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(54) **USE OF A NOISE REDUCTION ADDITIVE IN A REFRIGERATION SYSTEM**

VERWENDUNG EINES ADDITIVS ZUR GERÄUSCHVERMINDERUNG IN EINER KÄLTEMASCHINE
UTILISATION D'UN ADDITIF DE RÉDUCTION DU BRUIT DANS UN SYSTÈME FRIGORIFIQUE

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- **PATENT ABSTRACTS OF JAPAN vol. 1996, no. 10, 31 October 1996 (1996-10-31) -& JP 08 157847 A (JAPAN ENERGY CORP), 18 June 1996 (1996-06-18)**
- **PATENT ABSTRACTS OF JAPAN vol. 018, no. 182 (C-1184), 29 March 1994 (1994-03-29) -& JP 05 339588 A (NIPPON OIL CO LTD; others: 01), 21 December 1993 (1993-12-21)**

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Description

[0001] The present invention relates to use of a phosphate ester additive to reduce noise in and around a refrigerator compressor and.

[0002] One of the driving forces in the refrigeration industry today is manufacture of refrigeration systems, which are more energy efficient. This has led to the introduction of refrigeration systems that have more efficient compressors, which use less energy and run longer. However one undesired side effect of the increase in energy efficiency is that the compressors make more noise.

[0003] Noise reduction in refrigeration compressors has previously been addressed by the addition of additives that generate foam to the refrigeration lubricant. It is thought that the foam dampens compressor noise by reducing the transmission of vibration and noise to the outer shell of the compressor. However this method of noise reduction in compressors has major disadvantages.

[0004] Firstly, excessive foaming of the refrigeration lubricant can result in deleterious effects on the refrigeration system such as exacerbating lubricant carry over where the lubricant is then transported out of the compressor into other parts of the refrigeration system. This can result in lubricant starvation in the compressor, which means the compressor is more susceptible to wear. Furthermore where the lubricant is carried over and coats heat transfer surfaces in the condenser this leads to reduction in heat transfer in the refrigeration system.

[0005] Secondly, the most popular additives, which generate foaming in the refrigeration lubricant, are additives, which contain silicon, and these additives are known to have disadvantages. For example silicon containing additives have been found to block capillary tubes in refrigeration systems. Also additives containing silicon are known to thermally decompose to a powdery solid, which can interfere in the refrigeration process. Therefore care must be taken, for example, when attaching the compressor to the rest of the refrigeration system that there is no residual lubricant and silicon containing additive in the area, which is to be brazed. Silicon containing additives are also known to interfere with painting processes.

[0006] JPH08157847 relates to a lubricating oil composition useful for an air conditioner for an automobile, capable of extremely reducing wear of a bearing and a sliding part of an HFC compressor, stably preventing wear for a long period of time and effectively suppressing formation of sludge, comprising a tri(alkylphenyl) phosphate and triphenyl phosphate as essential components. The composition comprises (A) a mineral oil and/or a synthetic oil as a base oil for a lubricating oil, (B) 0.2-4.0wt. % of one or more of tri(alkylphenyl) phosphates and (C) 0.03-1.5wt. % of triphenyl phosphate.

[0007] EP0435253 relates to a refrigerator oil for use with a hydrogen-containing halogenocarbon refrigerant, comprising at least one kind of an ester selected from the group consisting of a specific pentaerythritol ester such as an ester of pentaerythritol with a mono- or dicarboxylic acid, a specific polyol ester such as an ester of trimethylolethane with a mono- or dicarboxylic acid, a specific ester such as an ester of ethylene glycol and a dicarboxylic acid, and a specific polyol ester synthesized from a neopentyl type polyhydric alcohol, a monocarboxylic acid and a dicarboxylic acid. EP0717098 relates to a refrigerating machine oil for use with a hydrofluorocarbon refrigerant in a refrigerator, which comprises at least one member selected from the group consisting of hydrocarbon compounds. In other embodiments there is disclosed, a fluid composition for use in refrigerating machine which comprises a hydrofluorocarbon refrigerant and at least one hydrocarbon compound, a refrigerating machine which uses therein the fluid composition as a circulating fluid, and a method of lubricating a cooling system of a refrigerator using therein a hydrofluorocarbon refrigerant by using said refrigerator oil in the cooling system.

