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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.

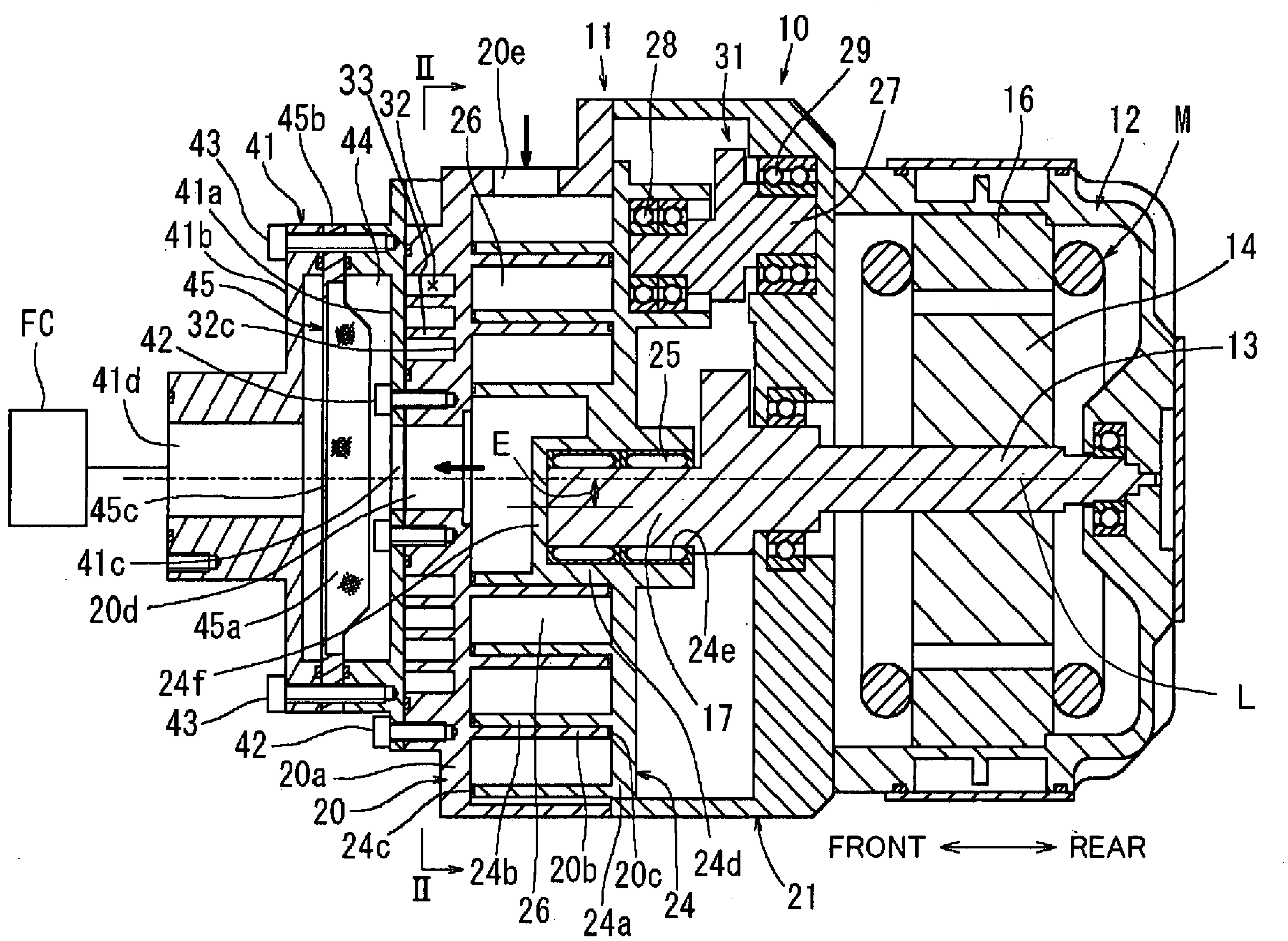

