United States Patent

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[73] Assignee **Union Carbide Corporation**

[54] **OUTSIDE CHANGE TUYERE**
6 Claims, 4 Drawing Figs.

[52] U.S. Cl. 266/41
[51] Int. Cl. C21c 5/46
[50] Field of Search ..... 266/34, DIG. 3, 41, 42

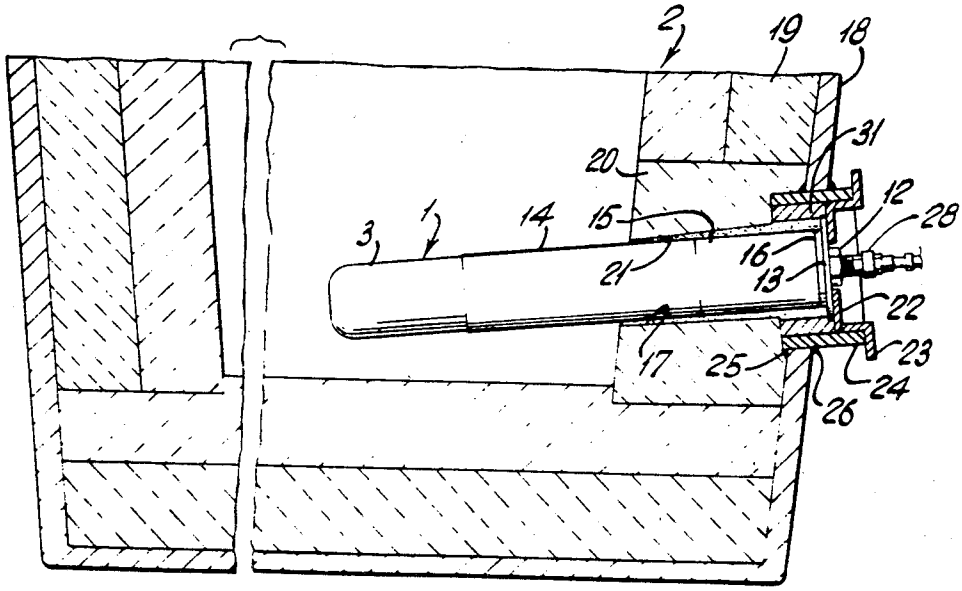
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ABSTRACT: Blowpipe assembly for introducing gas below the surface of a molten metal bath which is capable of rapid removal and installation in an opening in the wall of a refractory lined processing vessel. The assembly consists of a metal blowpipe having a nozzle capable of discharging a sonic velocity gas stream, and refractory protection substantially surrounding and secured to the blowpipe so that the blowpipe and refractory constitute an integral assembly. The vessel opening is provided with wear and erosion resistant refractory lining forming a socket for the blowpipe assembly. The assembly can be inserted into, removably secured to, and removed from the vessel from the outside.



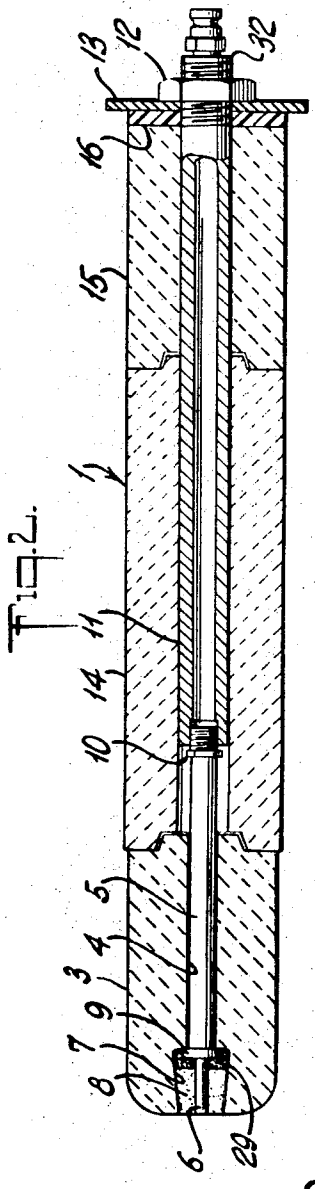


Fig. 2.

