



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.10.2008 Bulletin 2008/40

(51) Int Cl.:
F25B 43/00 (2006.01)

(21) Application number: **08001834.4**

(22) Date of filing: **31.01.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(72) Inventors:
• **Tsuboe, Hiroaki**
Shizuoka-shi
Shizuoka (JP)
• **Nakamura, Kenichi**
Shizuoka-shi
Shizuoka (JP)

(30) Priority: **28.03.2007 JP 2007084909**

(71) Applicant: **Hitachi Appliances, Inc.**
Minato-ku
Tokyo (JP)

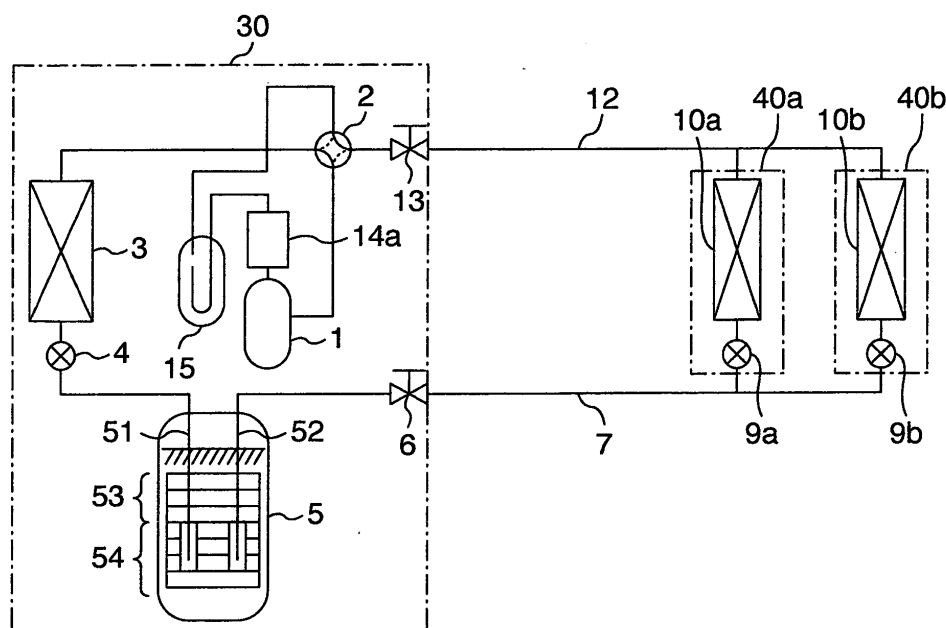
(74) Representative: **Beetz & Partner**
Patentanwälte
Steinsdorfstrasse 10
80538 München (DE)

(54) **Refrigeration cycle apparatus**

(57) To provide a refrigeration cycle apparatus capable of effectively reusing existing pipes, the refrigeration cycle apparatus is formed by connecting a compressor (1), a heat source unit side heat exchanger (3), an expansion device (4, 9a, 9b) and a using side heat exchanger (10a, 10b) by means of a liquid refrigerant pipe (7) and a gas refrigerant pipe (12). The gas refrigerant

pipe (12) is provided with a strainer (14), and the liquid refrigerant pipe (7) is provided with a receiver (5) in which an opening of each of pipes (51, 52) on an upstream side and a downstream side of the liquid refrigerant is provided, and in which a filter device which defines a space (62) at each of the openings, and has two filters (53, 54) for capturing different target objects, respectively, discharged from the refrigerant pipe is provided.

FIG.1



Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention relates to a refrigeration cycle apparatus, and particularly to a refrigeration cycle apparatus suitable for reusing existing pipes in which solid foreign matters and liquid impurities remain.

Description of related art

[0002] As a refrigeration cycle apparatus forming a refrigeration cycle by connecting a compressor, a heat source unit side heat exchanger, an expansion device, and a using side heat exchanger by means of a liquid refrigerant pipe and a gas refrigerant pipe, there is known an air conditioner, for example.

[0003] In the air conditioner, in order to address environmental problems, there is an increasing need to exchange a conventional air conditioner using a CFC-based refrigerant, an HCFC-based refrigerant or the like as a refrigerant (hereinafter referred to as an old machine) into a new air conditioner using an HFC-based refrigerant with no solubility with a mineral oil or the like and a refrigerating machine oil for the HFC-based refrigerant (hereinafter referred to as a new machine). At the time of exchanging these machines, existing refrigerant pipes having connected an indoor unit and an outdoor unit of the old machine are reused.

[0004] However, the reused connection pipes may retain residual contaminants (liquid impurities) enclosed within the old machine such as a refrigerating machine oil (an mineral oil, alkylbenzene or the like), an oxidation degraded reactant of the refrigerating machine oil and a chlorine compound, which are insoluble or poor soluble components with respect to the HFC-based refrigerant used in the new machine.

[0005] Further, when remarkable abrasion occurs in a sliding part of a refrigerant compressor mounted on the old machine, a large quantity of solid foreign matters originating from the abrasion powders are generated, discharged outside the refrigerating compressor together with a gas refrigerant and a refrigerating machine oil, and remain in the connection pipes to be reused.

[0006] If the existing pipes are reused without any countermeasure against these impurities and solid foreign matters, there is possibility that the reliability of the air conditioner remarkably decreases due to degradation of the refrigerating machine oil in the new machine caused by the impurities, acceleration of the abrasion of the sliding part of the refrigerant compressor caused by mixing of the solid foreign matters into the refrigerant compressor mounted on the new machine, or the like.

[0007] In connection with the degradation of the refrigerating machine oil in the new machine among the above factors, JP-A-2003-42603 discloses a working method

of setting the concentration of the impurities remaining in the connection pipes with respect to the refrigerating machine oil in the new machine to be equal to or smaller than an acceptable value by enclosing the same refrigerating machine oil as that in the new machine within the pipes at the time of vacuuming, for example. Moreover, JP-A-2000-9368 discloses to perform cleaning operation of collecting the impurities remaining in the connection pipes when reusing the connection pipes, for example.

