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(54) **SCROLL FLUID MACHINE**

(76) Inventors: **Akiyoshi Higashiyama**, Gunma (JP); **Hisashi Suzuki**, Gunma (JP)

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(57) **ABSTRACT**

There is provided a scroll fluid machine in which sealability is improved by uniforming a deformed shape of a fastened face of a spindle frame with respect to a fixed scroll, and compression performance is improved. The machine is characterized by comprising a scroll unit disposed in a container, a spindle frame that is interfitted in the container, fastened to the fixed scroll by fastening means at an outer circumferential portion, and houses the movable scroll in a space created between the spindle frame and the fixed scroll, a refrigerant path that is formed in the outer circumferential portion to penetrate the fixed scroll and the spindle frame in an axial direction to open in a rear face of the spindle frame, and guides a high-pressure refrigerant compressed and discharged by the scroll unit to the rear face side of the spindle frame, and a countersunk section that is formed in an opening rim of the refrigerant path of the spindle frame.

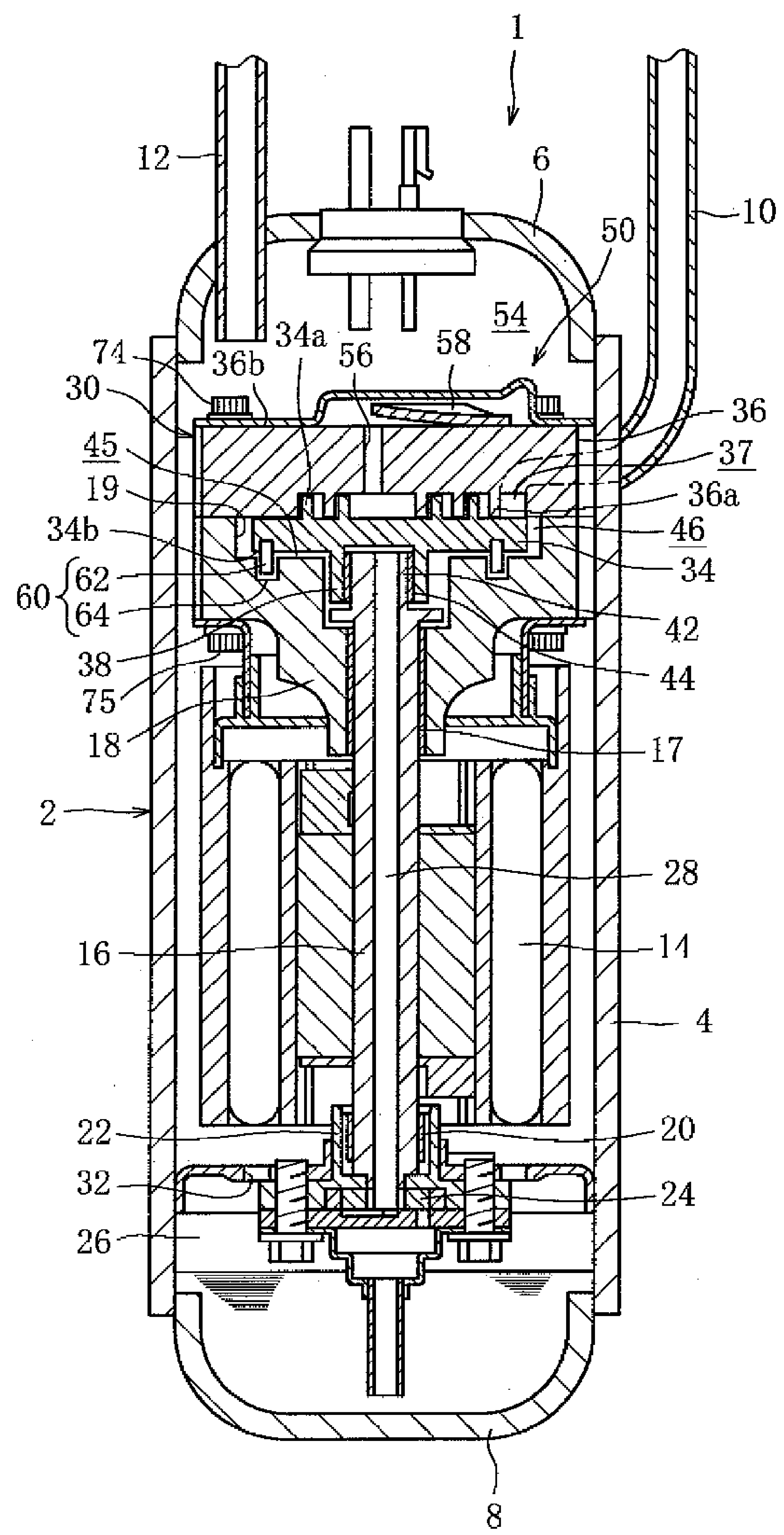

FIG. 1

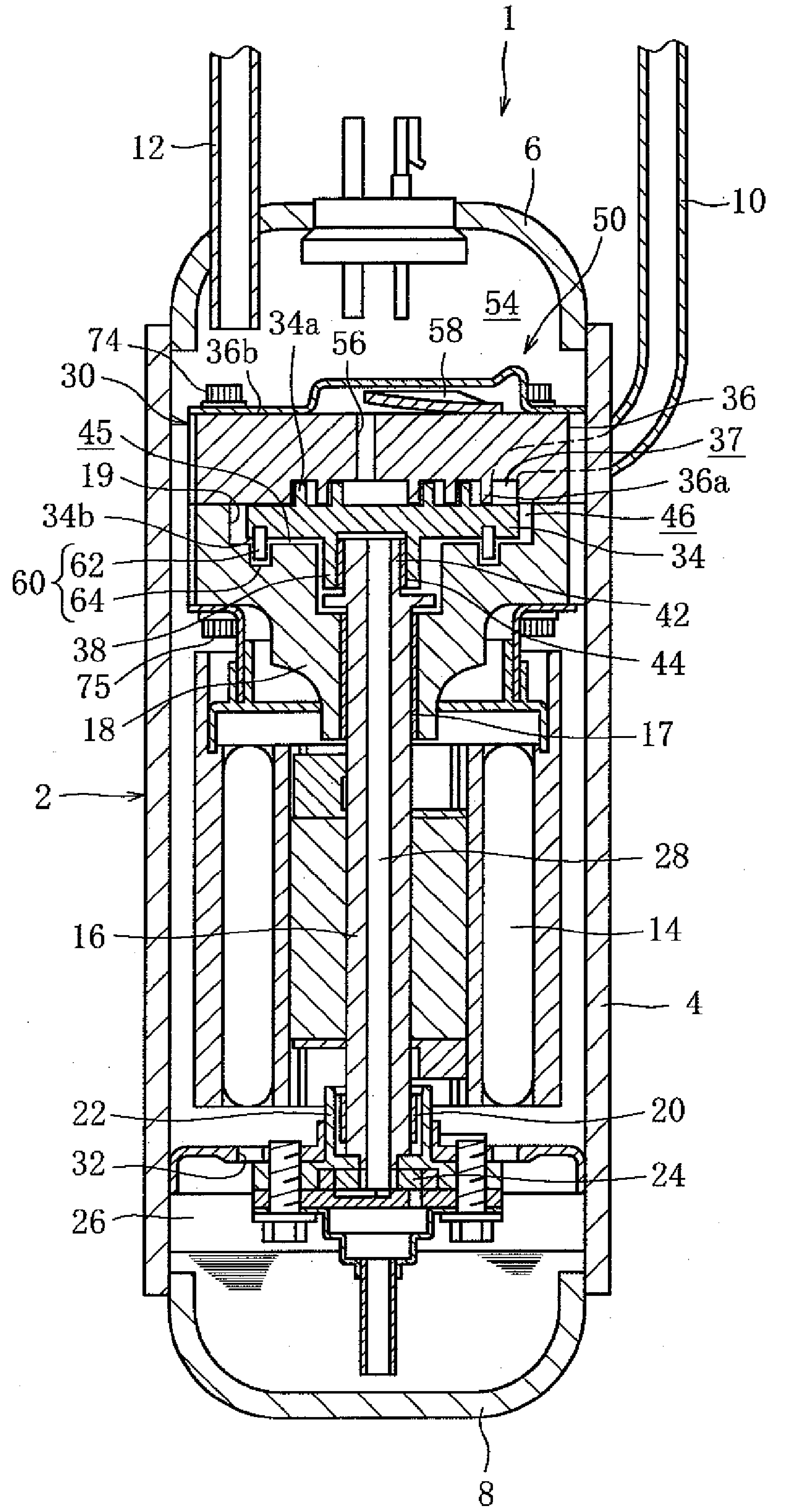

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FIG. 2

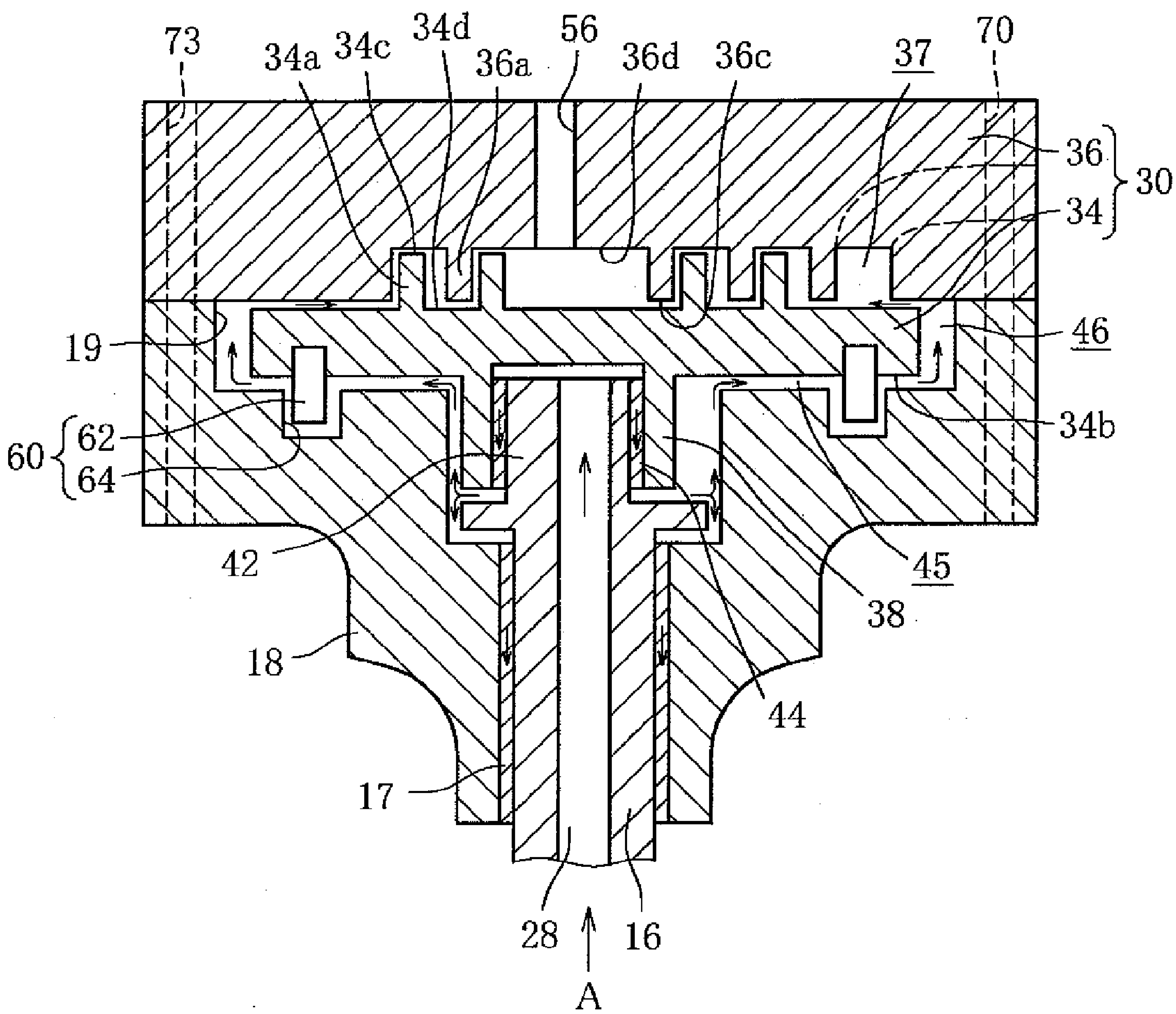
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FIG. 3

