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(11) **EP 1 288 594 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
05.03.2003 Bulletin 2003/10

(51) Int Cl.7: **F25B 49/02**

(21) Application number: **01936860.4**

(86) International application number:
PCT/JP01/04755

(22) Date of filing: **05.06.2001**

(87) International publication number:
WO 01/094863 (13.12.2001 Gazette 2001/50)

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**
Designated Extension States:
AL LT LV MK RO SI

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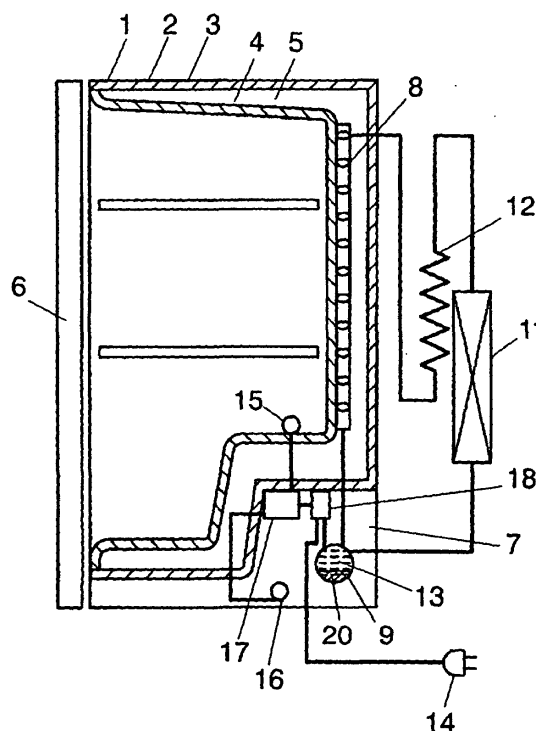
(30) Priority: **05.06.2000 JP 2000167272**

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(54) **REFRIGERATING CYCLE DEVICE**

(57) A refrigerating cycle system of the present invention uses a hydrocarbon refrigerant, and lubricating oil that does not include silicone. Also, the refrigerating cycle system of the present invention includes a detachable sensor section which detects the leakage of the hydrocarbon refrigerant. Even when the gas detecting sensor becomes unusable, the refrigerating cycle system can be safely used by replacing the gas detecting sensor with new one. Further, the refrigerating cycle system of the present invention is provided with silicone removing filters or sulfur compound removing filters in the sensor section. Also, the refrigerating cycle system of the present invention is provided with one of infrared type, hydrogen flame ionization type, and optical interference type sensors. By using the refrigerating cycle system of the present invention, it is possible to provide an inexpensive refrigerating cycle system which is environment-friendly and excellent in safety.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigerating cycle system using a gas detecting sensor which detects a leakage of flammable hydrocarbon refrigerant used in the refrigeration cycle system.

BACKGROUND OF THE INVENTION

[0002] Recently, as a refrigerant used in a refrigerating cycle system such as refrigerators and air conditioners, a hydrocarbon refrigerant which is zero in ozone destruction coefficient and less in global warming coefficient as compared with a conventional refrigerant is employed from the viewpoint of global environment protection. However, the hydrocarbon refrigerant involves a problem of flammability. Therefore, in a case of using the hydrocarbon refrigerant in the refrigerating cycle system, there is a proposal of a refrigerating cycle system provided with a safety device which detects a hydrocarbon refrigerant leaking from the refrigerating cycle system in order to assure safety with respect to flammability of the refrigerant.

[0003] For example, in the case of detecting the leak of the flammable refrigerant by means of a leak sensor disposed outside the refrigerating cycle system, Japanese Patent Laid-open Publication H6-180166 and Japanese Patent Laid-open Publication H8-166171 disclose a means for collecting the flammable refrigerant into the outdoor unit of the air conditioner, and Japanese Patent Laid-open Publication H8-178481 and Japanese Laid-open Patent H8-247646 disclose a means for stopping a compressor operation of the refrigerator.

[0004] A refrigerator using a hydrocarbon refrigerant as one of conventional refrigerating cycles will be described in the following with reference to the drawings.

[0005] Fig. 9 is a sectional view of a conventional refrigerator. The refrigerator comprises a main body 1, heat insulating casing 2, outer casing 3 made of steel, inner casing 4 made of ABS or PS, insulator 5 made of urethane or the like, and door 6 attached to the heat insulating casing 2.

[0006] At the rear bottom of the main body 1 is arranged a machine compartment 7, at a rear of the inner casing 4 is disposed an evaporator 8, and in the machine compartment 7 is installed a compressor 9. The compressor 9 includes lubricating oil 10. Also, the compressor 9 is connected to a condenser 11, an expansion device 12, and the evaporator 8 circularly in order, forming a refrigerating cycle. A hydrocarbon refrigerant 13 is sealed in the refrigerating cycle, to which power is supplied through plug 14.

[0007] Also, Fig. 10 is a simplified circuit diagram of the refrigerator of Fig. 9. Reference numerals 15, 16 indicate gas detecting sensors, numeral 17 indicates a gas detection control box, and numeral 18 indicates a

power relay.

[0008] Regarding the refrigerating cycle system having a configuration as described above, an operation will be described in the following. When the compressor 9 is operated with power supplied from the plug 14, the flammable hydrocarbon refrigerant 13 is discharged from the compressor 9 and raised in temperature and pressure, and then condensates and liquifies through a heat exchange with an atmosphere in the condenser 11. Subsequently, the hydrocarbon refrigerant 13 is lowered in temperature and pressure by the expansion device 12 and is evaporated by the evaporator 8 through a heat exchange in an interior of the refrigerator and again returns to the compressor 9. By repeating the refrigerating cycle, the hydrocarbon refrigerant 13 is circulated. At the same time, some of the lubricating oil 10 in the compressor 9 is also circulated together with the hydrocarbon refrigerant 13.

[0009] In a case the flammable hydrocarbon refrigerant 13 leaks from the refrigerating cycle of the refrigerator for some reasons such as a cracking in a pipe due to vibration, the gas detecting sensors 15, 16 detect the hydrocarbon refrigerant, and the gas detection control box 17 operates the power relay 18 according to the signal from the gas detecting sensors 15, 16 to cut off the power supply from the plug 14.

[0010] The sensor used for detecting the leakage of a hydrocarbon refrigerant is generally a catalytic combustion type or a semiconductor type sensor, which is a relatively inexpensive gas detector. The detection principle of the catalytic combustion type sensor is to utilize heat generation due to a resistance change of a platinum coil in combustion of flammable gas on an oxidation catalyst. The catalytic combustion has features such that an output from the sensor is nearly proportional to a gas concentration up to a lower limit of explosion and that the sensor is hardly influenced by a temperature and a humidity in the using environment, also being excellent in accuracy and reproducibility. On the other hand, a detection principle of the semiconductor type sensor is that a resistance change generated when a metal oxide semiconductor comes into contact with gas is utilized. Therefore, the sensor has a large output at low gas concentrations, and is capable of detecting various gases such as poisonous gas as well as flammable gas even at high concentrations, and ensures excellent endurance against relatively severe environments.

