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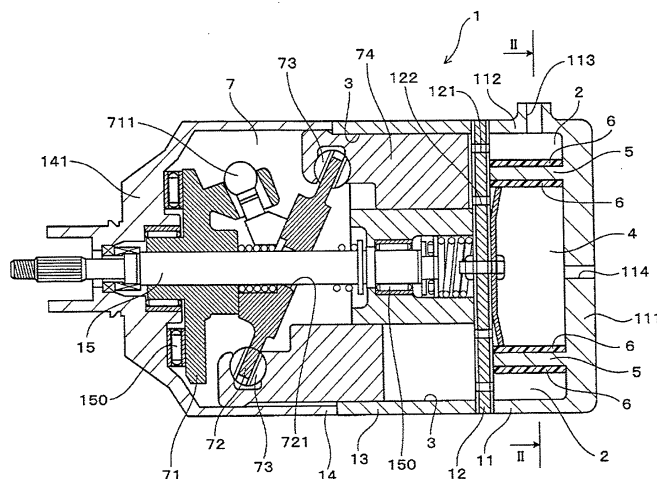
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(54) Compressor

(57) A compressor has therein a suction chamber into which refrigerant gas is introduced, a compression chamber in which the refrigerant gas in the suction chamber is introduced and compressed, and a discharge chamber into which the compressed refrigerant gas is discharged from the compression chamber. The suction chamber and the discharge chamber are formed adja-

cent to each other while being separated by a partition wall. At least one surface of the partition wall is provided with a thermal insulator which is formed by curing a thermal insulation coating composition. The thermal insulator includes hollow beads and one or more binder resin selected from the group consisting of epoxy resin, polyamide-imide resin, phenolic resin, and polyimide resin.

FIG. 1**EP 2 803 856 A1**

Description**BACKGROUND OF THE INVENTION**

5 **[0001]** The present invention relates to a compressor for use in an air conditioning system.

[0002] A compressor for use in a refrigeration cycle or a heat pump cycle of an air conditioning system compresses in a compression chamber thereof low-temperature, low-pressure refrigerant gas introduced into a suction chamber and discharges compressed high-temperature, high-pressure refrigerant gas into a discharge chamber. In order to enhance the compression efficiency of the refrigerant gas in such compressors, various compressors have been proposed.

10 **[0003]** For example, Japanese Unexamined Patent Application Publication No. 2005-344654 discloses a compressor in which a thermal insulator is provided on a part of a wall surrounding the discharge chamber. The compressor has a partition wall between the discharge chamber and the suction chamber and the thermal insulator is provided on the surface of the partition wall that faces the discharge chamber, and also on at least a part of the wall between the discharge chamber and the outside of the compressor. With this configuration, the temperature rise of the refrigerant gas in the suction chamber is suppressed and the compression efficiency is enhanced. Additionally, part of the heat of the refrigerant gas discharged into the discharge chamber is released to the outside and a drop in efficiency of an entire refrigeration cycle is prevented.

15 **[0004]** However, any peel-off occurring in any part of the thermal insulator on the inner surface of the discharge chamber may affect the operation of the compressor and there is a fear that the compressor may be damaged internally in some cases. Specifically, the temperature and the pressure in the compressor increase and the resin component contained in the thermal insulator is prone to deterioration. Excessive deterioration of the resin component may embrittle the thermal insulator and, in some cases, part of the thermal insulator may peel off. The compressor should be protected against such trouble and the thermal insulator needs to be prevented from being peeled off for ensuring the reliability of the compressor.

20 **[0005]** The present invention, which has been made in view of the above circumstances, is directed to a compressor which is excellent in compression efficiency and reliability.

SUMMARY OF THE INVENTION

30 **[0006]** In accordance with an aspect of the present invention, there is provided a compressor which has therein a suction chamber into which refrigerant gas is introduced, a compression chamber in which the refrigerant gas in the suction chamber is introduced and compressed, and a discharge chamber into which the compressed refrigerant gas is discharged from the compression chamber. The suction chamber and the discharge chamber are formed adjacent to each other while being separated by a partition wall. At least one surface of the partition wall is provided with a thermal insulator which is formed by curing a thermal insulation coating composition. The thermal insulator includes hollow beads and one or more binder resins selected from the group consisting of epoxy resin, polyamide-imide resin, phenolic resin, and polyimide resin.

35 **[0007]** Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

40 **[0008]** The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

45 FIG. 1 is a longitudinal sectional view of a compressor according to a first embodiment of the present invention;

FIG. 2 is a transverse sectional view taken along the line II-II of FIG. 1;

50 FIG. 3 is a graph showing the temperatures in suction chamber of a compressor in operation according to a third embodiment of the invention;

FIG. 4 is a longitudinal sectional view of a compressor according to a fourth embodiment of the invention in which a discharge chamber is formed surrounding a suction chamber;

55 FIG. 5 is a transverse sectional view taken along the line V-V of FIG. 4;

FIG. 6 is a graph showing the temperatures in suction chamber of a compressor in operation according to the fourth

embodiment of the invention; and

FIG. 7 is a cross-sectional view of a partition wall of a compressor according to a fifth embodiment of the invention, the partition wall having a suction chamber wall and a discharge chamber wall filled with a thermal insulator there-between.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0009] The following will describe the compressor according to the first embodiment of the present invention with reference to FIGS. 1 and 2. Referring to FIG. 1, the compressor is designated generally by numeral 1 and includes a suction chamber 2 into which refrigerant gas is introduced, compression chambers 3 in which the refrigerant gas in the suction chamber 2 is introduced and compressed, and a discharge chamber 4 into which the compressed refrigerant gas is discharged from the compression chamber 3. As shown in FIGS. 1 and 2, the suction chamber 2 and the discharge chamber 4 are formed adjacent to each other.

[0010] As shown in FIGS. 1 and 2, the suction chamber 2 and the discharge chamber 4 are separated by a partition wall 5 the opposite faces of which are provided with a thermal insulator 6. The thermal insulator 6 is formed by curing a thermal insulation coating composition. The thermal insulator 6 includes hollow beads and one or more binder resins selected from the group consisting of epoxy resin, polyamide-imide resin, phenolic resin and polyimide resin.

