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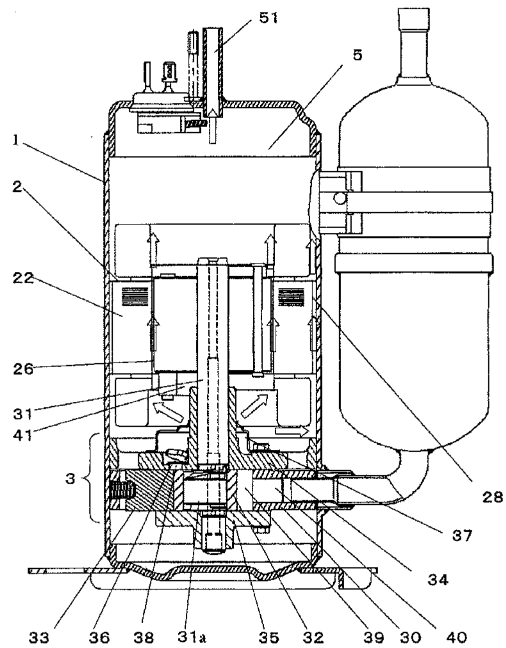
(54) ROTARY COMPRESSOR

(57) A rotary compressor contains, as a refrigerant, a single-component refrigerant comprising hydrofluoroolefin having a carbon-carbon double bond or a mixture refrigerant comprising this hydrofluoroolefin and hydrofluorocarbon having no double bond. The rotary compressor includes a compression mechanism 3 having a compression chamber 39 for increasing a pressure of the refrigerant inhaled through the suction port, a discharge port 38 for discharging the refrigerant, the pressure of which has been increased in the compression chamber, and a discharge muffler 37 to cover the discharge port. A spatial volume of the discharge muffler is determined depending on a density of the refrigerant, thereby making it possible to provide a rotary compressor capable of positively reducing a pressure loss associated with an increase in flow rate of the refrigerant, preventing a rise in discharge temperature, and restraining a reduction in reliability or durability that may be caused by decomposition of the refrigerant.

Fig. 1



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Description

Technical Field

[0001] The present invention relates to a rotary compressor that can be incorporated into refrigerating cycles such as, for example, room-air conditioners, refrigerators or other air conditioners in which a refrigerant containing no chlorine atoms, having a small global warming potential and also having, as a main component, hydrofluoroolefin having a carbon-carbon double bond is employed as a refrigerant.

Background Art

[0002] Conventional refrigerating appliances generally employ an HFC (hydrofluorocarbon) refrigerant having a zero-ozone depletion potential as a refrigerant, but in recent years the use of the HFC refrigerant becomes a problem because it has a large global warming potential. In view of this, an improved refrigerating appliance has been proposed that employs a refrigerant containing no chlorine atoms, having a small global warming potential and also having, as a main component, hydrofluoroolefin having a carbon-carbon double bond.

[0003] In the refrigerating appliance, a rotary compressor is used to inhale a refrigerant from an evaporator and compress the refrigerant to a pressure required for condensation, before a high-temperature and high-pressure refrigerant is introduced into a refrigerant circuit. Because most of power of the refrigerating appliance is used by the compressor, the performance of the refrigerating appliance depends greatly on that of the compressor. A conventional rotary compressor employing an HFC refrigerant is optimized in shape design to use HFC410A that is a typical refrigerant, thereby enhancing the performance.

[0004] Rotary compressors are known in patent documents (see, for example, Patent Document 1). A rotary compressor as shown in, for example, Fig. 9 includes an electric motor 101, a compression mechanism 102 connected to the electric motor 101 via a shaft 103, and a closed container 100 for accommodating the electric motor 101 and the compression mechanism 102 therein. The electric motor 101 is made up of a rotor 104 and a stator 105, and balance weights 106 are provided on top of and on bottom of the rotor 104 to reduce vertical vibration and noise. The rotor 104 is connected to the compression mechanism 102 by the shaft 103 and electrically rotated to drive the compression mechanism 102.

[0005] The compression mechanism 102 includes a cylinder 107, an upper end plate 108 and a lower end plate 109 for closing opposite ends of the cylinder 107 to define a compression chamber 110, and a roller 111 accommodated within the compression chamber 110 and mounted on an eccentric portion of the shaft 103, which is supported by the upper end plate 108 and the lower end plate 109. The compression mechanism 102 also includes a vane 112 held in contact with an outer peripheral surface of the roller 111. The vane 112 follows eccentric rotation of the roller 111 for reciprocating motion thereof and partitions the compression chamber 110 into a low-pressure portion and a high-pressure portion.

[0006] The cylinder 107 has a suction port 114 defined therein, through which a refrigerant is inhaled into the low-pressure portion of the compression chamber 110, and the upper end plate 108 has a discharge port (not shown) defined therein, through which the refrigerant is discharged from the high-pressure portion created upon transformation of the low-pressure portion. The roller 111 is accommodated within the compression chamber 110 that is formed by closing the cylinder 107 from above and from below with the upper end plate 108 and the lower end plate 109. A discharge valve (not shown) is mounted on the discharge port (not shown) to open the discharge port when a pressure greater than a predetermined value is applied thereto. A discharge muffler 117 is provided so as to cover the discharge valve.

[0007] In the rotary compressor of the above-described construction, on the low pressure side, a sliding contact portion of the roller 111 passes through the suction port 114 and then moves away therefrom while gradually enlarging a suction chamber, thereby drawing the refrigerant into the suction chamber through the suction port 114. On the other hand, on the high pressure side, the sliding contact portion of the roller 111 approaches the discharge port (not shown) while gradually reducing the compression chamber 110, and when the refrigerant is compressed over the predetermined pressure, the discharge valve (not shown) is opened to discharge the refrigerant through the discharge port (not shown). The refrigerant so discharged passes through a space formed by the discharge muffler and the upper end plate and is then discharged into a closed space.

