United States Patent [19]

Chang

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[45] **Sept. 3, 1974**

[54] **APPARATUS FOR REFINING OF STEEL**

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[73] Assignee: **Berry Metal Company,** Harmony, Pa.

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[21] Appl. No.: **347,944**

[52] **U.S. Cl.** ..... **266/34 L**

[51] **Int. Cl.** **C21c 7/06**

[58] **Field of Search** ..... 75/52, 59, 60; 239/132.3; 266/34 PT, 34 T, 34 L, 34 LM

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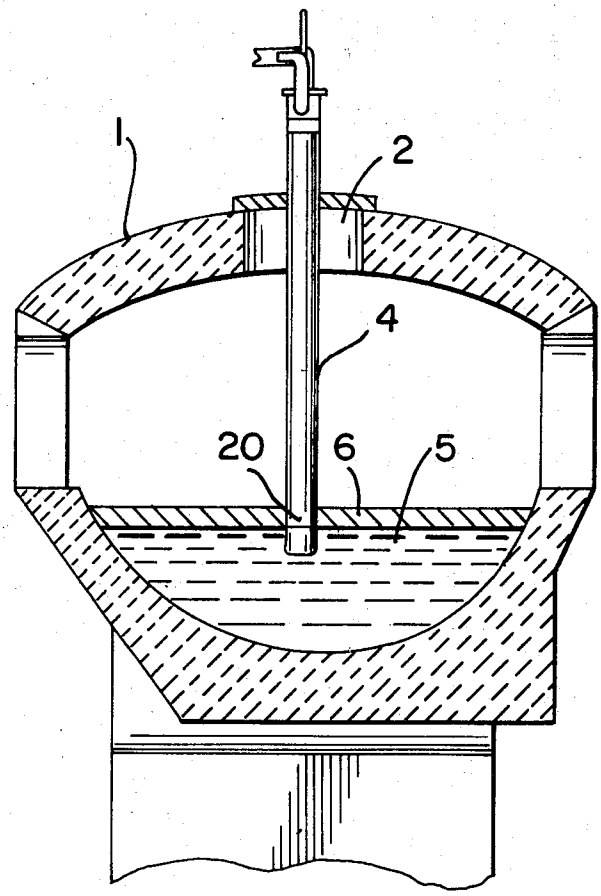
Primary Examiner—Gerald A. Dost
Attorney, Agent, or Firm—Richard J. Myers

[57] **ABSTRACT**

In a steel making apparatus, an oxygen injection lance having a copper tip section to which is attached a submersion nozzle for insertion into a molten bath of steel, the submersion nozzle including a short threaded copper section attached to the lance tip and a lower steel tube welded to the copper section and having extending thereabout fastener material for holding a layer of refractory material about the lower metallic tube of steel, the joint between the lance tip and the submersion nozzle being sealed by a refractory cement. The method involves the use of this submersion nozzle below the surface of the molten bath of steel, the nozzle being attached to the water-cooled lance which enters the furnace from its roof or side wall above the bath surface.

