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Chiang et al.

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(54) **ROTARY COMPRESSOR**

(71) Applicant: **RECHI PRECISION CO., LTD.**, Taoyuan (TW)

(72) Inventors: **Li-Yao Chiang**, Taoyuan (TW); **Chia-Pin Chang**, Taoyuan (TW); **Wen-Jen Kuo**, Taoyuan (TW); **Hsi-Kun Hsu**, Taoyuan (TW); **Shun-Yung Huang**, Taoyuan (TW)

(73) Assignee: **RECHI PRECISION CO., LTD.**, Taoyuan (TW)

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CPC ***F04C 18/3562*** (2013.01); *F04C 2230/231* (2013.01); *F04C 2240/30* (2013.01); *F04C 2240/809* (2013.01)

(58) **Field of Classification Search**
CPC F04C 18/3562; F04C 2230/231; F04C 2240/30; F04C 2240/809
See application file for complete search history.

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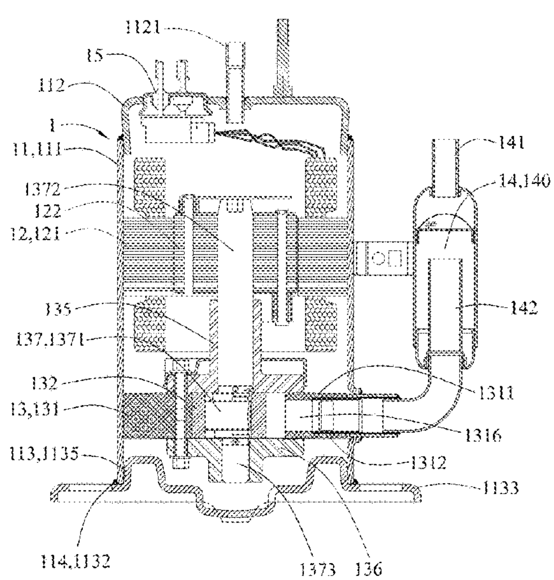
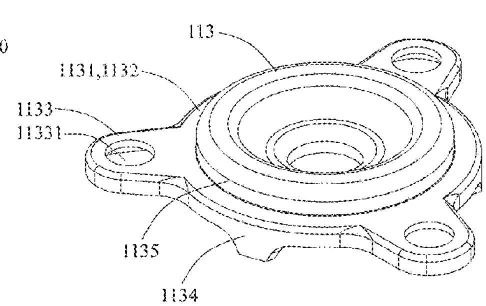
Primary Examiner — Jesse S Bogue
(74) *Attorney, Agent, or Firm* — MUNCY, GEISSLER, OLDS & LOWE, P.C.

(57) **ABSTRACT**

A rotary compressor includes a housing, a motor and a compression pump. The housing includes a main shell, a top cover and a bottom cover. The motor is located in the housing. The compression pump is located in the housing and below the motor. The compression pump includes a cylinder. The cylinder includes a first end surface and a second end surface, an oil storage area is formed between the second end surface of the cylinder of the compression pump and a bottom cover of the housing. Wherein a volume of the refrigerant oil in the oil storage area is V, an inner diameter of the main shell is M, a distance between a bottom surface of the bottom cover and a bottom surface of the cylinder of the compression pump is H, a circumference is IT, and the following condition is satisfied: $25\% \leq V/(\pi(M/2)^2H) \leq 40\%$.

