Jan. 21, 1964 W. V. BERRY 3,118,608
FUEL GAS AND OXYGEN INJECTION LANCE EMPLOYING WEBBED COOLANT DEFLECTORS
Filed Feb. 15, 1962 2 Sheets-Sheet 1

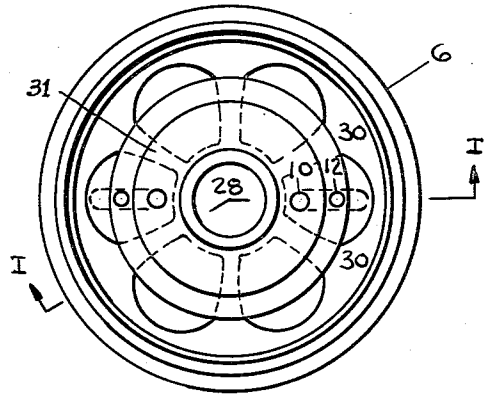
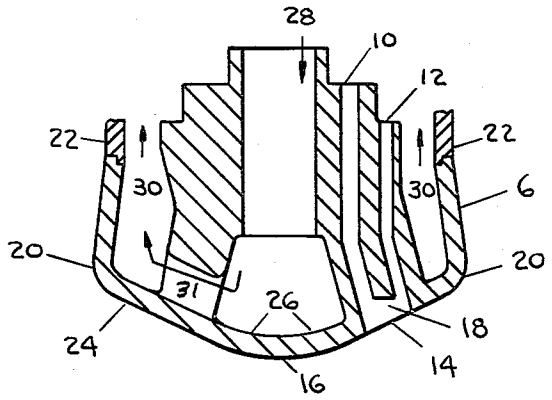


FIG II



SECTION I-I

FIG I

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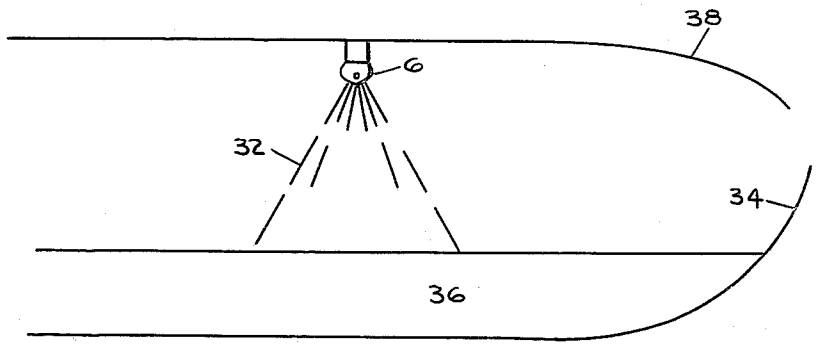


FIG III

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United States Patent Office 3,118,608 Patented Jan. 21, 1964

3,118,608

FUEL GAS AND OXYGEN INJECTION LANCE EMPLOYING WEBBED COOLANT DEFLECTORS

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Filed Feb. 15, 1962, Ser. No. 173,386
4 Claims. (Cl. 239—132)

This invention relates to burner nozzles and specifically to a combination fuel and oxygen burner nozzle that can deliver either fuel, or oxygen, or both into the interior of an open-hearth furnace continuously.

In accordance with the prior art, of which I am aware, open-hearth operators have been shortening the tap-to-tap time by injecting oxygen over the melt in order to increase the rate of carbon removal from the molten bath in preparation for tapping. Much activity has been devoted to providing a nozzle that can deliver oxygen to the interior of the furnace continuously without rapid deterioration. Water cooling the lance and the head of the burner has been used to reduce the temperature of the lance and the nozzle in order to prolong the life of these parts. The severe demands on the burner nozzle and the related parts is increased enormously when both fuel and oxygen are introduced together into the furnace in order to further increase the rate of heating of the melt. Many configurations of the interior passageways for the various fluids and gases have been devised and various exterior contours of the end of the burner nozzle have been tried. The common shape of the previous art in burner nozzles has resulted in burner nozzles that look like an extension, or cap, to a pipe section which delivers the gasses to the burner nozzle. Exit jets are grouped in the tip of the burner nozzle.

There are several severe dynamic restraints surrounding the problem of providing oxygen, or fuel, and especially both oxygen and fuel simultaneously into the very-high-temperature environment of an operating open-hearth furnace. The entire hot enclosure of the open-hearth furnace is lined with several layers of fire brick—floors, walls, and ceiling. This fire brick is designed to take the very-high-temperatures of the melt, or bath, which approaches 3000 degrees Fahrenheit.

However, in order to transfer heat energy into the bath, there must be a higher-temperature heat source. This is provided by combustion over the bath. These combustion temperatures are higher than the melting temperature of the fire brick. Open-hearth furnace operation requires balancing the combustion temperature and flow of fuel and oxygen to achieve (1) a high rate of energy transfer to the bath and (2) maintenance of refractories in the solid state.

