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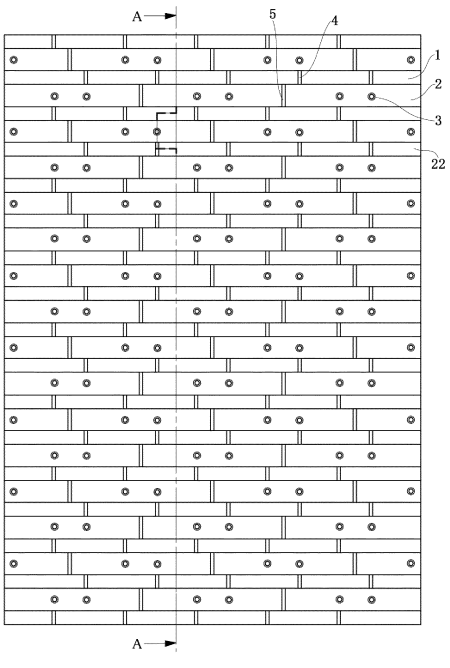
(54) BLAST FURNACE WALL-COOLING STAVES

(57) Provided is a wall-cooling stave for a blast furnace provided with a liner in an inside of the furnace, which can prevent the temperature rising of the liner to prolong the service life of the liner. The wall-cooling stave for the blast furnace comprises a stave body 1 provided in its interior with a water channel passing a cooling water therethrough and made from copper or a copper alloy, a plurality of horizontal grooves 13 formed on a surface side of the stave body facing the inside of the furnace to constitute concave portions formed of the plurality of horizontal grooves and convex portions formed between the plurality of horizontal grooves, a plurality of vertical grooves 4 formed in the convex portions between the horizontal grooves in a vertical direction, and a plurality of liners 2 formed so as to fit into the horizontal grooves in the stave body and protrude at their tops into the inside of the furnace, in which gaps 5 in a vertical direction between the plurality of liners is located at positions different from the vertical grooves 4 in the horizontal direction.

FIG. 1



EP 3 950 967 A1

Description

Technical Field

[0001] This invention relates to a wall-cooling stave used for cooling and protecting a furnace wall of a blast furnace or the like exposed to a higher temperature.

Background Art

[0002] A wall-cooling stave (also described as a stave hereinafter) has been used for protecting a blast furnace body from thermal load inside the furnace. The stave comprises a stave body made from cast iron, rolled copper, cast copper or the like and a water channel for cooling disposed in the stave body. The stave may have members for attaching the stave to the blast furnace, and metallic or refractory members of types different from the stave body may be attached to the stave body. The stave body, the water channel and the members attached to the stave body are collectively called as a stave. In recent years, the stave having a higher cooling capacity and a durability has been demanded to cope with the high thermal load of the blast furnace body.

[0003] The reason thereof is that depletion of resource for coking coal suitable in the production of coke as a main reducing material for the blast furnace has proceeded and the blowing amount of pulverized coal for blowing fuel coal from tuyeres of the blast furnace has been increasing instead of the coke. As the blowing amount of the pulverized coal is increased, ventilation resistance inside the furnace is increased thus to increase the gas flow rising along the furnace wall, and hence the thermal load of the stave becomes large, causing the service life thereof to be shorten.

[0004] Such a wall-cooling stave is attached and fixed to the inside of the blast furnace body with an iron shell on the furnace body and a bolt. That is, as shown by an example in FIG. 5, a stave body 51 is fixed to an iron shell 61 on a blast furnace body by screwing with bolts 52 and nuts 53. Water supply and drainage pipes 54-1, 54-2 for the stave body 51 are arranged through holes 62 formed in the iron shell 61 on the blast furnace body, and water is supplied and drained from the outside of the furnace body through the water supply and drainage pipes 54-1, 54-2.

[0005] A conventionally known technique for improving the wall-cooling stave includes providing a groove-like structure where the content in the blast furnace is likely to be deposited on the surface side of the stave body facing the inside of furnace, such that the stave is insulated by a stable slag fixing layer that is formed from the content in the blast furnace to thus extend the service life even in the case where the stave is used at a position having high thermal load in the blast furnace for a long time and the refractory on the surface side facing the inside of furnace is damaged. Also, it is known that a groove extending in the direction of a coolant pipe line is disposed on the surface side of the stave body to suppress the deformation of the stave by heat (Patent Literature 1). Furthermore, it is known that a liner made from a heat-resistant metallic material is provided so as to fit into a horizontal groove of the stave body in order to enhance the effect of protecting the stave (Patent Literature 2).

Citation List

Patent Literature

[0006]

Patent Literature 1: JP-A-2003-269867
Patent Literature 2: JP-A-2000-119713

Summary of Invention

Technical Problem

[0007] However, as described in Patent Literature 1, when a vertical groove is arranged among a plurality of kinds of grooves escaping stretch due to heat receiving from the inside of the furnace to prevent deformation, there is caused a gas flow rising along the vertical groove. As a result, the slag fixing layer is removed by the gas flow, and hence the slag fixing layer is not formed on the portion where a vertical groove is formed, and heat input from the portion to the stave becomes larger. Therefore, even with a structure that absorbs strain due to heat by the vertically penetrating groove, there is a problem that heat is received from the inner face of the groove to rather rise the temperature, causing a decrease in the effect of absorbing strain.

