United States Patent [19]

Rymarchyk et al.

[11] E **Re. 28,769**

[45] **Reissued Apr. 13, 1976**

[54] **NOZZLE FOR FUEL AND OXYGEN LANCE ASSEMBLY**

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

[22] Filed: **Dec. 9, 1974**

[21] Appl. No.: **531,005**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,823,929**
Issued: **July 16, 1974**
Appl. No.: **396,912**
Filed: **Sept. 13, 1973**

[52] **U.S. Cl.** ..... **266/34 L**; 239/132.3
[51] **Int. Cl.²** **F27D 23/00**
[58] **Field of Search** ..... 239/132.3; 266/34 L, 41

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

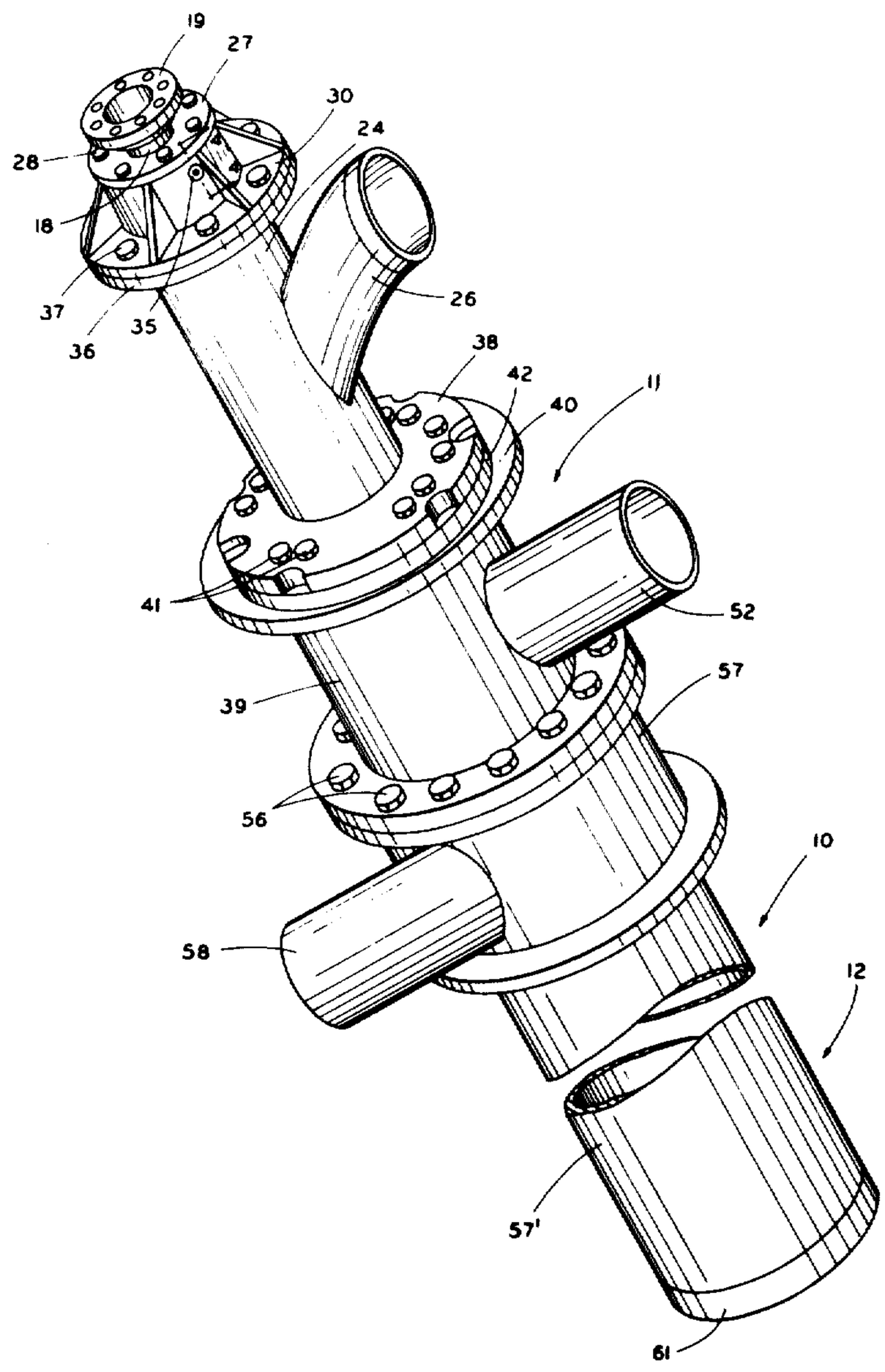
1,070,049 5/1967 United Kingdom ..... 266/34 L

Primary Examiner—Gerald A. Dost

[57] **ABSTRACT**

A lance for directing oxygen and fuel oil to a basic oxygen furnace includes a central fuel pipe, an insulating pipe around said fuel pipe, an oxygen pipe and water coolant pipes, all concentrically disposed. The central fuel pipe and insulating pipe have closed bottom walls and a plurality of relatively narrow fuel tubes are connected to bores in the bottom wall of the fuel tube, extend through the bottom wall of the insulating pipe and extend into three converging-diverging orifices. The narrow fuel tubes are supported in cantilever fashion and are concentric with each orifice.

