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Sanvordenker

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[54] **METHOD OF SUPPRESSING NOISE IN HERMETIC COMPRESSORS**

[75] Inventor: **Keshav S. Sanvordenker,** Ann Arbor, Mich.

[73] Assignee: **Tecumseh Products Company,** Tecumseh, Mich.

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[58] **Field of Search** ..... 181/33 B, 33 C, 33 K, 33 S, 181/33 R; 417/312, 363, 902; 184/1 E, 6.21, 6.23

[56] **References Cited**

UNITED STATES PATENTS

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3,614,384	10/1971	Heitchue	417/312

FOREIGN PATENTS OR APPLICATIONS

188,228	11/1966	U.S.S.R.	181/33 B

Primary Examiner—Richard B. Wilkinson
Assistant Examiner—John F. Gonzales
Attorney, Agent, or Firm—Barnes, Kisselle, Raisch & Choate

[57] **ABSTRACT**

The method of attenuating the noise produced by an operating hermetic compressor unit by adding a foaming agent to the lubricating oil of the unit and agitating the oil during operation of the unit.

15 Claims, No Drawings

METHOD OF SUPPRESSING NOISE IN HERMETIC COMPRESSORS

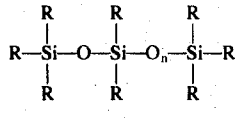
This invention relates to the control of noise in moving machinery and more particularly to a method of suppressing the noise produced by a hermetic compressor unit.

A typical hermetic compressor unit has a gas compressor with a piston driven by an electric motor totally enclosed in a sealed housing having inlet and outlet couplings for a compressible refrigerant gas. A predetermined amount of oil is received and retained within the housing to lubricate the moving parts of the compressor and motor. The noise produced by the compressor unit is conventionally attenuated by a suction muffler, discharge muffler and other mechanical means such as a spring suspension to dampen vibration of the motor and compressor. A typical hermetic compressor unit is shown in U.S. Heitchue Pat. No. 3,614,384, issued Oct. 19, 1971, which has an agitator rotated in the lubricating oil to stir the oil. This agitation produces some bubbles in the oil for the stated purpose of attenuating the noise produced by the hermetic compressor unit.

Objects of this invention are to provide a method of attenuating the noise produced by an operating hermetic compressor unit which can be readily adapted for conventional compressor designs; is compatible with existing assembly and testing techniques and procedures for manufacturing hermetic compressors; can be commercially practiced with unskilled personnel; and economically and efficiently attenuates the operating noise of hermetic compressors.

In the method of this invention a foaming agent is added to the lubricating oil of a hermetic compressor to assist in generating and sustaining a froth or foam of fine bubbles which acts to absorb and thus attenuates the operating noise produced by the compressor unit. The foaming agent causes substantial quantities of a froth or foam of fine bubbles to be rapidly created and sustained on the surface of the lubricating oil when it is agitated during operation of the hermetic compressor unit. In existing hermetic compressor designs which do not have a means for agitating the lubricating oil such an agitation means should be added for effective utilization of the method of this invention. In some conventional hermetic compressor designs there is a specific mechanical member, such as a disc or a finger, for agitating the lubricating oil. In other designs, the connecting rod of the compressor is partially submerged in the lubricating oil and is sufficient by itself to agitate the oil.

A suitable foaming agent in accordance with the present invention is a solution commercially available from Dow Corning Co. of Midland, Mich., sold under the trademark "SILANE XZ-83076." This solution is believed to be essentially 50 percent by weight of organosiloxane dissolved in toluene. Organosiloxanes have the following general chemical structure:



where the "R" group is a large class of organic substances, including hydrogen, aryl and alkyl groups. These compounds can be either linear or cross-linked

polymers having molecular weights in the range of 1,000 to 150,000. One of these simpler polymers is poly dimethylsiloxane in which the "R's" are methyl groups. More complex silicone polymers can be formed by incorporating side chains of greater complexity, such as methyl ethyl polysiloxane and diethyl polysiloxane. Fluorine atoms can be substituted for some of the hydrogen atoms on the side chains to produce a more complex polymer, such as trifluoropropyl methyl polysiloxane; likewise, aromatic groups such as phenyl can be incorporated into these polymers.

The performance of these various compounds in a hermetic compressor should be empirically checked, particularly for their foaming capabilities and compatability with the refrigerant and refrigeration system in which they are used. The depth of the foam produced appears to be dependent on operating conditions such as the pressure of the refrigerant, the amount of refrigerant dissolved in the lubricating oil, the extent of agitation of the oil, the temperature of the oil and refrigerant in the casing of the hermetic compressor, and the specific foaming agent and its concentration. The size of the bubbles of the foam appears to be dependent on the viscosity of the oil which varies with the temperature of the hermetic compressor unit, the pressure of the refrigerant, the extent of agitation of the oil, and the specific foaming agent and its concentration.

In general, the greater the depth or thickness of the foam and the smaller the average diameter of its bubbles the greater the attenuation of the compressor unit operating noise. The depth of the foam is primarily dependent on the concentration of the foaming agent in the lubricating oil and the extent of the agitation of the oil. Increased concentrations of the foaming agent and increased agitation produces a thicker or deeper layer of foam on the surface of the oil.

In practice, the maximum permissible thickness or depth of the foam is limited by the design of the hermetic compressor unit. If the foam were drawn into the suction inlet of the running compressor which is within the casing of the hermetic unit, it could enter the compression chamber and damage the compressor. Hence, the spacing between the surface of the lubricating oil and the suction inlet of the compressor within the casing, which is typically the inlet to the intake muffler, determines the maximum feasible depth of the foam. Preferably, the foam should be at least about one inch in depth and a depth in the range of about 1½ to 2½ inches has provided substantial noise attenuation.

