

Sept. 1, 1936.

G. M. HARRIS

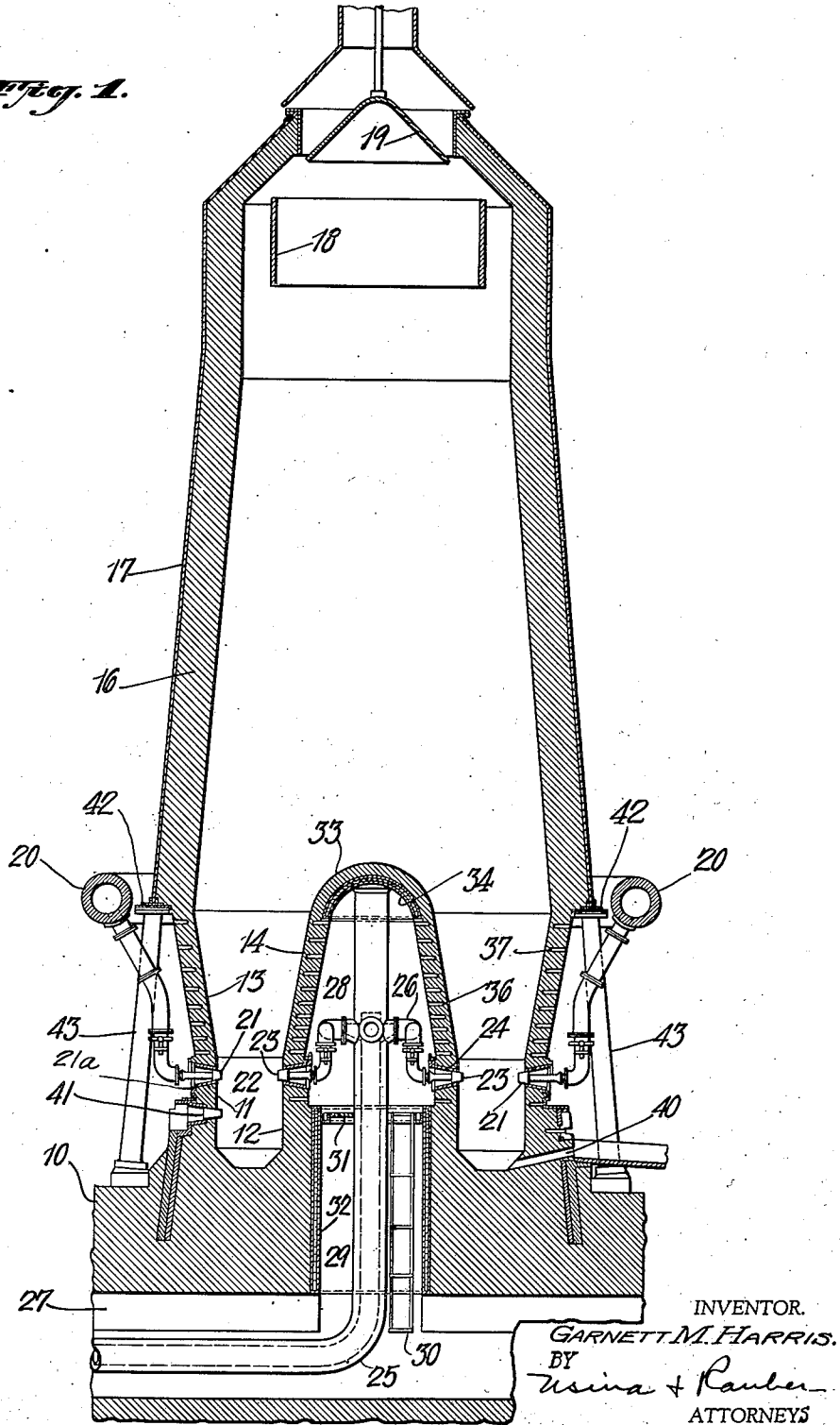
2,052,928

BLAST FURNACE HEARTH AND BOSH

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3 Sheets-Sheet 1

Fig. 1.



