

[54] SUB-HEARTH CONSTRUCTION FOR
METALLURGICAL FURNACES

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[51] Int. Cl. **C21b 7/06**

[58] Field of Search 266/25, 32, 43

[56] **References Cited**

UNITED STATES PATENTS

3,378,249	4/1968	French et al.	266/32
3,752,638	8/1973	Van Laar et al.	266/32

Primary Examiner—Gerald A. Dost

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[57] **ABSTRACT**

The construction of the invention comprises a plurality of layers of refractory material subjacent the hearth of a furnace, such as a blast furnace, between vertical carbon walls surrounding the hearth and projecting below the bottom thereof; a heat-barrier layer of non-iron-reactive material subjacent the refractory layers, and a plurality of layers of carbon subjacent the heat-barrier layer. A passageway for cooling fluids optionally extends through the lowermost layers of carbon. The improved sub-hearth construction of the invention reduces considerably the heat loss from the bottom of the furnace hearth.

6 Claims, 4 Drawing Figures

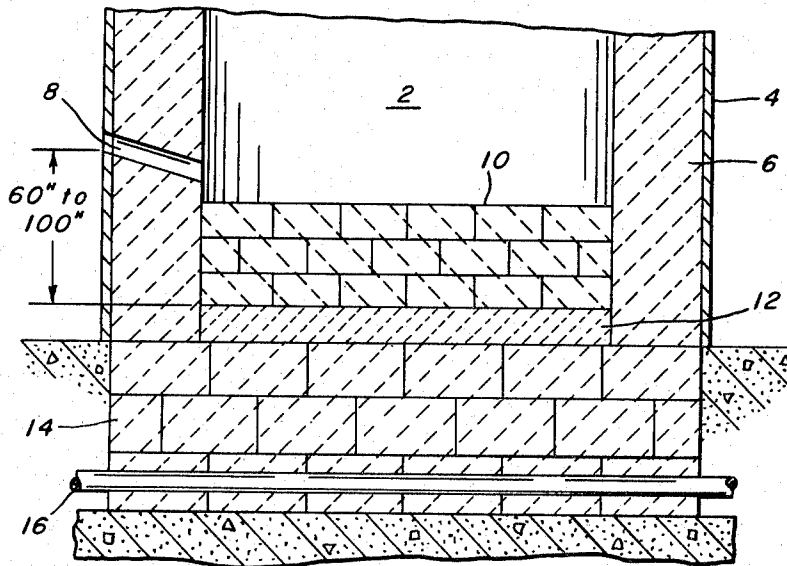


FIG. 1.
(PRIOR ART)

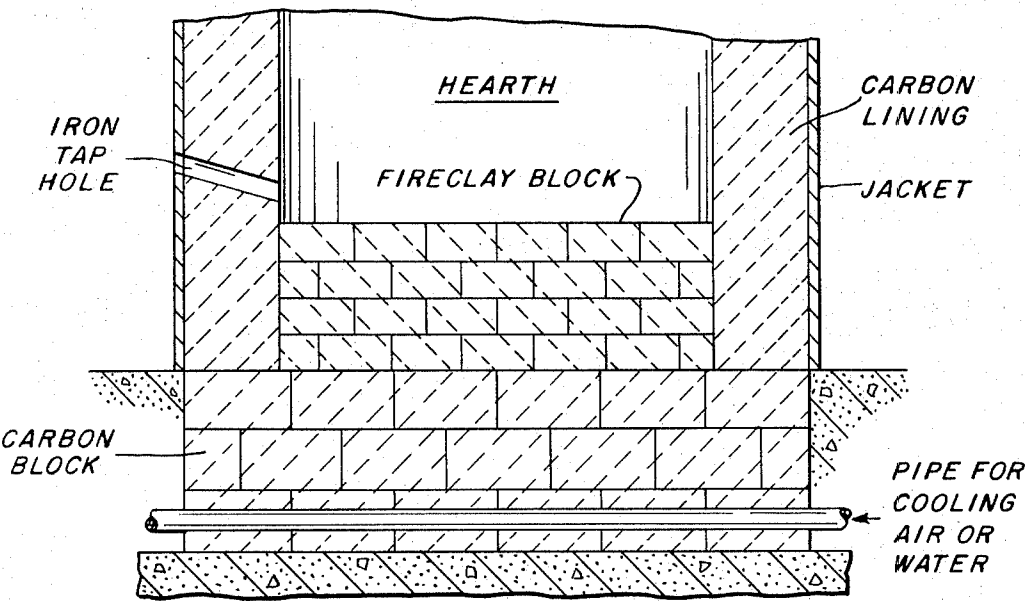


FIG. 2.

