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(54) **COMPRESSOR FOR AND METHOD OF
SIMULTANEOUSLY COOLING AND
CLEANING GAS**

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(57) **ABSTRACT**

A scroll type compressor includes a fixed scroll member and a movable scroll member to define compression chambers. The movable scroll member orbits relative to the fixed scroll member to compress gas in the compression chambers. The compressed gas is discharged to a discharge port. The compressor also includes a filter chamber and a cooling chamber. The filter chamber communicates with the discharge port for accommodating a first filter to at least partially filter the compressed gas. The cooling chamber is located adjacent to the filter chamber for containing coolant fluid that cools the compressed gas in the filter chamber.

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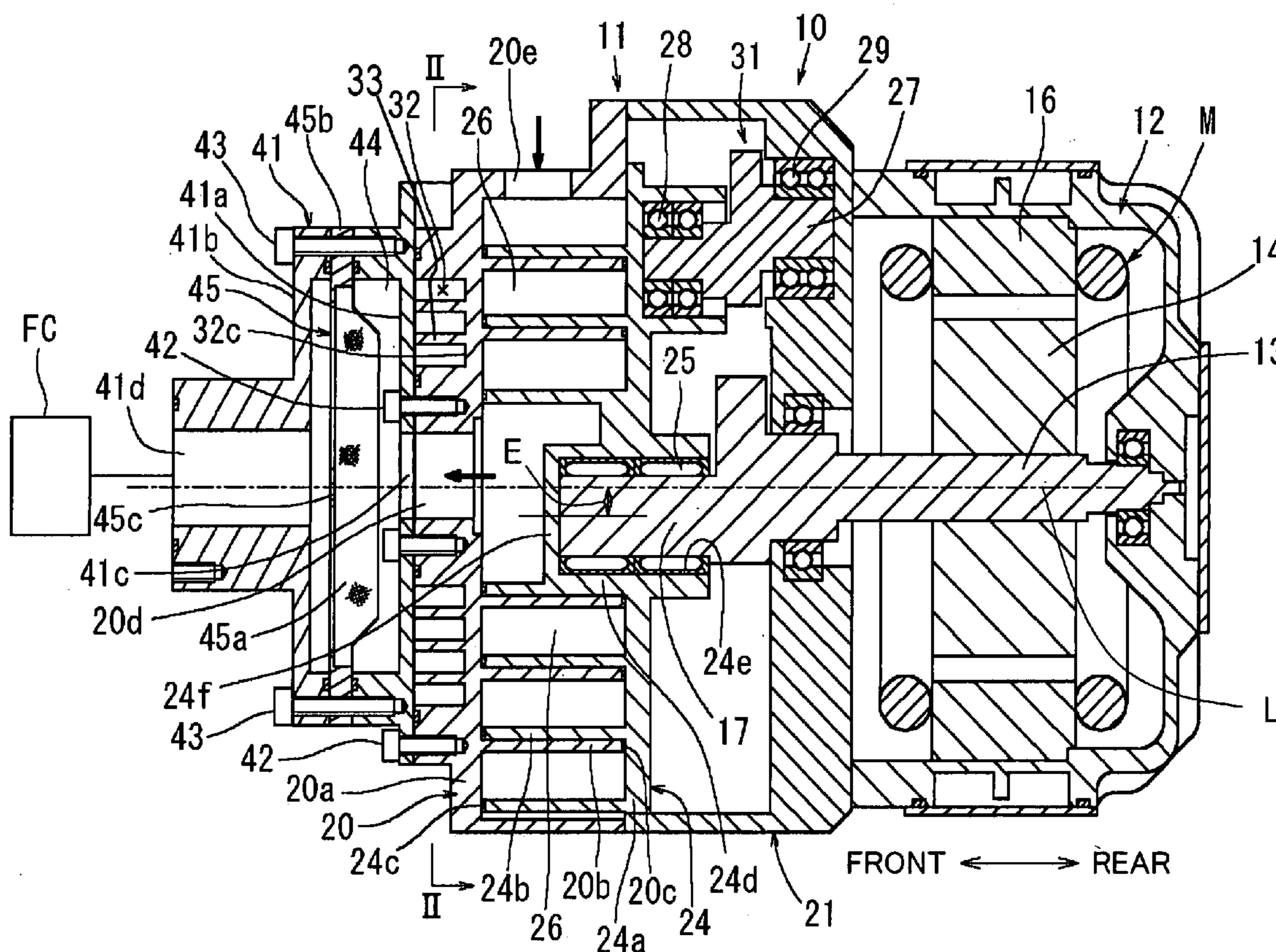


