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(54) **Scroll compressor with a check valve**

(57) A scroll compressor with a sealed container comprises a check valve (14) arranged in an inlet path (11) and a spring (15,17,18,19) mounted in the inlet path and configured to urge the check valve (14) in the direction of an inlet pipe (3). The spring (15) (having an outer diameter (doa) on a check valve side (15a), an outer diameter (dob) on a seating surface side (15b), an inner diameter (dia) on the check valve side (15a), and an inner diameter (dib) on the seating surface side (15b)), and the check valve (14) (having an inner diameter (Di), an outer diameter (Do), a cup depth (h)) satisfy both Expressions 1 and 2, and Expression 3 is satisfied between a protrusion (1e) provided on the inlet path (11) and a height (H):

$$(Di - doa) < (Di - dob) \text{..... (Expression 1)}$$

$$(dib - Do) < (Di - dob) \text{..... (Expression 2)}$$

$$H < h \text{ ..... (Expression 3)}$$

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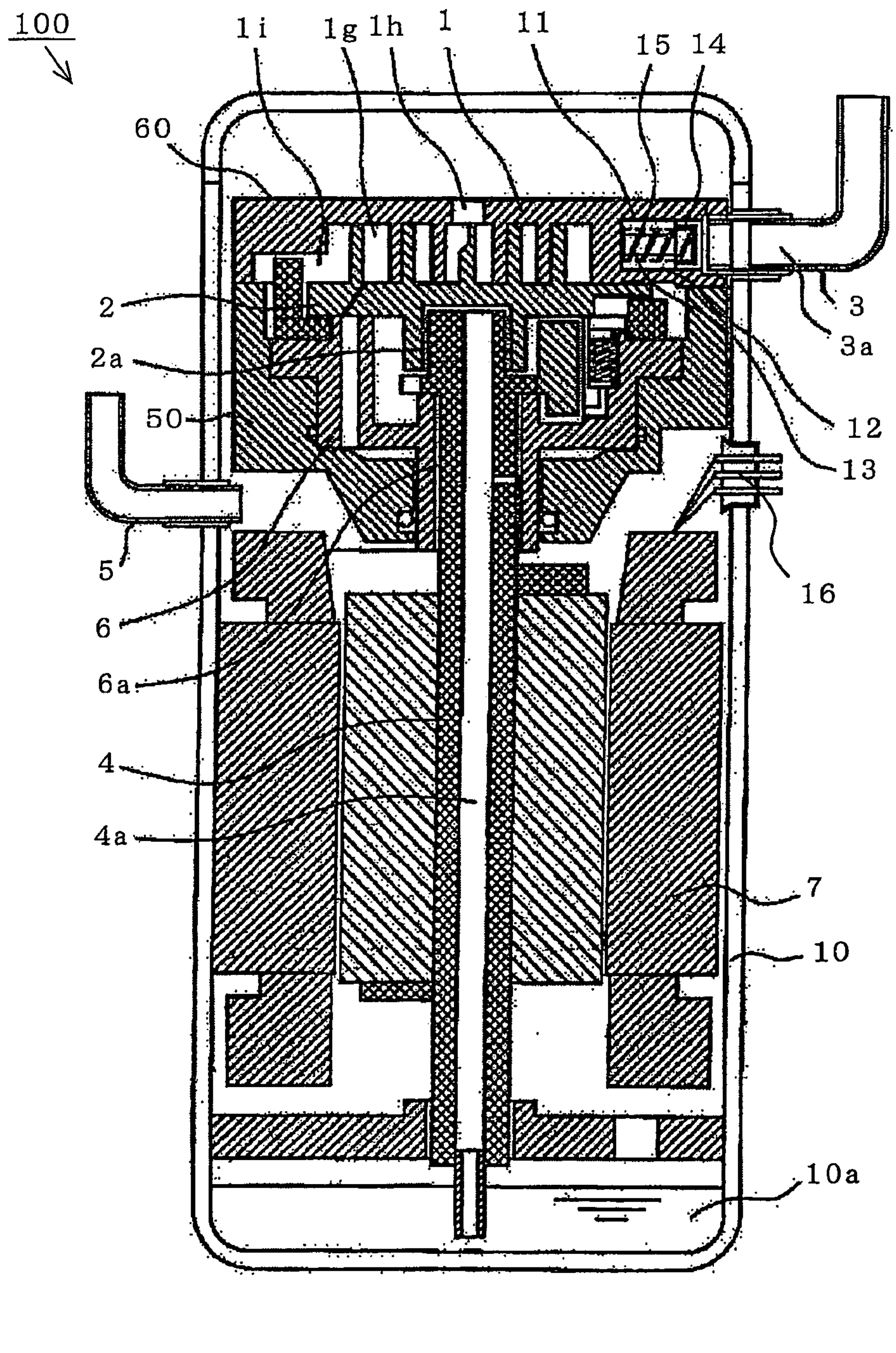
FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a scroll compressor configured to compress a refrigerant used in a refrigerating cycle apparatus or the like.

2. Description of the Related Art

[0002] In the related art, a scroll compressor equipped in a refrigerating cycle apparatus such as a refrigerator, an air conditioner, or a water heater includes a compressing chamber formed of a fixed scroll accommodated in a sealed container and a swing scroll configured to rotate in a state of facing the fixed scroll. The compression chamber is reduced in capacity gradually from an outer peripheral side to an inner peripheral side in association with the rotation of the swing scroll, so that refrigerant gas is sucked and compressed from the outer peripheral side of the compression chamber and is discharged from a central portion of the compression chamber into the sealed container.
At this time, the fixed scroll is provided with an inlet path penetrating therethrough from an outer periphery of a mirror plate in the radial direction, and the intake refrigerant gas is made to flow into the fixed scroll via the inlet path. The inlet path includes two concentric cylindrical surfaces having different inner diameters. An inlet pipe is connected to a large-diameter cylindrical surface, and an inlet hole which allows communication with an outer peripheral space of the compression chamber (in the circumferential direction) is formed on the small-diameter cylindrical surface (radial direction).
[0003] Arranged in the interior of the small-diameter cylindrical surface is a column-shaped check valve which moves by being guided by a small-diameter cylindrical surface and opens and closes an inlet opening of the inlet pipe. The check valve is urged by a spring in the closing direction, and hence inlet opening of the inlet pipe is closed when the scroll compressor is not in operation.
In contrast, when the operation of the scroll compressor is started, the refrigerant gas is discharged from the central portion of the compression chamber, so that the outer peripheral side of the compression chamber is brought into a negative pressure. Accordingly, the negative pressure acts on the check valve through the inlet hole provided on the small-diameter cylindrical surface, and hence the check valve moves toward a radial center of the compressor against an urging force of the spring, so that the opening of the inlet pipe is opened. Consequently, the refrigerant gas flows from the inlet pipe through the inlet path and is sucked into the compression chamber via the inlet hole (for example, see Japanese Patent No. 4321220 (pp. 4-5, Fig. 2)).
[0004] In the scroll compressor disclosed in Japanese Patent No. 4321220 (pp. 4-5, Fig. 2), an opposite phase preventing relay is normally activated so as not to supply electric power to the scroll compressor. In other words, for example, when a unit such as an air conditioning unit is installed, if there are errors in the wiring of the terminals of the unit (such that the order of phases of a three-phase power source is shifted, so-called "opposite phase"), the opposite phase preventing relay is normally activated.
However, there is a case where even when the opposite phase preventing relay is activated and hence the scroll compressor is not started, the scroll compressor is forcibly activated by causing the opposite phase preventing relay to short or removing the opposite phase preventing relay.
[0005] In such a case, the scroll compressor is started in a state in which the order of the phases of the three-phase power source is shifted, in a so-called "opposite phase", and the swing scroll performs a "reverse operation", which is an operation to rotate in the direction opposite from the normal rotation. When the scroll compressor performs the reverse operation continuously, a compression mechanism portion performs an action to expand the refrigerant instead of an action to compress the refrigerant.
Therefore, the refrigerant is forcibly made to flow from the discharge side to the inlet side in the compression chamber (reverse flow from the central side to the outer peripheral side). In this case, the refrigerant flows in the reverse direction from the inlet hole into the small-diameter cylindrical surface, and then hits against and reflects from the check valve in the small-diameter cylindrical surface, so that a flow of the refrigerant returning from the inlet hole to the compression chamber in turn is generated.
[0006] In this manner, by the reverse flow of the refrigerant from the inlet hole into the small-diameter cylindrical surface, the spring is made to contract by the reverse flow of the refrigerant,, so that the contracted spring may project from the inlet hole and penetrate into the compression chamber together with the refrigerant and may be caught between the fixed scroll and the swing scroll. Accordingly, a configuration in which a check valve and a spring are integrated is proposed as a countermeasure against the projection of the spring (for example, see Japanese Unexamined Patent Application Publication No. 2010-127244 (p. 5, Fig. 4)).
[0007] However, according to the invention disclosed in Japanese Unexamined Patent Application Publication No.