[0011] However, in a conventional sensor structure, if an organic silicone compound (hereafter referred to as "silicone") used in the lubricating oil sticks to the gas detecting sensor, it changes to a solid silicone oxide such as SiO_2 on the surface of the gas detecting sensor, and covers the surface of the catalyst, causing the catalyst to be decreased in catalyst activity and the detecting sensor to be lowered in sensitivity. On the other hand, if a sulfur compound such as hydrogen sulfide sticks to the gas detecting sensor, it acts as a catalyst poison against the platinum-based catalyst, and may corrode

the sensor member when the humidity is high in particular. Accordingly, if silicone included in the lubricating oil of the refrigerating cycle system or sulfur compounds included in car exhaust gas or in an atmosphere sticks to the gas detecting sensor, it lowers the sensitivity of the sensor, and it increases the possibility that the sensor become unable to serve its original function of avoiding danger by detecting the leakage of hydrocarbon refrigerant.

[0012] The present invention is intended to address the above conventional problem, and an object of the invention is to provide a refrigerating cycle system which may correctly detect the leakage of hydrocarbon refrigerant and assure the normal operation of the safety device.

DISCLOSURE OF THE INVENTION

[0013] A refrigerating cycle system of the present invention uses a lubricating oil that does not include silicone. Accordingly, a catalytic combustion type or semiconductor type gas detecting sensor which is decreased in sensitivity by a contact with silicone can be used for the refrigerating cycle system that uses a hydrocarbon refrigerant.

[0014] Also, the refrigerating cycle system of the present invention has a removable sensor section for detecting hydrocarbon. Even when the gas detecting sensor becomes unusable due to silicone or sulfur compound, it can be replaced with a new gas detecting sensor, and therefore, a gas detecting sensor which is liable to be contaminated by silicone or sulfur compound can be used for the refrigerating cycle system that uses hydrocarbon refrigerant.

[0015] Further, the refrigerating cycle system of the present invention has a silicone removing filter or sulfur compound removing filter attached to the sensor section. These filters are detachable and can be replaced with new ones. Thus, it is possible to protect the sensor and to prolong its life.

[0016] Also, the refrigerating cycle system of the present invention is provided with one of an infrared type, a hydrogen flame ionization type, and an optical interference type sensors. Since a sensor of such type is not affected by silicone or sulfur compound, it can be used for the refrigerating cycle system that uses hydrocarbon refrigerant even in a silicone or sulfur compound environment.

[0017] By using the refrigerating cycle system of the present invention, it is possible to provide a refrigerating cycle system which is environment-friendly and excellent in safety.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a sectional view of a refrigerator in a first

preferred embodiment of the present invention.

Fig. 2 is a sectional view of a refrigerator in a second preferred embodiment of the present invention.

Fig. 3 is a sectional view of a refrigerator in a third preferred embodiment of the present invention.

Fig. 4 is a sectional view of a refrigerator in a fourth preferred embodiment of the present invention.

Fig. 5 is a sectional view of a refrigerator in a fifth preferred embodiment of the present invention.

Fig. 6 is a sectional view of a refrigerator in a sixth preferred embodiment of the present invention.

Fig. 7 is a sectional view of a refrigerator in a seventh preferred embodiment of the present invention.

Fig. 8 is a sectional view of a refrigerator in an eighth preferred embodiment of the present invention.

Fig. 9 is a sectional view of a conventional refrigerator.

Fig. 10 is a circuit diagram of a conventional refrigerator.

BEST MODE FOR CARRYING OUT THE INVENTION

[0019] The preferred embodiments of the present invention will be described in the following with reference to the drawings. The same components as conventional ones are designated by similar numerals, and their detailed description is omitted.

First Preferred Embodiment

[0020] Fig. 1 is a sectional view of a refrigerator in one preferred embodiment of the present invention. In Fig. 1, the refrigerator of the present invention uses lubricating oil 20 including no silicone.

[0021] The operation of the refrigerator of the present invention is described in the following.

[0022] When compressor 9 is operated with power supplied from plug 14, flammable hydrocarbon refrigerant 13 is discharged from the compressor 9 and becomes raised in temperature and pressure, and condensed and liquified through heat exchange with an atmosphere in condenser 11. Subsequently, the hydrocarbon refrigerant 13 is decreased in temperature and pressure by expansion device 12 and is evaporated by evaporator 8 through heat exchange in an interior of the refrigerator and again returns to the compressor 9. The refrigerating cycle is repeated and the hydrocarbon refrigerant 13 is circulated. At the same time, small amount of the lubricating oil 20 in the compressor 9 is also circulated together with the hydrocarbon refrigerant 13.

[0023] In a case the flammable hydrocarbon refrigerant 13 leaks from the refrigerating cycle of the refrigerator for some reasons such as cracking in a pipe due to vibration, gas detecting sensors 15, 16 detect the hydrocarbon refrigerant, and gas detection control box 17 activates power relay 18 according to a signal from the

gas detecting sensors 15, 16 to cut off the power supply from the plug 14.

[0024] According to the present preferred embodiment, since the lubricating oil 20 includes no silicone, a relatively inexpensive catalytic combustion type or semiconductor type gas detecting sensor, which is deteriorated in sensitivity by a contact with silicone, can be used as a safety device for the refrigerating cycle system, although a mist of the lubricating oil 20 leaks together with the hydrocarbon refrigerant 13 and contacts to the gas detecting sensors 15, 16.

Second Preferred Embodiment

[0025] Fig. 2 is a sectional view of a refrigerator in the second preferred embodiment of the present invention as claimed in claim 2. In Fig. 2, the refrigerator of the present invention, uses lubricating oil 20' including silicone, and is also provided with gas detecting sensors 21, 22 which are detachably installed.

[0026] The operation of the refrigerator in the present embodiment is same as in the first preferred embodiment.

[0027] According to the present preferred embodiment, even when a mist of lubricating oil 20' including silicone leaks along with the hydrocarbon refrigerant 13 from the refrigerating cycle around gas detecting sensors 21, 22 and sticks to the gas detecting sensors 21, 22, making them unable to perform gas detection thereafter, the sensors can be replaced with new ones. Accordingly, the refrigerator can be safely used again. Also, even in a case the gas detecting sensors 21, 22 are corroded by sulfur compound floating around the gas detecting sensors 21, 22, and being unable to perform gas detection thereafter, it is possible to safely use the refrigerator again by replacing the sensors with new ones.