FIG. 1

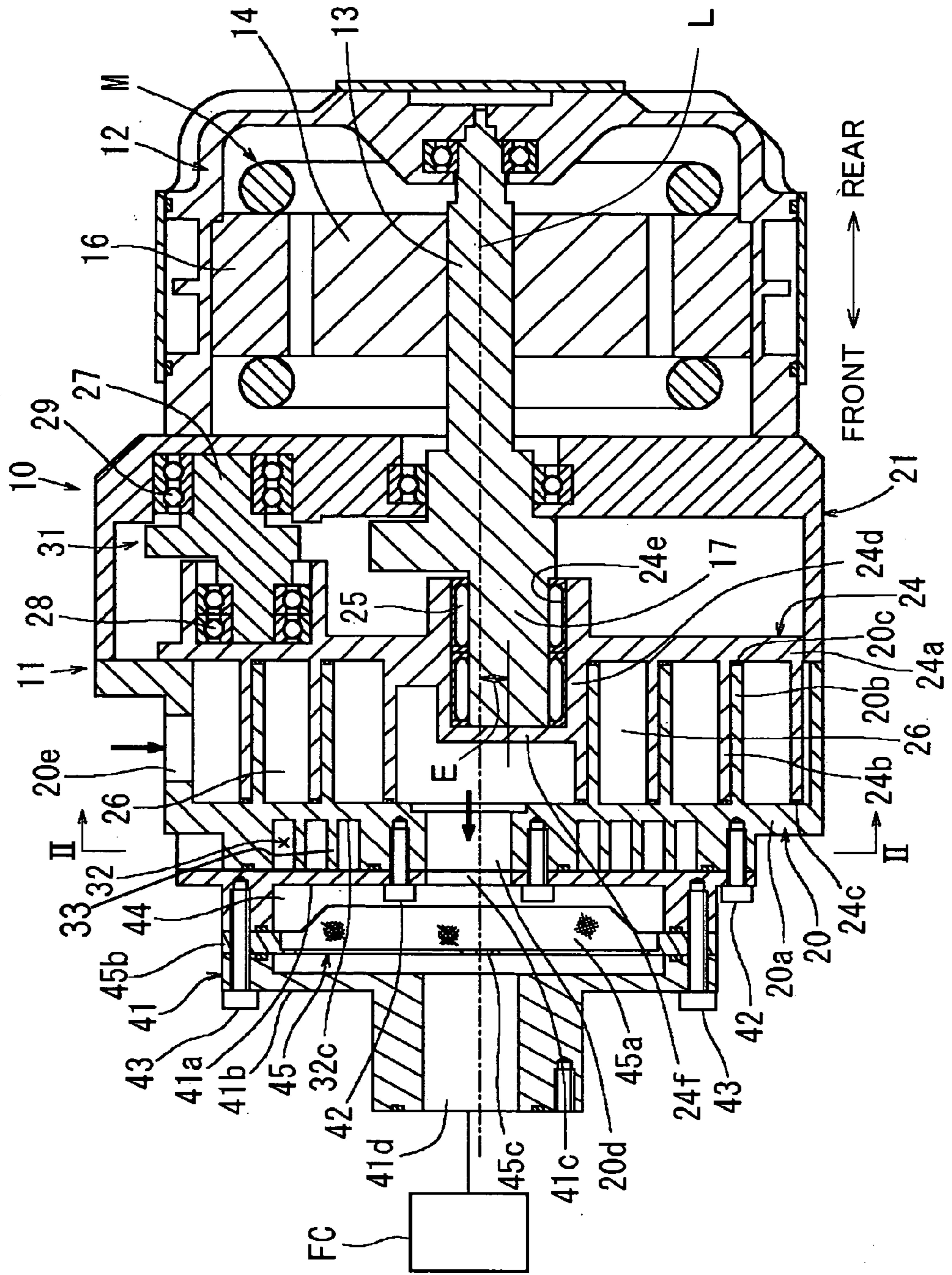


FIG. 2

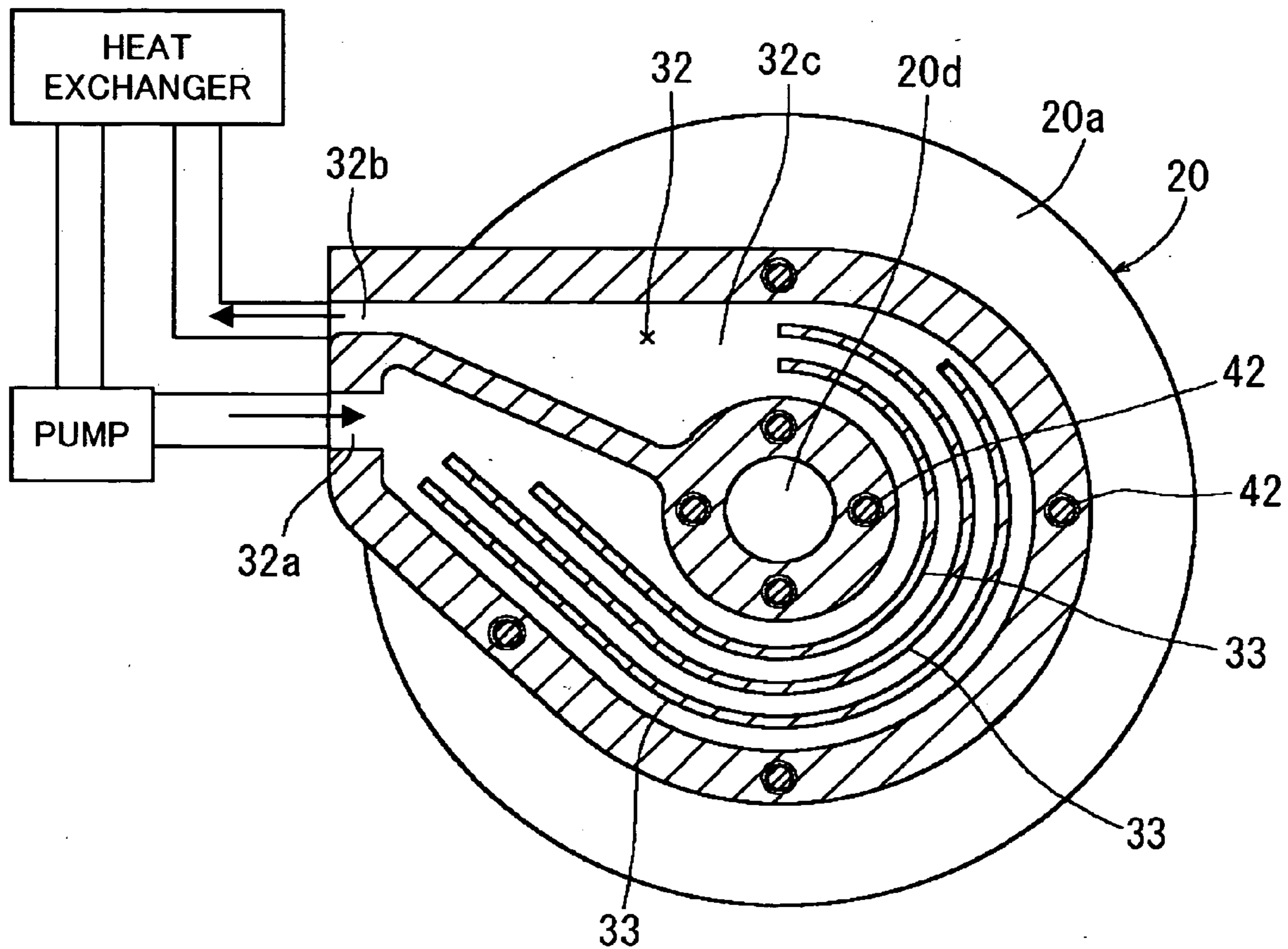


FIG. 3

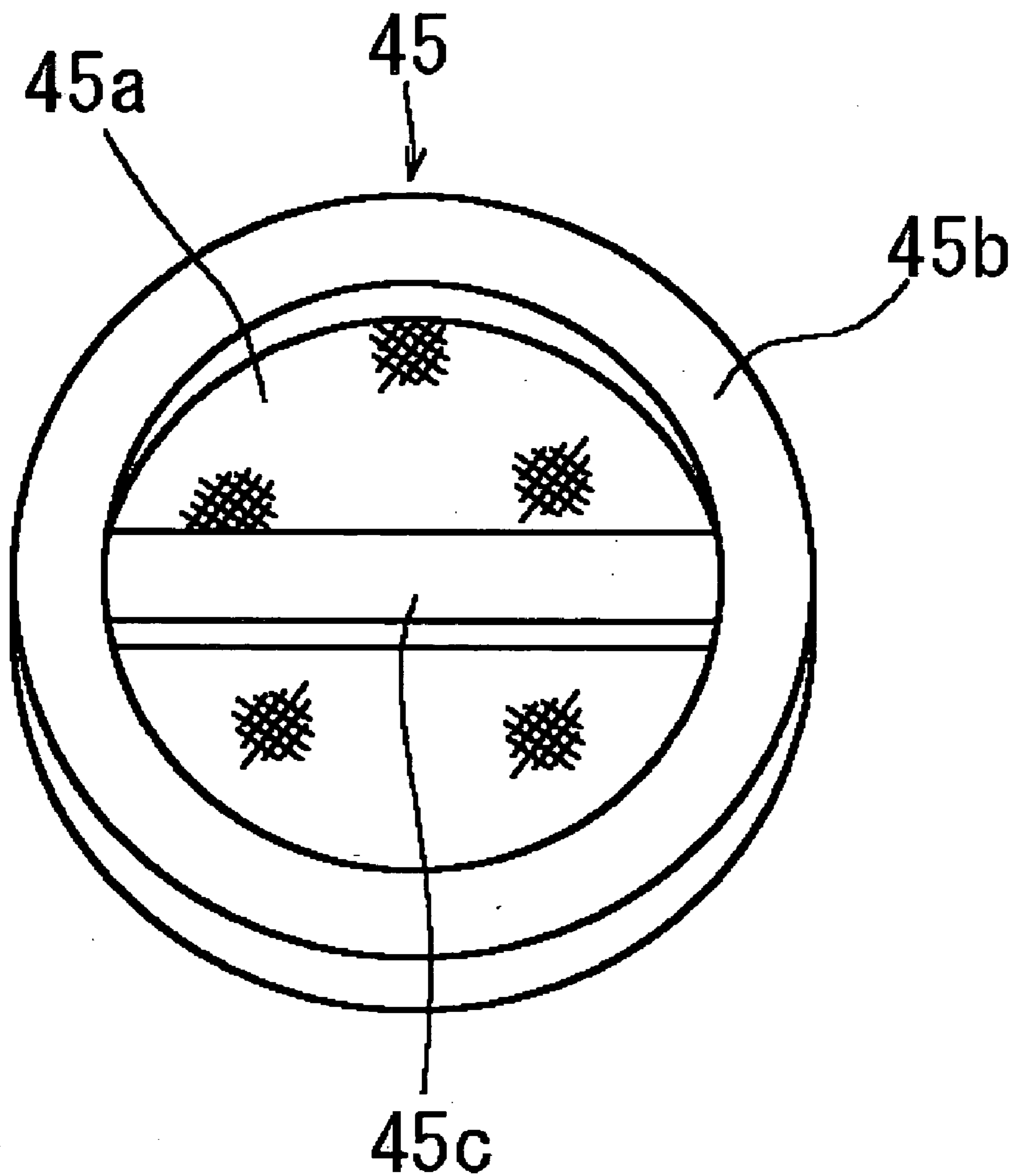


FIG. 4

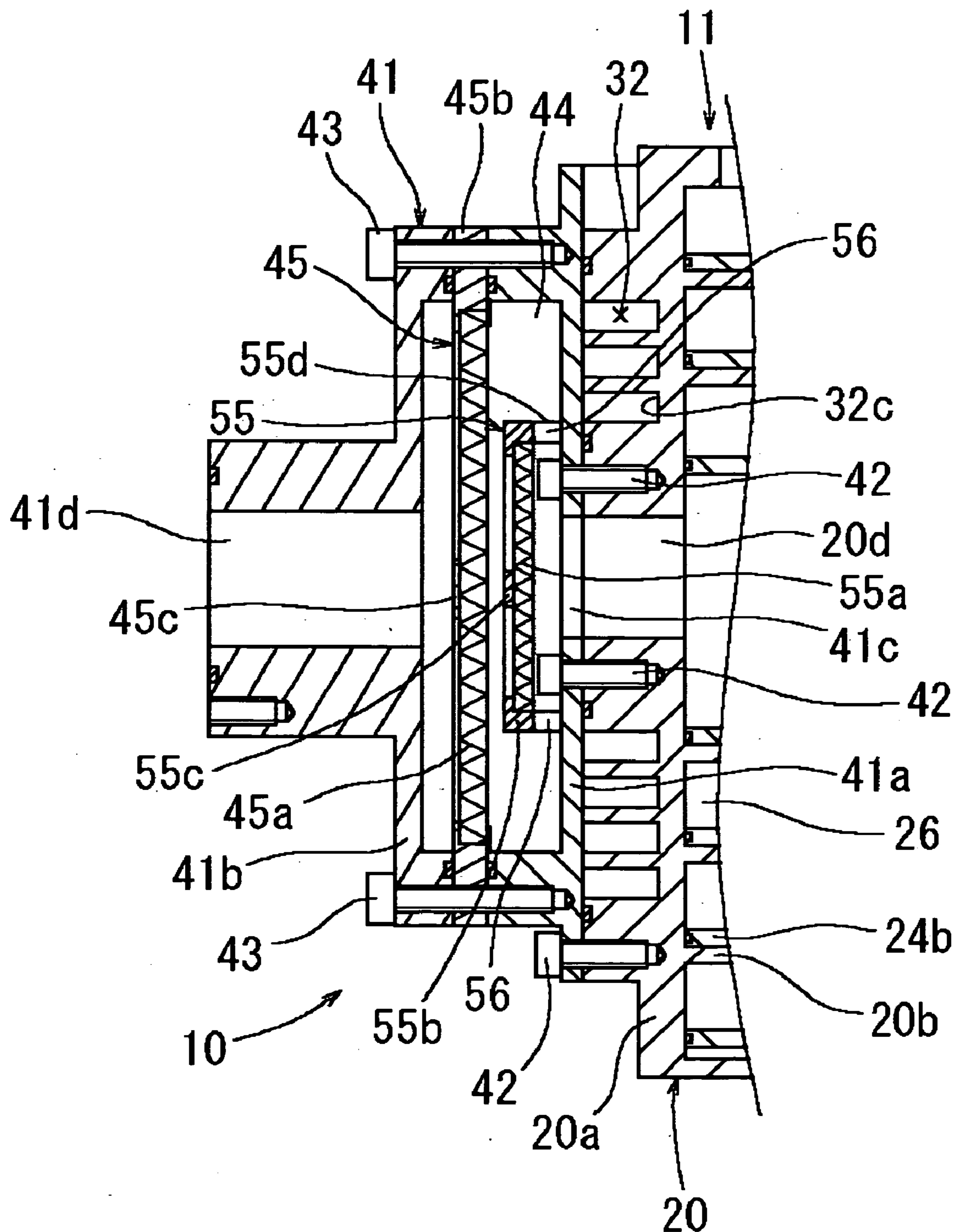


FIG. 5

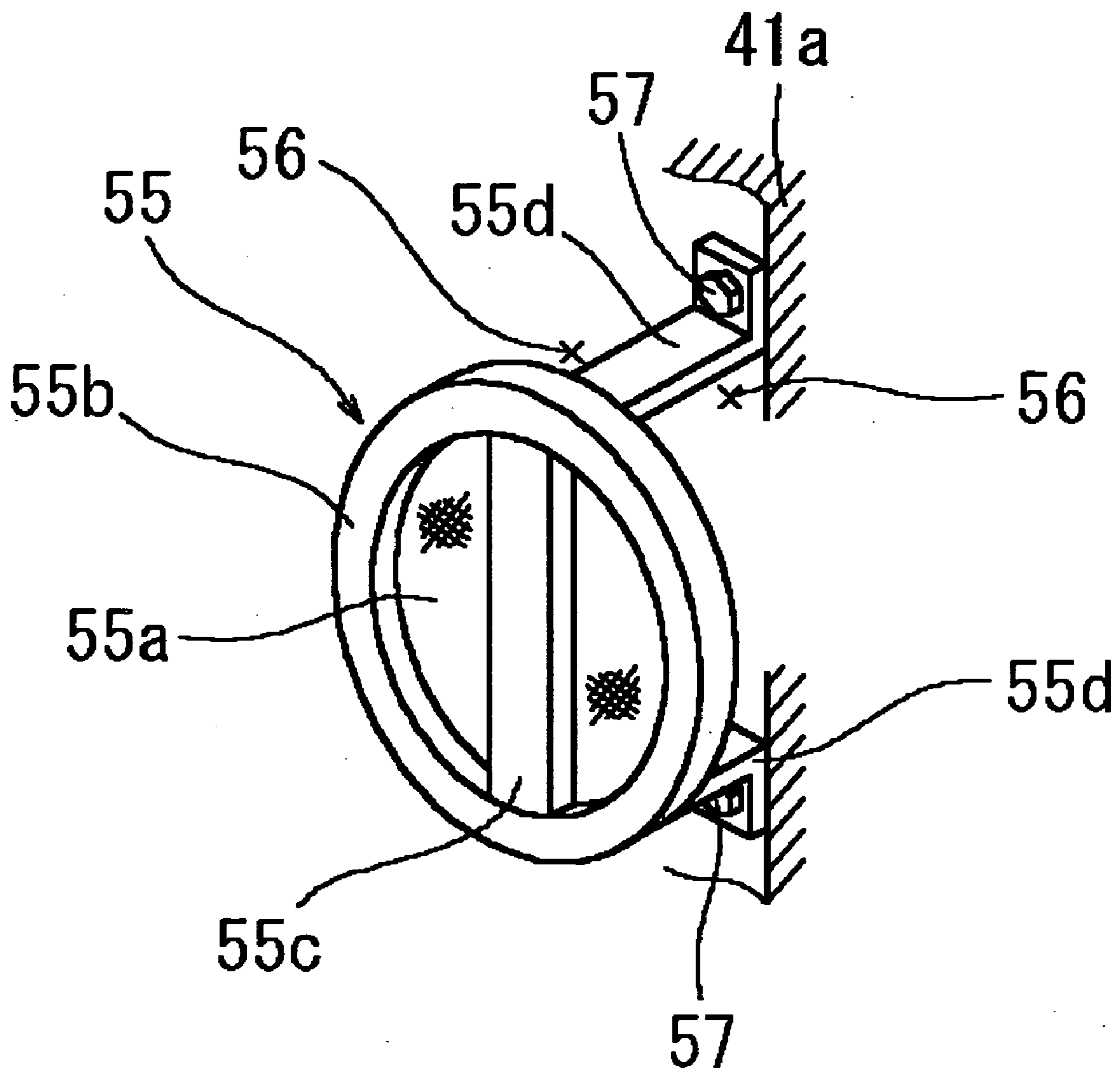


FIG. 6

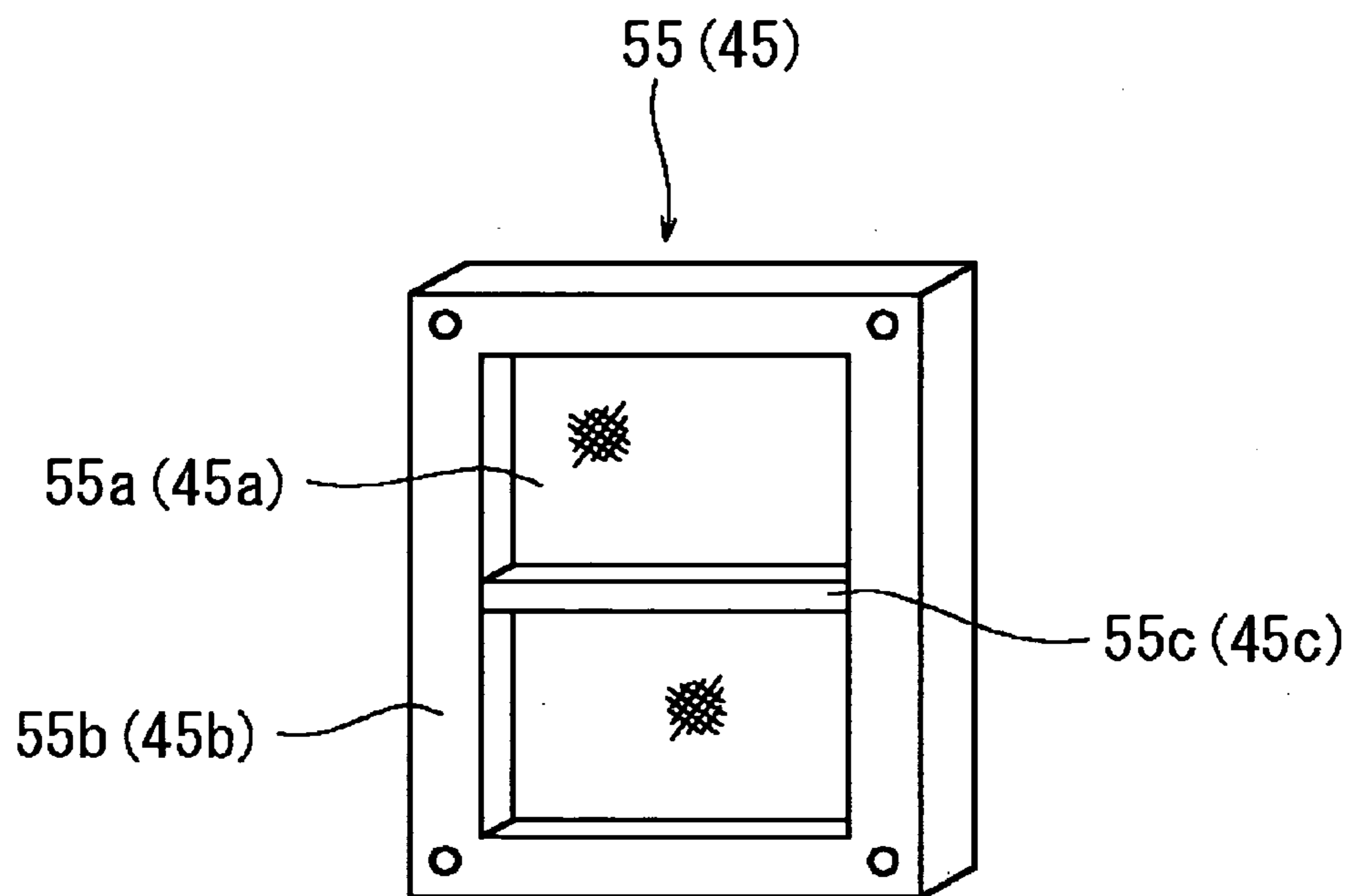


FIG. 7

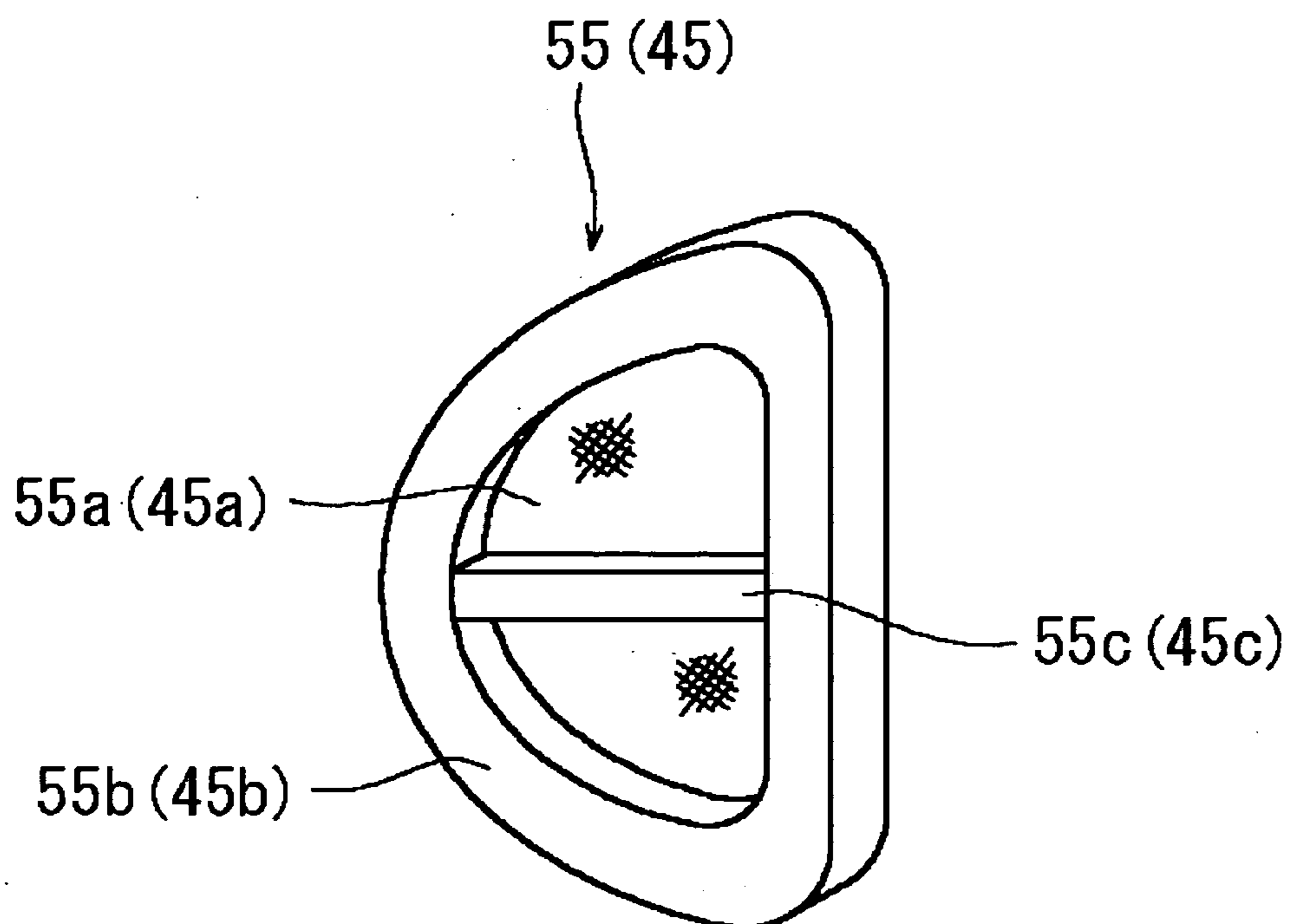


FIG. 8

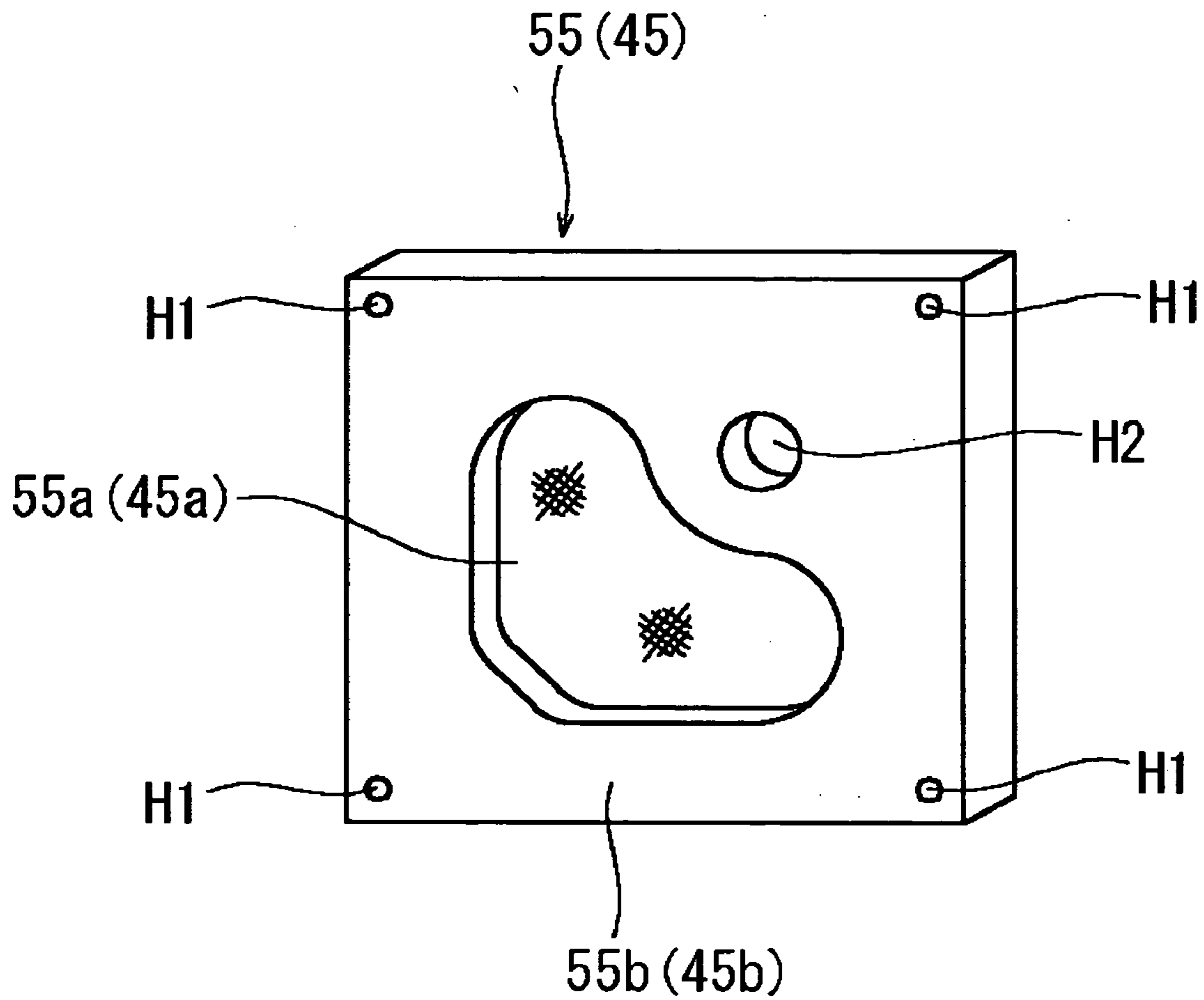


FIG. 9

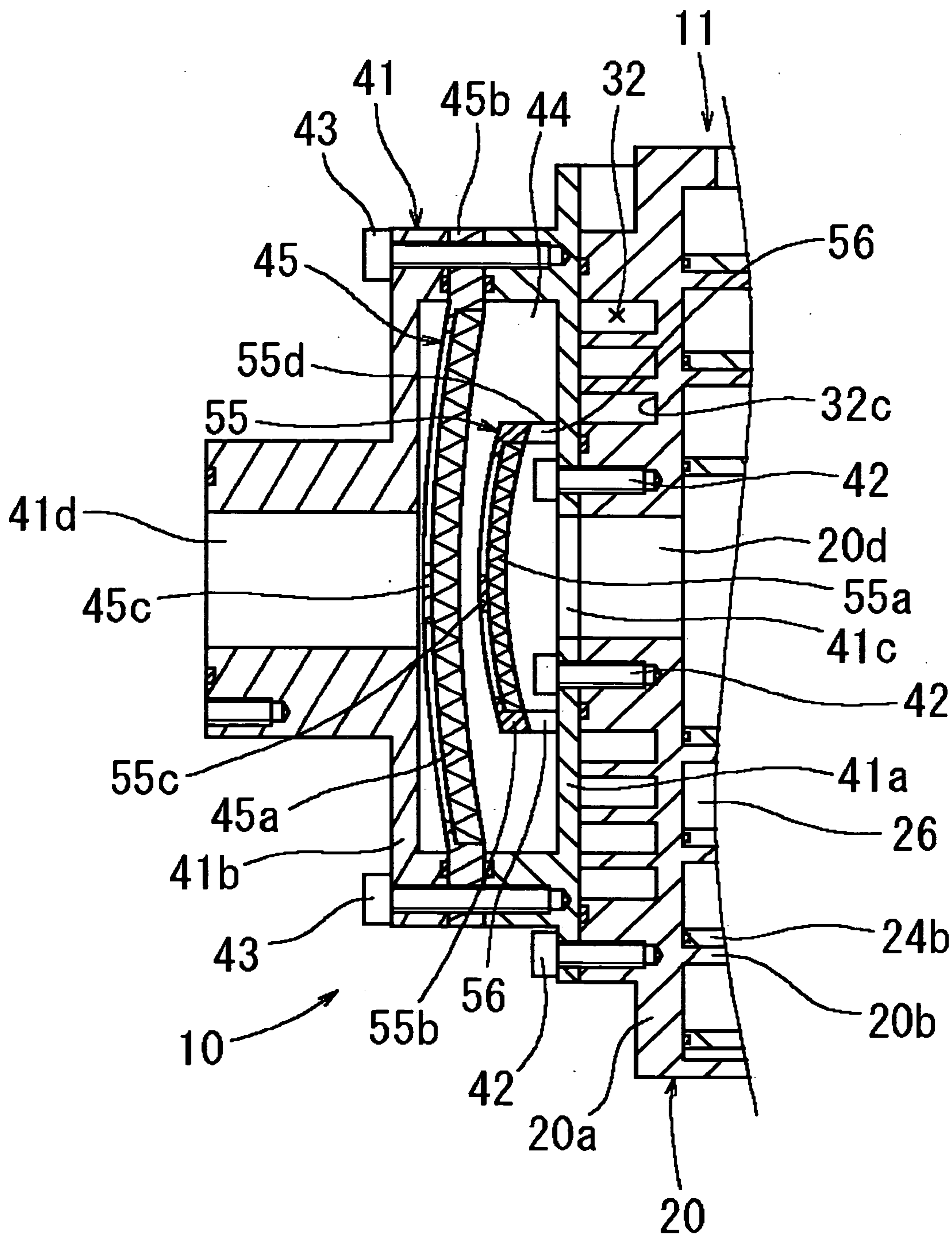


FIG. 10

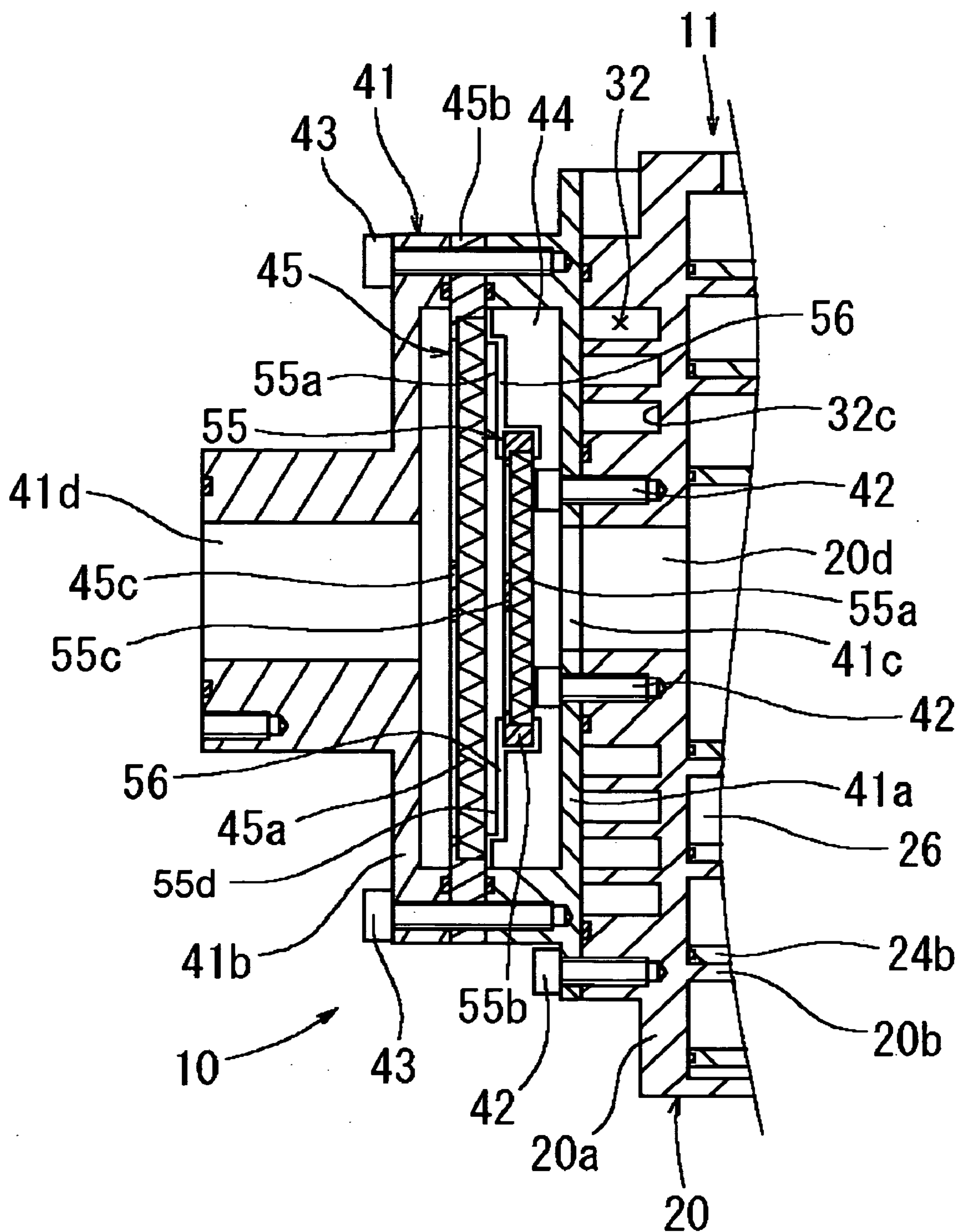


FIG. 11

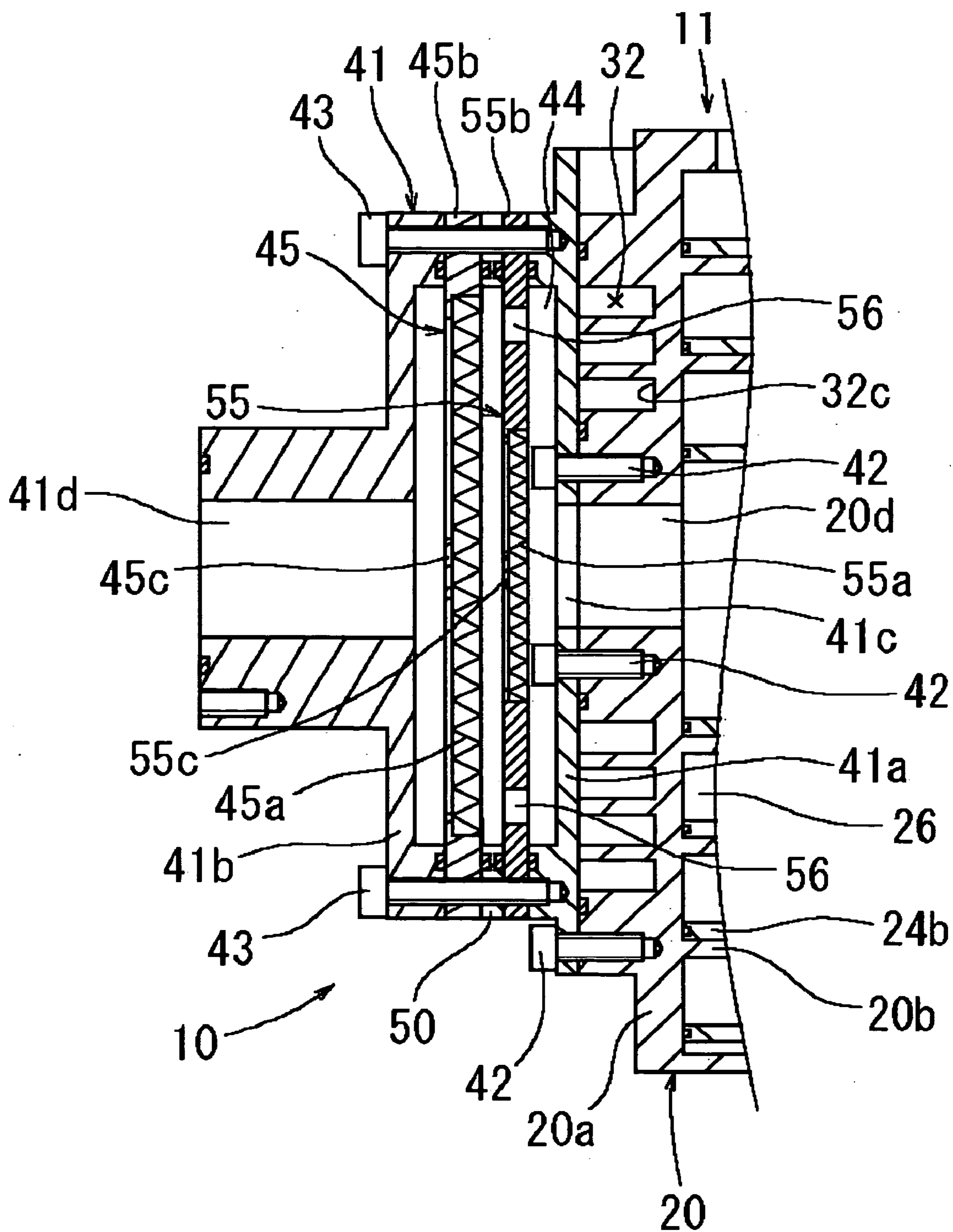
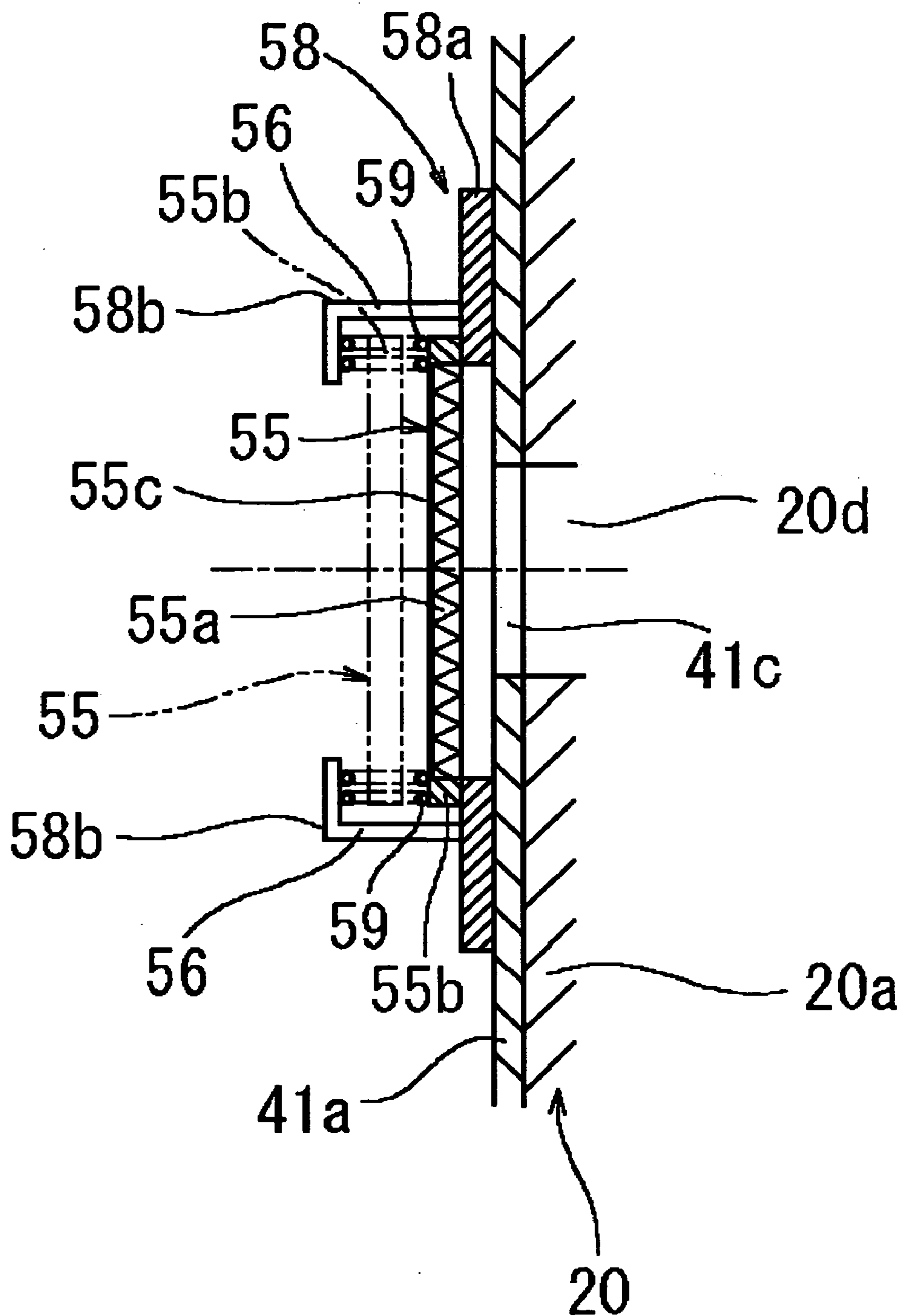


FIG. 12



COMPRESSOR FOR AND METHOD OF SIMULTANEOUSLY COOLING AND CLEANING GAS

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a compressor that compresses gas to be supplied preferably to a fuel cell, and more particularly to a technique for cooling the gas and removing foreign substances in the gas, such as abrasion powder, from the gas.

[0002] In a scroll type compressor, as gas is compressed, the temperature of the gas rises. Then, the compressed gas is discharged from a compression chamber. When the discharged gas at a high temperature flows out from the compressor to an external circuit, it is possible for the high temperature gas to give a thermally adverse effect to a device on a downstream side in the external circuit. As disclosed in Japanese Unexamined Patent Publication No. 2002-295386, a technique is known to avoid such thermally adverse effect on the downstream device, and the gas is cooled to a temperature that gives no thermally adverse effect to the downstream device before the gas flows out of a compressor. In the above cooling technique, a cooling chamber is disposed adjacent to a compression chamber, and a gas cooler that has a gas passage leading to a discharge port is arranged adjacent to the cooling chamber. Therefore, heat is exchanged between coolant fluid in the cooling chamber and the discharged gas in the gas passage so that the discharged gas is cooled while the discharged gas passes through the gas passage.

