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(54) TEMPERATURE CONTROL DEVICE AND INSPECTION DEVICE

(57) A temperature control apparatus according to one embodiment comprises: a refrigeration cycle device 10 including a compressor 11, a first heat exchanger 12, an expander 13, and a second heat exchanger 15, and causing a natural refrigerant to circulate; a first fluid passage 20 including a first side downstream flow path part that receives and causes the first fluid to flow, the first fluid exchanging heat with the natural refrigerant passing through the first heat exchanger 12, the first fluid then flowing out from the first heat exchanger 12; a second fluid passage 30 including a second side downstream flow path part that receives and causes the second fluid to flow, the second fluid exchanging heat with the natural refrigerant passing through the second heat exchanger 15, the second fluid then flowing out from the second heat exchanger 15; and a heat transfer member 40 capable of receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, and capable of receiving and causing the second fluid flowing out from the second side downstream flow path part to flow.

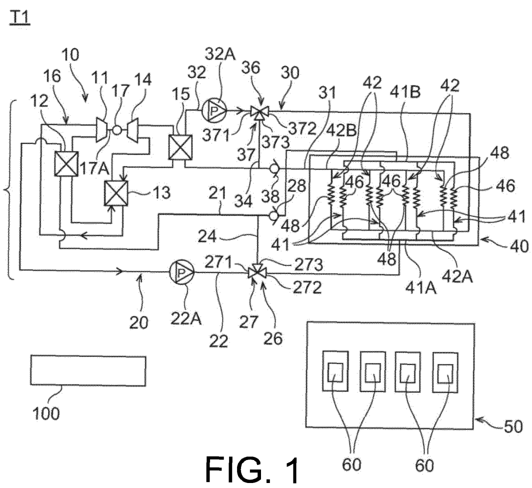

FIG. 1

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Description

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to a temperature control apparatus and an inspection apparatus.

BACKGROUND ART

[0002] Refrigeration cycle devices using natural refrigerants have attracted attention from a viewpoint of environmental protection. A natural refrigerant has an ozone depletion potential and a global warming potential that are extremely lower than those of a general fluorocarbon refrigerant. Therefore, the natural refrigerant is extremely useful from the viewpoint of environmental protection.

[0003] Examples of the natural refrigerant include ammonia, carbon dioxide, air, oxygen, and nitrogen. Among these, air, oxygen, and nitrogen have extremely low boiling points and thus enable cooling in an ultra-low temperature zone.

[0004] As refrigeration cycle devices using natural refrigerants, air refrigeration cycle devices using air are conventionally known (for example, JP6946113B). Such an air refrigeration cycle device is already used in a large freezer or the like.

SUMMARY OF THE INVENTION

[0005] When an operation test of a semiconductor device such as a large scale integration (LSI) or an integrated circuit (IC) is performed, a device called a handler device may be used. Generally, the handler device can cool and heat the semiconductor device, thereby enabling an operation test of the cooled or heated semiconductor device.

[0006] A conventional general handler device uses a freezer that circulates a Peltier element or a fluorocarbon refrigerant as means for cooling a semiconductor device.

[0007] However, there is a case where the Peltier element does not have sufficient durability depending on desired temperature conditions. In addition, use of fluorocarbon refrigerants is being restricted from the viewpoint of environmental protection.

[0008] In addition, in a case where a freezer that circulates a fluorocarbon refrigerant is used in a handler device, usually, brine is cooled by an evaporator of the freezer, and the semiconductor device is cooled through the cooled brine. Furthermore, in a case where the semiconductor device is heated in such a handler device, the brine used for cooling the semiconductor device may be heated by a heater, and the semiconductor device may be heated by the heated brine. However, in a case where the cooled brine is heated up to a desired temperature, time until the brine reaches the desired temperature is prolonged. Meanwhile, a handler device for heating may be used separately from the handler device for cooling, but it takes time and effort to replace the semiconductor device between the handler device for cooling and another handler device for heating. In addition, the occupying size and cost of a device in use may increase.

[0009] Therefore, an object of the present invention is to provide a temperature control apparatus and an inspection apparatus capable of improving durability and suppressing an increase in device size while ensuring favorable environmental performance by using a refrigeration cycle device using a natural refrigerant.

[0010] A temperature control apparatus according to an embodiment of the present invention includes: a refrigeration cycle device including a compressor, a first heat exchanger, an expander, and a second heat exchanger, in which a natural refrigerant flowing out from the compressor passes through the first heat exchanger, the expander, and the second heat exchanger in this order and then circulates to the compressor, and the compressor and the expander are connected by a common drive shaft; a first fluid passage including a first side upstream flow path part that causes a first fluid to flow into the first heat exchanger and a first side downstream flow path part that receives and causes the first fluid to flow, the first fluid exchanging heat with the natural refrigerant passing through the first heat exchanger, the first fluid then flowing out from the first heat exchanger; a second fluid passage including a second side upstream flow path part that causes a second fluid to flow into the second heat exchanger and a second side downstream flow path part that receives and causes the second fluid to flow, the second fluid exchanging heat with the natural refrigerant passing through the second heat exchanger, the second fluid then flowing out from the second heat exchanger; and a heat transfer member capable of causing the first fluid to flow out to the first side upstream flow path part after receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, the heat transfer member being capable of causing the second fluid to flow out to the second side upstream flow path part after receiving and causing the second fluid flowing out from the second side downstream flow path part to flow, in which the temperature of an object to be temperature-controlled is controlled through the heat transfer member.

[0011] The temperature control apparatus according to the one embodiment may further include: a first bypass flow path connecting the first side downstream flow path part and the first side upstream flow path part; a first valve mechanism that adjusts a ratio between a flow rate of the first fluid flowing from the first side downstream flow path part to the heat transfer member and a flow rate of the first fluid flowing through the first bypass flow path; a second bypass flow path connecting the second side downstream flow path part and the second side upstream flow path part; and a second valve mechanism that adjusts a ratio between a flow rate of the second fluid flowing from the second side downstream flow path part to the heat transfer member and a flow rate of the second fluid flowing through the second bypass flow path.

[0012] When the first fluid is caused to flow through the heat transfer member, the second valve mechanism may block a flow of the second fluid in the heat transfer member and allow a flow of the second fluid in the second bypass flow path, and when the second fluid is caused to flow through the heat transfer member, the first valve mechanism may block a flow of the first fluid in the heat transfer member and allow a flow of the first fluid in the first bypass flow path.

[0013] In the heat transfer member, there may be formed a plurality of first heat transfer flow path parts that causes the first fluid to flow out to the first side upstream flow path part after receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, and a plurality of the first heat transfer flow path parts may be positioned in parallel so as to be branched from the first side downstream flow path part.

[0014] In the heat transfer member, there may be formed a plurality of second heat transfer flow path parts that causes the second fluid to flow out to the second side upstream flow path part after receiving and causing the second fluid flowing out from the second side downstream flow path part to flow, and a plurality of the second heat transfer flow path parts may be positioned in parallel so as to be branched from the second side downstream flow path part.

