United States Patent [19]

Chang

[11] **3,901,445**

[45] **Aug. 26, 1975**

[54] **GAS BURNER - LANCE CONSTRUCTION**

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[73] Assignee: **Pullman Incorporated,** Chicago, Ill.

[22] Filed: **Nov. 8, 1974**

[21] Appl. No.: **522,180**

[52] **U.S. Cl.** ..... **239/132.3;** 75/60; 266/34 L

[51] **Int. Cl.²** **C21C 5/46**

[58] **Field of Search** ..... 239/132, 132.1, 132.3; 266/30, 34 L, 41; 75/43, 52, 59, 60

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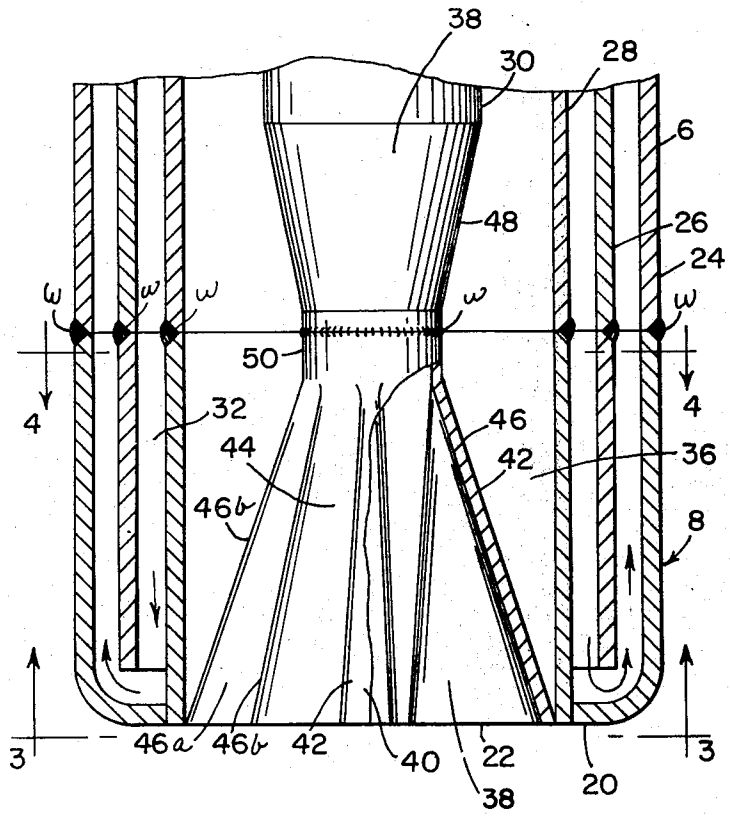
Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—Michael Mar
Attorney, Agent, or Firm—Richard J. Myers

[57] **ABSTRACT**

A gaseous burner-lance construction for burning a gaseous fuel with air or pure oxygen gas to generate heat in an industrial furnace including a specially constructed lance tip which improves the degree of mixing of the gaseous fuel and the gaseous oxidant issuing from the tip for more complete combustion, the tip having an outer concentric conduit conveying the gaseous fuel and an inner concentric conduit within the outer conduit conveying the gaseous oxidant and a gas separating partition wall structure connecting each of the conduits, said partition wall structure being deeply corrugated to provide for a plurality of fingers or lobes defining ridges communicating with the oxidant and grooves communicating with the gaseous fuel. In one embodiment the partition wall construction is an outwardly and downwardly diverging multi-lobed cone member communicating with each of the conduits and in a second embodiment a cylinder member is corrugated to provide for vertically extending fingers or ridges and in a third embodiment there is provided a partition wall construction in each of a plurality of circumferentially spaced orifices or ports on a single tip. In all of the three embodiments a sealing arrangement is provided to prevent intermingling of the gaseous fuel and the oxidant within the lance tip and yet to allow intermingling of the gases as they issue from the tip.

