

- 1 -

## HERMETIC COMPRESSOR

## BACKGROUND OF THE INVENTION

The present invention relates to a hermetic compressor used for refrigerators, and in particular, to a hermetic compressor wherein a stator of a motor has  
5 therein a bolt hole through which a bolt is tightened to fix the stator to a compression mechanism.

Fig. 5 is a vertical cross sectional view showing a reciprocating hermetic compressor that represents hermetic compressors used for refrigerators.  
10 In this figure, reference numeral 1 is a closed container, 2 is a motor, 21 is a stator, 22 is a rotor, 211 is a bolt hole, 3 is a compression mechanism, 31 is a crank shaft, 4 is a supporting member, 5 is a spring, and 6' is a bolt.

15 In Fig. 5, the motor 2 and the compression mechanism 3 are housed in the closed container 1, and this compressor body formed by the motor 2 and the compression mechanism 3 is supported via the springs 5 by the supporting members 4 disposed on the inner wall of  
20 the closed container 1. The stator 21 of the motor 2 is tightened and fixed by the bolts 6' to the compression mechanism 3 through the bolt holes 211 formed in the stator 21. Tightening is generally carried out at three or four positions using the bolts 6'. Rotational driving  
25 force generated by the motor 2 is transmitted to the

compression mechanism 3 by the crank shaft 31.

The end of each bolt 6' is threaded, and the outer diameter of the portion of the bolt 6' between its threaded portion and head is almost equal to the outer diameter of the threaded portion. The inner diameter of each bolt hole 211 formed in the stator 21 is significantly larger than the outer diameter of the bolt 6'. Thus, even if there are some differences in the locational relationships between the bolt holes 211 formed at three or four positions of the stator 21 and the screw holes (not shown) that are formed at three or four positions of the compression mechanism and in which the threaded portion of the bolt 6' is screwed, the screw holes can be aligned with the bolt holes 211, thereby enabling the stator 21 to be mounted in the compression mechanism 3.

Hermetic compressors of such a construction are commonly used, and have recently been described in Japanese Patent Unexamined Publication Nos. 4-5486 and 4-187874, and Japanese Patent Publication No. 5-10899.

In the hermetic compressor of the above construction, the gap between the stator 21 and rotor 22 of the motor 2 is ideally uniform. Under actual operating conditions, however, if this compressor is subjected to an impact during manufacturing or transfer of a product equipped with this compressor, the stator 21 may be deformed as shown in Fig. 6A or Fig. 6B, thereby preventing the gap between the stator 21 and the rotor 22

from being uniform. The reason for this is as follows. The stator 21 comprises laminated steel plates, and since the outer diameter of the bolt 6' is significantly smaller than the inner diameter of the bolt hole 211, there is a fair space between the outer surface of the bolt 6' and the inner surface of the bolt hole 211. Consequently, if the steel plates, which are placed in order in the stator 21 shown in Fig. 7A, are subjected to an impact, they start to slide in order to deform the stator 21, as shown in Fig. 7B.

When the stator 21 of the motor 2 is deformed in this manner, the gap between the stator 21 and the rotor 22 is narrowed in one area, thereby increasing the magnetic attractive force generated between the stator 21 and the rotor 22 to cause the following problems.

- (1) When the gap becomes smaller than a specified value, electromagnetic noise is generated.
- (2) Since the motor 2 side end of the crank shaft 31 is not supported and can move freely, the rotor 22 is pulled by that area of the stator 21 in which the magnetic pull force has been increased, and the crank shaft 31 accordingly rotates while inclining toward a shaft receiving section. As a result, the whirling of the end of the crank shaft 31 increases, and the shaft receiving section contacts the crank shaft only in its one side, thereby preventing lubricating oil from being supplied to that area of the shaft receiving section to cause abnormal wear therein.

(3) If the deformation of the stator 21 of the motor 2 is extreme, the gap between the stator 21 and the rotor 22 becomes zero, and the stator 21 contacts the rotor 22.

5 The magnitude of the magnetic pull force can be evaluated by, for example, the following equation.

$$F \propto D_r \cdot L_r \cdot B_g^2 / g \quad \dots\dots (1)$$

In this equation:

F is magnetic pull force,

10 D<sub>r</sub> is an outer diameter of the rotor,

L<sub>r</sub> is a laminated thickness of the rotor,

B<sub>g</sub> is a magnetic flux density,

g is a gap between the stator and the rotor.