[0008] Also, even with the liner arranged on the surface side of the stave facing the inside of the furnace so as not to directly transfer heat to the stave as disclosed in Patent Literature 2, when the surface of the liner is smooth, the slag fixing layer is not formed on the surface side of the stave facing the inside of the furnace, and the surface of the liner is directly exposed to the high-temperature gas flow inside the furnace. Thus, the temperature of the liner increases, and the service life of the liner is shortened, causing a problem that the effect of protecting the stave is definitive. Especially, when the liner is fixed from the side of the stave facing the inside of the furnace with a bolt, the temperature of the bolt becomes higher than that of the liner to thus shorten the service life of the bolt, causing a problem that a time period capable of fixing the bolt becomes shorter.

[0009] It is therefore an object of the invention to provide a furnace wall-cooling stave used for cooling and protecting a wall of a blast furnace or the like exposed to a higher temperature, in which a liner is disposed on the surface side of the stave facing the inside of the furnace and the wall-cooling stave can prevent the temperature rising of the liner and prolong the service life of the liner.

Solution to Problem

[0010] The inventors have made various studies to solve the above problems inherent to the conventional techniques and to realize the above object, and as a result, have developed the following novel wall-cooling stave for a blast furnace. That is, the invention is a wall-cooling stave for cooling a furnace wall of a blast furnace from an inner surface thereof, comprising

a stave body provided in its interior with a water channel for passing a cooling water therethrough and made from copper or a copper alloy,
a plurality of horizontal grooves formed on a surface side of the stave body facing the inside of the furnace to constitute concave portions formed of the plurality of horizontal grooves and convex portions formed between the plurality of horizontal grooves,
a plurality of vertical grooves vertically formed in the convex portions of the horizontal grooves, and
a plurality of liners formed so as to fit into the horizontal grooves in the stave body and protrude at their tops into the inside of the furnace, in which
gaps in the vertical direction between the plurality of liners are located at different positions in a horizontal direction from the vertical grooves.

[0011] In the wall-cooling stave for the blast furnace according to the invention having the above configuration, the followings are considered to be more preferable solution means:

(1) a counterbore hole and a bolt hole passing through the counterbore hole are formed in the liner from the side of the stave facing the inside of the furnace, and a female screw hole is formed on the bottom of the horizontal groove of the stave body at a position corresponding to the bolt hole, and a bolt is inserted from the side facing the inside of the furnace through the counterbore hole and the bolt hole and fixed to the female screw hole to thereby fit the liner into the horizontal groove;
(2) the concave portion has a vertical width larger than a vertical width of the convex portion;
(3) the liner is made from a material being high in the high-temperature strength as compared to the material of the stave body;
(4) the gaps between the liners adjoining in the vertical direction are located at different positions in the horizontal direction;
(5) the vertical grooves adjoining in the vertical direction are located at different positions in the horizontal direction; and
(6) the gaps between the liners adjoining in the vertical direction are located at different positions in the horizontal direction, and also the vertical grooves adjoining in the vertical direction are located at different positions in the horizontal direction.

Advantageous Effects of Invention

[0012] In the wall-cooling stave for the blast furnace according to the invention, the liner is protruded into the inside of the furnace, so that the slag fixing layer being low in the thermal conductivity is formed and maintained even on the tip portion of the convex portion between the horizontal grooves between the liners, and the base part of the liner (in the vicinity of the portion of the liner fitted into the concave portion of the stave body). Thus, the rise of the liner temperature can be hindered, allowing the service life of the liner to be prolonged. Also, the gaps in the vertical direction between the liners are arranged at positions different from those of the vertical grooves formed in the convex portion of the stave body, preventing the grooves from communicating in vertical directions, whereby the gas flow rising along the vertical groove is blocked to maintain the slag fixing layer, and at the same time, the heat receiving from the gaps between the liners and the inner face of the vertical grooves can be blocked to prolong the service life of the liner and the stave.

[0013] According to a preferable example of the invention, the counterbore hole and the bolt hole passing through the counterbore hole are formed in the liner from the side facing the inside of furnace, and also the female screw hole is formed on the bottom of the horizontal groove of the stave body at a position corresponding to the bolt hole, whereby the bolt is inserted from the side facing the inside of the furnace through the counterbore hole and the bolt hole and fixed to the female screw hole. Therefore, the movement of the liner in the horizontal direction is blocked during use to prevent the gap in the vertical direction between the liners from moving to the position of the vertical groove, and the gap between the liners can be kept constant. Furthermore, the slag fixing layer is formed in the counterbore hole and cooled effectively by the stave body, which is fitted into the liner at three upper, lower and bottom faces, so that the bolt is not damaged even by the use for a long period of time.

[0014] According to another preferable example of the invention, the positions of the gaps between the liners adjoining in the vertical direction are made different in the horizontal direction, preventing the gas flow from passing through the gaps between the liners and preventing the removal of the slag fixing layer by the gas flow, whereby the heat receiving from the gaps between the liners in the vertical direction and the inner face of the vertical grooves are prevented to prolong the service life of the liner. Further, according to another preferable example of the invention, the positions of the vertical grooves adjoining in the vertical direction are made different, preventing the gas flow from passing through the vertical grooves caused by penetrated vertical grooves to prevent the removal of the slag fixing layer by the gas flow. Moreover, the heat receiving from the inner face of the vertical grooves can be prevented to prolong the service life of the stave. Also, when the positions of the gaps

in the vertical direction between the liners adjoining in the vertical direction are made different, and at the same time, the positions of the vertical grooves adjoining in the vertical direction are made different, the effect of prolonging the service life of the stave can be further improved.