[0011] As shown in FIG. 1, a rear housing 11, a valve plate 12, a cylinder block 13, and a front housing 14 are disposed in this order in the compressor 1 and any two adjacent components are joined sealingly. It is to be noted that, in the following description, the front housing 14 side is referred to as the front side and the rear housing 11 side as the rear side of the compressor 1, respectively.

[0012] As shown in FIG. 1, the suction chamber 2 and the discharge chamber 4 are defined by and between the rear housing 11 and the valve plate 12, and the partition wall 5 separating the suction chamber 2 from the discharge chamber 4 is disposed in the rear housing 11. Specifically, the partition wall 5 is formed projecting horizontally from a rear end wall 111 of the rear housing 11 toward the front (see FIG. 1). As shown in FIG. 2, the partition wall 5 is formed annularly around the center of the rear housing 11, as viewed from the front side. As shown in FIG. 1, the rear housing 11 includes an outer peripheral wall 112. The outer peripheral wall 112 and the partition wall 5 of the rear housing 11 are sealingly joined at the respective ends thereof to the valve plate 12. With this configuration, two spaces separated by the partition wall 5 are formed between the rear housing 11 and the valve plate 12. In the first embodiment, of the two spaces separated by the partition wall 5, the radially inner space serves as the discharge chamber 4 and the radially outer space as the suction chamber 2, as shown in FIG. 2. In other words, the suction chamber 2 is formed so as to surround the discharge chamber 4.

[0013] Referring to FIGS. 1 and 2, the thermal insulator 6 which is formed by curing a thermal insulation coating composition is provided on both surfaces of the partition wall 5, namely the surface facing the discharge chamber 4 and the surface facing the suction chamber 2. In the first embodiment, the thermal insulation coating composition has the following composition. The ratios of the components shown below were used in the preparation of the thermal insulation coating composition.

[0014] Composition of the thermal insulation coating composition

Hollow beads: sodium aluminosilicate glass 28 percent by mass (average particle diameter 29 μm , specific gravity 0.12 g/cm^3)

Binder resin: phenolic resin 50 percent by mass

TiO₂: 22 percent by mass

[0015] The thermal insulation coating composition of the above composition was applied to the above both surfaces of the partition wall 5. Then the coating composition was heated until cured. The thickness of the resulting film of the cured thermal insulator 6 was 600 μm . In the first embodiment, the chemical compositions are the same between the thermal insulation coating composition and the thermal insulator 6.

[0016] The compressor 1 will be described further in detail with reference to FIG. 1.

[0017] The compressor 1 further includes a drive shaft 15. The drive shaft 15 extends through the cylinder block 13 and rotatably supported by bearings 150 mounted in the front housing 14 and the cylinder block 13. The drive shaft 15 receives at the front end thereof a drive force transmitted from an engine (not shown) through a pulley or the like (not shown either) to be driven to rotate.

[0018] The interior space of the front housing 14 serves as a crank chamber 7 of the compressor 1. A lug plate 71 and a swash plate 72 are mounted on the drive shaft 15 in the crank chamber 7. The lug plate 71 is disposed in the front part of the crank chamber 7 and fixed on the drive shaft 15 for rotation therewith. The lug plate 71 is rotatably supported by the bearing 150 which is mounted on a front end wall 141 of the front housing 14 (see FIG. 1).

[0019] The swash plate 72 is disk-shaped and mounted on the drive shaft 15 in an inclinable manner with respect to the axis of the drive shaft 15. The swash plate 72 has at the center thereof a hole 721 through which the drive shaft 15 is passed. The swash plate 72 is coupled with the lug plate 71 via a link mechanism 711. The swash plate 72 is rotatable in synchronization with the drive shaft 15 and the lug plate 71 via the link mechanism 711.

[0020] The swash plate 72 has on the opposite surfaces thereof at positions adjacent to the outer peripheral edge thereof a plurality of pairs of front and rear shoes 73. The pairs of shoes 73 are mounted so as to slidably hold therebetween the swash plate 72 and slidably fitted in the rear ends of cylindrical pistons 74 (see FIG. 1). The pairs of shoes 73 are moved back and forth by the rotation of the swash plate 72, and the pistons 74 are reciprocated back and forth by the reciprocating motion of the pairs of shoes 73.

[0021] The cylinder block 13 has therein a plurality of compression chambers 3, in each of which refrigerant gas introduced from the suction chamber 2 is compressed by the pistons 74. The compression chambers 3 are defined by the valve plate 12, the cylinder block 13 and the pistons 74, and disposed around the drive shaft 15. Although not shown, the compression chambers 3 are substantially cylindrical and extend in the cylinder block 13 in the longitudinal direction. The pistons 74 reciprocate as described above and vary the internal volume of the compression chambers 3, thereby compressing the refrigerant introduced into the compression chambers 3.

[0022] The valve plate 12 has therethrough suction ports 121 through which the suction chamber 2 is communicable with the compression chambers 3 (see FIG. 1) and discharge ports 122 through which the compression chamber 3 is communicable with the discharge chamber 4 (see FIG. 1).

[0023] The compressor 1 uses polyalkylene glycol as the lubricant for enhancing the lubrication of the sliding part of the pistons 74, the pairs of shoes 73 and the other parts.

[0024] The following will describe the operation of the compressor 1 configured as described above. The compressor 1 according to the first embodiment is adapted for use in an air conditioning system of an automobile. Compression of refrigerant gas is accomplished by the suction, compression and discharge phases of the pistons 74 in the respective compression chambers 3. Low-temperature refrigerant gas supplied from outside of the compressor 1 is introduced into the suction chamber 2 through an inlet port 113 formed in the outer peripheral wall 112 of the rear housing 11 (see FIG. 1).

[0025] Refrigerant gas in the suction chamber 2 passes through the suction port 121 and is drawn into the compression chamber 3 which is in the suction phase. In the compression chamber 3 in the suction phase, the piston 74 moves toward the front with the suction port 121 opened and the discharge port 122 closed, so that the volume in the compression chamber 3 increases and the refrigerant gas in the suction chamber 2 is introduced to the compression chamber 3 through the suction port 121.

