United States Patent [19]

Seo

[11] **3,794,307**

[45] **Feb. 26, 1974**

[54] **BLAST FURNACE COOLING SYSTEM**

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[73] Assignee: **Ishikawajima Harima Jukogyo Kabushiki Kaisha,** Tokyo-to, Japan

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[30] **Foreign Application Priority Data**

July 4, 1970 Japan 45-58442

[52] **U.S. Cl.** **266/32**

[51] **Int. Cl.** **C21b 7/10**

[58] **Field of Search** 266/32, 25

[56] **References Cited**

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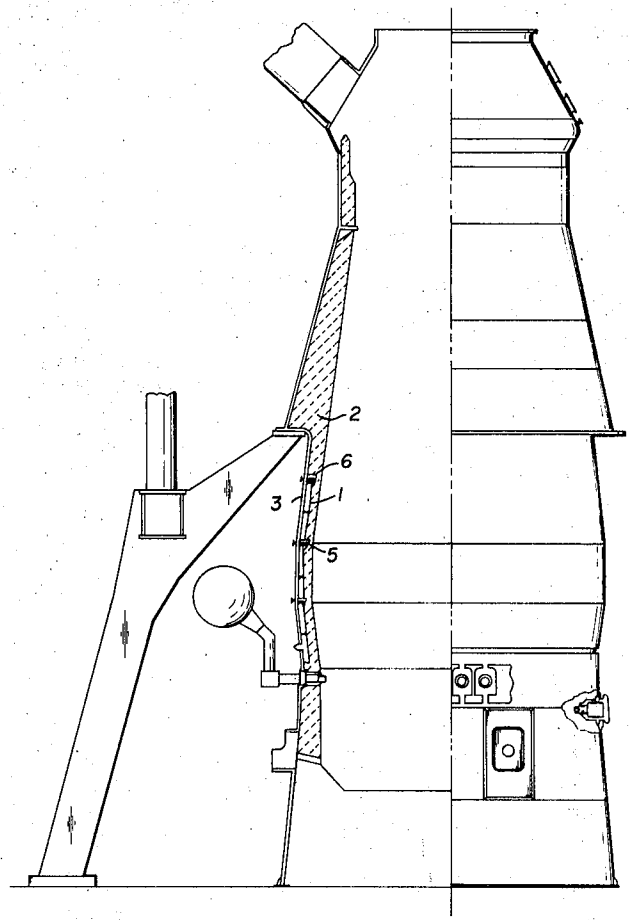
Attorney, Agent, or Firm—Albert C. Nolte, Jr.; Edward B. Hunter; C. Bruce Hamburg

[57] **ABSTRACT**

A blast furnace cooling system employing staves cooling system, and providing projection which interposed replaceable between staves arranged upper and lower direction of the furnace.