Brief Description of Drawings

[0015]

FIG. 1 is a schematic view of an example of the wall-cooling stave for a blast furnace according to the invention viewing from an inside of the furnace.
FIG. 2 is a sectional view of the wall-cooling stave for the blast furnace according to the invention taken along a line A-A of FIG. 1.
FIG. 3 is a schematic view of a wall-cooling stave for a blast furnace according to the invention illustrating an example of the stave before the attachment of a liner viewing from an inside of the furnace.
FIG. 4 is a sectional view of the stave before the liner taken along a line A-A of FIG. 3.
FIG. 5 is a view explaining a method for fixing a wall-cooling stave to an iron shell in the conventional example.

Description of Embodiments

[0016] There will be described a wall-cooling stave for a blast furnace according to the invention below.

[0017] The wall-cooling stave for the blast furnace according to the invention comprises:

a stave body provided in its interior with a water channel for passing a cooling water therethrough and made from copper or a copper alloy;
a plurality of horizontal grooves formed on the surface side of the stave body facing the inside of the furnace so as to extend in a horizontal direction and having concave portions constituted with the plurality of horizontal grooves and convex portions constituted between the plurality of horizontal grooves;
a plurality of vertical grooves formed in the convex portions between the horizontal grooves so as to extend in a vertical direction; and
a plurality of liners formed so as to fit into the horizontal grooves of the stave body and protrude at their tips into the inside of the furnace,
in which gaps extending in the vertical direction between the plurality of liners are constituted so as to be located at different positions from the vertical grooves in the horizontal direction, that is, gaps extending in the vertical direction between the plurality of liners are configured not so as to communicate with the vertical grooves.

[0018] To prevent the gaps from communicating with the grooves means a state that either the upper end or lower end, or both ends of the groove are closed with the liner in the vertical direction and a space constituting the groove is open only to a direction to the surface side facing the inside of the furnace. In the invention, it is preferable that not less than 70% of the upper and lower ends of the grooves present on the stave body be closed. It is more preferable that not less than 90% of the upper and lower ends of the grooves be closed with the liners, and it is most preferable that all positions be closed.

[0019] In the blast furnace where a high-temperature air is blown from the lower portion of the furnace and a generated gas is taken out from an upper portion thereof, when a speed of gas flowing upward along a stave surface is large in the stave that cools the furnace wall from the inner face thereof, a heat-transfer coefficient of the inner face of the stave increases and the temperature of the stave is likely to be raised. The wall-cooling stave for the blast furnace according to the invention having the above configuration is made from copper or a copper alloy having a high heat-transfer coefficient, and hence a slag inside the furnace is cooled to form a slag fixing layer on the surface side of the stave facing the inside of the furnace. Thus, the stave itself can be protected over a long time of period. In the wall-cooling stave for the blast furnace according to the invention, water is passed through the cooling water channels formed in the stave body to cool the stave.

[0020] A plurality of horizontal grooves are horizontally formed on the surface side of the stave body facing the inside of the furnace. Also, concave portions are constituted with the horizontal grooves, and convex portions are constituted between the horizontal grooves or between the horizontal groove and the upper or lower end portion of the stave body. A liner is provided in the horizontal groove of the stave body such that the liner fits into the upper face, lower face and bottom face thereof and its tip is protruded into the inside of the furnace. The material of the liner is preferable to be high in the hardness and high-temperature strength and small in the heat-transfer coefficient as compared to the material of the stave. Therefore, the liner is durable even if the temperature rises higher than the stave body and can reduce heat transferred to the stave body. Since the liner is protruded into the inside of the furnace, the slag fixing layer having a low heat-transfer coefficient is formed and maintained on the tip part of the convex portion between the horizontal grooves located between the liners, and the base portion of the liner. A base root portion where the liner fits into the horizontal groove in the stave is cooled by the stave and maintained at a low temperature, while the tip portion protruding into the inside of the furnace receives heat inside the furnace and becomes hot.

[0021] A groove is formed in the convex portion present adjacent to the horizontal grooves of the stave body so as to intersect with the extending direction of the convex portion. This groove has an opening portion communicating with the horizontal grooves located in the upper end and lower end of the convex portion or communicat-

ing with the end portion of the stave and is formed so as to communicate the opening portions with each other. In the invention, the groove formed in the convex portion is called as a vertical groove, a direction of which is not limited to 90° to the extending direction of the convex portion. The presence of the groove can mitigate the deformation of the stave body caused by heat stress due to the temperature change. The width of the vertical groove is preferably not less than 1 mm and not more than 50 mm. More preferably, it is not less than 8 mm and not more than 30 mm. The depth of the vertical groove may be same as in the horizontal groove, but the effect can be developed even with a shallower groove. The groove is preferable to have a depth corresponding to not less than 1/2 of the protruding height of the convex portion (distance from the upper end of the convex portion to the bottom face of the groove). More preferably, the depth of the groove is approximately 3/4 to 1 times of the protruding height of the convex portion. Also, the vertical groove formed in the convex portion is preferable to be arranged at an interval of 100 mm to 500 mm in the horizontal direction. The interval of the vertical grooves is further preferable to be 150 mm to 300 mm in accordance with a pitch between the cooling water channels.

[0022] The liner fitted into each horizontal groove is divided into a plurality of parts, and thermal expansion is absorbed by a gap in the vertical direction between the divided liners. When the gap between the liners is located at the same vertical position as the vertical groove in the stave body, the gap communicates with the vertical groove and gas flow passes therethrough. Thus, the slag fixing layer is removed by the gas flow, and heat is received from the gap between the liners and the inner face of the vertical groove to rise the temperature. However, the position of the gap between the liners and the position of the vertical groove are made different in the horizontal direction, whereby passing through of the gas flow is prevented and thermal expansion can be absorbed effectively.