[0015] Each of the first heat transfer flow path parts may include a first side interface part having a meandering shape, a helical shape, a spiral shape, or a shape that enlarges a flow path area, each of the second heat transfer flow path parts may include a second side interface part having a meandering shape, a helical shape, a spiral shape, or a shape that enlarges a flow path area, the heat transfer member may be provided with a plurality of temperature control parts, and any of a plurality of the first side interface parts and any of a plurality of the second side interface parts may be close to each other to form a temperature control source, and the temperature control part may be provided on a surface of the heat transfer member on the temperature control source.

[0016] In addition, an inspection apparatus according to an embodiment includes: a refrigeration cycle device including a compressor, a first heat exchanger, an expander, and a second heat exchanger, in which a natural refrigerant flowing out from the compressor passes through the first heat exchanger, the expander, and the second heat exchanger in this order and then circulates to the compressor, and the compressor and the expander are connected by a common drive shaft; a first fluid passage including a first side upstream flow path part that causes a first fluid to flow into the first heat exchanger and a first side downstream flow path part that receives and causes the first fluid to flow, the first fluid exchanging heat with the natural refrigerant passing through the first heat exchanger, the first fluid then flowing out from the first heat exchanger; a second fluid passage including a second side upstream flow path part that causes a second fluid to flow into the second heat exchanger and a second side downstream flow path part that receives and causes the second fluid to flow, the second fluid exchanging heat with the natural refrigerant passing through the second heat exchanger, the second fluid then flowing out from the second heat exchanger; and a heat transfer member capable of causing the first fluid to flow out to the first side upstream flow path part after receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, the heat transfer member being capable of causing the second fluid to flow out to the second side upstream flow path part after receiving and causing the second fluid flowing out from the second side downstream flow path part to flow, in which the temperature of an object to be inspected that is held by a holding member or an object to be inspected that is held by the heat transfer member is controlled through the heat transfer member.

[0017] The present invention makes it possible to improve durability while ensuring good environmental performance and to suppress an increase in device size.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

[Fig. 1] Fig. 1 is a diagram schematically illustrating an inspection apparatus according to a first embodiment.

[Fig. 2] Fig. 2 is a diagram illustrating a heat transfer member and a holding member constituting the inspection apparatus of Fig. 1.

[Fig. 3] Fig. 3 is a diagram illustrating a state in which the temperature of an object to be inspected is controlled by the inspection apparatus illustrated in Fig. 1.

[Fig. 4] Fig. 4 is a diagram illustrating a heat transfer member constituting an inspection apparatus according to a second embodiment.

[Fig. 5] Fig. 5 is a diagram illustrating a heat transfer member constituting an inspection apparatus according to a third embodiment.

[Fig. 6] Fig. 6 is a device illustrating a heat transfer member and a holding member constituting an inspection apparatus according to a fourth embodiment.

MODE FOR CARRYING OUT THE INVENTION

[0019] Hereinafter, embodiments of the present invention will be described.

<First Embodiment>

[0020] Fig. 1 is a schematic diagram of an inspection apparatus T1 according to a first embodiment of the present invention. The inspection apparatus T1 illustrated in Fig. 1 includes a refrigeration cycle device

10 that circulates a natural refrigerant, a first fluid passage 20 that causes a first fluid to flow, a second fluid passage 30 that causes a second fluid to flow, a heat transfer member 40 connected to the first fluid passage 20 and the second fluid passage 30, a holding member 50, and a controller 100. Here, the refrigeration cycle device 10, the first fluid passage 20, the second fluid passage 30, and the heat transfer member 40 constitute a temperature control apparatus 1.

[0021] The inspection apparatus T1 cools or heats an object to be inspected 60 held by the holding member 50 by the heat transfer member 40 to perform temperature control. In the present embodiment, the object to be inspected 60 is an electronic component such as an LSI or an IC as an example. The inspection apparatus T1 can perform an operation test of the object to be inspected 60 in a state where the temperature of the object to be inspected 60 is controlled to be in a high temperature range or a low temperature range. In other words, the inspection apparatus T1 according to the present embodiment is an inspection apparatus including a handler device. However, the object to be inspected 60 is not particularly limited, and an inspection apparatus according to the present invention may be an inspection apparatus including a prober that inspects a wafer as an object to be inspected. In addition, the inspection apparatus according to the present invention can also constitute various inspection apparatuses such as a tester.

[0022] The refrigeration cycle device 10 in the present embodiment circulates air as a natural refrigerant. In other words, the refrigeration cycle device 10 is an air refrigerant cycle device.

[0023] The refrigeration cycle device 10 includes a compressor 11, a first heat exchanger 12, a recovery heat exchanger 13, an expander 14, and a second heat exchanger 15. The refrigeration cycle device 10 connects the compressor 11, the first heat exchanger 12, the recovery heat exchanger 13, the expander 14, and the second heat exchanger 15 through a refrigerant circulation path 16 so that the air circulates in this order. After being compressed by the compressor 11, the air is cooled in stages by the first heat exchanger 12 and the recovery heat exchanger 13 and then flows into the expander 14. Thereafter, the air is expanded by the expander 14 and flows out from the expander 14.

[0024] The refrigeration cycle device 10 can lower the temperature of the air expanded by the expander 14 in a range of, for example, -10°C to -110°C and cause the air to flow into the second heat exchanger 15. The second heat exchanger 15 is connected to the second fluid passage 30. Here, the second heat exchanger 15 can cool the second fluid caused to flow by the second fluid passage 30 with the low-temperature air flowing therein. Furthermore, after passing through the second heat exchanger 15, the air circulates to the compressor 11.

[0025] Specifically, the air flowing out from the second heat exchanger 15 exchanges heat with the air flowing out from the first heat exchanger 12 in the recovery heat exchanger 13 before circulating to the compressor 11. As a result, the air before flowing into the expander 14 is cooled in stages by the first heat exchanger 12 and the recovery heat exchanger 13. Meanwhile, the temperature of the air flowing out from the second heat exchanger 15 is increased by the recovery heat exchanger 13 and then the air flows into the compressor 11.

[0026] The compressor 11 compresses the air flowing therein and then sends the compressed air to the first heat exchanger 12. The compressor 11 can raise the temperature of the compressed air to, for example, 80°C or more and cause the compressed air to flow into the first heat exchanger 12. The first heat exchanger 12 is connected to the first fluid passage 20. Here, the first heat exchanger 12 causes the high-temperature air flowing out from the compressor 11 and the first fluid to exchange heat with each other. As a result, the first heat exchanger 12 can cool the air. In addition, the first fluid can be heated by the high-temperature air flowing into the first heat exchanger 12.

[0027] In addition, the compressor 11 and the expander 14 are connected by a drive shaft 17A of a common motor 17. As a result, the compressor 11 and the expander 14 rotate in conjunction with each other by the rotation of the drive shaft 17A.