22 Claims, 15 Drawing Figures



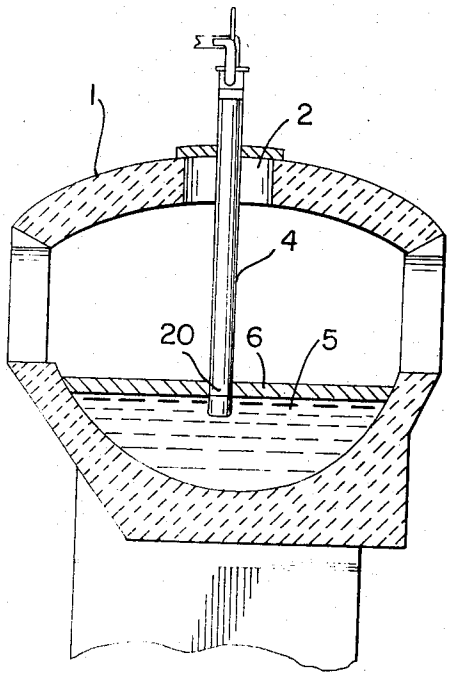


FIG-1

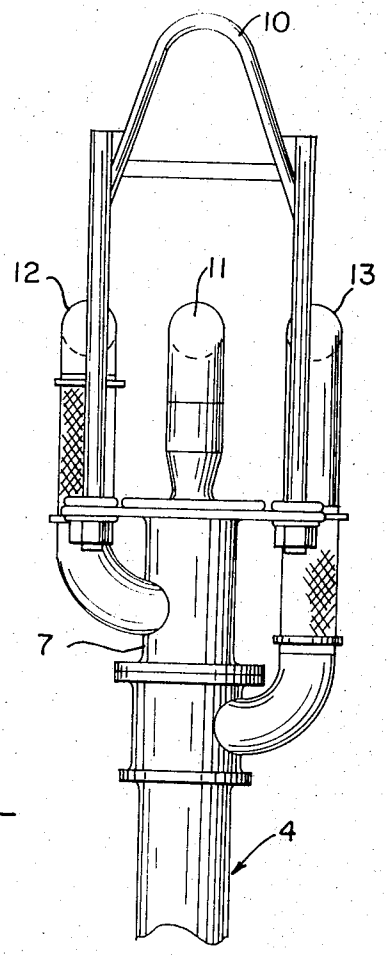
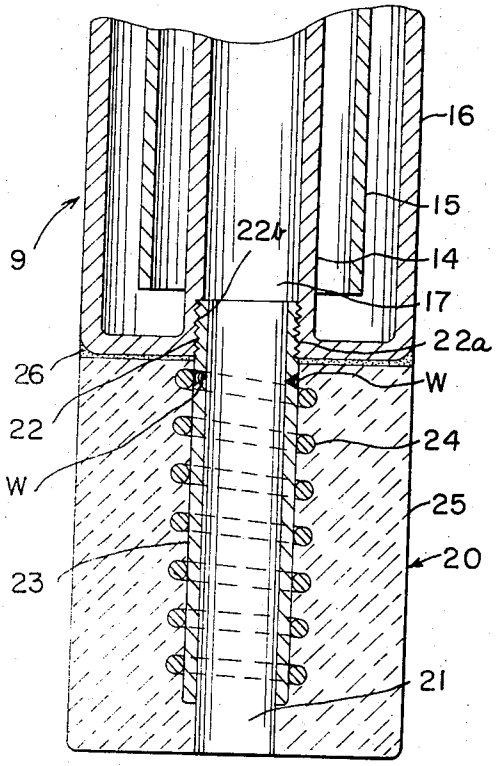


