June 1, 1937. G. FOX ET AL 2,082,280

TUYÈRE

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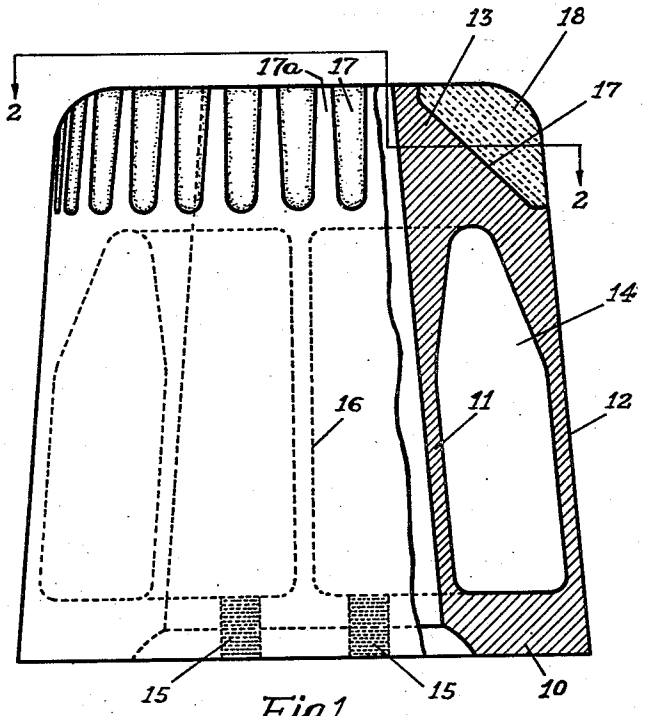


Fig.1

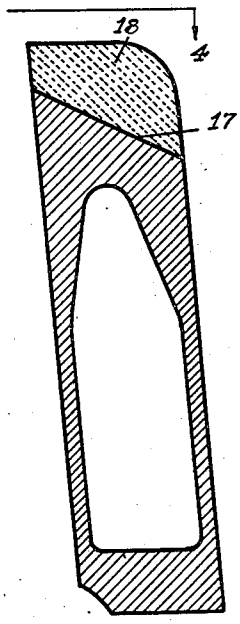


Fig.3

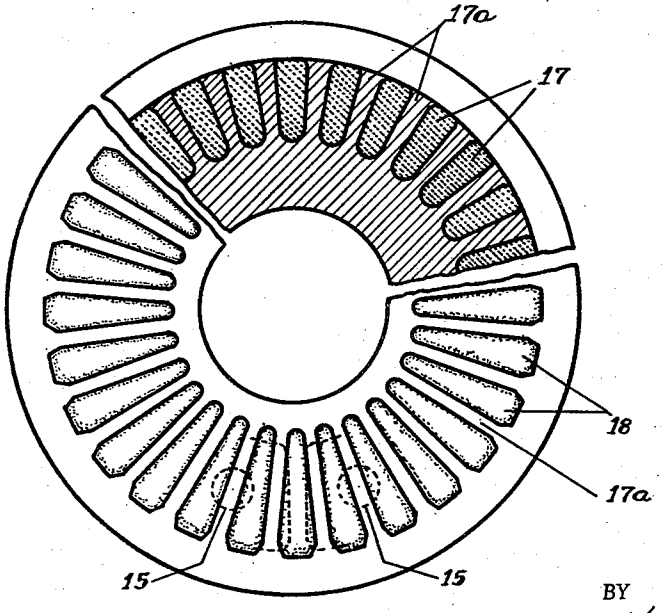


Fig.2

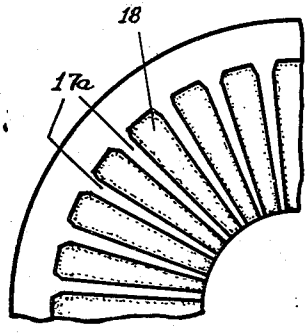


Fig.4

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TUYÈRE

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11 Claims. (Cl. 122—6.6)

The present invention relates to improvements in tuyères.