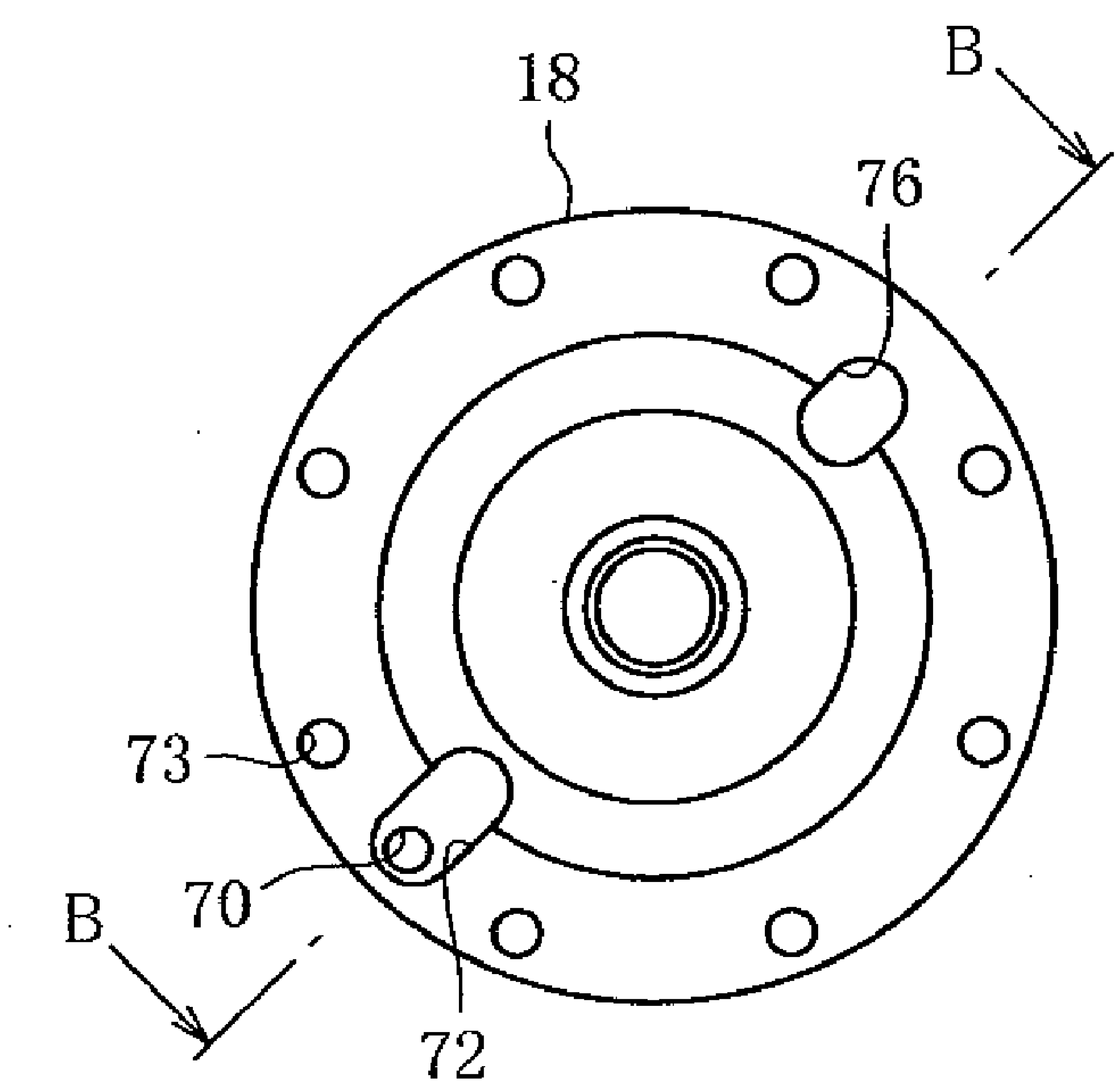


FIG. 4

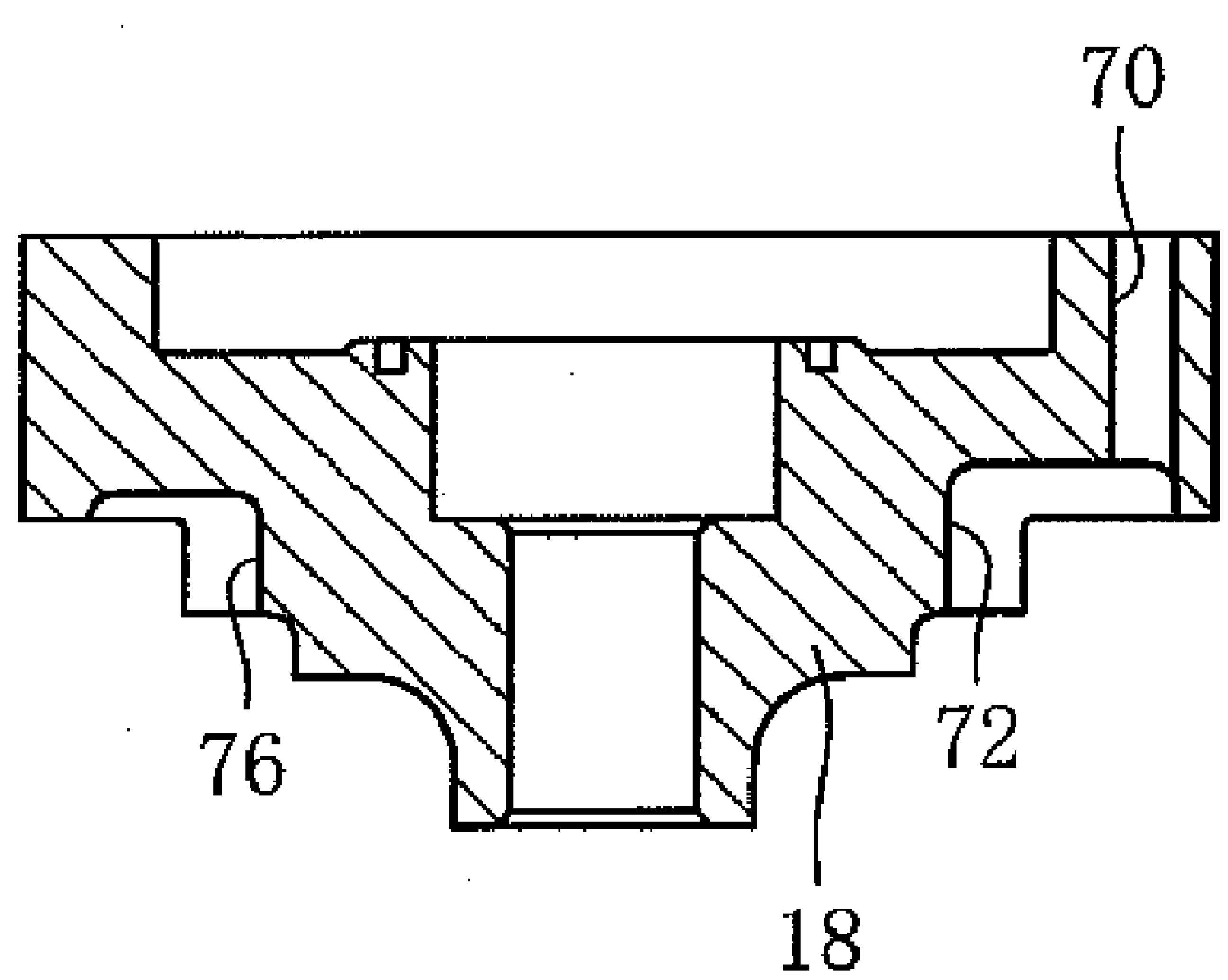