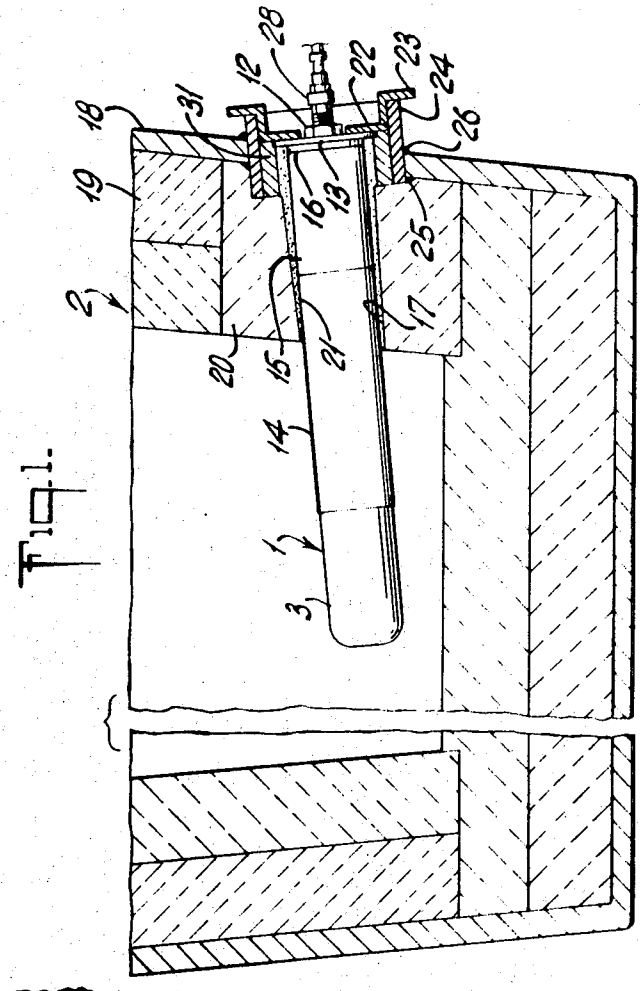


Fig. 1.

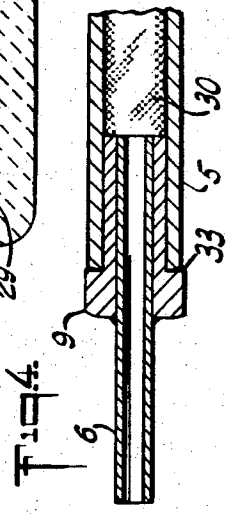


Fig. 4.

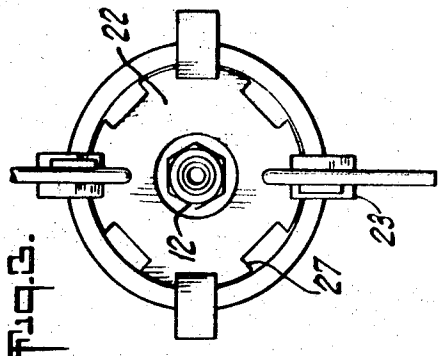


Fig. 3.

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OUTSIDE CHANGE TUYERE

This application is a division of application Ser. No. 653,929, filed July 17, 1967, now U.S. Pat. No. 3,495,815, issued Feb. 17, 1970.

BACKGROUND

The present invention relates in general to apparatus for treating molten metals, and more particularly, to apparatus suitable for introducing a gas, or mixture of gases below the surface of a molten metal bath.

According to prior art methods gases have been introduced beneath the surface of molten metal baths either by inserting a blowpipe, commonly called a lance, directly into a molten metal bath from above the surface thereof, or alternatively, by inserting a blowpipe, commonly called a tuyere, through a hole in the side or the bottom of the processing vessel containing the molten metal. The first of these methods suffers from several disadvantages, one being that for effective use of inert gases for either stirring or degassing of molten metal, the lance must penetrate to the bottom of the bath and be rigidly secured in position against the buoyant forces which will otherwise float it to the surface of the bath. Another disadvantage is that the lance will be structurally complicated, since the gases must exit in a substantially horizontal direction, while the lance is oriented vertically. Still other disadvantages are caused by the lance's large size and high cost.