[0026] Subsequently, the compression of the refrigerant gas in the compression chamber 3 is performed by the piston 74 moving rearward in the compression chamber 3 with the suction port 121 and the discharge port 122 both closed so that the volume in the compression chamber 3 is reduced and the refrigerant gas in the compression chamber 3 is compressed.

[0027] In the compression phase, the temperature of the compressed refrigerant gas reaches a predetermined temperature, and then discharging is performed. During the discharging, the suction port 121 is closed and the discharge port 122 is open and the volume of the compression chamber 3 is reduced with the movement of the piston 74 toward its top dead center. The compressed high-temperature refrigerant gas is discharged into the discharge chamber 4 through the discharge port 122. The refrigerant gas discharged into the discharge chamber 4 is supplied to the external circuit of the compressor 1 through an outlet port 114 formed through the rear end wall 111 of the rear housing 11 (see FIG. 1).

[0028] The following will describe advantageous effects of the compressor 1 according to the first embodiment. In the compressor 1 having the thermal insulator 6 on the opposite surfaces of the partition wall 5 separating the suction chamber 2 from the discharge chamber 4, heat of the refrigerant gas discharged into the discharge chamber 4 is prevented from being easily transferred to the suction chamber 2 that is located adjacent to the discharge chamber 4, with the result that the temperature rise of the refrigerant gas in the suction chamber 2 is suppressed easily and the compression efficiency is enhanced accordingly.

[0029] The thermal insulator 6 also includes the hollow beads. Each hollow bead has a shell having therein a hollow space. The presence of such spaces created easily within the thermal insulator 6 by mixing the hollow beads in the thermal insulator 6 provides high thermal insulation property to the thermal insulator 6 reliably. As a result, the temperature rise of the refrigerant gas in the suction chamber 2 is suppressed easily, and the compression efficiency is improved further.

[0030] The phenolic resin is selected for the binder resin. The phenolic resin is highly heat resistant and durable against refrigerant gas and lubricant. Therefore, the thermal insulator 6 when applied to the compressor 1 is less susceptible to deterioration.

[0031] The sodium aluminosilicate glass which is used for the hollow beads enhances the strength and the heat resistance of the hollow beads. As a result, the compressor 1 is more excellent both in compression efficiency and reliability.

[0032] The compressor 1 uses as the lubricant the polyalkylene glycol which is suitable for lubrication of the compressor

1 in that it offers good lubricating properties, heat resistance, cold fluidity, and flame retardancy. As a result, the compressor 1 is excellent both in compression efficiency and reliability.

[0033] The thermal insulator 6 is provided on both surfaces of the partition wall 5 facing the discharge chamber 4 and facing the suction chamber 2, respectively. The thermal insulator 6 that is provided on the surface of the partition wall 5 facing the discharge chamber 4 prevents direct contact between the partition wall 5 and the refrigerant gas discharged from the compression chamber 3 into the discharge chamber 4, so that heat of the compressed refrigerant gas is prevented from being transferred easily through the partition wall 5.

[0034] The thermal insulator 6 that is provided on the surface of the partition wall 5 facing the suction chamber 2 prevents easy temperature rise of the refrigerant gas in the suction chamber 2 as compared with the case in which the thermal insulator 6 is provided on only one surface of the partition wall 5. As a result, the compressor 1 is more excellent in compression efficiency.

[0035] The suction chamber 2 is formed radially outward of the discharge chamber 4 in the rear housing 11. Therefore, the temperature rise of the refrigerant gas in the suction chamber 2 created when the refrigerant gas stays in contact with the partition wall 5 for a relatively long time is suppressed more effectively. As a result, the compressor 1 is excellent in compression efficiency.

[0036] According to the first embodiment, the thermal insulation coating composition used for the compressor 1 contains TiO_2 (Titanium dioxide) having a high infrared reflectance and hence being capable of readily reflecting the infrared rays emitted from high-temperature refrigerant gas which is discharged into the discharge chamber 4. Therefore, by providing the thermal insulator 6 containing the TiO_2 , the heat transfer by radiation from the refrigerant gas to the partition wall 5 and hence the temperature rise of the refrigerant gas in the suction chamber 2 is suppressed easily and effectively. As a result, the compressor 1 is excellent in compression efficiency.

[0037] The above-described compressor 1 having excellent compression efficiency and reliability can be made smaller in size readily and has high reliability required for use in a vehicle. Thus, the compressor 1 is highly applicable to a vehicle air conditioning system.

[0038] The following will describe a second embodiment according to the present invention. In the second embodiment, evaluations were made on the thermal insulator 6 in the compressor 1 of the first embodiment by changing the binder resin in the test operation of the compressor 1. In the second embodiment, three different thermal insulation coating compositions containing phenolic resin, polyamide-imide resin and epoxy resin, respectively, were prepared. The polyamide-imide resin and the epoxy resin were used as an alternative to the phenolic resin used in the first embodiment. The thermal insulators 6 formed by curing the thermal insulation coating compositions were applied to the partition wall 5 of the compressors 1 in the same manner as in the first embodiment. Thus three different compressors 1 which use phenolic resin, polyamide-imide resin and epoxy resin, respectively, were prepared.

[0039] The three compressors 1 thus prepared were individually connected in an air conditioning system of a vehicle and operated at 2,500 rpm for 24 hours, using R134a as the refrigerant. As the testing conditions for the compressors 1, a pressure of 0.2 MPaG was used for the suction chamber 2 and a pressure of 2.5 MPaG was used for the discharge chamber 4, respectively.

[0040] After the testing operation, the rear housings 11 were removed from the respective compressors 1 and a visual check was made on each of the compressors 1 for peel-off of the thermal insulator 6. The results showed that there was no peel-off of the thermal insulator 6 in any of the compressors 1. It can be appreciated from the results that the use of phenolic resin, polyamide-imide resin, or epoxy resin as the binder resin enhances the reliability of the thermal insulator 6 and hence the reliability of the compressor 1.