FIG. 5

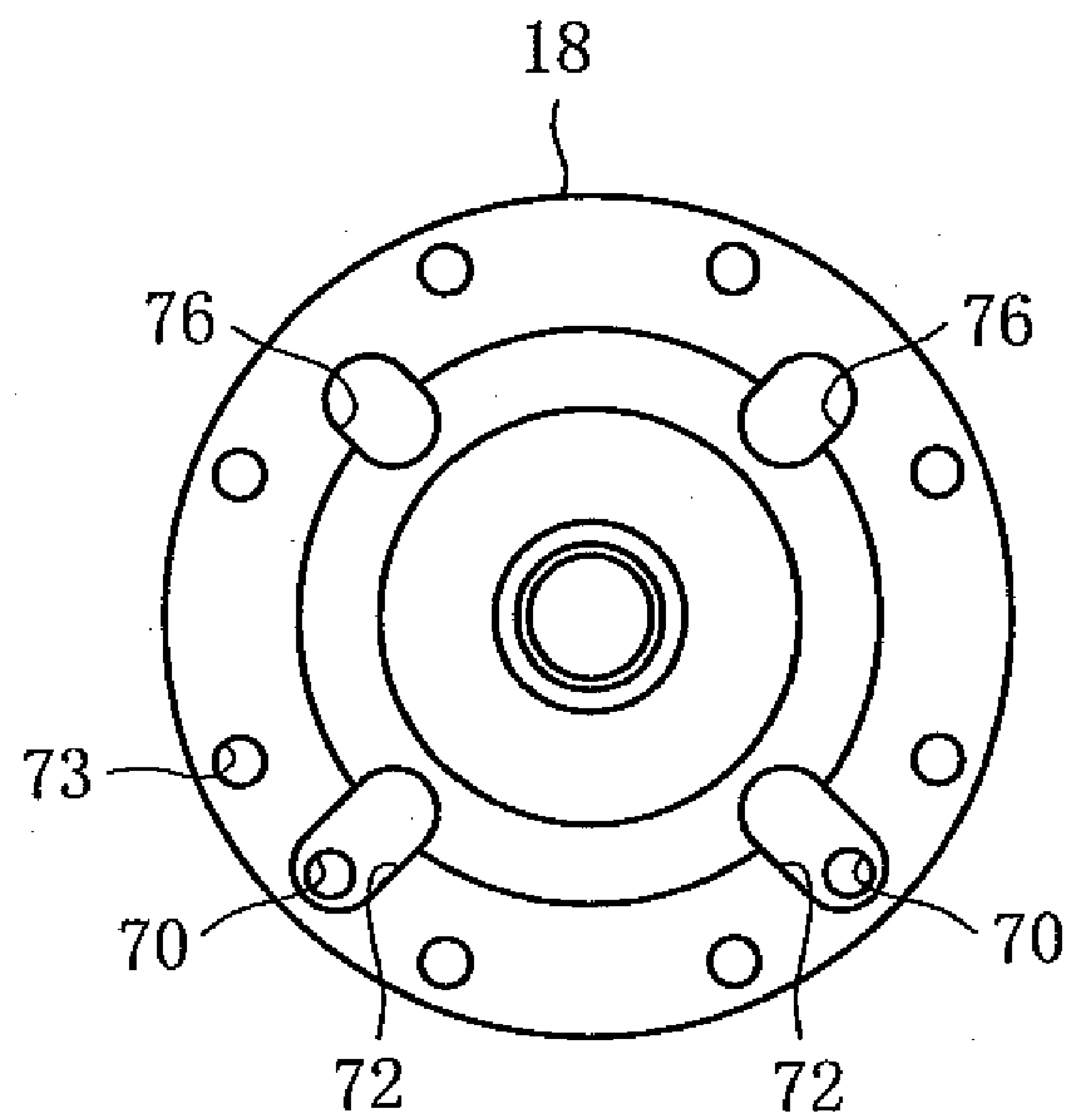
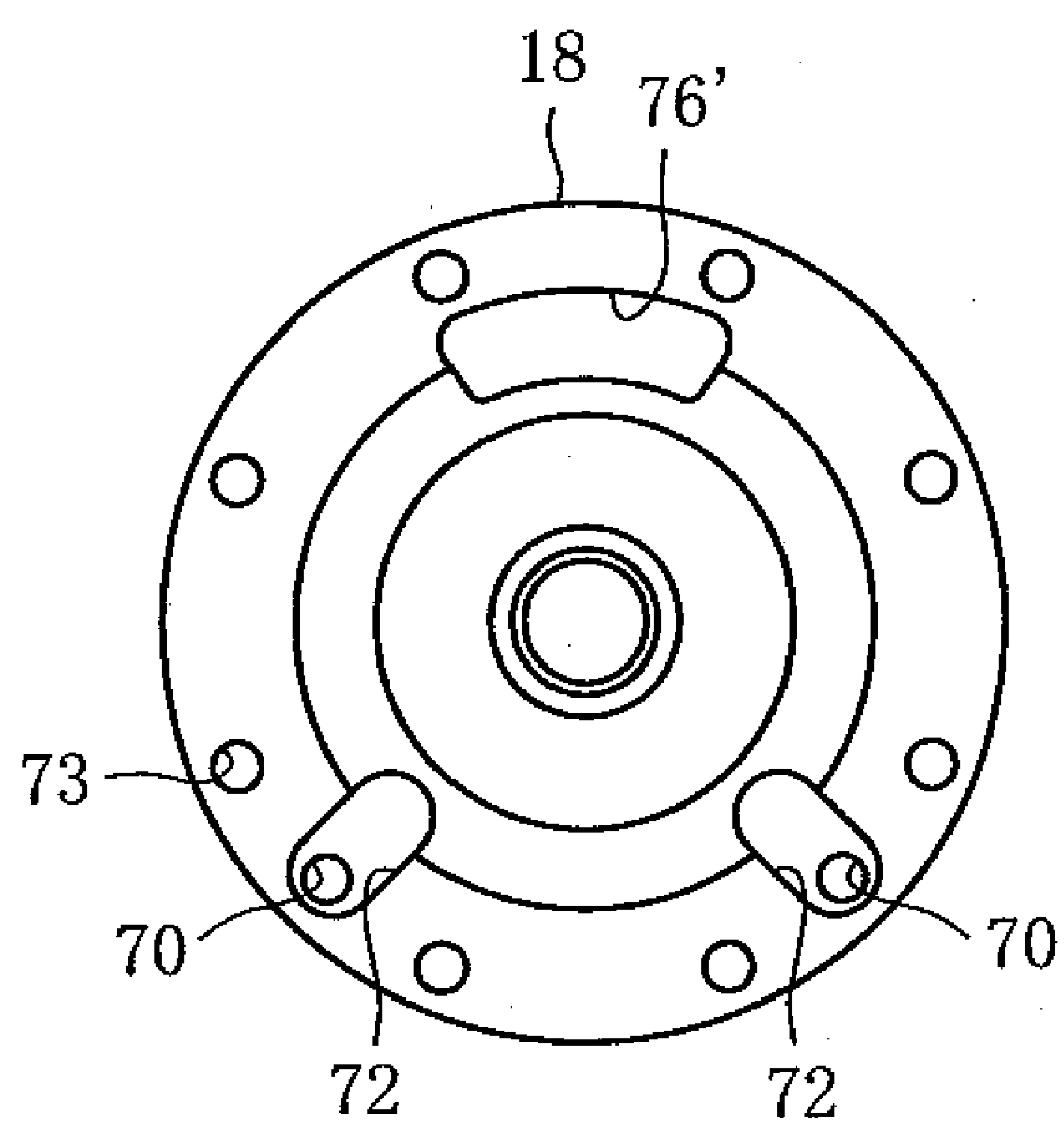