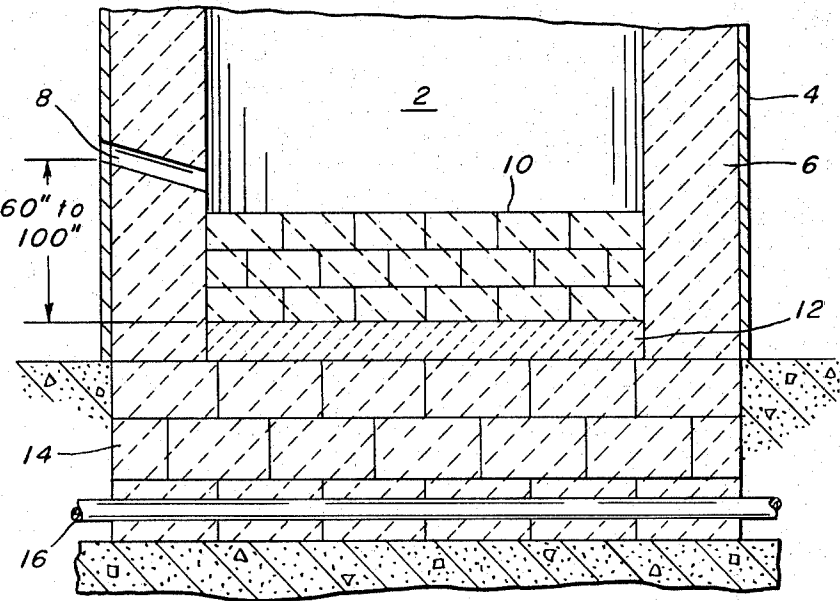


FIG. 3.

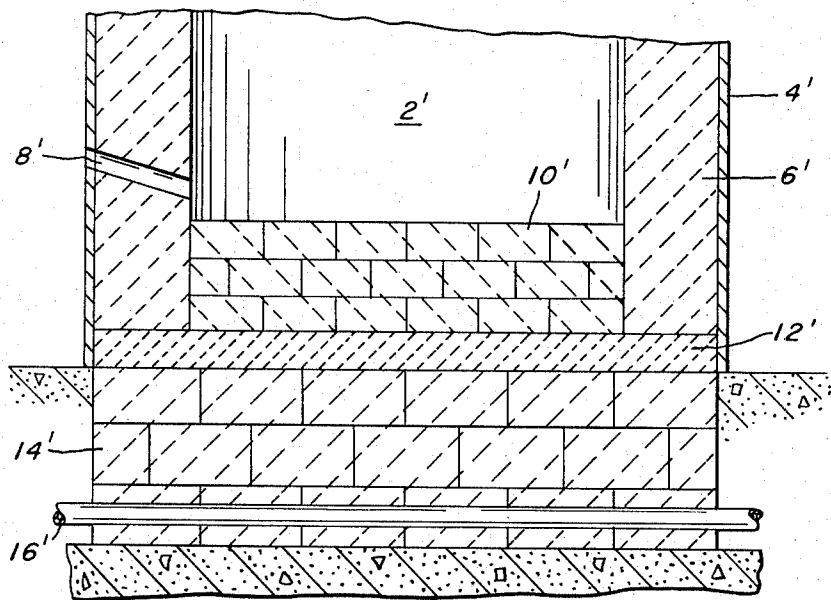
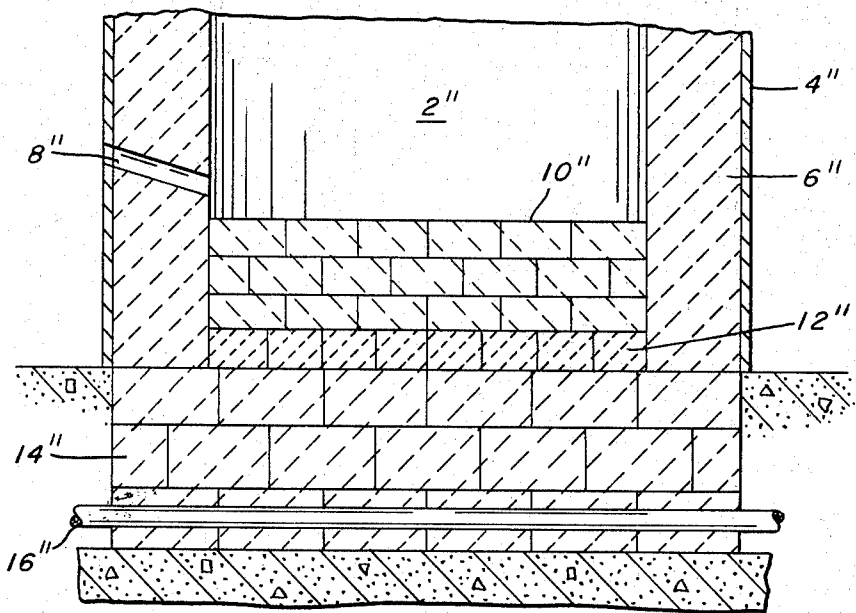