[0003] Meanwhile, when the scroll type compressor is operated, spiral walls of movable and fixed scroll members slide relative to each other, and tip seals at the axially distal ends of the spiral walls slide relative to base plates of the scroll members. Sliding surfaces abrade due to these sliding actions, and the abrasion produces abrasion powder. The abrasion powder is mixed in the gas and flows out to the external circuit. Although it adversely affects the downstream device, preventive measures against such abrasion powder have not been taken in the scroll type compressor in prior art.

[0004] Incidentally, Japanese Unexamined Patent Publication No. 2000-213831 discloses a technique in which a filter is provided in a conduit for collecting the abrasion powder in the gas that flows in the conduit. The above filter collects abrasion powder that is produced in the compressor and that is discharged to the outside of the compressor with the gas so as to prevent the abrasion powder from flowing into the downstream device. However, in the above structure, there is a limit to enlarge a cross section of a filter passage. Because of the small cross-sectional area, the filter is easily clogged, and the compression pressure is reduced.

SUMMARY OF THE INVENTION

[0005] The present invention provides a technique to effectively cool gas and to simultaneously remove foreign substances from the gas in a compressor before the discharged gas from a discharge port flows out to an external circuit.

[0006] According to the present invention, a scroll type compressor includes a fixed scroll member and a movable

scroll member to define compression chambers. The movable scroll member orbits relative to the fixed scroll member to compress gas in the compression chambers. The compressed gas is discharged to a discharge port. The compressor also includes a filter chamber and a cooling chamber. The filter chamber communicates with the discharge port for accommodating a first filter to at least partially filter the compressed gas. The cooling chamber is located adjacent to the filter chamber for containing coolant fluid that cools the compressed gas in the filter chamber.

