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(71) Applicant: **Kawakami, Isamu**
Goutsu-shi, Shimane 695-0156 (JP)

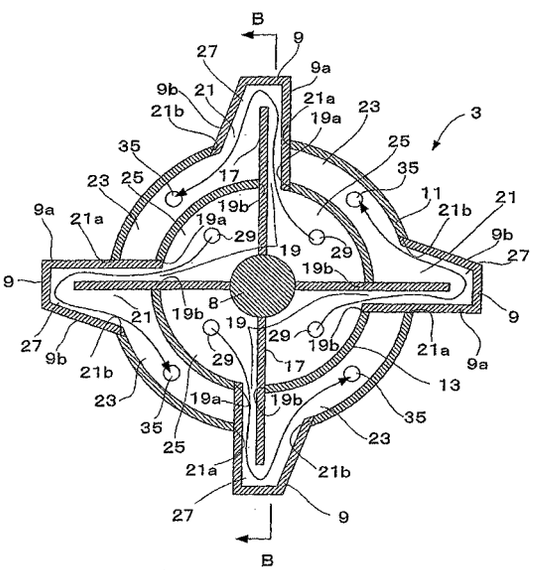
(72) Inventor: **Kawakami, Isamu**
Goutsu-shi, Shimane 695-0156 (JP)

(74) Representative:
Lepeudry-Gautherat, Thérèse (FR) et al
Cabinet Lepeudry
43, rue de la Brèche aux Loups
75012 Paris (FR)

(54) FAN DEVICE

(57) A fan apparatus 1, which comprises a main body 3 having a dual tube composed of an outer tube 11 and an inner tube 13 and being rotatably supported by supporting members 7, and vanes 9 protruding from the outer surface of the outer tube 11 in the outward radial direction, the fan apparatus 1 being provided with inlet holes 29 to draw cooling air into the main body 3 and outlet holes 35 to discharge the cooling air to the outside, wherein the outer tube 11 has outer slits 21 formed in the outer surface thereof so as to communicate with the inside of the vanes 9, the inner tube 13 has inner slits 19 in positions such that each inner slit corresponds to each outer slit 21 in the outer surface thereof, and the cooling air that is sent into the inner tube 13 is supplied inside the vanes 9 through the inner slits 19 and the outer slits 21, and after passing through the space between the outer tube 11 and the inner tube 13, the air is discharged from the outlet holes 35.

Fig. 2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a fan apparatus used for cooling a high-temperature chamber, such as in a tunnel kiln, a single kiln or the like.

BACKGROUND OF THE INVENTION

[0002] A kiln used in the ceramics industry for obtaining calcined products, including roof tiles, pottery and the like, comprises an inlet line communicatably opened to the outside. The inlet line is provided with a fan.apparatus to draw outside air of room temperature into a kiln furnace to cool the calcined products baked using a burner or the like.

[0003] In a kiln having such a structure, the temperature inside the kiln furnace reaches 900°C to 1250°C. On the other hand, the cooling air drawn into the kiln furnace is room temperature, resulting in a drawback as described below. Specifically, since the temperature of the cooling air is extremely low compared to that inside the kiln furnace, a slight change in the flow rate of the inlet air leads to an abrupt change in the temperature inside the kiln furnace, thus it is difficult to maintain the temperature inside the kiln furnace within a predetermined range. In some cases, this results in calcined products that are cooled below the predetermined temperature and causes cracks to appear in the calcined products. In order to resolve the above drawback, it is preferable that the temperature of the cooling air be kept relatively high, i.e., 500°C to 750°C. However, there has been no known fan apparatus which has satisfactory heat resistance against such high-temperature air.

[0004] An object of the present invention is to provide a fan apparatus having excellent heat resistance.

DISCLOSURE OF THE INVENTION

[0005] To achieve the above object, according to the present invention, a fan apparatus comprises a rotatably supported main body having a dual tube composed of an outer tube and an inner tube, and vanes protruding from the outer surface of the outer tube in an outward radial direction. The fan apparatus is provided with inlet holes to draw cooling air into the main body and outlet holes to discharge the drawn cooling air to the outside. The outer tube is provided with outer openings in the outer surface formed in a manner so as to communicate with the inside of the vanes. The inner tube is provided with inner openings in the outer surface in positions such that each inner opening corresponds to each outer opening. The fan apparatus is structured such that after the cooling air that is sent into the inner tube through the inlet holes is supplied inside the vanes through the inner openings and the outer openings, the cooling air passes through a space between the outer tube and the inner tube, and is discharged to the outside through the outlet holes.

[0006] It is preferable that the fan apparatus further comprise a guiding member to guide the air supplied inside the vanes to flow along the inner surface of the vanes.

[0007] It is more preferable that the fan apparatus further comprise at least one radiating member disposed on the surface of the main body somewhere between at least one end of the main body and one of the vanes, a cover to cover the heat radiating member or members, and a cooling unit to supply a cooling medium inside the cover.

[0008] It is also preferable that air-cooling fins be provided on at least one of the inner surfaces of the outer tube, the inner tube and the vane.

[0009] It is particularly preferable that a first induction board spirally extending in the axial direction be arranged in the inner tube and a second induction board spirally extending in the axial direction be arranged in the space between the outer tube and the inner tube, and, by rotating the first and the second induction boards in a manner united with the main body, the air inside the inner tube be guided to the center of the inner tube along the axial direction and the air in the space between the outer tube and the inner tube be guided to the end portions of the outer tube along the axial direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a perspective view showing a fan apparatus according to a first embodiment of the present invention.

Fig. 2 is a cross-sectional view of Fig. 1 taken in the direction of the arrows along the line A-A.

Fig. 3 is a cross-sectional view of Fig. 2 taken in the direction of the arrows along the line B-B.

Fig. 4 is a cross-sectional view showing another example of a fan apparatus according to the first embodiment.

Fig. 5 is a cross-sectional view showing a fan apparatus according to a second embodiment of the present invention.

Fig. 6 is a cross-sectional view showing another example of a main body and a vane of a fan apparatus according to the present invention.

Fig. 7 is a cross-sectional view showing another example of a casing of a fan apparatus according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011] A first embodiment in which a fan apparatus of the invention is applied to a single kiln for use in the ceramics industry will be described below in more detail

with reference to Figs. 1 to 3. Fig. 1 is a perspective view showing the fan apparatus of the present invention. Fig. 2 is a cross-sectional view of Fig. 1 taken in the direction of the arrows along the line A-A. Fig. 3 is a cross-sectional view of Fig. 2 taken in the direction of the arrows along the line B-B. In these figures, the airflow is shown by the arrows with thin lines.