8 Claims, 6 Drawing Figures



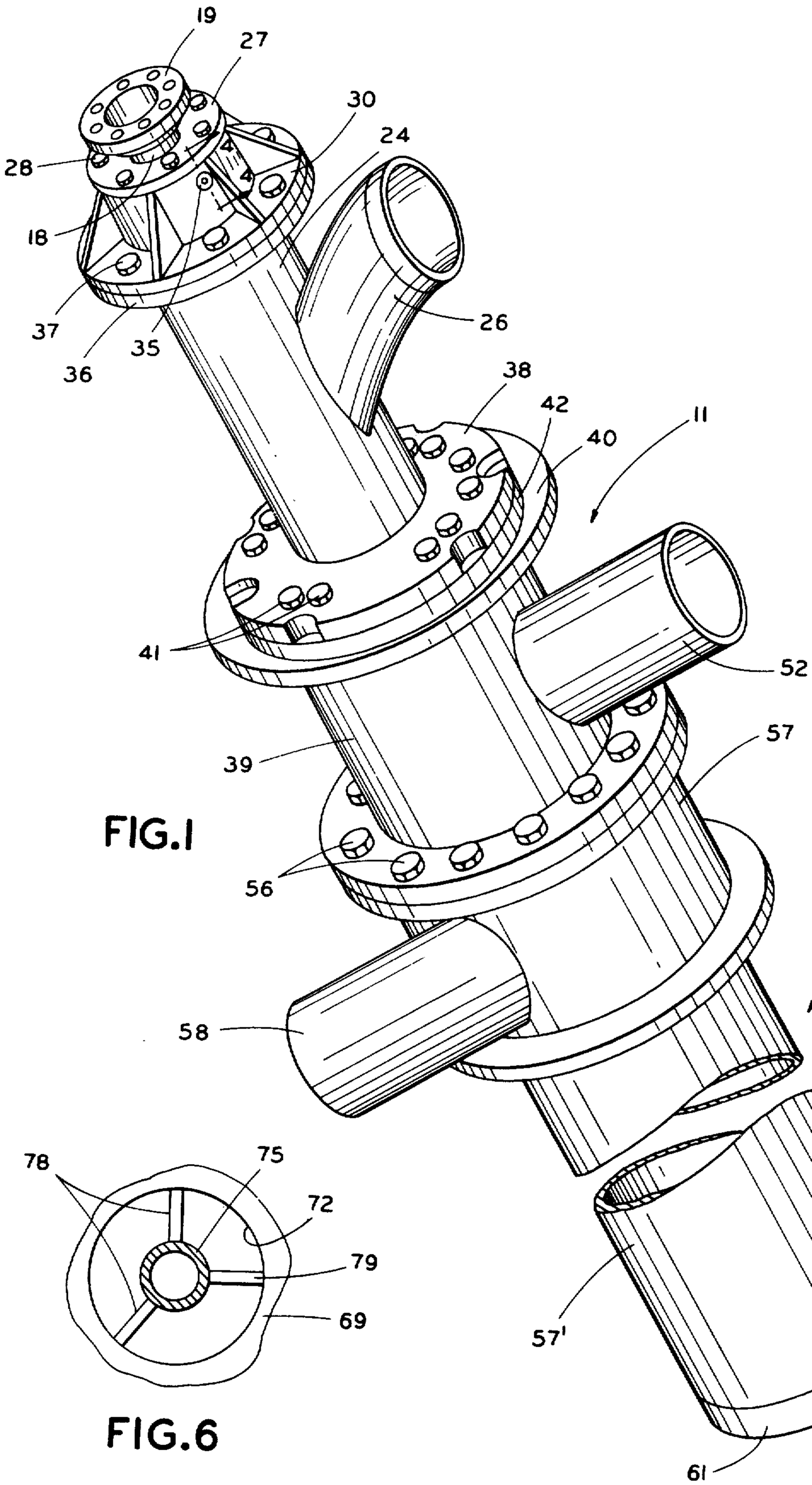

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FIG.1

78
