(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 499 150 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
19.06.2019 Bulletin 2019/25

(21) Application number: **17839188.4**

(22) Date of filing: **21.07.2017**

(51) Int Cl.:
F25B 41/06 *(2006.01)* ***F16K 31/68*** *(2006.01)*

(86) International application number:
PCT/JP2017/026432

(87) International publication number:
WO 2018/030115 (15.02.2018 Gazette 2018/07)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **09.08.2016 JP 2016156352**

(71) Applicants:
- **Fujikoki Corporation**
  Tokyo 158-0082 (JP)
- **Denso Corporation**
  Kariya-shi, Aichi 448-8661 (JP)

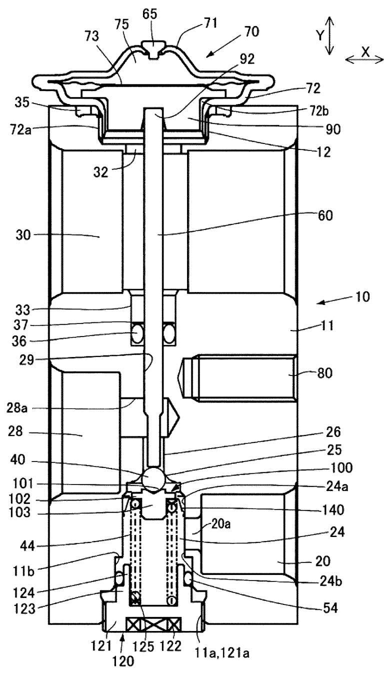
(72) Inventors:
- **KAMATA, Naoki**
  Tokyo 158-0082 (JP)
- **OKUTSU, Kinya**
  Tokyo 158-0082 (JP)
- **MOGI, Takashi**
  Tokyo 158-0082 (JP)
- **YAMASAKI, Kurato**
  Kariya-shi
  Aichi 448-8661 (JP)
- **ITO, Shigeki**
  Kariya-shi
  Aichi 448-8661 (JP)

(74) Representative: **Ter Meer Steinmeister & Partner**
Patentanwälte mbB
Artur-Ladebeck-Strasse 51
33617 Bielefeld (DE)

(54) **EXPANSION VALVE**

(57) This expansion valve is provided with a valve body including an inlet hole through which a refrigerant flows into a valve chamber, and a valve hole through which the refrigerant flows out from the valve chamber; a valve element configured to adjust an amount of the refrigerant flowing through the valve hole; a power element that is mounted to the valve body and configured to drive the valve element through a valve rod; a support member configured to support the valve element; a coil spring configured to press the valve element in a valve-closing direction through the support member; and a vibration isolation spring configured to prevent vibration of the valve element, wherein the vibration isolation spring is provided with an annular base portion disposed between the support member and the coil spring, and a plurality of leg portions that extend radially from the base portion, wherein the leg portions are bent toward the coil spring and are in contact with a side wall surface of the valve chamber on a valve hole side of the inlet hole.

FIG. 1



EP 3 499 150 A1

Description

[Technical Field]

[0001] Thr present invention relates to an expansion valve having a built-in temperature sensitive mechanism for use in a refrigerating cycle.

[Background Art]

[0002] Typically, thermal expansion valves having built-in temperature sensitive mechanisms capable of adjusting the amount of passing refrigerant based on temperature are used in the refrigerating cycles of air conditioners provided in automobiles and the like. A valve body of this type of expansion valve includes an inlet port through which a high-pressure refrigerant is introduced, a valve chamber that communicates with the inlet port, and a valve element driving mechanism referred to as a power element disposed on a top portion of the valve body.

[0003] A spherical valve element disposed in the valve chamber is arranged opposing a valve seat of a valve hole formed in the valve chamber. The valve element is supported by a support member disposed in the valve chamber, and the valve element is pushed toward a direction of the valve seat by a coil spring disposed between an adjusting screw mounted to the valve body and the support member. The valve element is operated by a valve rod that is driven by a power element, and controls an opening of a throttle passage formed between the valve element and the valve seat. The refrigerant that passes through the valve hole is sent from an outlet port toward an evaporator.

[0004] Here, although the high-pressure refrigerant flowing from the inlet port passes through the valve chamber, there are also cases where pressure fluctuation may occur in the high-pressure refrigerant sent to the expansion valve on the upstream side in the refrigerant cycle, and if the pressure fluctuation is transmitted, a problem may occur in that operation of the valve element becomes unstable. Such pressure fluctuation may cause vibration of the valve element, which leads to the occurrence of abnormal noise.

[0005] In order to prevent such vibration, configurations have been proposed in the related art in which a vibration isolation spring is provided in the valve chamber to elastically support the valve element (see Patent Literatures 1 and 2).

[Citation List]

[Patent Literature]

[0006]

[PTL 1] Japanese Patent Application Laid-Open Publication No. 2005-156046

[PTL 2] Japanese Patent Application Laid-Open Publication No. 2013-68368

[Summary of Invention]

[Technical Problem]

[0007] Although the configuration of the vibration isolation springs in the related art exerts a vibration isolation effect to some degree, it is associated with the following problems.

[0008] Patent Literature 1 discloses a configuration in which a vibration isolation spring having a plurality of elastic arms, or leg portions, is provided on a support member that supports a valve element, wherein leading ends of the respective leg portions are caused to be in contact elastically with an inner wall of the valve chamber such that the support member is stably supported from a circumference of the support member toward a center thereof.

[0009] However, since Patent Literature 1 utilizes a configuration in which the leg portions of the vibration isolation spring directly collide with the refrigerant flowing into the valve chamber through the inlet port, there is the concern that turbulence may occur in the high-pressure refrigerant introduced into the valve chamber. This problem will be described with reference to FIGs. 7 to 10.

[0010] As illustrated in FIG. 7, high-pressure refrigerant sent out from a compressor (not shown) enters an inlet port 320, as illustrated by arrow A, passes through an inlet hole 320a, and is introduced to a valve chamber 324. Here, the vibration isolation spring 300 of the related art is composed of an annular plate-shaped portion 301 sandwiched between a support member 400 of the valve element and a coil spring 344 that pushes the support member 400 toward the valve element, and a plurality of leg portions 302 that extend radially from the plate-shaped portion 301 and bend such that they are inclined with respect to a center axis direction of the valve rod. The plurality of leg portions 302 extend to a lower side wall 324b of the valve chamber 324, which is lower than the inlet hole 320a. Here, depending on the angle (the angle of rotation around the center point of the vibration isolation spring 300) at which the vibration isolation spring 300 is attached, the leg portions 302 form various flow path shapes with respect to the inlet hole 320a.

