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A. L. HENNE ET AL
REFRIGERATION COMPOSITION

2,852,470

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3 Sheets-Sheet 1

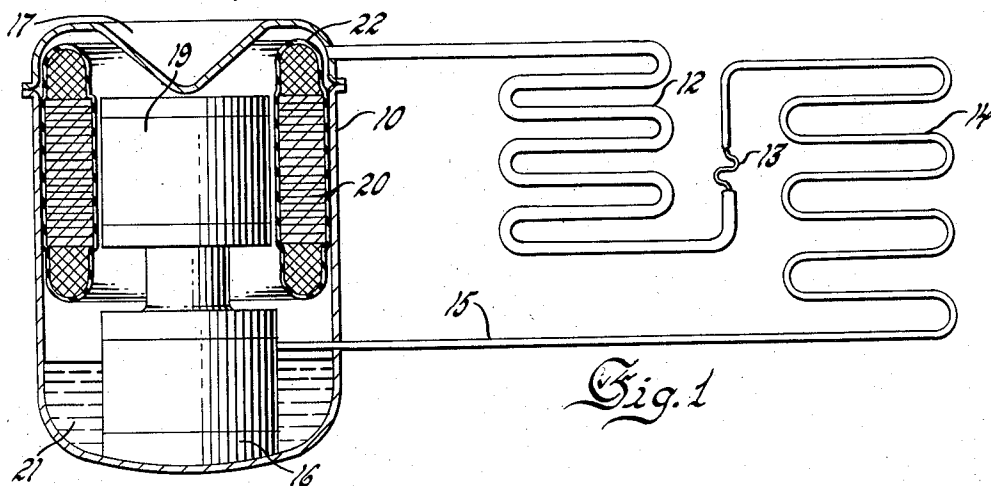


Fig. 1



Fig. 2



Fig. 3

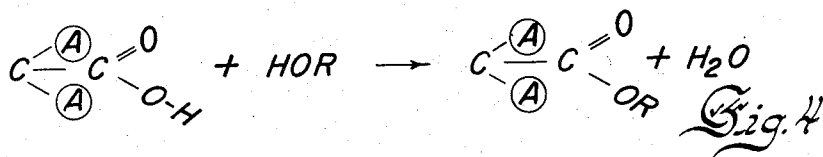


Fig. 4

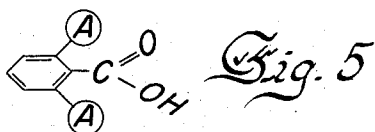


Fig. 5

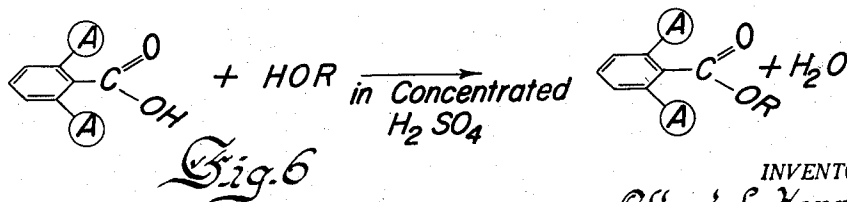


Fig. 6

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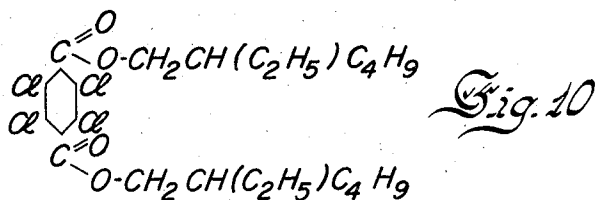
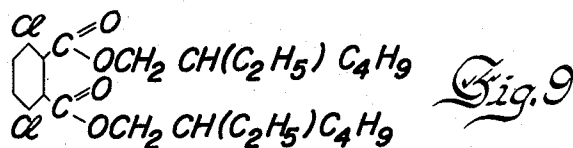
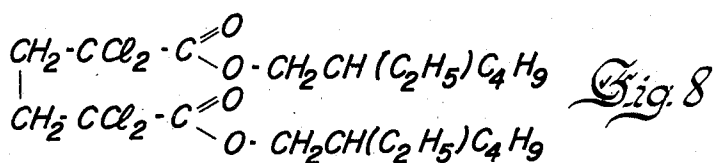
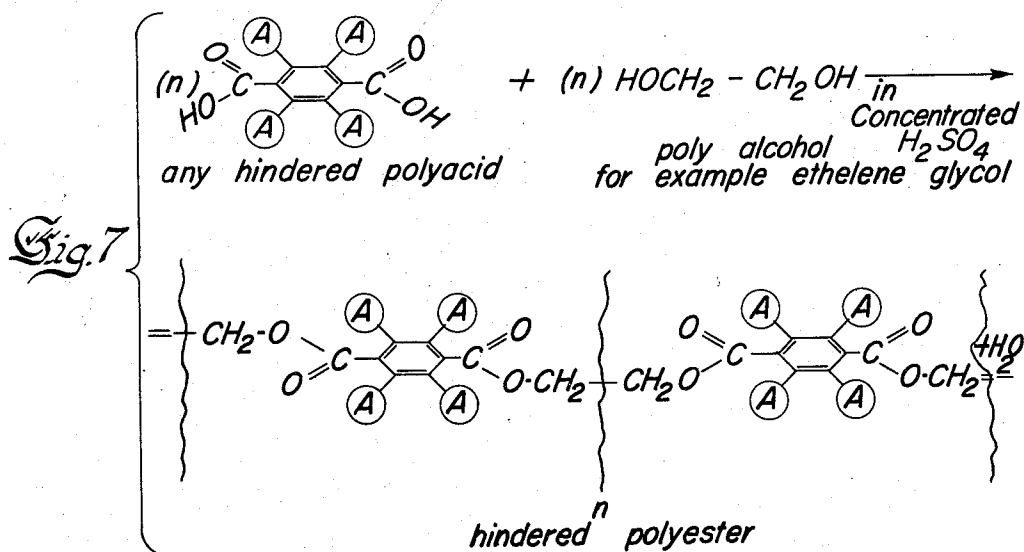
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3 Sheets-Sheet 2



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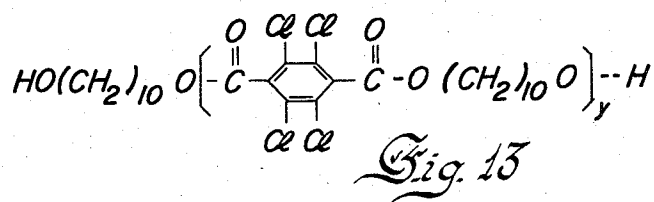
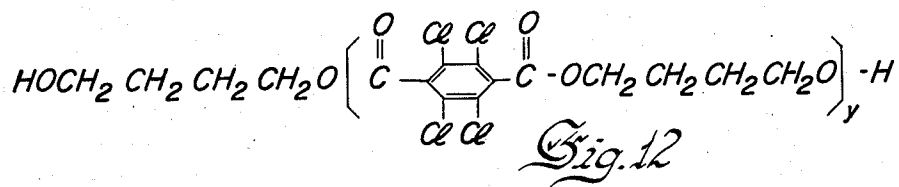
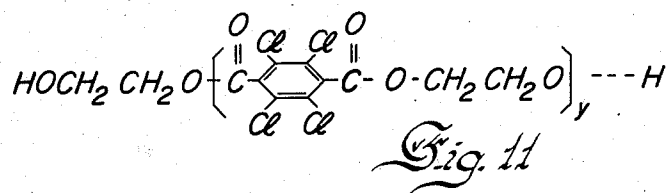
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REFRIGERATION COMPOSITION

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3 Sheets-Sheet 3



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1

2,852,470

REFRIGERATION COMPOSITION

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1 Claim. (Cl. 252—68)

This invention relates to refrigerating apparatus and particularly to refrigerating apparatus of the compression type wherein the non-metallic parts thereof, such as the lubricant and the motor stator insulation normally coming in direct contact with the refrigerant, are selected from the chemical group generally called "hindered esters" or esters which, under the conditions encountered in a refrigerating system, do not react in a reversible manner to produce the acids and the alcohols from which they were formed.

An object of this invention is to provide a working fluid consisting of a refrigerant and a lubricant miscible in the refrigerant, the lubricant being an ester (the word "ester" is used in the specification and claims to include a single ester or a polyester) which is hindered and which does not react with water and other attacking agents generally present in refrigerating apparatus to produce acids or other compounds harmful to the operation of the apparatus.

Another object of this invention is to provide a refrigerating apparatus in which the motor stator is insulated with an ester which is hindered and does not react with water or other attacking agents generally present in refrigerating apparatus to produce acids or other compounds harmful to the operation of the apparatus, and which hindered ester is insoluble in the refrigerant and/or lubricant being used in the refrigerating apparatus.

Another object of this invention is to provide in the same refrigerating apparatus a lubricant and a stator insulating material, each of a hindered ester of the character described in the foregoing objects, wherein preferably the ester as a lubricant is hindered to increase its chemical strength. The hindered esters used as lubricants are miscible in the refrigerant whereas the hindered esters used as insulating materials are not soluble in the refrigerant and/or the lubricant.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of the invention is clearly shown.