[0028] Note that although the refrigeration cycle device 10 is an air refrigerant cycle device in the present embodiment, other types of devices may be used. The refrigeration cycle device 10 may be a refrigeration cycle device that uses nitrogen or the like as a natural refrigerant. In addition, the recovery heat exchanger 13 does not need to be provided.

[0029] The first fluid passage 20 includes a first side upstream flow path part 21 and a first side downstream flow path part 22. The first heat exchanger 12 includes an inflow port into which the first fluid (not illustrated) flows and an outflow port from which the first fluid flows out. A downstream end opening of the first side upstream flow path part 21 is connected to the inflow port of the first heat exchanger 12, and an upstream end opening of the first side downstream flow path part 22 is connected to the outflow port of the first heat exchanger 12. In addition, the first fluid passage 20 connects an upstream end opening of the first side upstream flow path part 21 to a downstream end opening of a flow path part (first heat transfer flow path part 41 to be described later) formed in the heat transfer member 40, and the first fluid passage 20 connects a downstream end opening of the first side downstream flow path part 22 to an upstream end opening of the above-described flow path part formed in the heat transfer member 40. As a result, the first fluid passage 20 forms a closed circuit in cooperation with the heat transfer member 40 and circulates the first fluid through the heat transfer member 40.

[0030] In a case where the first fluid passage 20 circulates the first fluid through the heat transfer member 40, the first side upstream flow path part 21 causes the first fluid flowing out from the heat transfer member 40 to flow and flow into the first heat exchanger 12. The first side downstream flow path part 22 receives and causes the first fluid that has exchanged heat with the natural refrigerant in the first heat exchanger 12 to flow. A first side pump 22A is provided in the first side downstream flow path part 22. The first side pump 22A generates a driving force for causing the first fluid to flow. Note that an installation position of the first side pump 22A is not particularly limited, and for example, the first side pump 22A may be provided in the first side upstream flow path part 21.

[0031] In addition, in the present embodiment, there are provided a first bypass flow path 24 connecting the first side upstream flow path part 21 and the first side downstream flow path part 22 and a first valve mechanism 26 that adjusts a ratio between a flow rate of the first fluid flowing from the first side downstream flow path part 22 to the heat transfer member 40 and a flow rate of the first fluid flowing through the first bypass flow path 24.

[0032] Specifically, the first bypass flow path 24 is connected to a part on the downstream side of the first side pump 22A in the first side downstream flow path part 22. More specifically, the first valve mechanism 26 in the present embodiment includes a first side three-way valve 27. The first side three-way valve 27 includes a first side first port 271, a first side second port 272, and a first side third port 273. Furthermore, a flow path from the first side first port 271 to the first side second port 272 constitutes a part of the first side upstream flow path part 21. Furthermore, the first bypass flow path 24 has an upstream end opening connected to the first side third port 273 and a downstream end opening connected to the first side downstream flow path part 22.

[0033] The first side three-way valve 27 can adjust a ratio between a flow rate of the first fluid received in the first side first port 271 and flowing out from the first side second port 272 and a flow rate of the first fluid received in the first side first port 271 and flowing out from the first side third port 273. As a result, it is possible to adjust a ratio between the flow rate of the first fluid flowing from the first side downstream flow path part 22 to the heat transfer member 40 and the flow rate of the first fluid flowing through the first bypass flow path 24.

[0034] In a case where the first side three-way valve 27 connects the first side first port 271 and the first side second port 272 and blocks the first side first port 271 and the first side third port 273, the first fluid flowing out from the first heat exchanger 12 returns to the first heat exchanger 12 through the heat transfer member 40. In a case where the first side three-way valve 27 blocks the first side first port 271 and the first side second port 272 and connects the first side first port 271 and the first side third port 273, the first fluid flowing out from the first heat exchanger 12 does not pass through the heat transfer member 40 but returns to the first heat exchanger 12 through the first bypass flow path 24. Here, a first side check valve 28 is provided on the upstream side of a connection position of the first bypass flow path 24 in the first side upstream flow path part 21. The first side check valve 28 restricts the first fluid flowing from the first bypass flow path 24 into the first side upstream flow path part 21 from flowing back and into the heat transfer member 40. Note that although the first valve mechanism 26 includes the first side three-way valve 27, a configuration in which two or more two-way valves are combined may be used.

[0035] The first fluid is, for example, water. However, the first fluid is not particularly limited and may be, for example, brine. The brine may be an ether-based liquid or a fluorine-based liquid. In addition, the first fluid may be silicone oil. In addition, the first fluid may be a gas such as air, nitrogen, or argon.

[0036] The second fluid passage 30 includes a second side upstream flow path part 31 and a second side downstream flow path part 32. The second heat exchanger 15 includes an inflow port into which the second fluid (not illustrated) flows and an outflow port from which the second fluid flows out. A downstream end opening of the second side upstream flow path part 31 is connected to the inlet port of the second heat exchanger 15, and an upstream end opening of the second side downstream flow path part 32 is connected to the outflow port of the second heat exchanger 15. In addition, the second fluid passage 30 connects an upstream end opening of the second side upstream flow path part 31 to a downstream end opening of a flow path part (second heat transfer flow path part 42 to be described later) formed in the heat transfer member 40 and connects a downstream end opening of the second side downstream flow path part 32 to an upstream end opening of the above-described flow path part formed in the heat transfer member 40. As a result, the second fluid passage 30 forms a closed circuit in cooperation with the heat transfer member 40 and circulates the second fluid through the heat transfer member 40.

[0037] In a case where the second fluid passage 30 circulates the second fluid through the heat transfer member 40, the second side upstream flow path part 31 causes the second fluid flowing out from the heat transfer member 40 to flow and flow into the second heat exchanger 15. The second side downstream flow path part 32 receives and causes the second fluid that has exchanged heat with the natural refrigerant in the second heat exchanger 15 to flow. A second side pump 32A is provided in the second side downstream flow path part 32. The second side pump 32A generates a driving force for causing the second fluid to flow. Note that an installation position of the second side pump 32A is not particularly limited, and for example, the second side pump 32A may be provided in the second side upstream flow path part 31.

[0038] In addition, in the present embodiment, there are provided a second bypass flow path 34 connecting the second side upstream flow path part 31 and the second side downstream flow path part 32 and a second valve mechanism 36 that adjusts a ratio between a flow rate of the second fluid flowing from the second side downstream flow path part 32 to the heat transfer member 40 and a flow rate of the second fluid flowing through the second bypass flow path 34.

[0039] Specifically, the second bypass flow path 34 is connected to a part on the downstream side of the second side pump 32A in the second side downstream flow path part 32. More specifically, the second valve mechanism 36 in the present embodiment includes a second side three-way valve 37. The second side three-way valve 37 includes a second side first port 371, a second side second port 372, and a second side third port 373. Furthermore, a flow path from the second side first port 371 to the second side second port 372 constitutes a part of the second side downstream flow path part 32. Furthermore, the second bypass flow path 34 has an upstream end opening connected to the second side third port 373 and a downstream end opening connected to the second side downstream flow path part 32.