[0012] In a single kiln, the fan apparatus of the present embodiment is disposed in an inlet line which makes the air inside a kiln furnace communicate with the outside air. The fan apparatus serves to draw air into the kiln furnace for quenching the calcined products. In this embodiment, it is preferable that the air drawn into the kiln furnace to quench the calcined products have a temperature within the range of 500°C to 750°C. This is because, in the single kiln, the temperature inside the kiln furnace during the calcining process reaches as high as 900°C to 1250°C, and when air of room temperature, for example, which is considerably colder than the air inside the kiln furnace, is drawn into the kiln furnace, the abrupt change in the temperature may cause cracks to appear in the calcined products.

[0013] The fan apparatus is made of a material having high heat resistance, such as stainless steel or the like. As shown in Fig. 1, the fan apparatus comprises a main body 3 having supporting members 7 attached to its ends, a driving axis 8 united with the main body 3 while penetrating through the main body 3 and having its ends projected, and four vanes 9 mounted on the outer surface of the main body 3. As described below, a portion of the main body 3 that includes the vanes 9 is disposed in a casing 10 (shown by dotted lines in the figure) and outside air drawn into the casing 10 is sent out of the casing 10 by the fan apparatus 1.

[0014] The fan apparatus 1 is structured so that the length of the main body 3 is about 2.5 m and the height of the vanes 9 is about 0.4 m. The above described supporting members 7 are rotatably fitted to ball bearings 5 provided in an inlet line (not shown) and the fan apparatus 1 is rotated by a motor (not shown) mounted on the driving axis 8.

[0015] As shown in Fig. 2, the main body 3 is composed of a dual tube comprising an outer tube 11 and an inner tube 13 both having a tubular shape, with the ends of the inner tube 13 protruding from the outer tube 11. The vanes 9, which have substantially U-shaped cross-sections, are attached at 90-degree intervals to the outer surface of the outer tube 11. The driving axis 8 is slotted in the center of the inner tube 13, and four plate-shaped separators (guiding members) 17 are attached to the driving axis 8 radially in positions such that each separator corresponds to one of the vanes 9.

[0016] Four inner slits (inner openings) 19 extending in the axial direction are provided on the outer surface of the inner tube 13 every 90 degrees. Similarly, on the outer surface of the outer tube 11, four outer slits (outer openings) 21 extending in the axial direction are formed in positions corresponding to the inner slits 19. By attaching edge portions 19a and 21a of the inner slits 19 and the corresponding outer slits 21 to 9a of the vanes 9, the annular space formed between the outer tube 11 and the inner tube 13 is partitioned into four outer tube passages 23. The end portions 9b of the other side of the vanes 9 are attached to edge portions 21b of the outer slits 21, and therefore the outer slits 21 are completely covered by the vanes 9.

[0017] The separators 17 extend to inside the vanes 9 through the inner slits 19 and the outer slits 21. To one side of the separators 17, the periphery portions 19b of the inner slits 19 are attached. Thus, the inside of the inner tube 13 is partitioned into four inner tube passages 25. In each vane 9, a vane passage 27 communicating with the inner tube passage 25 and the outer tube passage 23 is formed to make the cooling air described later to flow therein. The cooling air is guided by the separator 17 extending in the vane passage 27 so as to flow along the inner surface of the vane 9. As described above, in the present embodiment, the inner tube passage 25, the vane passage 27 and the outer tube passage 23 are communicated to each other so that the cooling air passes trough them.

[0018] As shown in Fig. 3, in each of the supporting members 7 fixed to both ends of the inner tube 13, four inlet holes 29 are formed in the position corresponding to one of the inner tube passages 25 and an air compressor (not shown) is connected to the supporting member 7 having a rotary joint 31 in between. The cooling air pumped by the air compressor is introduced into each inner tube passage 25 through the inlet holes 29.

[0019] As shown in the figure, to both ends of the outer tube 11, covering members 33 are mounted to cover both ends of the annular space. In these covering members 33, four outlet holes 35 are formed such that the position of each one corresponds to one of the outer tube passages 23 to discharge the air inside the outer tube 11 outside.

[0020] As shown in Figs. 1 and 3, the casing 10 is structured so as to have an inside diameter slightly greater than the largest outer diameter of the fan apparatus 1 and a tubular shape slightly shorter than the outer tube 11, and, in both ends of the casing 10, holes 37 are formed by projections of the ends of the outer tube 11. In the outer surface of the casing 10, between the end portion of the vane 9 and the end portion of the outer tube 11, a pair of inlet ports 38 are formed to draw in outside air. Between the pair of inlet ports 38, a ventilation port 39 is formed to send the air inside the casing 10 out. In addition, on the inside surface of the casing 10, between the inlet port 38 and the ventilation port 39, an annular partition 40 having a slightly greater inside diameter than the outer diameter of the outer tube 11 is formed. The air drawn through the inlet port 38 is introduced toward the vane 9 through the space between the outer tube 11 and the partition 40, and then sent out of the casing 10 through the ventilation port 39 using the rotation of the vanes 9.

[0021] The operation of the fan apparatus 1 having the above-described structure will be explained below. Upon completion of the calcining process for obtaining calcined products, as shown in Fig. 1, the calcined products are quenched by sending the air drawn into the casing 10 into the kiln furnace by rotary driving the main body 3 with a motor. During this process, the airflow drawn into the kiln furnace can be controlled by regulating the motor speed.

[0022] If the air compressor described above is turned on at the same time, air is sent into the inner tube passages 25 from both sides of the main body 3 through the supporting members 7. As shown in Fig. 2, the air flows in an outward radial direction from the inner tube passage 25 through the inner slits 19 and is guided into the vane passages 27 by the separators 17. The air drawn into the vane passages 27 flows along the inner surfaces of the vanes 9 while being guided by the separators 17. Thereby, the vanes 9 are directly cooled from inside. As shown in Fig. 3, the air passed through the vane passages 27 cools the outer tube 11 while passing thorough the outer tube passages 23, and then is discharged from the fan apparatus 1 through the outlet holes 35.

[0023] As described above, the fan apparatus 1 according to the present embodiment allows the main body 3 and the vanes 9 of the fan apparatus 1, which are used under a high temperature, to be directly cooled, since the cooling air is pumped into the main body 3 from the air compressor and drawn into the vane passages 27 and the outer tube passages 23 through the inner tube passages 25. As a result, the heat resistance of the fan apparatus 1 can be greatly improved. This improved heat resistance prevents a decrease in the strength of the fan apparatus when used under a high temperature and enables the fan apparatus 1 to be rotated at high speed. This makes it possible to send a sufficient volume of air into the kiln furnace.