[0041] The polyimide resin has an imide linkage like the polyamide-imide resin. The imide linkage is very strong and, therefore, the polyimide resin is highly heat resistant and durable against refrigerant gas and lubricant, like the polyamide-imide resin. It is expected therefore that, when the polyimide resin is used as the binder resin, the reliability of the thermal insulator 6 is enhanced and the compressor 1 increases its reliability.

[0042] The following will describe the third embodiment according to the present invention. In the third embodiment, evaluations were made on the compressors 1 of the first embodiment as to the compression efficiency and the reliability. The thermal insulator 6 used in the third embodiment contains hollow beads with a breaking strength of 8 MPa. Other conditions conform to the first embodiment. The breaking strength of the hollow beads was determined as follows.

Measurement of the breaking strength of the hollow beads

[0043] The hollow beads were placed on a planar plate. Then a compression tool having at the tip thereof a flat end face was moved downward at the speed of $2 \mu\text{m}/\text{sec}$. The downward movement of the compression tool was continued even after the end face of the compression tool contacted the hollow beads, while maintaining the moving speed, and the load occurring when the hollow beads were broken was measured. Using the values of the measured loads and the shell thickness of the hollow beads, the stress applied to the hollow beads at the time of breaking was calculated to determine the breaking strength.

Evaluation

[0044] The compressor 1 configured as described above was connected in an air conditioning system of a vehicle and operated for 180 minutes using R134a as the refrigerant and temperatures were measured at the inner wall of the suction chamber 2 during the operation of the compressor 1 and also when the compressor 1 entered a steady state. After the operation, the rear housing 11 was removed from the compressor 1 and a visual check was made for peel-off of the thermal insulator 6. The above evaluation was performed for each of the three different rotational speeds shown in Table 1. The results are shown in Table 1 and FIG. 3. As the operating conditions for the compressor 1, a pressure of 0.2 MPaG was used for the suction chamber 2 and a pressure of 1.5 MPaG was used for the discharge chamber 4, respectively. It is to be noted that, in the compressor including the test body 2 shown in Table 1 and FIG. 3, the thermal insulator 6 was not provided on the rear housing 11. However, the compressor 1 including the test body 2 had the same configuration as the compressor 1 including the test body 1 in other respects, and the test bodies 1 and 2 were evaluated under the same conditions.

[Table 1]

	Rotational speed (rpm)	Temperature in suction chamber (°C)	Thermal insulation coating
Test body 1 (with thermal insulation coating)	1,000	27.50	Not peeled off
	1,800	25.40	Not peeled off
	3,000	25.50	Not peeled off
Test body 2 (no coating)	1,000	36.20	-
	1,800	33.70	-
	3,000	35.10	-

[0045] As can be seen from Table 1 and FIG. 3, the temperatures in the suction chamber 2 of the test body 1 provided with the thermal insulator 6 were lower than those of the test body 2 at any of the rotational speeds. It is therefore assumed that, heat is prevented from being easily transferred from the discharge chamber 4 to the suction chamber 2 in the test body 1 due to the effect of the thermal insulator 6. Accordingly, the temperature of the refrigerant gas in the suction chamber 2 can be maintained at a low level, so that refrigerant gas with a higher density can be introduced into the compression chamber 3 during the suction phase. As a result, the compression efficiency of the compressor 1 is enhanced further.

[0046] As can be seen from Table 1, no peel-off was observed on the thermal insulator 6 of the test body 1 at any of the rotational speeds. The thermal insulator 6 of the above composition has a high reliability, thus contributing to reliability of the compressor 1.

[0047] The hollow beads have a breaking strength of 3 MPa or more that is high enough for the hollow beads to resist breakage due to an external force such as pressure exerted by the refrigerant gas or pressure due to the heat-expanded binder resin. Therefore, the hollow beads in the thermal insulator 6 can well maintain the hollow shape during the operation of the compressor 1, so that the thermal insulator 6 offers excellent thermal insulation property. Furthermore, the strength of the hollow beads prevents generation of fragments due to any breakage of the hollow beads, which gives the thermal insulator 6 a high reliability. As a result, the compressor 1 is excellent both in compression efficiency and reliability.

[0048] The following will describe the fourth embodiment according to the present invention. FIGS. 4 and 5 illustrate a compressor 1 according to the fourth embodiment in which a discharge chamber 4 is formed so as to surround a suction chamber 2 in the rear housing 11. As shown in FIG. 4, a thermal insulator 6 is provided on both surfaces facing the discharge chamber 4 and facing the suction chamber 2, respectively, and also on the inner rear end wall 111 of the rear housing 11. The rest of the structure of the compressor 1 of the fourth embodiment is substantially identical to the corresponding structure of the compressor 1 according to the first embodiment. It is to be noted that same reference numerals are used in FIGS. 4 and 5 for common elements or components in the fourth and the first embodiments, unless otherwise specified.

[0049] The compressor 1 described above was connected in an air conditioning system of a vehicle, and experiments were performed in the same manner as the third embodiment for the temperature at the inner wall of the suction chamber 2 and the reliability of the thermal insulator 6. The results are shown in Table 2 and FIG. 6. It is to be noted that, in the compressor 1 including the test body 12 shown in Table 2 and FIG. 6, the thermal insulator 6 was not provided on the rear housing 11. However, the compressor 1 including the test body 12 had the same configuration as the compressor

1 including the test body 11 in other respects, and the test bodies 11 and 12 were subjected to the same conditions.

[Table 2]

	Rotational speed (rpm)	Temperature in suction chamber (°C)	Thermal insulation coating
Test body 11 (with thermal insulation coating)	1,000	26.70	Not peeled off
	1,800	22.20	Not peeled off
	3,000	21.70	Not peeled off
Test body 12 (no coating)	1,000	31.80	-
	1,800	26.30	-
	3,000	23.90	-

[0050] As can be seen from Table 2 and FIG. 6, the compressor 1 having the discharge chamber 4 formed so as to surround the suction chamber 2 provides the same effect of thermal insulator 6 as the second embodiment. It is therefore assumed that the provision of the thermal insulator 6 prevents heat from being transferred easily from the discharge chamber 4 to the suction chamber 2.