2010-127244 (p. 5, Fig. 4), since the movement of the spring on the seated side, which is an opposite-from-check-valve side, is not controlled, there are problems such that the check valve may crush and damage the spring may when the check valve opens, or an inner peripheral surface of the check valve and an outer peripheral surface of the spring are brought into friction.

[0008] There is also a problem in that the opposite-from-check-valve side of the spring projects out from the inlet path (via the inlet hole) and penetrates the compression chamber and may be caught by scrolls (the fixed scroll and the swing scroll).

[0009] Therefore, there is a configuration in which a protrusion is provided as a method of controlling the movement of the spring on the seated side (for example, see Japanese Unexamined Patent Application Publication No. 11-132164 (pp. 4-5, Fig. 7)).

[0010] In the invention disclosed in Japanese Unexamined Patent Application Publication No. 11-132164 (pp. 4-5, Fig. 7), design and machining of a part between the inlet path and the inlet hole are difficult, so that a protrusion cannot be provided in the inlet hole of the scroll compressor. However, when the refrigerant is forcibly made to flow in the reverse direction as in reverse operation, although the projection of the spring is prevented by the provision of the protrusion in the inlet path, since the spring is heavily moved, there arises a problem in that the check valve may crush and damage the opposite-check-valve side of the spring when the check valve opens, and the inner peripheral surface of the check valve and the outer peripheral surface of the spring are brought into friction, so that the coil of the spring in friction may be scraped and broken.

SUMMARY OF THE INVENTION

[0011] In order to solve the above-described problems, it is an object of the invention to provide a scroll compressor in which projection of a spring of a check valve from an inlet path at the time of reverse operation and a crush of the spring by the check valve, and friction between an inner peripheral surface of the check valve and an outer peripheral surface of the spring are prevented, so that reliability is improved.

[0012] A scroll compressor according to the invention includes a movable check valve and a spring configured to come into abutment with the check valve so as to urge the same arranged in an inlet path, and is characterized in that the spring has a shape such that an outer diameter of an end coil which comes into abutment with a spring seating surface on the opposite side from the check valve is smaller than an outer diameter of an end coil, which comes into abutment with the check valve, of the spring, and is attached with a protrusion formed on the spring seating surface inserted into the interior of the spring.

[0013] The scroll compressor according to the invention includes the movable check valve and the spring configured to come into abutment with the check valve to urge the same arranged in the inlet path, and the spring has a shape such that the outer diameter of the end coil which comes into abutment with the spring seating surface formed in the inlet path on the opposite side from the check valve is smaller than the outer diameter of the end coil, which comes into abutment with the check valve, of the spring and is attached to the inlet path by inserting the protrusion provided on the spring seating surface into the interior of the spring. Therefore, when the electric motor performs an operation of reverse rotation, the spring is prevented from projecting from the inlet path of the spring and, when the check valve is moved toward the spring seating surface, the seating surface side of the spring can be prevented from being crushed, and friction between the inner peripheral surface of the check valve and the outer peripheral surface of the spring which has been generated at the time of movement of the check valve of the related art can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a vertical cross-sectional view for explaining a configuration of a scroll compressor according to Embodiment 1 of the invention.
Fig. 2 is an enlarged vertical cross-sectional view illustrating part (near an inlet path) of the scroll compressor shown in Fig. 1;
Fig. 3 is an enlarged vertical cross-sectional view illustrating part (near the inlet path of a fixed scroll) of the scroll compressor shown in Fig. 1;
Fig. 4 is an enlarged vertical cross-sectional view illustrating part (near the inlet path) of the scroll compressor shown in Fig. 1;
Fig. 5 is an enlarged vertical cross-sectional view illustrating part (near the inlet path) of the scroll compressor for explaining a configuration of a scroll compressor according to Embodiment 2 of the invention;
Fig. 6 is an enlarged vertical cross-sectional view illustrating part (near the inlet path) of the scroll compressor for explaining a configuration of a scroll compressor according to Embodiment 3 of the invention;

Fig. 7 is an front view illustrating an extracted part (spring) of a scroll compressor according to Embodiment 4 of the invention;

Fig. 8A is a vertical cross-sectional view illustrating a normal mount of the spring of the scroll compressor according to Embodiment 4 of the invention;

Fig. 8B is a vertical cross-sectional view illustrating a wrong mount of the spring of the scroll compressor according to Embodiment 4 of the invention; and

Fig. 9 is a vertical cross-sectional view illustrating a state in which the spring of the scroll compressor according to Embodiment 4 of the invention is compressed to a maximum extent.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Embodiment 1: Scroll Compressor]

[0015] Figs. 1 to 4 are drawings for explaining a configuration of a scroll compressor according to Embodiment 1 of the invention, in which Fig. 1 is a vertical cross-sectional view illustrating the entirety of the scroll compressor, Fig. 2 is an enlarged vertical cross-sectional view illustrating part (near an inlet path) of the scroll compressor, Fig. 3 is an enlarged vertical cross-sectional view illustrating part (near the inlet path of a fixed scroll) of the scroll compressor, and Fig. 4 is an enlarged vertical cross-sectional view illustrating part (near the inlet path) of the scroll compressor. The respective drawings are diagrammatically illustrated, and the shapes and the sizes of the respective components are not limited to those illustrated in the drawings. The same parts or corresponding parts are designated by the same reference numerals and repeated description is avoided.

[0016] In Fig. 1, a scroll compressor 100 includes a compressor mechanism portion 60 and an electric motor 7 made up of a stator and a rotor both arranged in a sealed container 10.

The compressor mechanism portion 60 and the electric motor 7 are coupled by a drive shaft 4 which transmits a rotational force generated by the electric motor 7 to the compressor mechanism portion 60.

The compressor mechanism portion 60 includes a fixed scroll 1 having plate-shaped spiral tooth on one side of a mirror plate, a swing scroll 2 having a plate-shaped spiral tooth of the same shape and a bearing 2a, a compliant frame 6, and a frame 50.

(Inlet Path)

[0017] In Fig. 2, an inlet path 11 configured to introduce a refrigerant to a compression chamber 1 g defined by the fixed scroll 1 and the swing scroll 2 is formed on an outer peripheral side of the fixed scroll 1, and a discharge opening 1 h for discharging the compressed refrigerant into the sealed container 10 is formed at a center of the fixed scroll 1 (see Fig. 1).

The inlet path 11 is a path formed so as to penetrate from an outer periphery of the fixed scroll 1 to the compression chamber 1g and configured to introduce the refrigerant directly from the inlet pipe 3 to the compression chamber 1g, and includes a cylindrical path 12 defined by a substantially cylindrical shaped depression formed radially from an outer periphery of the mirror plate of the fixed scroll 1 and an inlet hole 13 formed from an inner peripheral surface of the cylindrical path 12 toward an outer peripheral space of the compression chamber so as to penetrate therethrough (in the circumferential direction).

[0018] The cylindrical path 12 includes coaxial cylindrical surfaces having three different diameters, in which a first cylindrical surface 1a on an open end of the cylindrical path 12 corresponds to an inlet pipe connecting portion 12a, and a second cylindrical surface 1b and a third cylindrical surface 1c correspond to a check valve sliding portion 12b. The inner diameter of the first cylindrical surface 1a is larger than that of the second cylindrical surface 1 b.

In Fig. 3, the cylindrical path 12 includes the check valve sliding portion 12b (the second cylindrical surface 1 b and the third cylindrical surface 1 c), a spring seating surface 1 d configured to close an end surface of the third cylindrical surface 1c in the direction of an axis of a cylindrical surface, and a cylindrical projection 1e projecting toward a check valve 14 provided on the spring seating surface 1d.

