(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 109 022 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.12.2022 Bulletin 2022/52

(21) Application number: **20920315.7**

(22) Date of filing: **22.12.2020**

(51) International Patent Classification (IPC):
F27D 11/02 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F27D 11/02

(86) International application number:
PCT/JP2020/047999

(87) International publication number:
WO 2021/166430 (26.08.2021 Gazette 2021/34)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **18.02.2020 JP 2020025454**

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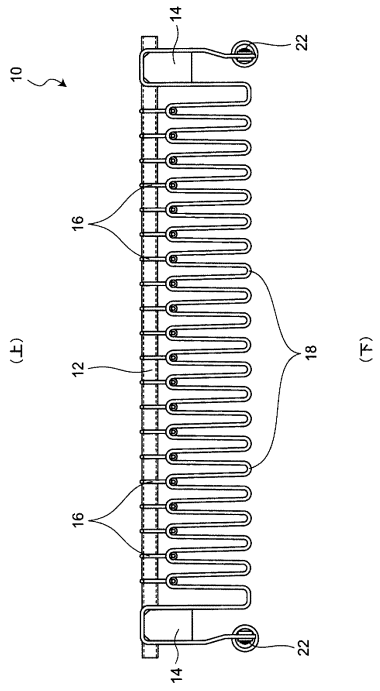
(54) ELECTRIC HEATER DEVICE AND HEAT-TREATMENT FURNACE PROVIDED WITH SAME

(57) An electric heater device attached to an inner side wall of a heat treatment furnace, includes a bar having a rod shape, a bar support for supporting an end portion of the bar with the inner side wall, a plurality of hooks suspended from the bar, and an electric heater hooked and supported by the plurality of hooks.

Fig.4



EP 4 109 022 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to an electric heater device attached to an inner side wall of a heat treatment furnace, and a heat treatment furnace provided with the electric heater device.

BACKGROUND ART

[0002] In a conventional heat treatment furnace of electric-heating, as in Patent Documents 1 and 2, a wire-like or flat plate-like heater element bent into a wave shape is suspended by hangers (pins or hooks) in the furnace with upper portions of the wave shape being hooked to the hangers.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0003]

Patent Document 1: Japanese Utility Model Laid-open Publication No. 62-163895

Patent Document 2: Japanese Utility Model Laid-open Publication No. 60-45367

Patent Document 3: Japanese Patent Laid-open Publication No. 2009-250548

Patent Document 4: Japanese Patent Laid-open Publication No. 06-221770

Patent Document 5: Japanese Patent Laid-open Publication No. 2005-282928

Patent Document 6: Japanese Patent Laid-open Publication No. 60-56025

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004] However, since the heater element is thermally deformable, it is necessary to suspend the heater element at all upper portions of the wave shape in order to fix its position. Therefore, it takes much time and effort to attach a large number of hangers in the furnace and suspend the heater element.

[0005] Further, there is also a cylindrical furnace body, and a heater is suspended on the entire circumference of the inner side wall as in Patent Document 3.

[0006] In addition, as in Patent Documents 4 and 5, when a furnace wall is made of a ceramic fiber, hangers are usually inserted and held thereto. In this case, the hangers may fall due to their own weight. Therefore, as in Patent Document 6, there is a case where hangers are inserted into a metal frame body protruding from an outer shell. However, since the hangers are horizontally inserted, the hangers may come off after many years of use.

[0007] The present disclosure has been made to solve the above problems, and an object of the present disclosure is to provide an electric heater device which can be installed easily, and a heat treatment furnace provided with the same.

SOLUTIONS TO THE PROBLEMS

[0008] An electric heater device according to an aspect of the present disclosure is an electric heater device attached to an inner side wall of a heat treatment furnace. The electric heater device includes a bar, a bar support for supporting an end portion of the bar with the inner side wall, a plurality of hooks suspended from the bar, and an electric heater hooked and supported by the plurality of hooks.

[0009] According to the above configuration, carrying the electric heater into the heat treatment furnace in a state of being hooked on the plurality of hooks suspended from the bar can perform attachment of the electric heater device to the inner side wall merely by placing the bar onto the bar support. Thus, assembling operation of the heater outside the furnace, arrangement operation of another heater in the furnace can be simultaneously performed, and thus construction period can be reduced. In addition, shortening work time in the furnace as aerial work also leads to a reduction in risk of dangerous work.

[0010] In the electric heater device, the bar support may be attachable to and detachable from a tubular portion of the inner side wall. According to the above configuration, replacement and repair of the bar support are easy.

[0011] In the electric heater device, the bar support may protrude inward of the heat treatment furnace at an upward angle with respect to a horizontal direction with being disposed in the tubular portion. According to the above configuration, the bar support is less likely to come off from the tubular portion.

[0012] The electric heater device may further include an electrode which protrudes from the inner side wall at a position lower than the bar support and to which an end portion of the electric heater is connected, and the electric heater may be hooked along an upper surface of the bar support and then extend downward toward the electrode. According to the above configuration, as compared with a case where the end portion of the electric heater is extended in the horizontal direction to be connected to the electrode, a stress generated at the end portion can be reduced, and thus the end portion of the electric heater can be accurately connected to the electrode.

[0013] In the electric heater device, the inner side wall may have a rectangular shape in a plan view, and the bar may extend linearly along the inner side wall. Accord-

ing to the above configuration, the bar of a general-purpose member can be used.

[0014] In the electric heater device, the inner side wall may have a circular shape in a plan view, and the bar may extend in an arc shape along the inner side wall. According to the above configuration, even when the inner side wall has a circular cross section, the electric heater device can be disposed depending on the shape of the inner side wall.

[0015] A heat treatment furnace according to an aspect of the present disclosure includes the electric heater device and the inner side wall to which the electric heater device is attached.

[0016] According to the above configuration, an effect similar to that of the electric heater device can be obtained.

EFFECTS OF THE INVENTION

[0017] According to the present disclosure, installation of the electric heater device can be easy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a plan view illustrating a schematic configuration of a heat treatment furnace in a first embodiment.

Fig. 2 is a plan view of an electric heater device in the first embodiment.

Fig. 3 is a perspective view of the electric heater device in the first embodiment.

Fig. 4 is a front view of the electric heater device in the first embodiment.

Fig. 5 is a vertical sectional view illustrating a bar support and its periphery of the electric heater device in the first embodiment.

Fig. 6 is a vertical sectional view illustrating a hook and its periphery of the electric heater device in the first embodiment.

Fig. 7 is a plan view illustrating the schematic configuration of the heat treatment furnace in a modification.

Fig. 8 is a schematic diagram illustrating an actual use example of the electric heater device in the first embodiment.

Fig. 9 is a plan view illustrating the schematic configuration of the heat treatment furnace in another modification.

