

[54] **METALLURGICAL LANCE**

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[58] Field of Search **266/34 L, 34 LM; 239/132.3**

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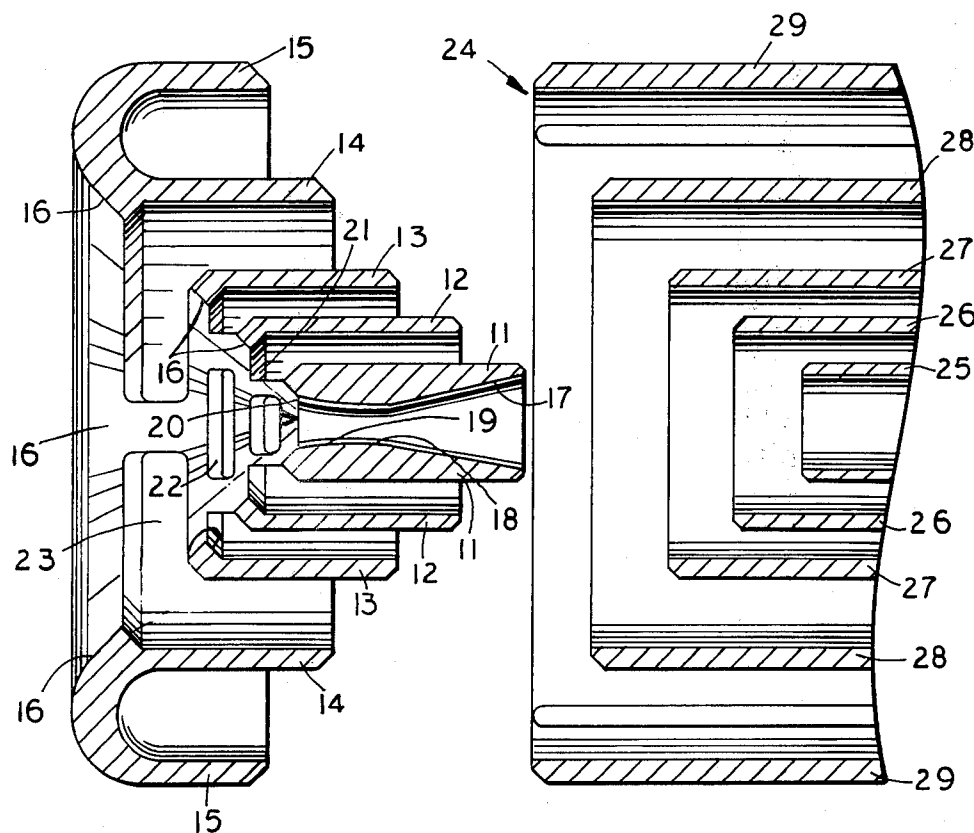
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[57]

ABSTRACT

A lancing system for introducing heat and process oxygen into a pyrometallurgical furnace comprising a lance of nested pipes, a lance tip of special design on one end of the lance, means to introduce high pressure process oxygen, low pressure combustion oxygen, air and natural gas to the other end of the lance and gas control means to provide at least 10% of the oxygen needed for combustion as pure oxygen.