This is a delicate dynamic balance permitted by the refractory tolerating a temperature somewhat higher than the peak bath temperature attained prior to tapping. Thus the heat of combustion is transferred primarily to the bath, as it is at a somewhat lower temperature than the refractory enclosure. The balance is increasingly delicate as furnaces are being forced harder in reducing tap-to-tap time.

One major problem thus is in devising how to improve the rate of heat transfer to the bath while inhibiting heat transfer to the refractory chamber.

A second problem is to protect the device inserted into the furnace to introduce oxygen and fuel from rapid deterioration in this severe environment and function. If the metal apparatus were left unattended inside this chamber, it would melt and drip into the bath. In burner tips where oxygen alone has been introduced it has been found sufficient to circulate water within the burner head. However, when both fuel and oxygen are introduced simultaneously into the chamber, these burner tips deteriorate rapidly under the combined strains of the severe requirements and environment. The increased severity due to the proximity of combustion of the fuel and oxygen introduced through the burner head aggravates the wear problems already acting on the metal burner head in the high-temperature environment. A burner head that can provide a continuous injection mixture and burning of fuel and oxygen within an open-hearth furnace must contain immensely improved structure, or a combination of improvements that act in combination to advance the state of the art.

It is accordingly an object of my invention to provide a burner head for mixing fuel and oxygen continuously for their combustion within an open-hearth furnace.

It is another object of my invention to provide a burner head that has a prolonged operating life within the open-hearth furnace.

It is another object of my invention to provide a means for shortening the tap-to-tap time, and thus increasing the output production of an open-hearth furnace.

It is another object of my invention to provide a burner head that will not delay production by requiring frequent replacement within the furnace.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawing in which:

FIGURE 1 is a showing in cross section of the burner head in the preferred embodiment of my invention.

FIGURE 2 is an end view of the burner head in the preferred embodiment of my invention.

FIGURE 3 is a showing in elevation of a section through an open-hearth furnace showing the use of an embodiment of my invention extending just below the roof of the furnace.

In accordance with the preferred embodiment of my invention, I provide a burner head 6 which contains several pairs of passageways, each pair comprising a fuel jet 12 and an oxygen jet 10. These fuel and oxygen ways are diverted within the burner head so that they exit from the exterior surface of the burner head at positions 14 well removed from the center 16 of the burner head. The exit jets 14 roughly establish a circle on the exterior surface of the burner head, that circle having a large diameter. The fuel and oxygen jets are open between one another 18 near their exit from the burner head 14 to provide early combination of fuel 12 and oxygen 10 and initial combustion as the two flow streams leave the burner head.

In the preferred embodiment of my invention the burner head 6 is bulbous in shape. That is, it has increasingly larger diameters as it extends from its mounting pipe. The largest diameter across the burner head 20 is appreciably larger than the diameter of the mounting pipe 22. This provides a much larger burner head face 24 permitting a larger diameter across the exit jets 14. This permits both a greater distance between the very-high-temperature exit jets 14 and also makes the central interior portion of the burner head 26 available to unrestricted flow of coolant water.

About halfway along the projection of the burner head beyond the mounting pipe 22 the surface of the head curves gradually inward to the said area where the exit jets 14 exit out from the burner head, and then the burner head again curves gradually across the central region 16 of the burner head. It can be seen that such an exterior peripheral shape approximates the nearest approach to a spherical enclosure as can be accommodated by the limitations of matching with the mounting pipe

section 22 and providing the widely-separated, and angled exit jets 14 for the fuel 12 and oxygen 10. The quality this provides is derived from the efficiency of a spherical volume related to its surface area. The shape provides increased coolant volume within the head related to the exterior surface area exposed to the high temperature within the furnace.

The efficiency of this shape of the burner head in the preferred embodiment of my invention insures the best use of the cooling water circulating into the burner at the center 28 and being returned at the outside of the head 30 passing through apertures 31 between the passageways 10, 12. This circulating water reduces the temperature of the metal of the burner head to guard against consumption in the furnace. The enlarged burner head provides sufficient distance across the central portion of the head 16 between the exit combustion jets 14 so that these localized hot spots can be served independently by the cooling water and will not act in combination to contribute to a possible central hot spot 26 between them.

In the preferred embodiment of my invention cooling is further enhanced by sizing the apertures 31 provided for the flow of cooling water between the passageways provided for fuel and oxygen. Webbings connecting between the passageways are opened near the front surface of the burner head leaving a small, proportioned opening 31 between the central interior region 26 and the outer region 30. The total area of all of these proportioned openings 31, through which the cooling water flows out from the central region 26 of the head, is approximately equal to the interior area of the central tubing down which the cooling water arrives 28, and also is approximately equal to the exit annular area of the return stream 30. Thus, the velocity of the cooling water is maintained along the interior wall of the burner head. Maintaining velocity flow along the interior metal surface within the burner head rinses away any air bubbles that may have a tendency to cling to the interior surface and inhibit cooling, and also rinses free any particles of foreign matter or oxides that may insulate the metal from the cooling water and thus inhibit cooling. The enlarged shape of the burner head provides ample flow of cooling water all around each of the burner jets 14.