[0008] Moreover, in connection with the abrasion of the sliding part of the refrigerant compressor in the new machine due to the solid foreign matters, it is known to install a strainer or the like between a heat source side unit of the new machine and the connection pipes so that a large quantity of solid foreign matters do not flow into the refrigerant compressor. JP-A-2002-224513 discloses one example of the strainer used herein, for example.

BRIEF SUMMARY OF THE INVENTION

[0009] However, the above prior art does not pay attention to reusing the existing pipes effectively.

[0010] That is, the period of renewal construction may become long due to addition of refrigerating machine oil enclosing work, cleaning operation work or the like for setting the concentration of impurities to be equal to or smaller than an acceptable value, for example.

[0011] Accordingly, a problem to be solved of the present invention is to provide a refrigeration cycle apparatus which can efficiently reuse existing pipes.

[0012] In order to solve the above problem, the refrigeration cycle apparatus of the present invention forms a refrigeration cycle by connecting a compressor, a heat source unit side heat exchanger, an expansion device and a using side heat exchanger using a liquid refrigerant pipe and a gas refrigerant pipe. A strainer is provided in the gas refrigerant pipe, and a container is provided in the liquid refrigerant pipe. Further, in the container, respective openings of an upstream side pipe and a downstream side pipe of the liquid refrigerant are provided while a space is defined at each of the openings, and a filter device including two filters each capturing different objects to be captured which are discharged from the refrigerant pipe is provided.

[0013] In this case, the different objects to be captured which are discharged from the refrigerant pipe may be a solid foreign matter circulating in the refrigerant cycle together with the refrigerant, and a liquid impurity which is insoluble or poor soluble with respect to the refrigerant.

[0014] According to this, since the solid foreign matter flowing with the refrigerant is captured by the strainer provided in a passage of the gas refrigerant and one of the filters provided in a passage of the liquid refrigerant, it is possible to prevent the solid foreign matter from flowing into the compressor even if the flow direction of the refrigerant changes during cooling and heating. Moreover, since the liquid impurity such as refrigerating machine oil enclosed within an old machine, which is a in-

soluble component or a poor soluble component with respect to the refrigerant, is captured by the other of the filters provided in the passage of the liquid refrigerant, it is possible to prevent the refrigerating machine oil in a new machine from being degraded. Therefore, when re-using the existing pipes, it is unnecessary to add enclosing work of the refrigerating machine oil or cleaning operation work, and the existing pipes can be effectively reused.

[0015] In addition, the expansion device may be composed by a first expansion device and a second expansion device, and the container may be a receiver which is provided between the first expansion device and the second expansion device to store the liquid refrigerant.

[0016] Further, it is desirable that the two filters are configured in a two stage configuration consisting of an upper stage and a lower stage wherein the filter for capturing the liquid impurity is provided in the upper stage and the filter for capturing the solid foreign matter is provided in the lower stage, while the space at each of the openings of the refrigerant pipes are defined by a filter capturing a solid foreign matter.

[0017] Since the liquid impurity, such as mineral oil is almost insoluble with respect to the liquid refrigerant, it is separated from the liquid refrigerant, and since the liquid impurity has a lower specific gravity than the liquid refrigerant, it moves upwards. Accordingly, by providing a filter for capturing the liquid impurity at the upper stage side in the liquid refrigerant stored in the receiver, the liquid impurity can be effectively captured. Further, since the space of each of the openings of the refrigerant pipes is defined by the lower stage side filter, the solid foreign matter is captured by the filter soon after discharged from the refrigerant pipes.

[0018] In addition, according to this configuration, since the flow rate of the liquid refrigerant at the place where the upper stage side filter is provided is relatively slow, it is possible to prevent the liquid impurity once captured from flowing out again together with the flow of the refrigerant.

[0019] Moreover, it is desirable that the filter device is provided in the receiver to have a predetermined gap from an inner wall surface of the receiver. This is for the purpose of suppressing occurrence of problems, such as meting of the filter resulting from the high temperature of the receiver wall beyond the durable temperature of the filter device, due to welding or the like during a manufacturing process of the receiver and the filter device in the receiver.

[0020] Further, the filter for capturing solid foreign matter may be formed from a fibrous material having a mesh number such that HFC refrigerating machine oil can pass through there and a solid foreign matter of several μm or more can be captured, and the filter for capturing the liquid impurity may be formed from a fibrous material having a mesh number such that HFC refrigerating machine oil can pass through there and mineral oil can be captured.

[0021] Moreover, the filter for capturing the liquid impurity and the filter for capturing the solid foreign matter may be formed from a fibrous material made of polyester, and the filter for capturing the solid foreign matter may be formed so that the density thereof is larger than that of the filter for capturing the liquid impurity.

[0022] Moreover, the strainer can be provided between the using side heat exchanger and the compressor, and the screen of the strainer can be formed from SUS capable of capturing a solid matter of several μm or more.

[0023] Moreover, by incorporating control of fully closing or slightly opening at least one of the first expansion device and the second expansion device when at least one of starting and stopping the compressor, it is possible to recover the liquid refrigerant in the receiver to surely capture the liquid impurity.

[0024] According to the present invention, it is possible to provide a refrigeration cycle apparatus enabling the existing pipes to be effectively reused.

[0025] Other objects, features and advantages of the invention will become apparent from the following description of an embodiment of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0026]

Fig. 1 is a view showing a system diagram of a refrigeration cycle of an air conditioner of the present invention;

Fig. 2 is a cycle system diagram showing another embodiment according to the present invention;

Fig. 3 is a graph showing mineral oil separation characteristics under a coexistence condition of an HFC-based refrigerant, refrigerating machine oil for HFC, and mineral oil;

Fig. 4 is a view showing a longitudinal cross-section of a receiver and a filter device installed in the receiver; and

Fig. 5 is a view showing a cross-section of a solid matter capturing strainer.