5 Claims, 11 Drawing Figures



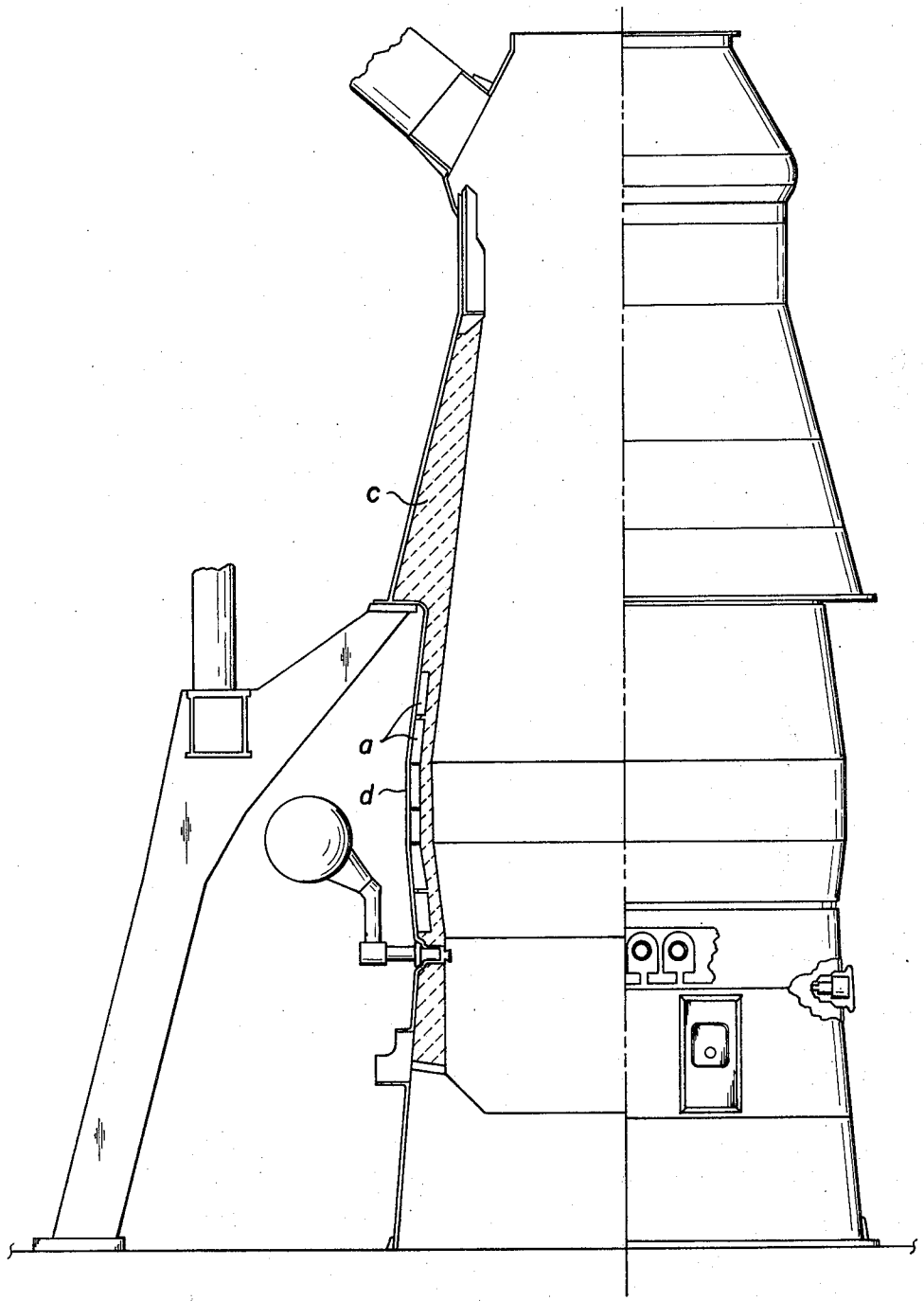


FIG. 1

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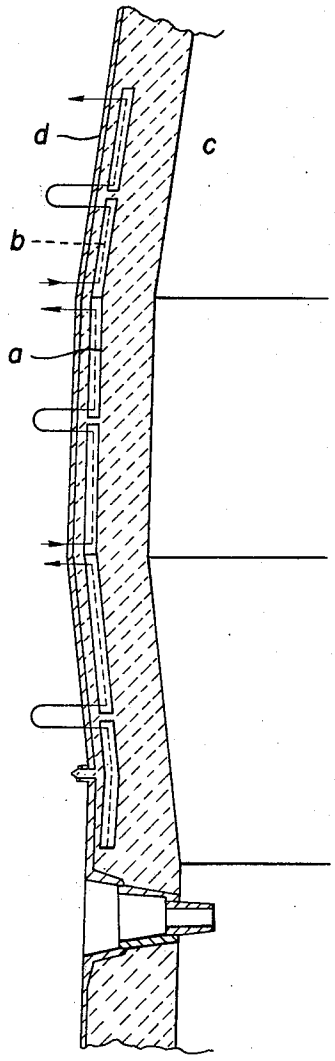