FIG. 1

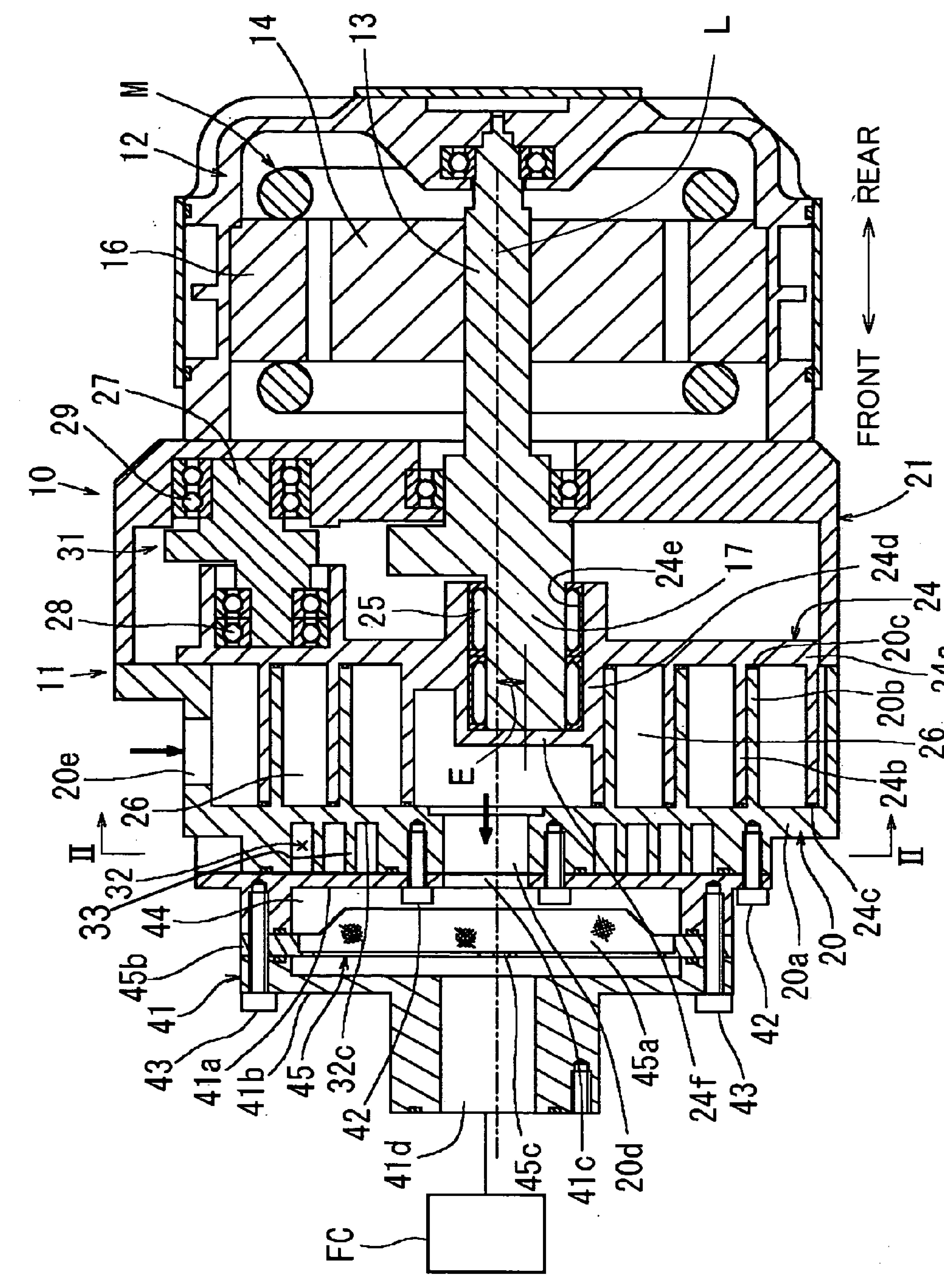

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FIG. 2

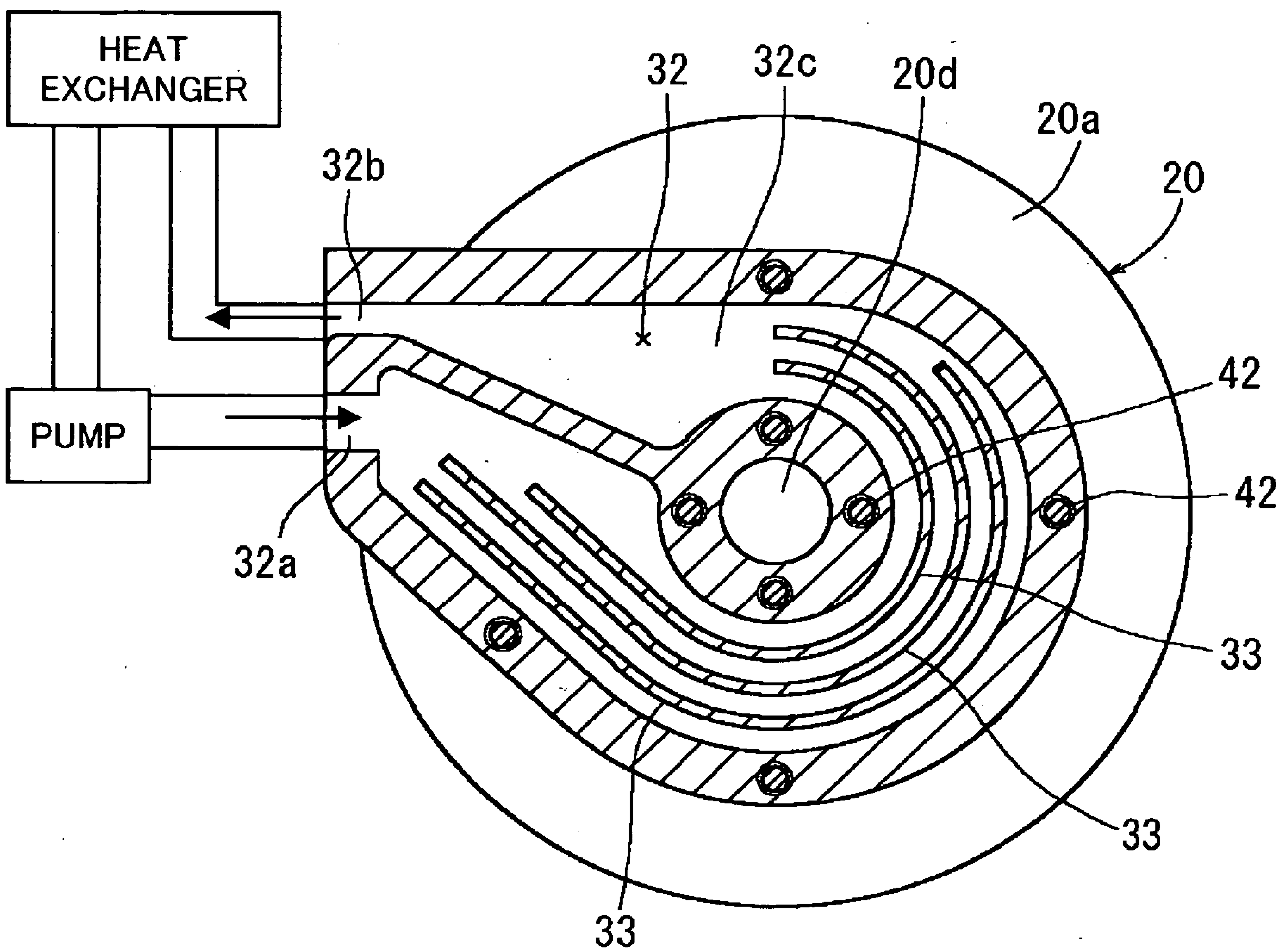

FIG. 3

