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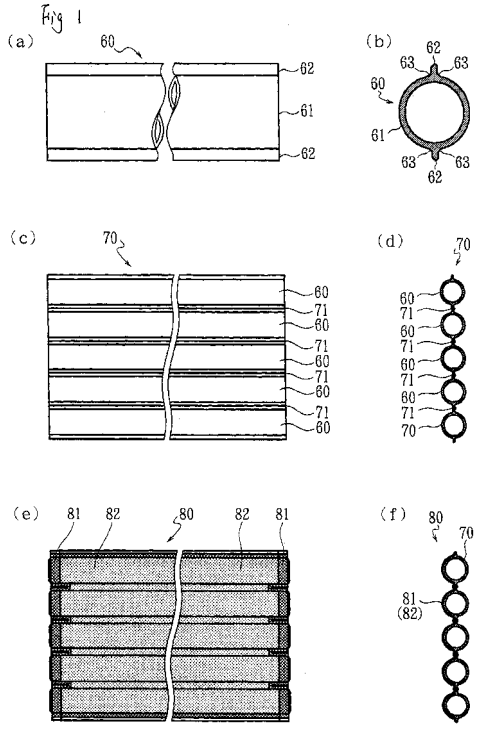
(54) BOILER WATER WALL PANEL

(57) It is an object to reduce the burden of a welding operation in producing a boiler waterwall panel and to reduce the burden of maintaining a furnace housing using the boiler waterwall panels thereby to improve the operating rate of the boiler. In a boiler waterwall panel 80, a panel body 70 with water passages is constituted by a plurality of metal seamless finned single tubes 60 as constituent units integrally produced by a hot extrusion method, etc., and joined by welding tip ends of fin portions 62. On at least one surface side of the panel body 70, fusion-bonded coating 81 for frame-like edge portions and fusion-bonded coating 82 for inner region, of a corrosion resistant alloy are formed. The finned single tube 60 has a single tubular portion 61 for a cooling water passage and a pair of fin portions 62 extending in the tube axial direction at peripheral opposite sides of the tube, and the external surface of the transition portion 63 is formed into a concave surface having a curvature radius of 3 to 6 mm.



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Description

Technical Field

[0001] The present invention relates to a boiler waterwall panel constituting a furnace housing with cooling water passages.

[0002] This boiler waterwall panel is a plate-pipe composite panel to be used as an element member at the time of forming a wall panel constituting a housing of a furnace (combustion chamber-cum-heat exchanger) as the core of a water heating boiler. A plurality of boiler waterwall panels are joined by welding vertically and horizontally to constitute a furnace housing.

[0003] To improve the durability of the furnace housing inner surface, one surface of the boiler waterwall panel is covered with an alloy, e.g. a self-fluxing alloy of nickel series.

Background Art

[0004] A method for heating a water-cooling panel segment comprising a metal tubular portion and a metal plate portion arranged alternately without causing heat strain is known (see e.g., Japanese Unexamined Laid-open Patent Publication No. 2000-329304). The structure and production method of this water-cooling panel segment 20 (boiler waterwall panel) will be explained with reference to figures. Fig. 3(a) is a side view showing metal tubular members 21 and metal plate members 22; Fig. 3(b) is a cross-sectional view thereof; and Fig. 3(c) is a cross-sectional view of a water-cooling panel segment 20. In this specification, the language "cross-section" denotes a cross-section perpendicular to a tubular axial direction.

[0005] The metal tubular member 21 and the metal plate member 22 are separately produced by the number required to constitute a panel by alternately arranging them. At the time of the production, they are configured to have the same length (see Figs. 3(a) and 3(b)). Then (see Fig. 3(c)), a first metal plate member 22 is placed on a first metal tubular member 21 in a direction that the first metal plate member 22 extending in the tubular axial direction. In this state, one long side of the metal plate member 22 is linearly joined by welding to the peripheral surface of the metal tubular member 21. Then, another metal plate member 22 is placed on the other peripheral side of the first metal tubular member 21 in a direction that the metal plate member 22 extending in the tubular axial direction. In this state, one long side of the metal plate member 22 is linearly joined by welding to the peripheral surface of the metal tubular member 21. Thereafter, another metal tubular member 21 is placed on the joined metal plate member 22 and another long side of the metal plate member 22 and the peripheral surface of the metal tubular member 21 are linearly joined by welding. The above welding connection is repeatedly performed to obtain a panel member with cooling water passages which is a panel body of the water-cooling panel segment 20.

[0006] Furthermore, every panel member with water passages, an alloy coating with self-fluxing alloy, such as a Ni-Cr based, is formed on one side or both sides of each piece of the panel bodies. Thus, a water-cooling panel segment 20 is provided. The coating is formed by a thermal spraying with post fusing method. Concretely, a coating material layer is formed on an external surface of the water-cooling panel segment 20 by a thermal spraying method, and then a fusing treatment is performed.

[0007] Because of the aforementioned production method, in this water-cooling panel segment 20, the panel body has a welded structure in which the transition portion 23 ranging from the metal tubular member 21 to the metal plate member 22, is formed by welding.

[0008] Another production methods and structures will be now explained. The following production method is known (see e.g., Japanese Unexamined Laid-open Publication 2001-004101). In this production method, a protection coating of the alloy is formed on an external surface of a finned tubular member in which metal plate vertical fins are provided at peripheral opposite sides of a metal tube to obtain a unit member for a water-cooling segment. Then, a plurality of the unit members are joined by welding at their vertical fin tips thereby to obtain a water-cooling panel segment. This structure and production method of the water-cooling panel segment 50 (boiler waterwall panel) will be explained with reference to figures. Fig. 4(a) is a side view of a metal tube 31 and vertical fins 32; Fig. 4(b) is a cross-sectional view thereof; Fig. 4 (c) is a cross-sectional view of a finned tubular member; Fig. 4(d) is a side view of a unit members 40 for a water-cooling panel segment; Fig. 4(e) is a cross-sectional view thereof; and Fig. 4(f) is a cross-sectional view of a water-cooling panel segment 50.

[0009] Also in this case, one piece of the metal tube 31 to be served as a cooling water passage and two sheets of the vertical fins 32 to be served as webs constitute one set, but each of them is produced separately (see Figs. 4(a) and 4(b)). The number of sets required to form a water-cooling panel segment 50 are configured to have the same length. Then (see Fig. 4(c)), each set, a pair of vertical fins 32 are placed on peripheral opposite sides of the metal tube 31 with the fins extending in the tubular axis direction. One long side of each vertical fin 32 and the peripheral surface of the metal tube 31 are linearly joined by welding. Thus, a finned tubular member 30 comprising a metal tube 31 and a pair of vertical fins 32 placed on both peripheral sides and extending in the tubular axis direction can be produced. Thus, in such a finned tubular member 30, it also has a welded structure in which the transition portion 33 ranging from the metal tube 31 to the vertical fin 32 is formed by welding.