22 Claims, 17 Drawing Figures



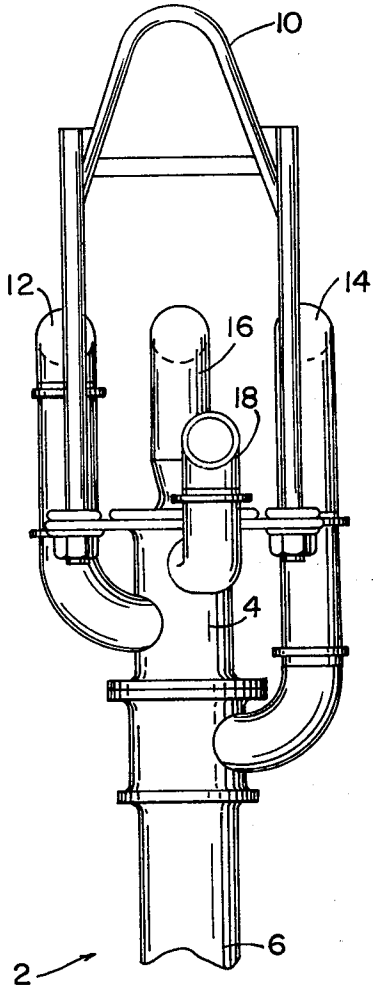


FIG. 1

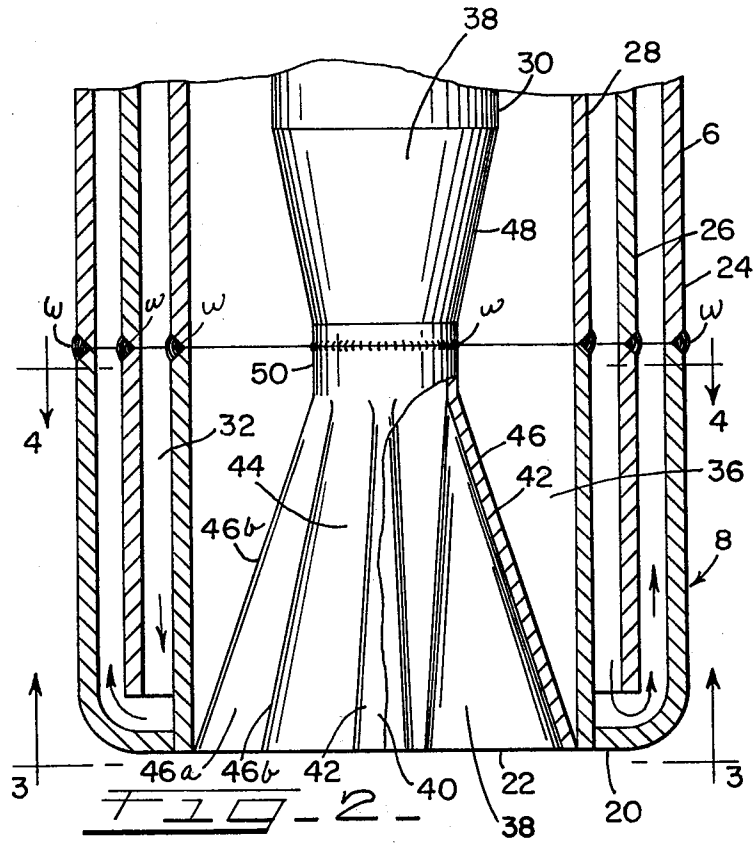


FIG. 2

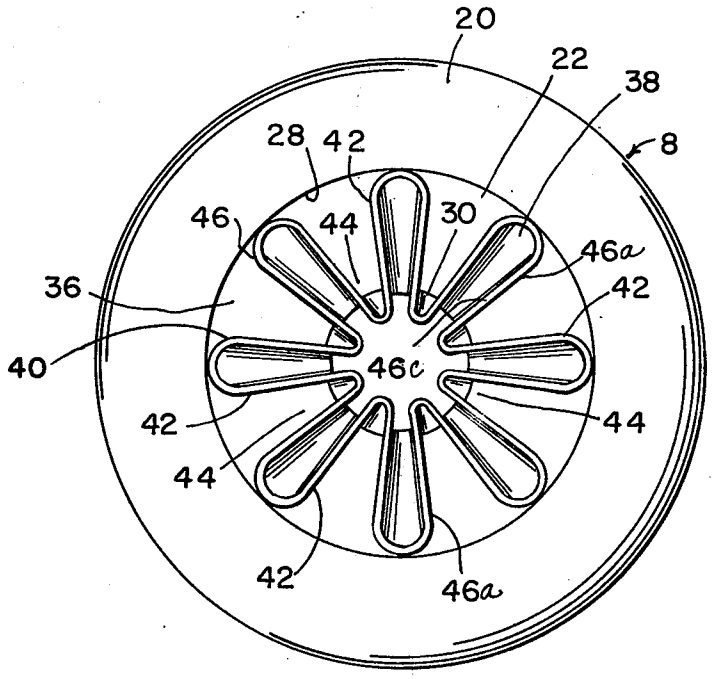


FIG. 3

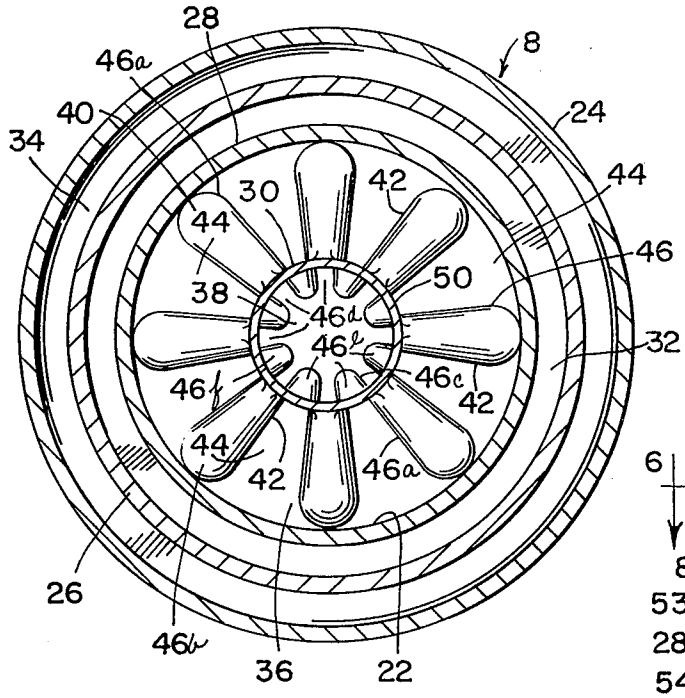