[0023] A preferable example of the wall-cooling stave for the blast furnace according to the invention will be described below.

[0024] First, when the liner is simply fitted into the horizontal groove of the stave body, the position of the gap in the vertical direction between the liners may be located at the same position as the vertical groove as the liner moves horizontally during use. In order to prevent such a state and keep the gap between the liners constant, a counterbore hole is formed on the side of the liner facing the the inside of the furnace and a bolt hole is formed on the bottom of the counterbore hole, and a bolt is inserted into the bolt hole and fixed to a female screw hole formed in the horizontal groove of the stave body, whereby the movement of the liner in the horizontal direction can be blocked. The bolt itself is cooled by the female screw hole of the stave body, and the slag fixing layer being low in the thermal conductivity is formed in the counterbore hole, so that the temperature rise of the bolt can be avoided. Furthermore, the counterbore hole is formed in the liner deeper in the direction toward the outside of the furnace than the tip of the convex portion between the horizontal grooves of the stave, and the position of the bolt is cooled effectively by the stave body fitted into the liner at three faces of the upper face, lower face and bottom face, so that the temperature rise of the bolt can be avoided, causing no damage of the bolt with use for a long period of time. In the method of fixing the liner according to the invention, falling-away and breakage of the liner can be prevented effectively as compared to the conventional method of fixing the liner, and the service life of the liner can be prolonged largely. Thus, the service life of the stave can be prolonged largely.

[0025] It is preferable that the vertical width of the concave portion in the stave body be larger than the vertical width of the convex portion. With such a configuration, the convex portion between the horizontal grooves directly receives heat inside the furnace to raise the temperature higher than the temperature of the horizontal groove, so that the width thereof is made smaller than that of concave portion, whereby the heat receiving amount of the convex portion can be reduced. Also, the liner protrudes into the inside of the furnace further than the tip of the convex portion between the horizontal grooves in the stave, so that the slag fixing layer, which is low in the thermal conductivity, is formed in the gap between liners adjoining in the vertical direction.

[0026] The liner is preferable to be made of a material having a high-temperature strength higher than that of the stave body. As an example of the liner material having a high-temperature strength higher than that of the stave body made from copper or a copper alloy, a stainless steel, SS steel and the like can be preferably used.

[0027] The horizontal positions of the gaps between liners adjoining in the vertical direction are made different, thus preventing the gaps between the liners from penetrating through and preventing the gas flow from passing therethrough, whereby the removal of the slag fixing layer by the gas flow is prevented and heat receiving from the gaps between the liners and the inner face of the vertical grooves are prevented. The gap between the liners is preferable to be not less than 5 mm and not more than 500 mm. To make the horizontal positions of the gaps between the liners different means to arrange the liners in such a manner that the protruded portions of the adjoining liners are located just above and/or just below the gap between the liners having a certain height. Therefore, an interval between the gaps formed between the liners is preferable to be shorter than the length of the liner arranged in the groove. In not less than 70% of the number of gaps between liners, the gaps should be located at positions horizontally different from gaps of liners adjoining in the vertical direction.

[0028] When the liner is worn out or fell away by use for a long period of time, the slag fixing layer being low in the thermal conductivity is formed in the horizontal groove of the stave body. In this case, the horizontal po-

sitions of vertical grooves adjoining in the vertical direction are made different to prevent the vertical grooves from penetrating and prevent the gas flow from passing through the vertical grooves, whereby the removal of the slag fixing layer by the gas flow can be prevented and the heat receiving from the inner face of the vertical groove can be prevented.

[0029] To make the horizontal positions of vertical grooves adjoining in the vertical direction different means to arrange the vertical grooves in such a manner that the adjacent stave body is located directly above and/or below the opening of the vertical groove of the convex portion of the stave body having a certain height. Even in this case, it is preferable that, in not less than 70% of the vertical grooves, the horizontal positions of the vertical grooves should be located at positions different from vertical grooves in adjacent convex portions.

[0030] Moreover, the removal of the slag fixing layer can be prevented more effectively by making the horizontal positions of the gaps between liners adjoining in the vertical direction different as well as by making the horizontal positions of vertical grooves adjoining in the vertical direction different as described above.

Examples

[0031] An example of the invention will be described with reference to the accompanying drawings.

[0032] FIG. 1 is a schematic view of an example of a wall-cooling stave for a blast furnace according to the invention, viewing from an inside of the furnace, and FIG. 2 is a sectional view of the wall-cooling stave for the blast furnace taken along a line A-A of FIG. 1. The configuration of the wall-cooling stave for the blast furnace according to the invention will be described with reference to FIGS. 1 ad 2 below.

[0033] In the example shown in FIGS. 1 and 2, a plurality of stave bodies 1 are arranged in a circumferential direction of a blast furnace, and an oxygen-free copper is used as an example of a material for the stave bodies. A plurality of liners 2 are fitted into horizontal grooves 13 formed by cutting work in the stave bodies 1 with a gap 5 in a vertical direction (upper and lower direction in the figure) between the liners 2 and fastened thereto by hexagon socket head bolts 3. The horizontal groove 13 has, as an example, a trapezoidal form being wider at the back having a size with a depth 13a of 55 mm and a width in vertical direction of 75 mm at the bottom 13b and 70 mm at an opening portion 13c. Therefore, the liner 2 never falls away from the horizontal groove 13. Also, the liner 2 is fitted into the horizontal groove 13 and fixed in the horizontal direction by the bolt 3, so that the width of the gap 5 in the vertical direction between the liners 2 is not varied by external force and can maintain an initial gap of 10 mm as an example.

