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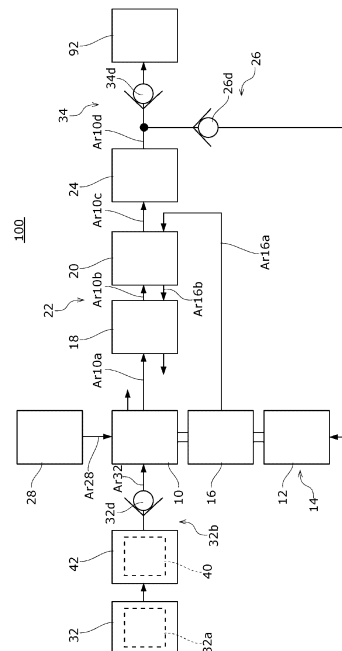
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(54) **AIR COMPRESSION DEVICE**

(57) An air compression device includes: a compressor structured to generate compressed air; a motor structured to drive the compressor; a multiblade fan structured to be driven by the motor to generate an air flow; and a first cooler structured to cool the compressed air and a second cooler structured to cool the compressed air cooled by the first cooler by the air flow. The first cooler cools the compressed air by an air flow that has cooled the second cooler.

FIG.1



Description

[0001] The present invention relates to an air compression device.

[0002] An air compression device is known which generates compressed air. For example, JP 2016-075159 A describes a package type compressor including a compressor body driven by an electric motor. This compressor includes the compressor body that compresses air, a motor that drives the compressor body, an inverter that controls the rotational speed of the motor, and a cooling fan for cooling the compressor body. An aftercooler for cooling the air compressed by the scroll compressor body is arranged on the back surface of the compressor.

[0003] The present inventors have obtained the following recognition about the air compression device.

[0004] The air compressed in the compressor body has a high temperature of 200°C or higher, and is preferably cooled to about room temperature when used. In the air compressor described in JP 2016-075159 A, the aftercooler is cooled by the cooling air from the cooling fan after cooling the scroll compressor body. That is, the cooling air from the cooling fan is used both for cooling the compressor body and for cooling the aftercooler. When the compressor body is sufficiently cooled, the temperature of the cooling air after cooling becomes high, and the aftercooler is not sufficiently cooled. On the other hand, when the aftercooler is sufficiently cooled, the cooling of the compressor body becomes insufficient.

[0005] In order to sufficiently cool the compressor body and the aftercooler, it is conceivable to increase the size of the cooling fan. However, this case is contrary to the demand for downsizing of the air compression device on which the cooling fan is mounted. In other words, there is a tradeoff between sufficiently cooling the aftercooler and downsizing the device.

[0006] From these, the present inventors have recognized that there is room for improvement in the viewpoint of efficiently cooling the compressed air in the air compression device.

[0007] The present invention has been made in view of these problems, and an object of the present invention is to provide an air compression device capable of efficiently cooling air compressed by a compressor while suppressing an increase in size.

[0008] In order to solve the above-described problems, an air compression device according to one aspect of the present invention includes: a compressor that generates compressed air; a motor that drives the compressor; a fan that is driven by the motor to generate an air flow; and a first cooler that cools the compressed air and a second cooler that cools the compressed air cooled by the first cooler by the air flow. The first cooler cools the compressed air by an air flow that has cooled the second cooler.

[0009] In addition, the above arbitrary combinations or ones obtained by mutually replacing the constituent elements and expressions of the present invention between

a method, a device, a program, a temporary or non-temporary storage medium recording the program, a system, and the like are effective as an embodiment of the present invention.

[0010] According to this invention, the air compression device can be provided which can cool efficiently the air compressed by the compressor while suppressing an increase in size.

Fig. 1 is a system diagram schematically illustrating a configuration of an air compression device according to a first embodiment of the present invention; Fig. 2 is a schematic view illustrating a state where the air compression device of Fig. 1 is installed in a railway vehicle;

Fig. 3 is a side sectional view schematically illustrating a periphery of a compressor driving part and a multiblade fan of the air compression device of Fig. 1; Fig. 4 is a perspective view schematically illustrating a cooler of the air compression device of Fig. 1; Fig. 5 is a schematic view for explaining the flow of air in the cooler of Fig. 4;

Fig. 6 is an enlarged side sectional view illustrating a periphery of a labyrinth portion of the compressor driving part of Fig. 3;

Fig. 7 is a perspective view illustrating a periphery of the multiblade fan of the air compression device of Fig. 1;

Fig. 8 is a front view illustrating a periphery of a balance weight of the compressor driving part of Fig. 3; Fig. 9 is a rear view illustrating the periphery of the balance weight of the compressor driving part in Fig. 3;

Fig. 10 is a front view schematically illustrating a compressor and a blower fan of the air compression device of Fig. 1;

Fig. 11 is another front view schematically illustrating the compressor and the blower fan of the air compression device of Fig. 1;

Fig. 12 is a view schematically illustrating a flow of air from the blower fan of Fig. 10; and

Fig. 13 is a front view schematically illustrating a periphery of a compressor of an air compression device according to a first modification.

[0011] Hereinafter, a preferred embodiment of the invention will be described with reference to the accompanying drawings. In an embodiment and its modification, the same or equivalent components and members are denoted by the same reference numerals, and repeated description is appropriately omitted. In addition, the dimensions of the members in each drawing are appropriately enlarged or reduced for easy understanding. In addition, in the drawings, some of the members that are not important for describing the embodiment are omitted.

[0012] In addition, terms including ordinal numbers such as first and second are used to describe various components. However, this term is used only for the pur-

pose of distinguishing one component from other components, and the components are not limited by the term.

[0013] With reference to the drawings, a configuration of an air compression device 100 according to a first embodiment of the present invention will be described. As an example, the air compression device 100 is provided under a floor of a railway vehicle and can be used as an air compression device for a railway vehicle which supplies compressed air to the vehicle. Fig. 1 is a system diagram schematically illustrating a configuration of the air compression device 100. Fig. 2 is a schematic view illustrating a state in which the air compression device 100 is installed in the railway vehicle 90. In this drawing, for easy understanding, a part of a bearing holder 38 and a multiblade fan 16 is fractured, and a blower fan 28 is shown smaller than an actual ratio.

[0014] The air compression device 100 of the present embodiment includes a compressor 10, a compressor driving part 14, a multiblade fan 16, a cooler 22, a dehumidifier 24, an air introduction unit 26, a blower fan 28, an air suction part 32, a compressed air delivery part 34, an inverter control device 40, and a housing case 36. The air compression device 100 compresses the air sucked from the air suction part 32 with the compressor 10, cools the air with the cooler 22, dehumidifies the air with the dehumidifier 24, delivers the air out from the compressed air delivery part 34, and supplies the air to the vehicle 90.

[0015] The compressor 10 generates compressed air. The compressor driving part 14 includes a motor 12 that drives the compressor 10. The inverter control device 40 drives the motor 12 of the compressor driving part 14. The multiblade fan 16 is driven by the motor 12 to generate an air flow used for cooling by the cooler 22. The multiblade fan 16 may be referred to as a sirocco fan. The air introduction unit 26 introduces the compressed air into the motor 12. The blower fan 28 generates an air flow that cools the compressor 10.

[0016] Hereinafter, the direction along the central axis La of the rotary shaft 10a of the compressor 10 is referred to as "axial direction", and the circumferential direction and the radial direction of the circle centered on the central axis La are respectively "circumferential direction" and "radial direction". Hereinafter, for convenience, one side (a right side in the drawing) in the axial direction is referred to as an input side, and the other side (a left side in the drawing) is referred to as a non-input side. In this example, the motor 12 is provided on the input side of the compressor 10, and the compressor 10 is provided on the non-input side of the motor 12.

[0017] The air suction part 32 is installed in the housing case 36 and functions as a mechanism for sucking air (outside air) compressed by the compressor 10. The air suction part 32 is formed so as to communicate with the compressor 10 through the suction pipe 32b. The air suction part 32 is provided with a suction filter 32a that suppresses the passage of dust such as sand dust when the suction air passes. The suction filter 32a may be a filter

using a mesh.

[0018] The compressed air delivery part 34 functions as a mechanism that delivers the compressed air Ar10d cooled by the cooler 22 described later and dehumidified by the dehumidifier 24. The compressed air delivery part 34 supplies the generated compressed air Ar10d to the compressed air reservoir 92 installed outside the housing case 36. The compressed air delivery part 34 may include a valve mechanism 34d provided in a path that allows the dehumidifier 24 and the compressed air reservoir 92 to communicate with each other. The valve mechanism 34d may be a check valve that allows the compressed air Ar10d to pass to the compressed air reservoir 92 side and prevent backflow from the compressed air reservoir 92 when the dehumidifier 24 side is equal to or higher than a predetermined pressure.

[0019] The cooler 22 will be described with reference to Figs. 2 to 5. Fig. 3 is a side sectional view schematically illustrating the periphery of the compressor driving part 14 and the multiblade fan 16. Fig. 4 is a perspective view schematically illustrating the cooler 22. Fig. 5 is a schematic view for explaining the flow of air in the cooler 22. The cooler 22 cools the compressed air supplied from the compressor 10 at a high temperature (for example, 200°C to 250°C) to a temperature slightly higher than the room temperature (for example, 40°C to 50°C) and supplies the compressed air to the dehumidifier 24.

[0020] The cooler 22 of the present embodiment includes a first cooler 18 and a second cooler 20 that sequentially cool the compressed air generated by the compressor 10. The first cooler 18 is a front-stage cooler provided in the front stage of the second cooler 20, and the second cooler 20 is a rear-stage cooler provided in the rear stage of the first cooler 18. The second cooler 20 may be referred to as an aftercooler, and the first cooler 18 may be referred to as a precooling. The second cooler 20 secondarily cools the compressed air cooled by the first cooler 18 by the air flow Ar16a generated by the multiblade fan 16. The first cooler 18 primarily cools the compressed air from the compressor 10 by the air flow Ar16b used for cooling by the second cooler 20.