FIG_4_

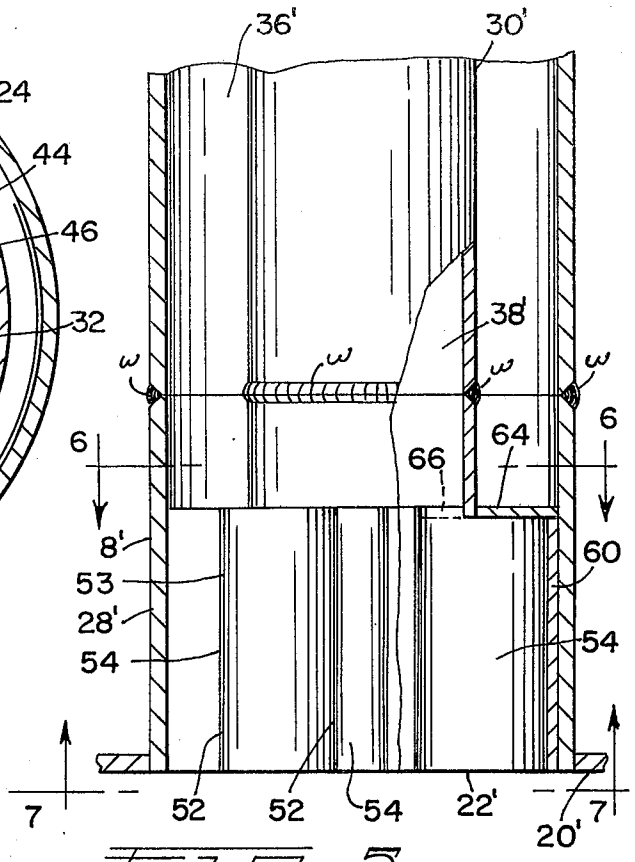


FIG_5_

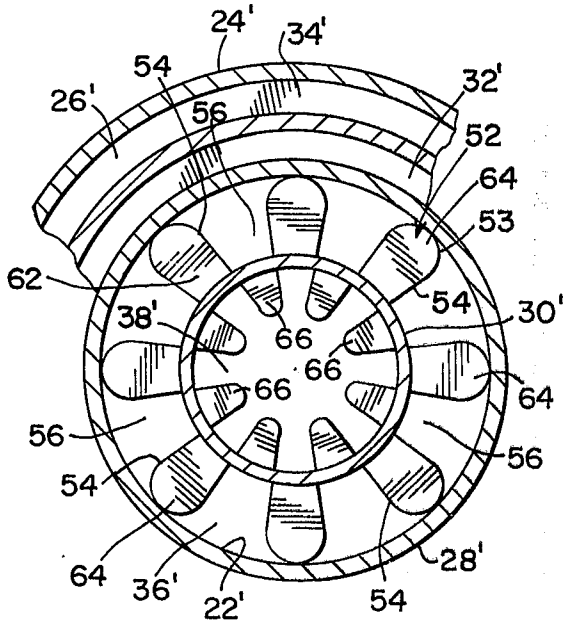


FIG_6_

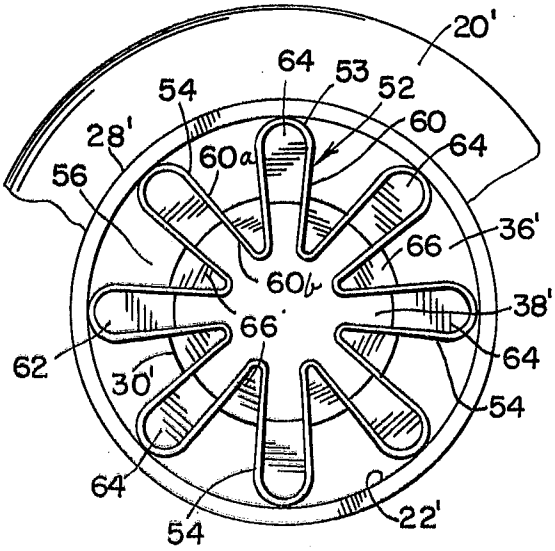
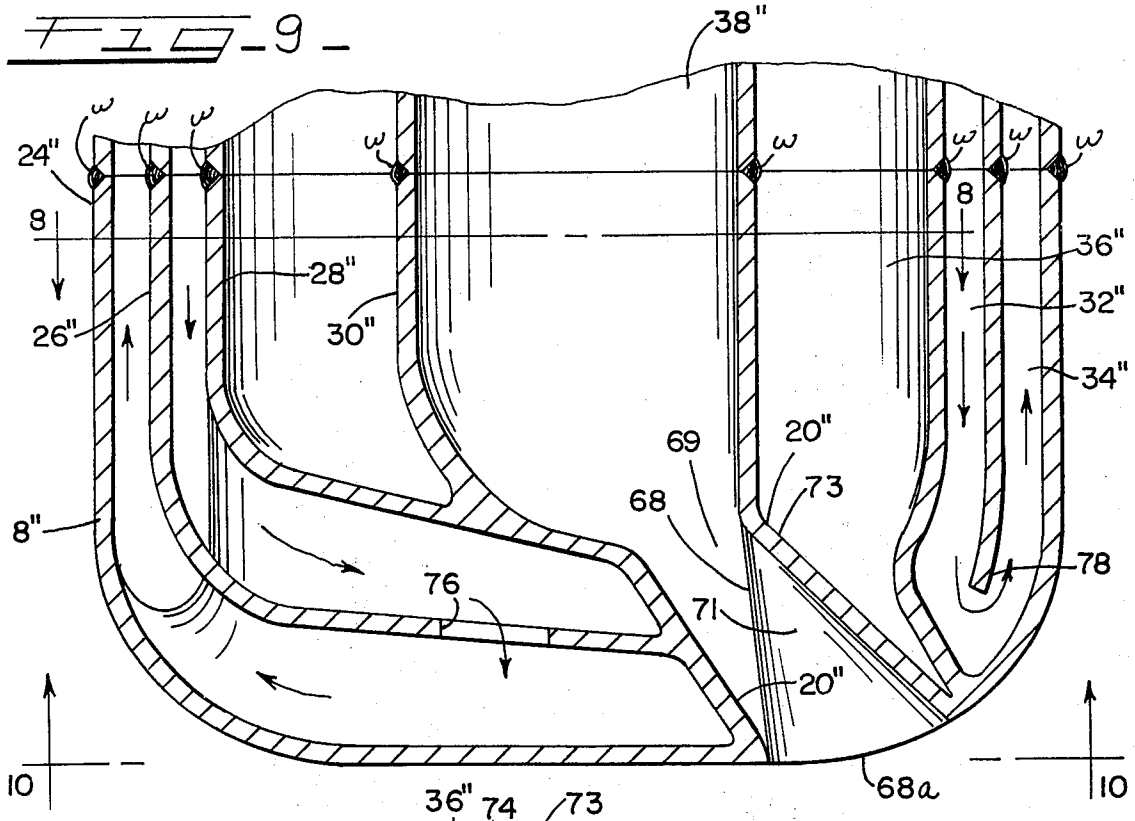