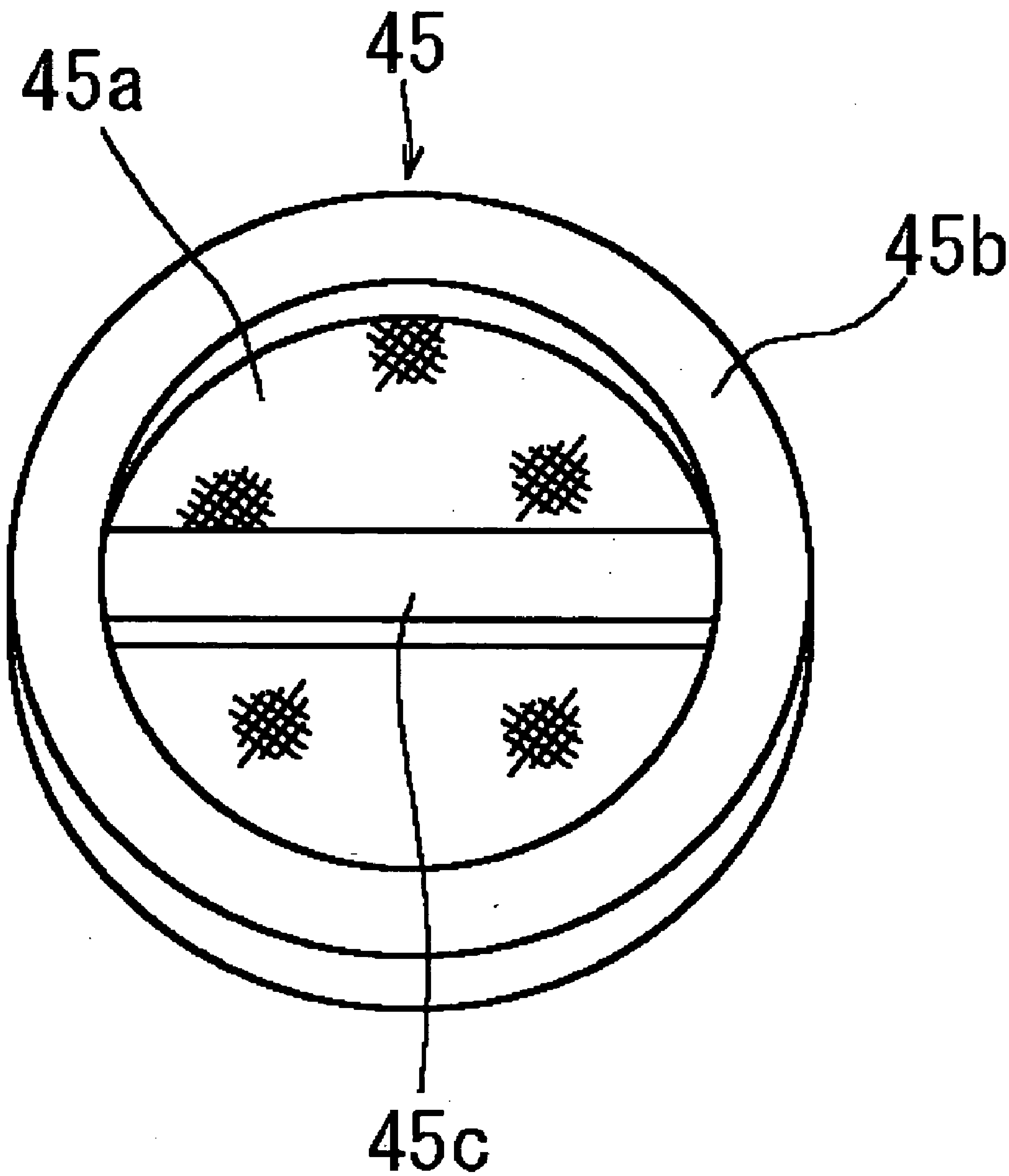

FIG. 4

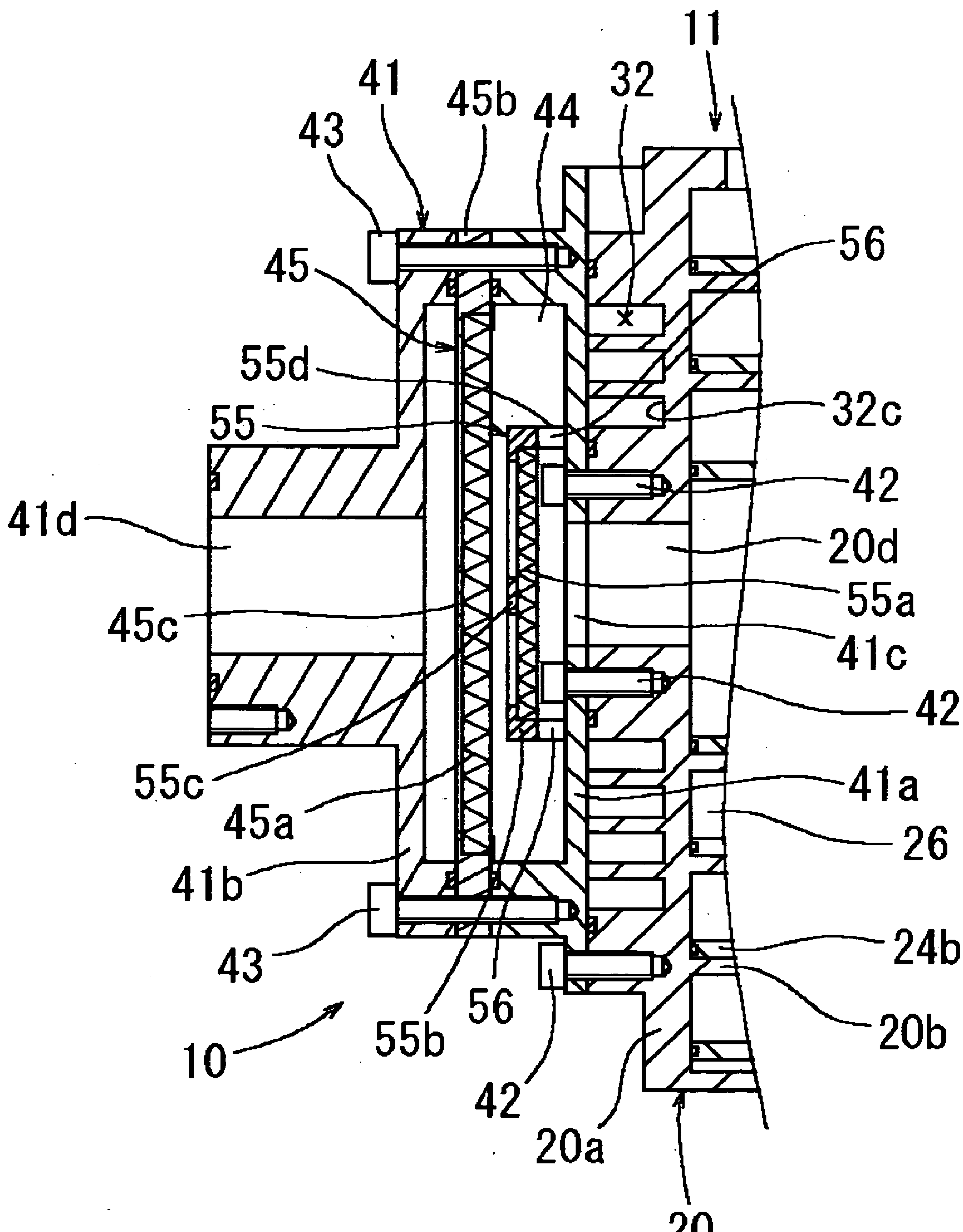
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FIG. 5