8 Claims, 6 Drawing Sheets





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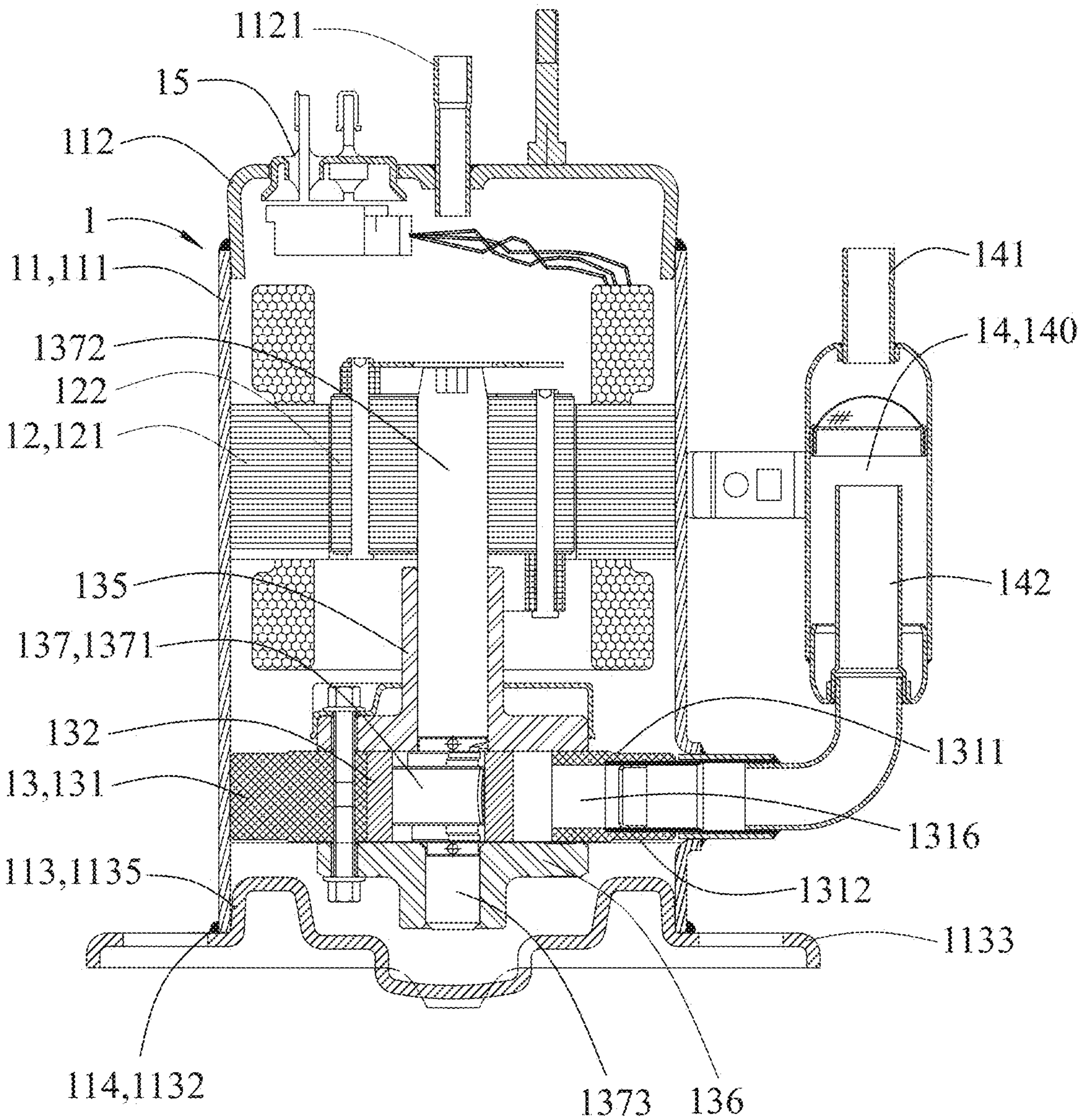
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FIG. 1