FIG. 2

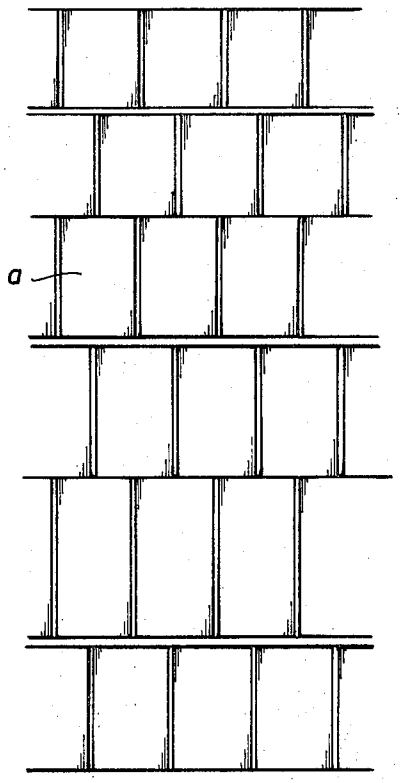

FIG. 3

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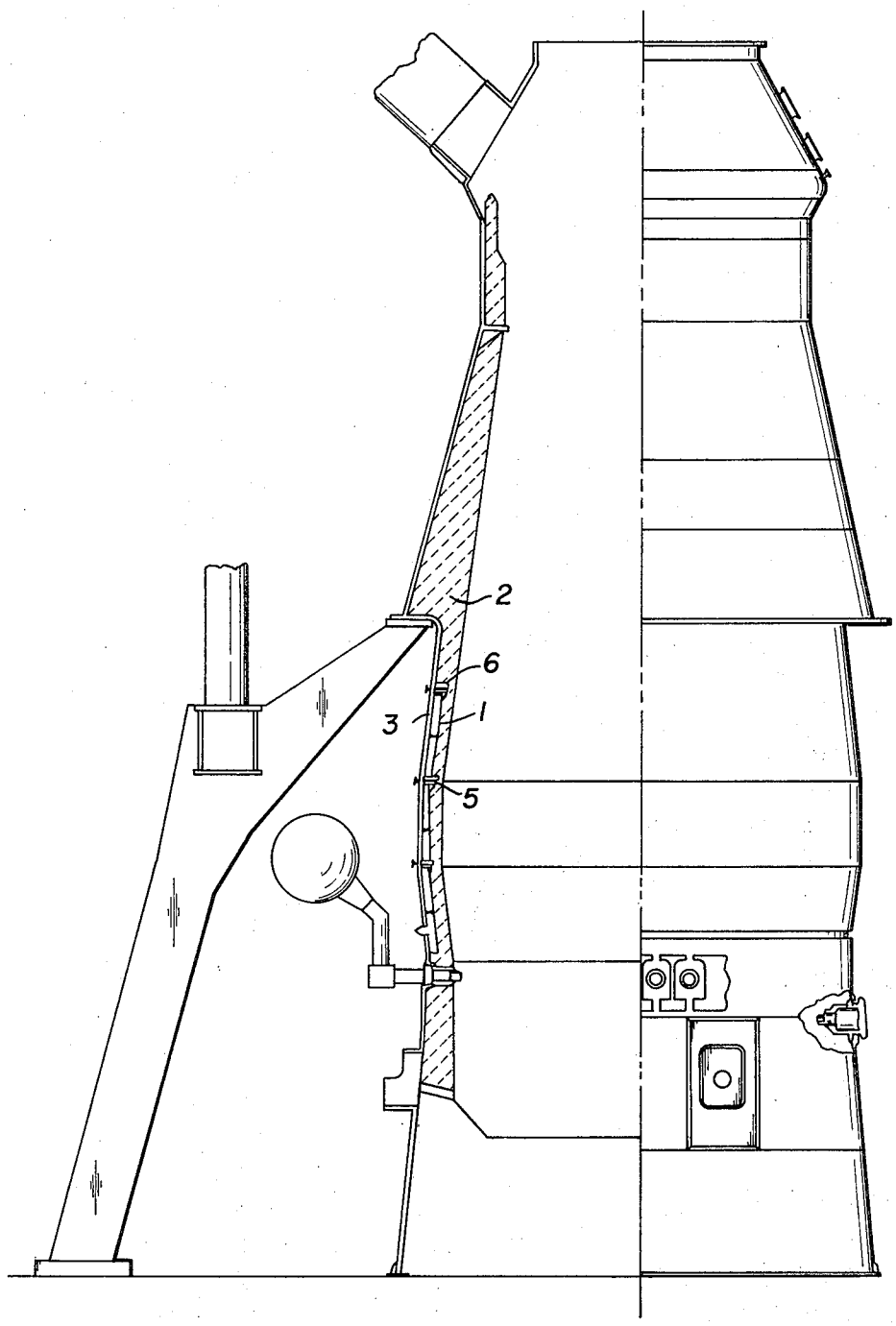

