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(54) **Stirling cooler**

Stirling-Kühlanlage

Refroidisseur Stirling

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Description

Field of the Invention

[0001] The present invention relates to a stirling cooler.

Description of the Related Art

[0002] As shown in Fig. 1, a conventional stirling cooler comprises a case 4 provided with a cold tip 2 at an opened end thereof, a cylinder 6 fixedly installed in the case 4 and filled with a fluid, a piston 8 installed in the cylinder 6 such that the piston 8 can reciprocate, and provided with a hollow 7 formed therein, a displacer 10 installed in the hollow 7 of the piston 8 such that the displacer 10 can reciprocate, a regenerator 12 longitudinally connected to the displacer 10, and provided with a cavity 1 positioned between the regenerator 12 and the cold tip 2 and filled with the fluid, and a heat exchanger 14 connected to the cylinder 6 and the regenerator 12.

[0003] A flange 5 is vertically formed along an outer surface of the cylinder 6 in a radial direction, and a protrusion 3, on which the flange 5 is seated in an axial direction of the cylinder 6, is formed on the case 4. The flange 5 of the cylinder 6 is connected to the protrusion 3 of the case 4 by screws 16.

[0004] The piston 8 is connected to a linear motor 18 installed between the case 4 and the cylinder 6, and reciprocates. The displacer 10 is connected to an elastic member 19 installed in the case 2 such that the displacer 10 is opposite to the regenerator 12, thus being elastically supported such that the displacer 10 faces the cold tip 2. A hole 11 is formed in a lower part of the regenerator 12 being opposite to the cold tip 2.

[0005] The heat exchanger 14 includes an inner heat exchanger 13 installed in a heat exchange chamber 20 prepared between the cylinder 6 and the case 4, and an outer heat exchanger 15 installed on an outer surface of the case 4 so that the case 4 is interposed between the inner heat exchanger 13 and the outer heat exchanger 15. A first hole 22 communicating with the heat exchanger chamber 20 is formed through the cylinder 6, and a second hole 24 communicating with a hole 9 formed through the displacer 10 positioned at the heat exchange chamber 20 and the regenerator 12.

[0006] An O-ring 30 is positioned at a contact portion of the outer surface of the cylinder 6 and the case 4 in a radial direction of the cylinder 6 so that the fluid does not leak from the heat exchange chamber 20.

[0007] Hereinafter, operation of the above-described conventional stirling cooler will be described in detail.

[0008] When the piston 8 moves close to the cold tip 2, the fluid of the cylinder 6 is isothermally compressed, and is discharged to the heat exchange chamber 20 to emit heat. Then, the fluid is introduced into the regenerator 12 to emit sensible heat, and fills the cavity 1 between the regenerator 12 and the cold tip 2 and is isothermally expanded simultaneously. Here, as the fluid fills the cavity 1 between the regenerator 12 and the cold tip 2, the regenerator 12 and the displacer 10 move away from the cold tip 2.

[0009] Thereafter, when the piston 8 moves away from the cold tip 2, the displacer 10 and the regenerator 12 are returned to their earlier positions toward the cold tip 2 by the elastic force of the elastic member 18. The fluid filling the cavity 1 between the regenerator 12 and the cold tip 2 subsequently passes through the regenerator 12 and the heat exchange chamber 20 to absorb heat, and re-fills the cylinder 6.

[0010] Since the cylinder 6 provided with the O-ring 30 is inserted into the case 4 in the conventional stirling cooler, the O-ring 30 between the case 4 and the cylinder 6 is overloaded, thus being damaged and causing change in an axis of the cylinder 6. Thereby, the displacer 10 and the piston 8 reciprocating in the cylinder 6 are easily worn out, thus causing errors in operating the stirling cooler.