[0051] The following will describe the fifth embodiment according to the present invention with reference to FIG. 7. The fifth embodiment differs from the first embodiment in that the partition wall 5 is double-walled, including two walls. Specifically, the partition wall 5 provided in the rear housing 11 is formed by a suction chamber wall 51 disposed on the suction chamber 2 side and a discharge chamber wall 52 disposed on the discharge chamber 4 side, as shown in FIG. 7. The suction chamber wall 51 and the discharge chamber wall 52 are spaced apart from each other and filled with a thermal insulator 6 therebetween. It is to be noted that same reference numerals are used in FIG. 7 for the common elements or components in the fifth and the first embodiments, unless otherwise specified.

[0052] The thermal insulator 6 is thus provided within the partition wall 5 and does not easily contact with the refrigerant gas or the lubricant, and therefore less susceptible to deterioration. As a result, the reliability of the thermal insulator 6 is enhanced further and the compressor 1 is more reliable.

[0053] Although, in the first to fourth embodiments, the thermal insulator 6 is provided on both surfaces of the partition wall 5 facing the discharge chamber 4 and facing the suction chamber 2, respectively, the compressor according to the present invention is not limited to these embodiments. For example, the thermal insulator 6 may be provided only on the surface of the partition wall 5 facing suction chamber 2, or only on the surface of the partition wall 5 facing the discharge chamber 4. In either case, transfer of heat between the suction chamber 2 and the discharge chamber 4 is suppressed and the effect of enhancing the compression efficiency of the compressor 1 can be expected.

[0054] Furthermore, the thermal insulation coating composition may contain a silane coupling agent in addition to the hollow beads and the binder resin. In such a case, the surface of the hollow beads is modified by the silane coupling agent and the affinity between the hollow beads and the binder resin is enhanced, accordingly. Therefore, the thermal insulator 6 which is formed of the thermal insulation coating composition containing the silane coupling agent becomes less susceptible to peeling off. As a result the compressor 1 improves its reliability.

[0055] The thermal insulation 6 may be prepared by previously coating the hollow beads with the silane coupling agent and then mixing the hollow beads with the thermal insulation coating composition. Alternatively, the silane coupling agent may be directly mixed with the thermal insulation coating composition. In the latter case, the surfaces of the hollow beads and the partition wall 5 are modified by the silane coupling agent, so that the affinity between the binder resin and the partition wall 5 is enhanced further and the thermal insulator 6 is harder to peel off.

[0056] In the compressor described above, the thermal insulator should preferably contain the hollow beads in the range of 10 to 90 percent by mass. With the content of the hollow beads falling within the above range, the thermal insulator offers good thermal insulation property and reliability, so that the compressor operates with an increased compression efficiency and reliability.

[0057] Specifically, when the content of the hollow beads is 10 percent by mass or more, the thermal insulation property of the thermal insulator is enhanced and, therefore, the temperature rise of the refrigerant gas in the suction chamber is suppressed. As a result, the compression efficiency of the compressor is enhanced. For further enhancement of the thermal insulation property of the thermal insulator, the content of the hollow beads should preferably be 10 percent by mass or more, and more preferably 25 percent by mass or more.

[0058] With 90 percent by mass or less of the hollow beads content, the thermal insulator may have sufficiently high content of the binder resin and, therefore, peel-off of a part of the hollow beads or the thermal insulator is prevented effectively. As a result, the reliability of the compressor is enhanced. For further enhancement of the reliability of the

thermal insulator, the content of the hollow beads should preferably be 90 percent by mass or less and more preferably 70 percent by mass or less.

[0059] The average particle diameter of the hollow beads should preferably be 100 μm or smaller and more preferably in the range between 15 μm and 60 μm . The hollow beads may be packed more tightly and distributed more evenly in the thermal insulator with a decrease of the average particle diameter of the hollow beads. As a result, the thermal insulation property of the thermal insulator may be enhanced further. For increasing the amount of the hollow beads packed in the thermal insulator, therefore, the average particle diameter of the hollow beads should preferably be 100 μm or smaller and more preferably 60 μm or smaller.

[0060] Although not specified, the lower limit of the average particle diameter of the hollow beads should preferably be 15 μm or larger. When the average particle diameter is 15 μm or larger, the hollow volume of the hollow beads is sufficiently large, so that the thermal insulation property of the thermal insulator is enhanced further.

[0061] The hollow beads should preferably have a breaking strength of 3 MPa or more. The hollow beads with the breaking strength of 3 MPa or more are strong enough to resist breakage by an external force such as pressure of the refrigerant gas or pressure due to the heat-expanded binder resin. Thus, the hollow shape of the hollow beads in the thermal insulator is well maintained during the operation of the compressor and the thermal insulator is more excellent in thermal insulation property. Furthermore, generation of fragments of the hollow beads is suppressed, which gives the thermal insulator higher reliability. As a result, the compressor operates with a high compression efficiency and reliability.

[0062] Various materials are usable for the hollow beads. The materials for the hollow beads include ceramics such as silica, alumina, flyash and glass, and also a plastic having a high heat resistance.

[0063] The hollow beads should preferably be formed of a sodium aluminosilicate glass. With the use of the sodium aluminosilicate glass, the strength and the heat resistance of the hollow beads are increased.

[0064] As the lubricant for the compressor, polyalkylene glycol or polyol ester may be used. Polyalkylene glycol and polyol ester are excellent in lubricity, heat resistance, cold fluidity, and flame retardancy, thus being suitable as a lubricant for a compressor. Therefore, the compressor is more excellent both in compression efficiency and reliability.

[0065] The thermal insulator should preferably be provided at least on the surface of the partition wall facing the discharge chamber. As described above, the provision of the thermal insulator on at least one surface of the partition wall suppresses transfer of heat from the discharge chamber to the suction chamber. Furthermore, the provision of the thermal insulator on the surface of the partition wall facing the discharge chamber prevents direct contact between the partition wall and the refrigerant gas discharged from the compression chamber into the discharge chamber. With this configuration, heat of the refrigerant gas is prevented from being transferred easily through the partition wall and the temperature rise of the refrigerant gas in the suction chamber is suppressed easily. As a result, the compressor is more excellent in compression efficiency.