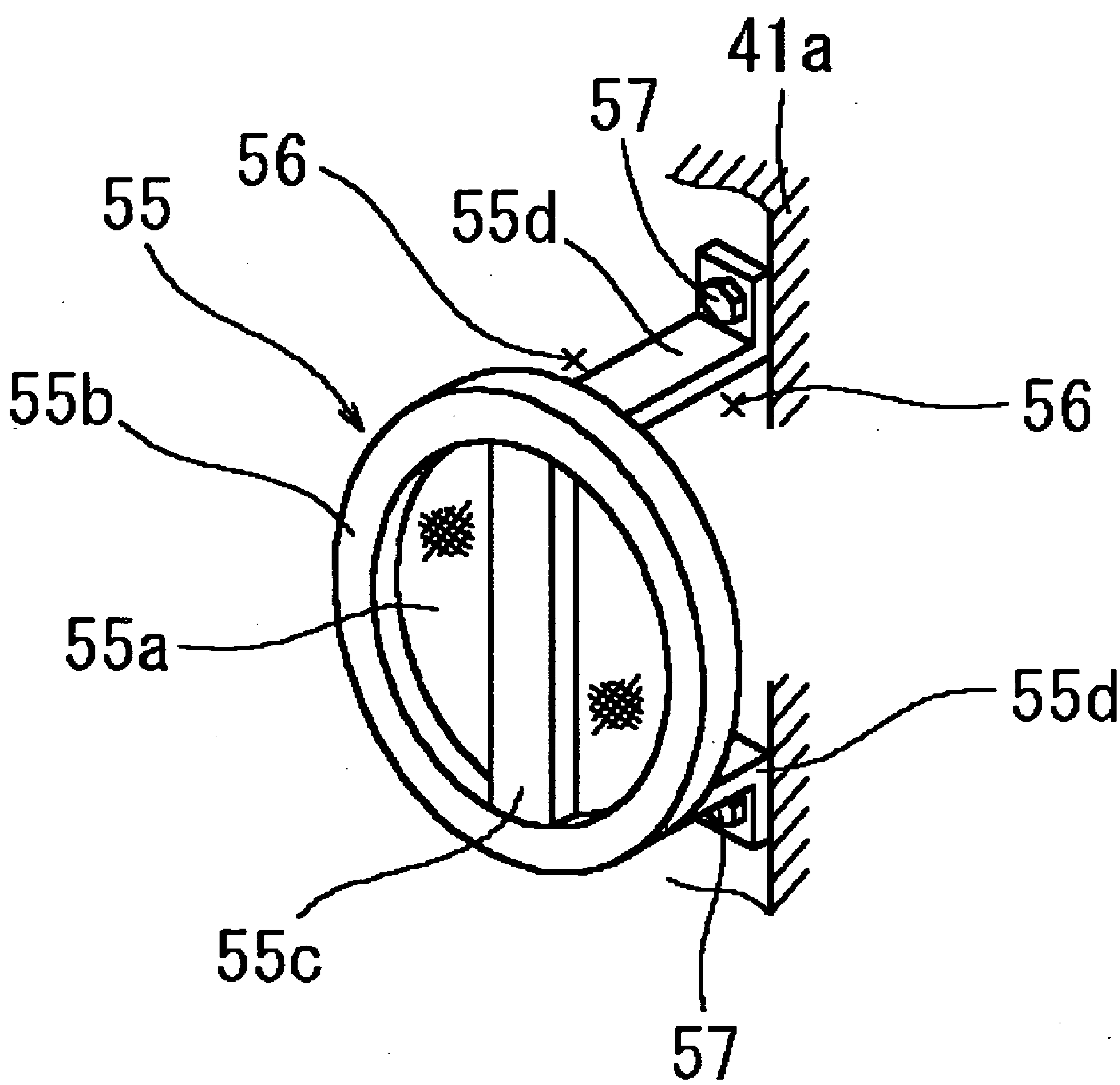

FIG. 6

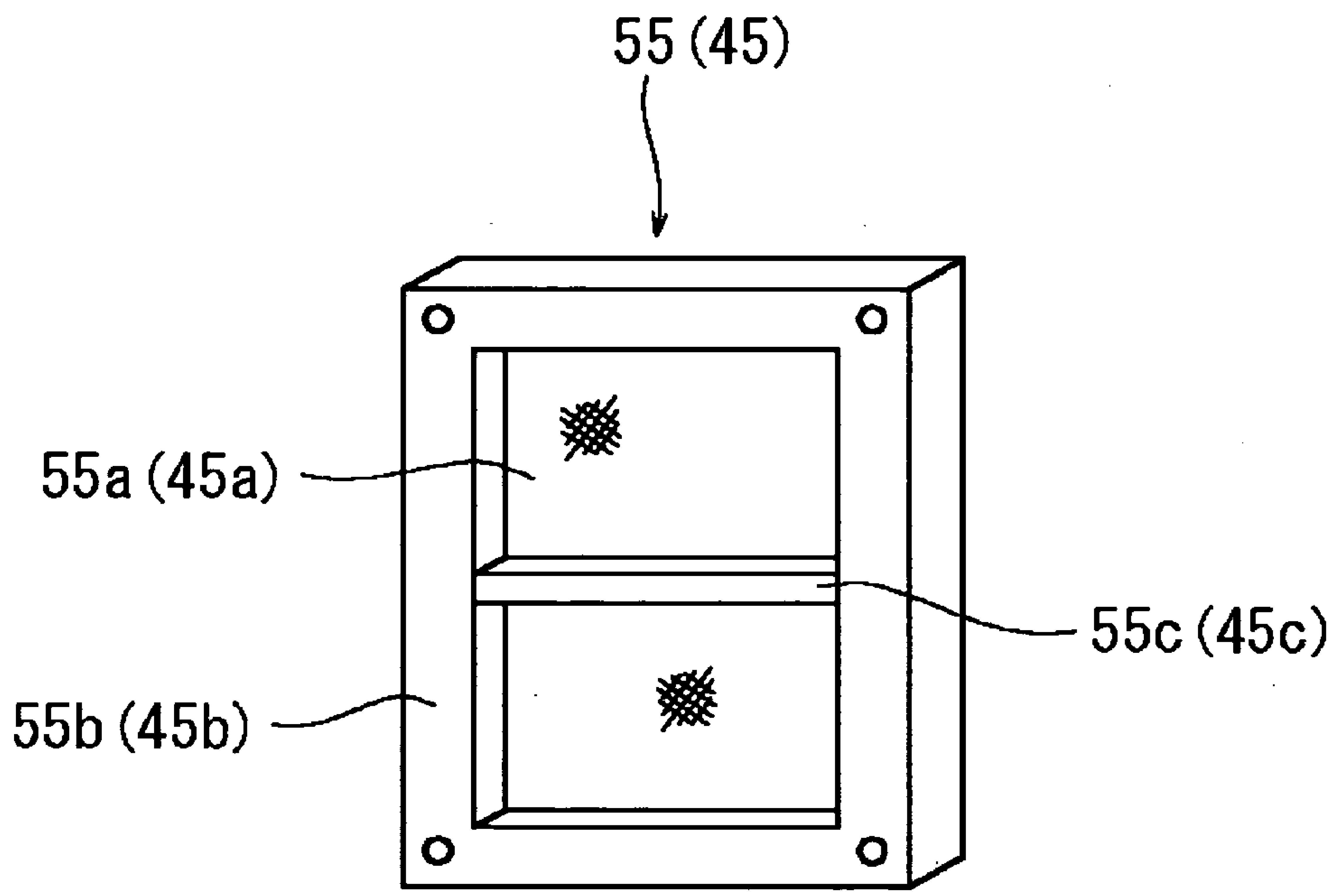

FIG. 7

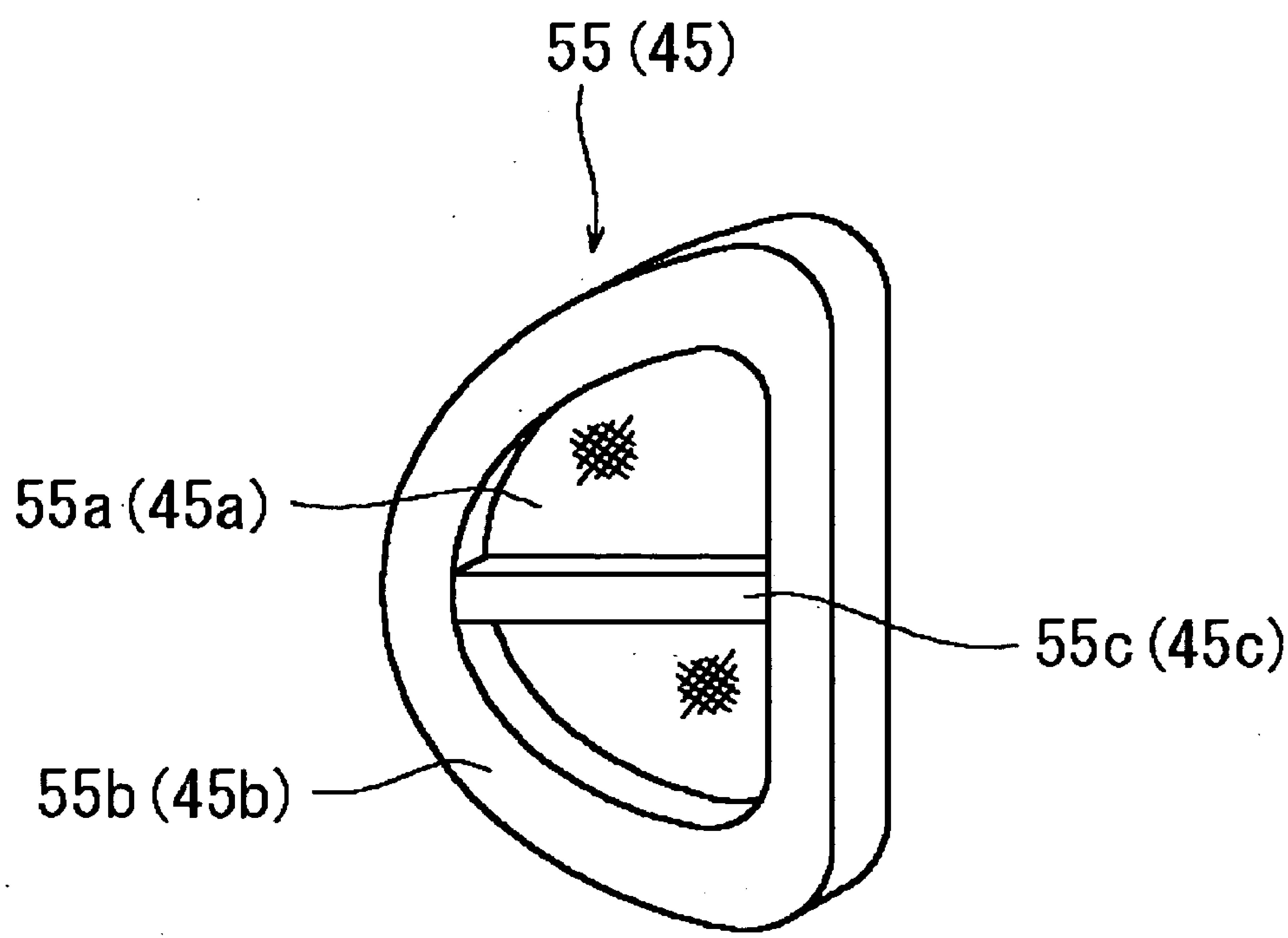

FIG. 8

