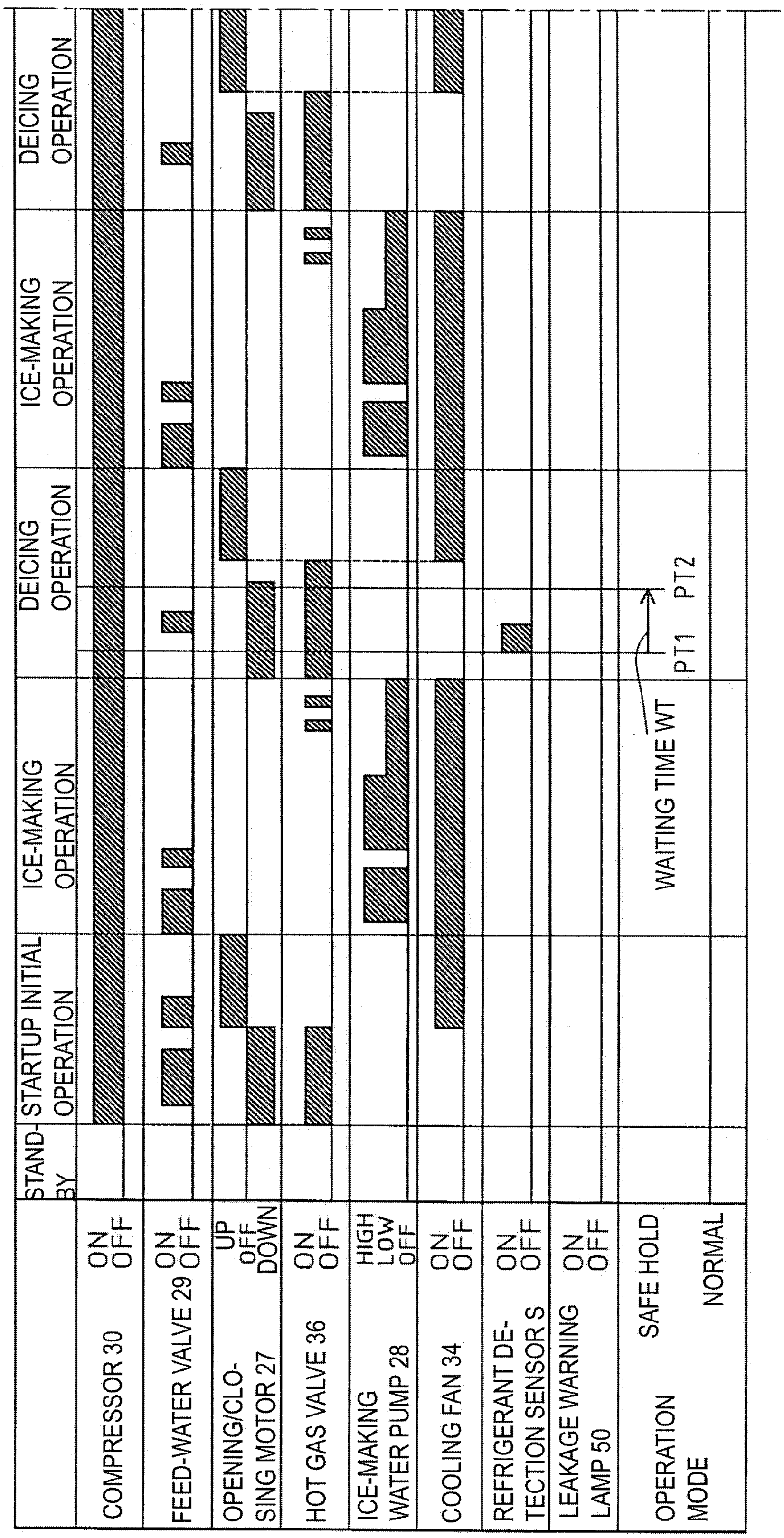
[FIG. 4]


STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSING MOTOR 27
OFF
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
DETECTION
NORMAL
FAILURE
LEAKAGE WARNING LAMP 50
ON
OFF
FAILURE INFORMING LAMP 51
ON
OFF
OPERATION MODE
SAFE
NORMAL
OCCURRENCE OF FAILURE

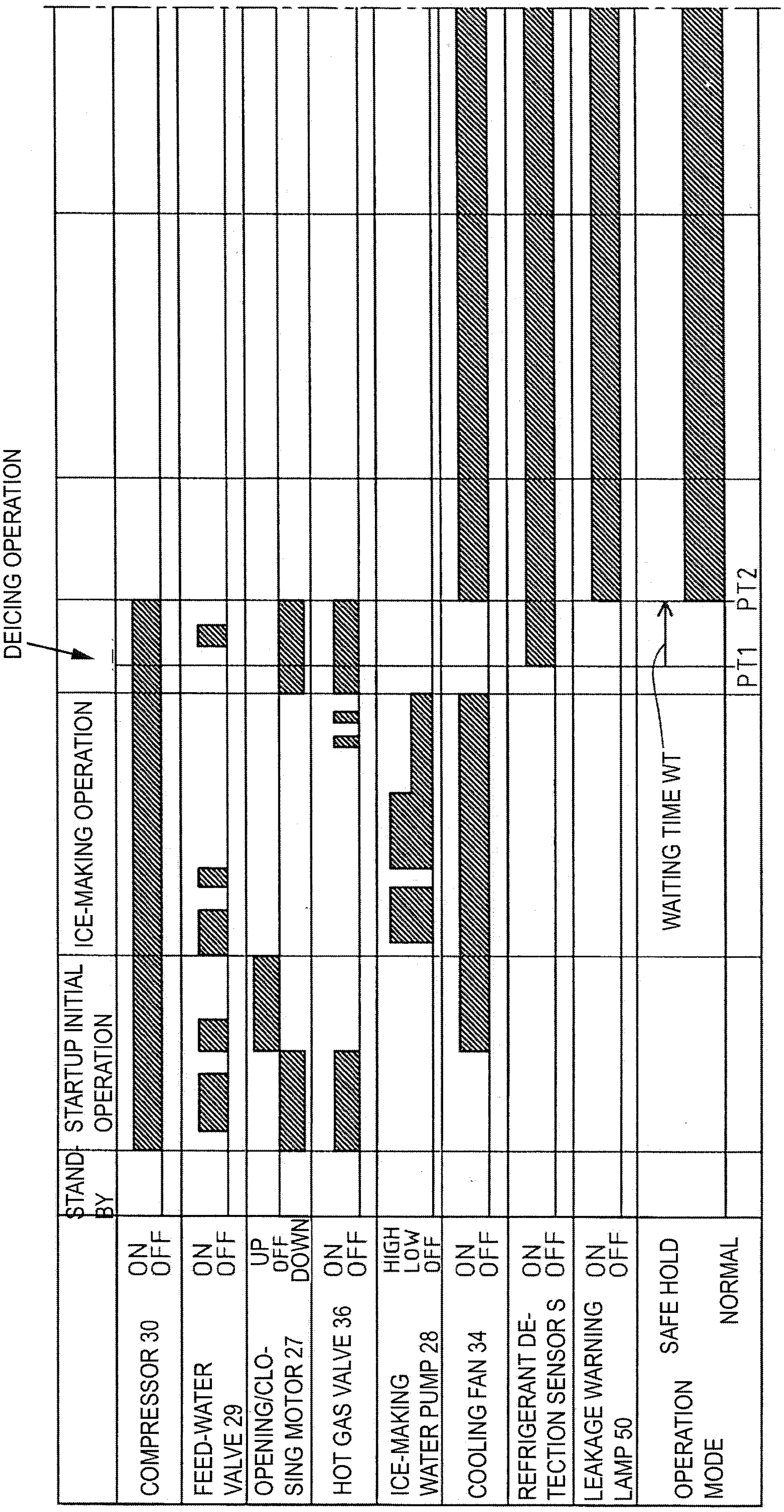
[FIG. 5]