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FIG.6

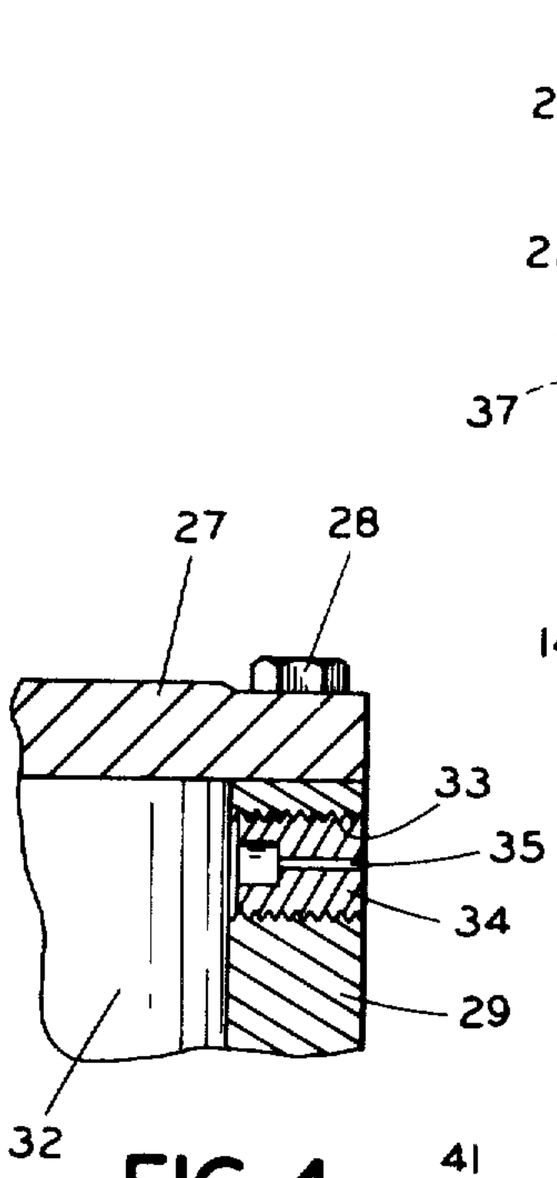
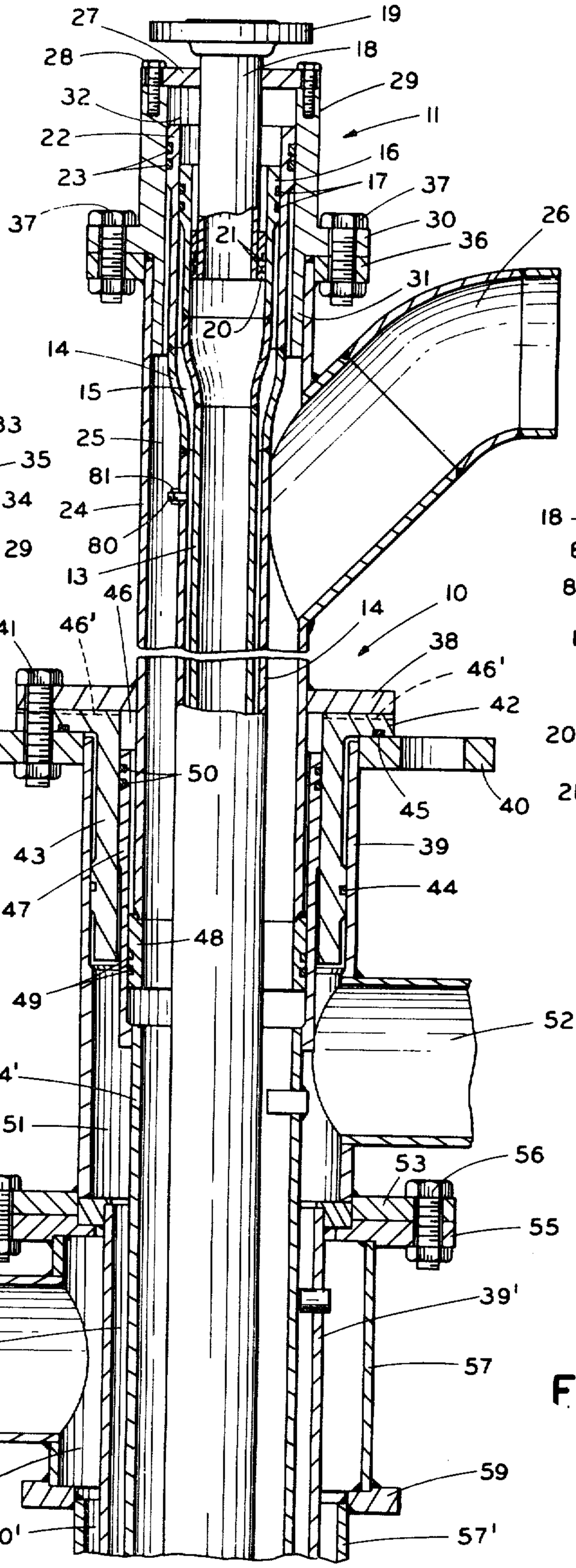