[0024] Specifically, according to the fan apparatus 1 of the present embodiment, the effect for cooling the vanes 9 can be greatly improved owing to the above-mentioned distinctive structure. In other words, in the inner tube 13, a plurality of inner slits 19 extending in the axial direction are formed such that the position of each one corresponds to one of the vanes 9. Thereby, the cooling air drawn in the axial direction from both ends of the inner tube 13 can be sent outward in a radial direction through the inner slits 19. As a result, it is possible to reliably send the air in the direction of each vane 9. Furthermore, the air sent through the inner slits 19 is led into the vane passages 27 by the separators 17 and guided so as to flow along the inner surfaces of the vanes 9. Therefore, the entire surface of the vanes 9 can be sufficiently cooled from inside by the air. Here, for example, air of room temperature can be used as the cooling air.

[0025] According to the present embodiment, the cooling air is circulated in the main body 3 and inside the vanes 9 by feeding the cooling air under pressure using the air compressor; however, for example, by arranging the inner tube 13 and the outer tube 11 as described below, a large volume of cooling air can be circulated.

[0026] As shown in Fig. 4, inside the inner tube 13, a pair of first screw boards (first induction boards) 34 fixed to the driving axis 8 are arranged on both sides of the separator 17 in a manner such that they extend from one end of the inner tube 13 to one end of the separator 17. The two first screw boards 34 have helix directions opposite to each other, and their outer edges are fixed to the inner surface of the inner tube 13. Therefore, if the main body 3 rotates in a predetermined direction, the first screw boards 34 also rotate as a unit with it. Accordingly, it generates airflow directed from both ends of the inner tube 13 to the separator 17. Thereby, the air fed into the inner tube 13 from the air compressor is guided in the direction of the separator 17, and a large volume of cooling air is reliably sent in the vane passage 27.

[0027] In the annular space formed between the inner tube 13 and the outer tube 11, similar to inside the inner tube 13, a pair of second screw boards (second induction boards) 36 are formed in a manner such that they have helix directions opposite to each other. The second screw boards 36 are fixed to the outer surface of the inner tube 13 and their outer edge is attached to the inner surface of the outer tube 11. Each of the .second screw boards 36 has a helix direction opposite to that of the first screw board 34 provided in the inner tube 13 located inside the outer tube 11. Therefore, if the second screw boards 36 rotate in a predetermined direction together with the main body 3, airflow is generated in a direction opposite to that in the inner tube 13, i.e., from the separator 17 to both ends of the outer tube 11. The air passed through the vane passages 27 and the outer tube passages 23 is guided to both ends of the outer tube 11 and a large volume of cooling air is reliably released from outlet holes 35.

[0028] Thus, by providing the first and the second screw boards 34 and 36 in the inner tube 13 and the space between the outer tube 11 and the inner tube 13, respectively, it is possible to draw a large volume of cooling air into the main body 3 and inside the vanes 9. As a result, the cooling ability of the fan apparatus 1 can be greatly improved.

[0029] In the first embodiment, only the main body 3 and the vanes 9 are cooled by the cooling air; however, heat in the main body 3 may be conducted to the bearing 5, the rotary joint 31 and the motor through the supporting .members 7 and the driving axis 8. In order to prevent this, heat resistance of the entire fan apparatus should be further improved by providing a cooling device as described below. A second embodiment according to the present invention will be explained below with reference to Fig. 5. Fig. 5 is a cross-sectional view of a fan apparatus of the second embodiment. In this

figure, the airflow is shown by the arrows with thin lines as described above, and the flow of the cooling water described below is shown by the arrows with bold lines.

[0030] The second embodiment is different from the above-described first embodiment in that it is equipped with a cooling device. In other respects, the second embodiment has the same structure as in the first embodiment, and therefore those elements that are identical to the elements of the first embodiment are identified with the same numerical symbols, and repetitious explanation will be omitted.

[0031] As shown in Fig. 5, the fan apparatus 51 according to the second embodiment is provided with cooling devices 53 on both ends of the main body 3 to release the heat conducted in the direction from the main body 3 toward the supporting members 7. These cooling devices 53 each comprise a heat radiating member 55 disposed between the inner tube 13 and the supporting member 7, a cover 57 covering the heat radiating member 55, and a pump 59 and a tank 60 circulating the cooling water (cooling medium) to be supplied inside the cover 57. Here, the pump 59 and the tank 60 in the present embodiment serve as the cooling unit of the present invention.

[0032] The heat radiating members 55 each comprise a connecting member 61 connecting the end portion of the inner tube 13 with the supporting member 7, and air-cooling fins 63 composed of doughnut-shaped disks fixed to the connecting member 61. The heat radiating effect can be improved by increasing the surface area of the heat radiating member 55 by providing the air-cooling fins 63. In the connecting member 61, communicating holes 58 connecting the inlet holes 29 in the supporting member 7 with the inner tube 13 are formed such that the position of each one corresponds to one of the inlet holes 29.

[0033] The cover 57 is formed in a tubular shape and structured so as to cover the bearing 5 and the heat radiating member 55, with one end portion thereof being attached to the outer surface of the bearing 5. In the upper portion of the cover 57, a supply hole 57a is formed to receive the cooling water sent from the pump. In the lower portion thereof, a discharge hole 57b is formed to discharge the cooling water to the outside. The cooling water drained through the discharge hole 57b is first sent back to the tank 60 and is then fed into the cover 57 again by the pump 59.

[0034] The operation of the fan apparatus 51 having the above-described structure will be described below. When the motor and the air compressor are turned on, the driving axis 8, the supporting members 7, the heat radiating members 55 and the main body 3 are rotated in a united manner and the sending of ventilation air into the kiln furnace is initiated. The air pumped from the air compressor is drawn into the inner tube passages 25 of the inner tube 13 through the supporting members 7 and the connecting members 61, and thereby the main body 3 and the vanes 9 are cooled. On the other hand, in the cooling device 53, the cooling water pumped from the pump 59 is fed into the cover 57 and cools the connecting members 61 and the air-cooling fins 63. Here, the air-cooling fins 63 rotate with the main body 3 in a united manner, and the cooling water is thereby evenly discharged to the air-cooling fins 63, enhancing the heat radiating effect.

[0035] As described above, an effect similar to that of the first embodiment can be obtained by the present embodiment. In addition, both ends of the main body 3 are cooled by the cooling devices 53 and this prevents heat from being conducted from the main body 3 to the bearing 5 and the rotary joint 31a. As a result, deformation of the bearings 5 and the rotary joints 31, and a malfunction of the motor can be prevented. If the bearings 5 were to be deformed, the rotational accuracy of the fan apparatus 51 would be lowered. This could make it impossible to supply an appropriate amount of air or cause a malfunction. Therefore, providing the cooling device 53 of the present embodiment is especially advantageous.