Third Preferred Embodiment

[0028] Fig. 3 is a sectional view of a refrigerator showing the third preferred embodiment of the present invention. The refrigerator in the present preferred embodiment has silicone removing filters 23, 24, and the silicone removing filters 23, 24 are disposed so as to cover gas detecting sensors 15, 16.

[0029] The operation of the refrigerator in the present preferred embodiment is also same as in the first preferred embodiment.

[0030] In the refrigerator of the present embodiment, even in case a mist of lubricating oil 20' including silicone leaks around gas detecting sensors 15, 16 together with hydrocarbon refrigerant 13, the silicone removing filters 23, 24 remove the silicone before sticking to the gas detecting sensors 23, 24, thereby protecting the gas detecting sensors. Also, the refrigerator of the present preferred embodiment is effective against not only the problem of refrigerant leaking from the refrigerator but also

the problem of silicone existing in an atmosphere around the gas detecting sensors, the silicone existing for some reasons such as floating from outside.

[0031] According to the present preferred embodiment, when the possibility is less with respect to the existence of silicone that may affect the gas detecting sensor or when the cost of silicone removing filter replacement is low, a relatively inexpensive catalytic combustion type or semiconductor type gas detecting sensor can be reliably employed.

Fourth Preferred Embodiment

[0032] Fig. 4 is a sectional view of a refrigerator in the fourth preferred embodiment of the present invention. The refrigerator in the present preferred embodiment has sulfur compound removing filters 25, 26, and the sulfur compound removing filters 25, 26 are disposed so as to cover gas detecting sensors 15, 16.

[0033] The operation of the refrigerator in the present preferred embodiment is also same as in the first preferred embodiment.

[0034] According to the present preferred embodiment, even when sulfur compound exists in an atmosphere around the gas detecting sensors 15, 16 for some reasons such as intrusion of sulfur compound from outside due to car exhaust or natural gas at a hot-spring resort, the sulfur removing filters 25, 26 remove the sulfur compound before sticking to the gas detecting sensors 15, 16, thereby protecting the gas detecting sensor.

[0035] The present preferred embodiment effectively functions when an existence of sulfur compound is less possible or when the cost of removing filter replacement is low.

Fifth Preferred Embodiment

[0036] Fig. 5 is a sectional view of a refrigerator in the fifth preferred embodiment of the present invention. The refrigerator in the present preferred embodiment has detachable silicone removing filters 27, 28, and detachable sulfur compound removing filters 29, 30. The filters 27, 28 and the filters 29, 30 are disposed so as to cover gas detecting sensors 15, 16.

[0037] The operation of the refrigerator in the present preferred embodiment is also same as in the first preferred embodiment.

[0038] In the present preferred embodiment, when the performance of each removing filter is saturated causing the filter to become unusable for some reasons such as refrigerant leakage from the refrigerator or car exhaust, the removing function can be restored by replacing the filter with new one. The present preferred embodiment is effective when a possibility that an existence of silicone or sulfur compound that may affect the gas detecting sensor is less or when the maintenance cost of filter replacement is low. Also, it is possible to select one of the silicone removing filter and the sulfur

removing filter in accordance with the atmospheric environment where the refrigerator is installed.

Sixth referred Embodiment 6

[0039] Fig. 6 is a sectional view of a refrigerator in the sixth preferred embodiment of the present invention. The refrigerator in the sixth preferred embodiment has non-dispersion type infrared detection sensors 31, 32. The detection principle of the non-dispersion type infrared sensor is to utilize a property of infrared ray that is absorbed by gas, and it is mainly characterized in that the measurement can be made with high accuracy and stability. The sensitivity is not deteriorated for a long period of time, and the sensor is less affected by coexisting gas, moisture or the like, and is excellent in selectivity.

[0040] The operation of the refrigerator in the present preferred embodiment is also same as in the first preferred embodiment.

[0041] The non-dispersion type infrared sensor detects hydrocarbon gas by measuring an amount of infrared ray (of specific wavelength) absorbed by hydrocarbon gas (infrared ray transmittance) at a specific wavelength. Since an absorption wavelength of hydrocarbon gas is different from those of silicone and sulfur compound, and is not affected by these, it is possible to detect the leakage of hydrocarbon refrigerant without lowering of the sensitivity or other influences on the gas detecting sensor, even in an environment where silicone included in the lubricating oil or sulfur compound included in car exhaust gas exist.

[0042] Thus, according to the present preferred embodiment, the sensor is able to serve its original function to avoid danger by detecting the leakage of hydrocarbon refrigerant, and it is possible to provide a safe refrigerator.

[0043] An infrared sensor as mentioned above can be simply produced by combining a light emitting diode or semiconductor laser having a specific wavelength light emitting characteristic with a light receiving element, besides the above non-dispersion type infrared sensor.

Seventh Preferred Embodiment

[0044] Fig. 7 is a sectional view of a refrigerator in the seventh preferred embodiment of the present invention. The refrigerator in the present preferred embodiment has hydrogen flame ionization type sensors 33, 34. The detection principle of the hydrogen flame ionization type sensor is to utilize a current change caused by an ionization of gas such as hydrocarbon gas in hydrogen flame, and it is mainly characterized in that the response is quick and the sensitivity is high. The hydrogen flame ionization type sensor is characterized in an output nearly proportional to the carbon number of hydrocarbon and is not affected by inorganic carbon compound.

[0045] The operation of the refrigerator in the present preferred embodiment is also same as in the first preferred

embodiment.

[0046] The hydrogen flame ionization type sensor used in the present preferred embodiment detects the current change by the ionization of gas such as hydrocarbon in hydrogen flame, and is not affected by silicone or sulfur compound. Accordingly, the hydrogen flame ionization type sensor is able to serve its original function to avoid danger by detecting the leakage of hydrocarbon refrigerant without lowering of the sensitivity or other influences on the gas detecting sensor, even in an environment where silicone included in the lubricating oil or sulfur compound included in car exhaust gas exist.

Eighth Preferred Embodiment

[0047] Fig. 8 is a sectional view of a refrigerator in the eighth preferred embodiment of the present invention as claimed in claim 8. The refrigerator in the present preferred embodiment has optical interference type sensors 35, 36. The detection principle of the optical interference type sensor is to utilize the property of light that is refracted by gas, and it is mainly characterized in that the sensitivity is less deteriorated because there is no chemical changes and is excellent in stability for a long period of time. Also, it is possible to perform continuous measurements of gas concentrations in various processes, with great accuracy, from a level of 1000 ppm to 100 vol%.

[0048] The operation of the refrigerator in the present preferred embodiment is also same as in the first preferred embodiment.

[0049] The optical interference type sensor in the present preferred embodiment detects gas by utilizing the property of light that is refracted by gas, and is not affected by silicone or sulfur compound. Accordingly, the optical interference type sensor is able to serve its original function to avoid danger by detecting the leakage of hydrocarbon refrigerant without decreasing the sensitivity or other influences on the gas detecting sensor, even in an environment where silicone included in the lubricating oil or sulfur compound included in car exhaust gas exist.