[0011] US 6,327,862 B1 is related with a stirling cycle cyrocooler with optimized cold end design and discloses a stirling cooler having a displacer unit, a heat exchanger unit and a compressor and linear motor assembly. The heat exchanger unit is located between the displacer unit and the compressor and linear motor assembly and includes a heat exchanger block mounted to a heat exchanger mounting flange. The heat exchanger mounting flange is coupled to a distal end of a pressure housing of the compressor and linear motor assembly. A cylinder that is provided with a piston reciprocating therein is mounted with one end to the heat exchanger mounting flange.

[0012] KR 20030066144 A is concerned with a coupling for a heat transfer member (heat exchanger) and discloses a stirling cooler comprising a case with a cold tip at an end thereof, a cylinder fixedly installed in the case and provided with a piston reciprocating therein, a displacer installed in the piston such that the displacer can reciprocate; a regenerator positioned between the displacer and the cold tip; a heat exchanger connected to the regenerator and the cylinder and a heat exchange chamber installed in the case at a lower part of the cylinder. The heat exchanger includes an inner heat exchanger or transfer member installed in the heat exchange chamber positioned between the case and the cylinder, and an outer heat exchanger or transfer member installed on an outer surface of the case opposite to the inner heat exchanger. For mounting the cylinder to the case the cylinder is provided with a flange protruding perpendicularly from the outer surface of the cylinder in a radial direction and being seated on a corresponding stair of the case in axial direction of the cylinder. The stair of the case and the flange of the cylinder are connected to each other by screws. In order to improve sealing capabilities between the respective components during manufacture of the stirling cooler, the front end of the case, the inner and outer heat exchangers and an adapter ring are coupled by brazing.

SUMMARY OF THE INVENTION

[0013] It is an object of the present invention to provide a stirling cooler, in which a packing prevents a fluid from leaking out of a heat exchange chamber and does not influence an axis of a cylinder when the cylinder is assembled in a case.

[0014] This object is achieved by the stirling cooler according to claim 1. Refinements and advantageous developments of the present invention are described in the depending claims.

[0015] Thus, according to the present invention a packing for maintaining a hermetically sealed state of the heat exchanged chamber is positioned at a portion connecting the cylinder and the case in an axial direction of the cylinder. The packing is combined with at least one O-ring installed at a portion of the cylinder contacting the case in a radial direction of the cylinder for defining the heat exchange chamber. Thus, the packing and the O-ring are respectively positioned at opposite sides of the heat exchange chamber in the axial direction of the cylinder.

[0016] Additionally, an O-ring is installed at an outer surface of the cylinder opposite to the inner heat exchanger.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal-sectional view of a conventional stirling cooler;

Fig. 2 is a longitudinal-sectional view of a stirling cooler in accordance with the present invention; and

Fig. 3 is a plan view of a packing of the stirling cooler in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Now, a preferred embodiment of the present invention will be described in detail with reference to the annexed drawings.

[0019] The present invention may comprise several embodiments, but the most preferred embodiment will be described hereinafter. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

[0020] As shown in Fig. 2, a stirling cooler in accordance with the present invention comprises a case 50 provided with a cold tip 52 at an opened end thereof, a cylinder 54 fixedly installed in the case 50 and filled with a fluid, and a packing 70 positioned at a contact area between the case 50 and the cylinder 54 in an axial direction of the cylinder 54.

[0021] A linear motor 56 is installed between the case 50 and an upper part of the cylinder 54, a piston 58 connected to the linear motor 56 is installed in the cylinder 54 such that the piston 58 can reciprocate, a displacer 62 supported by an elastic member 60 installed on the case 50 is installed in the piston 58 such that the displacer 62 can reciprocate, and a regenerator 64 is installed between the displacer 62 and the cold tip 52.

[0022] A heat exchange chamber 66 is installed in the case 50 and the lower part of the cylinder 52, and communicates with the cylinder 52 and the regenerator 64 such that the heat exchange chamber 66 exchanges heat of the fluid with the cylinder 52 and the regenerator 64. An inner heat exchanger 68 is installed in the heat exchange chamber 66, and an outer heat exchanger 69 surrounding the heat exchange chamber 66 is installed on an outer surface of the case 50 so that the case 50 is interposed between the inner heat exchanger 68 and the outer heat exchanger 69.

