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- (71) Applicant (for all designated States except US): **BERRY METAL COMPANY** [US/US]; 2408 Evans City Road, Harmony, PA 16037 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **DENGEL, Derek, S.** [US/US]; 2408 Evans City Road, Harmony, PA 16037 (US). **VALENTAS, Louis, S.** [US/US]; 2408 Evans City Road, Harmony, PA 16037 (US). **WERNER, David, R.** [US/US]; 2408 Evans City Road, Harmony, PA 16037 (US).
- (74) Agent: **BANGOR, JR., Paul, D.**; Thorp Reed & Armstrong, Llp, One Oxford Center, 14th Floor, 301 Grant Street, Pittsburgh, PA 15219-1425 (US).
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[Continued on next page]

(54) Title: EXTERNAL DISTRIBUTOR FOR METALLURGICAL LANCES

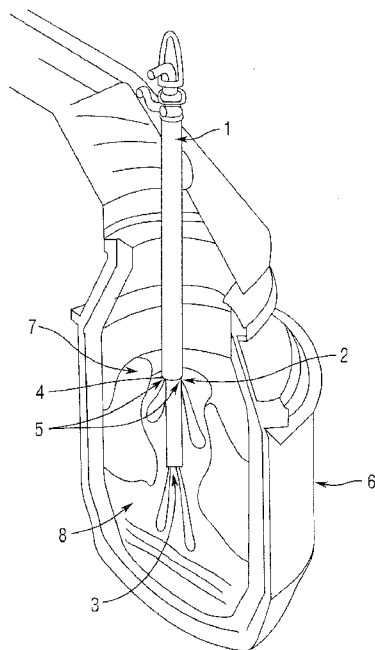


Fig.1

(57) Abstract: A distributor apparatus for external mounting on a metallurgical lance, comprising: a distributor ring having at least one internal concentric gas passage and at least one internal concentric coolant passage, a gas carrying tube in fluidic communication with the at least one gas passage, a plurality of ports in fluidic communication with the at least one gas passage and with the external surface of the distributor ring, and means for cooling in fluidic communication with the at least one coolant passage.



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TITLE OF INVENTION

EXTERNAL DISTRIBUTOR FOR METALLURGICAL LANCES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims benefit and priority from U.S. provisional application Ser. No. 61/480,994 entitled “**EXTERNAL DISTRIBUTOR FOR METALLURGICAL LANCES**”, filed April 29, 2011, the disclosure of which is hereby incorporated by reference herein in its entirety for all purposes.

FIELD OF THE INVENTION

[0002] This invention is related to an external distributor assembly for a metallurgical lance.

BACKGROUND OF THE INVENTION

[0003] As shown in **FIG. 1**, metallurgical processes such as basic oxygen steelmaking often employ large (typically, about 8 inches to about 16 inches in diameter, approximately 35-85 feet long, and up to approximately 5 to 10 tons in weight) metallurgical lances **1** to efficiently remove oxidizable elements from molten metal **8** below slag **7** in a metallurgical converter such as a basic oxygen furnace **6**. Typically, in addition to the primary oxygen ports **2** at the primary oxygen tip **3** of the lance **1**, the prior art metallurgical lance **1** may include a ring **4** of small oxygen ports **5** located on the outside of the lance **1** a distance up the lance **1** from the primary oxygen tip **3**. These lances **1** are known as post-combustion lances. The ring **4** of

small ports 5 distributes oxygen to the furnace atmosphere to react with gases from the process and is known as a post-combustion (or "PC") distributor.

[0004] Post Combustion is typically used for two primary reasons. First, PC oxygen is used in the process to react with carbon monoxide gas from the steelmaking process. This exothermic reaction allows for increased amounts of solid steel scrap to be used. The increase in heat helps to permit melting of larger charge of scrap and may reduce the amount of time required to make a heat of steel. PC is also used as a maintenance tool to minimize and reduce skull build up (slag and steel mixtures) to the lance itself and/or for inside the BOF vessel, specifically in the cone and mouth areas.

[0005] Due to heat transfer requirements, and also to protect the PC distributor from the furnace atmosphere and the localized heat generated from the post-combustion reaction, the PC distributor (and often, the piping associated therewith) is made of high thermal conductivity metals such as high purity copper.

[0006] Although the post-combustion lance often is used to direct oxygen into a metallurgical converter, various other gases may be directed through the lance, depending on the reactions desired. Any and all reaction gases directed through the lance are generally referred to hereinafter as a "gas" for convenience, it being understood that the gas may be oxygen or any other reactive or non-reactive gas or gases. Typically, the gas is injected through the lance at very high rates. For example, oxygen may be injected into the lance at rates of between 200 cubic meters/min. and 800 cubic meters/min.

[0007] As is well known in the art, lances are subjected to bending stresses during their service lives, particularly during loading and unloading operations and during

lance deskulling operations when the lance is typically placed horizontally on the service floor. During movement of the lance, whether for installation or deskulling, the lance typically is lifted only at the upper end (i.e., above the distributor) with the tip at the lower end resting on the floor at some point during such movements.

Accordingly, the prior art lance typically is subject to deflection (i.e., substantially or at least partially transverse deflection) due to the bending loads to which it is subjected.

[0008] PC Distributors are also subjected to high heat loads from the oxidation reactions during the steelmaking process as well as mechanical damage from the steelmaking process. The additional heat loading can cause melting or scarfing of the copper distributor and/or of the copper barrel sleeve. Insufficient lance cooling water flow rates can accelerate this melting and scarfing. Any melting or scarfing damage to the distributor will require replacement of the assembly. It is also common for distributor ports to become plugged with slag and steel. Typically these ports can be cleaned, but if they cannot, a new distributor is required.

[0009] The maintenance interval for a lance is normally driven by lance tip life, with the lance body lasting many times the life of the tip. Lances equipped with the PC distributor typically are prone to bending (i.e., permanent deflection) and, in some cases, failure at the PC distributor, because of the relatively low yield strength of the high thermal conductivity components in the PC distributor. Since the introduction of the mid-lance PC distributor (i.e., at least in the 1980s, and possibly earlier), no effective solutions to the bending and/or failure problems have been implemented. Prior art post-combustion lances typically bend after a relatively short period in service, requiring relatively frequent replacement of the PC distributor.

[0010] Previous attempts to address this problem included the development of external removable protective steel sleeves which are put on new and refurbished PC distributor equipped lances to protect the lances during shipping to the user's facilities. However, the protective sleeves must be removed before the lance is put into service. In practice, sleeves are typically removed prior to completion of the unloading and installation of the lance. As a result, the lance is often bent subsequent to the protective sleeve removal, i.e., during the completion of installation, while in service, or while the lance is loaded back onto the truck for return repair at the end of its maintenance interval.

[0011] Other attempts to address these bending problems included the use of an internal reinforcement. This has been by a tube disposed within the main gas passageway with apertured support collars that allow gas flow through the collars, wherein the internal reinforcing tube is not part of the PC distributor but extends within the main gas passageway upstream and downstream of the PC distributor. Another approach utilizes a reinforced distributor that uses internal, annular members, reinforcing sleeves and an outer sleeve. The distributor allows gas flow through the distributor.

