

Description

Title of the Invention

REFRACTORY TILE FOR PROTECTING BOILER WATER PIPE

5 Field of the Invention

[0001]

The present invention relates to a refractory tile for protecting boiler water pipe used to protect the boiler water pipe.

10 Background of the Invention

[0002]

A plurality of boiler water pipes are installed on a furnace wall of a combustion furnace in facilities such as waste incineration plant that includes a boiler and generates power while incinerating waste and a power plant that burns fuel such as coal, that is, a combustion plant including a boiler. Generally, the plurality of boiler water pipes are erected in the vertical direction, and are spaced apart from each other at equal intervals in the horizontal direction, that is, are evenly disposed. Then, two boiler water pipes adjacent to each other in the horizontal direction are connected to each other with a plate-shaped fin without any gap, and a water pipe panel is formed by the boiler water pipes and the fin.

[0003]

In order to protect these boiler water pipes from excessive heat, a refractory tile may be installed on the surface of the boiler water pipe on the side facing the inside of the furnace in the water pipe panel. At this time, for example, there is a technique in which hooks are uniformly installed on fins of the water pipe panel, and the refractory tile is mechanically supported by the hooks (see Patent Document 1).

According to this technique, a refractory joint material such as mortar serving as an adhesive is applied to the back surface of the rectangular refractory tile, the hook is hooked on a depressed portion (hereinafter, referred to as a "recess") provided near the center of the back surface of the refractory tile, and the refractory tile is pressed toward the water pipe panel, whereby the refractory tile is fixed on two adjacent boiler water pipes on both sides of the hook. By sequentially repeating this, the plurality of refractory tiles are installed on the upper surfaces of the plurality of boiler water pipes.

35 [0004]

The refractory tile described in Patent Document 1 is a refractory tile in which two boiler water pipes adjacent to each other in the horizontal direction are protected by one refractory tile, and a thickness is made thin and uniform in order to

make heat conduction from the combustion furnace to the boiler water pipe uniform. The refractory tile is called a “gull-type” refractory tile because a cross-sectional shape cut in the horizontal direction is a shape in which a seagull(gull) spreads its wings. There are a plurality of types of the “gull-type” refractory tiles, and for
 5 example, there is a refractory tile of Patent Document 2 having a structure different from that of Patent Document 1.

Conventionally, a large number of spacers have been formed on a back surface of such a “gull-type” refractory tile in order to make a refractory joint material as an adhesive applied to the back surface have a predetermined thickness. For
 10 example, on the back surface of the “gull-type” refractory tile of Patent Document 2, nine spacers are disposed for one boiler water pipe, that is, a total of eighteen spacers are disposed in one refractory tile.

Citation List

Patent Literature

[0005]

Patent Document 1: Utility Model Registration No. 3176108

Patent Document 2: Japanese Patent No. 6221186

Summary of the Invention

Issue to be solved by the Invention

[0006]

However, in a refractory tile including a large number of spacers, a crack starting from the spacers may occur.

25 In addition, when the refractory joint material as the adhesive is applied to the back surface of the refractory tile, it is easier to apply the refractory joint material when the number of spacers as the protrusions is small, and it is possible to enhance the adhesive force between the refractory tile and the water pipe panel when the number of spacers is small.

30 Therefore, it is conceivable to significantly reduce the number of spacers as compared with the conventional case, and to dispose three spacers, which is the minimum number that can stably bring one “gull-type” refractory tile into contact with the water pipe panel, on the refractory tile.

35 However, it has been found by the trial of the inventors that, even when these three spacers are disposed on one “gull-type” refractory tile, a crack starting from the spacers still occurs, and the refractory tile rattles, so that it may be difficult to construct the water pipe panel.

[0007]

Accordingly, an object of the present invention is to provide a “gull-type” refractory tile for protecting a boiler water pipe capable of preventing an occurrence of a crack starting from the spacers, allowing easy construction, and strengthening adhesive force and easily constructed on a water pipe panel while being stably in
 5 contact with a boiler water pipe.

Solution to the Issue

[0008]

The present invention relates to a “gull-type” refractory tile for protecting a
 10 boiler water pipe(hereinafter, referred to as “refractory tile”) in which a semi-tubular first individual wing portion having a width W and a height H, a center portion, and a semi-tubular second individual wing portion having a width W and a height H are connected sequentially in the width direction to be integrally molded into a rectangular shape with a total width L and a total height H, and a recess for hooking is
 15 formed near the center of the back surface of the center portion.

Particularly, in the refractory tile of the present invention, when viewed from a back side of the first individual wing portion and the second individual wing portion,

one of the individual wing portions is provided with
 20 only a first spacer disposed on an imaginary line extending in a height direction at a position of $(3/4)W$ in a width direction from the center portion or in the vicinity of the imaginary line, and

the other individual wing portion is provided with either
 a first spacer set including two spacers as only a second spacer
 25 disposed on an imaginary line extending in the height direction at a position of $(1/4)W$ in the width direction from the center portion or in the vicinity of the imaginary line and

only a third spacer disposed on an imaginary line extending in the height direction at a position of $(3/4)W$ in the width direction from the center portion
 30 or in the vicinity of the imaginary line

or
 a second spacer set including two spacers as the second spacer and the third spacer, each disposed by a distance of at least $(2/4)H$ to be separated on an imaginary line extending in the height direction or in the vicinity of the imaginary line
 35 at a position of $(1/4)W$ in the width direction from the center portion.