INDUSTRIAL APPLICABILITY

[0050] As is obvious in the above description of the preferred embodiments, according to the present invention, in a refrigerating cycle system using a hydrocarbon refrigerant, the system comprising at least a compressor, a condenser, an expansion device, and an evaporator, and provided with a sensor for detecting hydrocarbon, it is possible to use a relatively inexpensive resistance methanometer type or semiconductor type gas detecting sensor for the purpose of detecting the leakage of hydrocarbon refrigerant of the refrigerating cycle system. Further, the refrigerating cycle system of the present invention comprises one of infrared type, hydrogen flame ionization type, and optical interference type

sensors. Since a sensor of such type is not affected by silicone or sulfur compound, it can be used for the refrigerating cycle system using hydrocarbon refrigerant even in an environment including silicone or sulfur compound.

[0051] As a result, it is possible to provide an inexpensive refrigerating system such as a refrigerator which is excellent in terms of environmental protection, and also to provide a refrigerating system which is excellent in terms of environmental protection and also can be widely used in various environments.

Claims

1. A refrigerating cycle system using a hydrocarbon refrigerant as a refrigerant, the refrigerating cycle system comprising:

a compressor;
a condenser;
an expansion device;
an evaporator; and
a sensor for detecting hydrocarbon,

wherein said compressor uses lubricating oil that does not include organic silicone compound.

2. A refrigerating cycle system using a hydrocarbon refrigerant as a refrigerant, the refrigerating cycle system comprising:

a compressor;
a condenser;
an expansion device;
an evaporator; and
a sensor for detecting hydrocarbon,

wherein said sensor is detachable.

3. A refrigerating cycle system using a hydrocarbon refrigerant as a refrigerant, the refrigerating cycle system comprising:

a compressor;
a condenser;
an expansion device;
an evaporator; and
a sensor for detecting hydrocarbon,

wherein said sensor has at least one of a filter for removing organic silicone compound and a filter for removing sulfur compound.

4. The refrigerating cycle system of claim 3, wherein said filter is detachable.

5. A refrigerating cycle system using a hydrocarbon

refrigerant as a refrigerant, the refrigerating cycle system comprising:

a compressor;
a condenser;
an expansion device;
an evaporator; and
a sensor for detecting hydrocarbon,

wherein said sensor is one selected from the group consisting of an infrared detection type sensor, a hydrogen flame ionization type sensor, and an optical interference type sensor.

