United States Patent

Wirtz et al.

[15] **3,705,713**

[45] **Dec. 12, 1972**

[54] **BOTTOM COOLING DEVICE FOR SHAFT FURNACES**

[72] Inventors: **Walter Wirtz,** Duisburg; **Ulrich Genge,** Homberg, both of Germany

[73] Assignee: **Demag Aktiengesellschaft,** Duisburg, Germany

[22] Filed: **Nov. 2, 1970**

[21] Appl. No.: **85,978**

[30] **Foreign Application Priority Data**

Nov. 12, 1969 Germany.....P 19 56 837.7

[52] **U.S. Cl.**.....**263/44,** 263/46

[51] **Int. Cl.**.....**F27b 1/24**

[58] **Field of Search**.....263/44, 46

[56] **References Cited**

UNITED STATES PATENTS

2,673,083 3/1954 MacPherson et al.....263/44

2,514,871 7/1950 Jordan.....263/44

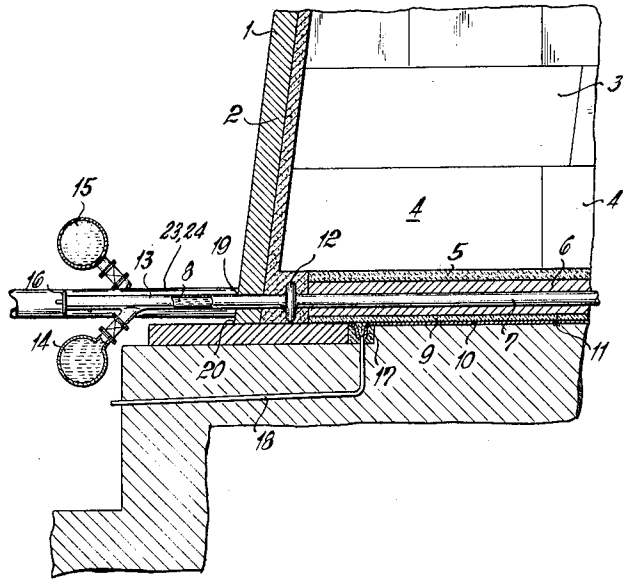
Primary Examiner—John J. Camby

Attorney—McGlew & Toren

[57] **ABSTRACT**

A bottom cooling device for shaft furnaces, particularly for blast furnaces, comprises an arrangement of cooling pipes behind a layer of lining bricks which are made of graphite or carbon. The lining bricks are adapted to contain a liquid metal which has a destructive effect on the bricks particularly a metal such as pig iron. The device includes a metal layer of high thermal conductivity which is arranged between a lining layer and a terminal plate and within which there is embedded a grid of cooling ducts. The cooling ducts form a secant in respect to the base circle of the furnace and they connect to a ring duct having diametrically opposite inlet and outlet connections.