Patent Document(s)

[0008]

Patent Document 1: JP 2008-303887 A

Summary of the Invention

Problems to be solved by the Invention

[0009] However, in the rotary compressor of the above-described construction, in applications where a refrigerant containing no chlorine atoms, having a small global warming potential and also having, as a main component, hydrofluoroolefin having a carbon-carbon double bond is employed as a refrigerant, a density of an inhaled refrigerant reduces compared with HFC410A, i.e., a conventionally-used typical HFC refrigerant. Because of this, if a compressor containing the conventional HFC410A as a refrigerant is used, it is necessary to increase a volume of the refrigerant, thus resulting in an increase in flow rate and, at the same time, in a deficiency in volume of a conventional discharge muffler. Also, the increased flow rate causes a pressure loss unless the refrigerant flows smoothly, thus giving rise to a reduction in compressor efficiency. Further, if the refrigerant remains in the discharge muffler, an excessive compression or re-expansion is caused or an inhaled refrigerant is caused to receive heat, which may in turn cause an excessive increase in temperature of a discharged refrigerant. Because a refrigerant containing no chlorine atoms and having, as a main component, hydrofluoroolefin having a carbon-carbon double bond decomposes easily at high temperatures, the increase of the discharge temperature caused by the excessive compression or re-expansion becomes a serious problem.

[0010] The present invention has been developed to overcome the above-described disadvantages. It is accordingly an objective of the present invention to provide a highly-efficient rotary compressor that can assuredly reduce a pressure loss and is superior in reliability and durability.

Means to Solve the Problems

[0011] In accomplishing the above objective, the rotary compressor according to the present invention is characterized in that a spatial volume of a discharge muffler is determined depending on a density of an inhaled refrigerant.

[0012] By doing so, a pressure loss can be assuredly reduced, thus making it possible to provide a highly-efficient rotary compressor that is superior in reliability and durability.

Effects of the Invention

[0013] Because the rotary compressor according to the present invention includes a discharge muffler appropriate for the density of the inhaled refrigerant, even if a refrigerant having a small global warming potential is used, a reduction in reliability and durability, which has been hitherto caused by decomposition of the refrigerant, can be restrained. Also, because an appropriate spatial volume of the discharge muffler is ensured, the pressure loss can be positively reduced, thus making it possible to provide a highly-reliable and highly-efficient rotary compressor.

Brief Description of the Drawings

[0014]

Fig. 1 is a vertical sectional view of a rotary compressor according to a first embodiment of the present invention.
Fig. 2 is a horizontal sectional view of a discharge muffler in the first embodiment.
Fig. 3 is a vertical sectional view of the discharge muffler in the first embodiment.
Fig. 4 is a graph indicating densities of inhaled refrigerants under the condition in which a condensation temperature and a saturation temperature thereof are the same as those of HFC410A in a certain operating range of the compressor.
Fig. 5 is a characteristic table indicating global warming potentials (GWPs) of two-component mixture refrigerants comprising tetrafluoropropene and difluoromethane at varying mixture ratios.
Fig. 6 is a vertical sectional view of a discharge muffler according to a second embodiment of the present invention.
Fig. 7 is a horizontal sectional view of a discharge muffler according to a third embodiment of the present invention.
Fig. 8 is a vertical sectional view of a compression mechanism according to a fourth embodiment of the present invention.
Fig. 9 is a vertical sectional view of a conventional rotary compressor.

Embodiments for Carrying out the Invention

[0015] A first invention is directed to a rotary compressor containing, as a refrigerant, a single-component refrigerant comprising hydrofluoroolefin having a carbon-carbon double bond or a mixture refrigerant comprising the hydrofluoroolefin having a carbon-carbon double bond and hydrofluorocarbon having no double bond. The rotary compressor includes a compression mechanism having a suction port for inhaling the refrigerant, a compression chamber for increasing a pressure of the refrigerant inhaled through the suction port, and a discharge port for discharging the refrigerant, the pressure of which has been increased in the compression chamber. A discharge muffler is incorporated in the compression mechanism to cover the discharge port. A spatial volume of the discharge muffler is determined depending on a density of the refrigerant, thereby making it possible to provide a rotary compressor capable of positively reducing a pressure loss associated with an increase in flow rate of the refrigerant, preventing a rise in discharge temperature, and restraining a reduction in reliability or durability that may be caused by decomposition of the refrigerant.

[0016] A second invention is such that in the first invention the discharge muffler forms a space above the discharge port. This feature prevents the refrigerant from impinging on the discharge muffler at a high speed immediately after it has been discharged from the discharge port, thus making it possible to provide a low-noise and low-loss rotary compressor.

[0017] A third invention is such that in the first or second invention the discharge muffler has a long side in a direction axially of a shaft. This feature can secure the special volume of the discharge muffler in a direction of flow of the refrigerant discharged from the discharge port and, hence, the pressure loss can be reduced. Also, because the refrigerant is discharged into a space distant from the compression chamber, an inhaled working receives only a reduced amount of heat, thus making it possible to further enhance the reliability and efficiency.

[0018] A fourth invention is such that in the first to third inventions the discharge muffler has a shape with no spatial volume around the suction port. This feature allows a high-temperature refrigerant not to remain around the suction port, thus making it possible to efficiently reduce heat received by the inhaled refrigerant and, at the same time, prevent an excessive increase in discharge temperature. Accordingly, decomposition of the refrigerant can be reduced, thus resulting in a highly-reliable rotary compressor.

[0019] A fifth invention is such that in the first to fourth inventions the discharge muffler is provided in the compression mechanism on an opposite side of an electric motor. This configuration enables the refrigerant to receive only a reduced amount of heat from a heat-generating portion created by rotation of the electric motor. Also, because a pace for the discharge muffler is easy to secure, thus making it possible to provide a highly reliable rotary compressor that can be designed easily. Further, because the discharge muffler is surrounded by oil, a low-noise rotary compressor can be realized.

[0020] A sixth invention is such that in the first to fifth inventions a plurality of discharge mufflers are provided. Even if only one discharge muffler cannot secure a required spatial volume, the provision of the plurality of discharge mufflers at different locations increases the degree of freedom in design, thereby making it possible to provide a small-sized highly-reliable rotary compressor.

[0021] A seventh invention is such that in the first to sixth inventions the spatial volume of the discharge muffler is 1.01 to 1.70 times greater than when R410A is used as the refrigerant, thus making it possible to assuredly provide a highly-reliable and highly-efficient rotary compressor.

[0022] An eighth invention is such that in the first to seventh inventions the single-component refrigerant comprises tetrafluoropropene or trifluoropropene as the hydrofluoroolefin and the mixture refrigerant is a two- or three-component mixture refrigerant comprising tetrafluoropropene or trifluoropropene as the hydrofluoroolefin as a main component, so as to make global warming potential greater than or equal to 5 and less than or equal to 750. This feature can reduce an environmental load and provide a highly-reliable and highly-efficient rotary compressor.