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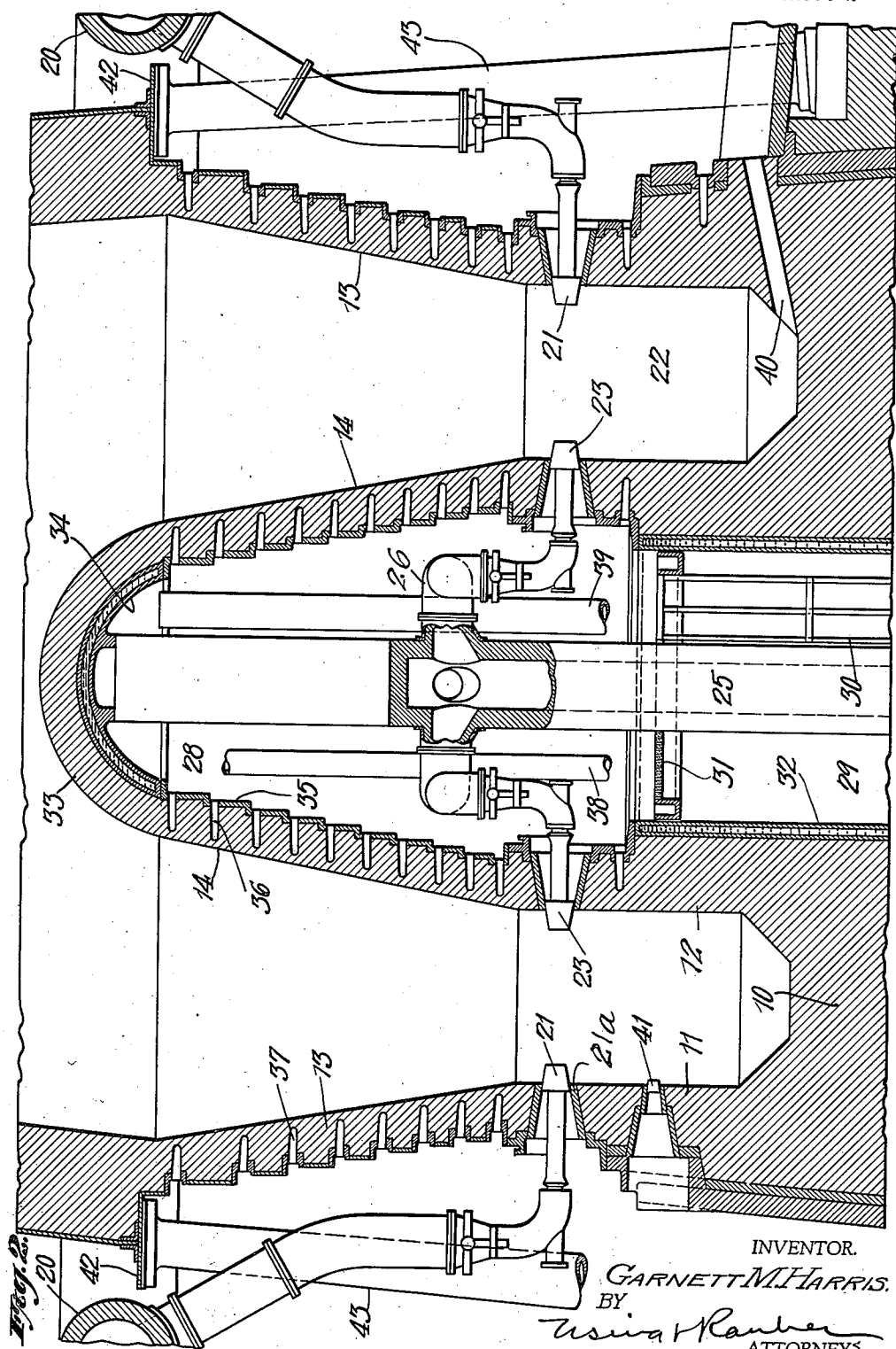