FIG_7_

FIG-9-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24"
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28"
26"
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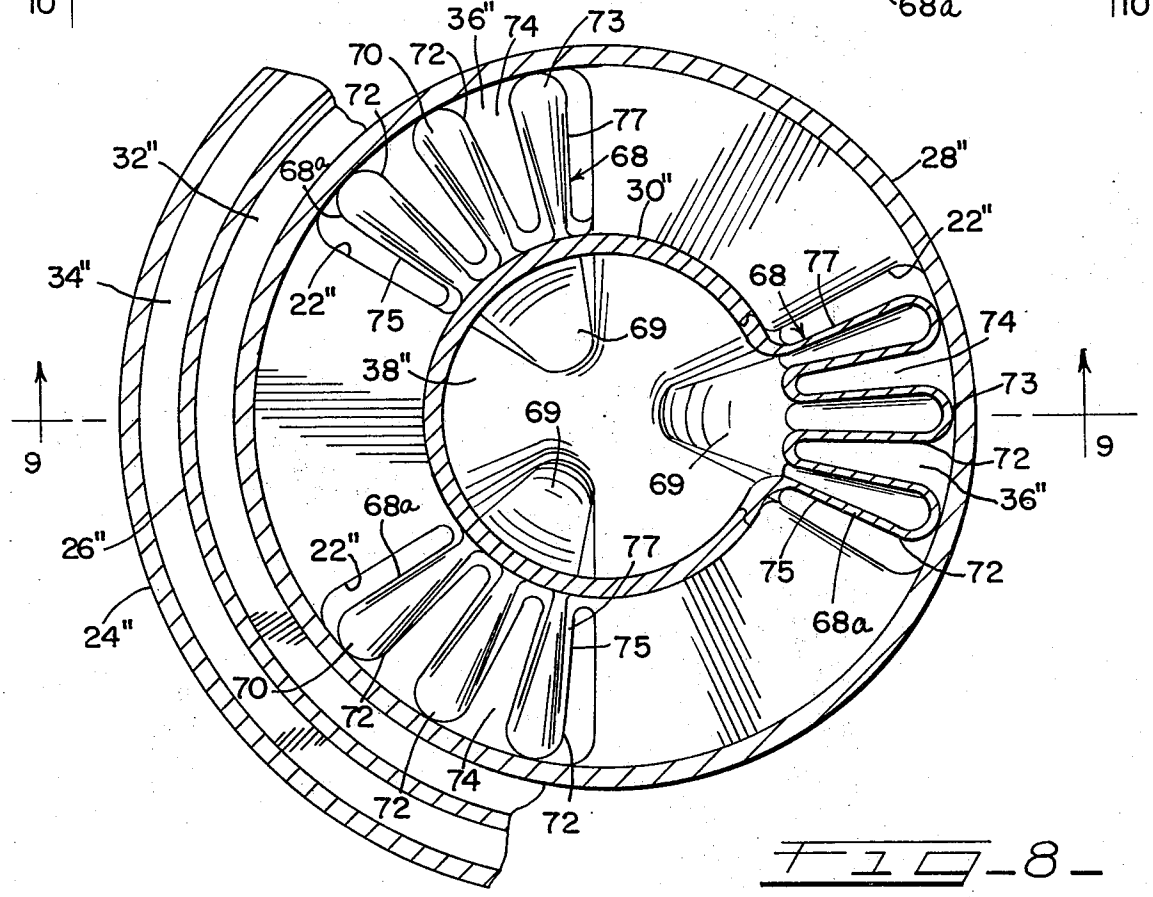
73
8"
78
76
71
20"
10
68a
10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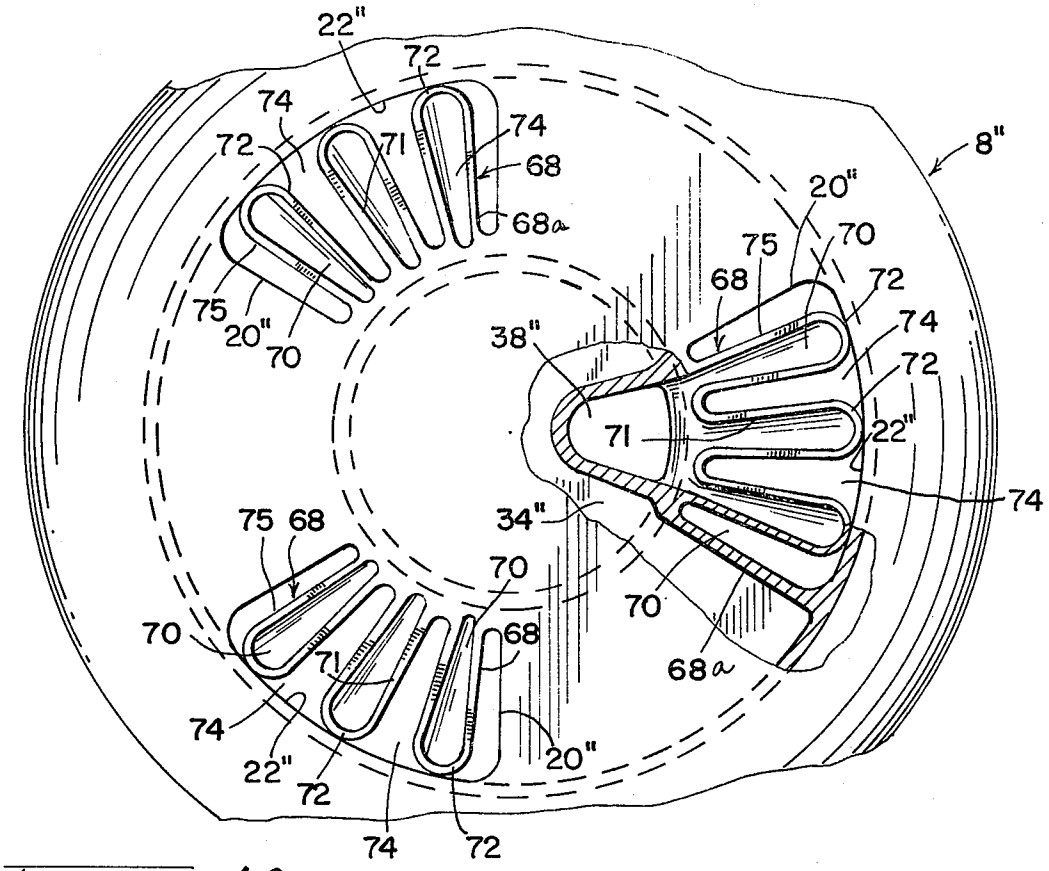
70
72
74
72
72

FIG-8-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22"
72
20"
74
72

FIG-10

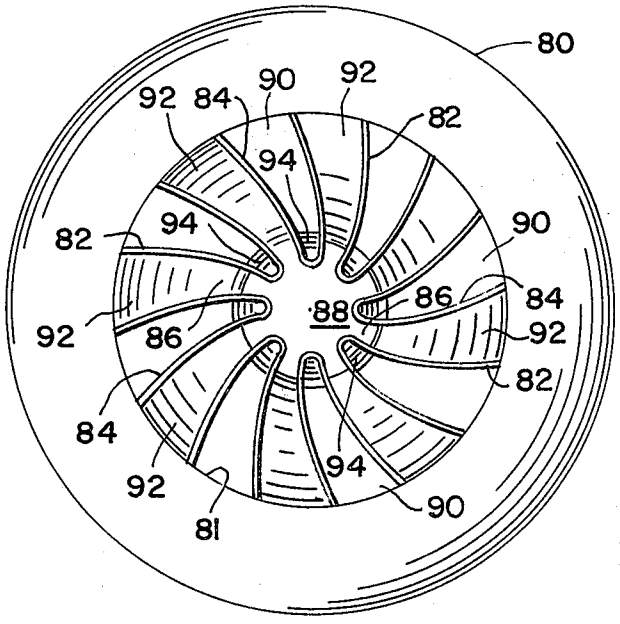
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FIG-11