SUMMARY OF THE INVENTION

[0012] The invention comprises an apparatus for making steel in a basic oxygen furnace installation, in which a basic metallurgical lance is converted to a post combustion lance by the use of an external distributor ring. The distributor ring has at least one internal and integral concentric gas passage and at least one internal concentric coolant passage, a gas carrying tube in fluidic communication with the gas passages, a plurality of ports in fluidic communication with the gas passages and with

the external surface of the distributor ring, and means for cooling in fluidic communication with the coolant passages.

[0013] The distributor ring is external to the metallurgical lance. The interior surface of the distributor ring is formed to mount slidably onto the metallurgical lance. The advantages of an external oxygen distributor include (a) since the metallurgical lance does not have an internal and integrated distributor (see FIG. 1A), it will be less expensive, stronger, and will not bend or be damaged during installation; (b) the distributor assembly can be installed onto existing lances of any size or configuration; (c) as the distributor assembly is slidable, its location on the metallurgical lance may be adjusted to allow for trials or experimentation for optimization of the furnace operation; (d) the distributor ring can be located on the metallurgical lance to optimize post combustion heating, and can be dynamically moved during the heat to allow post combustion during carbon removal and cone and mouth deskulling at the end of the heat; (e) reduced trial and repair costs; and (f) a conical shield or distributor ring shape reduces slag buildup. The design allows for both split flow feed coming off of existing oxygen lines or through dual or double-flow post combustion (two separate oxygen feeds) without modification of the lance. Further, two or more distributor rings can be used on a single lance.

[0014] The distributor ring will have at least one internal concentric gas passage to allow distribution of oxygen around the ring. The gas passage(s) will be fluidly connected to the exterior of the distributor ring by a plurality of gas ports. The gas ports may be created by drilling. The gas ports can be of any size, diameter, angle, or numerosity desired to achieve optimum post combustion heating.

[0015] The distributor ring will have at least one internal concentric cooling passage to allow for distribution of coolant around the ring. Typically, the coolant is water. The coolant may be used to pre-cool the gas carrying lines in addition to the distributor ring. The distributor assembly requires low water flow, about 50 to 150 gallons per minute as compared to a typical lance requirements of about 1,000 gallons per minute.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0016] For the present disclosure to be easily understood and readily practiced, the present disclosure will now be described for purposes of illustration and not limitation in connection with the following figures, wherein:

[0017] **FIG. 1** is a typical metallurgical process used in basic oxygen steelmaking using a metallurgical lance;

[0018] **FIG. 1A** is a typical metallurgical post combustion lance used in a basic oxygen furnace or other metallurgical vessel;

[0019] **FIG. 2** is a front elevational view of an external distributor assembly according to a first preferred embodiment of the present invention mounted on a metallurgical lance;

[0020] **FIG. 3** is a front elevational view of an external distributor assembly according to a preferred embodiment of the present invention mounted on a section of a metallurgical lance;

[0021] **FIG. 4** is a side elevational view of an external distributor assembly according to a preferred embodiment of the present invention mounted on a section of a metallurgical lance;

[0022] **FIG. 5** is a cross-sectional view of an external distributor assembly of a preferred embodiment at the plane H-H of **FIG. 3**;

[0023] **FIG. 6** is a cross-sectional view of an external distributor assembly of a preferred embodiment mounted on a section of a metallurgical lance at the plane A-A of **FIG. 8**;

[0024] **FIG. 7** is a side cross-sectional view of an external distributor assembly of a preferred embodiment mounted on a section of a metallurgical lance at the plane B-B of **FIG. 8**;

[0025] **FIG. 8** is a cross-sectional view of an external distributor assembly according to a preferred embodiment of the present invention at the plane I-I of **FIG. 3**;

[0026] **FIG. 9** is a perspective view of an external distributor assembly according to a second preferred embodiment of the present invention mounted on a section of a metallurgical lance;

[0027] **FIG. 10** is a front elevational view of an external distributor assembly according to a preferred embodiment of the present invention mounted on a section of a metallurgical lance;

[0028] **FIG. 11** is a side elevational view of an external distributor assembly according to a preferred embodiment of the present invention mounted on a section of a metallurgical lance;

[0029] **FIG. 12** is a side cross-sectional view of an external distributor assembly of a preferred embodiment mounted on a section of a metallurgical lance at the plane D-D of **FIG. 10**;

[0030] **FIG. 13** is a cross-sectional view of an external distributor assembly of a preferred embodiment mounted on a section of a metallurgical lance at the plane C-C of **FIG. 10**;

[0031] **FIG. 14** is a cross-sectional view of an external distributor assembly of a preferred embodiment mounted on a section of a metallurgical lance at the plane E-E of **FIG. 11**;

[0032] **FIG. 15** is a cross-sectional view of an external distributor assembly of a preferred embodiment at the plane F-F of **FIG. 14**;

[0033] **FIG. 16** is a cross-sectional view of an external distributor assembly of a preferred embodiment at the plane G-G of **FIG. 14**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S) OF THE INVENTION

[0034] In the following detailed description, reference is made to the accompanying examples and figures that form a part hereof, and in which is shown, by way of illustration, specific embodiments in which the inventive subject matter may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice them, and it is to be understood that other embodiments may be utilized and that structural or logical changes may be made without departing from the scope of the inventive subject matter. Such embodiments of the inventive subject matter may be referred to, individually and/or collectively, herein by the term "invention" merely for convenience and without intending to voluntarily limit the scope of this application to any single invention or inventive concept if more than one is in fact disclosed.

[0035] The following description is, therefore, not to be taken in a limited sense, and the scope of the inventive subject matter is defined by the appended claims and their equivalents.

[0036] FIGs. 2-8 illustrate a preferred embodiment of the present invention for use with a metallurgical lance 1 having a primary oxygen tip end 3 directed to an external distributor assembly 10, comprising a distributor ring 12, an oxygen feed pipe 14 for introducing oxygen into the distributor ring 12, and a housing 17 containing oxygen feed pipe 14 and defining, along with oxygen feed pipe 14, an inlet cooling-water conduit 35 in fluid communication with coolant inlet 34 and an outlet cooling-water conduit 37 in fluid communication with coolant outlet 36. The distributor ring 12 is slidably or fixedly mounted coaxially around the metallurgical lance 1. The distributor ring 12 has at least one annular oxygen passage 20 concentrically disposed adjacent to a coolant passage 30 defined by the interior of the distributor ring 12. The distributor ring 12 has a plurality of outlet ports 22 in fluid communication with the oxygen passage 20. Oxygen passage 20 is in fluid communication with oxygen feed pipe 14 such that oxygen from feed pipe 14 enters the oxygen passage 20 of the distributor ring 12 and exits the distributor ring 12 through the plurality of outlet ports 22. In the preferred embodiment as shown, the distributor ring 12 has one oxygen passage 20 and about eight outlet ports 22, but may comprise additional oxygen passages and outlet ports as needed.