[0040] The second side three-way valve 37 can adjust a ratio between a flow rate of the first fluid received in the second side first port 371 and flowing out from the second side second port 372 and a flow rate of the second fluid received in the second side first port 371 and flowing out from the second side third port 373. As a result, it is possible to adjust the ratio between the flow rate of the second fluid flowing from the second side downstream flow path part 32 to the heat transfer member 40 and the flow rate of the second fluid flowing through the second bypass flow path 34.

[0041] In a case where the second side three-way valve 37 connects the second side first port 371 and the second side second port 372 and blocks the second side first port 371 and the second side third port 373, the second fluid flowing out from the second heat exchanger 15 returns to the second heat exchanger 15 through the heat transfer member 40. In a case where the second side three-way valve 37 blocks the second side first port 371 and the second side second port 372 and connects the second side first port 371 and the second side third port 373, the second fluid flowing out from the second heat exchanger 15 does not pass through the heat transfer member 40 but returns to the second heat exchanger 15 through the second bypass flow path 34. Here, a second side check valve 38 is provided on the upstream side of a connection position of the second bypass flow path 34 in the second side upstream flow path part 31. The second side check valve 38 restricts the second fluid flowing from the second bypass flow path 34 into the second side upstream flow path part 31 from flowing back and into the heat transfer member 40. Note that although the second valve mechanism 36 includes the second side three-way valve 37, a configuration in which two or more two-way valves are combined may be used.

[0042] In the present embodiment, basically, when the first fluid is caused to flow through the heat transfer member 40, the second valve mechanism 36 blocks a flow of the second fluid in the heat transfer member 40 and allows a flow of the second fluid in the second bypass flow path 34. Meanwhile, when the second fluid is caused to flow through the heat transfer member 40, the first valve mechanism 26 blocks a flow of the first fluid in the heat transfer member 40 and allows a flow of the first fluid in the first bypass flow path 24. However, the operation of such valve mechanisms 26 and 36 is not particularly limited, and the first fluid and the second fluid may flow into the heat transfer member 40 simultaneously. Note that the valve mechanisms 26 and 36 are controlled by the controller 100.

[0043] The second fluid is, for example, brine. The brine may be an ether-based liquid or a fluorine-based liquid. However, the second fluid is not particularly limited and may be silicone oil or water. In addition, the second fluid may be a gas such as air, nitrogen, or argon.

[0044] The heat transfer member 40 can receive and cause the first fluid flowing out from the first side downstream flow path part 22 to flow and then flow out to the first side upstream flow path part 21, and the heat transfer member 40 can receive and cause the second fluid flowing out from the second side downstream flow path part 32 to flow and then flow out to the second side upstream flow path part 31. Specifically, the first heat transfer flow path part 41 and the second heat transfer flow path part 42 are formed in the heat transfer member 40. Furthermore, an upstream end opening of the first heat transfer flow path part 41 is connected to the downstream end opening of the first side downstream flow path part 22, and a downstream end opening of the first heat transfer flow path part 41 is connected to the upstream end opening of the first side upstream flow path part 21. In addition, an upstream end opening of the second heat transfer flow path part 42 is connected to the downstream end opening of the second side downstream flow path part 32, and a downstream end opening of the second heat transfer flow path part 42 is connected to the upstream end opening of the second side upstream flow path part 31.

[0045] A plurality of first heat transfer flow path parts 41 and a plurality of second heat transfer flow path parts 42 are formed in the heat transfer member 40 in the present embodiment. The plurality of first heat transfer flow path parts 41 is positioned in parallel so as to be branched from the first side downstream flow path part 22. The plurality of second heat transfer flow path parts 42 is positioned in parallel so as to be branched from the second side downstream flow path part 32. Specifically, an upstream end opening of each of the first heat transfer flow path parts 41 is connected to the downstream end opening of the first side downstream flow path part 22 through a first common distribution flow path part 41A formed in the heat transfer member 40. The downstream end opening of each of the first heat transfer flow path parts 41 is connected to the upstream end opening of the first side upstream flow path part 21 through a first confluence and distribution flow path part 41B formed in the heat transfer member 40. Similarly, an upstream end opening of each of the second heat transfer flow path parts 42 is connected to the downstream end opening of the second side downstream flow path part 32 through the second common distribution flow path part 42A formed in the heat transfer member 40. A downstream end opening of each of the second heat transfer flow path parts 42 is connected to the upstream end opening of the second side upstream flow path part 31 through a second confluence and distribution flow path part 42B formed in the heat transfer member 40.

[0046] Note that a flow path configuration formed in the heat transfer member 40 is not limited to the above-described aspect. For example, without the first common distribution flow path part 41A and the first confluence and distribution flow path part 41B formed, each of the first heat transfer flow path parts 41 may be directly connected to the first side upstream flow path part 21 and the first side downstream flow path part 22. In addition, each of the first heat transfer flow path part 41 and the second heat transfer flow path part 42 may be a single flow path.

[0047] Fig. 2 illustrates the heat transfer member 40 and the holding member 50. As illustrated in Figs. 1 and 2, the heat transfer member 40 according to the present embodiment has a plate shape. Furthermore, in the present embodiment, a plurality of temperature control parts 44 protruding in a protrusion shape is provided on one main surface of the heat transfer member 40. The plurality of temperature control parts 44 is regularly arranged and in the illustrated example, is arranged in a line. The temperature control parts 44 may be arranged in a matrix or in a staggered arrangement. The inspection apparatus T1 can bring each of the temperature control parts 44 into contact with the object to be inspected 60. As a result, the temperature of each of a plurality of objects to be inspected 60 can be controlled by a different temperature control part 44. The temperature control part 44 is raised, but may be flush with a surrounding part or recessed.

[0048] Here, in the present embodiment, each of the first heat transfer flow path parts 41 includes a first side interface part 46 having a meandering shape. Each of the second heat transfer flow path parts 42 includes a second side interface part 48 having a meandering shape. Furthermore, any of a plurality of first side interface parts 46 and any of a plurality of second side interface parts 48 are brought close to each other to form a temperature control source 40S. Furthermore, the above-described temperature control part 44 is provided on a surface of the heat transfer member 40 on each temperature control source 40S. The temperature control source 40S is positioned inside the temperature control part 44.

[0049] The heat transfer member 40 is cooled or heated by the first fluid from the first fluid passage 20 and/or the second fluid from the second fluid passage 30. Furthermore, the first side interface part 46 and the second side interface part 48 that are a pair close to each other constitute the temperature control source 40S, and the temperature control part 44 provided on the surface of the heat transfer member 40 is efficiently cooled or heated by the temperature control source 40S. In other words, in the first side interface part 46 and the second side interface part 48, long fluid contact time per predetermined area of the heat transfer member 40 is ensured. As a result, it is possible to efficiently transfer or absorb heat.

