Nov. 7, 1967 W. E. SLAGLEY 3,351,335

HIGH VELOCITY TUYERE WITH CONVOLUTE-SHAPED COOLING PASSAGEWAY

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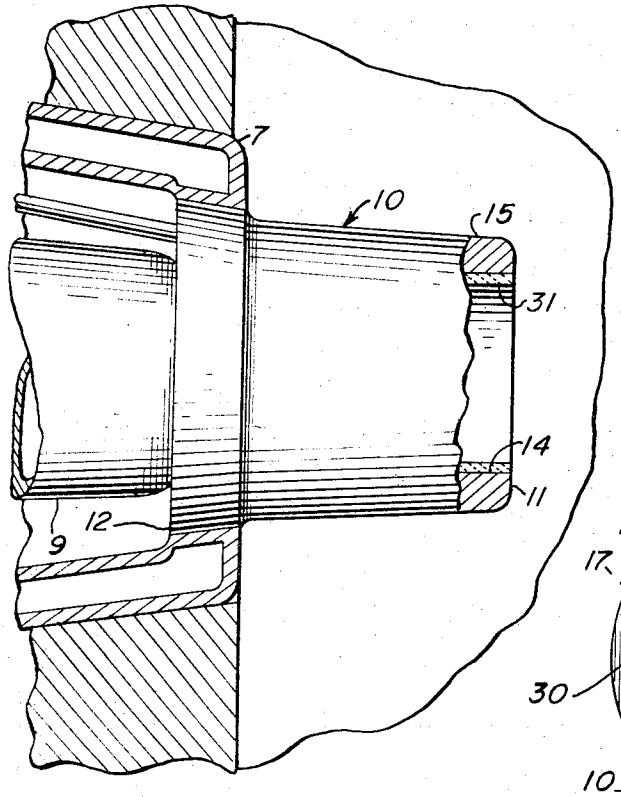