More particularly the present invention relates to tuyères such as are used in blast furnaces, which tuyères conduct into a furnace hot air at a high temperature, which may range from 1000 to 1600 degrees F. Such a tuyère is subjected to radiation from the furnace at a temperature of approximately 3000 degrees F. It has been proposed to provide the nose of a tuyère with a refractory substance, this refractory substance being disposed circumferentially of the tuyère and being retained between inner and outer retaining walls at the nose of the tuyère. These walls become very hot in service, for the reason that there is no water cooling immediately adjacent to these walls and they conduct the heat back to the water cooling chamber only with a considerable temperature gradient. A certain amount of melting and withering away of these walls probably occurs at their extremities, the tuyère gradually becoming foreshortened. This foreshortening has two bad effects: first, that the protecting portion of the nose is gradually lost, and, second, that the dimensions of the tuyère change and the blast distribution in the furnace is affected.

The refractory protection for the nose as heretofore used attains a very high temperature, probably exceeding 2000 degrees F. in certain portions thereof. Because the refractory reaches so high a temperature, it can be rather easily melted and washed out, and furthermore it can be readily attacked chemically by the slag, inasmuch as chemical reaction is more virulent at high temperatures.

An object of the present invention is to provide a tuyère having refractory protective means in the nose region thereof which tuyère will minimize absorption of heat from the furnace by the tuyère.

As a corollary to the object immediately above recited, it is a further object to provide a tuyère presenting as much refractory surface as possible in the nose region of the tuyère, for one or both of two purposes: (1) to protect the copper of the tuyère against contact with molten metal within the furnace, and (2) to shade the copper of the tuyère against radiant heat from the furnace.

A further object is to subdivide the refractory protecting material and to support it at frequent intervals with copper retaining walls which act both as supports and as cooling members.

A further object is to locate the refractory protecting material in such manner that in case of hot metal contact, said hot metal contacts the copper ribs only on their narrow edges.

A further object is to locate the refractory protecting material in such manner that in case of hot metal contact, said hot metal is subdivided into thin divisions which can be more readily combated.

A further object is to protect the portions of the tuyère subjected to the greatest punishment.

As corollaries to the objects immediately above recited, a further object is to provide a tuyère having protective refractory material so disposed as to reduce the absorption of heat by the tuyère through radiation from the furnace, and to provide a tuyère having protective refractory material so disposed that said refractory material is prevented from attaining excessive temperatures by providing heat passages of metal for carrying heat units from said refractory material to the water-cooled portions of the tuyère.

A further object is to provide a tuyère having a nose which will absorb a minimum of heat from a furnace, this result being accomplished due to the low emissivity of the surface of the tuyère presented to the heat within the furnace.

A further object is to combine a heavy nose wall with means for minimizing the temperature of the metal in that nose wall.

Further objects will appear as the description proceeds.

Referring to the drawing—

Figure 1 is an elevational view, partly in section, illustrating one embodiment of the present invention;

Figure 2 is a sectional view taken along the planes indicated by the arrows 2—2 of Figure 1;

Figure 3 is a fragmentary sectional view illustrating a modification of the structure shown in Figure 1; and

Figure 4 is a fragmentary end view of the structure shown in Figure 3.

Referring first to the construction illustrated in Figures 1 and 2, a water-cooled tuyère is illustrated having the rear wall 10, the inner side wall 11, the outer side wall 12 and the nose wall 13. Said walls provide an annular chamber for the reception of circulating cooling medium such as water, which chamber is indicated by the numeral 14. The numerals 15—15 indicate openings in the rear wall 10, one of

which openings may be a water inlet and the other of which openings may be a water outlet. A partition wall 16 separates one of the openings 15 from the other of said openings and extends from the rear wall 10 to the nose wall 13, whereby cooling water is caused to pass in a series path from inlet to outlet. In order to perform its cooling functions efficiently, the circulating water should travel at high velocity, particularly through the nose portion of the tuyère. Any preferred means for accomplishing this purpose may be utilized. It is at present preferred to utilize the construction illustrated and described in the patent to Fox and Whitcomb No. 1,969,693.