FIG-3



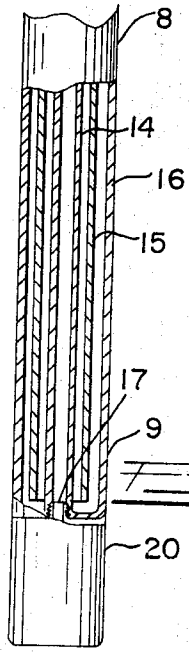


FIG-2

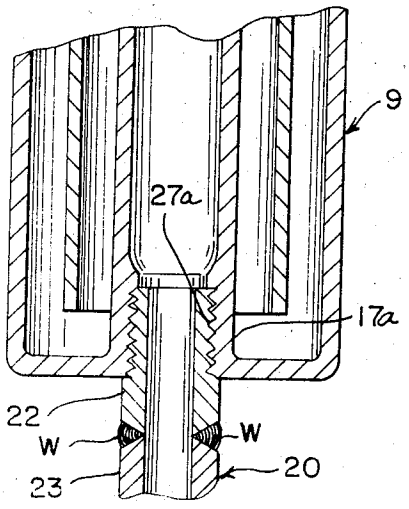


FIG. 4

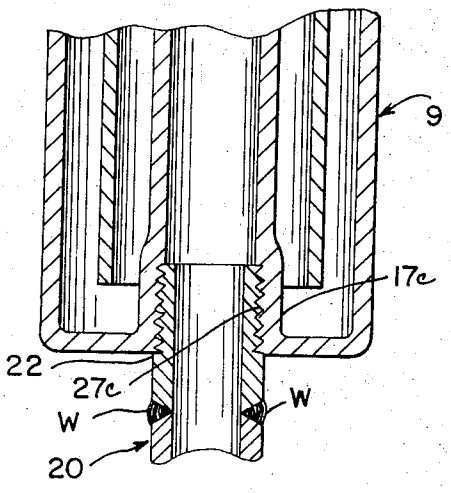


FIG. 6

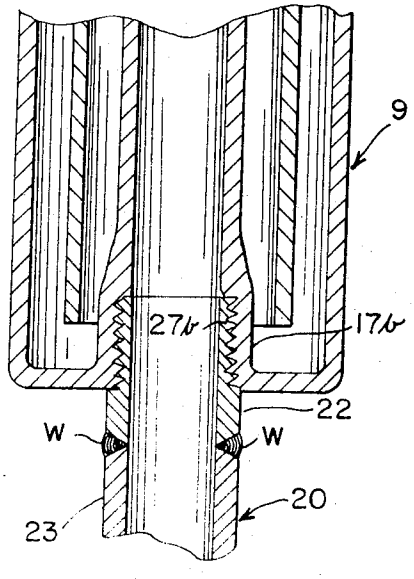


FIG. 5

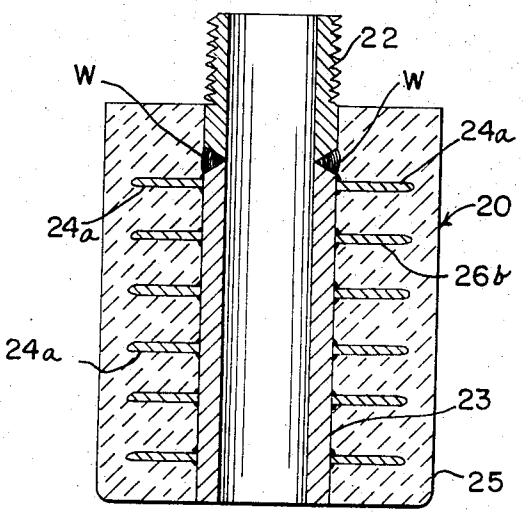


FIG. 7

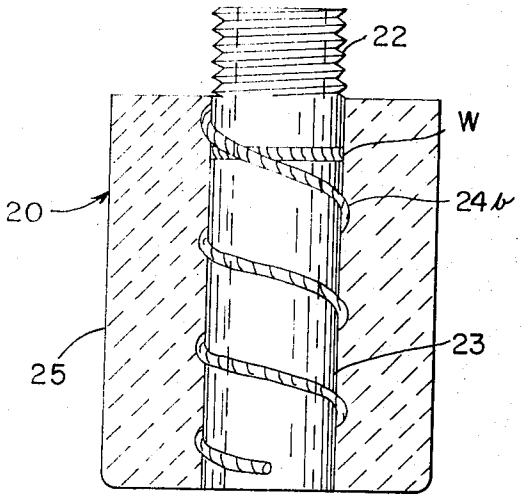


FIG. 8

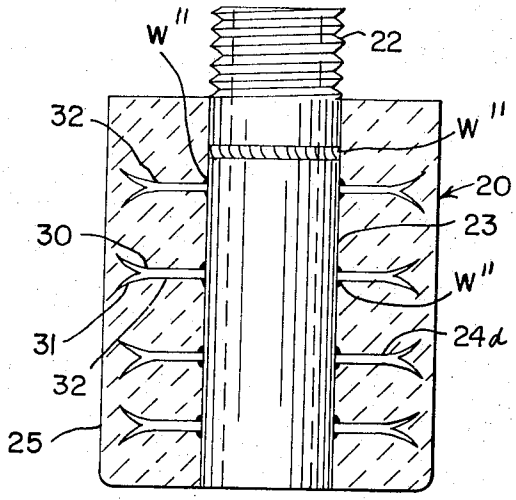


FIG. 9

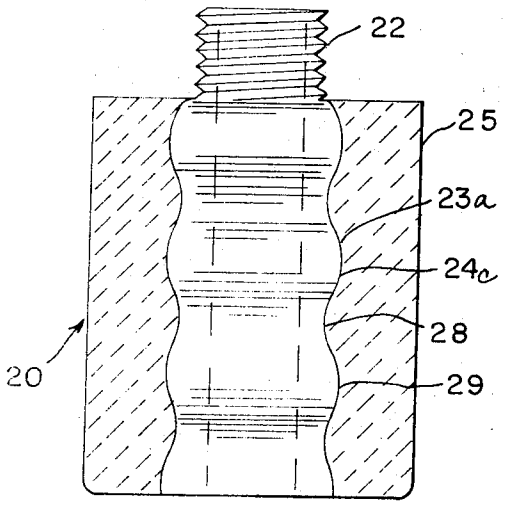


FIG. 10

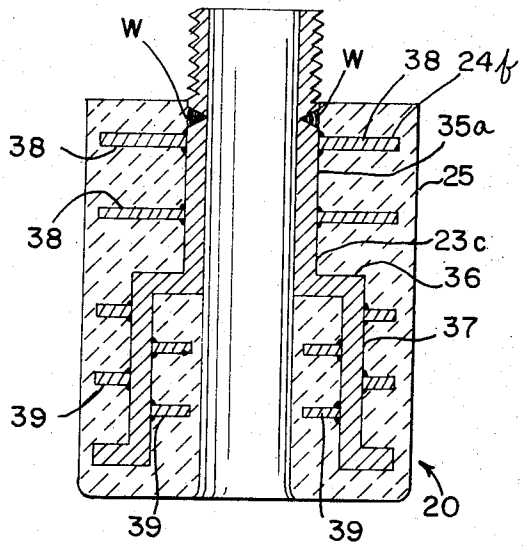


FIG. 13

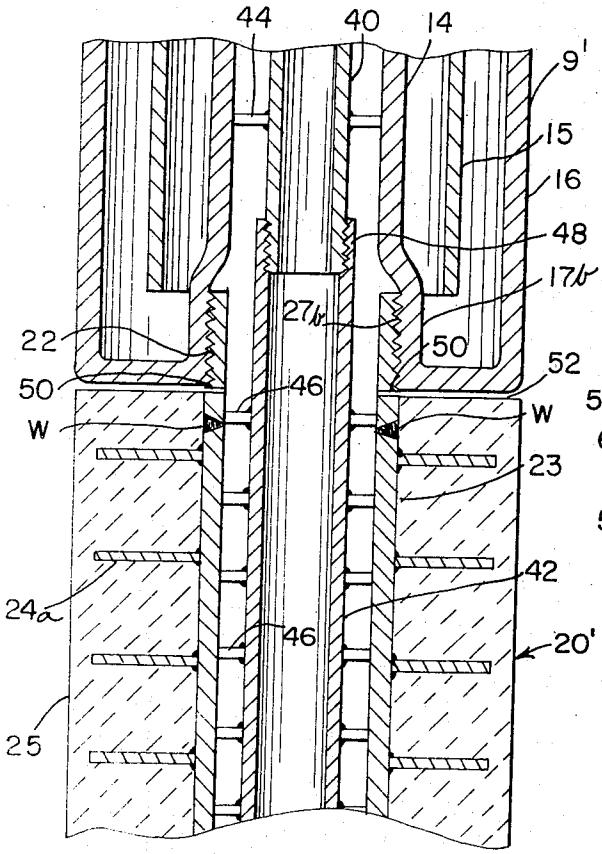


FIG. 14

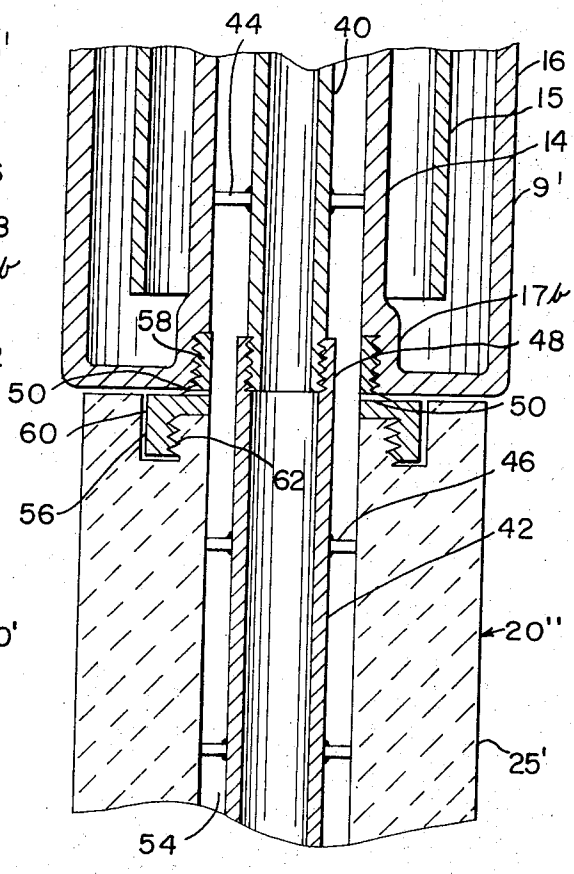


FIG. 15

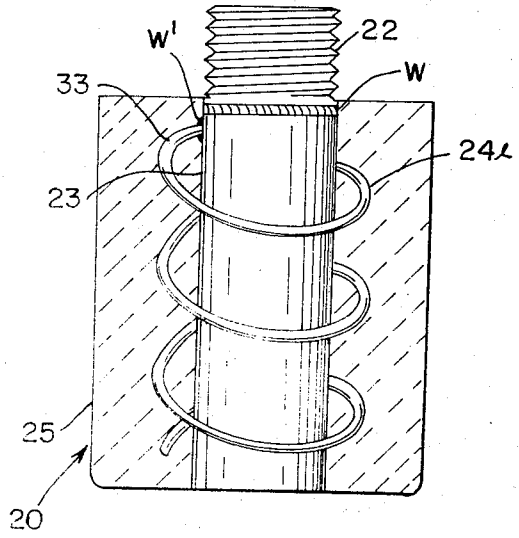


FIG. 11

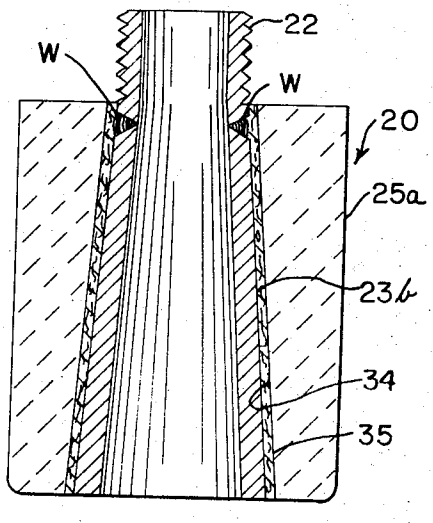


FIG. 12

APPARATUS FOR REFINING OF STEEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus for contacting oxygen gas with molten steel in a steelmaking furnace by injecting the oxygen gas into the interior of the steel bath by means of a submerged nozzle of an oxygen injection lance.

2. Description of the Prior Art

Refining of hot metal to steel by reacting with pure oxygen gas is a well known process. Previous methods of contacting the oxygen gas with the molten steel include blowing a stream of oxygen above the free surface of the bath in a technique known as top-blow method such as the basic oxygen process. The efficiency of mixing oxygen and the molten steel by this method is comparatively poor and large amounts of ejections of metal and fumes are generated. Another method of contacting the oxygen with the molten steel provides for the injection of the oxygen gas from tuyeres installed in the bottom refractory of the steelmaking converter known as the bottom-blow process, such as the Bessemer process and also the Q–B.O.F. process. This method requires a specially constructed bottom and cannot be applied to existing B.O.P. (basic oxygen process) and open hearth furnaces. Another technique of oxygen injection provides for the injecting of oxygen into the molten bath from the top of the converter by means of a consumable steel pipe, either bare, or coated with a refractory material. The service life of these pipes is very short from a few minutes to less than twenty minutes. It is desirable to have an apparatus for more efficiently contacting oxygen gas with molten steel wherein the apparatus has a long economical life. The instant invention accomplishes this goal.