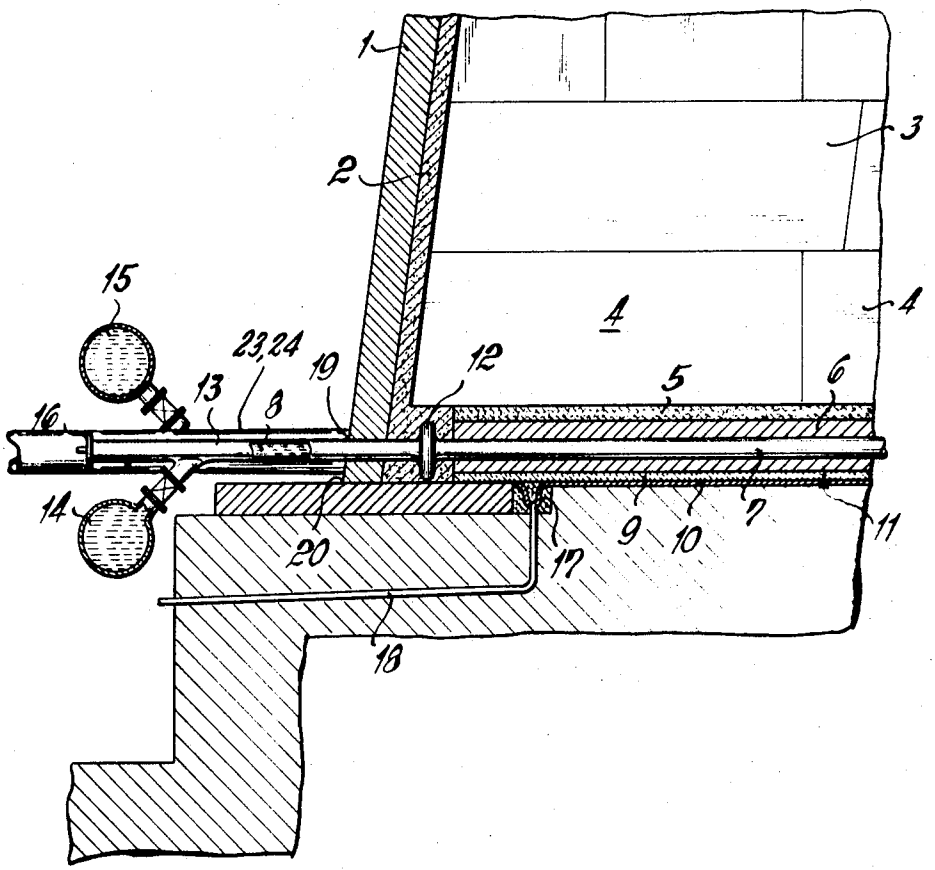
13 Claims, 2 Drawing Figures



PATENTED DEC 12 1972 3,705,713

SHEET 1 OF 2

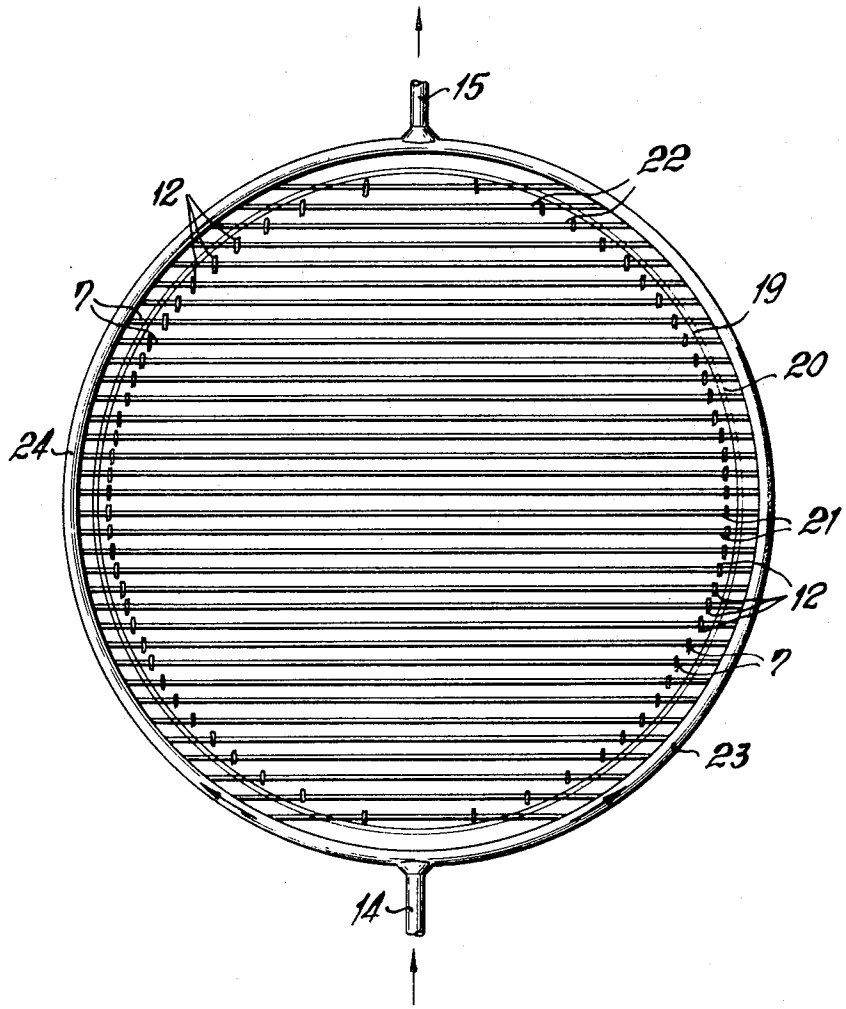
FIG. 1



INVENTORS
WALTER WIRTZ
ULRICH GENGE

McBlew & Toren
ATTORNEYS

FIG. 2



INVENTORS
WALTER WIRTZ
ULRICH GENGE

McGlew & Toren
ATTORNEYS

BOTTOM COOLING DEVICE FOR SHAFT FURNACES

SUMMARY OF THE INVENTION

This invention relates in general to the construction of furnaces and in particular to a new and useful metallurgical shaft furnace construction, particularly blast furnaces, which includes an arrangement of cooling pipes between a layer of lining bricks of carbon material which contain a liquid metal, particularly pig iron having a destructive effect on the lining bricks, and a terminal steel plate.