MODES FOR CARRYING OUT THE INVENTION

[0019] Hereinafter, preferred embodiments of an electric heater device and a heat treatment furnace provided with the same according to the present disclosure will be described with reference to the accompanying drawings. The present disclosure is not limited to specific configurations of the following embodiments, and configurations based on similar technical ideas are included in the present disclosure.

FIRST EMBODIMENT

[0020] Fig. 1 is a plan view illustrating a schematic configuration of a heat treatment furnace 2 in a first embodiment.

[0021] The heat treatment furnace 2 is a furnace body for including an object 6 therein to heat the object 6. In the heat treatment furnace 2 of the first embodiment, an electric heater is used as a heating means, and the object 6 is housed in a muffle 8 to be indirectly heated from outside the muffle 8. As illustrated in Fig. 1, the heat treatment furnace 2 includes a furnace wall 4, the muffle 8 to house the object 6, and a plurality of electric heater devices 10.

[0022] The furnace wall 4 is a wall member constituting an outer shell of the heat treatment furnace 2. The furnace wall 4 is made of a heat-insulating material such as a brick or a ceramic fiber board. An inner side surface of the furnace wall 4 is referred to as an inner side wall 5. The inner side wall 5 in the first embodiment is formed in a rectangular shape in a plan view.

[0023] The muffle 8 is a member to house the object 6. The object 6 is, for example, a steel strip, and is conveyed in a direction perpendicular to a paper surface. The muffle 8 in the first embodiment has a cylindrical shape.

[0024] An internal space S1 of the muffle 8 is sealed with respect to an external space S2 of the muffle 8, that is, a space surrounded by the inner side wall 5 and the muffle 8. The external space S2 of the muffle 8 is opened to the atmosphere, whereas the internal space S1 of the muffle 8 is filled with a gas (for example, nitrogen) different from the atmosphere. The internal space S1 of the muffle 8 is under a positive pressure so that the atmosphere does not flow into the internal space S1 from the external space S2.

[0025] The electric heater device 10 is a heater device of electric-heating to indirectly heat the object 6 in the internal space S1 of the muffle 8. The electric heater device 10 is attached to the inner side wall 5 in the external space S2 of the muffle 8.

[0026] The electric heater devices 10 in the first embodiment are provided for respective surfaces of the inner side wall 5, and are arranged in multiple stages in a vertical furnace length direction as illustrated in Fig. 8. Each of the electric heater devices 10 has the same configuration.

[0027] A detailed configuration of the electric heater device 10 will be described with reference to Figs. 2 to 6. Fig. 2 is a partially enlarged view of Fig. 1 illustrating the electric heater device 10 and its periphery. Fig. 3 is a perspective view of the electric heater device 10, and Fig. 4 is a front view of the electric heater device 10. Fig. 5 is a vertical sectional view illustrating a bar support 14

and its periphery of the electric heater device 10, and Fig. 6 is a vertical sectional view illustrating a hook 16 and its periphery of the electric heater device 10.

[0028] As illustrated in Figs. 2 to 4, the electric heater device 10 includes a bar 12, the bar support 14 (Figs. 2 and 4), a plurality of the hooks 16, and an electric heater 18.

[0029] The bar 12 is a rod-like member. The bar 12 is not limited to a rod shape having a circular cross section, and may have any shape such as a flat plate shape having a rectangular cross section. The bar 12 in the first embodiment extends in a straight line and has a hollow cylindrical shape. A material of the bar 12 is an insulating material such as ceramics. The bar 12 is supported by the bar supports 14.

[0030] The bar support 14 is a member for supporting the bar 12 on the inner side wall 5. Two bar supports 14 are provided to support both end portions of the bar 12. A material of the bar support 14 is an insulating member such as a brick.

[0031] The bar support 14 is attachable to and detachable from a tubular portion 20 provided on the inner side wall 5. The tubular portion 20 is reinforced by a triangular plate 21 (Fig. 2) and welded to the inner side wall 5. Figs. 2 and 5 illustrate a state in which the bar support 14 is inserted into the tubular portion 20 of the inner side wall 5.

[0032] As illustrated in Fig. 5, the bar support 14 extends in a direction A toward an internal space of the heat treatment furnace 2 with being inserted into the tubular portion 20. The direction A in which the bar support 14 extends is upward at an angle θ with respect to a horizontal direction H. The angle θ is an acute angle.

[0033] The bar support 14 has a recess 15 at its tip portion. The recess 15 is formed on an upper surface of the bar support 14 to receive the bar 12. Each of the end portions of the bar 12 is set in the recess 15 of the bar support 14 so that the bar 12 is supported by the bar supports 14.

[0034] Returning to Figs. 2 to 4, the hooks 16 are members suspended from the bar 12 to hook and support the electric heater 18. The plurality of hooks 16 are provided depending on a wave shape of the electric heater 18. The hooks 16 in the first embodiment are ring-shaped, and the bar 12 is passed through rings of the hooks 16. A shape of the hook 16 is not limited to a ring, and may be other shape such as an S shape as long as it can be suspended from the bar 12 to support the electric heater 18.

[0035] As illustrated in Fig. 6, the hook 16 in the first embodiment includes a main body 30, a shaft 32, and an insulator 34 made of ceramics. The main body 30 is a member that is engaged with the bar 12 to be suspended from the bar 12. The shaft 32 is a member that is passed through a hole of the insulator 34 and welded to the main body 30. The shaft 32 has a ring shape similarly to the main body 30. The insulator 34 is provided with a groove to support an upper end portion of the wave shape of the electric heater 18 from below.

[0036] Passing the electric heater 18 through the ring-shaped hooks 16 from an end of the electric heater 18 in order can achieve easy disposition of the electric heater 18 in the rings of the hooks 16.

[0037] The electric heater 18 is a heater of electric-heating to heat the object 6. The electric heater 18 in the first embodiment is an electric heating wire and has a rod shape (in other words, wire shape) made of metal (for example, a nichrome wire). As illustrated in Figs. 3 and 4, the electric heater 18 has a wave shape, and each of upper end portions, which are folded portions, is hooked on the hook 16. The electric heater 18 is not limited to a rod-like heater, and may be a flat ribbon-like heater.

[0038] As illustrated in Figs. 4 and 5, both end portions of the electric heater 18 are connected (for example, welded) to the electrodes 22. The electrodes 22 are metal members for energizing the electric heater 18, and protrude from outside the heat treatment furnace 2 into the heat treatment furnace 2 through the furnace wall 4. The electrodes 22 are disposed below the tubular portions 20 in which the bar supports 14 are disposed.