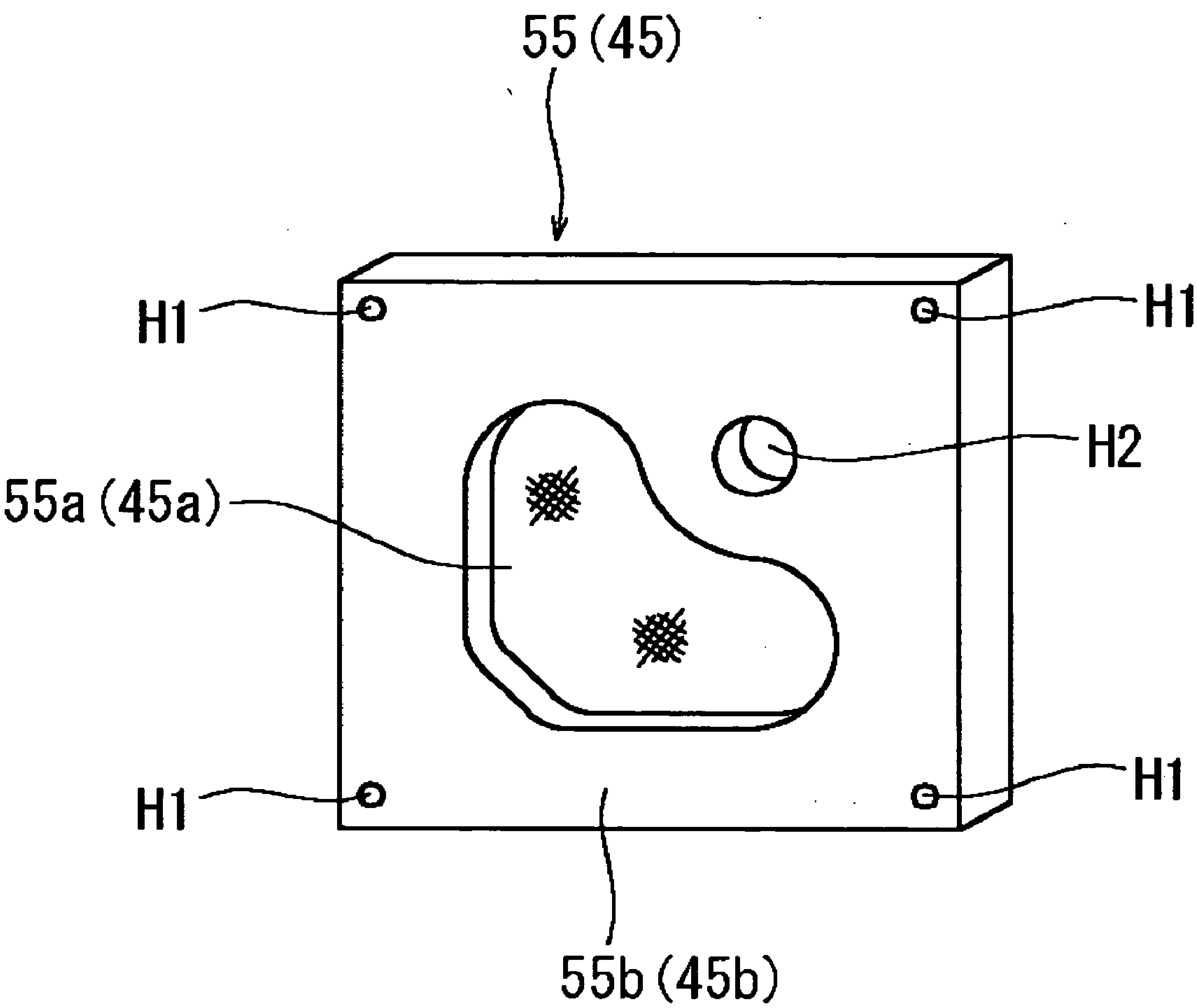

FIG. 9

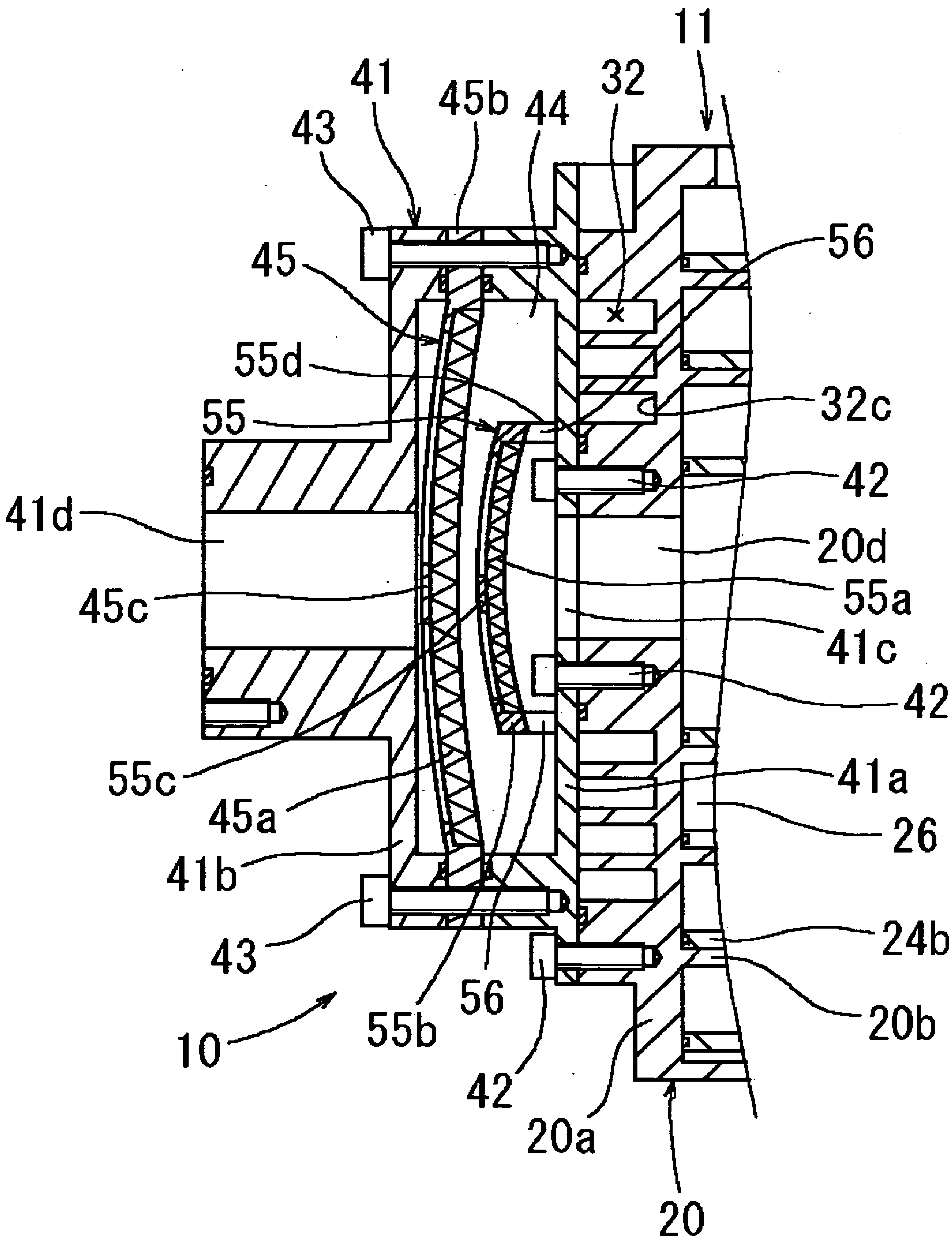
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FIG. 10

