

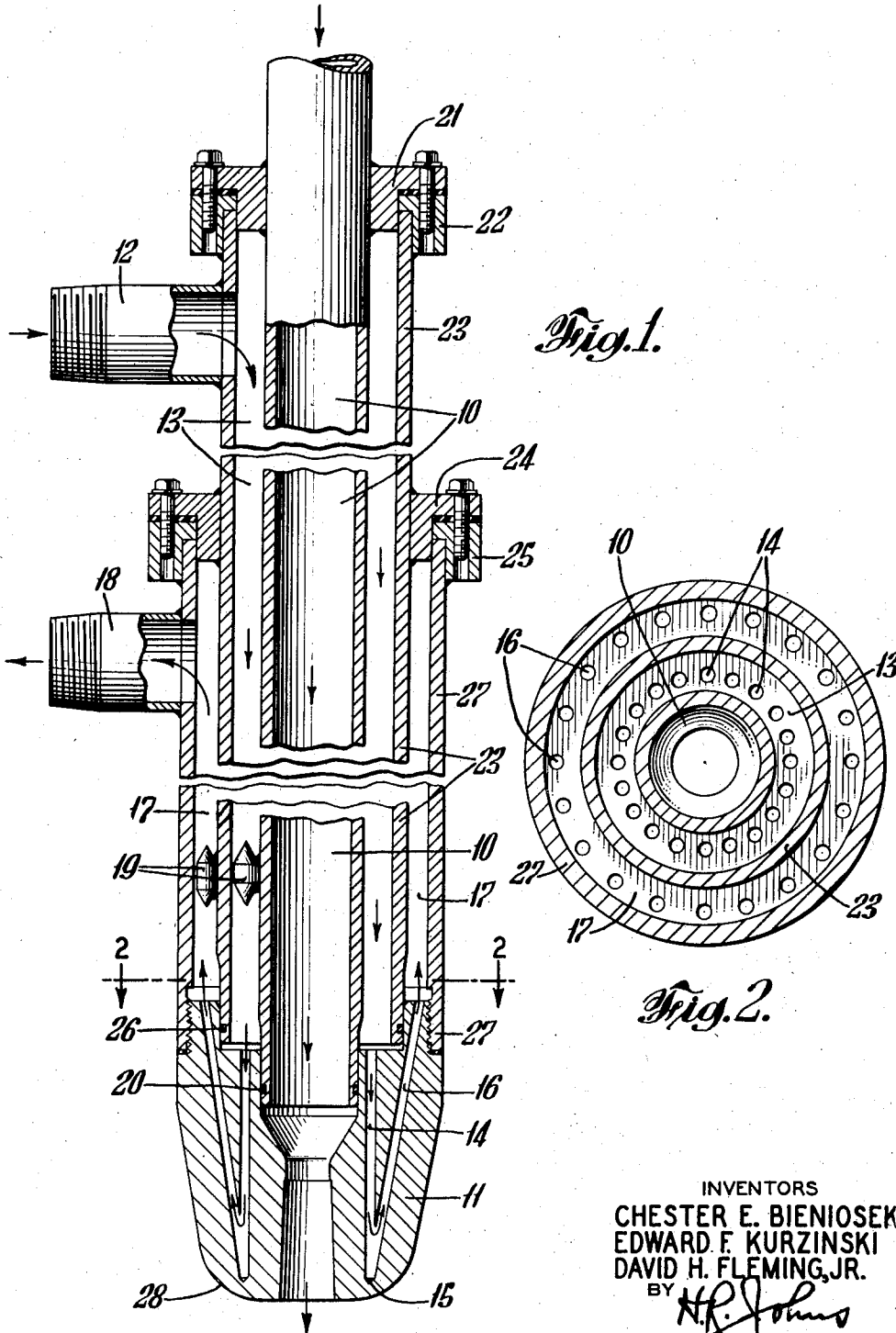
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TOP BLOWING OXYGEN NOZZLE IN MOLTEN METAL

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TOP BLOWING OXYGEN NOZZLE IN MOLTEN METAL

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This invention relates to a top blowing oxygen nozzle of the sort used in removal of impurities from molten steel, and for other similar purposes, and has for an object to provide such a nozzle having a longer useful life. Another object is to reduce the time in which such purification process is not operating during a change in the oxygen nozzle.

In a process for removal of impurities from molten steel by blowing oxygen under pressure into the hot metal from a nozzle spaced about 4 to 12 inches above the surface of the metal, the temperature at the center of the reaction zone or impingement point in such a process has been estimated to be about 4200° F. which is far above the melting temperature of around 1980° F. for copper, the material which has heretofore been used in such nozzles. Operation of a nozzle in conditions involving such great temperature difference is possible only by rapidly circulating water through the thermally conductive copper nozzle. Yet with rapid circulation of water the nozzle life has been short.

