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GAS CHROMATOGRAPH

Abstract

Provided is a gas chromatograph capable of efficiency circulating air in a column oven. The gas chromatograph is provided with a column oven, a heater, a fan, and a cylindrical member. The column oven accommodates a column. The heater heats the inside of the column oven. The fan has a blade that rotates about a rotation axis in the column oven, and sends air toward the column provided in the axial direction that is a direction along the rotation axis. The cylindrical member is arranged to accommodate at least a part of the fan in a state of being spaced apart from the column in the axial direction and surrounding an outer periphery of the fan along a rotational direction of the blade.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a Divisional of U.S. application Ser. No. 18/082,912 filed Dec. 16, 2022 which claims priority under 35 U.S.C. § 119 to Japanese Patent Application No. 2022-001367 filed on Jan. 7, 2022 and Japanese Patent Application No. 2022-091311 filed on Jun. 6, 2022, the entire disclosures of which are incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION
Field of the Invention
[0002] The present invention relates to a gas chromatograph.
Description of the Related Art
[0003] For example, in a gas chromatograph as disclosed in Patent Document 1 listed below, a fan for agitating air in a column oven is provided in a column oven. In the column oven, a heater and a column are provided.
PRIOR ART DOCUMENT
Patent Document
[0004] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2018-205079
SUMMARY OF THE INVENTION
Problems to be Solved by the Invention
[0005] In a gas chromatograph, for example, when heating the inside of the column oven, both the fan and the heater are activated in a state in which the air inlet port and the air outlet port of the column oven are closed. In this case, as the air in the column oven is heated while being circulated, the inside of the column oven is heated. When the inside of the column oven is heated, the column is also heated.
[0006] Further, for example, when cooling the inside of the column oven, the fan is activated in a state in which the heater is deactivated and that the air inlet port and the air outlet port of column oven are opened. In this case, the air taken into the column oven through the air inlet port circulates in the column oven to deprive the heat in the column oven. Further, the heat deprived the air in the column oven is discharged through the air outlet port. With this, the inside of the column oven is cooled. Further, when the inside of the column oven is cooled, the column is cooled.
[0007] As described above, in the gas chromatograph, the fan is activated to heat or cool the column oven. The wind generated by the fan tends to spread in a direction (radial direction) away from the rotation axis of the fan. Therefore, the wind generated by the fan is small in the velocity component in the axial direction. Consequently, it takes a time to circulate the air in the column oven.
[0008] In addition, in the case of providing a plurality of columns in a column oven, there is a case in which the volume of the column oven is increased. In a case where the volume of the column oven is increased, the airflow in the column oven needs to be circulated efficiently in order to make the temperature distribution in the column oven uniform.
[0009] The present invention has been made in view of the above-described circumstances. An object of the present invention is to provide a gas chromatograph capable of efficiency circulating air in a column oven.
Means for Solving the Problem
[0010] According to the first aspect of the present invention, a gas chromatograph is provided with

a column oven, a heater, a fan, and a cylindrical member. The column oven accommodates a column. The heater is configured to heat an inside of the column oven. The fan is provided with a blade that rotates about a rotation axis in the column oven. The fan is configured to send wind toward the column provided in an axial direction that is a direction along the rotation axis. The cylindrical member is arranged to accommodate at least a part of the fan in a state of being spaced apart from the column in the axial direction and surrounding an outer periphery of the fan along a rotational direction of the blade.

[0011] According to a second aspect of the present invention, a gas chromatograph is provided with a column oven, a heater, a fan, a rectifying member. The column oven accommodates a column. The heater is configured to heat an inside of the column oven. The fan is provided with a blade that rotates about a rotation axis in the column oven. The fan is configured to send wind toward the column provided in an axial direction that is a direction along the rotation axis. The rectifying member is configured to rectify the wind generated by the fan into a flow of wind centered on a rotation axis.

Effects of the Invention

[0012] According to the present invention, it is possible to efficiently circulate air in a column oven.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The preferred embodiments of the present invention are shown by way of example, and not limitation in the accompanying figures.