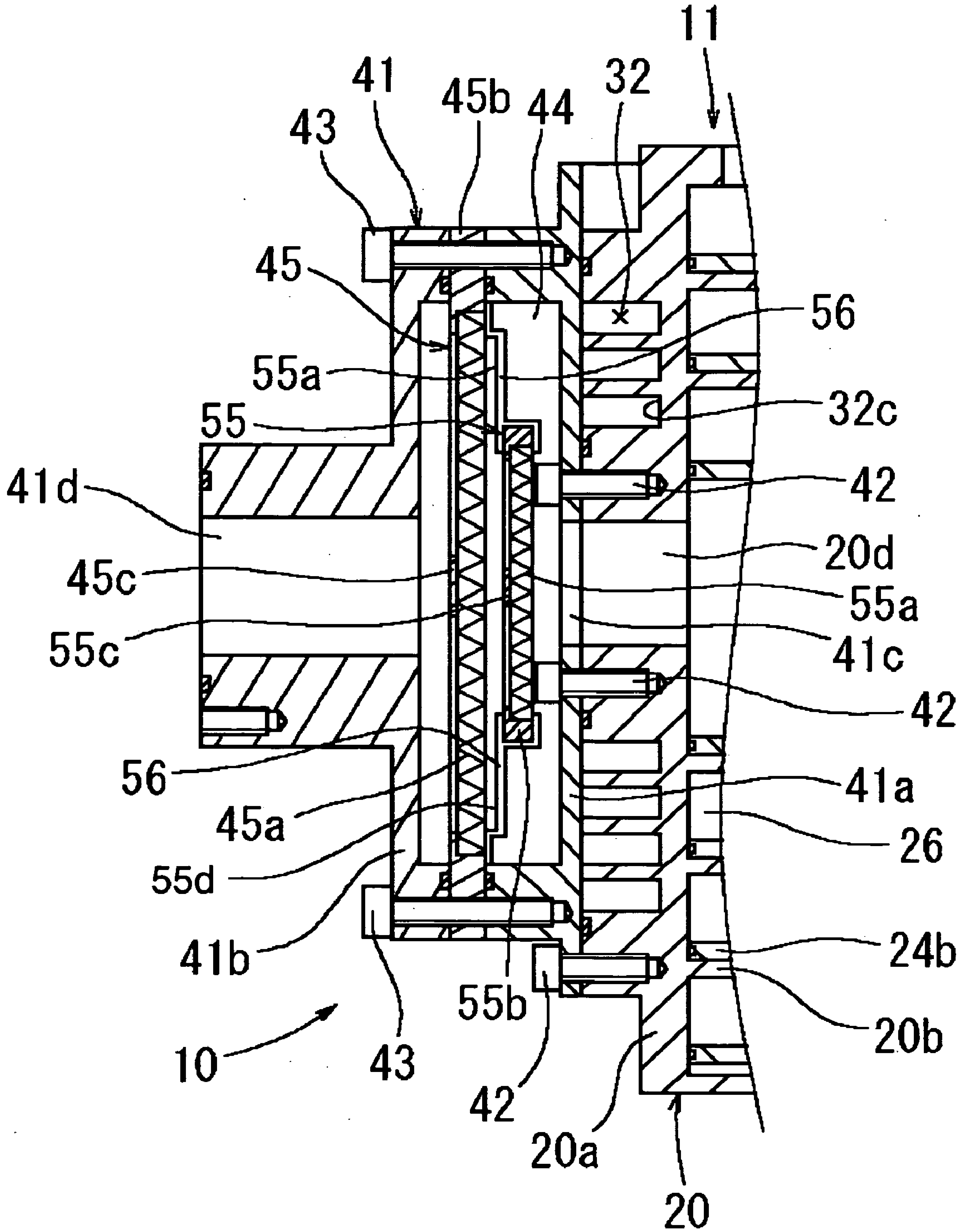
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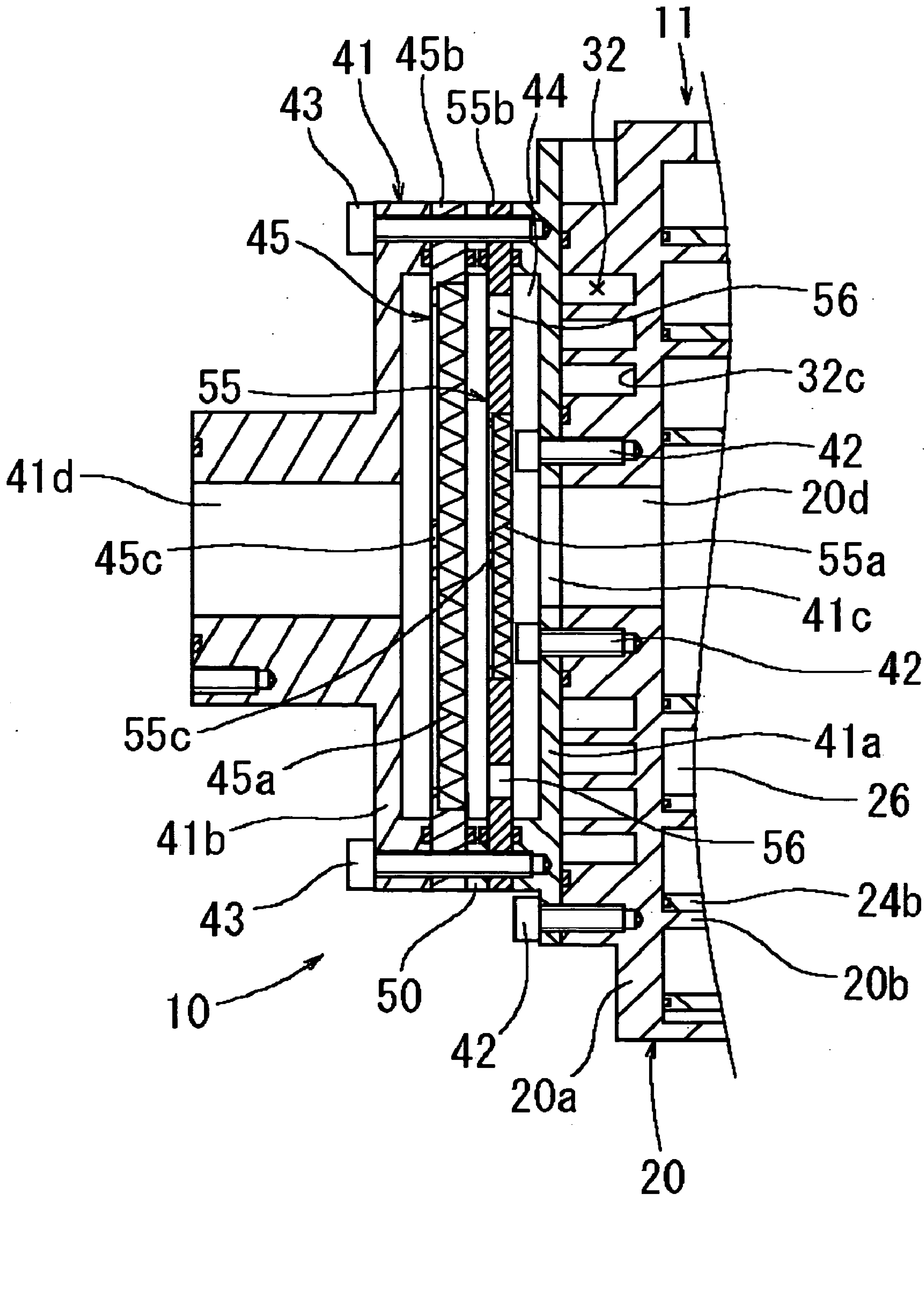
FIG. 11



