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(54) Injecting gas into molten metal.

(57) Gas is injected into molten metal by flowing the molten metal through a passageway (24), and by providing a plurality of openings about the periphery of the passageway (24). The gas is injected through the openings into the molten metal flowing through the passageway (24). Preferably, the openings are defined by a porous ceramic media disperser (32) that forms a portion of the passageway (24).

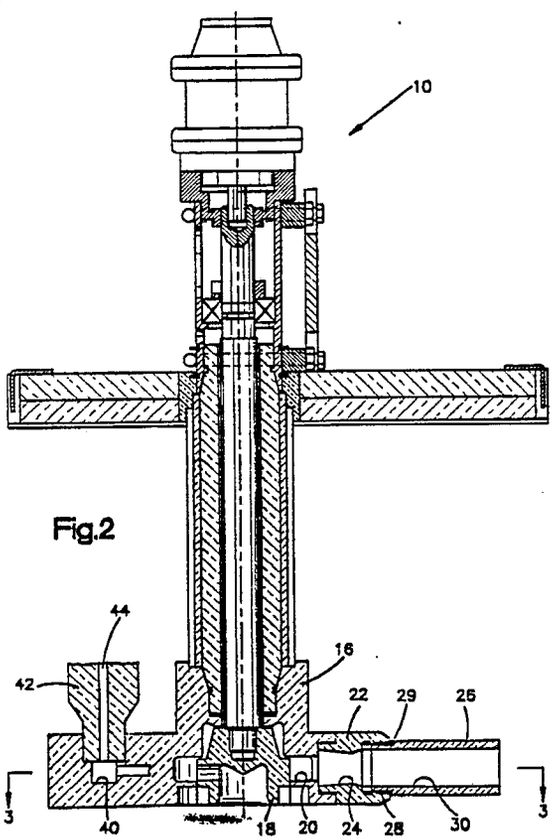

Fig.2

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INJECTING GAS INTO MOLTEN METAL

Background of the Invention

1. Field of the Invention

The invention relates to techniques for injecting gas into molten metal and, more particularly, to a technique for uniformly injecting gas into molten metal being pumped through a passageway.

2. Description of the Prior Art

In the course of processing molten metals, it sometimes is necessary to treat the metals with gas. For example, it is customary to inject gases such as nitrogen, chlorine, and argon into molten aluminum and molten aluminum alloys in order to remove undesirable constituents such as hydrogen gas, non-metallic inclusions, and alkali metals. The gases added to the molten metal chemically react with the undesired constituents to convert them to a form (such as a precipitate, a dross, or an insoluble gas compound) that can be separated readily from the remainder of the molten metal.

As used herein, reference to "molten metal" will be understood to mean any metal such as aluminum, magnesium, copper, iron, and alloys thereof, which are amenable to gas purification. Further, the term "gas" will be understood to mean any gas or combination of gases, including argon, nitrogen, chlorine, freon, sulfur hexafluoride, and the like, that have a purifying effect upon molten metals with which they are mixed.

In the particular case of molten metal that has been melted in a reverberatory furnace, gas injection typically is accomplished by immersing a molten metal pump into the molten metal, and by injecting gas through a conduit into the outlet passageway of the pump. Suitable gas injection pumps of the type described are available commercially from Metaullics Systems, 31935 Aurora Road, Solon, Ohio 44139, under the model designation M30-CSD-Cl_2, et al. In the referenced pumps, the gas is injected through a so-called flux tube, or injection tube having an inner diameter of approximately one-half inch. The flux tube is connected to the discharge passageway of the pump along the upper side of the passageway.

Although the referenced pumps function well to inject purifying gas into the molten metal, certain problems have not been addressed. One of these problems relates to mixing the purifying gas as uniformly as possible with the molten metal being pumped. Because the gas is injected through a relatively large tube at a single injection point, relatively large bubbles (incipient bubbles) of gas are discharged into the molten metal. It is only the high speed stream of molten metal which shears the incipient bubbles into a wide array of finely dispersed, smaller bubbles. The speed of the molten metal, which is dependent upon the speed of rotation of the pump's impeller, thus controls the reaction rate, with smaller bubbles, of the gas with the metal.

Desirably, the gas would be injected uniformly into the molten metal in the form of very small incipient bubbles so that intimate mixing of the gas and molten metal would occur as quickly as possible. It also would be desirable to be able to inject small bubbles and disperse them as rapidly as possible at all pump speeds, including very low speeds.