FIG. 6



SCROLL FLUID MACHINE

TECHNICAL FIELD

[0001] The present invention relates to a scroll fluid machine that is suitable as a compressor of a refrigeration circuit used for vehicle air conditioning.

BACKGROUND ART

[0002] A scroll fluid machine of this type is equipped in its airtight container with a scroll unit that performs a series of processes including the suction, compression and discharge of a refrigerant. This unit specifically has a fixed and a movable scroll engaged with each other. The fixed scroll is fixed to the airtight container with a spindle frame intervening therebetween. The movable scroll includes a boss formed in its rear face, and a crank pin formed integrally with a rotary shaft is interlocked with the boss.

[0003] The movable scroll is thus driven by the rotary shaft via the boss. As a result, the movable scroll orbits around the axis of the fixed scroll while being supported by the spindle frame, without rotating on its axis. The volume of a space created between the spiral wraps of the scrolls is decreased, and a series of the processes including compression and discharge is carried out. The spindle frame is fixed onto the inner wall of the airtight container, for example, by welding. In general, the fixed scroll is integrally fastened to the spindle frame by bolts or the like which are arranged in the outer circumferential portion of the fixed scroll. The movable scroll is housed in a space between the spindle frame and the fixed scroll so as to be capable of making orbital motion while being supplied with lubricant (see Patent Documents 1 and 2).

[0004] Patent Document 1: Unexamined Japanese Patent Publication No. 2005-201168

[0005] Patent Document 2: Unexamined Japanese Patent Publication No. 11-82327

DISCLOSURE OF THE INVENTION

Problem to be Solved by the Invention

[0006] When a scroll fluid machine is constructed as described above, and the fixed scroll is fastened to the spindle frame by bolts or the like, a space between the spindle frame and the fixed scroll is usually filled with lubricant. This requires good sealability (hermetic seal performance) to be ensured in a fastened face of the spindle frame with respect to the fixed scroll.

[0007] In many cases, however, the spindle frame is not completely uniform in its sectional shape around a shaft, and occasionally, the axial thickness of the spindle frame is partially uneven. When the fixed scroll and the spindle frame are fastened together by bolts or the like, the partial uneven thickness of the spindle frame makes non-uniform a deformed shape of the fastened face over the whole circumference of the spindle frame, and also makes non-uniform the deformed shape of the fastened face in regions where the thickness of the spindle frame is uneven. This causes the problem that good sealability cannot be ensured.

[0008] In a scroll fluid machine of this type, for example, one refrigerant path or two adjacent refrigerant paths that circulate a discharged high-pressure refrigerant are formed to penetrate from the fixed scroll through the spindle frame. In some cases, countersinking is applied to an outlet region of the path in the spindle frame to ensure a smooth circulation of the refrigerant. In such a case, the countersunk region becomes uneven in axial thickness, and the deformed shape of the fastened face becomes non-uniform in the countersunk region, making it difficult to ensure good sealability.

[0009] It is not preferable that good sealability cannot be ensured in the fastened face of the spindle frame with respect to the fixed scroll because there is a possibility that the scroll unit fails to carry out a good compression performance.

