Oct. 5, 1965 E. F. CHRISTIANSEN 3,209,992

HERMETICALLY ENCLOSED SMALL REFRIGERATING MACHINE AND PROCEDURE FOR THE OPERATION OF SAID MACHINE

Filed Feb. 21, 1964

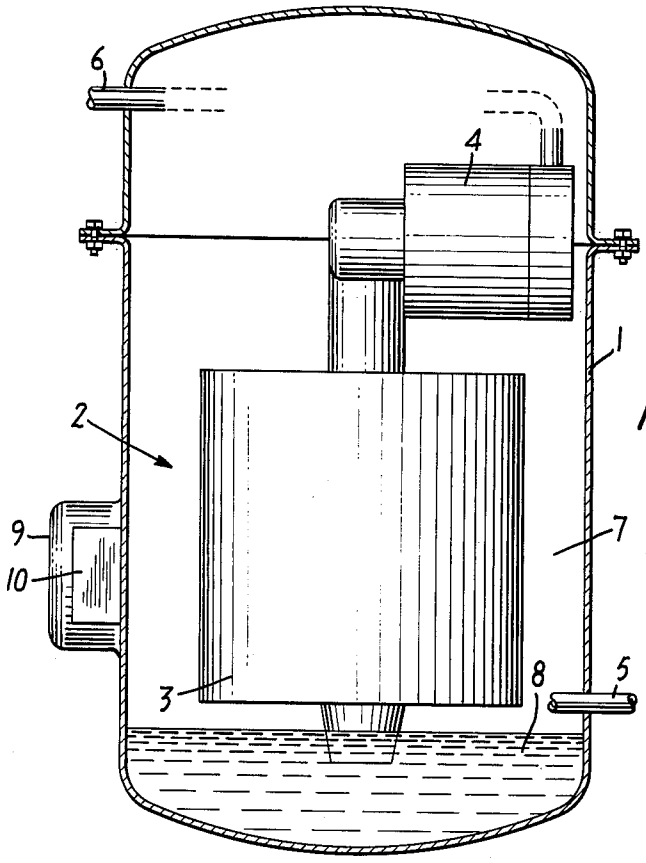


FIG. 1

FIG. 2

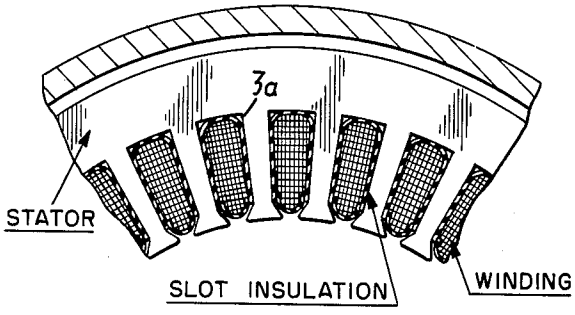
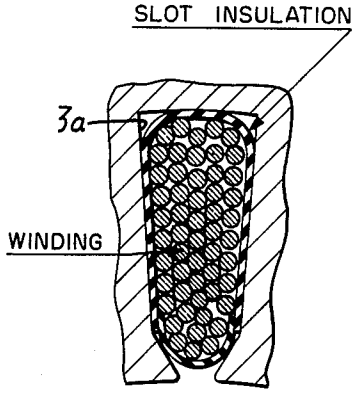


FIG. 3



United States Patent Office

3,209,992

Patented Oct. 5, 1965

3,209,992

HERMETICALLY ENCLOSED SMALL REFRIGERATING MACHINE AND PROCEDURE FOR THE OPERATION OF SAID MACHINE

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Filed Feb. 21, 1964, Ser. No. 346,491
Claims priority, application Germany, Feb. 21, 1963, D 40,948
10 Claims. (Cl. 230—206)

This invention relates generally to refrigeration and more particularly to hermetic small refrigeration compressors of the type using a refrigerant consisting of halogenized hydrocarbons, a lubricant comprising mineral oil and electric motor insulation composed of a platic material and relates to a method for operating such small refrigeration compressors.

The working life of hermetic small refrigeration compressors depends largely on the operating temperatures which occur in such machines. It is well known that not only the consistency of the substances used, for example the oil, refrigerant and insulation is reduced with increasing temperature, but also that reactions of the substances with each other occur to an increasing extent because of the increased temperatures. Cellulose-containing insulation materials, for example, will give off water which reacts with the lubricating oil and can form acids. With known compressor lubricating oils dissociation occurs as soon as the operating temperatures exceed 100° or 125° C. Anhydrous insulations made from plastic materials which normally are still resistant and effective at high temperatures tend to lose their insulation capabilities under the influence of decomposition products derived from the refrigerant and the oil, which are formed at elevated temperatures and which are capable of chemical reactions.