An area S of an imaginary triangle formed when midpoints of only a total of three spacers disposed in the one individual wing portion and the other individual

wing portion are connected on a plane in the width direction and the height direction satisfies $\{(H/2) \times (L-W)\}/2 \leq S < \{(L \times H)/2\}$.

Advantageous Effects of the Invention

5 [0009]

The refractory tile of the present invention includes only a total of three spacers of a first spacer in one of the two individual wing portions and a second spacer and a third spacer in the other individual wing portion.

10 Therefore, as compared with the conventional refractory tile including a large number of spacers, it is possible to easily construct the refractory joint material on the back surface of the refractory tile and to enhance the adhesive force of the refractory tile to the water pipe panel.

15 In the refractory tile of the present invention, only the first spacer is disposed on one individual wing portion, and the interval between the second spacer and the third spacer disposed on the other individual wing portion is separated by a distance of about $(2/4)W$ in the width direction as in the first spacer set, or is separated by a distance of at least $(2/4)H$ as in the second spacer set.

Therefore, since the spacers are disposed so as to be largely separated from each other, it is possible to prevent the occurrence of a crack starting from the spacers.

20 Further, the refractory tile of the present invention is disposed such that the area S of the imaginary triangle formed when the midpoints of the first spacer, the second spacer, and the third spacer are connected satisfies the following relational expression.

$$\{(H/2) \times (L-W)\}/2 \leq S < \{(L \times H)/2\}$$

25 Accordingly, when the refractory tile is constructed on the water pipe panel, the first spacer disposed on one of the individual wing portions and the second spacer and the third spacer disposed on the other one of the individual wing portions can be disposed in a well-balanced manner so that the refractory tile can be stably brought into contact with the boiler water pipe without rattling.

30 [0010]

Therefore, according to the present invention, it is possible to provide a “gull-type” refractory tile which can prevent the occurrence of a crack starting from the spacers, can easily perform construction and enhance adhesive force, and can be stably brought into contact with a boiler water pipe to facilitate construction on a
35 water pipe panel.

Brief Description of Drawings

[0011]

FIG. 1 shows a configuration example of a non-fitting and gull-type refractory tile of a first embodiment, where FIG. 1A is a front view as viewed from a surface side, FIG. 1B is a rear view as viewed from a back side, FIG. 1C is a cross-sectional view taken along line A-A along an X axis of FIG. 1B, and FIG. 1D is a cross-sectional view taken along line B-B along a Y axis of FIG. 1B.

FIG. 2 shows a configuration example of a fitting and gull-type refractory tile of a second embodiment, where FIG. 2A is a front view as viewed from a surface side, FIG. 2B is a rear view as viewed from a back side, FIG. 2C is a cross-sectional view taken along line A'-A' of FIG. 2B along an X axis, and FIG. 2D is a cross-sectional view taken along line B'-B' of FIG. 2B along a Y axis.

FIG. 3A is a cross-sectional view of FIG. 1C with added reference numerals, reference signs, and dotted lines to illustrate a thick portion, and FIG. 3B is a cross-sectional view of a refractory tile without a thick portion.

FIG. 4 is an arrangement example (pattern 1A) of each spacer including only three refractory tiles.

FIG. 5 is an arrangement example (pattern 1B) of each spacer including only three refractory tiles.

FIG. 6 is an arrangement example (pattern 2A) of each spacer including only three refractory tiles.

FIG. 7 is an arrangement example (pattern 2B) of each spacer including only three refractory tiles.

FIG. 8 is an arrangement example (pattern 3A) of each spacer including only three refractory tiles.

FIG. 9 is an arrangement example (pattern 3B) of three spacers provided in the refractory tile.

Description of Embodiments of the Invention

[0012]

Hereinafter, a gull-type refractory tile according to an embodiment of the present invention and a modification thereof will be described with reference to FIGS. 1 to 9.

FIG. 1 shows a structure of a refractory tile (non-fitting-type) of a first embodiment, and FIG. 2 shows a structure of a refractory tile (fitting-type) of a second embodiment. FIG. 3 is used to illustrate a difference in structure of a refractory tile with and without thick portions.

FIGS. 4 to 9 show a plurality of arrangement examples of the spacers using the refractory tile of the first embodiment, in which each refractory tile is equipped with only three spacers. Here, an arrangement example of the spacers will be

described using the refractory tile of the first embodiment, but since the arrangement of the spacers in the refractory tile of the second embodiment is similar, repeated description is omitted.

In the following description, the basic structure of two main types of refractory tiles, that is, of two types of “gull-type” refractory tiles will be first described as the non-fitting-type refractory tile of the first embodiment and the fitting-type refractory tile of the second embodiment. Next, the thick portions that may be provided in these two types of refractory tiles will be described. Finally, the arrangement examples of three individual spacers only, that is, the first to third spacers, provided in each of these refractory tiles will be described.

[0013]

In the drawings, for convenience of description, an orthogonal coordinate system including an X axis, a Y axis, and a Z axis is used as appropriate. Here, the Y axis is disposed vertically, and the X axis and the Z axis are disposed horizontally.