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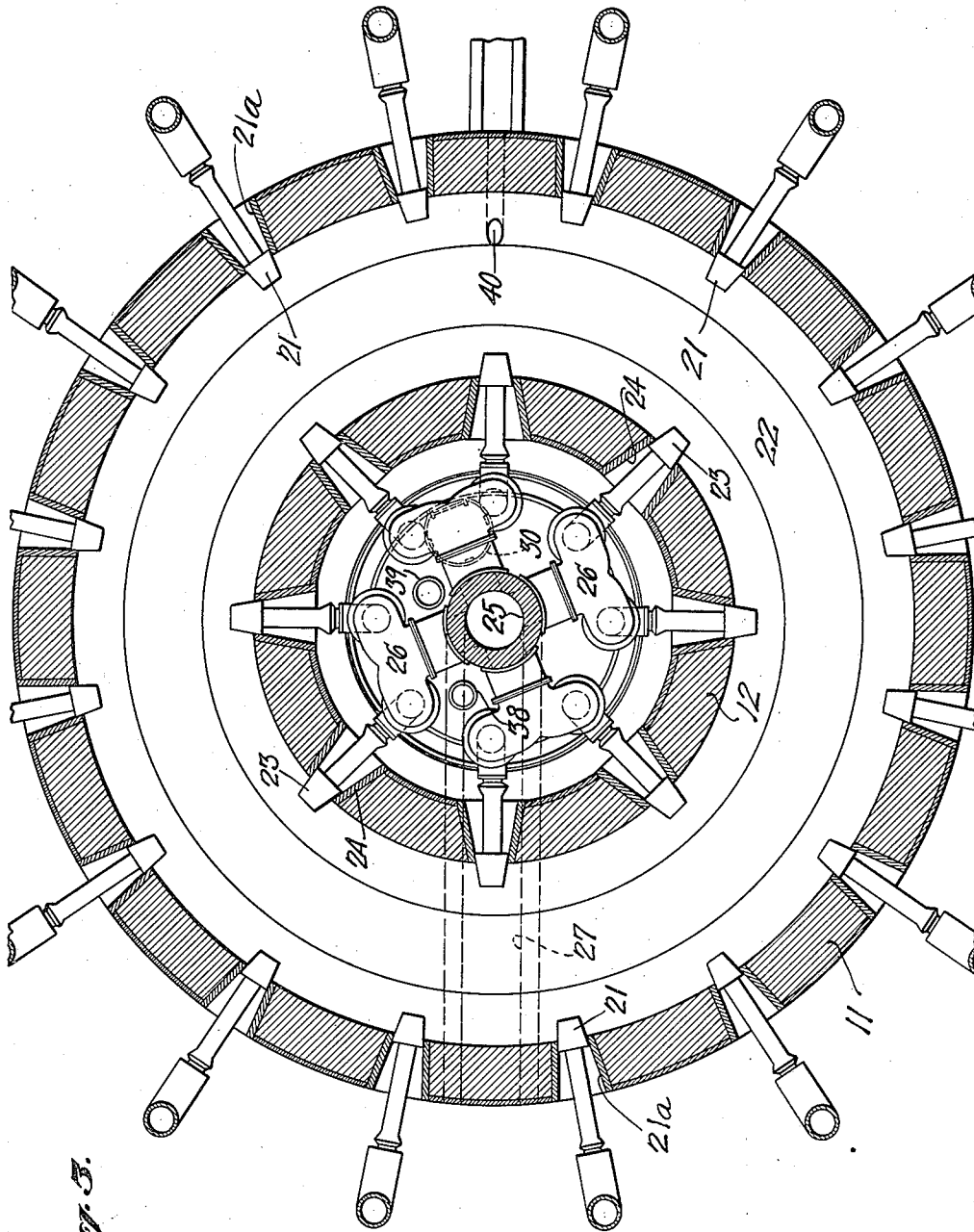