START OPERATION OF ICE-MAKING MACHINE
STARTUP INITIAL OPERATION
S21
ICE-MAKLNG/ DEICLNG OPERATION
S22
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTION SIGNAL?
S23
NO
YES
START MEASUREMENT OF WAITING TIME
S24
S25
IS REFRIGERANT DETECTION SENSOR TRANSMITTING DETECTION SIGNAL?
NO
YES
S26
HAS WAITING TIME ELAPSED?
NO
YES
S27
IS REFRIGERANT DETECTION SENSOR TRANSMITTING DETECTION SIGNAL?
NO
YES
OPERATE COOLING FAN
S28
TURN ON LEAKAGE WARNING LAMP
S29
STOP OPERATION OF ICE-MAKING MACHINE
S30

[FIG. 6]

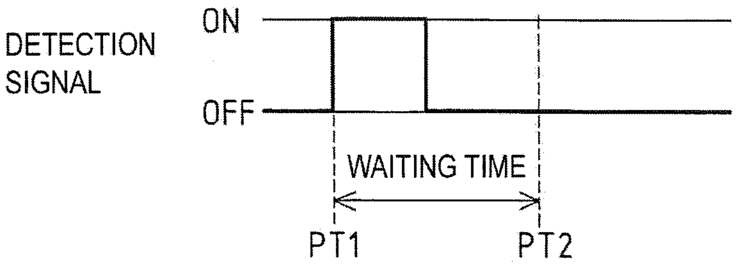

STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLO-SING MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DE-TECTION SENSOR S
ON
OFF
LEAKAGE WARNING LAMP 50
ON
OFF
OPERATION MODE
SAFE HOLD
NORMAL
WAITING TIME WT
PT1
PT2

[FIG. 7]

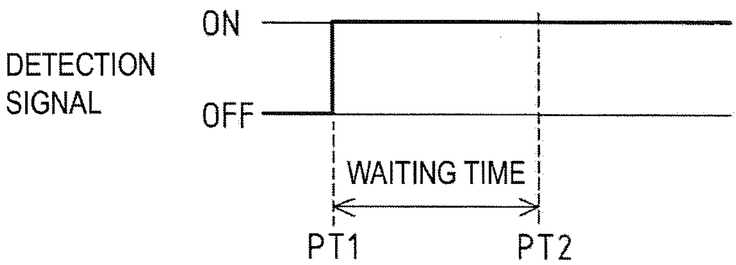

DEICING OPERATION
STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSING MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
ON
OFF
LEAKAGE WARNING LAMP 50
ON
OFF
OPERATION MODE
SAFE HOLD
NORMAL
WAITING TIME WT
PT1
PT2

[FIG. 8]

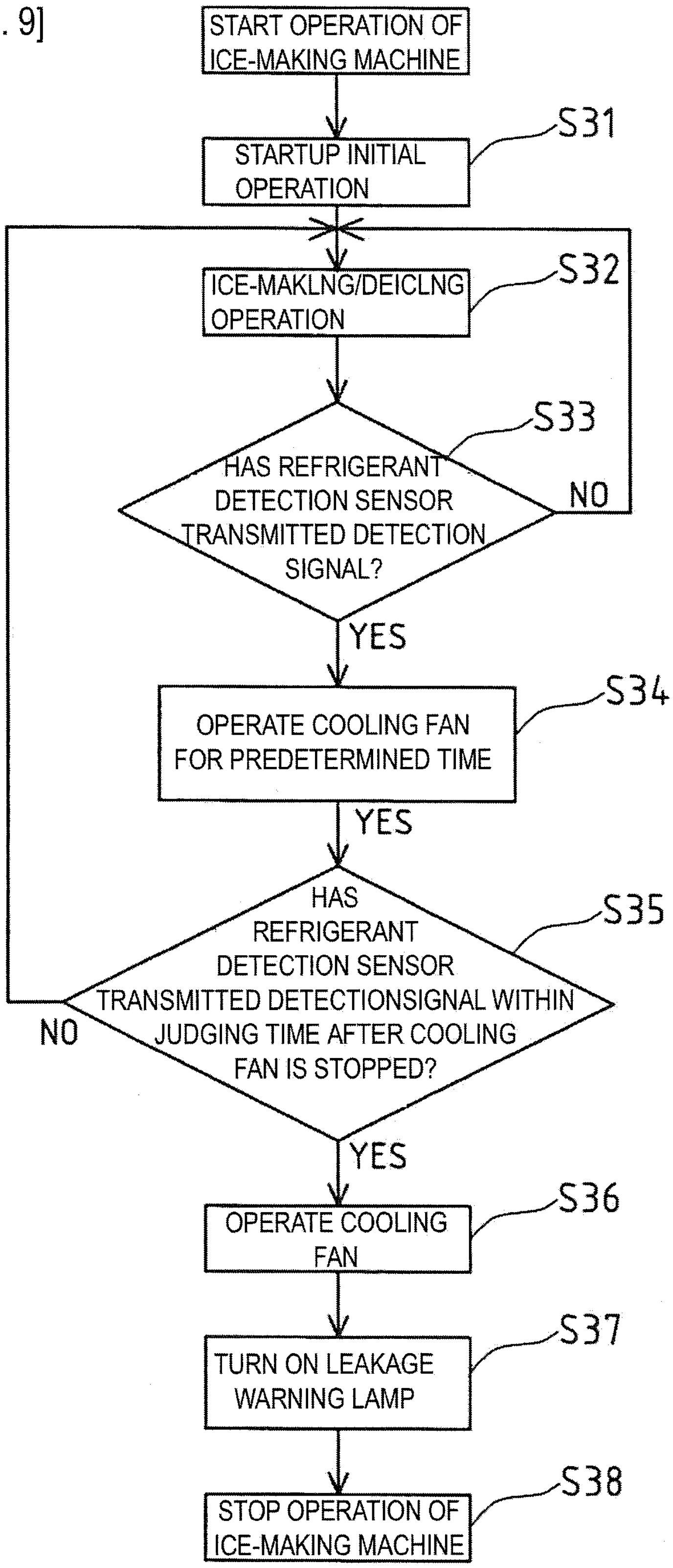
(a)