The Y axis indicates the vertical direction, i.e., the height direction, in which the plurality of refractory tiles are aligned with the water pipe panel. The arrow direction of the Y axis indicates a direction toward an upper side in the vertical direction. The X axis indicates the lateral direction, i.e., the width direction, in which the plurality of refractory tiles are aligned with the water pipe panel. The Z axis indicates the direction perpendicular to the water pipe panel, i.e. the thickness direction of the refractory tile. The arrow direction of the Z axis indicates a direction from the boiler water pipe toward the refractory tile installed on the upper surface of the boiler water pipe.

Here, as an example, the Y-axis direction is described as the vertical direction, but the Y-axis direction may be inclined with respect to the vertical direction as long as the Y-axis direction is along the vertical direction. For example, in certain parts of the combustion furnace, the furnace wall may be inclined from the vertical. In such cases, the following explanation should be understood based on an orthogonal coordinate system in which the X axis remains horizontal while the Y and Z axes are arranged at inclined angles.

When the refractory tile is constructed on the water pipe panel, a surface facing the boiler water pipe is referred to as a “back surface”, and a surface opposite to the back surface, that is, a surface facing the inside of the combustion furnace is referred to as a “surface”.

The material of the refractory tile may vary depending on the fuel of the combustion furnace and the furnace temperature, but it is desirable to use SiC as a main raw material.

Each embodiment and each modification are merely examples, and there is no intention to exclude various modifications and applications of technologies that are not explicitly described. Except for the configuration essential to the present invention, each configuration of each embodiment and each modification can be selected and modified as necessary.

[0014]

<Refractory tile (non-fitting-type) of first embodiment>

First, a basic structure of a “non-fitting-type” and “gull-type” refractory tile 1 will be described.

The rectangular refractory tile 1 is a refractory tile in which only one recess 4 is formed at the center of the back surface in the X-axis direction and slightly above the center in the Y-axis direction, and which covers two boiler water pipes. Although not described in detail, when constructing the refractory tile 1 on the water pipe panel, the recess 4 is used to hook L-shaped hooks regularly installed on the water pipe panel. As illustrated in FIGS. 1B and 1D, the recess 4 is formed in a center portion 3.

As illustrated in FIG. 1A, the rectangular refractory tile 1 includes a rectangular first individual wing portion 2A covering one boiler water pipe on the right side in the width direction of the rectangular center portion 3 provided at the center in the X-axis direction as viewed in the XY plane and the surface, and a rectangular second individual wing portion 2B covering one boiler water pipe on the left side in the width direction of the center portion 3. Since the refractory tile 1 is a gull-type refractory tile, two portions corresponding to the flying gull wings are referred to as the first individual wing portion 2A and the second individual wing portion 2B, respectively. The rectangular refractory tile 1 is formed by integrally molding the center portion 3, the first individual wing portion 2A, and the second individual wing portion 2B to be connected to each other.

As illustrated in FIG. 1C, when viewed in the XZ plane, the first individual wing portion 2A has a semi-tubular shape curved along about a half of the outer periphery of the boiler water pipe having a circular cross-sectional shape. Similarly, when viewed in the XZ plane, the second individual wing portion 2B has a semi-tubular shape curved along about a half of the outer periphery of the boiler water pipe having a circular cross-sectional shape. The thickness of each of the half tube-shaped individual wing portions 2A and 2B is substantially the same at all portions, and is thinner than the thickness of the center portion 3.

As illustrated in FIG. 1B, when viewed in the XY plane and the back side, a first spacer 5A having an elliptical shape elongated in the height direction is integrally molded with the first individual wing portion 2A, and a second spacer 5B and a third

spacer 5C having the same shape are integrally molded with the second individual wing portion 2B. That is, one refractory tile 1 includes only a total of three spacers. [0015]

In FIG. 1B, all of the three spacers 5A, 5B, and 5C have the same dimension, for example, a dimension in the X-axis direction of about 4 mm and a dimension in the Y-axis direction of about 20 mm. In addition, in order to make the thickness of the refractory joint material as the adhesive for fixing the refractory tile 1 to the water pipe panel constant, the dimension protruding from the back surface of the first individual wing portion 2A or the second individual wing portion 2B is set to, for example, about 1.5 mm. However, the dimensions of the spacers 5A, 5B, and 5C may be different from each other depending on the design. Each of the spacers 5A, 5B, and 5C is rounded so as not to have a corner. [0016]

<Refractory tile (fitting-type) of second embodiment>

Next, a basic structure of a “fitting-type” and “gull-type” refractory tile 1' will be described.

The refractory tile 1' of the second embodiment is different from the refractory tile 1 of the first embodiment only in that the refractory tile 1' is a “fitting-type” refractory tile, and thus the same components as those of the refractory tile 1 are denoted by the same reference numerals and description thereof is omitted.

As illustrated in FIG. 2A, when viewed in the XY plane and the surface side, the rectangular refractory tile 1' includes the first individual wing portion 2A on the right side in the width direction of a rectangular center portion 3' provided at the center in the X-axis direction, and the second individual wing portion 2B on the left side in the width direction of the center portion 3'. The rectangular refractory tile 1' is formed by integrally molding the center portion 3', the first individual wing portion 2A, and the second individual wing portion 2B to be connected to each other.