FIG.4



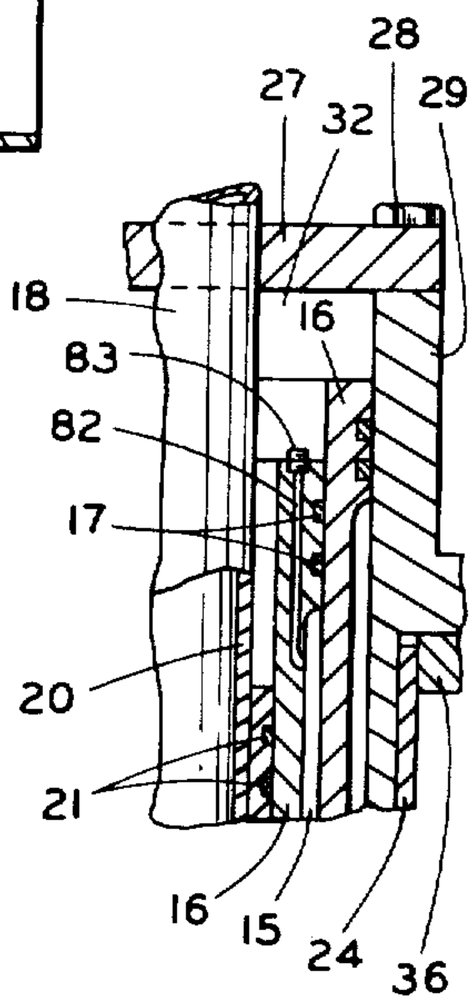
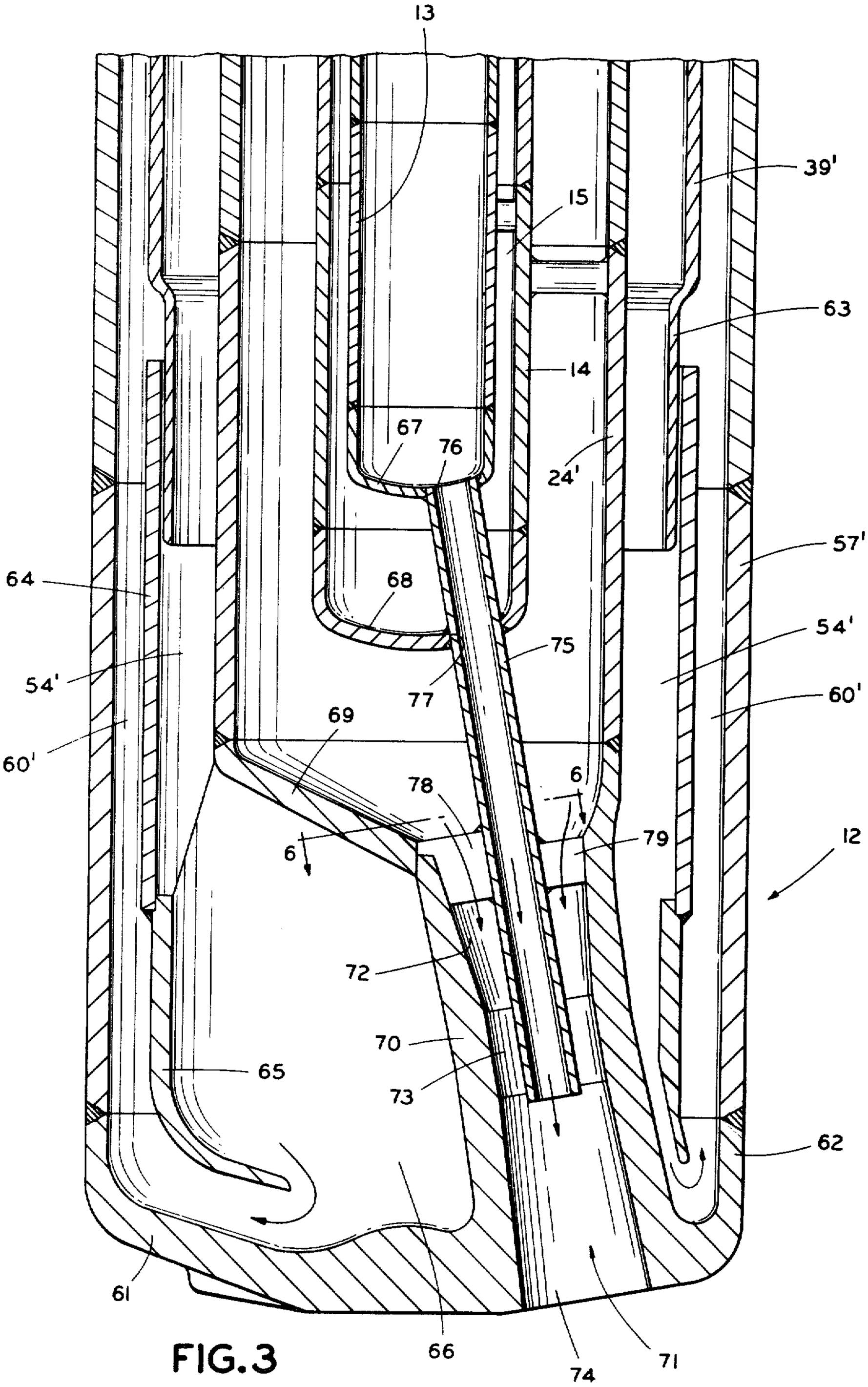