SUMMARY OF THE INVENTION

This invention has for its general object an apparatus for contacting molten metal with a gaseous substance and particularly relates to an apparatus for contacting oxygen gas with hot metal, that is, molten pig iron, to refine the metal to steel in an open hearth type furnace by the injecting of high purity oxygen gas into the molten bath of iron under its surface at selected location and depth, the injected gas breaking up into bubbles which rise to the free surface of the bath providing intimate contact between the gas and the metal with relatively little splashing. The apparatus consists of a permanent water-cooled lance which enters the furnace from the roof or the side wall and reaches to just above the bath surface and is provided with an attached consumable but replaceable submersion nozzle which is submerged in the molten bath. This combination of a permanent lance and a consumable nozzle offers operational versatility and economy. The lance is supported by a carriage outside the furnace for retraction and lateral movement within the confinement of the entering hole of the furnace. The submersion nozzle includes a metal tubular portion threadingly attached to the lance tip and surrounded by a refractory tube. The submersion nozzle is also constructed to provide for a shielding gas around the oxygen.

These and other objects and advantages of the invention will become more readily apparent from reference

to the following description, attached drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-section view of an open hearth furnace using the novel oxygen injection lance;

FIG. **2** is an enlarged view of the novel oxygen injection lance with the submersion nozzle;

FIG. **3** is an enlarged view of the attachment of the submersion nozzle to the tip of the lance;

FIG. **4** is a sectional view of one design showing the threaded connection between the lance tip and the submersion nozzle;

FIG. **5** is a modification of the threaded connection between the lance tip and the submersion nozzle as shown in FIG. **4**;

FIG. **6** is still another modification of the threaded connection between the lance tip and the submersion nozzle shown in FIG. **4**;

FIG. **7** is a sectional view of a modified form of fastener used in the submersion nozzle;

FIG. **8** is still another modification of the fastener used in the submersion nozzle;

FIG. **9** is still another modification of the fastener used in the submersion nozzle;

FIG. **10** is still a further modification of the fastener used in the submersion nozzle;

FIG. **11** is yet another modification of the fastener used in the submersion nozzle;

FIG. **12** is another modification of the submersion nozzle wherein no fastener is used;

FIG. **13** shows a modified refractory layer arrangement on the inside and outside of the oxygen tube of the submersion nozzle;

FIG. **14** is another modification of the submersion nozzle using a protective gas shield arrangement; and

FIG. **15** is another modification of the submersion nozzle using a protective gas shield arrangement as illustrated in FIG. **14.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the drawings and in particular with reference to FIG. **1** there is shown an open hearth furnace **1** having top entry opening **2** for entry of a water-cooled lance **4** for the injection of oxygen below the surface of the molten bath **5** which supports the usual slag **6.** The lance could enter into the bath from a hole in the back side wall of the furnace. This lance is made up of an upper or adaptor section **7,** a barrel section **8,** and a tip section or tip **9** as best seen in FIG. **2.** The adaptor section contains a bail **10** for extending the injection lance into the furnace, an oxygen gas inlet **11,** a cooling water inlet **12** and a cooling water outlet **13.** The barrel section **8** is made of three concentric tubes **14, 15** and **16.** Between the inner tube **14** and the outer tube **16,** the cooling water circulates with the intermediate tube **15** as a divider for downward and upward water streams. Inside the inner tube **14** the oxygen gas flows. The tip section **9** is made of high-thermal conductivity copper and is welded to the steel barrel section **8.** The construction of the lance is such that the shape of the oxygen port portion **17** at the bottom of the tip **9** is modified for the attachment of a novel submersion nozzle **20.**

It is seen in FIG. 3 that the submersion nozzle **20** is attached to the bottom of the tip **9** of the water-cooled lance **4** and includes an oxygen passage **21** in line with the oxygen port portion **17** and is made up by a short threaded copper section or copper nipple **22** which is provided with exterior threads **22***a* for engaging the threads **22***b* of the oxygen portion **17** of the tip **9,** and a welded-on lower metallic tube **23** which may be of a length of, say, 1 to 6 feet depending on the depth of the bath for passing the oxygen to the interior of the bath. Fasteners **24** are provided on the outside of the oxygen passage tube **23** for anchoring the tube **23** to the annular layer or ring **25** of refractory material. In FIG. **3** the fastener **24** comprises a spiral wire of high heat-resistant metal such as stainless steel wound about the oxygen tube **23** which is held to the nipple **22** by welds *w*. The fastener is imbedded in the refractory layer **25** giving it more body and being an aid to attach or retain the refractory material on the tube **23.** The joint **26** between the lance tip **9** and the submersion nozzle **20** is sealed or held together by a high heat-resistant refractory cement of ceramic material or the like.

FIGS. **4, 5** and **6** illustrate three modifications of alignment of the threaded connection between the tip **9** and the nozzle **20.** In FIG. **4** the threaded portion **27***a* of the oxygen port portion **17***a* has an inner enlarged or offset wall portion to provide sufficient gripping material for coupling with the nipple **22,** whereas in FIG. **5** the offset threaded portion **27***b* of the oxygen port portion **17***b* is outward, and in FIG. **6** there is shown an outer offset threaded portion **27***c* of the oxygen port portion **17***c* that is not as great as shown in FIG. **5** but is more modified and yet permits the threaded portion of the nipple **22** to extend inwardly of the threaded portion **27***c*.

