(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 617 504 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.03.2020 Bulletin 2020/10

(21) Application number: **18791980.8**

(22) Date of filing: **26.04.2018**

(51) Int Cl.:
F04B 39/00 (2006.01) ***C10M 101/02*** (2006.01)
C10M 105/06 (2006.01) ***C10M 105/18*** (2006.01)
C10M 105/32 (2006.01) ***C10M 107/34*** (2006.01)
C10N 20/00 (2006.01) ***C10N 20/02*** (2006.01)
C10N 30/00 (2006.01) ***C10N 30/02*** (2006.01)
C10N 40/30 (2006.01)

(86) International application number:
PCT/JP2018/016908

(87) International publication number:
WO 2018/199204 (01.11.2018 Gazette 2018/44)

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

(30) Priority: **28.04.2017 JP 2017089973**

(71) Applicant: **Panasonic Appliances Refrigeration Devices Singapore**
Singapore 469267 (SG)

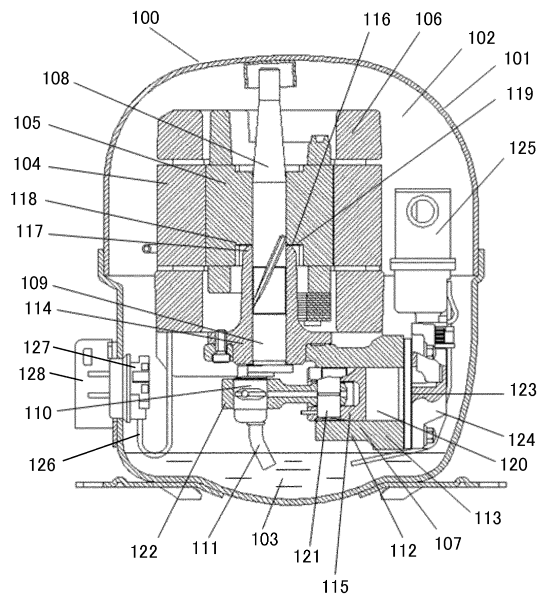
(72) Inventors:
- **OYAGI, Shingo**
  Osaka 571-8501 (JP)
- **KAWABATA, Hirotaka**
  Shiga 525-8555 (JP)
- **HAYASHI, Hiroto**
  Shiga 525-8555 (JP)

(74) Representative: **Thorpe, Aled Daniel**
Marks & Clerk LLP
15 Fetter Lane
London EC4A 1BW (GB)

(54) HERMETICALLY SEALED REFRIGERANT COMPRESSOR AND REFRIGERATION DEVICE USING SAME

(57) A sealed refrigerant compressor (100) includes: a compression element (107) accommodated in a sealed container (101) and configured to compress a refrigerant; and an electric element (106) configured to drive the compression element (107). Lubricating oil (103) is stored in the sealed container (101). The lubricating oil (103) is mixed oil constituted by at least mineral oil and synthetic oil. Kinetic viscosity of the lubricating oil (103) at 40°C falls within a range of 0.1 to 5.1 mm^2/s, and a flash point of the lubricating oil (103) is 110°C or more.

Fig. 1



EP 3 617 504 A1

Description

Technical Field

[0001] The present invention relates to a sealed refrigerant compressor which uses lower-viscosity lubricating oil and has high productivity, and a refrigeration device including the sealed refrigerant compressor.

Background Art

[0002] Highly efficient refrigerant compressors which reduce the use of fossil fuels from the viewpoint of the protection of the global environment have been developed in recent years. For example, in order to increase the efficiency of the refrigerant compressors, proposed is the use of lubricating oil having lower viscosity.

[0003] For example, each of PTLs 1 and 2 discloses a specific composition containing ester, as a freezer lubricating oil composition having low viscosity, high lubricity, and excellent long term stability in a low temperature range. Kinetic viscosity of the lubricating oil composition at 40°C falls within a range of 6 to 28 mm^2/s.

[0004] It is known that when the lubricating oil having lower viscosity is used in the refrigerant compressors, abrasion, seizure, or the like occurs at a slide member constituting a slide portion. Therefore, a technique for giving abrasion resistance to the slide member or the lubricating oil have been proposed.

[0005] For example, PTL 3 discloses that in order to prevent abrasion, seizure, and the like at the slide member when the lubricating oil having low viscosity is used, a piston and connecting rod constituting the slide portion are constituted by iron-based sintered materials and subjected to a steam treatment, a steam layer is cut and removed from the surface of the piston, and the connecting rod is subjected to a nitriding treatment after the steam treatment.

[0006] PTL 3 describes that it is preferable that the kinetic viscosity of the lubricating oil at 40°C fall within a range of 3 to 10 mm^2/s. PTL 3 describes that: when the kinetic viscosity of the lubricating oil is less than 3 mm^2/s, the viscosity of the lubricating oil when the refrigerant melts becomes low, and an oil film is not adequately held; and therefore, lubricity becomes poor, and a seal performance of a compression portion is not kept.

[0007] PTL 4 describes that in order to improve abrasion resistance of freezer oil, a predetermined amount of specific phosphorus compound is added to lubricating oil base oil. PTL 4 describes that it is preferable that the kinetic viscosity of the lubricating oil base oil at 40°C fall within a range of 3 to 300 mm^2/s.

Citation List

Patent Literature

[0008]

PTL 1: Japanese Laid-Open Patent Application Publication No. 2006-160781
PTL 2: Japanese Laid-Open Patent Application Publication No. 2006-328275
PTL 3: Japanese Laid-Open Patent Application Publication No. 2011-021530
PTL 4: Japanese Laid-Open Patent Application Publication No. 2013-203988

Summary of Invention

Technical Problem

[0009] That the lubricating oil having viscosity lower than lower limits of the ranges of the kinetic viscosities disclosed in PTLs 1 to 4 is used as the lubricating oil for the refrigerant compressors have been considered recently.

