

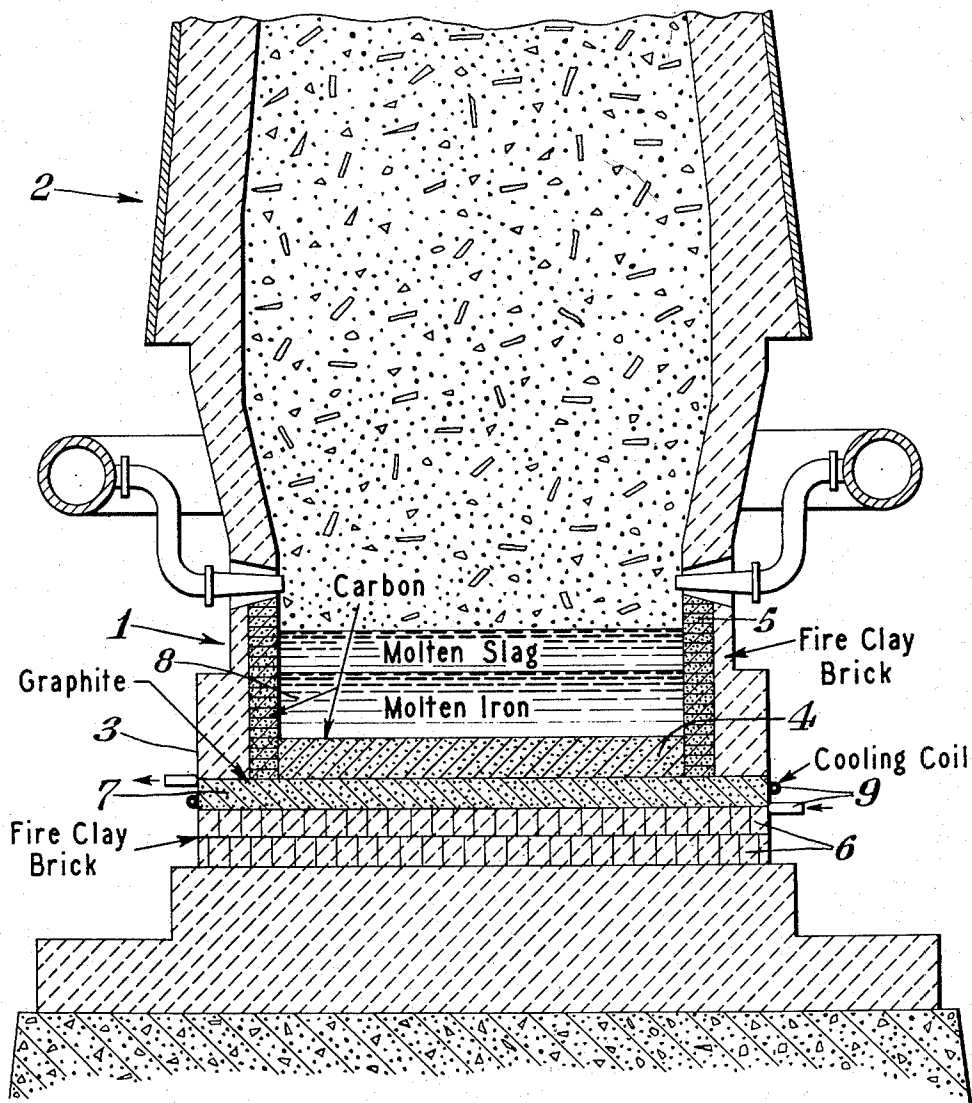
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COOLING APPARATUS FOR BLAST FURNACE HEARTHS

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COOLING APPARATUS FOR BLAST FURNACE
HEARTH

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This invention relates to means for cooling the bottoms of carbon lined hearths of metallurgical furnaces and particularly to means for cooling carbon lined blast furnace hearths.

In the production or processing of metals, the molten metal undergoing treatment is retained in the hearth of a furnace, such as a blast furnace. This metal in the hearth or crucible, as it is sometimes called, reaches temperatures greatly in excess of its melting point. Temperatures in the sides and bottom of the hearth are often higher than the melting point of the metal at points in the hearth a considerable distance from the pool of molten metal. Conventionally, the sides and bottom of the hearth are made of brick and in time the molten metal finds its way between these bricks. The metal will, of course, remain in the molten state until it is cooled below its melting point by the transfer of heat to the sides and bottom of the hearth.

In conventional furnace hearths of fire-clay brick, the sides are thick enough to prevent the heating of the outside bricks above the melting point of the metal. This measure prevents the molten metal from running out of the furnace. Similar precautions are taken with the bottom of the hearth. Commonly, the sides of the hearth are cooled by heat exchangers in contact with the periphery of the hearth to give added protection against the escape of the metal.

Cooling the outside of the bottom of the hearth as is done around the sides has little effect on the temperature of the bricks in the center of the bottom of the hearth. This is true because of the poor heat conductivity of the fire-clay bricks and the relatively larger distance from the center to the outside of the bottom of the hearth. Efforts to cool the bottom of the hearth with conventional heat exchangers embedded therein have not been too successful. Difficulty is encountered in finding materials capable of withstanding the temperatures in the bottom of the hearth. For example, in a blast furnace these temperatures may be in the neighborhood of 1500° C. Maintenance of such a system is also a serious drawback to its use since the furnace would have to be shut down and the bottom of the hearth torn up to make repairs on pipes which were leaking or otherwise defective.

When the hearth of the furnace is lined with carbon, the difficulties encountered in cooling the bottom of the hearth do not differ greatly from those arising in the cooling of an unlined hearth. There is the added problem of preventing the flow of molten metal between the carbon lining

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and the fire-clay bricks since this results in damage to the carbon lining. The temperatures and conductivity of the materials in both cases render conventional heat exchangers embedded in or disposed around the bottom of the hearth unsatisfactory. The problem of preventing the escape of metal from the carbon lined hearth of a furnace is solved in the prior art by increasing the thickness of the carbon lining.