[0011] FIGs. 8 to 10 illustrate examples of the shapes of inlet flow paths formed by the inlet hole 320a and a leg portion 302 as viewed from the inlet port 320 side. FIG. 8 illustrates a case where the leg portion 302 is positioned vertically at the center of the inlet hole 320a such that an opposing flow path is divided into two branches. FIG. 9 illustrates a case where the leg portion 302 is blocking one side of the inlet hole 320a. FIG. 10 illustrates a case where leg portions 302 are positioned at both sides of the inlet hole 320a, forming a gate-type flow path. Since the leg portions 302 block a portion of the inlet hole 320a in the various ways described above, and the shape of the inlet flow path changes accordingly, turbulence may be caused depending on the direction of the vibration isolation spring 300. Such turbulence may cause generation of refrigerant passing noise, and there is the concern that abnormal noise may be generated, by the bursting of bubbles, for example. Further, there is a concern that the flow rate of the introduced refrigerant may decrease.

[0012] In contrast, Patent Literature 2 discloses a technique of shortening the length of the leg portions in the central axis direction by bending the leg portions of a vibration isolation spring in a radial direction around a center axis of a valve rod. In this case, however, unless the vibration isolation spring is twisted when being inserted into the valve body, a load is applied, especially to the base portion of the leg portions, and there is also a concern that deformation of the vibration isolation spring may occur.

[0013] Accordingly, an object of the present invention is to provide an expansion valve including a vibration isolation spring that suppresses vibration of a valve body and suppresses deformation of the vibration isolation spring to reduce refrigerant passing noise.

[Solution to Problem]

[0014] In order to solve the problems described above, one typical example of an example valve according to the present invention includes a valve body comprising an inlet hole through which a refrigerant flows into a valve chamber, and a valve hole through which the refrigerant flows out from the valve chamber; a valve element configured to adjust an amount of the refrigerant flowing through the valve hole; a power element that is mounted to the valve body and configured to drive the valve element through a valve rod; a support member configured to support the valve element; a coil spring configured to press the valve element in a valve-closing direction through the support member; and a vibration isolation spring configured to prevent vibration of the valve element, wherein the vibration isolation spring includes an annular base portion disposed between the support member and the coil spring, and a plurality of leg portions that extend radially from the base portion, and wherein the leg portions are bent toward the coil spring and are in contact with a side wall surface of the valve chamber on a valve hole side of the inlet hole.

[0015] According to an embodiment of the expansion valve according to the present invention, the plurality of leg portions may include connecting portions of leg portions that are adjacent in a same plane as the base portion.

[Advantageous Effects of Invention]

[0016] As the expansion valve according to the present invention is configured as described above, it is possible to suppress the vibration of the valve element and to suppress the deformation of the vibration isolation spring to reduce the refrigerant passing noise.

[Brief Description of Drawings]

[0017]

FIG. 1 is a vertical cross-sectional view illustrating a first embodiment of an expansion valve according to the present invention.

FIG. 2 is a vertical cross-sectional view of a main portion of the expansion valve according to the first embodiment.

FIG. 3 is a perspective view illustrating a vibration isolation spring according to the first embodiment.

FIG. 4 is a plan view illustrating the vibration isolation spring according to the first embodiment.

FIG. 5 is a side view illustrating the vibration isolation spring according to the first embodiment.

FIG. 6 is a plan view illustrating the vibration isolation spring according to a second embodiment.

FIG. 7 is a vertical cross-sectional view illustrating one example of an expansion valve of the related art.

FIG. 8 is a view illustrating an example of a shape of an inlet flow path according to the expansion valve of the related art.

FIG. 9 is a view illustrating an example of a shape of the inlet flow path according to the expansion valve of the related art.

FIG. 10 is a view illustrating an example of a shape of the inlet flow path according to the expansion valve of the related art.

[Description of Embodiments]

First Embodiment

[0018] FIG. 1 is a vertical cross-sectional view illustrating a first embodiment of an expansion valve according to the present invention. FIG. 2 is a vertical cross-sectional view of a relevant portion of an expansion valve according to a first embodiment.

[0019] As illustrated in FIG. 1, the expansion valve 10 includes a valve body 11, a power element 70, a valve element 40, a valve rod 60, an O ring 36, a support member 100, a vibration isolation spring 140, a coil spring 44 and an adjusting screw 120.

[0020] The valve body 11 is made of an aluminum alloy, for example, and can be obtained by subjecting an aluminum alloy or the like to extrusion molding with the X direction of FIG. 1 set as the extrusion direction, and then performing machining. The valve body 11 includes a power element mounting portion 12, which is an internal screw formed on an upper surface portion and engaged with an external screw 72a of the power element 70 to thereby fix the power element 70, an inlet port 20 through which a high-pressure refrigerant is introduced, a refrigerant outlet port 28 through which the refrigerant flowing in from the inlet port 20 flows out, a return passage 30 for the refrigerant, a hole portion 33 to which the O ring 36 is attached, an internal screw 11a formed on a bottom side portion of the valve body 11, and a mounting hole (or an internal screw for mounting) 80 for mounting the valve body 11 to an evaporator or other components not shown.

[0021] The power element mounting portion 12 is formed as a bottomed cylindrical hole having a circular opening on an upper surface of the valve body 11 and having an internal screw formed on an inner wall surface thereof. An opening 32 that reaches (communicates with) the return passage 30 is formed at the center of the bottom portion of the hole. Here, the direction of the center axis of the power element mounting portion 12 is a direction (the Y direction) that is substantially orthogonal to the passing direction (the X direction) of the refrigerant passing through the inside of the return passage 30.

[0022] The internal screw 11a is formed so as to open on the lower side of the valve body 11, and an insertion hole 11b is formed on an upper portion thereof. By sealing an opening of the internal screw 11a with the adjusting screw 120, a valve chamber 24 is formed in the inner side of the valve body 11. The valve chamber 24 has a cylindrical side wall surface, and the surface above the upper end of the inlet hole 20a is referred to as an upper wall surface 24a, and the surface below the lower end of the inlet hole 20a is referred to as a lower wall surface 24b. The vertical length of the upper wall surface 24a is sufficient to enable the vibration isolation spring 140 described later to move in a sliding motion. In addition, it is sufficient for the area between the upper end of the insertion hole 11b and the inlet hole 20a to have a thickness capable of ensuring the necessary strength.

[0023] The inlet port 20 is formed to communicate with the valve chamber 24 from the side of the valve chamber 24 via an inlet hole 20a having a smaller diameter than the inlet port 20. In addition, a narrow portion 28a having a smaller diameter than the outlet port 28 is provided behind the outlet port 28, and the narrow portion 28a is disposed above the valve chamber 24. The narrow portion 28a communicates with an upper end portion of the valve chamber 24 via a valve hole 26 that serves as an orifice. A valve seat 25 is formed on the valve chamber 24 side of the valve hole 26. A through hole 29 is formed vertically (the Y direction of FIG. 1) in the valve body 11 so as to communicate the return passage 30 with the narrow portion 28a. The valve hole 26, the through hole 29, the opening 32 and the valve chamber 24 are disposed so that their respective center axes are aligned in a straight line. The return passage 30 is formed further above the outlet port 28 in the valve body 11, and passes through the valve body 11 in a lateral direction (the X direction of FIG. 1). Further, a hole portion 33 that is coaxial with the through hole 29 and having a greater inner diameter than the through hole 29 is formed on a lower side of the return passage 30.