[0037] Preferably, water is used as the coolant and is supplied through inlet cooling-water conduit 35 into coolant passage 30 of the distributor ring 12. The cooling-water exits the coolant passage 30 into outlet conduit 37 of housing 17. As seen in FIG. 5, housing 17 preferably has a curved, oval-shaped cross-sectional profile

complementary with the outside diameter of the lance **1**. Coolant inlet **34** and coolant outlet **36** are disposed on the end of housing **17** distal to the distributor ring **12**. The oxygen feed pipe **14** sufficiently blocks transverse flow of coolant through the housing **17** such that coolant flows from the coolant inlet **34** into inlet conduit **35**, alongside feed pipe **14**, through the cooling passage **30** into outlet conduit **37** and, alongside the other side of feed pipe **14**, and exits housing **17** through the coolant outlet **36**.

[0038] Referring to **FIGs. 7-8**, distributor ring **12** has an annular inner surface **40** nearest the metallurgical lance **1**, a lower surface **42**, an outer surface **44** and an upper surface **46**. The inner surface **40** is preferably made to slide over the metallurgical lance **1**. The upper surface **46** defines a conical shield **48** which tapers from the outer surface **44** down to the outer diameter of the metallurgical lance **1**. In such manner, the conical shield **48** lessens slag buildup on the metallurgical lance **1** and upper surface **46**.

[0039] **FIGs. 9-16** show another preferred embodiment of the present invention for use with a metallurgical lance **1**, comprising an external distributor assembly **50**, comprising a distributor ring **52** and two, water-cooled oxygen feed pipes **54** and **56**, respectively for introducing oxygen and coolant, such as water, into the distributor ring **52**. The distributor ring **52** is slidably or fixedly mounted coaxially around the metallurgical lance **1**. The distributor ring **52** preferably has a concentric oxygen passage **60** disposed annularly between an upper coolant passage **70** and a lower coolant passage **71** as shown in **FIG. 12**. The distribution ring **52** has a plurality of gas outlet ports **62** in fluid communication with the oxygen passage **60**. The oxygen passage **60** is in fluid communication with each of the oxygen feed pipes **54** and **56**

such that oxygen or other gas from the feed pipes **54** and **56** may enter the passage **60** of the distributor ring **52** and exit through the plurality of gas outlet ports **62**. The gas feed pipes **54** and **56** extend along lance **1** as shown in **FIGs. 9-11**. In a preferred embodiment, the distributor ring has one gas passage **60** but may be constructed with multiple oxygen/gas passages. Each of the water-cooled oxygen feed pipes **54** and **56** comprises a feed pipe **55** for oxygen or other desired gas disposed between a concentric outer pipe **57** for transporting a coolant such as water. Preferably, the coolant/water conveyed by pipe **54** is inlet into both coolant passages **70** and **71** of distributor ring **52** while coolant/water outlet from coolant passages **70** and **71** enters the outer pipe of oxygen feed pipe **56** to be expelled from distributor assembly **50** through coolant outlet **76**. Preferably, the coolant/water exiting coolant outlet **76** is conveyed to a heat-exchanger where heat is extracted from such coolant/water which may then be recirculated back through distributor assembly **50** via coolant inlet **74** and feed pipe **54**.

[0040] Referring to **FIG. 12**, distributor ring **52** has an inner surface **80** nearest the metallurgical lance **1**, a lower surface **82**, an outer surface **84** furthest from the metallurgical lance **1**, and an upper surface **86**. The inner surface **80** is preferably made to slide over the metallurgical lance **1**. The upper surface **86** forms a conical shape from the outer surface **84** to the metallurgical lance **1**. The lower surface **82** also preferably forms a conical shape from outer surface **84** to metallurgical lance **1**. In such manner, slag build-up is reduced on the upper surface **86** and the lower surface **82**, as well as on the metallurgical lance **1**.

[0041] Preferably, the distributor rings **12** and **52** may be fed with an external manifold, either a single gas carrying pipe, or multiple gas carrying pipes. In some

preferred embodiments, the external distributor assembly **50** has one oxygen pipe **54** and concentric water pipe **57**.

[0042] The gas carrying pipes may use oxygen split off of the main oxygen line supplying the metallurgical lance **1** or may have their own source of oxygen or other gas. In preferred embodiments, the gas carrying pipes are protected inside outer water-carrying pipes as shown herein. The coolant inlets may be split off the main water line supplying the metallurgical lance **1**, or may be supplied from a separate feed. Preferably, the gas carrying pipes and cooling pipes are welded to the distribution rings **12** and **52**, although other known means of attaching the three components, such as brazing and other chemical or mechanical attachment means are within the scope of this invention.

[0043] The gas ports **22**, **62** are preferably drilled. The diameters of the ports **22**, **62**, the angles of the ports, and the number of ports may be adjusted for any situation. The gas ports **22**, **62** may be at one angle relative to the longitudinal axis **26**, **66** of the lance **1**, or at a plurality of angles. As shown in cross-sectional **FIG. 16**, the angles **90** can vary from +70 degrees to -70 degrees from latitudinal axis **88**. Adjacent gas ports **22**, **62** may be, in some embodiments, at different angles. In preferred embodiments, the gas ports **22**, **62** are at angles directed to features of the surrounding furnace, such as the basic oxygen furnace opening. Gas ports **22**, **62** may be fitted with interchangeable nozzles (not shown) to provide different oxygen flow patterns.

[0044] In other preferred embodiments, the external distributor has ports in the distributor ring for water to exit. In more preferred embodiments of this type, the external distributor has no pipe water outlet as all water exits through ports in the distributor ring.

[0045] Distributor rings 12 and 52 are preferably made of a heat conducting material such as copper and may be cast or forged as preferred. More preferably, the distributor rings 12 and 52 are made of high purity copper. In some preferred embodiments, multiple distributor rings may be used on a single lance 1 to reduce lance skulls, furnace skulls and/or for metallurgical benefits.

[0046] In the foregoing Detailed Description, various features are grouped together in a single embodiment to streamline the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments of the invention require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

What is claimed is:

1. A distributor apparatus for external mounting on a metallurgical lance, comprising:

a distributor ring having at least one internal concentric gas passage and at least one internal concentric coolant passage, a gas carrying tube in fluidic communication with the at least one gas passage, a plurality of ports in fluidic communication with the at least one gas passage and with the external surface of the distributor ring, and means for cooling in fluidic communication with the at least one coolant passage.

2. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring and gas carrying tube are of high thermal conductivity and/or high oxidation resistance.

3. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor is made of copper or copper alloys or other metal selected from the group consisting of stainless steel, Inconel or a ferrous or non-ferrous alloy.

4. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring is made of fabricated copper.

5. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring is made of cast copper.

6. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring is made of high purity copper.

7. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring has exit ports aimed at at least two different angles.

8. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring is slidably mounted on the metallurgical lance.

9. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the cooling means is at least one cooling tube in fluidic communication with at least one concentric cooling passage in the distributor ring.

10. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the cooling means is at least one cooling tube in fluidic communication with at least one concentric cooling passage and encompassing the at least one gas carrying tube.

11. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein there is a first and second gas carrying tube, and wherein the cooling means is a first annular tube encompassing the first gas carrying tube and a second annular tube encompassing the second gas carrying tube.

12. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein there is one gas carrying tube, and wherein the cooling means is a cooling tube with a kidney-shaped cross-section encompassing the gas carrying tube such that a coolant entering the cooling tube passes along a first side of the gas carrying tube, then through the coolant passage, and then along a second side of the gas carrying tube.

13. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring has an upper surface distal to a tip of the

metallurgical lance, an outer surface opposite the metallurgical lance, and wherein the upper surface forms a conical shape from the outer surface to the combustion lance and cooling means.

14. The distributor apparatus for external mounting on a metallurgical lance of claim 1 wherein the distributor ring has an upper surface distal to a primary oxygen tip of the metallurgical lance, an outer surface opposite the metallurgical lance, and further comprises a conical shield extending from the outer surface to the combustion lance and cooling means.

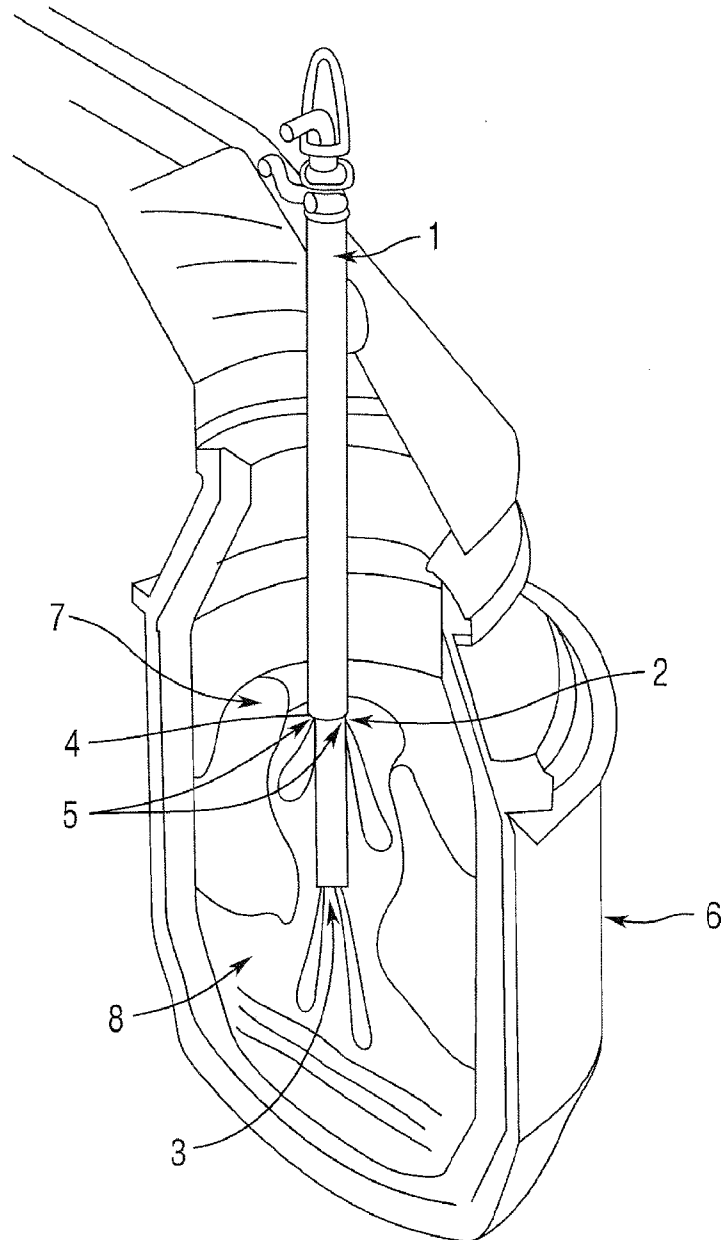


Fig. 1

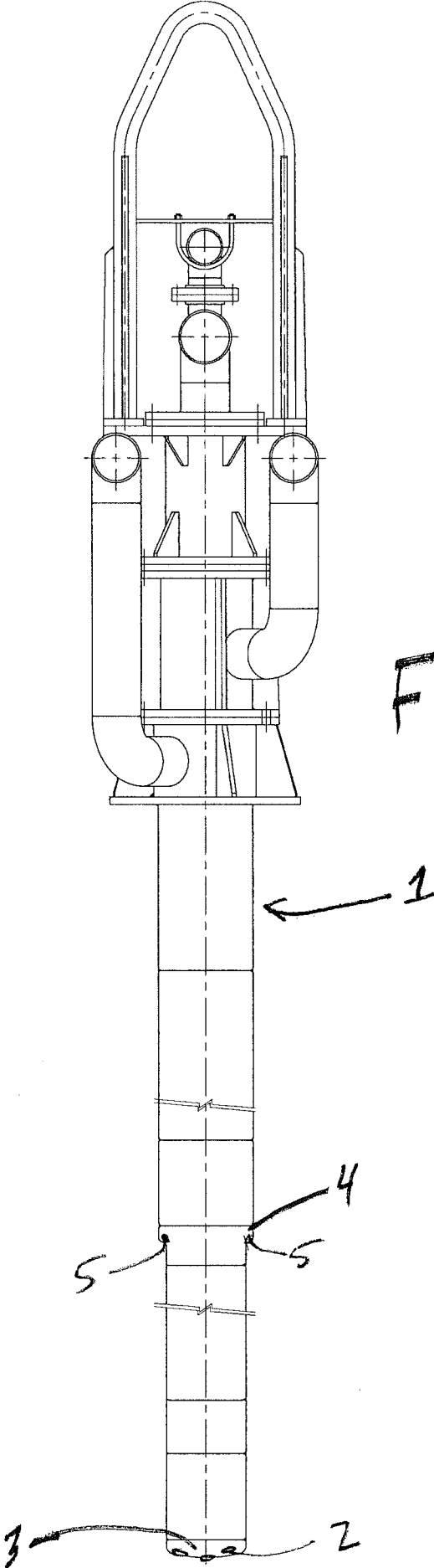


FIG 1A

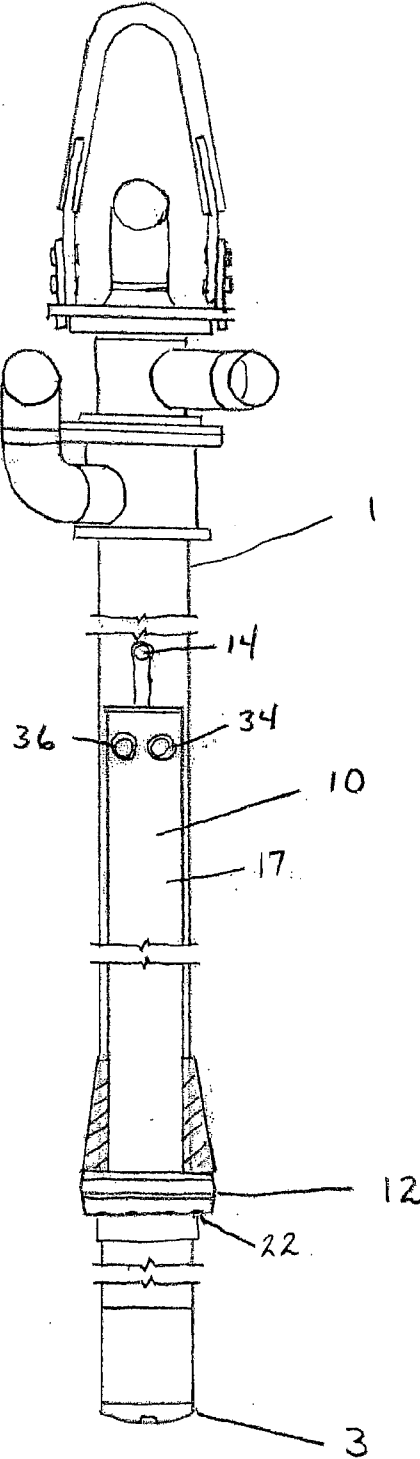


FIG. 2

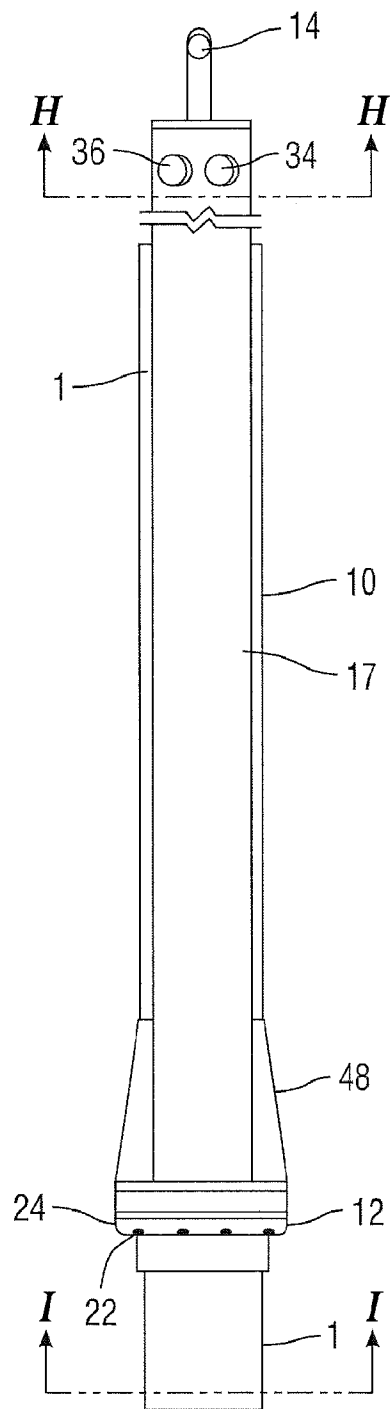


Fig.3

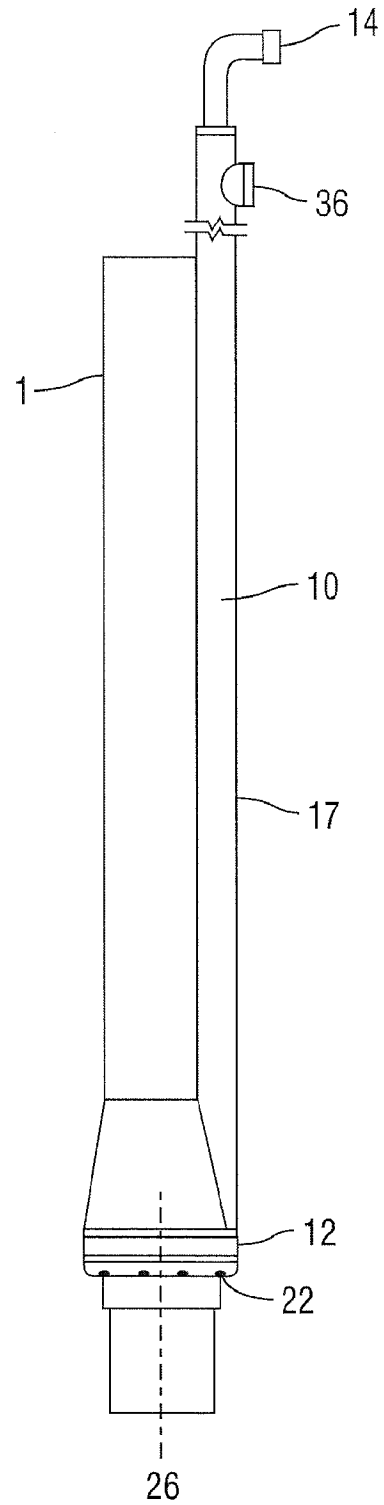


Fig.4