DETAILED DESCRIPTION OF THE INVENTION

[0027] Hereinafter, an embodiment of the refrigeration cycle apparatus to which the present invention is applied will be described with reference to Figs 1 to 5. Although the following description will be made using an air conditioner as one example, the present invention is not only limited to this but also applicable to a refrigeration cycle apparatus which forms a refrigeration cycle and reuses existing pipes. Moreover, in the embodiment, a multi-type air conditioner in which a plurality of indoor units are connected to one outdoor unit is described as an example, the present invention is not limited to this but also appli-

cable to an air conditioner with one to one connection. In the following description, the same functional parts are denoted by the same reference numerals to eliminate duplicated descriptions.

[0028] Fig. 1 is a view showing a cycle system diagram of the air conditioner of the present embodiment. As illustrated in the figure, the air conditioner is composed by an outdoor unit 30, indoor units 40a and 40b, a liquid refrigerant pipe 7 and a gas refrigerant pipe 12 which connect these, and the like.

[0029] The outdoor unit 30 is provided with a compressor 1, a four-way valve 2, a heat source unit side heat exchanger 3, an outdoor expansion valve 4, a receiver 5, an accumulator 15 and the like, and constructed by connecting those with a refrigerant pipe. At connection ports to the liquid refrigerant pipe 7 and the gas refrigerant pipe 12, gate valves 6 and 13 are provided, and a solid matter capturing strainer 14a is provided in the refrigerant pipe on a suction side of the compressor 1. Moreover, the respective indoor units 40a and 40b are provided with indoor expansion valves 9a and 9b, using side heat exchangers 10a and 10b, and the like, and constructed by connecting those with the refrigerant pipes.

[0030] Fig. 2 is a view showing a modified embodiment of the air conditioner of the present embodiment. The difference between Fig. 1 and Fig. 2 is only the position on which the strainer 14 is arranged. In other words, the solid matter capturing strainer 14a is provided on the suction side of the compressor 1 in the outdoor unit 30 in Fig. 1, however, alternatively, a solid matter capturing strainer 14b may be provided in the gas refrigerant pipe 12 as shown in Fig. 2.

[0031] In such an air conditioner, when renewing the outdoor unit 30 and the indoor units 40a and 40b, reusing the liquid refrigerant pipe 7 and the gas refrigerant pipe 12 is performed. However, if these existing pipes are simply reused, there is possibility that the reliability of the air conditioner is significantly degraded due to degradation of refrigerating machine oil in a new machine caused by liquid impurities (mineral oil enclosed in an old machine, refrigerating machine oil such as alkylbenzene, an oxidation degraded reactant in the refrigerating machine oil, a chlorine based compound, and the like) remaining in the pipes, and acceleration of abrasion of a sliding part of the refrigerant compressor caused by foreign matters mixing into the refrigerant compressor mounted on the new machine.

[0032] Hereinafter, a method for recovering solid foreign matters and impurities remaining in the existing pipes will be described. Hereinafter, the description is made by using mineral oil as one example of the impurities.

[0033] When an air conditioning device using CFC or HCFC becomes life-expired, it is replaced. First, the CFC or HCFC refrigerant is recovered, and the outdoor unit 30 and the indoor units 40a and 40b are replaced with those illustrated in Fig. 1. The liquid connection pipe 7 and the gas connection pipe 12 of the old machine are

reused. Since the HFC is charged in the outdoor unit 30 in advance, the indoor units 40a and 40b, the liquid connection pipe 7 and the gas connection pipe 12 are vacuumed in a connecting state while closing the gate valves 6 and 13, and then additional charging of the HFC and opening of the gate valves 6 and 13 are performed.

[0034] As basic operation of the air conditioner, in case of the cooling operation, a high temperature and high pressure gas refrigerant compressed by the compressor 1 is discharged from the compressor 1, passes through the four-way valve 2, flows into the heat source unit side heat exchanger 3, and exchanges heat there to be condensed into liquid. The condensed liquid refrigerant passes through the outdoor expansion valve 4, which is a first expansion device and fully opened, an excess refrigerant is accumulated in the receiver 5, and a remaining refrigerant passes through the gate valve 6 and is sent to the indoor units 40a and 40b.

[0035] The sent liquid refrigerant flows into the indoor expansion valves 9a and 9b, which are second expansion devices, is decompressed there to be at a low pressure so as to be in a low pressure two phase state, and exchanges heat with a using side medium, such as air, to be evaporated into gas in the using side heat exchangers 10a and 10b. After that, the gas refrigerant returns to the compressor 1 through the solid matter capturing strainer 14b, the gate valve 13 and the four-way valve 2 in the case of Fig. 2, through the gate valve 13, the four-way valve 2, and through the solid matter capturing strainer 14a in the case of Fig. 1.

[0036] In case of the heating operation, the high temperature and high pressure gas refrigerant compressed by the compressor 1 is discharged from the compressor 1 together with the refrigerating machine oil for HFC, flows into the using side heat exchangers 10a and 10b through the four-way valve 2 and the gate valve 13 (and the solid matter capturing strainer 14b in the case of Fig. 2), exchanges heat there with the using side medium such as air and is condensed into liquid. The condensed liquid refrigerant is flown into the gate valve 6 and the receiver 5, decompressed to be at a low pressure by the outdoor expansion valve 4, exchanges heat with a heat source unit side medium such as air and water in the heat source unit side heat exchanger 3, and is evaporated into gas. The gas refrigerant returns to the compressor 1 through the four-way valve (and the solid matter capturing strainer 14a in the case of Fig. 1).