[0050] The first side interface part 46 and the second side interface part 48 may have any shapes as long as the shapes make it possible to ensure long fluid contact time per predetermined area of the heat transfer member 40, and the shape may be, for example, a helical shape, a spiral shape, a shape that enlarges a flow path area, or the like. The thermal conductivity of the heat transfer member 40 is preferably high, and the heat transfer member 40 is preferably formed of metal such as aluminum or an aluminum alloy.

[0051] Note that in the present embodiment, the first heat transfer flow path part 41 and the second heat transfer flow path part 42 are formed in the heat transfer member 40. However, alternatively, a space for accommodating a part of the first fluid passage 20 and a part of the second fluid passage 30 may be formed in the heat transfer member 40. In this case, the temperature of the heat transfer member 40 is controlled by the first fluid through the part of the first fluid passage 20 and is controlled by the second fluid through the part of the second fluid passage 30.

[0052] As illustrated in Fig. 2, the holding member 50 has a plurality of accommodating parts 51 that have recessed shapes and accommodate surfaces of the objects to be inspected 60 while exposing the surfaces. An arrangement pattern of the plurality of accommodating parts 51 is the same as an arrangement pattern of the temperature control parts 44 in the heat transfer member 40.

[0053] In the present embodiment, the inspection apparatus T1 can adjust a relative distance between the heat transfer member 40 and the holding member 50 such that the temperature control part 44 of the heat transfer member 40 and the object to be inspected 60 held by the holding member 50 come into contact with each other as illustrated in Fig. 3. Only one of the heat transfer member 40 and the holding member 50 may be configured to be movable, or both may be configured to be movable. Note that although not illustrated, the holding member 50 is provided with a contact pin that is electrically connected to the object to be inspected 60 that is an electronic component.

[0054] Returning to Fig. 1, the controller 100 can control the first valve mechanism 26 and the second valve mechanism 36. Specifically, when the first fluid is caused to flow through the heat transfer member 40, the controller 100 controls the first valve mechanism 26 so that the first valve mechanism 26 allows the flow of the first fluid in the heat transfer member 40 and blocks the flow of the first fluid in the first bypass flow path 24. In addition, at this time, the controller 100 controls the second valve mechanism 36 so that the second valve mechanism 36 blocks the flow of the second fluid in the heat transfer member 40 and allows the flow of the second fluid in the second bypass flow path 34. Meanwhile, when the second fluid is caused to flow through the heat transfer member 40, the controller 100 controls the first valve mechanism 26 and the second valve mechanism 36 so that the first valve mechanism 26 and the second valve mechanism 36 are in states reverse to the above-described states. In addition, the controller 100 can adjust the relative distance between the heat transfer member 40 and the holding member 50 and can also adjust a rotation speed of the motor 17.

[0055] The controller 100 may include a computer including, for example, a CPU, a ROM, and the like and in this case, performs various processing according to a program stored in the ROM. In addition, the controller 100 may include another processor or an electric circuit (for example, field programmable gate alley (FPGA) or the like).

[0056] The inspection apparatus T1 according to the present embodiment described above can ensure good environmental performance by using the refrigeration cycle device 10 using the natural refrigerant. In addition, the heat transfer member 40 is cooled or heated by the first fluid and/or the second fluid cooled or heated by the refrigeration cycle device 10. Furthermore, since the heat transfer member 40 has a mechanical configuration for controlling the temperature of the object to be inspected 60, good durability can be ensured. Furthermore, the inspection apparatus T1 can cool and heat the heat transfer member 40 by the single refrigeration cycle device 10. Therefore, it is possible to suppress an increase in device size.

[0057] In the present embodiment, when the first fluid is caused to flow through the heat transfer member 40, the second valve mechanism 36 blocks the flow of the second fluid in the heat transfer member 40 and allows the flow of the second fluid in the second bypass flow path 34. When the second fluid is caused to flow through the heat transfer member 40, the first valve mechanism 26 blocks the flow of the first fluid in the heat transfer member 40 and allows the flow of the first fluid in the first bypass flow path 24. As a result, it is possible to suppress time for switching between the temperature control at low temperatures and the temperature control at high temperatures.

[0058] In addition, in the heat transfer member 40, the plurality of first heat transfer flow path parts 41 is positioned in parallel so as to be branched from the first side downstream flow path part 22. The plurality of second heat transfer flow path parts 42 is positioned in parallel so as to be branched from the second side downstream flow path part 32. As a result, the temperatures of the plurality of objects to be inspected 60 can be efficiently controlled. In particular, the refrigeration cycle device 10 using the natural refrigerant can generally ensure high refrigeration capacity and heating capacity. Therefore, the present embodiment makes it possible to uniformly and sufficiently cool or heat the plurality of objects to be inspected 60, so that a highly reliable inspection can be efficiently performed.

<Second Embodiment>

[0059] Next, with reference to Fig. 4, an inspection apparatus T2 according to a second embodiment will be described. Components in the present embodiment similar to those in the first embodiment are denoted by the same reference signs. Hereinafter, only differences from the first embodiment will be described.

[0060] In the second embodiment, a heat transfer member 40 holds an object to be inspected 60. The heat transfer member 40 is formed with a plurality of accommodating part and temperature control parts 44' that have recessed shapes and accommodates the objects to be inspected 60. A first side interface part 46 of a first heat transfer flow path part 41 and a second side interface part 48 of a second heat transfer flow path part 42 are positioned inside the heat transfer member 40 around the accommodating part and temperature control part 44'.

[0061] The accommodating part and temperature control part 44' holds the object to be inspected 60 through a mount member 49 placed on a bottom surface. The mount member 49 is in contact with the bottom surface and a side surface of the accommodating part and temperature control part 44'. Furthermore, the first side interface part 46 of the first heat transfer flow path part 41 and the second side interface part 48 of the second heat transfer flow path part 42 are configured to control the temperature of the object to be inspected 60 through the mount member 49. In addition, a contact pin that is electrically connected to the object to be inspected 60 is passed through the mount member 49. The inspection apparatus T2 according to the present embodiment may be configured as an inspection apparatus including a handler apparatus, may be configured as an inspection apparatus including a prober, or may be configured as a tester or the like.

<Third Embodiment>

[0062] Next, with reference to Fig. 5, an inspection apparatus T3 according to a third embodiment will be described. Components in the present embodiment similar to those in the first and second embodiments are denoted by the same reference signs. Hereinafter, only differences from the first and second embodiments will be described.

[0063] In the third embodiment, a holding member 50 has an accommodating part 51 that accommodates an object to be inspected 60. Furthermore, a fluid jacket 52 that causes air or liquid to flow inside the holding member 50 around the accommodating part 51 is formed. The fluid jacket 52 is opened to an outside in the accommodating part 51 and can cause air or liquid to flow into the accommodating part 51. In the present embodiment, the accommodating part 51 holds a mount member 49, and a space is formed between the mount member 49 and a bottom surface of the accommodating part 51. Furthermore, the air or liquid from the fluid jacket 52 flows into the space into the accommodating part 51. As a result, the air or liquid from the fluid jacket 52 cools or heats the object to be inspected 60 through the mount member 49.