FIG.5

FIG.2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74
71

FIG. 3

NOZZLE FOR FUEL AND OXYGEN LANCE ASSEMBLY

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATION

Application Ser. No. 396,911 filed Sept. 13, 1973.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the art of steel making equipment and more particularly to an improved oxygen-fuel injection lance for introducing oxygen and fuel gas simultaneously into an open hearth furnace or basic oxygen furnace with the intermixture of the oxygen and fuel anywhere in the lance except in the nozzle ejecting orifices.

2. Description of the Prior Art

The prior art is disclosed in the following patents:

2,991,173	7/4/61	75/52	Trentini and Vayssiere
3,076,642	2/5/63	266/41	Dhenein
3,313,535	4/11/67	266/34	Hopkins
3,342,473	9/19/67	266/41	White
3,556,497	1/19/71	266/34	Grenfell
3,608,881	9/28/71	266/41	Yordanov et al.
3,626,501	12/7/71	266/41	Baird et al.

SUMMARY OF THE INVENTION

The present lance includes five concentric pipes, with a central fuel pipe having a transverse first closure wall. An insulating pipe around said closure wall also includes a second transverse closure wall below said first wall. The lance end or nozzle is of the multiple type including three equally spaced orifices of convergent-divergent cylindrical wall construction. Three relatively narrow fuel tubes are secured to the first wall, communicate with the first or central fuel pipe and project through the second wall in cantilever relation. The narrow tubes are supported further by spacers within the orifices, the said spacers permitting the free flow of oxygen around the narrow tubes. The ends of the narrow tube terminate within the orifices where the gas and oxygen are intermixed and directed to the B.O.F. bath.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view disclosing one embodiment of the gas injection lance of this invention;

FIG. **2** is a cross sectional view disclosing a top adapter assembly of the injection lance shown in FIG. **1**;

FIG. **3** is a cross sectional view through the lower portion or nozzle end of a gas injection lance;

FIG. **4** is a detail view in cross section taken substantially along the line **4—4** of FIG. **1**;

FIG. **5** is a detail cross sectional view through the uppermost part of an adaptor assembly showing a modified detail of the invention; and

FIG. **6** is a cross sectional view taken substantially along the line **6—6** of FIG. **3.**

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, an oxygen fuel lance assembly is designated at **10** and includes a top assembly **11** and a lower nozzle or lance tip designated at **12.** The lance assembly **10** comprises a first inner pipe **13** which is utilized for the flow of fuel oil, or similar type of fuel, adapted to effectively mix with the oxygen at the nozzle end and to be directed therewith to the interior of a basic oxygen furnace to provide for the refining of steel. The basic oxygen process is well known to those skilled in the art and the physical and organic reactions occurring in the steel and bath assembly as a result of the oxygen and fuel flow need not be described in detail since the present invention is primarily detailed to the construction of the lance assembly.