[0066] When the thermal insulator is provided on both surfaces of the partition wall facing the discharge chamber and facing the suction chamber, respectively, the effect that the temperature rise of the refrigerant gas in the suction chamber is suppressed is enhanced further.

[0067] The partition wall may be double-walled, including a suction chamber wall disposed on the suction chamber side and a discharge chamber wall disposed on the discharge chamber side. The suction chamber wall and the discharge chamber wall may be spaced from each other and filled with the thermal insulator therebetween. With this configuration, direct contact does not hardly occur between the thermal insulation and refrigerant gas or lubricant, so that the thermal insulation is less susceptible to deterioration. As a result, reliability of the thermal insulation is more enhanced and the compressor is more reliable.

[0068] The suction chamber should preferably be formed so as to surround the discharge chamber. With this configuration, the temperature rise of the refrigerant gas in the suction chamber is suppressed more effectively. As a result, the compressor is more excellent in compression efficiency. Specifically, with such arrangement of the suction chamber and the discharge chamber, the refrigerant gas introduced into the suction chamber flows on the outer peripheral side of the partition wall, so that the refrigerant gas would be in contact with the partition wall for a relatively long time. With the use of the thermal insulator, however, the temperature rise in the partition wall and hence the temperature rise of the refrigerant gas in the suction chamber is suppressed.

[0069] The compressor should preferably be used in a vehicle air conditioning system. Compressors for use in a vehicle such as an automobile are required to be small in size and of high performance for improvement of fuel consumption. Compressors for vehicles are also required to be highly reliable because they are used in harsh environmental conditions involving vibrations and the like. The compressor according to the present invention provides the desired compression efficiency and reliability that meet the above requirements. The compressor can easily be downsized with a high level of reliability required for use in a vehicle. Accordingly, the compressor is suitable for use in a vehicle air conditioning system.

[0070] A compressor has therein a suction chamber into which refrigerant gas is introduced, a compression chamber in which the refrigerant gas in the suction chamber is introduced and compressed, and a discharge chamber into which the compressed refrigerant gas is discharged from the compression chamber. The suction chamber and the discharge

chamber are formed adjacent to each other while being separated by a partition wall. At least one surface of the partition wall is provided with a thermal insulator which is formed by curing a thermal insulation coating composition. The thermal insulator includes hollow beads and one or more binder resin selected from the group consisting of epoxy resin, polyamide-imide resin, phenolic resin, and polyimide resin.

Claims

1. A compressor (1) comprising:

a suction chamber (2) into which refrigerant gas is introduced;
 a compression chamber (3) in which the refrigerant gas in the suction chamber (2) is introduced and compressed;
 and
 a discharge chamber (4) into which the compressed refrigerant gas is discharged from the compression chamber (3), the suction chamber (2) and the discharge chamber (4) being formed adjacent to each other while being separated by a partition wall (5), **characterized in that**
 at least one surface of the partition wall (5) is provided with a thermal insulator (6) which is made by curing a thermal insulation coating composition, and
 the thermal insulator (6) includes hollow beads and one or more binder resins selected from the group consisting of epoxy resin, polyamide-imide resin, phenolic resin, and polyimide resin.

2. The compressor (1) according to claim 1, **characterized in that** the hollow beads have a breaking strength of 3 MPa or more.

3. The compressor (1) according to claim 1 or 2, **characterized in that** the hollow beads comprise a sodium aluminosilicate glass.

4. The compressor (1) according to any one of claims 1 to 3, the compressor (1) using polyalkylene glycol or polyol ester as the lubricant.

5. The compressor (1) according to any one of claims 1 to 4, **characterized in that** the thermal insulator (6) is provided at least on a surface of the partition wall (5) facing the discharge chamber (4).

6. The compressor (1) according to any one of claims 1 to 4, **characterized in that** the partition wall (5) includes a suction chamber wall (51) disposed on the suction chamber (2) side and a discharge chamber wall (52) disposed on the discharge chamber (4) side, the suction chamber wall (51) and the discharge chamber wall (52) being disposed apart from each other and filled with thermal insulator (6) therebetween.

7. The compressor (1) according to any one of claims 1 to 6, **characterized in that** the suction chamber (2) is disposed so as to surround the discharge chamber (4).

8. The compressor (1) according to any one of claims 1 to 7, the compressor (1) being used in a vehicle air conditioning system.