[0064] Meanwhile, a heat transfer member 40 is in contact with the holding member 50 on the fluid jacket 52 that controls the temperature of the air or liquid flowing through the fluid jacket 52. The heat transfer member 40 cools or heats the air or liquid flowing through the fluid jacket 52 by a first heat transfer flow path part 41 and/or a second heat transfer flow path part 42. The inspection apparatus T3 according to the present embodiment may be configured as an inspection apparatus including a handler apparatus, may be configured as an inspection apparatus including a prober, or may be configured as a tester or the like.

<Fourth Embodiment>

[0065] Next, with reference to Fig. 6, an inspection apparatus T4 according to a fourth embodiment will be described. Components in the present embodiment similar to those in the first to third embodiments are denoted by the same reference signs. Hereinafter, only differences from the first to third embodiments will be described.

[0066] In the third embodiment, a heat transfer member 40 is in contact with a holding member 50, and the temperature of an object to be inspected 60 held by the holding member 50 is controlled through the holding member 50. A configuration of the heat transfer member 40 is similar to that in the first embodiment. Furthermore, the inspection apparatus T4 includes a movable probe base 71 that holds a probe 70 in contact with the object to be inspected 60.

[0067] Although the embodiments of the present invention have been described above, the present invention is not limited to the above-described embodiments, and various modifications can be made to the above-described embodiments. For example, in the above-described embodiments, the first fluid passage 20 and the second fluid passage 30 are connected to the common heat transfer member 40. Alternatively, a first heat transfer member and a second heat transfer member that are separated from each other may be used. In this case, the first heat transfer member receives and causes a first fluid flowing out from a first side downstream flow path part 22 of a first fluid passage 20 to flow and then causes a first fluid to flow out to a first side upstream flow path part 21. The second heat transfer member receives and causes a second fluid flowing out from a second side downstream flow path part 32 of a second fluid passage 30 to flow and then causes the second fluid to flow out to a second side upstream flow path part 31. In this case, the temperature of an object to be temperature-controlled is controlled through the first heat transfer member or the second heat transfer member.

Claims

1. A temperature control apparatus comprising:

   a refrigeration cycle device including a compressor, a first heat exchanger, an expander, and a second heat exchanger, wherein a natural refrigerant flowing out from the compressor passes through the first heat exchanger, the expander, and the second heat exchanger in this order and then circulates to the compressor, and the compressor and the expander are connected by a common drive shaft;

   a first fluid passage including a first side upstream flow path part that causes a first fluid to flow into the first heat exchanger and a first side downstream flow path part that receives and causes the first fluid to flow, the first fluid exchanging heat with the natural refrigerant passing through the first heat exchanger, the first fluid then flowing out from the first heat exchanger;

   a second fluid passage including a second side upstream flow path part that causes a second fluid to flow into the second heat exchanger and a second side downstream flow path part that receives and causes the second fluid to flow, the second fluid exchanging heat with the natural refrigerant passing through the second heat exchanger, the second fluid then flowing out from the second heat exchanger; and

   a heat transfer member capable of causing the first fluid to flow out to the first side upstream flow path part after receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, the heat transfer member being capable of causing the second fluid to flow out to the second side upstream flow path part after receiving and causing the second fluid flowing out from the second side downstream flow path part to flow, wherein

   a temperature of an object to be temperature-controlled is controlled through the heat transfer member.

2. The temperature control apparatus according to claim 1, further comprising:

   a first bypass flow path connecting the first side downstream flow path part and the first side upstream flow path part;

   a first valve mechanism that adjusts a ratio between a flow rate of the first fluid flowing from the first side downstream flow path part to the heat transfer member and a flow rate of the first fluid flowing through the first bypass flow path;

a second bypass flow path connecting the second side downstream flow path part and the second side upstream flow path part; and

a second valve mechanism that adjusts a ratio between a flow rate of the second fluid flowing from the second side downstream flow path part to the heat transfer member and a flow rate of the second fluid flowing through the second bypass flow path.

3. The temperature control apparatus according to claim 2, wherein

when the first fluid is caused to flow through the heat transfer member, the second valve mechanism blocks a flow of the second fluid in the heat transfer member and allows a flow of the second fluid in the second bypass flow path, and

when the second fluid is caused to flow through the heat transfer member, the first valve mechanism blocks a flow of the first fluid in the heat transfer member and allows a flow of the first fluid in the first bypass flow path.

4. The temperature control apparatus according to any one of claims 1 to 3, wherein in the heat transfer member, there is formed a plurality of first heat transfer flow path parts that causes the first fluid to flow out to the first side upstream flow path part after receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, and wherein a plurality of the first heat transfer flow path parts is positioned in parallel so as to be branched from the first side downstream flow path part.

5. The temperature control apparatus according to claim 4, wherein in the heat transfer member, there is formed a plurality of second heat transfer flow path parts that causes the second fluid to flow out to the second side upstream flow path part after receiving and causing the second fluid flowing out from the second side downstream flow path part to flow, and wherein a plurality of the second heat transfer flow path parts is positioned in parallel so as to be branched from the second side downstream flow path part.

6. The temperature control apparatus according to claim 5, wherein

each of the first heat transfer flow path parts includes a first side interface part having a meandering shape, a helical shape, a spiral shape, or a shape that enlarges a flow path area,

each of the second heat transfer flow path parts includes a second side interface part having a meandering shape, a helical shape, a spiral shape, or a shape that enlarges a flow path area,

the heat transfer member is provided with a plurality of temperature control parts, and

any of a plurality of the first side interface parts and any of a plurality of the second side interface parts are close to each other to form a temperature control source, and the temperature control part is provided on a surface of the heat transfer member on the temperature control source.

7. An inspection apparatus comprising:

a refrigeration cycle device including a compressor, a first heat exchanger, an expander, and a second heat exchanger, wherein a natural refrigerant flowing out from the compressor passes through the first heat exchanger, the expander, and the second heat exchanger in this order and then circulates to the compressor, and the compressor and the expander are connected by a common drive shaft;

a first fluid passage including a first side upstream flow path part that causes a first fluid to flow into the first heat exchanger and a first side downstream flow path part that receives and causes the first fluid to flow, the first fluid exchanging heat with the natural refrigerant passing through the first heat exchanger, the first fluid then flowing out from the first heat exchanger;

a second fluid passage including a second side upstream flow path part that causes a second fluid to flow into the second heat exchanger and a second side downstream flow path part that receives and causes the second fluid to flow, the second fluid exchanging heat with the natural refrigerant passing through the second heat exchanger, the second fluid then flowing out from the second heat exchanger; and

a heat transfer member capable of causing the first fluid to flow out to the first side upstream flow path part after receiving and causing the first fluid flowing out from the first side downstream flow path part to flow, the heat transfer member being capable of causing the second fluid to flow out to the second side upstream flow path part after receiving and causing the second fluid flowing out from the second side downstream flow path part to flow, wherein

a temperature of an object to be inspected that is held by a holding member or an object to be inspected that is held by the heat transfer member is controlled through the heat transfer member.