Fig. 3.

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BLAST FURNACE HEARTH AND BOSH

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15 Claims. (Cl. 266—30)

This invention relates in general to blast furnaces of the character used for the smelting of ores such as iron ore and the like and more particularly to those parts of the furnace known as the crucible and the bosh.

The conventional blast furnaces of the modern type in general use for smelting iron ore usually comprise a refractory lined structure approximately ninety feet in height and about twenty-five feet outside diameter. Such furnaces usually comprise elements corresponding to hollow cylinders and hollow truncated cones superposed on each other. The bottommost section of the furnace is usually referred to either as the hearth or the crucible and in common practice it is usually about eighteen feet in diameter and about twelve feet high. Liquid iron and slag collect in this crucible portion and are withdrawn at regular intervals through the iron and cinder notches located near the bottom and top of the crucible.

Above the crucible portion, there is usually a portion corresponding to a hollow truncated cone whose walls diverge upwardly, known as the bosh. Above the bosh, there is a long section known as the stack, resembling a hollow truncated cone whose walls converge upwardly. At the top of the stack, suitable charging bells and platforms are ordinarily provided.

The stack of the furnace is usually insulated with a layer of firebrick approximately four feet thick, while the bosh and crucible portions are considerably thinner. However, they customarily have refractory linings which are water cooled by incorporating in the structure hollow copper blocks through which water is continuously circulated.

Near the top of the crucible or hearth, there is a circumferential series of tuyères through which air is forced under pressure from an annular pipe surrounding the furnace, commonly known as a bustle-pipe. The several tuyères are suitably connected with the bustle-pipe and the connections are customarily so arranged that as the tuyères burn out they can be readily withdrawn and new ones inserted.

In all iron blast furnaces or other ore smelting furnaces of which I have knowledge, the air blast is directed inwardly from the exterior of the furnace toward the central portion thereof.

My invention contemplates a radical departure from the design and arrangement of blast furnaces now in general use in that instead of discharging the blast air only from the outer portion of the furnace inward, I provide means whereby a separate series of tuyères are opera-

tive to discharge blasts of air from the central zone of the furnace outwardly. This is considered to be highly desirable in order to cause the blast to penetrate practically the entire cross sectional area of the crucible. This will result in a more even burning of the coke charged to the furnace and a more even or gentle settlement of the stock and a better distribution of the gases as they rise through the stack of the furnace above the tuyère level. And the whole operation of the furnace would be improved and its efficiency considerably increased.

In the old furnaces of the prior art hereinabove briefly described, the air blast performs three major functions, one, preheating the ore, coke and limestone, deoxidizing the metallic oxides of the ore and converting the resulting iron and slag to a molten state. The raw charging materials, such as iron ore, coke and flux such as limestone, are charged into the top of the furnace and descend countercurrent to the great volumes of carbon monoxide and nitrogen generated near the lower part of the furnace.

As the charging materials descend countercurrent to the rising reducing gases, the more easily reduced high oxides come in contact with the gas of the lowest reducing power, and the gas richest in carbon monoxide reacts with the ore in the final stages of reduction at the lower levels of the furnace. This well known phenomena results in an excellent utilization of the reducing power of the gases and is in a measure largely responsible for the almost universal utilization of the conventional type of iron smelting blast furnace above briefly referred to.

It is fairly well recognized that the seat of life of a blast furnace is in the neighborhood of the combustion zones in front of the tuyères because the heat as well as the reducing gases for carrying on the process are generated in this part of the furnace. But, in the types of furnaces heretofore generally used, there is an inactive zone, by which I mean, there is a zone wherein combustion is not taking place throughout the entire cross sectional area of the furnace at the tuyère zone. Studies and investigations establish the fact that combustion zones are about the same area for a small furnace as for a large one. Thus, in conventional furnaces, there is an inactive zone at the tuyère level of the furnace. With a furnace having a crucible diameter of twenty-five feet, this inactive area represents a large fraction of the total area. But, in spite of this crucible condition in this art crucible areas have been increased until the fur-

nace of the type used ten years ago, which would produce about six hundred tons of iron per day, now produces about one thousand tons per day. Such large furnaces have operated smoothly and efficiently.

But, the gain in the furnace production has not been in proportion to the increase in crucible area and there has been little or no real improvement in the efficiency of the furnace as measured by fuel consumption.