[0036] In the present embodiment, each of the heat radiating members 55 is disposed between the supporting member 7 and the inner tube 13; however, for example, the heat radiating member 55 can be united with the supporting member 7 in a manner such that a portion of the supporting member 7 functions as a heat radiating member to directly cool the supporting member 7. It is also possible to obtain the same effect described above by disposing the heat radiating members 55 on the surface of the main body 3 somewhere between the vanes 9 and the ends of the main body 3, for example, on some portion of the inner tube 13 protruding from the outer tube 11. The air-cooling fins 63 in the heat radiating member 55 are not essential and can be provided, if necessary, depending on the heat radiating capability required. Furthermore, according to the present embodiment, the cooling water is circulated between the pump 59 and the heat radiating member 55; however, it can be structured such that the cooling water is not circulated but simply ejected toward the heat radiating member 55. However, from a viewpoint of the effective use of water, the structure of the present embodiment is preferable in which the cooling water is collected by the pump. Alternately, air can be used instead of water as a cooling medium.

[0037] It is to be understood that the scope of the present invention is not limited to the embodiments described above and various changes and modifications may be made to the invention without departing from the spirit and scope thereof. For example, as shown in Fig. 6, air-cooling fins 71 can be arranged on the inner surfaces of the outer tube 11, the inner tube 13 and the vanes 9 to cool the fan apparatus with enhanced efficiency. Such an arrangement can increase the surface area of the outer tube passages 23, the inner tube passages 25 and the vane passages 27 and enhance the heat radiating effect thereof, resulting in further im-

proved heat resistance of the fan apparatus. Note also that, it is not absolutely necessary to provide the air-cooling fins 71 in all of the passages 23, 25 and 27 described above, and they can be disposed on the inner surfaces of only one or two of the passages.

[0038] It is also possible to have a structure in which not only the fan apparatus 1 but also the casing 10 is cooled. For example, as shown in Fig. 7, the casing 10 is formed as a dual tube comprising an outer tube 81 and an inner tube 83, and, in the outer surface of the outer tube 81, an inlet hole 85 and a discharge hole 87 are formed, wherein the inlet hole 85 draws in the cooling air from outside and the discharge hole 87 discharges the used cooling air to the outside. This arrangement allows the cooling air to circulate between the outer tube 81 and the inner tube 83, and the casing 10 is thereby made cool. As shown in the enlarged view of the figure, it is also possible to provide air-cooling fins 89 on the inner surface of the outer tube 81 and the outer surface of the inner tube 83. This arrangement enhances the heat radiating effect, and the casing 10 is thereby made cool in a more efficient manner.

[0039] In the above embodiments, four each of the inner tube passages 25, outer tube passages 23 and vanes 9 are provided. However, the number of inner tube passages 25, outer tube passages 23 and vanes 9 is not limited to four and can be selected depending on the operating conditions of the fan apparatus. Furthermore, the shapes of the outer tube 11 and the inner tube 13 are not limited to tubular shapes, and they can have polygonal cross-sections. In addition, the length of the main body 3 and the height of the vanes 9 are not limited within the range described above, and can be selected depending on the performance required in the fan apparatus. It is also possible to make the outer tube 11 and the inner tube 13 have the same length.

[0040] In the above embodiments, both ends of the fan apparatus 1 are rotatably supported; however, it is also possible to build it in a manner such that only one of the ends is supported or the cooling air is drawn in from one end thereof. In this case, the cooling device is mounted on only that end.

[0041] In the above embodiments, the inner and outer openings are formed out of the slits extending in the axial direction. However, it is also possible, for example, to arrange a plurality of holes in a line along the axial direction. Furthermore, the screw boards 34 and 36 disposed in the main body 3 are not limited to the ones described above and their lengths and shapes, etc., can be selected depending on the specifications of the fan apparatus.

[0042] In addition, the structure of the casing 10 is not limited to the above embodiments, and the shape and dimensions of the casing, the positions and dimensions of the inlet ports, the ventilation ports and the partitions are selected depending on the size and required specifications of the fan apparatus.

[0043] In the above embodiments, the fan apparatus of the present invention is applied to a single kiln for use in the ceramics industry; however, its usage is not limited to this. For example, the fan apparatus can be applied to a tunnel kiln in which a cart carrying products to be calcined is made to pass through a preheating zone, a calcining zone, a quenching zone and a cooling zone to obtain the calcined products. In this case, the fan apparatus can be disposed in the inlet line, which introduces the cooling air into the quenching zone. The fan apparatus can be applied not only to the above kilns but also to any high-temperature chambers including heat treatment furnaces, heating furnaces or like industrial furnaces, which are used under high temperatures or which carry gases of high temperature.

[0044] As described above, in the fan apparatus according to the present invention, the cooling air drawn into the inner tube passes through the inside of the vanes and the outer tube, and then is discharged from the main body. Therefore, the air directly cools the vanes and the main body of the fan apparatus, which is used under high temperatures. As a result, the heat resistance of the fan apparatus can be greatly improved. Furthermore, the improved heat resistance can prevent a decrease in the strength of the fan apparatus under high temperatures. Therefore, the fan apparatus can be rotated at high speed and generate sufficient airflow.

[0045] In the present invention, the cooling effect of the vanes can be greatly improved by having the structure as described below. Specifically, the inner openings are formed in the outer surface of the inner tube in positions such that each inner opening corresponds to one of the vanes, and the air introduced into the inner tube along the axial direction can thereby be discharged outward in a radial direction through the inner openings. As a result, the air drawn into the inner tube can be reliably sent in the direction of the vanes. Furthermore, the air sent from the inner tube is guided by guiding members so as to flow along the inner surfaces of the vanes, and therefore the entire surface of the vanes can be adequately cooled from the inside.

[0046] If the fan apparatus is structured in a manner such that a heat radiating member is provided on the surface of the main body somewhere between at least one of the ends of the main body and the vanes, and such that a cooling medium is supplied to the heat radiating member, it is possible to prevent the heat of the main body from being conducted outward in a radial direction.

Claims

1. A fan apparatus comprising:

a rotatably supported main body having a dual tube composed of an outer tube and an inner tube; and

vanes protruding from the outer surface of the outer tube in an outward radial direction,

the main body being provided with inlet holes to draw cooling air into the main body and outlet holes to discharge the drawn cooling air to the outside,

the outer tube being provided with outer openings in the outer surface thereof formed in a manner so as to communicate with the inside of the vanes,

the inner tube being provided with inner openings in the outer surface thereof in positions such that each inner opening corresponds to each outer opening,

the fan apparatus being structured such that after the cooling air that is sent into the inner tube through the inlet holes is supplied inside the vanes through the inner openings and the outer openings, the cooling air passes through a space between the outer tube and the inner tube and is discharged to the outside through the outlet holes.