FIG. **7** shows a modified form of the submersion nozzle **20.** In all instances of any of the presentations of modified forms of this invention like reference characters will be used where various components of the submersion nozzle are the same as that previously discussed. For instance, in FIG. **7** the upper portion or nipple **22** is made of copper and is threaded for attachment to the similarly threaded oxygen port portion **17** of the tip **9** as is the case of the novel arrangement shown in FIG. **3.** The oxygen port portion **17** is made of the same material as the upper nipple **22** of the nozzle, namely, copper, so that there will not be any large thermal stresses develop between them during the heating and cooling cycle of the nozzle. The material for the oxygen tube **23** that is welded to the nipple **22** by welds *w''* is of a suitable metal which has high temperature strength and is compatible in thermal expansion with the refractory sheath material **25,** such material being made of carbon steel or alloy steel, such as stainless steel. In FIG. **7** the arms **24***a* are the fasteners used as distinguished from the metal coil **24** shown in FIG. **3,** these horizontally extending arms being welded to the lower oxygen tube **23.** Further, fastener arrangements for binding the annular refractory layer **25** to the lower oxygen tube **23** as shown in FIGS. **8, 9** and **10.** In FIG. **8** a rope-like fastener **24***b* of asbestos material to withstand high temperature is wound about the oxygen tube **23** and in FIG. **9** there is shown fasteners **24***d* that are elongated metal barbed hooks **32** each having a stem **30** and a forked end **31** and are welded by welds *w* to the oxygen tube **23,** and in FIG. **10** there is shown a fastener arrangement **24***c* made from the undulated surface of a modified oxygen tube **23***a* having troughs **28** and crests **29** forming the attaching surface for the refractory layer **25.** FIG. **11** shows a modified fastener arrangement **24***e* which is a coil of wire in a spiral shape that is attached at its upper end **33** by weld *w'* to the oxygen metallic tube **23** so that the other lower end of the coil is free to move. This latter arrangement permits easy packing of the refractory material of the layer **25** around the coil **24***e* during the molding stage of the refractory sheath. The shape of the cross-section of the oxygen passage tube **23** need not be limited to a circular configuration as shown, but it can also be elliptical, square, triangular, rectangular or corrugated. A preferred construction of the submersion nozzle **20** is shown in FIG. **12** and has a conical or tapered metallic tube **23***b* for the oxygen, the tube **23***b* having a larger lower end and having a refractory sheath or layer **25***a* with a correspondingly tapered bore **34** around the tapered oxygen tube **23***b*. A stuffing material **35,** such as asbestos, graphite fibers, or mineral wool is placed in the gap between the metal tube **23***b* and the refractory tapered bore to take up tolerances between the tube **23***b* and the refractory sheath **25***a*. Because of the geometry of this tapered construction, the refractory sheath **25***a* cannot slip off the tube **23.** The porous stuffing **35** also keeps the refractory sheath tightly on the tube **23***b* and also accommodates for the difference in thermal expansion between the tube **23** and the refractory sheath **25***a*. FIG. **13** shows another modification of the submersion nozzle **20** where the protective refractory material **25** can be applied to both the inside and outside of the oxygen passage tube **23,** the configuration of the oxygen tube **23***c* including an upper narrow or reduced part **35***a*, a central middle or shoulder part **36** and a lower widened part **37** all of which is provided with long extensions or arms **38** and shorter extensions or arms **39** of the fastener arrangement **24***f*.

The refractory material for the refractory sheath or layer **25** is fire clay refractory, high alumina refractory, silica refractory, basic refractory of dolomite and magnesite, asbestos, graphite, silicon carbide, zircon, zirconia, berryllia, zirconium deboride, and cermets of molybdenum metal and zirconium oxides. Methods of application of the ceramic layer **25** about the oxygen tube **23** is by dipping and solidification of the refractory material on the tube **23,** applying a slurry of the refractory material on the heated tube **23,** snugly fitting sleeves of the refractory material over the tube **23,** molding and baking refractory sleeves **25** on the tube **23,** and casting of refractory material on the tube **23.**

FIGS. **14** and **15** are modifications of the submersion nozzle wherein these nozzles are provided with structure to receive a protective gas shield about the oxygen gas tube of the submersion nozzle to protect the erosion of the submersion nozzle at the exit end of the oxygen tube of the submersion nozzle and also at the interface between the lance tip of the injection lance and the submersion nozzle. It is well known in the prior art to provide for a shield gas to be injected into the molten bath around the oxygen gas, such as methane or other hydrocarbon gases. It is, therefore, desirable to construct the submersion nozzle to conform to an injection lance that injects along with the oxygen gas a protective or shield gas into the molten bath. The shield gas prevents or reduces the burning of the oxygen at the nozzle end of the lance and, therefore, preserves the life of the nozzle. Referring now to FIG. **14,** there is shown an ox-