Summary of the Invention

The present invention provides a new and improved technique for injecting gas into molten metal that addresses the foregoing concerns. Apparatus according to the invention includes a passageway through which molten metal can be passed. A plurality of openings are disposed about the periphery of the passageway, and a means for injecting gas through the openings is provided.

In the preferred embodiment of the invention, the passageway constitutes the outlet of a molten metal pump, and the openings are defined by a porous media disperser that is disposed within the passageway so as to form a portion of the inner wall of the passageway. The media disperser preferably is made from bonded ceramic grain porous media, but it can be made from other materials, including graphite. The means for injecting gas includes a circumferential groove formed about the media disperser, the groove being in fluid communication with a source of compressed gas.

The invention also includes a method for injecting gas into molten metal that comprises the steps of passing the molten metal through a passageway having a predetermined cross-section, providing a plurality of openings in the passageway about the periphery of the passageway, and injecting gas into the molten metal through the openings of the passageway. In the preferred embodiment, the cross-section defines a circle, and the openings are defined by a porous ceramic media disperser.

By use of the present invention, the gas is

injected into the molten metal uniformly about the periphery of the passageway. Moreover, because the gas is passed through a porous media disperser, exceedingly small bubbles of gas are discharged into the molten metal. By injecting very small bubbles and by injecting them uniformly about the periphery of the passageway, the gas is intimately mixed with the molten metal in a very short period of time. Excellent results are obtained at all pump speeds.

The foregoing and other features and advantages of the invention are illustrated in the accompanying drawings and are described in more detail in the specification and claims that follow.

Brief Description of the Drawings

Figure 1 is a perspective view of a vessel containing molten metal into which a gas injection apparatus has been immersed;

Figure 2 is a cross-sectional view of the gas injection apparatus of Figure 1 with a gas injection conduit being shown out of position for purposes of clarity of illustration;

Figure 3 is a cross-sectional view of the apparatus of Figure 1, taken along a plane indicated by line 3-3 in Figure 2; and

Figure 4 is a view similar to Figure 3, showing an alternative embodiment of the invention.

Description of the Preferred Embodiment

Referring to Figures 1-3, a gas injection apparatus according to the invention is indicated generally by the reference numeral 10. The apparatus 10 is in the form of a pump that is adapted to be immersed in molten metal contained within a vessel 14. The vessel 14 can be any container containing molten metal that is desired to be purified, although it is expected that the vessel 14 will be the external well of a reverberatory furnace.

It is to be understood that the pump can be any type of pump suitable for pumping molten metal. Generally speaking, however, and as particularly shown in Figures 2 and 3, the pump will have a base member 16 within which an impeller 18 is disposed. The base member 16 includes an outlet passageway 20. A fitting 22 is secured to the base member 16, the fitting including a passageway 24 that is aligned with the outlet passageway 20. A sleeve 26 is secured to the fitting 22 by means of a threaded connection indicated at 28. A fluid-tight seal is effected by refractory cement indicated by the reference numeral 29. The sleeve 26 is hollow so as to define a longitudinally extending bore 30. The bore 30 is axially aligned with the passageway 24.

Referring particularly to Figure 3, a porous ceramic media disperser 32 in the form of a ring is disposed within the fitting 22, and is held in place there by the sleeve 26. The media disperser 32 is compressed against a shoulder 34 formed within the fitting 22, the compression being accomplished by the end of the sleeve 26. A circumferential groove 36 is formed in the fitting 22 about the outer periphery of the media disperser 32. The fitting 22 includes a passageway 38 that is in fluid communication with the groove 36. Similarly, the base member 16 includes a passageway 40 that is in fluid communication with the passageway 38. A gas injection conduit 42 is connected to the base member 16. The conduit 42 includes an internal passageway 44 that is in fluid communication with the passageway 40 and with a source of compressed gas (not shown). The conduit 42 also functions as a support for the base member 16.

The media disperser 32 preferably is made from bonded ceramic grain porous media commercially available from Metaullics Systems of Solon, Ohio. A variety of materials can be used to make the media disperser 32. It has been found that glass frit-bonded aluminum oxide or glass frit-bonded silicon carbide works especially well when injecting inert gases such as nitrogen, argon, or sulfur hexafluoride into molten aluminum, magnesium, copper, or alloys thereof. Alternatively, a porous graphite media disperser or a sintered oxide-based ceramic media disperser may be used when the gas being injected is chlorine. The size and number of the openings in the media disperser 32 are important because they determine, in large measure, the size of the bubbles that are injected into the molten metal discharged by the pump 10. Commercially available porous media dispersers that provide acceptable gas flow rates and small bubble size have pore diameters in the range of 10-100 microns. Gas flow rates and volumes are dependent upon the size of the media disperser and applied pressure. Those skilled in the art will be able to select appropriate media dispersers to suit their particular needs.