[0037] Fig. 3 is a view illustrating the separation characteristics of the mineral oil when the mineral oil which is an insoluble component with respect to the HFC-based refrigerant is mixed into the HFC-based refrigerant and the refrigerating machine oil for HFC at the ratio of about 10 % (= mineral oil quantity / (quantity of refrigerating machine oil for HFC + mineral oil quantity)). The horizontal axis indicates the solubility of refrigerant with respect to the refrigerating machine oil (refrigerating machine oil for HFC + mineral oil quantity), 0% indicates the case of consisting only of the refrigerating machine oil (refriger-

ating machine oil for HFC + mineral oil), and 100% indicated the case of consisting only of the refrigerant. The vertical axis indicates temperature.

[0038] As illustrated in this figure, the mineral oil is hardly dissolved in the HFC-based refrigerant while it is dissolved in the refrigerating machine oil for HFC. In addition, the mineral oil do not separate in the compressor in which a large quantity of refrigerating machine oil for HFC exists, but separates in the liquid connection pipe 7 and the receiver 5 in which a large quantity of liquid refrigerant exists.

[0039] Subsequently, the filter device which is a characteristic part of the present embodiment and installed in the receiver 5 will be described with reference to Fig. 4. The filter device is composed by different filters 53 and 54 and the like, which are configured in a two stage of upper and lower sides in the receiver 5. The filter 53 is provided in the upper stage in the receiver 5 and made of a fibrous material with a relatively large mesh number, and the material of the fiber is composed of at least one of polyester and polypropylene.

[0040] The liquid refrigerant and the refrigerating machine oil for HFC dissolved in the liquid refrigerant are the liquid with remarkably low viscosity. On the contrary, the mineral oil is the liquid with remarkably higher viscosity as compared to those of the liquid refrigerant and the refrigerating machine oil for HFC dissolved in the liquid refrigerant. Therefore, while the liquid refrigerant and the refrigerating machine oil for HFC dissolved in the liquid refrigerant pass through the filter 53, the mineral oil is trapped between the fibers of the filter 53 with the large mesh number, and after that, it is captured by a capillary phenomenon in the fibers.

[0041] Therefore, by arranging the filter 53 in the receiver 5, the mineral oil discharged together with the refrigerating machine oil for HFC from the inside of the compressor 1 separates in the receiver 5, and it is possible to capture only the separated mineral oil by the filter 53.

[0042] In the case that the compressor 1 is of a high-pressure chamber type in which the pressure of the refrigerating machine oil accumulating part in the compressor 1 is high, or that an oil separator is arranged at the discharge part of the compressor 1, the temperature of the refrigerating machine oil accumulated in the compressor 1 and the oil separator becomes high. On the other hand, the temperature of the receiver 5 becomes lower than that temperature. In addition, since the degradation of the refrigerating machine oil is accelerated as the temperature thereof increases, and further the degradation of the refrigerating machine oil for HFC is accelerated as the mixing amount of mineral oil (degraded oil) remaining in the existing pipes is larger, by capturing the mineral oil with the receiver 5 of which temperature is lower than that in the compressor 1 or the oil separator, it is possible to prevent the refrigerating machine oil for HFC from being degraded.

[0043] Moreover, in order to capture the mineral oil in the filter 53, it is necessary for the filter 53 to be brought

into contact with the mineral oil. Therefore, when starting and stopping the compressor 1, the refrigerant is recovered in the receiver 5 by performing operation while setting the expansion device on the downstream side of the receiver 5 (which is the indoor expansion valves 9a and 9b in the case of cooling operation, or the outdoor expansion valve 4 in the case of heating operation) in a fully closed state or a slightly opened state close to the fully closed state.

[0044] This enables the filter 53 to be brought into contact with the mixed liquid of the HFC-based refrigerant, the refrigerating machine oil for HFC and the mineral oil, and thus only the mineral oil separates in the receiver 5 so that only the mineral oil can be captured.

[0045] Further, the captured amount of the mineral oil by the filter 53 decreases as the flow rate with respect to the filter 53 becomes higher. This is because the mineral oil once captured by the filter 53 is extruded outside the filter 53 by fluid force of the refrigerant. In addition, since the flowing-in speed of the mixed liquid becomes higher as it is close to pipe tip end parts of refrigerant introducing and delivering pipes 51 and 52 for introducing the mixed liquid of the HFC-based refrigerant, the refrigerating machine oil for HFC and the mineral oil into the receiver 5, the mixed liquid of the HFC-based refrigerant, the refrigerating machine oil for HFC and the mineral oil introduced in the receiver 5 is delivered from the receiver 5 after passing through the filter 53 by directing the pipe tip end parts downwards. This enables the mineral oil introduced in the receiver 5 to be prevented from being delivered without passing through the filter 53.

[0046] By the above mentioned configuration, it is possible to suppress the time of renewing construction work without requiring such a work that the refrigerating machine oil provided by a drum can container from the maker of the refrigerating machine oil is charged while using a special hose taking care of prevention of mixing of a contaminant when setting the density of the impurities to be equal to or below an allowable value, as in the case of a conventional art. Moreover, it is possible to suppress such a problem that when a multi-air-conditioner for a building with long pipes is renewed, a new machine becomes large in volume by charging a large quantity of refrigerating machine oil corresponding to a large quantity of impurities remaining in the connection pipes into the new machine so that the new machine cannot be installed as in the case of a conventional method of preliminarily charging refrigerating machine oil to be added into the new machine oil.

[0047] Moreover, when reusing the connection pipes, it is unnecessary to perform cleaning operation for recovering the impurities remaining in the connection pipes, and thus the working time of the renewing construction work can be suppressed, resulting in effectively reusing of the existing pipes.