ygen injection lance tip 9' that is similar to the lance tip 9 shown in FIGS. 1–3, except for the provision of an additional central tube 40 and, therefore, like parts of the tip as well as the lance in this modification will bear the same reference characters as shown in FIGS. 1–3. The additional tube 40 is added to the previously described water-cooled lance inside the tube 14 and now in this arrangement oxygen gas flows in the additional tube 40, and in the annular passage between the tube 14 and the tube 40 a protective gas flows. An inlet (not shown) is provided for the protective gas at the adaptor or upper section 7. In the submersion nozzle 20' that is attached to the lance tip 9', there is provided a nozzle inner tube 42 which has been added inside the oxygen tube 23, as shown in FIG. 7. The tube 42 conducts the oxygen gas from the tube 40 into the bath and the space between the tube 42 and the tube 23 conducts the protective gas from the tip 9' into the molten bath. Sliding spacers 44 are welded to the tube 40 and sliding spacers 46 are welded to the tube 42 and provide for accurately positioning the tube 40 on the nozzle inner tube 42. The connection between the nozzle inner tube 42 and the additional tube 40 is also of threaded construction to provide a threaded coupling therebetween as indicated at 48. Purge holes 50 are provided through the walls of the tube 23 at the interface joint 52 between the nozzle 20' and the lance tip 9' of the lance 4 for issuing a continuous apron of protective gas to prolong the life of the submersion nozzle at its upper end. FIG. 15 shows a further modification of a double concentric tube submersion nozzle 20'' for attachment to a lance tip 9'. In this construction the tube 23 of the submersion nozzle 20'' is omitted and a refractory sheath 25' is used and has a smooth bore that telescopes over tube 42 to form the annular passage 54 that communicates with the annular passage between the tubes 40 and 14 to conduct the protecting or shielding gas from the tip 9' through the submersion nozzle 20'' and into the bath. A metallic adaptor 56 of high heat resistance, such as stainless steel, is employed to anchor the refractory sheath 25' to the tip 9' of the water-cooled lance 4. The adaptor 56 replaces the nipple 22 as shown in FIGS. 1–3 and is provided with an upper threaded portion 58 to couple with the lower threaded end of the tip 9' and a lower threaded portion 60 to couple with upper threaded portion 62 of the ceramic refractory sheath 25'.

It can be seen by the foregoing description that there is provided a novel consumable type of submersion nozzle which may be either partially or completely destroyed by the molten bath. The damaged submersion nozzle may simply be removed by unthreading its nipple 22, nipples 22 and 42 or nipple 42 and adaptor 56 from the lance tip and having another submersion nozzle put in its place. The submersion nozzle is the only part that is introduced below the surface of the molten bath and is easily replaceable. The foregoing description and drawings merely explain and illustrate the invention and the invention is not limited thereto, except insofar as the appended claims are so limited, as those skilled in the art who have the disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

What is claimed is:

1. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said connector tube means including an upper coupler tube portion releasably connectible with the lower part of the tip section and a lower portion defining an oxygen exit tube,

said refractory sheath surrounding and being carried by said oxygen exit tube,

said oxygen exit tube being provided with fastener means being imbedded in the refractory sheath and said fastener means attaching to said oxygen exit tube, and

said fastener means including a coil immersed in the refractory sheath and being tightly wound about said oxygen exit tube.

2. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising;

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said connector tube means including an upper coupler tube portion releasably connectible with the lower part of the tip section and a lower portion defining an oxygen exit tube,

said refractory sheath surrounding and being carried by said oxygen exit tube,

said oxygen exit tube being provided with fastener means being imbedded in the refractory sheath and said fastener means attaching to said oxygen exit tube, and

said fastener means including an asbestos-like rope material spirally wound about said oxygen exit tube.

3. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip

section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said connector tube means including an upper coupler tube portion releasably connectible with the lower part of the tip section and a lower portion defining an oxygen exit tube,

said refractory sheath surrounding and being carried by said oxygen exit tube,

said oxygen exit tube being provided with fastener means being imbedded in the refractory sheath and said fastener means attaching to said oxygen exit tube, and

said fastener means including a vertically extending undulating surface on said oxygen exit tube which is entrained in said sheath surrounding said oxygen exit tube.

4. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said connector tube means including an upper coupler tube portion releasably connectible with the lower part of the tip portion and a lower portion defining an oxygen exit tube,

said refractory sheath surrounding and being carried by said oxygen exit tube,

said oxygen exit tube being provided with fastener means being imbedded in the refractory sheath and said fastener means attaching to said oxygen exit tube,

said fastener means including a metal coil spirally surrounding said oxygen exit tube and having an upper end fixedly attached to the oxygen exit tube with the remainder of the coil having a free end imbedded in the refractory sheath.

5. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said connector tube means including an upper coupler tube portion releasably connectible with the lower part of the tip section and a lower portion defining an oxygen exit tube,

said refractory sheath surrounding and being carried by said oxygen exit tube,

said oxygen exit tube being a first cone part with the wide base of the cone part extending in outwardly tapered manner downward and said refractory sheath being a second cone part extending its widened bottom part downward and extending over said oxygen exit tube.

6. The invention according to claim **5**, and

stuffing material of a high resistant-to-heat nature extending between the exit tube and the sheath as packing therebetween.

7. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said connector tube means including an upper coupler tube portion releasably connectible with the lower part of the tip section and a lower portion defining an oxygen exit tube,

said refractory sheath surrounding and being carried by said oxygen exit tube,

said oxygen exit tube being provided with fastener means being imbedded in the refractory sheath and said fastener means attaching to said oxygen exit tube,

said oxygen exit tube including an upper reduced vertically extending portion and a lower enlarged vertically extending portion,

said fastener means extending transversely outward of the reduced and enlarged portions and said refractory sheath surrounding the enlarged and reduced portions.

8. The invention according to claim **7**, and

said enlarged portion having transversely extending and inwardly directed fastener means and refractory sheath enveloping said inwardly directed fastener means with the refractory sheath being on all sides of said enlarged portion.