By reference to Figures 1 and 2 it will be noted that the nose wall 13 is a thick wall and that it is provided with a plurality of recesses 17—17, which are disposed preferably symmetrically throughout the circumference of the nose wall 13, forming corresponding ribs 17*a*—17*a*. The bottoms of said recesses are inclined relative to the axis of the tuyère and relative to a plane normal to said axis. The bottoms of said recesses 17—17 are preferably located in the surface of a frustum of a cone coaxially disposed relative to the tuyère. The recesses 17—17 are filled with refractory material, indicated by the numeral 18. The material of the refractory 18 may be chosen as desired. Many materials suitable for the purpose are available on the market, such for example as carbon, silicon carbide, carborundum, or graphite. Other materials suitable for the purpose are fire clay, bauxite, magnesite, chromite, and blast furnace slag. A number of materials which may be chosen are recited in the United States patent to Beaton No. 1,517,185. The refractory material may be preformed, if desired, and cast within the ribs 17*a*—17*a* when the tuyère is cast, or the refractory may be packed in like sand and hardened after the tuyère has been cast. The large area of contact between the refractory and the ribs 17*a*—17*a* is sufficient under normal conditions to hold the refractory in place. To provide this large area of contact, the recesses 17—17 are narrow relative to their depth, whereby the sections of refractory material in said recesses are presented edge on to the exterior of the tuyère, thereby minimizing any tendency of such sections of refractory material to become loose and come out. It is perfectly feasible to supplement the effect of this area by roughening the sides of the ribs 17*a*—17*a* by means of a chisel or the like. As will be pointed out hereinafter, the material of the refractory 18 should preferably be so chosen that its emissivity is low. It is possible and practicable to select a refractory having a low value of emissivity, an example of such material being alumina.

In the construction illustrated in Figures 1 and 2, the recesses 17—17 do not intersect the throat of the tuyère. According to this construction the segments of refractory material 18 do not contact with the throat.

According to the construction illustrated in Figure 4, however, the recesses 17 are so disposed that the bottoms thereof intersect the throat of the tuyère, whereby a portion of said throat at the nose end of the tuyère is bounded by segments of the refactory 18.

The above described embodiments of the invention have the following advantages:

Not only is the face of the nose protected, but the side of the tuyère at the nose region is also protected.

The refractory segments 18—18 are closely interspersed with copper retaining walls which restrict the temperature attained by the refractory segments and thus prevent or minimize deterioration or loss of said refractory segments.

The radial copper retaining walls between the refractory segments are exposed to radiation on their edges only, whereby to restrict the temperature attained by said retaining walls. The construction illustrated and described has the inherent advantage that it presents much more refractory surface in the nose region than has been possible in constructions heretofore known, and the exposure of vulnerable copper is correspondingly reduced. It is unavoidable that in the case of attack by hot metal there is a tendency for the radial copper segmental walls between the refractory segements 18—18 to be melted away. However, said refractory segments remain and divide up the molten iron attacking the nose portion of the tuyère into extended finlike portions entering the crevices between said refractory segments. Such relatively thin streams of molten iron are more easily cooled by the substantial mass of relatively cool copper behind the refractory segments and ahead of the water chamber 14. It is quite probable, further, that after some of the radial copper segments between the refractory segments 18 have been melted away by attack of molten iron, the spaces left between the refractory segments will fill up either with iron or with slag.

While the inner side wall or the throat of the embodiment of the present invention illustrated in Figure 1 is fully exposed to radiation and to absorption of heat from the blast, this portion of the tuyère presents an ample copper section to enable the heat thus absorbed to pass to the water chamber 14 without a steep temperature gradient.

The absorption of heat by the nose of the tuyère is decreased because of the large amount of refractory in this region. The copper located behind the refractory is shielded by said refractory. This copper in normal operation is cooler than it would be if the entire nose were of metal. The fact that this mass of copper has a very low normal temperature causes this copper to have greater transient ability to absorb heat in case of hot metal attack.

Moreover, the total absorption of heat by a tuyère embodying the present invention is relatively low because of the relatively large amount of refractory shading.