As is apparent from equation (1), as the size  
15 of the motor increases (that is, the outer diameter of the rotor D<sub>r</sub> or the laminated thickness L<sub>r</sub> increases), magnetic pull force increases. It is thus important to maintain the gap g at a specified value.

#### SUMMARY OF THE INVENTION

20 It is an objective of this invention to provide a hermetic compressor that improves reliability by solving the above problems and maintaining the gap between the stator and rotor of the motor at a specified value to prevent abnormal noises.

25 To solve the above problems, this invention provides means for forming in the space formed by the inner diameter of the bolt hole formed in the stator of

the motor and the outer diameter of the bolt screwed therein, a narrow space smaller than the one formed by the outer diameter of the threaded portion of the bolt and the inner diameter of the bolt hole.

5           Such means limits the amount of deformation of the stator due to an impact to enable the gap between the stator and the rotor to be maintained at an almost constant value, thereby preventing various problems due to an increase in magnetic pull force.

#### 10   BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view showing one embodiment of a hermetic compressor according to this invention.

15           Figs. 2A and 2B describe a specific example of a relationship between a bolt and a bolt hole formed in a stator of a motor according to the first embodiment shown in Fig. 1.

Fig. 3 is a partial cross sectional view showing the main part of another embodiment of the hermetic  
20   compressor according to this invention.

Fig. 4 is a perspective view showing a specific example of the approximately cylindrical member in Fig. 3.

Fig. 5 is a vertical cross sectional view  
25   showing one example of a conventional hermetic compressor.

Fig. 6 is a perspective view showing how the

motor stator of the conventional hermetic compressor shown in Fig. 5 is deformed.

Figs. 7A and 7B are perspective views showing in more detail the deformation shown in Fig. 6.

## 5 DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of this invention is described using the drawings.

Fig. 1 is a cross sectional view showing one embodiment of a hermetic compressor according to this  
10 invention. Reference numeral 6 designates a bolt, and the same components as in Fig. 5 have the same reference numerals with their description omitted.

In this figure, each bolt hole 211 has a larger diameter than the screw hole of the compression mechanism  
15 3 in which the threaded portion of each bolt 6 is screwed, as in the conventional technique. The portion of the bolt 6 between its head and threaded portion has a larger diameter than the threaded portion to provide a sufficiently narrow space between the bolt hole 211 of  
20 the stator 21 of the motor 2 and the bolt 6.

Means for providing such a narrow space may be achieved by increasing the diameter of the bolt 6 along its length including the threaded portion, but this increases torque required to obtain a required amount of  
25 tightening force on the bolt 6 to reduce productivity, and degrades workability in introducing the bolt 6 into the bolt hole 211. Thus, this means is not preferable.

On the contrary, it is advantageous that the outer diameter of the threaded portion of the bolt 6 is smaller than that of the portion between the head and the threaded portion.

5           According to this embodiment, the outer diameter  $D_1$  of the portion of the bolt 6 between its threaded portion and head is larger than the outer diameter  $D_2$  of the threaded portion and almost equal to the inner diameter  $D_0$  of the bolt hole 211 formed in the  
10 stator 21, as shown in Fig. 2B in further detail. Thus, when the bolt 6 is inserted into the bolt hole 211, the bolt hole 211 is substantially occluded by the bolt 6, and there is virtually no space between the inner surface of the bolt hole 211 and the outer surface of the portion  
15 of the bolt 6 between its threaded portion and head.

In addition, the length  $L_1$  (Fig. 2A) of that portion of the bolt 6 which has the outer diameter  $D_1$  is half or more than the length of the bolt hole 211, that is, the laminated thickness  $L_s$  of the stator 21.

20           Consequently, the portion of the bolt 6 which has the outer diameter  $D_1$  buries the bolt hole 211 from the bottom end at least up to the center of gravity of the stator 21. That portion of the stator 21 which is lower than its center of gravity (the center in the  
25 direction of its thickness) and which is remote from its fixed portion is subjected to deformation as described above. By occluding the bolt hole 211 with the rigid bolt 6 at least in this portion, the stator 21 is

prevented from being deformed even if it is subjected to an impact. This serves to provide a desired gap, in particular, in the range subject to magnetic attractive force, that is, between the rotor 22 and that portion of the stator 21 which is remote from the shaft receiving section.

Since the outer diameter of the portion of the bolt 6 between its threaded portion and head is almost equal to the inner diameter of the bolt hole 211, the bolt 6 cannot be always screwed into the screw hole easily when the stator 21 is tightened to the compression mechanism 3 with the bolt, compared to the conventional technique shown in Fig. 5. This problem, however, can be solved by improving the precision in setting a locational relationship between the three or four bolt holes 211 in the stator 21 and the three or four screw holes in the compression mechanism 3, and such improvement is not so difficult.