[0010] Then (see Figs. 4(d) and 4(e)), each finned tubular member 30, a alloy coating 41 with of self-fluxing alloy, such as Ni-Cr based, is formed on one side surface

of the tubular member 30. Thus, a unit member 40 for a water-cooling panel segment is produced. Although the coating is also formed by a thermal spraying with post fusing method, the treating object is segmentalized. That is, the treatment is performed not to the assembled water-cooling panel segment 50 but to the not-yet-assembled unit member 40 of the water-cooling panel segment 50. Thereafter, (see Fig. 4(f)), a plurality of such unit members 40 for a water-cooling panel segment 50 as units are joined by welding at their tip ends of the vertical fins 32 as joint portions 51. Thus, the water-cooling panel segment 50 is formed.

[0011] Other than the above, (although not illustrated here), technique of producing a boiler furnace panel (e.g., Japanese Unexamined Laid-open Patent Publication No. 2005-274022) and a method of producing an alloy coated boiler panel (e.g., Japanese Unexamined Laid-open Patent Publication No. 2005-337623) are also known. In the boiler furnace panel producing technique of the former, employing not-yet-coated panel body of the aforementioned water-cooling panel segment 20 as the substrate, then, at the time of forming a fusion-bonded coating of a corrosion resistant alloy on one side surface of the panel body, a super alloy coating is formed at the end (frame-like region including edge) portions to be joined to another panel by a weld overlaying method, and a self-fluxing alloy coating is formed at the inner side thereof by a thermal spraying with post fusing method. In the method of producing the alloy coated boiler panel of the latter, deformation is corrected by controlling displacement in the dual direction perpendicular to the longitudinal direction at plural portions with a positional correction tool, while pulling the boiler panel in the longitudinal direction with a pulling tool, during the heating in fusing treatment after the thermal spraying. Also in these boiler waterwall panels, the transition portion 23 ranging from the metal tubular portion 21 to the metal plate portion 22 is a welded structure formed by welding.

[0012] In the aforementioned conventional boiler waterwall panels however, since the transition portion ranging from the tubular portion to the plate shaped fin portion is a welded portion, the quality of the welding exerts a great influence on the quality of the boiler waterwall panel. In detail, when a boiler is in use, although both the tubular portion and the fin portion are exposed to a high temperature environment, the tubular portion is cooled from the inside with water or steam, but the fin portion is not cooled. Thus, a steep temperature gradient, i.e., a steep thermal strain driving force, is generated at the transition portion. If the welding of the transition portion is not perfect, e.g., if there is any welding defect such as, e.g. pinholes, unevenness, blowholes, overlaps, undercuts, slag inclusions, weld cracks, sputters, and extremely uneven weld bead configurations, such welding defects become notches, resulting in a breakdown of the corrosion resistant alloy coating started from the welding defect. As a result, corrosion of the substrate material occurs at an early stage.

[0013] Defects of the welded portion are hard to be found through visual examination and therefore dye penetrant testing should be employed to find such weld defects. The repair of the found welding defects requires troublesome works, such as, e.g. blasting treatment and then TIG welding.

[0014] Furthermore, since the welding between the tubular member and the plate fin member is harder than the butt welding of the fin tip ends each other, welding defects tend to occur despite of spending much working hours, which bears a great burden of examination and repair of welding defects after the welding, as well as welding operation.

[0015] Therefore, a technical object is to improve the construction/formation of the boiler waterwall, panel to reduce the burden of welding operation at the time of producing the boiler waterwall panel and to reduce the burden of maintaining a furnace housing consist of the boiler waterwall panels thereby to improve the operating rate of the boiler.

Disclosure of Invention

[0016] The boiler waterwall panel (claim 1) according to the present invention was made to solve the aforementioned problems. A boiler waterwall panel comprises a metal panel member with water passages as a panel body equipped with plural rows of tubular portions to serve as cooling water passages, web portions connecting the rows of tubular portions, and a pair of fin portions located at the outside of the outermost tubular portions and extending in a tubular axial direction, at least one surface of the panel body being covered with a fusion-bonded coating of a corrosion resistant alloy,

wherein the panel member with water passages as the panel body, comprises a plurality of metal seamless finned single tubes as constituent units, each provided with a single tubular portion and a pair of fin portions disposed at peripheral opposite sides of the single tubular portion, the single tubular portion and the fin portions exist sharing a common metal phase continuously extended, and

wherein the plurality of metal seamless finned single tubular portions are joined by welding with each other at tip ends of the fin portions of the constituent units so that a welded portion is located at a median line position of the web portion.

[0017] The boiler waterwall panel according to the present invention (claim 2) comprises a metal panel member with water passages as a panel body equipped with a plurality of rows of tubular portions to serve as cooling water passages, web portions connecting the rows of tubular portions, and a pair of fin portions located at the outside of the outermost tubular portions and extending in a tubular axial direction, at least one surface of the panel body being covered with a fusion-bonded coating of a corrosion resistant alloy,

wherein the panel member with water passages as the

panel body comprises a plurality of seamless metal finned tube-web assemblies as constituent units, each having a few rows of tubular portions corresponding to a part of the plural rows of the tubular portions, a web portion connecting said few rows of the tubular portions, and a pair of fin portions provided at outer sides of the outermost tubular portions, the tubular portions, the web portions and the fin portions exist sharing a common metal phase continuously extended, and

wherein the plurality of metal seamless finned tube-web assemblies are joined by welding with each other at tip ends of the fin portions of the constituent units so that a welded portion is located at a median line position of the limited web portions.

[0018] The boiler waterwall panel according to the present invention (claim 3) comprises a metal panel member with water passages as a panel body equipped with a plurality of rows of tubular portions as cooling passages, web portions connecting the rows of tubular portions, and a pair of fin portions located at the outside of the outermost tubular portions and extending in a tubular axial direction, at least one surface of the panel body being covered with a fusion-bonded coating of a corrosion resistant alloy,

wherein the panel member with water passages as the panel body has a seamless integrated structure in which an entirety of the panel member is constituted by a single metal seamless finned tube-web assembly comprising the plurality of rows of the tubular portions, the web portions connecting the rows of tubular portions, and the pair of fin portions located at the outside of the outermost tubular portions, wherein the tubular portions, the web portions and the fin portions exist sharing a common metal phase continuously extended.