DETECTION SIGNAL
ON
OFF
WAITING TIME
PT1
PT2

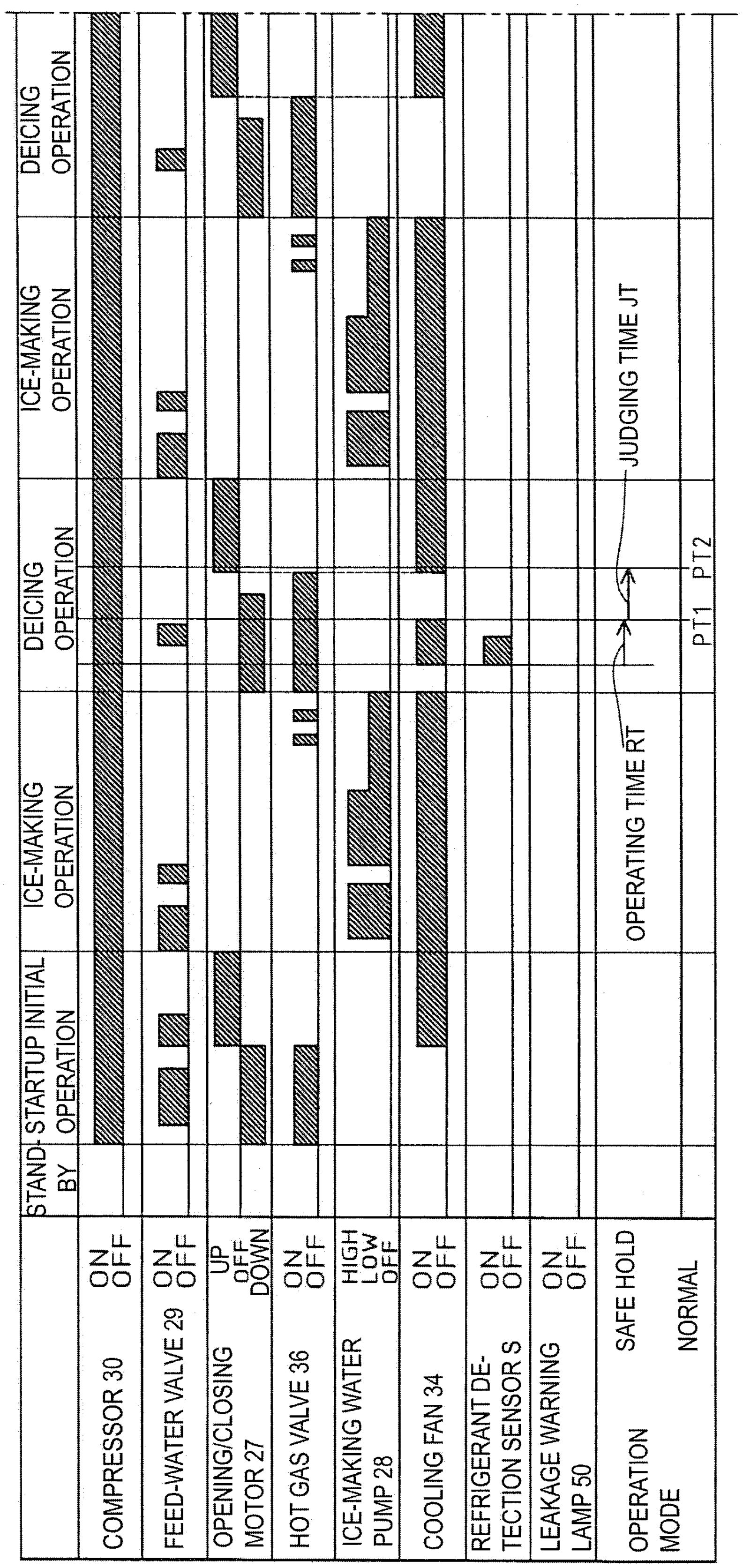
(b)


DETECTION SIGNAL
ON
OFF
WAITING TIME
PT1
PT2

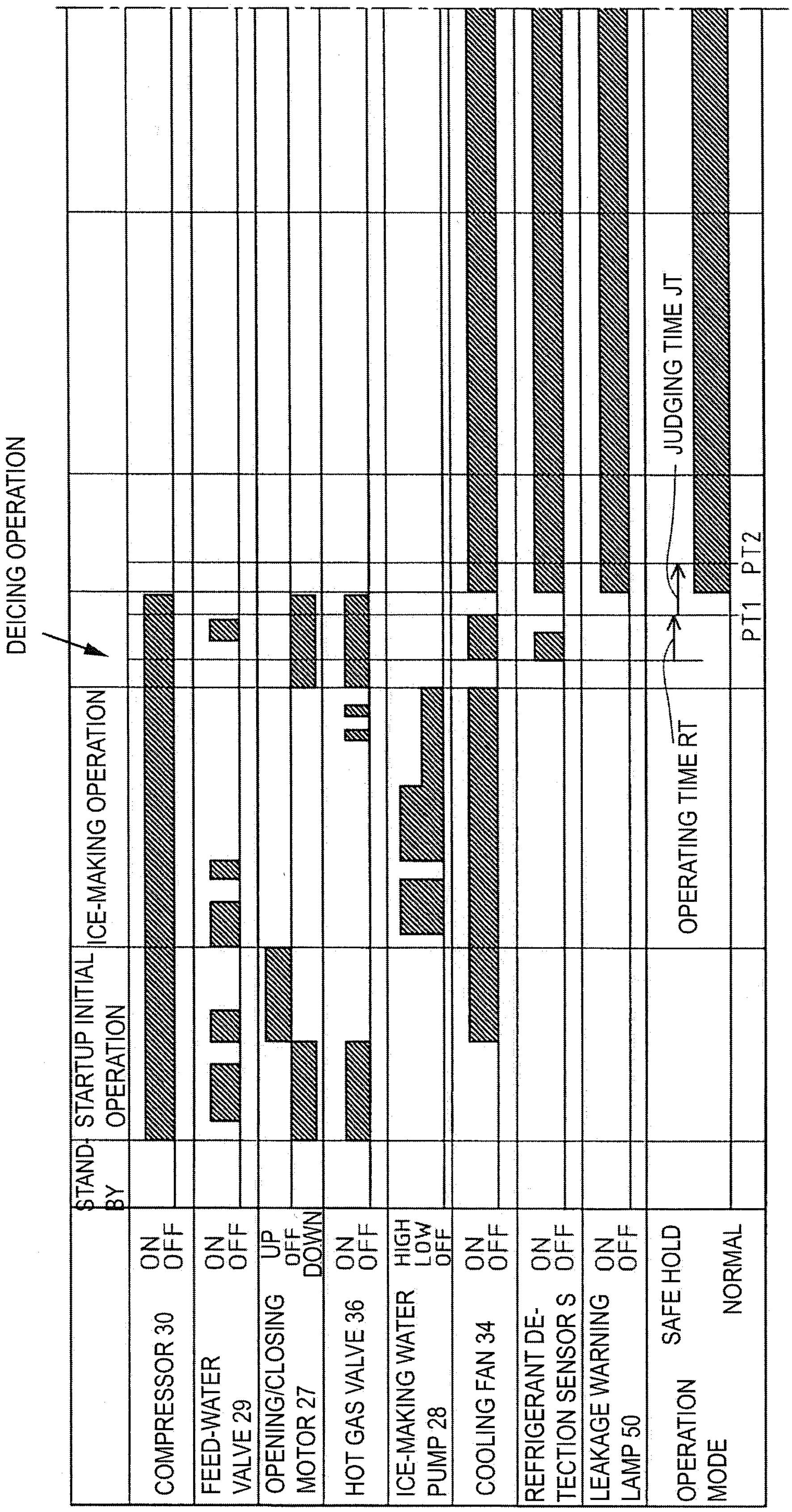
[FIG. 9]


START OPERATION OF ICE-MAKING MACHINE
STARTUP INITIAL OPERATION
S31
ICE-MAKLNG/DEICLNG OPERATION
S32
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTION SIGNAL?
S33
NO
YES
OPERATE COOLING FAN FOR PREDETERMINED TIME
S34
YES
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTIONSIGNAL WITHIN JUDGING TIME AFTER COOLING FAN IS STOPPED?
S35
NO
YES
OPERATE COOLING FAN
S36
TURN ON LEAKAGE WARNING LAMP
S37
STOP OPERATION OF ICE-MAKING MACHINE
S38

[FIG. 10]


STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSING MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
ON
OFF
LEAKAGE WARNING LAMP 50
ON
OFF
OPERATION MODE
SAFE HOLD
NORMAL
OPERATING TIME RT
JUDGING TIME JT
PT1
PT2

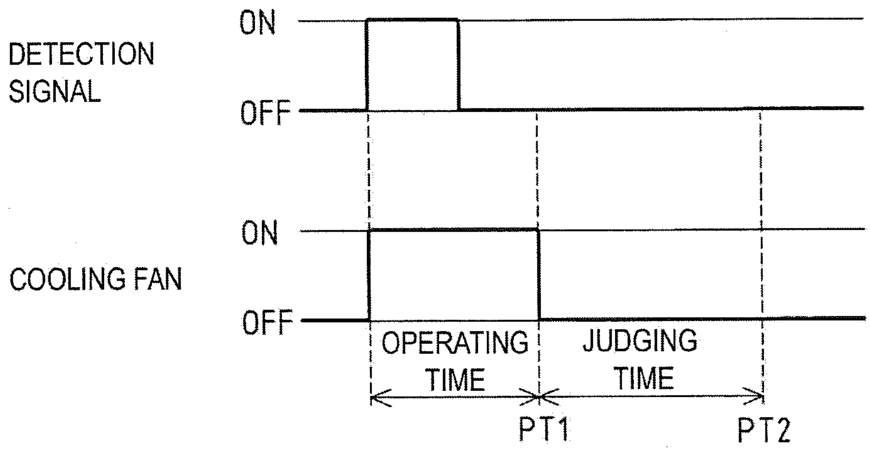
[FIG. 11]