[0021] The first cooler 18 and the second cooler 20 may be arranged anywhere as long as a desired cooling effect is obtained. The first cooler 18 and the second cooler 20 of the present embodiment are arranged above the center of the air compression device 100 in the vertical direction. The first cooler 18 and the second cooler 20 may be arranged in a direction orthogonal to the rotation axis of the multiblade fan 16. In particular, the first cooler 18 and the second cooler 20 are arranged above the multiblade fan 16 and between the multiblade fan and the floor of the railway vehicle 90. By shortening the path of the air flow Ar16a delivered from the multiblade fan 16, an extra piping space can be saved. Further, the longitudinal length of the air compression device 100 can be shortened compared to the case of being arranged in the longitudinal direction of the multiblade fan 16.

[0022] Although the first cooler 18 and the second cool-

er 20 may be spaced apart from each other, in the present embodiment, the first cooler 18 may be arranged on the opposite side of the second cooler 20 from the multiblade fan 16. In this example, the first cooler 18 is laminated and integrally arranged above the second cooler 20. By integrally arranging the coolers, the connecting hose having heat resistance between them can be shortened or omitted. The air flow may flow around the first and second coolers 18 and 20 in a direction orthogonal to the rotation axis of the multiblade fan 16. In this example, the air flow from the multiblade fan 16 flows from the bottom to the top through the first and second coolers 18 and 20 that are integrally arranged.

[0023] Detailed configurations of the first cooler 18 and the second cooler 20 will be described. The first cooler 18 and the second cooler 20 have bent pipes 18p and 20p and pipe housing parts 18c and 20c for housing the pipes, respectively. The bent pipes 18p and 20p meander so that they have a plurality of bent portions, and compressed air flows from one end of the pipe toward the other end. The pipe housing parts 18c and 20c have vertically thin rectangular tube-shaped outer walls, and function as a wind tunnel for allowing a cooling air to flow vertically.

[0024] Wire mesh portions 18m and 20m for supporting the bent pipes 18p and 20p are fixed to the lower portions of the pipe housing parts 18c and 20c. The upper surface of the pipe housing part 20c is opened, and the wire mesh portion 20n is fixed to the upper surface of the pipe housing part 18c. As described above, the pipe housing parts 18c and 20c have a configuration in which the air flow easily passes vertically.

[0025] The first introduction part 18b provided at one end of the bent pipe 18p protrudes outside from the side wall of the pipe housing part 18c of the first cooler 18. The first introduction part 18b communicates with the discharge port 10e of the compressor 10. A first lead-out part 18e provided at the other end of the bent pipe 18p protrudes outside from the side wall of the pipe housing part 18c of the first cooler 18. The first lead-out part 18e communicates with a second introduction part 20b.

[0026] The second introduction part 20b provided at one end of the bent pipe 20p protrudes outside from the bottom of the pipe housing part 20c of the second cooler 20. The second introduction part 20b communicates with the first lead-out part 18e by a heat-resistant connecting hose. A second lead-out part 20e provided at the other end of the bent pipe 20p protrudes outside from the side wall of the pipe housing part 20c of the second cooler 20. The second lead-out part 20e communicates with the dehumidifier 24.

[0027] The pipe housing part 18c is arranged on the upper side of the pipe housing part 20c. The air flow Ar16a delivered from the multiblade fan 16 is supplied to the lower surface of the pipe housing part 20c through the duct 16d. The air flow Ar16a flows through the gap of the wire mesh portion 20m and the gap of the bent pipe 20p, and is discharged from the upper surface of the pipe

housing part 20c. As the air flow Ar16a passes through the outer peripheral surface of the bent pipe 20p, the compressed air of the bent pipe 20p is cooled.

[0028] The air flow Ar16b discharged from the pipe housing part 20c is supplied to the lower surface of the pipe housing part 18c. The air flow Ar16b flows through the gap of the wire mesh portion 18m, the gap of the bent pipe 18p, and the gap of the wire mesh portion 20n, and is discharged from the upper surface of the pipe housing part 18c. The compressed air Ar20c of the bent pipe 18p is cooled by the air flow Ar16b passing through the outer peripheral surface of the bent pipe 18p. The air discharged from the pipe housing part 18c is diffused into the atmosphere.

[0029] As described above, the air flow Ar16a delivered from the multiblade fan 16 is supplied to the second cooler 20 first and is used for secondary cooling of the compressed air after the primary cooling. The air flow Ar16b discharged from the second cooler 20 is supplied to the first cooler 18 and is used for primary cooling of the compressed air. Compared to the case where the air flow Ar16a is used for the primary cooling first, the temperature difference between the compressed air and the cooling air in the secondary cooling becomes large, so that the cooling efficiency can be increased.

[0030] The compressor driving part 14 will be described with reference to Figs. 2, 3, and 6. Fig. 6 is an enlarged side sectional view illustrating the periphery of the labyrinth portion 12f of the compressor driving part 14. The compressor driving part 14 mainly includes a motor 12 that rotationally drives the compressor 10 and a balance weight 15.

[0031] The motor 12 will be described. The motor 12 includes an output shaft 12a, a rotor 12k, a stator 12s, a casing 12c, and a labyrinth portion 12f. In the present embodiment, the output shaft 12a of the motor 12 is provided integrally with the rotary shaft 10a of the compressor 10. The rotor 12k includes a magnet 12m having a plurality of magnetic poles in the circumferential direction and is fixed to the outer periphery of the output shaft 12a. The rotor 12k is fixed to an input side of a rotor fixing part 15d of the balance weight 15 described later by a fastener such as a bolt (not illustrated). An adhesive may be used in combination for these fixations.

[0032] The stator 12s includes a stator core 12j that surrounds the rotor 12k via a magnetic gap and a coil 12g that is wound around the stator core 12j. The outer periphery of the stator 12s is fixed to the inner peripheral surface of the casing 12c. The casing 12c includes a cylindrical portion 12d and a bottom portion 12e, and functions as an outer shell that surrounds the rotor 12k and the stator 12s. In this example, the casing 12c has a bottomed cylindrical shape in which the non-input side is opened and the bottom portion 12e is provided on the input side. The bottom portion 12e is provided with an introduction port 12h for taking in air from the air introduction unit 26.

[0033] The labyrinth portion 12f is provided so as to

cover the non-input side of the cylindrical portion 12d, and has a disc shape in this example. The labyrinth portion 12f includes a rotating body portion 12n fixed to the output shaft 12a and a stationary body portion 12p fixed to the cylindrical portion 12d. The stationary body portion 12p is a donut-shaped disc member in which a stationary body side labyrinth forming part 12q is provided on the outer periphery of the non-input side end surface. The stationary body side labyrinth forming part 12q includes a stationary body side concave portion 12t and a stationary body side convex portion 12u. The labyrinth convex portion 15h described later enters the stationary body side concave portion 12t. The stationary body side convex portion 12u enters a labyrinth concave portion 15g described later. The stationary body side convex portion 12u is an annular wall provided on the inner peripheral side of the stationary body side concave portion 12t. The rotating body portion 12n also serves as the balance weight 15 described later. A labyrinth 12r is provided between the rotating body portion 12n and the stationary body portion 12p. In this example, the labyrinth 12r is a maze that combines bended spaces. The labyrinth portion 12f includes the labyrinth 12r to reduce the intrusion of dust into the motor 12.

[0034] Further, since the compressed air Ar10e introduced from the introduction port 12h flows outward from the labyrinth 12r, the dust in the labyrinth 12r is easily discharged to the outside by this air flow.

[0035] The motor 12 generates a field magnetic field in the magnetic gap when a drive current is provided to the coil 12g of the stator 12s from an inverter control device 40 (drive circuit) described later. The motor 12 generates a rotational driving force on the rotor 12k and the output shaft 12a due to the field magnetic field and the magnet 12m of the rotor 12k. The rotational driving force of the output shaft 12a drives the multiblade fan 16 and the compressor 10 through the rotary shaft 10a. The bearing that supports the rotary shaft 10a is provided in the bearing holder 38 outside the compressor driving part 14, and is not provided in the compressor driving part 14.

[0036] The multiblade fan 16 will be described with reference to Fig. 3, 6, and 7. Fig. 7 is a perspective view illustrating the periphery of the multiblade fan 16. This drawing illustrates the balance weight 15 integrated with the rotor 12k and the multiblade fan 16. The multiblade fan 16 is arranged between the compressor 10 and the motor 12 in the axial direction. The multiblade fan 16 functions as a fan that rotates integrally with the rotor 12k of the motor 12. In particular, the multiblade fan 16 functions as a blower that collects and sends the air flow generated from the central portion toward the outer periphery in a delivery duct 16d. The multiblade fan 16 includes a disc portion 16b and a plurality of blades 16c.

[0037] The disc portion 16b is a donut-shaped disc member of which the inner peripheral side is fixed to the rotary shaft 10a via a balance weight 15. In particular, the disc portion 16b is fixed to a fan fixing part 15c provided on the non-input side end surface of the balance

weight 15 with a fastener such as a bolt (not illustrated). An adhesive may be used in combination for these fixations. The plurality of blades 16c extend from the disc portion 16b to the non-input side in the vicinity of the outer periphery of the disc portion 16b. The plurality of blades 16c are arranged at predetermined angles in the circumferential direction. The plurality of blades 16c function as an air flow generation part that generates an air flow toward the outer periphery by rotating. The casing 16e is a cylindrical member that surrounds the disc portion 16b and the plurality of blades 16c.

[0038] As illustrated in Fig. 6, the disc portion 16b is arranged on the non-input side end surface of the motor 12 with the axial gap 16g interposed therebetween. The width W16 of the axial gap 16g may be narrower than the thickness H16 of the disc portion 16b. As illustrated in Fig. 3, in the axial direction, the blade 16c overlaps a second bearing 13e in the axial direction.