FIG. 4.



SUB-HEARTH CONSTRUCTION FOR METALLURGICAL FURNACES

The present invention relates in general to metallurgical furnaces and more particularly, to an improved sub-hearth construction for metallurgical furnaces having a hearth adapted to contain molten metal and is especially suitable for use in the construction of blast furnaces.

As shown in FIG. 1 of the drawing, a bottom-cooled blast furnace hearth is conventionally installed with carbon side walls and a plug made up of layers of fireclay block disposed on a base made up of a plurality of layers of carbon blocks or beams. In this construction, heat is removed from the lowermost layer of carbon beams or blocks by means of cooling air or water circulated through pipes that are installed in the lowermost layer of carbon beams or blocks. In service, the fireclay plug of a conventional sub-hearth construction may be lost in the first 3 to 6 months of the furnace campaign, allowing molten iron to filter into the pores of the carbon beams thereby increasing the heat conductivity thereof. Further, the molten iron on the hearth floor might sometimes be undersaturated with respect to carbon, and, in the absence of the fireclay plug, the deficient amount of carbon is obtained from the carbon beams. This results in erosion of the carbon beams or blocks. However, more important is the heat loss from the hearth through the carbon beams or blocks which normally have a heat conductivity of approximately 100 Btu/sq ft/F/hr/inch. The removal of this heat from the carbon beams or blocks is costly because of the cooling water or air which has to be circulated in the pipes disposed in the carbon beams or blocks.

G. L. French et al. U.S. Pat. No. 3,378,249 discloses a typical prior art sub-hearth construction. Another patent which discloses sub-hearth construction for a blast furnace is Greaves et al. U.S. Pat. No. 3,586,304.

My invention contemplates the construction of a blast furnace with a stable oxide refractory brick or block layer between the fireclay plug and the carbon beams so as to act as a barrier between the molten iron and the carbon beams in the event of failure of the fireclay plug.

It is, accordingly, the primary object of my invention to minimize the loss of heat through the hearth floor of a metallurgical furnace, such as a blast furnace which is initially covered by a plug of fireclay, while the furnace is in operation after the fireclay plug separating the molten metal from the carbon beams is lost.

As a corollary to the above statement of object, it is another object of my invention to provide a sub-hearth construction including a barrier layer of non-iron-reactive material between the fireclay plug on the bottom of the hearth and the carbon beams below the hearth which barrier layer will function as a heat barrier and also prevent physical contact between the molten metal in the hearth and the carbon beams after the fireclay plug has been lost or eroded away.

It is a more specialized object of my invention to provide a sub-hearth construction for a metallurgical furnace, such as a blast furnace, which includes a plurality of layers of refractory material in the bottom of the hearth; a heat-barrier layer of non-iron-reactive stable oxide refractory, such as $ZrSiO_4$, Al_2O_3 , mullite, fusion cast mullite or fusion cast alumina.

These and other objects will become more apparent after referring to the following specification and drawing in which:

FIG. 1 is a diagrammatic vertical section view of the prior art sub-hearth construction of a blast furnace.

FIG. 2 is a view similar to FIG. 1 but showing my improved sub-hearth construction for a blast furnace.