[0039] As illustrated in Figs. 4 and 5, the both end portions of the electric heater 18 extend downward after being hooked on the upper surfaces of the bar supports 14, and are connected to the electrodes 22. According to such an arrangement, stress applied to the both end portions of the electric heater 18 is smaller than that in a case where the both end portions of the electric heater 18 are extended in the horizontal direction to be connected to the electrodes 22. The both end portions of the electric heater 18 may be wound around tips of the bar supports 14.

[0040] As described above, the electric heater device 10 of the first embodiment is a device attached to the inner side wall 5 of the heat treatment furnace 2, and includes the bar 12, the bar support 14 for supporting an end portion of the bar 12 with the inner side wall 5, the plurality of hooks 16 suspended from the bar 12, and the electric heater 18 hooked and supported by the plurality of hooks 16.

[0041] According to such a configuration, carrying the electric heater 18 into the heat treatment furnace 2 in a state of being hooked on the plurality of hooks 16 suspended from the bar 12 can perform attachment of the electric heater device 10 to the inner side wall 5 merely by placing the bar 12 onto the bar support 14. Thus, assembling operation of the electric heater device 10 outside the furnace, arrangement operation of another electric heater device 10 in the furnace can be simultaneously performed, and thus construction period can be reduced. In addition, shortening work time in the furnace as an aerial work also leads to a reduction in risk of dangerous work. In this manner, installation work of the electric heater device 10 can be easy. In addition, since the electric heater 18 is supported by the bar 12 via the plurality of hooks 16, heat of the electric heater 18 is not directly transmitted to the bar 12, so that thermal damage of the bar 12 can be suppressed. Thus, heat-resistant life of

the bar 12 and the electric heater device 10 can be extended.

[0042] Further, according to the electric heater device 10 of the first embodiment, the bar support 14 is attachable to and detachable from the tubular portion 20 of the inner side wall 5. According to such a configuration, replacement and repair of the bar support 14 are easy.

[0043] Further, according to the electric heater device 10 of the first embodiment, the bar support 14 protrudes inward of the heat treatment furnace 2 at an upward angle with respect to the horizontal direction H with being disposed in the tubular portion 20. According to such a configuration, the bar support 14 can be made difficult to come off from the tubular portion 20.

[0044] In addition, the electric heater device 10 of the first embodiment further includes the electrode 22 which protrudes from the inner side wall 5 at a position lower than the bar support 14 and to which an end portion of the electric heater 18 is connected. The electric heater 18 is hooked along the upper surface of the bar support 14 and then extends downward toward the electrode 22. According to such a configuration, as compared with a case where the end portion of the electric heater 18 is extended in the horizontal direction and connected to the electrode 22, a stress generated at the end portion can be reduced, and deformation and damage of the end portion can be suppressed. Thus, the electric heater 18 can be accurately connected to the electrode 22.

[0045] Further, according to the electric heater device 10 of the first embodiment, the inner side wall 5 has a rectangular shape in a plan view, and the bar 12 extends linearly along the linear inner side wall 5. According to such a configuration, the bar 12 of a general-purpose member can be used, and thus the manufacturing cost of the electric heater device 10 can be reduced.

[0046] Further, the heat treatment furnace 2 of the first embodiment includes the electric heater device 10 described above and the inner side wall 5 to which the electric heater device 10 is attached. According to such a configuration, an effect similar to that of the electric heater device 10 described above can be obtained.

[0047] Hereinabove, although the invention of the present disclosure has been described with reference to the first embodiment described above, the invention of the present disclosure is not limited to the first embodiment. For example, although the bar supports 14 to support the bar 12 are attachable to and detachable from the tubular portions 20 of the inner side wall 5 in the first embodiment described above, the present disclosure is not limited to such a case. For example, as in a heat treatment furnace 100 illustrated in Fig. 7, an electric heater device 106 may be attached to a furnace wall 102 via through-holes 104 provided in the furnace wall 102 with a bar 108 of the electric heater device 106 being inserted into the through-holes 104. According to such a configuration, the electric heater device 106 can be supported by the furnace wall 102 while omitting the bar supports 14 as in the first embodiment, thereby achieving simple configuration. In a modification illustrated in Fig. 7, the through-holes 104 provided in the furnace wall 102 functions as the "bar supports". A gap between the through-hole 104 and the bar 108 may be closed by a separate means, for example, by filling a heat insulating material.

[0048] Further, although the inner side wall 5 has a rectangular shape in a plan view in the first embodiment, the present disclosure is not limited to such a case. The inner side wall 5 may have, for example, a circular shape as illustrated in Fig. 9. As shown in Fig. 9, a bar having a gently curved shape may be used instead of the linear bar 12 of the first embodiment. In a heat treatment furnace 200 illustrated in Fig. 9, a furnace wall 204 is formed in an arc shape, and has an inner side wall 205 having a circular cross-sectional shape. Bars 212 of an electric heater device 210 extend in an arc shape along the inner side wall 205. The bars 212 are supported by first bar supports 214A and second bar supports 214B.

[0049] Each of the first bar supports 214A is a brick support to support two end portions close to each other of two bars 212, and each of the second bar supports 214B is a brick support to support an intermediate portion of one bar 212. Using the first bar support 214A for the two bars 212 leads to an efficient configuration. In addition, providing the second bar support 214B in addition to the first bar support 214A can support the bar 212 stably with restricting rotation of the bar 212, as compared with a configuration in which only the both end portions of the bar 212 are supported by the first bar supports 214A.

[0050] Note that by appropriately combining arbitrary embodiments among various embodiments described above, effects of respective embodiments can be achieved.

[0051] Although the present disclosure has been fully described in connection with the preferred embodiments with reference to the accompanying drawings, various variations and modifications will be apparent to those skilled in the art. It should be understood that such variations and modifications are included within the present disclosure as long as they do not depart from the scope of the present disclosure as set forth in the appended claims. In addition, combinations of elements and changes in order in each embodiment can be realized without departing from the scope and spirit of the present disclosure.

INDUSTRIAL APPLICABILITY

[0052] The present disclosure is applicable to any electric heater device attached to an inner side wall of a heat treatment furnace, and to any heat treatment furnace provided with the electric heater device.

DESCRIPTION OF REFERENCE SIGNS

[0053]

2: Heat treatment furnace
4: Furnace wall
5: Inner side wall
6: Object (to be heated)
8: Muffle
10: Electric heater device
12: Bar
14: Bar support
15: Recess
16: Hook
18: Electric heater
20: Tubular portion
21: Triangular plate
22: Electrode
30: Main body
32: Shaft
34: Insulator
100: Heat treatment furnace
102: Furnace wall
104: Through-hole
106: Electric heater device
108: Bar
200: Heat treatment furnace
204: Furnace wall
205: Inner side wall
210: Electric heater device
212: Bar
214A: First bar support
214B: Second bar support
S1: Internal space of muffle
S2: External space of muffle
A: Direction in which bar support extends
H: Horizontal direction
θ: Angle

Claims

1. An electric heater device attached to an inner side wall of a heat treatment furnace, the electric heater device comprising:

a bar;
a bar support for supporting an end portion of the bar with the inner side wall;
a plurality of hooks suspended from the bar; and
an electric heater hooked and supported by the plurality of hooks.