[0023] A ninth invention is such that in the first to eighth inventions the mixture refrigerant is a two- or three-component mixture refrigerant comprising tetrafluoropropene or trifluoropropene as the hydrofluoroolefin as a main component, and difluoromethane and pentafluoroethane, so as to make global warming potential greater than or equal to 5 and less than or equal to 750. This feature can reduce an environmental load, restrain a flow rate, and reduce a discharge temperature, thus making it possible to provide a highly-reliable and highly-efficient rotary compressor.

[0024] A tenth invention is such that in the eighth or ninth invention the global warming potential is less than or equal to 350.

[0025] An eleventh invention is such that in the first to eighth inventions a refrigerant oil is a synthetic oil comprising an oxygenated compound as a main component which includes one of polyoxyalkylene glycols, polyvinyl ethers, copolymers of poly(oxy)alkylene glycol or mono ether thereof and polyvinyl ether, polyol esthers, and polycarbonates, or a synthetic oil comprising one of alkyl benzenes and alpha olefins as a main component. This feature is effective in providing a highly-reliable and highly-efficient rotary compressor.

[0026] A twelfth invention is such that in the first to eleventh inventions the mixture refrigerant comprises tetrafluoropropene (HFO1234yf) as the hydrofluoroolefin and difluoromethane (HFC32) as the hydrofluorocarbon, and 80% of the tetrafluoropropene (HFO1234yf) is mixed with 20% of the difluoromethane (HFC32), and wherein the spatial volume of the discharge muffler is 1.01 to 1.4 times greater than when R410A is used as the refrigerant. This feature can satisfy a GWP of 150 or less, reduce an environmental load, and provide a highly-reliable and highly-efficient rotary compressor.

[0027] A thirteenth invention is such that in the first to eleventh inventions the mixture refrigerant comprises tetrafluoropropene (HFO1234yf) as the hydrofluoroolefin and difluoromethane (HFC32) as the hydrofluorocarbon, and 60% of the tetrafluoropropene (HFO1234yf) is mixed with 40% of the difluoromethane (HFC32), and wherein the spatial volume of the discharge muffler is 1.01 to 1.2 times greater than when R410A is used as the refrigerant. This feature allows an air conditioner to have the same year-round energy efficiency as when using HFC410A and can reduce an environmental load, thus making it possible to provide a highly-efficient and highly-reliable rotary compressor.

[0028] Embodiments of the present invention are described hereinafter with reference to the drawings, but the present invention is not limited to the embodiments.

(Embodiment 1)

[0029] Fig. 1 is a vertical sectional view of a hermetic compressor according to a first embodiment of the present invention. As shown in Fig. 1, the rotary compressor includes an electric motor 2, a compression mechanism 3 connected to the electric motor 2 via a shaft 31, and a closed container 1 for accommodating the electric motor 2 and the compression mechanism 3 therein. The compression mechanism 3 includes a cylinder 30, an upper end plate 34 and a lower end plate 35 for closing opposite ends of the cylinder 30 to define a compression chamber 39, and a roller 32 accommodated within the compression chamber 39 and mounted on an eccentric portion 31 a of the shaft 31, which is supported by the upper end plate 34 and the lower end plate 35. The compression mechanism 3 also includes a vane 33 held in contact with an outer peripheral surface of the roller 32. The vane 33 follows eccentric rotation of the roller 32 for reciprocating motion thereof and partitions the compression chamber 39 into a low-pressure portion and a high-pressure portion.

[0030] The cylinder 30 has a suction port 40 defined therein, through which a refrigerant is inhaled into the low-pressure portion of the compression chamber 39, and the upper end plate 34 has a discharge port 38 defined therein, through which the refrigerant is discharged from the high-pressure portion created upon transformation of the low-pressure portion. The roller 32 is accommodated within the compression chamber 39 that is formed by closing the cylinder 30 from above and from below with the upper end plate 34 and the lower end plate 35. The discharge port 38 is a hole extending through the upper end plate 34 and a discharge valve 36 is mounted on the discharge port 38 to open the discharge port 38 when a pressure greater than a predetermined value is applied thereto. A discharge muffler 37 is provided so as to cover the discharge valve 36.

[0031] Operation and function of the rotary compressor of the above-described construction are explained hereinafter. On the low pressure side, a sliding contact portion of the roller 32 passes through the suction port 40 and then moves away therefrom while gradually enlarging a suction chamber, thereby drawing the refrigerant into the suction chamber through the suction port 40. On the other hand, on the high pressure side, the sliding contact portion of the roller 32 approaches the discharge port 38 while gradually reducing the compression chamber 39, and when the refrigerant is compressed over the predetermined pressure, the discharge valve 36 is opened to discharge the refrigerant into the closed container 1 through the discharge port 38. The refrigerant is then discharged into the closed container 1 through the discharge muffler 37. The refrigerant so discharged passes through grooves 28 formed between a stator 22 and a side wall of the closed container 1 and through an air gap 26 defined in the electric motor 2. The refrigerant is then introduced into a space inside an upper shell 5 disposed above the electric motor 2 and finally discharged out of the closed container 1 through a refrigerant discharge pipe 51. Arrows indicate a flow of refrigerant.

[0032] It is to be noted here that a single-component refrigerant containing hydrofluoroolefin having a carbon-carbon double bond or a mixture refrigerant containing hydrofluoroolefin and hydrofluorocarbon having no double bond and mixed therewith is used as the refrigerant.

[0033] Fig. 2 is a horizontal sectional view of the discharge muffler 37 as viewed from the upper end plate 34 and Fig. 3 is a vertical sectional view of the discharge muffler 37.

[0034] As shown in Figs. 2 and 3, diagonal lines indicate a spatial volume of the discharge muffler 37 delimited by the upper end plate 34 and the discharge muffler 37. This spatial volume is determined in the light of the fact that a density of an inhaled refrigerant employed in the present invention differs from that of a refrigerant employed in generally-used compressors.