In the furnace embodying my invention, the crucible is materially increased in diameter. But, its area may be decreased or increased because I so arrange the structure of the furnace that an annular crucible is provided and I arrange the tuyères in such a way that one series of tuyères directs the air blast inwardly and another set of tuyères directs the blast outwardly and I arrange the tuyères in the different sets or series in a staggered relationship so that the zone of influence of the blast from the tuyères is felt virtually throughout the entire sectional area of the hearth or crucible. This comprises a blast furnace structure having an annular crucible and an annular bosh and with provision for a tuyère room in the center of the furnace where workmen can enter for the purpose of changing tuyères or observing the action of the furnace through suitable peep-holes in the tuyères. The top of this tuyère room, to withstand the heat, is provided with a water cooled dome and the inner bosh wall is water cooled. And fresh air is supplied to the tuyère room, so as to maintain the atmosphere in such condition that the workmen can perform their necessary duties in this location, which it will be remembered is surrounded by molten iron, iron ore, flux and other stock materials in the annular bosh of the furnace.

A furnace embodying the above described and other features of my invention is illustrated in the accompanying drawings, in which—

Fig. 1 is a vertical longitudinal section through the improved furnace, the stack portion having been foreshortened, however, to enable showing of the bosh and crucible portions on a legible scale; Fig. 2 is a cross section of the crucible and bosh portions of the furnace, at a scale much greater than that of Fig. 1; Fig. 3 is a horizontal section taken through the furnace at the tuyère level.

With reference to the detailed features of the structure illustrated, 10 represents a suitable foundation portion which supports the concentric annular outer and inner wall portions 11 and 12, respectively, of the crucible portion of the furnace. Above the crucible, there are outer and inner annular bosh walls 13 and 14, the outer bosh wall diverging upwardly and outwardly and the inner bosh wall converging inwardly and upwardly. Above the bosh wall, the furnace is substantially of conventional construction and includes the usual stack wall 16 and the usual outer shell 17. At the stock line, I provide a conventional form of stock line armor 18. And the charge fed to the furnace is under control of conventional charging apparatus including the usual charging bell 19.

A bustle pipe 20 surrounds the furnace and serves in the usual manner as a manifold for blast air delivered to the outer circumferential series of tuyères 21. These tuyères are of conventional type and are positioned in a conventional manner in water cooled tuyère coolers, indicated at 21^a. All of the tuyères of the se-

ries indicated by the numerals 21 direct the blast inwardly into the annular hearth or crucible 22.

An inner series of tuyères 23 are positioned in suitable tuyère coolers 24 and they each direct an air blast into the crucible in a direction extending radially outward from the center of the furnace. The tuyères 23, as viewed in plan, are arranged in staggered relation to the tuyères 21 of the outer series. It is thus clear that in such an arrangement the blast coming from two directions will penetrate practically the entire cross section of the crucible and the combined combustion zones will practically cover this area, hence all inactive spaces will be eliminated. This will result in a more even burning of the coke, a more uniform settlement of the stock and a better distribution of the reducing gases as they arise through the stock above the tuyère level.

For supplying the blast air to the inner set of tuyères 23, I provide a blast main 25 which communicates with a suitable supply of hot blast air. At its upper end, the pipe has a plurality of lateral branches which communicate by means of fittings 26 with adjacent pairs of tuyères 23 as fully apparent from Figs. 2 and 3. This pipe enters through a tunnel 27 formed in the foundation 10 of the furnace, which tunnel also serves as means of access and egress for the workmen, who must enter the central tuyère room 28. This tuyère room connects with the tunnel 27 by a vertical shaft 29, which is provided with a suitable stair or with a ladder 30.

The tuyère room is provided with a floor in the form of a grating 31. This floor and the shaft are cooled by shell-like water jacket 32.

At its top, the inner annular bosh wall 14 merges into a dome-like roof 33. This roof dome is lined on the interior with a hollow metal shell 34 conforming in shape to the dome. This jacket is supported by a metal lining indicated at 35. This lining is of stepped formation and is provided with a plurality of inward extensions 36 which are water cooled. These resemble the conventional forms of insert members, indicated at 37, which extend inwardly into the outer bosh wall 13, so as to prolong the life of the bosh wall.

A water supply pipe 38 enters through the tunnel 27 and extends upwardly through the shaft 29 and into the central tuyère room and connects in a suitable manner with the water jacketed shell 34 and with the inserts 36 in any suitable manner by the use of any conventional form of pipe fittings and connections which need not be shown or described in detail.