[0019] The boiler waterwall panel according to the present invention (claim 4) is the boiler waterwall panel as recited in claims 1 to 3, wherein an external surface of a transition portion ranging from the tubular portion to the fin portion or the web portion of the panel member as the panel body is formed into a concave surface.

[0020] The boiler waterwall panel according to the present invention (claim 5) is the boiler waterwall panel as recited in claims 1 to 4, wherein the seamless finned tubular member or the seamless finned tube-web assembly, each being formed with the single common metal phase, constituting the panel body, is produced by a seamless forming method such as a hot extrusion method.

[0021] The boiler waterwall panel according to the present invention (claim 6) is the boiler waterwall panel as recited in claims 1 to 5, wherein the corrosion resistant alloy constituting the fusion-bonded coating is made of a Ni-rich Ni-Cr based alloy in which an amount of boron is restricted to 0.1 mass % or below and an amount of silicon is restricted to 0.5 mass % or less at a frame-like region including edge portions of the panel.

Effects of the invention

[0022] According to the boiler waterwall panel of the present invention (claim 1), since an integrally continued metal seamless finned single tube of an entire continuous phase having a tubular portion and a pair of fin portions located at opposite peripheral sides of the tubular portion and extending in the tubular axial direction capable of being produced by a hot extrusion method is employed as a constituent unit, the transition portion ranging from the tubular portion to the fin portion is not required to be welded. Furthermore, the welding of the tip ends of the fin portions can be performed more easily than the welding of the transition portion, and the welded portion is higher in quality. This reduces the burden of the welding operation for producing the boiler waterwall panel. As to the furnace housing using aforementioned boiler waterwall panels, since no welded portion exists at the transition portion, the fusion-bonded coating is free from the influence of the notch due to unevenness of the welding of this portion. Furthermore, since the welded portion formed in the middle of the web portion instead of the welded portion of the transition is high in quality, damages of the fusion-bonded coating can be remarkably reduced, resulting in a remarkably reduced necessity of the maintenance, which in turn results in stable operation and an improved operation rate of the boiler with furnace housing.

[0023] According to the boiler waterwall panel of the present invention (claim 2), since a seamless finned tube-web assembly, which is equivalent to the case in which a small number of the aforementioned integrally continued seamless finned single tubes are united with an entire continuous phase manner, then employed as a constituent unit, the transition portion ranging from the tubular portion to the fin portion is not required to be welded, too. Furthermore, the number of the welding operation for welding the tip ends of the fin portions can be reduced. This reduces the burden of the welding operation at the time of producing the boiler waterwall panel. In a furnace housing in which the boiler waterwall panel is assembled, damages of the fusion-boned coating can be further remarkably reduced.

[0024] Accordingly, in the present invention (claims 1 and 2), the burden of the welding operation at the time of producing the boiler waterwall panel can be reduced, and the operation rate of the boiler can be improved.

[0025] According to the boiler waterwall panel of the present invention (claim 3), since a seamless finned tube-web assembly, which is equivalent to the case in which a plurality of the aforementioned seamless finned single tubes are integrated into an entire continuous phase, then constitutes an entirety of the panel member, the transition portion ranging from the tubular portion to the fin portion is not required to be welded, too. Furthermore, the welding of the tip ends of the fin portions is not required. This eliminates the necessity of the welding operation at the time of producing the boiler waterwall panel.

In a furnace housing using the boiler waterwall panels, damages of the fusion-bonded coating can be further remarkably reduced.

[0026] Accordingly, in the present invention (claim 3), not only the burden of the welding operation at the time of producing the boiler waterwall panel can be eliminated, but also in an improved operation rate of the boiler can be obtained, further remarkably.

[0027] According to the boiler waterwall panel of the present invention (claim 4), since the external surface of the transition portion ranging from the tubular portion to the fin portion or the web portion in the panel member is formed into a concave surface, the stress concentration thereto can be reduced. Furthermore, since the cross-section of this portion has a configuration gradually increasing in thickness towards the basal portion, resulting in an enhanced rigidity of this portion, undesired effects by the stress due to the aforementioned steep temperature gradient can be reduced, which enhances the aforementioned preferable functions and results. Furthermore, the concave surface can be easily formed by a seamless forming method, such as e.g., a hot extrusion method, which in turn contributes a longer operating life of an extruding die for use in a hot extrusion method, etc.

[0028] Here, it is preferable that the curvature radius of the concave surface to be formed on the external surface of the transition portion ranging from the tubular portion to the fin portion is set to 3 mm or more. With this, in a panel with a tubular portion or a web portion a few mm in thickness, in most cases the stress concentration can be sufficiently reduced and the rigidity can be remarkably increased. Furthermore, the notch function against the fusion-bonded coating can be sufficiently reduced by a radius of 3 mm or more. Although these effects increase as the radius increases, it is preferable to set the radius up to 6 mm or so, in the light of the effect of saturation and/or to avoid wasting material.

[0029] According to the boiler waterwall panel of the present invention (claim 5), since the seamless finned single tube or finned tube-web assembly of a continuous phase constituting the panel body is produced by a seamless forming method, such as e.g., a hot extrusion method, the integration as the continuous phase can be performed assuredly, and the production can be performed efficiently.

[0030] In the meantime, currently, it is generally considered that a hot extrusion method is the most suitable method of producing a seamless finned single tube or a seamless finned tube-web assembly. However, it is possible to produce a seamless constituent unit, etc., constituting the panel body, by another seamless forming method, such as e.g., a powder sintering method, a casting method using a sand mold, or a centrifugal casting method, so long as facility circumstances and cost allowed it.

[0031] According to the boiler waterwall panel of the present invention (claim 6), since the amount of B and Si is minimized in the fusion-bonded coating of the frame-like portion to be subjected to welding thereby, thermal shock crack sensitivity is remarkably reduced than the coating with self-fluxing alloy material in which sufficient B and Si is added, this said sensitivity is enhanced. Therefore, even if a furnace housing is formed by welding the boiler waterwall panels, the problems of thermal shock crack can be eliminated. As to the corrosion resistant alloy low in thermal shock crack sensitivity, it is preferable to use the alloy as recited in claim 6, in terms of the thermal shock crack-vs-cost performance or the availability. Depending on the situation, however, another alloy (e.g., another group alloys defined by JIS 4901, 4902 or ISO 4955, 9723) can be used.

Brief Description of Drawings

[0032] Fig. 1 shows a structure and production method of a boiler waterwall panel according to an embodiment of the present invention, wherein Fig. 1 (a) is a side view of a finned tubular member (seamless finned single tube), Fig. 1 (b) is a cross-sectional view thereof, Fig. 1 (c) is a side view of a panel body (panel member with water passages), Fig. 1 (d) is a cross-sectional view thereof, Fig. 1 (e) is a side view of a boiler waterwall panel, and Fig. 1 (f) is a cross-sectional view thereof.