Dielectric plastic materials for insulation for refrigeration machines are known, which do not cause disadvantageous chemical reactions with the refrigerants and the various lubricating oils at temperatures up to 150° C., for example: polyethylene terephthalate or polyamide, which had been subjected to a special pretreatment. However, the utilization of such synthetic materials do not insure that a refrigeration compressor can actually be operated at temperatures up to 150° C. in view of the fact that most known compressor lubricating oils will dissociate at lower temperatures, and, according to the circumstances, even attack the insulation's synthetic material. In connection with the utilization of mineral oil lubricants, an operating temperature within the range of 130° to 150° C. can only be obtained with the addition of inhibitors.

Up to the present time the operating temperature of 150° has been considered as being the critical operating temperature limit. Above this limiting value, the above mentioned insulation, synthetic materials cause disadvantageous chemical reactions such that even the lubricating mineral oil itself, which has been made temperature-resistant by means of the addition of inhibitors, will dissociate, whereby the inhibitors result in particularly detrimental reaction products, and even the best suited refrigerants from halogenized hydrocarbons are stronger reactions. Therefore, the limiting value of 150° C. has always been carefully observed in connection with the practical design of small refrigeration machines. The permissible operating temperatures are far below the limiting value of 150° C.

The invention relates in part to use of insulation-synthetic material composed of a material which is resistant to the refrigerant in hermetic refrigeration compressors up to a limiting temperature, which exceeds 155°, and which preferably lies within the range of 160° to 225° C., and relates to the use of a mineral oil lubricant which is composed of a paraffin-based oil, from which those components or ingredients have been refined out or removed which crystallize out at temperatures under —40° C.

A feature of the invention is that it teaches selection of insulation-synthetic material to being with only according to whether the material is resistant in the hermetic machine to the above-mentioned high temperatures in the presence of a refrigerant and, if necessary, in the presence of its dissociation products. Since the refrigerant is generally selected for a given purpose, a usable or suitable synthetic material can be determined by relatively simple means, as can be seen from the examples mentioned hereinafter. If a specific paraffin-based mineral oil is used in the system of oil, refrigerant and insulation, the resistance values of the entire system do not change at all or, if at all, to such an extent only that the limiting temperature of 155° or, preferably, 160° to 225° C. remain effective.

Paraffin-based oil is utilized in hermetic refrigeration machines only reluctantly in view of the fact that the crystalline paraffin separates out at vapor temperatures of —20°, —30° or lower so that it covers the heat-exchanger surfaces and congests or chokes the various lines. Therefore, in order to be usable in refrigeration machines at all, paraffin-based oil must be cleaned as much as possible by removal of the paraffin. In the entire refrigeration industry, a naphthene-based oil lubricant has therefore been utilized, or preferably utilized. All known attempts to produce a highly temperature-resistant mineral oil have therefore been made on the basis of using naphthene-based oils. However, quite contrary thereto, according to the invention a paraffin-based oil, free from components which crystallize out at low temperatures, is used. It has been established, that if one intends to utilize a mineral oil lubricant in hermetic refrigeration machines at temperatures above 155° one must unquestionably use a paraffin-based oil. Only such an oil is capable of withstanding temperatures around a value of 200° C. for a long period of time. Furthermore, it has also been surprisingly established that this oil can be exposed to considerably higher temperatures for a short period of time. Normally carbon deposits form during high temperatures but tests, according to the invention show the absence of oil carbonization even at temperatures of 270° C.

According to the invention all parts of the compressor motor insulation that is to say the winding slots lining or coating, the slot closures or inserts and the winding wire insulation should, in customary manner, be composed of plastic material. However, it is useful and effective to utilize different plastic materials for the winding slots insulation on the one hand, and for the wire insulation on the other hand. The winding slots insulation preferably is composed of a plastic material which is heat resistant up to a temperature of 180° C. within the hermetic compressor whereas the wire insulation consists of a plastic material which is heat resistant to a temperature up to 220° C. within the operating environment in the hermetic compressor.

It is recommendable, by way of example, according to the invention to utilize dimethylenecyclohexylene-polyester of terephthal acid for the winding slot insulation. There is, of course, a special terephthalic acid ester which is known to be temperature-resistant up to 150° C. However, terephthalaciddimethyl - encyclohexylenepolyester has a temperature resistance up to 180° C. in an enclosed machine in the presence of a refrigerant.