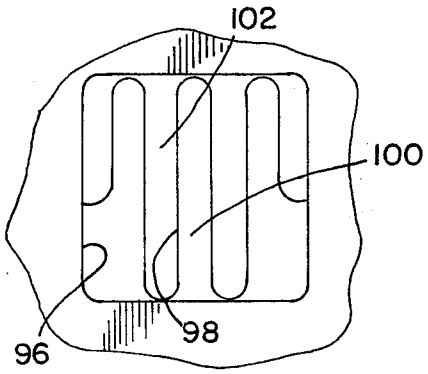

FIG. 12

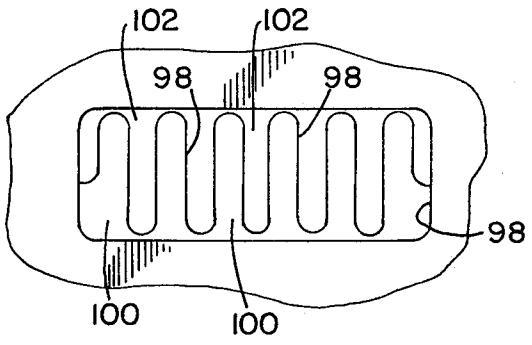

FIG. 13

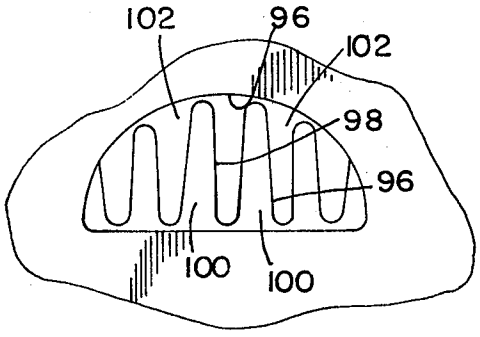

FIG. 14

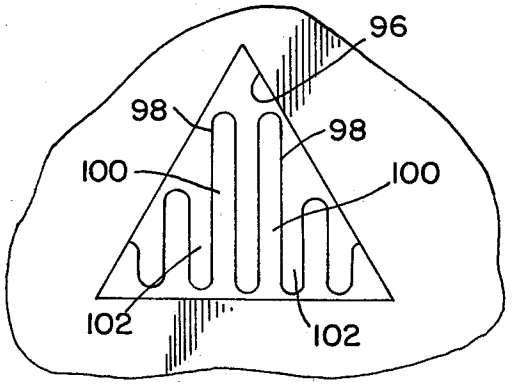

FIG. 15

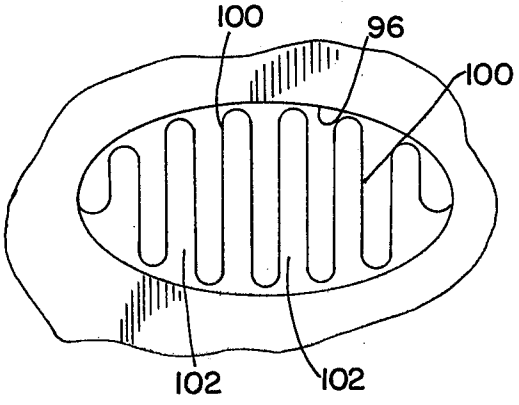

FIG. 16

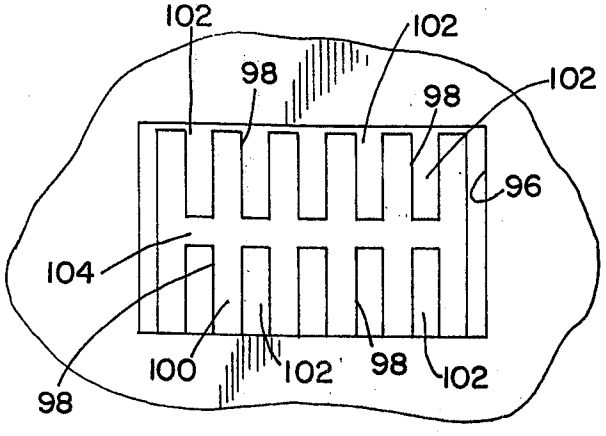

FIG. 17

GAS BURNER - LANCE CONSTRUCTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a burner-lance apparatus for burning a gaseous fuel with air or pure oxygen gas to generate heat in an industrial furnace. More particularly, the invention relates to a gas burner-lance tip constuction to provide for mixing of the gaseous fuel and the gaseous oxidant for more complete combustion.

2. Description of the Prior Art

The use of a burner-lance apparatus which introduces in a central tube of the apparatus oxygen into the molten bath and which further introduces a gaseous fuel such as methane from an outer concentric tube into the molten bath in the melting and refining of metals is known, for instance, from U.S. Pat. Nos. 3,638,932 and 3,202,201 as well as from French Patent No. 1,450,718 granted July 18, 1966. However, it is desirable that the gaseous fuel and the gaseous oxidant issuing from the lance tip should mix well with one another so as to produce a more complete combustion with a more compact and intense flame and this is what the following described invention accomplishes.

SUMMARY OF THE INVENTION

It is a general object of this invention to provide for a novel gas burner-lance that will insure more complete mixing of the oxygen and fuel gas emitting from the tip of the lance.

The invention has for its object to provide for a lance construction that has an outer concentric pipe or conduit to convey and to deliver the gaseous fuel into the furnace for burning and to further provide for a second pipe or tube of smaller diameter concentrically disposed as a central tube within the first mentioned pipe for conveying and delivering the gaseous oxidant into the furnace for mixing with the gaseous fuel for burning whereby there is provided a multi-lobed partition wall construction connecting with each of the pipes or conduits, the walls of this partition wall construction being deeply corrugated with ridges touching the inside walls of the larger outer pipe and grooves reaching nearly the centeer of the smaller or inner pipe. The gaseous oxidant flows in the lobes or ridges formed by the inner pipe or tube and the gaseous fuel flows in the spaces or grooves between the lobes and bounded by the outer pipe. This sandwiching of slices of oxidant and fuel gas insures rapid and thorough mixing of the two upon leaving the tip for burning. The construction of the partion wall construction may be a downwardly outwardly diverging corrugated cone or a corrugated upright cylinder in form or a partition wall cnstruction may consist of a plurality of partition walls each being located within a port circumferentially spaced from an adjacent port on a single lance tip.