[0023] Here, the heat exchange chamber 66 is configured such that two contact portions 53 and 53' of the cylinder 54, which are separated from each other in the axial direction of the cylinder 54, contact the case 50, and the lower contact portion 53' of the cylinder 54 has a width narrower than that of the upper contact portion 53 of the cylinder 54. Further, the case 50 has a stepwise structure including two stairs 51 and 51' so that the upper stair 51 of the case 50 contacts the upper contact portion 53 of the cylinder 54 and the lower stair 51' of the case 50 contacts the lower contact portion 53' of the cylinder 54, thereby being provided with the heat exchange chamber 66.

[0024] The fluid flows in the heat exchange chamber 66 between the cylinder 54 and the regenerator 64, and requires the packing 70 for maintaining a hermetically sealed state of the heat exchange chamber 66, inserting the cylinder 54 into a gap between the stairs 51 and 51' of the case 50 and preventing the change in an axis of the cylinder 54.

[0025] Since the upper stair 51 of the case 50 more influences the axis of the cylinder 54, the packing 70 is positioned at the upper stair 51 of the case 50.

[0026] Accordingly, a flange 55 is protruded perpendicularly from the outer surface of the cylinder 54 in a radial direction, and seated on the upper stair 51 of the case 50 in the axial direction of the cylinder 54, and the packing 70 is interposed between the upper stair 51 of the case 50 and the flange 55 of the cylinder 54.

[0027] The above packing 70 has a ring shape so that it is inserted into the whole outer circumference of the cylinder 54 for hermetically sealing the heat exchange chamber 66. Further, a radius of the packing 70, i.e., a distance from a center of the packing 70 to the outer circumference of the packing 70, is approximately the same as a distance from the center of the cylinder 54 to the flange 55 of the cylinder 54 in the radial direction of the cylinder 54. Here, in order to uniformly compress the ring-shaped packing 70 in the radial direction of the cyl-

inder 54 and firmly sealing the heat exchange chamber 66, the flange 55 of the cylinder 54 has a ring shape. Therefore, the packing 70 and the flange 55 of the cylinder 54 have the same shape.

[0028] Since the upper stair 51 of the case 50 and the flange 55 of the cylinder 54 are connected to each other by screws 80, the packing 70 includes through holes 71, into which the screws 80 are inserted, so that the packing 70 together with the cylinder 54 is fixed to the case 50.

[0029] An O-ring 72 for firmly maintaining the sealed state of the heat exchange chamber 66 is positioned at the lower contact portion 53' of the cylinder 54. The O-ring 72 and the packing 70 are opposite to the heat exchange chamber 66 in the axial direction of the cylinder 54, thus maintaining the sealed state of the heat exchange chamber 66.

[0030] Further, an O-ring 74 for maintaining the sealed state of the inner heat exchanger 68 is positioned at the outer surface of the cylinder 54 located at the height of the heat exchange chamber 66.

[0031] Hereinafter, operation and effects of the cryogenic regenerator in accordance with the present invention will be described in detail.

[0032] When the linear motor 56 is operated, the piston 58 moves close to the cold tip 52 and the fluid of the cylinder 54 passes through the heat exchange chamber 66 and the regenerator 64 and flows between the regenerator 64 and the cold tip 52. Then, the regenerator 64 and the displacer 62 move away from the cold tip 52.

[0033] On the other hand, when the piston 58 moves away from the cold tip 52 by means of the operation of the linear motor 56, the fluid filling a gap between the regenerator 64 and the cold tip 52 flows into the regenerator 64 and the heat exchange chamber 66 and re-fills the cylinder 54.

[0034] Here, since the heat exchange chamber 66 is firmly sealed by the packing 70 and the O-rings 72 and 74, the fluid filling the heat exchange chamber 66 cannot leak into spaces other than the regenerator 64.