[0033] Fig. 2 shows a structure and production method of a boiler waterwall panel according to another embodiment of the present invention, wherein Fig. 2(a) is a side view showing a seamless finned tube-web assembly, Fig. 2(b) is a cross-sectional view thereof, Fig. 2(c) is a side view of a panel body (panel member with water passages), and Fig. 2(d) is a cross-sectional view thereof.

[0034] Fig. 3 shows an example of a conventional water cooling panel segment, wherein Fig. 3(a) is a side view showing metal tubular members and metal plate members, Fig. 3(b) is a cross-sectional view thereof, Fig. 3(c) is a cross-sectional view of a water-cooling panel segment.

[0035] Fig. 4 shows another example of a conventional water-cooling panel segment, wherein Fig. 4(a) is a side view of a metal tube and vertical fins, Fig. 4(b) is a cross-sectional view thereof, Fig. 4(c) is a cross-sectional view of a finned tubular member, Fig. 4(d) is a side view of unit members for a water-cooling panel segment, Fig. 4 (e) is a cross-sectional view thereof, and Fig. 4(f) is a cross-sectional view of the water-cooling panel segment.

Brief Description of Reference Marks

[0036]

20...Water-cooling panel segment (boiler waterwall panel)
21...Metal tubular member
22...Metal plate member
23...Transition portion (welded)
30...Finned tubular member
31...Metal tube

32...Vertical fin
33...Transition portion (welded)
40...Water-cooling panel segment unit
41...Self-fluxing alloy series coating
50...Water-cooling panel segment (boiler watewall panel)
51...Joint (welded)
60...Finned tubular member (seamless finned single tube)
61...Tubular portion
62...Fin portion
63...Transition portion (integrally formed)
70...Panel body (panel member with water passages)
71...Joint (welded portion formed in the middle of the web)
80...Boiler waterwall panel
81...Frame-like portion fusion-bonded coating
82...Inner region fusion-bonded coating
90...Seamless finned tube-web assembly
91...Tubular portion
92...Web portion
93...Fin portion
94...Transition portion (integrally formed)
95...Panel body (panel member with water passages)
96...Joint (welded portion formed in the middle of the web)

Best Mode for Carrying Out the Invention

[0037] The structure and production method of a boiler waterwall panel according to an embodiment of the present invention will be explained with reference to drawings. Fig. 1 (a) is a side view of a finned tubular member 60, Fig. 1 (b) is a cross-sectional view thereof, Fig. 1 (c) is a side view of a panel body 70, Fig. 1 (d) is a cross-sectional view thereof, Fig. 2(e) is a side view of a boiler waterwall panel 80, and Fig. 1 (f) is a cross-sectional view thereof. The cross-section of each cross-sectional view denotes a cross-section perpendicular to the axial direction of the tubular portion 61.

[0038] This boiler waterwall panel 80 is produced as follows. That is, initially, a tubular member 60, which is a metal seamless finned pipe as the minimum constituent unit, is integrally produced by a hot extrusion method (see Figs. 1 (a) and 1 (b)). A plurality of finned tubular members 60 are aligned in length, and the tip ends of the fin portions 62 as joining portions are welded with each other to obtain a panel body 70 (see Figs. 1 (c) and 1 (d)). Thereafter, a fusion-bonded coating of a corrosion resistant alloy is formed on one surface side of the panel body 70 as a treating surface. As the fusion-bonded coating, thermal spraying with post-fusing method and weld overlaying method are mentioned typically, other methods e.g. power-slurry coating with post-fusing method etc. can be employed. That is to say, any method, in which a fusible alloy can be bonded on a metallic substrate with mutual alloying through fusing step thereof, is available. Thus, the boiler waterwall panel 80 is produced. The fusion-bonded coating of a corrosion resistant alloy according to the boiler waterwall panel 80 is formed by the following steps (see Figs. 1 (e) and 1 (f)). For example, an alloy having no thermal shock crack sensitivity is applied to the frame-like region 81 including edge portion of the treating surface by a weld overlaying method. Then, to the inner region 82 surrounded by the frame-like region 81, an alloy good in workability, such as, e.g., Ni series (Ni-Cr group, etc.) or Co series (Co-Cr group, etc.) self-fluxing alloy, or an alloy in which WC is added to the above alloy, etc., are applied by a thermal spraying with post fusing method.

[0039] The finned tubular member 60 (see Figs. 1 (a) and 1 (b)) is a metal elongated member having a tubular portion 61 serving as a cooling water passage and a pair of fin portions 62 provided at peripheral opposite sides of the tubular portion so as to extend in the tubular member axial direction. A transition portion 63 ranging from the tubular portion 61 to the fin portion 62 is not a welded portion but an integral portion formed by a hot extrusion method. The external surface of the transition portion 63 is formed into a concave curve having a curvature radius of 3 mm to 6 mm at the minimum curvature radius portion. The finned tubular member 60 is commonly made from a rolled member of cheap carbon steel or low-alloy steel (e.g., Cr-Mo steel), but the material can be stainless steel, casting material, or another metal. In the case of a common boiler furnace panel, the dimensional data is, for example, about 60 to 80 mm in diameter of the tubular portion 61, about 5 to 7 mm in thickness of the tubular portion 61, about 10 to 20 mm in width of the fin portion 62, and about 5 to 7 mm in thickness of the fin portion 62. As the hot extrusion method, the Ugine-Sejournet method using glass as lubricant agent is popular, but any method can be employed.

[0040] The panel body 70 (see Figs. 1 (c) and (d)) is produced by welding a plurality of the aforementioned finned tubular members 60. Concretely, for example, about 5 to 20 pieces of the finned tubular members 60 are arranged in parallel with the length aligned, and the tip ends of the adjacent fin portions 62 are welded to obtain a flat shaped member. In the case of a commonly used boiler furnace panel, a general size of the panel body 70 is about 4,000 to 8,000 mm in length and about 400 to 1,200 mm in width. The welding connection of the joint 71 in the panel body 70 is performed by a common welding method, such as e.g., a CO_2 arc welding method or a TIG welding method. This welding is not performed in a state in which a plate member and a tubular member are placed together, but can be simply performed in a state in which edges of adjacent plate portions are placed in a mutually butt state. This makes the welding easier and enhances the efficiency, and almost no welding defects will be generated. In the panel body 70 produced as mentioned above and having the aforementioned structure, the butt welded fin portions 62 and 62 constitute

a web portion connecting the tubular portions 61 and 61, and the joint 71 which is a welded portion is located at the median line position of the web.