These and other objects will become apparent from reference to the following description and appended claims and attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a burner-lance partly in section and illustrating my invention;

FIG. 2 is an enlarged sectional elevational view of the novel burner-lance tip of my invention;

FIG. 3 is a bottom plan view taken along line 3—3 of FIG. 2;

FIG. 4 is a sectional view taken along line 4—4 of FIG. 2;

FIG. 5 is a sectional elevational view of a modified form of the tip construction of my invention;

FIG. 6 is a partial sectional view taken along line 6—6 of FIG. 5;

FIG. 7 is a partial bottom plan view taken along line 7—7 of FIG. 5;

FIG. 8 is a partial cross-sectional view of a modified form of the burner-lance tip of my invention and also taken along line 8—8 of FIG. 9;

FIG. 9 is an elevational sectional view taken along line 9—9 of FIG. 8;

FIG. 10 is a bottom plan view taken along line 10—10 of FIG. 9;

FIG. 11 is still another modified burner-lance tip with a spiral corrugation arrangement as viewed from the bottom of the tip; and

FIGS. 12–17 are diagrams of various types of nozzle profiles utilizing various orifice and ridge and groove partition wall arrangements.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the drawings and in particular with reference to FIGS. 1–4 it is seen in FIG. 1 that there is shown a gas burner-lance 2 for burning gaseous fuel with air or pure oxygen gas to generate heat in an industrial furnace in order to do such things as refine a molten bath of steel. The gas burner-lance is provided with an upper section 4 and an intermediate or barrel section 6 and a lower or tip section or burner tip 8 that is provided with a single nozzle 20 that has a single orifice 22. The lance 2 is carried by a bale 10 when introducing the tip into the molten bath and the lance has its tip maintained cool by coolant means such as water which is introduced into the liquid coolant line 12 and is removed from the lance by liquid coolant line 14. The lance is further provided with an oxygen inlet line 16 and a fuel inlet line 18. The tip 8 is held to the intermediate or barrel section 6 by welds w as best seen in FIG. 2 and the barrel section as well as the tip section are provided with outer concentric tube or pipe 24, outer intermediate concentric tube 26, inner intermediate concentric tube 28 and central or inner tube or oxygen tube 30. The inlet coolant passage 32 is located between the inner and outer intermediate concentric tubes 28 and 26 and the outlet coolant passage 34 is located between the outer intermediate concentric tube 26 and the outer concentric tube 24. The gaseous fuel passage in the intermediate and tip sections is located between the oxygen tube 30 and the inner intermediate concentric tube 28 and the oxygen passage 38 for the oxygen is located within the oxygen bearing tube 30 extending into both the intermediate and tip sections. The foregoing description of the lance is conventional and its construction and design may be found in such patents as U.S. Pat. Nos. 3,525,508 and 3,638,932.

The novel aspect of my invention is the utilization of the deeply corrugated partition wall structure 40 as best seen in FIGS. 2–4. According to my invention, improved and rapid mixing of fuel gas and oxidant gas at the exit of the burner tip (that is, so called surface-mixing) is realized by arranging the flow of channels of the two said gases in such a way that each of the two

gas streams are subdivided into a number of thin slices of plumes or lobes and the two kinds of slices sandwich each other. This is done by providing a deeply corrugated partition wall **46** of the partition wall structure **40** between the fuel-gas-stream and the oxidant-gas-stream so that one gas flows in subdivided form in the ridged area of the corrugation and the other gas flows in the subdivided form in the alternating groove area. This is the characteristic of my invention. In FIGS. **2–4** it is seen that the burner tip has a single gas port or orifice **22** corresponding to the entire cross-sectional area of pipe or tube **28.** It is seen that the tip section of pipe **30** is gradually expanded to fill pipe **28** at the exiting plane, the lower part of pipe **30** actually being in the form of a cone member **40** and the wall **46** of the cone member **40** are deeply corrugated with the degree of corrugation gradually increasing from top to bottom for the orifice **22** and thus it is seen that the exiting end view of this construction is a lobed type or deeply corrugated partition wall **46** which is the partition wall between the oxygen gas and the fuel gas with the tip of the lobes or hollow ridges **42** touching the inside wall of the tube **28** adjacent the orifice **22** with the inner ends of the lobes or bases of the lobes reaching nearly to the center of the oxygen tube **30** or the cone structure **40.** Thus you have the petals or hollow ridges or flanges **42** having spaced alternately between them the grooves or valleys **44** which at their base also approach near the center of the oxygen tube **30.** The cone wall **46** of the cone structure **40** is provided with upright sides **46***a* and sloped cover or outsides for sealing means **46***b* and the cone wall **46** is provided with a cone inside **46***c*. As seen in FIG. **4,** lobe pockets **46***d* connect with the oxygen passage **38** and groove protuberances **46***e* extend inside the passage **38** and are provided with top sealing covers **46***f* to prevent oxygen from escaping from passage **38** into the fuel passage **36.** Lastly, it will be seen that the tube **30,** see FIG. **2,** connects with the lower cone structure **40** by means of the converging tapered portion **48** and the straight portion **50** of the oxygen tube **30** with the cone member **40** cooperating to provide for a converging/diverging type nozzle. It will be appreciated that the individual nozzle arrangement shown in FIG. **2** shows a converging/diverging type having the converging portion **48,** the straight portion **50** and the cone portion **46** of the oxygen tube **30.** However, the individual nozzles can be of any desired profile, that is, straight converging or diverging/converging or any combination of straight and converging or straight and diverging or just diverging. Therefore, portion **48** could be diverging or straight as well as converging while portion **46** could be straight or converging as well as diverging and these parts **48** and **46** could have any combination of this with the portion **50** being straight. It can be seen from the foregoing cone partition wall construction that the oxygen gas stream in pipe **30** upon reaching the tip section of the burner-lance will subdivide itself and fill up the lobes **42,** and will exist from the tip in a number of thin plumes whose cross-section is defined by the shape of the lobes. Similarly, the fuel gas stream in pipe **28** will subdivide itself and fill up the alternating spaces **44** between the said hollow lobes **42** bounded by the pipe or tube **28** and will exit from the tip **8** in thin slices sandwiched with that of the oxygen gas. Upon leaving the burner tip **8,** the tube gases will mix rapidly and thoroughly by traveling the short distance across the thickness of the gas-slices into each other.