2. The electric heater device according to claim 1, wherein the bar support is attachable to and detachable from a tubular portion of the inner side wall.

3. The electric heater device according to claim 2, wherein the bar support protrudes inward of the heat treatment furnace at an upward angle with respect to a horizontal direction with being disposed in the tubular portion.

4. The electric heater device according to any one of claims 1 to 3, further comprising

an electrode which protrudes from the inner side wall at a position lower than the bar support and to which an end portion of the electric heater is connected, wherein
the electric heater is hooked along an upper surface of the bar support and then extends downward toward the electrode.

5. The electric heater device according to any one of claims 1 to 4, wherein

the inner side wall has a rectangular shape in a plan view, and
the bar extends linearly along the inner side wall.

6. The electric heater device according to any one of claims 1 to 4, wherein

the inner side wall has a circular shape in a plan view, and
the bar extends in an arc shape along the inner side wall.

7. A heat treatment furnace comprising:

the electric heater device according to any one of claims 1 to 6; and
the inner side wall to which the electric heater device is attached.

Fig.1

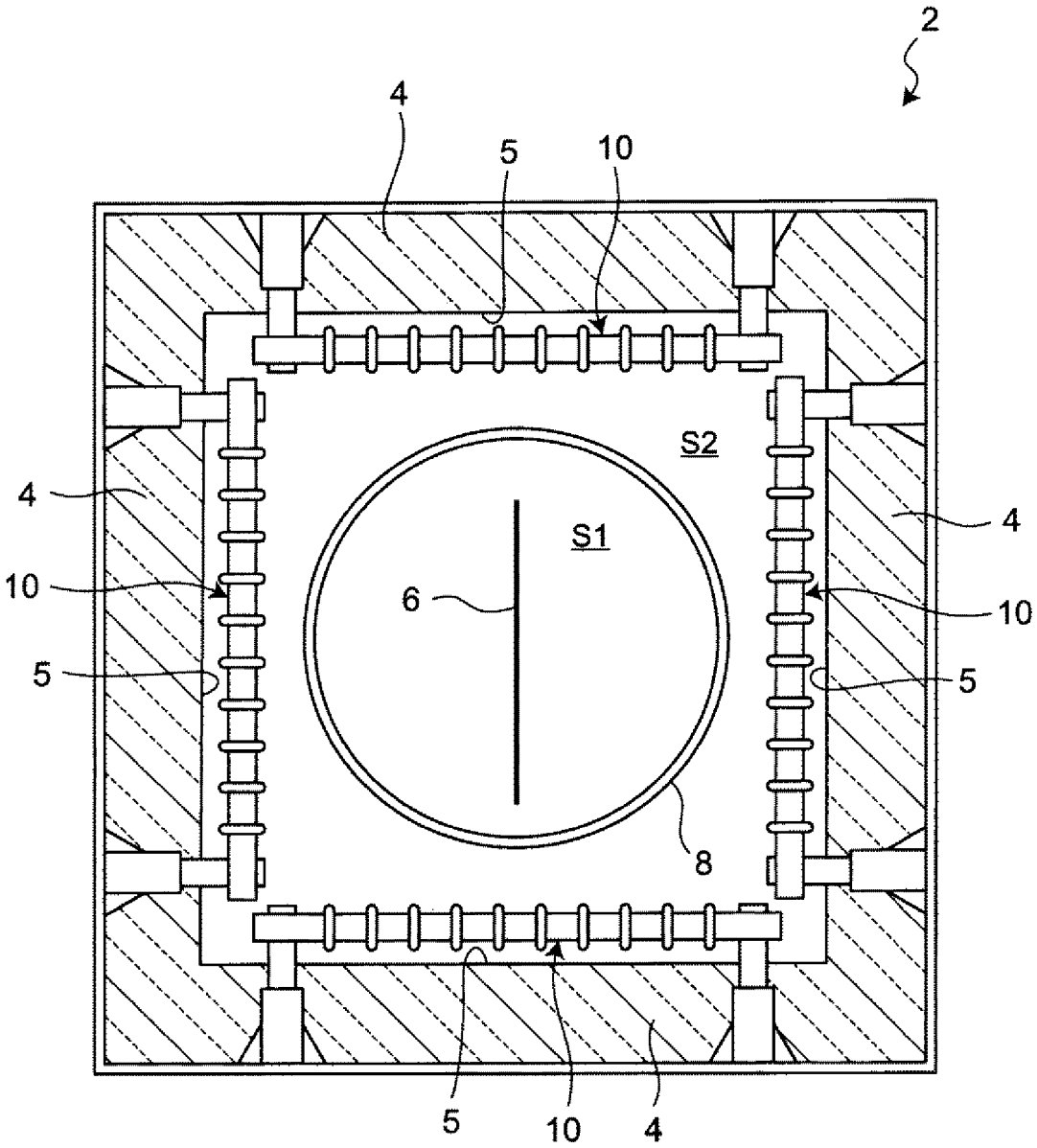


Fig.2

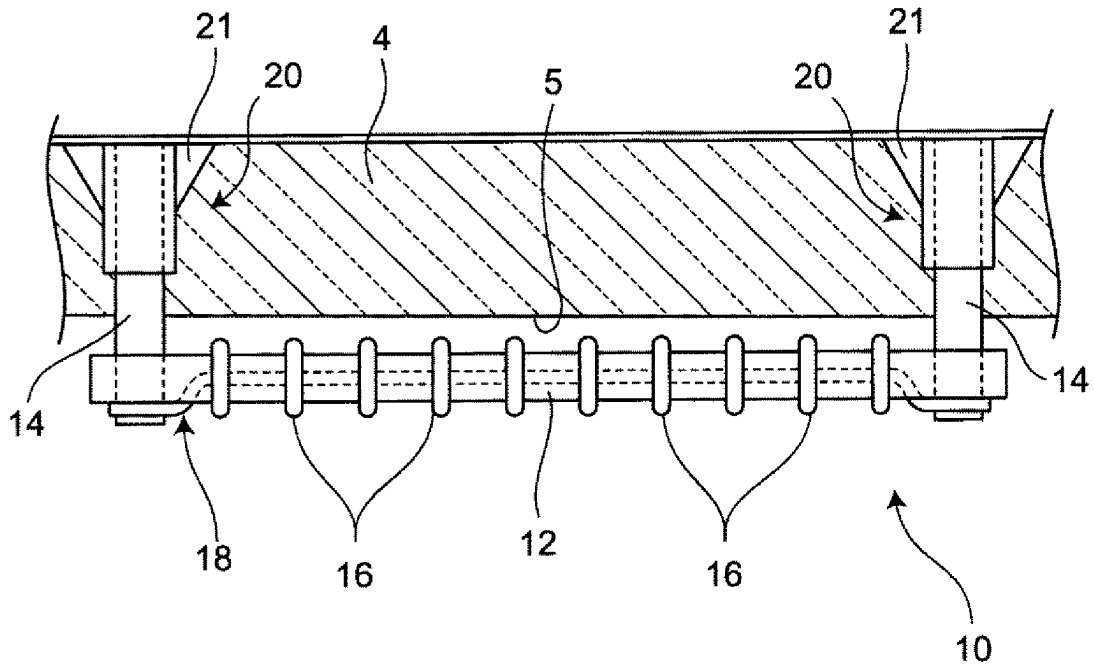


Fig.3

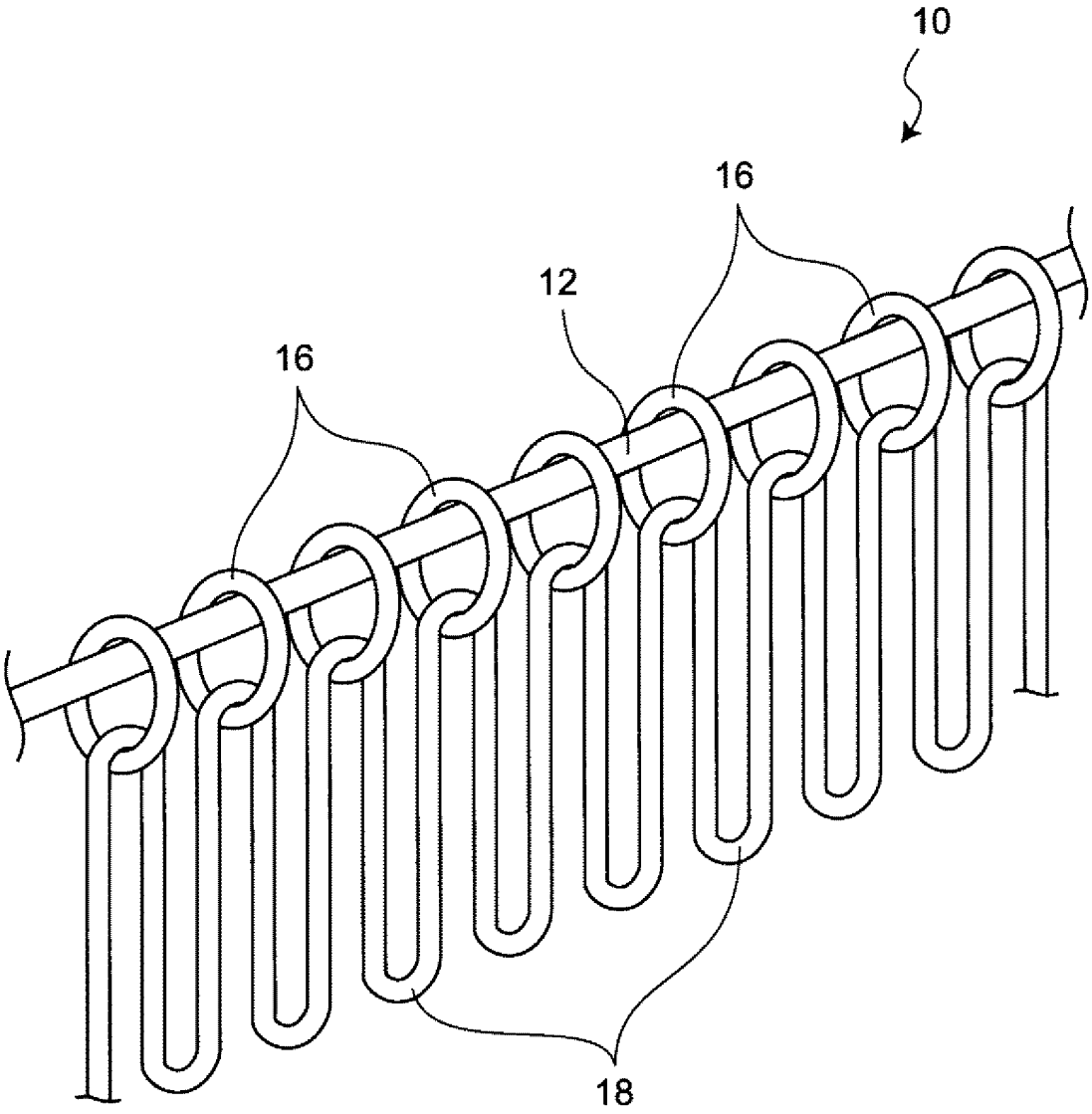


Fig.4

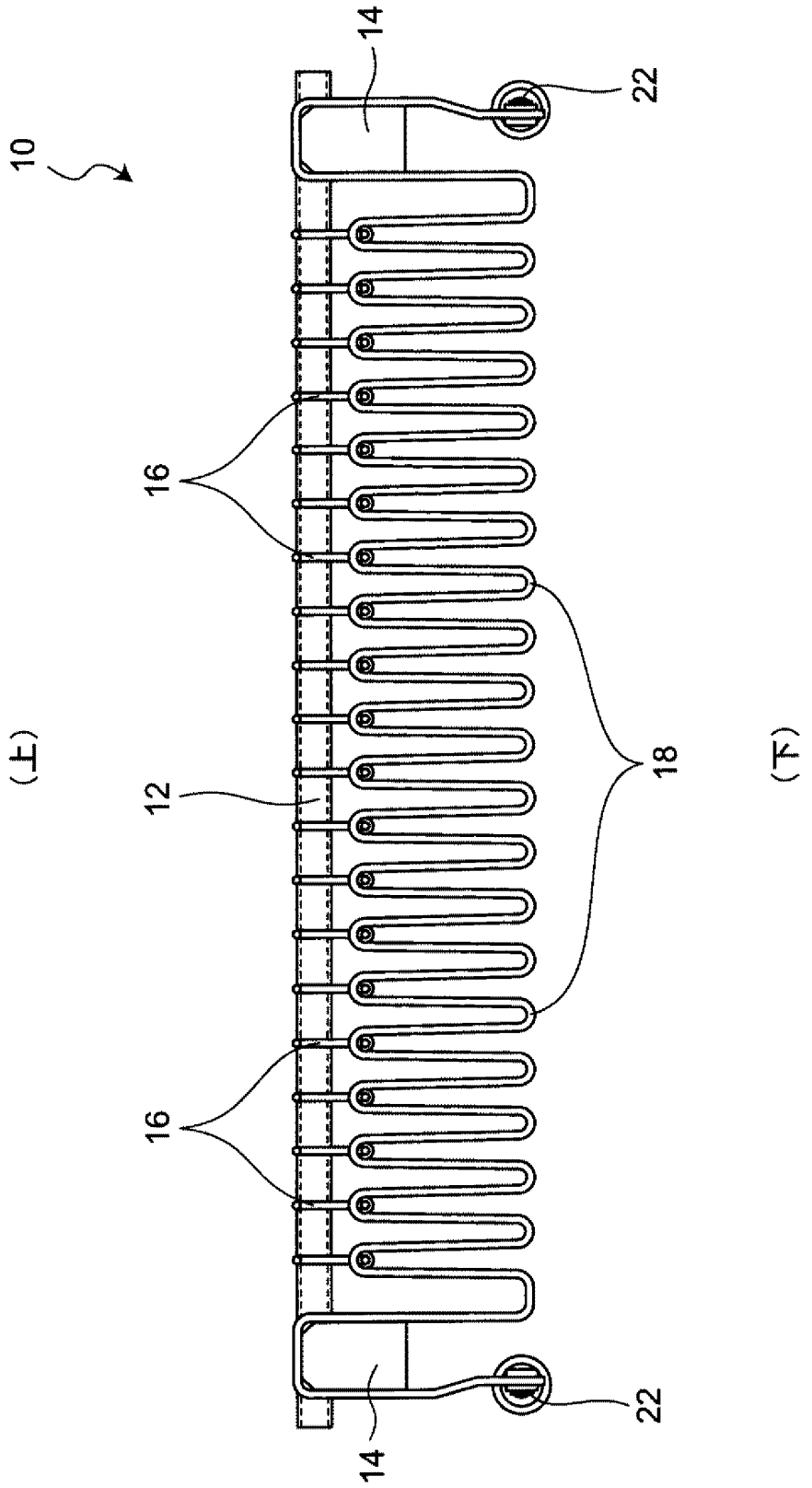


Fig.5

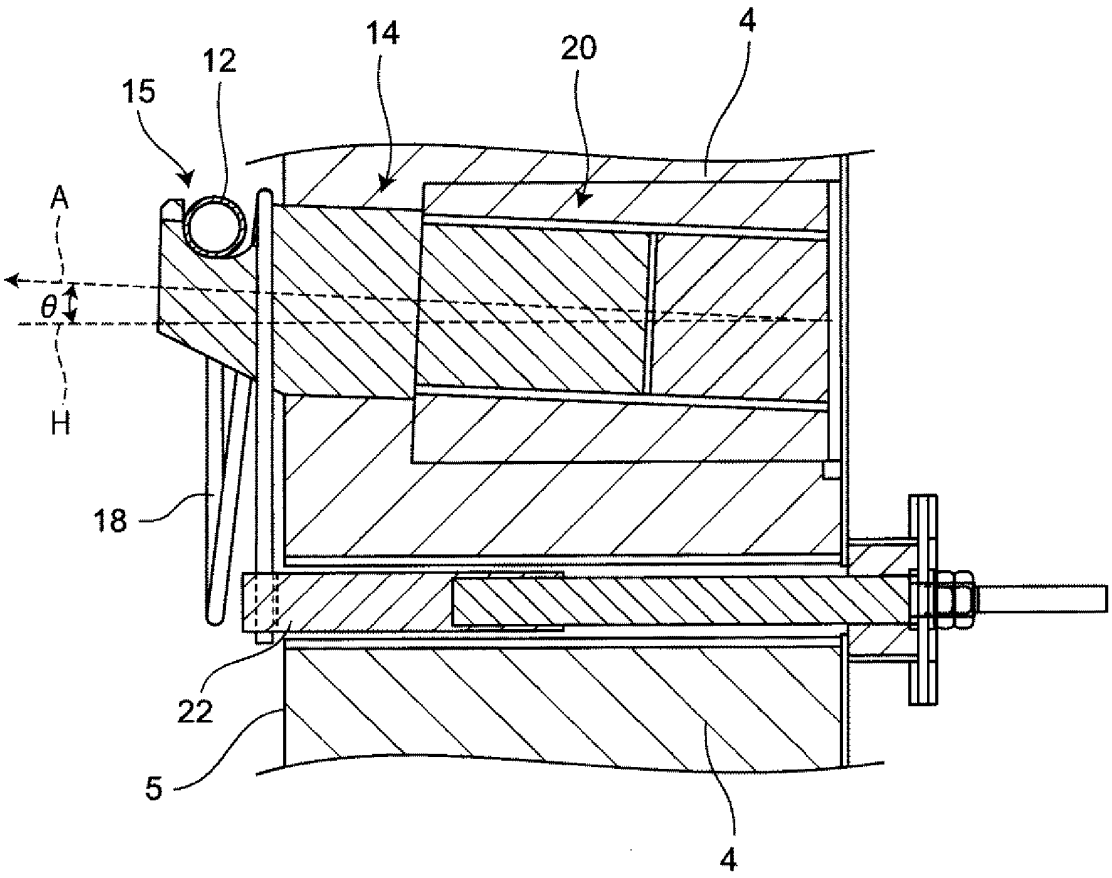


Fig.6

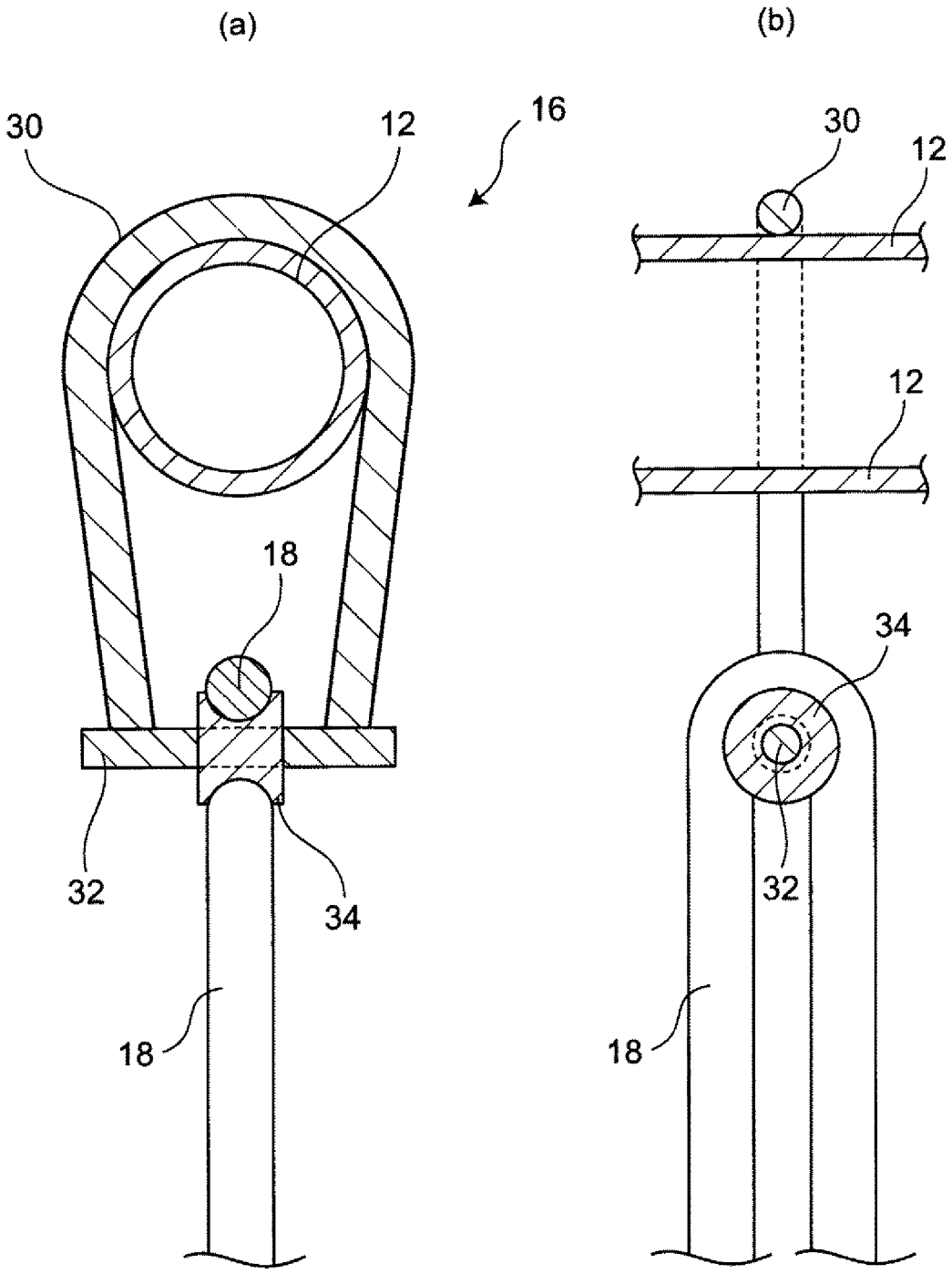


Fig.7

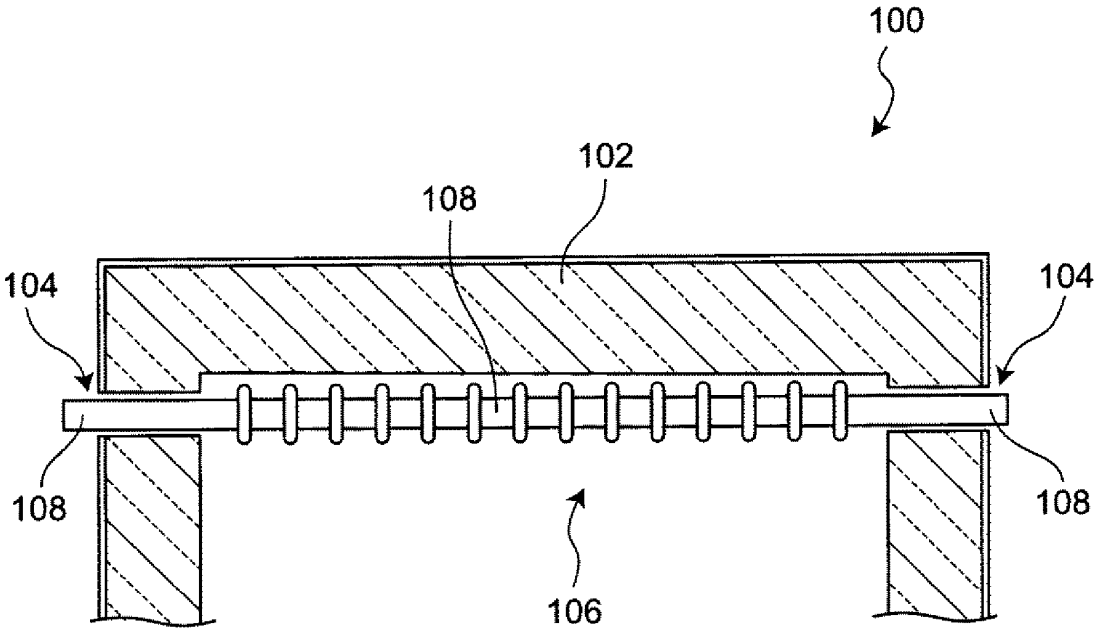


Fig.8

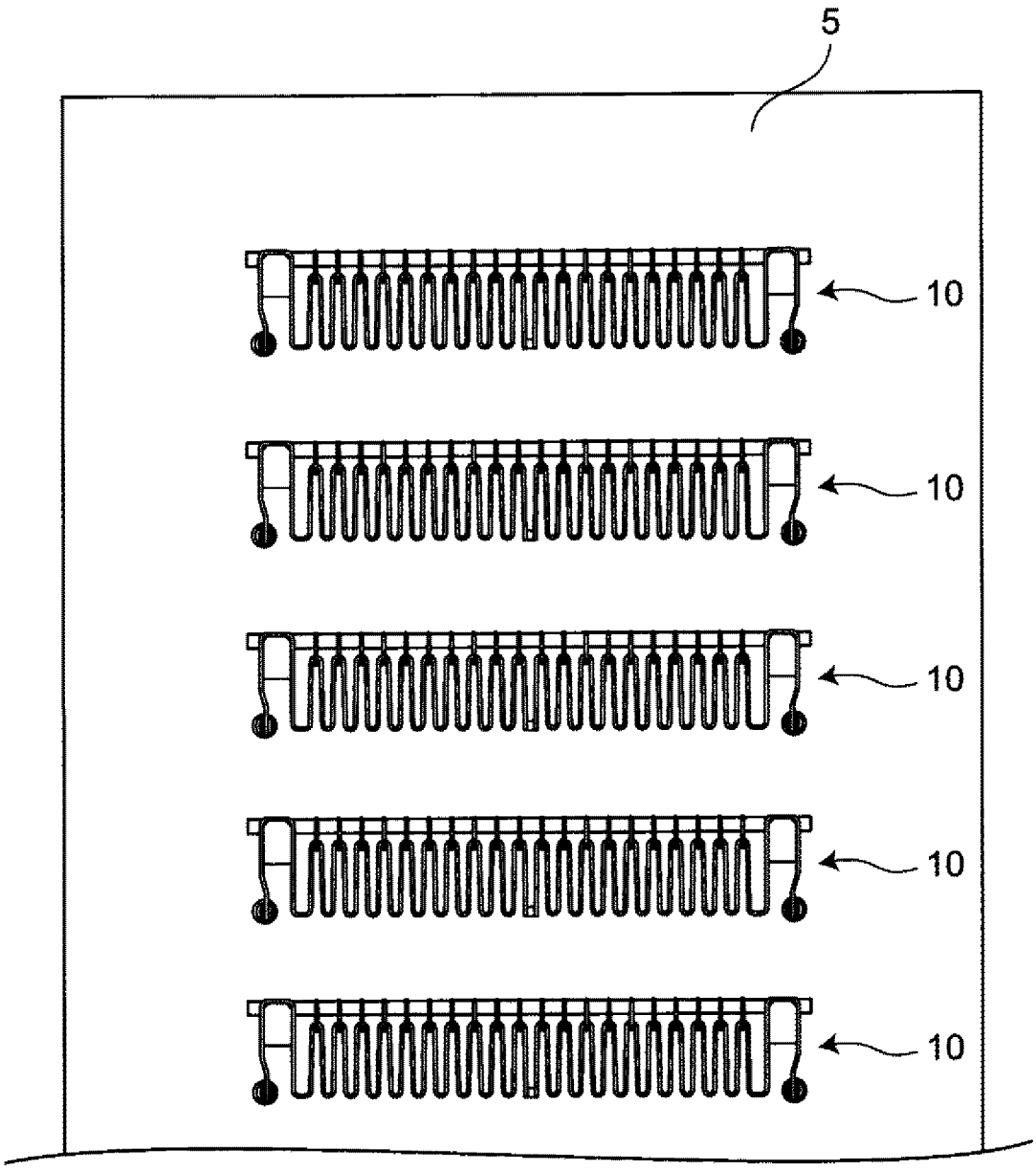
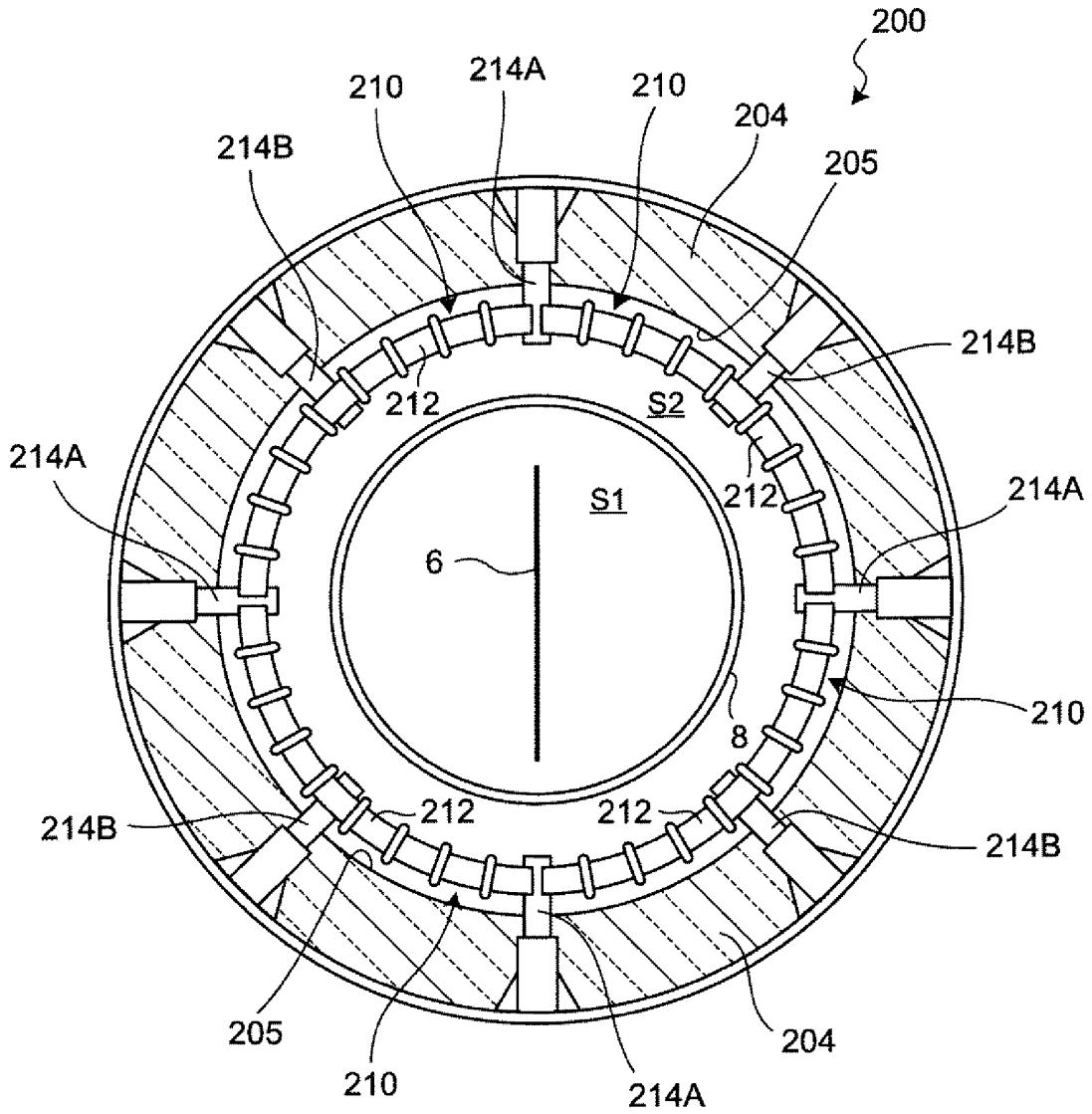


Fig.9


200
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214A
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/047999

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F27D11/02(2006.01)i
FI: F27D11/02A

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F27D11/02, F27B5/00-5/18

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	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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.
X A	US 4620309 A (PPG INDUSTRIES, INC.) 28 October 1986 (1986-10-28), column 2, line 37 to column 5, line 7, fig. 1-3	1, 5-7 2-4
X A	JP 53-124337 A (SAUDER INDUSTRIES, INC.) 30 October 1978 (1978-10-30), page 4, upper right column, line 11 to page 8, upper left column, line 9, fig. 1-3	1, 5-7 2-4
A	JP 58-160790 A (KENNECOTT CORPORATION) 24 September 1983 (1983-09-24)	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
"E" earlier application or patent but published on or after the international filing date
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 March 2021	09 March 2021

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

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/047999

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