[0010] When the viscosity of the lubricating oil is lowered, volatility of the lubricating oil becomes high. Therefore, a flash point of the lubricating oil lowers as the viscosity of the lubricating oil lowers. If the flash point of the lubricating oil lowers, more extreme care against fire is required when handling the lubricating oil. In addition, low distillation components contained in the lubricating oil may evaporate first, and this may increase the viscosity of the lubricating oil. Therefore, a special storage condition is required. As above, lowering the viscosity of the lubricating oil leads to deterioration of the handleability of the lubricating oil. As a result, the productivity of the refrigerant compressor also deteriorates.

[0011] As is clear from the fact that PTLs 1 to 4 do not describe the deterioration of the handleability of the lubricating oil and the deterioration of the productivity of the refrigerant compressor due to the deterioration of the handleability of the lubricating oil, such deteriorations have been discussed little.

[0012] The present invention was made to solve the above problems, and an object of the present invention is to provide a sealed refrigerant compressor capable of realizing high productivity even when lubricating oil having lower viscosity is used, and a refrigeration device including the sealed refrigerant compressor.

Solution to Problem

[0013] To solve the above problems, a sealed refrigerant compressor according to the present invention includes: a compression element accommodated in a sealed container and configured to compress a refrigerant; and an electric element configured to drive the compression element. Lubricating oil is stored in the sealed container. The lubricating oil is mixed oil constituted by at least mineral oil and synthetic oil. Kinetic viscosity of the lubricating oil at 40°C falls within a range of 0.1 to 5.1 mm^2/s. A flash point of the lubricating oil is 110°C or more.

[0014] According to the above configuration, the major component (base oil) of the lubricating oil is not the mineral oil but the mixed oil constituted by the mineral oil and the synthetic oil. When mixing the mineral oil and the synthetic oil with each other, the kinetic viscosity is adjusted to fall within the above range, and the lower limit of the flash point is adjusted to become the above value. With this, the lubricating oil having low viscosity and high flash point is obtained, and therefore, the deterioration of the handleability of the lubricating oil can be effectively suppressed. On this account, by using the lubricating oil, the efficiency of the sealed refrigerant compressor can be increased. In addition, even when the lubricating oil having lower viscosity is used, the high productivity can be realized.

[0015] Further, the present invention includes a refrigeration device including the sealed refrigerant compressor configured as above. Therefore, the present invention can provide the refrigeration device having high performance and high productivity.

Advantageous Effects of Invention

[0016] By the above configurations, the present invention has an effect of being able to provide a sealed refrigerant compressor capable of realizing high productivity even when lubricating oil having lower viscosity is used, and a refrigeration device including such sealed refrigerant compressor.

Brief Description of Drawings

[0017]

Fig. 1 is a schematic sectional view showing one example of a typical configuration of a sealed refrigerant compressor according to Embodiment 1 of the present disclosure.

Fig. 2 is a schematic diagram showing one example of a typical configuration of a refrigeration device according to Embodiment 2 of the present disclosure.

Description of Embodiments

[0018] A sealed refrigerant compressor according to the present disclosure includes: a compression element accommodated in a sealed container and configured to compress a refrigerant; and an electric element configured to drive the compression element. Lubricating oil is stored in the sealed container. The lubricating oil is mixed oil constituted by at least mineral oil and synthetic oil. Kinetic viscosity of the lubricating oil at 40°C falls within a range of 0.1 to 5.1 mm^2/s. A flash point of the lubricating oil is 110°C or more.

[0019] According to the above configuration, the major component (base oil) of the lubricating oil is not the mineral oil but the mixed oil constituted by the mineral oil and the synthetic oil. When mixing the mineral oil and the synthetic oil with each other, the kinetic viscosity is adjusted to fall within the above range, and the lower limit of the flash point is adjusted to become the above value. With this, the lubricating oil having low viscosity and high flash point is obtained, and therefore, the deterioration of the handleability of the lubricating oil can be effectively suppressed. On this account, by using the lubricating oil, the efficiency of the sealed refrigerant compressor can be increased. In addition, even when the lubricating oil having lower viscosity is used, the high productivity can be realized.

[0020] In the sealed refrigerant compressor configured as above, a content of the synthetic oil in the lubricating oil may fall within a range of 0.1 to 40.0 wt.% of an entire amount of the lubricating oil.

[0021] According to the above configuration, when the content of the synthetic oil is set to fall within the above range, the kinetic viscosity of the lubricating oil and the lower limit of the flash point of the lubricating oil can be easily adjusted to fall within the above-described respective numerical ranges.

[0022] In the sealed refrigerant compressor configured as above, the synthetic oil may be at least one selected from the group consisting of ester oil, ether oil, polyalkylene glycol oil, and alkyl benzene oil.

[0023] According to the above configuration, by mixing the synthetic oil that is at least one selected from the above group with the mineral oil, the kinetic viscosity of the lubricating oil and the lower limit of the flash point of the lubricating oil can be easily adjusted to fall within the above-described respective numerical ranges.

[0024] In the sealed refrigerant compressor configured as above, at least one of additives that are an extreme pressure additive, an oily agent, an antifoaming agent, and a stabilizing agent may be added to the lubricating oil.

[0025] According to the above configuration, by adding such additive to the lubricating oil, the property of the lubricating oil improves, and the reliability of the sealed refrigerant compressor improves.

[0026] In the sealed refrigerant compressor configured as above, a content of the additive may fall within a range of 0.1 to 4.0 wt.% of the entire amount of the lubricating oil.

[0027] According to the above configuration, by adjusting the content of the additive added to the lubricating oil within the above range, the properties of the lubricating oil can be improved by an appropriate amount of the additive. Therefore, the reliability of the sealed refrigerant compressor can be improved.