As illustrated in FIG. 2B, when viewed in the XY plane and the back side, the rectangular refractory tile 1' has only one recess 4 formed at the center in the X-axis direction and slightly above the center in the Y-axis direction. As illustrated in FIGS. 2B and 2D, the recess 4 is formed in the center portion 3'.

As illustrated in FIG. 2B, when viewed in the XY plane and the back side, a fitting protrusion 7 protruding in a rectangular shape upward from the positions of the upper ends of the first individual wing portion 2A and the second individual wing portion 2B, and a fitting recess 8 recessed in a rectangular shape upward from the positions of the lower ends of the first individual wing portion 2A and the second individual wing portion 2B and having a size with which the fitting protrusion 7 can be fitted are formed in the center portion 3'.

[0017]

As described above, since the refractory tile 1' includes the fitting protrusion 7 and the fitting recess 8, it is possible to construct the water pipe panel by fitting the plurality of refractory tiles 1' to each other in the vertical direction. Therefore, as compared with the case where the non-fitting-type refractory tile 1 is constructed on the water pipe panel, when the fitting-type refractory tile 1' is constructed on the water pipe panel, the refractory tile 1' is resistant to shaking such as an earthquake, and peeling and falling of the refractory tile 1' can be more firmly prevented.

[0018]

Here, the structure including both the fitting protrusion 7 and the fitting recess 8 as the refractory tile 1' has been described. However, as a modification of the refractory tile 1', the same refractory tile as the refractory tile 1' except that the fitting protrusion 7 is not provided and the fitting recess 8 is provided, and the same refractory tiles as the refractory tile 1' except that the fitting protrusion 7 is provided and the fitting recess 8 is not provided as the fitting protrusions 7 and the fitting recesses 8 are prepared, and these three types (that is, the refractory tile 1' of the second embodiment and the two types of refractory tiles of the modification of the second embodiment) of fitting-type refractory tiles can be constructed by being vertically combined in the water pipe panel.

[0019]

<Thick portions provided in refractory tiles of embodiments and modifications>

In each of the refractory tiles 1 and 1' of the embodiments illustrated in FIGS. 1 and 2, the center portion 3 has a thick portion 6. However, these refractory tiles do not necessarily have to include the thick portion 6.

The thick portion 6 that can be provided in the refractory tile of each embodiment and each modification will be briefly described with reference to FIG. 3.

When the refractory tile of each of the first embodiment and the second embodiment does not include the thick portion 6, the refractory tile is treated as the refractory tile of the modification of the first embodiment or the refractory tile of the modification of the second embodiment.

[0020]

FIG. 3A is a cross-sectional view of the refractory tile 1 according to the first embodiment, which is a cross-sectional view taken along line A-A of FIG. 1C, to which reference numerals, reference signs, and dotted lines are added for description of the thick portion 6. FIG. 3B is a cross-sectional view of the refractory tile in a state where the thick portion 6 is removed from the refractory tile 1, in other words, a refractory tile 1A which is the refractory tile of the modification of the first

embodiment and does not include the thick portion 6. FIG. 3B corresponds to FIG. 3A.

Although the refractory tile 1 of the first embodiment is used in FIG. 3, the same applies to the refractory tile 1' of the second embodiment. Therefore, in the refractory tile 1', the drawing corresponding to FIG. 3 will not be described.

[0021]

First, FIG. 3B will be described, and then FIG. 3A will be described.

As illustrated in FIG. 3B, the refractory tile 1A includes the first individual wing portion 2A on the +X direction side of a rectangular center portion 3A provided at the center in the X-axis direction as viewed in the XZ plane, and the second individual wing portion 2B on the -X direction side of the center portion 3. At this time, the surface of the center portion 3A corresponds to the surface indicated as the center portion 3 in FIG. 1A in the refractory tile 1. In addition, the back surface of the center portion 3A corresponds to the back surface indicated as the center portion 3 in FIG. 1B in the refractory tile 1.

In FIG. 3B, a substantially rectangular portion between two dotted lines parallel to the Z axis is the center portion 3A. Of the two dotted lines, the dimension from the dotted line indicating the connection point between the center portion 3A and the first individual wing portion 2A to the position of the farthest end of the first individual wing portion 2A along the X axis is defined as the width W of the first individual wing portion 2A. Of the two dotted lines, the dimension from the dotted line indicating the connection point between the center portion 3A and the second individual wing portion 2B to the position of the farthest end of the second individual wing portion 2B along the X axis is defined as the width W of the second individual wing portion 2B. The dimension from the position of the farthest end of the first individual wing portion 2A to the position of the farthest end of the second individual wing portion 2B along the X axis is defined as the entire width L of the refractory tile.

The total width L of the refractory tile and the width W of each of the individual wing portions are also used in FIGS. 4 to 9.