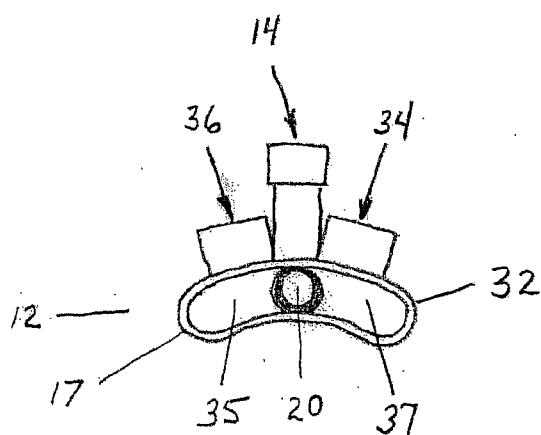


FIG. 5

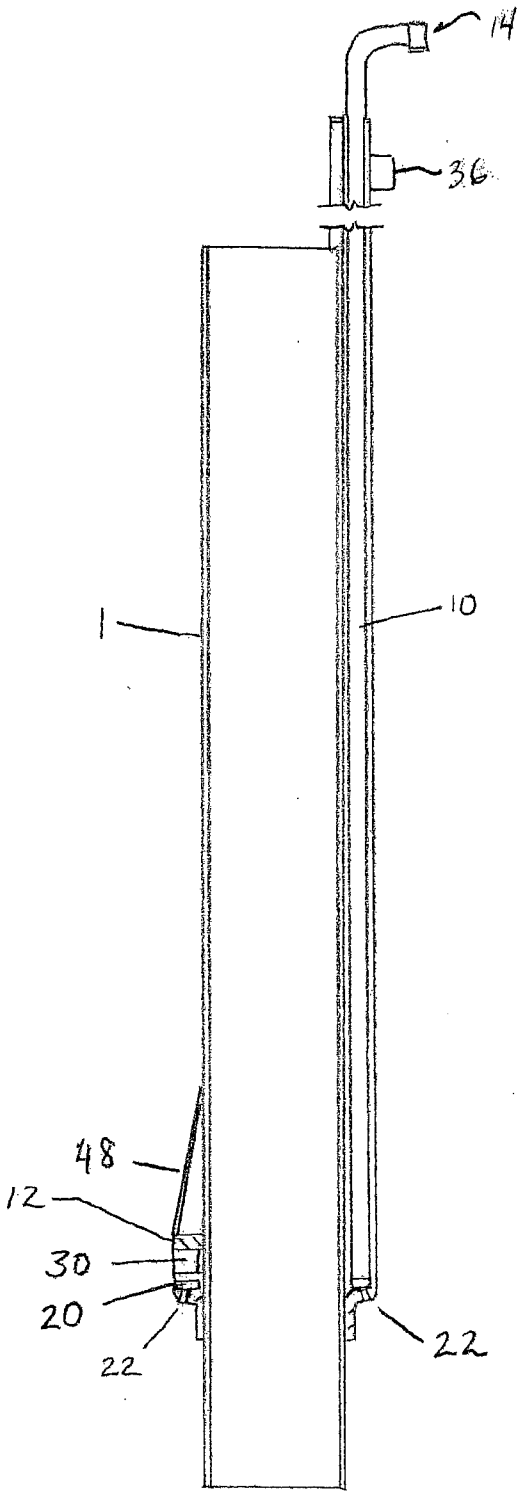


FIG. 6

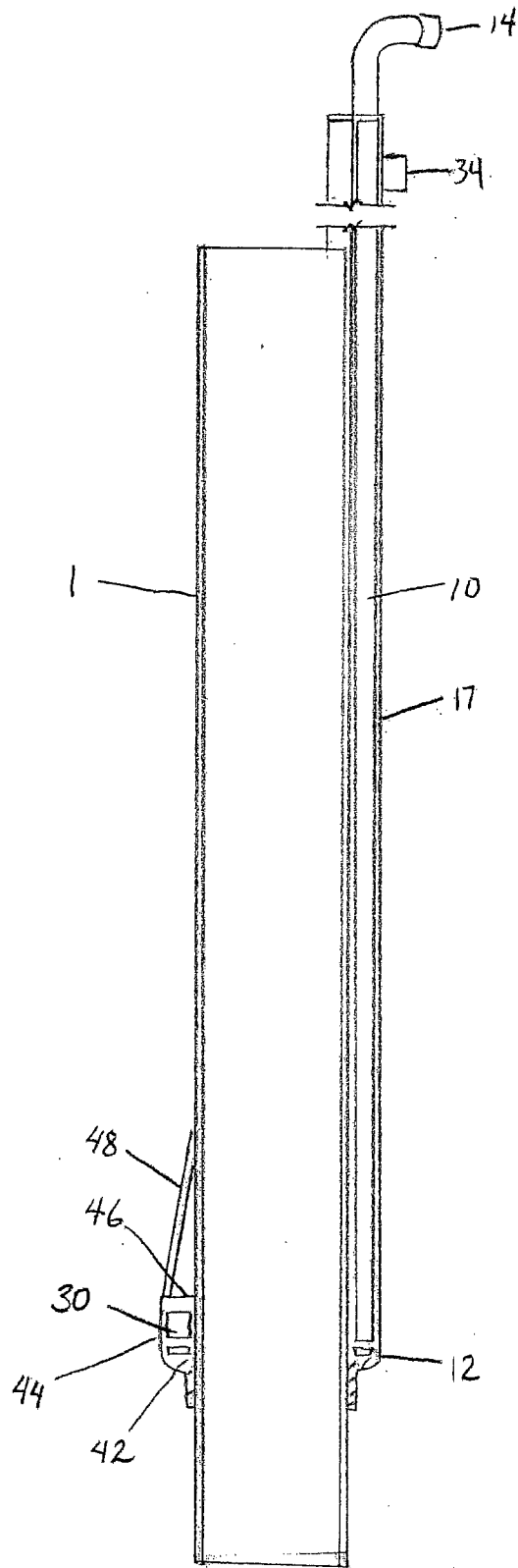


FIG. 7

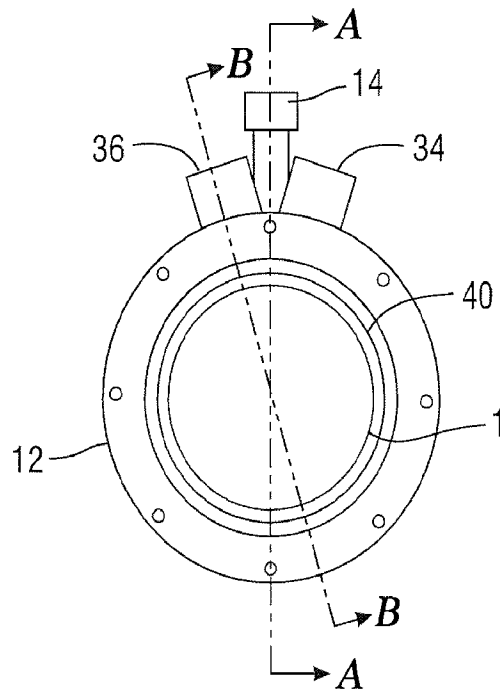


Fig. 8

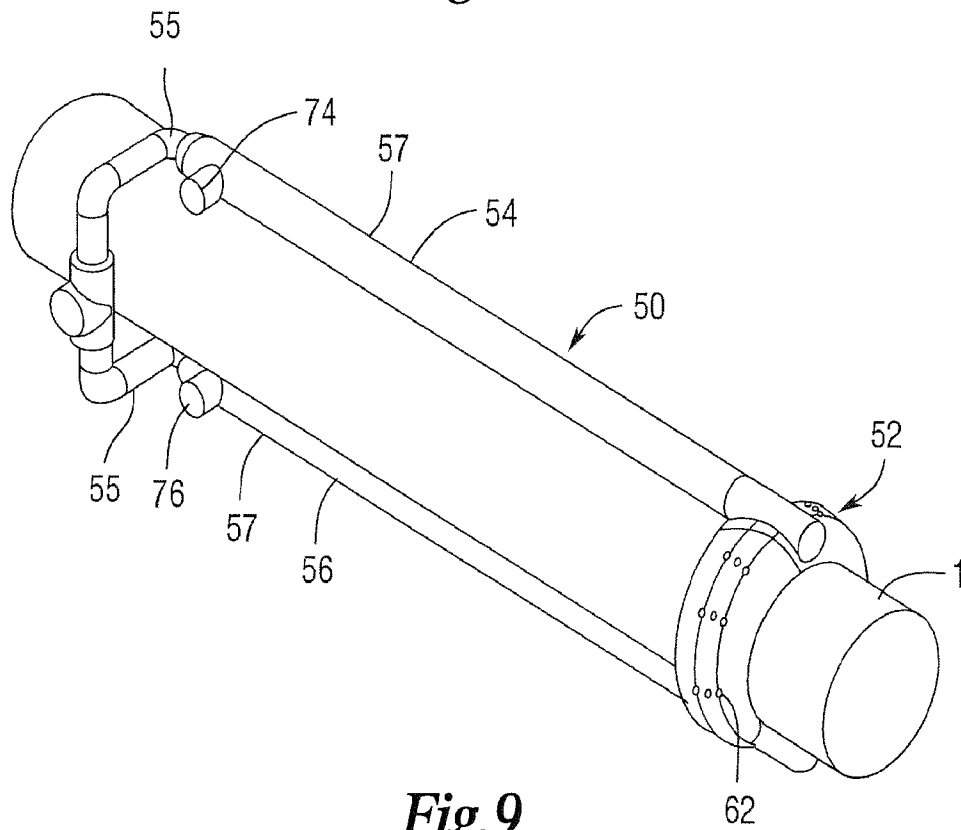


Fig. 9

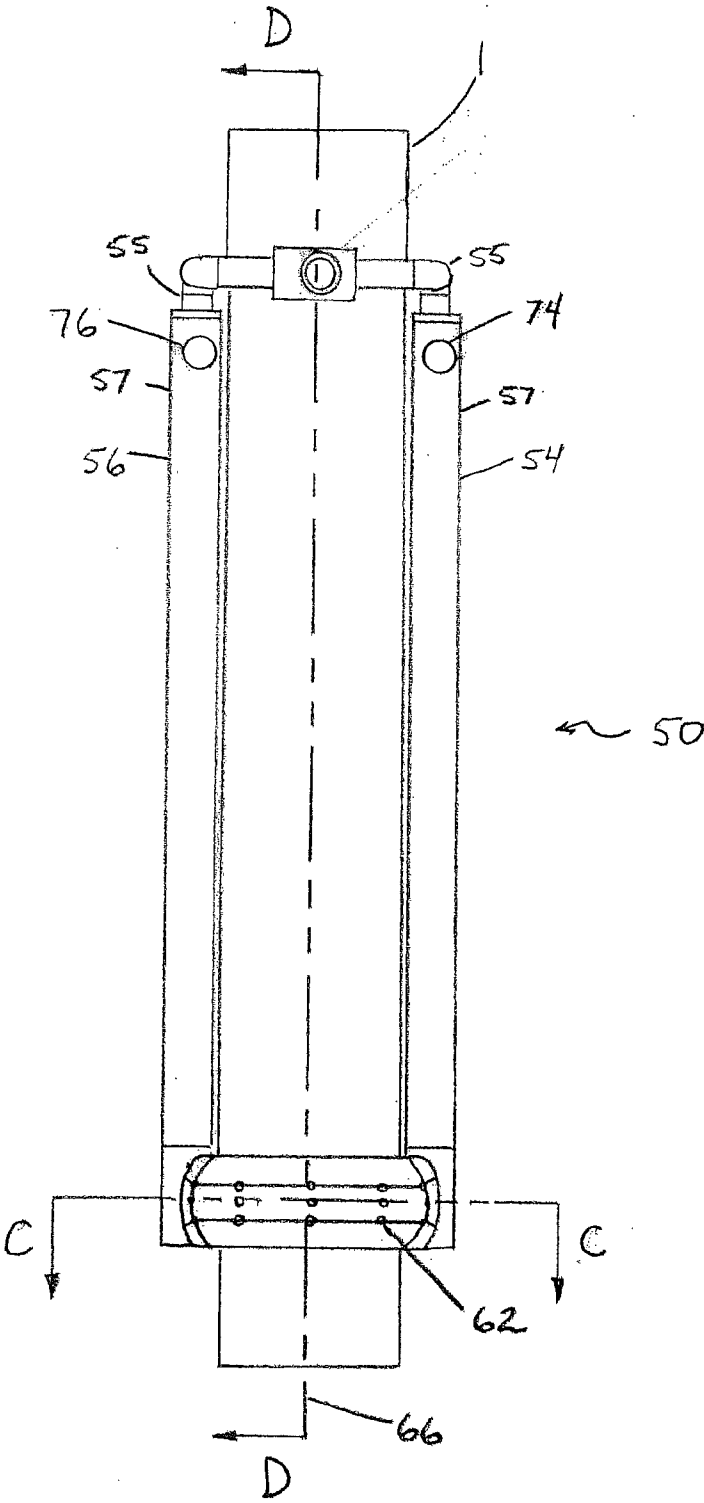


FIG. 10