[0007] The present invention also provides a method of processing compressed gas in a compressor. The compressor forms a compression chambers for compressing the gas, a filter chamber having a filter and a cooling chamber that is located adjacent to the filter chamber for containing coolant fluid. The method includes the steps of transmitting cooling temperature of the coolant fluid to the filter chamber, cooling the compressed gas in the filter chamber and removing foreign substances in the compressed gas through the filter in the filter chamber simultaneously with the above cooling step.

[0008] The present invention also provides a compressor for compressing gas. The compressor includes a filter chamber and a cooling chamber. The filter chamber accommodates a filter so as to at least partially filter the compressed gas. The cooling chamber is located adjacent to the filter chamber for containing coolant fluid so that cooling temperature of the coolant fluid is transmitted to the filter chamber.

[0009] The present invention also provides a cooling circuit for cooling gas in a compressor that compresses the gas. The cooling circuit includes a filter chamber, a cooling chamber, a heat exchanger and a pump. The filter chamber is located in the compressor and accommodates a filter to filter at least partially the compressed gas. The cooling chamber is located in the compressor adjacent to the filter chamber for passing coolant fluid. The heat exchanger is connected to the cooling chamber for cooling the coolant fluid from the cooling chamber. The pump connected to the heat exchanger for supplying the coolant fluid to the cooling chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

[0011] **FIG. 1** is a longitudinal cross-sectional view of a scroll type compressor according to a first preferred embodiment of the present invention;