[0041] The boiler waterwall panel 80 (see Figs. 1 (e) and 1 (f)) is finished by forming a frame-like portion fusion-bonded coating 81 and an inner region fusion-bonded coating 82 on the aforementioned panel body 70.

[0042] As a corrosion resistant alloy having no thermal shock crack sensitivity to be used as the frame-like portion fusion-bonded coating 81, a Ni-rich Ni-Cr based alloy in which the amount of boron B as a melting-point lowering element is restricted to 0.1 mass % or below and the amount of silicon Si as a melting-point lowering element is restricted to 0.5 mass % or less can be exemplified. As the standard of defining such alloy material, JIS G4901 for bar members, JIS G4902 for plate members can be exemplified in Japan, and ISO 4955 or ISO 9723 can be exemplified in the International Standard. The thickness of the frame-like portion fusion-bonded coating 81 is about 1 to 3 mm.

[0043] As to the frame-like portion of the panel body 70, it is important that the frame-like portion has no thermal shock crack sensitivity because it is subjected to be welded to another panel after it becomes a boiler waterwall panel 80. On the other hand, as to the remaining inner region, the easiness and/or cost of the coating treatment is given more importance since the region is not to be welded anymore.

[0044] As the corrosion resistant alloy to be used for the inner region fusion-bonded coating 82, a Ni-Cr group self-fluxing alloy can be exemplified because it is suitable to the thermal spraying with post-fusing method and excellent in applicability. In the material, although the Ni-rich Ni-Cr component occupies the predominant quantity, the amount of B and that of Si are regulated to 1 to 5 mass %, respectively, so as to provide an easy-to-melt nature, a self-fluxing function etc., preferable to a thermal spraying treatment or a fusing treatment while avoiding excessive increase of brittleness. As such alloy material, nickel self-fluxing alloy material defined by Japanese Industrial Standard JIS H8303 or International Standard ISO 4920 can be exemplified. The thickness of the inner region fusion-boned coating 82 is usually set to about 0.5 to 3.0 mm. In the present invention structure, since the surface configuration of the tubular member-fin/web transition portion and the welded portion of the panel body are smoothly formed, the coating having a thickness of 0.2 mm or above can give sufficient corrosion prevention.

[0045] In forming the inner region fusion-bonded coating 82, in the fusing treatment to be performed after thermally spraying the inner region fusion-bonded coating 82 on one surface of the panel body 70, it is more preferable to correct deformation of the panel body 70 by regulating the displacements in the dual direction perpendicular to the longitudinal direction at plural points with a positional correction tool while pulling the panel body 70 in the longitudinal direction with a pulling tool during the heating while heating the panel body 70 with a manner in which a partially heating tool, e.g., an induction coil, being moved in the longitudinal direction.

[0046] The boiler waterwall panel 80 produced as mentioned above will be transported from a panel production factory to a boiler installation site, and joined by welding to another panel at frame-like portions to be fabricated in a furnace housing.

[0047] As to a structure and production method of a boiler waterwall panel according to the present invention, another embodiment will be explained with reference to the drawings. Fig. 2(a) is a side view showing seamless finned tube-web assembly 90, Fig. 2(b) is a cross-sectional view thereof, Fig. 2(c) is a side view of a panel body 95 (panel member with water passages), and Fig. 2(d) is a cross-sectional view thereof. Here, the "cross-section" of each cross-sectional view denotes a cross-section perpendicular to the axial direction of the tubular portion 91.

[0048] This boiler waterwall panel is different from the aforementioned boiler waterwall panel 80 in that the constituent unit of the panel body 95 which is a panel member with water passages as a panel body is constituted by seamless finned tube-web assemblies 90.

[0049] The seamless finned tube-web assembly 90 is equipped with a few rows of tubular portions 91, web portions 92 connecting the rows of tubular portions and a pair of fin portions 93 located at the outside of the outermost rows of the tubular portions 91, which are connected as a continuous phase. Like the finned tubular member 60, the assembly 90 is integrally formed by a hot extrusion method. However, not like a single tube such as the finned tubular member 60, a few tubular portions 91 are included in a plane in a parallel arranged manner as if a part of the panel is previously assembled by arranging the finned tubular members 60.

[0050] Partially, the tubular portion 91 to be served as a cooling water passage can be the same as the aforementioned tubular portion 61, the fin portion 93 can be the same as the fin portion 62, the web portion 92 can have a size almost equal to the size corresponding to two fin portions 93, and the transition portion 94 ranging from the tubular portion 91 to the web portion 92 or the fin portion 93 can be the same as the transition portion 63.

[0051] The few rows of the tubular portions 91 contained in the seamless finned tube-web assembly 90 correspond to a part of plural rows of the tubular portions 91 contained in the panel body 95 or the boiler waterwall panel. In this embodiment, an assembly having three rows of tubular portions is illustrated, but the number of rows of tubular portions can be two, four, or more.

[0052] The panel body 95 can be formed by welding a plurality of seamless finned tube-web assemblies 90 in the same manner as in the panel body 70. Concretely, tip ends of the adjacent fin portions 93 are welded to be assembled into a flat panel. In the web formed by welding the fin portions 93 and 93, the joint 96 which is a welded portion is located at the median line position of the web.

However, at the time of producing the seamless finned tube-web assembly 90, since no joint 96 exists at the web portion 92 integrally formed together with the tubular portion 91, the panel body 95 has a welding structure in which a welded portion is located at the median line positions of some web portions among web portions connecting the plural rows of tubular portions 91 to be served as cooling passages. A pair of fin portions 93 are located at the outside of the outermost tubular members.

[0053] In the same manner as in the aforementioned panel body 70, a frame-like portion fusion-bonded coating 81 and inner region fusion-bonded coating 82 are formed on the panel body 95 having the aforementioned welding structure produced as mentioned above into a boiler waterwall panel. The number of joints 96 in the panel body 95 is fewer than the number of joints 71 in the panel body 70.

[0054] The boiler waterwall panel produced as mentioned above will also be transported from a panel production factory to a boiler installation site, and joined by welding to another panel at frame-like portions to be fabricated in a furnace housing.

[0055] A structure and production method of a boiler waterpanel according to still another embodiment of the present invention will now be explained.

[0056] This embodiment is a deformation of the aforementioned second embodiment. If this embodiment is explained using Fig. 2 showing the structure or the panel body according to the second embodiment, this is an embodiment in which the joint 96 in the panel body 95 is eliminated.