[0024] It should be noted that, in FIG. 1, although the inlet port 20 and the outlet port 28 are opened on the right and left sides of the valve body 11, and similarly, the return passage 30 is formed to pass through the right and left sides of the valve body 11, the arrangement of the inlet port, the outlet port and both openings of the return passage can be changed arbitrarily depending on the layout of the refrigerant cycle in which the expansion valve is disposed. For example, the outlet port 28 and the left side opening of the return passage 30 may be disposed to be opened to the front side or the back side of the drawing of FIG. 1, that is, the inlet port and the outlet port may be arranged orthogonally when viewed from the center line of the valve rod 60, and similarly, both openings of the return passage may be arranged orthogonally.

[0025] The power element 70 is composed of an upper lid member 71 and a receiving member 72 having a through port 72b formed at a center portion thereof, both of which are formed of stainless steel or the like, for example, a diaphragm 73 sandwiched between the upper lid member 71 and the receiving member 72, and a stopper member 90 disposed between the diaphragm 73 and the receiving member 72. By circumferentially welding the edge portions where the upper lid member 71, the diaphragm 73 and the receiving member 72 overlap, these members are integrated. A pressure operation chamber 75 is formed between the upper lid member 71 and the diaphragm 73, and after filling the pressure operation chamber 75 with a working gas, the chamber is sealed with a sealing plug 65. The lower portion of the receiving member 72 is cylindrical, and an external screw 72a is formed on the periphery thereof. The power element 70 is attached to the valve body 11 by screwing the external screw 72a into the internal screw (the internal screw opening on the upper surface of the valve body 11) of the power element mounting portion 12 via the packing 35.

[0026] The valve element 40 is a spherical member that is disposed in the valve chamber 24 at a position opposed to the valve seat 25. The valve rod 60 is provided to pass through the valve hole 26, the through hole 29 and the opening 32 of the valve body 11, wherein an upper end of the valve rod 60 is abutted against a receiving portion 92 provided on a lower side of the stopper member 90 of the power element 70 and a lower end of the valve rod 60 is disposed to contact the valve element 40. The O ring 36 is arranged in the hole portion 33, and a stopper member 37 attached to an upper portion thereof serves as a stopper to retain the O ring 36.

[0027] The support member 100 is a member that supports the valve element 40 in the direction of the valve seat 25 (the direction of the valve rod 60). Although the valve element 40 is fixed to the support member 100, since the support member 100 is constantly pushed toward the direction of the valve seat 25 and the valve rod 60 by the coil spring 44, a configuration in which the support member 100 merely contacts the valve element 40 may be utilized. The support member 100 includes a body portion 103, an upper surface portion 101 and a flange portion 102. The upper surface of the cylindrical body portion 103 has a conical recess and serves as the upper surface portion 101 that supports a lower surface of the valve element 40. In addition, the support member 100 includes a flange portion 102 that protrudes toward a lateral side (to the outer circumferential side) from the body portion 103, and a lower surface of the flange portion 102 is configured to receive one end of the vibration isolation spring 140 and the coil spring 44. In this state, the outer diameter of the body portion 103 below the flange portion 102 is configured to be smaller than an inner diameter of the coil spring 44, such that the body portion 103 fits inside the coil spring 44.

[0028] The coil spring 44 is disposed between a lower surface of the flange portion 102 provided on the support member 100 and a concave portion 125 formed in the adjusting screw 120. Due to the elastic force of the coil spring 44, the valve element 40 is pushed toward the valve seat 25 via the support member 100. The vibration isolation spring 140 is disposed between the lower surface of the flange portion 102 and the coil spring 44, the detailed configuration of which will be described later.

[0029] The adjusting screw 120 includes a body portion 121, a hexagonal socket 122, an insertion portion 123, a leading edge portion 124, and the concave portion 125. The insertion portion 123 is formed above the body portion 121 with a smaller outer diameter than the body portion 121, and the leading edge portion 124 is formed above the insertion portion 123 with a smaller outer diameter than the insertion portion 123. In addition, the outer circumference of the body portion 121 is formed to be an external screw portion 121a designed to engage with the internal screw 11a formed on a lower side of the valve body 11. Further, a concave portion 125 having a cylindrical space with the upper portion opened is provided on an upper portion of the adjusting screw 120. The concave portion 125 is formed to have a depth that reaches the vicinity of the body portion 121. In addition, the inner diameter of the concave portion 125 is designed to be slightly greater than the outer diameter of the coil spring 44, such that the coil spring 44 is stably disposed within the concave portion 125. Furthermore, the hexagonal socket 122 that allows insertion of a hexagonal wrench (not shown) for turning the adjusting screw 120 is disposed at a lower portion of the adjusting screw 120 (the body portion 121).

[0030] FIG. 3 is a perspective view illustrating the vibration isolation spring 140 according to a first embodiment. FIG. 4 is a plan view illustrating the vibration isolation spring 140 according to the first embodiment. FIG. 5 is a side view illustrating the vibration isolation spring according to the first embodiment. The vibration isolation spring 140 includes a base portion 141 and a leg portion 142. The vibration isolation spring 140 can be formed by press-forming a plate member having elasticity, such as stainless steel or an alloy thereof, for example.

[0031] The base portion 141 is an annular plate-like member that forms an upper portion of the vibration isolation spring 140 and includes a mounting hole 141a formed at the center thereof.

[0032] A plurality of the leg portions 142 extend from an outer circumferential side of the base portion 141 in a direction perpendicular with respect to a tangent in the circumferential direction; that is to say, radially. In the first embodiment, eight leg portions 142 having the same lengths are provided at regular angular intervals. Each leg portion 142 is composed of an upper portion 142a, a bent portion 142b, a side portion 142c, and a projected portion 142d. The leg portions 142 are bent downward at the bent portion 142b.

[0033] The upper portion 142a is formed substantially on the same plane as the base portion 141. Therefore, in the base portion of each of the leg portions 142, a cutout 145 having a predetermined shape is formed respectively on the side having the base portion 141. In FIG. 4, length C refers to the length of the upper portion 142a. Since the leg portions 142 include the upper portions 142a, the leg portions 142 are formed closer to a center side of the base portion 141 than the bent portions on the same plane as the base portion 141. In addition, in the vicinity of the connecting portion of the upper portion 142a and the base portion 141 (near the base end of the leg portions 142), the cutouts 145 formed between the side surfaces in the width direction of adjacent upper portions 142a are formed in an arc shape by continuously connecting base sides of the upper portions 142a with the same curvature, and as a result, the upper portions 142a (the leg portions 142) are smoothly connected to each other. Of course, the cutouts 145 may also be formed in a shape other than an arc shape by connecting the base sides of the upper portions 142a with a different curvature.

[0034] The bent portion 142b is formed continuously bending outward from the upper portion 142a toward the lower side (toward the coil spring 44). The bent portion 142b may be formed with a fixed curvature radius. The bent portion 142b is formed by bending the portion with a $(90 - \theta)$ degree bending process.