[0022]

As illustrated in FIG. 3B, the thicknesses of the first individual wing portion 2A and the second individual wing portion 2B are substantially the same at all portions except for the vicinity of the connection portion with the center portion 3A. Therefore, the thickness TA of the refractory tile at the position where the first spacer 5A is formed in the first individual wing portion 2A, the thickness TB of the refractory tile at the position where the second spacer 5B is formed in the second individual wing portion 2B, and the thickness TC of the refractory tile at the position

where the third spacer 5C is formed in the second individual wing portion 2B are substantially the same. That is, substantially, the relationship of $TA=TB=TC$ holds. [0023]

5 Next, the refractory tile 1 including the thick portion 6 will be described with reference to FIG. 3A.

The thick portion 6 has a shape in which the thick portion is thickened from the surface of the center portion 3A in FIG. 3B toward the +Z direction side so as to have a surface on the XY plane while being in contact with the surfaces of the first individual wing portion 2A and the second individual wing portion 2B. That is, in 10 FIG. 3A, a portion whose thickness increases in a widening shape from the surface of the center portion 3A of FIG. 3B toward the +Z direction side, specifically, an inverted trapezoidal portion indicated by a two-dot chain line is the thick portion 6.

At this time, the surface of the thick portion 6 formed to be connected to the center portion 3A is illustrated as the center portion 3 in FIG. 1A. That is, the center 15 portion 3 is formed by integrating the center portion 3A having a rectangular shape and the thick portion 6 having an inverted trapezoidal shape as viewed in the XZ plane.

As illustrated in FIG. 3A, the thickness TB of the refractory tile 1 at the position where the second spacer 5B is formed, which is close to the connection 20 portion between the center portion 3 and the second individual wing portion 2B, is larger than the thickness TA of the refractory tile 1 at the position where the first spacer 5A is formed and the thickness TC of the refractory tile 1 at the position where the third spacer 5C is formed, because the thickness is increased by the thick portion 6. That is, a relationship of $TB>TA=TC$ substantially holds.

25 [0024]

The refractory tile having the thick portion 6 has higher mechanical strength and is less likely to be cracked than the refractory tile having no thick portion 6. However, the refractory tile is lighter in weight and more uniform in heat conduction to the boiler water pipe when the thick portion 6 is not provided than when the thick 30 portion 6 is provided.

Therefore, the refractory tile 1 in which the thick portion 6 is formed and the refractory tile 1A in which the thick portion 6 is not formed may be appropriately used according to the design specification.

[0025]

35 <Arrangement example of spacers including only three refractory tiles of each embodiment and each modification >

Hereinafter, an arrangement example of the spacers provided by only three refractory tiles of each embodiment and each modification will be described with reference to FIGS. 4 to 9.

First, the premise in each drawing will be described, and then a technical idea when each spacer is disposed will be described. Thereafter, an arrangement example of each spacer based on the technical idea will be sequentially described.

<Premise>

In FIGS. 4 to 9, the arrangement of the spacers will be described using the non-fitting-type refractory tile 1 illustrated in FIG. 1 for convenience of description.

However, the arrangement of the spacers can be applied to the refractory tile of any of the above embodiments or modifications.

Each of FIGS. 4 to 9 shows the back surface of the refractory tile 1 as viewed in the XY plane.

The shape of the non-fitting-type refractory tile 1 is a rectangle having a full width L in the X-axis direction and a full height H in the Y-axis direction as viewed in the XY plane. For example, the full width L may be about 198 mm and the full height H may be about 194 mm.

As described in the description of FIG. 3, the dimension from the connection point between the center portion 3 and the first individual wing portion 2A to the position of the farthest end of the first individual wing portion 2A along the X axis is defined as the width W of the first individual wing portion 2A. The dimension from the connection point between the center portion 3 and the second individual wing portion 2B to the position of the farthest end of the second individual wing portion 2B along the X axis is defined as the width W of the second individual wing portion 2B. For example, the width W can be about 87 mm. The thickness of each of the individual wing portions 2A and 2B is formed thin as described above, and can be about 12 mm.

In the case of the fitting-type refractory tile 1', since the fitting protrusion 7 is provided, the dimension in the Y-axis direction as a whole is larger than the total height H, but the configuration of the claims is understood in the rectangular portion having the total width L $\times$ the total height H when viewed in the XY plane.

In addition, since the thickness of each of the individual wing portions 2A and 2B of the refractory tile 1 is thin, the width W is set to a dimension from the center portion 3 to an end of the outer shape of each of the individual wing portions 2A and 2B. However, when the thickness of the refractory tile is large, the configuration of the claims may be understood as that the width W is the dimension of the inner diameter of each of the semi-tubular individual wing portions.

[0026]

In addition, in FIGS. 4 to 9, for convenience of description, imaginary lines are set as follows.

The width W of the first individual wing portion 2A is equally divided into four, an imaginary line L1 parallel to the Y axis is set at a position of $(1/4) W$, an
 5 imaginary line L2 parallel to the Y axis is set at a position of $(2/4) W$, and an imaginary line L3 parallel to the Y axis is set at a position of $(3/4) W$ in the +X-axis direction from the center portion 3.

The width W of the second individual wing portion 2B is equally divided into four, and an imaginary line L4 parallel to the Y axis is set at a position of $(1/4) W$, an
 10 imaginary line L5 parallel to the Y axis is set at a position of $(2/4) W$, and an imaginary line L6 parallel to the Y axis is set at a position of $(3/4) W$ in the -X-axis direction from the center portion 3.

Further, the overall height H of the refractory tile 1 is equally divided into four, and an imaginary line L7 parallel to the X axis is set at a position of $(1/4) H$, an
 15 imaginary line L8 parallel to the X axis is set at a position of $(2/4) H$, and an imaginary line L9 parallel to the X axis is set at a position of $(3/4) H$ in the +X-axis direction from the lower ends of the first individual wing portion 2A and the second individual wing portion 2B.