2. The fan apparatus according to claim 1, which further comprises a guiding member to guide the air supplied inside the vanes to flow along the inner surface of the vanes.

3. The fan apparatus according to claim 1, which further comprises at least one heat radiating member disposed on the surface of the main body somewhere between at least one end of the main body and one of the vanes, a cover to cover the heat radiating member or members, and a cooling unit to supply a cooling medium inside the cover.

4. The fan apparatus according to claim 1, wherein air-cooling fins are provided on at least one of the inner surfaces of the outer tube, the inner tube and the vane.

5. The fan apparatus according to claim 1, which further comprises a first induction board spirally extending in the axial direction in the inner tube and a second induction board spirally extending in the axial direction in the space between the outer tube and the inner tube,
being structured such that, by rotating the first and the second induction boards in a manner united with the main body, the air inside the inner tube is guided to the center of the inner tube along the axial direction and the air in the space between the outer tube and the inner tube is guided to the end portions of the outer tube along the axial direction.

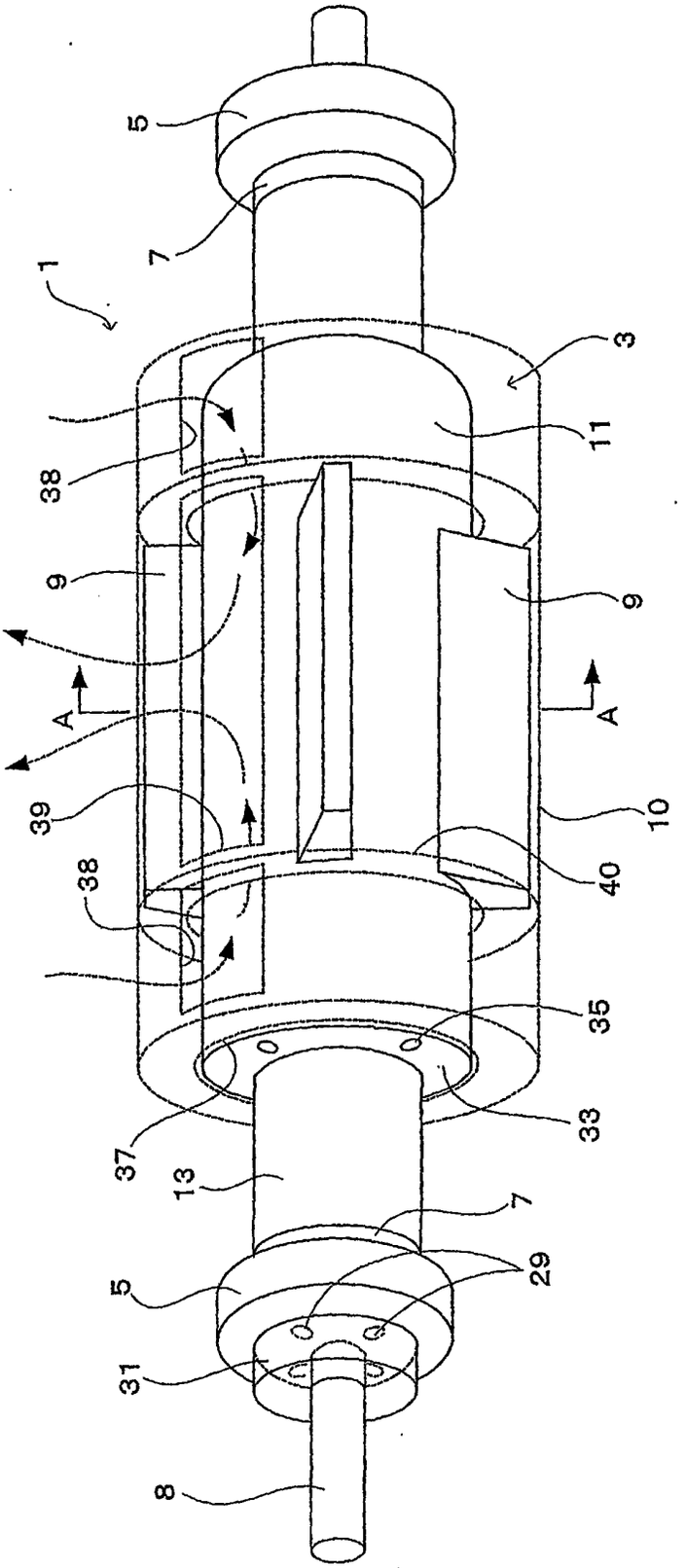
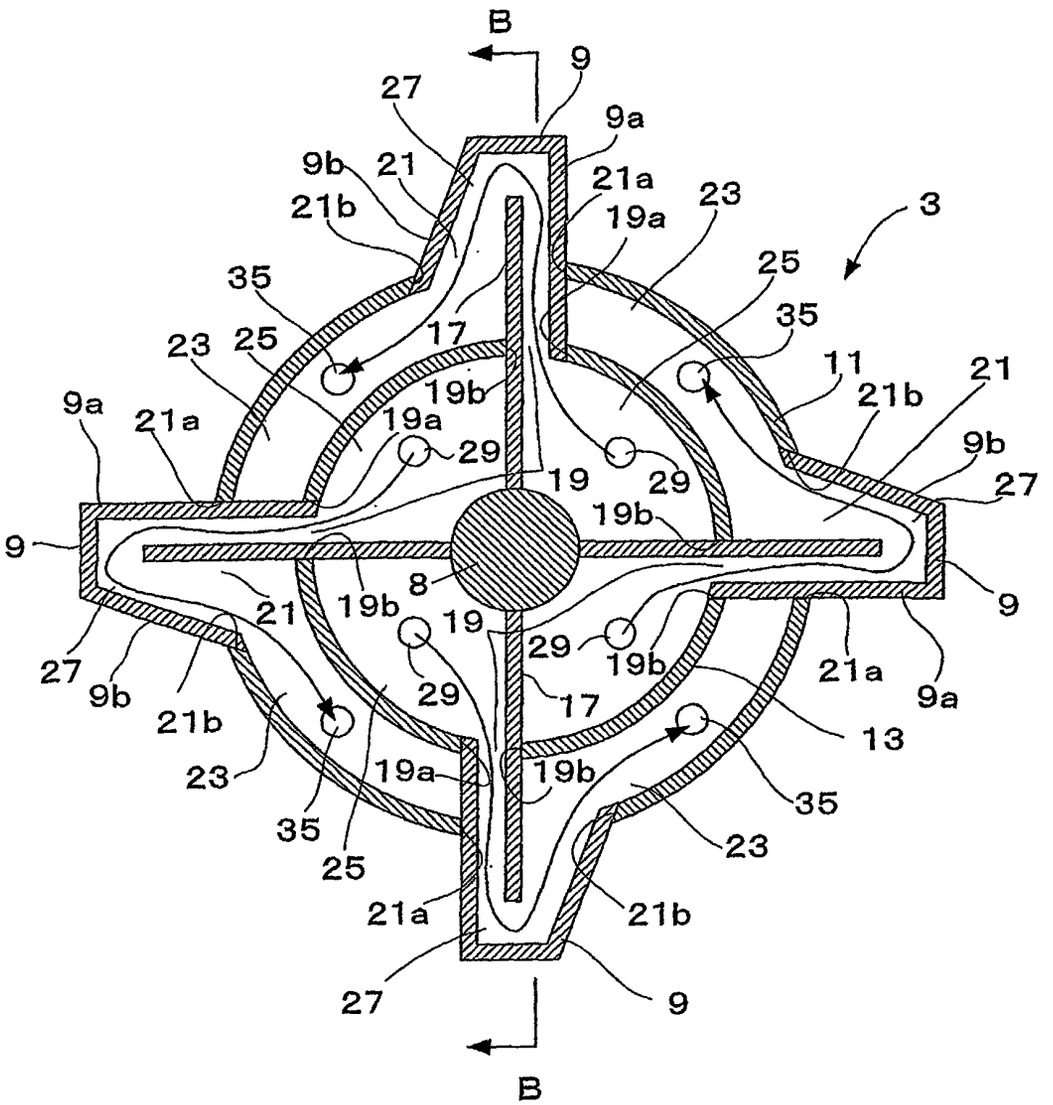