[0035] Since the packing 70 between the upper stair 51 of the case 50 and the flange 55 of the cylinder 54 is compressed in the axial direction of the cylinder 54, the cylinder 54 is easily assembled in the case 50. Further, the piston 58 and the displacer 62 reciprocate in the axial direction of the cylinder 54, thus improving the life span of the cylinder 54, the piston 58 and the displacer 62.

[0036] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the accompanying claims.

Claims

1. A stirling cooler comprising:

- a case (50) provided with a cold tip (52) at an end thereof;
- a cylinder (54) fixedly installed in the case (50) and provided with a piston (58) reciprocating therein;
- a displacer (62) installed in the piston (58) such that the displacer can reciprocate;
- a regenerator (64) positioned between the displacer (62) and the cold tip (52);
- a heat exchanger (68, 69) connected to the regenerator (64) and the cylinder (54); and
- a heat exchange chamber (66) installed in the case (50) at a lower part of the cylinder (52);

wherein the heat exchanger includes an inner heat exchanger (68) installed in the heat exchange chamber (66) positioned between the cylinder (54) and the case (50), and an outer heat exchanger (69) installed on an outer surface of the case opposite to the inner heat exchanger (68);

characterized in that

- a packing (70) is positioned at one side of the heat exchange chamber (66) for maintaining the sealed state of the heat exchanger chamber (66) at an area, in which the cylinder (54) contacts the case (50) in an axial direction of the cylinder (54);
- an O-ring (72) is installed at another side of the heat exchange chamber (66) at a portion of the cylinder (54) contacting the case (50) in a radial direction of the cylinder (54) for defining the heat exchange chamber (66), so that the O-ring (72) and the packing (70) are respectively positioned at opposite sides of the heat exchange chamber (66) in the axial direction of the cylinder (54); and
- an O-ring (74) is installed at an outer surface of the cylinder (54) opposite to the inner heat exchanger (68).

2. The stirling cooler as set forth in claim 1, wherein the packing (70) is interposed between a flange (55) protruded perpendicularly from an outer surface of the cylinder (54) and a stair (51, 51') of the case (50) on which the flange (55) is seated.

3. The stirling cooler as set forth in claim 2, wherein through holes (71) for connecting the flange (55) of the cylinder (54) and the stair (51, 51') of the case (50) by screws (80) are formed through the packing (70).

4. The stirling cooler as set forth in claim 2, wherein the packing (70) has a ring shape so that it is inserted into the outer surface of the cylinder (54).

5. The stirling cooler as set forth in claim 1, wherein

- the heat exchanger (68, 69) includes inner and outer units respectively installed at the inside and outside of the heat exchange chamber (66) positioned between the cylinder (54) and the case (50) and connected to the regenerator (64) and the cylinder (54); and
- the packing (70) is interposed between a flange (55) protruded perpendicularly from an outer surface of the cylinder (54) and a stair (51, 51') of the case (50) on which the flange (55) is seated in an axial direction of the cylinder (54) for maintaining the sealed state of the heat exchange chamber (66.)

6. The stirling cooler as set forth in claim 5, wherein through holes (71) for connecting the flange (55) of the cylinder (54) and the stair (51, 51') of the case (50) by screws (80) are formed through the packing (70).

Patentansprüche

1. Stirling-Kühleinrichtung, die umfasst:

- ein Gehäuse (50), das an einem Ende mit einer kalten Spitze (52) versehen ist;
- einen Zylinder (54), der in dem Gehäuse (50) fest installiert ist und mit einem Kolben (58) versehen ist, der sich darin hin und her bewegt;
- einen Verdrängerkolben (62), der in dem Kolben (58) installiert ist, so dass sich der Verdrängerkolben hin und her bewegen kann;
- einen Regenerator (64), der zwischen dem Verdrängerkolben (62) und der kalten Spitze (52) positioniert ist;
- einen Wärmetauscher (68, 69), der mit dem Regenerator (64) und dem Zylinder (54) verbunden ist; und
- eine Wärmetauscherkammer (66), die im Gehäuse (50) in einem unteren Teil des Zylinders (52) installiert ist;

wobei der Wärmetauscher einen inneren Wärmetauscher (68), der in der Wärmetauscherkammer (66) installiert ist und zwischen dem Zylinder (54) und dem Gehäuse (50) positioniert ist, und einen äußeren Wärmetauscher (69), der an einer äußeren Oberfläche des Gehäuses gegenüber dem inneren Wärmetauscher (68) installiert ist, enthält;
dadurch gekennzeichnet, dass