[0014] FIG. **1** is a schematic cross-sectional view showing a part of one example of a configuration of a gas chromatograph according to this embodiment.

[0015] FIG. **2** is a schematic diagram showing one example of a configuration of a fan and its surroundings according to this embodiment.

[0016] FIG. **3** is a schematic cross-sectional view showing one example of a configuration of a cylindrical member according to this embodiment.

[0017] FIG. **4** is a schematic cross-sectional view showing another example of a configuration of a cylindrical member according to this embodiment.

[0018] FIG. **5** is a schematic cross-sectional view showing still another example of a configuration of a cylindrical member according to this embodiment.

[0019] FIG. **6** is a schematic cross-sectional view showing a part of one example of a configuration of a gas chromatograph according to another embodiment.

[0020] FIG. **7** is a schematic front view showing one example of a configuration of a rectifying member shown in FIG. **6**.

[0021] FIG. **8** is a schematic cross-sectional view showing a modification of the gas chromatograph shown in FIG. **6**.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0022] In the following paragraphs, some preferred embodiments of the present invention will be described by way of example and not limitation. It should be understood based on this disclosure that various other modifications can be made by those skilled in the art based on these illustrated embodiments.

1. Configuration of Gas Chromatograph

[0023] FIG. **1** is a schematic cross-sectional view showing a part of one example of a configuration of a gas chromatograph **10** according to this embodiment. The gas chromatograph **10** is provided with a temperature-controllable column oven **12**. The column oven **12** is provided with an air inlet port **14** and an air outlet port **16**. The column oven **12** is further provided with an air inlet flap **18**

for opening and closing the air inlet port **14** and an air outlet flap **20** for opening and closing the air outlet port **16**.

[0024] Further, the gas chromatograph **10** is provided with a sample introduction unit **22**, a column **24**, a detector **26**, a temperature sensor **28**, and the like. These members are provided in the column oven **12**. Specifically, the sample introduction unit **22** and the detector **26** are partially provided in the column oven **12**.

[0025] The sample introduction unit **22** is a sample introduction unit for introducing a carrier gas and a sample gas into the column **24** and is provided with a septum (not shown). A sample vaporization chamber **22***a* is formed in the sample introduction unit **22**.

[0026] Further, the sample introduction unit **22** is provided with a heater (not shown). A liquid sample introduced into the sample vaporization chamber **22***a* is vaporized by the heater to be served as a sample gas. Note that the sample is not limited to a liquid and may be a solid or a gas.

[0027] Furthermore, the sample vaporization chamber **22***a* is in communication with a gas supply flow path **30** and a split flow path **32**. The gas supply flow path **30** is a flow path for supplying a carrier gas into the sample vaporization chamber **22***a* of the sample introduction unit **22**.

[0028] The split flow path **32** is a flow path for discharging a part of the gas (a mixed gas of a carrier gas and a sample gas) in the sample vaporization chamber **22***a* to the outside at a predetermined split rate when introducing a carrier gas and a sample gas into the column **24** by a split introduction method.

[0029] That is, according to the sample introduction unit **22**, a sample gas is introduced into the column **24** together with a carrier gas. Further, when the sample gas is introduced into the column **24**, the sample components contained in the sample gas are separated by components by the column **24**. Note that the column **24** is a general-purpose column.

[0030] Note that the form of a sample to be introduced into the sample introduction unit **22** is not particularly limited as long as a sample can be introduced from the sample introduction unit **22** to the column **24**. As for the sample introduction unit **22**, a sample introduction unit of a type suitable for a type of a sample is appropriately used. For example, in a case where the sample to be supplied to the sample introduction unit **22** is a gas, as the sample introduction unit **22**, a sample introduction unit of a type in which no sample vaporization chamber **22***a* is formed is used.

[0031] The detector **26** is provided for sequentially detecting various components separated by the column **24**. The detector **26** is configured by, for example, a hydrogen flame ionization detector (FID). Further, the temperature sensor **28** is provided to detect the temperature in the column oven **12**.