Fig. 1

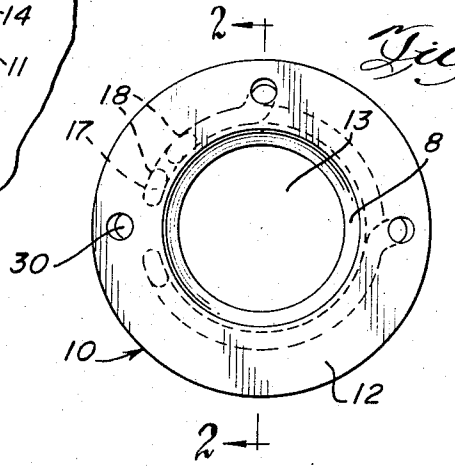


Fig. 4

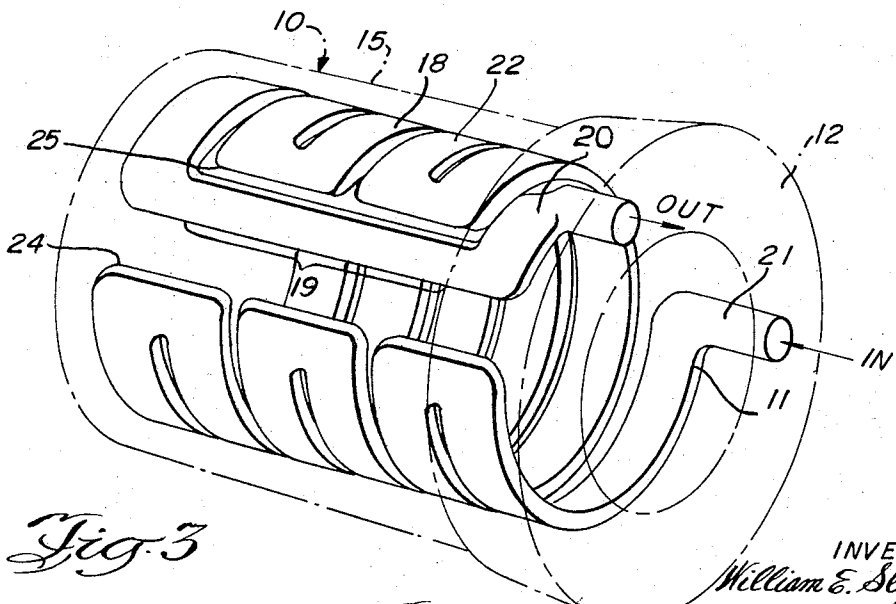


Fig. 3

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Fig. 2

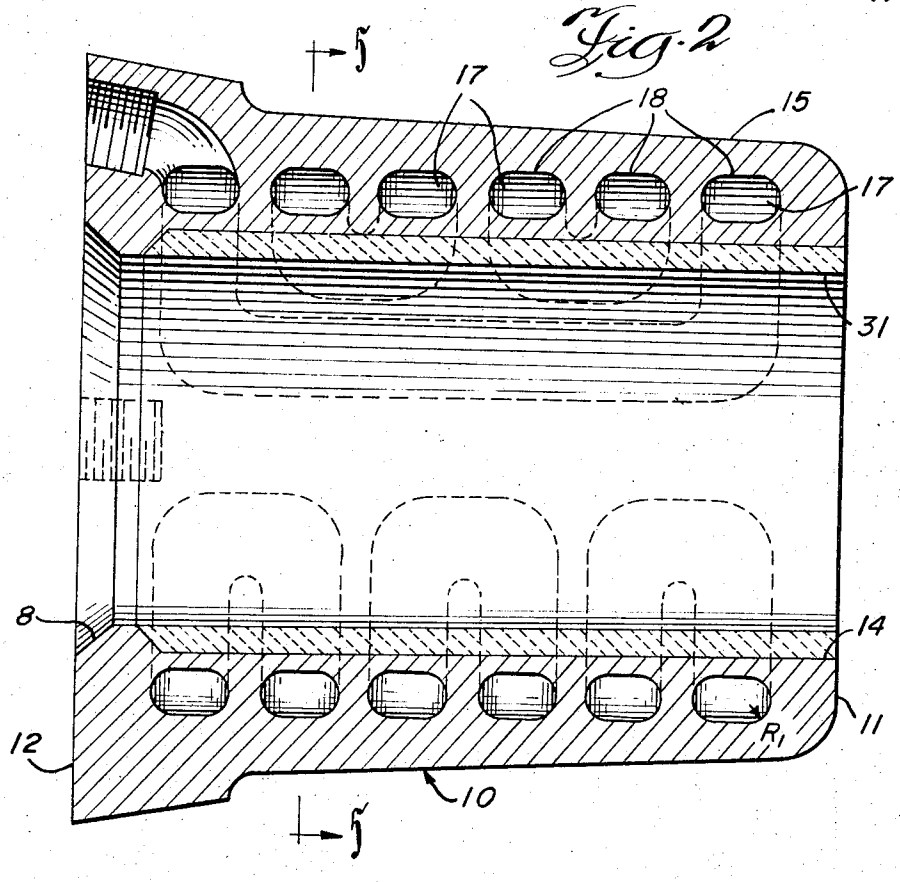
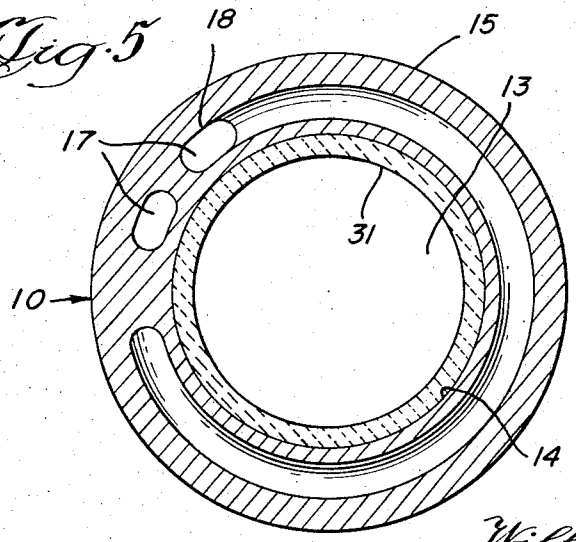


Fig. 5



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HIGH VELOCITY TUYERE WITH CONVOLUTE-SHAPED COOLING PASSAGEWAY

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ABSTRACT OF THE DISCLOSURE

A tuyere having a cooling medium passage therein which includes a first convolute-shaped section, an inlet section connected to the inlet end of the convolute-shaped section, a third section which has one end terminating with the outlet end of the convolute-shaped section while the remaining end of the third section terminates as an end of an outlet section whereby a cooling medium moves progressively from the head end toward the nose end of the tuyere and passes through the inlet section, convolute-shaped section and third section before exiting from the tuyere through the outlet section.

The present invention relates generally to an improvement in air blast nozzles and more particularly relates to tuyeres employed in blast furnaces.

In blast furnace operations, circulating water cooling systems are employed in tuyeres in order that the heat transferred from the blast furnace to the tuyeres is carried away by the circulating water to minimize heat build-up in the tuyeres.