[0039] The delivery duct 16d is a cylindrical member extending from the casing 16e to the cooler 22. A lower portion 16h of the delivery duct 16d is a substantially rectangular tube-shaped portion extending upward from the upper portion of the casing 16e. An upper portion 16j of the delivery duct 16d is a portion that communicates with the lower portion of the cooler 22 from the upper portion of the lower portion 16h. The upper portion 16j has a substantially quadrangular pyramid shape with a wide upper side.

[0040] The multiblade fan 16 may overlap with at least a part of a bearing 38j that supports the rotary shaft 10a of the compressor 10 in the axial direction. In this case, the axial length of the air compression device 100 can be shortened compared to the case where the multiblade fan 16 does not overlap the bearing 38j.

[0041] The balance weight 15 will be described with reference to Figs. 8 and 9. Fig. 8 is a front view illustrating the periphery of the balance weight 15. Fig. 9 is a rear view illustrating the periphery of the balance weight 15. The balance weight 15 also functions as an intermediate member arranged between the rotor 12k and the multiblade fan 16. The balance weight 15 is a disc-shaped member made of metal such as brass, and also serves as the rotating body portion 12n of the labyrinth portion 12f as described above. The balance weight 15 includes balance adjusting units 15a and 15b, a fan fixing part 15c, a rotor fixing part 15d, a shaft fastening part 15f, and a labyrinth forming part 15e.

[0042] The fan fixing part 15c is an annular portion in which the multiblade fan 16 is fixed on the non-input side end surface. The rotor fixing part 15d is an annular portion to which the rotor 12k is fixed on the input side end surface, and in this example, has a cylindrical outer shape protruding from the outer periphery to the input side. The shaft fastening part 15f is a through hole into which the output shaft 12a is inserted and fixed.

[0043] The labyrinth forming part 15e is a portion where the labyrinth concave portion 15g and the labyrinth convex portion 15h are provided in the outer periphery of the

input side end surface. The labyrinth concave portion 15g is an annular concave portion formed on the non-input side in the labyrinth forming part 15e. The stationary body side convex portion 12u enters the labyrinth concave portion 15g through a gap. The labyrinth convex portion 15h is a portion that enters the stationary body side concave portion 12t through a gap. The labyrinth convex portion 15h in this example is an annular wall provided so as to surround the outer peripheral side of the labyrinth concave portion 15g.

[0044] The balance adjusting units 15a and 15b are portions that are subjected to processing for reducing the total unbalance amount of the balance weight 15, the rotor 12k, and the multiblade fan 16. That is, in a state where the multiblade fan 16 and the rotor 12k are fixed and integrated with the balance weight 15, the balance adjusting units 15a and 15b are subjected to balance adjustment for reducing the total unbalance amount.

[0045] The balance adjusting units 15a and 15b may be provided only on one end surface of the balance weight 15. However, in the present embodiment, the balance adjusting units 15a and 15b are provided on both end surfaces. The balance adjusting units 15a and 15b include a fan side adjusting part 15a provided on the radially inner side from the fan fixing part 15c and a rotor side adjusting part 15b provided on the radially outer side from the rotor fixing part 15d. In particular, the balance adjusting unit 15a may be provided on the radially inner side from the air flow generation part of the multiblade fan 16. In this example, the balance adjusting unit 15a is provided on the radially inner side from the plurality of blades 16c. As illustrated in Figs. 8 and 9, the balance adjusting units 15a and 15b in this example are flat annular portions in the radial intermediate region of the balance weight 15.

[0046] The compressor 10 will be described with reference to Figs. 2 and 10 to 12. These drawings illustrate the compressor 10 and the blower fan 28 as viewed from the arrow F in Fig. 2. Fig. 10 is a front view schematically illustrating the compressor 10 and the blower fan 28. Fig. 11 illustrates a state where a fixed scroll portion 10j is removed. Fig. 12 illustrates a back space 10g with an orbiting scroll portion 10h removed. The compressor 10 of the present embodiment is a scroll type air compressor which includes a rotary shaft 10a, a body portion 10b, a suction port 10c, a discharge port 10e, an air cooling fin 10f, an orbiting scroll portion 10h, a fixed scroll portion 10j, and a back space 10g.

[0047] In the compressor 10, the suction port 10c communicates with the air suction part 32, and compresses the air Ar32 sucked into the pump space 10d from the air suction part 32 through the suction pipe 32b. The valve mechanism 32d is provided between the air suction part 32 and the suction port 10c of the compressor 10. The valve mechanism 32d opens when the compressor 10 is operated and the compressor 10 side becomes negative pressure. The discharge port 10e communicates with the cooler 22, and the compressed air is discharged from the

discharge port 10e to the cooler 22.

[0048] The body portion 10b is a circumferential outer peripheral wall that defines the pump space 10d. The body portion 10b surrounds a fixed scroll 10m and an orbiting scroll 10n in the pump space 10d. The fixed scroll portion 10j includes a fixed disc portion 10k provided with a plurality of air cooling fins 10f on the outside and a fixed scroll 10m fixed inside the fixed disc portion 10k. The discharge port 10e is provided at the center of the fixed disc portion 10k. The orbiting scroll portion 10h includes an orbiting disc portion 10p and an orbiting scroll 10n fixed to the orbiting disc portion 10p. The rotary shaft 10a extending to the input side is fixed at the center of the orbiting disc portion 10p. The back space 10g is provided on the input side of the orbiting disc portion 10p, that is, on the back side of the orbiting scroll portion 10h. Cooling air is introduced from the blower fan 28 into the back space 10g, and the orbiting disc portion 10p and the rotary shaft 10a are forcibly cooled by air. The blower fan 28 will be described later.

[0049] The orbiting scroll 10n and the fixed scroll 10m are spiral bodies having the same shape. The compressor 10 compresses air when the volume of the compression space is changed by orbiting the orbiting scroll 10n integrally with the rotary shaft 10a with respect to the fixed scroll 10m. The compressor 10 sucks air from the outer periphery and performs compression toward the center. The compressor 10 may be an oil-free type.

[0050] The blower fan 28 will be described with reference to Figs. 2 and 10 to 12. The blower fan 28 is a blower mechanism that delivers cooling air (hereinafter referred to as a cooling air Ar28) to the compressor 10. The blower fan 28 supplies the cooling air Ar28 to the back space 10g on the back side of the orbiting scroll portion 10h to mainly cool the orbiting scroll portion 10h.

[0051] The blower fan 28 of the present embodiment is an electric axial flow blower having a propeller 28b. As illustrated in Fig. 12, the blower fan 28 is arranged on the side of the compressor 10 so that the rotation axis L28 of the propeller 28b is orthogonal to the rotary shaft 10a of the compressor 10. An outside air filter 28a formed of a wire mesh or the like is provided on the upstream side of the blower fan 28. A blower duct 28g for guiding the cooling air Ar28 to the central portion of the orbiting scroll portion 10h is provided on the downstream side of the blower fan 28.

[0052] The blower duct 28g has a substantially quadrangular frustum shape of which the cross-sectional area decreases toward the compressor 10. The cooling air Ar28 is throttled along the inner surface of the blower duct 28g and cools the central portion of the orbiting scroll portion 10h intensively. Since the temperature of the central portion of the orbiting scroll portion 10h is the highest, the cooling effect can be enhanced by intensively cooling the center portion. An exhaust duct 28h is provided on the downstream side of the back space 10g. In this example, the upstream side of the exhaust duct 28h faces the blower duct 28g, and the downstream side is directed

downward.

[0053] The dehumidifier 24 is provided in a path that allows the cooler 22 and the compressed air delivery part 34 to communicate with each other. The dehumidifier 24 is a hollow fiber membrane type dehumidifier that dehumidifies the cooled compressed air Ar10c. The dehumidifier 24 may include a filter element that includes a desiccant. In the dehumidifier 24, final dehumidification is performed on the compressed air Ar10d delivered from the compressed air delivery part 34. The compressed air Ar10d is delivered to the compressed air reservoir 92 via the compressed air delivery part 34.

[0054] The air introduction unit 26 introduces the compressed air Ar10d dehumidified by the dehumidifier 24 into the casing 12c of the motor 12. When the compressed air Ar10d is introduced to make the pressure inside the casing 12c a positive pressure higher than the external pressure, it is possible to reduce the intrusion of dust. The air introduction unit 26 delivers the compressed air Ar10d to the introduction port 12h provided in the bottom portion 12e. The air introduction unit 26 is provided with a valve mechanism 26d on a path for guiding the compressed air Ar10d from the dehumidifier 24 to the casing 12c. The valve mechanism 26d may be a check valve that allows the compressed air Ar10d to pass to the casing 12c side and block backflow from the casing 12c to the dehumidifier 24 when the dehumidifier 24 side is equal to or higher than a predetermined pressure.

[0055] The bearing holder 38 will be described with reference to Figs. 2 and 3. The bearing holder 38 is a portion that is provided on the input side of the compressor 10 and supports bearings 38h and 38j that rotatably support the rotary shaft 10a. The bearing holder 38 has a hollow cylindrical portion 38a and a plurality of fins 38f extending radially outward from the cylindrical portion 38a. The fin 38f has a triangular shape of which radially outer end extends radially outward as it approaches the compressor 10 in the axial direction. In this example, four fins 38f are provided at 90° intervals in the circumferential direction on the outer periphery of the cylindrical portion 38a. The bearing holder 38 also has a function of radiating heat generated in the compressor 10 to suppress an excessive temperature rise of the bearings 38h and 38j.

[0056] The bearings 38h and 38j include a first bearing 38h arranged near the compressor 10 and a second bearing 38j arranged near the motor 12. The first and second bearings 38h and 38j rotatably support the rotary shaft 10a. The first and second bearings 38h and 38j are held in the hollow portion of the cylindrical portion 38a while being separated in the axial direction.

[0057] A part of the bearing holder 38 enters the inner peripheral portion of the multiblade fan 16 in the axial direction. Further, at least a part of the bearing 38j that supports the rotary shaft 10a of the compressor 10 overlaps the multiblade fan 16 in the axial direction. In this case, the axial space can be used more effectively than the case of no overlap.