2. Configuration of Fan and Therearound

[0032] The gas chromatograph **10** according to this embodiment is provided with, in addition to the column **24** and the like, a driving unit **34**, a transfer mechanism **36**, a fan **38**, a cylindrical member **40**, a heater **42**, and the like.

[0033] FIG. **2** is a schematic diagram showing one example of the configuration of the fan **38** and therearound according to this embodiment. FIG. **2** shows the fan **38**, etc., as viewed from the side of the transfer mechanism **36**. Hereinafter, the configuration of the fan **38** and therearound according to this embodiment will be described with reference to FIG. **1** and FIG. **2**.

[0034] The driving unit **34** is a general-purpose motor. The transfer mechanism **36** is a mechanism that transmits the rotational force generated by the driving unit **34** to the fan **38**.

[0035] The fan **38** is a general-purpose fan and is provided in the column oven **12**. The fan **38** rotates about the rotation axis **38***a* in the column oven **12**. In this embodiment, the fan **38** is a propeller fan having a plurality of blades **38***b* extending radially centered on the rotation axis **38***a*. The fan **38** is arranged such that the rotation axis **38***a* extends horizontally. Note that the fan **38** has a plurality of blades **38***b*, and therefore, rotating the fan **38** about the rotation axis **38***a* means that the blades **38***b* of the fan **38** rotate about the rotation axis **38***a*.

[0036] According to the fan **38**, as shown in FIG. **1**, the wind is sent toward the column **24**

provided in the direction (axial direction) along the rotation axis **38***a*. However, in a case where the fan **38** is a propeller fan, the wind generated by the fan **38** tends to spread away from the rotation axis **38***a* of the fan **38** (in the radial direction).

[0037] The cylindrical member **40** is provided to accommodate the fan **38**. The cylindrical member **40** accommodates at least a part of the fan **38** by enclosing an outer periphery of the fan **38** along the rotational direction of the blades **38***b* of the fan **38**. The cylindrical member **40** is configured by, for example, a cylindrical member having a circular cross section perpendicular to the rotation axis **38***a*. The cylindrical member **40** is coaxially arranged centerred on the rotation axis **38***a* of the fan **38** and surrounds the outer side of the fan **38** in an annular shape. The end of the blade **38***b* of the fan **38** is close to the inner periphery of the cylindrical member **40**.

[0038] However, the cylindrical member **40** is not limited to a member having a circular shape in the cross section perpendicular to the rotation axis **38***a*, and may be a member having another shape, such as, e.g., a rectangular shape, in the cross section. In the example shown in FIG. **1**, the cylindrical member **40** accommodates the entire fan **38**. That is, the fan **38** is provided not to protrude from the cylindrical member **40** in the axial direction along the rotation axis **38***a*.

[0039] The cylindrical member **40** is spaced apart from the column **24** in the axial direction. That is, the column **24** is arranged outside the cylindrical member **40** in the column oven **12**. Further, it can be said that the column **24** is arranged side by side with respect to the cylindrical member **40** spaced apart in the axial direction. Specifically, the column **24** is arranged on the downstream side of the wind generated by the fan **38** to be spaced apart from the cylindrical member **40**. Between the cylindrical member **40** and the column **24**, as a safety measure, a net, a grid, etc., for preventing the user from accidentally touching the fan **38**, may be provided.

[0040] The heater **42** is provided to heat the inside of the column oven **12**. In the example shown in FIG. **1** and FIG. **2**, the heater **42** is mounted on the outer periphery of the cylindrical member **40** along the rotational direction of the blade **38***b* of the fan **38**. That is, the heater **42** is attached to the outer side of the cylindrical member **40** to be integrally formed with the cylindrical member **40**. The heater **42** includes, for example, a coil (not shown) formed by winding a metallic wire, and generates heat by energizing the coil. The heater **42** is provided not to protrude from the cylindrical member **40** in the axial direction along the rotation axis **38***a*. However, the heater **42** is not limited to a configuration in which a coil is provide, but may be a configuration in which an annular or arc-shaped heating element is provided along the outer periphery of the cylindrical member **40**.