(Check Valve, Spring)

[0019] An inlet pipe 3 to be inserted through the sealed container 10 is connected to the inlet pipe connecting portion 12a. The check valve 14 and a spring 15 are accommodated in the check valve sliding portion 12b.

The check valve 14 is movable by being guided by the second cylindrical surface 1b, and is formed into a cup shape for preventing the reverse flow of the refrigerant.

One end of the spring 15 abuts the spring seating surface 1 d in the inlet path 11, the other end of the spring 15 penetrates the check valve (cup) 14 from an open end 14c and comes into abutment with an inner surface (bottom surface of the cup) 14b of a closing panel, thereby urging the check valve 14 in the direction for closing an opening of the inlet pipe 3. Then, the spring 15 has a tapered shape, and is fitted on an outer periphery of the protrusion 1e with a small-diameter end (hereinafter, referred to as "seating surface side") 15b having a smaller outline located on the side of the spring seating surface 1d.

[0020] In the check valve sliding portion 12b configured as described above, the check valve 14 presses the spring 15 against its urging force (is compressed) and releases the inlet pipe 3 from the state of being closed when the compressor is performing normal rotation operation. Accordingly, the inlet path 11 and the inlet pipe 3 are brought into communication with each other and the refrigerant is sucked from the inlet pipe 3 into the cylindrical path 12 of the inlet path 11, and is sucked into the compression chamber 1g through the inlet hole 13.

In contrast, when the compressor is stopped, the check valve 14 closes the opening of the inlet pipe 3 through the urging force of the spring 15 to prevent reverse flow of the refrigerant.

(Operation: Normal Operation)

[0021] Subsequently, the operation will be described. When the operation of the scroll compressor 100 is started, the compression chamber 1g is made to have a negative pressure, and intake refrigerant gas is introduced therein. At this time, the negative pressure acts on the check valve 14 via the inlet hole 13 and the cylindrical path 12, and the check valve 14 moves toward a radial center of the scroll compressor 100 against the urging force of the spring 15.

Accordingly, the inlet pipe 3 is released from being in the closed state, and the inlet pipe 3 and the inlet path (the cylindrical path 12 and the inlet hole 13) are brought into communication, whereby the refrigerant gas is taken into the sealed container 10 via the inlet pipe 3. The refrigerant gas flows into the outer peripheral portion (a compression chamber outer peripheral space 1 i) of the compression chamber 1g via the inlet path 11 (the cylindrical path 12 and the inlet hole 13). Subsequently, the refrigerant gas is compressed using a rotational force provided by the electric motor 7 via the drive shaft 4, and is discharged from the discharge opening 1 h formed at a central portion of the fixed scroll 1 into the sealed container 10 in a high-pressure state.

The interior of the sealed container 10 is filled with high pressure atmosphere by high-pressure refrigerant gas discharged into the sealed container 10, and the high-pressure refrigerant gas is discharged out from the sealed container 10 via a drain pipe 5 provided in a body portion of the sealed container 10.

[0022] Lubricant 10a is stored in a bottom portion of the sealed container 10, and a lower end of the drive shaft 4 is immersed in the lubricant 10a. The drive shaft 4 is formed with a lubrication hole 4a at a center thereof, and the bottom portion of the sealed container 10 is bought into communication with the compression chamber outer peripheral space 1i via the lubrication hole 4a, the bearing 2a, and a main bearing 6a.

During the operation of the scroll compressor 100, the interior of the sealed container 10 is filled with the high-pressure atmosphere. Therefore, the lubricant 10a rises in the lubrication hole 4a by the pressure difference between the high-pressure atmosphere and the low-pressure atmosphere of the intake refrigerant gas to lubricate the bearing 2a provided on the swing scroll 2 and the main bearing 6a provided on the compliant frame 6, and then is introduced to the compression chamber outer peripheral space 1i.

(Action: Operation of Reverse Rotation)

[0023] Subsequently, an action of the structure of a characteristic portion of Embodiment 1 of the invention will be described. In the scroll compressor 100 configured as described above, when using a three-phase or a single-phase induction motor as the electric motor 7, there is a case where the electric motor 7 performs a reverse operation during testing in a manufacturing line due to a connection error or the like of an operation condenser in the three-phase induction motor when assembling a unit (for example, an air-conditioning unit).

In the case of a brushless D motor driven by an inverter, since a normal drive circuit (not illustrated) includes a protection circuit which blocks distribution of electricity to the brushless DC motor upon detection of the reverse phase of the power source built therein, if there is a connection error between power source terminals and glass terminals 16 of the scroll compressor 100 (see Fig. 1), the scroll compressor 100 is not started. However, in a case where the protection circuit configured to block the distribution of electricity to the brushless DC motor upon detection of the reverse phase of the power source is not built in the drive circuit, if there is a connection error between the power source terminals and the scroll compressor, the scroll compressor may rotate in the reverse direction.

[0024] By connecting three power source terminals (U-phase, V-phase, and W-phase) to the glass terminals 16 of the scroll compressor (see Fig. 1) correctly when connecting the three-phase induction motor, the electric motor 7 is brought into a predetermined operation of normal rotation. However, when the U-phase is mistaken for the V-phase (that is, the V-phase of the power source is connected to a U-phase coil and the U-phase of the power source is connected to a V-phase coil), the electric motor 7 rotates in the opposite direction (operation of reverse rotation) with respect to the operation of normal rotation, which is a rotation in the predetermined direction.

Also, normally when connecting the single-phase induction motor, the operation condenser is connected to an auxiliary winding in series, and a series circuit thereof is connected to a main winding in parallel. When the operation condenser is connected to the main winding and the series circuit is connected to the auxiliary winding in parallel due to the connection error of the operation condenser, the electric motor 7 performs an operation of reverse rotation, in which the electric motor 7 rotates in the reverse direction, which is an opposite direction from that of the operation of normal rotation in the predetermined direction.

[0025] Subsequently, the operation of reverse rotation caused by a connection error at the installation of the outdoor unit having the scroll compressor 100 mounted thereon and an air-conditioning unit (not illustrated) having an indoor unit therein will be described. In this case, the scroll compressor 100 in which the three-phase induction motor is used as the electric motor 7 is exemplified for description.

When the electric motor 7 is a brushless DC motor driven by the inverter, if there is no protection circuit configured to block distribution of electricity to the brushless DC motor upon detection of the opposite phase of the power source built in the drive circuit, the electric motor in the scroll compressor performs the operation of reverse rotation when the order of the phase is shifted when connecting the three-phase power source to the power source connection terminals of the outdoor unit at the time of installation.

In the case of the scroll compressor in which the single-phase induction motor is used as the electric motor 7, even when the order of the phases (two phases) is shifted when connecting a single-phase power source to the power source connecting terminal of the outdoor unit at the time of installation, the operation of reverse rotation of the electric motor 7 does not occur, but the operation of reverse rotation due to the connection error occurs at the time of service (replacement) of the operation condenser after installation.

[0026] When the scroll compressor 100 performs the operation of reverse rotation in the cases described above, the refrigerant is forcibly made to flow in the reverse direction from the discharge side to the intake side. At this time, the refrigerant flows from the inlet hole 13 toward the cylindrical path 12, and impinges against the spring 15. With the flow of the refrigerant as describe above, the spring 15 moves or contracts in the cylindrical path 12 of the inlet path 11. However, since the protrusion 1 e penetrating to the inside of the spring 15 is provided, the movement of the spring 15 is restricted, and the spring 15 is prevented from detaching from the inlet path 11. Accordingly, the problem of the spring 15 detaching from the inlet path 11 in an abnormal mode such as the operation in the opposite phase can be resolved. Accordingly, by restoring the power source to the normal connecting state after having released the reverse phase, the normal operation can be restarted, so that a scroll compressor with high reliability can be obtained.

However, in a case where the spring 15 has a straight shape, since the spring 15 repeatedly expands and contracts at a high speed when the refrigerant flows in the reverse direction as a result of preventing the spring 15 from detaching, an outer peripheral surface of the attached spring 15 and an inner peripheral surface of the check valve 14 are brought into friction, so that the wire rod which forms the coil of the spring 15 may be scraped or worn down, thereby causing the wire rod to fracture, that is, the spring 15 to break. Therefore, the spring 15 is formed to have a tapered shape to prevent such breakage.