Fig. 1

Fig. 2



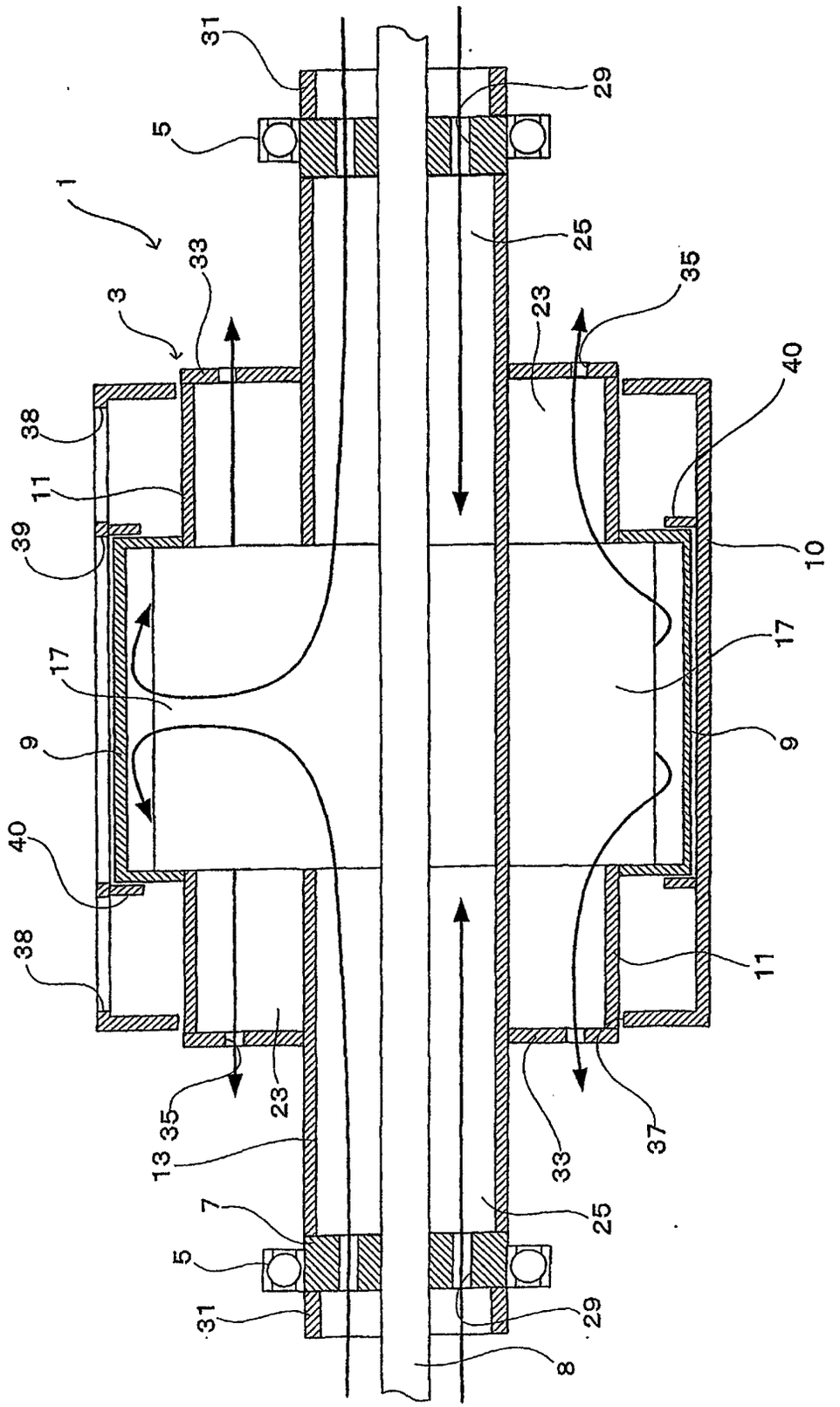

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Fig. 3

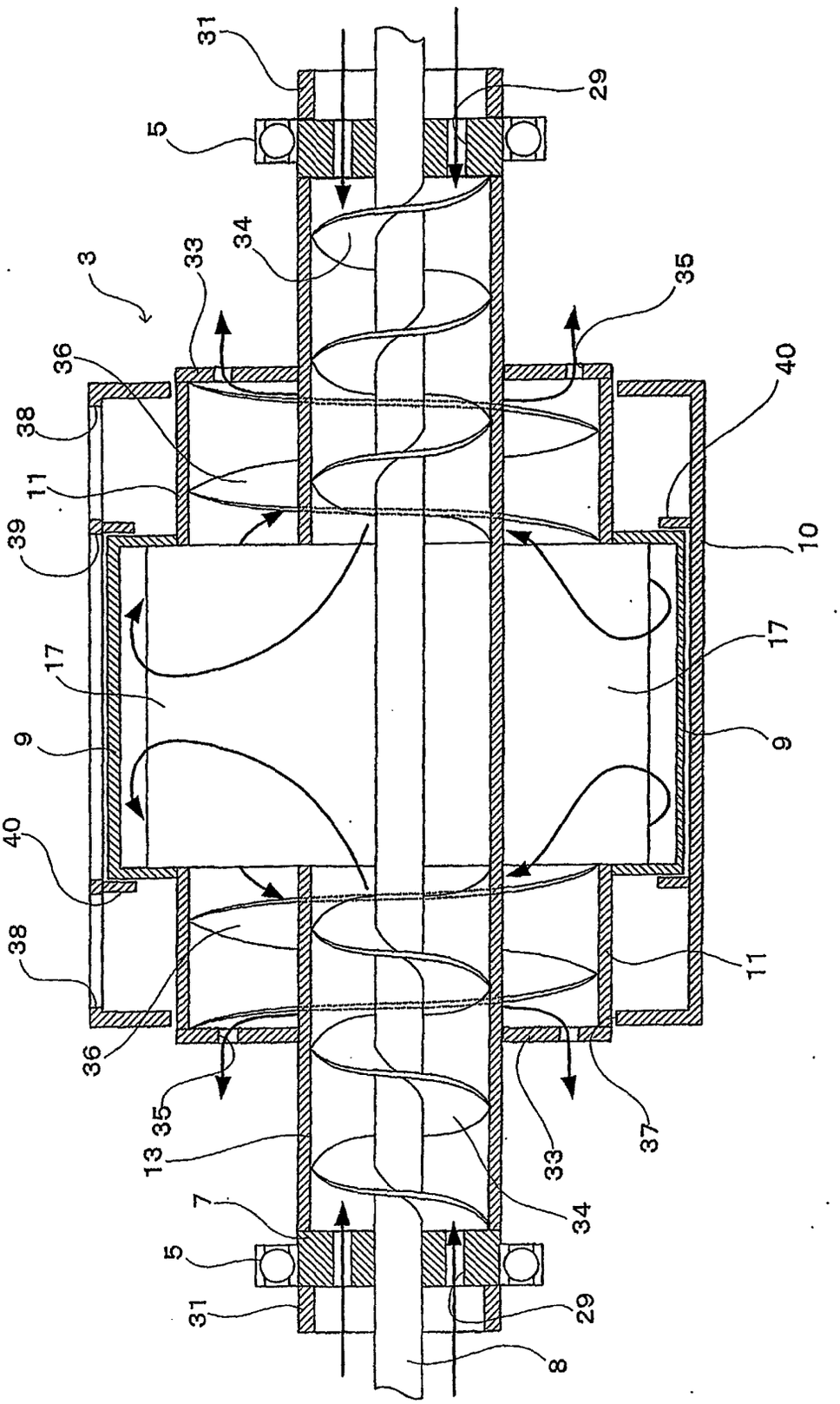