[0034] A concave portion 21 is formed by the horizontal groove 13, and a convex portion 22 is formed between the horizontal grooves 13 adjoining in the vertical direction. In this example, a plurality of vertical grooves 4 having a width of 10 mm and a depth of 55 mm as an example are formed in the resulting convex portion 22 by cutting work. The plurality of vertical grooves 4 are located in positions horizontally shifted from the gaps 5 in the vertical direction between the liners 2. Thus, in the blast furnace, the vertically rising gas flow does not go through, and the slag fixing layer formed on the surface side facing the inside of the furnace is maintained on the liners 2.

[0035] In the invention, the horizontal position of the gap 5 in the vertical direction between the vertically adjacent liners 2 and the horizontal position of the vertical grooves 4 adjoining in the vertical direction are not particularly limited. However, as shown in FIGS. 1 and 2, the gaps 5 in the vertical direction between the vertically adjacent liners 2 are preferable to positioned differently in the horizontal direction as a preferable embodiment. When the gaps 5 in the vertical direction between the liners 2 are constituted as above, the vertically rising gas flow can be more preferably prevented from passing through in the case when the liners 2 are present. Also, the horizontal positions of the vertical grooves 4 adjoining in the vertical direction are preferable to be made different as another preferable example as shown in FIGS. 1 and 2. With the vertical grooves 4 having such a configuration, even when the liner 2 is worn out or fell away with use for a long time, as the vertical grooves 4 adjoining in the vertical direction being horizontally shifted to each other, the vertically rising gas flow is prevented from passing through and the slag fixing layer formed on the surface side facing inside of the furnace is maintained.

[0036] FIG. 2 is a sectional view of the wall-cooling stave for the blast furnace according to the invention taken along a line A-A of FIG. 1. In the example shown in FIG. 2, the horizontal groove 13 having a wider bottom than its tip is formed in the stave body 1 being a plate made of a wrought copper product with a given thickness. The cooling water channel 6 arranged in the vertical direction of the stave is formed by drilled upward from a lower end face of the plate with a gun drill and stopped without passing through the plate.

[0037] With the configuration, a feed-water inlet 7 and a drain outlet 8, which have the same diameter as the cooling water channel 6, are opened in the cooling water channel 6 from a rear surface corresponding to the surface side of the stave facing the outside of the furnace. A feed-water pipe 9 for feeding a cooling water from the outside of the furnace through an iron shell of the blast furnace to the feed-water inlet 7, and a drainage pipe 10 for discharging the cooling water to the outside of the furnace through the iron shell of the blast furnace from the drain outlet 8 are attached to the stave body 1 by fillet welding. The lower hole of the cooling water channel 6 is sealed with a plug 11 by V-shaped groove welding.

[0038] The liner 2 is horizontally inserted along the horizontal groove 13 formed in the stave body 1 and fastened at a given position by the bolt 3. The bolt 3 is positioned on the bottom of the counterbore hole 12 and thus fas-

tened by using a hexagon socket head bolt with a hexagon wrench. In the inside of the furnace, the slag fixing layer is also formed in the counterbore hole 12 thus can protect the head of the bolt 3. The counterbore hole 12 is formed in a position deeper than the tip of the convex portion 22 between the horizontal grooves 13 to prevent the temperature rise of the bolt 3.

[0039] FIG. 3 is a schematic view of an example of the wall-cooling stave for the blast furnace according to the invention before the attachment of the liner viewing from the inside of the furnace, and FIG. 4 is a sectional view of the stave before the attachment of the liner taken along a line A-A of FIG. 3. In the example shown in FIGS. 3 and 4, the horizontal groove 13 is formed in the stave body 1 by milling. On the bottom of the horizontal groove 13, a female screw hole 14 for fastening the liner 2 with the bolt 3 is opened by tapping working. The female screw hole 14 is arranged at a position shifted in the horizontal direction from the cooling water channel 6 so as not to pass through the cooling water channel 6. After the completion of the cutting work and welding work, a plurality of liners 2 that fit into the horizontal grooves 13 are sequentially inserted from the side. When the centers of the female screw hole 14, counterbore hole 12 and concentric bolt hole 23 are aligned, the sliding of the liner along the horizontal groove 13 is stopped by the fastening with the bolt 3.

Industrial Applicability

[0040] The wall-cooling stave for the blast furnace according to the invention is particularly effective as a stave for cooling the wall of the blast furnace, which feeds high-temperature air from a lower portion of the furnace and takes out a generated gas from an upper portion, from the inner face thereof but is also effective as in use for protecting an inside of a furnace wall exposed to a high temperature by cooling in a shaft furnace or the like other than the blast furnace. Reference Signs List

[0041]

1 stave body
2 liner
3 hexagon socket head bolt
4 vertical groove
5 gap
6 cooling water channel
7 feed-water inlet
8 drain outlet
10 drainage pipe
11 plug
12 counterbore hole
13 horizontal groove
13a depth
13b bottom
13c opening portion
14 female screw hole
21 concave portion
22 convex portion
23 bolt hole

Claims

1. A wall-cooling stave for cooling a furnace wall of a blast furnace from an inner surface thereof, comprising

a stave body provided in its interior with a water channel for passing a cooling water therethrough and made from copper or a copper alloy,
a plurality of horizontal grooves formed on a surface side of the stave body facing the inside of the furnace to constitute concave portions formed of the plurality of horizontal grooves and convex portions formed between the plurality of horizontal grooves,
a plurality of vertical grooves vertically formed in the convex portions of the horizontal grooves, and
a plurality of liners formed so as to fit into the horizontal grooves in the stave body and protrude at their tops into the inside of the furnace,
characterized in that
gaps in the vertical direction between the plurality of liners are located at different positions in a horizontal direction from the vertical grooves.