The divergence of the passageways for fuel and oxygen provide an angle of departure from the burner head that, acting in combination with the distance across the head of opposite exit jets, insures that the burner head develops a far-flung wide-angle cone-of-combustion 32, or cone of flame extending down into the open-hearth chamber 34.

The sum total of these combined improvements provides a burner head and a means for heating the bath 36 of the open-hearth furnace, to such a degree that the operation of this burner head within the furnace 34 requires particular mention. It is common to insert a burner tip down through the roof 38 of the furnace and drop the burner head close to the surface of the bath 36. Such operation contributes to excessive wear on burner heads, and also the high-velocity burning gasses splash out across the surface of the bath 36 and impinge on the walls of the furnace 34, there causing accelerated deterioration.

Use of the burner head that I provide permits the open-hearth furnace operator to insert the burner head 6 until it just protrudes beneath the roof 38 of the open hearth. The jet flames 32 extending in all directions below the burner head in effect establish a cone-shaped wall of high-temperature gas, sufficiently high in temperature to communicate heat energy down into the bath surface. The enlarged head combined with the angle of the jet protruding from the head provides a large-diameter, or wide-angle cone that has a large diameter at its approach to the surface of the bath. The surface of the bath within this ring "sees" this wall of high-temperature gas provided by the combustion of the fuel and oxygen in any direction above the surface of the bath. Therefore, each burner inserted into the roof of the furnace provides a circular bath area that is surrounded by the high temperature of the gas of the burning fuel and oxygen. This, in effect, provides a relatively high-temperature heat chamber within the furnace without contributing to the deterioration of the refractory material lining that furnace. Several such high-temperature areas can be provided in each furnace by inserting several such burner heads through the roof of the open-hearth furnace.

Therefore, the enlarged bulbous shape of the head and the many other contributing factors provide at once both an improved burner life expectancy within the furnace and, by providing a wide cone of flame within the furnace and directed over the bath, permit an improved technique for safely forcing the furnace to higher rates of production. This, in combination, provides a significant advance in the state of the art.

Although I have shown and described specific embodiments of my invention, I am aware that other modifications thereof are possible; my invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and the spirit of the invention.

I claim as my invention:

1. A burner nozzle for use in an open hearth furnace comprising: a bulbous end shell having sides and a generally spherical face and having therein a plurality of circumferentially spaced pairs of inclined cooperating oxygen and fuel gas conduits diverging outwardly toward and through the end of said shell and spaced from the sides of said shell, said nozzle having a centrally located passageway for coolant extending to the face of said shell and restricted coolant passageways between adjacent pairs of said conduits and contiguous with the inner face of said shell interconnecting said centrally located passageway and the outer region between said conduits and the sides of said shell, said restricted passageways being sized so their total summarized apertures are equal to the cross-sectional area of the narrowest portion of said central coolant passageway.

2. A lance nozzle for use in an open hearth furnace comprising a burner nozzle head adapted at one end thereof to be fastened to a supporting pipe, said nozzle head having a plurality of dual cooperating passageways, one of each of said dual passageways being for fuel gas and the other for oxygen, said dual passageways being arrayed around a central coolant supply tube, the external walls of said burner head being bulbous in shape so that said head increases in exterior diameter from the region where it is adapted to be connected to said support pipe toward its opposite end so that space is provided to allow each of said dual passageways to be angularly diverted away from the axis of the burner head sufficiently to provide a wide angle of discharge for the combined fuel and oxygen from the said burner head without causing said dual passageways to interfere with the flow of coolant between said dual passageways and the outside wall of said burner head, said dual passageways extending outward at an angle to the axis of said burner head in the region near their exit ends, said burner having openings between adjacent dual passageways contiguous to the face of said burner head sized to equal in total summarized area the cross sectional area of the central coolant tube in the region where said head is adapted to be fastened to a supporting pipe.

3. A nozzle for use in an open hearth furnace comprising: a bulbous end shell having outwardly sloping sides toward an end thereof and a generally spherical end face, a plurality of circumferentially spaced conduits diverging outwardly toward and through said end face and spaced from the sides of said shell, coolant return means between said shell and said conduits, said shell having therein a centrally located passageway for coolant extending to said end face, and restricted coolant passageways between adjacent pairs of said conduits and contiguous with an inner face of said shell for interconnecting said centrally located passageway and said coolant re-

turn means between said conduits and the sides of said shell.

4. A nozzle for injecting gases into an open hearth furnace comprising: a bulbous end shell having outwardly sloping sides toward the end thereof and a generally spherical end face and having therein a plurality of circumferentially spaced conduits diverging outwardly toward and through the end of said shell and spaced from the sides of said shell, coolant return means between the sides of said shell and said conduits, said nozzle having a centrally located passageway for coolant extending to the face of said shell and restricted coolant passageways between adjacent pairs of said conduits and contiguous with the inner face of said shell interconnecting said centrally located passageway and said coolant return means between said conduits and the sides of said shell.

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