[0028] In the sealed refrigerant compressor configured as above, the lubricating oil may have a distillation property in which a distillation range is 200 to 400°C.

[0029] According to the above configuration, when the distillation property of the lubricating oil has the above distillation range, the tendency of the lowering of the flash point of the lubricating oil can be suppressed more effectively, and the stability of the lubricating oil can be made satisfactory. As a result, the handleability of the lubricating oil can be made more suitable.

[0030] Further, a refrigeration device according to the present disclosure includes any one of the sealed refrigerant compressors configured as above. With this, the refrigeration device includes the sealed refrigerant compressor having high efficiency and high productivity, and therefore, the present invention can provide the refrigeration device having high performance and high productivity.

[0031] Hereinafter, typical embodiments of the present disclosure will be described with reference to the drawings. In the following description and the drawings, the same reference signs are used for the same or corresponding members, and a repetition of the same explanation is avoided.

Embodiment 1

Configuration of Refrigerant Compressor

[0032] First, a typical example of a refrigerant compressor according to Embodiment 1 will be specifically described with referent to Fig. 1. Fig. 1 is a schematic sectional view of a refrigerant compressor 100 according to Embodiment 1.

[0033] As shown in Fig. 1, a refrigerant gas 102 is filled in a sealed container 101 of the refrigerant compressor 100, and lubricating oil 103 is stored in a bottom portion of the sealed container 101. In the present disclosure, as described below, for example, a hydrocarbon refrigerant is used as the refrigerant gas 102, and a mixed oil constituted by at least mineral oil and synthetic oil is used as the lubricating oil 103. An electric element 106 and a compression element 107 are accommodated in the sealed container 101. The electric element 106 is constituted by a stator 104 and a rotor 105. The compression element 107 is a reciprocating type driven by the electric element 106.

[0034] The compression element 107 is constituted by a crank shaft 108, a cylinder block 112, a piston 115, and the like. The configuration of the compression element 107 will be described below.

[0035] The crank shaft 108 is constituted by at least a main shaft 109 and an eccentric shaft 110. The main shaft 109 is press-fitted and fixed to the rotor 105. The eccentric shaft 110 is formed eccentrically with respect to the main shaft 109. An oil supply pump 111 communicating with the lubricating oil 103 is provided at a lower end of the crank shaft 108.

[0036] The cylinder block 112 is made of cast iron. The cylinder block 112 forms a substantially cylindrical bore 113 and includes a bearing 114 supporting the main shaft 109.

[0037] The rotor 105 includes a flange surface 116, and an upper end surface of the bearing 114 is a thrust surface 117. A thrust washer 118 is inserted between the flange surface 116 and the thrust surface 117 of the bearing 114. The flange surface 116, the thrust surface 117, and the thrust washer 118 constitute a thrust bearing 119.

[0038] The piston 115 is loosely fitted into the bore 113 with a certain amount of clearance and is made of an iron-based material. The piston 115 forms a compression chamber 120 together with the bore 113. The piston 115 is coupled to the eccentric shaft 110 by a connecting rod 122 as a coupler through a piston pin 121. An end surface of the bore 113 is sealed by a valve plate 123.

[0039] A head 124 forms a high pressure chamber. The head 124 is fixed to the valve plate 123 at an opposite side of the bore 113. A suction tube (not shown) is fixed to the sealed container 101 and connected to a low-pressure side (not shown) of a refrigeration cycle. The suction tube introduces the refrigerant gas 102 into the sealed container 101. A suction muffler 125 is sandwiched between the valve plate 123 and the head 124.

[0040] A cluster 127 is connected through a lead wire 126 to the stator 104 constituting the electric element 106. A terminal 128 is provided at the sealed container 101 so as to penetrate the sealed container 101 from inside to outside. The cluster 127 is coupled to the terminal 128. With this, electric power is supplied from a commercial power supply (not shown) to the electric element 106.

[0041] The type of the refrigerant gas 102 used in the refrigerant compressor 100 according to the present disclosure is not especially limited, but the above-described hydrocarbon refrigerant is preferably used. Specific examples of the hydrocarbon refrigerant include R290 (propane), R600a (isobutane), R600 (butane), and R1270 (propylene), but the hydrocarbon refrigerant is not especially limited. Typical examples of the hydrocarbon refrigerant include R600a and R290.

[0042] As described below, the refrigerant compressor 100 according to the present disclosure uses the lubricating oil 103 having low viscosity and a high flash point. As described above, the lubricating oil 103 is the mixed oil constituted by the mineral oil and the synthetic oil. The refrigerant gas 102 is used in a refrigerant circuit (refrigeration cycle; see Embodiment 2) including the refrigerant compressor 100. The refrigerant gas 102 and the lubricating oil 103 exist in the sealed container 101 in a state where the refrigerant gas 102 and the lubricating oil 103 can contact and be mixed with each other. Therefore, the refrigerant gas 102 and the lubricating oil 103 can be regarded as constituting a working medium for the refrigeration cycle. The working medium for the refrigeration cycle contains a refrigerant component and a lubricating oil component and may further contain other components.

[0043] In the refrigerant compressor 100 according to the present disclosure, resin members are included as members accommodated in the sealed container 101. The resin members are not especially limited as long as the resin members are constituted by at least resin, i.e., polymer. Typical examples of the resin members include the suction muffler 125, an insulating member attached to the electric element 106, and the cluster 127.

[0044] These resin members may be constituted only by resin (polymer). However, for example, the resin members may be constituted by composite materials containing a different material, such as a fibrous material or a filler, in addition to the resin. The cluster 127 is, for example, a member made of polyester resin containing glass fibers. Similarly, the suction muffler 125 is, for example, a member made of polyester resin containing glass fibers.