[0048] Further, the filter 54 arranged in the lower stage than the filter 53 is provided near the pipe tip end parts of the refrigerant introducing and delivering pipes 51 and

52 in the receiver 5. In other words, the spaces 62 at the tip end portions of the refrigerant introducing and delivering pipes 51 and 52 are defined by the filter 54. The filter 54 is made of a fibrous material of which size is greater than that of the filter 53, and has a mesh number enabling solid matters of several μm to be removed. That is, the material is fibrous in which fibers are more densely superposed, gaps between fibers are smaller, and the density is larger than those of the filter 53, and is composed of at least one of polyester, polypropylene, and SUS, as a characteristic of the fiber.

[0049] As the filter 53 for capturing the mineral oil, it is desirable to set a different density from that of the filter 54 in order to make the gaps between the fibers of the filter 53 large possibly, and to set the amount of the mineral oil which can be captured to be large possibly, since the mineral oil is captured inside the fibers by means of the capillary phenomena. In addition, in order not to deliver the solid foreign matters introduced from the refrigerant introducing and delivering pipes 51 and 52 from the inside of the receiver 5, the filter 54 is arranged to surround the vicinity of the pipe tip end parts of the refrigerant introducing and delivering pipes 51 and 52.

[0050] Here, a strainer for capturing foreign matters or the prior art can capture solid foreign matters of which particle size is equal to or greater than $20\ \mu\text{m}$. However, as a result of measuring the particle size distribution of the solid foreign matters generated by the abrasion of the sliding part of the refrigerant compressor and recovered from the actual machine, it has been found that the number of the solid foreign matters having a particle diameter equal to or greater than $20\ \mu\text{m}$ is half or more of the total number of the solid foreign matters, and thus in case of the strainer which can capture solid foreign matters of which particle diameter is equal to or greater than $20\ \mu\text{m}$, solid foreign matters of which particle diameter is equal to or smaller than $20\ \mu\text{m}$ will flow into the refrigerant compressor.

[0051] Moreover, in the document of "Lubrication", volume 17, No. 11 (1972), pages 741 to 746, the minimum gap in a slide bearing also used in a refrigerant compressor is 1 to $20\ \mu\text{m}$, and the document "Tribology and Environment" K.K. Shinjusha, page 53, Fig. 2.2.3.7(b) describes that the abrasion of a sliding part is accelerated mostly under a condition in which the particle size of a solid foreign matter is equal to the minimum gap of a bearing.

[0052] In this respect, according to the present embodiment, the solid foreign matters discharged from the refrigerant introducing and delivering pipes 51 and 52 are attached on a surface of the filter 54 on a side of the refrigerant introducing and delivering pipes 51 and 52 by the above mentioned configuration. As a result thereof, it is possible to prevent the solid foreign matters from mixing into the compressor mounted on the new machine to accelerate the abrasion of the sliding part of the compressor, so that the reliability of the air conditioner can be prevented from being degraded.

[0053] In addition, in order to prevent the filter 54 from being clogged by the solid foreign matters, it is desirable to sufficiently ensure the area of the filter 54 on the side of the refrigerant introducing and delivering pipes 51 and 52.

[0054] Next, an installing method of the filter 53 for removing the refrigerant insoluble components in the upper stage and the filter 54 for removing the solid foreign matters in the lower stage, which are accommodated in the receiver, will be described.

[0055] At the time of manufacturing, after sandwiching the filters 53 and 54 between punching metals 55 and 56, caps 58 and 59 and a body 60 are welded together. At that time, the temperature of the inner wall surface of the body 60 exceeds the maximum operation temperature of the filters 53 and 54. Accordingly, if the filters 53 and 54 are constructed so as to be in contact with the inner wall surface of the body 60, the filters 53 and 54 will be melted by the heat, and will not be able to capture the refrigerant insoluble components. Further, this causes the passage of the liquid refrigerant introduced in the receiver 5 and the refrigerating machine oil for HFC dissolved in the liquid refrigerant to be blocked in the receiver 5, so that those can not be delivered from the inside of the receiver 5, and the equipment stops due to overshooting of the discharge temperature of the compressor 1, or the abrasion of the sliding part occurs due to lack of the refrigerating machine oil in the compressor 1.

[0056] Therefore, in the present embodiment, a predetermined gap Δd is provided between the body 60 and the filters 53 and 54 so that the temperatures of the filters 53 and 54 is equal to or smaller than the maximum operation temperature, to prevent the temperature of the inner wall surface of the body 60 from being transmitted to the filters.

[0057] As illustrated in Fig. 5, the solid matter capturing strainers 14a and 14b have the structure in which an introducing cap 71 having an opening in its center is connected on one bottom side, and a cylindrical screen 70 having a screen arranged therein for capturing solid foreign matters is encapsulated in a pressure-resistant container 74 on the other bottom side. The connection of the introducing cap 71 and the screen 70 prevents the solid foreign matters from flowing into and out from a connection part of the introducing cap 71 and the screen 70 by entire welding in the circumferential direction.

[0058] Further, the connection between the inner surface of the pressure-resistant container 74 and the introducing cap 71 also prevents the flowing-in and flowing-out of the solid foreign matters by entire caulking in the circumferential direction or by entire welding in the circumferential direction.

[0059] The flow of the refrigerant, the refrigerating machine oil and the solid foreign matters in the solid matter capturing strainer 14a and 14b flows as shown in the solid line arrows when the refrigerant, the refrigerating machine oil and the solid foreign matters firstly flow into the strainers from the side of the pipe 72. The refrigerant

and the refrigerating machine oil pass through the openings of the screen and flow out from the side of the pipe 73. Since the solid matters having a particle size equal to or greater than that of the openings of the screen 70 cannot pass through the screen 70, those are captured by the inner surface of the screen 70.

[0060] Moreover, the flow of the refrigerant, the refrigerating machine oil, and the solid foreign matters in case of performing the reverse cycle operation such as a cooling and heating combined machine is illustrated shown in the dotted line arrows.