[0008] EP1314772 relates to a refrigerating machine oil composition comprising an alicyclic dicarboxylic acid ester compound containing an alicyclic ring and two ester groups, the two ester groups bonded to mutually adjacent carbon atoms on the alicyclic ring, wherein the molar ratio of cis-forms and trans-forms for the orientation of the two ester groups of the alicyclic dicarboxylic acid ester compound is from 20/80 to 80/20.

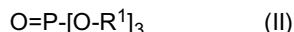
[0009] EP0461262 relates to a refrigerator oil composition for hydrofluorocarbon refrigerants comprising (A) a polyoxyalkylene glycol derivative and/or (B) a polyester compound and (a) a polyalcohol partial fatty acid ester (0.1-10 wt. %) and/or (b) a phosphate compound and/or a phosphite compound (0.1-5 wt. %).

[0010] Triaryl phosphate esters are widely used as antiwear additives in petroleum and synthetic base stock hydraulic fluids, tractor fluids and aircraft turbine and piston engine lubricants. It is widely recognized that the triaryl phosphate esters are most effective at levels of up to 2%, preferably at 1.5% by weight in the lubricant.

[0011] Trialkyl phosphate esters are used principally as components of aircraft hydraulic fluids or as solvents in industrial processes. There is some interest in their use as antiwear additives for applications where the release of phenols from the degradation of the phosphate is to be avoided and they are also used in metal working applications.

[0012] Surprisingly it has been found that addition of a trialkyl phosphate ester additive to a lubricant in the compressor of a refrigeration system reduces noise in and around the compressor with minimal foaming of the lubricant. Furthermore the phosphate ester additive does not contain silicon.

[0013] Accordingly, the present invention provides the use of 0.01% to 10% by weight of a trialkyl phosphate ester additive of formula (II)

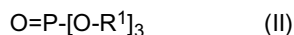


where each R^1 may be the same or different and is chosen from an alkyl group having 1 to 20 carbon atoms, in a compressor lubricant to reduce noise in and around the compressor of a refrigeration system by at least 1dB at a frequency between 0 and 20KHz.

[0014] The refrigeration system comprises a compressor, a condenser, an expansion device and an evaporator. A liquid refrigerant vaporises in the evaporator to provide the required cooling for the refrigeration system. The refrigerant gas then passes to the compressor where it is compressed to condensation pressure. In the condenser a cooling medium, such as water or air, is used to condense the superheated refrigerant gas to a liquid. The liquid refrigerant then passes through an expansion valve to reduce pressure and is returned to the evaporator.

[0015] Noise originates from transfer of energy of various frequencies from their noise source through solid (compressor case and pipe work), liquid (lubricant) and gaseous (refrigerant) media to the shell of the compressor from which pressure waves, i.e. noise, are generated. Noise sources in and around the compressor include suction flow inside the compressor as a result of the flow characteristics of the refrigerant gas, these flow characteristics being themselves determined by the operating conditions of the compressor; noise from the stirring of the lubricant in the compressor which is needed to deliver lubricant to the mechanical parts of the compressor for lubrication; lubricant dripping from the compressor pump and from the top side of the compressor shell and subsequently splashing into the lubricant at the base of the compressor and on to the compressor shell; the motor of the compressor itself and also from the opening and closing of discharge valves. The noise from the various noise sources is at a variety of frequencies, typically ranging from 0.5 to 20kHz. For example the suction flow is typically at 500Hz, the stirring of the lubricant in the compressor is typically at 2.5kHz and dripping and splashing is typically at 5 and 6.3kHz for a Maris DC compressor.

[0016] The phosphate ester additive used in the present invention is a trialkyl phosphate ester of formula (II)



where each R^1 may be the same or different and is chosen from an alkyl group having 1 to 20 carbon atoms, preferably 1 to 10 carbon atoms. Each R^1 may be independently saturated or unsaturated, preferably saturated, and may be independently straight chained or branched.

[0017] The additive is present in the lubricant at levels of 0.01 to 10%, preferably 0.1 to 7%, especially 1 to 5% by weight.

[0018] The noise level in and around the compressor is reduced by at least 1 dB, preferably at least 1.5dB, more preferably at least 2dB.