The first inner pipe **13** which extends substantially the full length of the lance is surrounded and concentric with a second insulating pipe **14** which provides therebetween an insulataing space **15.** As disclosed in FIG. **2,** the upper end of the pipe **13** is provided with an enlargement and which has integral therewith an enlarged sleeve **16** of piston-like configuration. The enlarged piston type sleeve is provided with a plurality of sealing rings **17.** The sealing rings **17** may be of any suitable conventional construction and O-type sealing rings are effective for this purpose. A stub pipe **18** is in mating relation with respect to the sleeve **16** and is provided at its upper end with an adaptor connection **19** which may be suitably connected to a source of fuel oil. The lower end of the stub pipe **18** is provided with a piston sleeve portion **20,** also including a plurality of sealing rings **21.** The second insulating pipe **14** is also similarly provided with an enlarged piston sleeve **22** at its upper end which projects upwardly beyond the sleeve **16.** The piston sleeve **22** is also provided with a plurality of seals **23.**

A third pipe is indicated at **24** and is provided with an extension or lower section **24'**, the connection therebetween which will be later described. The third pipe **24** has connected thereto an oxygen inlet connection **26** which provides for the flow of oxygen through an oxygen passage **25** provided between the pipe **24** and the pipe **14.** As best shown in the upper portions of FIGS. **1** and **2,** a cover plate **27** is removably connected by means of cap screws **28** to the upper ends of a sleeve or bushing **29.** For the purposes of terminology, the piston sleeves **16** may be simply referred to as sleeves, as well as the bushing **29,** since they are of sleeve-like construction and are all connected to respective pipes. The sleeve **29** is provided with a circumferential flange **30** and has also connected thereto a reduced portion **31** which is in overlapping engagement with the upper end of the third pipe **24.** Since the upper terminal ends of the enlarged sleeves **16** and **22** are disposed below or in spaced relation with respect to the cover plate **27,** there is provided a space or chamber **32.** The upper portions of the bushing **29** are provided with a pair of threaded bores **33,** only one of which is shown in FIG. **4,** the said bores **33** having contained therein threaded plugs **34** which each include a vent bore **35** adapted to vent the chamber **32** to the atmosphere. A circumferential flange **36** is connected to the flange **30** by means of bolt and nut assemblies **37.** A circumferential flange **38** is connected to the third pipe **24** and a fourth pipe **39** is provided with a flange **40** suitably connected to the flange **38** by means of bolt and nut assemblies **41.** A

flange **42** is sandwiched between flanges **38** and **40**, the said flange **42** being provided on a bushing or sleeve **43** which is provided with a circumferential seal **44** in sealing engagement with respect to the fourth pipe **39**. The flange **42** is sealed against the flange **40** by means of a circumferential seal **45**. A vent space or chamber **46** is provided between the pipe **24** and the bushing **43**, the same being vented to the atmosphere by virtue of a pair of vent openings **46'**. As shown in FIG. **2**, the third pipe **24** consists of two sections and the section **24'** is provided with an upwardly extending sleeve **47** which is in sliding engagement with a piston sleeve **48** connected to the lower end of the third pipe **24**. Suitable seals **49** on the piston sleeve **48** are in sealing engagement with an inner surface of the sleeve **47** and similarly, seals **50** on the sleeve **47** are in sealing relation with respect to the cylindrical surface of the bushing or sleeve **43**.

The third pipe section **24'** and fourth pipe extension section **39'** provide a water directing space **51** which communicates with the water inlet **52**. A flange **53** is connected to the lower end of the section **39** and the extension **39'** of the pipe **39** provides a passage **54** in communication with the water circulating space **51**. A flange **55** is connected to a fifth pipe **57** and suitable bolt and nut connections **56** connect flanges **53** and **55**. The lower portions of the fifth pipe **57** are connected by means of a flange **59** to which is connected a downwardly projecting pipe extension **57'** providing for a continuation of the pipe **57**. The fifth pipe **57** provides for a water outlet space **60** which is fed by means of a water circulating space **60'** formed by the fifth pipe extension **57'** thereby circulating water outwardly through the discharge pipe **58**.

Referring now particularly to FIG. **3**, the lower or nozzle end **12** of the lance will be described. The fifth pipe extension **57'** extends downwardly and is suitably connected by welding to a dish-shaped lower or transverse wall **61** having upwardly extending peripheral edge portions **62** conforming and being connected to the pipe extension **57'**. The pipe extension **57'** may consist of suitable similar extensions connected together by welding, these additional extensions not being designated separately but being considered part of the fifth pipe arrangement. The same is true for the other pipes in that the extensions are provided and are necessary to form slip joints accommodating the longitudinal expansion and contraction to which these assemblies are subjected by extreme temperatures. The pipe extension **39'**, for instance, is provided with a reduced portion **63** which is in relative sliding and mating relation with a pipe extension **64** which still is considered an extension of the pipes **39** and **39'**. This type of arrangement accommodates the contractions and expansions which occur. The extension **64** is provided at its lower end with a skirt **65** defining a portion of an enlarged cooling chamber **66**.