[0058] The inverter control device 40 will be described

with reference to Figs. 1 and 2. The inverter control device 40 functions as an inverter power supply device for driving and controlling the motor 12. The inverter control device 40 is protected from dust or rainwater by being stored in the storage box 42. The storage box 42 may be made of metal. The inverter control device 40 includes electronic components (all not illustrated) such as a switching power module and a smoothing capacitor for supplying a drive current to the coil 12g.

[0059] Since these electronic components self-heat during operation, the inner temperature of the storage box 42 increases. When the inner temperature of the box becomes high, the lifetime of these electronic components is shortened, and may cause failure. In the present embodiment, the storage box 42 is provided on the path of the suction air Ar32 between the air suction part 32 and the suction port 10c of the compressor 10. In this example, the storage box 42 is provided between the air suction part 32 and the valve mechanism 32d. That is, part or all of the suction air Ar32 passes through the storage box 42 and is delivered to the compressor 10 side. As the suction air Ar32 passes through the storage box 42, the inside of the box is forcibly ventilated, and the electronic components of the inverter control device 40 are air-cooled. In this case, the rise of the inner temperature of the storage box 42 is suppressed, and the lifetime of the electronic component is extended.

[0060] The housing case 36 houses the compressor 10, the compressor driving part 14, the multiblade fan 16, the cooler 22, the dehumidifier 24, the air introduction unit 26, the blower fan 28, the air suction part 32, the compressed air delivery part 34, and the storage box 42 of the inverter control device 40.

[0061] The outline of one aspect of the present invention is as follows. The air compression device 100 according to one aspect of the present invention includes: the compressor 10 that generates compressed air; the motor 12 that drives the compressor 10; the multiblade fan 16 that is driven by the motor 12 to generate an air flow; and the first cooler 18 that cools the compressed air and the second cooler 20 that cools the compressed air cooled by the first cooler 18 by the air flow. The first cooler 18 cools the compressed air by an air flow that has cooled the second cooler 20.

[0062] According to this aspect, by providing the first cooler 18, the second cooler 20 can be reduced in size and weight. Further, by providing the first cooler 18, the input air temperature of the second cooler 20 is lowered, so that the thermal stress of the second cooler 20 is relieved.

[0063] Further, the first cooler 18 can effectively use the exhaust air after cooling the second cooler 20. In addition, since the temperature difference between the cooling target air and the cooling air in the first cooler 18 is small, the thermal stress in the second cooler 20 is relieved. Further, since the temperature difference between the cooling target air and the cooling air in the second cooler 20 is large, the efficiency of heat exchange

can be improved.

[0064] The multiblade fan 16 may be arranged between the motor 12 and the compressor 10. In this case, when the multiblade fan 16 is provided on the side opposite to the compressor 10, it is necessary to provide protrusions on both the front and rear sides of the motor 12 shaft. Since the protrusions are reduced, it is possible to reduce the intrusion of dust into the motor 12 from the gaps of the protrusions.

[0065] The first and second coolers 18 and 20 may be arranged in a direction orthogonal to the rotation axis of the multiblade fan 16. In this case, the flow path of the air flow from the multiblade fan 16 to the first and second coolers 18 and 20 is shortened, and the efficiency of the multiblade fan 16 is improved. The air flow path can be simplified.

[0066] The first cooler 18 may be integrally arranged on the opposite side of the second cooler 20 from the multiblade fan 16. In this case, by arranging the first cooler 18 and the second cooler 20 integrally, a heat-resistant connecting hose that connects the two can be shortened or omitted.

[0067] The air flow described above may flow around the first and second coolers 18 and 20 arranged integrally in a direction orthogonal to the rotation axis of the fan. In this case, the flow path of the air flow is shortened, the flow resistance is reduced, and the efficiency of the multiblade fan 16 is improved. The air flow path can be simplified.

[0068] The air compression device 100 is an air compression device for a railway vehicle mounted under the floor of the railway vehicle 90, and the multiblade fan 16 may deliver an air flow in a direction orthogonal to the traveling direction of the railway vehicle 90. In this case, compressed air can be used in the vehicle 90. Further, since the air flow is delivered in the orthogonal direction, the flow velocity fluctuation of the air flow due to the acceleration/deceleration of the vehicle 90 can be reduced. Further, when the vehicle 90 travels, it is possible to reduce dust flying from the traveling direction and entering the first and second coolers 18 and 20.

The above is the description of the first embodiment.

[0069] A second embodiment of the present invention is also an air compression device. The air compression device 100 includes: a front-stage cooler and a rear-stage cooler that sequentially cools compressed air generated by the compressor 10. The front-stage cooler includes a cooler that cools the compressed air by an air flow that has cooled the rear-stage cooler. For example, the front-stage cooler may be the first cooler 18, and the rear-stage cooler may be the second cooler 20. The cooled compressed air may be cooled by the air flow generated by the multiblade fan 16.

[0070] According to the second embodiment, the same operations and effects as in the first embodiment are achieved.

[0071] In the above, the example of embodiment of this invention was described in detail. Each of the above-

described embodiments is merely a specific example for carrying out the present invention. The contents of the embodiments do not limit the technical scope of the present invention, and many design changes such as changes, additions, and deletions of constituent elements are possible without departing from the spirit of the invention defined in the claims. In the above-described embodiments, the contents that allow such a design change have been described with the notation of "of embodiment", "in the embodiment", or the like. However, design changes are not unacceptable for content without such notation.

[0072] Hereinafter, modifications will be described. In the drawings and descriptions of the modifications, the same reference numerals are given to the same or equivalent components and members as those in the embodiment. The description overlapping with the embodiment will be omitted as appropriate, and the configuration different from the first embodiment will be mainly described.

[0073] With reference to Fig. 13, an air compression device 200 according to a first modification will be described. This modification is different from the embodiment in that a supercharger 210 is provided at the suction port of the compressor 10 and is the same in the other configuration. Thus, the supercharger 210 will be described mainly. Fig. 13 is a front view illustrating the periphery of the compressor 10 and corresponds to Fig. 10.

[0074] In the scroll compressor, since the outer periphery has a negative pressure, it is easy to suck dust due to a pressure difference between the outside and the inside. In order to reduce the intrusion of dust, the compressor 10 is provided with a face seal (not illustrated) that seals the outer peripheral surface. However, the face seal has a gap called a joint portion, and dust enters through this gap. For this reason, in this modification, the supercharger 210 is provided at the suction port 10c of the compressor 10.

[0075] The supercharger 210 is not particularly limited as long as the supercharger can increase the internal pressure of the compressor 10. The supercharger 210 of this modification has an impeller 210b that is rotated by a motor 210m. The supercharger 210 pressurizes the upstream air, makes the downstream air equal to or higher than the atmospheric pressure, and supplies the air to the suction port 10c of the compressor 10. The supercharger 210 is provided in the path between the valve mechanism 32d and the suction port 10c. By providing the supercharger 210, it is possible to increase the internal pressure in the vicinity of the suction port 10c of the compressor 10, that is, the outer periphery of the compressor 10, and to suppress the intrusion of dust due to negative pressure.

[0076] In the description of the embodiment, the coolers 18 and 20 are heat exchangers that bring the cooling air into contact with the pipe through which the cooling target air flows. However, the invention is not limited to this. The cooler may be based on another principle. For example, the cooler may be structured to contact the

cooling air with cooling fins provided on the pipe, may be structured to contact the cooling air with two metal plates sandwiching the cooling target air, or may be structured to use a double pipe.

[0077] In the description of the embodiment, an example is described in which the output shaft 12a of the motor 12 is integrated with the rotary shaft 10a of the compressor 10, but the invention is not limited to this. For example, the output shaft of the motor may be separated from the rotary shaft of the compressor and connected by a coupling or the like.

[0078] In the description of the embodiment, the motor 12 is described which does not include a bearing and in which the stator and the rotor are built in the compressor. However, the invention is not limited to this. For example, the motor may be a non-built-in structure in which a bearing, a rotor, and a stator are integrated in a motor case.

[0079] In the description of the embodiment, an example is described in which the motor 12 is a surface magnet type DC brushless motor, but the invention is not limited to this. The motor may be any motor as long as the motor can drive the compressor. For example, the motor may be another type of motor such as a magnet-embedded motor, an AC motor, a brushed motor, or a geared motor.

[0080] In the description of the embodiment, an example is described in which the compressor 10 is a scroll type, but the invention is not limited to this. The compressor may be any compressor as long as the compressor can generate compressed air. For example, the compressor may be another type of air compressor such as a screw type or a reciprocating type.

[0081] In the description of the embodiment, an example is described in which the rotating body portion 12n of the labyrinth portion 12f also serves as the balance weight 15. However, the invention is not limited to this. The rotating body portion of the labyrinth portion may be provided separately from the balance weight.

[0082] In the description of the embodiment, an example is described in which the valve mechanism 26d is a check valve, but the invention is not limited to this. For example, the valve mechanism 26d may be a secondary pressure adjusting valve (pressure reducing valve) capable of adjusting the pressure on the secondary side.

[0083] The above-described modification has the same operations and effects as those of the first embodiment.

[0084] Any combination of the above-described embodiments and modifications is also useful as an embodiment of the present invention. The new embodiment made by the combination has the effects of the combined embodiment and modifications.

Claims

1. An air compression device (100) comprising:

a compressor (10) that generates compressed

air;

a motor (12) that drives the compressor;

a fan (16) that is driven by the motor to generate an air flow; and

a first cooler (8) that cools the compressed air and a second cooler (20) that cools the compressed air cooled by the first cooler by the air flow, wherein

the first cooler cools the compressed air by an air flow that has cooled the second cooler.

2. The air compression device according to claim 1, wherein the fan is arranged between the motor and the compressor.

3. The air compression device according to claim 1 or 2, wherein the first and second coolers are arranged in a direction orthogonal to a rotation axis of the fan.

