Dec. 7, 1965 R. F. OBENCHAIN 3,222,044

APPARATUS FOR DELIVERING A FLUID INTO A FURNACE

Original Filed Sept. 17, 1959 2 Sheets-Sheet 1

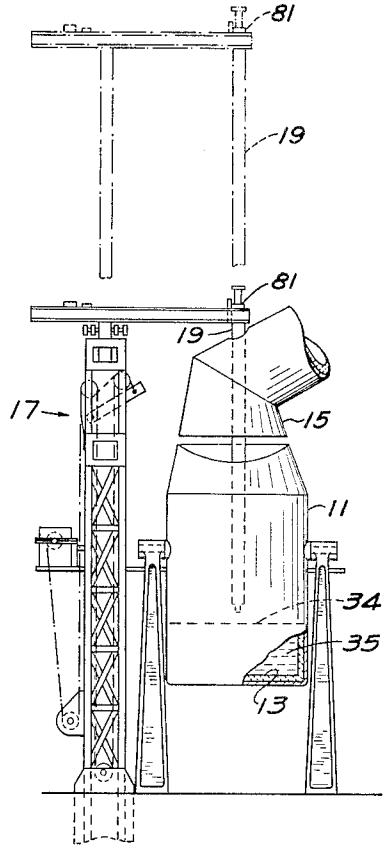


FIG. 1

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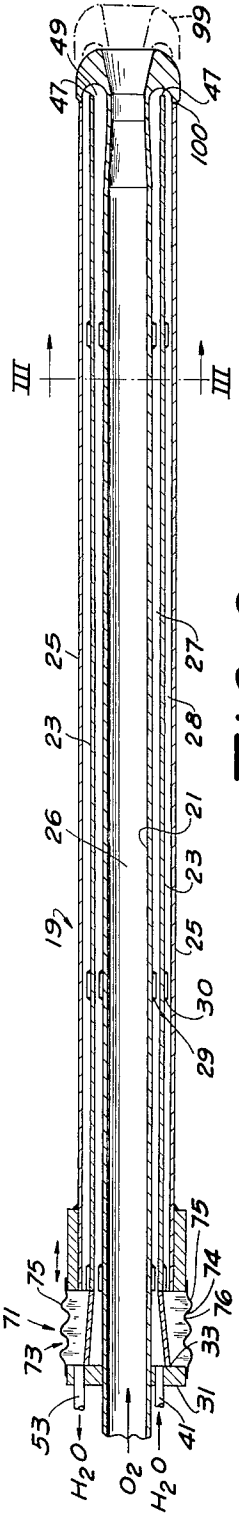


FIG. 2

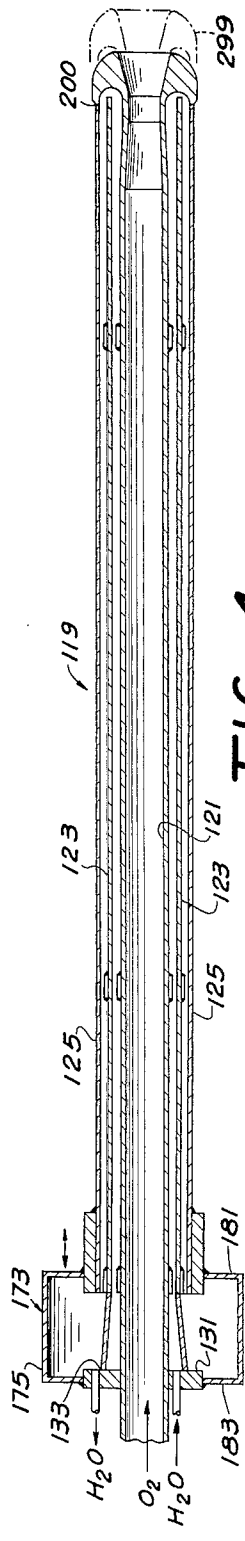


FIG. 4

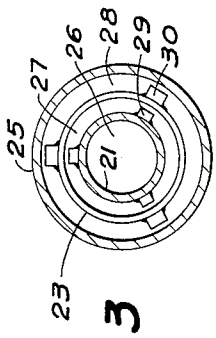


FIG. 3

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APPARATUS FOR DELIVERING A FLUID INTO A FURNACE

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Continuation of application Ser. No. 840,635, Sept. 17, 1959. This application Oct. 11, 1962, Ser. No. 229,796
2 Claims. (Cl. 266—41)

This application is a continuation of copending U.S. patent application Serial No. 840,635 filed September 17, 1959, now abandoned.

This invention relates to apparatus for treating baths of molten material with fluids and relates more particularly to apparatus for treating molten metal with oxygen.