The present nozzle arrangement is of the multiple orifice type, meaning that in this case three orifices are utilized. FIG. **3** discloses only one such orifice since they are identical and are equally spaced about the circumference of the nozzle arrangement **12**. The dish-shaped lower wall **61** which encloses the lower end of the nozzle can be described as transverse in that it extends across the lower end of the pipe section **57'**. Similarly, an arcuate but nevertheless somewhat transverse closure wall **67** encloses the lower end of the first inner pipe **13**. Similarly, the insulating pipe **14** is enclosed by a transverse or generally arcuate closure wall **68**. A similarly extending wall **69** encloses the oxygen space which is provided between the pipes **14** and **24'**. Three cylindrical walls **70** are provided in the lower end of the nozzle arrangement **12**, only one of which is shown. The cylindrical walls **70** are cooled by means of the water circulating within the chamber **66**. The lower ends of each of the cylindrical walls **70** are provided with an outlet orifice **71** through which the combined fuel and oxygen flows into the oxygen vessel of a BOF operation. Each orifice **71** is of converging diverging type in that a cylindrical diverging wall portion **74** is provided at the upper end of the orifice **71** and communicates with a cylindrical portion **73** of constant diameter throughout its length, the said cylindrical portion **73** then communicating with the diverging cylindrical portion **74** extending to the end of the nozzle tip. Each of the orifices **74** is provided with a fuel tube **75** welded within an opening **76** in the closure wall **67**. Each fuel tube **75** extends through an opening **77** provided in the transverse closure walls **68** to which it is also welded. The fuel tube **75** is thus supported in cantilever relation relative to the tube **13** and **14** and projects centrally into the nozzle **71** terminating slightly below the terminal end of the constant cylindrical wall portion **73**. The tube **75** is also supported as best shown in FIGS. **3** and **6** by means of spacers **78** and **79** in turn rigidly welded to the cylindrical converging wall portion **72'**. Each tube **75** thus is effectively supported within each orifice **71**, yet permitting the free flow of oxygen and fuel through the ends of each orifice.

Referring now to FIG. **2** and particularly to the portion of the insulating pipe **14** below its piston sleeve **22**, there is provided a threaded test opening **80** which is normally closed by means of a threaded plug **81**. Similarly, referring now to the modifcation of FIG. **5**, the parts are identical except that the piston sleeve **16** forming part of the first pipe **13** is provided with one or more passages **82** which communicate at their lower ends with the insulating space **15**, the said passage **82** being normally closed at its upper end by means of a threaded plug **83**.

THE OPERATION

In the operation of the lance, it is supported at its upper end by means of a suitable crane type structure above a bath provided in a basic oxygen furnace. The nozzle is disposed a predetermined distance from the bath and fuel oil may enter through the stub pipe **18**, whereupon it flows to the ends thereof and out through the tubes **75** where it is mixed in the orifices **71**. Oxygen, of course, is supplied through the oxygen pipe **26** downwardly through the passage **25** through the converging cylindrical portion **70** through and outwardly through the portion **74**. Water is circulating through the inlet **52** downwardly through the spaces **51** and **54** to the lower end of the nozzle tip whereupon it is circulated around the cylindrical wall **72** in the chamber **66**, then flows outwardly through water circulating space **60'** upwardly into the space **60** and outwardly through the water outlet **58**.

One of the primary features of the invention is the easily repairable feature and also the ease with which the sealing surfaces and seals may be inspected. When the removable bushing **29** is removed by removal of the bolts **37**, the seals **23** may be immediately inspected and replaced. Further, by the removal of the stub pipe **18**, the seals **21** may be either inspected or replaced.

As indicated in the above referenced Berry patent, the vent chamber is extremely important in venting any leaking oxygen to the atmosphere before it can be intermixed with other elements which might be leaking. In other words, oxygen which may leak past the seals **23** immediately is vented to the atmosphere through the vent openings **35.** The threaded bores **33** also serve the purpose of permitting the insertion of a test nipple replacing the one-half inch plug which is shown in FIG. **4.** A test nipple may be a portion of a pressure testing unit which provides high pressure fluid into the vent chamber **32** for the purpose of testing the seals **23** and **21.**

The insulating pipe **14** provides an insulating space **15** which serves as a safety chamber between the oxygen passage **25** in the event that there is a leakage of any of the connections of the pipe **13.** As indicated previously, the pipes may all be made in sections which are welded together and any leakage such as could occur because of an improper weld in the fuel tube **13** will be taken care of because of the insulating space **15.** The seal **17** prevents the escape of fuel oil from the insulating chamber, but in the event some does escape by the seals **17,** the same is carried from the vent chamber **32** through the vent openings and is quickly noticed the operator so that the operation may be halted for repair.