[0041] In such a gas chromatograph **10**, for example, in a state in which the air inlet port **14** and the air outlet port **16** are closed, when the fan **38** and the heater **42** are activated together, the air is heated by the heater **42** while being circulated in the column oven **12**. Accordingly, the inside of the column oven **12** is heated, and the column **24** is also heated. Note that the control of the heater **42** may be performed based on the detection temperature of the temperature sensor **28**.

[0042] On the other hand, when the heater **42** is deactivated and the fan **38** is activated in a state in which the air inlet port **14** and the air outlet port **16** are opened, the air entrained from the air inlet port **14** circulates in the column oven **12** and deprives the heat in the column oven **12**. The air deprived the heat in the column oven **12** is discharged from the air outlet port **16**. Accordingly, the inside of the column oven **12** is cooled, and the column **24** is also cooled. The operations of the air inlet flap **18** and the air outlet flap **20** for opening and closing the air inlet port **14** and the air outlet port **16** may be controlled based on the detection temperature of the temperature sensor **28**.

[0043] Further, in this embodiment, as described above, since the cylindrical member **40** surrounds the outer periphery of the fan **38**, the blade tip vortex generated at the end of the blades **38***b* of the fan **38** is suppressed. Therefore, the wind generated by the fan **38** is less likely to spread in a direction (radial direction) away from the rotation axis **38***a* of the fan **38**, and a decrease in velocity components in the axial direction of the wind is suppressed.

[0044] Therefore, according to the cylindrical member **40**, it is possible to efficiently circulate the air in the column oven **12**. With this, according to the cylindrical member **40**, it is possible to

efficiently heat or cool the inside of the column oven **12**.

[0045] Further, in this embodiment, in order to further suppress the generation of the blade tip vortex, that is, in order to more efficiently circulate the air in the column oven **12**, the fan **38** is arranged not to protrude from the cylindrical member **40** toward the downstream side of the wind generated by the fan **38**. In particular, at least the end of the blade **38***b* is positioned not to protrude from the cylindrical member **40** toward the downstream side of the wind caused by the fan **38**.

[0046] On the other hand, it may be configured such that the fan **38** protrudes from the cylindrical member **40** toward the upstream side of the wind generated by the fan **38**. However, in this case, as described above, a part of the fan **38** is accommodated in the cylindrical member **40**. That is, a part of the end of the blade **38***b* may project from the cylindrical member **40** toward the upstream side of the wind caused by the fan **38**.

[0047] Further, in this embodiment, the heater **42** is provided on the outer periphery of the cylindrical member **40** as described above, and therefore, the cylindrical member **40** is interposed between at least a part of the column **24** and the heater **42**. As a result, the propagation of the radiant heat from the heater **42** to at least a part of of the column **24** is suppressed.

3. Configuration of Cylindrical Member

[0048] FIG. **3** is a schematic cross-sectional view showing one example of the configuration of the cylindrical member **40** according to this embodiment. FIG. **4** is a schematic cross-sectional view showing another example of the configuration of the cylindrical member **40** according to this embodiment. FIG. **5** is a schematic cross-sectional view showing still another example of the configuration of the cylindrical member **40** according to this embodiment.

[0049] As shown in FIG. **3** to FIG. **5**, the cylindrical member **40** of this embodiment specifically includes a cylindrical portion **40***a* and a flange portion **40***b*. The cylindrical portion **40***a* accommodates at least a part of the fan **38** by surrounding the outer perimeter of the fan **38** along the rotational direction of of the blade **38***b* of the fan **38**.

[0050] The flange portion **40***b* is provided to the cylindrical portion **40***a* to protrude radially outward from the end of the cylindrical portion **40***a* on the downstream side of the wind generated by the fan **38**. The flange portion **40***b* is a ring-shaped member arranged coaxially with the cylindrical portion **40***a* and having an outer diameter larger than the outer diameter of the cylindrical portion **40***a*. In the cylindrical member **40**, the cylindrical portion **40***a* and the flange portion **40***b* may be formed by connecting separate members or may be formed by a single member.