One cause has been found to be the abrasion and wear from hot particles of slag and molten metal striking the nozzle and wearing the peripheral edge. The trouble from this cause has been alleviated by rounding of the nozzle periphery. If the radius of curvature for such rounding is too large not enough room will be left for the necessary cooling water passageways. On the other hand if too small a radius of curvature is used the wear and the abrasion is present. We have found what is believed to be the best compromise for such radius of curvature to be about .25 to .30 of the maximum diameter of the nozzle.

Another cause of short life in these nozzles has been found to be the melting of the copper starting at locations where it has been welded or brazed. The thermal conductivity of the metal in a welded or brazed portion has been found to be not as good as it is elsewhere, due perhaps to such welded or brazed portion being more porous. Cast copper nozzles possess an objectionably short life and we believe such to be due to its being too poor a thermal conductor. One feature of this invention resides in our providing a type of copper that is a better thermal conductor, namely a more dense copper which has been both deoxidized and forged.

The life of such a nozzle has been prolonged as much as a thousand percent by a number of factors contributing to this new result. One factor is the use of deoxidized and forged copper possessing the best available thermal conductivity because less porous and freer from impurities. Another feature is the construction of the nozzle to avoid the presence of any welded or brazed portions previously used in the formation of water cooling passageways and plugs therefor where transverse connecting passageways are formed. A further feature is having the nose rounded at a curvature between .15 and .40 of the maximum diameter of the nozzle and preferably between .25 to .30 of that diameter.

In order to form water passageways extending into the

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nozzle without any portion of them having to be transversely drilled, plugged and welded, we have formed such passageways by longitudinally drilling in the nozzle body pairs of passageways at an angle from about 10° to 45° to one another and arranged in pairs close together to take full advantage of turbulence in the coolant at the vertex of these passageways. A change in direction of the coolant at the end of the nozzle has been found to be efficient in heat transfer from the nozzle to the water. We have also discovered that the lower limit for the velocity of the coolant should be at least 10 ft. per second. There is no upper limit for this velocity except the questionable practicability of operating at an unnecessarily high pressure. We have also found the desirable closeness in circumferential spacing between adjacent edges of these passageways should be not less than $\frac{3}{16}$ " and not more than $\frac{5}{8}$ ". With closer spacing more water is needed and with more spacing between these passageways there is greater danger of the nozzle melting. Approximately 3000 to 5000 gallons of water per hour are consumed in the illustrated nozzle of $6\frac{1}{2}$ inches outside diameter.

Referring to the drawing Fig. 1 is a longitudinal section through a preferred embodiment of this invention. Fig. 2 is a section on the line 2—2 of Fig. 1.

A central oxygen passageway 10 leads the gas under pressure to a nozzle 11 of forged and deoxidized copper. A water inlet 12 leads to the water passageway 13 around and contiguous to the oxygen passageway 10 for supplying coolant to the passageways 14 in the nozzle 11. The water coming through passageways 14 impinges upon the end wall 15 absorbing heat from the nozzle 11 and passing out passageways 16 as shown in Fig. 1. The cooling water then moves through the passageway 17 around the outside of passageway 13 and out through the outlet connection 18. Any convenient type spacing members 19 are welded to the innermost pipe which they separate and may be angularly spaced as much as about 120° when three of them are used connected to any one pipe or passageway. O ring 20 or other convenient type packing is provided around the wall of passageway 10 between it and the nozzle 11. A pressure drop in the coolant is inversely proportional to the 5th power of the passage diameter and it has been found a desirable size for the passageways 14 and 16 should be from $\frac{1}{4}$ inch to $\frac{5}{16}$ inch in diameter although from $\frac{3}{16}$ inch to $\frac{3}{8}$ inch may be useful as the diameter of these passageways. A thickness of the copper outside the coolant passageways should be preferably between $\frac{3}{16}$ inch and $\frac{5}{8}$ inch. The ratio of the total cross sectional area of the coolant passageways 14 and 16 to the total cross sectional area of copper in the nozzle in the same transverse plane should be from about 1:25 to about 1:5.