It is the object of the present invention to provide a means of cooling the bottom of a carbon lined hearth which will provide improved protection against the escape of metal.

The object of the invention is accomplished by placing a block or layer of graphite between the fire-clay bricks forming the bottom of the hearth and the carbon lining and providing a cooling medium in heat absorbing relationship with the periphery of the graphite. Because of the good thermal conductivity of the graphite, heat is conducted away from the center of the hearth rapidly enough to lower the temperature at the carbon-graphite interface below the melting point of the metal. The heat conducted away from the center of the graphite is dissipated by the cooling medium.

The drawing illustrates the principles of the invention.

In the drawing a sectional view of a blast furnace which has a carbon lined hearth and is equipped with the cooling means of the invention is shown.

The hearth 1 of the furnace 2 consists of sides 3 and a bottom 6 of fire-clay brick. A carbon lining 4, suitably of large carbon sections or carbon bricks, extends across the bottom of the hearth 1, and carbon bricks 5 line the sides of the hearth. A layer of graphite 7 between the carbon lining 4 and fire-clay bricks 5 conducts the heat transferred from the molten metal 8 to the carbon lining 4 away from the center of the hearth to the cooling coils 9 where it is dissipated by the cooling medium in the coils.

The advantages of the invention will be apparent from the comparisons given below. The temperatures and other data on which the comparisons are based are approximate since they are calculated from experimental results obtained with a model of a blast furnace hearth. The hearth for which the comparative values are calculated contains molten iron at a temperature of from about 1500° C. to about 1600° C. and has an outside diameter of twenty-six feet and an inside diameter of twenty feet. Tempera-

tures in the hearth are those occurring along the center line of the hearth.

In the first instance a lining of carbon 50 inches thick on the bottom of the hearth separates the fire-clay brick and the pool of molten iron. The temperature at the carbon-fireclay brick interface when the periphery of the carbon is cooled to 600° C. reaches about 1300° C. This temperature is above the melting point of iron which is between 1100° C. to 1150° C. When the thickness of the carbon lining is increased to 76 inches and the temperature of the periphery of the carbon again is cooled to 600° C., the temperature of the carbon-fireclay brick interface is about 1165° C. or slightly above the melting point of iron.

But when a layer of graphite 23 inches thick is inserted between the fifty inch thick carbon lining and the fire-clay brick according to the invention, the temperature at the carbon-graphite interface is about 900° C. and at the graphite-fireclay brick interface about 800° C. if the periphery of the graphite is maintained by cooling at 600° C. Thus it can be seen that a temperature safely below the melting point of iron is obtained at the interface of the fifty inch thick carbon lining and graphite layer installed according to the invention. Under similar conditions the temperature at the interface of the seventy-six inch carbon lining and the fire-clay brick in the absence of the cooling means of the invention is above the melting point of iron.

It will be understood that the thickness of the layers of carbon and graphite may be varied over a wide range to meet the requirements of a particular furnace. Preferably, the graphite should be so shaped that a considerable portion of it provides a continuous path for the heat from the center of the hearth to the periphery. Joints or other discontinuities in the graphite will lessen its heat conductivity.

The dissipation of the heat conducted to the periphery of the graphite can be accomplished by several conventional procedures. Metal pipes in contact with the periphery of the graphite and through which water or steam is circulated are satisfactory. The periphery of the graphite can also be cooled, for example, by passing a stream of a cooling fluid in direct contact with it. The heat may also be dissipated, at least in part, by directing a stream of a cooling medium, for example, air, under and along the layer of graphite. This latter arrangement is particularly efficient with a blast furnace having a hearth built at an elevation above the ground so that there is a free space directly below the graphite.

What is claimed is:

1. In a metallurgical furnace which has a carbon lining on the bottom of the hearth of said furnace, a cooling means for the bottom of the hearth of said furnace which comprises graphite placed between the carbon lining and bricks of the bottom of said hearth and extending from the center of said hearth to the periphery of said hearth, said graphite being in contact with said carbon lining, and a cooling medium disposed in heat absorbing relationship with said graphite adjacent the periphery of said hearth.

2. In a metallurgical furnace which has a carbon lining on the bottom of the hearth of said furnace, a cooling means for the bottom of the hearth of said furnace which comprises graphite placed between the carbon lining and bricks of the bottom of said hearth and extending from the center of said hearth to the periphery of said hearth, said graphite being in contact with said carbon lining, and cooling coils in contact with said graphite adjacent the periphery of said hearth.

3. In a metallurgical furnace which has a carbon lining on the bottom of the hearth of said furnace, a cooling means for the bottom of the hearth of said furnace which comprises a layer of graphite placed between the carbon lining and bricks of the bottom of said hearth and extending from the center of said hearth to the periphery of said hearth, said layer of graphite being in contact with said carbon lining, and cooling coils in contact with said graphite layer adjacent the periphery of said hearth.

4. In a metallurgical furnace which has a carbon lining on the bottom of the hearth of said furnace, a cooling means for the bottom of the hearth of said furnace which comprises a block of graphite placed between the carbon lining and bricks of the bottom of said hearth and extending from the center of said hearth to the periphery of said hearth, said block of graphite being in contact with said carbon lining, and cooling coils in contact with said graphite block adjacent the periphery of said hearth.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,775,396	Jackman et al.	Sept. 9, 1930
1,937,940	Boynton	Dec. 5, 1933
1,940,115	Broadwell	Dec. 19, 1933
2,423,898	McLain	July 15, 1947
2,532,322	McFarlin	Dec. 5, 1950