[0019] To measure the noise level in and around the compressor the compressor is mounted on a steel base in an acoustic chamber.

[0020] The acoustic chamber is specially designed to dampen background noise and vibration. It is constructed out of plasterboard with a piece of fibreglass sandwiched between two sheets of the plasterboard. The inside surface of the inner plasterboard sheet is coated with open cell foam. The acoustic chamber is itself mounted on a rubber mat. The compressor is connected, via vibration free hoses, to the rest of the refrigeration system, which is outside the acoustic chamber, and may be located in a separate room. Appropriate amounts of lubricant plus phosphate ester additive and refrigerant are added to the system. The system is allowed to run for a few minutes to allow the noise level to reach a steady state, as it is expected that the noise level will be high at system start up, before the noise level is measured.

[0021] The noise level is measured using a microphone positioned at a variety of positions, typically 4-5 around the compressor case and the values are averaged. Typical positions for the microphone are one central above the top of the compressor case, one at the front and rear face of the compressor case and one at each side of the compressor case. The distance of the microphone from the compressor is optimized for each compressor under test. Typically the microphone is positioned 5-50 cm from the compressor, particularly 10-30cm. The microphone is attached to a real time fast Fourier transform (FFT) analyser which records the signal at each microphone point over a 20 second time period. The FFT analyser converts the signal over time to a noise measurement and frequency spectrum.

[0022] The presence of the additive leads to minimal foaming of the lubricant in the compressor. Preferably the foam height, determined by bubbling refrigerant gas through lubricant containing 0.01 to 10% by weight phosphate ester additive in a measuring cylinder for 10 minutes is not more than 10mm, more preferably not more than 5mm, specifically not more than 4mm.

[0023] The refrigeration system is set up with a compressor as discussed above. The compressor may also have a sight glass on its front face to enable measurement to be taken of the height of foam generated when the refrigeration system is running where the compressor lubricant contains phosphate ester additive.

[0024] Preferably the foam height, determined by measuring the height of foam in a sight glass on the front face of the compressor of a refrigeration system, is not more than 2.5mm, more preferably not more than 2mm when 0.01 to 10% of phosphate ester additive is added to the compressor lubricant.

[0025] The compressor lubricant is selected from polyalkylene glycols, polyol esters, diesters, carbonate esters, polyvinyl ethers, poly alpha olefins and alkylbenzenes and mixtures thereof. Preferred oils are polyol esters, mixtures of polyol esters with alkyl benzenes, polyvinyl ethers and diesters. Especially preferred oils are polyol esters or mixtures of polyol esters with alkyl benzenes.

[0026] Polyol esters particularly suitable for use in the invention are made from polyhydric alcohols and monobasic carboxylic acids by standard direct esterification methods. They may also be made by transesterification routes. Both routes are described in "Synthetic lubricants and high-performance functional fluids, 2nd edition, edited by L. R Rudnick and R. L. Shubkin, pages 70-71. Particularly preferred are polymerisation routes that do not use a catalyst. Particularly preferred polyol esters are made from one or more alcohols selected from neopentylglycol, trimethylolpropane and pentaerythritol and dimers and trimers thereof and one or more acids selected from linear and/or branched C₅ to C₁₈ acids, particularly C₅ to C₁₃ acids and more particularly C₅ to C₉ acids.

[0027] Preferred polyol esters have a kinematic viscosity of at least 5 cSt but not more than 240 cSt at 40 °C and a kinematic viscosity of at least 1.5 cSt at 100 °C.

[0028] Preferred polyol esters have a pour point of less than -30°C more preferably less than -40°C. Preferred polyol esters have an acid number of less than 0.04 mgKOH/g. Preferred polyol esters have water content of less than 50 ppm. Preferred polyol esters have hydroxyl numbers less than 5 mgKOH/g. Examples of preferred polyol esters include the EMKARATE® RL range of polyol esters available ex Uniqema Ltd, a Business of ICI.

[0029] The compressor lubricant according to the invention also comprises one or more other lubricant additives of known functionality at levels between 0.0001 and 20 weight%, more preferably between 0.01 and 10 weight% more especially between 0.01 and 5 weight% based on the weight of the lubricant. Suitable additives include antioxidants, antiwear additives, extreme pressure agents, acid scavengers, stabilisers, surfactants, viscosity index improvers, corrosion inhibitors, metal deactivators or passivators, lubricity improvers or oiliness agents and friction modifiers.