[0012] **FIG. 2** is a cross-sectional view of the scroll type compressor taken along the line II-II in **FIG. 1**;

[0013] **FIG. 3** is a perspective view of a filter according to the first preferred embodiment of the present invention;

[0014] **FIG. 4** is a partially enlarged cross-sectional view of a scroll type compressor according to a second preferred embodiment of the present invention;

[0015] FIG. 5 is a perspective view of a filter on an upstream side according to the second preferred embodiment of the present invention;

[0016] FIG. 6 is a perspective view of a filter according to a first alternative embodiment of the present invention;

[0017] FIG. 7 is a perspective view of a filter according to a second alternative embodiment of the present invention;

[0018] FIG. 8 is a perspective view of a filter according to a third alternative embodiment of the present invention;

[0019] FIG. 9 is a cross-sectional view showing a filter according to a fourth alternative embodiment of the present invention;

[0020] FIG. 10 is a cross-sectional view showing a support structure for a filter on an upstream side according to a fifth alternative embodiment;

[0021] FIG. 11 is a cross-sectional view showing a support structure for a filter on an upstream side according to a sixth alternative embodiment; and

[0022] FIG. 12 is a cross-sectional view showing an open-close structure of an escape passage for a filter on an upstream side according to a seventh alternative embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] A first preferred embodiment will be now described in reference to FIGS. 1 through 3. FIG. 1 is a longitudinal cross-sectional view of a scroll type electric compressor 10 according to the first preferred embodiment of the present invention. FIG. 2 is a cross-sectional view of the compressor 10 taken along the line II-II in FIG. 1. FIG. 3 is a perspective view of a filter. The left and right sides of FIG. 1 respectively correspond to the front and rear sides of the compressor 10.