FIG. 1

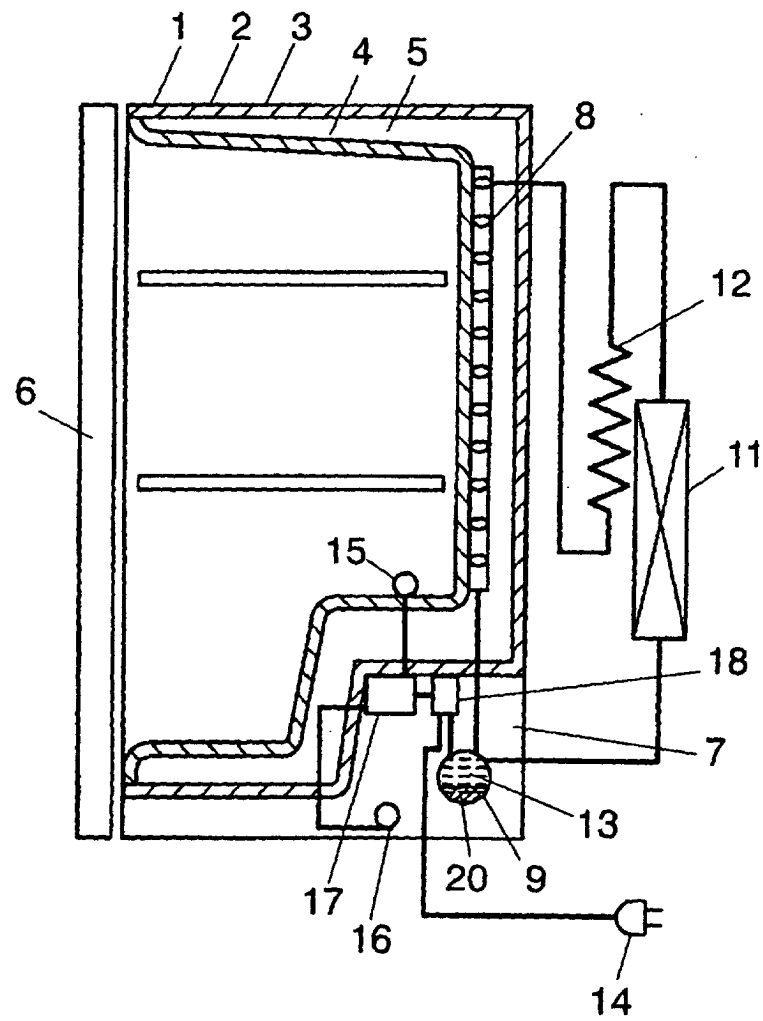


FIG. 2

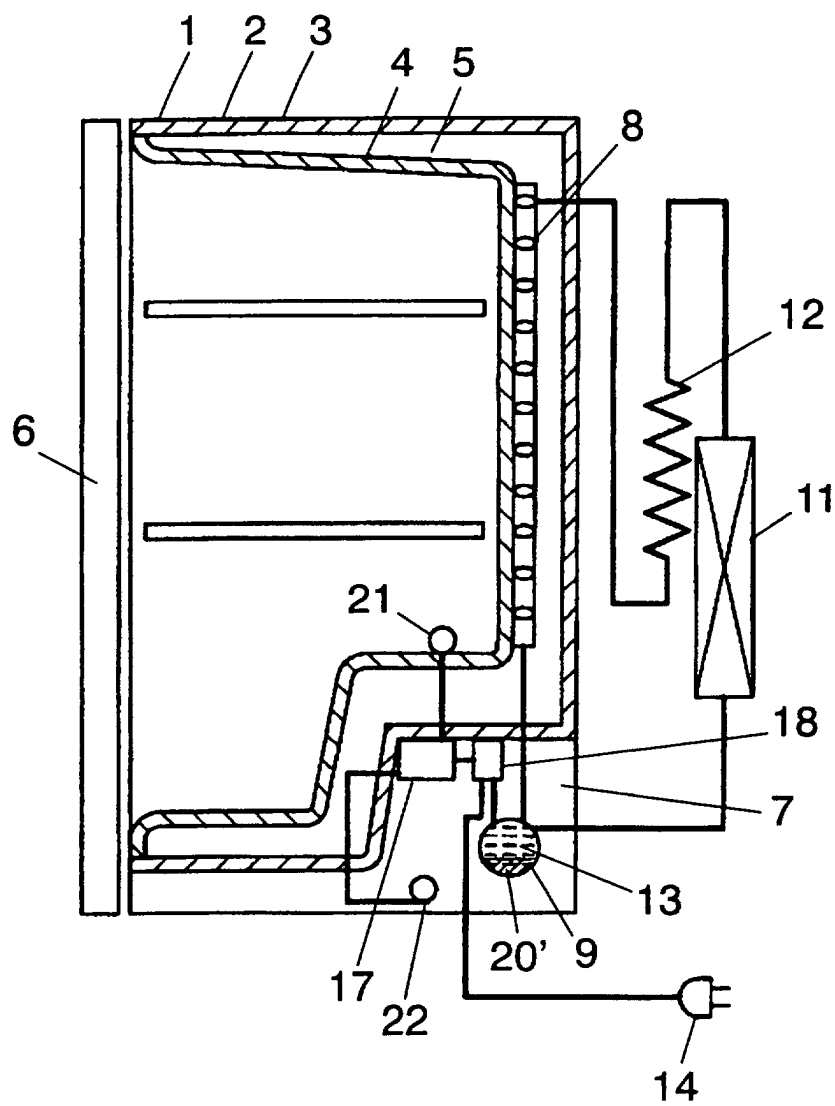


FIG. 3

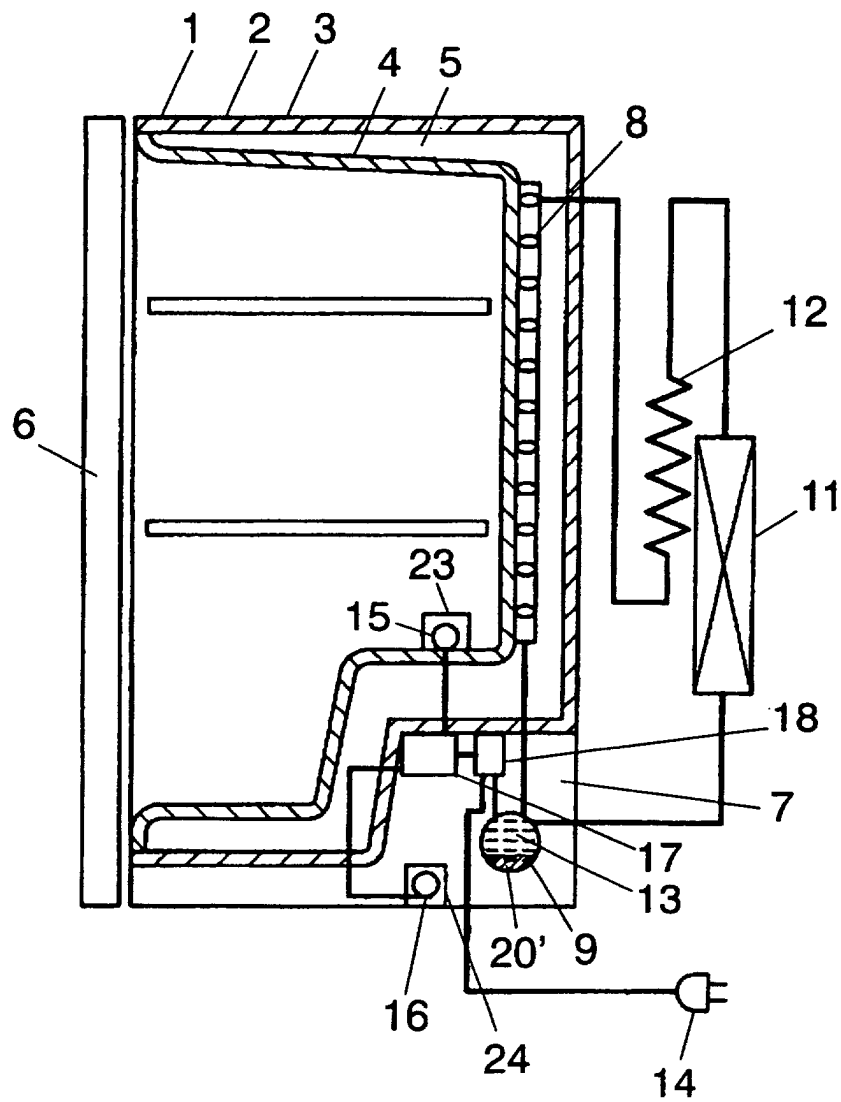


FIG. 4

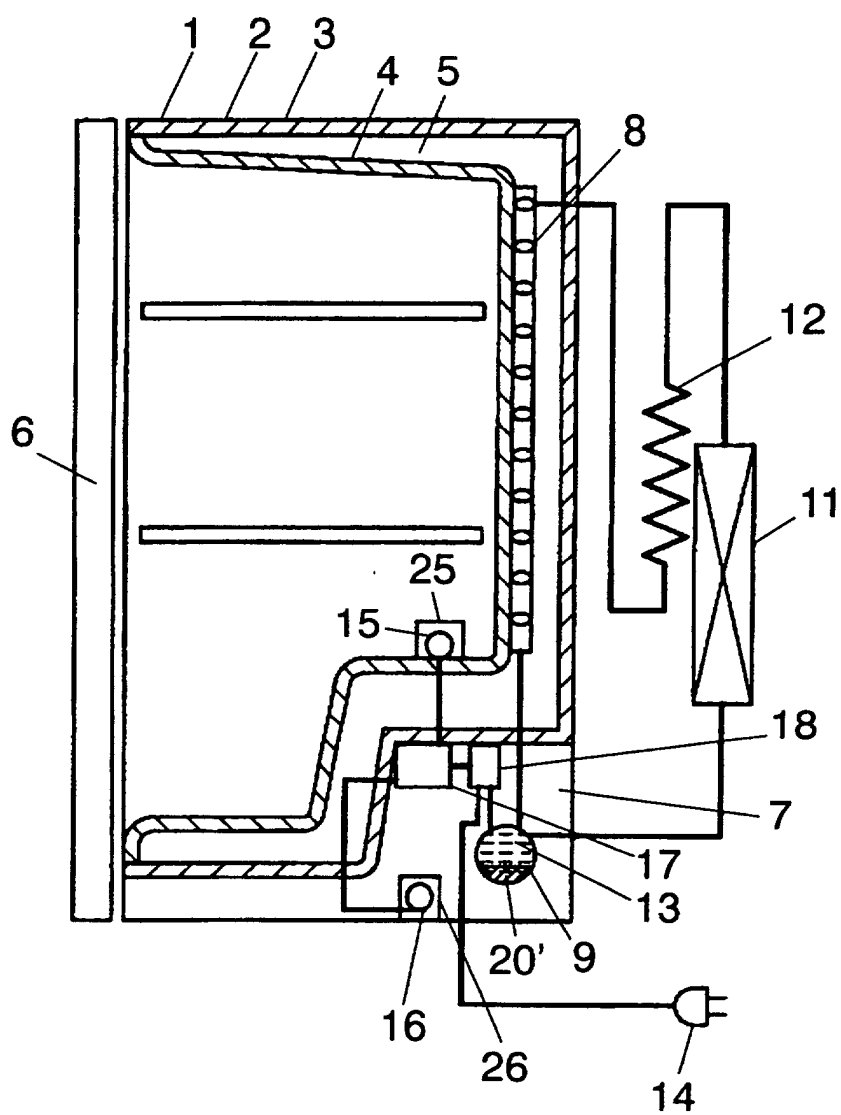


FIG. 5

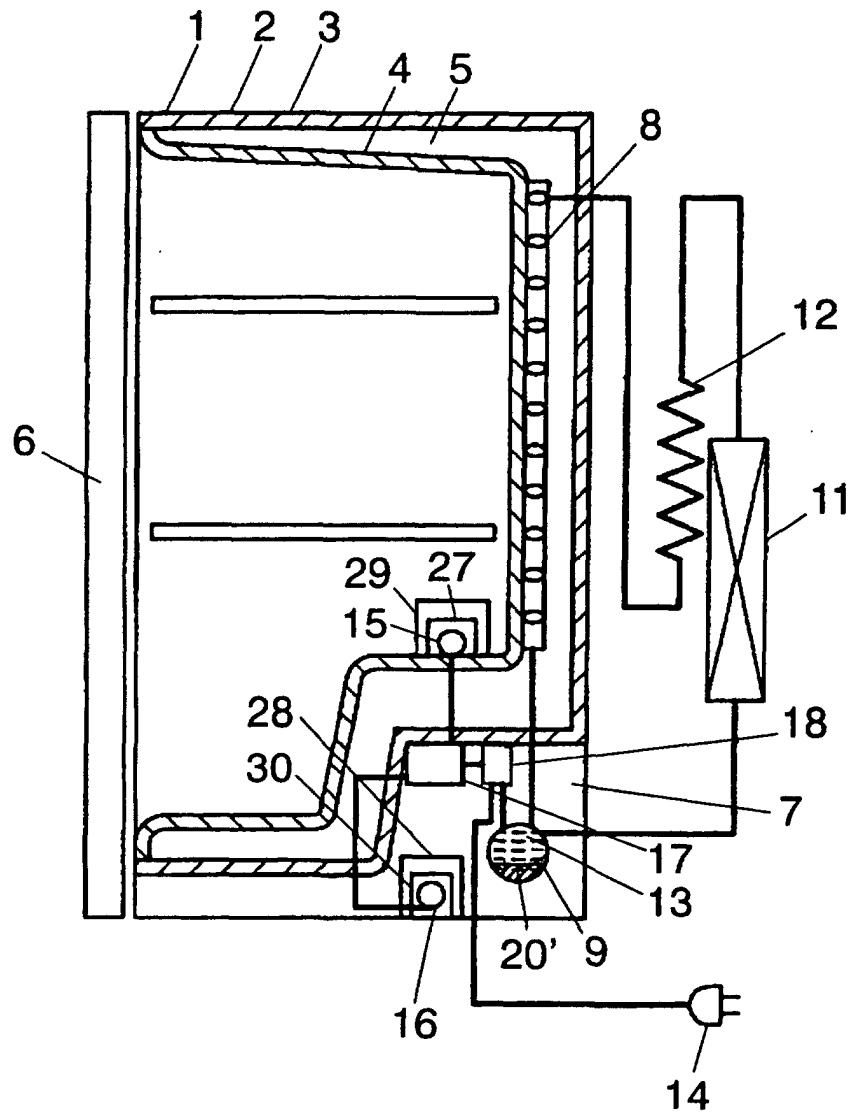


FIG. 6

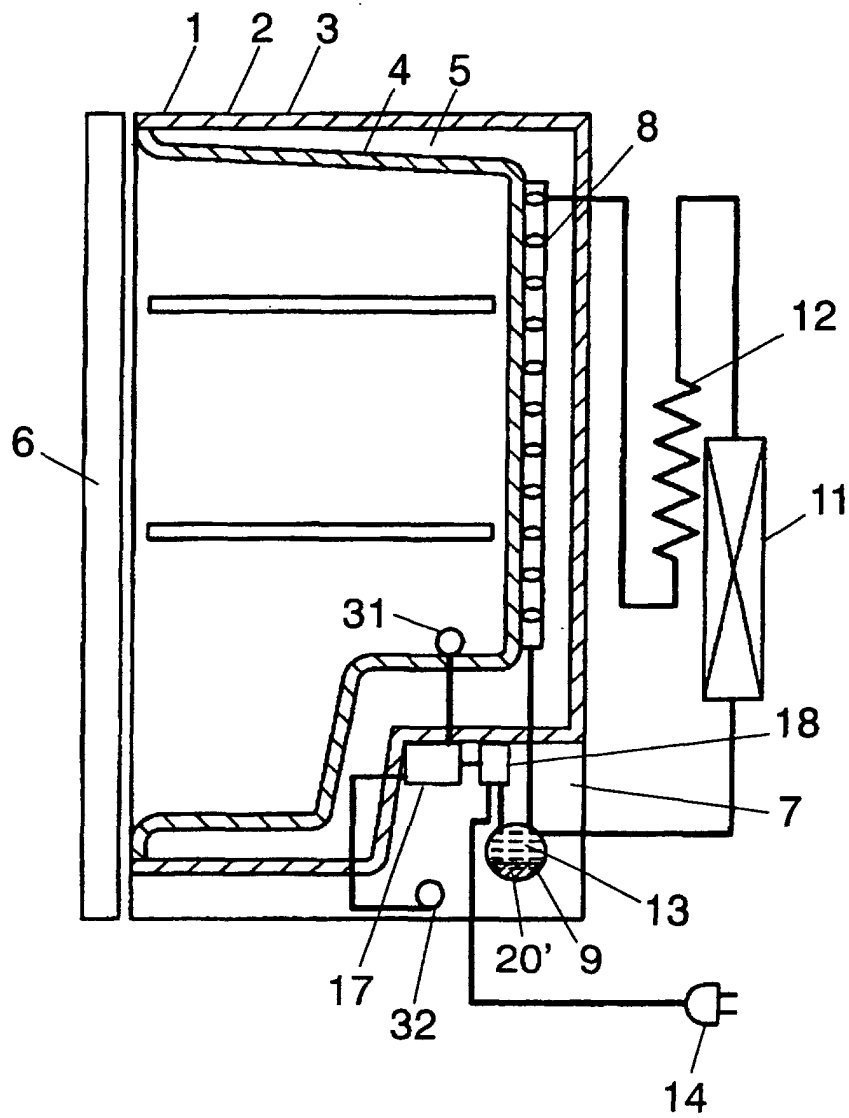


FIG. 7

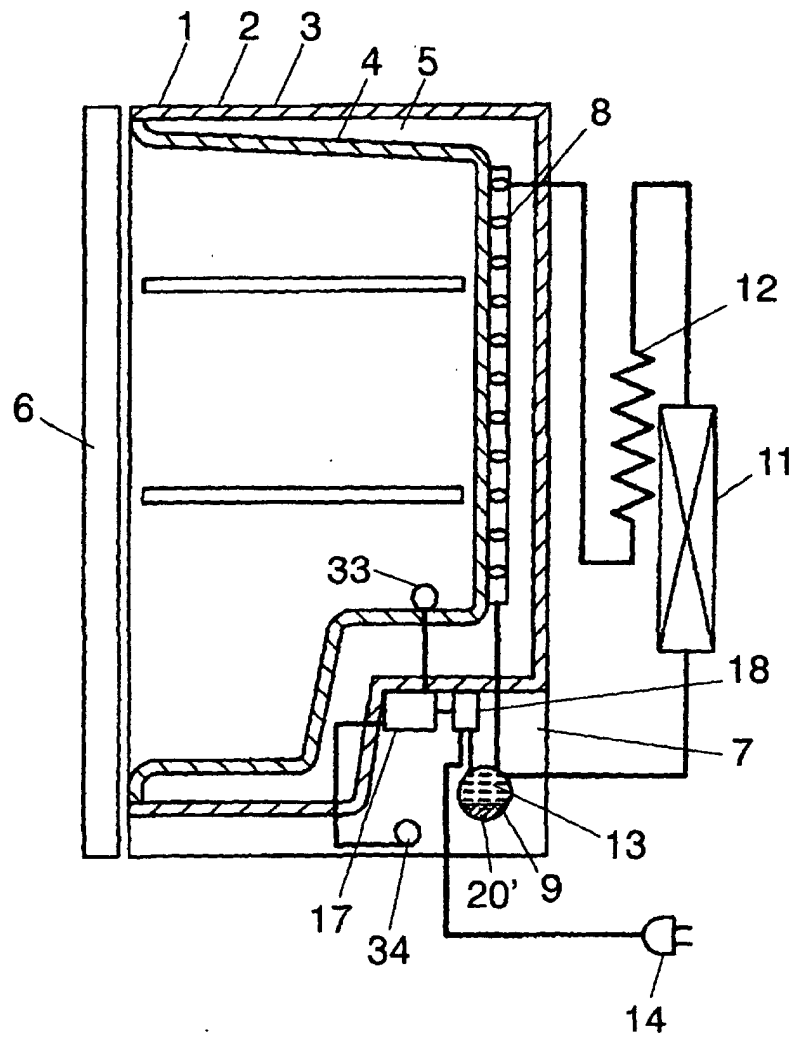


FIG. 8

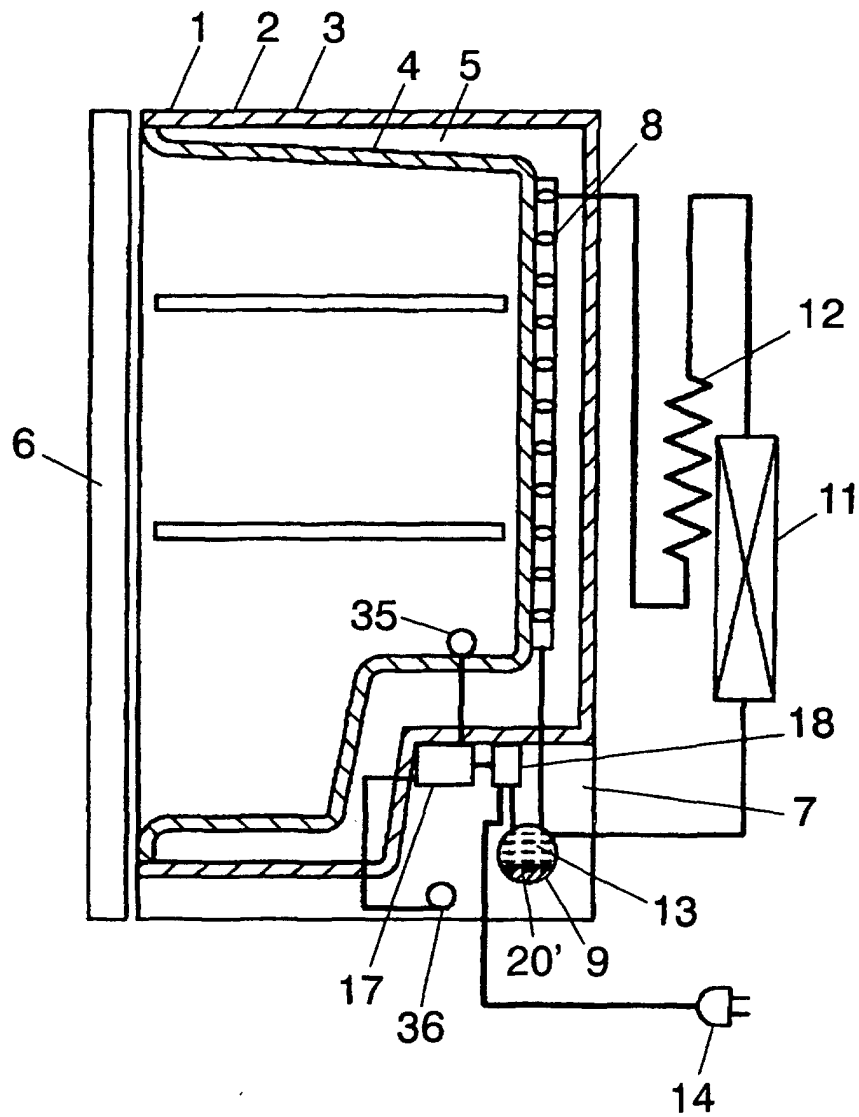


FIG. 9

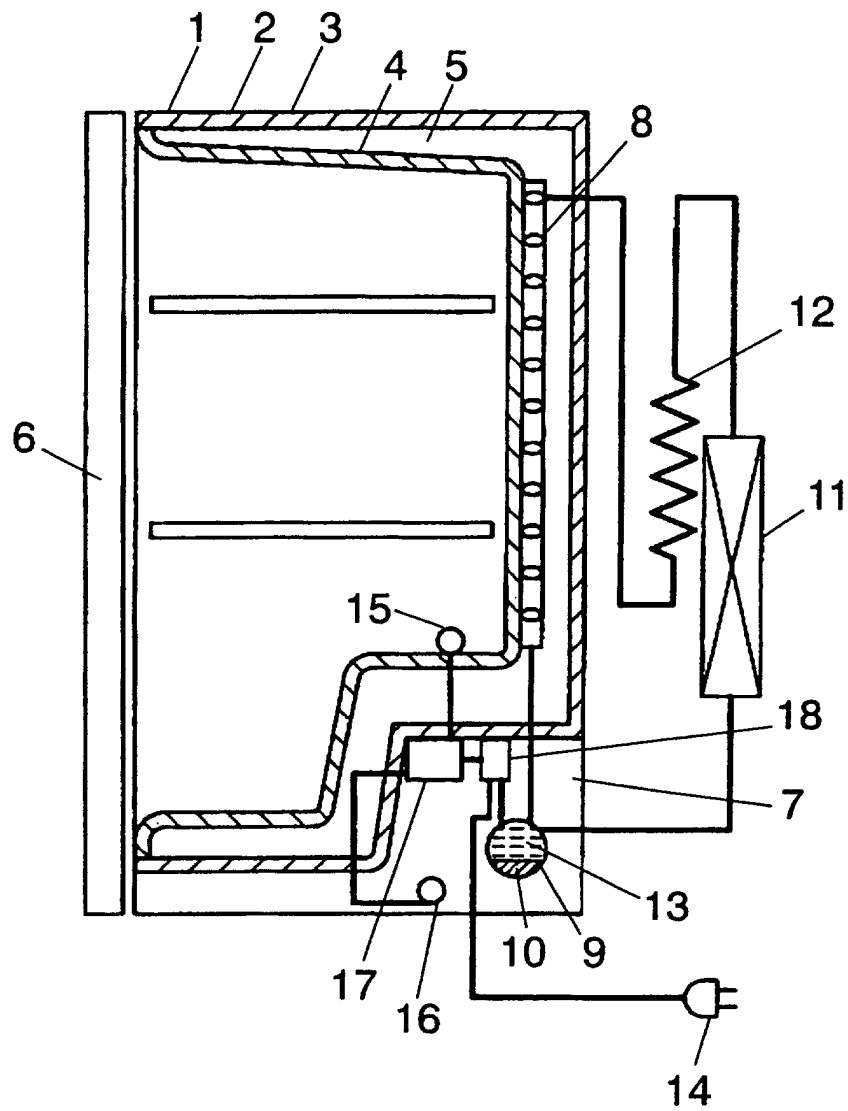
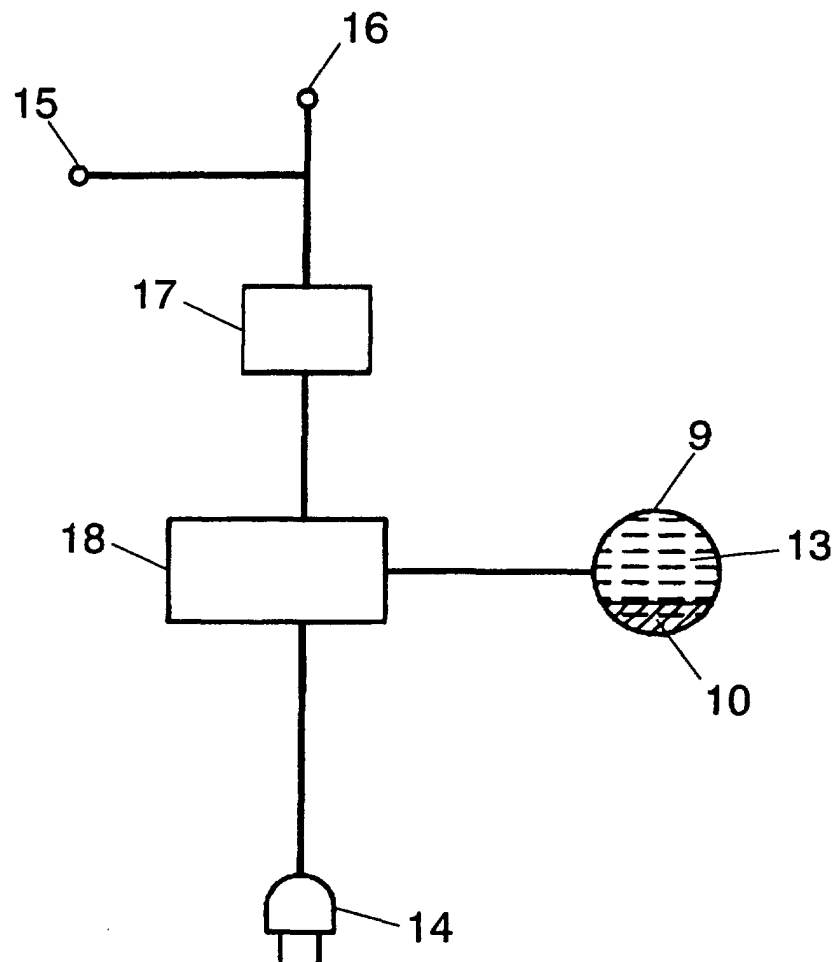


FIG. 10



Reference Numerals

- 1 Main body