[0030] The refrigerant in the refrigerant system suitably comprises a hydrochlorofluorocarbon (HCFC), a hydrofluorocarbon (HFC), a blend of refrigerants containing at least one HFC, HCFC or both, carbon dioxide or ammonia. Preferably the refrigerant does not contain any chlorine atoms. In particular the refrigerant gas is a HFC or blend of HFCs. Suitable HFC refrigeration gases include R-134a (1,1,1,2-tetrafluoroethane), R-32 (difluoromethane), R-125 (1,1,1,2,2-pentafluoroethane), R-152a (1,1-difluoroethane), R-143a (1,1,1-trifluoroethane) and mixtures thereof and the R-400 and R-500 series. Other components typically found in refrigerant blends may also be included in the refrigeration gas. These include hydrocarbons, especially hydrocarbons having from 1 to 6 carbon atoms for example propane, isobutane, butane, pentane and hexane, fluorinated hydrocarbons and other refrigerants, for example carbon dioxide. Disclosed are the following reference examples and the accompanying drawing, Figure 1 of which is a schematic drawing of a simple foaming test apparatus, which is described in Example 3 below.

[0031] For Examples 1 and 2 below, noise levels were measured as follows. The compressor was mounted on a steel base in an acoustic chamber. The acoustic chamber is a cube with a length, width and height of 1.5m made from plasterboard, which has a sealed door. The acoustic chamber is constructed out of plasterboard with a 2.54cm thick piece of fibreglass sandwiched between two 0.64cm sheets of the plasterboard. The inside surface of the inner plasterboard sheet is coated with 1.27cm thickness open cell foam. The acoustic chamber is itself mounted on a rubber mat.

[0032] The compressor was connected, via vibration free hoses, to the rest of the refrigeration system, which was outside the acoustic chamber on an adjacent surface. The refrigeration system was evacuated and 235g of polyol ester lubricant containing 5% by weight of the lubricant of phosphate ester additive was "sucked" into the compressor. Then 60g of HFC 134a refrigerant was added to the refrigeration system. The system was allowed to run for a few minutes, typically up to 30 minutes, to allow the noise level to reach a steady state.

[0033] The noise level was measured using a 1.27cm microphone positioned at 5 places around the compressor case (one central above the top of the compressor case, one at the front and rear face of the compressor case and one at each side of the compressor case) and the values averaged. In each case the microphone was 30mm from the compressor case. The microphone was connected to a real time fast Fourier transform (FFT) analyser which recorded the signal at each microphone point over a 20 second time period. The FFT analyser converted the signal over time to a noise measurement (dB) and frequency. The noise measurement was then averaged for the amount of microphone readings taken.

Example 1

[0034] In this Example the compressor used was a Samsung MK compressor. Table 1 below illustrates noise levels measured using this method over a frequency range of 0 to 20. KHz where the compressor lubricant is a polyol ester, Emkarate TM RL10H ex Uniqema, which contains 5% by weight of a range of phosphate esters according to the invention.

[0035] Table 2 below illustrates noise levels measured using this method over a frequency range of 350Hz to 20 KHz where the compressor lubricant is a polyol ester, Emkarate ® RL10H ex Uniqema, which contains 5% by weight of a range of phosphate esters. In each case the presence of the phosphate ester additive according to the disclosure has

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led to a noise reduction in and around the compressor of at least 1dB.

Table 1

Compressor Lubricant	5% by weight of lubricant phosphate ester additive	Noise Level in dB
Emkarate® RL10H		72.6
Emkarate® RL10H	Tricresylphosphate	68.8
Emkarate® RL10H	Durad® 220	71.0
Emkarate® RL10H	Durad® 220x	71.5

Table 2

Compressor Lubricant	5% by weight of lubricant phosphate ester additive	Noise Level in dB
Emkarate® RL10H		43.0
Emkarate® RL10H	Tricresylphosphate	40.7
Emkarate® RL10H	Durad® 220	41.3
Emkarate® RL10H	Durad® 220x	41.4
Durad® 220 is isopropylated triphenyl phosphate and Durad® 220x is trixylenyl phosphate both ex FMC Corporation		

Example 2

[0036] Table 3 illustrates noise levels measured using this method, for a range of compressors over a frequency range of 0 to 20 KHz where the compressor lubricant is a polyol ester from the Emkarate range, which contains 5% by weight of a range of phosphate esters according to the disclosure.