[0061] As illustrated in Fig. 2, when the solid matter capturing strainer 14b is arranged between the gas connection pipe 12 and the gas gate valve 13, there is the possibility that the solid foreign matters captured by the inner surface of the screen 70 are flown outside the solid matter capturing strainer 14b by the fluid forces of the refrigerant and the refrigerating machine oil. However, it is possible to prevent the solid foreign matters from flowing into the refrigerant compressor 1 by enclosing those in the liquid refrigerant pipe 7 and the gas refrigerant pipe 12 by the solid matter capturing strainer 14b and the filter 54 arranged in the receiver.

[0062] The material of the screen 70 used for the solid matter capturing strainer 14a and 14b is desirably made from SUS, which is a material which captures solid foreign matters having a particle size equal to or greater than several μm , does not degrades the refrigerant and the refrigerating machine oil to be used, as well as the screen 70 itself.

[0063] Moreover, according to the document "Tribology and Environment" K.K. Shinjusha, page 53, Fig. 2.2.3.7(c), as the amount of foreign matters to be supplied to the sliding part of a bearing increases, the amount of abrasion increases. In view of this fact, the acceptable value of the mixing amount of the solid foreign matters is set as a specification of the refrigerant compressor 1, and if the mixing amount of the solid foreign matters is equal to or smaller than the acceptable value, there is no problem even if a part of the solid foreign matters remaining in the liquid refrigerant pipe 7 and the gas refrigerant pipe 12, passes through the screen 70 and flows into the refrigerant compressor 1.

[0064] That is, although the screen 70 used for the solid matter capturing strainer 14a and 14b captures solid foreign matters having a particle size equal to or greater than several μm , there is no problem if the capturing rate is equal to or smaller than 100%.

[0065] Moreover, in order to withstand the fluid forces from the refrigerator and the refrigerating machine oil, the inner periphery and the outer periphery of the screen 70 may be reinforced by a high-strength member such as punching metal

[0066] At that time, if the solid matter capturing strainer 14a is arranged on the suction side of the compressor 1 as illustrated in Fig. 1, the solid foreign matters remaining in the liquid refrigerant pipe 7 and the gas refrigerant pipe 12, which are solid foreign matters in the refrigeration

cycle, and abrasion powder generated due to the aging degradation of the compressor 1 are all gathered in the solid matter capturing strainer 14a. Therefore, it is important to ensure the area of the screen 70 of the solid matter capturing strainer 14a sufficiently, so as not to clog the solid matter capturing strainer 14a by the solid foreign matters.

[0067] As illustrated in Fig. 2, if the solid matter capturing strainer 14b is arranged between the gas connection pipe 12 and the gas gate valve 13, only the solid foreign matters remaining in the liquid refrigerant pipe 7 and the gas refrigerant pipe 12 flow into the solid matter capturing strainer 14b during the cooling operation. On the contrary, during the heating operation, only abrasion powder generated due to the aging degradation of the compressor 1 flows into the solid matter capturing strainer 14b. By this fact, the amount of the solid foreign matters flowing into the solid matter capturing strainer 14b is smaller than the solid matter capturing strainer 14a, and the area of the screen 70 of the solid matter capturing strainer 14b can be set smaller, which enables downsizing.

[0068] It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims.

Claims

1. A refrigeration cycle apparatus, forming a refrigeration cycle by connecting a compressor (1), a heat source unit side heat exchanger (3), an expansion device, and a using side heat exchanger by means of a liquid refrigerant pipe (7) and a gas refrigerant pipe (12), wherein the gas refrigerant pipe (12) is provided with a strainer (14), and the liquid refrigerant pipe (7) is provided with a container, and in the container, respective openings of pipes on an upstream side and a downstream side of the liquid refrigerant are provided, and two filters (53, 54) are provided, the two filters defining a space at each opening and capturing different target objects respectively, discharged from the refrigerant pipe (7).
2. The refrigeration cycle apparatus according to claim 1, wherein the different target objects discharged from the refrigerant pipe (7) are solid foreign matters circulating in the refrigeration cycle together with the refrigerant, and liquid impurities which are at least one of insoluble and poor soluble with respect to the refrigerant.
3. The refrigeration cycle apparatus according to claim 1, wherein the expansion device comprises a first

expansion device (4) and a second expansion device (9a, 9b), and the container is a receiver (5) provided between the first expansion device (4) and the second expansion device (9a, 9b) to store the liquid refrigerant.

4. The refrigeration cycle apparatus according to claim 3, wherein the two filters (53, 54) are arranged in two upper and lower stages, a filter (53) for capturing the liquid impurities is provided in the upper stage, a filter (54) for capturing the solid foreign matters is provided in the lower stage, and the space of each of the openings is defined by the filter for capturing the solid foreign matters. 5
5. The refrigeration cycle apparatus according to claim 4, wherein the two filters (53, 54) are provided in the receiver with a predetermined gap from an inner wall surface of the receiver (5). 10
6. The refrigeration cycle apparatus according to claim 4 or 5, wherein the filter (53) for capturing the solid foreign matters is made of a fibrous material of a mesh number enabling HFC refrigerating machine oil to pass through and solid foreign matters of several μm or more to be captured, and the filter (54) for capturing the liquid impurities is made of a fibrous material of a mesh number enabling the HFC refrigerating machine oil to pass through and mineral oil to be captured. 15
7. The refrigeration cycle apparatus according to claim 4 or 5, wherein the filter (53) for capturing the solid foreign matters and the filter (54) for capturing the liquid impurities are formed from a fibrous material made of polyester, and the filter (53) for capturing the solid foreign matters is formed to have a density larger than that of the filter (54) for capturing the liquid impurities. 20
8. The refrigeration cycle apparatus according to claim 4 or 5, wherein the strainer (14) is provided between the using side heat exchangers (10a, 10b) and the compressor (1), and a screen of the strainer (14) is formed from SUS enabling solid matters of several μm or more to be captured. 25
9. The refrigeration cycle apparatus according to claim 4 or 5, wherein one of the first expansion device (4) and the second expansion device (9a, 9b) is fully closed, or at a slightly opened angle when at least one of starting and stopping the compressor. 30
10. A refrigeration cycle apparatus, forming a refrigeration cycle by connecting a compressor (1), a four-way valve (2), a heat source unit side heat exchanger (3), a first expansion device, a receiver (5), a second expansion device, and a using side heat exchanger 35