The invention is based on the finding that resistant bottoms or lining layers of furnaces and similar metallurgical vessels can be obtained mainly by cooling because the mechanical and chemical wear is frequently negligible compared to the thermal wear. It is also known that the liquid pig iron dissolves carbon bricks. The reason is to be found in the varying content of the aggressive substances in the pig iron. Nevertheless, carbon brick show a definitely favorable behavior to slag, gases and vapors. The use of carbon bricks also seems indicated because of the high thermal conductivity since the total temperature level can be kept low by the rapid elimination of heat which in turn has a retarding effect on the chemical and physical reactions. The resistance to sudden temperature changes plays an important part depending upon the smelting course in the blast furnace. The carbon bricks show a relatively good behavior and are as a whole superior to fireclay bricks in several respects.

The reduction of the temperatures in thick lining layers is the most effective measure available to prevent extensive dissolution of the bricks and to considerably increase the life of the furnaces. In blast furnaces, there is the particular difficulty that an irregular layer of a mixture of iron, ore and coke is formed, the so-called furnace sow. The thicker the furnace sow, the more difficult is the relining of the furnace. This work is only possible by employing highly dangerous blasting techniques. The blast furnace operator tries to keep these blastings within reasonable limits so that the parts of the furnace and the personnel surrounding these parts are not endangered.

The invention is based on the principal of eliminating as much heat as possible by keeping the brickwork cool and not by employing highly effective insulation which prevents the elimination of heat and which cause localization of heat in certain layers of the brick lining.

In order to enhance the elimination of heat, it is known to conduct cooling air at a rate of 35,000 Nm^3/h through a central pipe in the furnace foundation under the bottom plate and radially to the outside through 60 segments. The heat transfer from the brickwork to the bottom plate and from the bottom plate to the cooling medium depends in its nature on the factors which exclude the elimination of a large amount of heat per unit of time. The necessary high thermal efficiency is obtained in practice only at higher temperature levels which the invention tries to prevent as far as the brickwork is concerned.

The present invention therefore starts from the problem of improving the heat transfer from the brickwork to the cooling medium by maintaining an isotherm of about 1,100° C with a possibly thin initial brickwork layer, which is slightly reduced in the course of the operation.

In accordance with the invention, a highly conductive metal layer is arranged between the lining layer and the terminal plate and ducts for the cooling medium are embedded in this metal layer. With the arrangement, the heat current which originates from the lining layer can be absorbed on all sides by the cooling duct arrangement within the conductive layer and an increased heat transfer can take place from the highly conductive layer to the cooling medium. The more intensive the contact between the cooling medium and the walls of the cooling ducts which is possible, for example with the use of a liquid cooling medium, the more favorable is the heat balance and the amount of heat eliminated per unit of time.

According to a particular advantageous embodiment of the invention, the highly conductive layer comprises an aluminum material and the cooling pipes for the cooling liquid are made of copper. This combination leads to an economically justifiable solution, because the portion of the aluminum is greater than that of the expense of the copper and both metals have good thermal conductivity.

In a realization of the basic idea of the invention, the highly conductive layer comprises hollow aluminum plates or bars which are provided in sufficient number and which have cooling ducts connected to the inlets and outlets for the cooling medium. With a relatively large surface to be covered, as is the case in blast furnaces with crucible diameters of 10m and more, this represents a considerable advantage for the production and assembly of the highly conductive layers to be installed. In the preferred arrangement, the cooling pipes for the cooling medium are formed as a plurality of parallel secants within an annular connecting feed and return duct which are related to the base circle of the furnace. The flow of the cooling medium can therefore be effected without deflection to result in higher velocities of flow, lower resistances, and hence, greater elimination of heat.

According to another feature of the invention, the cooling pipes are provided at the exterior of the furnace with a socket which has a closable opening to permit the introduction of a cleaning agent. Unless a cooling cycle is used, deposits and similar impurities can therefore be easily removed from time to time from the straight secant cooling pipes. In addition, it is possible to install temperature measuring elements at different points of the furnace diameter.

A high security against unforeseen deficiencies of the cooling medium is provided by the fact that the main connection for the return pipes is arranged higher than the main connection for the feed pipes. If the flow of the cooling medium stops temporarily, the pipe system can therefore not run empty and the cooling medium is only heated temporarily to a higher temperature and the higher conductive layer of the metal offer additional heat storage facility.