Table 3

Compressor	Compressor Lubricant	5% by weight of phosphate ester additive	Noise Level in dB
Maris DC	Emkarate® RL10H		70.6
	Emkarate® RL10H	Tricresylphosphate	68.9
Electrolux GQY	Emkarate® RL15H		63.0
	Emkarate® RL15H	Tricresylphosphate	58.8
Samsung	Emkarate® RL10H		72.9
	Emkarate® RL10H	Tricresylphosphate	69.6
Atlant75	Emkarate® RL15H		71.5
	Emkarate® RL15H	Tricresylphosphate	69.0
Atlant 160	Emkarate® RL15H		70.4
	Emkarate® RL15H	Tricresylphosphate	71.1
Tecumseh CAJ	Emkarate® RL32H		73.4
	Emkarate® RL32H	Tricresylphosphate	70.8

[0037] For the majority of the different compressor types the presence of the phosphate ester additive according to the disclosure leads to a reduction in the noise level in and around the compressor of at least 1 dB.

Example 3

[0038] The foam height in mm was measured according to a simple foaming test. The apparatus for the foaming test is shown in Figure 1. The water bath (7) was set to 25°C. The canister (6) of 134a refrigerant was placed inside the water bath (7). The needle valve (5) of the canister (6) was opened fully and the system needle valve (5A) positioned next to the rotameter (4) was slowly opened until a flow of 1 litre/min was achieved. The refrigerant was then passed through the sintered glass rod (3) which was suspended in the compressor lubricant (1) containing the phosphate ester additive 5cm from the base of the measuring cylinder (2). The refrigerant was allowed to bubble through the sintered glass rod (3) for 10 minutes. The foam level, if any, was then recorded in mm. The results are presented in Table 4 below.

Table 4

Compressor Lubricant	Phosphate ester additive (% by weight)	Foam	Height of Foam (mm)
Emkarate® RL10H	Tricresylphosphate (0.01%)	No	0
Emkarate® RL10H	Tricresylphosphate (0.1%)	No	0
Emkarate® RL10H	Tricresylphosphate (1%)	No	0
Emkarate® RL10H	Tricresylphosphate (5%)	Yes	2
Emkarate® RL10H	Tricresylphosphate (10%)	Yes	3
Emkarate® RL10H	SynOAd 8478 (0.01%)	No	0
Emkarate® RL10H	SynOAd 8478 (0.1%)	No	0
Emkarate® RL10H	SynOAd 8478 (1%)	No	0
Emkarate® RL10H	SynOAd 8478 (5%)	Yes	1-2
Emkarate® RL10H	SynOAd 8478 (10%)	Yes	2
SynOAd 8478 is t-butylated triphenyl phosphate ex Akzo			

[0039] Table 5 presents results where the lubricant additive is a commercially available silicon containing foaming additive.

Table 5

Compressor Lubricant	Lubricant additive (weight)	Foam	Height of Foam (mm)
Emkarate® RL10H	LN (120ppm)	Yes	20-50
Emkarate® RL10H	LN (200ppm)	Yes	20-50
Emkarate® RL10H	LN (1%)	Yes	Up to 30
Emkarate® RL10H	DC57 (120ppm)	No	0
Emkarate® RL10H	DC57 (200ppm)	No	0
Emkarate® RL10H	DC57 (0.25%)	Yes	70
Emkarate® RL10H	DC57 (1%)	Yes	70
LN is Akrochem 50 a 50cSt polydimethylsiloxane ex Akrochem/silchem. DC57 is a copolymer of a polydimethylsiloxane and a polyoxyalkylene ether (polyether modified polysiloxane) ex Dow.			

Example 4

[0040] The foam height was measured for a refrigeration system as described in Examples 1 and 2. A Samsung compressor was modified to accommodate a sight glass towards the bottom of the front face. The compressor was then connected to the refrigeration system. The refrigeration system was evacuated and 235g of polyol ester lubricant con-

taining lubricant additive was "sucked" into the compressor. Then 60g of HFC 134a refrigerant was added to the refrigeration system. The system was allowed to run for a few minutes, typically up to 30 minutes, to allow the noise level to reach a steady state. The foam height was then measured at the sight glass. The results are presented in Table 6.