[0035] It is supposed that the density of the inhaled refrigerant employed in the generally-used compressors is A and that of the inhaled refrigerant employed in the present invention is B. If B is less than A, a ratio of a flow rate of the refrigerant employed in the present invention to that of the generally-used refrigerant is about A/B. Accordingly, if the discharge muffler 37 has the same spatial volume as a conventional one, the refrigerant discharged from the discharge port 38 cannot be received in the spatial volume of the discharge muffler 37 due to an excessive flow rate. As a result, the refrigerant is not smoothly discharged from the discharge muffler 37 into the closed container, thus giving rise to a loss. Also, because the refrigerant is likely to flow back to the discharge port 38, an excessive compression or re-expansion may occur. For these reasons, the refrigerant increases in temperature and experiences progression of decomposition at high temperatures, which is a problem peculiar to the refrigerant of this kind.

[0036] From the above, the spatial volume of the discharge muffler 37 for use with the refrigerant as employed in the present invention is changed from that of a discharge muffler in a rotary compressor that has been designed to employ a conventional refrigerant depending on a density ratio of the inhaled refrigerants. A specific example of determining the spatial volume of the discharge muffler 37 is next explained.

[0037] Fig. 4 is a graph indicating densities of inhaled refrigerants under the condition in which a condensation temperature and a saturation temperature thereof are the same as those of R410A in a certain operating range of the compressor according to the first embodiment. A dotted line in Fig. 4 indicates a density of an inhaled refrigerant when HFO1234yf and R32 were mixed at a mixture ratio of 5:5. Even when HFO1234yf and R32 are mixed at a varying ratio, the density of the inhaled refrigerant can be calculated.

[0038] As shown in Fig. 4, a density ratio of the inhaled refrigerants under the same condition when the generally-used HFC410A refrigerant was used and when HFO1234yf was used as a refrigerant in the present invention is HFO1234yf: HFC410A% 1:1.7. Accordingly, when HFO1234yf is used as the refrigerant, it is necessary to flow it at a flow rate about 1.7 times greater than that of HFC410A.

[0039] Because of this, unless the spatial volume of the discharge muffler 37 is set greater than that of a discharge muffler designed for use with HFC410A, a pressure loss occurs due to an insufficient spatial volume. However, if the spatial volume is increased unnecessarily, the closed container 1 is required to have a larger size, thus making it impossible to design a compact rotary compressor. Accordingly, the spatial volume of the discharge muffler 37 for use with HFO1234y is determined to be about 1.01 to 1.7 times greater than that of a discharge muffler for use with HFC410A. By doing so, even if HFO134yf is used, the loss can be reduced and, at the same time, decomposition of the refrigerant can be restrained, thus making it possible to provide a highly-efficient and highly-reliable compact rotary compressor.

[0040] Fig. 5 is a characteristic table indicating global warming potentials of two-component mixture refrigerants comprising tetrafluoropropene and difluoromethane at varying mixture ratios. A refrigerant comprising only tetrafluoropropene has an excellent GWP value of 4. However, this refrigerant has a large specific volume and a refrigerating capacity thereof is accordingly small compared with a mixture refrigerant made up of this refrigerant and hydrofluorocarbon and, hence, larger refrigerating cycle equipment is required. In other words, a mixture refrigerant containing a main component of hydrofluoroolefin having a carbon-carbon double bond and hydrofluorocarbon having no double bond mixed therewith is easy to use as a refrigerant because given characteristics such as, for example, the refrigerating capacity are improved compared with the single-component refrigerant of hydrofluoroolefin. Accordingly, in the case of refrigerants, including the single-component refrigerant, filled in a refrigerating cycle, a percentage of tetrafluoropropene may be appropriately selected depending on objectives of, for example, refrigerating cycle equipment having a compressor incorporated therein or conditions such as, for example, a limitation of GWP referred to above.

[0041] Specifically, as shown in Fig. 5, in order to make the global warming potential less than or equal to a GWP of 150, it is necessary to mix 20 wt% or less of difluoromethane with tetrafluoropropene, and in order to make the global warming potential less than or equal to a GWP of 300, it is necessary to mix 40 wt% or less of difluoromethane with tetrafluoropropene. That is, when a mixture ratio of HFO1234yf to R32 is 8:2, a GWP of 150 or less is satisfied and, at this time, a density ratio of inhaled gases is HFO1234yf:HFC410A≒ 1:1.4. Accordingly, in applications where HFO1234yf and R32 are both used as a refrigerant, the refrigerant flows at a flow rate about 1.4 times greater than that of HFC410A. This means that the spatial volume of the discharge muffler 37 suited for use with HFO1234yf is about 1.01 to 1.4 times greater than that of the discharge muffler suited for use with HFC410A, thereby making it possible to restrain the influence on the global environment, reduce the loss and restrain decomposition of the refrigerant. Thus, a highly-efficient and highly-reliable rotary compressor can be provided.

[0042] Also, when a mixture refrigerant of HFO1234yf and R32 was used at a mixture ratio of 6:4, the GWP could be reduced to a minimum while maintaining the same performance as a traditional year-round energy efficiency in terms of the efficiency including, for example, the pressure loss as required for refrigerating cycle equipment. The density ratio of the inhaled gases at this time was HFO1234yf:HFC410A≒ 1:1.2. Accordingly, in applications where HFO1234yf and R32 are both used as a refrigerant, the refrigerant flows at a flow rate about 1.2 times greater than that of HFC410A. This means that the spatial volume of the discharge muffler 37 suited for use with HFO1234yf is about 1.01 to 1.2 times greater than that of the discharge muffler suited for use with HFC410A, thereby making it possible to restrain an environmental load, reduce the loss and restrain decomposition of the refrigerant. Thus, a highly-efficient and highly-reliable rotary compressor can be provided.

[0043] Further, even if part of the refrigerant that cannot be collected is vented to atmosphere, the influence of the refrigerant on global warming can be minimized. In addition, the mixture refrigerant having the aforementioned mixture ratio can reduce a temperature difference in spite of being a zeotropic mixture refrigerant and because it resembles a pseudo azeotropic mixture refrigerant in behavior, it can improve a cooling performance or a coefficient of cooling performance (COP) of the refrigerating appliance.

[0044] Also, the discharge muffler 37 is formed into a shape in which a space is formed above the discharge port 38 and, hence, the refrigerant is prevented from impinging on the discharge muffler 37 at a high speed immediately after it has been discharged from the discharge port 38, thus making it possible to provide a low-noise and low-loss rotary compressor.