[0027]

20 <Technical idea in disposing each spacer>

One refractory tile 1 includes, as spacers, only a total of three spacers, i.e., one spacer for one of the first individual wing portion 2A and the second individual wing portion 2B and two spacers for the other one of the first individual wing portion and the second individual wing portion, that is, only three of the first spacer, the
 25 second spacer, and the third spacer.

As the spacer set including the second spacer and the third spacer, there are two types: a first spacer set in which the second spacer and the third spacer are disposed on imaginary lines parallel to the Y axis and different from each other or in the vicinity thereof; and a second spacer set in which the second spacer and the third
 30 spacer are disposed on the same imaginary line parallel to the Y axis or in the vicinity thereof while being separated by a distance of at least $(2/4) H$.

[0028]

The inventors have studied a plurality of refractory tiles in which only three spacers are variously disposed. As a result, even when each of the semi-tubular
 35 individual wing portions has substantially the same thickness as a whole, a crack may occur from the spacer disposed in the vicinity of the apex of the semi-tube of each of the semi-tubular individual wing portions, that is, on or near the imaginary line L2

and the imaginary line L5. Therefore, no spacer is disposed on or near the imaginary line L2 and the imaginary line L5.

[0029]

In addition, the inventors have studied a plurality of refractory tiles in which only three spacers are variously disposed. As a result, in a case where the thickness of each individual wing portion is as thin as about 12 mm, when a plurality of spacers are disposed on the same imaginary line parallel to the Y axis or in the vicinity thereof, a crack starting from any one of the plurality of spacers may occur. However, when the thickness of each individual wing portion was as thick as about 14 mm, a crack did not occur even in the same arrangement.

Therefore, for the two spacers disposed on the other individual wing portion, the first spacer set may be adopted when the thickness of each individual wing portion is thin, and the first spacer set or the second spacer set may be adopted when the thickness is thick.

For example, in the case of the refractory tile 1 including the thick portion 6, the thickness of the thick portion 6 is added to the original thickness of each of the individual wing portions 2A and 2B in the vicinity of the connection portion between the center portion 3 and each of the individual wing portions 2A and 2B, which corresponds to the case where the thickness described above is large. Therefore, the second spacer set may be adopted on the imaginary line L1 or L4 or in the vicinity thereof.

However, if the two spacers of the second spacer set are disposed immediately adjacent to each other, rattling may occur in the refractory tile when the refractory tile is constructed on the water pipe panel, and stable construction may be difficult. Therefore, a space of at least $(2/4) H$ is provided between the midpoints of the two spacers of the second spacer set, that is, the midpoints are separated from each other.

[0030]

Further, the inventors have studied a plurality of refractory tiles in which only three spacers are variously disposed, and found that the refractory tile can be stably constructed on the water pipe panel as the area S of the imaginary triangle 9 connecting the midpoints of the first spacer, the second spacer, and the third spacer on the XY plane is larger than a predetermined area.

Therefore, the first spacer, the second spacer, and the third spacer are disposed in a well-balanced manner such that the area S of the imaginary triangle is larger than the predetermined area while taking the above-described technical idea into consideration.

However, since the refractory tile 1 is a rectangle having the total width $L \times$ the total height H when viewed in the XY plane, the area S of the imaginary triangle 9 connecting the midpoints of the spacers cannot be $\{(L \times H)/2\}$ at the maximum, and is less than $\{(L \times H)/2\}$. Therefore, a relationship of $S < \{(L \times H)/2\}$ holds.

5 On the other hand, according to the inventors, for example, the refractory tile in which the first spacer is disposed on the imaginary line $L1$ of the first individual wing portion 2A and the second spacer set is disposed on the imaginary line $L4$ of the second individual wing portion 2B cannot be stably constructed on the water pipe panel. However, in the refractory tile in which the first spacer is disposed on the
10 imaginary line $L3$ of the first individual wing portion 2A and the second spacer set is disposed on the imaginary line $L4$ of the second individual wing portion 2B, when the interval between the midpoints of the second spacer and the third spacer is at least $(2/4)H$, the refractory tile can be stably constructed on the water pipe panel. Therefore, the area S in this case is set to a minimum required area from the viewpoint
15 of stable construction. In this case, the area S of the imaginary triangle 9 connecting the midpoints of the spacers is $\{(H/2) \times (L-W)/2\}$.

As a result, a range of the area S in which the refractory tile including only the three spacers can be stably constructed on the water pipe panel is as follows.

$$\{(H/2) \times (L-W)/2\} \leq S < \{(L \times H)/2\}$$

20 [0031]

<Arrangement example of spacers (pattern 1) >

As an arrangement example of three spacers included in the refractory tile 1, an arrangement example of the pattern 1 is illustrated in FIGS. 4 and 5. FIG. 4 illustrates an arrangement of the pattern 1A, and FIG. 5 illustrates an arrangement of
25 the pattern 1B which is a bilaterally symmetric arrangement of the pattern 1A. In the arrangement example of the pattern 1, the second spacer 5B and the third spacer 5C are arrangement examples of the first spacer set.

Next, the arrangement of the pattern 1A will be described with reference to FIG. 4.