In a number of tuyeres presently available, the cooling water system is inefficient in heat removal such that hot spots build up on the tuyere which eventually cause a tuyere rupture thereby allowing the cooling water to enter into the furnace or permitting furnace gases to force the cooling water backwards in the cooling system. Cooling water systems in other tuyere arrangements suffer from the fact that to achieve an increased water rate at a particular location in the tuyere, the area of the cooling water passage at that point is so reduced that a distinct danger of plugging the water passage is inherent in these units.

Other tuyere arrangements, while perhaps achieving the desired rate of flow for the cooling medium, are either too bulky in construction or have a tuyere contour which requires special handling in order to properly install and position the tuyere within the furnace. This is quite unsatisfactory, particularly when in the course of proper furnace maintenance or some emergency, one or more of the furnace tuyeres must be replaced in which instance it is necessary to complete the withdrawal of the old tuyeres and installation of the new tuyeres in as short a time as possible.

In order to obviate these and other disadvantages, I have invented a new and novel tuyere having a cooling system which increases the tuyere cooling efficiency by circulating the flow of water conventionally utilized, at a substantially higher velocity.

The increased velocity achieved with my tuyere is achieved by passing the cooling medium through a convolute-shaped water passage. The tuyere, generally made of copper, is maintained cold enough so that at substantially all times during operation of the blast furnace it is covered with slag and thus protected. Moreover, the cooling rate of my improved tuyere is sufficiently high that even contact with molten iron will not burn the tuyere.

The velocity of the cooling water tuyere is uniform throughout the cooling system such that restrictions,

which are required in some tuyeres available today, are eliminated thereby obviating the possibility of plugging up the cooling medium passage.

Also, because the arrangement of my cooling system is in one cylindrical plane so that the tuyere shape is symmetrical about its center line, the need for the inlet or outlet passage to cross over other cooling water passages thereby causing a hump in the tuyere or a special tuyere contour is eliminated. Further, because of the increased cooling efficiency accomplished with my tuyere, tuyere life is substantially extended so that maintenance costs incurred for replacing conventional tuyeres is reduced.

In my new and improved tuyere, a convolute-shaped cooling passage provides the flow path for cooling water traveling at a high, uniform velocity whereby the cooling medium travels in a substantially helical movement as it moves along the length of the tuyere.

In the drawings:

FIGURE 1 shows a fragmentary view of my tuyere positioned within a wall of a furnace;

FIGURE 2 shows a sectional view along line 2—2 in FIGURE 4;

FIGURE 3 shows a perspective view of the cooling water passage positioned within the outline of the tuyere;

FIGURE 4 shows an end view of my tuyere; and,

FIGURE 5 shows a sectional view taken along line 5—5 in FIGURE 2.

In the drawings and more particularly FIGURE 2, there is shown tuyere **10** having a nose end **11**, which extends into the furnace, and a head end **12**, the tuyere having central opening **13** throughout its length. Blow pipe **9** engages with tuyere **10**, the blow pipe fitting against recess **8**, FIGURE 2, of head end **12**. Head end **12** is tapered to fit against a complementary tapered portion of tuyere cooler **7**. Disposed between the inner wall **14** and outer tapered wall **15** is a cooling medium passage **17** through which a suitable cooling medium, e.g., water, is circulated for heat transfer purposes.

Passage **17**, as more clearly shown in FIGURE 3, is comprised of a first convolute shaped section **18**, a second inlet section **21**, a third section **19** and a fourth outlet section **20**. Convolute section **18** comprises a plurality of convolutions which, when bent into the cylindrical shape shown in FIGURE 3, provide a cooling water passage for substantially the entire length of tuyere **10**. When the individual convolutes **22** are bent to form the cylindrical shape, the edges **24**, **25** of the convolutes, which normally would be in an abutting position if a complete cylinder were formed, are spaced apart for reasons to be described hereinafter.

Section **19** which has one end integral with convolute section **18** is a substantially straight tubular section whose remaining end terminates as an end of outlet section **20**. The remaining end of outlet section **20** is circular in shape and tapped to receive a threaded conduit means, not shown. Similarly, section **21** has one end which terminates into an end of convolute section **18** while the remaining end of inlet section **21** is circular in shape and tapped to receive a threaded water conduit, not shown, the inlet and outlet conduits serving to transport a cooling medium throughout passage **17**.

Section **19** which extends for a major portion of the length of the cooling water passage is located in close proximity to edge **25** of convolute section **18** as seen in FIGURE 3, while the remaining edge **24** of section **18** is spaced substantially away from section **19**. If desired this space could be eliminated and edges **24**, **25** of convolute section **18** could be located contiguous to each other. However, in some instances, it is desirable to have an additional gas conduit passage, not shown, into the tuyere, and I have provided room for such occurrence

whereby an opening could be made in the tuyere wall without interferring with cooling medium passage **17**.