T1

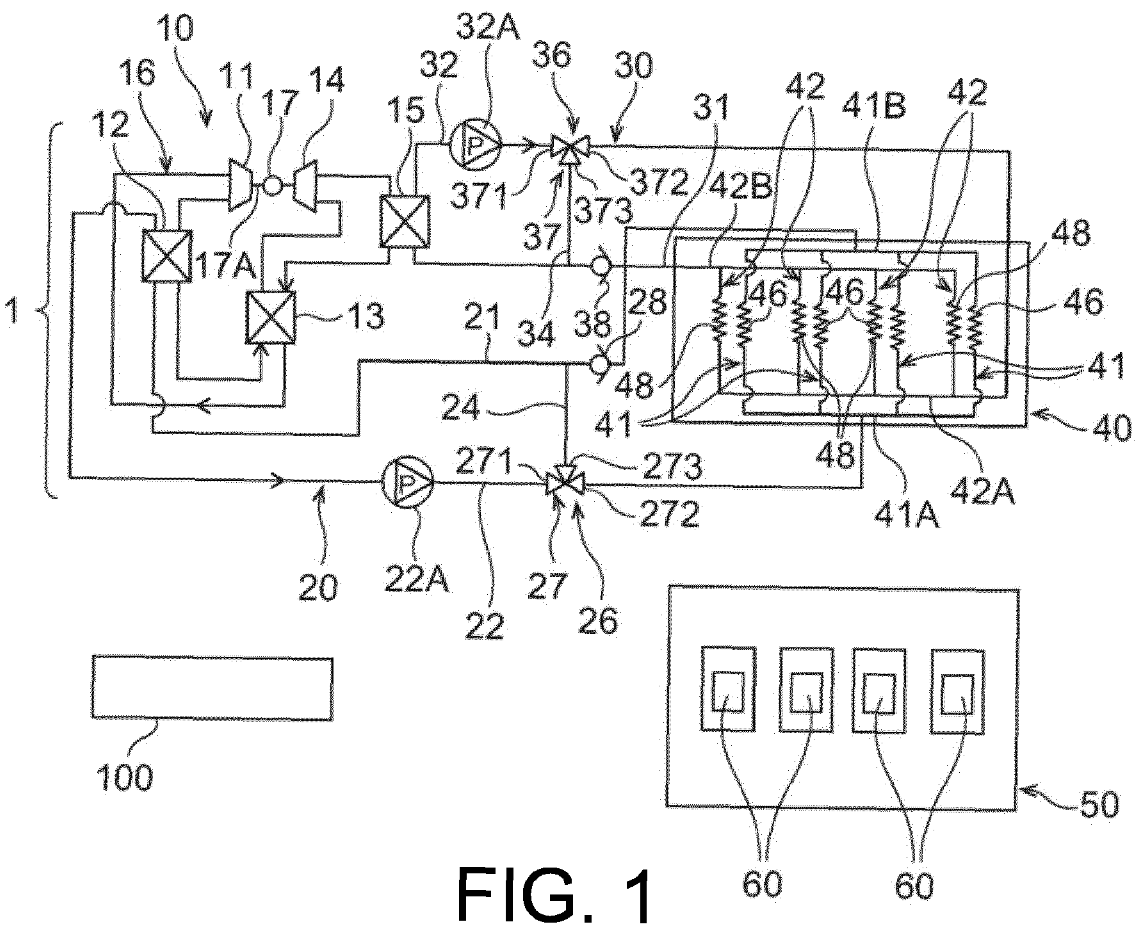
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FIG. 1

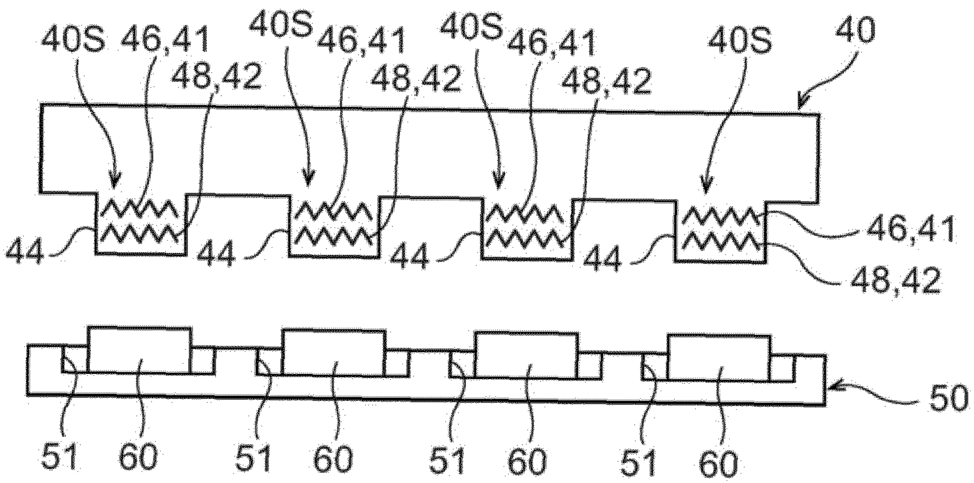
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FIG. 2

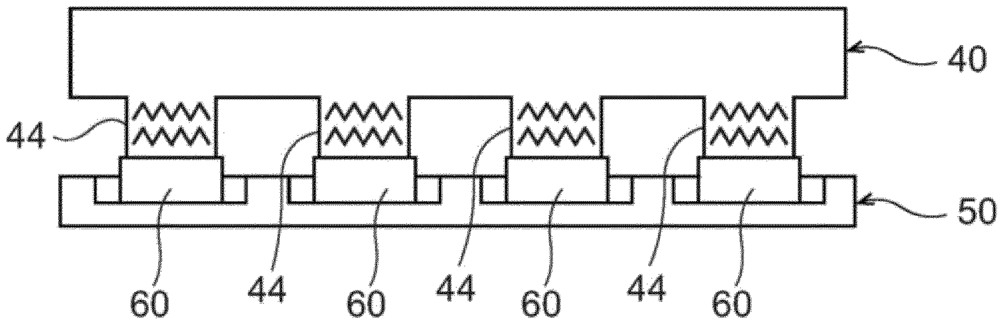
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FIG. 3

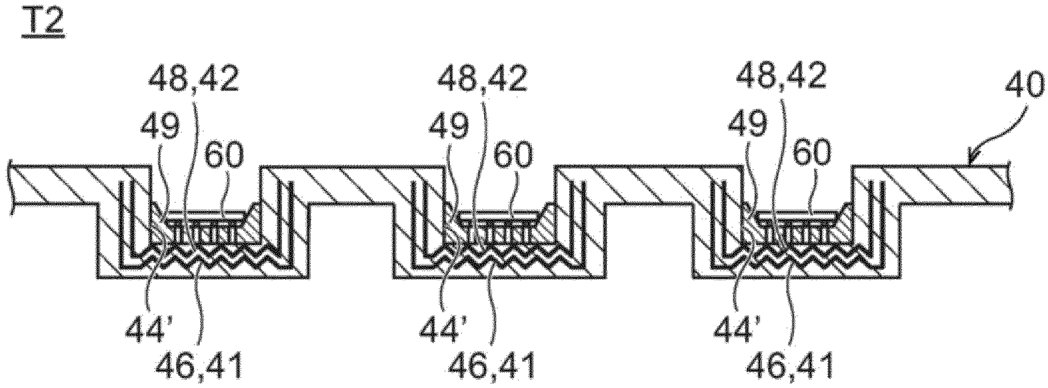
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FIG. 4