[0045] The resin (polymer) constituting the resin member is not especially limited. Specific examples of the resin (polymer) include polyester resin (such as polyethylene terephthalate (PET) and polybutylene terephthalate (PBT)), polyamide (PA), polyphenylene sulfide (PPS), and liquid crystal polymer (liquid crystal polyester (LCP)). Since such resin excels in heat resistance, refrigerant resistance, oil resistance, and the like, such resin is preferably used as the material of the resin member accommodated in the sealed container 101. The resin material constituting the resin member is only required to be one type of resin but may be a polymer alloy (polymer blend) prepared by suitably combining two or more types of resin. Further, a known additive may be contained in the resin constituting the resin member.

[0046] As described above, examples of the different material contained in the resin member include the fibrous material and the filler. Examples of the fibrous material include an aramid fiber, a nylon fiber, a polyester fiber, a glass fiber, and a carbon fiber. However, the fibrous material is not especially limited. Only one type of fibrous material may be used, or two or more types of fibrous materials may be used suitably in combination. The filler is only required to be in the form of particles or powder, but may be in the form of short fibers. In some cases, the fibrous material is regarded as the filler. Specific examples of the filler include inorganic fillers, such as silica, silicate, clay, plaster, alumina, titanium dioxide, talc, and carbon black. However, the filler is not especially limited.

[0047] One example of operations of the refrigerant compressor 100 according to the present disclosure will be described below. First, electric power is supplied from a commercial power supply (not shown) through the terminal 128 and the cluster 127 to the electric element 106, and this rotates the rotor 105 of the electric element 106. The rotor 105 rotates the crank shaft 108, and an eccentric motion of the eccentric shaft 110 drives the piston 115 through the connecting rod 122 as the coupler and the piston pin 121.

[0048] The piston 115 reciprocates in the bore 113, and with this, the refrigerant gas 102 introduced into the sealed container 101 through the suction tube (not shown) is sucked from the suction muffler 125 and compressed in the compression chamber 120. In accordance with the rotation of the crank shaft 108, the lubricating oil 103 is supplied from the oil supply pump 111 to respective slide portions. Thus, the slide portions are lubricated, and the lubricating oil 103 serves as a seal between the piston 115 and the bore 113.

Configuration of Lubricating Oil

[0049] In recent years, in order to further increase the efficiency, measures are being taken, i.e., for example, oil having lower viscosity is used as the lubricating oil 103. As described above, in the present disclosure, the lubricating oil 103 used in the refrigerant compressor 100 is the mixed oil constituted by at least the mineral oil and the synthetic oil. The kinetic viscosity of the lubricating oil 103 (mixed oil) at 40°C falls within a range of 0.1 to 5.1 mm^2/s and is relatively lower than that of conventional oil. In addition, the flash point of the lubricating oil 103 is 110°C or more.

[0050] The lubricating oil 103 according to the present disclosure contains the mineral oil as a major component and the synthetic oil as a subcomponent and may contain other components. Therefore, the lubricating oil 103 according to the present disclosure is a lubricating oil composition containing the mineral oil and the synthetic oil. The content (content rate) of the mineral oil in the lubricating oil 103 is not especially limited, and the content of the mineral oil in the lubricating oil 103 is only required to be set such that the mineral oil is regarded as the "major component" in the entire lubricating oil 103 (lubricating oil composition). Further, the content (content rate) of the synthetic oil in the lubricating oil 103 is not especially limited, and the content of the synthetic oil in the lubricating oil 103 is only required to be set such that: the synthetic oil is regarded as the "subcomponent" in the entire lubricating oil 103 (lubricating oil composition); and the content of the synthetic oil is smaller than the content of the mineral oil.

[0051] When the entire amount of the lubricating oil 103 is regarded as 100 wt.%, the content of the synthetic oil as the subcomponent is only required to fall within, for example, a range of 0.1 to 40.0 wt.%, preferably a range of 1 to 35 wt.%, more preferably a range of 5 to 25 wt.%. Further, the content of the mineral oil as the major component in the lubricating oil 103 is only required to be larger than the content of the synthetic oil. For example, when the content of the synthetic oil is 40.0 wt.% or less of the entire amount of the lubricating oil 103 as described above, the content of the mineral oil is only required to exceed 40.0 wt.% of the entire amount of the lubricating oil 103 and may be, for example, 50 wt.% or more.

[0052] In the present disclosure, the synthetic oil is mixed (blended) with the mineral oil such that the viscosity of the lubricating oil 1 03 is lowered, and in addition, the flash point of the lubricating oil 103 is prevented from lowering. Therefore, when the content of the synthetic oil is set to fall within the above range, the kinetic viscosity of the lubricating oil 103 and a lower limit of the flash point of the lubricating oil 103 can be easily adjusted to fall within the above-described respective numerical ranges.

[0053] The types of the mineral oil and synthetic oil constituting the lubricating oil 103 are not especially limited. General examples of the mineral oil include paraffin mineral oil and naphthenic mineral oil. In the present disclosure, the paraffin mineral oil or the naphthenic mineral oil may be used, or a mixture of the paraffin mineral oil and the naphthenic mineral oil may be used. Further, plural types of paraffin mineral oils having different physical properties may be used in combination. Similarly, plural types of naphthenic mineral oils having different physical properties may be used in combination. Further, a mixture of a combination of different paraffin mineral oils and a combination of different naphthenic mineral oils may be used.

[0054] Specific examples of the synthetic oil include polyalphaolefin oil, alkyl benzene oil, ester oil, ether oil, polyalkylene glycol oil, fluorinated synthetic oil, and silicon synthetic oil. However, the synthetic oil is not especially limited. Only one type of synthetic oil may be selected and mixed with the mineral oil, or a combination of plural types of synthetic oils may be mixed with the mineral oil.