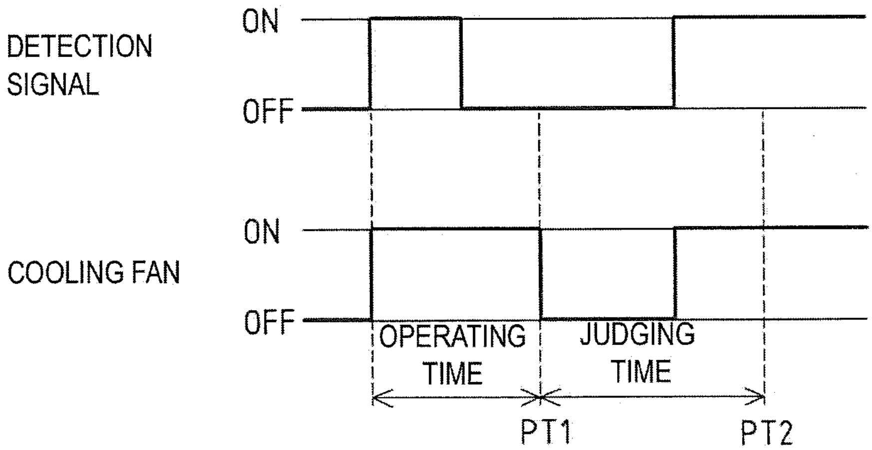
DEICING OPERATION
STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSING MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
ON
OFF
LEAKAGE WARNING LAMP 50
ON
OFF
OPERATION MODE
SAFE HOLD
NORMAL
OPERATING TIME RT
JUDGING TIME JT
PT1
PT2

[FIG. 12]

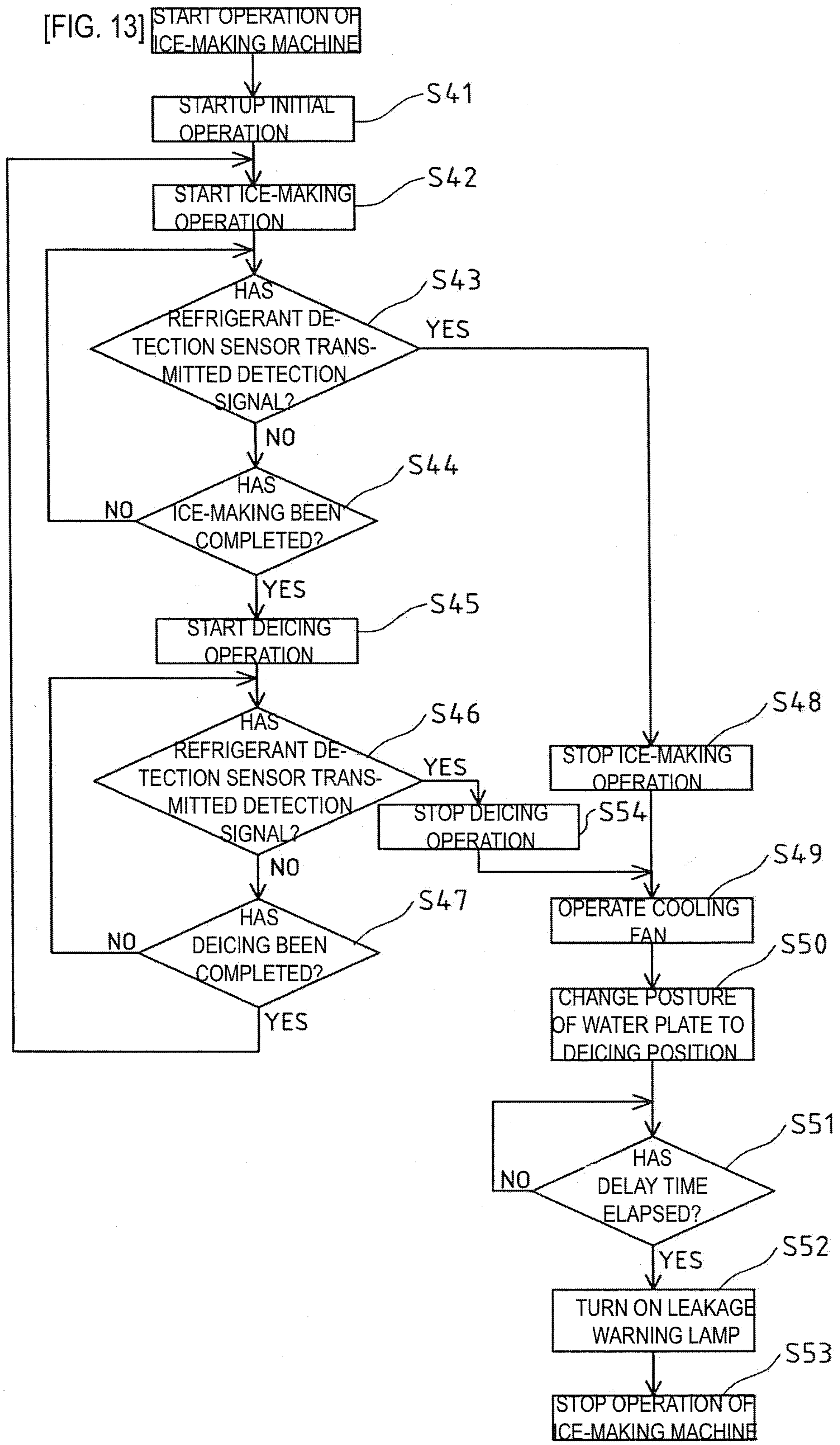
(a)