FIG. 1

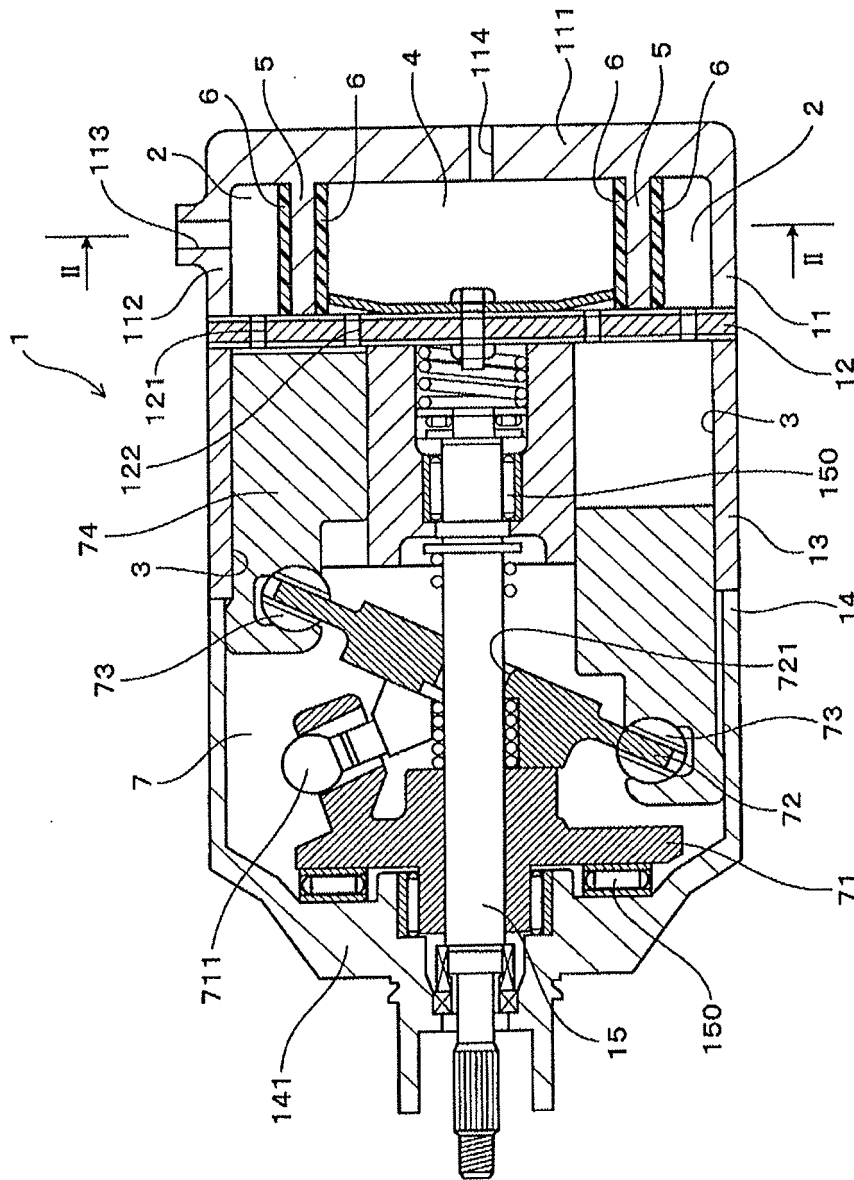


FIG. 2

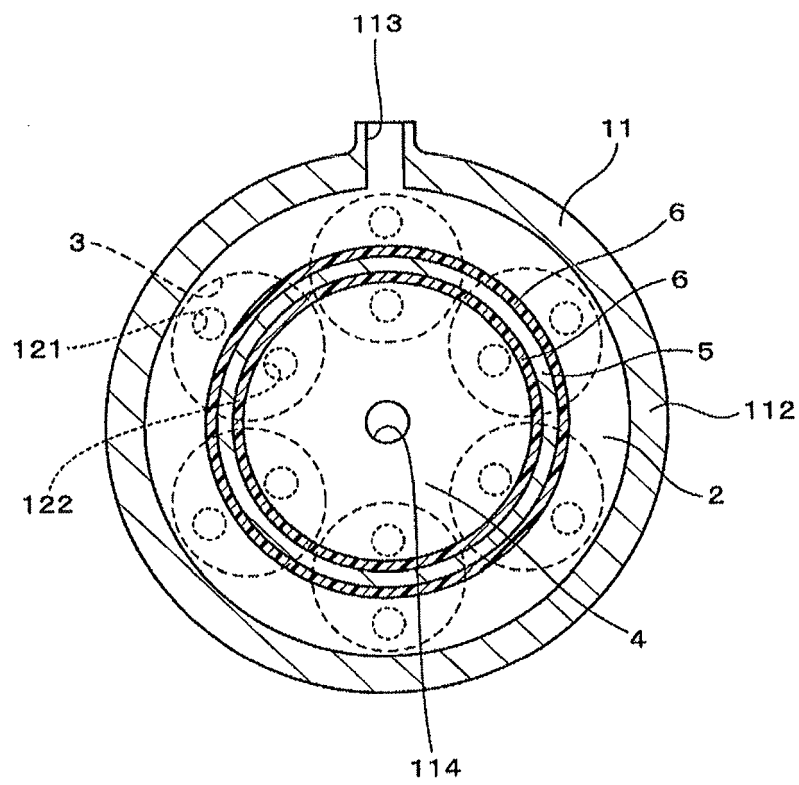


FIG. 3

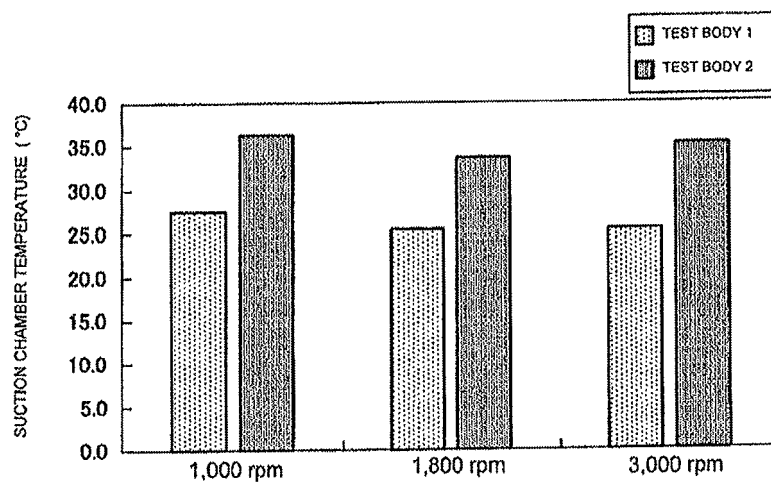


FIG. 4

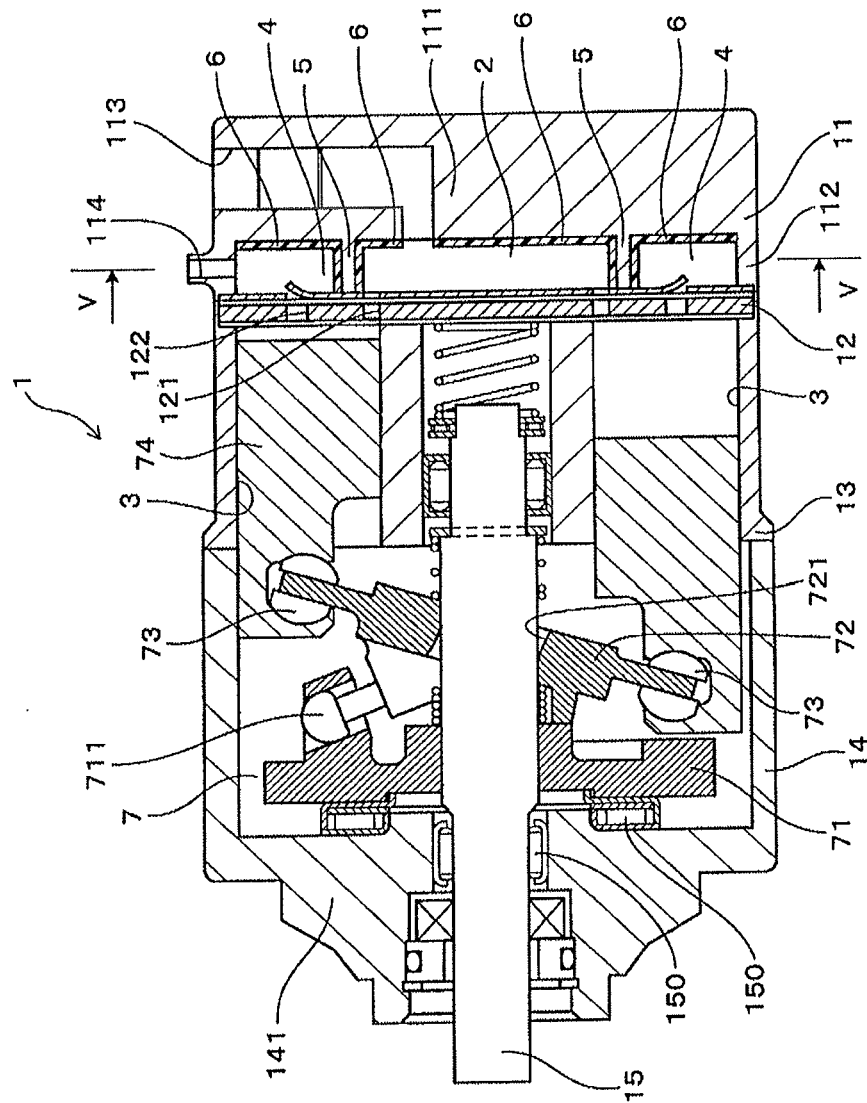


FIG. 5

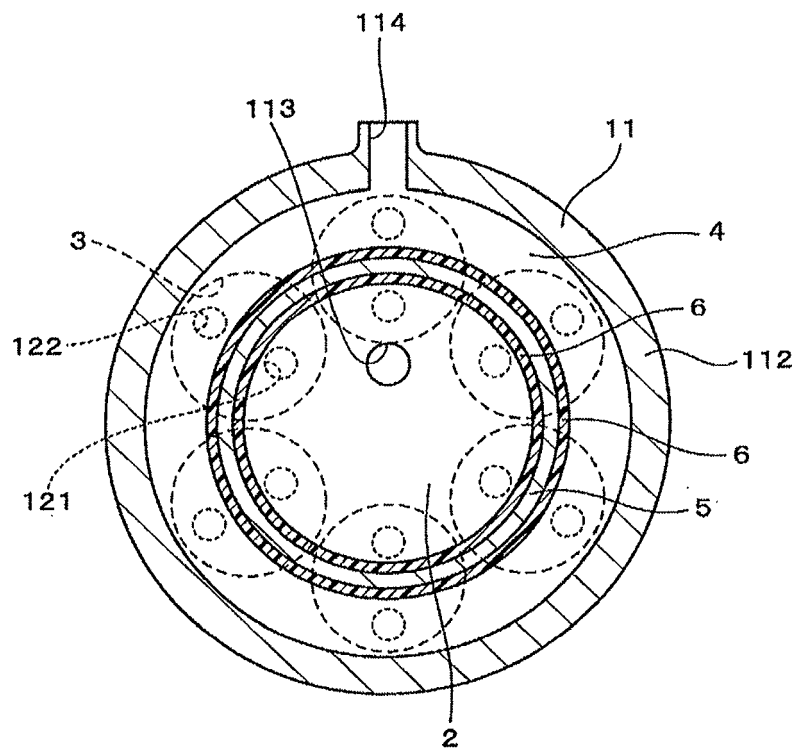