[0057] That is, in this embodiment, the number of rows of the tubular portions 91 in the seamless finned tube-web assembly 90 which is a panel constituent unit of the second embodiment is increased to the number of rows of the tubular portions 91 in the panel body 95. Thus, the seamless finned tube-web assembly 90 constitutes not a panel constituent unit but an entire panel structural member.

[0058] This embodiment is useful for the case in which the panel body 95 is relatively small in width (e.g., 400 to 600 mm width /3 to 6 rows of tubular portions). Depending on the improvement of assembly production technique such as a hot extrusion method, the preferable applicable target will be expanded to a wider panel.

[Other]

[0059] In the above embodiments, the seamless finned single tube 60 and the seamless finned tube-web assembly 90 are produced by a hot extrusion method. As a seamless member production method of producing an integral member in which tubular members and fins or webs extending in the tubular axial direction are united with a continuous metal phase to be replaced with a hot extrusion method, a powder sintering method, a casting method using a sand mold, and a centrifugal casting method can be exemplified.

[0060] In the aforementioned embodiments, the frame-like portion fusion-bonded coating 81 of a low thermal shock crack sensitivity alloy is formed by a weld overlaying method. However, in cases where the coating can be formed by another method, such as e.g., a thermal spraying with post-fusing method, the frame-like portion fusion-bonded coating 81 can be formed by such a method.

Industrial Applicability

[0061] The boiler waterwall panel of the present invention can be applied to various boiler furnace housings including the so-called super boiler. As an installation example of a boiler, an incinerator can be exemplified. An incinerator of a garbage incineration power generation equipment is also included in the installation example.

Claims

1. A boiler waterwall panel comprising a metal panel member with water passages as a panel body equipped with a plurality of rows of tubular portions to be served as cooling water passages, web portions connecting the rows of tubular portions, and a pair of fin portions located at outsides of outermost tubular portions and extending in a tubular axial direction, at least one surface of the panel body being covered with a fusion-bonded coating of a corrosion resistant alloy,
wherein the panel member with water passages as the panel body comprises a plurality of metal seamless finned single tubes as constituent units, each provided with a single tubular portion and a pair of fin portions provided at peripheral opposite sides of the single tubular portion, the single tubular portion and the fin portions exist sharing a common metal phase continuously extended, and
wherein the plurality of metal seamless finned single tubular portions are joined by welding with each other at tip ends of the fin portions of the constituent units so that a welded portion is located at a median line position of the web portion.

2. A boiler waterwall panel comprising a metal panel member with water passages as a panel body equipped with a plurality of rows of tubular portions to be served as cooling water passages, web portions connecting the rows of tubular portions, and a pair of fin portions located at outsides of outermost tubular portions and extending in a tubular axial direction, at least one surface of the panel body being covered with a fusion-bonded coating of a corrosion resistant alloy,
wherein the panel member with water passages as the panel body comprises a plurality of metal seam-

less finned tube-web assembles as constituent units, each having a few rows of tubular portions corresponding to a part of the plural rows of the tubular portions, the web portions connecting said few rows of the tubular portions, and a pair of fin portions provided at outer sides of outermost tubular portions, the tubular portions, the web portions and the fin portions exist sharing a common metal phase continuously extended, and
wherein the plurality of metal seamless finned tube-web assemblies are joined by welding with each other at tip ends of the fin portions of the constituent units so that a welded portion is located at a median line position of the limited web portions.

3. A boiler waterwall panel comprising a metal panel member with water passages as a panel body equipped with a plurality of rows of tubular portions to be served as cooling water passages, web portions connecting the rows of tubular portions, and a pair of fin portions located at outsides of outermost tubular portions and extending in a tubular axial direction, at least one surface of the panel body being covered with a fusion-bonded coating of a corrosion resistant alloy,
wherein the panel member with water passages as the panel body has a seamless integrated structure in which an entirety of the panel member is constituted by a single metal seamless finned tube-web assembly, comprising the plurality of rows of the tubular portions, the web portions connecting the rows of tubular portions, and the pair of fin portions located at the outsides of the outermost tubular portions, exist sharing a common metal phase continuously extended.

4. The boiler waterwall panel as recited in any one of claims 1 to 3, wherein an external surface of a transition portion ranging from the tubular portion to the fin portion or the web portion of the panel member as the panel body is formed into a concave surface.

5. The boiler waterwall panel as recited in any one of claims 1 to 4, wherein the seamless finned tubular member or the seamless finned tube-web assembly, each being formed with the single common metal phase, constituting the panel body is produced by a seamless forming method such as a hot extrusion method.

6. The boiler waterwall panel as recited in any one of claims 1 to 5, wherein the corrosion resistant alloy constituting the fusion-bonded coating is made of a Ni-rich Ni-Cr based alloy in which an amount of boron is restricted to 0.1 mass % or below and an amount of silicon is restricted to 0.5 mass % or less at a frame-like region including frame-like edge portions of the panel.