The velocity of the cooling medium is substantially uniform throughout the entire passage **17**, the size of the opening in passage **17** being the same throughout the system.

The size of the opening throughout passage **17** is substantially uniform so that no clogging or plugging occurs as is the case with some tuyeres which require restrictions in the cooling medium passages in order to achieve maximum cooling medium velocity at the nose portion of the tuyere. With my design, I achieve an increased water velocity over tuyeres presently available while utilizing the same anticipated flow of cooling medium which normally is about 43 gallons of water per minute (g.p.m.). The cooling water is directed through cooling passage **17** having a passage area of about 1.25 square inches at a velocity of about 11 ft./sec. as opposed to present designs wherein water velocity is maintained at about 0.41 ft./sec. and special restricting means are required to increase the velocity at the nose of the tuyere. It is the increased water velocity with the water flow remaining the same as presently utilized that accomplishes the high heat transfer rate and keeps my tuyere cooler than tuyeres presently available. Moreover, the cooling medium path is directed to essentially the entire surface of the tuyere which serves to minimize the presence of local hot spots.

For satisfactory results, I desire to design passage **17** whereby it will provide a minimum water velocity of about 5 ft./sec. with a preferable velocity of about 10 ft./sec. based on a cooling water flow between 40–45 g.p.m.

As seen in FIGURE 2, passage **17** is preferably elliptical-shaped throughout its length save at is inlet and outlet ends where it is circular to receive standard conduit means. A specific embodiment of my novel tuyere has a length of 15 inches with a gas opening **13** of about 7 inches diameter. The cross-section of passage **17** as exemplified at the location shown in FIGURE 2 has an over-all passage width of about 1⅝ inches with R equalling 7/16 inch.

The tuyere is preferably copper cast having the cooling water passage placed therein by means of a shell core. However, if desired, one could initially form a copper tubing to have a cooling medium passage comprising the convolute section, substantially straight section and outlet and inlet sections after which the remaining portion of the tuyere could be cast around the formed tubing.

In addition to tapping inlet and outlet opening in the passage for receipt of conventional cooling water pipes, a third hole **30** is tapped into the tuyere. In removing the tuyere from its position in the blast furnace, a rod is screwed into tapped hole **30** and the tuyere can be pulled from the furnace wall.

Insulation **31** which lines opening **13** for a substantial portion of its length is employed to prevent heat loss from hot gas being blasted into the furnace, the insulation being generally ½ inch thick high aluminum costable refractory insulation or otther suitable material.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. In a blast furnace tuyere having an outer wall, a nose end, a head end and an inner wall forming a central opening along the longitudinal axis of said tuyere, a cooling medium passage, disposed between said central opening and the outer surface of said tuyere, said cooling medium passage comprising:

a first convolute-shaped section curved about said longitudinal axis in a substantially cylindrical shape, whereby the axis of said convolute-shaped section is substantially coaxial with said tuyere axis, said convolute-shaped section having an inlet end and an outlet end and two edges;

said convolute-shaped section extending between said head end and said nose end of said tuyere and including means for progressively cooling from said head end toward said nose end of said tuyere;

one of said edges being spaced from said remaining edge;

a second inlet section having one end integral with said inlet end of said convolute-shaped section, and another end terminating at said head end of said tuyere;

a third section having one end integral with said outlet end of said convolute-shaped section and extending from said nose end of said tuyere rearwardly toward said head end of said tuyere between said edges of said convolute-shaped section;

and a fourth outlet section having one end integral with the remaining end of said third section and another end terminating at said head end of said tuyere;

said cooling medium passage comprising said four sections all of which are positioned in a substantially cylindrical plane;

the cross sectional area of said passage, transverse to the direction of flow of a cooling medium, being substantially uniform throughout said cooling medium passage;

whereby said cooling medium passage is adapted to receive a cooling medium which moves progressively from said head end toward said nose end and passes through said inlet section, said convolute-shaped section and said third section prior to exiting from said tuyere through said outlet section.

2. A tuyere in accordance with claim **1** wherein said passage is made therein by a shell core.

3. A tuyere in accordance with claim **1** wherein said passage is formed of tubing with the rest of said tuyere being cast over said tubing.

4. A tuyere in accordance with claim **1** wherein said tuyere has a threaded tuyere-removal hole located at said head end of said tuyere.

5. A tuyere in accordance with claim **1** further including insulation means located along said inner wall of said tuyere.

6. A tuyere in accordance with claim **1** wherein said terminating ends of said inlet and outlet sections are circular while said transverse area of said passage is shaped to have substantially parallel sides and substantially hemispherical ends.

7. A tuyere in accordance with claim **6** wherein said terminating ends of said inlet and outlet sections are threaded.

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