In the making of steel, a common practice has been to flow substantially pure oxygen through a long pipe or "lance" inserted vertically in the top charging opening of a solid bottom converter containing molten metal, such as pig iron, so that the oxygen contacts the metal as a supersonic jet of substantially pure oxygen. The oxygen combines with elements, such as carbon, silicon, manganese and phosphorus, in the molten metal and the exothermic heat of this reaction raises the temperature in the converter to such an extent that problems have been encountered in providing a suitable lance with sufficient operating life. The lances known heretofore have comprised an inner tube, an outer tube forming a cooling jacket around the inner tube, and means for circulating water in the jacket to cool the outside thereof. Exposure of the outside pipe to the hot ambient in the converter causes more expansion in the outside pipe than in the inside pipe so that the lance often distorts or deforms.

To overcome this problem, the outside or inside pipe has heretofore been made in two pieces, and the gap between these pieces is sealed by a stuffing box. Stuffing boxes are ineffective, however, because they leak and are subject to frequent maintenance. Leakage is particularly disadvantageous when the water contacts the hot elements of or around the converter as it may cause steam which is dangerous to persons working around the converter.

An object of this invention, therefore, is to provide an improved apparatus for treating molten metal with a fluid.

This invention contemplates a lance for delivering a fluid into contact with molten metal in a furnace or converter, the lance being comprised of three tubes arranged concentrically so that the inner tube delivers the fluid to the furnace and the outer tubes provide annular spaces for the flow of a coolant, and a provision whereby the tubes may expand at different rates without distortion and deformation of the lance yet maintain the outside tube water-tight.

The above and further objects and novel features of the invention will appear more fully from the following detailed description when the same is read in connection with the accompanying drawing. It is to be expressly understood, however, that the drawings are not intended as a definition of the invention but are for the purpose of illustration only.

FIG. 1 is a partial elevation of this invention.

FIG. 2 is a detailed view of FIG. 1.

FIG. 3 is a partial cross section of FIG. 2 taken through III—III.

FIG. 4 is another embodiment of FIG. 2.

Referring to FIG. 1, this invention has particular advantage in the making of steel by contacting molten metal with substantially pure oxygen. The drawing shows a portion of a conventional solid bottom converter **11** lined with high temperature material such as dolomite magnesia **13** and having a removable hood **15** for receiving fumes.

The converter has the usual charging and tapping means, which are not shown since they are not involved in this invention. For simplicity the lifting and lowering means **17** for the lance **19** of this invention is shown schematically.

In accordance with one embodiment of this invention, shown in FIG. 2, lance **19** has three concentrically nested tubular members or pipes **21**, **23**, and **25** connected to form passageways **26**, **27**, and **28**. Passageway **26** formed by tube **21** feeds oxygen from a suitable source (not shown) into the converter and passageways **27** and **28** formed by the interposition of intermediate tube **23** subdividing the space enclosed by tubes **21** and **25**, tubes **21** and **25** being connected at end **100** circulate water in the lance as described in more detail hereinafter. Spacers **29** placed at suitable intervals between pipes **21** and **23** and spacers **30** placed at suitable intervals between pipes **23** and **25** separate the three tubes from each other and allow for relative movement therebetween. To this end spacers **29** are advantageously welded to the outside of inner pipe **21** with a small clearance between the spacers and the inside diameter of pipe **23**. Similarly spacers **30** are welded to the outside of pipe **23** with a small clearance between the spacers and the inside diameter of pipe **25**. The spacers are relatively narrow so that they do not unduly retrict passageways **27** and **28** formed by the tubes. Additionally header **31** rigidly connects the end **33** of tube **23** with the outside of inner pipe **21** near the inlet thereof into lance **19**.

Water inlet **41** connected to a suitable water source (not shown) forces water into channel **27** between pipes **21** and **23**. The water flows longitudinally through channel **27**, around end **47** of tube **23** which acts as a baffle forming opening **49** with tubes **21** and **25**, and into channel **28** from whence the flow is reversed and the water flows through outlet **53** in header **31**. Suitable piping connected to inlet and outlets **41** and **53**, including valves and the water source (not shown) circulate water freely in lance **19** to cool the lance sufficiently to operate it in the adverse ambients presented by a furnace.

It will be understood that before the lance is inserted into the converter, all three tubes **21**, **23**, and **25** are at very nearly the same temperatures. After the lance is inserted into the converter, however, the outer tube **25** is exposed to temperatures in excess of 2000° F. This causes large expansion in outer tube **25** while the water and oxygen flowing around inner tube **21** and intermediate tube **23** maintain the inner and intermediate tubes at relatively low temperatures and consequently there is much less expansion in the inner and intermediate tubes than in the outer tube.

To prevent the differential expansion from causing distortion, buckling and the like in the inner, intermediate and outer tubes, a flexible water-tight joint **71** is welded between pipe **25** and header **31** at the cool end **33** of the pipe **23**. Joint **71** advantageously comprises an extensible member **73** advantageously having annular metallic sinuous convolutions **75** which freely expand and contract to take up the difference in expansion and contraction between pipes **21** and **25**. The convolutions take up little space and are rugged so that the joint remains water-tight despite the vibration caused by the air blast coming out the end of the lance. Also the joint of this invention is simple and inexpensive to install. Additionally, member **73** can be located in hot ambients without affecting its efficiency as a seal.