An alternative embodiment of the invention is illustrated in Figure 4. In this embodiment of the invention, the fitting 22 is replaced by a fitting 50. The fitting 50 is substantially similar to the fitting 22, and like elements are indicated by like reference numerals carried over from Figures 2 and 3. Instead of employing the passageway 38, however, the embodiment shown in Figure 4 employs a passageway 52 which opens into a counterbored portion 54. A gas injection conduit 56 having an internal passageway 58 is secured within the counterbored portion 54 so that the passageways 52, 58

are in fluid communication with each other. The embodiment of the invention illustrated in Figure 4 thus is usable with a molten metal pump of virtually any type, provided the fitting 50 can be secured to the outlet of the pump.

By use of the present invention, gas is injected into the molten metal uniformly about the periphery of the passageway 24. The bubbles that are injected are very small, and they become intimately mixed with the molten metal flowing through the passageway 24 and the bore 30. The only significant limitation on the sleeve 26 is that it should be long enough to ensure complete mixing of the gas and the molten metal. Additionally, because the media disperser 32 is formed of a ceramic material, it withstands very well the corrosive and erosive action of the molten metal. Additionally, because the sleeve 26 is threaded into the fitting 22, the media disperser 32 can be replaced conveniently when necessary.

Although the invention has been described in its preferred form with a certain degree of particularity, it will be understood that the present disclosure of the preferred embodiment has been made only by way of example and that various changes may be resorted to without departing from the true spirit and scope of the invention as hereinafter claimed. It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty exist in the invention disclosed.

Claims

1. A method of injecting gas into molten metal, comprising the steps of:
passing the molten metal through a passageway (24) having a predetermined cross-section;
providing a plurality of openings about the periphery of the passageway (24); and
injecting gas through the openings into the metal in the passageway (24).

2. The method of claim 1, wherein the openings are defined by a porous media disperser (32).

3. The method of claim 2, wherein the media disperser (32) is in the form of a porous body of ceramic or graphite.

4. A method of injecting gas into molten metal, comprising the steps of:
providing a molten metal pump (10) having an outlet passageway (24) of a predetermined cross-section;
passing molten metal under pressure through the outlet passageway (24);
providing a plurality of openings about the periphery of the passageway (24); and
injecting gas through the openings into molten metal flowing through the passageway (24).

5. The method of claim 4, wherein the openings are defined by a porous media disperser (32).

6. The method of claim 5, wherein the media disperser (32) is in the form of a porous body of ceramic or graphite.

7. The method of claim 4, wherein the openings are defined by a porous media disperser (32), and the inner diameter of the media disperser (32) defines the inner diameter of a portion of the passageway (24).

8. Apparatus for injecting gas into molten metal, comprising:
a passageway (24) through which the molten metal can flow;
a porous media disperser (32) disposed within the passageway (24) about the periphery of the passageway (24); and
means for injecting gas through the porous media disperser (32) into the molten metal flowing through the passageway (24).

9. The apparatus of claim 8, wherein the passageway (24) is defined by a fitting (22) to which a sleeve (26) is secured, the sleeve (26) engaging the media disperser (32) and holding the media disperser (32) in place within the fitting (22).

10. The apparatus of claim 8, wherein the inner diameter of the media disperser (32) defines the inner diameter of a portion of the passageway (24).