- 2 Heat insulating casing
- 3 Outer casing
- 4 Inner casing
- 5 Insulator
- 6 Door
- 7 Machine compartment
- 8 Evaporator
- 9 Compressor
- 10 Lubricating oil
- 11 Condenser
- 12 Expansion device
- 13 Hydrocarbon refrigerant
- 14 Plug
- 15, 16 Gas detecting sensor
- 17 Control box
- 18 Power relay
- 20 Lubricating oil including no silicone
- 20' Lubricating oil including silicone
- 21, 22 Detachable gas detecting sensor
- 23, 24 Silicone removing filter
- 25, 26 Sulfur compound removing filter
- 27, 28 Detachable silicone removing filter
- 29, 30 Detachable sulfur compound removing filter
- 31, 32 Non-dispersion type infrared sensor
- 33, 34 Hydrogen flame ionization type sensor
- 35, 36 Optical interference type filter

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/04755

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F25B49/02		
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) Int.Cl. ⁷ F25B49/02		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2001 Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001		
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.
Y	JP 9-325115 A (Koumiyou Rikagaku Kogyo K.K.), 16 December, 1997 (16.12.97) (Family: none) Full text	1-5
Y	JP 8-247582 A (Toshiba Corporation), 27 September, 1996 (27.09.96) (Family: none) Full text	1-5
Y	JP 9-316439 A (Daikin Industries, Ltd.), 09 December, 1997 (09.12.97) (Family: none) Full text	1-5
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Date of the actual completion of the international search 11 September, 2001 (11.09.01)		Date of mailing of the international search report 18 September, 2001 (18.09.01)
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