[0051] Specifically, the heater **42** is provided on the outer periphery of the cylindrical portion **40***a* of the fan **38** along the rotational direction of the blade **38***b* of the fan **38**. That is, the heater **42** is integrally formed with the cylindrical portion **40***a* by being attached to the outer side of the cylindrical portion **40***a*. Further, the heater **42** faces the column **24** via the flange portion **40***b*. Thus, the flange portion **40***b* is interposed between the column **24** and the **42**.

[0052] In the example shown in FIG. **3**, the cylindrical portion **40***a* extends straight along the axial direction. That is, in the axial direction, the inner diameter and the outer diameter of the cylindrical portion **40***a* do not change. In the outer periphery of the cylindrical portion **40***a*, the angle formed between the cylindrical portion **40***a* and the flange portion **40***b* is a right angle.

[0053] In the cylindrical member **40** shown in FIG. **4**, the periphery of the part corresponding to the boundary between the cylindrical portion **40***a* and the flange portion **40***b* is rounded, as compared with the cylindrical member **40** shown in FIG. **3**. That is, the inner peripheral surface of the cylindrical portion **40***a* is continuous with the flange portion **40***b* via a curved surface. In the cylindrical member **40** shown in FIG. **4**, the cylindrical portion **40***a* and the flange portion **40***b* are formed by a single member.

[0054] Note that in the cylindrical member **40** as shown in FIG. **3** and FIG. **4**, the angle formed between the cylindrical portion **40***a* and the flange portion **40***b* on the outer periphery of the cylindrical portion **40***a* may be an obtuse angle. That is, the flange portion **40***b* may be inclined to

gradually approach the downstream side of the wind caused by the fan **38** (toward the column **24**) as it approaches the distal end. However, the angle formed between the cylindrical portion **40***a* and the flange portion **40***b* may be set such that the heater **42** can face the column **24** via the flange portion **40***b*.

[0055] Further, as shown in FIG. **5**, the cylindrical member **40** may be formed in a bell-mouth shape. In a case where the cylindrical member **40** is formed in a bell-mouth shape, the inner and outer diameters of the cylindrical portion **40***a* increase as they approach the downstream side (the column **24** side) of the wind caused by the fan **38**.

[0056] In the example shown in FIG. **5**, the angle formed between the cylindrical portion **40***a* and the flange portion **40***b* at the outer periphery of the cylindrical portion **40***a* is an obtuse angle. Further, the flange portion **40***b* is inclined to gradually approach the downstream side (toward column **24** side) of the wind caused by the fan **38** as it approaches the distal end. However, the angle formed between the cylindrical portion **40***a* and the flange portion **40***b* is set to such a degree that the heater **42** can face the column **24** via the flange portion **40***b*.

[0057] Further, in the same manner as the examples shown in FIG. **3** and FIG. **4**, the flange portion **40***b* may be configured to extend in a direction perpendicular to the axial direction. For example, in a case where the cylindrical member **40** is formed in a bell-mouth shape, the perimeter of the part corresponding to the boundary between the cylindrical portion **40***a* and the flange portion **40***b* may be rounded, as shown in FIG. **4**. In other words, the inner peripheral surface of the cylindrical portion **40***a* may be continuous to the flange portion **40***b* via a curved surface.

[0058] The cylindrical portion **40***a* is interposed between at least a part of the column **24** and the heater **42** in a direction intersecting the axial direction to suppress the propagation of the radiant heat from the heater **42** to the column **24**. The flange portion **40***b* is interposed between the remaining part of the column **24** and the heater **42** in the axial direction to suppress the propagation of the radiated heat from the heater **42** to the column **24**. That is, in a case where the cylindrical member **40** includes the cylindrical portion **40***a* and the flange portion **40***b*, the propagation of the radiant heat from the heater **42** to the entire column **24** is suppressed.

[0059] As described above, in a case where the cylindrical member **40** suppresses the propagation of the radiated heat from the heater **42** to the column **24**, it is possible to prevent the temperature of the column **24** from being biased when the column **24** is heated as the column oven **12** is heated.