- eine Dichtung (70) an einer Seite der Wärmetauscherkammer (66) positioniert ist, um den dichten Zustand der Wärmetauscherkammer (66) in einem Bereich, in dem der Zylinder (54) in axialer Richtung des Zylinders (54) mit dem Gehäuse (50) in Kontakt ist, aufrecht zu erhalten;
- ein O-Ring (72) an einer weiteren Seite der Wärmetauscherkammer (66) in einem Abschnitt des Zylinders (54), der mit dem Gehäuse (50) in radialer Richtung des Zylinders (54) in Kontakt ist, um die Wärmetauscherkammer (66) zu definieren, installiert ist, so dass der O-Ring (72) und die Dichtung (70) auf jeweils gegenüberliegenden Seiten der Wärmetauscherkammer (66) in axialer Richtung des Zylinders (54) positioniert sind; und
- ein O-Ring (74) an einer äußeren Oberfläche des Zylinders (54) gegenüber dem inneren Wärmetauscher (68) installiert ist.

2. Stirling-Kühleinrichtung nach Anspruch 1, wobei die Dichtung (70) zwischen einem Flansch (55), der von einer äußeren Oberfläche des Zylinders (64) senkrecht vorsteht, und einer Stufe (51, 51') des Gehäuses (50), an der der Flansch (55) sitzt, eingefügt ist.

3. Stirling-Kühleinrichtung nach Anspruch 2, wobei Durchgangslöcher (71) durch die Dichtung (70) ausgebildet sind, um den Flansch (55) des Zylinders (54) und die Stufe (51, 51') des Gehäuses (50) durch Schrauben (80) zu verbinden.

4. Stirling-Kühleinrichtung nach Anspruch 2, wobei die Dichtung (70) eine Ringform hat, so dass sie in die äußere Oberfläche des Zylinders (54) eingesetzt ist.

5. Stirling-Kühleinrichtung nach Anspruch 1, wobei

- der Wärmetauscher (68, 69) eine innere und eine äußere Einheit umfasst, die an der Innenseite bzw. an der Außenseite der Wärmetauscherkammer (66) installiert sind, die zwischen dem Zylinder (54) und dem Gehäuse (50) positioniert ist und mit dem Regenerator (54) verbunden ist; und
- die Dichtung (70) zwischen einem Flansch (55), der von einer äußeren Oberfläche des Zylinders (54) senkrecht vorsteht, und einer Stufe (51, 51') des Gehäuses (50), auf der der Flansch (55) in axialer Richtung des Zylinders (54) sitzt, eingefügt ist, um den dichten Zustand der Wärmetauscherkammer (66) aufrecht zu erhalten.

6. Stirling-Kühleinrichtung nach Anspruch 5, wobei Durchgangslöcher (71) durch die Dichtung (70) ausgebildet sind, um den Flansch (55) des Zylinders (54) und die Stufe (51, 51') des Gehäuses (50) durch Schrauben (80) zu verbinden.