In the drawings:

Figure 1 is a diagrammatic representation of a refrigerating apparatus embodying this invention.

Figures 2 through 13 are chemical formulae used in the explanation of the chemical principles involved in the manufacture and use of the hindered esters embodying this invention.

A refrigerating apparatus embodying this invention is diagrammatically indicated in Figure 1. A motor compressor unit 10 discharges compressed refrigerant, carrying some lubricant, through a pipe 11, to a condenser 12, from whence condensed refrigerant and lubricant pass to an expanding device such as a capillary tube 13, and from thence to an evaporator 14 from whence the evaporated refrigerant with the lubricant flows through the pipe 15 to the compressor 16. The compressor 16 discharges the compressed refrigerant mixture into the dome 17 from whence the compressed mixture flows again through

2

the pipe 11 to the condenser 12 for recirculation through the refrigerating apparatus. The compressor 16 is driven by a motor rotor 19 energized by a stator 20. A body of lubricating liquid 21 is maintained in the motor compressor 20 for lubrication of the moving parts and in which lubricant of the character described in this application is concentrated by the heat of the compressor and motor. The stator 20 has electric windings, which are protected by an insulator, applied as wire coatings to the windings individually or applied as stator slot insulators and coil separators to the stator as a whole; such insulation is diagrammatically indicated at 22. The lubricant is soluble in the refrigerant, whereas the insulator 22 is insoluble in the refrigerant and remains in the solid, or nearly solid, phase at all operating temperatures of the apparatus.

The refrigerant exists in the liquid and gaseous phase at the operating temperatures of the apparatus, and preferably comprises a fluoro halo derivative of an aliphatic hydrocarbon of the character disclosed in the patent to Midgley et al., Re. 19,265, reissued August 7, 1934. This patent discloses the various compounds which can be derived from CH_3F or $\text{CH}_3\text{CH}_2\text{F}$ by chlorine and/or fluorine and/or bromine substitution. The preferred compounds include fluorochloro derivatives of methane and ethane such as CF_2Cl_2 , CHFCl_2 , $\text{C}_2\text{F}_4\text{Cl}_2$ and $\text{C}_2\text{F}_2\text{Cl}_4$.

Esters have been used heretofore as lubricants in various machines. However, such esters have been unhindered as to water, and other attacking agents, and react with water or such agents to produce the original acids and alcohols and other compounds which are harmful to the operation of the mechanism being lubricated. Hence such esters are particularly unsatisfactory in refrigerating apparatus. The two-way, or reversible, character of the equation between an unhindered ester and water (as an example of an attacking agent) which could harmfully take place in a refrigerating apparatus, is indicated in Figure 2.

According to this invention, any of a group of hindered esters may be used as a lubricant and/or as a stator insulator, which esters have a one-way, or irreversible, equation with respect to water, and similar attacking agents, so that such esters cannot be changed to acids or similarly harmful compounds.

The one-way, irreversible character of an equation of a hindered ester, according to this invention, with water (as illustrative of an attacking agent) is indicated in Figure 3. This indicates that a hindered ester in the refrigerating apparatus cannot react with water to form an acid, even if the ester can be produced outside the refrigerating apparatus from a hindered acid with the formation of water.

A general equation to form such a hindered ester, and of its irreversible equation with an alcohol on one side of the equation and with water on the other side is indicated in Figure 4. The "hindrance" is here pictured by "obstacles," denoted as "A" in this and other figures in this application to indicate radicals which render the hindered ester non-reactant to water or the like in the refrigerating apparatus. The forming acid is also hindered by the same radicals but can be caused to react with an alcohol in the presence of concentrated sulphuric acid, for example (outside the refrigerating apparatus), to produce the hindered ester, which, once formed, cannot return to the acid state in the refrigerating apparatus in the presence of water or the like.

The obstacle producers, generally indicated by the character "A" in this application, and which produce the hindered compounds referred to in this application, may be alkyl radicals, such as CH_3 , $\text{C}_n\text{H}_{2n-1}$, or may be suitable aryl radicals, or a halogen radical such as Cl.