FIG. 4

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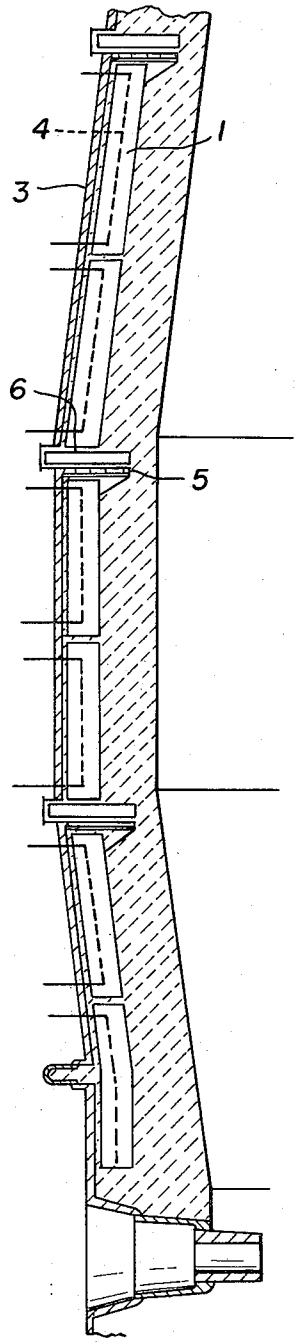

FIG. 5

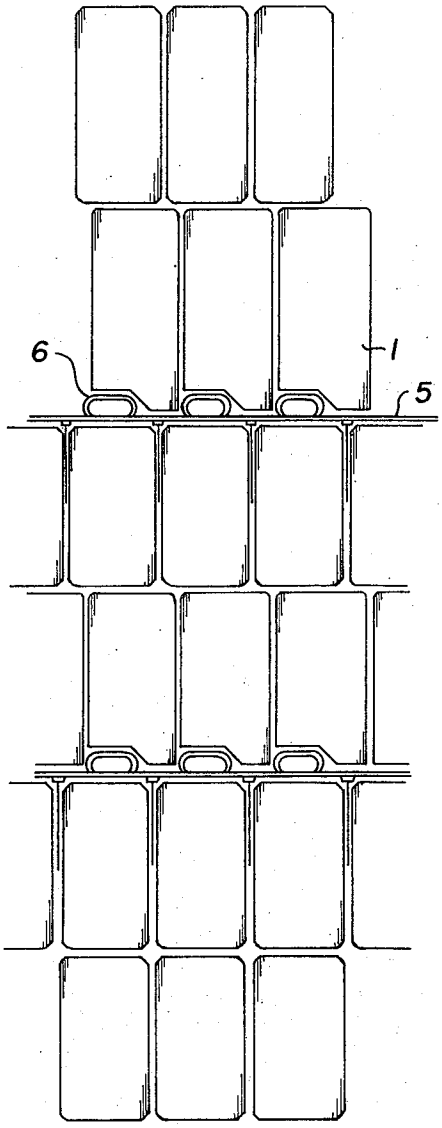

FIG. 6

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FIG.7

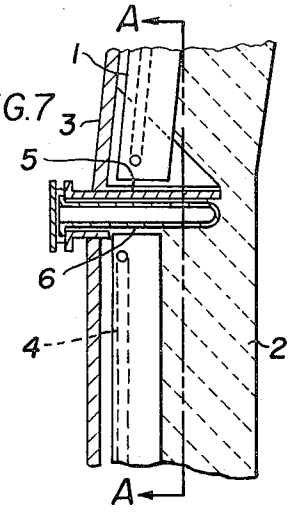


FIG.8

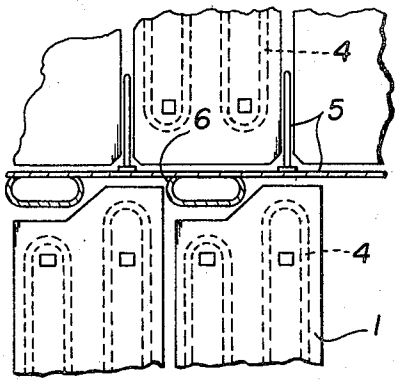


FIG.9

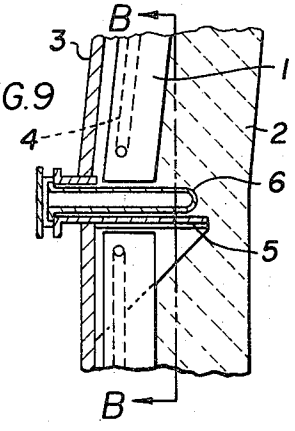
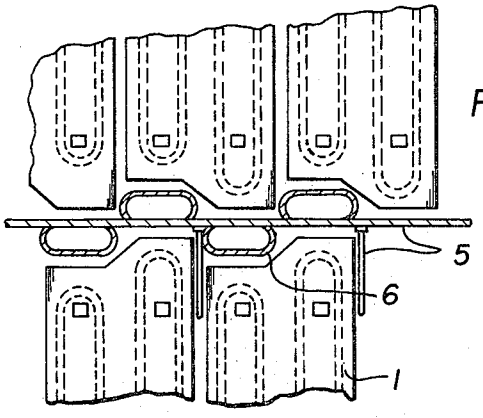