The second method requires complex tuyere installation, including extensive buildup of a refractory material into and around the hole in the processing vessel to provide protection for the tuyere. In practice it has been found that tuyeres, and all or part of its protective refractory, require replacement after each heat. Replacement of prior art tuyeres which are cemented in the sides or the bottom of vessels is extremely costly and inefficient, since it necessitates breaking the refractory material and rebuilding the broken refractory and metal blowpipe parts from inside the vessel. This, in turn, requires that the vessel be cooled for about 6 to 8 hours so that it permits inside work. The replacement work itself, including patching the refractory lining of the vessel, usually takes at least 1 hour. The length of time required for vessel cooling and replacement of prior art tuyeres mounted in the sides or bottom of a vessel necessarily limits the availability of the vessel for operating purposes.

OBJECTS

It is an object of the present invention to provide apparatus for introducing a gas below the surface of a molten metal bath which will permit rapid removal and installation of a blowpipe assembly in the wall of a metal-processing vessel. It is another object of this invention to provide apparatus which permits installation and removal of a blowpipe, and the refractory means for protecting said blowpipe, from the outside of a metal-processing vessel. It is another object of this invention to provide apparatus which permits outside installation of a metal blowpipe and the refractory means for protecting said blowpipe as an integral assembly. It is yet another object of this invention to provide apparatus which permits a blowpipe assembly to form a fluidtight seal with a socket in a vessel wall.

SUMMARY OF INVENTION

These and other objects, which will become apparent from the detailed disclosure and claims to follow, are achieved by the present invention which provides in an apparatus suitable for introducing gas beneath the surface of a molten metal bath contained in a vessel comprising, in combination, a refractory lined processing vessel provided with at least one opening through the refractory and metal walls thereof, and a metal blowpipe which extends through said opening for discharging at least one gas stream into said bath, the improvement comprising: (1) providing the metal blowpipe, (a) with refractory protection means which substantially surround the blowpipe, (b) with a nozzle portion at the discharge end of said blowpipe which is capable of discharging gas at at least sonic velocity,

(c) with means to prevent steel runback into the gas passages of said blowpipe when the flow of gas is reduced or stopped, and (d) with means for securing said refractory protection means to said blowpipe such that the metal blowpipe and said refractory means constitute an integral blowpipe assembly, whereby said assembly is adapted to be inserted into, and removably secured to, said vessel from the outside; (2) providing said vessel opening with a wear and erosion resistant refractory socket for the blowpipe assembly, whereby said blowpipe assembly and said socket are adapted to provide a fluidtight seal therebetween, and (3) means for removing said blowpipe assembly from said socket from outside the vessel. Another aspect of the present invention is the blowpipe assembly itself.

The term "integral blowpipe assembly" is defined for purposes of this specification and claims as meaning that the metal parts of the blowpipe constituting the gas passage, and the refractory parts constituting the insulating protection for the metal parts are securely fastened together so that the entire assembly can be inserted as an entity into the socket in the vessel. While the assembly can be inserted as an entity into said socket, such assembly, nevertheless, is adapted to be removed from the vessel either in parts, or as a single unit.

THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a view in vertical section of the preferred embodiment of the invention showing a blowpipe assembly removably secured in its operative position in the lower sidewall portion of a metal processing vessel.

FIG. 2 is a longitudinal cross-sectional view of the blowpipe assembly of FIG. 1 prior to installation in the vessel wall.

FIG. 3 is a side view of the apparatus of FIG. 1 showing one type of locking means suitable for securing the blowpipe assembly to the vessel.

FIG. 4 is a longitudinal cross-sectional view of the preferred embodiment of the nozzle portion of the blowpipe assembly showing a nozzle adapter and a screen which are provided to prevent steel runback into the blowpipe assembly.

Referring to FIGS. 1 and 2, the apparatus comprises a blowpipe assembly 1 which is removably secured to the sidewall of a metal-processing vessel 2. The blowpipe assembly consists of a refractory head 3 having a central passageway 4 through which a nozzle 5 extends for discharging a gas stream from the nozzle tip 6. Head 3 is provided at its front end with a central cavity 7 which is packed with a highly refractory ramming material 8, such as phosphate bonded high alumina refractory material, to protect the nozzle tip 6 from the molten metal bath. While the ramming material 8 is extremely resistant to erosion from molten metal, the alumina portion renders it conductive to heat. For this reason, the inner portion of the cavity 7 is preferably packed with a dry fire clay 29 to better insulate the nozzle. The nozzle 5 includes a nozzle adapter 9 having a shoulder portion 33 which fits into the base of cavity 7 and retains head 3 in the blowpipe assembly. As shown in FIG. 4, nozzle adapter 9 is constructed from a metal head bolt with the center drilled out to accommodate the nozzle tip 6 therein. Adapter 9 is secured to the nozzle body 5.