FIG. 3 is a modification of the sub-hearth construction shown in FIG. 2.

FIG. 4 is another modification of the sub-hearth construction shown in FIG. 2.

In the drawing like characters of reference, unprimed or primed, indicate corresponding parts in the different figures.

Referring to the drawing and more particularly to FIG. 2 for the time being, reference numeral 2 indicates generally the hearth of a blast furnace wherein accumulates molten iron formed in the blast furnace shaft. The hearth 2 is surrounded by a metal outer jacket 4 which projects below the hearth and has an inner lining of carbon 6 affixed to the inner surface thereof. A molten metal tap hole 8 extends through the outer jacket 4, the carbon inner lining 6 and communicates at its inner end with the interior of the hearth 2. The sub-hearth construction of the invention includes a fireclay plug which consists of a plurality of superposed layers of fireclay block 10 which form the bottom of the hearth. The fireclay block 10 is surrounded by the carbon inner lining 6 and the outer jacket 4.

A barrier layer 12 is disposed subjacent the fireclay block 10 and is surrounded by the inner carbon lining 6 as well as the outer jacket 4. The barrier layer is made up of a non-iron-reactive stable oxide refractory, such as $ZrSiO_4$, Al_2O_3 , mullite, fusion cast mullite or fusion cast alumina. The barrier layer is preferably disposed 60 to 100 inches beneath the tap hole 8 of the furnace so that the barrier layer will not be eroded by the wash of slag or by slag carried in the pores of coke in the furnace.

A plurality of carbon beams or blocks 14 are disposed in layers subjacent the barrier layer 12. If desired, a pipe 16 for circulating cooling air or water through the lowermost beam may be provided.

As best shown in FIG. 3, the barrier layer 12' may extend co-extensively with the carbon beams.

As best shown in FIG. 4, the barrier layer 12'' could be formed of individual blocks laid in contiguous fashion.

By the provision of the barrier layer 12 in the sub-hearth construction of the invention, any undersaturated low-carbon iron that is produced in the furnace is kept separate from the carbon beams even though the fireclay block 10 is worn away, and this eliminates erosion of the carbon beams by solution in the iron.

The pipes 16 may be eliminated since the barrier layer 12 will have a very low heat conductivity. For example, mullite or fusion cast mullite, which is made up of approximately 70-80% alumina and 20-30% SiO_2 , will have a conductivity of only 24 Btu/sq ft/F/hr/inch at 2,000°F as compared to 100 Btu for the carbon beams in contact with the molten iron. This value would be increased if iron penetrates the pores of the carbon beams. The barrier layer 12, therefore, is effective to sufficiently lower the total Btu loss through the hearth so that heat could be dissipated through the hearth shell without the necessity of costly sub-hearth cooling by means of cooling air or water circulating

through pipes or other cooling means. The lesser heat loss through the hearth would also result in either a lower coke rate or hotter blast-furnace iron.

Although I have shown but three embodiments of my invention, other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. In a metallurgical furnace having a vertically disposed hearth for molten metal including an upstanding metal jacket surrounding said hearth and projecting therebelow, an inner lining of carbon on the inner surface of said jacket, a molten metal tapping hole extending through said jacket and said carbon inner lining and communicating at its inner end with the interior of said hearth, the improvement therewith of a sub-hearth construction for said furnace including a plurality of superposed layers of refractory material in the bottom of said hearth below the level of said iron tapping hole surrounded by said carbon inner lining, a layer of non-iron-reactive heat insulating material disposed below

said layers of refractory material, and a plurality of superposed layers of carbon subjacent said non-iron-reactive material layer.

2. Sub-hearth construction as defined by claim 1 including a conduit for cooling fluid extending through the lowermost of said plurality of layers of carbon.

3. Sub-hearth construction as defined by claim 1 in which said non-iron-reactive material is one of the group consisting of $ZrSiO_4$, Al_2O_3 and mullite.

4. Sub-hearth construction as defined by claim 3 in which said mullite is comprised of 70 to 80% by weight Al_2O_3 and 20 to 30% by weight SiO_2 .

5. Sub-hearth construction as defined by claim 1 in which said non-iron-reactive material is one of the group consisting of fusion cast mullite and fusion cast alumina.

6. Sub-hearth construction as defined by claim 1 in which said layer of non-iron-reactive material is surrounded by said carbon inner lining.

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