According to this embodiment, the inner diameter of the bolt hole 211 is significantly larger than the diameter of the screw hole formed in the compression mechanism 3, as in the conventional technique shown in Fig. 5, so the bolt holes 211 can be aligned with the screw holes easily.

Fig. 3 is a partial cross sectional view showing the main part of another embodiment of the hermetic compressor according to this invention. Reference numeral 6' denotes a bolt similar to the bolt in Fig. 5,

7 is an approximately cylindrical member, and the same components as in the above drawings have the same reference numerals with their description omitted.

As shown in this figure, according to this embodiment, the outer diameter of the threaded portion of the bolt 6 is equal to that of its portion between its threaded portion and head and significantly smaller than the inner diameter of the bolt hole 211 formed in the stator 21, as in the conventional technique shown in Fig. 5. In this case, there is a significantly gap between the inner surface of the bolt hole 211 and the bolt 6 inserted into it, but the approximately cylindrical member 7 is fitted in the bolt hole 211 to fill and sufficiently reduce the gap.

The approximately cylindrical member 7 is a cylindrical member that has an approximately C-shaped horizontal cross section and which is formed of a material having a spring characteristic such as stainless steel, as shown in Fig. 4. The approximately cylindrical member 7 is pressed into the bolt hole 211 of the stator 21 with its diameter reduced so as not to jump out of the hole. This allows the approximately cylindrical member 7 to be mounted so as to elastically contact the inner surface of the bolt hole 211, thereby preventing deformation due to the slippage of the laminated plates in the stator 21.

The length  $L_2$  of the approximately cylindrical member 7 is half or longer than the laminated thickness

Is of the stator 21 (Fig. 2B), and is fitted in the bolt hole 211 from its bottom end up to the center of gravity of the stator 21.

When the stator 21 is tightened to the  
5 compression mechanism 3 by inserting the bolt 6 into the bolt hole 211 in which the approximately cylindrical member 7 has been fitted, the bolt 6 and the approximately cylindrical member 7 fill the bolt hole 211 from its bottom end at least up to the center of gravity of  
10 the stator 21, thereby preventing the stator 21 from being deformed even when subjected to an impact and providing a desired gap, in particular, in the range that is likely to be subjected to magnetic pull force, that is, between that portion of stator 21 which is remote  
15 from the shaft receiving section and the rotor 22, as in the embodiment shown in Fig. 1.

This embodiment has a basic configuration similar to that of the conventional technique shown in Fig. 5, and produces the above excellent effects by using  
20 the simple means of providing the approximately cylindrical member 7 in the bolt hole 211.

As described above, this invention can provide a hermetic compressor that can reliably prevent various problems arising from magnetic pull force generated due  
25 to the reduced gap between the stator and rotor of the motor caused by the deformation of the stator, such as electromagnetic noise, abnormal wear caused by the biased

contact of the shaft receiving section, and the contact between the stator and the rotor.



WHAT IS CLAIMED IS:

1. A hermetic compressor wherein a compressor body comprising a motor and a compression mechanism is housed in a closed container and wherein a stator of a motor is fixed by bolts to the compression mechanism via bolt holes formed in the stator, characterized by means for forming in the space formed by the inner diameter of each bolt hole formed in the stator of the motor and the outer diameter of each bolt screwed therein, a narrow space smaller than the one formed by the outer diameter of the threaded portion of the bolt and the inner diameter of the bolt hole.
2. A hermetic compressor according to Claim 1 wherein said narrow space is formed in the direction of the laminated thickness of said stator from the end face opposite to its compression mechanism side over the distance including the center of gravity of said stator.
3. A hermetic compressor according to Claim 1 or 2 wherein said means for forming said narrow space is formed by part of the outer diameter of said bolt larger than that of said threaded portion.
4. A hermetic compressor according to Claim 1 or 2 wherein an approximately cylindrical member that is elastically and engagingly locked to the inner diameter of said bolt hole of the stator of said motor is used as said means for forming said narrow space.
5. A hermetic compressor according to Claim 4 wherein said approximately cylindrical member has a



- 13 -

longitudinal cross section of approximately C-shaped.

6. A hermetic compressor according to Claim 4 or 5 wherein said approximately cylindrical member is made of a metallic material having a spring characteristic such as stainless.