After degassing of a heat has been completed, the gas flow to the tuyere is stopped and the pressure in the tuyere decreases rapidly. This would ordinarily permit the molten steel to run back into the nozzle. However, because of the large mass of the nozzle adapter 9 relative to the molten steel, which can get into nozzle tip 6, the adapter 9 acts as a heat sink and stops the molten steel from running back into the nozzle by causing it to solidify. For prolonged degassing times or for superheated steel, the heat sink effect of the nozzle adapter 9 may be insufficient to stop steel runback. To guard against this, another heat sink consisting of a metal screen 30 of, for example, steel or copper coiled in the nozzle, or optionally also in the other gas passages of the blowpipe assembly, is provided to cause solidification of the molten steel, thereby preventing steel runback.

The inlet end of the nozzle 5 threadably engages with a pipe coupling 10 which in turn is threadably engaged to the outlet end of tuyere tube 11. The inlet end of tube 11 is threaded so as to mate with a nut 12 which, together with a metal backplate 13, serve as the retaining means at the inlet end of the blowpipe assembly for containing the refractory sleeves 14 and 15 between the refractory head 3 and the backplate 13. The number and size of the refractory sleeves employed may vary depending upon the particular requirements and size of the vessel. When the blowpipe assembly is held rigidly in the vessel, the difference in expansion between the metal and the refractory parts would ordinarily cause cracking of the refractory parts. To prevent this cracking, an asbestos expansion washer 16 is fitted between the refractory sleeve 15 and the backplate 13.

The metal parts of the blowpipe assembly 1 comprising nozzle 5, pipe coupling 10 and tuyere tube 11 constitute the preferred embodiment of the gas passage of the blowpipe assembly. However, instead of these parts, a one piece metal construction may be used. The internal diameter of the metal blowpipe parts and the flow rate of the gas through it determine the velocity of the exiting gas. The smaller the size of the injected gas bubbles, the greater will be the surface area available for reaction with the steel bath. Accordingly, the nozzle portion is designed to discharge the gas entering the bath at at least sonic velocity. The metal parts of the blowpipe are insulated from the molten metal bath by the refractory protection afforded by refractory head 3 and refractory sleeves 14 and 15. During assembly of such refractory parts a cement (not shown) is applied on the abutting end surfaces of such parts for sealing the spaces between them. The metal parts and the refractory parts is assembled before the blowpipe assembly shown in FIG. 2 is inserted into and secured to the vessel 2.

As shown in FIG. 1, the blowpipe assembly 1 is installed in a socket or opening 17 extending through the sidewall 18 and the refractory lining 19 of the vessel. The opening 17 may be inclined into the vessel in a slightly downwards direction from a horizontal plane. The socket 17 is lined with a refractory ramming material 20, such as phosphate bonded alumina, or ceramic bonded fire clay, to make the socket resistant to erosion and wear due to repeated changes of the blowpipe assembly. The socket 17 may also be slightly tapered conically towards the inside of the vessel 2 for the purpose of facilitating removal of the blowpipe assembly 1 after completing a heat. Alternatively, the socket 17 may be cylindrical while the blowpipe refractory sleeves fitting in said socket are conically tapered. Socket 17 and the sleeves may both be tapered at the same or different angles if desired.

When installing the blowpipe assembly 1 in vessel 2, a mortar mixture 21 which may consist of fire-clay and water is initially applied to the inside walls of the socket 17. The mortar mixture 21 must be of such consistency that it extrudes into the vessel 2 when the blowpipe assembly 1 is inserted into socket 17. With the blowpipe assembly 1 seated in socket 17, a fluidtight seal is formed therebetween, and a locking plate 22 is used to secure the assembly 1 to a cylindrical steel holder assembly comprised of inner sleeve 31 and outer sleeve 24 which is welded at 25 and 26 to the vessel wall 18.

Referring to FIG. 3, the locking plate 22 is formed of a circular steel plate with four notches 27 cut therein. Four angle stops 23 which have mating dimensions to the notches 27 are welded to the sleeves 24 and 31. When the assembly 1 is placed in socket 17 the locking plate 22 is placed behind the backplate 13 and rotated about 45° into the locking position as shown in FIG. 3 whereby the angle stops 23 hold the locking plate 22 in position securing the blowpipe assembly 1 in vessel 2. A pipe coupling 28 screws into the inlet end of the tuyere tube 11 and is adapted to communicate with a gas supply.