Welded to the outer surface of the passageway 10 is a flange 21 of the general type shown in Fig. 1 to which is bolted a flange 22 welded to the outside of the pipe 23 constituting the outer wall of the coolant inlet passageway 13. This pipe 23 also constitutes the inner wall of the water outlet passageway 17. Spaced from flanges 21 and 22 by an amount approximately the same as the spacing of the axes of the inlet and outlet connections 12 and 18 respectively, is flange 24 welded to the outer surface of the pipe 23. A flange 25 is bolted to flange 24 and welded to the outer surface of the pipe 27. O ring 26 or other type packing is placed between the outer surface of pipe 23 and the rear end of the nozzle 11 into which the pipe 23 extends. As shown in the drawing the pipe 27 constituting the outer wall of the water outlet passageway is threaded to the nozzle 11 to permit ready removal of the nozzle when worn. Pipes 10, 23, and 27 connected to the nozzle 11 are preferably of stainless steel and need not have the high thermal conductivity of the nozzle 11 because they are not subjected to the same intense heat

and abrasion to which the nozzle 11 is subjected. To remove the nozzle 11 it is unscrewed from the threads on the lower inner end of the pipe 27 when the O ring packings 20 and 26 permit the nozzle to be disconnected from the pipes 10 and 23 as the nozzle is unscrewed from the pipe 27.

The central oxygen passageway is constricted and tapered as shown in the drawing. The edge 28 of the nozzle is rounded on a radius of curvature stated above, namely between about .15 to .40 of the maximum diameter of the nozzle and preferably between .25 to .30 of that maximum diameter.

The water passageways 14 and 16 are arranged in pairs in the same radial plane as shown in Figs. 1 and 2 or they may be connected in a plane angled to the radial plane. Before the nozzle 11 is connected to the gas and water pipes these passageways are drilled from the rear end of the nozzle and arranged to meet at a small acute angle. An advantage of this arrangement for these coolant passageways 14 and 16 is that no lateral drilling of any transverse connecting passageways is necessary and no plug has to be brazed or otherwise secured in place. It has been found that such plugs cannot be molecularly secured in place to possess as good conductivity as is desired in the main body portion of the nozzle because under the intense heat to which the nozzle is subjected any such plug tends to melt and threaten the life of the nozzle. The longitudinal and tapered outer surface of the nozzle is approximately parallel with the axes of the passageways 16.

Among the advantages of this invention may be mentioned the fact that the increase in life of the present nozzle has been as much as 2000% as compared with that of a copper nozzle which is not both forged and deoxidized and which may be possessed of a plugged transversely drilled hole. The spacing of these pairs of passageways has been mentioned above and is important to obtain satisfactory cooling.

We claim:

1. Apparatus for the top blowing of oxygen into molten metal having a nozzle portion for insertion into a furnace and a rear body portion communicating therewith and adapted for connection to an oxygen and coolant source, said nozzle portion having a unitary construction of high thermal conductivity metal, a central longitudinal passageway for the passage of oxygen therethrough, a plurality of coolant borings radially arranged in pairs around said central passageway, each pair of borings lying in the same radial plane including the nozzle axis and extending from the rear face of said nozzle portion and converging to a point of intersection short of the forward face of said

nozzle portion, said pairs of borings being circumferentially spaced between about $\frac{3}{16}$ " and $\frac{5}{8}$ ", thereby forming a plurality of radially-arranged series coolant paths through the nozzle.

2. A nozzle according to claim 1 in which the thickness of copper radially outside the radially outer coolant borings is between about $\frac{3}{16}$ of an inch and $\frac{3}{8}$ of an inch and the ratio of the total cross sectional area of coolant borings to the total cross sectional area of copper is between about 1:25 and 1:5.

3. A nozzle according to claim 1 in which the radius of curvature at the forward face of the nozzle portion is between about .25 to .30 of the maximum nozzle diameter.

4. An apparatus for blowing of oxygen into molten metal and including a nozzle of deoxidized and forged copper free of any weld or brazed portion, pairs of coolant passageways arranged in a generally radial plane with the passageways of each pair meeting adjacent the outer end portion of said nozzle, the pairs being arranged circumferentially, an oxygen supply pipe centrally of and attached to said nozzle, a projection secured to said pipe at a rear portion thereof, a second pipe forming an outer wall of a coolant passageway for said nozzle, the inner wall of said passageway being constituted by an outer surface of said oxygen supply pipe, spaced flanges secured to said second pipe, means removably securing the rear one of said spaced flanges to the flange on said oxygen supply pipe, a third pipe surrounding the second and forming a coolant passageway between them, a rear flange secured on said third pipe, means removably holding the last mentioned flange to the forward one of said flanges on the second pipe, and a removable connection between said nozzle and each of the three of said pipes.

5. A nozzle according to claim 1 in which said coolant borings meet adjacent the forward face of the nozzle portion at an angle of between about 10° to 45° .

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