FIG.10



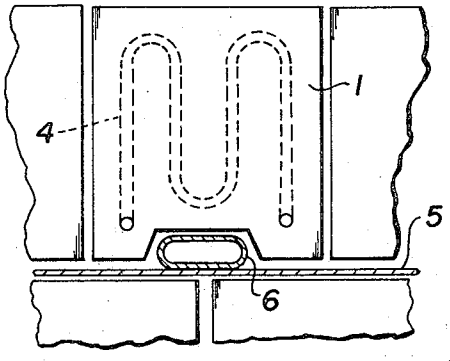


FIG.11

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BLAST FURNACE COOLING SYSTEM

In general the conventional blast furnace cooling system employs cooling plates or the combination of cooling plates and water-cooled jackets to cool the higher temperature sections extending from the tuyere mantel mantel to the portion above the shaft mantel.

The cooling system employing the cooling plates has a defect that the bricks are locally cooled only around the cooling plates and the bricks not cooled are easily subjected to corrosion so that the uniform cooling effect is not attained.

To overcome this defect, there has been proposed a cooling system employing staves which can cool the blast furnace uniformly. But in this conventional stave cooling system the bricks are easily to be fallen off and the staves are also easily to be damaged.

To overcome the defects of the cooling system employing the staves, there has been proposed to form a projection intergrally with each stave to extend inwardly. However, these projections are also easily damaged so that the staves have the same shape as that of the conventional staves. As a consequence, the staves do not have a sufficient durability, and the life of the blast furnace is accordingly lowered.

The present invention was made to eliminate the defects encountered in the prior art blast furnace cooling systems, and is characterized in that a number of staves are interposed between the furnace bricks and the steel shell; and replaceable members are inserted from the exterior of the blast furnace into appropriate stave cooling portions so as to extend inward beyond the inner surface of the furnace.

The present invention will become more apparent from the following description of the preferred embodiment thereof taken in conjunction with the accompanying drawings.

FIGS. 1 to 3 are explanatory views illustrating the conventional blast furnace employing the conventional staves for cooling the furnace;

FIG. 4 is a schematic side view partly in section of a blast furnace employing the cooling system in accord with the present invention;

FIG. 5 is an enlarged sectional view thereof illustrating the furance wall thereof;

FIG. 6 is a view illustrating the development of the blast furnace employing the cooling system in accord with the present invention;

FIG. 7 is a fragmentary enlarged sectional view illustrating another embodiment of the present invention;

FIG. 8 is a view looking in the direction indicated by the arrow A of FIG. 7;

FIG. 9 is a fragmentary enlarged sectional view illustrating a still another embodiment of the present invention;

FIG. 10 is a view looking in the direction indicated by the arrow B of FIG. 9; and

FIG. 11 is a view similar to FIGS. 8 and 10 illustrating a further embodiment of the present invention.

In the conventional stave cooling system as shown in FIGS. 1 – 3, a stave a having cooling tubes b cast as inserts and having flat surfaces is interposed between the bricks c and a steel shell d. This stave cooling system has an advantage that all of the bricks may be uniformly cooled, but the bricks c tend to fall off because of the furnace operation methods and the conditions within the blast furnaces. As shown in FIGS. 1 – 3, when the inner surface of the blast furnace is flat and the bricks are fallen off from the blast furnace wall, the staves are subjected to high temperature furnace gases. That is, when the bricks are fallen off from the furnace wall, the high temperature gases tend to pass between the staves and the charge rather than through the iron ores and coke, so that the staves are overheated. As a consequence they are damaged under the thermal shocks, thermal fatigues, the crystal growth of the material of the staves and the like. Since the replacement of the staves damaged is impossible, other suitable cooling systems must be employed, so that the blast furnaces must remain idle for a long time, thus resulting in the poor productivity.

In a preferred embodiment of the present cooling system as shown FIGS. 4 – 6, a great number of staves 1 enclosing cooling water tubes 4 are interposed cylindrically between the bricks 2 and a steel shell 3 of a blast furnace, and the feed and discharge pipes are connected through the steel shell 3 to the cooling tubes 4 in the staves 1. A metal plate 5 is inserted between the adjacent upper and lower edges of the staves 1 as shown in FIG. 5 or between respective upper and lower staves, in such a manner that the inner end of the metal plate 5 may reach the interior of the bricks 2. The other end is securely fixed to the steel shell 3, and a cooling plate 6 having substantially same length as that of the metal plate 5 is placed parallelly over the plate 5 so that both of the metal plate 5 and the bricks 2 may be cooled by the cooling plate 6. The length of the cooling plate 6 may be arbitrarily selected as needs demand. The outer end of each cooling plates 6 is sealable fixed to the steel shell 3 by for example a flange coupling.