5 Claims, 3 Drawing Figures



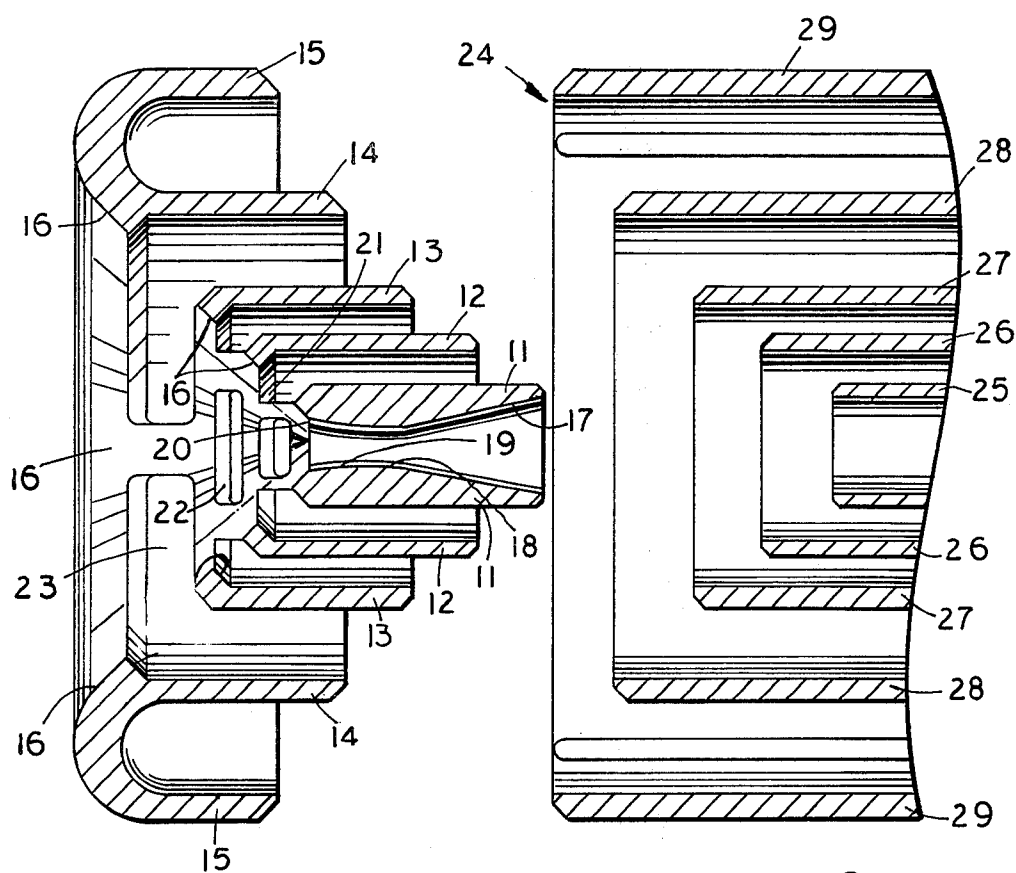


FIG. 1

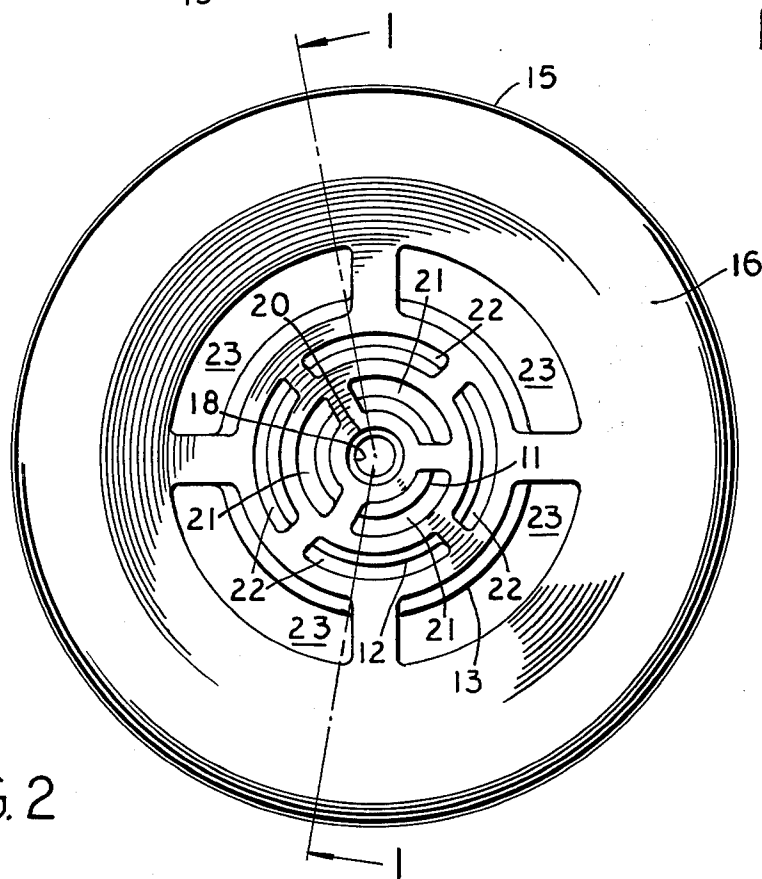


FIG. 2

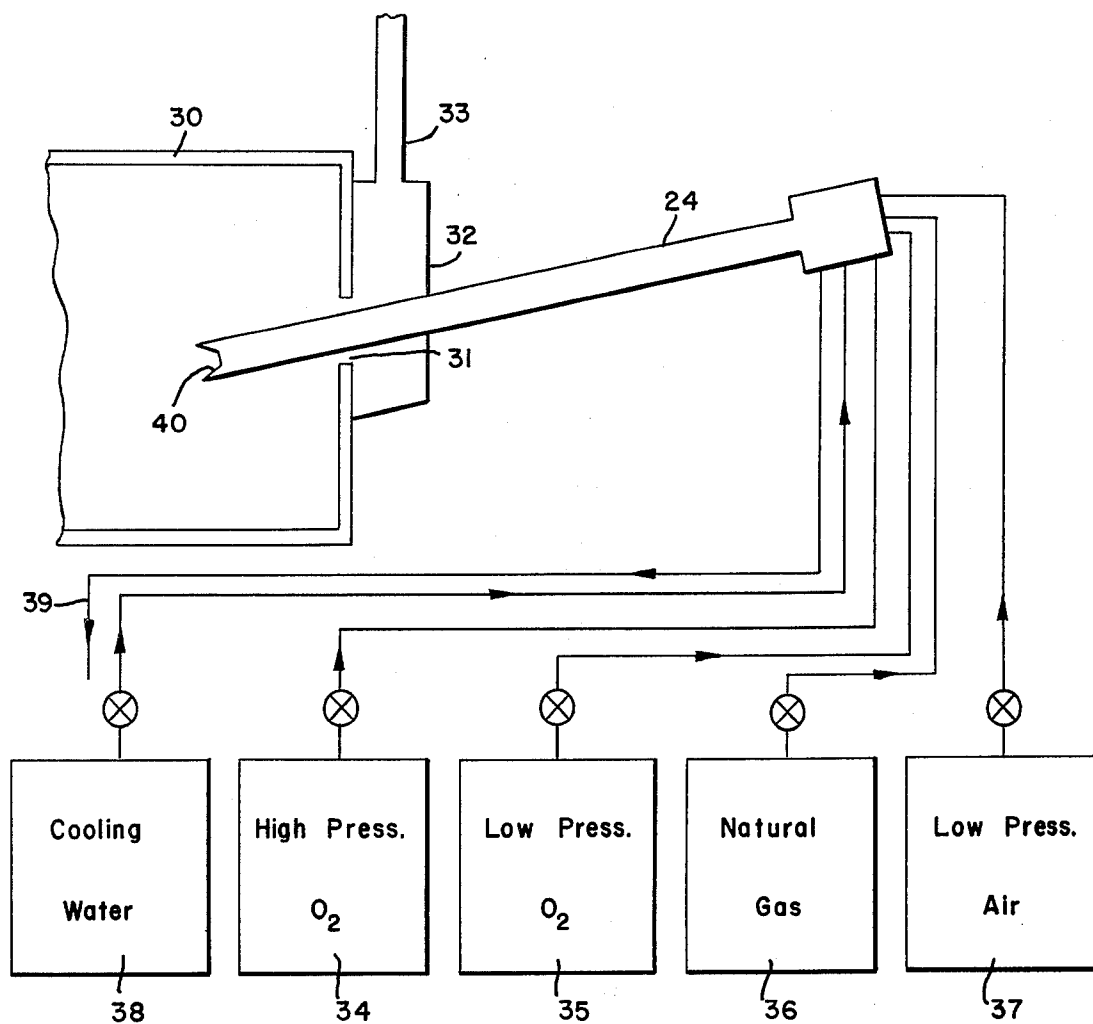


FIG. 3

METALLURGICAL LANCE

The present invention is concerned with a lancing system employed in pyrometallurgical operations and, more particularly, with a lancing system capable of both introducing a stream of high velocity oxygen into a metallurgical furnace and introducing a combustible mixture of oxidizer and fuel into a furnace and maintaining a flame with said mixture under both oxidizing and reducing conditions.

Lances (and tips therefor) for injecting oxygen into metallurgical furnaces are well known. Lances and tips therefor are also known which are capable of introducing into metallurgical furnaces combustible mixtures of fuel and oxidizer so as to provide a flame in the furnace. The present invention is concerned with a system which permits both functions to be carried on sequentially or simultaneously without the necessity of employing separate lances and which also permits the use of air for supplying up to about 90% of the oxygen needed for combustion of the fuel.

It has now been discovered that by means of a special construction and special operation, a novel dual purpose pyrometallurgical lancing system can be provided.