[0055] In the present disclosure, it is preferable to use at least one selected from the group consisting of ester oil, ether oil, polyalkylene glycol oil, and alkyl benzene oil. By mixing at least one of these synthetic oils with the mineral oil, the kinetic viscosity of the lubricating oil 103 and the lower limit of the flash point of the lubricating oil 103 can be easily adjusted to fall within the above-described respective numerical ranges. Further, depending on the type of the synthetic oil, properties other than the kinetic viscosity and the lower limit of the flash point can be given to the lubricating oil 103. For example, when ester oil having polarity is selected as the synthetic oil and mixed with the mineral oil, the polarity can be given to the lubricating oil 103.

[0056] In the present disclosure, the lubricating oil 103 is manufactured by mixing at least the mineral oil and the synthetic oil with each other. With this, as described above, the kinetic viscosity of the lubricating oil 103 at 40°C is adjusted to fall within a range of 0.1 to 5.1 mm^2/s, and the flash point of the lubricating oil 103 is adjusted to 110°C or more. The kinetic viscosity of the lubricating oil 103 at 40°C is not especially limited as long as it falls within the above range. However, a preferable example is that the kinetic viscosity of the lubricating oil 103 at 40°C falls within a range of 0.1 to 4.5 mm^2/s, and a more preferable example is that the kinetic viscosity of the lubricating oil 103 at 40°C falls within a range of 0.1 mm^2/s or more and less than 3.0 mm^2/s. In the present disclosure, the kinetic viscosity is measured based on JIS K2283.

[0057] If the kinetic viscosity of the lubricating oil 103 at 40°C exceeds 5.1 mm^2/s, this does not mean that the viscosity of the lubricating oil 103 is lowered. Therefore, the effect of the increase in the efficiency by the lowering of the viscosity cannot be adequately obtained. In contrast, if the kinetic viscosity of the lubricating oil 103 at 40°C is less than 0.1 mm^2/s, the lubricating effect of the lubricating oil 103 may not be adequately obtained.

[0058] Similarly, in the present disclosure, the lower limit of the flash point of the lubricating oil 103 is not especially limited as long as it is 110°C or more. However, a preferable example is 120°C or more, and a more preferable example is 150°C or more. In the present disclosure, the flash point is measured based on JIS K2265. If the lower limit of the flash point of the lubricating oil 103 is less than 110°C, more extreme care against fire is required when handling the lubricating oil 103. In addition, if a special storage condition is not satisfied, the viscosity of the lubricating oil 103 may increase over time. Therefore, the handleability of the lubricating oil 103 deteriorates.

[0059] Specifically, if the flash point of the lubricating oil 1 03 lowers, the amount of low distillation components contained in the lubricating oil 103 increases. Therefore, if the lubricating oil 103 is stored under a normal condition, the low distillation components contained in the lubricating oil 103 may evaporate first, and this may increase the viscosity of the lubricating oil 103 over time. The general lubricating oil 103 is stored under a low-vacuum and high-temperature condition, such as a 10^{-2}Pa atmosphere and a temperature range of 40 to 60°C. However, if the flash point of the lubricating oil 103 is low, the low distillation components evaporate under such low-vacuum and high-temperature condition, and this increases the viscosity over time. Therefore, a special storage condition using a chemical filter is required.

[0060] It is more preferable that in addition to the range of the kinetic viscosity of the lubricating oil 103 at 40°C and the lower limit of the flash point of the lubricating oil 103, a predetermined distillation property be satisfied. Specifically, it is preferable that the lubricating oil 103 according to the present disclosure have a distillation property in which a distillation range is 200 to 400°C (i.e., a distillation property in which an initial boiling point is 200°C, and an end point is 400°C). In the present disclosure, the distillation property is measured based on JIS K2254.

[0061] Since the mineral oil is basically a mixture of many types of oily substances, the mineral oil has a wide variety of distillation properties. However, since the synthetic oil is basically constituted by one type of synthetic compound (or several types of synthetic compounds), one distillation property is specified (or several distillation properties are specified). Therefore, by mixing the synthetic oil with the mineral oil, the distillation property of the lubricating oil 103 that is the mixed oil can be adjusted to fall within the above distillation range. It should be noted that the mineral oil may be refined so as to also fall within the above distillation range according to need.

[0062] In the present disclosure, when the lubricating oil 103 satisfies a condition that is the distillation property in addition to basic conditions that are the range of the kinetic viscosity at 40°C and the lower limit of the flash point, the amount of the low distillation components contained in the lubricating oil 103 can be made smaller. Therefore, the tendency of the lowering of the flash point of the lubricating oil 103 can be suppressed more effectively, and the stability of the lubricating oil 103 can be made satisfactory. As a result, the handleability of the lubricating oil 103 can be made more suitable.

[0063] As described above, the lubricating oil 103 according to the present disclosure is the lubricating oil composition constituted by the mineral oil and the synthetic oil and may contain a component other than the mineral oil and the synthetic oil. Specific examples of such component include various additives known in the field of the lubricating oil 1 03.

[0064] The additive is not especially limited but is, for example, at least one of an extreme pressure additive, an oily agent, an antifoaming agent, and a stabilizing agent. By adding such additive to the mixed oil constituted by the mineral oil and the synthetic oil, the property of the lubricating oil 103 improves, and the reliability of the refrigerant compressor 100 improves.

[0065] The amount of the additive added (the content of the additive) is not not especially limited. In the present disclosure, the amount of the additive added is only required to fall within a range of 0.1 to 4.0 wt.% of the entire amount of the lubricating oil 103. If the content of the additive is less than 0.1 wt.% of the entire amount of the lubricating oil 103, the amount of the additive added may be too small, and therefore, the effect of the additive may not be adequately obtained, although it depends on the type of the additive. In contrast, if the content of the additive exceeds 4.0 wt.% of the entire amount of the lubricating oil 103, the effect corresponding to the amount of the additive added may not be obtained, although it depends on the type of the additive. In addition, since the content of the additive is excessive, this may influence other physical properties of the lubricating oil 103.