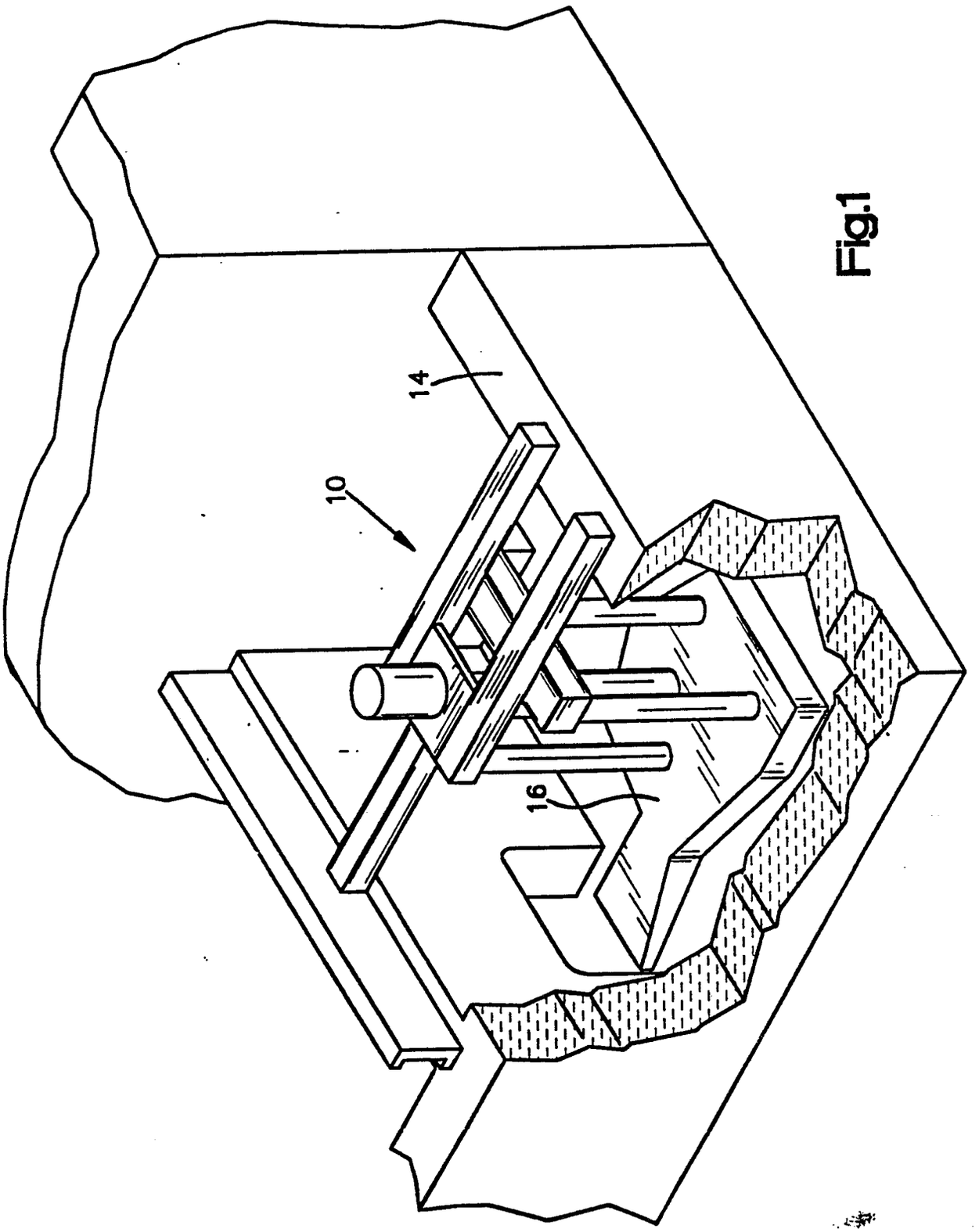

Fig.1

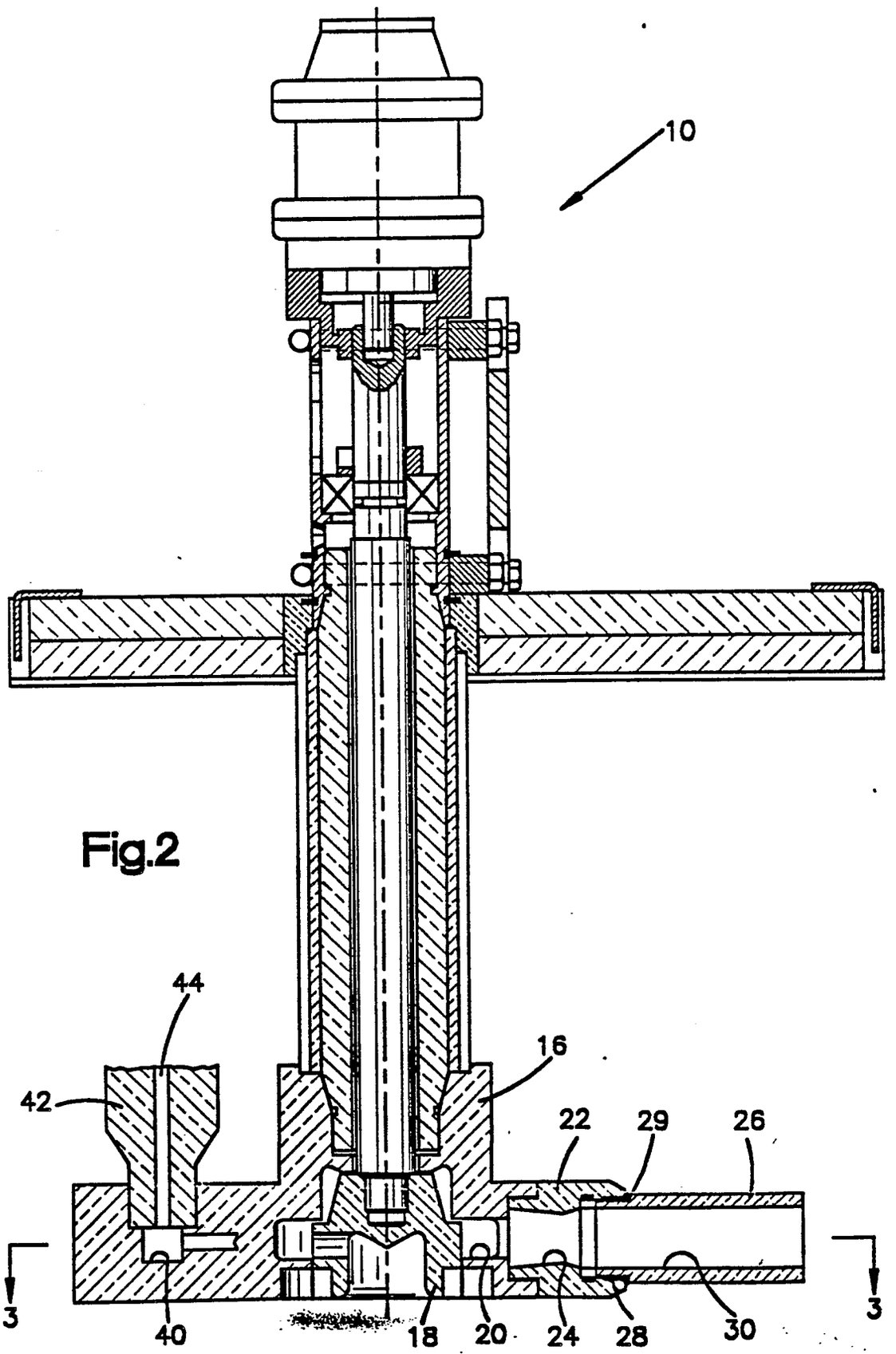

Fig.2