Revendications

1. Refroidisseur à cycle de Stirling, comprenant :

- un carter (50) pourvu d'un embout froid (42) à une extrémité de celui-ci ;
- un cylindre (54) installé à demeure dans le carter (50) et pourvu d'un piston (58) allant et venant dans celui-ci ;
- un piston auxiliaire (62) installé dans le piston (58) de façon que le piston auxiliaire puisse aller et venir ;
- un régénérateur (64) placé entre le piston auxiliaire (62) et l'embout froid (52) ;
- un échangeur de chaleur (68, 69) couplé au régénérateur (64) et au cylindre (54) ; et
- une chambre d'échange de chaleur (66) installée dans le carter (50) au niveau d'une partie inférieure du cylindre (52) ;

dans lequel l'échangeur de chaleur comprend un échangeur de chaleur intérieur (68) installé dans la chambre d'échange de chaleur (66) à un emplacement entre le cylindre (54) et le carter (50), et un échangeur de chaleur extérieur (69) installé sur une surface extérieure du carter en regard de l'échangeur de chaleur intérieur (68) ;
caractérisé en ce que

- une garniture (70) est placée sur un premier côté de la chambre d'échange de chaleur (66) pour maintenir l'étanchéité de la chambre d'échange de chaleur (66) dans une zone dans laquelle le cylindre (54) touche le carter (50) dans une direction axiale du cylindre (54) ;
- un joint torique (72) est installé sur un autre côté de la chambre d'échange de chaleur (66) sur une partie du cylindre (54) touchant le carter (50) dans une direction radiale du cylindre (54) pour définir la chambre d'échange de chaleur (66), si bien que le joint torique (72) et la garniture (70) sont respectivement placés sur des côtés opposés de la chambre d'échange de chaleur (66) dans la direction axiale du cylindre (54) ; et
- un joint torique (74) est installé sur une surface extérieure du cylindre (54) en regard de l'échangeur de chaleur intérieur (68).

2. Refroidisseur à cycle de Stirling selon la revendication 1, dans lequel la garniture (70) est intercalée entre une collerette faisant saillie perpendiculairement depuis une surface extérieure du cylindre (54) et un gradin (51, 51') du carter (50) sur lequel repose la collerette (55).

3. Refroidisseur à cycle de Stirling selon la revendication 2, dans lequel des trous traversants (71) pour assujettir l'un à l'autre par des vis (80) la collerette (55) du cylindre (54) et le gradin (51,51') du carter (50) sont ménagés à travers la garniture (70).

4. Refroidisseur à cycle de Stirling selon la revendication 2, dans lequel la garniture (70) a une forme annulaire de façon à être insérée dans la surface extérieure du cylindre (54).

5. Refroidisseur à cycle de Stirling selon la revendication 1, dans lequel :

- l'échangeur de chaleur (68, 69) comprend des ensembles intérieur et extérieur respectivement installés à l'intérieur et à l'extérieur de la chambre d'échange de chaleur (66), placés entre le cylindre (64) et le carter (50) et couplés au régénérateur (64) et au cylindre (64) ; et
- la garniture (70) est intercalée entre une collerette faisant saillie perpendiculairement depuis une surface extérieure du cylindre (54) et un gradin (51, 51') du carter (50) sur lequel la collerette (55) repose dans une direction axiale du cylindre (54) pour maintenir l'étanchéité de la chambre d'échange de chaleur (66).

6. Refroidisseur à cycle de Stirling selon la revendication 5, dans lequel des trous traversants (71) pour assujettir l'un à l'autre par des vis (80) la collerette (55) du cylindre (54) et le gradin (51, 51') du carter (50) sont ménagés à travers la garniture (70).

FIG. 1 (Prior Art)