[0035] The side portion 142c is formed in a straight line that extends continuously downward from the bent portion 142b. The angle of the side portion 142c is θ degrees toward the outer downward direction with respect to the vertical direction.

[0036] The projected portion 142d is formed outward in the vicinity of the lower end of the side portion 142c. For example, the projected portion 142d may be formed as a part of a spherical surface, such as a hemispherical shape. When the projected portion 142d is mounted on the valve body 11, although the projected portion 142d elastically contacts a portion above the opening portion of the inlet hole 20a (the upper wall surface 24a), the dimensions of the respective portions are designed such that the projected portion 142d is not inserted into the opening of the inlet hole 20a even if the valve element 40 is positioned at a lowermost position.

[0037] Although the vertical length of the leg portions 142 may be set to an arbitrary length as long as the lower edge portions of the leg portions 142 do not fall into the opening portion of the inlet hole 20a at the lowermost end of the vertical movement of the vibration isolation spring 140, in order to prevent interference of the flow of refrigerant introduced from the inlet port 20, it is preferable that the lower edge portion of the leg portions 142 does not reach the opening of the inlet hole 20a. In addition, according to the present embodiment, although the widths of the respective leg portions 142 are formed to be constant in each of the upper portion 142a, the bent portion 142b and the side portion 142c, the present invention is not restricted to this example, and narrowing or widening the width at the leading ends or other design modifications for most effectively suppressing the vibration of the valve element may be utilized. In addition, the thickness of the leg portion 142 (the thickness of the vibration isolation spring 140 in the case that the vibration isolation spring 140 is formed by press-forming a single elastic plate material) may be configured to a thickness that is suitable for suppressing the vibration of the valve element.

[0038] In the vibration isolation spring 140, a gap D (FIG. 4) through which the refrigerant passes is formed between the respective adjacent leg portions 142. In addition, the outer diameter connected by the leading edge portions of the projected portion 142d of the vibration isolation spring 140 is formed to be greater than the inner diameter of the upper wall surface 24a within the valve chamber 24, such that an elastic force acts when the vibration isolation spring 140 is mounted, and the projected portions 142d are pressed against the upper wall surface 24a of the valve chamber 24. In addition, a space large enough for the coil spring 44 to be disposed therein is secured on the inner side of the leg portions 142.

[0039] As illustrated in FIGs. 1 and 2, when attaching the vibration isolation spring 140, first, the vibration isolation spring 140 is passed through the mounting hole 141a from the lower side to the body portion 103 of the support member 100, and the upper surface of the base portion 141 of the vibration isolation spring 140 is brought into contact with the lower surface of the flange portion 102 of the support member 100. Next, the coil spring 44 is attached from the lower side of the vibration isolation spring 140. In this state, the body portion 103 of the support member 100 is disposed on an inner side of the coil spring 44, and the upper surface of the coil spring 44 abuts against the lower surface of the base portion 141 of the vibration isolation spring 140. In this way, the vibration isolation spring 140 is disposed inside the valve chamber 24.

[0040] In the expansion valve 10 to which the vibration isolation spring 140 is attached, since the base portion 141 of the vibration isolation spring 140 is pushed by the coil spring 44 from the lower side, the vibration isolation spring 140 is attached by being sandwiched between the flange portion 102 of the support member 100 and the coil spring 44 with a predetermined force. Then, in the vibration isolation spring 140, the projected portions 142d are pushed toward the upper wall surface 24a of the valve chamber 24 with a predetermined force due to the elastic force of the leg portions 142, and a sliding resistance is generated in accordance with the movement of the valve element 40.

[0041] Next, the operation of the expansion valve will be described. In the expansion valve 10 of the first embodiment according to the present invention, a high-pressure refrigerant discharged from a compressor (not shown) flows from the inlet port 20 through the inlet hole 20a into the valve chamber 24, passes through the valve hole 26 and expands, and is subsequently sent out through the outlet port 28 to an evaporator (not shown). The refrigerant sent out from the evaporator enters from the left side entrance of the return passage 30, passes through the return passage 30 to exit from the right side exit, and returns to the compressor. At this time, a portion of the refrigerant passing through the return passage 30 flows through the opening 32 to a lower portion of the power element 70. Then, the temperature change of the refrigerant that flows to the lower portion of the power element 70 causes the pressure of the working gas inside the pressure operation chamber 75 to change accordingly. At this time, the stopper member 90 moves up and down in response to the movement of the diaphragm 73 that deformed according to the fluctuation of the internal pressure of the pressure operation chamber 75. The movement of the stopper member 90 is transmitted through the valve rod 60 to the valve element 40, and the flow rate of the expanded refrigerant is controlled.

[0042] In the case that the valve element 40 moves in an opening and closing direction (the vertical direction), the vibration isolation spring 140 moves together with the valve element 40 and the support member 100. At this time, since the vibration isolation spring 140 presses the upper wall surface 24a of the valve chamber 24 of the valve body 11 with a predetermined force, when the vibration isolation spring 140 moves in a sliding motion, a frictional force is generated between the projected portion 142d of the leg portions 242 and the upper wall surface 24a of the valve chamber 24. In this way, the valve element 40 and the support member 100 do not respond sensitively in the vertical direction due to the pressure fluctuation of the high-pressure refrigerant from the inlet port 20, and the vibration in the vertical direction can be prevented or reduced. Further, since the plurality of leg portions 142 of the vibration isolation spring 140 press the upper wall surface 24a of the valve chamber 24 at multiple positions, the valve element 40 and the support member 100 do not move easily in the lateral direction against the pressing force due to the pressure fluctuation of the high-pressure refrigerant from the inlet port 20, and they exert an effect of preventing vibration in the lateral direction. At the same time, the movement of the valve element 40 and the support member 100 in the vertical direction is guided.

[0043] In addition, since the vibration isolation spring 140 contacts the upper wall surface 24a above the inlet hole 20a in the valve chamber 24, the leg portions 142 do not interfere with the inlet hole 20a, such that the flow rate and the occurrence of turbulence of the refrigerant can be suppressed and the passing noise of the refrigerant can be reduced. In addition, since the vibration isolation spring 140 is constituted by the radially extending leg portions 142, the vibration isolation spring can be easily attached in the valve body 11 by simple insertion through the opening portion of the internal screw 11a formed at the bottom portion of the valve body 11. Further, since the vibration isolation spring 140 has a certain cutout depth (the cutout 145) on the surface having the base portion 141, the length of the leg portions 142 can be set to be greater than the height of the vibration isolation spring. Accordingly, the spring constant of the leg portions 142 can be set to be smaller, and the change in force against the deformation of the leg portions 142 can be reduced, such that a more stable sliding resistance can be obtained. In addition, by adopting the same width for the leg portions 142, the calculation of the spring constant, that is, the design of the first vibration isolation spring 140, becomes easier. Further, since the leg portions 142 are formed in a direction perpendicular (radial) with respect to a tangent in the circumferential direction of the base portion 141, the sliding resistance is generated without applying the torsional force of the base portion 141 in the circumferential direction.