Between the cooling pipes and the main connections for the feed and return flow is arranged a member which absorbs the longitudinal expansion of the pipes in accordance with another feature of the invention. Such a compensator also compensates automatically for the thermal expansions between the socket projecting through the furnace shell and the shell itself and also acts as a compensator for longitudinal movements which are caused by displacement of the metal layer.

The longest pipes of the secant pipes forming the cooling medium grid have larger diameters than the shorter ones and thus the greater amounts of heat generated in the center or in the individual zones can therefore be taken into consideration. In such a zone, larger diameters are provided so that a greater flow of the cooling medium takes place there. Under certain circumstances, it is also of advantage to accept a somewhat reduced wall thickness of the metal layer because it reduces the path of heat flow.

In general, the cooling can be effected according to the invention by means of gases but water cooling increases the amount of heat eliminated per unit of time. The cooling medium may also consist of a glycerin material or a mixture of water and glycerin.

The invention offers not only advantages with regard to the increased heat flow from the lining layer into the cooling medium, but it also provides a production method for the highly conductive layer assembly. According to one proposal, several cooling pipes are laid inside a casting mold in fixed parallel relationship. The mold is then filled with liquid metal to cover the pipes while the heating of the material of the pipes is regulated from the inside. This production of the connection between the thermally conductive metal layer formed by the liquid melt and the cooling pipes is particularly effective to avoid an air gap between the metal layer and the cooling pipes which may reduce the heat flow and increase the heat resistance.

A further method for the production of the highly conductive layer comprises selecting a certain pipe length of a straight single pipe having a bar-shaped cross-section and obtaining therefrom pieces of different length of cutting. This production method is simple for forming individual parts for the circular surface of the blast furnace foundation. Consequently, only a single casting mold is required for all part lengths, and it can thus be designed to prepare the above-mentioned sockets by projecting pipe pieces.

Accordingly, it is an object of the invention to provide an improved bottom cooling device for a shaft furnace, particularly for blast furnaces, which comprises an arrangement of cooling pipes behind a layer of lining bricks of a carbon material, which bricks are arranged to carry a metal which is destructive to such lining and which includes a metal layer of high thermal conductivity which is arranged between the lining and a terminal plate and, which has a plurality of cooling ducts extending therethrough.

A further object of the invention is to provide a metallurgical furnace construction which is simple in design, rugged in construction, and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a partial vertical section of the lower portion of a blast furnace constructed in accordance with the invention; and

FIG. 2 is a top plan view of the arrangement of the cooling ducts within the conductive metal layer of the furnace shown in FIG. 1.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in particular, the invention embodied therein, comprises a blast furnace construction which includes an outer furnace shell or casing **1** which is separated from an interior lining layer **3** by a tamping layer **2**. The lining layer **3** includes a lowermost course or bottom course of brick **4** which bears on a bottom wall having an interior bottom layer **5** of a graphite or carbon brick material. The interior layer **5** extends over an inner metal layer **6**.

In accordance with the invention, the inner metal layer **6** comprises an assembly which includes a plurality of cooling ducts or pipes **7** arranged in a grid pattern and integrally formed or cast with the conductive layer **6**. A feature of the construction is that the cooling ducts **7** are formed with the conductive layer in a manner such that there are no gaps between the ducts and the conductive layer **6** so that there is no possibility of an air space being formed to provide an insulation space between the metal layer **6** and the cooling medium **8** which will flow through the ducts **7**.

In contrast to the known furnace constructions, an insulation **9** is arranged above an outer or bottom terminal plate **10** and below the underside **11** of the conductive layer **6**. The cooling ducts **7** are in communication with pipe sockets **13** through compensators **12** which are arranged in the tamping layer **2** at each side of the bottom of the furnace. Inlets **14** are connected to the sockets **13** to provide a main connection feed for the coolant and outlets **15** are connected at the opposite side to provide a main connection for the return flow. The sockets **13** are provided with closures **16** at open ends thereof which may be removed, for example, for the purpose of cleaning the tubular grid work by flushing it out with a cleaning medium.

The terminal plate **10** is provided with an offset portion forming a trough **17** into which is drained the water of condensation from the lining layer **3** and from the tamping layer **2** and it is passed outwardly through a downwardly extending line **18**.