Now, turning to FIGS. **5–7** there is shown a modified form of my invention of providing means of subdividing the gaseous fuel and gaseous oxidant streams into sandwiched thin plumes and this second embodiment differs from the first embodiment mainly in the construction of the corrugated partitional wall structure. While in the first embodiment, the corrugation wall is in the form of a cone, this corrugated partitional wall structure **52** of my second embodiment is in the form of a cylindrical member or cylinder **53.** The depth of the corrugation for ridges or lobes **54** instead of varying as in the first embodiment of the cone structure is uniform from one end to the other vertically of the cylinder. The second embodiment is provided with elements that are similar to those shown in the first embodiment and these elements are marked with a short vertical line to the upper right part of the number or primed. For instance, the inner intermediate concentric tube is marked **28′** and the fuel passage is marked **36′**, etc. See oxygen passage **38′**, tip section **8′**, oxygen tube **30′**, orifice **22′**, outer concentric tube **24′**, outer intermediate concentric tube **26′**, nozzle **20′**, outlet coolant passage **34′**, and inlet coolant passage **32′**. Between the ridges or lobes **54** are provided the U-shaped grooves or spaces **56** in which flows the gaseous fuel such as a hydro-carbon as methane while the oxygen or air flows in the hollow spaces in the ridges or lobes **54.** The corrugated cylindrical member **53** is comprised of a continuous undulating or corrugated side wall **60** which has an outside surface **60***a* where the gaseous fuel is and an inside surface **60***b* where the oxygen is. The U-shaped portions of the groove formed between two ridges and extending within the oxygen tube **30′** on the top of the corrugated wall **60** are covered by groove seal plate portions **66** and the tops of the ridges extending into the gaseous fuel chamber **36′** are covered by ridge seal plate portions **64,** the portions **64** and **66** being a sealing or sealer plate **62** shown in FIGS. **6** and **7** which plate alternatingly seals the groove portions inside the oxygen pipe and the ridge portions outside the oxygen pipe.

My third embodiment is shown by FIGS. **8–10** In the two previous embodiments, the burner tip utilizes a single port, whereas the third embodiment concerns a burner tip **8″** with multiple ports or orifices **22″**. The number of ports can be any number greater than two and there is illustrated herein a three-port tip. As mentioned in the previous or second embodiment there are elements in this third embodiment that are common to or similar to the embodiment shown in the first design of FIGS. **1–4** and where this occurs the reference characters of these elements will be double prime, as for instance, in the case of the elements, outer concentric tube **24″**, outer intermediate concentric tube **26″**, inner intermediate concentric tube **28″**, central or inner tube **30″**, inlet coolant passage **32″**, outlet coolant passage **34″**, nozzle **20″**, fuel passage **36″** and oxygen passage **38″**. In each of these three ports there is provided a corrugated partition wall structure **68** including a corrugated wall **68***a* separating the oxidant stream and the fuel stream. This corrugated partition wall **68***a* is constructed by modifying the end portion of the oxidant pipe **30,** wherein the oxidant and fuel gases coming out of each port are in the form of sandwiched thin plumes. The corrugated wall portion **68***a* defines

a plurality of ridges or lobes or fingers **72** which form oxygen chambers **70** each of which has an inside surface **71** and an outside surface **75.** The oxygen gas flows into the finger or ridge **72** and the methane gas flows into the grooves or methane chambers **74** between the ridges **72.** The nozzle **20''** is of the diverging type and communicates with the oxygen tube **30''** via the prechamber opening **69.** The ridges or lobes **72** have their tops all covered by the sealer cap portions or tops **73.** The coolant flows from passages **32''** to passages **34''** by way of water port **76** (see FIG. **9**) and the coolant is deflected on the right side of the nozzle by deflector **78** when passing from coolant passage **32''** to coolant passage **34''**.

In any of these modifications described above the corrugated partition wall is dependent somewhat on the diameters of the oxygen pipe **30** and the adjacent outer concentric pipe **26,** but the length of the corrugated partition wall can be varied considerably without violating the spirit of the invention. In the case of a cone-shaped partiton wall, the sustained angle of the cone can also be varied considerably. The number of corrugations, that is, the number of grooves and ridges, is somewhat dependent on the size of the oxygen pipe **30** but is closely related to the desired thickness of the gas plumes. In general, the larger the number of corrugations, the thinner the gas plume, the more efficient the mixing of the gases upon exiting from the tip. In general, the lobes are shaped in such a way that the gas slices will be more or less uniform in thickness, but the shape of the lobe can be varied in an unlimited number of ways without departing from the spirit of this invention. Furthermore, the depth of corrugation can be varied.

The direction of the corrugation of the corrugated partition wall is not limited to the axial direction of the port. It can be spiralized to impart some swirling motion to the gas plume to accelerate mixing. FIG. **11** is illustrative of such a spiralized corrugation where there is provided a burner tip **80** having an orifice **81** and partition lobes or fingers **82** each being provided with a pair of lobe or finger walls **84** that extend vertically but are spiral or curved, each lobe **82** defining a chamber **86** for receiving the oxygen from the central oxygen passage **88.** The grooves **90** as viewed in the bottom view of FIG. **11** are the methane chambers and are disposed between the finger chambers **86.** Oxygen sealer caps or plates **92** are provided on the tops of the lobes **82** extending in the fuel gas or methane pipe and methane or fuel gas sealer caps or plates **94** are provided on the groove portions of the groove **90** extending into the central oxygen passage **88.** Lastly, FIGs. **12–16** are illustrative of the cross-sectional shape that the port of the tip of the burner can take and FIG. **17** is illustrative of the shape that the groove and ridges can take. Specifically, FIG. **12** shows that the port or orifice can be square in shape and be provided with fingers **96,** finger chamber **100,** and groove or fuel gas chamber **102.** FIG. **13** shows the port to be rectangular in shape and FIG. **14** shows the port to be crescent shaped and FIG. **15** shows the port to be triangular shaped and FIG. **16** shows the port to be oval in shape. FIG. **17** shows the fingers or ridges **98** to be multiple H-shaped in form with a lateral finger or ridge connector branch **104.**

The burner tip can be made of any suitable material such as metal, ceramic, cermet, or a combination of these in the form of a coating or composite. Further, the burner tip can be fabricated by any suitable method such as casting, welding, machining or combination of them.