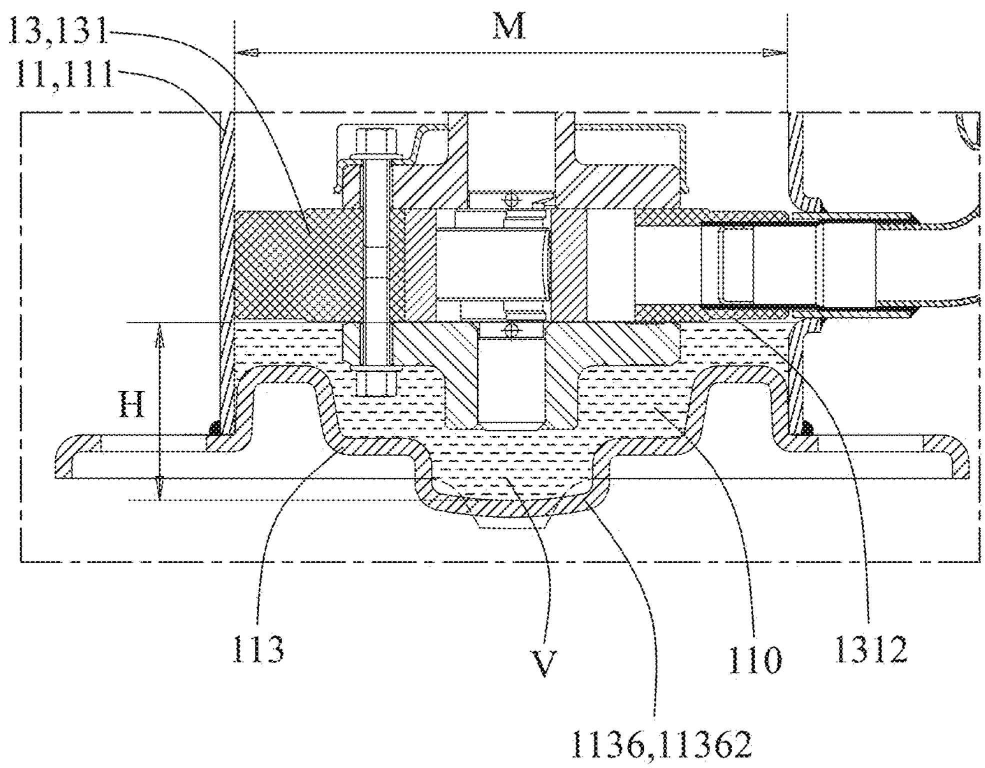

FIG. 2

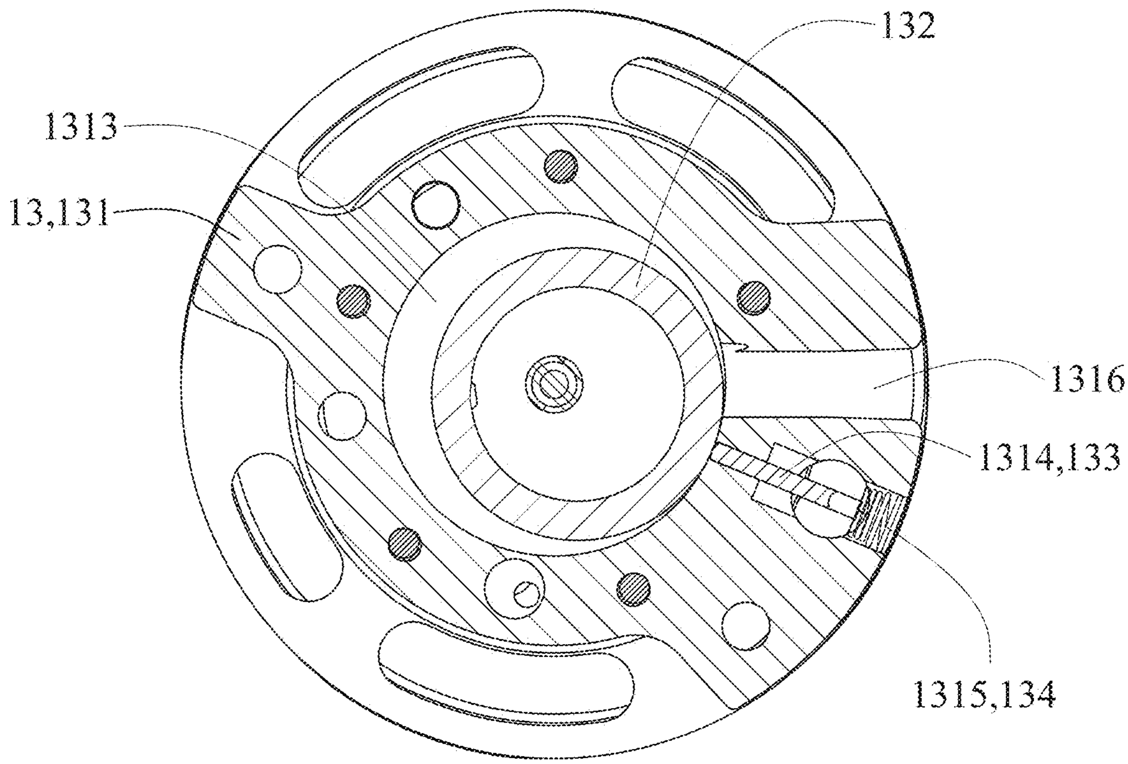

FIG. 3

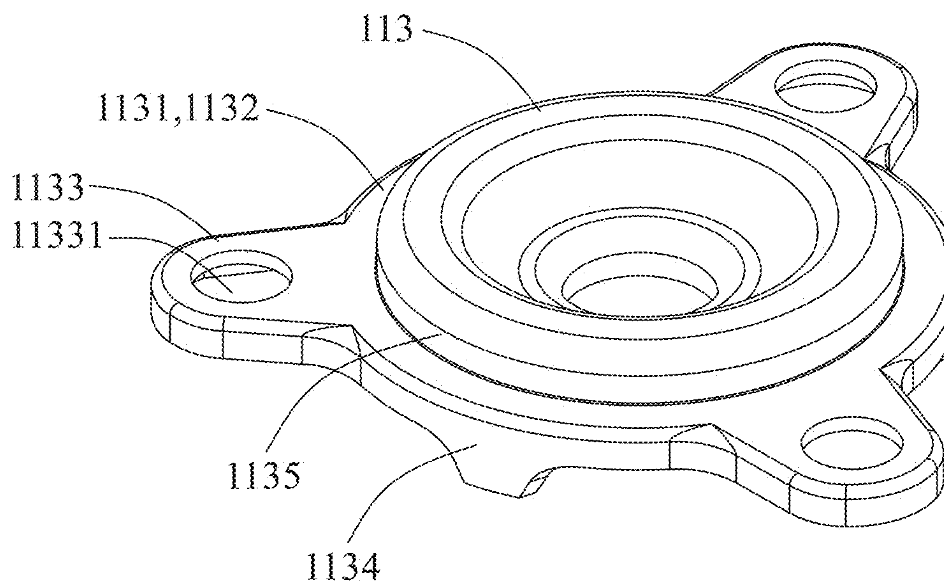

FIG. 4

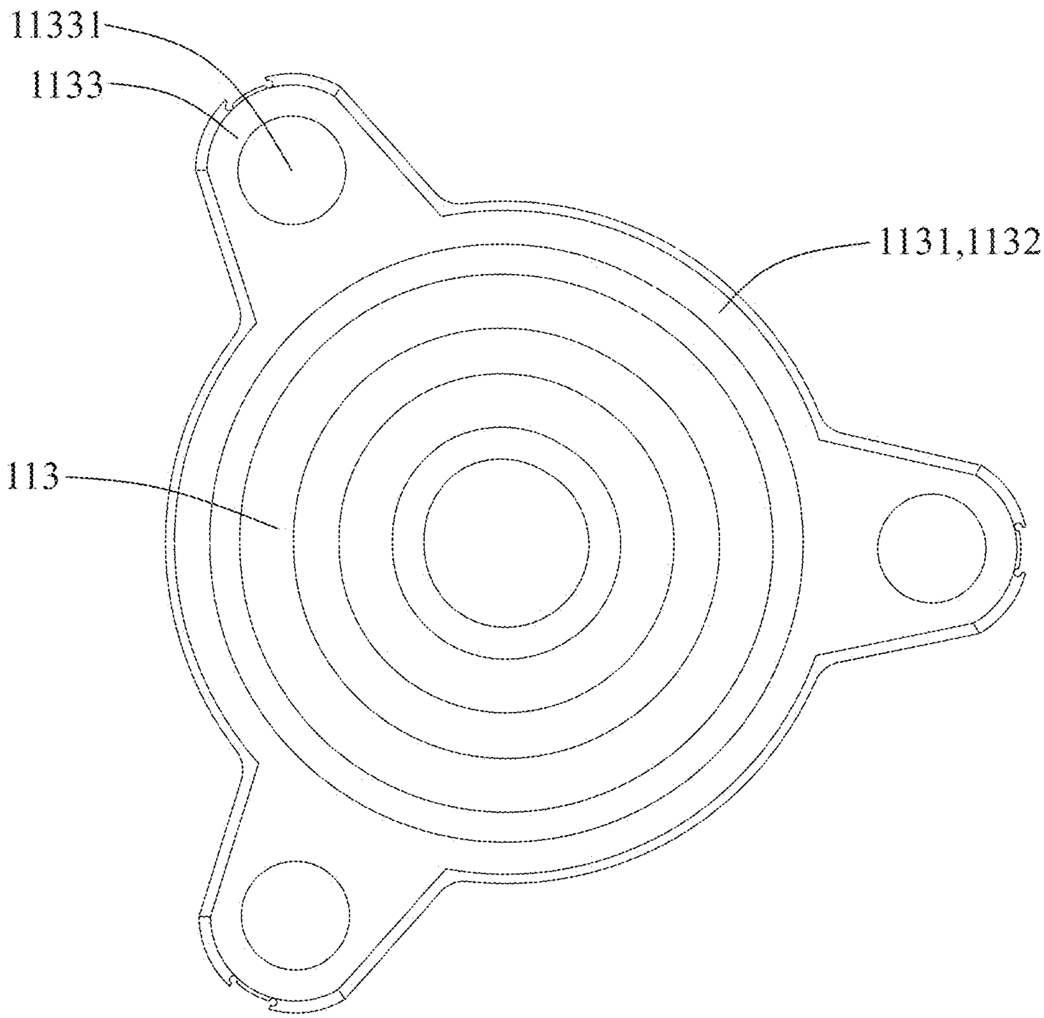

FIG. 5

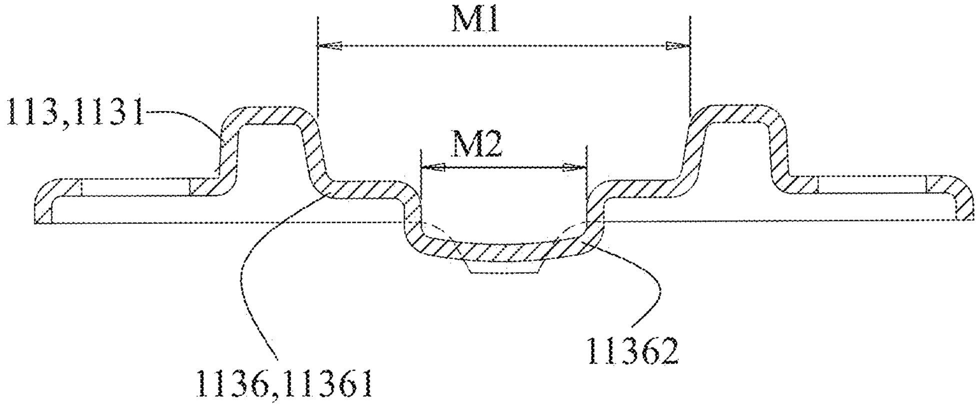

FIG. 6

ROTARY COMPRESSOR

RELATED APPLICATIONS

This application claims priority to Taiwan Application Serial Number 113130002, filed Aug. 9, 2024, which is herein incorporated by reference.

BACKGROUND

Technical Field

The present disclosure relates to a compressor, especially relates to a rotary compressor.

Description of Related Art

The existing rotary compressor mainly includes the following components: exhaust pipe, casing, motor (stator, rotor), crankshaft, upper bearing, muffler, compression unit (cylinder, rings, vanes), lower bearing, bottom cover, outlet pipe, liquid reservoir and inlet pipe. The basic working principle of the compressor is as follows: when the compressor is energized, the stator generates a magnetic field, which rotates the rotor, drives the crankshaft, and causes the rings to move eccentrically in the cylinder, thus compressing the low-temperature and low-pressure gas into a high-temperature and high-pressure gas. The gas is then discharged from the cylinder through the muffler and into the shell, and then through a cut edge on the outside of the stator and the gap between the rotor, and then discharged into the refrigeration cycle system through the outlet pipe.