After the heat has been teemed, i.e. poured, the gas pipe coupling 28 is disconnected to permit locking plate 22 to be rotated 45° out of its locking position and withdrawn from the holder 24, 31. Other suitable quick-connecting locking devices than that described and shown may be used. In the preferred embodiment, there is intentionally provided a weak point either in the nozzle 5, head 3, pipe coupling 10, or the tuyere tube 11 whereby breakage of one of such parts will occur upon application of a given pulling force on the blowpipe assembly 1 from the outside of the vessel 2 which will disconnect the metal blowpipe parts from the remainder of the blowpipe assembly and consequently enable such metal parts to be withdrawn from the vessel. Preferably, the threads connecting pipe coupling 10 with either nozzle 5 or tuyere tube 11 are designed to strip, and thus break. Alternatively, head 3 will break or crush from the compression stresses thereon, whereupon the metal parts are pulled out of the refractory sleeves which are then chipped out.

Rather than the preferred manner of pulling the tuyere tube 11 out of the vessel from outside thereof, the nut 12 and backplate 13 can be removed and the entire metal tube assembly pushed through the refractory sleeves into the vessel 2 by hammering at the inlet end 32 of tuyere tube 11. After the metal blowpipe parts are removed from the socket 17, the remaining refractory sleeve is then broken out of the socket by using a chisel or pneumatic chipping hammer, followed by scraping the inside walls and rim of the socket 17 clean. The vessel 2 is then inverted to remove any slag and the metal blowpipe parts and refractory which have fallen into the vessel. Vessel 2 is now ready for installation of a new or rebuilt assembly. The entire replacement procedure generally takes no longer than ordinary maintenance time between heats. This procedure likewise permits the entire change to be made without the necessity of entering the vessel to perform work. Despite the fact that parts of the blowpipe assembly 1 will fall into the vessel during its removal, these parts, as mentioned above, will be discarded when the vessel 2 is inverted to remove slag and other debris before the next heat.

In another embodiment, after a heat, the entire blowpipe assembly 1 is removed from the socket 17 as an integral assembly rather than by being first disassembled and then removed according to the described preferred embodiment. In this embodiment, there are no weak points provided in any part of the blowpipe assembly 1. Accordingly, when said assembly is pulled from the outside of the vessel 2, the mortar bond 21 will be the first to fail. This permits the entire blowpipe assembly, including the refractory sleeves, to be removed from the socket as an integral assembly. While it is simpler, more expedient and hence more desirable to remove the entire blowpipe assembly from the socket as an integral assembly, in practice it has been found that this cannot be achieved with sufficient reliability, since the mortar bond 21 does not always break by pulling on the assembly from outside the vessel. To insure that the blowpipe assembly can be rapidly removed from the outside of the vessel, a weak point is provided in the blowpipe assembly in the preferred embodiment.

I claim:

1. A tuyere suitable for introducing gas beneath the surface of molten metal comprising a metal blowpipe provided with: (a) refractory protection means which substantially surround said blowpipe, (b) a nozzle portion at the discharge end of said blowpipe capable of discharging gas at at least sonic velocity, (c) means to prevent steel runback into the gas passages of said blowpipe when the flow of gas is reduced or stopped, and (d) means for securing said refractory protection means to said blowpipe such that the metal blowpipe and said refractory means constitute an integral blowpipe assembly, whereby said assembly is adapted to be inserted into and removably secured to said vessel from the outside; and wherein the refractory protection means which surround the nozzle portion of the metal blowpipe contains a central cavity around the discharge end thereof filled with refractory material which is resistant to molten metal.

2. The tuyere of claim 1 wherein the inner portion of said cavity is filled with highly insulating refractory material and at the outer exposed portion is filled with refractory which is resistant to erosion from molten metal.

3. The tuyere of claim 1 wherein the means to prevent steel runback into the gas passages of said blowpipe comprises screen means located in the nozzle portion of said blowpipe.

4. The tuyere of claim 1 wherein said metal blowpipe is comprised of a nozzle connected to a tuyere tube.

5. The tuyere of claim 4 wherein said nozzle is threadably

connected to said tuyere tube by means of a pipe coupling.

6. The tuyere of claim 1 wherein the refractory protection means which substantially surround said blowpipe have an inwardly tapering frustoconical shape.