[0060] Note that in a case where the cylindrical member **40** is formed in a bell-mouth shape, the blade tip vortex generated at the end of the blade **38***b* of the fan **38** is further suppressed. In other words, the circulation of the air in the column oven **12** can be performed more efficiently. Therefore, the cylindrical member **40** is preferably formed in a bell-mouth shape.

[0061] Further, considering only the point of view of suppressing the radial direction spread of the wind caused by the fan **38**, the heater **42** is not required to be provided at the cylindrical member **40**. For example, the heater **42** may be provided at another location in the column oven **12** or may be provided outside the column oven **12**.

[0062] Further, in this embodiment, the fan **38** is accommodated in the cylindrical member **40**, but the column **24** or the like is not accommodated in the cylindrical member **40**. In the column oven **12**, since the outside of the cylindrical member **40** is brighter and wider than the inside of the cylindrical member **40**, the operation in the column oven **12**, specifically, the replacement of the column **24** or the like, can be easily performed in a case where the column **24** or the like is not accommodated in the cylindrical member **40**.

4. Another Embodiment

[0063] FIG. **6** is a schematic cross-sectional view showing a part of one example of a configuration of a gas chromatograph **10** according to another embodiment. In the gas chromatograph **10**, only the configuration around the fan **38** is different from that of the embodiment shown in FIG. **1**, and the other configurations are the same as those of the embodiment shown in FIG. **1**. Therefore, the same reference symbol is assigned to the same configuration in the drawings, and the detailed

explanation thereof will be omitted.

[0064] In the example shown in FIG. **6**, a heater **42** is provided between the fan **38** and the column **24**. That is, the heater **42** is arranged on the downstream side of the wind generated by the fan **38**, and the column **24** is arranged on the further downstream side. The heater **42** is formed in, for example, a mesh-like or spiral shape, and is arranged to face the blade **38***b* of the fan **38** in front of the blade.

[0065] Further, in the example shown in FIG. **6**, a rectifying member **50** is provided between the heater **42** and the column **24**. The rectifying member **50** is spaced apart from the column **24** in a direction (axial direction) along the rotation axis **38***a* of the fan **38**. The rectifying member **50** is provided with air vents **51**, so that the air generated by the fan **38** is rectified by passing through the air vents **51** and guided to the column **24**. Note that it is not limited that the heater **42** is provided between the fan **38** and the rectifying member **50**. But, the heater **42** may be provided between the rectifying member **50** and the column **24**, or elsewhere.

[0066] The wind generated by the fan **38** is rectified by passing through the air vents **51** of the rectifying member **50** into a flow of wind centered on the rotation axis **38***a*. The "wind flow centered on the rotation axis **38***a*" denotes, for example, a flow of wind swirling centered on the rotation axis **38***a*, and may be a flow of wind swirling in a spiral shape.

[0067] The rectifying member **50** is, for example, a plate-shaped member and functions as a partition wall that partitions a space in the column oven **12**. That is, the rectifying member **50** may be configured such that a first space in which the fan **38** is arranged and a second space in which the column **24** is arranged are partitioned and that the first space and the second space are communicated to each other via the air vents **51**. In this case, the heater **42** may be arranged in the first space or may be arranged in the second space. Note that it is not limited to such a configuration that the space in the column oven **12** is completely partitioned by the rectifying member **50**, and but may be configured such that another air vent is provided around the rectifying member **50**.

[0068] FIG. **7** is a schematic front view showing one example of a configuration of a rectifying member **50** shown in FIG. **6**. In this embodiment, a plurality of air vents **51** is formed radially centered on the rotation axis **38***a* of the fan **38** in the central portion of the plate-shaped rectifying member **50**.

[0069] Each of the plurality of air vents **51** is formed to extend in an arc shape from a central portion **52** (a part on the rotation axis **38***a*) of the rectifying member **50**, and is formed in a vortex shape centered on the rotation axis **38***a*. Specifically, arc-shaped ribs **53** are radially formed from the central portion **52**, so that an arc-shaped air vent **51** is formed between the ribs **53**.