30 In the arrangement of the pattern 1A, the first spacer 5A is disposed on the imaginary line $L3$ of the first individual wing portion 2A and above the imaginary line $L9$, the second spacer 5B is disposed on the imaginary line $L4$ of the second individual wing portion 2B and below the imaginary line $L7$, and the third spacer 5C is disposed on the imaginary line $L6$ of the second individual wing portion 2B and
35 above the imaginary line $L9$.

In order to satisfy all of the technical ideas described above, the refractory tile 1 having the pattern 1A is a refractory tile capable of preventing the occurrence of a crack starting from the spacers, allowing easy construction and strengthening of

adhesive force, and allowing stable contact with the boiler water pipe to be easily constructed on the water pipe panel.

Next, the arrangement of the pattern 1B will be described with reference to FIG. 5. In the arrangement of the pattern 1B, the first spacer 5A is disposed on the
 5 imaginary line L6 of the second individual wing portion 2B and above the imaginary line L9, the second spacer 5B is disposed on the imaginary line L1 of the first individual wing portion 2A and below the imaginary line L7, and the third spacer 5C is disposed on the imaginary line L3 of the first individual wing portion 2A and above the imaginary line L9. That is, the pattern 1B is disposed symmetrically with respect
 10 to the pattern 1A.

Therefore, the refractory tile 1 of the pattern 1B has the same effect as the refractory tile 1 of the pattern 1A.

[0032]

<Arrangement example of spacer (pattern 2) >

15 As an arrangement example of three spacers included in the refractory tile 1, an arrangement example of the pattern 2 is illustrated in FIGS. 6 and 7. FIG. 6 illustrates an arrangement of the pattern 2A, and FIG. 7 illustrates an arrangement of the pattern 2B that is a bilaterally symmetric arrangement of the pattern 2A. In the arrangement example of the pattern 2, the second spacer 5B and the third spacer 5C
 20 are arrangement examples of the first spacer set.

Next, the arrangement of the pattern 2A will be described with reference to FIG. 6.

In the arrangement of the pattern 2A, the first spacer 5A is disposed on the imaginary line L3 of the first individual wing portion 2A and below the imaginary line
 25 L7, the second spacer 5B is disposed on the imaginary line L4 of the second individual wing portion 2B and above the imaginary line L9, and the third spacer 5C is disposed on the imaginary line L6 of the second individual wing portion 2B and below the imaginary line L7.

30 Since this arrangement satisfies all the technical ideas described above, the refractory tile 1 having the pattern 2A can achieve the same effect as the refractory tile 1 having the pattern 1.

Next, the arrangement of the pattern 2B will be described with reference to FIG. 7. In the arrangement of the pattern 2B, the first spacer 5A is disposed on the imaginary line L6 of the second individual wing portion 2B and below the imaginary
 35 line L7, the second spacer 5B is disposed on the imaginary line L1 of the first individual wing portion 2A and above the imaginary line L9, and the third spacer 5C is disposed on the imaginary line L3 of the first individual wing portion 2A and below

the imaginary line L7. That is, the pattern 2B is disposed symmetrically with respect to the pattern 2A.

Therefore, the refractory tile 1 of the pattern 2B has the same effect as the refractory tile 1 of the pattern 2A.

5 [0033]

<Arrangement example of spacers (pattern 3)>

As an arrangement example of three spacers included in the refractory tile 1, an arrangement example of the pattern 3 is illustrated in FIGS. 8 and 9. In the arrangement example of the pattern 3, the second spacer 5B and the third spacer 5D
10 are arrangement examples of the second spacer set. Therefore, it is desirable that the refractory tile of the pattern 3 includes the thick portion 6. The third spacer 5D has the same shape as the third spacer 5C in the pattern 1 and the pattern 2.

FIG. 8 illustrates an arrangement of the pattern 3A, and FIG. 9 illustrates an arrangement of the pattern 3B which is a bilaterally symmetric arrangement of the
15 pattern 3A.

Next, the arrangement of the pattern 3A will be described with reference to FIG. 8.

In the arrangement of the pattern 3A, the first spacer 5A is disposed on the imaginary line L3 of the first individual wing portion 2A and on the imaginary line
20 L8, the second spacer 5B is disposed on the imaginary line L4 of the second individual wing portion 2B and below the imaginary line L7, and the third spacer 5D is disposed on the imaginary line L4 of the second individual wing portion 2B and above the imaginary line L9.

Since this arrangement satisfies all the technical ideas described above, the refractory tile 1 having the pattern 3A can achieve the same effects as those of the
25 refractory tiles 1 having the pattern 1 and the pattern 2.

Next, the arrangement of the pattern 3B will be described with reference to FIG. 9. In the arrangement of the pattern 3B, the first spacer 5A is disposed on the imaginary line L6 and the imaginary line L8 of the second individual wing portion
30 2B, the second spacer 5B is disposed on the imaginary line L1 of the first individual wing portion 2A and below the imaginary line L7, and the third spacer 5D is disposed on the imaginary line L1 of the first individual wing portion 2A and above the imaginary line L9. That is, the pattern 3B is disposed symmetrically with respect to the pattern 3A.

Therefore, the refractory tile 1 of the pattern 3B has the same effect as the refractory tile 1 of the pattern 3A.