Hydrocarbon refrigerants are attracting a lot of attention in the industry as a result of concerns about energy conservation and carbon reduction. There is an important technical challenge when applying hydrocarbon refrigerant to refrigeration systems: the high flammability of hydrocarbon refrigerant requires that the refrigerant charge in the refrigeration system be strictly limited. As a result, the amount of refrigerant in the compressor housing must be significantly reduced, thereby reducing the refrigerant charge in the entire refrigeration system. In conventional compressors, in order to ensure the reliability of the compressor operation, it is necessary to fill the compressor with sufficient lubricating oil to ensure the height of the oil level inside the compressor. However, due to the high miscibility between hydrocarbon refrigerant and lubricating oil, the lubricating oil will contain a higher proportion of refrigerant, which may result in insufficient refrigerant charge during operation of the refrigeration system. Therefore, an effective way to solve this problem is to reduce the refrigerant charge inside the compressor by reducing the lubricating oil filling volume inside the compressor. This not only reduces the refrigerant charge of the entire refrigeration system, but also ensures the safety and operational efficiency of the system.

However, in order to ensure the reliability of operation, the existing rotary compressors need to be filled with lubricating oil to maintain the height of the oil level inside the compressor. Due to the good solubility between R290 refrigerant and lubricating oils, the more the compressor is filled with oil, the more R290 refrigerant will be dissolved in the refrigerant oil. This phenomenon will have an impact on the performance of the compressor and lead to a reduction in operation efficiency. This is still a problem that must be continuously overcome and solved by the developers of compressors and other related industries.

SUMMARY

This Summary is provided merely to summarize some example embodiments, so as to provide a basic understanding of some aspects of the subject matter described in the present disclosure. Accordingly, the features described in this Summary are merely examples and should not be construed to narrow the scope or spirit of the subject matter described herein in any way. Other features, aspects, and advantages of the subject matter described herein will become apparent from the following Detailed Description, Figures, and Claims.

According to one aspect of the present disclosure, a rotary compressor includes a housing, a motor and a compression pump. The housing includes a main shell, a top cover and a bottom cover. The motor is located in the housing. The compression pump is located in the housing and below the motor. The compression pump includes a cylinder, a ring, a vane, at least one spring, an upper support, a lower support and a crankshaft. The cylinder includes a compression chamber thereof. The compression chamber includes a vane groove, a spring hole and a suction hole, wherein the spring hole is communicated with the vane groove, the suction hole, the vane groove and the spring hole are independent of each other and are not communicated with each other. The ring is rotatably located in the compression chamber of the cylinder. The vane is reciprocally moved in the vane groove of the cylinder. A front end of the vane and a peripheral surface of the ring are in contact with each other. At least one spring is located at each of the spring holes of the vane, so that the front end of the vane is in contact with the peripheral surface of the ring. The upper support is located in the housing and above the cylinder. The lower support is located in the housing and below the cylinder. The crankshaft is located in the housing for disposing the upper support, the motor, the ring and the lower support. The bottom cover is surrounded by a tripod, the tripod and the bottom cover is a one-piece structure. The tripod includes a ring connection plate and a plurality of support parts. The support parts are arranged in a ring shape uniformly on an outside of the ring connection plate, and each of the support parts includes a support hole in a middle thereof. The cylinder includes a first end surface and a second end surface, an oil storage area is formed between the second end surface of the cylinder of the compression pump and the bottom cover of the housing for storing refrigerant oil. Wherein a volume of the refrigerant oil in the oil storage area is V, an inner diameter of the main shell is M, a distance between a bottom surface of the bottom cover and a bottom surface of the cylinder of the compression pump is H, a circumference is IT, and the following condition is satisfied: $25\% \leq V/(\pi(M/2)^2H) \leq 40\%$.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure can be more fully understood by reading the following detailed description of the embodiment, with reference made to the accompanying drawings as follows:

FIG. **1** is a cross-sectional view of the rotary compressor of the present disclosure.

FIG. **2** is a partial sectional view of FIG. **1** of the present disclosure.

FIG. **3** is a cross-sectional view of the compression pump of the rotary compressor of the present disclosure.

FIG. **4** is a three-dimensional drawing of the bottom cover of the rotary compressor of the present disclosure.

FIG. **5** is a top view of the bottom cover of the rotary compressor of the present disclosure.

FIG. **6** shows a cross-section of the bottom cover of the rotary compressor of the present disclosure.

DETAILED DESCRIPTION

FIGS. **1** to **6** show a rotary compressor of the present disclosure. The rotary compressor **1** includes a housing **11**, a motor **12** and a compression pump **13**, and the rotary compressor **1** of the present disclosure is in the form of a vertical compressor.

The housing **11** is a hollow structure. The housing **11** includes a main shell **111**, a top cover **112** and a bottom cover **113**. The main shell **11** is used to accommodate the motor **12** and the compression pump **13** and other components. The housing **11** includes an outlet tube **1121**, the outlet tube **1121** is disposed at either the top cover **112** or the main shell **111**. In an example shown in the drawing, the outlet tube **1121** is disposed on the top cover **112**. The housing **11** may be of various existing structural types available on the market, and there is no special restriction on the structural type thereof.