ON
DETECTION SIGNAL
OFF
ON
COOLING FAN
OFF
OPERATING TIME
JUDGING TIME
PT1
PT2

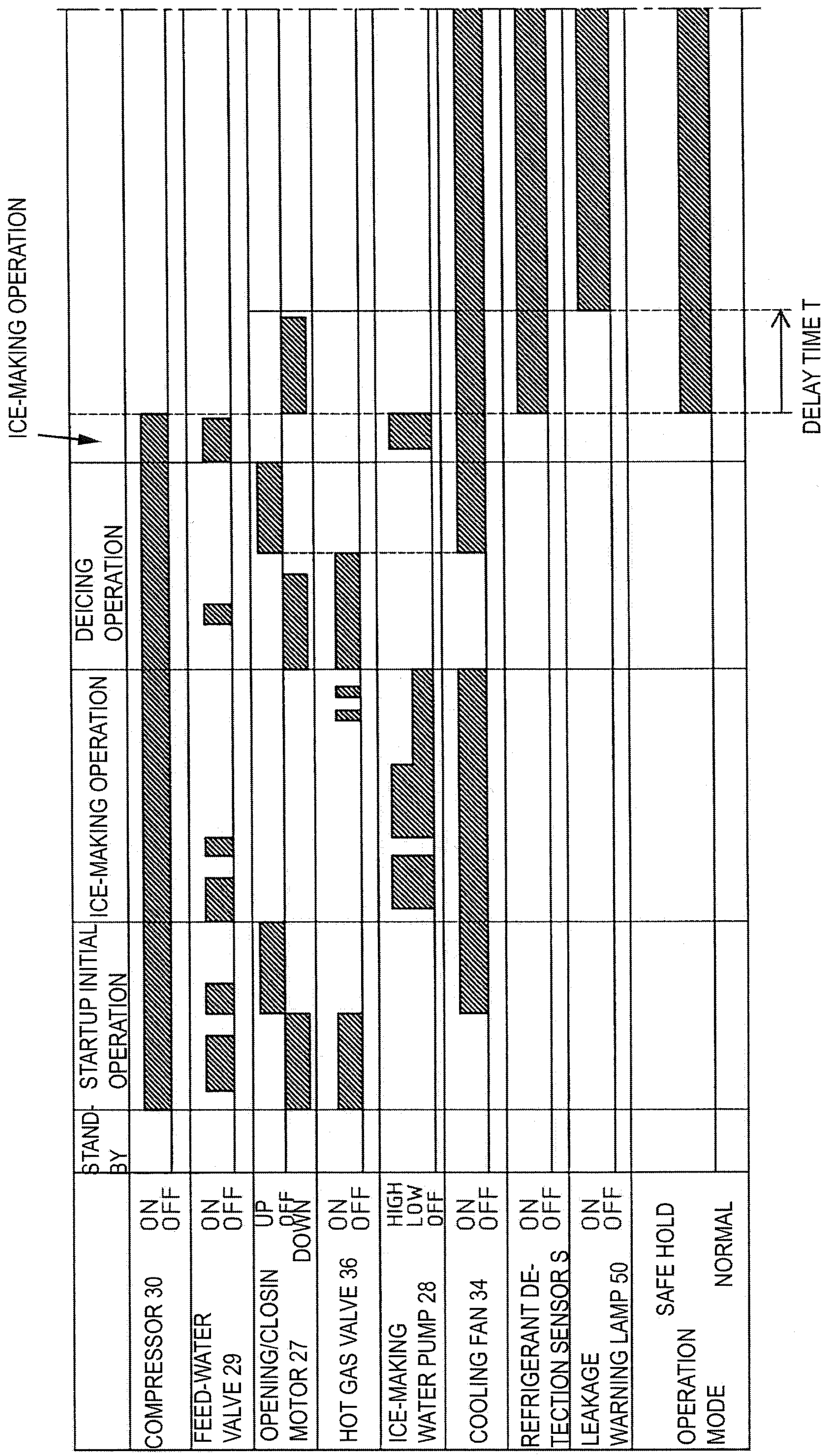
(b)


ON
DETECTION SIGNAL
OFF
ON
COOLING FAN
OFF
OPERATING TIME
JUDGING TIME
PT1
PT2

[FIG. 13]


START OPERATION OF ICE-MAKING MACHINE
STARTUP INITIAL OPERATION
S41
START ICE-MAKING OPERATION
S42
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTION SIGNAL?
S43
YES
NO
HAS ICE-MAKING BEEN COMPLETED?
S44
NO
YES
START DEICING OPERATION
S45
HAS REFRIGERANT DETECTION SENSOR TRANSMITTED DETECTION SIGNAL?
S46
YES
NO
STOP DEICING OPERATION
S54
HAS DEICING BEEN COMPLETED?
S47
NO
YES
STOP ICE-MAKING OPERATION
S48
OPERATE COOLING FAN
S49
CHANGE POSTURE OF WATER PLATE TO DEICING POSITION
S50
HAS DELAY TIME ELAPSED?
S51
NO
YES
TURN ON LEAKAGE WARNING LAMP
S52
STOP OPERATION OF ICE-MAKING MACHINE
S53

[FIG. 14]


ICE-MAKING OPERATION
DELAY TIME T
STAND-BY
STARTUP INITIAL OPERATION
ICE-MAKING OPERATION
DEICING OPERATION
COMPRESSOR 30
ON
OFF
FEED-WATER VALVE 29
ON
OFF
OPENING/CLOSIN MOTOR 27
UP
OFF
DOWN
HOT GAS VALVE 36
ON
OFF
ICE-MAKING WATER PUMP 28
HIGH
LOW
OFF
COOLING FAN 34
ON
OFF
REFRIGERANT DETECTION SENSOR S
ON
OFF
LEAKAGE WARNING LAMP 50
ON
OFF
OPERATION MODE
SAFE HOLD
NORMAL

[FIG. 15]

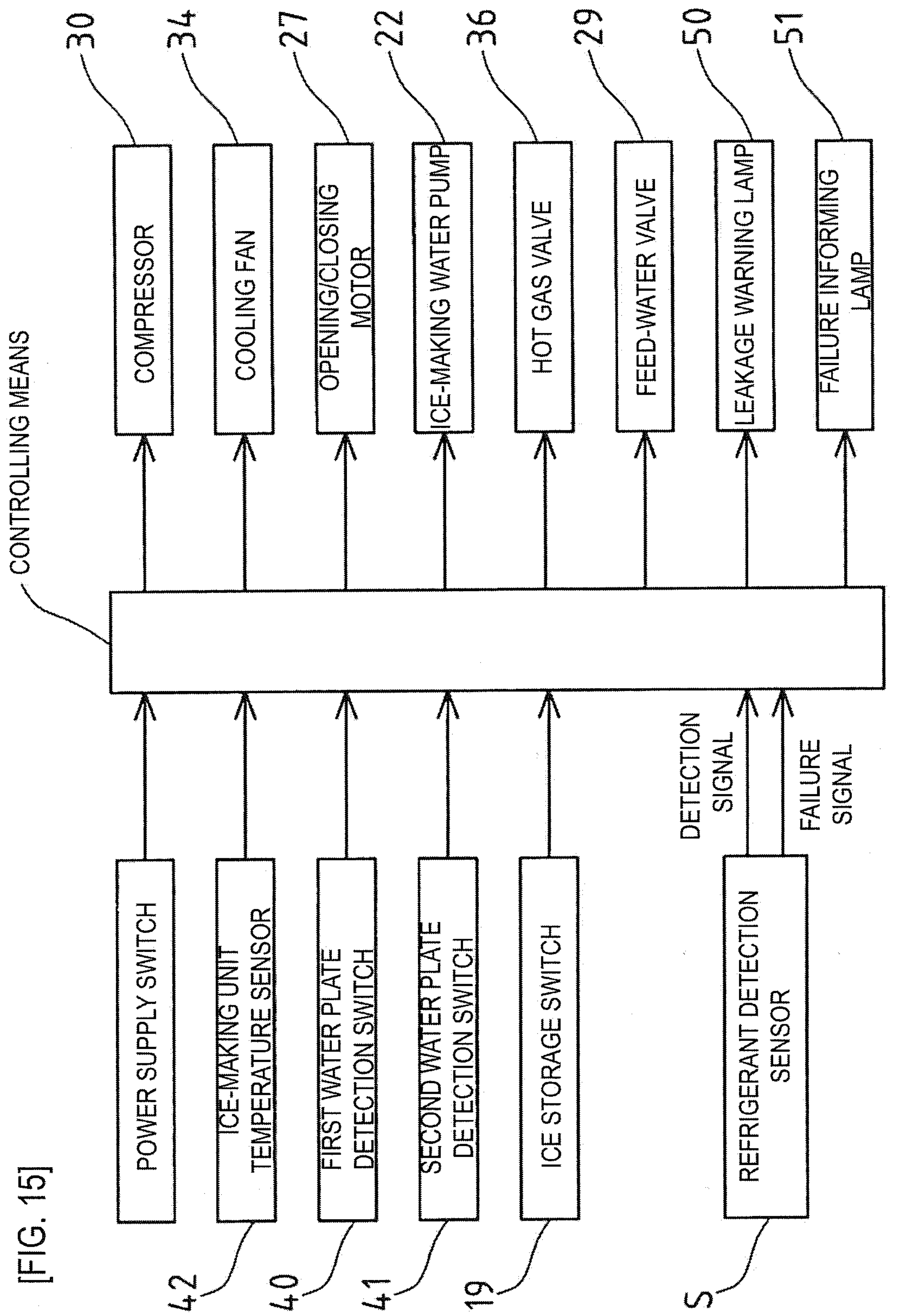

CONTROLLING MEANS
COMPRESSOR
COOLING FAN
OPENING/CLOSING MOTOR
ICE-MAKING WATER PUMP
HOT GAS VALVE
FEED-WATER VALVE
LEAKAGE WARNING LAMP
FAILURE INFORMING LAMP
30
34
27
22
36
29
50
51
POWER SUPPLY SWITCH
ICE-MAKING UNIT TEMPERATURE SENSOR
FIRST WATER PLATE DETECTION SWITCH
SECOND WATER PLATE DETECTION SWITCH
ICE STORAGE SWITCH
REFRIGERANT DETECTION SENSOR
DETECTION SIGNAL
FAILURE SIGNAL
42
40
41
19
S