It is an object of the present invention to provide a novel dual purpose lancing system for use in pyrometallurgical operations.

Another object of the present invention is to provide a lance tip having a high velocity oxygen port exiting axially with respect to the lance and having sets of ports supplying fuel and oxidizer positioned forward of the high velocity oxygen port at critical axial distances apart.

Other objects and advantages will become apparent from the following description taken in conjunction with the drawing in which:

FIG. 1 depicts in longitudinal cross-section an advantageous embodiment of the lance tip useful in the lancing system of the present invention;

FIG. 2 shows a front view of the lance tip of the present invention indicating at line I—I the plane of cross-section of FIG. 1; and

FIG. 3 is a schematic representation of the total lancing system of the present invention.

Generally speaking the present invention is directed to a system for supplying heat and process oxygen to a pyrometallurgical operation which comprises essentially four components, i.e., a lance, supply means to feed gases to the lance, a special lance tip, and gas regulating means. The lance comprises at least four and, advantageously, five nesting pipes spaced apart from one another. The supply means are connected to one end of the lance to supply high pressure, e.g., about 15 to about 50 psig oxygen to the centermost pipe; to supply low pressure, e.g., about 2 to about 10 psig oxygen to the space between the centermost pipe and the next outer pipe; to supply low pressure natural gas to the next outboard space between pipes; to supply low pressure air to the still next outward space between pipes and to supply and circulate cooling water in the outermost space between the nesting pipes. If desired, low pressure oxygen and air can be premixed and passed through a single conduit in the lance. The special tip is affixed to the other end of the lance and comprises a concave end wall enclosing the space carrying water. At the depth of the concavity of the end wall is a nozzle port from which high pressure oxygen exits. Surround-

ing this nozzle port are sets of ports forward of the nozzle port through which low pressure (combustion) oxygen, natural gas and air exit. These sets of ports are spaced about 0.7 to 1.5 inch (in the axial direction) apart from the next set of ports. The gas regulating means include conventional means to provide a proper combustible mixture of the oxidizers and natural gas with the further proviso that at least 10% of the oxygen needed for combustion be supplied by low pressure oxygen.

In commercial scale pyrometallurgical operations of the character contemplated by applicant, it is often necessary to introduce heat at a rate of about 0.5×10^6 to 1×10^6 British Thermal Units (BTUs) per minute. This implies, as an order of magnitude, the combustion of natural gas at a rate of about 1,000 standard cubic feet (S ft³) per minute. For sake of economy it is desirable to use air as much as practical for combustion. However, at the same time, it is undesirable, because of fire or explosion hazards, to mix natural gas and air inside a burner when feeding fuel and oxidizer, at the required rates. It has been discovered with a lancing system of the present invention which provides for external mixing of fuel and oxidizers, that; if the fuel and oxidizer are caused to flow turbulently in the lance; if the exit ports for fuel and oxidizer are spaced about 0.75 to about 1.5 inch (about 1.9 to about 3.8 centimeter) apart in the axial direction and if at least about 10% of the oxidizer is in the form of essentially pure oxygen, a stable, useful flame structure can be maintained using air as the balance of the oxidizer.

In the lancing system of the present invention most components are conventional, e.g., valves, fittings, pumps and the like and thus are not illustrated. The special lance tip is depicted in FIGS. 1 and 2 of the drawing. Referring now thereto, a lance tip 10 comprises a plurality of coaxially nested, spaced apart pipe sections 11, 12, 13, 14 and 15 affixed to and as shown in FIG. 1, being unitary with end wall 16. End wall 16 has the shape of the surface of a frustum of a right circular cone having an included angle of about 45° to about 90°. The lower base of the cone is essentially a plane perpendicular to the axis of the tip and extending across the internal diameter of pipe section 15. Innermost pipe section 11 is formed as a nozzle having converging section 17, throat area 18, diverging section 19 and mouth 20. The upper base of the cone, the surface of which comprises outer face 16, lies essentially on a plane perpendicular to the axis of the tip and passing across mouth 20 of the nozzle. Surrounding nozzle mouth 20 on end wall 16, are three series of ports 21, 22 and 23, respectively, which advantageously are, as depicted, arcuate. The series of ports 21, 22 and 23 are spaced apart from each other (on a center-to-center basis and in the axial direction) by a distance of about 0.75 to 1.5 inch. Arcuate ports comprising series 21 open onto the space between pipe section 11 and pipe section 12. Arcuate ports comprising series 22 open onto the space between pipe section 12 and 13 and arcuate ports comprising series 23 open onto the space between pipe section 13 and 14. The spaces between the pipe sections in the tip of the present invention are adapted to open onto, and be contiguous with, corresponding spaces in a lance as schematically depicted in FIG. 1 as 23. Lance 24 comprises a plurality of nested pipes 25, 26, 27, 28 and 29. Thus, when the tip of the present invention is affixed on lance 24, gaseous fluid

