Jan. 2, 1962 A. H. CLINGENSMITH 3,015,481

TUYERE ASSEMBLY

Filed Dec. 11, 1959

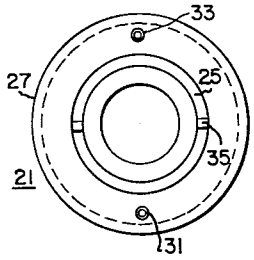


Fig.2

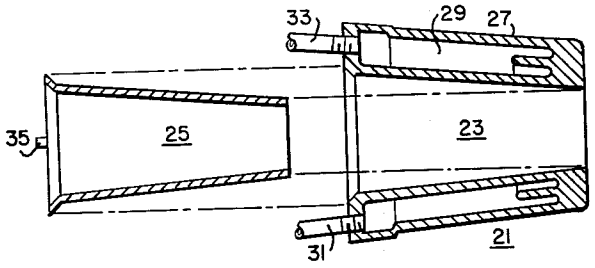


Fig.1

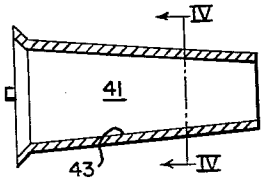


Fig.3

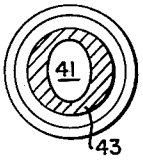


Fig.4

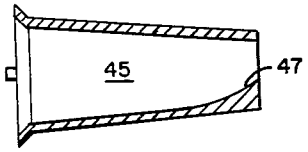


Fig.5

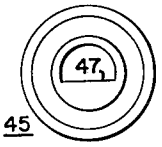


Fig.6

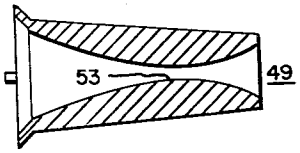


Fig.7

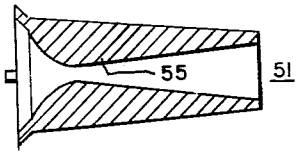


Fig.8

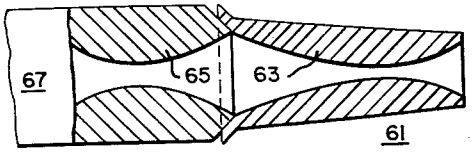


Fig.9

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3,015,481

TUYERE ASSEMBLY

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1 Claim. (Cl. 266—41)

This invention relates to the metallurgical art and has particular relationship to tuyeres for blast furnaces.

Tuyeres serve to conduct air or oxygen to the hot plasma of a blast furnace particularly in the smelting of iron ore. Tuyeres are usually in the form of hollow generally frustro-conical structures inserted in openings around the periphery near the bottom of a blast furnace. Each tuyere is connected to an air or oxygen supply and the air or oxygen is transmitted thru the tuyeres into the furnace. The walls of the tuyere are hollow providing a cavity thru which a cooling fluid such as water is transmitted.

The inside diameter of the tuyeres governs the velocity and quantity of the gas being blown into the furnace and the speed of the smelting reaction taking place in the furnace. When it is desired to change the speed of reaction the diameter of the tuyeres must be changed. In accordance with the present practice the tuyeres as a whole are removed and replaced by tuyeres of different diameter. This operation is highly time consuming and requires that the furnace be shut down for a long time, typically about 15 minutes per tuyere. During this time the furnace is out of production. A furnace produces between 40 and 50 tons per hour and has between 12 and 20 tuyeres. The loss in changing tuyeres is then high.

It is an object of this invention to provide tuyere assemblies which shall not suffer from the above described disadvantages.

In accordance with the broad aspects of this invention a tuyere assembly is provided which includes a cooling member with hollow walls thru which the cooling liquid (usually water) flows and a nozzle bushing removeably mounted in the cooling member. In accordance with this invention the bushing may be dimensioned and formed to produce the desired gas flow. When it is necessary to change the gas flow it is only necessary to replace the bushing with another suitable bushing.

A tuyere with a bushing is shown in Hartman patent application 399,262, now U.S. Patent No. 2,765,869 (see G, FIG. 4). A tuyere with a replaceable nose bushing is shown in Gerwig Patent 2,087,842 (see 2, FIG. 2). These typify the published prior art, not in use at the present time. The difficulty with such tuyere assemblies is that the inner surface of the assembly thru which the gas flows is of sharply changing contour. There is a crevice between the end *g* and the adjacent portion of nozzle G of Hartman and a like irregularity between the bushing 2 and the adjacent portions of the wall of tuyere 10 of Gerwig. Gerwig also includes grooves 6 and 8. It is desirable that during the blast-furnace operation the plasma be highly turbulent and the use of Hartman's liner or Gerwig's nose with highly turbulent plasma would result in the flow or injection of liquid metal and slag into the bushing. This becomes entrapped in the corners and crevices just described quickly destroying the utility of the assembly.