Second Embodiment

[0044] FIG. 6 is a plan view illustrating a vibration isolation spring according to a second embodiment. The second embodiment has a configuration in which the vibration isolation spring 140 of the first embodiment is replaced with a vibration isolation spring 240, and since the rest of the configuration is the same as that of the first embodiment, a description of the shared portions is omitted.

[0045] The vibration isolation spring 240 includes a base portion 241 and a leg portion 242. The vibration isolation spring 240 is formed by press-forming a plate member having elasticity, such as stainless steel or an alloy thereof, for example.

[0046] The base portion 241 is an annular plate-like member that forms the upper portion of the vibration isolation spring 240 and includes a mounting hole 141a formed at a center thereof, similar to the first embodiment.

[0047] A plurality of the leg portions 242 extend from an outer circumferential side of the base portion 241 in a direction perpendicular with respect to a tangent in the circumferential direction; that is to say, radially. In the second embodiment, eight leg portions 242 having the same lengths are provided at regular angular intervals. Each leg portion 242 is composed of an upper portion 242a, a bent portion 142b, a side portion 142c and a projected portion 142d. The bent portion 142b, the side portion 142c and the projected portion 142d are the same as in the first embodiment.

[0048] Herein, although the first embodiment includes an arc-shaped cutout 145, the second embodiment differs in that a substantially triangular cutout 245 is provided. Accordingly, the length E of the upper portion 242a according to the second embodiment is longer than length C of the upper portion 142a of the first embodiment. The length of the leg portions 242 of the second embodiment is set to be longer in correspondence thereto. In addition, the outer circumference of the base portion 241 of the second embodiment is set to be smaller than the outer circumference of the base portion 141 of the first embodiment. It should be noted, in consideration of strength and stress concentration, small arc-shaped portions may be formed in the side surfaces of adjacent upper portions 242a in the width direction.

[0049] In the second embodiment, the length of the vibration isolation spring 240 can be further extended by forming the substantially triangular cutout 245. Accordingly, the spring constant of the leg portions 242 can be further reduced, the change in force of the leg portions 242 with respect to the deformation can be reduced, and a more stable sliding resistance can be achieved.

[0050] As described above, the first and second embodiments have been described as embodiments of the present invention, but the present invention is not restricted to the embodiments described above, and various modifications are included in the scope of the invention. For example, the present invention is not restricted to those having all the components (structures) provided in the above-described embodiments. In addition, a portion of a configuration of one embodiment may be deleted or replaced with a configuration of the other embodiment, or the configuration of one embodiment may be added to another embodiment.

[0051] For example, the above-described embodiments illustrate the leg portions 142 and 242 as having eight leg portions 142 of the same length provided at regular angular intervals. If the number of leg portions 142 and 242 is eight, it becomes possible to ensure stability of behavior and sliding resistance while maintaining balance of the gaps between the leg portions, but the present invention is not restricted to these examples. The number of leg portions should merely be two or greater, and the lengths and angular intervals need not be the same. In addition, the leg portions illustrated in the above embodiments can have widths that vary along their length.

[0052] Furthermore, although the power element 70 illustrated in the embodiments is attached by screws, in addition to this, a configuration can be utilized in which a cylindrical portion is formed on an upper portion of the valve body, the power element 70 is inserted inside of the cylindrical portion, and caulking is performed on the inner side of the cylindrical portion to thereby attach the power element 70.

[Reference Signs List]

[0053]

10 expansion valve
11 valve body
20 inlet port
20a inlet hole
24 valve chamber
24a upper wall surface
25 valve seat
26 valve hole
28 outlet port
30 return passage
40 valve element
44 coil spring
60 valve rod
70 power element
100 support member
120 adjusting screw
140, 240 vibration isolation spring
141, 241 base portion
142, 242 leg portion

Claims

1. An expansion valve comprising:

a valve body comprising an inlet hole through which a refrigerant flows into a valve chamber, and a valve hole through which the refrigerant flows out from the valve chamber;
a valve element configured to adjust an amount of the refrigerant flowing through the valve hole;
a power element that is mounted to the valve body and configured to drive the valve element via a valve rod;
a support member configured to support the valve element;
a coil spring configured to press the valve element in a valve-closing direction via the support member; and
a vibration isolation spring configured to prevent vibration of the valve element,
wherein the vibration isolation spring includes an annular base portion disposed between the support member and the coil spring, and a plurality of leg portions that extend radially from the base portion, and
the leg portions are bent toward the coil spring and are in contact with a side wall surface of the valve chamber on a valve hole side of the inlet hole.

2. The expansion valve according to claim 1,
wherein the plurality of leg portions include connecting portions of leg portions that are adjacent in a same plane as the annular base portion.