[0027] In Fig. 4, the spring 15 has a tapered shape, and reference signs showing dimensions indicate the following.

doa: outer diameter of a check valve side 15a of the spring 15
dob: outer diameter of the seating surface side 15b of the spring 15
dia: inner diameter of the check valve side 15a of the spring 15
dib: inner diameter of the seating surface side 15b of the spring 15
Di: inner diameter of the check valve 14
Do: outer diameter of the protrusion 1 e
H: height of the protrusion 1e
h: depth of the cup of the check valve 14

Then, the spring 15 is characterized in that the respective dimensions satisfy both Expression 1 and Expression 2.

$$(Di - doa) < (Di - dob)\ldots\ldots \text{(Expression 1)}$$

$$(dib - Do) < (Di - dob)\ldots\ldots \text{(Expression 2)}$$

[0028] Since "h" is the depth of the cup of the check valve 14, that is, corresponds to the distance from the inner surface 14b of the closing panel 14a (which corresponds to an inner surface of the cup bottom) to the open end 14c (the length of an internal space of the check valve 14 in the axial direction) since the check valve 14 has a cup shape closed at one end thereof by the closing panel 14a (which corresponds to a cup bottom).

The height "H" of the protrusion 1 e is a height equal to or larger than the height which allows a spire of the spring 15 to be caught in the state in which the check valve 14 is closed, and is characterized by a structure satisfying Expression 3.

$$H < h \text{ ..... (Expression 3)}$$

[0029] In this manner, since the scroll compressor 100 includes the spring 15 having a tapered shape, the cylindrical protrusion 1e which projects in the direction of expansion and contraction of the spring 15 and is inserted into the interior of the spring 15 on the spring seating surface 1d in the inlet path 11, and is configured to satisfy the dimensional relationships defined in Expression 1 to Expression 3 described above, heavy and rough movement of the spring 15 at the time of the operation of reverse rotation is prevented. In addition, by forming the spring 15 so as to have the tapered shape which satisfies Expression 1 and Expression 2, breakage of the spring 15 due to the friction between the inner peripheral surface of the check valve 14 and the outer peripheral surface of the spring 15 can be prevented and damage incurred on the seating side of the spring 15 by being crushed by the check valve 14 can be prevented. Also, by employing the tapered shape as described above, an inner peripheral surface of the spring 15 is prevented from being brought into frictional contact with an outer peripheral surface of the cylindrical protrusion 1e so that the damage to the spring 15 can be prevented and smooth expansion and contraction are achieved. In other words, during normal operation, even when the check valve 14 is activated, the spring 15 does not have to work against the force of friction (frictional force) with respect to the inner peripheral surface of the check valve 14 or the outer peripheral surface of the protrusion 1e, and the operation is achieved sufficiently only with the urging force of the spring 15. Therefore, needless generation of force can be restrained.
In addition, since the inner peripheral surface of the check valve 14 and the outer peripheral surface of the spring 15 are not brought into frictional contact, or the inner peripheral surface of the spring 15 and the outer peripheral surface of the cylindrical protrusion 1e are not brought into frictional contact, a, spring lifetime equal to or longer than that of the related art is ensured with the wire rod formed by inexpensive materials or processing methods without using an expensive wire rod having high durability or a wire rod applied with a complex and expensive surface treatment such as soldering or coating for restraining abrasion of the wire rod, whereby the spring 15 with higher reliability and capable of long-term use is obtained.
The cylindrical protrusion 1e has been described to have a cylindrical shape having a uniform outer diameter from the spring seating surface 1d to a distal end of the protrusion 1 e. However, the outer diameter of the protrusion 1 e does not necessarily have to be uniform. For example, the protrusion 1e may have a tapered cylindrical shape having a smaller diameter on the side of the spring seating surface 1d. In this configuration, the spring 15 is prevented from detaching from the protrusion 1e. It is also possible to provide the connecting portion between the spring seating surface and the protrusion 1e with a groove for allowing an end coil portion of the spring 15 to engage therewith so as to allow the end coil portion of the spring 15 to engage therewith by being fitted thereto. In the same manner as the shape of the protrusion 1e, the spring 15 is prevented from easily detaching from the protrusion 1e. The groove in this case preferably has a width which is the same as the wire rod diameter of the spring 15 and a depth equal to or larger than 50% of the wire rod diameter of the spring 15. In other words, when the wire rod is fitted to the groove by 50%, since the wire rod diameter of the spring 15 is held by the width of the groove, an effect of engaging the end coil portion of the spring is sufficiently achieved.
Instead of being brought into abutment with or fixed to the inner surface 14b of the closing panel 14a of the check valve 14, a method of bringing the end coil portion of the spring 15 into abutment with or to be fixed to the inside of a side surface portion of the check valve 14 is also applicable. In other words, a method of increasing the diameter of the end coil portion of the spring 15 to a diameter slightly larger than the inner peripheral diameter of the check valve 14 to utilize an expanding force of the end coil portion as a side pressure so as to come into abutment with and be engaged with the side surface portion of the check valve 14 is also applicable. The spring 15 has a tapered shape, other parts of the spring does not come into contact with the side surface portion of the check valve 14 even when it is expanded or contracted. Therefore, the coil of the spring 15 is prevented from coming into friction and being shaved, or from being worn. The spring 15 may be engaged by being held by both of the side surface portion of the check valve 14 and the inner surface 14b of the closing panel 14a as a matter of course.
With the configuration described above, by restoring the power source to the normal connecting state after having released the operation of reverse rotation, the normal operation can be restarted, so that the scroll compressor 100 with high reliability can be obtained.

[Embodiment 2]

[0030] Fig. 5 is an enlarged vertical cross-sectional view illustrating part (near the inlet path) of the scroll compressor for explaining a configuration of a scroll compressor according to Embodiment 2 of the invention. The respective drawings are diagrammatically illustrated, and the shapes and the sizes of the respective components are not limited to those illustrated in the drawings. The same parts or corresponding parts as Embodiment 1 are designated by the same reference numerals and repeated description is avoided.

[0031] In Fig. 5, a scroll compressor 200 includes a spring 17 having a shape including a combination of two cylindrical springs having different outer diameters, which is easier to process than the spring 15 having a tapered shape provided in the scroll compressor 100.

In other words, the spring 17 includes a check-valve-side cylindrical spring portion (large diameter portion) 17a having several turns, and a seating-surface-side cylindrical spring portion (small diameter portion) 17b having several turns with an outer diameter smaller than an inner diameter of the check-valve-side cylindrical spring portion 17a. Therefore, in the same manner as the spring 15, a crush of the seating surface side 17b of the spring 17 by the check valve 14 or friction between the inner peripheral surface of the check valve 14 and an outer peripheral surface of the spring 17 can be prevented.

[0032] The shape of the spring 17 is the shape of the combination of the check-valve-side cylindrical spring portion 17a and the seating-surface-side cylindrical spring portion 17b, and the reference signs showing dimensions indicate the follows.

doa: outer diameter of the check-valve-side cylindrical spring portion 17a of the spring 17

dob: outer diameter of the seating-surface-side cylindrical spring portion 17b of the spring 17

dia: inner diameter of the check-valve-side cylindrical spring portion 17a dib: inner diameter of the seating-surface-side cylindrical spring portion 17b Di: inner diameter of the check valve 14

Do: outer diameter of the protrusion 1 e

La: length of the check-valve-side cylindrical spring portion 17a of the spring 17 in a state in which the check valve 14 is closed.

Lb: length of the seating-surface-side cylindrical spring portion 17b in a state in which the check valve 14 is closed.

H: height of the protrusion 1e

h: distance between the inner surface 14b of the closing panel 14a of the check valve 14 and the open end 14c of the check valve 14 (the length of the internal space of the check valve 14 in the axial direction)

The respective dimensions have relationships from Expression 4 to Expression 6.

$$(Di - doa) < (Di - dob) \text{..... (Expression 4)}$$

$$(dib - Do) < (Di - dob) \text{..... (Expression 5)}$$

$$La \leq h \text{ ..... (Expression 6)}$$

In addition, the height "H" of the protrusion 1e is a height equal to or larger than the height which allows a spire of the seating-surface-side cylindrical spring portion 17b of the spring 17 to be caught in the state in which the check valve 14 is closed, and is characterized by a structure satisfying the dimensional relationship of the expression H < h.

$$H < h \text{ ..... (Expression 7)}$$

Accordingly, the same effects as the spring having a tapered shape are obtained with the spring which can be manufactured with an inexpensive design process.