[0070] Note that the rectifying member **50** is not limited to the shape shown in FIG. **7** as long as it can rectify the wind generated by the fan **38** into the wind flow centered on the rotation axis **38***a*. The flow of the wind centered on the rotation axis **38***a* generated by the rectifying member **50** may be clockwise or counterclockwise with respect to the rotation axis **38***a*.

[0071] FIG. **8** is a schematic cross-sectional view showing a modification of the gas chromatograph shown in FIG. **6**. In this example, unlike the example shown in FIG. **6**, only the point that the cylindrical member **54** for guiding the wind generated by the fan **38** to the rectifying member **50** is provided is different. The other configurations are the same as those of the example shown in FIG. **6**. Therefore, the same reference symbol will be assigned to the same configuration in the drawings, and the detailed explanation thereof will be omitted.

[0072] The cylindrical member **54** covers the outer periphery of the fan **38** along the blades **38***b*. Specifically, the front (upstream) end of the cylindrical member **54** is radially opposed to the blade **38***b*, and the rear (downstream side) end thereof is proximate to or connected to the rectifying member **50**. With this configuration, at least a part of the fan **38** is covered with the cylindrical member **54**, and the wind generated by the fan **38** is guided toward the rectifying member **50** through the space (wind tunnel) in the cylindrical member **54**.

[0073] The cylindrical member **54** is not limited to the configuration that the cylindrical member **54** covers all of the fan **38**, and may be a configuration in which the cylindrical member **54** covers only a part thereof. The cylindrical member **54** is preferably proximate to the distal end of the blade **38***b*, but not limited thereto. The cylindrical member **54** may be provided along the inner surface of the column oven **12**, for example. Further, the cylindrical member **54** is not limited to a cylindrical shape, and may have other shapes. In the example shown in FIG. **8**, the heater **42** is provided inside the cylindrical member **54**, but the present invention is not limited thereto. The heater **42** may be provided outside the cylindrical member **54**.

5. Aspects

[0074] It will be understood by those skilled in the art that the plurality of exemplary embodiments described above is illustrative of the following aspects.

Item 1

[0075] A gas chromatograph according to one aspect of the present invention is provided with:

[0076] a column oven accommodating a column; [0077] a heater configured to heat an inside of the column oven; [0078] a fan provided with a blade that rotates about a rotation axis in the column oven, the fan being configured to send wind toward the column provided in an axial direction that is a direction along the rotation axis; and [0079] a cylindrical member arranged to accommodate at least a part of the fan in a state of being spaced apart from the column in the axial direction and surrounding an outer periphery of the fan along a rotational direction of the blade.

[0080] According to the gas chromatograph as recited in the above-described Item **1**, the wind generated by the fan is less likely to spread away from the rotation axis of the fan, so that the air in the column oven can be circulated efficiently. When heating or cooling the inside of the column oven, the inside of the column oven is circulated by the fan. Therefore, the inside of the column oven can be efficiently heated or cooled as long as the inside of the column oven can be efficiently circulated.

Item 2

[0081] In the gas chromatograph as recited in the above-described Item 1, it may be configured such that the fan is arranged not to protrude from the cylindrical member toward a downstream side of the wind generated by the fan.

[0082] According to the gas chromatograph as recited in the above-described Item 2, since the wind generated by the fan is less likely to spread further away from the rotation axis of the fan, the air in the column oven can be circulated more efficiently.

Item 3

[0083] In the gas chromatograph as recited in the above-described Item 1 or 2, it may be configured such that the heater is mounted on an outer periphery of the cylindrical member along the rotational direction of the blade.

[0084] According to the gas chromatograph as recited in the above-described Item 3, the propagation of the radiant heat from the heater to at least a part of the column is suppressed. Further, when heating the column, the propagation of the radiant heat from the heater is suppressed, and therefore, it is possible to prevent the heat of the column from being biased when the column oven is heated.