FIG. 1

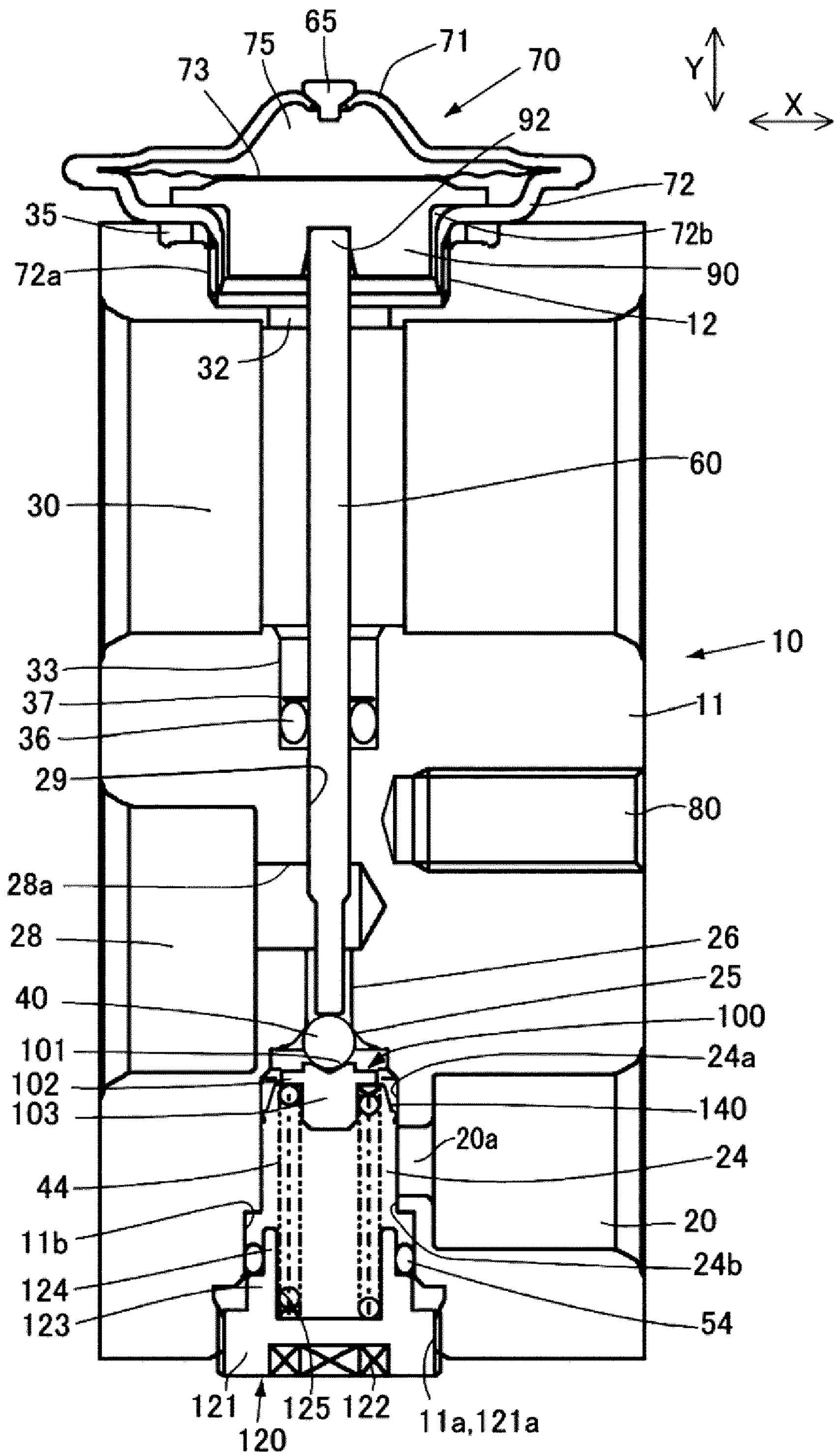

65
71
75
73
70
Y
X
92
72
35
72b
72a
90
12
32
60
30
10
33
11
37
36
29
80
28a
28
26
40
25
100
101
24a
102
140
103
20a
44
24
11b
20
24b
124
123
54
121
125
122
11a,121a
120

FIG. 2

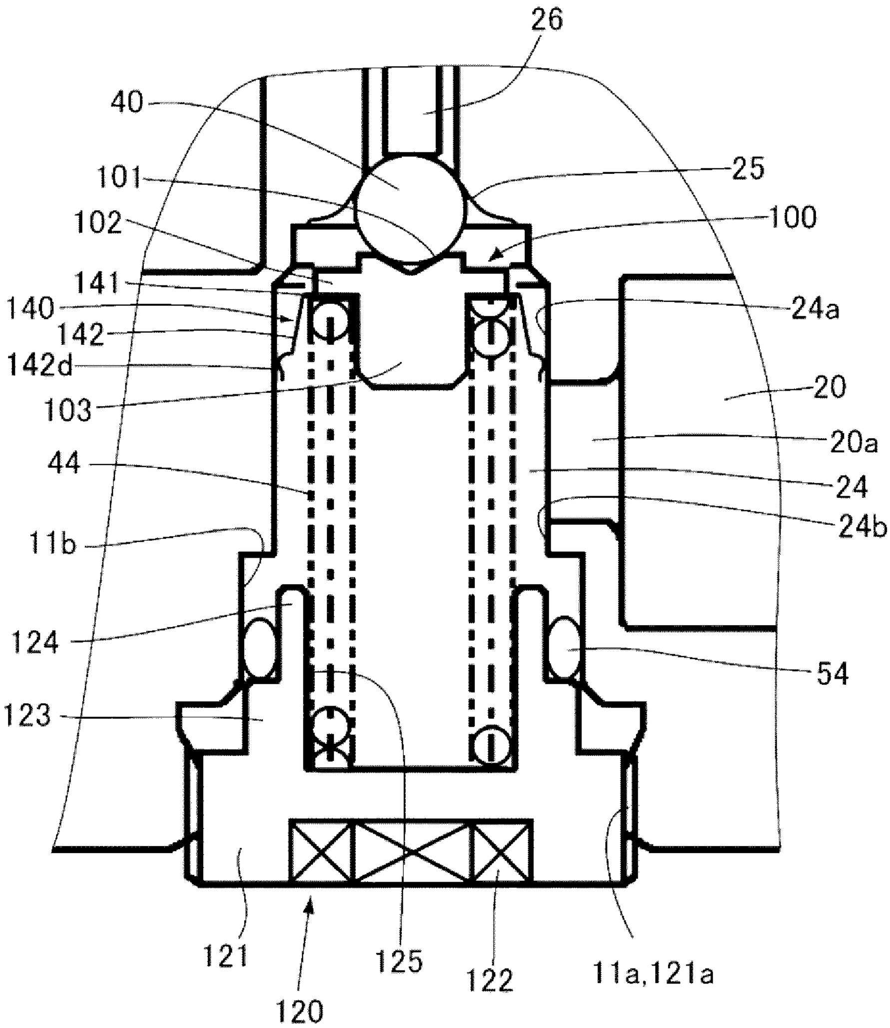

26
40
101
25
102
100
141
24a
140
142
142d
20
103
20a
44
24
24b
11b
124
54
123
121
125
122
11a,121a
120