[0066] In the present disclosure, a typical example of the additive is the stabilizing agent. By adding the stabilizing agent, the physical properties of the lubricating oil 103 having the low viscosity and the high flash point can be satisfactorily stabilized. In the present disclosure, examples of the stabilizing agent include an acid capturing agent and fullerene.

[0067] The acid capturing agent is used to prevent a case where the base oil (i.e., the mixed oil constituted by the mineral oil and the synthetic oil) is deteriorated by water or oxygen, and this increases the acid value. By suppressing the deterioration of the mixed oil (base oil) by the addition of the acid capturing agent, the kinetic viscosity of the lubricating oil 103 at 40°C can be effectively prevented from falling outside the above range.

[0068] The specific type of the acid capturing agent is not especially limited, and a known acid capturing agent can be suitably used. Since the fullerene has an effect of suppressing the lowering of the flash point of the lubricating oil 103, the fullerene can be used as a "flash point lowering suppressing agent." Therefore, the lowering of the flash point of the lubricating oil 103 can be further effectively suppressed by the addition of the fullerene.

[0069] The amount of the acid capturing agent and/or fullerene added as the stabilizing agent is only required to fall within a range of 0.1 to 4.0 wt.% of the entire amount of the lubricating oil 103. By adjusting the amount of the stabilizing agent added (i.e., the content of the stabilizing agent) within the above range, the properties of the lubricating oil 103 can be improved by an appropriate amount of stabilizing agent. Therefore, the reliability of the refrigerant compressor 100 can be further improved.

[0070] As above, in the refrigerant compressor 100 according to the present disclosure, the electric element 106, the compression element 107, and the like are accommodated in the sealed container 101, and the lubricating oil 103 is stored in the sealed container 101. The lubricating oil 103 is the mixed oil constituted by at least the mineral oil and the synthetic oil. The kinetic viscosity of the lubricating oil 103 at 40°C falls within a range of 0.1 to 5.1 mm^2/s, and the flash point of the lubricating oil 103 is 110°C or more.

[0071] The base oil of the lubricating oil 103 is not the mineral oil but the mixed oil constituted by the mineral oil and the synthetic oil. When mixing the mineral oil and the synthetic oil with each other, the kinetic viscosity is adjusted to fall within the above range, and the lower limit of the flash point is adjusted to become the above value. With this, the lubricating oil 103 having the low viscosity and the high flash point is obtained, and therefore, the deterioration of the handleability of the lubricating oil 103 can be effectively suppressed. On this account, by using the lubricating oil 103, the efficiency of the refrigerant compressor 100 can be increased. In addition, even when the lubricating oil 103 having lower viscosity is used, the high productivity can be realized.

[0072] In Embodiment 1, the refrigerant compressor 100 is configured such that the electric element 106 is arranged above the compression element 107. However, needless to say, the refrigerant compressor according to the present disclosure may be configured such that the electric element 106 is arranged under the compression element 107. When a refrigerant compressor to which the present disclosure is applicable is configured to be able to use the above-described lubricating oil 103, such refrigerant compressor can obtain the same operational advantages as Embodiment 1.

[0073] As described above, in Embodiment 1, the refrigerant compressor 100 is the reciprocating type. However, needless to say, the refrigerant compressor according to the present disclosure is not limited to the reciprocating type and may be a known type, such as a rotary type, a scroll type, or a vibration type. When a refrigerant compressor to which the present disclosure is applicable is configured to be able to use the above-described lubricating oil 103, such refrigerant compressor can obtain the same operational advantages as Embodiment 1.

[0074] In Embodiment 1, the refrigerant compressor 100 is driven by a commercial power supply. However, the refrigerant compressor according to the present disclosure is not limited to this and may be, for example, inverter-driven at a plurality of driving frequencies. Even when the refrigerant compressor is configured as above, high lubricity can be realized by using the above-described lubricating oil 103. Therefore, the reliability of the refrigerant compressor can be improved even at the time of low-speed driving in which the amount of oil supplied to the respective slide portions becomes small or at the time of high-speed driving in which the rotational frequency of the electric element increases.

Embodiment 2

[0075] In Embodiment 2, one example of a refrigeration device including the refrigerant compressor 100 described in Embodiment 1 will be specifically described with reference to Fig. 2. Fig. 2 schematically shows a schematic configuration of a refrigeration device 200 including the refrigerant compressor 100 according to Embodiment 1. Therefore, Embodiment 2 schematically describes a basic configuration of the refrigeration device 200. However, needless to say, the specific configuration of the refrigeration device 200 is not limited to this.

[0076] As shown in Fig. 2, the refrigeration device 200 according to Embodiment 2 includes a main body 206, a partition wall 209, a refrigerant circuit 201 (refrigeration cycle), and the like. The main body 206 is constituted by a heat-insulation box body, a door body, and the like. The box body includes an opening on one surface thereof, and the door body opens and closes the opening of the box body. The inside of the main body 206 is divided by the partition wall 209 into a storage space 207 for articles and a machine room 208. A blower (not shown) is provided in the storage space 207. It should be noted that the inside of the main body 206 may be divided into, for example, spaces other than the storage space 207 and the machine room 208.

[0077] The refrigerant circuit 201 (refrigeration cycle) is configured to cool the inside of the storage space 207 and includes, for example, the refrigerant compressor 100 described in Embodiment 1, a heat radiator 202, a decompressor 203, and a heat absorber 204. The refrigerant compressor 100, the heat radiator 202, the decompressor 203, and the heat absorber 204 are annularly connected to one another by a pipe 205. The heat absorber 204 is arranged inside the storage space 207. As shown by broken line arrows in Fig. 2, cooling heat of the heat absorber 204 is stirred by the blower (not shown) so as to circulate in the storage space 207. With this, the inside of the storage space 207 is cooled.