Item 4

[0085] In the gas chromatograph as recited in the above-described Item 3, it may be configured such that [0086] the cylindrical member includes a cylindrical portion and a flange portion, [0087] the cylindrical portion accommodates the at least a part of the fan in a state of surrounding the outer periphery of the fan along the rotational direction of the blade, [0088] the flange portion is provided to the cylindrical portion to protrude radially outward from an end of the cylindrical portion on a downstream side of the wind generated by the fan, and [0089] the heater is mounted on the outer periphery of the cylindrical portion along the rotational direction of the blade to face the column via the flange portion.

[0090] According to the gas chromatograph as recited in the above-described Item 4, the propagation of the radiation heat from the heater to the entire column is suppressed. As a result, when the column is heated in accordance with the heating of the column oven, the temperature of the column can be further suppressed from being biased.

Item 5

[0091] In the gas chromatograph as recited in the above-described Item 4, it may be configured such that the cylindrical member is formed in a bell-mouth shape.

[0092] According to the gas chromatograph as described in the above-described Item 5, since the blade tip vortex generated at the end of the blade of the fan is further suppressed, it is possible to more efficiently circulate the air in column oven.

Item 6

[0093] A gas chromatograph according to a second aspect of the present invention, is provided with: [0094] a column oven accommodating a column; [0095] a heater configured to heat an inside of the column oven; [0096] a fan provided with a blade that rotates about a rotation axis in the column oven, the fan being configured to send wind toward the column provided in an axial direction that is a direction along the rotation axis; and [0097] a rectifying member configured to rectify the wind generated by the fan into a flow of wind centered on the rotation axis.

[0098] According to the gas chromatograph as recited in the above-described Item 6, since the wind generated by the fan is rectified into the wind flow centered on the rotation axis, the ratio of the wind in the axial direction is increased, and therefore, the agitation efficiency of the air in the column oven is improved. As a result, the air in the column oven can be circulated efficiently, so that the air in the column oven can be uniformly distributed. Further, since the ratio of the wind in the axial direction is increased, even if the rotation speed of the fan is decreased, it is possible to uniformly distribute the temperature of the air in the column oven. Therefore, it contributes to prolonging the life of the fan, reducing the power consumption, and reducing the noise, as well as improving the cooling efficiency in the column oven, which in turn contributes to shortening the cooling time.

Item 7

[0099] In the gas chromatograph as recited in the above-described Item 6, it may be configured such that the gas chromatograph is further provided with a cylindrical member configured to direct the wind generated by the fan toward the rectifying member, the cylindrical member accommodating at least a part of the fan in a state of surrounding an outer periphery of the fan along a rotational direction of the blade.

[0100] According to the gas chromatograph described in the above-described Item 7, since the wind generated by the fan can be efficiently guided to the rectifying member, a strong wind flow centered on the rotation axis can be generated. Therefore, the stirring efficiency of the air in the column oven is further improved, and therefore, the air in the column oven can be circulated more efficiently.

Item 8

[0101] In the gas chromatograph as recited in the above-described Item 6 or 7, it may be configured such that the rectifying member has an air vent formed in a spiral shape centered on the rotation axis.

[0102] According to the gas chromatograph as recited in the above-described Item 8, it is possible to efficiently convert the wind generated by the fan into the wind flow centered on the rotation axis via the air vent formed in a vortex shape centered on the rotation axis.

Claims

1. A gas chromatograph comprising: a column oven accommodating a column; a heater configured to heat an inside of the column oven; a fan provided with a blade that rotates about a rotation axis

in the column oven, the fan being configured to send wind toward the column provided in an axial direction that is a direction along the rotation axis; and a rectifying member configured to rectify the wind generated by the fan into a flow of wind centered on the rotation axis.

2. The gas chromatograph as recited in claim 1, further comprising: a cylindrical member configured to direct the wind generated by the fan toward the rectifying member, the cylindrical member accommodating at least a part of the fan in a state of surrounding an outer periphery of the fan along a rotational direction of the blade.

3. The gas chromatograph as recited in claim 1, wherein the rectifying member has an air vent formed in a spiral shape centered on the rotation axis.