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Fig. 4

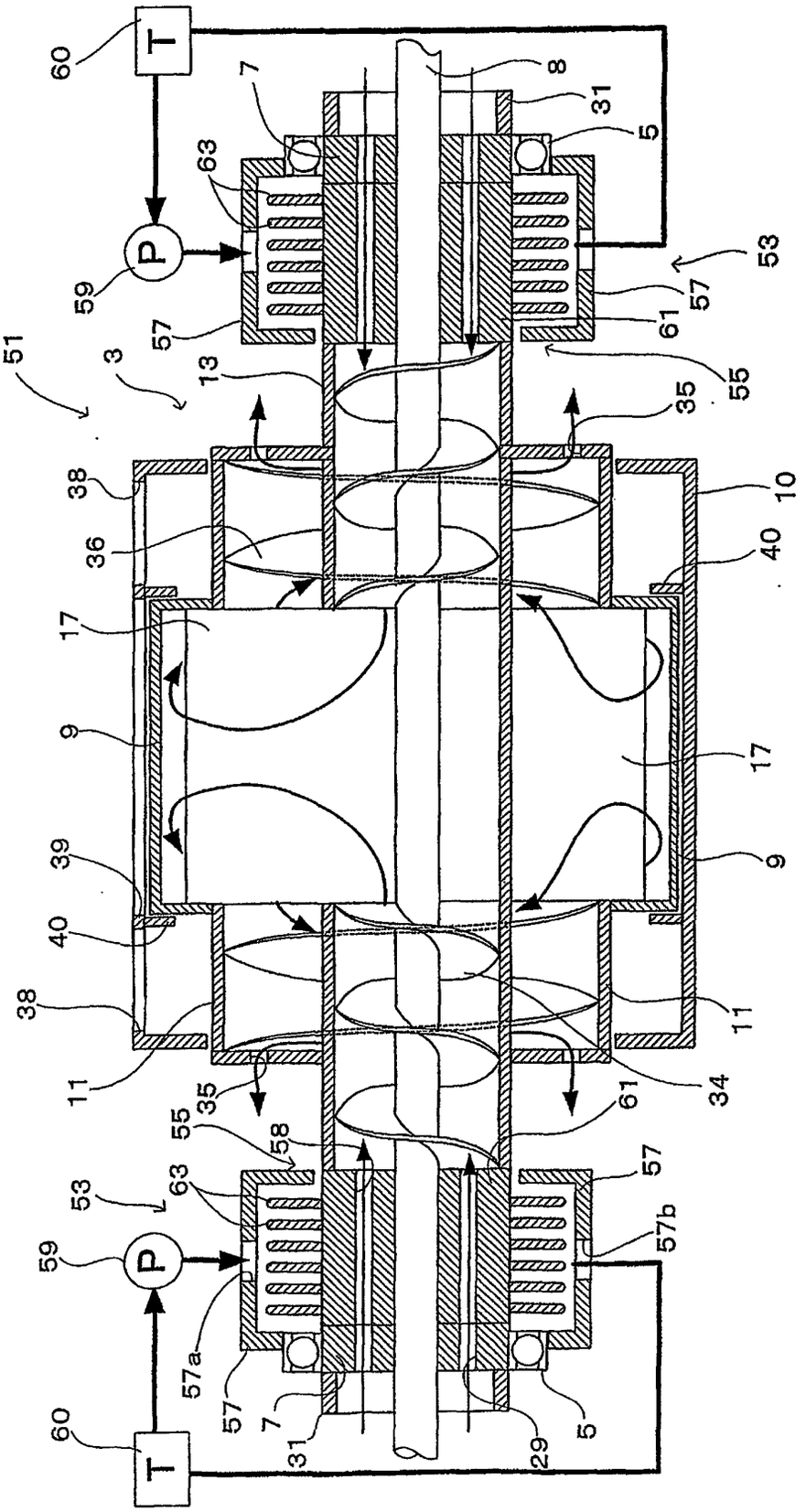
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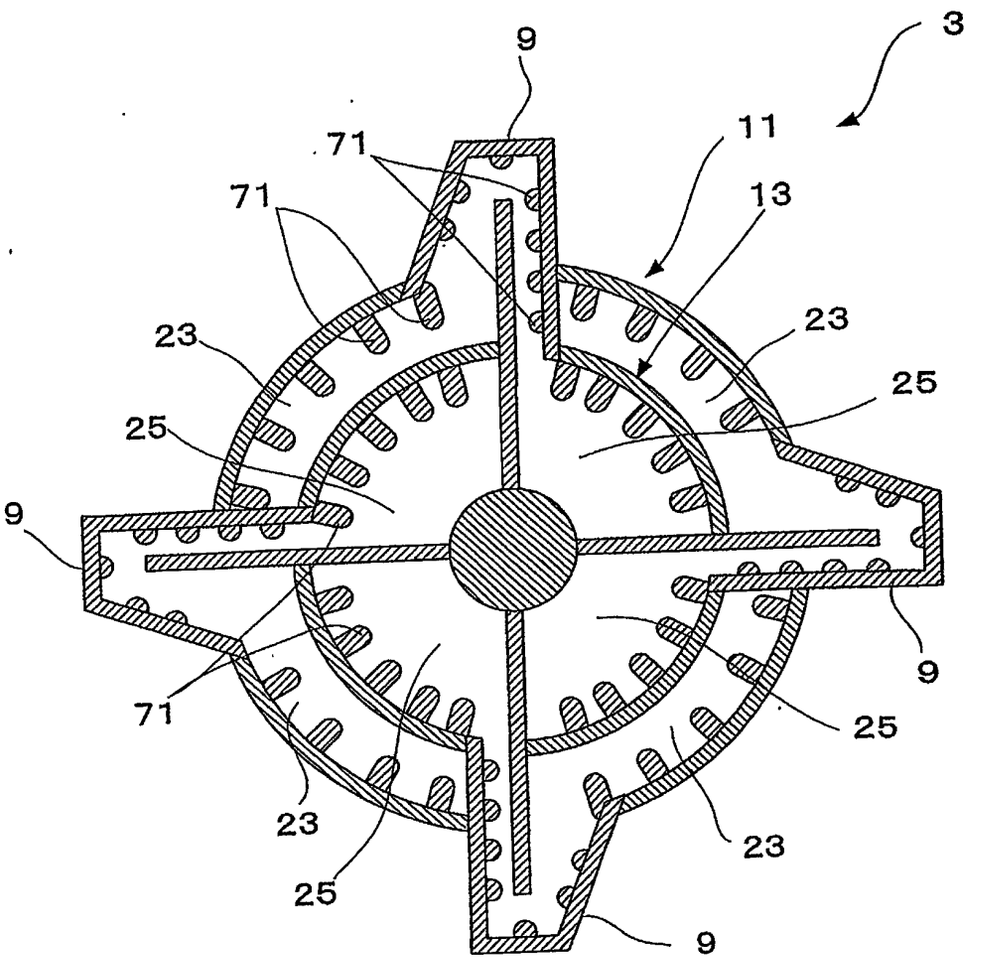
Fig. 5