According to a further embodiment of a combination or system according to the invention fluorized polyethylenes, such as polytetrafluorethylene, preferably chlorine-containing polyfluorethylene, can be utilized for winding slot insulation. Polytetrafluorethylene is a known insulating material. However, the surprising fact not known heretofore is that the latter can be used in a system according to the invention at temperatures which greatly exceed the customary limiting temperature of 150° C. Furthermore, an expoxy resin can be used for the slot insulation, which, in addition to its good temperature resistance, possesses the quality that it adheres directly onto the metal of the motor, thereby resulting in an especially stable and strong insulation.

For wire insulation, a diaminopyromellitic acid compound is particularly suitable, which is resistant in the presence of the refrigerant to temperatures up to 220° C. An insulation compound of pyrmedin-compound is also usable according to the invention. The expressions "combination" or "compound" is herein employed in connection with synthetic materials mean that the synthetic material in the insulation need not necessarily be in a pure form but that additional substances can be contained. It is also rather surprising that also polyethylene terephthalate is suitable as wire-lacquer or insulation in a combination according to the invention. Moreover, a wire insulation is suitable in connection with which a thin coat of class C-lacquer is applied onto a copper wire with a further coat of phenolformvar thereon, whereby a temperature resistance of class H is obtained.

Different possibilities exist in order to make the paraffin-based oil suitable for the purpose according to the invention. For example, the naphthene-component can be reduced to a small value. This is in contrast to the up to now technical procedure, according to which it was desired to utilize an oil with as high as possible naphthene-component.

According to a preferred embodiment, by way of example, the paraffin-based oil can be additionally refined in a manner which applies to lubricants for nozzle-propulsion machines, gas turbines and turbocompressors. In this field, it has already been recognized how lubricating oils have to be treated in order to prevent these lubricants from decomposing, inside the hot operating machine, into undesired components.

One of the preventive steps, for example, consists in removing the nitrogeneous heterogeneous aromatic components from the oil as much as possible. It is, of course, known to refine the aromatic components out in connection with oils. However, these aromatic components have essentially been considered as being secondary, and were only removed up to a certain extent. However, it is essential according to the invention that the portion of nitrogenous heterogeneous aromatics is considerably smaller than the portion of remaining aromatics. The aniline point, which is to say that temperature at which aniline separates, should lie above 90° C., whereas this point in connection with normal oils lies approximately at temperatures of 60° to 80° C. In view of the fact that the lubricaing qualities of paraffin-based oils are to a large extent dependent on the aromatic content, the aromatics should be removed completely, but only the less stable ones, namely those which are more easily oxidixable.

If one utilizes difluorodichloromethane as the refrigerant the synthetic materials of the insulation as well as the paraffin-based oil should be resistant to breakdown in the presence of difluoromonochloromethane in view of the fact that at those high operating temperatures, which are desired, part of the difluorodichloromethane is converted into difluoromonochloromethane.

With respect to the drying agent used in the refrigerant circuit, a special selection has to be made on account of the high temperatures involved. Preferably a synthetic sodium-aluminum-silicate (a zeolite under the trade-

name LMS) should be used as the drying agent. As compared to silica gel this material possesses the advantage that it remains active after a longer period of operation even if subjected to the influence of circulating oil entrained in the refrigerant.

If one constructs small hermetic refrigreation machines in accordance with the invention, the thermal circuit breaker or overload cutout can be adjusted to a temperature above 155° C., preferably to temperatures between 160° to 225° C. A small refrigeration compressor which is designed with respect to its parts in customary and known manner, can therefore be loaded to a greater extent than could be done previously, which is to say that a machine of a certain capacity can generate a larger output of capacity than it could before.

In order to better explain the invention, reference is made to the appended drawing in which: FIG. 1 schematically illustrates a hermetic small refrigeration motor-compressor employing a system of components according to the invention; FIG. 2 is a fragmentary sectional view of a motor stator in the motor-compressor in FIG. 1; and FIG. 3 is an enlarged view of a portion of the sectional view in FIG. 2.

According to the drawing a hermetic capsule **1** encloses a motor-compressor **2**. The latter comprises a driving electric motor **3** for driving a piston in a piston-cylinder-arrangement **4**. A refrigerant suction line **5** is provided for supplying refrigerant which is compressed in the compressor and discharged through a pressure or hot line **6** shown fragmentarily in broken lines. The interior of the capsule comprising a space **7** is under suction pressure by the compressor. The lubricating oil is collected in a sump or oil basin **8**, and comprises a mineral oil having a paraffin base, from which have been refined out or removed those components which crystallize out at temperatures under —40° C. In view of the fact that the refrigerant is constantly in contact with the oil and carries along oil into the refrigerant circuit, a refrigerant-oil-mixture is obtained in the refrigerant circuit.