[0010] The invention has been made in light of the foregoing circumstances. It is an object of the invention to provide a scroll fluid machine in which sealability is improved by uniforming the deformed shape of a fastened face of a spindle frame with respect to a fixed scroll, and compression performance is thus improved.

Means for Solving the Problem

[0011] In order to achieve the object, a scroll fluid machine claimed in claim **1** has a rotary shaft that stretches in a container and is freely supported by the container; a crank pin that is eccentrically and integrally formed in an upper end side of the rotary shaft; a scroll unit that is disposed in the container, includes a fixed scroll and a movable scroll that orbits around an axis of the fixed scroll by being connected with the crank pin and driven by the rotary shaft, engages a spiral wrap of the movable scroll with a spiral wrap of the fixed scroll by causing the movable scroll to make the orbital motion, and carries out a series of process including the compression and discharge of a working fluid while reducing the volume of a space created between the spiral wraps; a spindle frame that is interfitted in the container, fastened to the fixed scroll by fastening means at an outer circumferential portion, penetrates to support the rotary shaft at the center, and houses the movable scroll connected to the crank pin in a space created between the spindle frame and the fixed scroll so as to allow the movable scroll to make the orbital motion; a refrigerant path that is formed in the outer circumferential portion to penetrate the fixed scroll and the spindle frame in an axial direction to open in a rear face of the spindle frame, and guides a high-pressure refrigerant compressed and discharged by the scroll unit to the rear face side of the spindle frame; and a countersunk section that is formed in an opening rim of the refrigerant path of the spindle frame, in which a recessed section is formed in a predetermined position symmetric to the countersunk section across the axis.

[0012] In the scroll fluid machine claimed in claim **2** according to claim **1**, the recessed section is formed to be on a concentric circle and point-symmetric relative to the countersunk section across the axis.

[0013] In the scroll fluid machine claimed in claim **3** according to claim **1** or **2**, the refrigerant path and the countersunk section are plurally formed, and the predetermined position is plurally provided to be symmetric to the countersunk sections across the axis.

[0014] In the scroll fluid machine claimed in claim **4** according to claim **1**, the refrigerant path and the countersunk section are plurally formed, and the predetermined position is located in a given area between positions symmetric to the countersunk sections across the axis.

Effective Advantages of the Invention

[0015] According to the scroll fluid machine claimed in claim **1**, since the recessed section is formed in the predetermined position symmetric to the countersunk section across the axis, the deformed shape of the fastened face between the spindle frame and the fixed scroll is uniform. It is then possible to improve the sealability of the fastened face and improve the compression performance in the scroll unit.

[0016] According to the scroll fluid machine claimed in claim **2**, since the recessed section is formed to be on a concentric circle and point-symmetric relative to the countersunk section across the axis, it is possible to position the recessed section without difficulty, and at the same time, improve the sealability of the fastened face between the spindle frame and the fixed scroll and improve the compression performance in the scroll unit.

[0017] According to the scroll fluid machine claimed in claim **3**, the refrigerant path and the countersunk section are plurally formed, and the predetermined position of the recessed section is plurally provided to be symmetric to the countersunk sections across the axis. For this reason, if the refrigerant path and the countersunk section are plurally formed, the deformed shape of the fastened face between the spindle frame and the fixed scroll is uniform, and it is possible to improve the sealability of the fastened face and improve the compression performance in the scroll unit.

[0018] According to the scroll fluid machine claimed in claim **4**, the refrigerant path and the countersunk section are plurally formed, and the predetermined position of the recessed section is located in the given area between the positions symmetric to the countersunk sections across the axis. For this reason, if the refrigerant path and the countersunk section are plurally formed, it is possible to increase the degree of freedom in disposition of the recessed section, and at the same time, improve the sealability of the fastened face and improve the compression performance in the scroll unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a longitudinal sectional view of a scroll fluid machine according to an embodiment of the invention;

[0020] FIG. **2** is an enlarged view of a scroll unit section of FIG. **1**;

[0021] FIG. **3** is a rear view of a spindle frame according to a first example as viewed in a direction of arrow A of FIG. **2**;

[0022] FIG. **4** is a sectional view taken along line B-B of FIG. **3**;

[0023] FIG. **5** is a rear view of the spindle frame according to a second example; and

[0024] FIG. **6** is a rear view of the spindle frame according to a third example.

REFERENCE MARKS

[0025] **1** scroll fluid machine

[0026] **2** housing (container)

[0027] **16** rotary shaft

[0028] **18** spindle frame

[0029] **30** scroll unit

[0030] **34** movable scroll

[0031] **36** fixed scroll

[0032] **70** refrigerant path

[0033] **72** countersunk section

[0034] **74** bolt

[0035] **75** nut

[0036] **76**, **76'** recessed section

BEST MODE OF CARRYING OUT THE INVENTION

[0037] The mode of carrying out the invention will be described below in detail with reference to the drawings.

EXAMPLES

[0038] FIG. **1** is a longitudinal sectional view of a scroll fluid machine according to the invention.

[0039] A scroll fluid machine **1** is a fluid machine of a longitudinal-mounted type which is installed in a refrigeration circuit, such as a refrigeration and air-conditioning system and a heat-pump water heater. The circuit includes a path through which a carbon dioxide refrigerant (hereinafter, referred to as a refrigerant) that is one example of a working fluid. The scroll fluid machine **1** sucks in the refrigerant from the path, and compresses and discharges the refrigerant toward the path.

[0040] As shown in FIG. **1**, the scroll fluid machine **1** has a housing (container) **2**. A body **4** of the housing **2** is airtightly fitted by an upper lid **6** and a lower lid **8** at upper and lower sides, respectively. The inside of the body **4** is thus sealed, and a high-pressure discharge pressure acts thereon. A suction pipe **10** that sucks in the refrigerant drawn in from the circuit is connected to the body **4**. A discharge pipe **12** that delivers a compressed refrigerant in the housing **2** to the circuit is connected to a proper position of the upper lid **6**.

[0041] An electric motor **14** is housed in the body **4**. Disposed in the motor **14** is a rotary shaft **16**, which is driven by energization of the motor **14**. The rotary shaft **16** is rotatably supported at an upper end side by a spindle frame **18** with a bearing **17** intervening therebetween.