With the configuration described above, by restoring the power source to the normal connecting state after having released the operation of reverse rotation, the normal operation can be restarted, so that the scroll compressor with high reliability can be obtained.

[Embodiment 3]

[0033] Fig. 6 is an enlarged vertical cross-sectional view illustrating part (near the inlet path) of the scroll compressor for explaining a configuration of a scroll compressor according to Embodiment 3 of the invention. The respective drawings are diagrammatically illustrated, and the shapes and the sizes of the respective components are not limited to those illustrated in the drawings. The same parts or corresponding parts as Embodiment 1 are designated by the same reference numerals and repeated description is avoided.

[0034] In Fig. 6, a scroll compressor 300 includes a spring 18 having a tapered shape instead of the spring 15 provided in the scroll compressor 100.
The tight-contact height of the spring 18 is "Hs" which is smaller than the depth of the cup of the check valve 14 "h (the distance from the inner surface 14b of the closing panel 14a to the open end 14c)". In other words, it satisfies Expression 8.

$$Hs < h \text{ ..... (Expression 8)}$$

[0035] Here, the tight-contact height Hs is a height of the entire spring 18 in a state in which the spring 18 is pressed and compressed and the coils come in contact with each other. When the spring 18 is pressed to the tight-contact height Hs, an excessive stress is generated in the spring 18.
In Fig. 6, when the check valve 14 is pressed to a maximum extent against the urging force of the spring 15, the open end 14c of the check valve 14 comes into abutment with the spring seating surface 1d. Therefore, the length of the space which houses the spring 18 becomes the depth "h" of the cap of the check valve 14. In other words, the spring 18 can be contracted to the length "h" when it is compressed to a maximum extent.
Therefore, on the condition that the length h of the space housing the spring is shorter than the tight-contact height Hs of the spring 18, an excessive stress is generated in the spring 18, and if the pressing is repeated for a long time, the spring 18 is at risk of breakage. However, the scroll compressor 300 has a form which satisfies Expression 8, the spring 18 is not contracted to the tight-contact height Hs, and contact (press contact) between adjacent parts of the wire rod of the coil is prevented. In other words, the adjacent parts of the wire rod of the coil can be prevented from damaging each other.
In addition, since the adjacent parts of the wire rod of the coil do not damage each other, the lifetime of the spring equal to or longer than that of the related art is ensured with the coil using the wire rod formed by the inexpensive material or the processing without using the expensive wire rod having high durability or the wire rod applied with the complex and expensive surface treatment such as soldering or coating for the surface protection of the wire rod, whereby the spring with higher reliability also for the long-time use is obtained.

[0036] Subsequently, an action of the structure of a characteristic portion of the scroll compressor 300 will be described. The operation of a compression mechanism is the same as that of the scroll compressor 100 (Embodiments 1 and 2). When the scroll compressor 300 is in operation, the refrigerant gas flows in the inlet path 11, and the check valve 14 is pressed in the direction against the urging force of the spring 18. At this time, even in a state in which the check valve 14 is pressed to a maximum extent and the open end 14c of the check valve 14 comes into abutment with the spring seating surface 1 d, the spring 18 is not contracted to the tight-contact height Hs. As described above, in the scroll compressor 300, by setting the distance h between the spring seating surface 1d and the closing panel 14a of the check valve 14 in a state in which the check valve 14 is pressed to a maximum extent in the direction against the urging force of the spring 18 to be larger than the tight-contact height Hs of the spring 18, the spring 18 is not caused to generate an excessive stress, and the adjacent parts of the wire rod of the coil are prevented from coming into contact with and pressing each other and hence scraping or damaging each other even when the spring 18 is contacted to the tight-contact height, so that the scroll compressor 100 with still higher level of reliability than those in Embodiments 1 and 2, which can prevent the spring 18 from being damaged in the long-term usage can be obtained.

[Embodiment 4]

[0037] Fig. 7 to Fig. 9 are drawings for explaining a configuration of a scroll compressor according to Embodiment 4 of the invention, in which Fig. 7 is a front view illustrating an extracted part (spring) of the scroll compressor, Fig. 8A is a vertical cross-sectional view illustrating a normal mount of the spring, Fig. 8B is a vertical cross-sectional view illustrating a wrong mount of the spring, and Fig. 9 is a vertical cross-sectional view illustrating a state in which the spring is compressed to a maximum extent. The respective drawings are diagrammatically illustrated, and the shapes and the sizes of the respective components are not limited to those illustrated in the drawings. The same parts or corresponding parts as Embodiment 1 are designated by the same reference numerals and repeated description is avoided.

[0038] In Fig. 7, a scroll compressor 400 includes a spring 19 instead of the spring 15 provided in the scroll compressor 100.
The spring 19 is bent inward (toward the center axis) at the end of turn on a check valve side 19a and is formed with a linear bent portion 19c continuing from the end of turn.

Therefore, when the spring 19 is mounted in a normal position shown in Fig. 8A, an opposite-from-check-valve side 19b of the spring 19 is inserted into the protrusion 1e. In contrast, when an attempt is made to mount the spring 19 in the wrong position shown in Fig. 8B, the bent portion 19c formed on the check valve side 19a of the spring 19 climbs over (comes into abutment with) the top of the protrusion 1 e, so that the spring 19 cannot be mounted on the protrusion 1 e. Accordingly, with the spring 19, the problem of mounting upside down is resolved.

[0039] Also, as shown in Fig. 9, when an outer diameter of the wire rod which forms the spring 19 (the same as an outer diameter of the bent portion 19c) is expressed by "e", a relationship;

$$e < (h - H) \text{.... (Expression 9)}$$

is satisfied.

Therefore, even when the check valve 14 is pressed in to a maximum extent (the state in which the open end 14c of the check valve 14 is in abutment with the spring seating surface 1d), the bent portion 19c of the spring 19 is placed between the protrusion 1 e and the check valve 14 and is prevented from becoming damaged.

Although the spring 15 in Embodiment 1 is formed with the bent portion in the description given above, the invention is not limited thereto, and the bent portions may be formed on the spring 17 and the spring 18 in Embodiments 2 and 3.

With the configuration as described above, the scroll compressor with less assembly error at the time of assembly of the compressor is achieved, and a scroll compressor with high degree of reliability in which the spring is prevented from becoming damaged even when the check valve is pressed in to a maximum extent and a high reliability can be obtained even during the operation can be obtained.

REFERENCE SIGNS LIST

[0040] 1: fixed scroll, 1a: first cylindrical surface, 1b: second cylindrical surface, 1c: third cylindrical surface, 1d: spring seating surface, 1e: protrusion, 1g: compression chamber, 1 h: discharge opening, 1i: compression chamber outer peripheral space, 2: swing scroll, 2a: bearing, 3: inlet pipe, 4: drive shaft, 4a: lubrication hole, 5: drain pipe, 6: compliant frame, 6a: main bearing, 7: electric motor, 10: sealed container, 10a: lubricant, 11: inlet path, 12: cylindrical path, 12a: inlet pipe connecting portion, 12b: check valve sliding portion, 13: inlet hole, 14: check valve, 14a: closing panel, 14b: inner surface, 14c: open end, 15: spring (Embodiment 1), 15a: check valve side, 15b: seating surface side, 16: glass terminal, 17: spring (Embodiment 2), 17a: check-valve-side cylindrical spring portion, 17b: seating-surface-side cylindrical spring portion, 18: spring (Embodiment 3), 19: spring (Embodiment 4), 19a: check valve side, 19b: opposite-from-check-valve side, 19c: bent portion, 50: frame, 60: compressor mechanism portion, 100: scroll compressor (Embodiment 1), 200: scroll compressor (Embodiment 2), 300: scroll compressor (Embodiment 3), 400: scroll compressor (Embodiment 4), Di: inner diameter of a check valve, Do: outer diameter of a protrusion, dia: inner diameter of a check-valve-side cylindrical spring portion, dib: inner diameter of a seating-surface-side cylindrical spring portion, doa: outer diameter of the check-valve-side cylindrical spring portion, dob: outer diameter of the seating-surface-side cylindrical spring portion, e: spring diameter, h: length of the internal space of the check valve in the axial direction, H: height of the protrusion, Hs: tight-contact height.