Referring to FIG. **2** which shows the interior grid pattern of the tubes within the conductive layer **6**, it is noted that the cooling ducts **7** form secants **19** to a furnace base circle **20**. The grid construction is such that only straight pipes are required since they may be arranged in parallel within an annular tubular framework formed by a collecting conduit **24** and a discharge conduit **23**. The central group **21** of tubular pipes **7** are medium-sized longer pipes and the end group **22** are relatively short and of smaller diameter than the tubes of group **21**. Each is connected to the respective collecting conduit **24** and distributing conduit **23**. The cooling gridwork is preferably operated by the circulation of a cooling water through the inlet **14** and out through the outlet **15**.

The construction may be used both on SM furnaces and on electric furnaces as well as on converter bot-

toms. Particularly, the feature of safely embedded cooling pipes prevent the danger of a breakout of the cooling pipes and provides an adequate cooling of the furnace at such a location.

The metal conductive layer 6 advantageously comprises an aluminum material and the ducts 7 are preferably made of a material such as copper. The conductive layer 6 may, for example, comprise a plurality of hollow aluminum plates or bars.

In some instances, the cooling medium which is circulated, may be a mixture of glycerin and water or merely glycerin alone.

The conductive layer assembly 6 including the duct 7 is advantageously produced by embedding the gridwork of the cooling pipes inside a casting mold in a manner such that they cannot change their spacing therebetween and then casting the outer conductive metal within the mold and around the pipes while the heating of the pipes is regulated from the inside thereof. A certain pipe length of a straight single pipe with a cross-sectional form of a bar is preferably selected for the ducts 7 and it is then covered with metal such as aluminum. The different lengths of tubing which are required, such as for the central portions of the tubes 21 and the end portions 22, are obtained from cutting a standard size pipe in order to provide pipes of intermediate and shorter lengths.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A bottom wall construction for shaft furnaces, particularly blast furnaces, and which is adapted to be arranged behind a layer of carbon lining bricks which are exposed, on the interior of the furnace, to a liquid metal particularly pig iron which has a destructive on the bricks, comprising a metal layer of high-thermal conductivity, and a plurality of cooling ducts arranged in a pattern and embedded within the metal layer.

2. A bottom wall construction, according to claim 1, including a terminal steel plate arranged outside of said metal layer of high-thermal conductivity.

3. A bottom wall construction, according to claim 1, wherein said highly conductive layer comprises an aluminum metal material said cooling ducts comprising cooling pipes made of copper.

4. A furnace construction comprising an outer shell, an inner tamping layer, a brickwork lining within said inner tamping layer forming the interior wall of said furnace, said furnace having a bottom wall comprising an interior layer of graphite bricks, an intermediate conductive layer assembly comprising a metal layer of high-thermal conductivity, a plurality of tubes arranged in a pattern and adapted to be interconnected for the flow of a coolant therethrough and embedded within said metal layer of high-thermal conductivity, and a terminal steel plate arranged on the exterior of said metal layer of high-thermal conductivity.

5. A furnace construction, according to claim 4, wherein said conductive layer comprises hollow aluminum plates, said cooling pipes having an inlet and an outlet for the passage of a cooling medium therethrough.

6. A furnace construction, according to claim 4, wherein said cooling ducts are arranged in a pattern such that each tube forms a secant to a base circle of said furnace wall.

7. A furnace wall construction, according to claim 4, wherein said cooling ducts extend outside said furnace wall, and a socket connected to said ducts having a closable opening for the introduction of a cleaning agent.

8. A furnace construction, according to claim 4, including an inlet connected to said cooling ducts for the inflow of the cooling medium thereto and an outlet connected to said duct for the return flow of the cooling medium arranged above said inlet.

9. A furnace construction, according to claim 8, including compensator means connected within each of said ducts and permitting longitudinal expansion and contraction thereof.

10. A furnace wall construction, according to claim 4, including an annular connector ring connected to the ends of said ducts having inlet and outlet means for the cooling medium, said ducts extending in spaced parallel relationship and wherein the longest of said ducts have a diameter which is larger than the shortest of said ducts.

11. A furnace construction, according to claim 4, including means for circulating a cooling medium through said ducts, said cooling medium comprising a portion thereof which is glycerin.

12. A method for producing a highly conductive assembly for the bottom of a shaft furnace using a casting mold, comprising arranging a plurality of cooling pipes within the mold in spaced parallel relationship, and then applying a metal to completely cover the pipes and be cast thereover while regulating the temperature of the pipes from the interiors thereof.

13. A method according to claim 12, wherein the cooling ducts are madeup of a plurality of straight single pipe having a bar-shaped cross-sectional form and wherein the pipes are formed within a frame of annular configuration, comprising forming the central pipes of a standard length interconnecting the frame and forming the others of shorter length by cutting.

* * * * *