FIG. 16

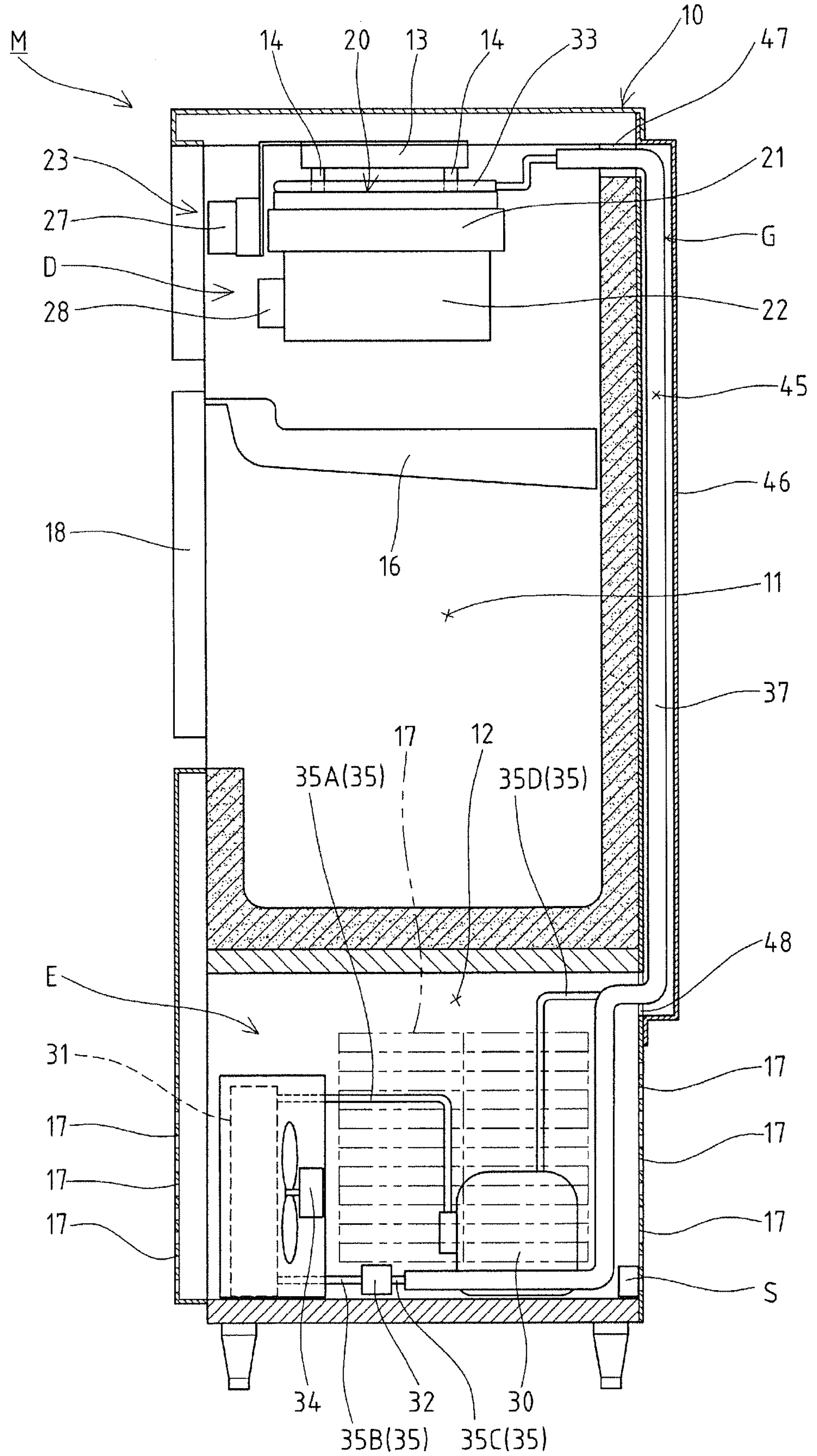

M
14
20
13
14
33
10
47
23
21
27
G
D
28
22
45
46
18
16
11
37
17
12
35A(35)
35D(35)
48
E
31
17
17
17
17
17
17
S
34
32
30
35B(35)
35C(35)