(Embodiment 2)

[0045] Fig. 6 is a vertical sectional view of a discharge muffler 37b according to a second embodiment of the present invention. The second embodiment differs from the first embodiment in the following points and is basically the same as the first embodiment in other points. Accordingly, duplicative explanation is omitted and only different portions are explained. This applies to other embodiments explained later.

[0046] As shown in Fig. 6, the discharge muffler 37b has a spatial volume formed in a direction axially of a shaft 31. A height L of the discharge muffler 37b in the axial direction of the shaft 31 is greater than a width W of the discharge muffler 37b in a radial direction of the shaft 31. Because this configuration can secure the spatial volume of the discharge muffler 37b while reducing a heat receiving area from the discharge muffler 37b to a compression chamber 39, an excessive compression or re-expansion can be prevented to thereby restrain a rise in discharge temperature. Accordingly, decomposition of a refrigerant can be reduced, thus resulting in a highly-efficient and highly-reliable rotary compressor.

(Embodiment 3)

[0047] Fig. 7 is a horizontal sectional view of a discharge muffler according to a third embodiment of the present invention. As shown in Fig. 7, the discharge muffler 37c has a shape spaced from a suction port 40. This configuration can efficiently reduce heat that is received by an inhaled refrigerant through the discharge muffler 37c to thereby prevent an excessive increase in temperature of a discharged refrigerant. Accordingly, a highly--reliable rotary compressor capable of reducing decomposition of the refrigerant can be provided.

(Embodiment 4)

[0048] Fig. 8 is a vertical sectional view of a compression mechanism according to a fourth embodiment of the present invention. As shown in Fig. 8, a discharge muffler 37d is positioned on an opposite side of an electric motor 2 so as to cover a lower end plate 35 below a compression chamber 39. This configuration enables a refrigerant to receive only a reduced amount of heat from a heat-generating portion created by rotation of the electric motor 2. Also, because component parts such as the electric motor 2 are not present in the vicinity of the discharge muffler 37d, a pace for the discharge muffler 37d is easy to secure, thus making it possible to provide a highly--reliable rotary compressor that can be designed easily.

[0049] Further, because the discharge muffler 37d is surrounded by oil stored around the lower end plate 35, a low-noise rotary compressor can be provided.

[0050] An increase in flow rate is not limited to the discharge muffler 37 and it is desired that a volume of all the pressure-loss generating portions be determined depending on a density of the refrigerant. Based on this design guide, a simple design change allows a conventionally-used rotary compressor to be used with a different refrigerant.

[0051] Although in the above-described embodiment a refrigerant mainly comprising hydrofluoroolefin having a carbon-carbon double bond is used alone or in combination with another refrigerant as a refrigerant, a refrigerant mainly comprising hydrofluoroolefin having a carbon-carbon double bond and mixed with hydrofluorocarbon having no double bond may be used as a refrigerant.

[0052] Also, a mixture refrigerant comprising tetrafluoropropene (HFO1234yf or HFO1234ze) as a hydrofluoroolefin and difluoromethane (HFC32) as a hydrofluorocarbon may be used as a refrigerant.

[0053] Further, a mixture refrigerant comprising tetrafluoropropene (HFO1234yf) as a hydrofluoroolefin and pentafluoroethane (HFC125) as a hydrofluorocarbon may be used as a refrigerant.

[0054] A three-component mixture refrigerant comprising tetrafluoropropene (HFO1234yf) as a hydrofluoroolefin and of pentafluoroethane (HFC125) and difluoromethane (HFC32) as hydrofluorocarbons may be used as a refrigerant.

[0055] In each case, the use of a two- or three-component refrigerant is preferable in which two or three components are mixed so as to make the global warming potential greater than or equal to 5 and less than or equal to 750, preferably less than or equal to 350.

[0056] As a refrigerant oil for use with the above-described refrigerants, the use of a synthetic oil mainly comprising an oxygenated compound such as, for example, polyoxyalkylene glycols, polyvinyl ethers, copolymers of poly(oxy) alkylene glycol or mono ether thereof and polyvinyl ether, polyol esthers, and polycarbonates is preferred. The use of a synthetic oil mainly comprising one of alkyl benzenes and alpha olefins is also preferred.

[0057] It is to be noted that although the above-described embodiments have been explained taking a rotary compressor, the present invention is naturally applicable to a scroll compressor that is one of the rotary compressors.

Industrial Applicability

[0058] As described above, even if a refrigerant mainly comprising hydrofluoroolefin having a carbon-carbon double bond is used alone or in combination with another refrigerant as a refrigerant, a rotary compressor according to the present invention is highly efficient and highly reliable. Accordingly, the rotary compressor according to the present invention can be incorporated in air conditioners, heat pump water heaters, refrigerator-freezers, dehumidifiers or the like.

Explanation of reference numerals

[0059]

1	closed container
2	electric motor
26	air gap
28	groove
3	compression mechanism
30	cylinder
31	shaft
31 a	eccentric portion
32	roller
33	vane
34	upper end plate
35	lower end plate
36	discharge valve
37, 37b, 37c, 37d	discharge muffler
38	discharge port
39	compression chamber
40	suction port
51	refrigerant discharge pipe

Claims

1. A rotary compressor containing, as a refrigerant, a single-component refrigerant comprising hydrofluoroolefin having a carbon-carbon double bond or a mixture refrigerant comprising the hydrofluoroolefin having a carbon-carbon double bond and hydrofluorocarbon having no double bond, the rotary compressor comprising:

    a compression mechanism having a suction port inhaling the refrigerant, a compression chamber increasing a pressure of the refrigerant inhaled through the suction port, and a discharge port discharging the refrigerant, the pressure of which has been increased in the compression chamber; and
    a discharge muffler incorporated in the compression mechanism to cover the discharge port;
    wherein a spatial volume of the discharge muffler is determined depending on a density of the refrigerant.

2. The rotary compressor according to claim 1, wherein the discharge muffler forms a space above the discharge port.

3. The rotary compressor according to claim 1 or 2, wherein the discharge muffler has a long side in a direction axially of a shaft.

4. The rotary compressor according to any one of claims 1 to 3, wherein the discharge muffler has a shape with no spatial volume around the suction port.