Claims

1. A scroll compressor (100, 200, 300, 400) comprising:

   a sealed container (10);
   a fixed scroll (1) and a swing scroll (2) provided in the sealed container (10) and engaged each other so as to define a compression chamber (1g) by respective plate-shaped spiral teeth;
   a drive shaft (4) driving the swing scroll (2) and an electric motor (7) driving the drive shaft (4);
   a frame (50) that constitutes a compressor mechanism portion (60) in cooperation with the fixed scroll (1) and the swing scroll (2);
   an inlet pipe (3) inserted through the sealed container (10);
   an inlet path (11) provided at a position near an outer periphery of the fixed scroll (1) and to which the inlet pipe (3) is connected at a radially outer peripheral end of the fixed scroll (1);
   a check valve (14) arranged in the inlet path (11) so as to be movable and configured to be capable of closing an opening of the inlet pipe (3);
   a spring (15, 17, 18, 19) mounted in the inlet path (11) and configured to urge the check valve (14) in the direction

of the inlet pipe (3);
an inlet opening (13) formed on a side surface of the inlet path (11) in the circumferential direction so as to communicate with the compression chamber (1g);
a spring seating surface (1d) formed at a radially inner peripheral end of the inlet path (11) and with which one of end portions of the spring (15, 17, 18, 19) comes into abutment; and
a protrusion (1e) formed on the spring seating surface (1d) so as to protrude toward the check valve (14) and penetrate the interior of the spring (15, 17, 18, 19);
wherein an outer diameter of the end portion, which comes into abutment with the spring seating surface (1d), of the spring (15, 17, 18, 19) is smaller than an outer diameter of the end portion, which comes into abutment with the check valve (14), of the spring (15, 17, 18, 19).

2. The scroll compressor (200) of claim 1, wherein the outer diameter of the spring (15, 17, 18, 19) is changed smoothly or step-by-step from one of the end portions to the other end portion.

3. The scroll compressor (300) of claim 1 or 2, wherein the check valve (14) is a bottomed cylinder opened at one end and closed by a closing panel (14a) at the other end, and
the distance between the open one end and the closing panel (14a) is larger than a tight-contact height (Hs) of the spring (18).

4. The scroll compressor (400) of any one of claims 1 to 3, wherein a bent portion (19c) bent radially inward is formed at the end portion which comes into abutment with the check valve (14) of the spring (19).