In operation, the cooling water flows through the staves 1 and the cooling plates 6 thereby cooling the bricks 2. Even when the bricks 2 tends to start to fall off from the furnace wall after a long operation of the blast furnace, the bricks 2 above the metal plates 5 are supported by the metal plate 5 through the cooling plates 6 or directly by the metal plates 5 so that the bricks 2 may be prevented from falling off from the furnace wall. Even when the bricks 2 immediately below the plate 5 should fall off from the furnace wall, the upward blow of hot gases between the staves 1 and the charge may be prevented.

When the cooling plates 6 are damaged, by heat they may be moved out of the steel shell 3 and the new cooling plates 6 may be placed in position, whereby the damage to the metal plates 5 may be minimized.

Another embodiment of the present invention is illustrated in FIGS. 7 and 8. The cooling plate 6 is removably fixed to the undersurface of the metal plate 5 to cool both of the bricks 2 and the metal plate 5.

FIGS. 9 and 10 illustrate a still another embodiment of the present invention, in which the cooling plates 6 are placed on both of the upper and under surfaces of the steel plate 5.

In the embodiments discussed above with reference to FIGS. 4 – 10, the portion of the metal plates 5 between the heating plates 6 are not sufficiently cooled, so that the staves 1 on the side of the cooling plates 6 are modified as illustrated in FIGS. 6, 8 and 10 to sufficiently cool the metal plates 5. When the width of the stave 1 is relatively greater and the cooling plate 6 is placed inside the stave 1, both of the sides of the stave 1 are modified as illustrated in FIG. 11 so that the metal plate 5 may be sufficiently cooled.

In the embodiments disclosed above, the metal plates **5** which are inserted between the staves **1** have been described as being fixed to the steel shell **3** and the cooling plates **6** are disposed along the metal plates **5** to cool it and the bricks **2**. However, the following variations and modifications are possible within the scope of the present invention. First of all, the metal plate **5** made of steel plate may be removably inserted. In this case, no cooling plate **6** is used. Alternatively, only the cooling plates **6** having a sufficient strength to support the bricks **2** may be used without use of the metal plates **5**. In addition, both of the metal plates **5** and the cooling plates **6** may be removably disposed within each stave **1** instead of being interposed between the staves **1**.

As described hereinabove, the members (the metal plates **5** and the cooling plates **6**) of a blast furnace cooling system are removably disposed between the staves or within the staves which in turn are interposed between the furnace bricks and the steel shell. Therefore, the bricks may be prevented from falling off from the furnace wall, and the upward blow of the high temperature gases between the furnace wall or bricks and the charge may be prevented even when the bricks are damaged, so that the service life of the staves may become longer. Furthermore the members (the metal plates **5** and the cooling plates **6**) may be immediately replaced with new ones when they are damaged, so that the service life of the staves may be increased. Therefore the productivity may be much improved with the conventional cooling systems.

What is claimed is:

1. A blast furnace comprising a steel shell, a refractory brick lining, horizontal rows of cooling staves between the lining and shell, a cooling plate disposed between adjacent rows of staves and a metal plate disposed between the cooling plate and the row of staves below the cooling plate, said cooling plate and metal plate extending inwardly of the staves within the lining to support the bricks on the upper row of staves, said cooling plates being removably supported on the shell.

2. A blast furnace as claimed in claim **1** wherein a cooling plate is disposed between the metal plate and the row of staves below that metal plate.

3. A blast furnace comprising a steel shell, a refractory brick lining, horizontal rows of cooling staves between the lining and shell, a cooling plate disposed between adjacent rows of staves and a metal plate disposed between the cooling plate and the row of staves above the cooling plate, said cooling plate and metal plate extending inwardly of the staves within the lining to support the bricks on the upper row of staves, said cooling plates being removably supported on the shell.

4. A blast furnace as claimed in claim **1** wherein said metal plate extends inwardly into said refractory brick lining at least to the same extent as said cooling plate.

5. A blast furnace as claimed in claim **3** wherein said metal plate extends inwardly into said refractory brick lining at least to the same extent as said cooling plate.

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