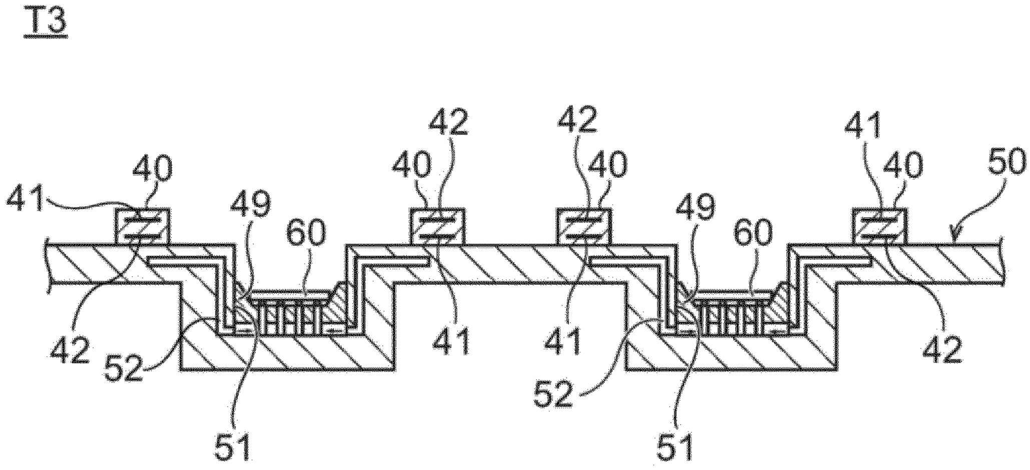
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FIG. 5

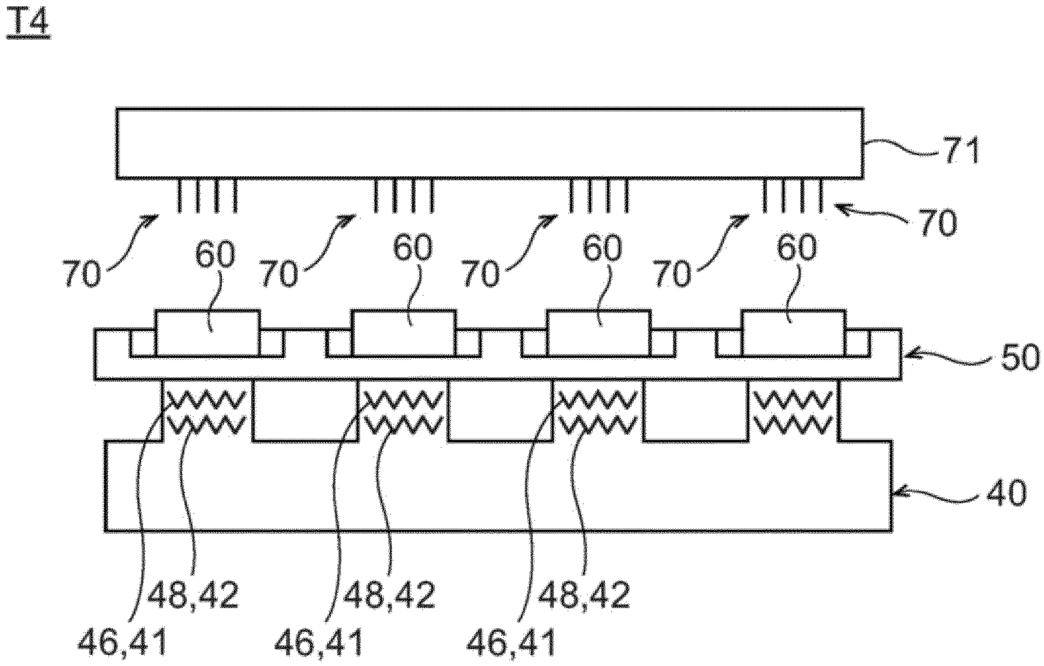
T4
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FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/023094

A. CLASSIFICATION OF SUBJECT MATTER

F25B 9/06(2006.01)i; ***F25B 1/00***(2006.01)i; ***F25B 9/00***(2006.01)i
FI: F25B9/06 K; F25B9/00 301; F25B1/00 396C; F25B1/00 399Y

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)

F25B1/00; F25B9/00; F25B9/06

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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.
Y A	JP 2013-60190 A (BEHR GMBH & CO KG) 04 April 2013 (2013-04-04) paragraphs [0022]-[0043], fig. 1	1, 4-5, 7 2-3, 6
Y	JP 57-40969 B2 (KOBE STEEL LTD) 31 August 1982 (1982-08-31) column 5, line 22 to column 7, line 10, drawings	1, 4-5, 7
Y	JP 6946113 B2 (MAEKAWA SEISAKUSHO KK) 06 October 2021 (2021-10-06) paragraphs [0028]-[0032], fig. 1	1, 4-5, 7
Y A	JP 2003-269809 A (ESPEC CORP) 25 September 2003 (2003-09-25) paragraph [0053], fig. 1-2	7 6
A	JP 2019-24055 A (SHINWA CONTROLS CO LTD) 14 February 2019 (2019-02-14) entire text, all drawings	1-7
A	JP 2002-168551 A (TOKYO ELECTRON LTD) 14 June 2002 (2002-06-14) entire text, all drawings	1-7

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"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 2023	**29 August 2023**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/023094

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 209961863 U (SHENZHEN JIANKUN METAL PRODUCT CO., LTD.) 17 January 2020 (2020-01-17) entire text, all drawings	1-7

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/023094

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2013-60190 A	04 April 2013	US 2013/0061627 A1 paragraphs [0025]-[0047], fig. 1 EP 2570288 A2 DE 102011082584 A1	
JP 57-40969 B2	31 August 1982	(Family: none)	
JP 6946113 B2	06 October 2021	(Family: none)	
JP 2003-269809 A	25 September 2003	US 2003/0126875 A1 paragraph [0108], fig. 1-2 DE 10300487 A1 CN 1432782 A	
JP 2019-24055 A	14 February 2019	US 2020/0132344 A1 WO 2019/021968 A1 TW 201920887 A KR 10-2020-0032041 A CN 110959187 A	
JP 2002-168551 A	14 June 2002	US 2004/0068997 A1 WO 2002/044634 A1	
CN 209961863 U	17 January 2020	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6946113 B **[0004]**