In accordance with this invention in its broader aspects a tuyere assembly is provided including a cooling body and a nozzle bushing, the surface of the bushing over which the gas flows being smooth and continuous. In accordance with an important specific aspect of this invention the surface of the bushing over which the gas flows is formed so that the gas emitted from the assembly has the desired speed and turbulence. In addition this surface may be so formed as to project the gas at a predetermined angle to the axis of the assembly rather than directly radially into the blast furnace.

In accordance with a further important specific aspect of this invention the bushing is made of a material having a substantially higher thermal coefficient of expansion than that of the cooling body. For example, the cooling body may be composed of copper and the bushing of nickel steel having a nickel content of about 20% or like nickel-chrome steel, or bronze, particularly 70% copper and 30% tin. The bushing has an outside diameter of the order of 1/16" less than the inside diameter of the cooling body. When a bushing is being replaced the temperature of the assembly is relatively low about 300° F. and bushings may be readily removed and inserted. During operation the temperature of the gas passing thru the tuyere assembly rises to as high as 1500° F. The differential expansion of the bushing and cooling body causes the bushing to engage the body tightly and to be in good heat-exchange relationship with the cooling fluid in the body.

The novel features considered characteristic of this invention are disclosed generally above. The invention itself both as to its organization and as to its method of operation together with additional objects and advantages thereof will be understood in detail from the following description of specific embodiments taken in connection with the accompanying drawing, in which:

FIG. 1 is an exploded view partly in longitudinal section and partly in side elevation showing a preferred embodiment of this invention;

FIG. 2 is a view in end elevation of the embodiment shown in FIG. 1;

FIG. 3 is a view in longitudinal section of a bushing in accordance with a modification of this invention;

FIG. 4 is a view in section taken along line IV—IV of FIG. 3;

FIG. 5 is a view in longitudinal section of a bushing in accordance with a further modification of this invention;

FIG. 6 is a view in end elevation of the bushing shown in FIG. 5; and

FIGS. 7, 8 and 9 are views in longitudinal section of bushings in accordance with additional modifications of this invention.

The tuyere assembly shown in FIGS. 1 and 2 includes a cooling body or member **21** of generally frustro-conical construction having an opening **23** in which a nozzle bushing **25** is secured. The body **21** has a generally frustro-conical bounding surface but may also have a circularly cylindrical surface. The wall **27** of the body **21** is hollow providing a cavity **29** thru which cooling water is conducted by inlet conductor **31** and outlet conductor **33**. The bushing has ears or lugs **35** by means of which it may be readily removed from, or inserted in, the opening **29**.

The body **21** may be composed of a material such as copper; the bushing **25** may be composed of a material such as nickel-steel or nickel-chromium steel or bronze alloy or broadly any other material useable at the high operational temperatures having a higher coefficient of expansion than copper. The bushing **25** may have a diameter thruout its length which is slightly smaller than the diameter of the opening **23** thruout its length. The bushing **25** is inserted in the opening **23** while both the bushing and the body **21** are at room temperature. When the assembly is in use the temperature of the gas passing thru the bushing **25** is of the order of 1500° F. and the bushing **25** engages the surface opening **23** tightly.

In the use of the tuyere assembly shown in FIGS. 1 and 2 air or oxygen is blown thru the nozzle bushing **25** and cooling water flows thru the cavity **29**. Because of

the differential expansions of **25** and **21** at the temperatures at which the assembly is used the bushing engages the body **21** firmly and is effectively cooled.

FIGS. 3 and 4 disclose a bushing **41** having a generally elliptical inner surface **43**. Such a bushing would tend to produce turbulence in the gas and cause the gas to expand laterally and thus speed up the smelting reaction.

FIGS. 5 and 6 disclose a bushing **45** having a surface **47** which would tend to project the gas upwardly, downwardly, (usually downwardly) or at any other angle.

FIGS. 7 and 8 disclose bushings **49** and **51** with double conoidal surfaces **53** and **55**. Turbulence aiding the reaction would be produced by such surfaces.

FIG. 9 shows a bushing **61** having a double conoidal surface **63** which joins a like surface **65** at the end of gas conductor **67** that supplies the gas to the tuyere assembly in which bushing **61** is inserted.

The pressure of the gas supplied to the assembly may be so high that the gas is at supersonic speed at or near the narrowest point in the bushing (**49**, **51** or **61**).

While preferred embodiments of this invention are disclosed herein, many modifications thereof are feasible. This invention then is not to be restricted except in so far as is necessitated by the spirit of the appended claim.

I claim:

A tuyere assembly for a blast furnace including a cooling member having an outer surface adapted to be engaged by the wall of a tuyere opening in said blast furnace and having an inner wall surface defining an opening and having a cooling cavity between said wall surfaces, said

assembly also including a nozzle bushing engaging said inner wall surface throughout and having throughout a smooth substantially continuous inner surface through which a gas may flow into the said blast furnace, said bushing when at room temperature having a cross-sectional dimension throughout its length slightly smaller than the corresponding dimension of said inner surface throughout its length, and said bushing being composed of a material having a substantially higher thermal coefficient of expansion than said cooling member so that when said bushing is heated it engages said inner wall surface in good heat-exchange relationship.

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