The bottom cover **113** is surrounded with a tripod **1131**. The tripod **1131** and the bottom cover **113** are of one-piece structure. The tripod **1131** includes a ring connection plate **1132** and a plurality of support parts **1133**. The support parts **1133** are arranged in a ring shape uniformly on the outer side of the ring connection plate **1132**. Each of the support parts **1133** has a support hole **11331** in the middle thereof. The support holes **11331** are for assembling the foot pad, and the shape of the support parts **1133** are not limited. The number of the support parts **1133** is three or more, and the support parts **1133** are arranged at an equal interval. If the number of the support parts **1133** is three, the support parts **1133** are in a triangular arrangement, and the edge between two support parts **1133** includes a flanging **1134**.

The bottom cover **113** includes a joint portion **1135** that corresponds to an inner wall of the main shell **111**, and the joint portion **1135** is bent in the shape of upside-down U shape. The joint portion **1135** is integrated with the ring connection plate **1132**, and when the joint portion **1135** of the bottom cover **113** is located within the bottom end of the main shell **111**, the bottom end of the main shell **111** is connected to the ring connection plate **1132**. The bottom cover **113** also includes a step portion **1136**. The step portion **1136** is connected to the joint portion **1135** and is a hollow structure.

The rotary compressor further includes a plurality of fixing members **114**. The fixing members **114** are disposed at a location where the ring connection plate **1132** and the bottom end of the main shell **111** are connected. The fixing member **114** is used for fixing the bottom cover **113** to the main shell **111**, and further, the fixing member **114** is a spot-welded structure and is welded between the ring connection plate **1132** and the bottom end of the main shell **111**.

The step portion **1136** of the bottom cover **113** includes a ring-shaped area **11361** and a recessed area **11362**, the recessed area **11362** is located at the ring-shaped area **11361** and is extended downwardly. Furthermore, the recessed area **11362** is a ring-shaped structure and is located at a center of the ring-shaped area **11361**. A radial end of the recessed area **11362** is connected to a radial outer end of the ring-shaped area **11361**, and the recessed area **11362** is a downwardly-extended structure. An outer diameter of the ring-shaped area **11361** is M1, an inner diameter of the recessed area **11362** is M2, and the following condition is satisfied: $2 \leq M1/M2 \leq 3$. The ring-shaped **11361** and the recessed area **11362** can be made of one-piece.

The motor **12** is located within the housing **11** and includes a stator **121** and a rotor **122**. The stator **121** is fixed on an inner wall of the main shell **111** of the housing **11**, and the rotor **122** is rotatably located inside the stator **121**. The motor **12** may be of various existing structural types available on the market and the structural type is not limited.

The compression pump **13** is located in the main shell **111** of the housing **11** and is located below the motor **12**. The compression pump **13** includes a cylinder **131**. The cylinder **131** is located in the main shell **111** of the housing **11**, and is located below the motor **12**. The cylinder **131** includes a first end surface **1311** and a second end surface **1312**. The cylinder **131** includes a compression chamber **1313** located in a center thereof, the compression chamber **1313** runs through the upper and lower ends. A wall of the compression chamber **1313** includes a vane groove **1314**, a spring hole **1315** and a suction hole **1316**. The spring hole **1315** is not fully penetrated through the wall of the compression chamber **1313**. The spring hole **1315** is communicated with the vane groove **1314**, the suction hole **1316**, the vane groove **1314** and the spring hole **1315** are independent of each other and are not communicated with each other. A ring **132** is rotatably located in the compression chamber **1313** of the cylinder **131**. A vane **133** is reciprocally moved in the vane groove **1314** of the cylinder **131**. A front end of the vane **133** and a peripheral surface of the ring **132** are in contact with each other, thus dividing the compression chamber **1313** into a suction region and a compression region. At least one spring **134** is disposed in the spring hole **1315**. The spring **134** is located at a rear end of the vane **133**, so that the front end of the vane **133** and the peripheral surface of the ring **132** are in contact with each other, and the rear end of the spring **134** is in contact with the inner wall of the main shell **111** of the housing **11**. The spring **134** can be extended and retracted within the spring hole **1315**, so that the front end of the vane **133** can be in contact with the ring **132** which is rotated eccentrically in the compression chamber **1313**, and then produce a reciprocal motion. An upper support **135** is disposed within the housing **11** and is located above the cylinder **131**. A lower support **136** is disposed within the housing **11** and is located below the cylinder **131**. A crankshaft **137** has an appropriate length and is extended along a longitudinal direction. The crankshaft **137** is disposed in the housing **11**, and the crankshaft **137** includes at least one eccentric portion **1371**. The eccentric portion **1371** is located at an appropriate distance from the lower end of the crankshaft **137**, so that the crankshaft **137** defines an upper shaft section **1372** and a lower shaft section **1373**. The upper shaft section **1372** is for the upper support **135** and the rotor **122** of the motor **12** to fit, and the lower shaft section **1373** is for the lower support **136** to fit, and each eccentric portion **1371** is for the ring **132** of the cylinders **131** to fit. Therefore, the crankshaft **137** is for the upper support **135**, the motor **13**, the ring **132** and the lower support **136** to fit.