5. The rotary compressor according to any one of claims 1 to 4, wherein the discharge muffler is provided in the compression mechanism on an opposite side of an electric motor.

6. The rotary compressor according to any one of claims 1 to 5, wherein a plurality of discharge mufflers are provided.

7. The rotary compressor according to any one of claims 1 to 6, wherein the spatial volume of the discharge muffler is 1.01 to 1.70 times greater than when R410A is used as the refrigerant.

8. The rotary compressor according to any one of claims 1 to 7, wherein the single-component refrigerant comprises tetrafluoropropene or trifluoropropene as the hydrofluoroolefin and the mixture refrigerant is a two- or three-compo-

nent mixture refrigerant comprising tetrafluoropropene or trifluoropropene as the hydrofluoroolefin as a main component, so as to make global warming potential greater than or equal to 5 and less than or equal to 750.

9. The rotary compressor according to any one of claims 1 to 8, wherein the mixture refrigerant is a two- or three-component mixture refrigerant comprising tetrafluoropropene or trifluoropropene as the hydrofluoroolefin as a main component, and difluoromethane and pentafluoroethane, so as to make global warming potential greater than or equal to 5 and less than or equal to 750.

10. The rotary compressor according to claim 8 or 9, wherein the global warming potential is less than or equal to 350.

11. The rotary compressor according to any one of claims 1 to 8, wherein a refrigerant oil is a synthetic oil comprising an oxygenated compound as a main component which includes one of polyoxyalkylene glycols, polyvinyl ethers, copolymers of poly(oxy)alkylene glycol or mono ether thereof and polyvinyl ether, polyol esthers, and polycarbonates, or a synthetic oil comprising one of alkyl benzenes and alpha olefins as a main component.

12. The rotary compressor according to any one of claims 1 to 11, wherein the mixture refrigerant comprises tetrafluoropropene (HFO1234yf) as the hydrofluoroolefin and difluoromethane (HFC32) as the hydrofluorocarbon, and 80% of the tetrafluoropropene (HFO1234yf) is mixed with 20% of the difluoromethane (HFC32), and
wherein the spatial volume of the discharge muffler is 1.01 to 1.4 times greater than when R410A is used as the refrigerant.

13. The rotary compressor according to any one of claims 1 to 11, wherein the mixture refrigerant comprises tetrafluoropropene (HFO1234yf) as the hydrofluoroolefin and difluoromethane (HFC32) as the hydrofluorocarbon, and 60% of the tetrafluoropropene (HFO1234yf) is mixed with 40% of the difluoromethane (HFC32), and
wherein the spatial volume of the discharge muffler is 1.01 to 1.2 times greater than when R410A is used as the refrigerant.