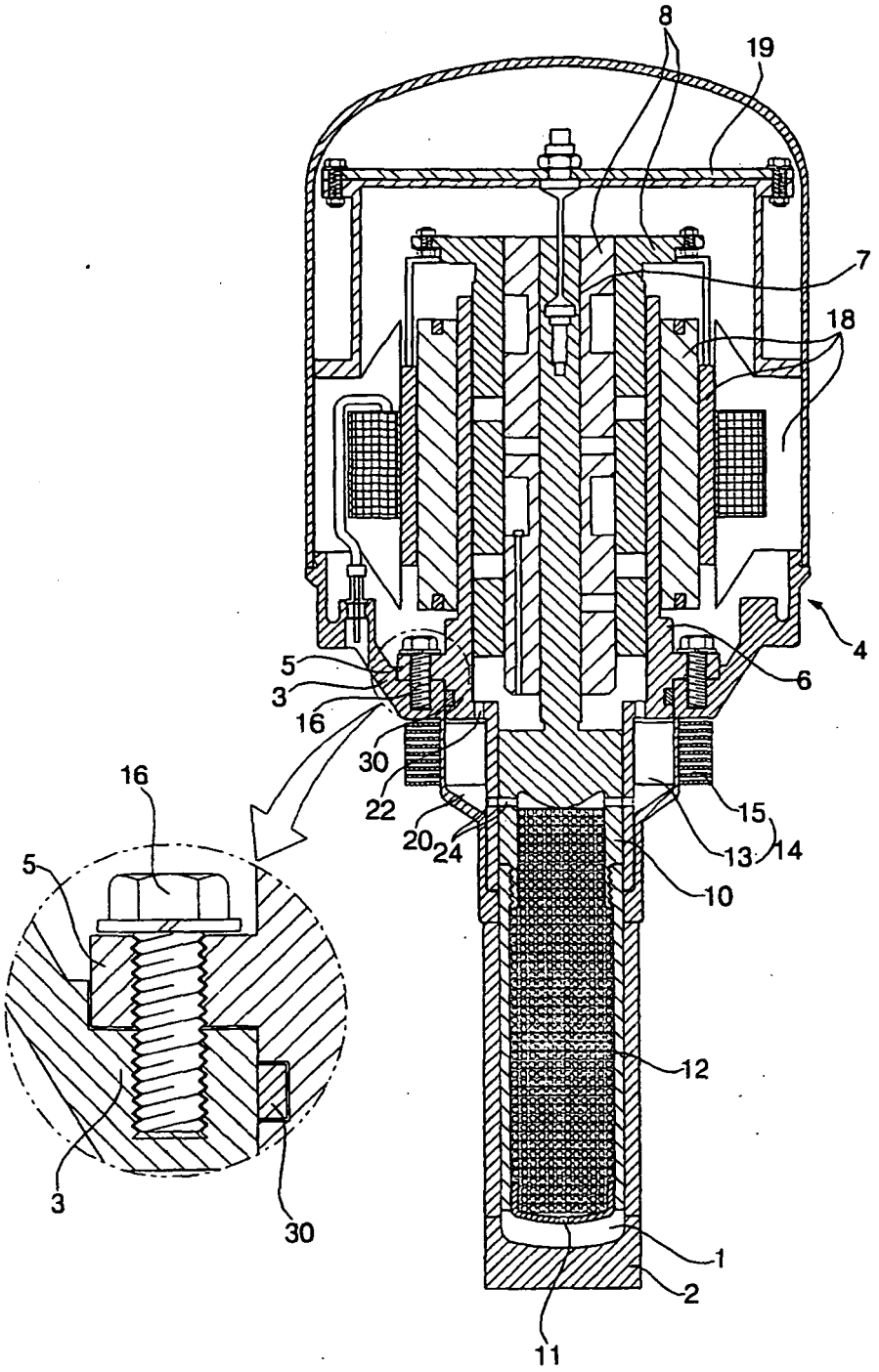


FIG. 2

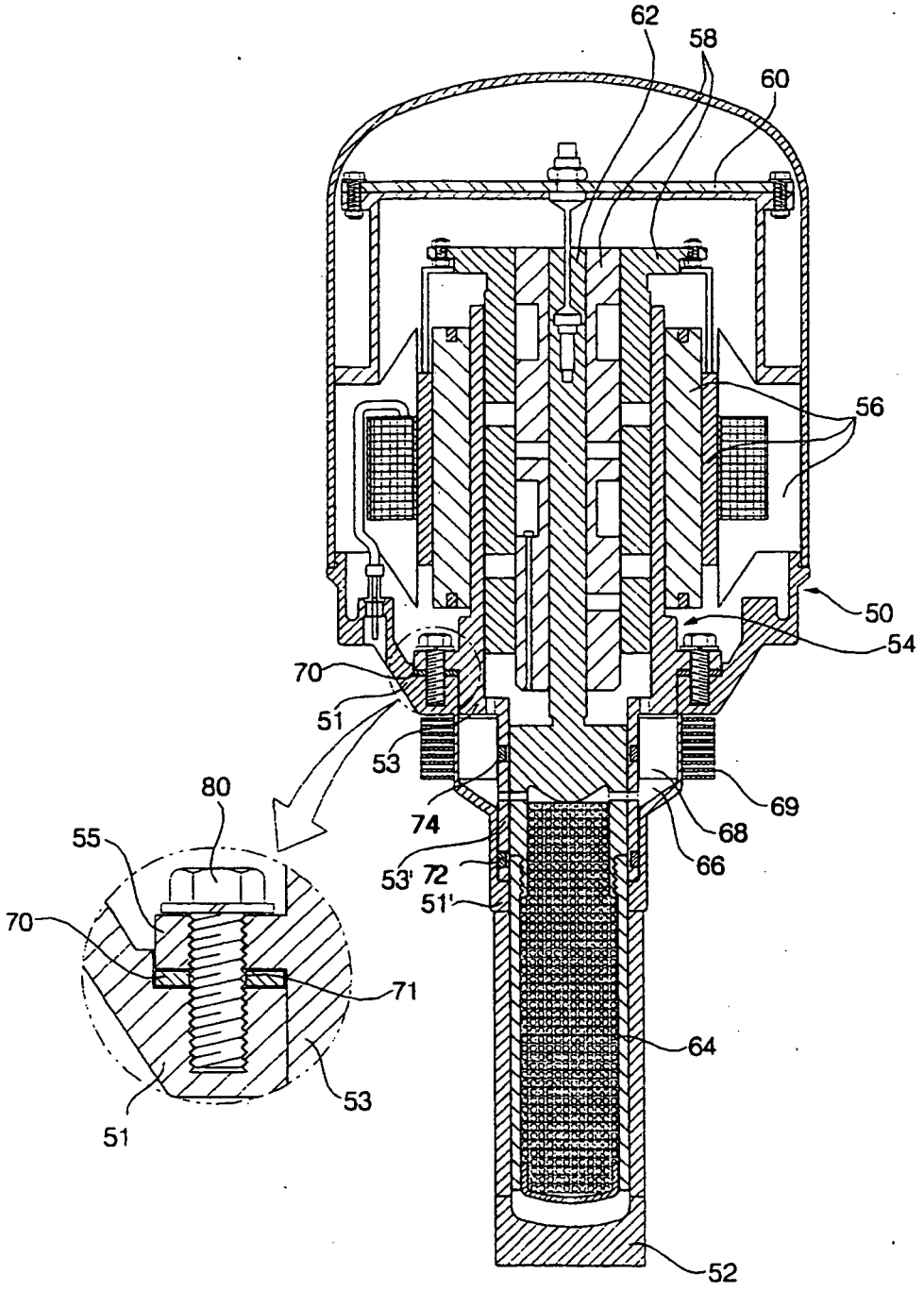
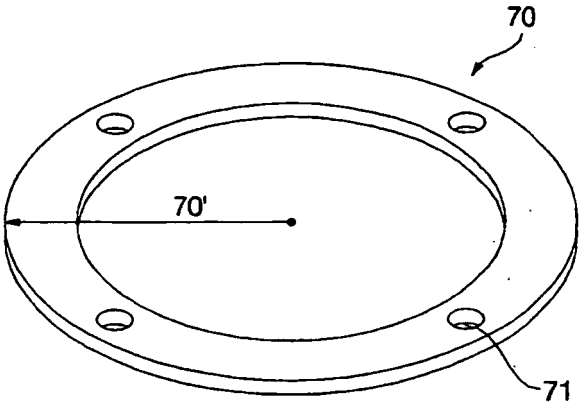


FIG. 3



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6327862 B1 **[0011]**
- KR 20030066144 A **[0012]**