FIG. 6

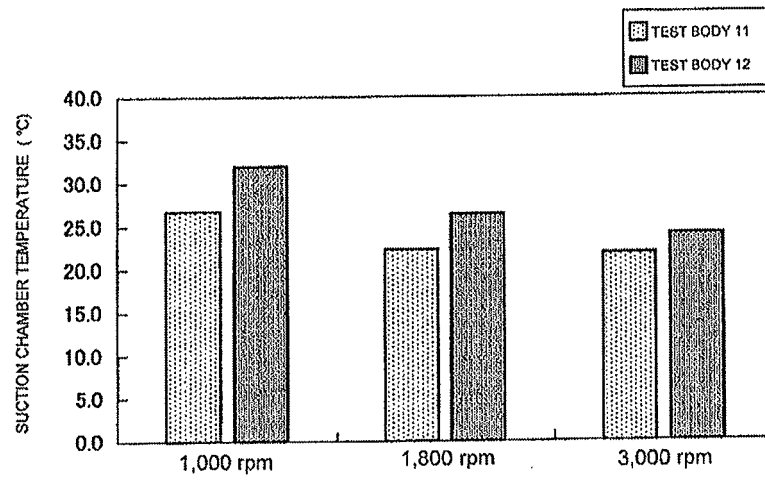
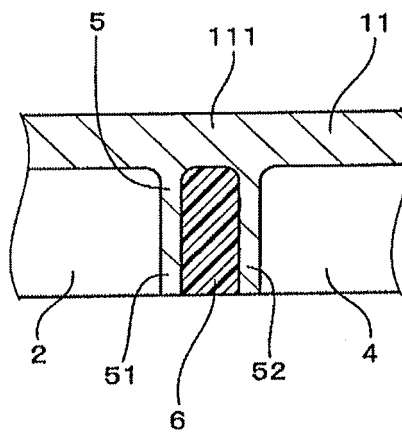


FIG. 7





EUROPEAN SEARCH REPORT

 Application Number
EP 14 16 6957

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