[0024] The present preferred embodiment is applied for compressing gas, and it is more particularly applied for compressing air which is supplied to a fuel cell in an electric vehicle. An outer hull of the compressor 10 includes a front housing 11 and a rear housing 12 both of which are made of aluminum or aluminum alloy. A rotary shaft 13 is rotatably supported in the front and rear housings 11 and 12. A rotor 14 constituting an electric motor M is rotatably mounted on the rotary shaft 13 in the rear housing 12. A stator 16 constituting the electric motor M is fixedly arranged on the inner circumferential surface of the rear housing 12 so as to surround the rotor 14.

[0025] The front housing 11 includes a fixed scroll member 20, a filter casing 41 and a support housing 21. The filter casing 41 is fixedly joined to the front end of the fixed scroll member 20. The support housing 21 is fixedly joined to the rear end of the fixed scroll member 20 and to the front end of the rear housing 12. The fixed scroll member 20 includes a fixed base plate 20a that has a substantially disc-shaped configuration and a fixed spiral wall 20b that extends from the rear surface of the fixed base plate 20a.

[0026] A crankshaft 17 is provided at the front end of the rotary shaft 13 and is offset from an axis L of the rotary shaft 13 by a predetermined length E of eccentricity. A movable scroll member 24 is rotatably supported by the crankshaft 17

through a pair of bearings 25 so as to face the fixed scroll member 20. The movable scroll member 24 includes a movable base plate 24a that is substantially disc-shaped and a movable spiral wall 24b that extends from the front surface of the movable base plate 24a.

[0027] The fixed and movable scroll members 20 and 24 are arranged so as to engage with each other. The distal end surfaces of the fixed and movable spiral walls 20b and 24b respectively contact the movable and fixed base plates 24a and 20a at tip seals 20c and 24c. The fixed spiral wall 20b overlaps the movable spiral wall 24b to contact each other at a plurality of points. Therefore, the fixed base plate 20a and the fixed spiral wall 20b of the fixed scroll member 20 as well as the movable base plate 24a and the movable spiral wall 24b of the movable scroll member 24 define a plurality of falcate compression chambers 26.

[0028] A boss 24d is formed at the intermediate portion of the movable base plate 24a of the movable scroll member 24. The boss 24d axially protrudes toward the front side of the compressor 10. An inserting recess 24e is formed in the boss 24d for accepting the crankshaft 17 thereinto. In the inserting recess 24e, a bottom wall 24f of the boss 24d is formed at the front side opposite to an opening and rear side where the crankshaft 17 is inserted. Thus, the crankshaft 17 protrudes from the movable base plate 24a toward the fixed base plate 20a. Consequently, the compressor 10 is shortened along the axis L of the rotary shaft 13 by a partial length of the crankshaft 17 that protrudes from the movable base plate 24a toward the fixed base plate 20a.

[0029] A discharge port 20d is formed in the center of the fixed base plate 20a of the fixed scroll member 20. A suction port 20e is formed in the outer circumferential wall of the fixed scroll member 20. A self-rotation preventing mechanism 31 includes a crankshaft 27 and bearings 28 and 29. The self-rotation preventing mechanism 31 is located between the movable base plate 24a of the movable scroll member 24 and the inner wall surface of the support housing 21 that faces the movable base plate 24a of the movable scroll member 24.

[0030] As the rotary shaft 13 is rotated by the electric motor M, the movable scroll member 24 orbits around the axis of the fixed scroll member 20 by the crankshaft 17. At the same time, the self-rotation preventing mechanism 31 prevents the movable scroll member 24 from self-rotating while it allows the movable scroll member 24 to orbit around the axis of the fixed scroll member 20. As the compression chambers 26 move inwardly from an outer circumferential side of the fixed and movable spiral walls 20b and 24b by the orbital movement, the compression chambers 26 reduce in volume. Thereby, the air introduced from the suction port 20e into the compression chambers 26 is compressed. The compressed air is discharged from the compression chambers 26 to a filter chamber 44 through the discharge port 20d when the compression chambers 26 have approached the center of the fixed base plate 20a.

[0031] A cooling chamber 32 is defined between the front surface of the fixed scroll member 20 and the filter casing 41, the filter casing 41 is fixed to the fixed scroll member 20. Specifically, a recess 32c is formed at the front side of the fixed base plate 20a of the fixed scroll member 20, and the filter casing 41 is fixed to the front surface of the fixed base plate 20a so as to cover the recess 32c. Accordingly, the

cooling chamber 32 is adjacent to the compression chambers 26 across the fixed base plate 20a.

[0032] As shown in FIG. 2, the cooling chamber 32 is formed in a substantially U-shaped manner so as to surround the discharge port 20d. The cooling chamber 32 has a coolant inlet 32a for flowing cooling water as coolant fluid into the cooling chamber 32 and a coolant outlet 32b for removing the cooling water. A plurality of flow-dividing fins 33 is provided in the cooling chamber 32. The flow-dividing fins 33 divide the flow of the cooling water flowing in from the coolant inlet 32a, and the cooling water flows toward the coolant outlet 32b. In the present preferred embodiment, the flow-dividing fins 33 extend from the front surface of the fixed base plate 20a of the fixed scroll member 20. The cooling chamber 32 partially constitutes a cooling circuit. As shown in FIG. 2, a heat exchanger and a 10 pump are provided in the cooling circuit. The heat exchanger cools the high-temperature cooling water that flows out from the coolant outlet 32b. The pump supplies the cooling water that has been cooled into the cooling chamber 32 through the coolant inlet 32a. Pure water generated by cell reaction at a fuel cell FC as shown in FIG. 1 is utilized as the cooling water that circulates in the cooling circuit.

[0033] Referring back to FIG. 1, the filter casing 41 has a two-part structure including an inner casing 41a at the rear side and an outer casing 41b at the front side. The inner casing 41a is fixed to the front surface of the fixed scroll member 20 by a predetermined number of bolts 42 while the outer casing 41b is fixed to the inner casing 41a by a predetermined number of bolts 43. Namely, the outer casing 41b is detachable from the inner casing 41a. As necessary, the outer casing 41b is detached from the inner casing 41a. The inner and outer casings 41a and 41b define the filter chamber 44. The filter chamber 44 is adjacent to the cooling chamber 32 across the inner casing 41a. Namely, the cooling chamber 32 is located between the compression chambers 26 and the filter chamber 44. Also, the inner casing 41a contacts the flow-dividing fins 33.

[0034] Still referring to FIGS. 1 and 2, the filter chamber 44 accommodates a filter 45 for removing foreign substances when the compressed air is introduced from the discharge port 20d into the filter chamber 44. The filter 45 includes a filter portion 45a for removing the foreign substances and a frame 45b arranged around the edges of the filter portion 45a for supporting the filter portion 45a.

[0035] The filter 45 is schematically illustrated in FIG. 3. In the filter 45, the frame 45b preferably includes a rib 45c for reinforcing. In order to enhance capacity for collecting the foreign substances and cooling effect, the filter portion 45a is preferably a pleated type filter element that has been formed by bending a flat stainless screen in zigzags. The filter 45 is supported in such a manner that the filter 45 is sandwiched by the inner and outer casings 41a and 41b. As shown in FIG. 1, the filter portion 45a is suspended in the filter chamber 44.

[0036] Referring to FIG. 1, a communication hole 41c is formed as an inlet in the center of the inner casing 41a. The filter chamber 44 communicates with the discharge port 20d of the compression chamber 26 through the communication hole 41c. An outlet 41d is formed in the center of the outer casing 41b. That is, the compressed air discharged from the discharge port 20d of the compression chamber 26 is input-

ted to the filter chamber 44 through the communication hole 41c. After passing through the filter 45, the compressed air is outputted through the outlet 41d to the fuel cell FC, which is located outside of the compressor 10. The compressed air flows in the filter chamber 44 substantially in the same direction as the compressed air flows in the discharge port 20d as shown by an arrow in FIG. 1. Also, the filter 45 is located so as to be perpendicular to the above flow direction.

[0037] Referring to FIGS. 1 and 2, as the compressor 10 is operated, the cooling water flows into the cooling chamber 32 from the coolant inlet 32a. The cooling water flowing into the cooling chamber 32 cools the air that is being compressed in the compression chambers 26 and the discharged air in the filter chamber 44. Namely, heat is exchanged between the cooling water in the cooling chamber 32 and the compressed air in the compression chambers 26 through the fixed base plate 20a as well as between the cooling water and the compressed gas in the filter chamber 44 through the inner casing 41a. More specifically, cooling temperature of the cooling water is transmitted to the compressed air in the compression chambers 26 through the fixed base plate 20a as well as the compressed gas in the filter chamber 44 through the inner casing 41a. The cooling water that has been used for cooling flows out from the coolant outlet 32b and is substantially cooled by the heat exchanger to circulate back into the cooling chamber 32 by the pump. Namely, as the cooling water circulates in the cooling circuit, the temperature of the cooling water repeatedly rises and lowers. A part of the cooling water that flows out from the coolant outlet 32b is discarded, and the same amount of the pure water generated at the fuel cell FC is added into the cooling circuit for the discarded part.

[0038] In accordance with the operation of the compressor 10, the movable spiral wall 24b rotates relative to the fixed spiral wall 20b while the movable spiral wall 24b contacts the fixed spiral wall 20b. That is, the movable spiral wall 24b slides over the fixed spiral wall 20b. Also, the tip seals 20c and 24c respectively slide over the movable and fixed base plate 24a and 20a. Thereby, sliding surfaces abrade to produce abrasion powder. The abrasion powder is mixed in the compressed air and is sent to the filter chamber 44 through the discharge port 20d and the communication hole 41c. When the discharged air passes through the filter 45 in the filter chamber 44, the filter 45 collects the abrasion powder in the discharged air and the discharged air is cooled substantially at the same time. Namely, as the abrasion powder is removed from the discharged air in the filter chamber 44 by the filter 45, the cooling water in the cooling chamber 32 cools the discharged air. The filtered air having a low temperature is outputted to the outside or an external circuit of the compressor 10 from the outlet 41d.

[0039] In the first preferred embodiment, following effects are obtained. As described above, in the present preferred embodiment, the filter chamber 44 accommodating the filter 45 is formed in the compressor 10 and is adjacent to the cooling chamber 32. Accordingly, since cleaning and cooling of the discharged air are simultaneously conducted in one space, the space is efficiently and logically utilized. Also, since the cooling chamber 32 is adjacent to the compression chambers 26, cooling action is applied to the compressed air in the compression chambers 26 and the filter chamber 44. Accordingly, the compressed air is effectively cooled.

[0040] Also, in the present preferred embodiment, the filter chamber 44 is formed in the compressor 10. In this regard, a conduit in the external circuit is generally not large enough in diameter for efficient circulation. A filter area size is limited to a small cross-sectional area of the conduit in the external circuit. No significant limitation is applicable for the cross-sectional size in the present preferred embodiment since the filter is in the compressor. The filter 45 is enlarged in the preferred embodiment in an orthogonal direction relative to the compressed air flow direction in which the compressed air flows in the filter chamber 44. Based on this design, the area of the filter 45 is substantially larger than that in the external circuit, and the capacity for collecting the foreign substances is also substantially enhanced. Consequently, since a flow rate of the air is reduced due to the large area, cooling time of the compressed air in the filter chamber 44 is longer, and a strong cooling effect is obtained.

[0041] In the present preferred embodiment, the cooling chamber 32 is formed between the compression chambers 26 and the filter chamber 44. The heat is exchanged between the cooling water in the cooling chamber 32 and the compressed air to cool the compressed air in the compression chambers 26 and the filter chamber 44. Therefore, in comparison to cooling the compressed air only in the filter chamber 44, the cooling effect on the air is further enhanced.