The compression pump **13** may be of various commercially available configurations and is not limited to such configurations. Furthermore, there is no limit to the number of the cylinder **131** and ring **132**. The compression pump **13** can be a single-cylinder type, a double-cylinder type, a triple-cylinder or more than three cylinders can be used. The number of the cylinder **131** and the ring **132** can be correspondingly set to one, two, three or more than three. The number of the ring **132** is determined in accordance with the type of the cylinder **131**, and the ring **132** is rotationally disposed in the compression chamber **1313** of the cylinder **131**. In the figure, the compression pump **13** is a single-cylinder type.

Furthermore, an oil storage area **110** is formed between the second end surface **1312** of the cylinder **131** of the compression pump **13** and the bottom cover **113** of the housing **11**, which is used for storing refrigerant oil. An oil volume of the refrigerant oil in the oil storage area **110** is V, an inner diameter of the main shell **111** is M, a distance between the bottom surface of the bottom cover **113** and the bottom surface of the cylinder **131** of the compression pump **13** is H, the bottom surface of the cylinder **131** is the second end surface **1312** of the cylinder **131**, and a circumference is TT, and the following condition is satisfied: $25\% \leq V/(\pi(M/2)^2H) \leq 40\%$. Therefore, the overall filling volume of the oil and the refrigerant of the rotary compressor **1** can be reduced.

With the structure described above, it is further explained as follows:

In the embodiment, the rotary compressor **1** further includes a filter bottle **14**. The filter bottle **14** is made of metal and has an appropriate length extended in a longitudinal direction. An inner space **140** is formed in the filter bottle **14**. An inlet tube **141** is located at the top end of the filter bottle **14**, and at least one inner tube **142** is disposed inside the filter bottle **14**. The inner tube **142** extends to the outside of the filter bottle **14** and extends into the housing **11**, and is connected to the suction hole **1316** of the cylinder **131** of the compression pump **13**, so that the filter bottle **14** is located on one side of the housing **11**. The low-pressure gas (refrigerant) inside the filter bottle **14** is transferred to the suction hole **1316** of the cylinder **131** of the compression pump **13** through the inner tube **142**, and then transferred to the compression chamber **1313** to be continuously compressed to a certain pressure, and then output to the space located in the housing **11**.

In more detail, the inner tube **142** of the filter bottle **14** and the cylinder **131** of the compression pump **13** are connected, and a refrigeration cycle system is connected between the inlet pipe **141** of the filter bottle **14** and the outlet pipe **1121** of the housing **11** of the rotary compressor **1**. The number of the inner tubes **142** of the filter bottle **14** is not limited and can be determined by the type of the compression pump **13** (i.e., single-cylinder type, double-cylinder type, triple-cylinder type or more than three cylinder). The filter bottle **14** may be of various existing structural types on the market and is not limited to the structural type thereof.

In the embodiment, the rotary compressor **1** further includes an electrical connector assembly **15**. The electrical connector assembly **15** can be disposed in the main shell **111** or the top cover **112**. In the example of the figures, the electrical connector assembly **15** is disposed in the top cover **112** and is coupled to the motor **12**. The electrical connector assembly **15** may be of various existing structural types on the market and is not limited to the structural type thereof.

According to the structure described above, when the rotor **122** of the motor **12** rotates, the crankshaft **137** is driven to rotate eccentrically, so that the eccentric portion **1371** of the crankshaft **137** can drive the ring **132** to rotate in the compression chamber **1313** of the cylinder **131**, and the upper support **135** and the lower support **136** are supported by the upper shaft section **1372** and the lower shaft section **1373** of the crankshaft **137** and operate at high speed. And the compression pump **13** is in an operation status, so that the gas refrigerant is sucked into the compression chamber **1313** inside the cylinder **131** of the compression pump **13** and is continuously compressed to a certain pressure, and then the compressed refrigerant is discharged. However, in order to achieve a reduction in the amount of lubricating oil (refrigerant oil) and the refrigerant filled into the rotary compressor **1**, a design of oil-reduction bottom cover is proposed for all series of rotary compressors **1**, which is able to reduce the oil volume between the cylinder **131** and the bottom cover **113** by 55%, while maintaining the original performance (i.e., if the structure of the present disclosure is used, assuming that the refrigerant in the housing **11** is R290, and the original oil filling volume is 140 c.c., the filling volume can be reduced to 60 c.c.). It is defined that an oil storage area **10** is formed between the second end surface **1312** of the cylinder **131** of the compression pump **13** and the bottom cover **113** of the housing **11**, and the oil storage area **10** is for the storing refrigerant oil, and the oil volume of the refrigerant oil in the oil storage area **10** is V, the inner diameter of the main shell **111** of the housing **11** is M, and the distance between the bottom surface of the bottom cover **113** and the bottom surface of the cylinder **131** of the compression pump **13** is H. In more detail, the bottom surface of the bottom cover **113** is the inner bottom surface of the recessed area **11362** of the step portion **1136** of the bottom cover **113**, and the bottom surface of the cylinder **131** of the compression pump **13** is the second end surface **1312** of the cylinder **131** of the compression pump **13**, which means that the distance H is the distance between the second end surface **1312** of the cylinder **131** of the compression pump **13** and the inner bottom surface of the recessed area **11362** of the bottom cover **113**, and the circumference is IT, and the condition: $25\% \leq V/(\pi(M/2)^2H) \leq 40\%$ is satisfied. Under this condition, the space of the oil storage area **110** can be reduced, and the height level of the refrigerant oil still can be maintained, thereby reducing the refrigerant mixing into the refrigerant oil, the limited amount of refrigerant can produce the maximum capacity of the cold room, and the overall filling amount of the oil and refrigerant can be reduced, and the energy efficiency can be increased. There is no need to add additional additives (quality blocks, pads, etc.) in the bottom cover **113**, and the problems of previous technologies can be effectively solved. In addition, the design is in line with the trend of hydrocarbon refrigerants and has the feature of simplifying the assembly process, which helps the refrigerant to work optimally in the system. It should be noted that the structure of the rotary compressor **1** of the present disclosure is not only applicable to the rotary compressor **1** using R290 refrigerant, but also applicable to the rotary compressor **1** using other environmentally friendly refrigerants.