Fig 1

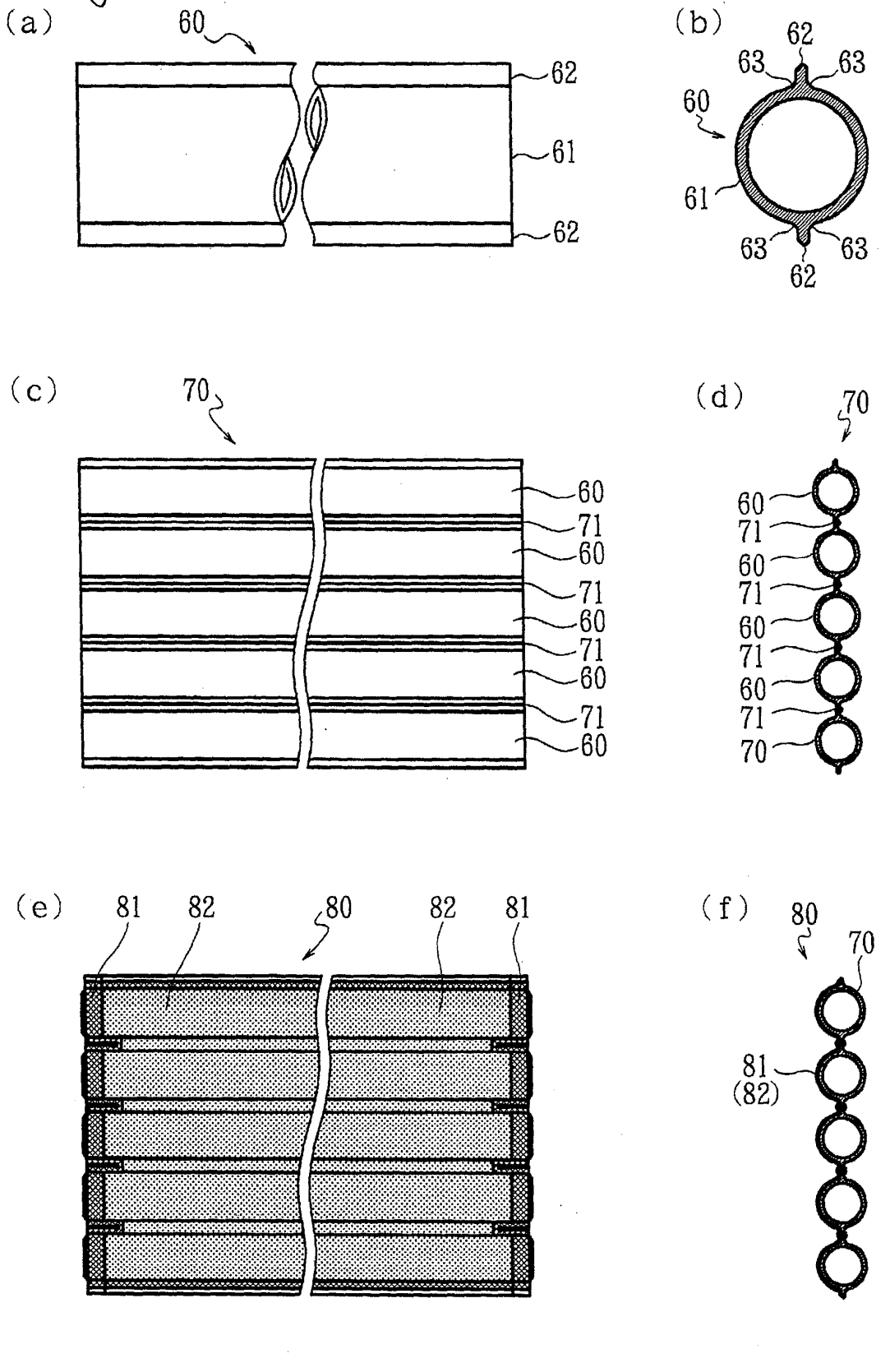
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Fig 2

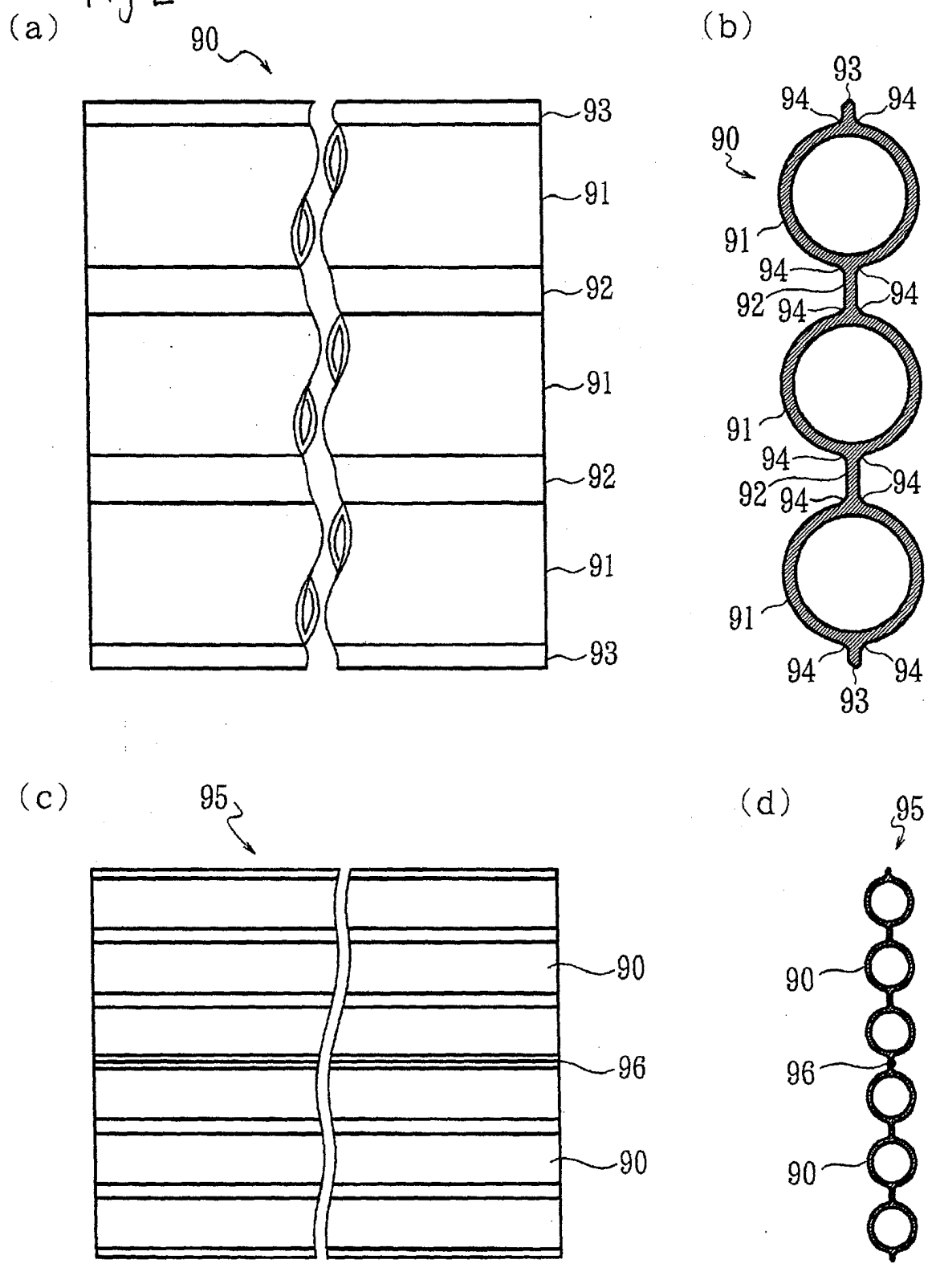
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Fig 3