Fresh cooled air is supplied to the tuyère room 28 by pipe 39, so as to maintain livable working conditions in this room, which must be occupied by blast furnace attendants, in order to permit inspection of the tuyères and the removal and renewal of the same when necessary.

The furnace is provided with the usual iron notch 40 through which the molten iron is periodically withdrawn and also a typical form of cinder notch 41, through which a slag is discharged each time the furnace is tapped.

The exterior of the furnace is formed with the usual mantle 42 which is carried by pillars 43 resting on the foundation so as to support the weight of the stack.

It is apparent that the innermost bosh and crucible walls of my improved furnace are supported by the same foundation 14 which supports the outer walls 11 and 13 of the crucible and bosh, respectively.

While I have described quite precisely the design and arrangement of the furnace herein illustrated, it is to be understood that the drawings and description are to be interpreted in an illustrative rather than a limiting sense since various modifications may be made by those skilled in the art without departure from the invention as defined in the appended claims.

What I claim is:

1. A blast furnace for smelting ores comprising inner and outer walls defining an annular crucible, an annular bosh thereabove, a stack above the bosh and crucible, an outer series of tuyères extending through the outer wall of said crucible and an inner series of tuyères extending through the inner wall of said crucible.

2. A blast furnace for smelting ores comprising a pair of upright walls defining an annular crucible, a pair of bosh walls thereabove defining an annular bosh, a stack wall rising from the bosh wall, and respective sets of tuyères for directing air blasts into the annular crucible in respectively inward and outward directions.

3. A blast furnace of the character described comprising a pair of substantially concentric crucible walls defining an annular hearth, an upwardly and outwardly diverging bosh wall rising from the outer wall of the crucible and an inwardly and upwardly converging bosh wall rising from the inner wall of the crucible, an outer series of tuyères for directing air blasts inwardly into the crucible, and an inner series of tuyères for directing air blasts outwardly into the crucible.

4. A blast furnace of the character described comprising inner and outer crucible walls defining an annular hearth, an outer annular bosh wall diverging outwardly and upwardly from the upper portion of the outer crucible wall, an inner annular bosh wall rising from the inner wall of the crucible and having a dome-like roof defining a tuyère chamber, an outer set of tuyères for directing an air blast inwardly into the crucible, an inner set of tuyères located in said tuyère chamber for directing air blasts outwardly into the crucible.

5. A blast furnace of the character described comprising inner and outer crucible walls defining an annular crucible, an outer annular bosh wall diverging outwardly and upwardly from the upper portion of the outer crucible wall, an inner annular bosh wall rising from the inner walls of the crucible and having a dome-like roof defining a tuyère chamber, an outer set of tuyères for directing an air blast inwardly into the crucible, an inner set of tuyères located in the tuyère chamber for directing air blasts outwardly into the crucible, a foundation for the crucible having a tunnel and a shaftway therein to permit the passage of workmen to and from the tuyère chamber.

6. A blast furnace of the character described comprising inner and outer crucible walls defining an annular crucible, an outer annular bosh wall diverging outwardly from the upper portion of the outer crucible wall, an inner annular bosh wall rising from the inner wall of the crucible and having a dome-like roof lined with a water cooled shell forming the top of a tuyère chamber, an outer set of tuyères for directing an air blast inwardly into the crucible, an inner set of tuyères located in the tuyère chamber for directing air blasts outwardly into the crucible, a foundation for the crucible having a tunnel and a shaftway

therein to permit the passage of workmen to and from the tuyère chamber.

7. A blast furnace of the character described comprising inner and outer crucible walls defining an annular hearth, an outer annular bosh wall diverging outwardly and upwardly from the upper portion of the outer crucible wall, an inner annular bosh wall rising from the inner wall of the crucible and having a dome-like roof defining a tuyère chamber, an outer set of tuyères for directing an air blast inwardly into the crucible, an inner set of tuyères located in the tuyère chamber for directing air blasts outwardly into the crucible, a foundation for the crucible having a tunnel and a shaftway therein to permit the passage of workmen to and from the tuyère chamber, and a water cooled lining for said shaftway.