4. The air compression device according to claim 3, wherein the first cooler is integrally arranged on a side of the second cooler opposite to the fan.

5. The air compression device according to claim 4, wherein the air flow flows around the first and second coolers arranged integrally in a direction orthogonal to the rotation axis of the fan.

6. An air compression device comprising:

a front-stage cooler (18) and a rear-stage cooler (20) that sequentially cools compressed air generated by a compressor, wherein the front-stage cooler includes a cooler that cools the compressed air by an air flow that has cooled the rear-stage cooler.

FIG.1

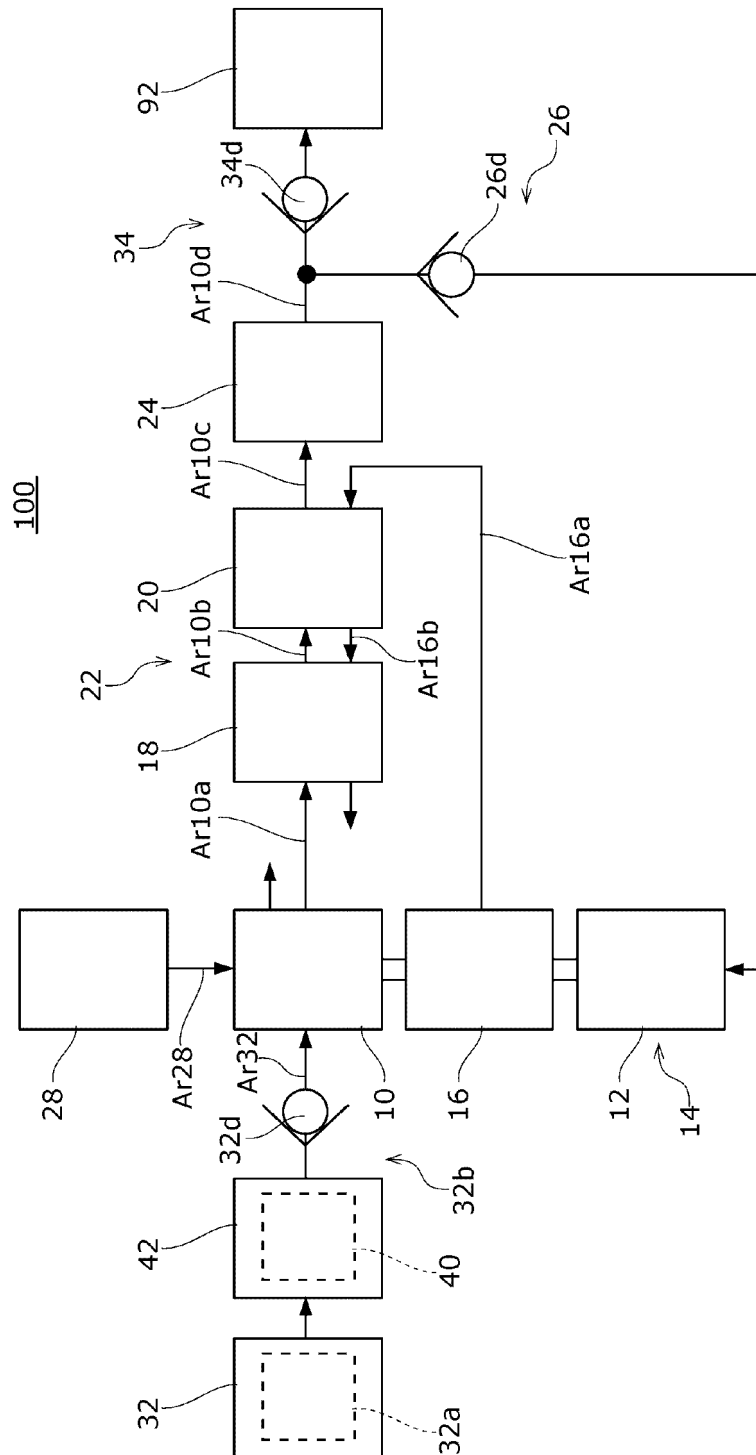


FIG.2