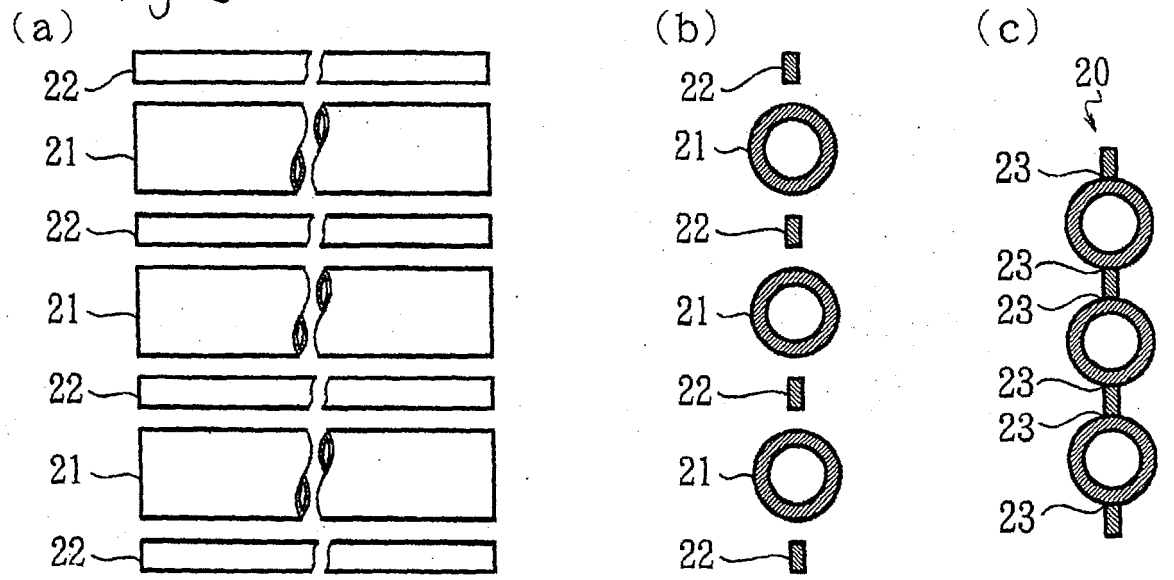
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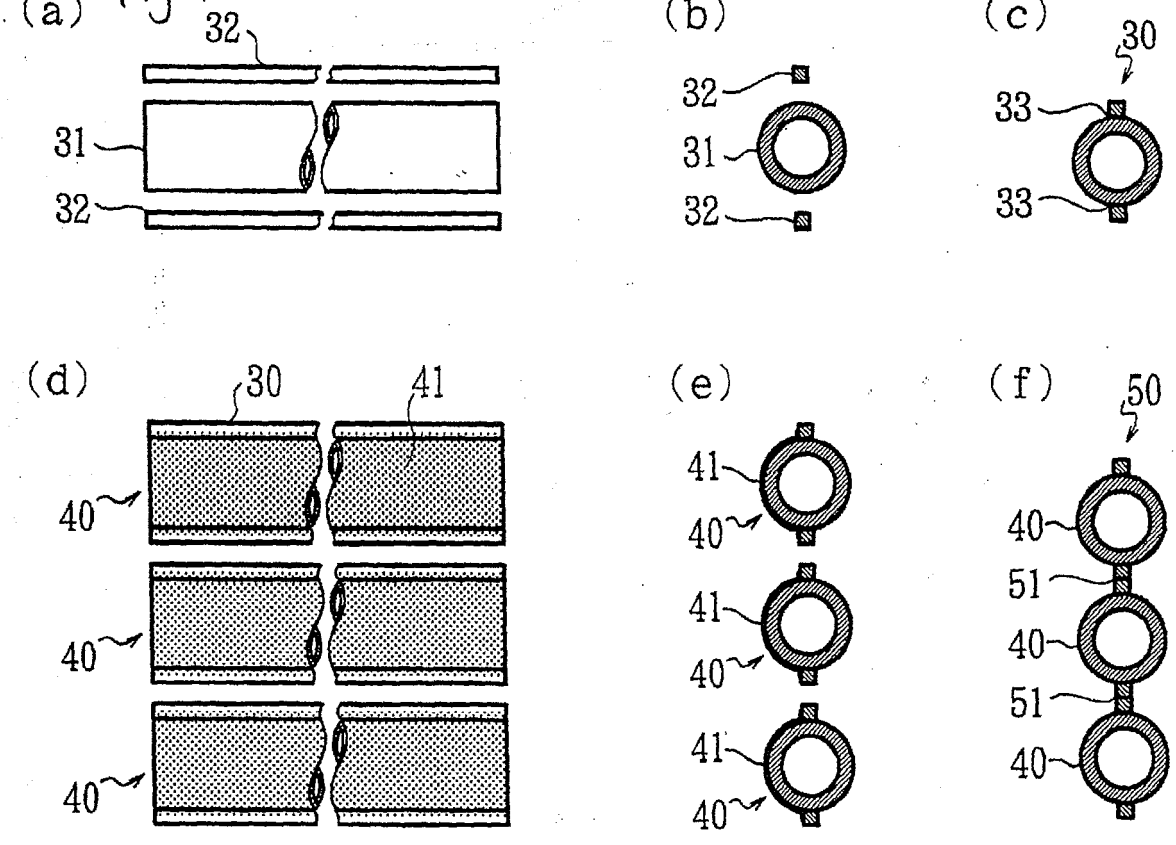
Fig 4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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/058443

A. CLASSIFICATION OF SUBJECT MATTER
F22B37/10(2006.01)i, *F22B37/04*(2006.01)i

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)
F22B37/10, F22B37/04, F28F1/00-1/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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	JP 2005-274022 A (Dai-Ichi High Frequency Co., Ltd.), 06 October, 2005 (06.10.05), Claims; Fig. 1 & WO 2005/090862 A1	1-6
Y	JP 6-193808 A (Siemens AG.), 15 July, 1994 (15.07.94), Par. No. [0020]; Fig. 3 & US 5347955 A1 Column 4, lines 41 to 45; Fig. 3	1-6

☒ 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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Date of the actual completion of the international search	Date of mailing of the international search report
01 June, 2007 (01.06.07)	12 June, 2007 (12.06.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/058443

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 54-101539 A (Kobe Steel, Ltd.), 10 August, 1979 (10.08.79), Page 8, upper right column, line 9 to lower right column, line 12; Fig. 5 & US 4296539 A1 Column 4, lines 7 to 62; Fig. 5	1-6
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 65081/1993(Laid-open No. 41268/1995) (Kobe Steel, Ltd.), 21 July, 1995 (21.07.95), Par. Nos. [0012] to [0013] (Family: none)	1-6
A	JP 7-218172 A (Sanden Corp.), 18 August, 1995 (18.08.95), Par. No. [0027] & EP 657711 A1 Column 7, line 54 to column 8, line 43	1-6

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2000329304 A **[0004]**
- JP 2001004101 A **[0008]**
- JP 2005274022 A **[0011]**
- JP 2005337623 A **[0011]**