Fig. 1

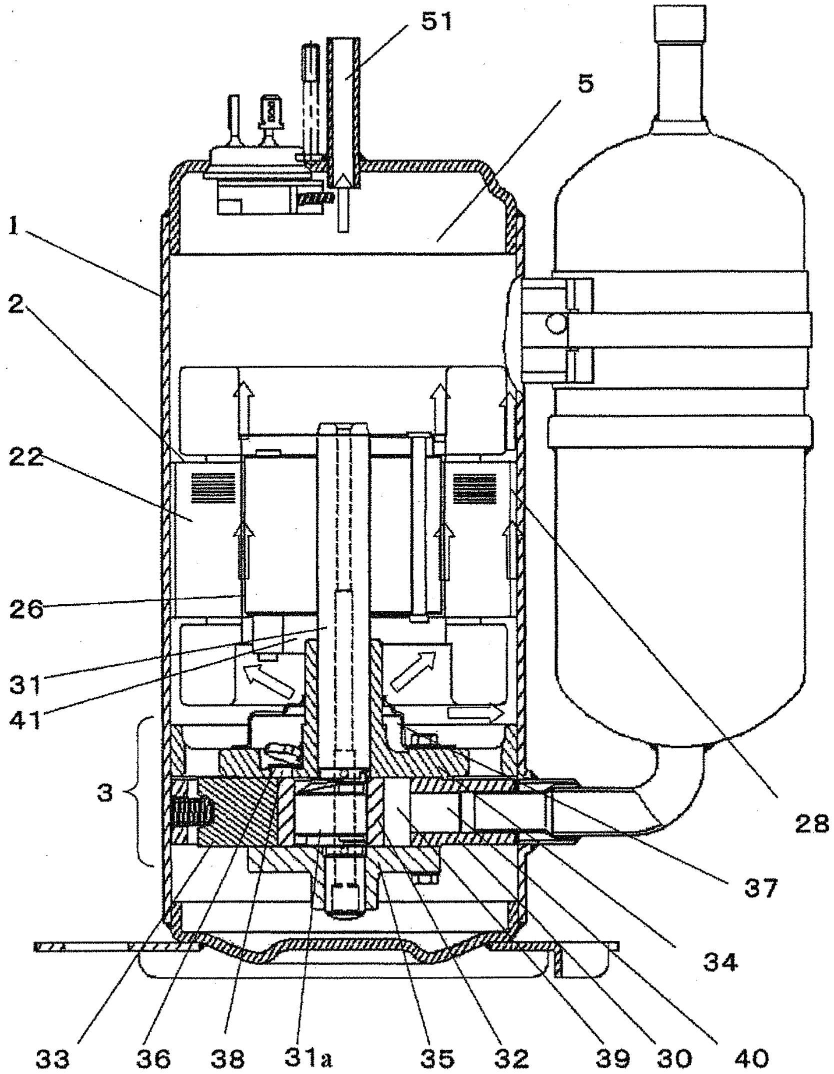

Fig. 2

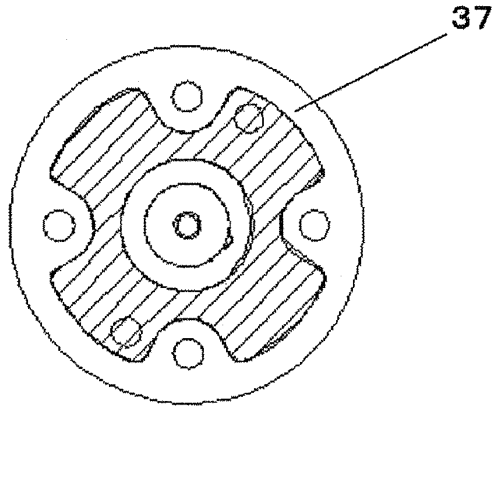

Fig. 3

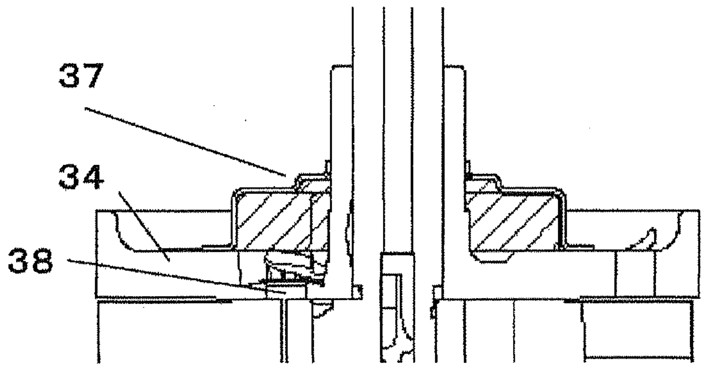

Fig. 4

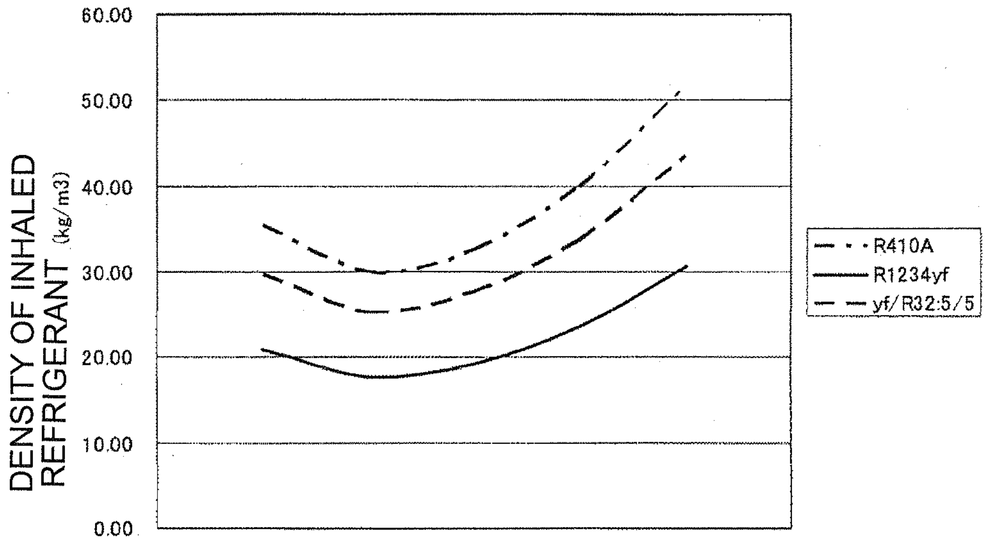

Fig. 5

R1234yf	R32	GLOBAL WARMING POTENTIAL (GWP)
0	100	675
60	40	272
80	20	138
100	0	4

Fig. 6

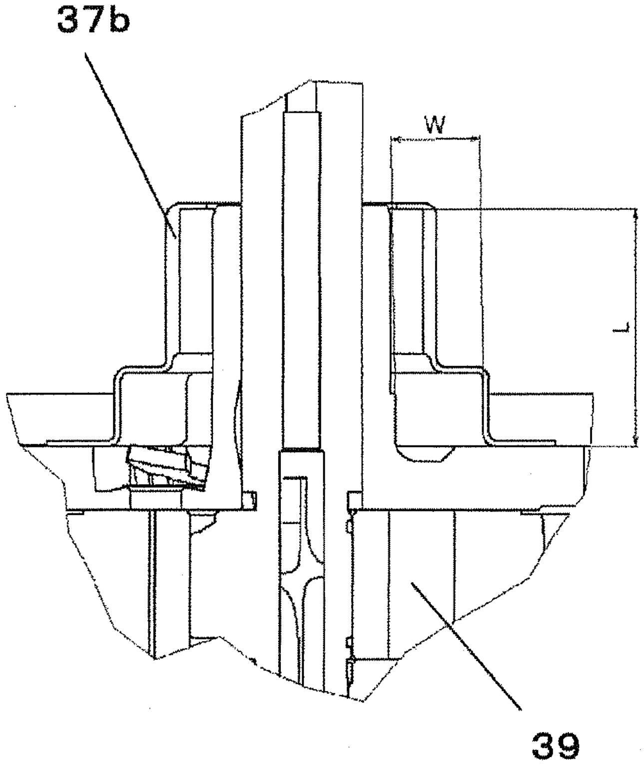

Fig. 7

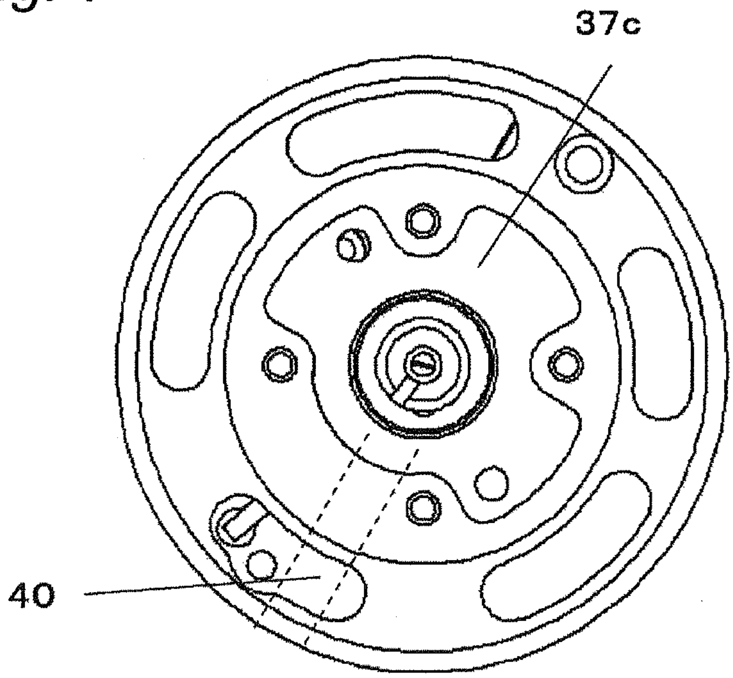

Fig. 8

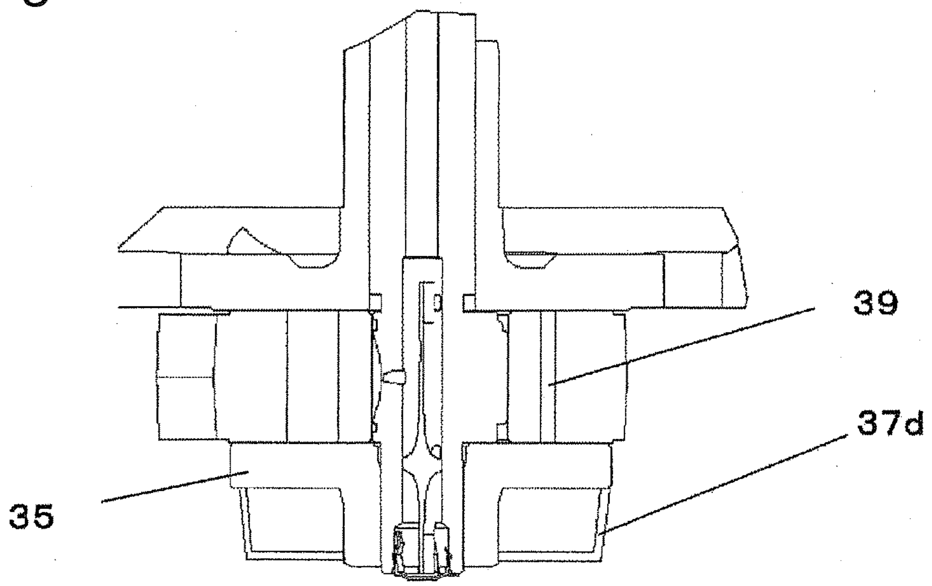
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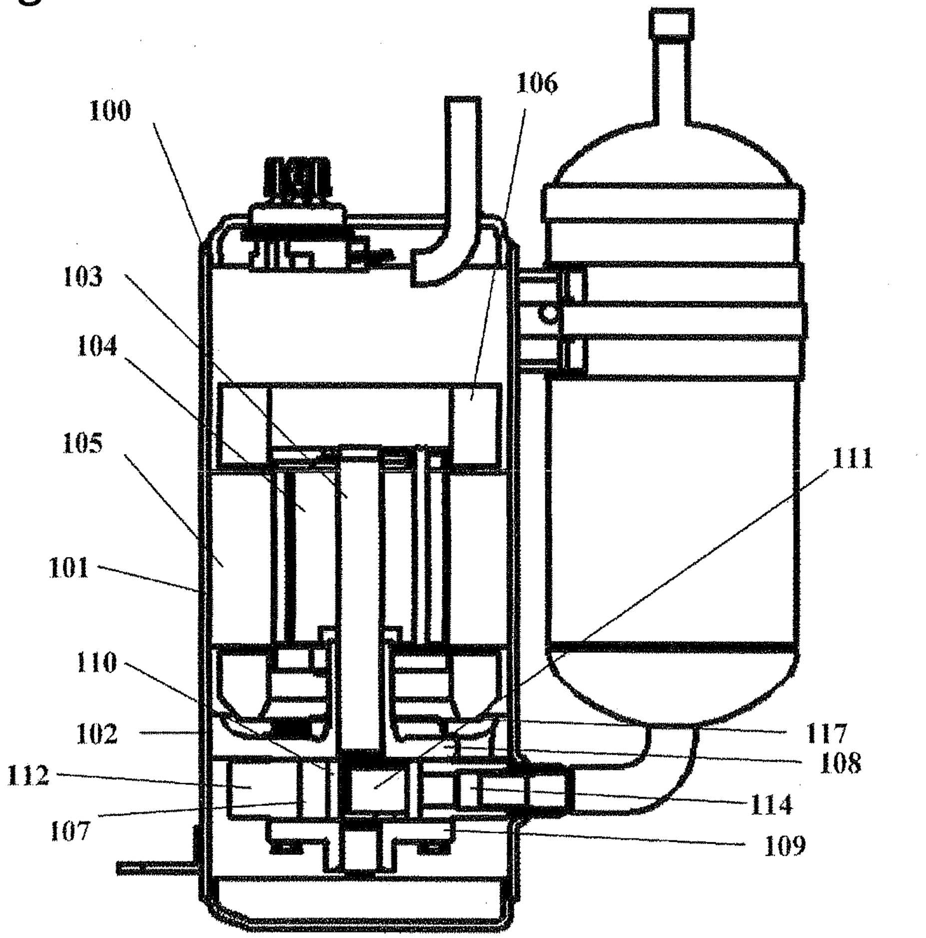
Fig. 9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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2011/002370

A. CLASSIFICATION OF SUBJECT MATTER
F04C29/06(2006.01)i, *F04C18/32*(2006.01)i, *F04C29/00*(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)
F04C29/06, F04C18/32, F04C29/00

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	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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 2010-1775 A (Mitsubishi Electric Corp.), 07 January 2010 (07.01.2010), paragraphs [0078] to [0084]; fig. 1 (Family: none)	1-10
Y	JP 2010-24984 A (Daikin Industries, Ltd.), 04 February 2010 (04.02.2010), paragraphs [0051] to [0055] (Family: none)	1,4,6-9, 12-13
Y	JP 2009-298927 A (Mitsubishi Electric Corp.), 24 December 2009 (24.12.2009), claims 1 to 3, 9; paragraphs [0018] to [0040]; fig. 1 (Family: none)	1,4,6-9,11

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

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Date of the actual completion of the international search	Date of mailing of the international search report
19 July, 2011 (19.07.11)	02 August, 2011 (02.08.11)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/002370

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 9-203386 A (Hitachi, Ltd.), 05 August 1997 (05.08.1997), paragraphs [0008] to [0015] (Family: none)	1-13
Y	JP 8-334095 A (Sanyo Electric Co., Ltd.), 17 December 1996 (17.12.1996), fig. 2, 4 (Family: none)	4
Y	JP 5-133377 A (Sanyo Electric Co., Ltd.), 28 May 1993 (28.05.1993), claim 1; paragraphs [0008] to [0012]; fig. 1 (Family: none)	6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008303887 A **[0008]**