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55a
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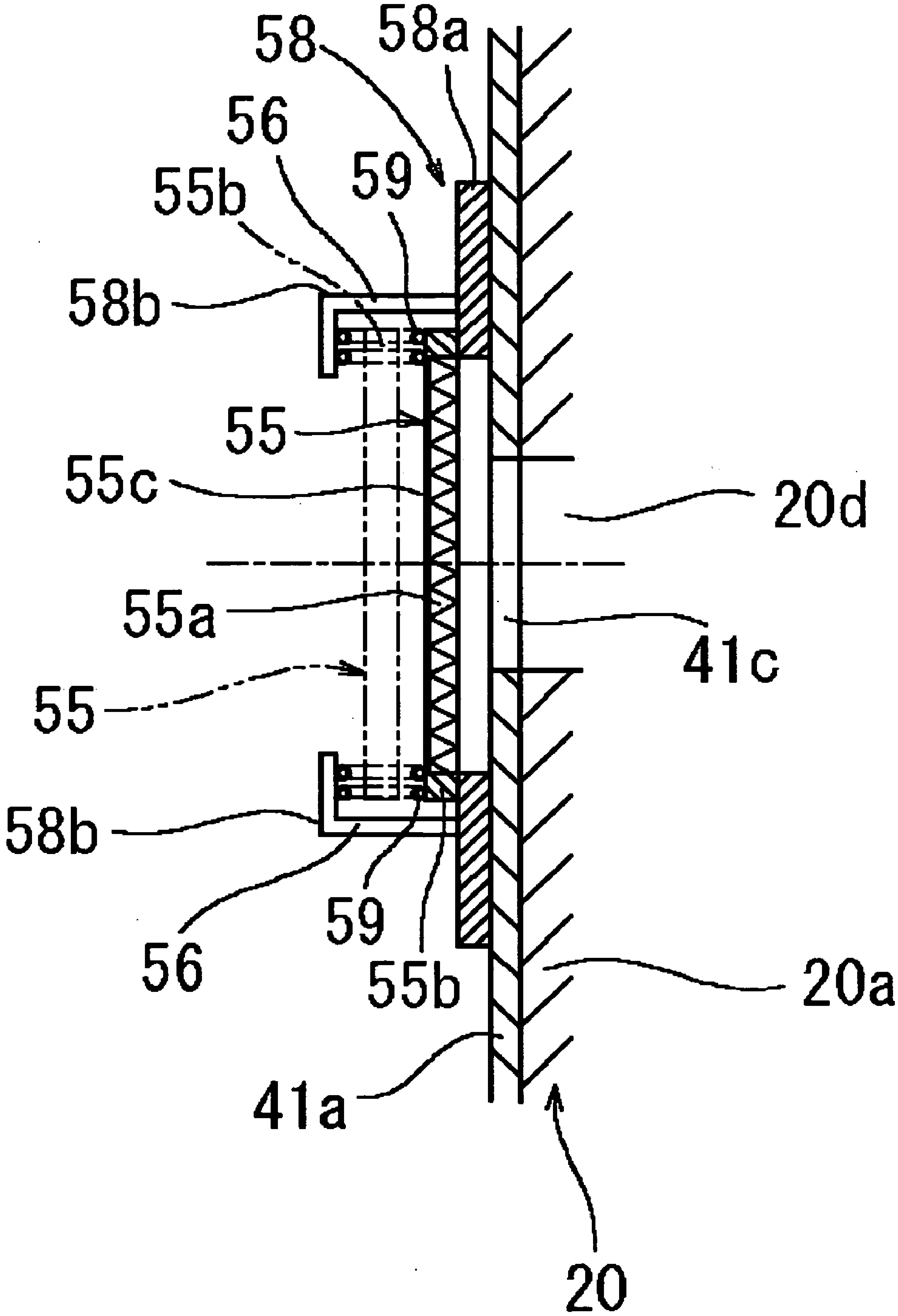
FIG. 12



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 **20***a* that has a substantially disc-shaped configuration and a fixed spiral wall **20***b* that extends from the rear surface of the fixed base plate **20***a*.

[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 **24***a* that is substantially disc-shaped and a movable spiral wall **24***b* that extends from the front surface of the movable base plate **24***b*.

[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 **20***b* and **24***b* respectively contact the movable and fixed base plates **24***a* and **20***a* at tip seals **20***c* and **24***c*. The fixed spiral wall **20***b* overlaps the movable spiral wall **24***b* to contact each other at a plurality of points. Therefore, the fixed base plate **20***a* and the fixed spiral wall **20***b* of the fixed scroll member **20** as well as the movable base plate **24***a* and the movable spiral wall **24***b* of the movable scroll member **24** define a plurality of falcate compression chambers **26**.

[0028] A boss **24***d* is formed at the intermediate portion of the movable base plate **24***a* of the movable scroll member **24**. The boss **24***d* axially protrudes toward the front side of the compressor **10**. An inserting recess **24***e* is formed in the boss **24***d* for accepting the crankshaft **17** thereinto. In the inserting recess **24***e*, a bottom wall **24***f* of the boss **24***d* 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 **24***a* toward the fixed base plate **20***a*. 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 **24***a* toward the fixed base plate **20***a*.

[0029] A discharge port **20***d* is formed in the center of the fixed base plate **20***a* of the fixed scroll member **20**. A suction port **20***e* 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 **24***a* of the movable scroll member **24** and the inner wall surface of the support housing **21** that faces the movable base plate **24***a* 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 **20***b* and **24***b* by the orbital movement, the compression chambers **26** reduce in volume. Thereby, the air introduced from the suction port **20***e* 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 **20***d* when the compression chambers **26** have approached the center of the fixed base plate **20***a*.

[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 **32***c* is formed at the front side of the fixed base plate **20***a* of the fixed scroll member **20**, and the filter casing **41** is fixed to the front surface of the fixed base plate **20***a* so as to cover the recess **32***c*. Accordingly, the cooling chamber **32** is adjacent to the compression chambers **26** across the fixed base plate **20***a*.