conveyed in pipes 25 through 28 of the lance 24 can emerge from the tip through the nozzle of pipe section 11 or the series of ports in end wall 16. The radially outermost pipe 29 of lance 24 connecting with pipe section 15 of the tip is adapted to contain and convey cooling water in a manner well known to those skilled in the art. Accordingly, as depicted in the drawing, there is no port through end wall 16 opening upon the space between pipe sections 14 and 15. One advantage of the lance tip of the present invention is that recessed nozzle mouth 20 is protected from clogging by splashing metal, slag or the like which occurs in metallurgical operations.

In operation, the lance tip of the present invention as depicted in the drawing has the capacity for conveying four gaseous fluids into a metallurgical furnace. The gaseous fluid passing through pipe section 11 comprises high pressure oxygen which by virtue of the construction of the nozzle in the interior wall of pipe section 11 and the supply pressure exits from the tip at supersonic velocity. This high pressure (process) oxygen which exits in a direction essentially axial with respect to the lance can be used for various metallurgical purposes such as refining pig iron in various types of oxygen or oxygen-enriched furnacing operations, burning sulfur out of matte compositions and the like. Gas streams exiting from the series of arcuate ports 21, 22 and 23 are caused to be thoroughly mixed by a combination of turbulent flow of gas in the lance (for example at a Reynolds number of greater than 10,000) and the axially spaced apart positions of the exit ports. If, as is generally desirable, the space between pipe sections 11 and 12 carries low pressure oxygen, the space between pipe sections 12 and 13 carries a gaseous fuel such as natural gas and the space between pipe sections 13 and 14 carries air all flowing turbulently, this efficient mixing will permit the maintenance of a flame directly in front of the tip provided that at least 10% of the combustion oxygen is in the form of pure oxygen, (i.e., the oxidizer is air enriched at least to about 23% by volume of oxygen). Of course, if desired, high pressure oxygen or additional low pressure oxygen can be exiting from pipe section 11 at the same time. The respective areas of the series of ports 21, 22 and 23 are determined by the character of fuel and oxidizer used. The port areas as depicted in the drawing are operative for a natural gas fuel with the oxidizer comprising about 10% (of that theoretically required) low pressure oxygen with the balance being low pressure (e.g., about 2PSIG (pounds per square inch gage) air. Those skilled in the art will appreciate that various kinds of fuel and oxidizer will require various port designs. As an additional feature, oxygen can be premixed with air to provide at least the necessary 10% enrichment and the lance and tip modified to provide only a single passage for combustion oxidizer.

While the lance tip used in the system of the present invention has been depicted in the drawing as comprising a set of coaxially nested pipe sections of substantially equal length, those skilled in the art will appreciate that the pipe sections can be of any desired length provided that the end of lance 24 is configured appropriately. Furthermore, the pipe sections can be nested in a non-coaxial fashion, especially if it is desired to modify, for example, by fanning out, the flame resulting from combustion of the gas mixture emerging from arcuate ports 21, 22 and 23. With a non-coaxial arrange-

ment of the pipe sections, end wall 16 has a configuration of the surface of a truncated cone which may or may not be circular depending upon the cross-sectional shape of the pipe sections. As a further alternative, concave end wall 16 can have the shape of any curved surfaces such as, for example, the surface of a hemisphere, the surface of a hemi-ellipsoid or the like with mouth 20 of the nozzle opening through end wall 16 at or near the point of greatest concavity.

The lance tip used in the system of the present invention can be made from any metal having high heat conductivity. Embodiments of the lance tip actually constructed and used as described herein have been made of essentially pure copper.