8. A blast furnace of the character described comprising inner and outer crucible walls defining an annular hearth, an outer annular bosh wall diverging outwardly and upwardly from the upper portion of the outer crucible wall, an inner annular bosh wall rising from the inner wall of the crucible and having a dome-like roof defining a tuyère chamber, an outer set of tuyères for directing an air blast inwardly into the crucible, an inner set of tuyères located in the tuyère chamber for directing air blasts outwardly into the crucible, a foundation for the crucible having a tunnel and a shaftway therein to permit the passage of workmen to and from the tuyère chamber, and an air blast pipe extending through said shaftway and having a plurality of branches communicating with the inner series of tuyères.

9. A blast furnace of the character described comprising inner and outer crucible walls defining an annular hearth, an outer annular bosh wall diverging outwardly and upwardly from the upper portion of the outer crucible wall, an inner annular bosh wall rising from the inner wall of the crucible and having a dome-like roof defining a tuyère chamber, an outer set of tuyères for directing an air blast inwardly into the crucible, an inner set of tuyères located in the tuyère chamber for directing air blasts outwardly into the crucible, a foundation for the crucible having a tunnel and a shaftway therein to permit the passage of workmen to and from the tuyère chamber, and a pipe opening into said tuyère room for supplying fresh air thereto.

10. A blast furnace of the character described comprising a foundation having inner and outer substantially concentric crucible walls defining an annular crucible, an outer bosh wall rising from the crucible wall, an inner upwardly and inwardly converging bosh wall rising from the inner crucible wall and having a dome-like roof defining a tuyère chamber, a water cooled metallic lining for said chamber, an outer set of tuyères communicating with a bustle-pipe for supplying blast air to said outer series of tuyères, an inner series of tuyères located in said tuyère chamber and an air blast pipe having a plurality of branches communicating with said inner set of tuyères, a tunnel below the crucible and a shaftway communicating with said tunnel and said tuyère chamber so as to permit passage of workmen to and from said chamber.

11. A blast furnace of the character described having inner and outer wall portions defining an annular crucible and an inner shaftway, inner and outer bosh walls rising respectively from the inner and outer wall portions, a stack supported by pillars carried by the foundation and rising above the outer bosh wall, an outer set of tuyères for

directing air blasts inwardly into the annular crucible, an inner set of tuyères for directing air blasts outwardly into the annular crucible, a roof which with the inner bosh wall defines a tuyère chamber, a flooring for the accommodation of workmen in said chamber and an air blast supply pipe for the inner set of tuyères extending into said tuyère chamber.

12. A blast furnace of the character described having inner and outer wall portions defining an annular crucible and an inner shaftway, inner and outer bosh walls rising respectively from said inner and outer wall portions, a stack supported by pillars carried by the foundation and rising above the outer bosh wall, an outer set of tuyères for directing air blasts inwardly into the annular crucible, an inner set of tuyères for directing air blasts outwardly into the annular crucible, a roof which with the inner bosh wall defines a tuyère chamber, a flooring for the accommodation of workmen in said chamber, an air blast supply pipe for the inner set of tuyères extending into said tuyère chamber, means for water cooling the roof of said tuyère chamber and means for discharging fresh air into said cham-

ber so as to maintain a livable atmosphere therein.

13. A blast furnace for smelting ores comprising inner and outer wall portions defining an annular crucible and an annular bosh, a stack above the bosh and inner and outer sets of tuyères effective to distribute air blasts over substantially the entire sectional area of the crucible.

14. A blast furnace for smelting ores comprising inner and outer wall portions defining an annular crucible and an annular bosh, a stack portion above the bosh, and tuyères effective to distribute an air blast throughout substantially the entire cross sectional area of said annular crucible.

15. A blast furnace for smelting ores comprising inner and outer wall portions defining an annular crucible, an inner structure which in conjunction with the inner wall of the crucible defines an inner tuyère chamber, an outer annular wall rising from the outer wall of the crucible, an inner set of tuyères in said chamber effective to direct air blasts outwardly into the crucible and an outer set of tuyères effective to direct air blasts inwardly into the crucible.

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