[0042] In the present preferred embodiment, the filter casing 41 has the two-part structure including the inner and outer casings 41a and 41b. The inner casing 41a is fixed to the fixed scroll member 20, and the outer casing 41b is detachably fixed to the inner casing 41a. Since the outer casing 41b is detached from the inner casing 41a as necessary, the filter 45 in the filter chamber 44 is easily replaced or cleaned. Also, the filter casing 41 is connected to the fixed scroll member 20 so as to provide the filter chamber 44. To an existing compressor, a filter casing is newly placed to a housing so that a filter chamber is newly provided for the existing compressor. Therefore, the above simple design change enables the existing scroll type electric compressor to cool air and remove foreign substances.

[0043] A plurality of the flow-dividing fins 33 is provided in the cooling chamber 32 and protrudes from the fixed base plate 20a of the fixed scroll member 20. The flow-dividing fins 33 contact the inner casing 41a. Thus, a heat transfer area between the cooling chamber 32 and the compression chambers 26 as well as between cooling chamber 32 and the filter chamber 44 is increased. Consequently, the cooling effect is enhanced.

[0044] A second preferred embodiment will be now described in reference to FIGS. 4 and 5. Since the second preferred embodiment is modified from the above-described first preferred embodiment, only the modified parts will be described, and the same description will be omitted. FIG. 4 is a partially enlarged cross-sectional view of a scroll type compressor according to the second preferred embodiment of the present invention. As shown in FIG. 4, in the present preferred embodiment, an additional filter 55 is added in the filter chamber 44 on an upstream side, that is, a rear side as indicated in the right in FIG. 4 relative to the filter 45 of the above-described first preferred embodiment. The two filters 45 and 55 are located along the compressed air flow direction. For the convenience of the description, the filter 55 located at the upstream side and the filter 45 located at a

downstream side or the front side are respectively referred to as a first filter and a second filter. Since the second filter 45 has substantially the same structure as in the first preferred embodiment, the description for the second filter 45 is omitted.

[0045] As schematically shown in FIG. 5, the first filter 55 includes a filter portion 55a for removing the foreign substances and a frame 55b arranged around the edges of the filter portion 55a for supporting the filter portion 55a. The frame 55b preferably includes a rib 55c for reinforcing. In order to enhance the capacity for collecting the foreign substances and the cooling effect, the filter portion 55a is preferably a pleated type filter element that a flat stainless screen is bent in zigzags as similarly done to the filter portion 45a of the second filter 45 as described with respect to FIG. 3. In addition to the stainless filter element, filter elements made of material such as steel, aluminum alloy, resin and fabric are also used for either of the first and second filter portions 55a and 45a. The first and second filter portions 55a and 45a have a micro structure or a mesh in which circular or square pores are formed in a plate material.

[0046] A plurality of mounting portions or first filter mounting portions 55d is formed at the periphery of the frame 55b. Two mounting portions 55d are shown in FIG. 5. The end portions of the mounting portions 55d are outwardly bent. The end portion of each mounting portion 55d is fixed to an inner surface of the inner casing 41a by a bolt 57 so that the first filter 55 is supported in the filter chamber 44 as shown in FIG. 4. Thereby, the filter portion 55a of the first filter 55 is supported in the filter chamber 44. Also, an escape passage 56 bypasses the first filter 55 and leads to the second filter 45. The first and second filters 55 and 45 are placed at a predetermined interval along the compressed air flow direction or a horizontal direction in FIG. 4. The first and second filters 55 and 45 are both located so as to face the discharge port 20d. Namely, the first and second filters 55 and 45 are located so as to be perpendicular to the compressed air flow direction in the filter chamber 44.

[0047] In general, a mesh size M1 of the first filter 55 and a mesh size M2 of the second filter 45 preferably satisfy the following inequality. The mesh size is determined by the number of mesh openings in a square inch.

$$M1 \leq M2$$

[0048] In the present preferred embodiment, the mesh size M1 and M2 of the first and second filters 55 and 45 satisfy the following inequality:

$$M1 < M2$$

[0049] Namely, the mesh size M1 of the first filter 55 is smaller than the mesh size M2 of the second filter 45. More precisely, the mesh size of the first filter portion 55a in the first filter 55 ranges from 25 to 40 while the mesh size of the second filter portion 45a in the second filter 45 is approximately 100.

[0050] In general, a receiving area A1 of the filter portion 55a and a receiving area A2 of the filter portion 45a preferably satisfy the following inequality. The receiving area of the filter in the present specification means the area of the filter portion that receives the compressed air.

$$A1 \leq A2$$

[0051] In the preferred embodiment, the receiving areas **A1** and **A2** of the first and second filters **55** and **45** satisfy the following inequality:

$$A1 < A2$$

[0052] Namely, the receiving area **A1** of the first filter **55** on the upstream side is smaller than the receiving area **A2** of the second filter **45** on the downstream side.

[0053] According to the above scroll compressor **10** as shown in **FIG. 4**, while the compressor **10** is operated, the compressed air is discharged from the discharge port **20d** and is sent to the filter chamber **44** through the communication hole **41c**. The compressed air passes through the first and second filters **55** and **45** in this order. Therefore, the foreign substances such as the abrasion powder mixed in the compressed air are collected by the first and second filters **55** and **45**, and the compressed air is cooled by the cooling water in the cooling chamber **32**. Then, the filtered compressed air at a lower temperature is outputted from the outlet **45d** to the external circuit of the compressor **10**.

[0054] According to the scroll compressor **10** of the second preferred embodiment as constructed above, substantially the same advantageous effects are obtained as described in the first preferred embodiment.

[0055] Furthermore, the foreign substances such as the abrasion powder mixed in the compressed air are collected by the first and second filters **55** and **45** in a sequential manner so that the compressed air is cleaned through two filters over a longer period of time. Also, as the air flowing in the filter chamber **44** passes through the two filters **55** and **45**, the flow rate of the air is further reduced. Therefore, the compressed air is effectively cooled. The escape passage **56** is formed so that the compressed air bypasses the first filter **55**. The escape passage **56** includes the space between the first filter **55** and the inner casing **41a** as indicated by "X" in **FIG. 5**. If the first filter **55** is clogged, the compressed air bypasses the first filter **55** through the escape passage **56**. Consequently, the pressure loss due to the clogged filter is prevented or reduced. Even though the first filter **55** is clogged, the compressor **10** effectively performs. In this regard, life of the scroll compressor **10** is extended. As described above, not only the foreign substances such as the abrasion powder mixed in the compressed air are substantially collected but also the temperature is substantially lower in the compressed air that is discharged from the outlet **41d** of the filter chamber **44**.

[0056] Also, the escape passage **56** are formed so as to bypass the first filter **55** that is located on the upstream side. Thus, even though the compressed air bypasses the first filter **55**, the foreign substances in the compressed air are eventually collected by the second filter **45** on the downstream side. Consequently, the foreign substances such as the abrasion powder mixed in the compressed air are effectively collected. Also, if the second filter **45** is clogged, the first and second filters **55** and **45** are replaced or cleaned. Without replacement or cleaning, the amount of clogged material on the second filter **45** is one indication of remaining life of the compressor **10**.

[0057] The first and second filters **55** and **45** are located so as to face the discharge port **20d**. Thus, the compressed air discharged from the discharge port **20d** effectively passes through the two filters **55** and **45**. Consequently, the foreign

substances such as the abrasion powder mixed in the compressed air are effectively collected. Also, the two filters **55** and **45** are compactly installed in the compressor **10**.

[0058] The mesh size **M1** of the first filter **55** is smaller than the mesh size **M2** of the second filter **45**. Thus, the foreign substances such as the abrasion powder mixed in the compressed air are collected separately according to the size through the first filter **55** on the upstream side and then the second filter **45** on the downstream side.

[0059] The receiving area **A1** of the first filter **55** on the upstream side is smaller than the receiving area **A2** of the second filter **45** on the downstream side. Thus, the compressed air smoothly flows toward the second filter **45** on the downstream side after passing through the first filter **55** on the upstream side so that the foreign substances such as the abrasion powder mixed in the compressed air are effectively collected.

[0060] The second filter **45** is located on the downstream side with respect to first filter **55**, and an escape passage is not formed at the second filter **45**. Thus, since the compressed air cannot bypass the second filter **45**, the foreign substances in the compressed air are eventually collected by the second filter **45**. It is possible to avoid the flow of the foreign substances to the external circuit of the compressor **10** due to the insufficient cleaning which is expected when the compressed air supposedly bypasses the second filter **45**.

[0061] The present invention is not limited to the above-described preferred embodiments, and the above-described preferred embodiments are also modified according to the present invention in the following manners.

[0062] The shapes of the first and second filters **55** and **45** are circular in the above-described preferred embodiments. However, the outer shapes of the first and second filters **55** and **45** are changed. For example, in a first alternative embodiment, the shape of at least one of the first and second filters **55** and **45** is substantially rectangular as shown in **FIG. 6**. In a second alternative embodiment, the shape of at least one of the first and second filters **55** and **45** is substantially semicircular as shown in **FIG. 7**.

[0063] As shown in **FIG. 8**, the filter **55** or **45** has a substantially rectangular shape, and the shape of the filter portion **55a** or **45a** is different from the shape of the frame **55b** or **45b** in a third alternative embodiment. In this case, the filter portion **55a** or **45a** avoids holes **H1** for inserting bolts and a hole **H2** that leads to the coolant inlet **32a** or the coolant outlet **32b** of the cooling chamber **32** as shown in **FIG. 2**, which are formed in the frame **55b** or **45b**. Namely, the shape of the filter portion **55a** or **45a** is appropriately changed in accordance with the design requirements including the location for inserting bolts, the location for the coolant inlet **32a** and the coolant outlet **32b** of the cooling chamber **32**, and the location for the communication hole **41c** and the outlet **41d** of the filter chamber **44** in the filter casing **41**.

[0064] The first and second filters **55** and **45** have planar shapes in the above-described preferred embodiment. However, in a fourth alternative embodiment, the first and second filters **55** and **45** have substantially hemispherical shapes as shown in **FIG. 9**. The first filter **55** is connected to the inner casing **41a** of the filter casing **41** in the above-described second preferred embodiment. However, as shown in **FIG.**

10, the first filter **55** is connected to the frame **45b** of the second filter **45** in a fifth alternative embodiment. In this case, the end portion of each mounting portion **55d** of the frame **55b** of the first filter **55** is similarly fixed to the frame **45b** of the second filter **45** by a bolt that is not shown in the drawings as the above description. Thereby, the filter portion **55a** of the first filter **55** is suspended in the filter chamber **44**, and a part of the escape passage **56** is formed between the frame **55b** of the first filter **55** and the inner casing **41a**.

[0065] As shown in **FIG. 11**, the frame **45b** of the second filter **45** and the frame **55b** of the first filter **55** are sandwiched between the inner and outer casings **41a** and **41b** in a sixth alternative embodiment. Thereby, the frame **45b** of the second filter **45** and the frame **55b** of the first filter **55** are supported. A ring-shaped spacer **50** is interposed between the first filter frame **55b** and the second filter frame **45b**. Therefore, an interval is maintained between the first and second filters **55** and **45**. In this case, an escape passage **56** includes through holes that are formed in the first filter frame **55b**. Meanwhile, the spacer **50** is formed integrally with either of the first filter frame **55b** or the second filter frame **45b**, and the number of components is reduced.