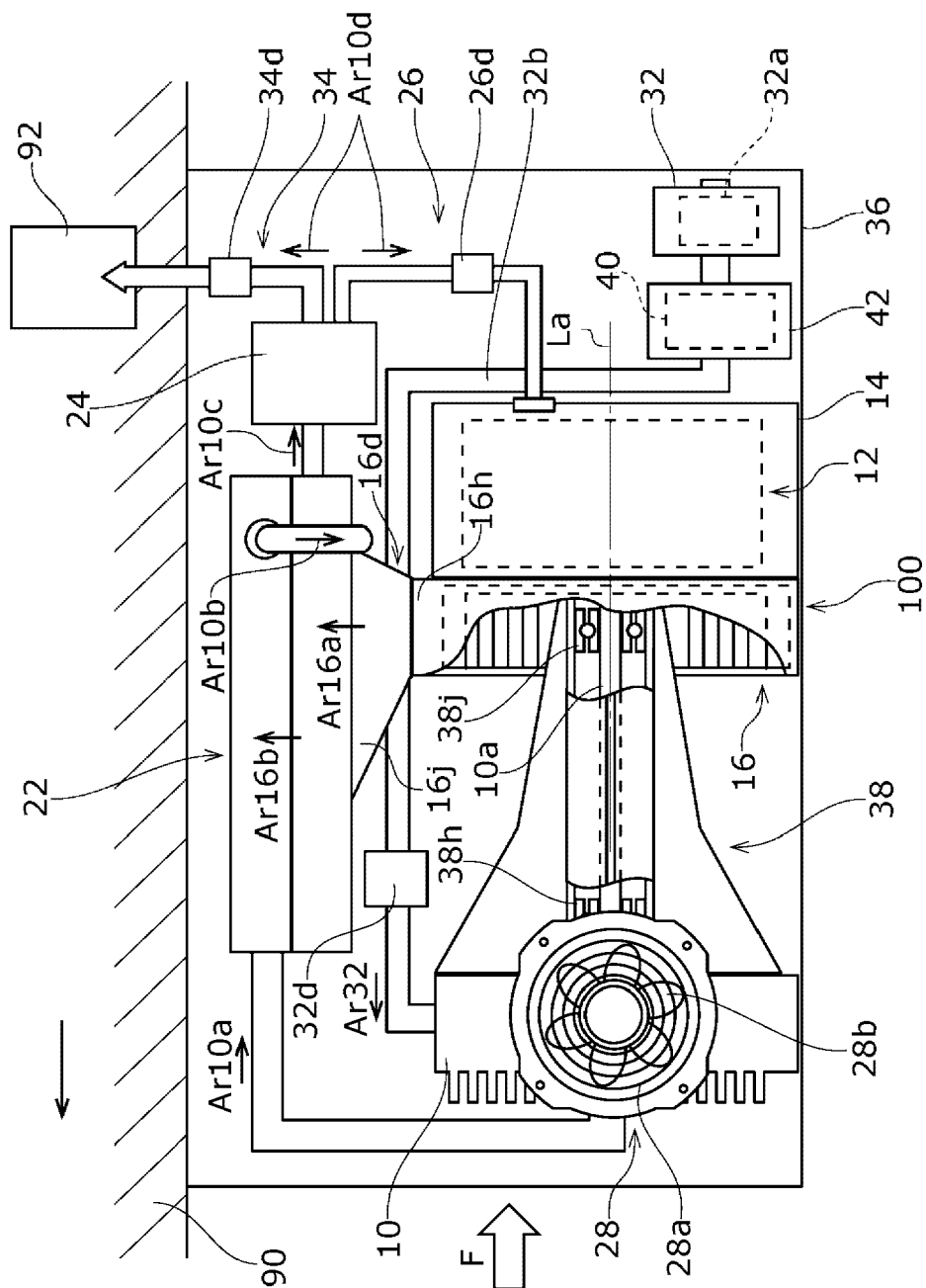


FIG.3

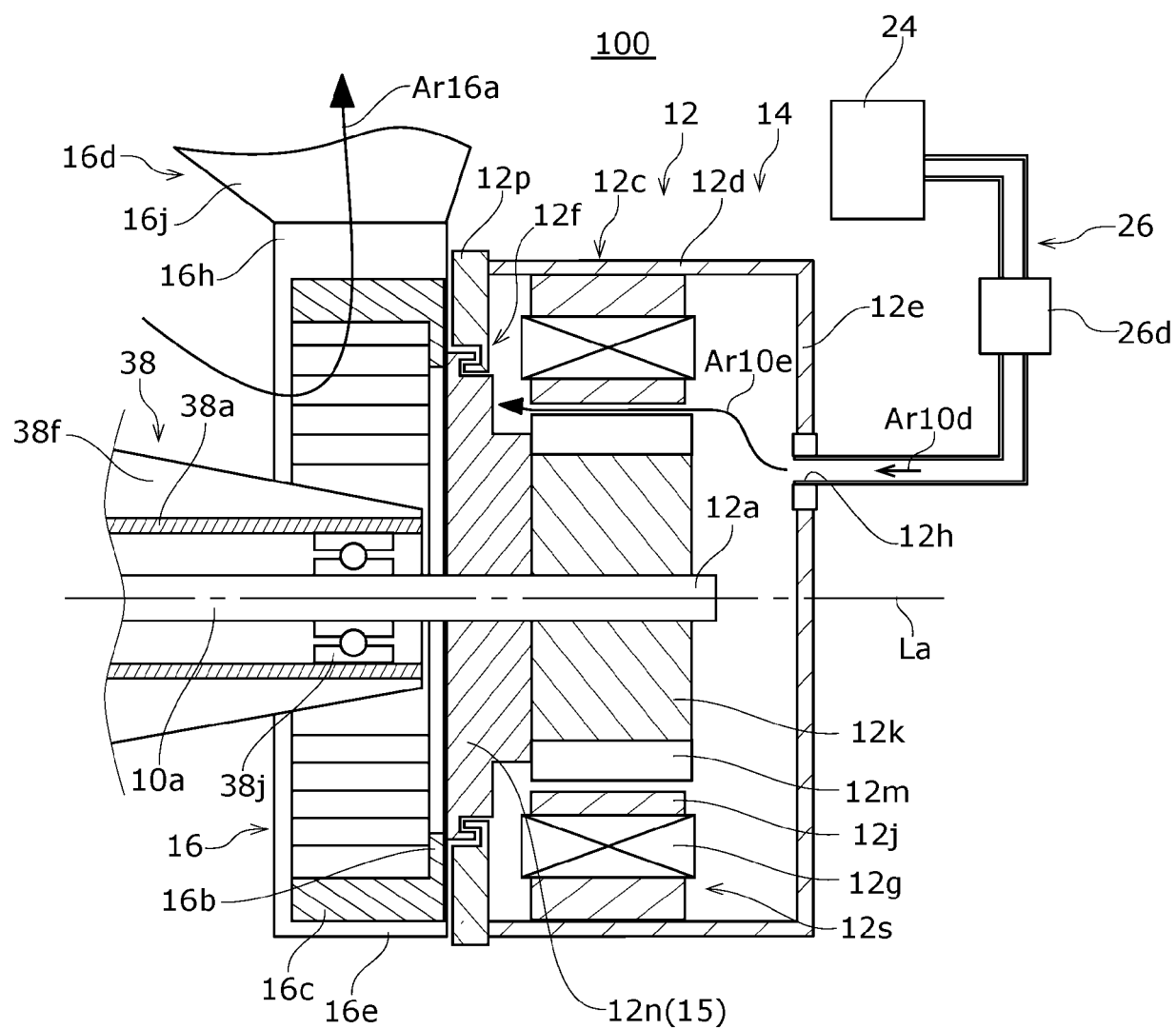


FIG.4

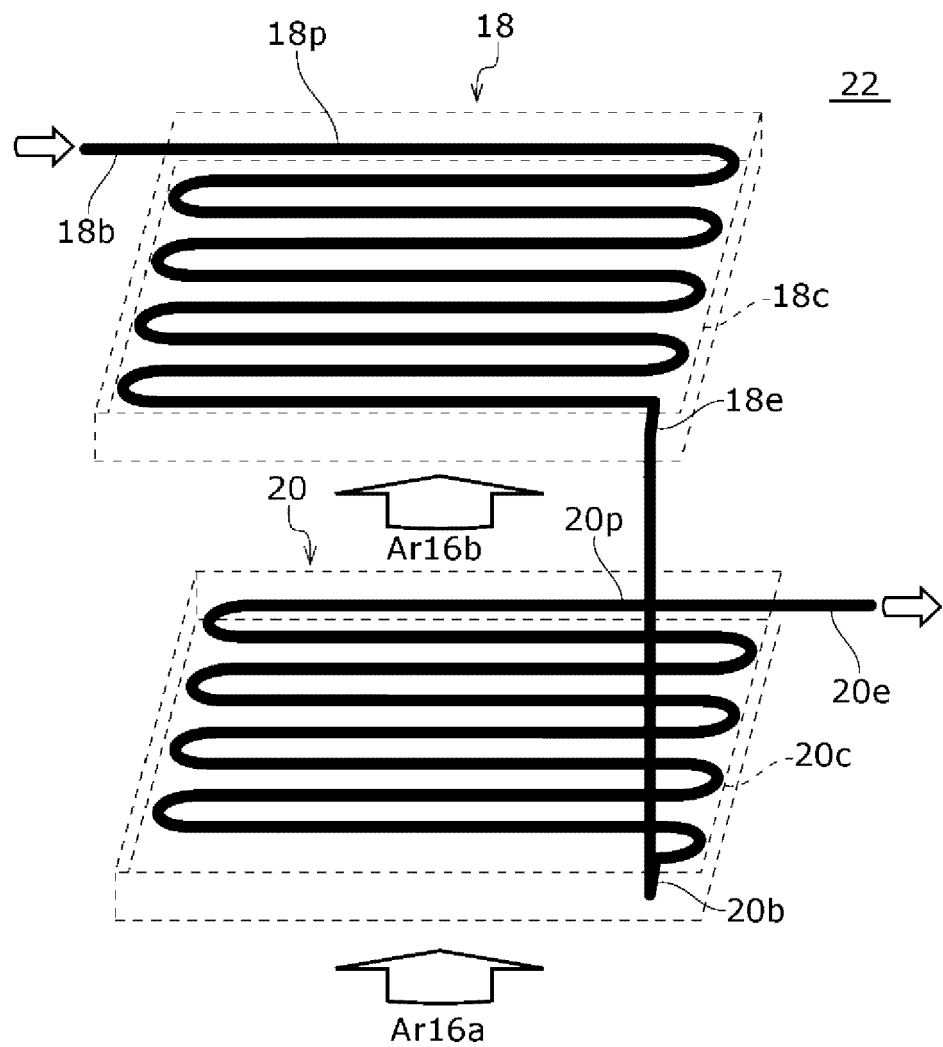


FIG.5

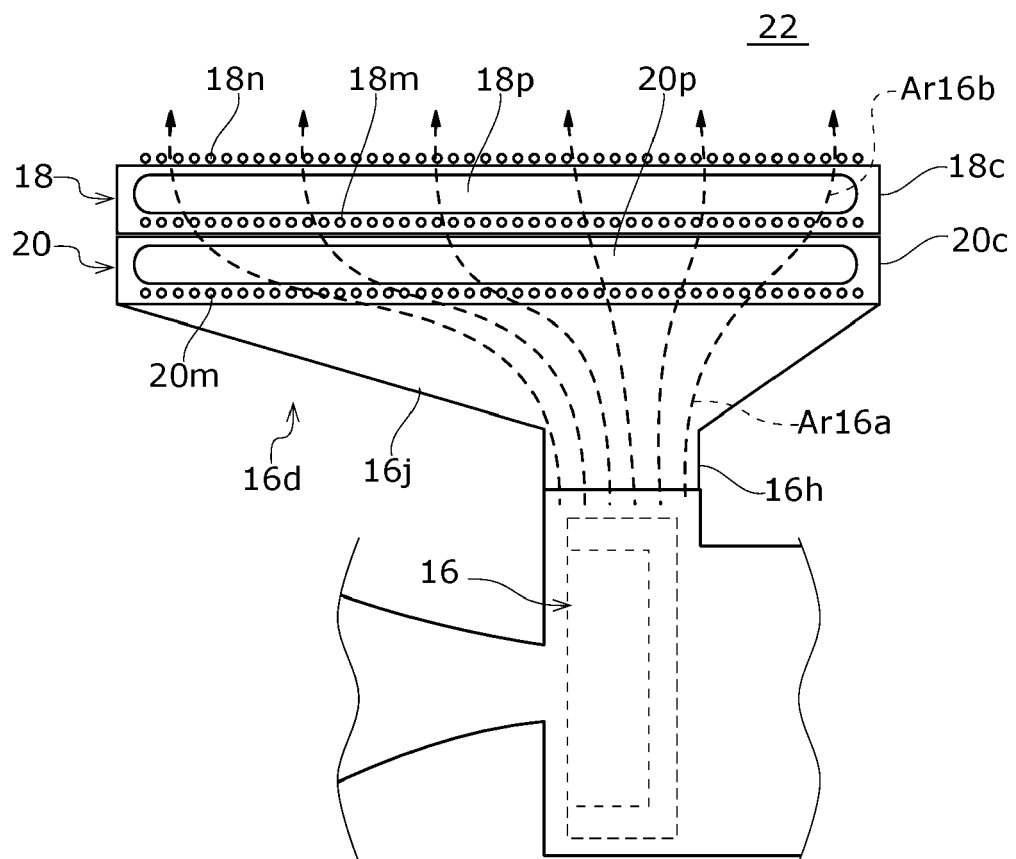


FIG.6

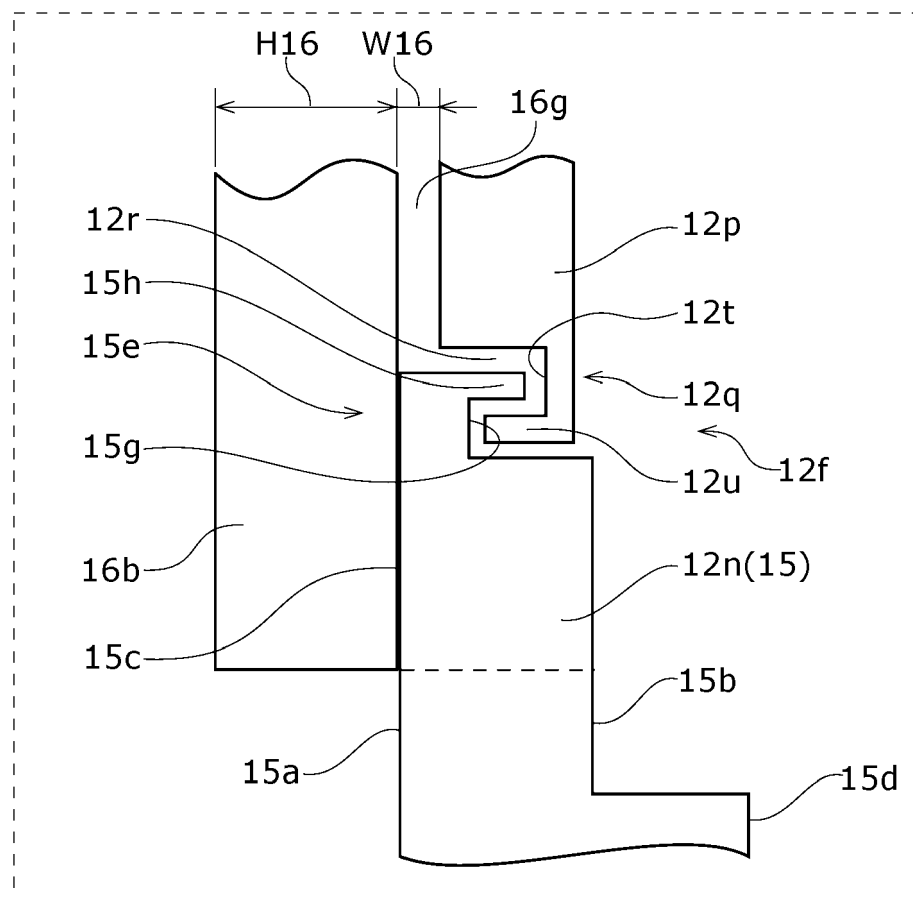


FIG.7

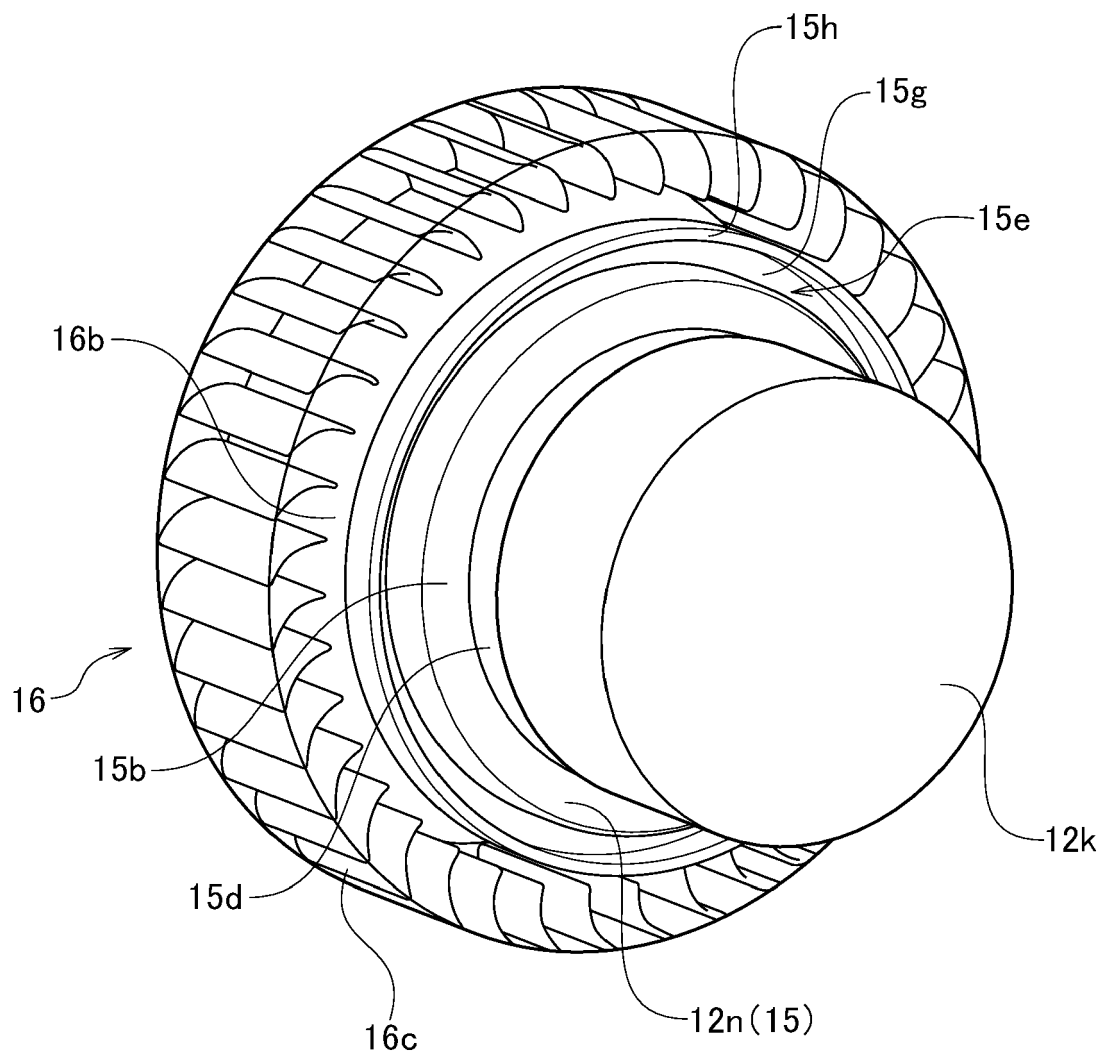


FIG.8

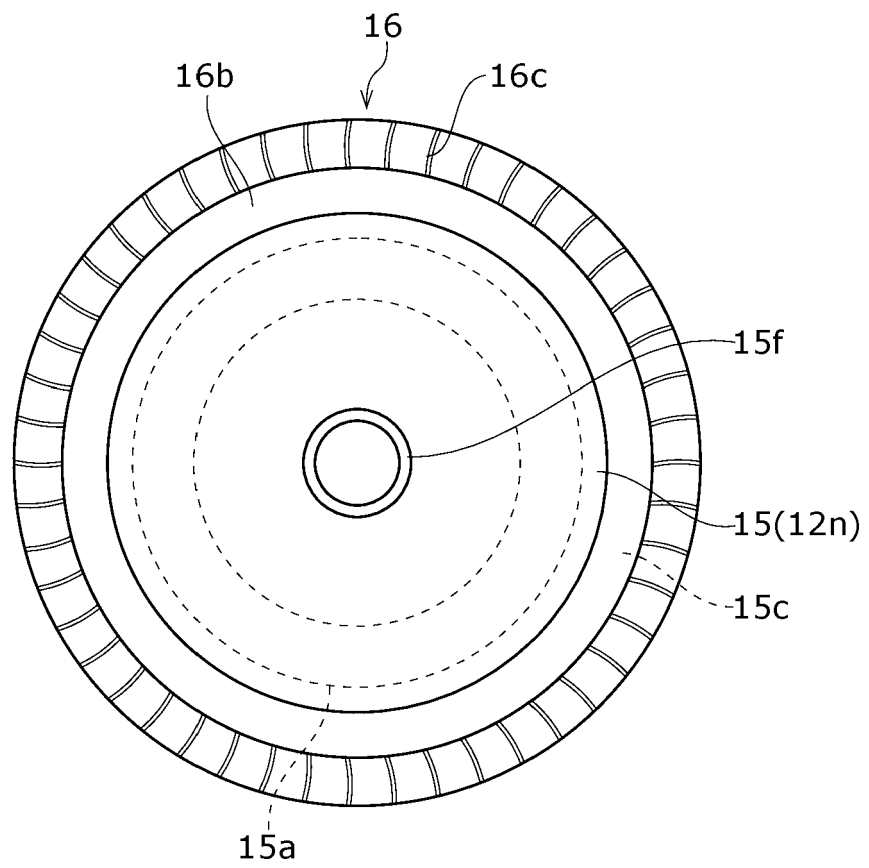


FIG.9

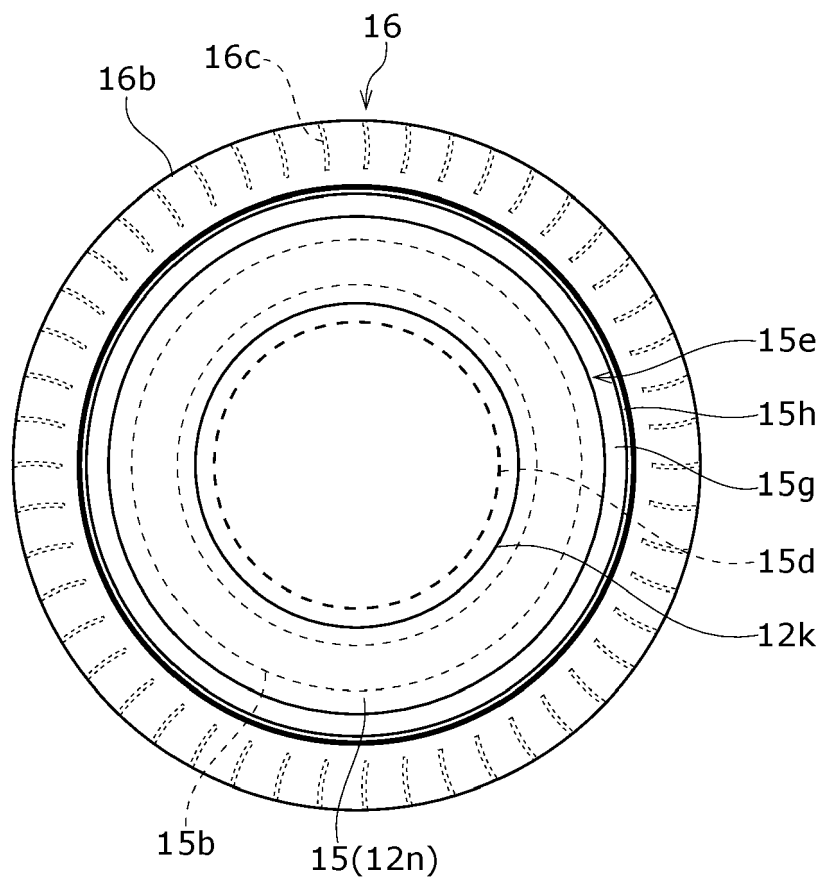