The present disclosure provides a rotary compressor **1** capable of reducing the oil filling of the compressor, reducing the amount of refrigerant dissolved in the oil, thereby effectively reducing the refrigerant charge, improving the safety of operation of the combustible refrigerant compressor, and enhancing the efficiency of the rotary compressor **1**.

Although the present disclosure has been described in considerable detail with reference to certain embodiments thereof, other embodiments are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the embodiments contained herein.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present disclosure without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the present disclosure cover modifications and variations of this disclosure provided they fall within the scope of the following claims.

What is claimed is:

1. A rotary compressor comprising:

a housing comprising a main shell, a top cover and a bottom cover;

a motor located in the housing;

a compression pump located in the housing and below the motor, the compression pump comprising:

a cylinder comprising a compression chamber in a center thereof, the compression chamber comprising a vane groove, a spring hole and a suction hole, wherein the spring hole is communicated with the vane groove;

a ring rotatably located in the compression chamber of the cylinder;

a vane reciprocally moved in the vane groove of the cylinder, a front end of the vane and a peripheral surface of the ring are in contact with each other;

at least one spring located at the spring hole of the vane, so that the front end of the vane is in contact with the peripheral surface of the ring;

an upper support located in the housing and above the cylinder;

a lower support located in the housing and below the cylinder; and

a crankshaft located in the housing and passed through the upper support, the motor, the ring and the lower support;

wherein the bottom cover is surrounded by a tripod, the tripod and the bottom cover is a one-piece structure, the tripod comprises a ring connection plate and a plurality of support parts, the support parts are arranged in a ring shape uniformly on an outside of the ring connection plate, each of the support parts comprises a support hole in a middle thereof;

wherein the cylinder comprises a first end surface and a second end surface, an oil storage area is formed between the second end surface of the cylinder of the compression pump and the bottom cover of the housing for storing refrigerant oil;

wherein an oil volume of the refrigerant oil is V, an inner diameter of the main shell is M, a distance between a bottom surface of the bottom cover and a bottom surface of the cylinder of the compression pump is H, and the following condition is satisfied:

$$25\% \leq V/(\pi(M/2)^2 H) \leq 40\%;$$

wherein the bottom cover comprises a step portion, the step portion comprises a ring-shaped area and a recessed area, wherein an outer diameter of the ring-shaped area is M1, an inner diameter of the recessed area is M2, and the following condition is satisfied:

$2 \leq M1/M2 \leq 3$, wherein the recessed area extends below the support parts.

2. The rotary compressor of claim 1, wherein the bottom cover comprises a joint portion, the joint portion is corresponded to an inner wall of the main shell and is bent in a shape of upside-down U shape, the joint portion is integrated with the ring connection plate, and when the joint portion of the bottom cover is located within the bottom end of the main shell, the bottom end of the main shell is connected to the ring connection plate, and the step portion is a hollow structure.

3. The rotary compressor of claim 1, wherein the tripod comprises at least three support parts, and each of the support parts is arranged at an equal interval.

4. The rotary compressor of claim 1, wherein an edge between two support parts comprises a flanging.

5. The rotary compressor of claim 2, further comprising a plurality of fixing members, wherein the fixing members are disposed at a location where the ring connection plate and a bottom end of the main shell are connected, and the fixing members are for fixing the bottom cover to the main shell.

6. The rotary compressor of claim 5, wherein each of the fixing members is a spot-welded structure and is welded between the ring connection plate and the bottom end of the main shell.

7. The rotary compressor of claim 2, wherein the recessed area is located at the ring-shaped area and is extended downwardly.

8. The rotary compressor of claim 7, wherein the recessed area is a ring-shaped structure and is located at a center of the ring-shaped area, a radial end of the recessed area is connected to a radial outer end of the ring-shaped area, and the recessed area is a downwardly-extended structure.

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