The "A" obstacle, in open chain compounds, should be attached on the carbon adjacent to the CO_2H of the hindered acid from which the hindered ester is derived. In Figure 4, which refers to open chain compounds, the obstacles are on the adjacent C, but in Figure 5 which refers to benzene derivatives, there must be two carbons removed from the acid group. Preferably, two such obstacles should be attached to block any access to the molecule by water or other attacking agent. A special case, for illustration only, of such properly hindered benzene type acid capable of forming the hindered ester is indicated in Figure 5, wherein the obstacle producers "A" are either CH_3 , CnH_{2n-1} , or Cl, or similar radicals above referred to and in which the figure illustrates a representative hindered acid of the benzene group, which acid is used in forming a representative hindered ester for use according to this invention.

A hindered ester of the benzene type may be made from a hindered acid and an alcohol in the presence of concentrated sulphuric acid, for example, as indicated in Figure 6. In Figure 6, any hindered acid, benzene type or otherwise, as illustratively indicated in Figure 5, is brought into contact with any alcohol, illustratively indicated as HOR, in the presence of concentrated sulphuric acid, outside the refrigerating apparatus, produces a hindered ester and water. Thus Figure 6 indicates any of the hindered esters which may be used as lubricants or as stator insulators in the refrigerating apparatus indicated in Figure 1. Such hindered esters, in the presence of water or similar attacking agent, cannot react in the refrigerating apparatus to return to the acid condition or to form any similarly undesirable compound.

For practical purposes, the hindered ester is at present preferred to be a large molecule ester, i. e., a hindered ester of a large acid, formed with a large alcohol, or else a hindered polyester of a hindered polyacid formed with polyalcohol (for instance ethylene glycol). Such large molecule hindered ester, and its formation, is indicated, by way of example, in Figure 7, in which the acid is a hindered polyacid of the benzene type, and in which any alcohol or any polyalcohol, such as ethylene glycol, may be used in the presence of concentrated sulphuric acid to produce a hindered polyester and water.

Hindered polyesters of the general type disclosed in Figure 7 may be used either as lubricants or as stator insulators, depending on the melting temperature. In general, those polyesters in which "n" (n indicates the number of benzene or alkyl groups or radicals) is small have relatively low melting temperatures, and are suitable as lubricants, whereas those in which "n" is relatively large have relatively high melting temperatures, and are suitable as stator insulators. The character of the "A" obstacle producers also has an influence on the melting temperature.

In the application of a hindered ester to electrical insulation, a hindered polyester is preferred in sufficient molecular size to be a solid under all operating temperatures of the apparatus. The hindering groups "A" preferably are CH_3 or CnH_{2n-1} rather than Cl or halogen for the purpose of eliminating solubility in the refrigerants being used.

Figures 8, 9 and 10 indicate specific examples of a large group of hindered esters which may be used as lubricants in refrigerating apparatus or the like.

Figure 8 indicates the formula for di-2-ethylhexyl- α -A-tetrachloro-adipate. Methyl or ethyl groups (or similar) could be used instead of the chlorine.

Figure 9 indicates the formula for di-2-ethylhexyl-3-6-dichloro-orthophthalate.

Figure 10 indicates the formula for di-2-ethylhexyl-2,3,5,6-tetrachloro-terephthalate.

Figures 11, 12 and 13 indicate specific examples of a large group of hindered esters which may be used as insulators for stators in refrigerating apparatus or the like.

Figure 11 indicates the formula for polyester of tetrachloro-terephthalic acid and ethylene glycol.

Figure 12 indicates the formula for polyester of tetrachloro-terephthalic acid and tetra-methylene glycol.

Figure 13 indicates the formula for polyester of tetrachloro-terephthalic acid and decamethylene glycol.

In Figures 11, 12 and 13 "n" is to be high enough to give molecular weights of 15,000 or higher.

A hindered ester of the type soluble in the refrigerant may be used as a lubricant in the same apparatus in which another hindered ester, insoluble in the refrigerant and the lubricant, is used as a motor stator insulator. In this case, the soluble hindered ester circulates with the refrigerant throughout the system for lubricating purposes, whereas the insoluble hindered ester remains on the motor stator and protects the windings, because it remains solid under all normal operating temperatures of the apparatus, and is insoluble in the refrigerant, and in the lubricant.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted as may come within the scope of the claim which follows.

What is claimed is as follows:

As a working fluid for a refrigeration apparatus of the seal compressor of the compression type, a refrigerant which is a fluorochloro derivative of a class of aliphatic compounds selected from the group consisting of methane and ethane capable of being in the liquid and gaseous phases within the operating temperatures of said refrigerating apparatus, and a lubricant comprising a fully esterified reaction product of di-2-ethylhexyl alcohol and a polybasic acid selected from the group consisting of α -A-tetrachloro-adipic acid, 3-6-dichloro-orthophthalic acid and 2,3,5,6-tetrachloro-terephthalic acid.

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