[0078] As above, the refrigeration device 200 according to Embodiment 2 includes the refrigerant circuit 201 including the refrigerant compressor 100 according to Embodiment 1. As described in Embodiment 1, the efficiency of the refrigerant compressor 100 is increased by using the lubricating oil 103 having the low viscosity and the high flash point. Therefore, the refrigeration device 200 according to Embodiment 2 can reduce power consumption. On this account, energy saving can be realized, and reliability can be improved.

[0079] The refrigeration device 200 described in Embodiment 2 is one example of the refrigeration device according to the present disclosure (i.e., the refrigeration device including the refrigerant compressor according to the present disclosure). Needless to say, the present disclosure is not limited to the refrigeration device 200. Examples of the refrigeration device according to the present disclosure include refrigerators (home use, business use), dehumidifiers, showcases, ice makers, heat pump water heaters, heat pump washing/drying machines, vending machines, and air conditioners.

[0080] The present invention is not limited to the above described embodiments and may be modified in various ways within the scope of the claims, and embodiments obtained by suitably combining technical means disclosed in different embodiments and/or plural modified examples are included in the technical scope of the present invention.

[0081] From the foregoing explanation, many modifications and other embodiments of the present invention are obvious to one skilled in the art. Therefore, the foregoing explanation should be interpreted only as an example and is provided for the purpose of teaching the best mode for carrying out the present invention to one skilled in the art. The structures and/or functional details may be substantially modified within the scope of the present invention.

Industrial Applicability

[0082] The present invention is widely and suitably applicable to the field of refrigerant compressors using lubricating oil having low viscosity and refrigeration device s including such refrigerant compressors.

Reference Signs List

[0083]

100	refrigerant compressor
101	sealed container
102	refrigerant gas
103	lubricating oil
104	stator
105	rotor
106	electric element
107	compression element
200	refrigeration device
201	refrigerant circuit
202	heat radiator
203	decompressor
204	heat absorber
205	pipe

Claims

1. A sealed refrigerant compressor comprising:

a compression element accommodated in a sealed container and configured to compress a refrigerant; and
an electric element configured to drive the compression element, wherein:

lubricating oil is stored in the sealed container;
the lubricating oil is mixed oil constituted by at least mineral oil and synthetic oil;
kinetic viscosity of the lubricating oil at 40°C falls within a range of 0.1 to 5.1 mm^2/s; and
a flash point of the lubricating oil is 110°C or more.

2. The sealed refrigerant compressor according to claim 1, wherein a content of the synthetic oil in the lubricating oil falls within a range of 0.1 to 40.0 wt.% of an entire amount of the lubricating oil.

3. The sealed refrigerant compressor according to claim 1 or 2, wherein the synthetic oil is at least one selected from the group consisting of ester oil, ether oil, polyalkylene glycol oil, and alkyl benzene oil.

4. The sealed refrigerant compressor according to any one of claims 1 to 3, wherein at least one of additives that are an extreme pressure additive, an oily agent, an antifoaming agent, and a stabilizing agent is added to the lubricating oil.

5. The sealed refrigerant compressor according to claim 4, wherein a content of the additive falls within a range of 0.1 to 4.0 wt.% of the entire amount of the lubricating oil.

6. The sealed refrigerant compressor according to any one of claims 1 to 5, wherein the lubricating oil has a distillation property in which a distillation range is 200 to 400°C.