FIG. 17

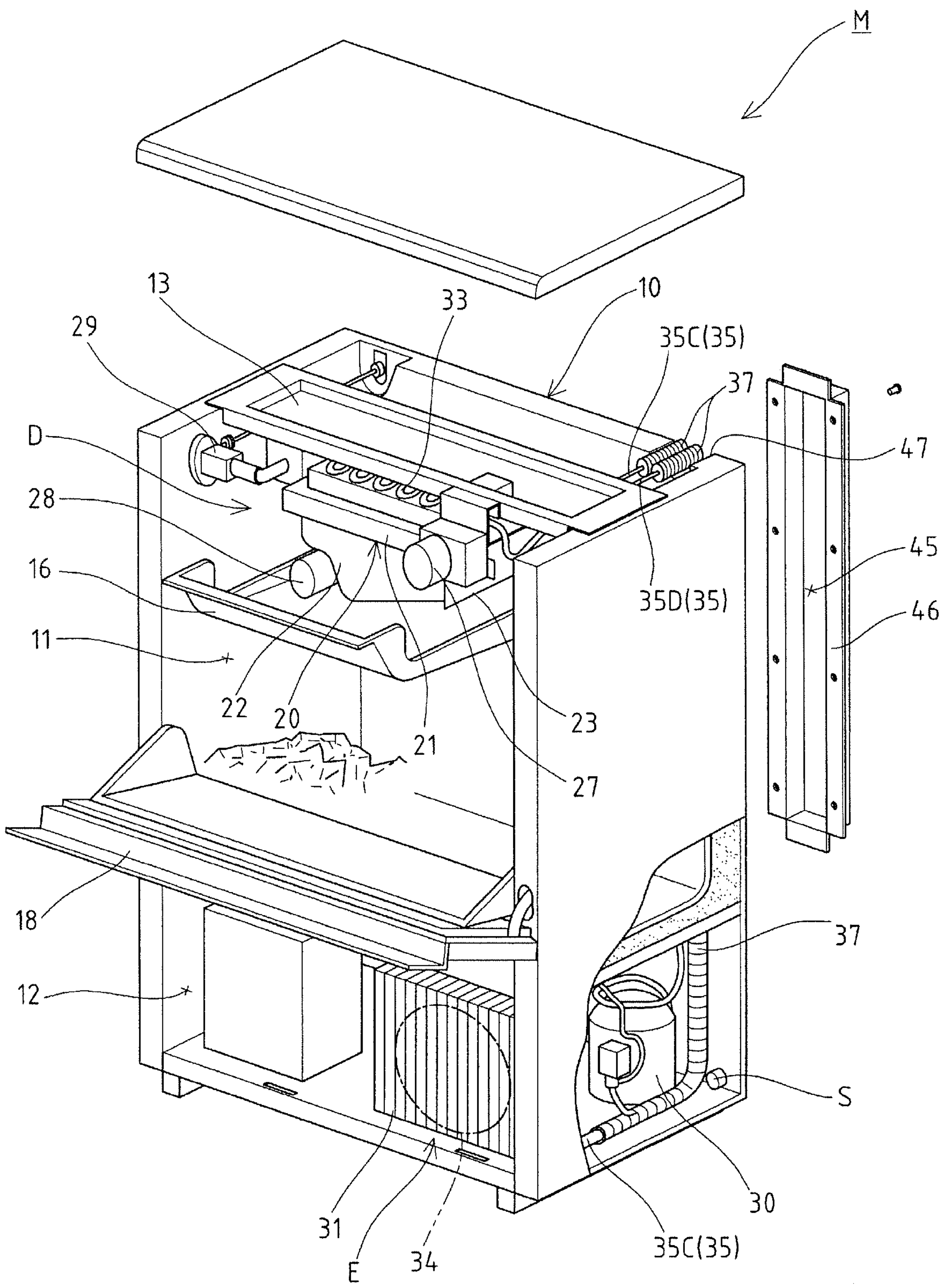

M
13
33
10
29
35C(35)
37
D
47
28
16
45
35D(35)
46
11
22
20
23
21
27
18
37
12
S
31
30
E
34
35C(35)