2. The wall-cooling stave for the blast furnace according to claim 1, wherein

a counterbore hole and a bolt hole passing through the counterbore hole are formed in the liner from the side of the stave facing the inside of the furnace, and
a female screw hole is formed on the bottom of the horizontal groove of the stave body at a position corresponding to the bolt hole, and
a bolt is inserted from the side facing the inside of the furnace through the counterbore hole and the bolt hole and fixed to the female screw hole to thereby fit the liner into the horizontal groove.

3. The wall-cooling stave for the blast furnace according to claim 1 or 2, wherein
the concave portion has a vertical width larger than a vertical width of the convex portion.

4. The wall-cooling stave for the blast furnace according to any one of claims 1 to 3, wherein
the liner is made from a material being high in a high-temperature strength as compared to a material of the stave body.

5. The wall-cooling stave for the blast furnace accord-

ing to any one of claims 1 to 4, wherein the gaps between the liners adjoining in the vertical direction are located at different positions in the horizontal direction.

6. The wall-cooling stave for the blast furnace according to any one of claims 1 to 4, wherein the vertical grooves adjoining in the vertical direction are located at different positions in the horizontal direction

7. The wall-cooling stave for the blast furnace according to any one of claims 1 to 4, wherein the gaps between the liners adjoining in the vertical direction are located at different positions in the horizontal direction, and also the vertical groove adjoining in the vertical direction are located at different positions in the horizontal direction.