9. The invention according to claim **7**, and said nozzle having a refractory coating on the inside surface of the enlarged portion of said exit tube.

10. The invention according to claim **8**, and

said reduced portion being above said enlarged portion.

11. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said upper lance and tip sections each having a concentric shielding gas tube encircling the oxygen conduit and providing an annular shielding gas passage between the coolant conduit means and the oxygen conduit,

said connector tube means including an outer shielding gas tube and an inner oxygen exit tube within the outer tube defining the oxygen exit passage, each of the inner and outer tubes being releasably connected with said lance tip section and defining between them an annular shielding gas exit passage surrounding the oxygen exit tube and connecting with the shielding gas tube.

12. The invention according to claim **11**, and

said connector tube means being provided with purge hole means communicating with the concentric shielding gas tube.

13. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said upper lance and tip sections each having a concentric shielding gas tube encircling the oxygen conduit and providing an annular shielding gas passage between the coolant conduit means and the oxygen conduit,

said connector tube means including an outer shielding gas tube and an inner oxygen exit tube within the outer tube defining the oxygen exit passage, each of the inner and outer tubes being releasably connected with said lance tip section and defining between them an annular shielding gas exit passage surrounding the oxygen exit tube and connecting with the shielding gas tube,

said outer tube being of metal and resistant to high heat and surrounded by said refractory sheath and said inner tube being of metal and resistant to high heat.

14. The invention according to claim **13**, and

said inner and outer tubes having spacer means between them.

15. The invention according to claim **13**, and

said outer tube having fastener means projecting out transversely therefrom and said refractory sheath imbedding said fastener means and being reinforced thereby.

16. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a tip section each having a central oxygen gas conduit and coolant conduit means surrounding the oxygen conduit,

a replaceable and consumable submersion nozzle being connected with the lower end of the tip section and including a connector tube means being releasably coupled with the lower end of the tip section and having an oxygen gas exit passage and a refractory sheath of highly thermal insulative material surrounding said connector tube means and insulating the connector tube means from premature consumption by the molten bath,

said upper lance and tip sections each having a concentric shielding gas tube encircling the conduit tube and providing an annular shielding gas passage between the coolant conduit means and the oxygen conduit,

said connector tube means including an outer shielding gas tube and an inner oxygen exit tube within the outer tube defining the oxygen exit passage, each of the inner and outer tubes being releasably connected with said lance tip section and defining between them an annular shielding gas exit passage surrounding the oxygen exit tube and connecting with the shielding gas tube,

said outer tube including a releasable coupler releasably connecting with said lance tip section and including a lower outer tube defining said refractory sheath being releasably connected to said coupler and said inner tube being of high heat resistant metal.

17. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a lower lance tip section each having a central oxygen conduit and coolant conduit means surrounding the oxygen conduit,

said upper and lower lance sections having a shielding gas conduit surrounding said oxygen conduit and being surrounded by said coolant conduit means,

a replaceable and consumable submersion nozzle being releasably connected with the lower end of said tip section and having a central oxygen tube communicating with the oxygen conduits in the upper and tip sections and having an outer concentric shielding gas tube surrounding the oxygen tube and communicating with said shielding gas conduits of the upper and lower lance sections.

18. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a lower lance tip section each having a central oxygen conduit and coolant conduit means surrounding the oxygen conduit,

said upper and lower lance sections having a shielding gas conduit surrounding said oxygen conduit

and being surrounded by said coolant conduit means,

a replaceable and consumable submersion nozzle being releasably connected with the lower end of said tip section and having a central oxygen tube communicating with the oxygen conduits in the upper and tip sections and having an outer concentric shielding gas tube surrounding the oxygen tube and communicating with said shielding gas conduits of the upper and lower lance sections,

said shielding gas tube being a refractory sheath of high resistance to heat and means releasably coupling said sheath to said shielding gas conduit and said oxygen tube being of high heat resistant metal and being releasably coupled to said oxygen conduit.

19. The invention according to claim **18,** and

said means releasably coupling the shielding gas conduit to the shielding gas tube including a coupler threaded to the shielding gas conduit and to the shielding gas tube.

20. A water-cooled oxygen injection submergible lance for injecting oxygen below the surface of a molten steel producing bath from above the molten bath comprising:

an upper lance section and a lower lance tip section each having a central oxygen conduit and coolant conduit means surrounding the oxygen conduit,

said upper and lower lance sections having a shielding gas conduit surrounding said oxygen conduit and being surrounded by said coolant conduit means,

a replaceable and consumable submersion nozzle being releasably connected with the lower end of said tip section and having a central oxygen tube communicating with the oxygen conduits in the upper and tip sections and having an outer concentric shielding gas tube surrounding the oxygen tube and communicating with said shielding gas conduits of the upper and lower lance sections,

said shielding gas tube including a metal tube releasably connected to said shielding gas conduit,

said oxygen tube being a metal tube releasably connected to said oxygen conduit,

a refractory sheath surrounding said shielding gas tube.

21. The invention according to claim **20,** and

fastener means imbedded therein being attached on said shielding gas tube for connecting of the refractory sheath to the shielding gas tube.

22. The invention according to claim **20,** and

spacer means being the shielding gas tube and the oxygen tube for keeping the shielding gas tube concentric with respect to said oxygen tube.

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