[0042] The rotary shaft **16** is rotatably supported at a lower end side by a countershaft frame **22** with a bearing **20** intervening therebetween. An oil pump **24** is mounted on the lower end side of the rotary shaft **16**. The pump **24** sucks in lubricant L in a storage chamber **26** formed in an inner side of the lower lid **8**, that is, at a bottom of the housing **2**. The lubricant L flows through an oil supply path **28** formed through the rotary shaft **16** in an axial direction and functions to lubricate sliding areas, bearings, etc., and seal sliding surfaces.

[0043] Discharge pressure of the refrigerant acts upon an oil level of the lubricant L in the storage chamber **26**. The refrigerant's discharge pressure acting upon the oil level of the lubricant L also contributes to the rise of the lubricant L in the oil supply path **28**. This creates a high-pressure environment around an outlet of the oil supply path **28**, under which pressure is virtually equal to the discharge pressure of the refrigerant.

[0044] An entrance **32** of the lubricant L is formed in a proper position of the countershaft frame **22**. The lubricant L supplied to each sliding area of the scroll fluid machine is stored in the storage chamber **26** through the entrance **32**.

[0045] The scroll unit **30** is disposed above the motor **14** within the body **4**, and performs a series of processes including the suction, compression and discharge of the refrigerant.

[0046] More specifically, as shown in an enlarged scale in FIG. **2**, the scroll unit **30** is formed of a movable scroll **34** and a fixed scroll **36**. In the scrolls **34** and **36**, spiral wraps **34*a*** and **36*a*** are formed integral with and perpendicular to end plate faces **34*d*** and **36*d*** facing each other, thereby forming a compression chamber between the spiral wraps **34*a*** and **36*a***.

When the movable scroll **34** revolves relative to the fixed scroll **36**, the spiral wraps **34***a* and **36***a* are engaged with each other, and in consort, cause the refrigerant to be sucked from a suction chamber **37** formed on an outer circumferential side of the movable scroll **34** through the suction pipe **10** into the compression chamber. The compression chamber is reduced in volume as it moves toward the center of the spiral wraps **34***a* and **36***a*, and the compression of the refrigerant is carried out.

[0047] To be more specific, when the movable scroll **34** makes a revolving motion, the side faces of the spiral wraps **34***a* and **36***a* are engaged together, leaving a minute gap therebetween. At the same time, top faces **34***c* and **36***c* of the spiral wraps **34***a* and **36***a* are engaged with the end plate faces **36***d* and **34***d* of the fixed and movable scrolls **36** and **34**, respectively, leaving minute gaps. Simultaneously, the volume of the compression chamber is reduced, and the series of processes including the suction, compression and discharge of the refrigerant is performed.

[0048] In order to provide a revolving motion to the movable scroll **34**, a boss **38** is formed in a convex shape in a rear face **34***b* of the movable scroll **34**. The boss **38** is connected to a crank pin **42** with a bearing **44** intervening therebetween. The crank pin **42** is integrally formed in the upper end side of the rotary shaft **16**, and causes the movable scroll **34** to make an orbital motion on the spindle frame **18** along with rotation of the rotary shaft **16**.

[0049] The movable scroll **34** is prevented from rotating on its axis by a rotation blocking pin **62**. The pin **62** is formed in a protruding manner in the rear face **34***b* of the movable scroll **34**, and loosely fitted in a blind hole (cylindrical hole) **64** formed in the spindle frame **18**. In other words, a so-called pin-hole rotation blocking mechanism **60** is provided in a gap **45** between the rear face **34***b* of the movable scroll **34** and the spindle frame **18**. The rotation blocking mechanism **60** includes, for example, four pins **62** and their respective holes **64**.

[0050] A plurality of bolt through-holes **73** are axially formed through the outer circumferential portion of the fixed scroll **36** and that of the spindle frame **18**. The fixed scroll **36** is fastened to the spindle frame **18** by screwing nuts **75** onto bolts **74** penetrating the bolt through-holes **73** (fastening means). Consequently, the fixed scroll **36** separates a discharge chamber **54** formed in an inner side of the upper lid **6** and the compression chamber from each other. The spindle frame **18** has a cylindrical outer circumferential wall **19** being concentric with the rotary shaft **16** and extending towards the fixed scroll **36**. The fixed scroll **36** is joined to the spindle frame **18** at an upper edge of the outer circumferential wall **19**.

[0051] Since the fixed scroll **36** is joined to the upper edge of the outer circumferential wall **19**, the movable scroll **34** is surrounded by the outer circumferential wall **19**, and there creates between the fixed scroll **36** and the spindle frame **18** a revolving-sliding area (space) **46** in which the movable scroll **34** makes a sliding motion.

[0052] A discharge hole **56** leading to the compression chamber side is formed through the fixed scroll **36** at a proper position in a central portion of the fixed scroll **36**. The discharge hole **56** is opened/closed by a discharge valve **58** placed on the rear face **36***b* side of the fixed scroll **36**.

[0053] The discharge valve **58** is covered with a discharge head **50**. The discharge head **50** muffles noises produced when the discharge valve **58** is opened.

[0054] A refrigerant path **70** is axially formed in the fixed scroll **36** and the spindle frame **18** to penetrate the outer circumferential portions thereof. The refrigerant path **70** is a path for guiding a high-pressure refrigerant, which is compressed by the scroll unit **30** and discharged from the discharge hole **56**, to the rear face side of the spindle frame **18**. Although details are omitted here, the refrigerant discharged from the discharge hole **56** can circulate in the housing **2** by passing through the refrigerant path **70**.

[0055] FIG. **3** shows the rear face of the spindle frame **18** according to a first example as viewed from arrow A of FIG. **2**, and FIG. **4** shows a cross section taken along line B-B of FIG. **3**. The first example will be described below.

[0056] As shown in FIGS. **3** and **4**, in an opening rim of the refrigerant path **70** of the spindle frame **18**, there is formed a countersunk section **72** having an oval planar shape. The countersunk section **72** ensures a smooth circulation of the refrigerant that is guided by the refrigerant path **70**.

[0057] A recessed section **76** is formed in the outer circumferential portion of the spindle frame **18** at a position (predetermined position) that is on a concentric circle and point-symmetric relative to the countersunk section **72** across the axis of the rotary shaft **16**. The recessed section **76** has, for example, an oval planar shape like the shape of the countersunk section **72**.