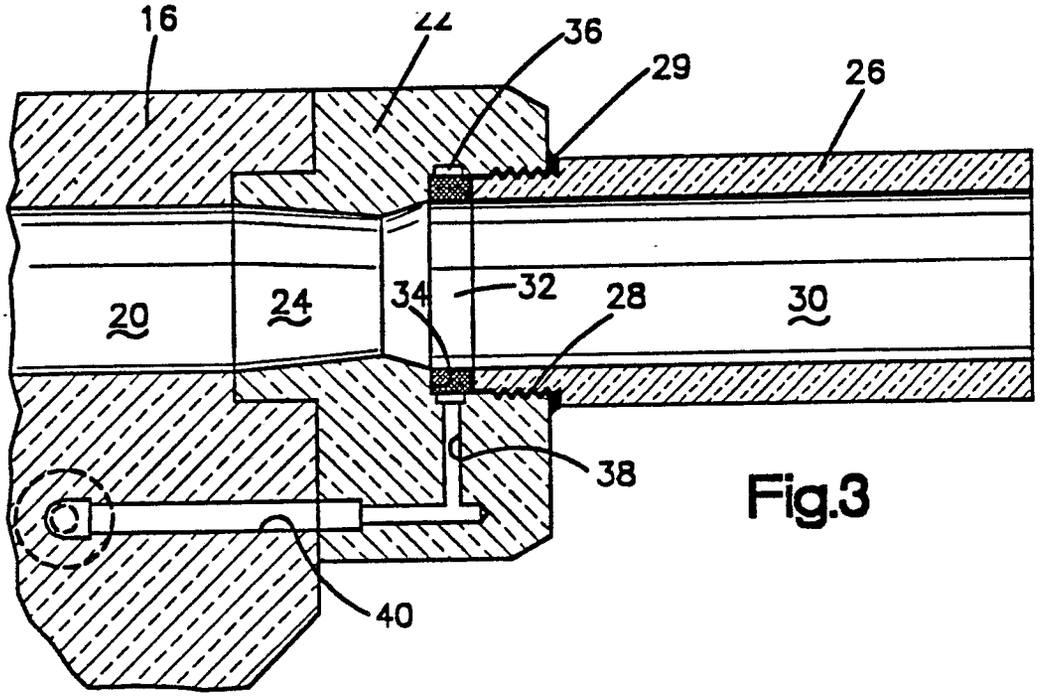
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Fig.3