FIG. 1

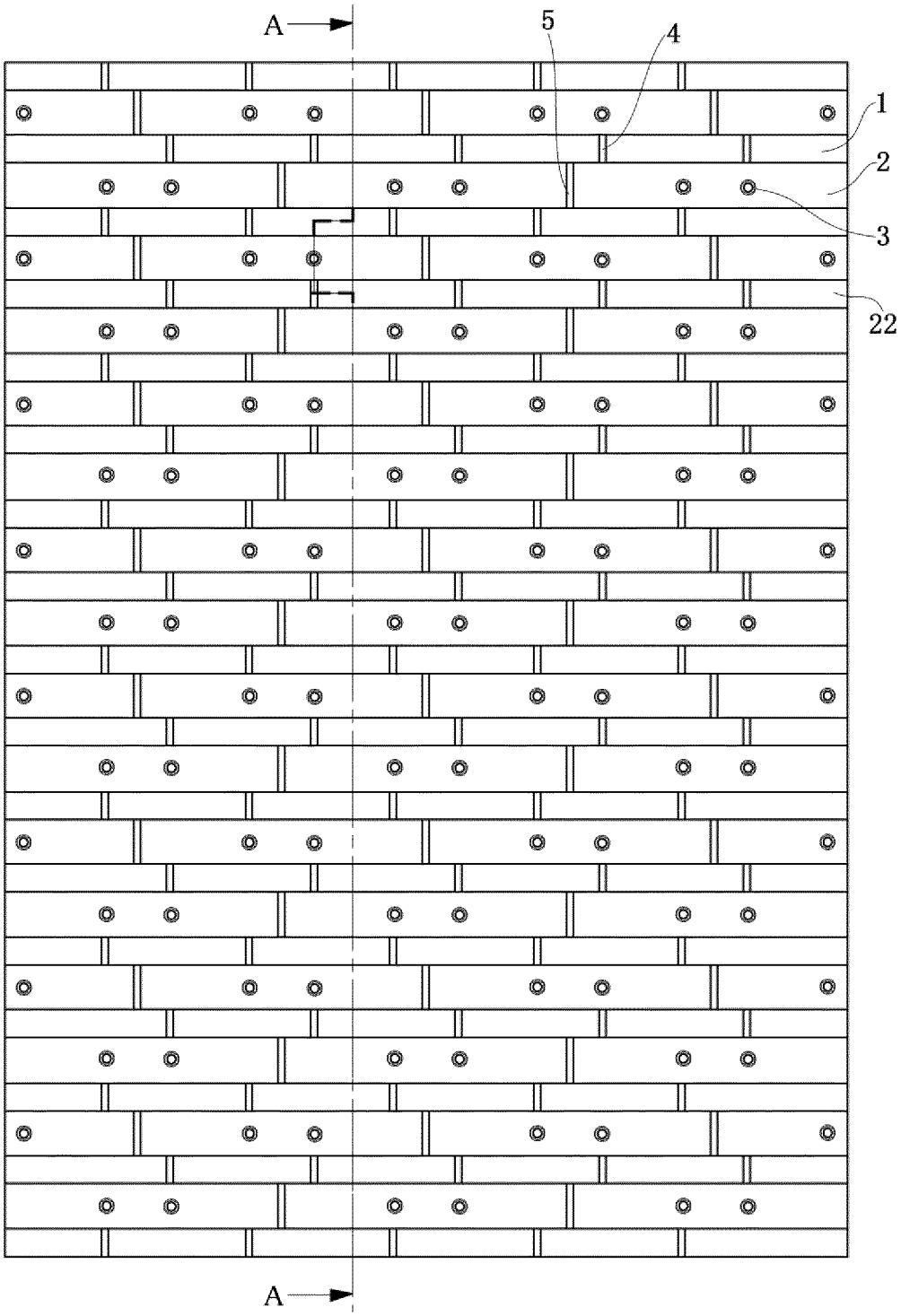


FIG. 2

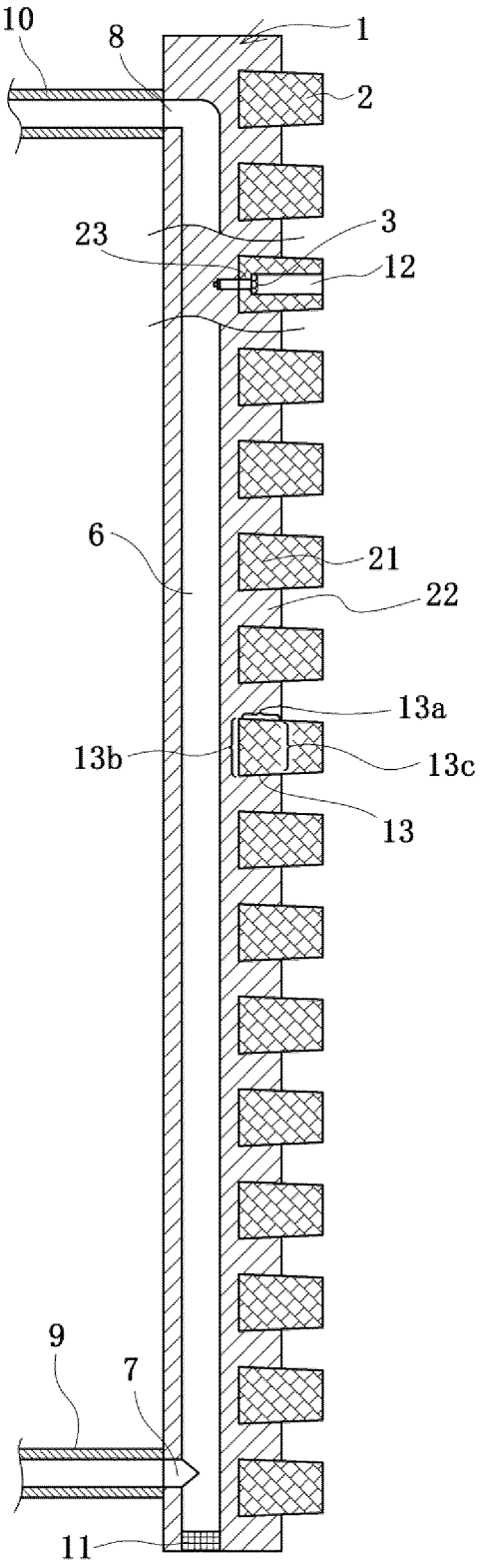


FIG. 3

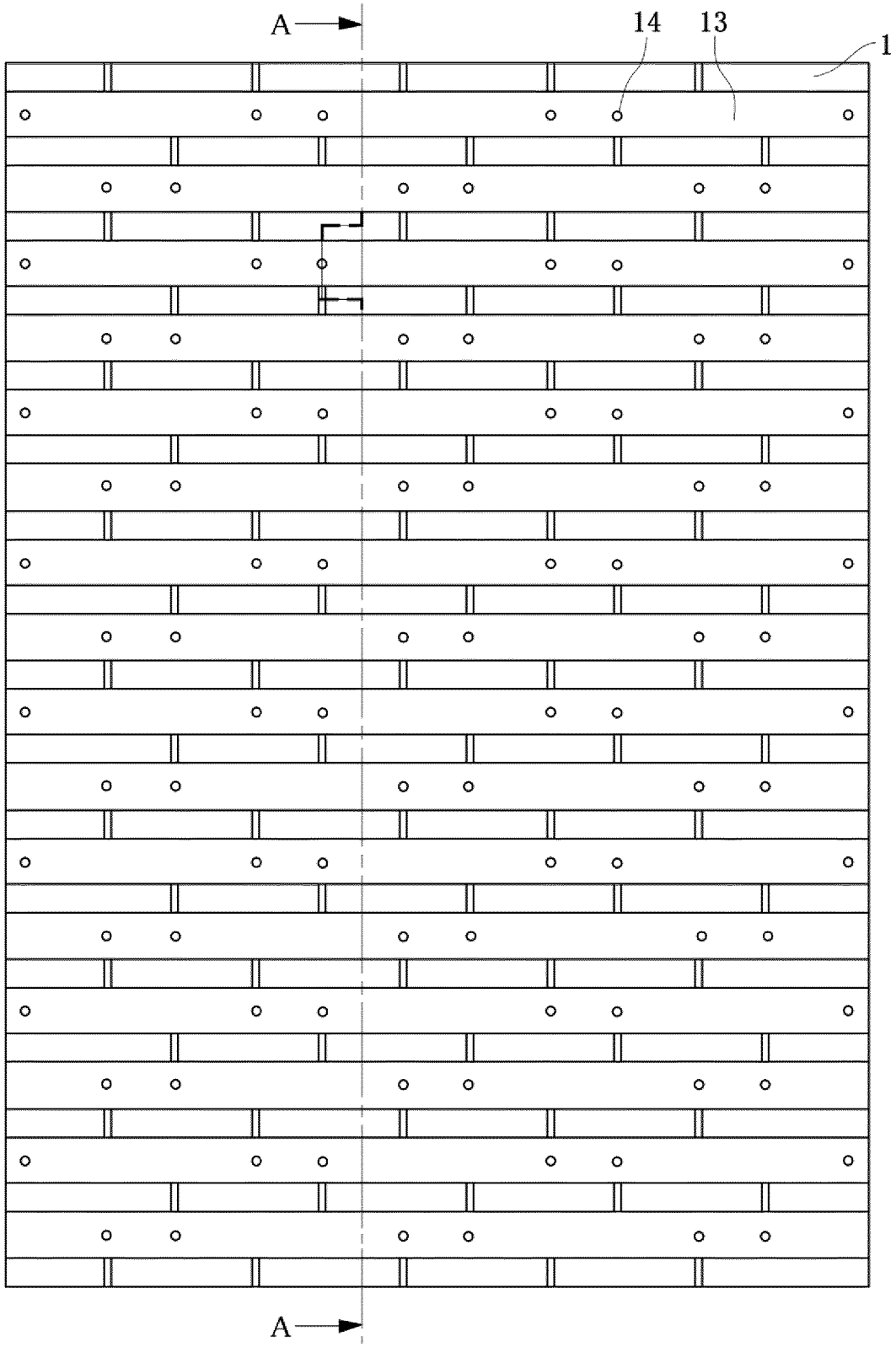


FIG. 4

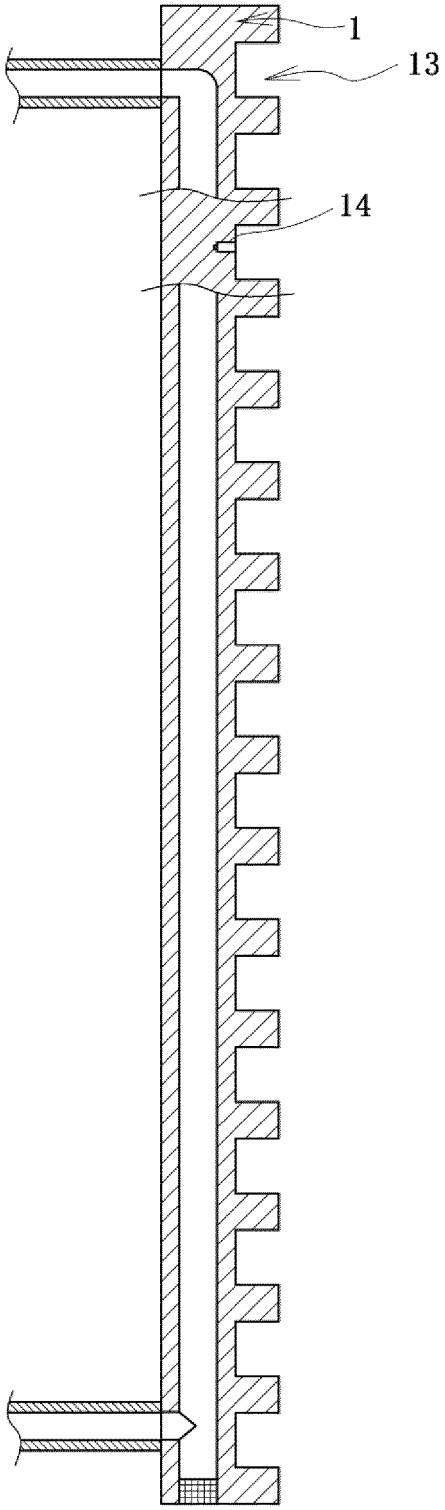
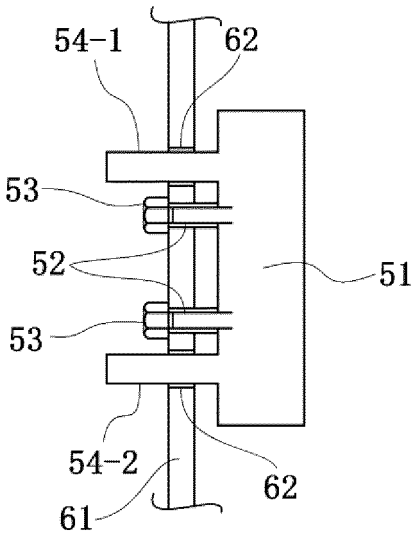


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/013231

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. C21B7/10(2006.01)i, F27D1/12(2006.01)i
FI: C21B7/10301, F27D1/12A

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. C21B7/10, F27D1/12

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 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-224914 A (SUMITOMO METAL INDUSTRIES, LTD.) 15.11.2012 (2012-11-15), entire text	1-7
A	JP 2016-000868 A (NIPPON STEEL & SUMIKIN ENGINEERING CO., LTD.) 07.01.2016 (2016-01-07), entire text	1-7
A	JP 2014-234536 A (IHI CORPORATION) 15.12.2014 (2014-12-15), entire text	1-7
A	JP 61-153217 A (NIPPON STEEL CORPORATION) 11.07.1986 (1986-07-11), entire text	1-7

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

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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
25.05.2020	02.06.2020
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/013231

JP 2012-224914 A	15.11.2012	(Family: none)	
JP 2016-000868 A	07.01.2016	(Family: none)	
JP 2014-234536 A	15.12.2014	(Family: none)	
JP 61-153217 A	11.07.1986	(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 2003269867 A **[0006]**
- JP 2000119713 A **[0006]**