FIG. 1

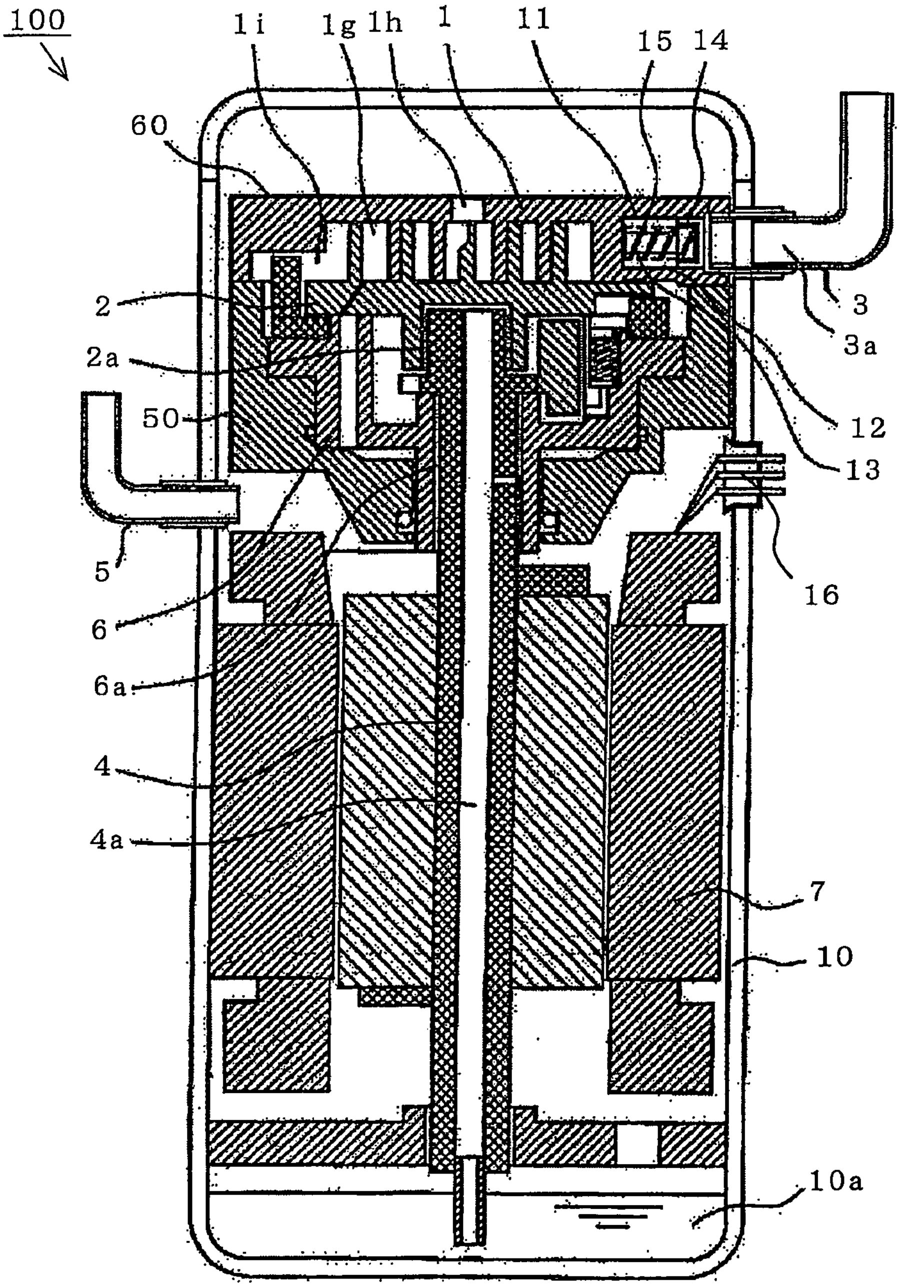


FIG. 2

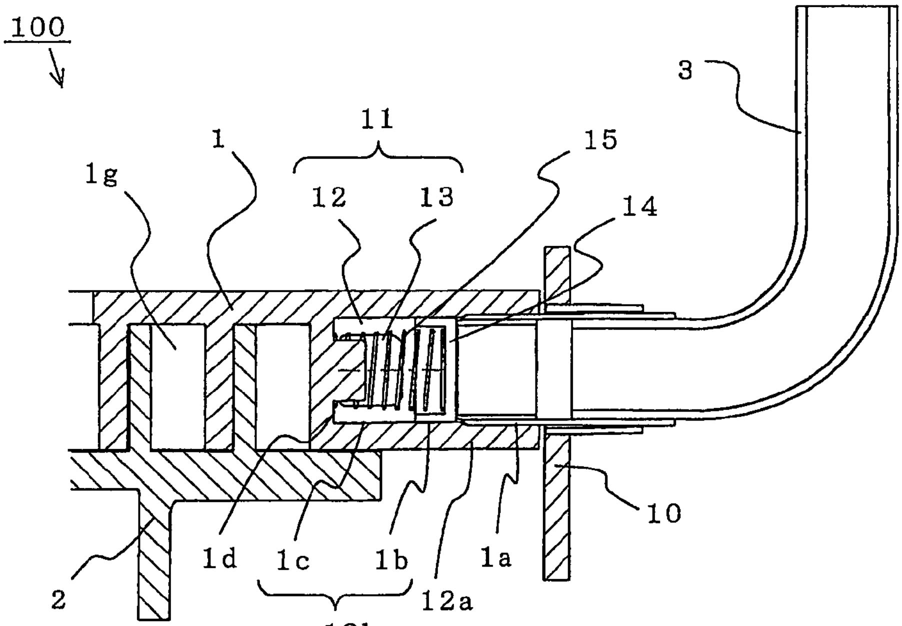

100
11
1
1g
12
13
15
14
3
10
2
1d
1c
1b
1a
12a
12b

FIG. 3

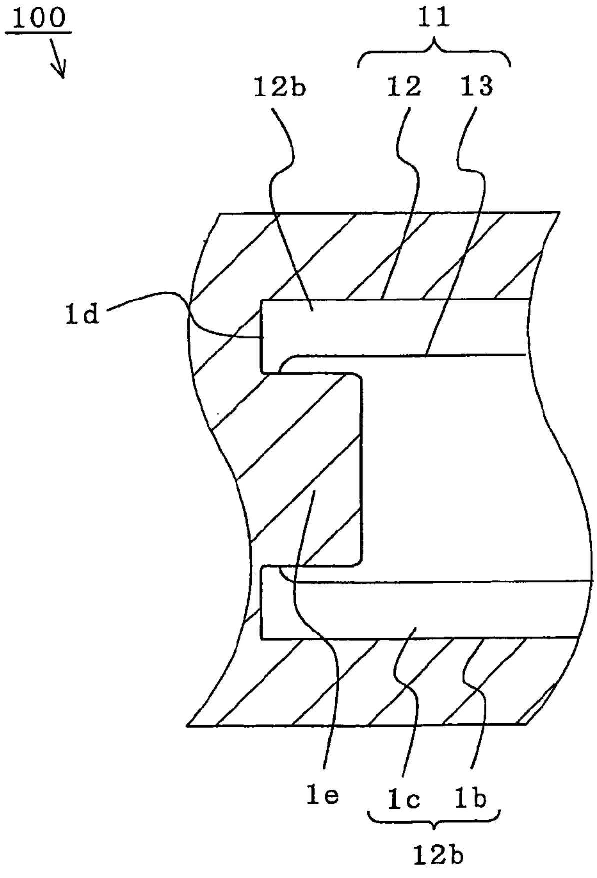
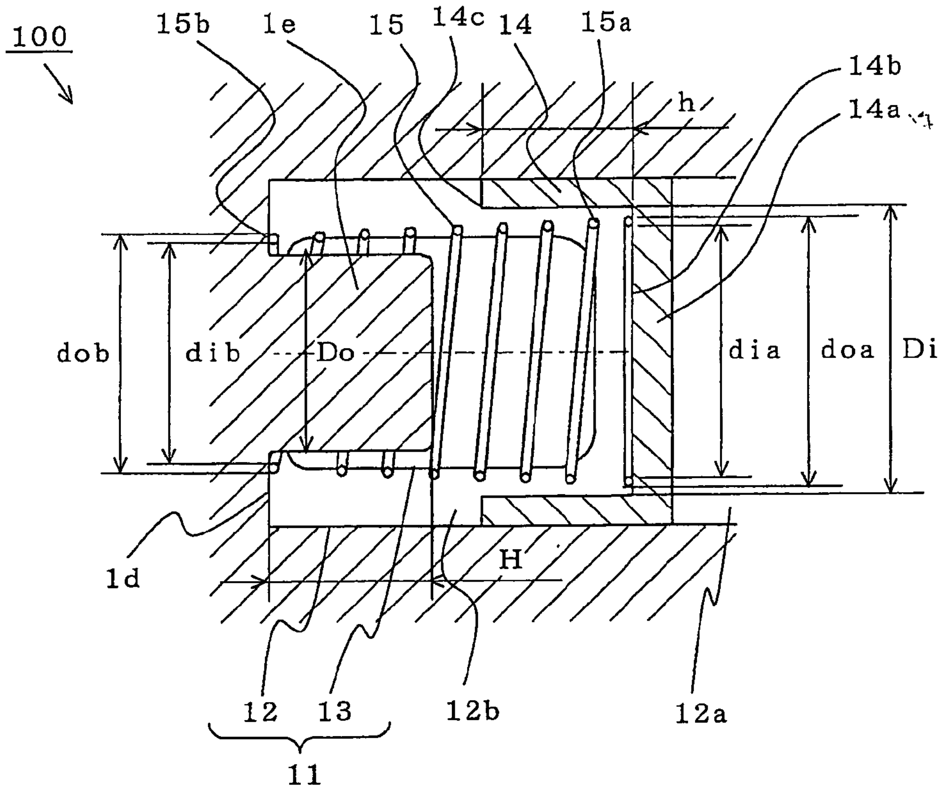

100
11
12b
12
13
1d
1e
1c
1b
12b

FIG. 4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15b
1e
15
14c
14
15a
14b
14a
h
dob
dib
Do
dia
doa
Di
1d
H
12
13
12b
12a
11