[0066] As shown in **FIG. 12**, an escape passage **56** at the first filter **55** is formed so as to be opened and closed by an open-close means in a seventh alternative embodiment. The open-close means closes the escape passage **56** when the compressed air pressure on the upstream side relative to the first filter **55** is smaller than a predetermined pressure. The open-close means opens the escape passage **56** when the compressed air pressure on the upstream side relative to the first filter **55** is equal to or larger than the predetermined pressure. Namely, a support member **58** is arranged at the inner casing **41a**. The support member **58** includes a fixed support portion **58a** that has a ring shape and a plurality of movable support portions **58b** that extends from the fixed support portion **58a**. The fixed support portion **58a** is fixed to the inner casing **41a**. The end portions of the movable support portions **58b** movably support the first filter frame **55b** in an axial direction as shown in a horizontal direction in **FIG. 12**. The movable support portions **58b** are arranged in a circumferential direction of the support member **58**. Therefore, a part of the escape passage **56** is formed between the movable support portions **58b**. The first filter frame **55b** contacts the fixed support portion **58a** to close the escape passage **56** as shown by a solid line in **FIG. 12**. The first filter frame **55b** separates itself from the fixed support portion **58a** to open the escape passage **56** as shown by a double-dotted line in **FIG. 12**. Furthermore, an elastic member **59** such as a coil spring is interposed between the first filter frame **55b** and the movable support portions **58b** for urging the first filter **55** in a direction in which the escape passage **56** are closed or rightward in **FIG. 12**. That is, the direction is to urge the first filter **55** to close the escape passage **56**. The first filter **55**, the support member **58** and the elastic member **59** constitute an open-close means of the present invention.

[0067] As constructed above, the first filter **55** is urged by the elastic member **59** to close the escape passage **56** when the first filter **55** is at a position as shown by the solid line in **FIG. 12**. Thereby, the compressed air discharged from the discharge port **20d** through the communication hole **41c** passes through the first filter **55**. Consequently, the foreign

substances such as the abrasion powder mixed in the compressed air are effectively collected by the first filter **55**.

[0068] Also, when the first filter **55** is clogged and the compressed air pressure on the upstream side relative to the first filter **55** is equal to or more than the predetermined pressure, the first filter **55** is forced to move against the urging of the elastic member **59** to open the escape passage **56** at a position as shown by the double-dotted line in **FIG. 12**. Thereby, the compressed air bypasses the first filter **55** through the opened escape passage **56**. Consequently, the pressure loss due to the clogging of the first filter **55** is substantially prevented or reduced. As described above, even though the first filter **55** is clogged, the compressor **10** effectively performs without cleaning or replacing the clogged filter **55**. Thus, the life of the scroll compressor **10** is extended beyond the point when the first filter **55** is clogged.

[0069] Since the first filter **55**, the support member **58** and the elastic member **59** constitute the open-close means according to the present invention as described above, the first filter **55** effectively functions as a valve body. Meanwhile, instead of the above open-close means, another alternative embodiment utilizes a known escape valve at an escape passage in the filter casing **41** for bypassing the first filter **55**.

[0070] Also, in an eighth alternative embodiment, in the second filter **45**, an escape passage is similarly formed so as to be opened and closed by an open-close means as in the above first filter **55**. The open-close means usually closes the escape passage while the open-close means opens the escape passage when the pressure of the compressed air on the upstream side relative to the second filter **45** is equal to or larger than a predetermined pressure.

[0071] The recess **32c** is formed in the fixed base plate **20a** of the fixed scroll member **20** for defining the cooling chamber **32** in the above-described preferred embodiments. However, in a ninth alternative embodiment, the recess **32c** is formed in the inner casing **41a** of the filter casing **41**, or in both the fixed base plate **20a** and the inner casing **41a**.

[0072] Also, in a tenth alternative embodiment, an additional cooling chamber is defined on the front side of the filter casing **41** for cooling the discharged air in the filter chamber **44** from both the front side and the rear side of the filter chamber **44**.

[0073] The flow-dividing fins **33** are formed in the cooling chamber **32**. However, in an eleventh alternative embodiment, the flow-dividing fins **33** are formed on the rear side of the inner casing **41a** of the filter casing **41**, or are omitted.

[0074] The above-described preferred embodiments apply to the compressor for compressing the gas, more particularly the air, which is supplied to the fuel cell FC of the electric vehicle. However, in a twelfth alternative embodiment, the present invention is applied to a compressor in an air conditioner or a refrigerating device.

[0075] The two filters **55** and **45** in the second preferred embodiment are located. However, in a thirteenth alternative embodiment, three filters or more are located along the flow direction of the gas. An escape passage is formed so as to bypass at least one of the filters. Also, the first and second

filters **55** and **45** are located so as to be offset from the discharge port **20d** and do not face the discharge port **20d**.

[0076] In the above-mentioned preferred embodiments, the present invention is applied to a scroll type compressor. However, the present invention is also applied to other type compressors.

[0077] The present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.

What is claimed is:

1. A scroll type compressor including a fixed scroll member and a movable scroll member to define compression chambers, the movable scroll member orbiting relative to the fixed scroll member to compress gas in the compression chambers, the compressed gas being discharged to a discharge port, comprising:

a filter chamber communicating with the discharge port for accommodating a first filter to at least partially filter the compressed gas; and

a cooling chamber located adjacent to the filter chamber for containing coolant fluid that cools the compressed gas in the filter chamber.

2. The scroll type compressor according to claim 1, wherein the cooling chamber is located between the compression chambers and the filter chamber.

3. The scroll type compressor according to claim 1, further comprising an inner casing and an outer casing that define the filter chamber, the inner casing being fixed to the fixed scroll member, the outer casing being detachably fixed to the inner casing.

4. The scroll type compressor according to claim 3, wherein the first filter is supported in such a manner that the first filter is sandwiched by the inner and outer casings.

5. The scroll type compressor according to claim 1, wherein the first filter is located so as to be perpendicular to a first flow direction in which the compressed gas flows in the filter chamber, the first flow direction being substantially the same as a second flow direction in which the compressed gas flows in the discharge port.

6. The scroll type compressor according to claim 1, wherein the filter chamber further accommodates a second filter, the first and second filters being located along a first flow direction in which the compressed gas flows in the filter chamber, an escape passage being formed in such a manner that the compressed gas bypasses at least one of the first and second filters.

7. The scroll type compressor according to claim 6, wherein the compressed gas flows in the discharge port in a second flow direction that is substantially the same as the first flow direction.

8. The scroll type compressor according to claim 7, wherein the first and second filters are located so as to be perpendicular to the first flow direction.

9. The scroll type compressor according to claim 6, wherein the first filter is located on an upstream side with respect to the second filter, each of the first and second filters having a mesh, a mesh size of the second filter being equal to or larger than that of the first filter.

10. The scroll type compressor according to claim 6, wherein the first filter is located on an upstream side with respect to the second filter, the first filter having a first

predetermined receiving area, the second filter having a second predetermined receiving area that is equal to or larger than the first predetermined receiving area.

11. The scroll type compressor according to claim 6, further comprising an open-close means for closing the escape passage when a pressure of the compressed gas on an upstream side of the escape passage is lower than a predetermined pressure, the open-close means opening the escape passage when the pressure of the compressed gas on the upstream side of the escape passage is equal to or larger than the predetermined pressure.

12. The scroll type compressor according to claim 11, wherein the open-close means further comprises a fixed support portion that is fixed to the inner casing and a movable support portion for movably supporting the first filter, the first filter contacting the fixed support portion so as to close the escape passage, the first filter moving away from the fixed support portion so as to open the escape passage.

13. The scroll type compressor according to claim 12, wherein the open-close means further comprises an elastic member for urging the first filter to close the escape passage.

14. The scroll type compressor according to claim 6, wherein the second filter is located on a downstream side with respect to the first filter, the escape passage being formed in such a manner that the compressed gas bypasses the first filter.

15. The scroll type compressor according to claim 6, wherein the second filter is located on a downstream side with respect to the first filter, the compressed gas passing through the second filter without bypassing the second filter.

16. The scroll type compressor according to claim 6, wherein the first and second filters are supported in such a manner that the first and second filters are sandwiched between the inner and outer casings.

17. The scroll type compressor according to claim 6, further comprising a first filter mounting portion for placing the first filter adjacent to the second filter at a predetermined distance from the second filter.

18. The scroll type compressor according to claim 17, wherein the first filter mounting portion is connected to the inner casing.

19. The scroll type compressor according to claim 17, wherein the second filter has a frame, the first filter mounting portion being connected to the frame of the second filter.

20. The scroll type compressor according to claim 1, wherein the first filter further comprises a filter portion and a frame.

21. The scroll type compressor according to claim 20, wherein a shape of the filter portion is different from that of the frame.

22. The scroll type compressor according to claim 20, wherein the first filter has a circular shape.

23. The scroll type compressor according to claim 20, wherein the first filter has a rectangular shape.

24. The scroll type compressor according to claim 20, wherein the first filter has a semicircular shape.

25. The scroll type compressor according to claim 20, wherein the first filter has a planar shape.

26. The scroll type compressor according to claim 20, wherein the first filter has a hemispherical shape.

27. The scroll type compressor according to claim 1, wherein flow-dividing fins are provided in the cooling chamber for dividing flow of the coolant fluid.

28. The scroll type compressor according to claim 1, further comprising a suction port for introducing the compressed gas into the compression chambers.

29. The scroll type compressor according to claim 1, wherein an inlet is formed at the filter chamber for communicating with the discharge port, an outlet being formed at the filter chamber for leading the compressed gas to an external circuit.

30. A method of processing compressed gas in a compressor that forms a compression chambers for compressing the gas, a filter chamber having a filter and a cooling chamber that is located adjacent to the filter chamber for containing coolant fluid, the method comprising the steps of:

transmitting cooling temperature of the coolant fluid to the filter chamber;

cooling the compressed gas in the filter chamber; and

removing foreign substances in the compressed gas through the filter in the filter chamber simultaneously with said cooling.

31. The method according to claim 30, further comprising the steps of:

transmitting the cooling temperature of the coolant fluid to the compression chambers; and

cooling the compressed gas in the compression chambers simultaneously with said cooling the compressed gas in the filter chamber.

32. The method according to claim 30, wherein the compressor is a scroll type compressor.

33. A compressor for compressing gas, comprising:

a filter chamber for accommodating a filter so as to at least partially filter the compressed gas; and

a cooling chamber located adjacent to the filter chamber for containing coolant fluid so that cooling temperature of the coolant fluid is transmitted to the filter chamber.

34. The compressor according to claim 33, further comprising compression chambers located adjacent to the cooling chamber for compressing the gas so that the cooling temperature of the coolant fluid is transmitted to the compression chambers.

35. A cooling circuit for cooling gas in a compressor that compresses the gas, comprising:

a filter chamber located in the compressor and accommodating a filter to filter at least partially the compressed gas;

a cooling chamber located in the compressor adjacent to the filter chamber for passing coolant fluid;

a heat exchanger connected to the cooling chamber for cooling the coolant fluid from the cooling chamber; and

a pump connected to the heat exchanger for supplying the coolant fluid to the cooling chamber.

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