The foam produces maximum attenuation at discrete frequencies believed to be dependent primarily on the average diameter of the bubbles. Since the most objectionable noise produced by hermetic compressor units is in relatively narrow bands, the foam can be tuned for maximum attenuation of the noise of a particular compressor unit by varying the average bubble diameter of the foam. The smaller the average bubble diameter the more stable the foam layer and the better the absorbtion of higher frequency sounds above about 400 Hz.

The aforementioned organosiloxane foaming agents are soluble in various aromatic hydrocarbons such as benzene, toluene and xylene; ketones such as acetone and methylethyl ketone; alcohols such as isopropyl alcohol; and chlorinated hydrocarbons such as trichlorethylene, dichlorodifluoromethane (R-12) and monochlorodifluoromethane (R-22). The use of refrigerants R-12 and R-22 as solvents for organosiloxane foaming

agents facilitates injecting the foaming agents into a refrigeration system utilizing a hermetic compressor unit. The foaming agent is first dissolved in the R-12 or R-22 refrigerant and this solution is then charged into such a refrigeration system as a final step in the assembly of the complete system. Thus, all other manufacturing operations would be unaffected if the foaming agent is dissolved in the refrigerant which is charged into the system. This also allows existing equipment and procedures for charging the refrigeration system to be used in injecting the foaming agent and, thus, does not disturb or adversely affect the conventional steps and techniques in the assembly and testing of the refrigeration system.

Alternatively, the foaming agent may be mixed with a lubricating oil and the mixture injected directly into the casing of the hermetic compressor unit. Controlling within close tolerances the ratio of foaming agent to oil is facilitated by dissolving the foaming agent in a volatile carrier which is compatible with and will evaporate from the lubricating oil such as acetone before mixing the foaming agent and carrier with the lubricating oil for injection of the mixture into the hermetic compressor unit.

A suitable concentration by weight of an organosiloxane foaming agent is believed to be in the range of 100 to 3,000 parts per million (PPM) by weight of the lubricating oil. It is believed to be preferable to use a concentration by weight of an organosiloxane foaming agent in the range of 100 to 1,000 PPM and approximately 150 to 800 PPM and particularly 300 to 800 PPM has been found to satisfactorily substantially attenuate the operating noise of a Tecumseh Products Co. hermetic compressor (Model No. AH20L12) with a mechanical oil agitator. The organosiloxane foaming agent added to the lubricating oil was SILANE XZ-83076 (without the toluene solvent). The oil was a refrigeration grade mineral lubricating oil having a viscosity of approximately 150 SUS at 100° F.

The use of a foaming agent pursuant to the present invention decreases substantially the amount of time required to form a suitable foam or froth for attenuating hermetic unit operating noise, greatly increases the quantity of the foam produced and stabilizes the foam by greatly increasing the average life of the bubbles. In fact, it is believed to be a practical impossibility to produce stable bubbles of sufficient depth on the surface of the lubricating oil to significantly attenuate hermetic unit operating noise without using a foaming agent. Since this method only requires the addition of a foaming agent to the lubricating oil and agitation thereof, it is economical and can be readily adapted to conventional hermetic unit designs. The foaming agent can be mixed with the refrigerant charge and injected into a hermetic compressor unit refrigeration system along with the refrigerant and therefore the method of this invention is compatible with conventional assembly and testing techniques and can be economically practiced by unskilled labor.

I claim:

1. A method of attenuating the noise produced by an operating hermetic compressor unit having a means for agitating the lubricating oil received therein when the hermetic compressor unit is operating, comprising the steps of selecting a foaming agent compatible with the liquid refrigerant and lubricating oil employed in said compressor, and adding a predetermined quantity of said foaming agent to the lubricating oil sufficient to produce a quantity of foam within the hermetic compressor unit when it is operating to attenuate the noise produced by the operating hermetic compressor unit.

2. The method of claim **1** wherein the predetermined quantity of foaming agent produces a foam when the hermetic compressor unit is operating having a depth in the range of 1 to 2½ inches.

3. The method of claim **1** wherein the predetermined quantity of foaming agent is in the range of 100 to 1,000 parts per million by weight of the lubricating oil.

4. The method of claim **1** wherein the predetermined quantity of foaming agent is in the range of 150 to 800 parts per million by weight of the lubricating oil.

5. The method of claim **1** wherein the predetermined quantity of foaming agent is in the range of 300 to 800 parts per million by weight of the lubricating oil.

6. The method of claim **1** wherein the foaming agent is an organosiloxane.

7. The method of claim **2** wherein the foaming agent is an organosiloxane.

8. The method of claim **3** wherein the foaming agent is an organosiloxane.

9. The method of claim **1** wherein the foaming agent is an organosiloxane having hydrogen aryl or alkyl "R" groups.

10. The method of claim **1** wherein the foaming agent is added to the lubricating oil by being dissolved in a refrigerant which is charged into the refrigeration system in which the hermetic compressor unit is utilized.

11. The method of claim **2** wherein the foaming agent is added to the lubricating oil by being dissolved in a refrigerant which is charged into the refrigeration system in which the hermetic compressor unit is utilized.

12. The method of claim **6** wherein the foaming agent is added to the lubricating oil by being dissolved in a refrigerant which is charged into the refrigeration system in which the hermetic compressor unit is utilized.

13. The method of claim **1** wherein the foaming agent is added directly to the lubricating oil charged into the hermetic compressor unit.

14. The method of claim **2** wherein the foaming agent is added directly to the lubricating oil charged into the hermetic compressor unit.

15. The method of claim **6** wherein the foaming agent is added directly to the lubricating oil charged into the hermetic compressor unit.

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