FIG. 3

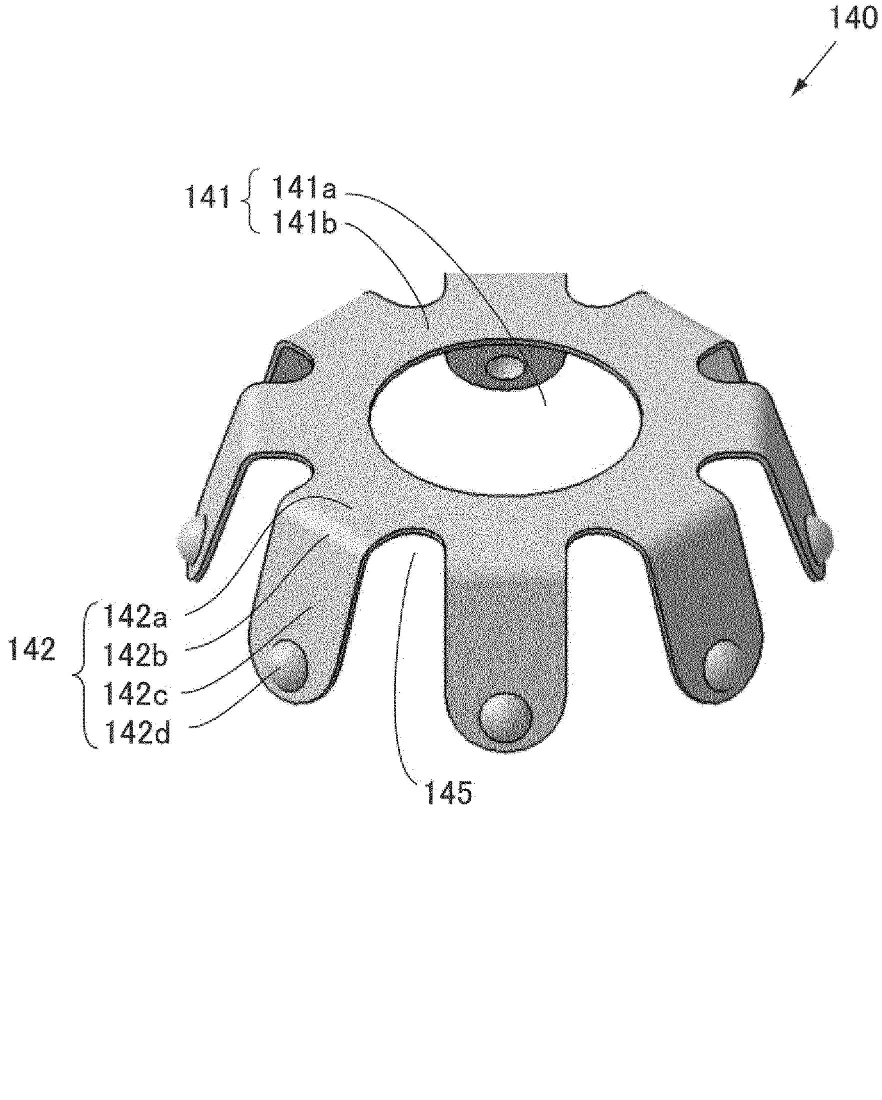


FIG. 4

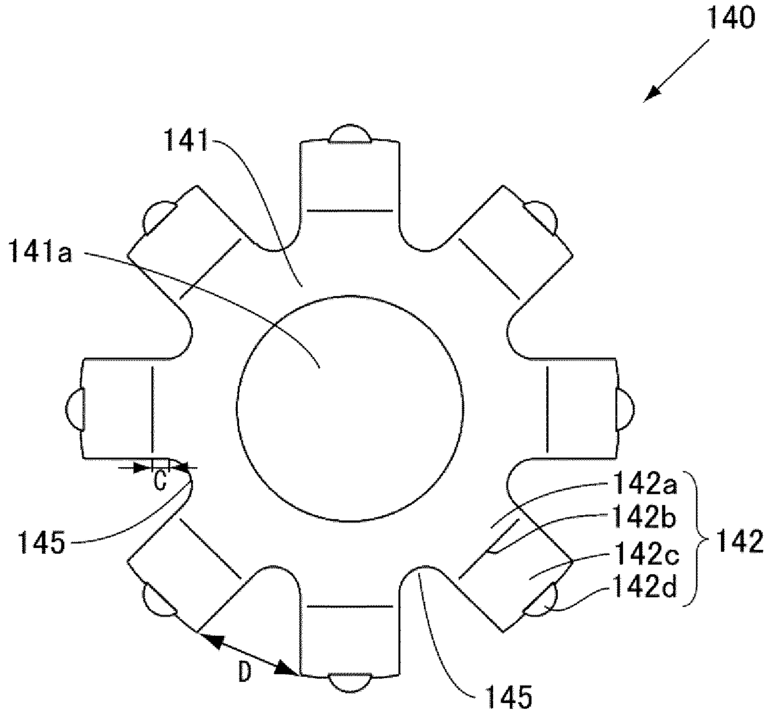

140
141
141a
C
145
D
145
142a
142b
142c
142d
142

FIG. 5

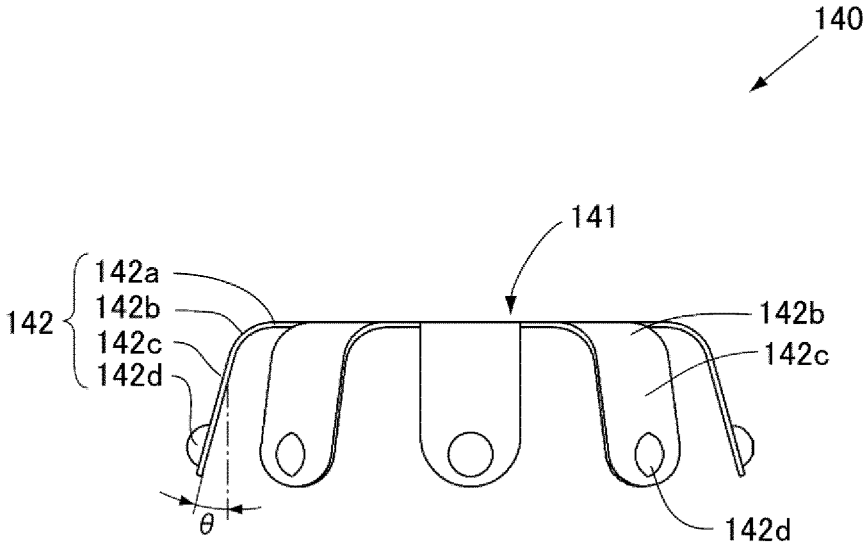

140
141
142
142a
142b
142c
142d
θ
142b
142c
142d

FIG. 6

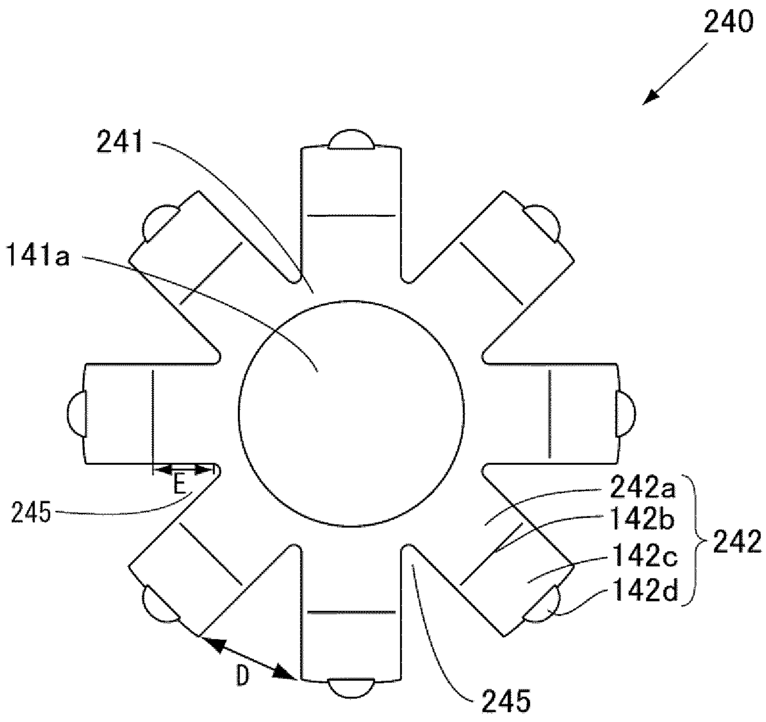


FIG. 7

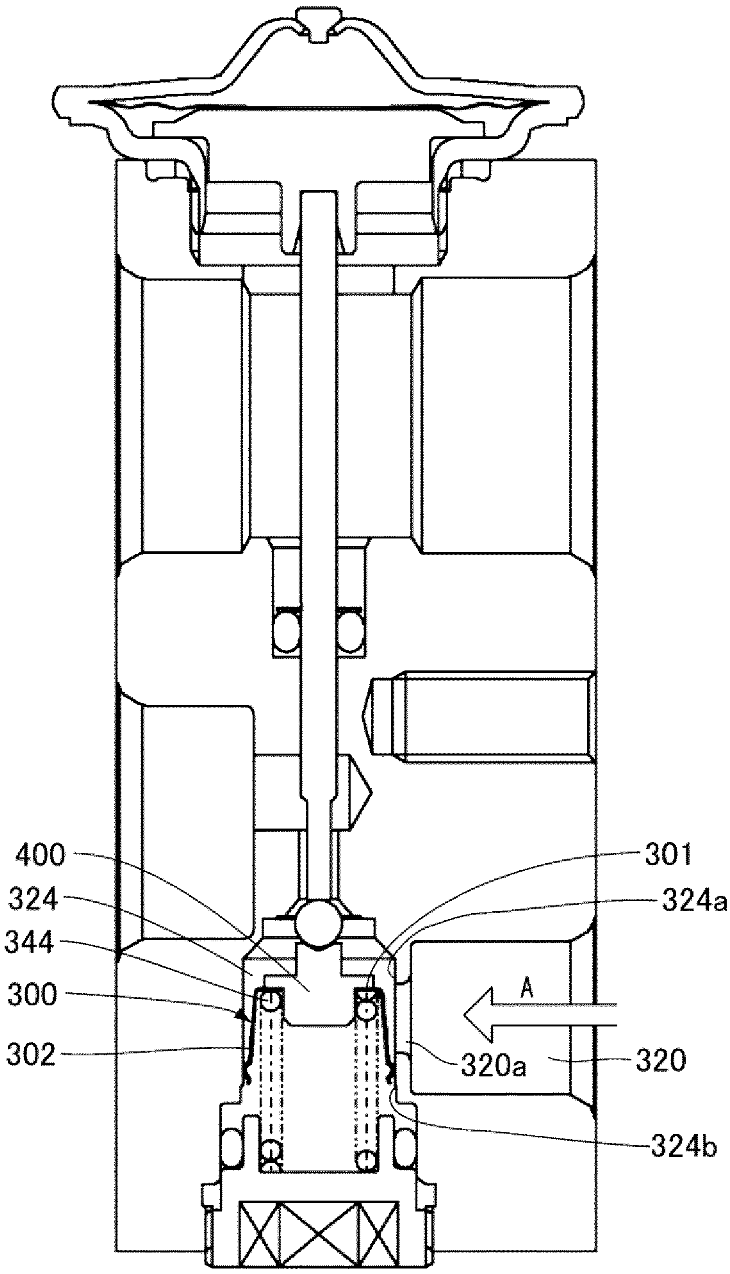


FIG. 8

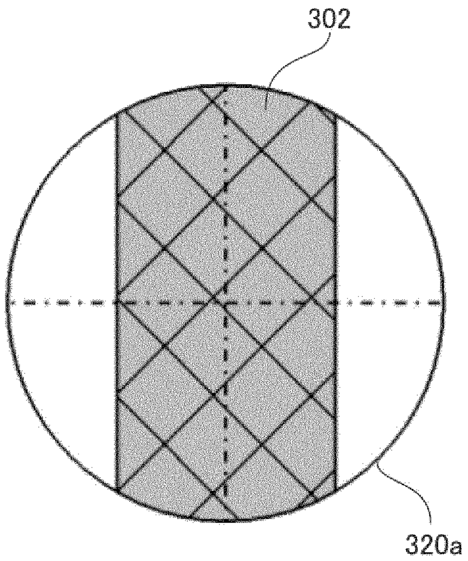


FIG. 9

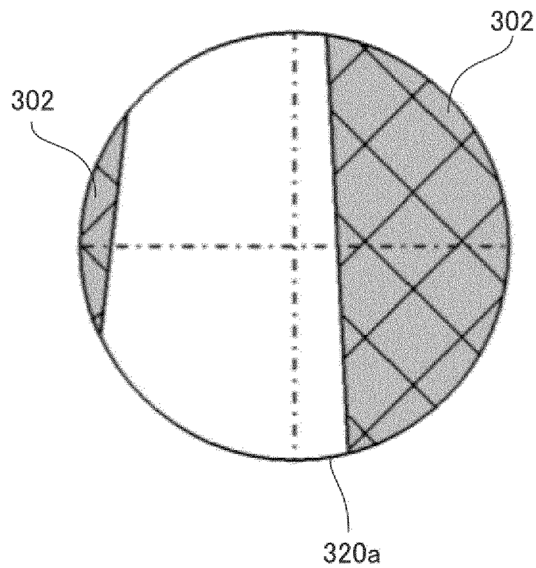
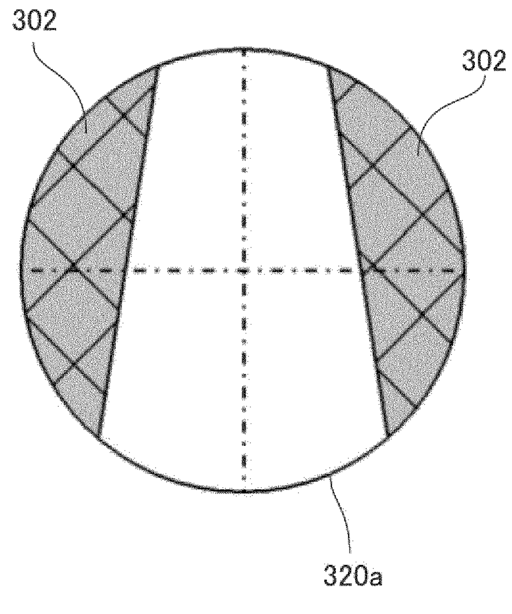


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/026432

A. CLASSIFICATION OF SUBJECT MATTER
F25B41/06(2006.01)i, *F16K31/68*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B41/06, F16K31/68

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-090648 A (TGK Co., Ltd.), 28 March 2003 (28.03.2003), paragraphs [0011] to [0024]; fig. 1 to 3 (Family: none)	1-2
Y	JP 2005-156046 A (Fuji Koki Corp.), 16 June 2005 (16.06.2005), paragraphs [0021] to [0023]; fig. 1 (Family: none)	1-2
Y	JP 2001-082835 A (Denso Corp.), 30 March 2001 (30.03.2001), paragraphs [0030] to [0032]; fig. 4 (Family: none)	1-2

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 2017 (25.09.17)	03 October 2017 (03.10.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/026432

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2013-068368 A (Fuji Koki Corp.), 18 April 2013 (18.04.2013), paragraphs [0004] to [0007], [0016] to [0026]; fig. 1 to 7 & CN 103075566 A	1-2
P,A	WO 2016/199610 A1 (Denso Corp.), 15 December 2016 (15.12.2016), paragraphs [0090] to [0098]; fig. 13 to 17 (Family: none)	1-2
A	JP 2001-012824 A (Denso Corp.), 19 January 2001 (19.01.2001), paragraphs [0051] to [0066]; fig. 6 to 9 (Family: none)	1-2

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2005156046 A **[0006]**
- JP 2013068368 A **[0006]**