7. A refrigeration device comprising the sealed refrigerant compressor according to any one of claims 1 to 6.

Fig. 1

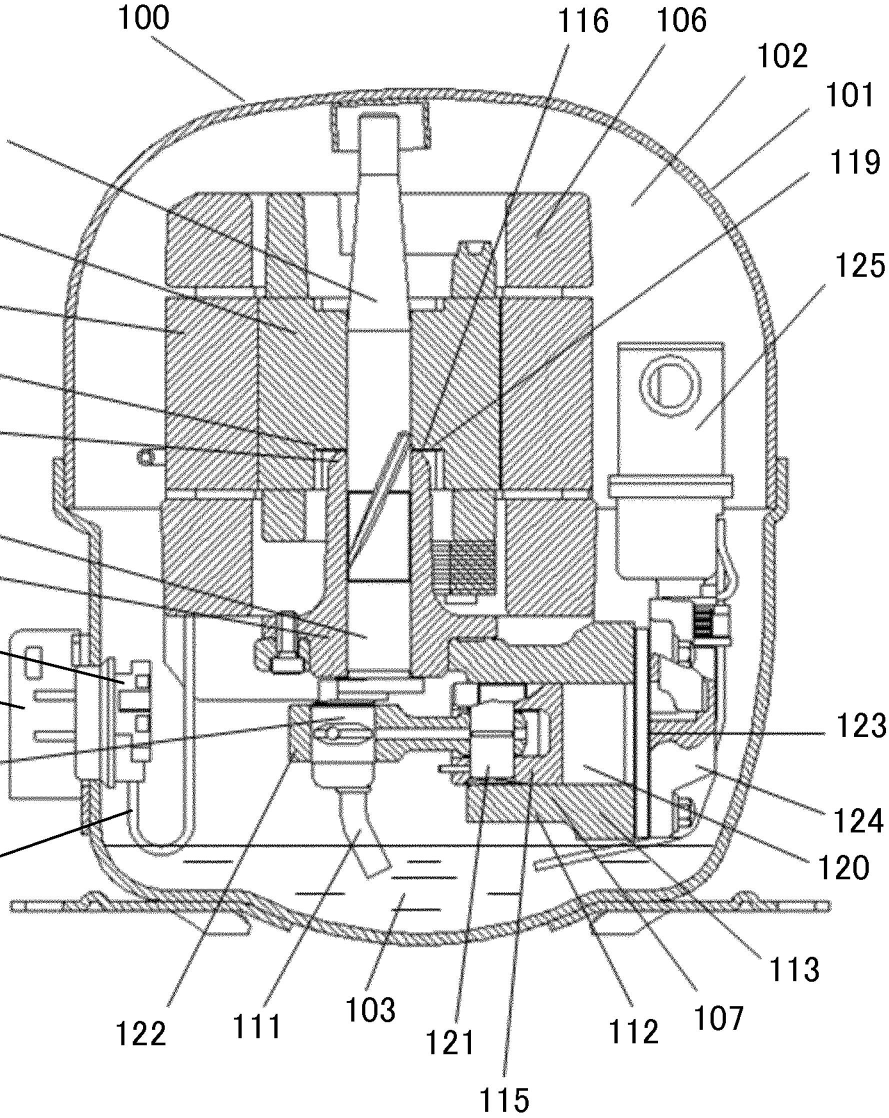
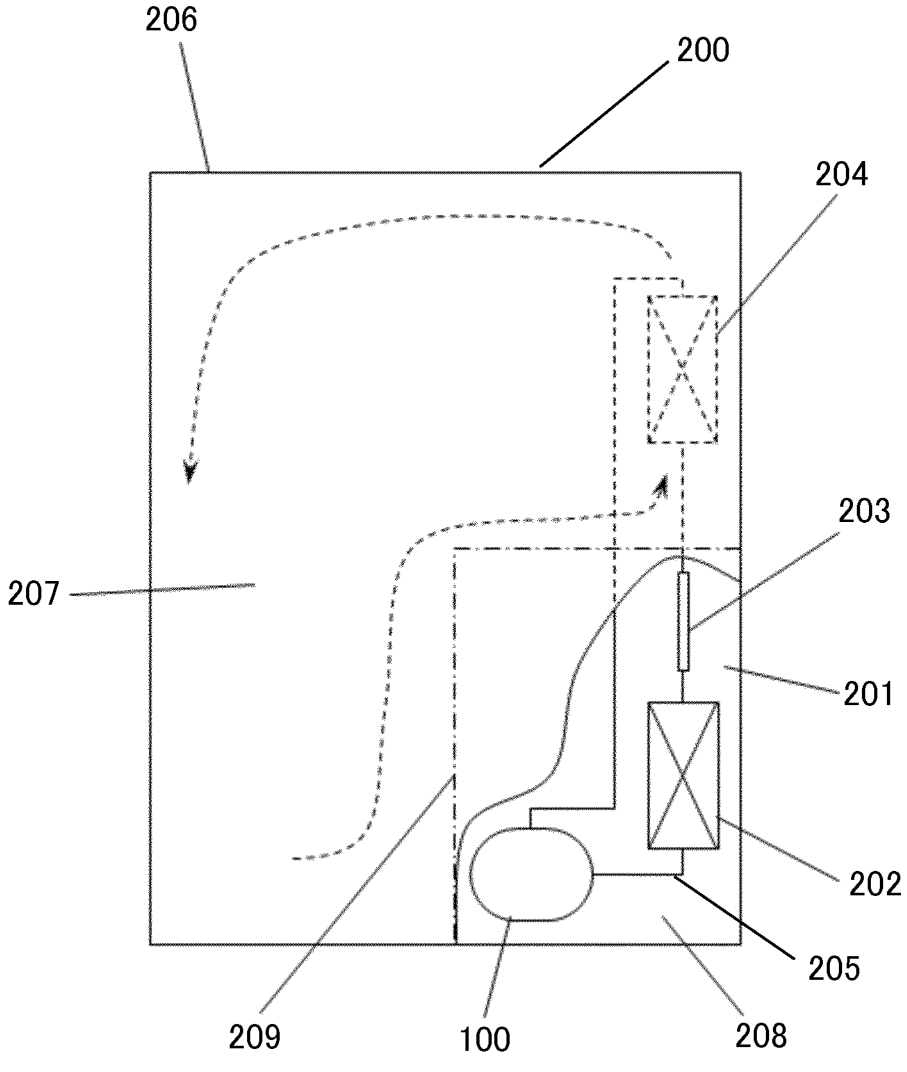

100
116
106
102
101
119
108
105
104
125
118
117
109
114
127
128
123
110
124
126
120
113
122
111
103
121
112
107
115

Fig. 2



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/016908

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04B39/00(2006.01)i, C10M101/02(2006.01)i, C10M105/06(2006.01)i, C10M105/18(2006.01)i, C10M105/32(2006.01)i, C10M107/34(2006.01)i, C10N20/00(2006.01)n, C10N20/02(2006.01)n, C10N30/00(2006.01)n, C10N30/02(2006.01)n, C10N40/30(2006.01)n
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F04B39/00, C10M101/02, C10M105/06, C10M105/18, C10M105/32, C10M107/34, C10N20/00, C10N20/02, C10N30/00, C10N30/02, C10N40/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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 2010-127218 A (PANASONIC CORP.) 10 June 2010, paragraphs [0051], [0054], fig. 1 (Family: none)	1-7
Y	JP 2016-193994 A (IDEMITSU KOSAN CO., LTD.) 17 November 2016, paragraphs [0050]-[0051] & WO 2016/159041 A1	1-7

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
13 July 2018 (13.07.2018)	31 July 2018 (31.07.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/016908

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 2016-190918 A (JX ENERGY CORPORATION) 10 November 2016, paragraph [0028] (Family: none)	1-7
Y A	WO 2017/057614 A1 (KH NEOCHEM CO., LTD.) 06 April 2017, paragraph [0021] (Family: none)	4-5 1-3
Y A	JP 2006-241436 A (NIPPON OIL CORPORATION) 14 September 2006, paragraph [0118] & US 2010/0035777 A1, paragraph [0152]	6-7 1-5

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

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 2006160781 A **[0008]**
- JP 2006328275 A **[0008]**
- JP 2011021530 A **[0008]**
- JP 2013203988 A **[0008]**