Fig. 6



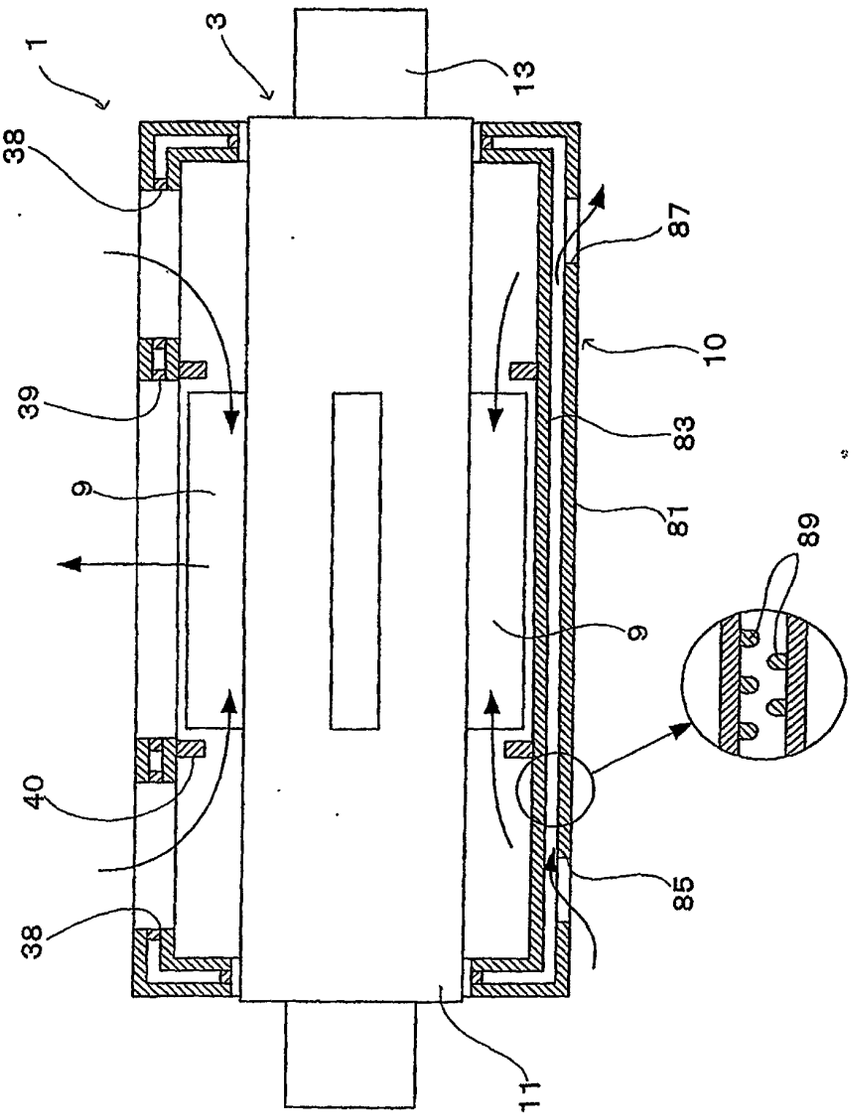


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/05105

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F04D29/58, F04D29/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F04D29/58, F04D29/44, F04D29/28, F27B9/12, F27D9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2-86998 A (Mitsubishi Electric Corp.), 27 March, 1990 (27.03.90), Full text; Figs. 1 to 7 (Family: none)	1-5
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 50798/1984 (Laid-open No. 164699/1985) (Nissan Motor Co., Ltd.), 01 November, 1985 (01.11.85), Full text; Figs. 1 to 3 (Family: none)	1-5

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August, 2002 (21.08.02)	03 September, 2002 (03.09.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/05105

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 118483/1986 (Laid-open No. 26100/1988) (Ishikawajima-Harima Heavy Industries Co., Ltd.), 20 February, 1988 (20.02.88), Full text; Figs. 1 to 3 (Family: none)	1-5

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