FIG. 5

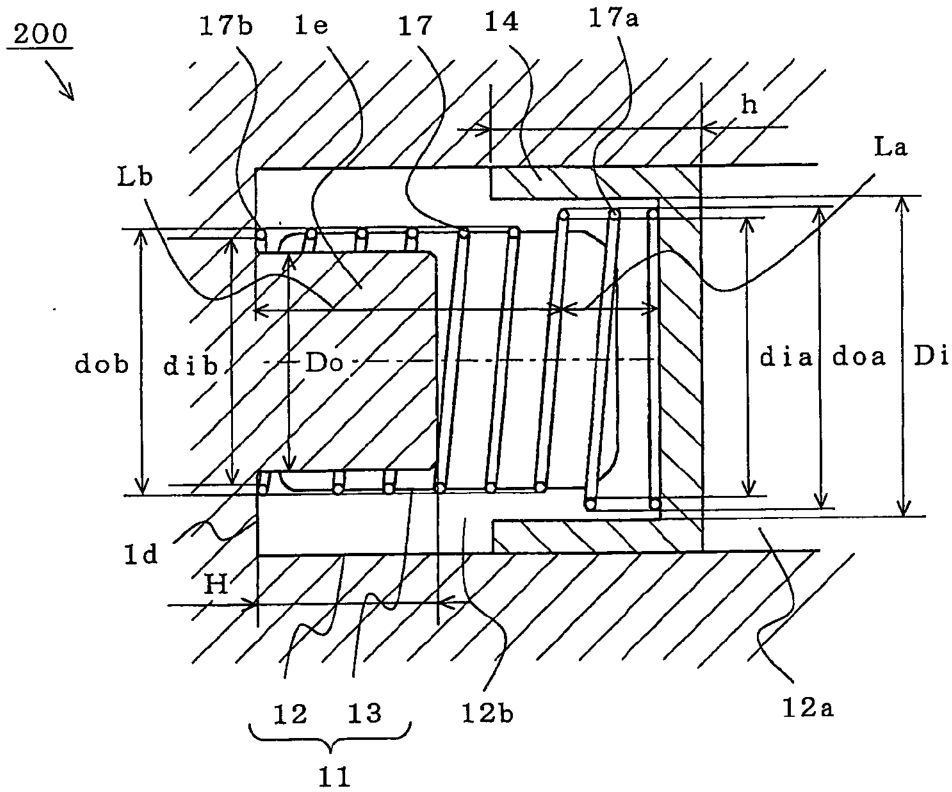

200
17b
1e
17
14
17a
h
La
Lb
dob
dib
Do
dia
doa
Di
1d
H
12
13
12b
12a
11

FIG. 6

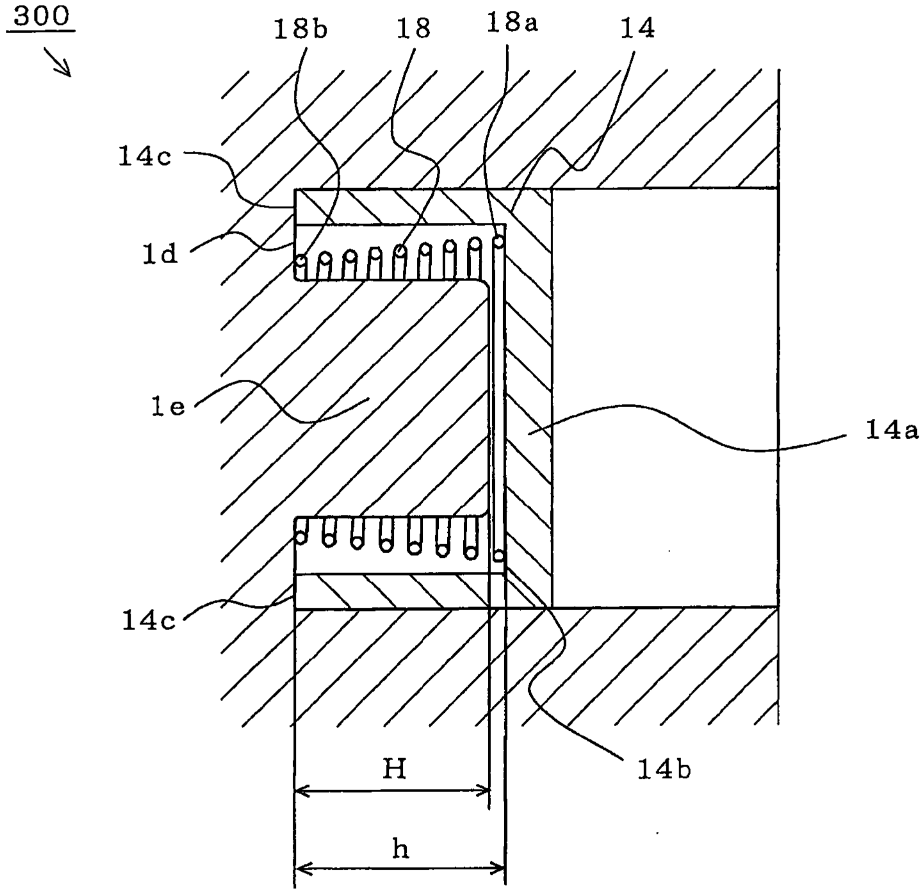


FIG. 7

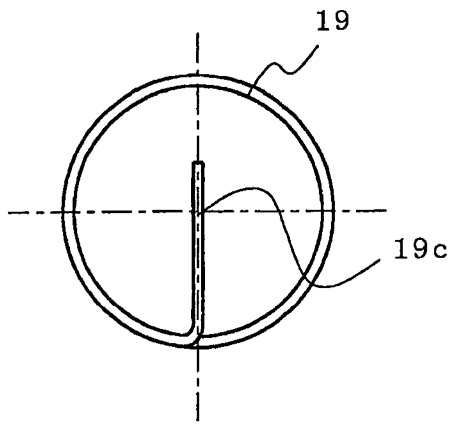


FIG. 8

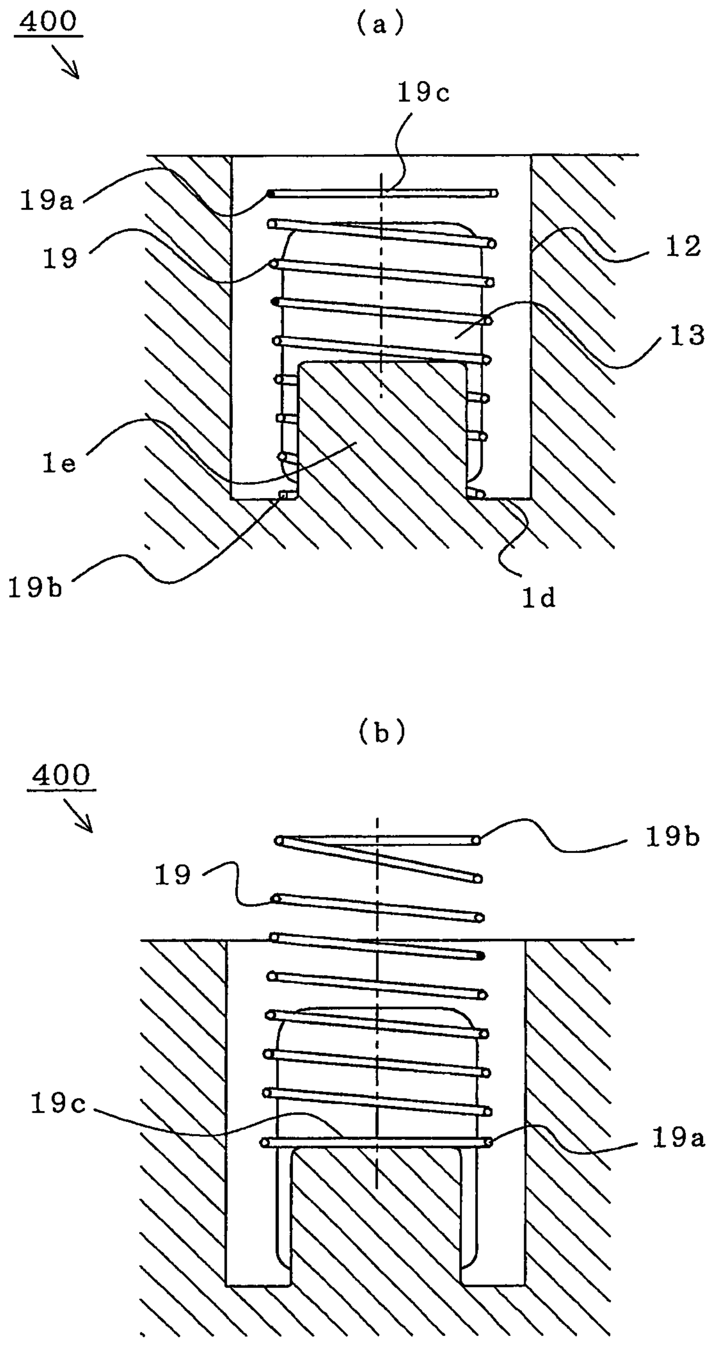
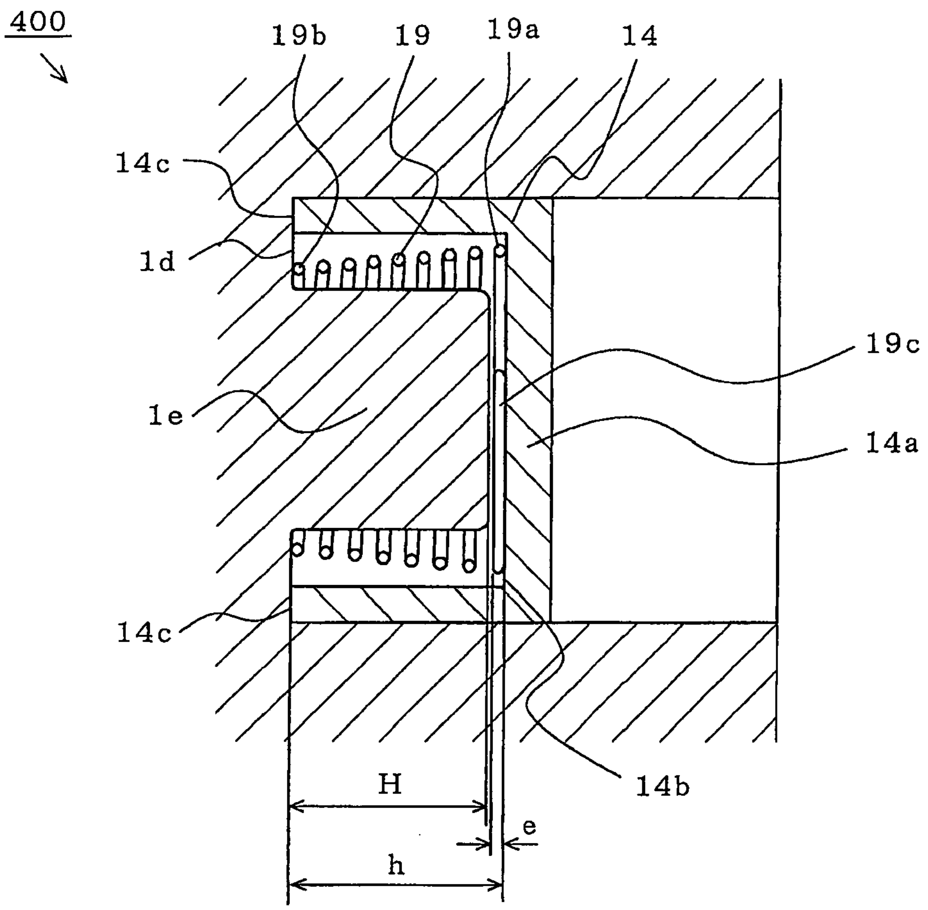


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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- JP 4321220 B **[0003] [0004]**
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- JP 11132164 A **[0009] [0010]**