[0034]

The “gull-type” refractory tile of the embodiment and the modification of the present invention has been described above. Although the pattern 1, the pattern 2, and the pattern 3 are shown for the arrangement example of the three spacers that can be applied to the “gull-type” refractory tile of the embodiment and the like, the present invention is not limited to these arrangement examples, and the present invention is applied to any “gull-type” refractory tile as long as the three spacers are disposed to satisfy the claims.

Reference Signs List

- 10 [0035]
- 1, 1', 1A Gull-type refractory tile
- 2A First individual wing portion
- 2B Second individual wing portion
- 3, 3', 3A Center portion
- 15 4 Recess
- 5A First spacer
- 5B Second spacer
- 5C Third spacer
- 5D Third spacer
- 20 6 Thick portion
- 7 Fitting protrusion
- 8 Fitting recess
- 9 Imaginary triangle
- H Total height
- 25 L Full width
- L1 TO L9 Imaginary line
- W Width of individual wing portion
- TA Thickness of refractory tile at position of first spacer
- TB Thickness of refractory tile at position of second spacer
- 30 TC Thickness of refractory tile at position of third spacer

Claims

[Claim 1]

5 A gull-type refractory tile for protecting boiler water pipe in which a semi-tubular first individual wing portion having a width W and a height H, a center portion, and a semi-tubular second individual wing portion having a width W and a height H are connected sequentially in a width direction to be integrally molded into a rectangular shape with a total width L and a total height H, and a recess for hooking is formed near a center of a back surface of the center portion,

10 wherein when viewed from a back side of the first individual wing portion and the second individual wing portion,

one of the individual wing portions is provided with

only a first spacer disposed on an imaginary line extending in a height direction at a position of $(3/4)W$ in a width direction from the center portion or in the vicinity of the imaginary line, and

the other individual wing portion is provided with either

a first spacer set including two spacers as

only a second spacer disposed on an imaginary line extending in the height direction at a position of $(1/4)W$ in the width direction from the center portion or in the vicinity of the imaginary line and

only a third spacer disposed on an imaginary line extending in the height direction at a position of $(3/4)W$ in the width direction from the center portion or in the vicinity of the imaginary line

or

25 a second spacer set including two spacers as the second spacer and the third spacer, each disposed by a distance of at least $(2/4)H$ to be separated, on an imaginary line extending in the height direction at a position of $(1/4)W$ in the width direction from the center portion or in the vicinity of the imaginary line, and

30 wherein an area S of an imaginary triangle formed when midpoints of only a total of three spacers disposed in the one individual wing portion and the other individual wing portion are connected on a plane in the width direction and the height direction satisfies $\{(H/2) \times (L-W)/2\} \leq S < \{(L \times H)/2\}$.

[Claim 2]

35 The refractory tiles for protecting boiler water pipe according to claim 1, wherein the first spacer set is provided in the other individual wing portion,

the first spacer is disposed at a position of $(3/4) H$ in the height direction from a lower end of the one individual wing portion toward an upper side or at a position equal to or higher than the position in the height direction,

5 the second spacer is disposed at a position of $(1/4) H$ in the height direction from a lower end of the other individual wing portion toward an upper side or at a position equal to or lower than the position in the height direction, and

the third spacer is disposed at a position of $(3/4) H$ in the height direction from the lower end of the other individual wing portion toward an upper side or at a position equal to or higher than the position in the height direction.

10

[Claim 3]

The refractory tiles for protecting boiler water pipe according to claim 1, wherein the first spacer set is provided in the other individual wing portion, the first spacer is disposed at a position of $(1/4) H$ in the height direction
15 from a lower end of the one individual wing portion toward an upper side or at a position equal to or lower than the position in the height direction,

the second spacer is disposed at a position of $(3/4) H$ in the height direction from a lower end of the other individual wing portion toward an upper side or at a position equal to or higher than the position in the height direction, and

20 the third spacer is disposed at a position of $(1/4) H$ in the height direction from the lower end of the other individual wing portion toward an upper side or at a position equal to or lower than the position in the height direction.

[Claim 4]

25 The refractory tile for protecting boiler water pipe according to claim 1, wherein the second spacer set is provided in the other individual wing portion,

the center portion includes a thick portion whose thickness increases in a fan shape from a back surface toward a surface in a cross-sectional shape thereof,

30 the first spacer is disposed at a position of $(2/4) H$ or at a position in the vicinity of $(2/4) H$ in the height direction from a lower end of the one individual wing portion toward an upper side,

the second spacer is disposed at a position of $(1/4) H$ in the height direction from a lower end of the other individual wing portion toward an upper side or at a
35 position equal to or lower than the position in the height direction, and

the third spacer is disposed at a position of $(3/4) H$ in the height direction from the lower end of the other individual wing portion or at a position equal to or higher than the position in the height direction.

[Claim 5]

The refractory tile for protecting boiler water pipe according to any one of claims 1 to 4,

- 5 wherein a fitting protrusion protruding from an upper end of the center portion is further integrally formed above the center portion,
 a fitting recess into which the fitting protrusion is fittable is further integrally formed below the center portion, and
 wherein when two of the refractory tiles for protecting boiler water pipe are
10 disposed in the vertical direction, the fitting protrusion included in the refractory tile for protecting boiler water pipe positioned on a lower side is fitted to the fitting recess included in the refractory tile for protecting boiler water pipe positioned on an upper side.