(10a, 10b) by means of a refrigerant pipe (7), wherein a strainer (14) for capturing solid foreign matters circulating in the refrigeration cycle together with refrigerant is provided between the using side heat exchangers (10a, 10b) and the compressor (1), and a filter device (53, 54) for capturing the solid foreign matters and liquid impurities which are at least one of insoluble and poor soluble with respect to the refrigerant is provided in the receiver (5), and the filter device (53, 54) is constructed by arranging a filter (54) for capturing the liquid impurities which are at least one of insoluble and poor soluble with respect to the refrigerant in an upper stage and a filter (54) for capturing the solid foreign matters discharged from the refrigerant pipe (7) in a lower stage, and a space is defined by the filter (53, 54) for capturing the solid foreign matters at an opening of each on an upstream side and a downstream side of the refrigerant pipes (7) inserted in the receiver (5). 40

FIG.1

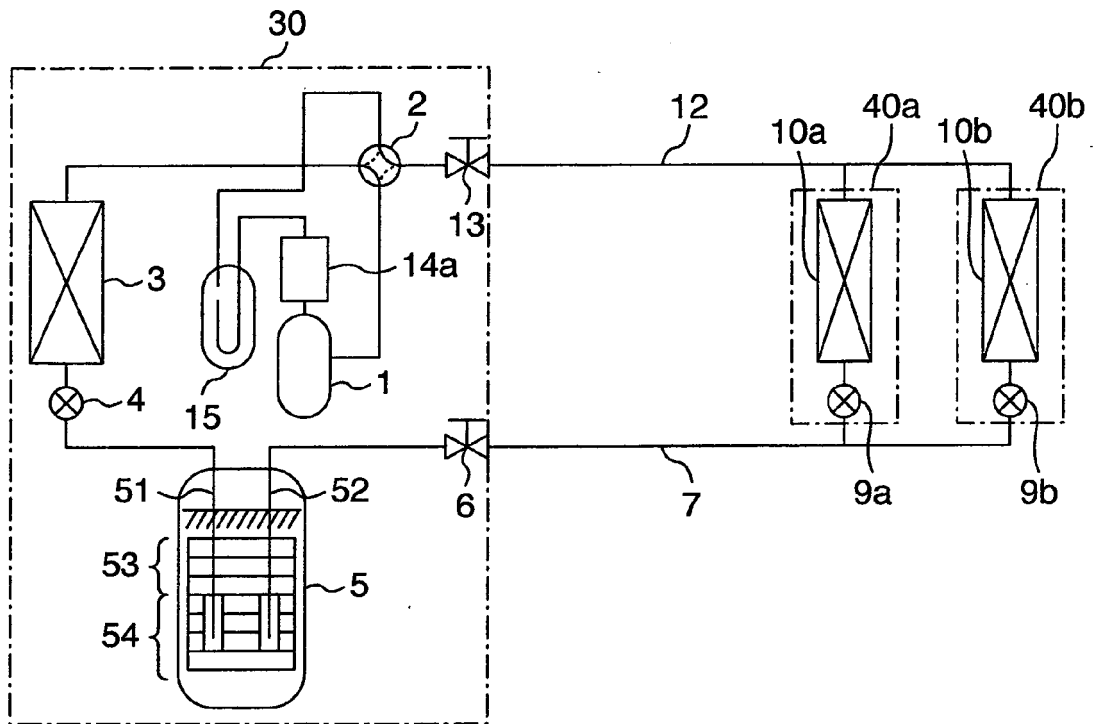


FIG.2

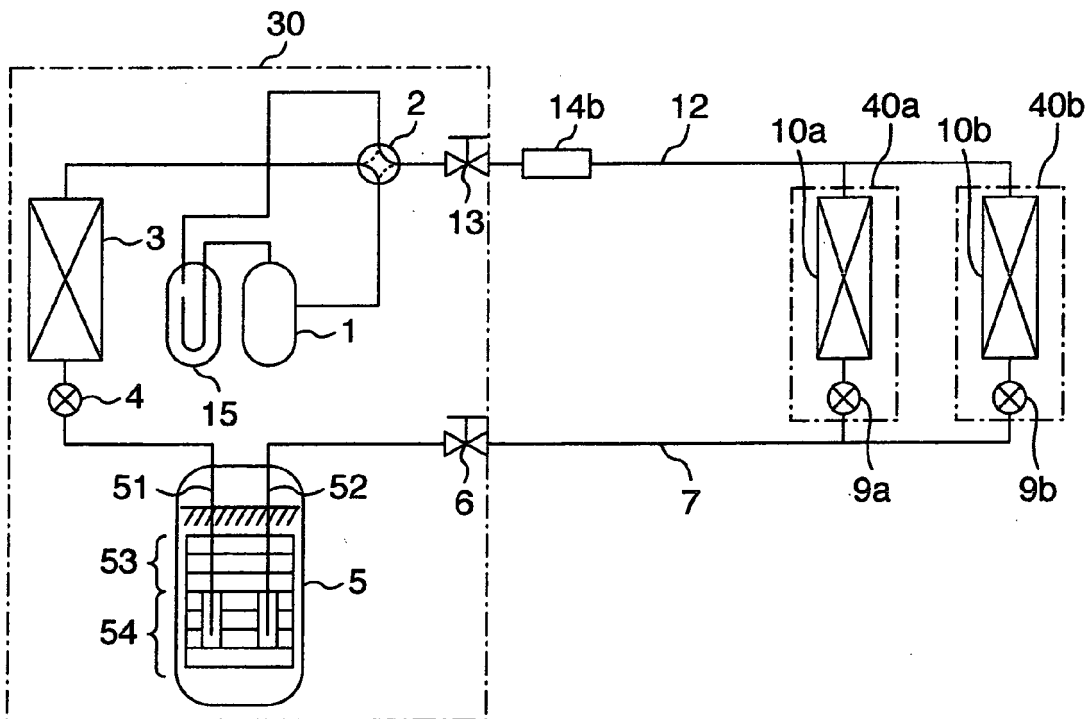


FIG.3

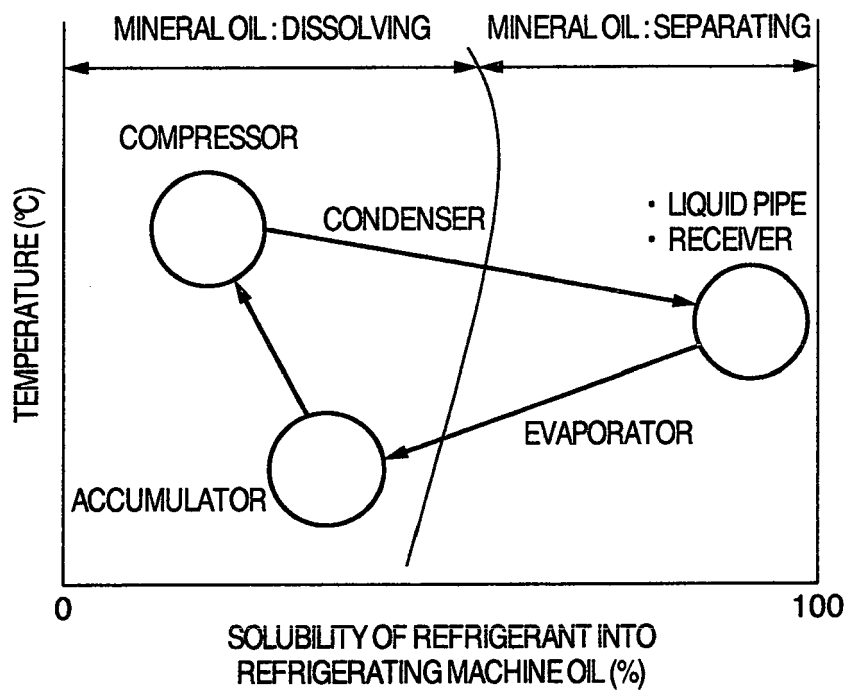


FIG.4

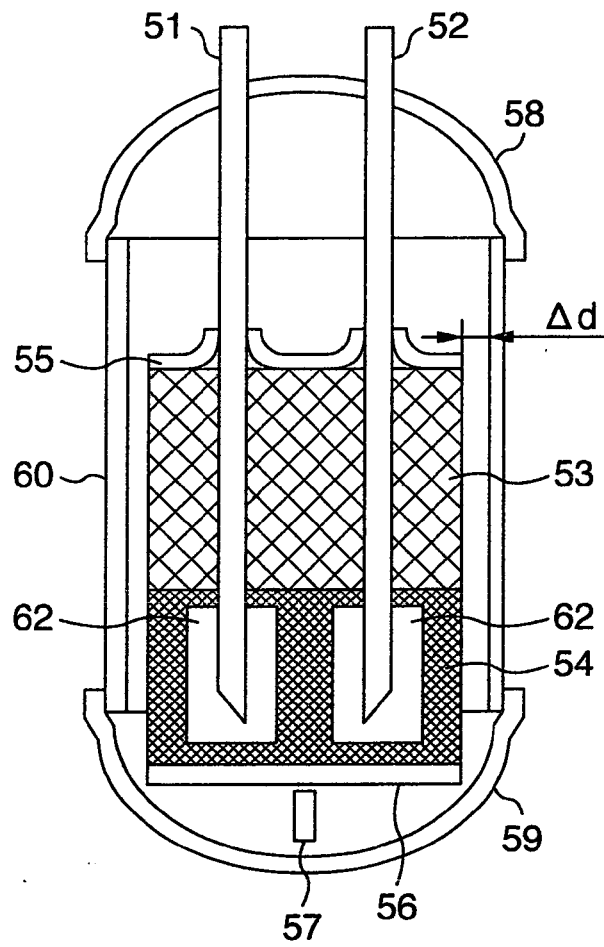
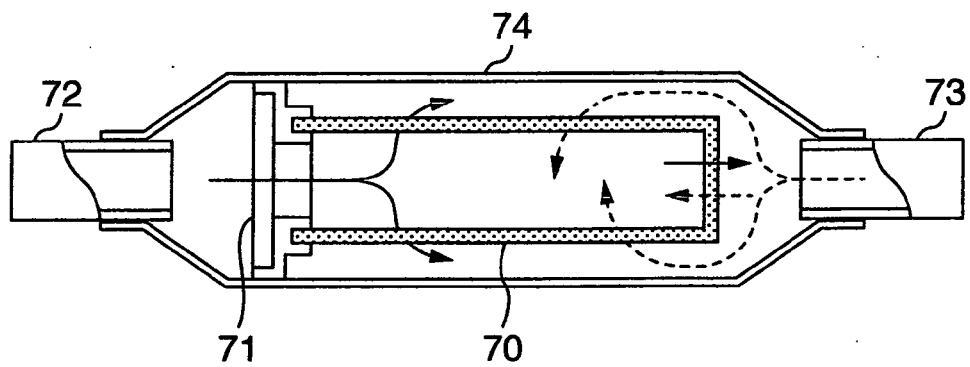


FIG.5



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2003042603 A [0007]
- JP 2000009368 A [0007]
- JP 2002224513 A [0008]

Non-patent literature cited in the description

- *Lubrication*, 1972, vol. 17 (11), 741-746 [0051]