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. In a burner-lance for burning a fuel-gas with a gaseous oxidant in a furnace having a substantially elongated lance barrel section and a lance tip section, said lance tip section comprising:

a port means in the end thereof,

a corrugated partition structure within said port means,

an inner tube connecting with said partition structure and defining a first gaseous passage,

an outer tube concentric about said inner tube and defining a second gas passage, and

said corrugated partition structure having a deeply corrugated vertically extending partition wall formed into an upright tubular member and defining a plurality of alternating depp upright hollow ridge portions and open groove portions with the ridge portions communicating with the first passage and the grove portions communicating with second passage, whereby alternating plume layer gases can mix with one another outwardly of the port means.

2. The invention according to claim **1,** and

said ridge portions and groove portions having alternating ports extending respectively into said second passage and said first passage, and

said partition structure having sealing means on the partition wall preventing mixing of the first gas with the second gas between the alternating ports of the ridge portions and groove portions within the port means.

3. The invention according to claim **1,** and

said partition wall comprising an annular upright cone-shaped member having its upper narrowest part connecting with the inner tube and its lowest widest part being adjacent said lower end of said concentric outer tube.

4. The invention according to claim **1,** and

said ridge portions and groove portions having alternating ports extending respectively into said second passage and said first passage,

said partition structure having sealing means on the partition wall preventing mixing of the first gas with the second gas between the alternating ports of the ridge portions and groove portions within the port means,

said partition wall comprising an annular upright cone-shaped member having its upper narrowest part connecting with the inner tube and its lowest widest part being adjacent said lower end of said concentric outer tube, and

including the downward sloping portion and said sealing means of the ridge portions.

5. The invention according to claim **1,** and

said partition wall comprising an annular upright cone-shaped member having its upper narrowest part connecting with the inner tube and its lowest

widest part being adjacent said lower end of said concentric outer tube, and

said lowest widest part of said cone-shaped member touching the inner wall of said outer concentric tube.

6. The invention according to claim **1**, and

said first gas passage being oxygen bearing and said second gas passage being fuel bearing.

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

said fuel being a hydrocarbon gas.

8. The invention according to claim **1**, and

said barrel section having an inner pipe for carrying a first gas connecting with the inner tube and having an outer concentric pipe for carrying a second gas connecting with said outer concentric tube.

9. The invention according to claim **1**, and

said ridge portions forming a curved spiral shape for giving gyrating motion to gases exiting from the tip section to increase mixing of the first and second gases.

10. The invention according to claim **1**, and

said port means being rectangular in shape.

11. The invention according to claim **1**, and

said port means being triangular in shape.

12. The invention according to claim **1**, and

said port means being oval in shape.

13. The invention according to claim **1**, and

said port means being circular in shape.

14. The invention according to claim **1**, and

said port means being crescent in shape.

15. The invention according to claim **1**, and

said port means including a plurality of circumferentially spaced ports on the outer peripheral portion of the tip section,

a corrugated partition structure being in each port and communicating with the inner tube and the outer tube, and

each port having a passageway communicating with the hollow interior of the ridge portions and the inner tube.

16. In a burner-lance for burning a fuel-gas with a gaseous oxidant in a furnace having a substantially elongated lance barrel section and a lance tip section, said lance tip section comprising:

a port means in the end thereof,

a corrugated partition structure within said port means,

an inner tube connecting with said partition structure and defining a first gaseous passage,

an outer tube concentric about said inner tube and defining a second gas passage,

said corrugated partition structure having a deeply corrugated vertically extending partition wall formed into an upright tubular member and defining a plurality of alternating deep upright hollow ridge portions and open groove portions with the ridge portions communicating with the first passage and the groove portions communicating with second passage, whereby alternating plume layer gases can mix with one another outwardly of the port means,

said partition wall comprising an annular upright cone-shaped member having its upper narrowest part connecting with the inner tube and its lowest widest part being adjacent said lower end of said concentric outer tube, and

said cone-shaped member including sealer means for the portions of the ridge portions and groove portions extending respectively into the outer tube and inner tube to prevent commingling of the first gases and second gases within the tip section.

17. In a burner-lance for burning a fuel-gas with a gaseous oxidant in a furnace having a substantially elongated lance barrel section and a lance tip section, said lance tip section comprising:

a port means in the end thereof,

a corrugated partition structure within said port means,

an inner tube connecting with said partition structure and defining a first gaseous passage,

an outer tube concentric about said inner tube and defining a second gas passage,

said corrugated partition structure having a deeply corrugated vertically extending partition wall formed into an upright tubular member and defining a plurality of alternating deep upright hollow ridge portions and open groove portions with the ridge portions communicating with the first passage and the groove portions communicating with second passage, whereby alternating plume layer gases can mix with one another outwardly of the port means, and

said partition wall including a generally corrugated annularly shaped member having said ridge portions and groove portions forming vertical walls.

18. The invention according to claim **17**, and

said partition structure including sealer means extending over the parts of the ridge portions extending into the outer concentric tube to prevent gas in the ridge portions from passing into the outer concentric tube, and

said sealer means extending over the parts of the groove portions extending into the inner tube to prevent the gas in the groove portions from passing into the inner tube.

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

said sealer means including a top sealer plate on said annularly shaped member, said plate having alternating oppositely directed tab portions alternately covering the ridge portions extending into the outer tube and the groove portions extending into the inner tube.

20. The invention according to claim **17**, and

said annularly shaped member being generally cylindrical in shape.

21. In a burner-lance for burning a fuel-gas with a gaseous oxidant in a furnace having a substantially elongated lance barrel section and a lance tip section, said lance tip section comprising:

a port means in the end thereof,

a corrugated partition structure within said port means,

an inner tube connecting with said partition structure and defining a first gaseous passage,

an outer tube concentric about said inner tube and defining a second gas passage,

said corrugated partition structure having a deeply corrugated vertically extending partition wall formed into an upright tubular member and defining a plurality of alternating deep upright hollow ridge portions and open groove portions with the ridge portions communicating with the first passage and the groove portions communicating with

the second passage, whereby alternating plume layer gases can mix with one another outwardly of the port means,

said port means including a plurality of circumferentially spaced ports on the outer peripheral portion of the tip section, and

a corrugated partition structure being in each port and communicating with the inner tube and the outer tube.

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

said ridge portions and groove portions having cover parts sealing the ridge portions from the outer tube and the groove portions from the inner tube.

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