Table 6

Compressor Lubricant	Phosphate ester additive (% by wt)	Foam Height (mm)
Emkarate® RL10H		0
Emkarate® RL10H	Tricresylphosphate(0.1%)	0
Emkarate® RL10H	Tricresylphosphate (1%)	0
Emkarate® RL10H	Tricresylphosphate (5%)	0
Emkarate® RL10H	Tricresylphosphate (10%)	0
Emkarate® RL10H	Durad® 220x (55)	0

[0041] Table 7 presents results where the lubricant additive is a commercially available silicon containing foaming additive.

Table 7

Compressor Lubricant	Comparative lubricant additive (by wt)	Foam Height (mm)
Emkarate® RL10H	LN (120ppm)	0
Emkarate® RL10H	LN (250ppm)	5
Emkarate® RL10H	LN (1000ppm)	10

[0042] Both LN and DC57 are known as foaming additives for use in compressors to reduce compressor noise level. Typical levels of addition can be from 100ppm up to 0.5%. The data in Examples 3 and 4 clearly illustrates that use of the phosphate esters according to the disclosure does not lead to excessive foaming, which can result in deleterious effects on the refrigeration system. Such deleterious effects are those that are detailed in the early part of this specification.

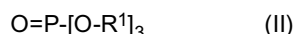
Table 7

Compressor Lubricant	Comparative lubricant additive (by wt)	Foam Height (mm)
Emkarate® RL10H	LN (120ppm)	0
Emkarate® RL10H	LN (250ppm)	5
Emkarate® RL10H	LN (1000ppm)	10

[0043] Both LN and DC57 are known as foaming additives for use in compressors to reduce compressor noise level. Typical levels of addition can be from 100ppm up to 0.5%. The data in Examples 3 and 4 clearly illustrates that use of the phosphate esters according to the disclosure does not lead to excessive foaming, which can result in deleterious effects on the refrigeration system. Such deleterious effects are those that are detailed in the early part of this specification.

Claims

1. Use of 0.01 % to 10% by weight of a trialkyl phosphate ester additive of formula (II)



where each R^1 may be the same or different and is chosen from an alkyl group having 1 to 20 carbon atoms, in a compressor lubricant to reduce noise in and around the compressor of a refrigeration system by at least 1dB at a frequency between 0 and 20KHz.

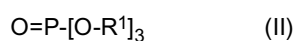
2. Use of a phosphate ester additive in a compressor lubricant according to claim 1 where each R^1 may be the same

or different and is chosen from an alkyl group having 1 to 10 carbon atoms.

3. Use of a phosphate ester additive in a compressor lubricant according to claim 1 or 2 wherein each R¹ is independently saturated or unsaturated, and is independently straight chained or branched.
4. Use of a phosphate ester additive in a compressor lubricant according to claim 3 wherein each R¹ is saturated.
5. Use of a phosphate ester additive in a compressor lubricant according to any one of the preceding claims wherein said additive is present in the lubricant at levels of 0.1 to 7%.
6. Use of a phosphate ester additive in a compressor lubricant according to claim 5 wherein said additive is present in the lubricant at levels of 1 to 5% by weight.

Patentansprüche

1. Verwendung von 0,01 bis 10 Gew.-% eines Trialkylphosphatester-Additivs der Formel (II)

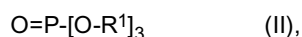


wobei R¹ jeweils gleich oder verschieden sein kann und aus einer Alkylgruppe mit 1 bis 20 Kohlenstoffatomen ausgewählt ist, in einem Kompressor-Schmiermittel zur Verringerung von Lärm in dem und um den Kompressor eines Kälteerzeugungs-systems um mindestens 1 dB bei einer Frequenz zwischen 0 und 20 kHz.