FIG.10

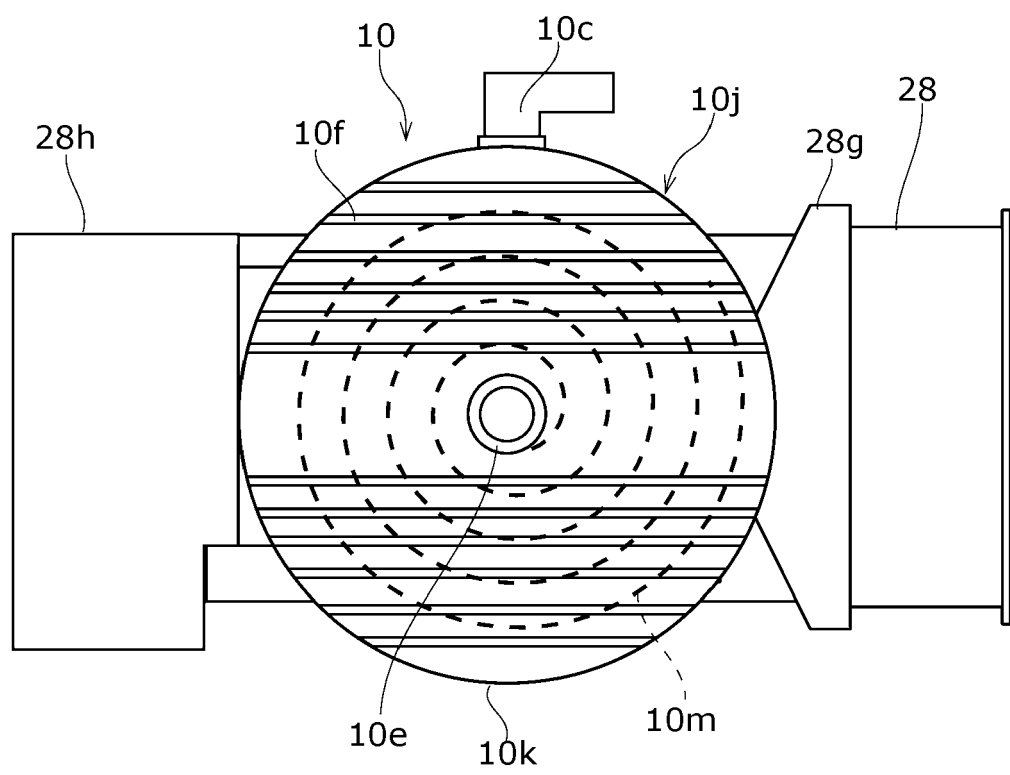


FIG.11

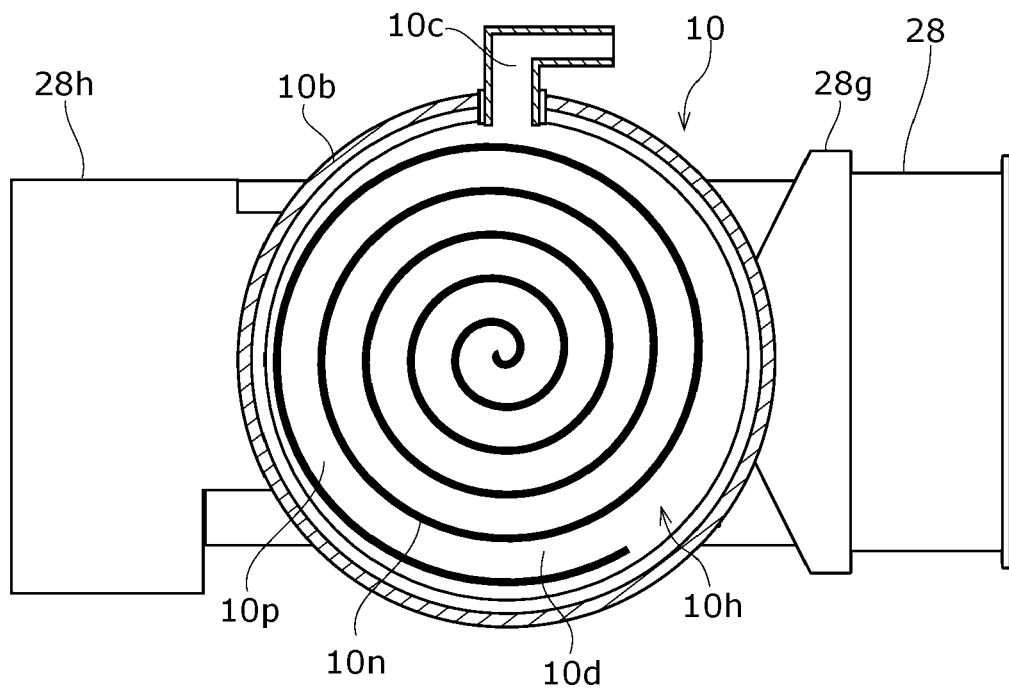


FIG.12

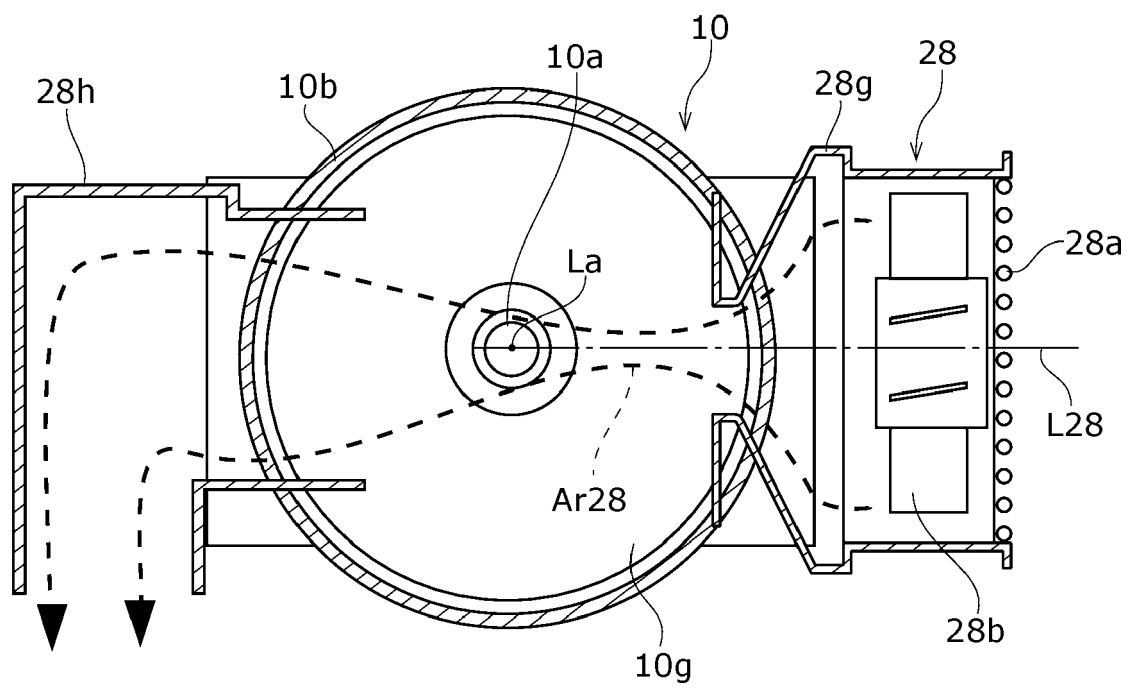
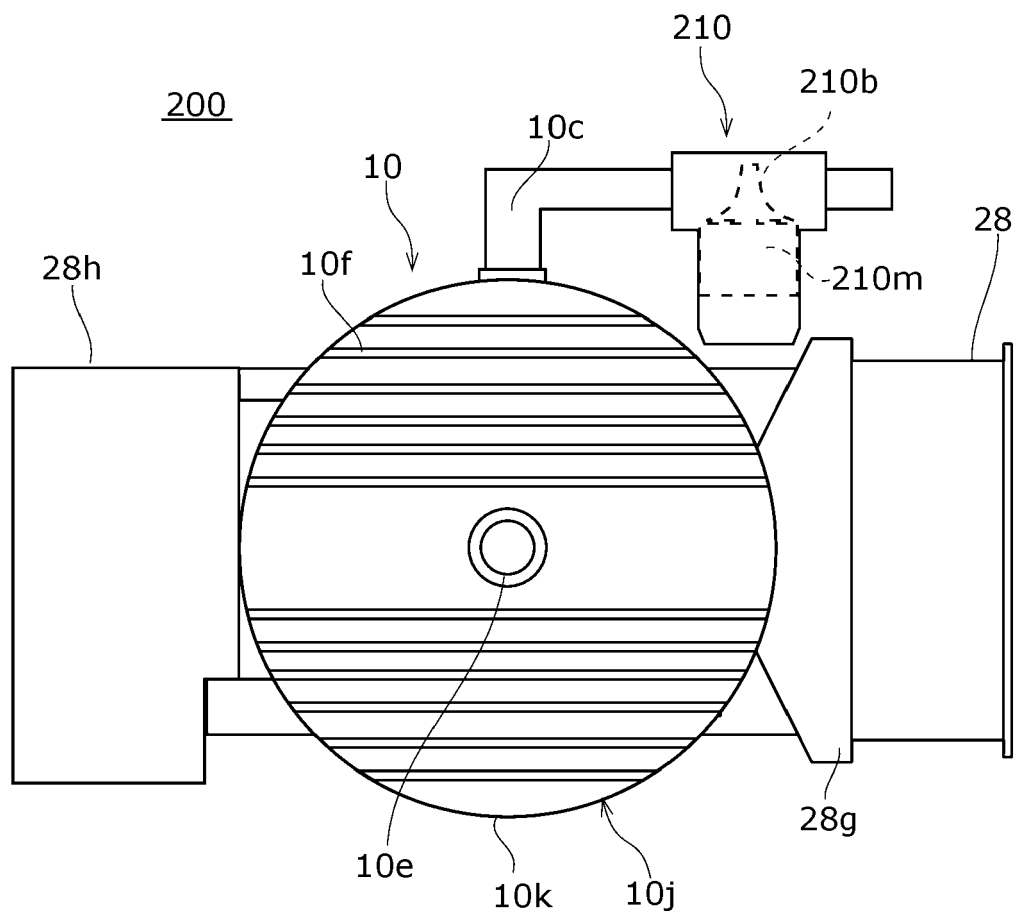


FIG.13





EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 June 2020	Examiner Alquezar Getan, M
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