The threaded test opening **80** and pipe plug arrangement **81** also serve a distinct and effective purpose during the testing procedure of the lance. In order to properly test the welds and the seals **17** upon partial disassembly of the upper end of the arrangement, a suitable nipple is attached to the threaded opening **18** to direct water under pressure into the insulating chamber **15** thereby providing for the desired test of the seals **17** and the welds of the various sections of the pipes involved. It is apparent that in view of the arrangement of the sleeves **16, 22** and bushing **29** with their respective seals, vertical expansion and contraction of the pipes is accommodated. Expansion of the pipe **39** and section **39'** is accommodated as shown in FIG. **3** by the sliding slip joint or reduced section **63** relative to the pipe extension **64.**

FIG. **5** shows a modified arrangement. In this case the sleeve **16** is provided with one or more vertical passages **82** which communicates with the insulating chamber **15.** In the pressure tests of the seals **17** the passages **82** would be closed by the pipe plug **83.** Thus, the seals **17** would be effectively tested. However, it is contemplated that the seals **17** could be eliminated or the passage **82** could remain open so as to permit any leakage from the chamber **15** to be immediately directed into the chamber **32** where it would become quickly visible to the operator. Thus, the alternate is provided in that during operation where the seals **17** are employed the operator may remove the pipe plug **83,** opening the bore **82** to accommodate the free flow of escaping fuel oil into the vent chamber **32,** whereupon it would be quickly noticed due to leakage outwardly of the vent openings. In this type of modification the O-rings or seals **17** would be primarily utilized in the pressure testing of the unit, but would not have any effect during the normal operation of the lance, since the passages **82** would be open.

A further advantage is the provision of the venting chamber **46** and the vent opening **46'.** Thus, any leakage of oxygen past the seals **49** would immediately appear in the chamber **46** and be dissipated through the

openings **46'.** The advantages of the quickly removable disconnect of the bushing **43** is also apparent, the same permitting quick inspection of the seals and proper replacement of any portions of this particular assembly. Thus, it is also apparent that the arrangement permits pressure testing of the lance prior to its use which is not accomplished or contemplated in the prior art.

Referring now particularly to the nozzle structure disclosed, the tubes **75** are effectively cantilevered on the lower ends of the pipes **13** and **14,** and thus an effective operation is secured.

The cantilever arrangement of the tubes **75** provides for a strong anchoring of said tubes. Further, the spacers **78** and **79** further support the tubes **75** in the orifices **71** effectively and thereby eliminate the tendency of vibration which would otherwise occur. Yet the passage of oxygen through the orifices is facilitated and mixture of oxygen and oil is achieved in the diverging position of the orifice thereby effectively mixing and discharging the combination.

What is claimed is:

1. For a lance adapted for mixing oxygen and fuel and including,

a first central fuel pipe,

a second pipe concentric with said first pipe and providing an insulating space around said fuel pipe,

a third pipe concentric with and providing an oxygen conveying space around said second pipe,

fourth and fifth pipes concentric with each other and said other pipes providing concentric coolant circulating spaces;

a nozzle head,

a first lower closure wall connected at its peripheral edge to said fifth pipe,

at least one cylindrical passage means opening outwardly of said first closure wall to provide an oxygen and fuel discharge orifice,

an extension of said fourth pipe providing at a lower portion of said nozzle head a coolant chamber surrounding said cylindrical passage and communicating with said coolant circulating spaces,

a second closure wall on said third pipe above said first closure wall,

a third closure wall on said second pipe enclosing said insulating space and being disposed above said second closure wall,

a fourth closure wall on said first pipe disposed above said third closure wall, and

a tube connected to said fourth closure wall and communicating with said first fuel pipe,

said tube being connected to and extending through said third closure wall, and

said tube having a discharge end [terminating] within said cylindrical passage. [in spaced relation relative to said oxygen and fuel discharge orifice]

2. The invention in accordance with claim **1,**

said closure walls extending transversely to the axis of said lance.

3. The invention in accordance with claim **1,**

wherein said tube is supported on said third and fourth closure walls in cantilever relation.

4. The invention in accordance with claim **3,**

said discharge orifice having a cylindrical wall portion converging inwardly and then outwardly toward said first closure wall.

5. The invention in accordance with claim **4,**

said cylindrical wall having a portion thereof disposed between said converging diverging portion

of constant cross sectional diameter.

6. The invention in accordance with claim 5,

the discharge end of said tube terminating outwardly relative to said portion of constant cross section.

7. The invention is accordance with claim 3,

including supporting means for supporting an intermediate portion of said tube on said third pipe.

8. The invention in accordance with claim 7,

said supporting means including circumferentially spaced space elements supported in said orifice adjacent to said coolant chamber.

* * * * *