2. Verwendung eines Phosphatester-Additivs in einem Kompressor-Schmiermittel nach Anspruch 1, wobei R¹ jeweils gleich oder verschieden sein kann und aus einer Alkylgruppe mit 1 bis 10 Kohlenstoffatomen ausgewählt ist.
3. Verwendung eines Phosphatester-Additivs in einem Kompressor-Schmiermittel nach Anspruch 1 oder 2, wobei R¹ jeweils unabhängig gesättigt oder ungesättigt und unabhängig geradkettig oder verzweigt ist.
4. Verwendung eines Phosphatester-Additivs in einem Kompressor-Schmiermittel nach Anspruch 3, wobei R¹ jeweils gesättigt ist.
5. Verwendung eines Phosphatester-Additivs in einem Kompressor-Schmiermittel nach einem der vorhergehenden Ansprüche, wobei das Additiv in dem Schmiermittel in Gehalten von 0,1 bis 7 % vorliegt.
6. Verwendung eines Phosphatester-Additivs in einem Kompressor-Schmiermittel nach Anspruch 5, wobei das Additiv in dem Schmiermittel in Gehalten von 1 bis 5 Gew.-% vorliegt.

Revendications

1. Utilisation de 0,01 % à 10 % en poids d'un additif ester trialkylique de l'acide phosphorique de formule (II)



chaque R¹ pouvant être identique ou différent et étant choisi parmi un groupe alkyle ayant 1 à 20 atomes de carbone, dans un lubrifiant pour compresseur pour réduire le bruit dans le compresseur d'un système frigorifique et autour de celui-ci d'au moins 1 dB à une fréquence comprise entre 0 et 20 kHz.

2. Utilisation d'un additif ester de l'acide phosphorique dans un lubrifiant pour compresseur selon la revendication 1, chaque R¹ pouvant être identique ou différent et étant choisi parmi un groupe alkyle ayant 1 à 10 atomes de carbone.
3. Utilisation d'un additif ester de l'acide phosphorique dans un lubrifiant pour compresseur selon la revendication 1 ou 2, chaque R¹ étant indépendamment saturé ou insaturé et étant indépendamment à chaîne droite ou ramifié.

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4. Utilisation d'un additif ester de l'acide phosphorique dans un lubrifiant pour compresseur selon la revendication 3, chaque R¹ étant saturé.
5. Utilisation d'un additif ester de l'acide phosphorique dans un lubrifiant pour compresseur selon l'une quelconque des revendications précédentes, ledit additif étant présent dans le lubrifiant à des niveaux de 0,1 à 7 %.
6. Utilisation d'un additif ester de l'acide phosphorique dans un lubrifiant pour compresseur selon la revendication 5, ledit additif étant présent dans le lubrifiant à des niveaux de 1 à 5 % en poids.

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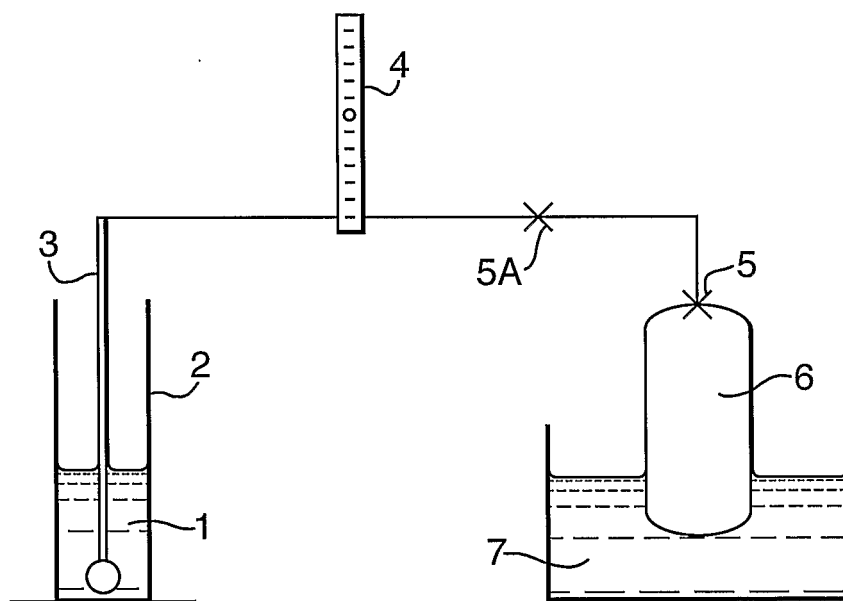
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Fig.1.



REFERENCES CITED IN THE DESCRIPTION

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