The motor **3** rotor and stator comprise winding slots **3***a* provided with slot insulation as shown and windings having wire insulation consisting of a synthetic material, which is resistant to the refrigerant up to a limiting temperature, which lies above 155° C. and preferably within a temperature range of 160° to 225° C. The temperature resistance limit applies to the oil and the refrigerant-oil mixture. A switch box **9** is mounted on the capsule in which a circuit breaker or thermostat control **10** is arranged, which reacts to an over-temperature of the capsule wall, and turns off the compressor when over heated or over loaded. The thermostat control **10** can be adjusted to trip at a temperature not less than at least 155° C.

As an especially advantageous example of a combination of the individual materials in a system in accordance with the invention, the following components are illustrative:

Refrigerant	Difluorodichloromethane.
Mineral oil lubricant (paraffin-based)	Shell 6090 A–Clarus 929 (temperature resistant at temperatures from —40° to 180° C.).
Slot insulation	Terephthalaciddiamethylene-cyclohexylenepolyester (temperature resistant up to 180° C.).
Wire lacquer insulation	Pyromelliteaciddiamine-compound (temperature resistant up to 220° C.).

As a further example of a combination or system according to the invention, the following is recommended:

Refrigerant	Difluoromonochloromethane.

Mineral oil lubricant (paraffin-based)	Esso Zerise 43 (temperature resistant from —43° C. up to 180° C.).
Slot insulation	Chlorine - containing polyfluoroethylene (temperature resistant up to 210° C.) .
Wire lacquer insulation	Polyethylene terephalate (temperature resistant up to 180° C.).

The above described refrigeration compressor is part of a refrigeration system, not shown, in which a refrigerant circuit, not shown, is connected between the hot line **6** and the suction line **5**. The drying agent used in the refrigerant circuit is preferably a synthetic zeolite, for example, a sodium-aluminum-silicate.

What I claim and desire to secure by Letters Patent is:

1. In a refrigeration system a hermetic refrigeration compressor having a capsule, a motor driven compressor having a motor comprising insulated windings comprising insulated wire, and winding slots, in combination, a gaseous refrigerant in said capsule comprising halogenized hydrocarbons, a lubricant in said capsule comprising a paraffin-base mineral oil in contact with said refrigerant and resistant to reaction therewith, said oil comprising an oil pretreated to remove therefrom crystallizable constituents crystallizable and removable from the oil at temperatures below —40° C.; wire insulation on said windings and insulation on said slots each comprising a separate synthetic material resistant to said refrigerant, said oil, and a mixture of said oil and said refrigerant, the synthetic materials being temperature resistant to temperatures over 155° C.

2. In a hermetic refrigeration compressor according to claim **1** in which said slot insulation comprises terephthalaciddimethylenecyclohexylenepolyester.

3. In a hermetic refrigeration compressor according to claim **1** in which said slot insulation comprises a fluorinated polyethylene.

4. In a hermetic refrigeration compressor according to claim **3**, in which said fluorinated polyethylene comprises polytetrafluorethylene.

5. In a hermetic refrigeration compressor according to claim **3**, in which said fluorinated polyethylene comprises chlorine-containing polyfluorethylene.

6. In a hermetic refrigeration compressor according to claim **1**, in which said slot insulation comprises an epoxyresin.

7. In a hermetic compressor according to claim **1**, in which said wire insulation comprises a pyromelliteacid-diamine-compound.

8. In a hermetic refrigeration compressor according to claim **1**, in which said wire insulation comprises a polyethyleneterephthalate-compound.

9. In a hermetic refrigeration compressor according to claim **1**, in which said paraffin-based oil is substantially free of nitrogenous heterogene aromatics.

10. In a hermetic refrigeration compressor according to claim **1**, in which said refrigerant comprises difluordichloromethane, and in which said insulations and paraffin-based oil are resistant to difluormonochloromethane.

References Cited by the Examiner

UNITED STATES PATENTS

2,852,470	9/58	Henne et al.	310—45 X
2,936,296	5/60	Precopio et al.	310—215 X
3,034,004	5/62	Von Cube et al.	310—43 X

OTHER REFERENCES

Journal of Inst. of Elec. Engrs., Great Britain, vol. 5, No. 60, December 1959, pp. 695–699.

ROBERT M. WALKER, *Primary Examiner.*

LAURENCE V. EFNER, *Examiner.*