Referring further to the subject matter of the last two paragraphs, it will be apparent that the present invention provides a tuyère which has very much more refractory surface exposed to the heat of the furnace than has been the case with tuyères as heretofore known and used. This is of value not alone in protecting the tuyère from hot metal attack, but can be made a valuable attribute in reducing the heat absorption of the tuyère in normal operation.

Most of the heat received by the nose face and outer wall surface in normal operation is due to radiation. One factor in the radiant heat absorption by a surface is the emissivity of the surface. A black body (the emissivity of which may be represented by the numeral 1.0) absorbs all of the heat radiated to it. The emissivity of an oxidized copper surface is about 0.3 to 0.7, depending upon and varying with its

temperature. In other words, 0.3 to 0.7 of the heat radiated upon the copper surfaces of the tuyère is absorbed by said surfaces. Refractory substances have a wide range of values of emissivity. It is possible and practicable to select a refractory having a value of emissivity of a magnitude of as low as 0.1, or possibly less. Such refractory will absorb only about $\frac{1}{10}$ of the heat radiated upon it. In other words, it will absorb about ⅓ to ⅐ as much heat as an equivalent area of oxidized copper surface. Thus, by exposing a relatively large area of refractory surface in the nose region and by using a refractory having low emissivity, it is possible to greatly reduce the normal heat absorption of the nose region of the tuyère. The reduced heat absorption results in cooler copper and cooler refractory in normal operation. Thus the refractory is made to serve a double purpose, first, as a protection against hot metal attack, and, second, as a means to minimize heat absorption by the tuyère.

As indicated above, a preferred form of refractory having low emissivity is alumina. Other examples of refractory which may be chosen are magnesia, silica, or zirconia.

The present invention has decided advantages also in those cases where the operator may prefer to omit the refractory segments 18—18, relying upon the action of the furnace in depositing material borne during the furnace operation in the spaces between the ribs 17*a*—17*a*.

Though certain embodiments of the present invention have been described in detail, many modifications will occur to those skilled in the art. It is intended to cover all such modifications that fall within the scope of the appended claims.

What is claimed is—

1. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with radial ribs extending at least approximately thereacross and providing between them radial recesses, said recesses being narrow relative to their depth and being filled with refractory material, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

2. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs extending at least approximately thereacross and providing between them recesses, said recesses communicating with the front face and the outer surface of said tuyère, said recesses being narrow relative to their depth.

3. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs extending at least approximately thereacross and providing between them recesses, said recesses communicating with the front face and the outer surface of said tuyère, the bottoms of said recesses being outwardly and rearwardly inclined, said recesses being narrow relative to their depth.

4. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with radial ribs extending at least approximately thereacross and providing between them radial recesses, said recesses being filled with refractory material, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

5. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs providing between them recesses, said recesses communicating with the front face and the outer surface of said nose wall, said recesses being filled with refractory material, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

6. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs extending at least approximately thereacross and providing between them recesses, said recesses being filled with refractory material of the nature of alumina, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

7. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs providing between them recesses, said recesses being narrow relative to their depth, said recesses communicating with the front face and the outer surface of said nose wall, said recesses being filled with refractory material of the nature of alumina, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

8. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with radial ribs extending at least approximately thereacross and providing between them radial recesses, said recesses being filled with refractory material of low emissivity, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

9. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs providing between them recesses being narrow relative to their depth and said recesses communicating with the front face and the outer surface of said nose wall, said recesses being filled with refractory material of low emissivity, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

10. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère

throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs providing between them recesses, said recesses communicating with the front face and the outer surface of said nose wall, said recesses being filled with refractory material of low emissivity, said recesses being narrow relative to their depth whereby the refractory material in said recesses is presented edge on exteriorly of said tuyère.

11. In a tuyère, in combination, a nose wall, side walls and a rear wall forming a tuyère throat and an annular cooling chamber, the nose wall of said tuyère being provided with ribs providing between them recesses, said recesses communicating with the front face and the outer surface of said nose wall, said recesses being filled with refractory material of low emissivity, the outer surfaces of said ribs and the corresponding surfaces of said refractory material between said ribs being the outermost surfaces of said nose wall at the corresponding region of said nose wall.

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