[0058] An experiment by the inventors confirmed that, if the recessed section **76** was formed at the position point-symmetric to the countersunk section **72** as described above, and the fixed scroll **36** was fastened to the spindle frame **18** by the bolts **74** and the nuts **75**, a deformed shape of the fastened face between the spindle frame **18** and the fixed scroll **36** became uniform.

[0059] To put it differently, if there is not the recessed section **76**, but only the countersunk section **72**, the deformed shape of the fastened face over the whole circumference of the spindle frame **18** does not become uniform, and the deformed shape of the fastened face becomes non-uniform in the countersunk section **72**. This causes the problem that good sealability is not ensured. The deformed shape of the fastened face can be uniformed by forming the recessed section **76** at the position point-symmetric to the countersunk section **72** across the axis.

[0060] It is then possible to improve sealability in the fastened face between the fixed scroll **36** and the spindle frame **18** and improve compression performance in the scroll unit **30**.

[0061] In this case, since the recessed section **76** is located at the position point-symmetric to the countersunk section **72** across the axis, the recessed section **76** can be positioned without difficulty.

[0062] FIG. **5** shows the rear face of the spindle frame **18** according to a second example. The second example will be described below.

[0063] According to the second example, as shown in FIG. **5**, the refrigerant path **70** is plurally (two here) formed. The countersunk section **72** formed in the opening rim of the refrigerant path **70** is accordingly formed plurally (two here). The recessed sections **76** are formed at positions (predetermined positions) on a concentric circle and point-symmetric relative to the respective countersunk sections **72** across the axis.

[0064] In this manner, when the refrigerant path **70** and the countersunk section **72** are plurally formed, and the recessed sections **76** are formed at the positions point-symmetric to the respective countersunk sections **72** across the axis, the deformed shape of the fastened face between the spindle frame **18** and the fixed scroll **36** is uniform as in the first example. It is then possible to improve the sealability in the fastened face between the fixed scroll **36** and the spindle frame **18**, and improve the compression performance in the scroll unit **30**.

[0065] Again, the recessed sections **76** can be positioned without difficulty since the recessed sections **76** are located at the positions point-symmetric to the respective countersunk sections **72** across the axis.

[0066] FIG. **6** shows the rear face of the spindle frame **18** according to a third example. The third example will be described below.

[0067] In the third example, as shown in FIG. **6**, the refrigerant path **70** is plurally (two here) formed, and the countersunk section **72** formed in the opening rim of the refrigerant path **70** is accordingly plurally (two here) formed as in the second example. Moreover, a recessed section **76'** is formed in a given area (predetermined position) between positions on a concentric circle and point-symmetric relative to the countersunk sections **72** across the axis.

[0068] If the recessed section **76'** is formed in the given area between the positions point-symmetric to the respective countersunk sections **72** across the axis as mentioned above, since the recessed section **76'** is in a symmetrical position relative to the countersunk section **72** across the axis, it is possible to uniform the deformed shape of the fastened face between the spindle frame **18** and the fixed scroll **36** as in the second example. This also improves the sealability in the fastened face between the fixed scroll **36** and the spindle frame **18**, and improves the compression performance in the scroll unit **30**.

[0069] The third example has the advantage of providing a high degree of freedom in disposition of the recessed section **76**. One embodiment of the invention has been described, but the invention is not limited to the embodiment. The invention may be modified in various ways without deviating from the gist thereof.

[0070] For example, although the embodiment sets the shape of the recessed section **76** to an oval in a planar view in the first and second examples, the planar shape of the recessed section **76** is not limited to an oval. Likewise, the planar shape of the recessed section **76'** in the third example is not limited to the shape shown in FIG. **6**.

[0071] The embodiment does not particularly mention the depth of the recessed sections **76** and **76'**, but the depth may also be properly determined.

[0072] In the first and second examples, the embodiment forms the recessed section **76** at the position point-symmetric to the countersunk section **72** across the axis. The predetermined position for forming the recessed section **76**, however, does not have to be exactly point-symmetric as long as it is symmetric to the countersunk section **72** across the axis. Likewise, in the third example, the recessed section **76'** is formed between the positions point-symmetric to the respective countersunk sections **72** across the axis, but the predetermined position for forming the recessed section **76'** may be between positions symmetric to the respective countersunk sections **72**.

INDUSTRIAL APPLICABILITY

[0073] As the invention improves compression performance in a scroll unit, it is widely applicable as a compressor for air-conditioning, freezing, refrigeration, hot-water supply, etc.

1. A scroll fluid machine comprising:
- a rotary shall that stretches in a container and is freely supported by the container;
- a crank pin that is eccentrically and integrally formed in an upper end side of the rotary shaft;
- a scroll unit that is disposed in the container, includes a fixed scroll and a movable scroll that orbits around an axis of the fixed scroll by being connected with the crank pin and driven by the rotary shaft, engages a spiral wrap of the movable scroll with a spiral wrap of the fixed scroll by causing the movable scroll to make the orbital motion, and carries out a series of process including the compression and discharge of a working fluid while reducing the volume of a space created between the spiral wraps;
- a spindle frame that is interfitted in the container, fastened to the fixed scroll by fastening means at an outer circumferential portion, penetrates to support the rotary shaft at the center, and houses the movable scroll connected to the crank pin in a space created between the spindle frame and the fixed scroll so as to allow the movable scroll to make the orbital motion;
- a refrigerant path that is formed in the outer circumferential portion to penetrate the fixed scroll and the spindle frame in an axial direction to open in a rear face of the spindle frame, and guides a high-pressure refrigerant compressed and discharged by the scroll unit to the rear face side of the spindle frame; and
- a countersunk section that is formed in an opening rim of the refrigerant path of the spindle frame, the scroll fluid machine wherein a recessed section is fanned in a predetermined position symmetric to the countersunk section across the axis.

2. The scroll fluid machine according to claim **1**, wherein the recessed section is formed to be on a concentric circle and point-symmetric relative to the countersunk section across the axis.

3. The scroll fluid machine according to claim **1**, wherein:
- the refrigerant path and the countersunk section are plurally formed, and
- the predetermined position is plurally provided to be symmetric to the countersunk sections across the axis.

4. The scroll fluid machine according to claim **1**, wherein:
- the refrigerant path and the countersunk section are plurally formed, and
- the predetermined position is located in a given area between positions symmetric to the countersunk sections across the axis.

* * * * *