In order to give those skilled in the art a better understanding and appreciation of the invention, the following example is given:

EXAMPLE

A lance having a tip as depicted in the drawing was employed to introduce heat and process oxygen into a top blown rotary converter containing a copper matte. Natural gas was caused to flow turbulently through the space between pipes 26 and 27 and out arcuate ports 22 at a rate of about 1,000 sft³ per minute. When only air flowing turbulently at a rate of about 9,600 sft³ per minute was supplied through the space between pipes 27 and 28 as an oxidizer, a stable flame was not obtained on ignition. By introducing at least 10% of the oxygen needed for combustion as relatively pure oxygen through the space between pipes 25 and 26 at a stable flame structure was obtained which released about 1×10⁶ BTUs per minute to the top blown rotary converter. Thereafter, at the appropriate point of the metallurgical cycle, process oxygen was introduced into the rotary converter at supersonic speed through the central nozzle. Thus by means of the lancing system of the present invention, both highly efficient heating and highly efficient use of process oxygen are obtained. The spiral lance tip design as depicted in the drawing minimized blocking effects of slag and metal splash on the oxygen nozzle.

The system employed in the example is schematically depicted in FIG. 3 of the drawing wherein lance 24 is shown to be inserted in furnace 30 through opening 31. Opening 31 is covered by hood 32 which connects to exhaust line 33. Lance 24 is fed through appropriately valved lines from source of high pressure oxygen 34, source of low pressure oxygen 35, source of natural gas 36, and source of low pressure air 37. Cooling water is fed from source 38 and exits from lance 24 through cooling water return line 39. Conically concave end 40 of lance 24 is shown within the furnace and contributes greatly to efficiency of the lancing system. When lance 24 is not in use it is withdrawn from the furnace along with hood 32. Thus it will be understood by those skilled in the art that all the lines supplying lance 24 and exhausting hood 32 are designed to facilitate the movement of the lance.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

I claim:

1. A system for supplying heat and process oxygen to a metallurgical operation comprising:
 1. a lance consisting of at least four nesting pipes spaced apart from one another,
 2. means connected to one end of the lance
 - a. to supply high pressure oxygen to the centermost pipe,
 - b. to supply low pressure oxygen and air to at least one conduit between the nesting pipes,
 - c. to supply natural gas to one other conduit between the nesting pipes,
 - d. to supply and circulate water within the outermost conduit between said nesting pipes;
 3. a tip affixed to the other end of said lance and enclosing said conduit carrying water, comprising a concave end wall having at the point of greatest concavity a port comprising a nozzle for said high pressure oxygen and having arcuate sets of ports therein communicating with the conduits carrying low pressure oxygen, natural gas and air each set of ports being spaced apart from the next set of ports by a distance of about 0.75 to 1.5 inch in the axial direction and
 4. means to regulate the flow of said low pressure oxygen, natural gas and low pressure air to provide at least 10% of the oxygen needed for combustion of said natural gas in the form of low pressure oxygen.
2. A system as in claim 1 wherein the end wall of the lance tip has the shape of the surface of a truncated cone.
3. A system as in claim 1 wherein the lance comprises five concentrically nesting pipes adapted to convey natural gas, low pressure oxygen and air in separate conduits.
4. In a process for operating a top blown rotary converter the improvement comprising introducing heat and process oxygen by means of a lancing system com-

prising:

1. a lance consisting of at least four nesting pipes spaced apart from one another,
2. means connected to one end of the lance
 - a. to supply high pressure oxygen to the centermost pipe,
 - b. to supply combustion oxidizer in the forms of low pressure oxygen and air to at least one conduit between the nesting pipes,
 - c. to supply natural gas to one other conduit between the nesting pipes,
 - d. to supply and circulate water within the outermost conduit between said nesting pipes;
3. a tip affixed to the other end of said lance and enclosing said conduit carrying water, comprising a concave end wall having at the point of greatest concavity a port comprising a nozzle for said high pressure oxygen and having arcuate sets of ports therein communicating with the conduits carrying low pressure oxygen, natural gas and air each set of ports being spaced apart from the next set of ports by a distance of about 0.75 to 1.5 inch in the axial direction and
4. means to regulate the flow of said low pressure oxygen, natural gas and low pressure air to provide at least 10% of the oxygen needed for combustion of said natural gas in the form of low pressure oxygen, under conditions whereby the combustion oxidizer and natural gas flow turbulently from the supply means through the lance, thoroughly mix in the space immediately external to the lance tip and maintain a stable flame structure forward of the lance tip.
5. A process as in claim 4 wherein turbulently flowing low pressure air and oxygen flow in separate conduits in the lance which separate conduits radially about the conduit carrying turbulently flowing natural gas.

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