FIG. 18

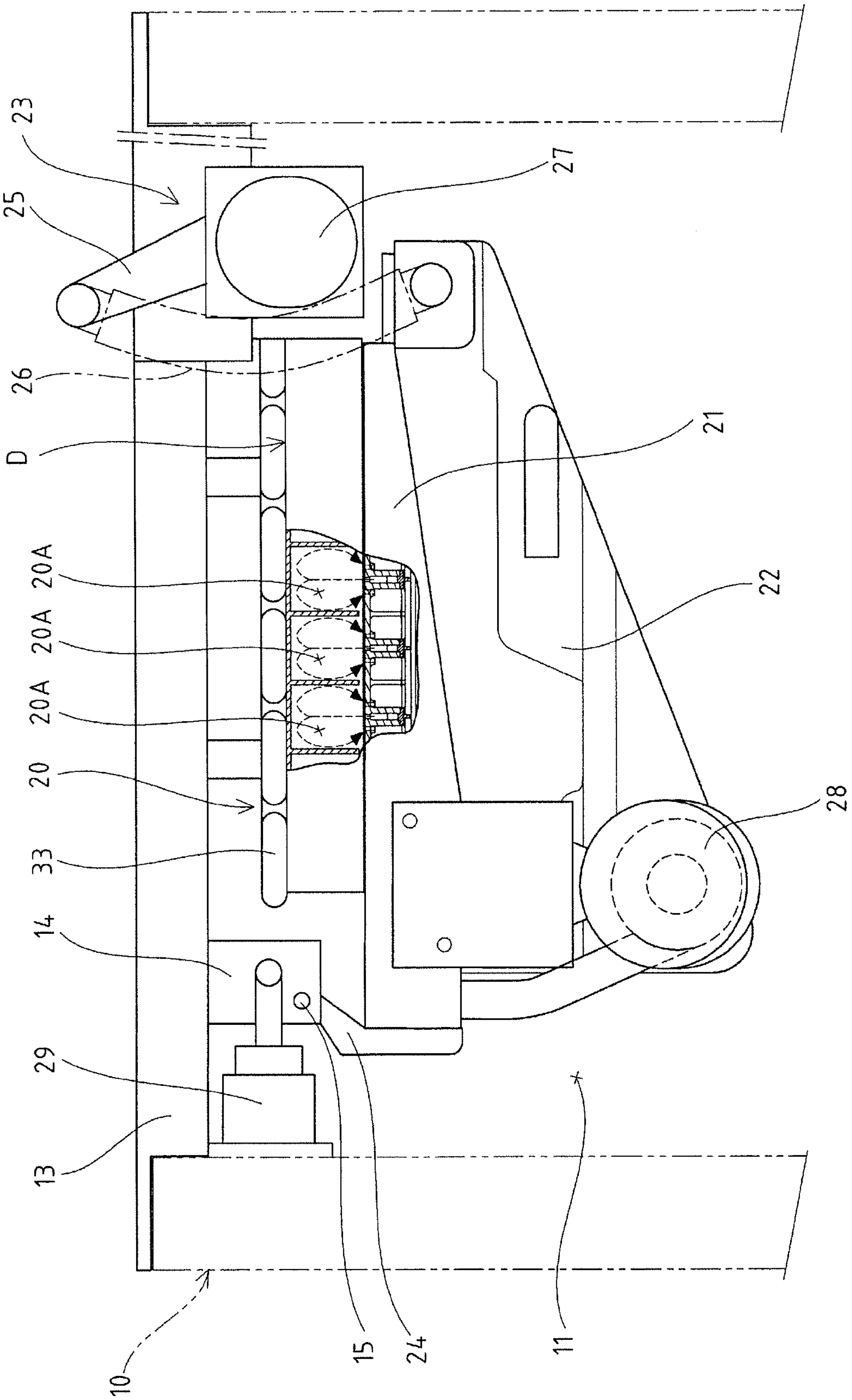


FIG. 19

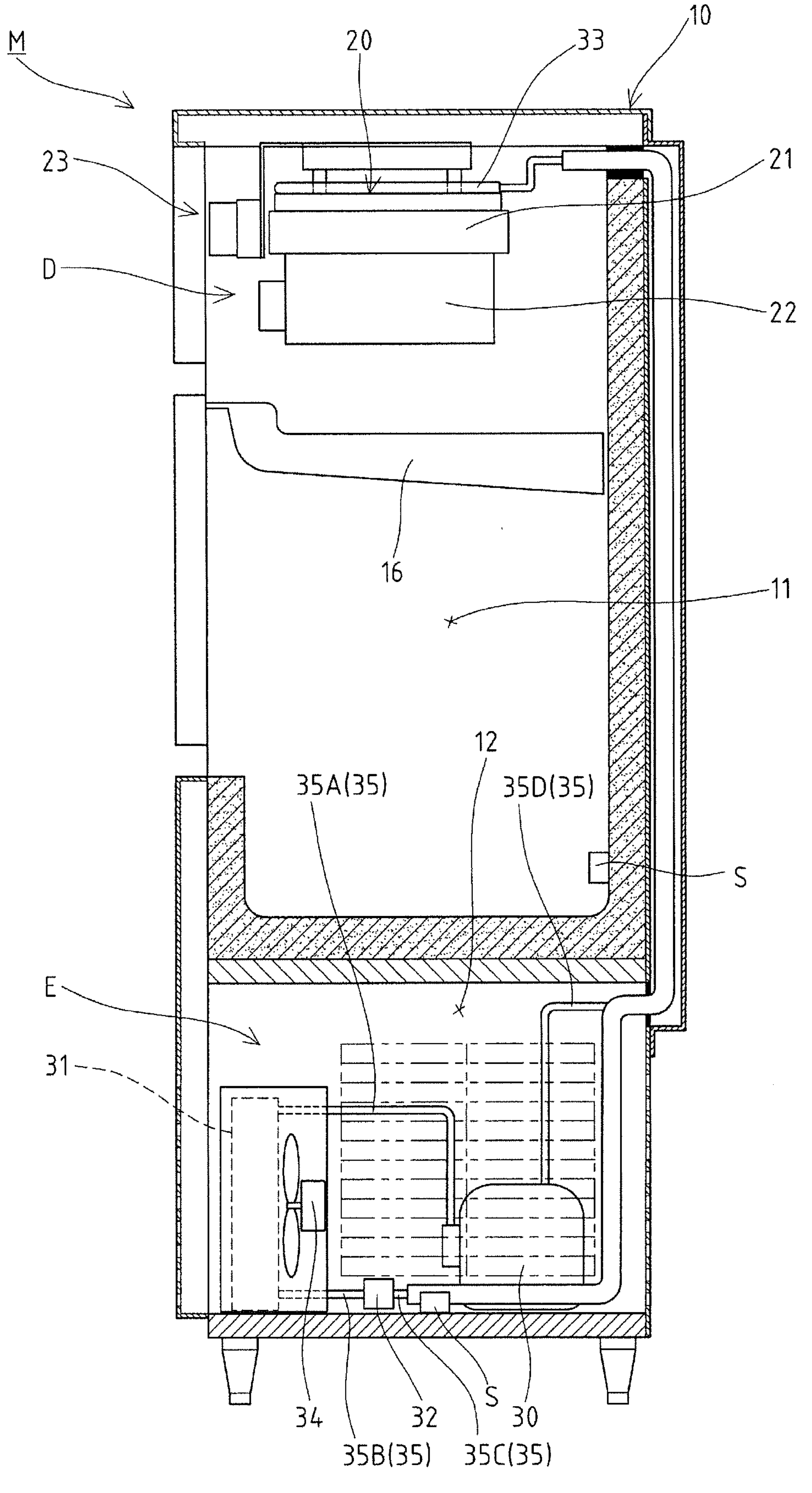
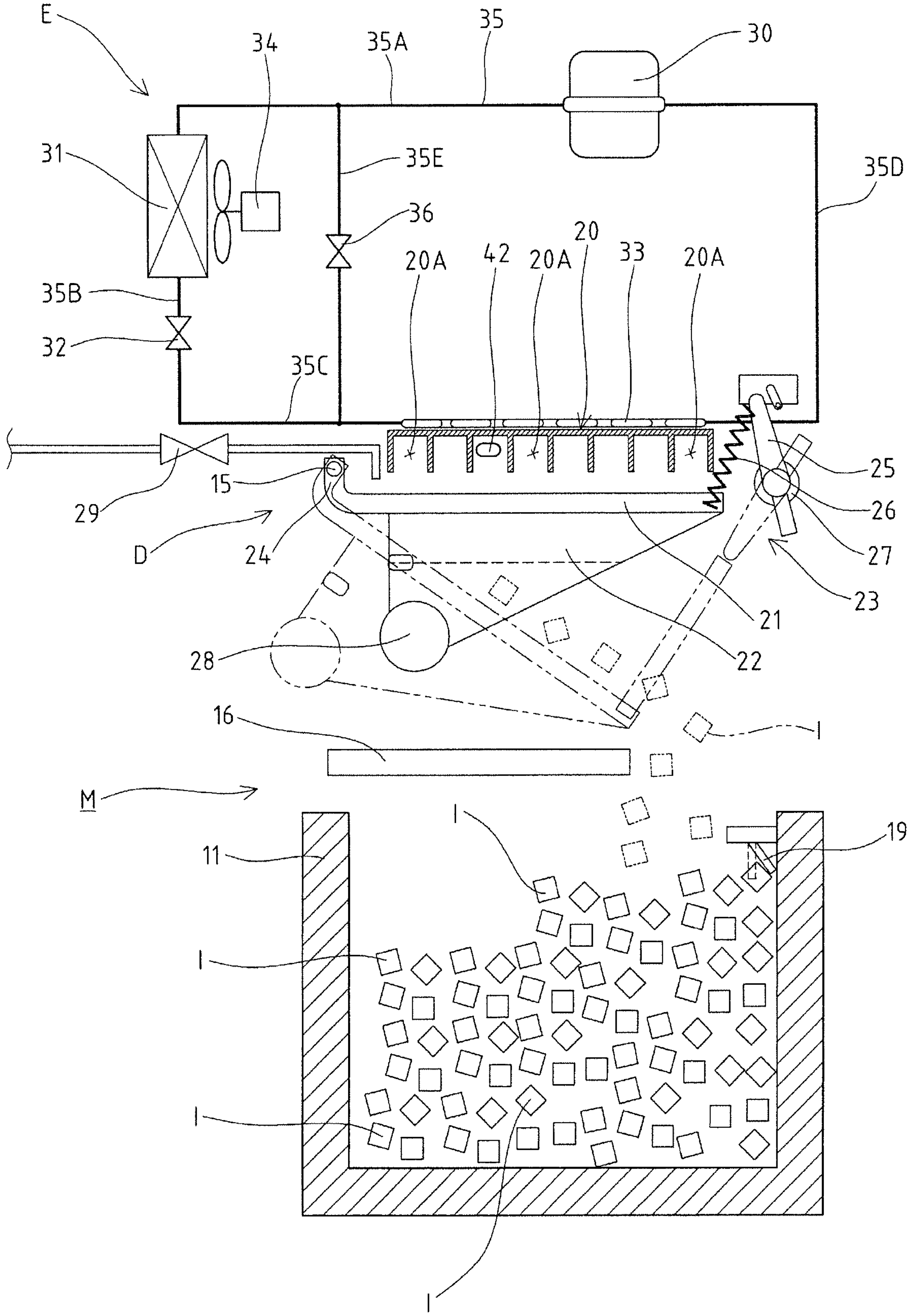

M
20
33
10
23
21
D
22
16
11
12
35A(35)
35D(35)
S
E
31
34
32
S
30
35B(35)
35C(35)

FIG. 20


E
34
35A
35
30
31
35E
35D
36
20
42
20A
33
20A
20A
35B
32
35C
29
15
25
26
27
D
24
23
21
28
22
16
I
M
I
19
11
I
I
I

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/060477

A. CLASSIFICATION OF SUBJECT MATTER
F25C1/04(2006.01)i, *F25B1/00*(2006.01)i, *F25B49/02*(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)
F25C1/04, F25B1/00, F25B49/02

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2003-207239 A (Toshiba Corp.), 25 July 2003 (25.07.2003), paragraphs [0091] to [0098] (Family: none)	1 5,10 2-4,6-9
Y	JP 2008-64453 A (Mitsubishi Electric Corp.), 21 March 2008 (21.03.2008), paragraph [0057] (Family: none)	5,10
Y	JP 2005-9857 A (Daikin Industries, Ltd.), 13 January 2005 (13.01.2005), paragraph [0063] (Family: none)	5,10

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 July, 2012 (09.07.12)	24 July, 2012 (24.07.12)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/060477

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-170134 A (Daido Industries Inc.), 26 June 1998 (26.06.1998), paragraph [0030] (Family: none)	5,10
Y	JP 8-327195 A (Sanyo Electric Co., Ltd.), 13 December 1996 (13.12.1996), paragraphs [0023], [0024] (Family: none)	10
Y	JP 2002-5548 A (Mitsubishi Electric Corp.), 09 January 2002 (09.01.2002), paragraph [0029] (Family: none)	10
A	JP 2009-93468 A (Panasonic Corp.), 30 April 2009 (30.04.2009), entire text; all drawings (Family: none)	1-10

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2012/060477

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The invention of claim 1 does not have a special technical feature in the light of the invention disclosed in the document 1 (JP 2003-207239 A (Toshiba Corp.), 25 July 2003 (25.07.2003), paragraphs [0091] to [0098]).

Consequently, a group of inventions in claims (claims 1-10) have no technical relationship involving a same or corresponding special technical feature, and therefore cannot be considered to be so linked as to form a single general inventive concept.

Four inventions (invention groups) each having a special technical feature indicated below are involved in claims.

(Continued to extra sheet)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/060477

Continuation of Box No.III of continuation of first sheet(2)

Meanwhile, the invention of claim 1 having no special technical feature is classified into invention 1.

(Invention 1) claims 1-4 and 10
(Invention 2) claim 5
(Invention 3) claim 6
(Invention 4) claims 7-9

Form PCT/ISA/210 (extra sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2003207244 A **[0005]**