[**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 **20***d*. The cooling chamber **32** has a coolant inlet **32***a* for flowing cooling water as coolant fluid into the cooling chamber **32** and a coolant outlet **32***b* 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 **32***a*, and the cooling water flows toward the coolant outlet **32***b*. In the present preferred embodiment, the flow-dividing fins **33** extend from the front surface of the fixed base plate **20***a* 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 **32***b*. The pump supplies the cooling water that has been cooled into the cooling chamber **32** through the coolant inlet **32***a*. 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 **41***a* at the rear side and an outer casing **41***b* at the front side. The inner casing **41***a* is fixed to the front surface of the fixed scroll member **20** by a predetermined number of bolts **42** while the outer casing **41***b* is fixed to the inner casing **41***a* by a predetermined number of bolts **43**. Namely, the outer casing **41***b* is detachable from the inner casing **41***a*. As necessary, the outer casing **41***b* is detached from the inner casing **41***a*. The inner and outer casings **41***a* and **41***b* define the filter chamber **44**. The filter chamber **44** is adjacent to the cooling chamber **32** across the inner casing **41***a*. Namely, the cooling chamber **32** is located between the compression chambers **26** and the filter chamber **44**. Also, the inner casing **41***a* 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 **20***d* into the filter chamber **44**. The filter **45** includes a filter portion **45***a* for removing the foreign substances and a frame **45***b* arranged around the edges of the filter portion **45***a* for supporting the filter portion **45***a*.

[**0035**] The filter **45** is schematically illustrated in **FIG. 3**. In the filter **45**, the frame **45***b* preferably includes a rib **45***c* for reinforcing. In order to enhance capacity for collecting the foreign substances and cooling effect, the filter portion **45***a* 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 **41***a* and **41***b*. As shown in **FIG. 1**, the filter portion **45***a* is suspended in the filter chamber **44**.

[**0036**] Referring to **FIG. 1**, a communication hole **41***c* is formed as an inlet in the center of the inner casing **41***a*. The filter chamber **44** communicates with the discharge port **20***d* of the compression chamber **26** through the communication hole **41***c*. An outlet **41***d* is formed in the center of the outer casing **41***b*. That is, the compressed air discharged from the discharge port **20***d* of the compression chamber **26** is inputted to the filter chamber **44** through the communication hole **41***c*. After passing through the filter **45**, the compressed air is outputted through the outlet **41***d* 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 **20***d* 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 **32***a*. 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 **20***a* as well as between the cooling water and the compressed gas in the filter chamber **44** through the inner casing **41***a*. More specifically, cooling temperature of the cooling water is transmitted to the compressed air in the compression chambers **26** through the fixed base pate **20***a* as well as the compressed gas in the filter chamber **44** through the inner casing **41***a*. The cooling water that has been used for cooling flows out from the coolant outlet **32***b* 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 **32***b* 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 **24***b* rotates relative to the fixed spiral wall **20***b* while the movable spiral wall **24***b* contacts the fixed spiral wall **20***b*. That is, the movable spiral wall **24***b* slides over the fixed spiral wall **20***b*. Also, the tip seals **20***c* and **24***c* respectively slide over the movable and fixed base plate **24***a* and **20***a*. 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 **20***d* and the communication hole **41***c*. 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 **41***d*.

[**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 **41***a* and **41***b*. The inner casing **41***a* is fixed to the fixed scroll member **20**, and the outer casing **41***b* is detachably fixed to the inner casing **41***a*. Since the outer casing **41***b* is detached from the inner casing **41***a* 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 **20***a* of the fixed scroll member **20**. The flow-dividing fins **33** contact the inner casing **41***a*. 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 **55***a* for removing the foreign substances and a frame **55***b* arranged around the edges of the filter portion **55***a* for supporting the filter portion **55***a*. The frame **55***b* preferably includes a rib **55***c* for reinforcing. In order to enhance the capacity for collecting the foreign substances and the cooling effect, the filter portion **55***a* is preferably a pleated type filter element that a flat stainless screen is bent in zigzags as similarly done to the filter portion **45***a* 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 **55***a* and **45***a*. The first and second filter portions **55***a* and **45***a* 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 **55***d* is formed at the periphery of the frame **55***b*. Two mounting portions **55***d* are shown in **FIG. 5**. The end portions of the mounting portions **55***d* are outwardly bent. The end portion of each mounting portion **55***d* is fixed to an inner surface of the inner casing **41***a* 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 **55***a* 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 **20***d*. 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.

$$M1 \leqq M2$$

[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 **55***a* in the first filter **55** ranges from 25 to 40 while the mesh size of the second filter portion **45***a* in the second filter **45** is approximately 100.

[0050] In general, a receiving area A1 of the filter portion **55***a* and a receiving area A2 of the filter portion **45***a* 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.

$$A1 \leqq A2$$

[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 **20***d* and is sent to the filter chamber **44** through the communication hole **41***c*. 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 **45***d* 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 filer 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 **41***a* 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 **41***d* 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 **20***d*. Thus, the compressed air discharged from the discharge port **20***d* 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 **55***a* or **45***a* is different from the shape of the frame **55***b* or **45***b* in a third alternative embodiment. In this case, the filter portion **55***a* or **45***a* avoids holes H1 for inserting bolts and a hole H2 that leads to the coolant inlet **32***a* or the coolant outlet **32***b* of the cooling chamber **32** as shown in **FIG. 2**, which are formed in the frame **55***b* or **45***b*. Namely, the shape of the filter portion **55***a* or **45***a* is appropriately changed in accordance with the design requirements including the location for inserting bolts, the location for the coolant inlet **32***a* and the coolant outlet **32***b* of the cooling chamber **32**, and the location for the communication hole **41***c* and the outlet **41***d* 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 **41***a* 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 **45***b* of the second filter **45** in a fifth alternative embodiment. In this case, the end portion of each mounting portion **55***d* of the frame **55***b* of the first filter **55** is similarly fixed to the frame **45***b* of the second filter **45** by a bolt that is not shown in the drawings as the above description. Thereby, the filter portion **55***a* 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 **55***b* of the first filter **55** and the inner casing **41***a*.

[**0065**] As shown in **FIG. 11**, the frame **45***b* of the second filter **45** and the frame **55***b* of the first filter **55** are sandwiched between the inner and outer casings **41***a* and **41***b* in a sixth alternative embodiment. Thereby, the frame **45***b* of the second filter **45** and the frame **55***b* of the first filter **55** are supported. A ring-shaped spacer **50** is interposed between the first filter frame **55***b* and the second filter frame **45***b*. 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 **55***b*. Meanwhile, the spacer **50** is formed integrally with either of the first filter frame **55***b* or the second filter frame **45***b*, 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 **41***a*. The support member **58** includes a fixed support portion **58***a* that has a ring shape and a plurality of movable support portions **58***b* that extends from the fixed support portion **58***a*. The fixed support portion **58***a* is fixed to the inner casing **41***a*. The end portions of the movable support portions **58***b* movably support the first filter frame **55***b* in an axial direction as shown in a horizontal direction in **FIG. 12**. The movable support portions **58***b* 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 **58***b*. The first filter frame **55***b* contacts the fixed support portion **58***a* to close the escape passage **56** as shown by a solid line in **FIG. 12**. The first filter frame **55***b* separates itself from the fixed support portion **58***a* 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 **55***b* and the movable support portions **58***b* 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 **20***d* through the communication hole **41***c* 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 **32***c* is formed in the fixed base plate **20***a* 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 **32***c* is formed in the inner casing **41***a* of the filter casing **41**, or in both the fixed base plate **20***a* and the inner casing **41***a*.

[**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 **41***a* 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 **20***d* and do not face the discharge port **20***d*.

[**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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