Members **73** is advantageously made from annular dished discs **74** each joined by welding at its outer edge **75** to a similar disc at one side and at its inner edge **76** to a similar disc on the other side. The discs are formed from sheet metal of substantially uniform thickness and

flexibility throughout so that the member 73 expands and contracts at a uniform rate.

Clamp 81 attached to the lifting and lowering machanism 17 holds the lance in a fixed position relative to the surface 34 of the molten metal 35 in converter 11 so that the oxygen forced through pipe 21 properly contacts metal in vessel 11 and causes combustion in the vessel.

In operation, mechanism 17 lowers lance 19 through hood 15 into vessel 11. Oxygen forced through pipe 21 causes combustion of materials such as carbon and silicon in molten pig iron in the vessel. The heat produced causes outer tube 25 to expand so that end 100 thereof moves longitudinally toward the molten metal. Since pipe 21 is cooler than pipe 25, pipe 21 does not expand as much pipe 25 but connection of pipes 21 and 25 at end 100 causes pipe 21 to move longitudinally with pipe 25 to the position shown by dotted lines 99 and to compress member 73. Also, pipe 23 does not expand as much as pipe 25 but the connection of pipes 21 and 23 at end 33 of pipe 23 causes pipe 23 to move longitudinally with pipe 21 to the position shown by the dotted lines 99. The connection between pipes 21 and 23, as described, has the advantage that the opening 49 provided by end 47 of pipe 23 from channel 27 to channel 28 remains relatively constant in area so that the flow of water in the channels is not unduly restricted.

Referring to FIG. 4, in another embodiment of this invention three tubes 121, 123 and 125 are nested with suitable water connections as described above with reference to tubes 21, 23, and 25 of FIG. 2 and member 173 takes up differential expansion between inner tube 121, intermediate tube 123 and outer tube 125 as member 73 does with reference to FIG. 2. To this end member 173 is formed from a thin sheet metal ring 175 with parallel sides 181 and 183 welded at right angles to the edges of ring 175 so that member 173 is substantially U shaped in cross section. The free edge of side 181 is welded to the outside of spacer 131 and the free edge of side 183 is welded to the outside of outer tube 125 to form a closed joint between outer tube 125 and header 131. Header 131 is connected with end 133 of intermediate tube 123 and the outside of inner tube 121 advantageously by welding and inner tube 121 is connected with outer tube 125 advantageously by welding at end 200 of lance 119.

In operation, insertion of lance 119 in furnace 11 and flowing of oxygen and water therethrough as described above with reference to lance 19 of FIG. 2 causes outer tube 125 to expand much more than inner tube 121 and intermediate tube 123. Thereupon inner tube 121 and intermediate tube 123 move with outer tube 125 to the position shown by the dotted lines 299 and sides 181 and 183 of member 173 are deflected toward each other to prevent distortion or buckling in lance 119.

It is understood from the above that the apparatus of this invention can also be used in open hearth furnaces and other applications where molten material is treated with a fluid.

This invention provides a water-tight joint in the outer tube of a lance formed with inner and outer concentric tubes which are connected at a first end and extensible means connecting the inner and outer tubes at a second end whereby uneven expansion in the inner and outer tubes does not result in distortion of the lance,

I claim:

1. A lance for feeding oxygen to the molten bath of metal in a metallurgical furnace comprising:

(a) first, second, and third concentric spaced apart tubular members with the innermost first tubular member being adapted to feed the oxygen into said furnace;

(b) a collar member fixed to the first and to the intermediary second tubular members adjacent one pair of ends whereby one end of a first annular space between said first and second tubular members is closed;

(c) means connecting the other end of the first tubular member and the adjacent end of the outermost third tubular member whereby one end of a second annular space between said first and third tubular members is closed;

(d) flexible means connecting the free end of said third tubular member and said collar whereby the other end of the second annular space is closed and whereby said third tubular member can expand when heated relative to said first and second tubular members;

(e) means to flow cooling liquid into said first annular space adjacent its closed end whereby said liquid courses said first annular space longitudinally and courses a third annular space between said second and third tubular members; and

(f) means to conduct said liquid from said third annular space.

2. A lance for feeding oxygen to the bath of molten metal in a metallurgical furnace comprising:

(a) first and second spaced apart concentric tubular members having one pair of adjacent ends connected together to form a closed-ended annulus therebetween, the inner first tubular member being adapted to feed the oxygen into said furnace;

(b) a third tubular member concentrically disposed intermediate said first and second tubular members and spaced apart therefrom;

(c) a collar member fixed to the first and third tubular members adjacent the free end of said first tubular member;

(d) flexible means connecting said collar member and the free end of said second tubular member whereby the other end of the annular space is closed;

(e) means to flow a cooling liquid into the annular space between said first and third tubular members whereby said liquid courses said annular space longitudinally and courses the annular space between said second and third tubular members; and

(f) means to conduct said liquid from the annular space between said second and third tubular members.

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