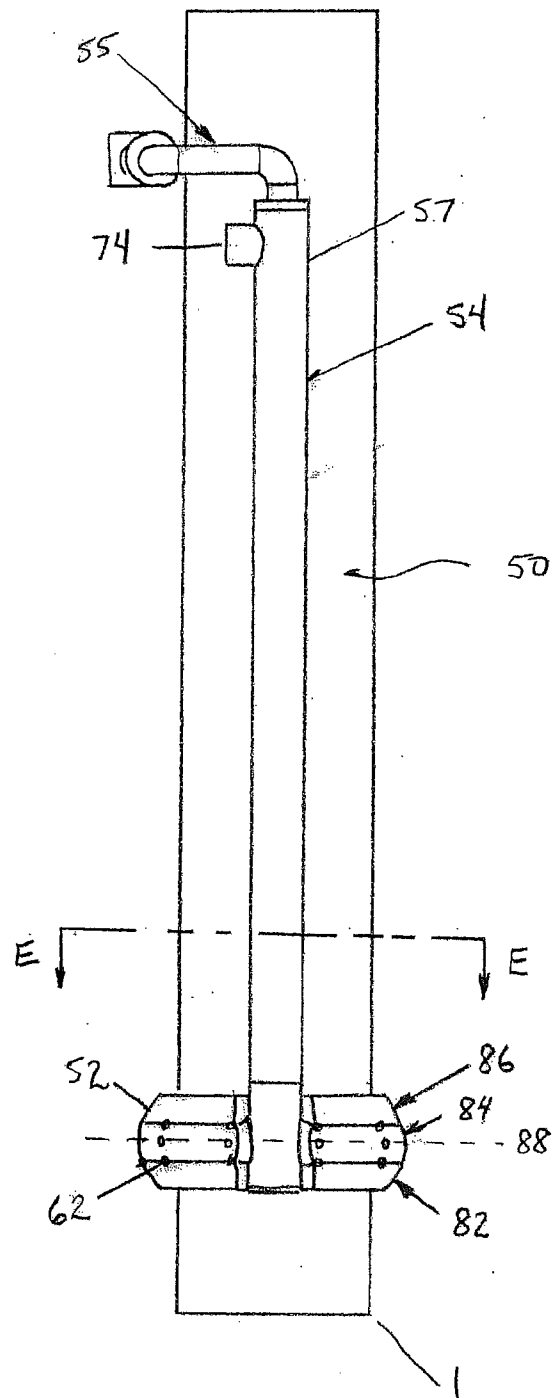


FIG. 11

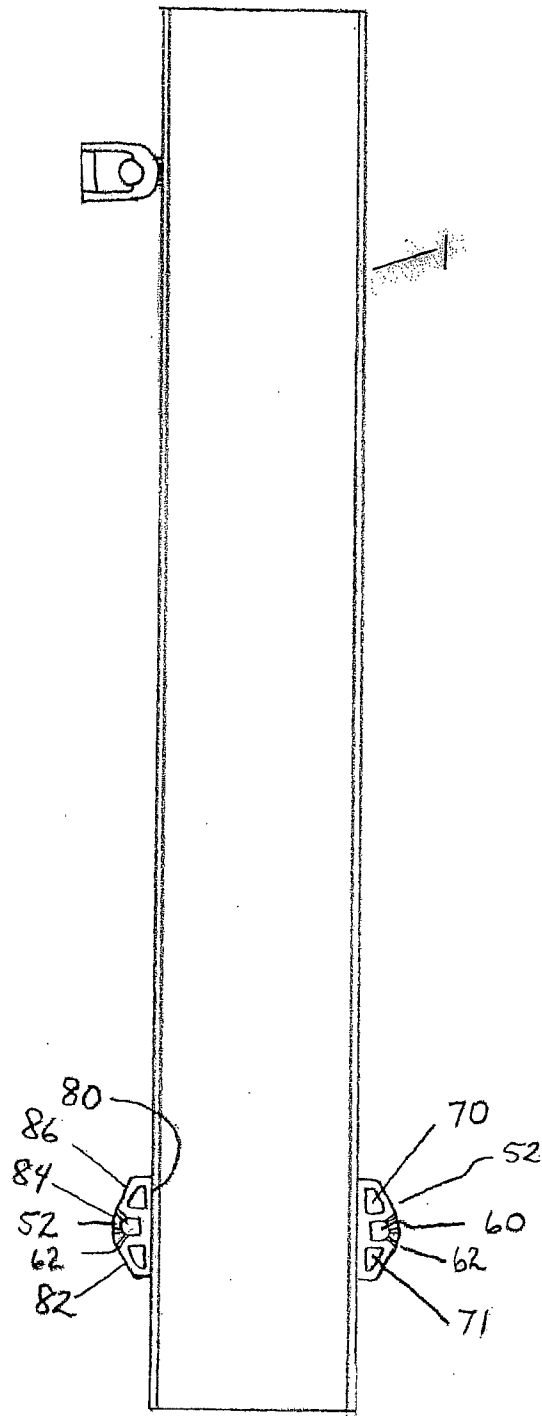


FIG. 12

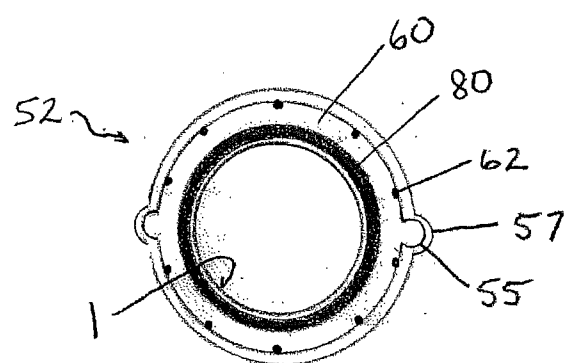


FIG. 13

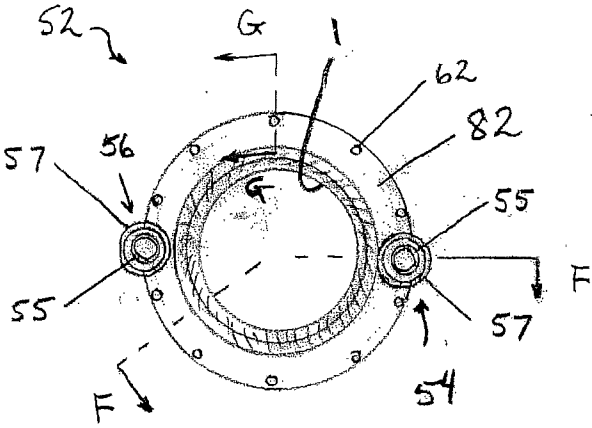


FIG. 14

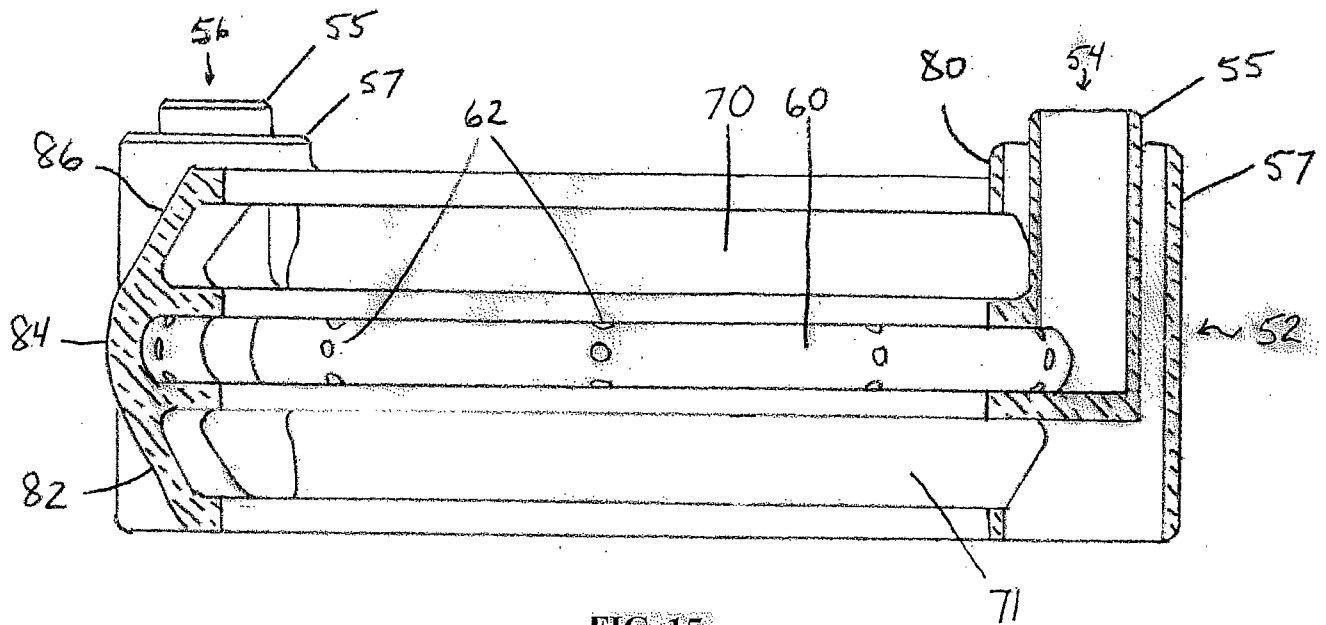


FIG. 15

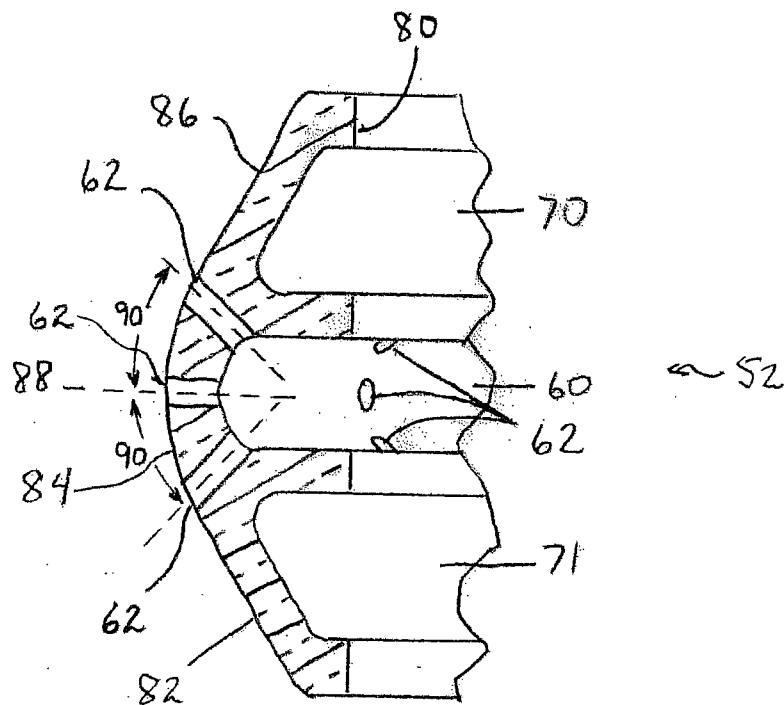


FIG. 16