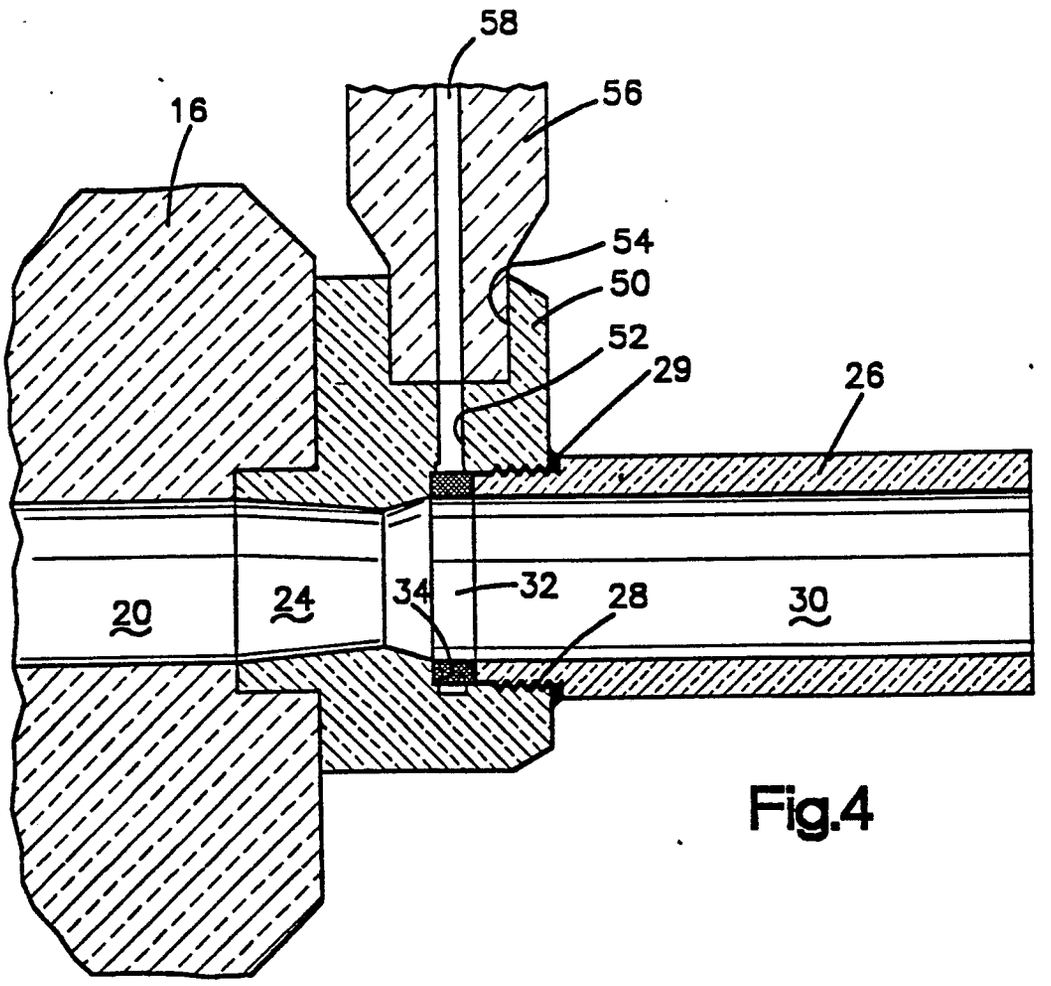
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Fig.4

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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 1657

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 295 883 (R. LAJH) * figure 5 * ---	1	C 21 C 7/072 C 22 B 9/05
A	US-A-4 351 514 (F.C. KOCH) * figures 3,4 * ---	1	
A	US-A-4 052 199 (M.C. MANGALICK) * figure * ---	1	
A	US-A-3 715 112 (H. CARBONNEL) * figure 1 * ---	1	
A	EP-A-0 171 589 (RADEX ITALIANA) * figures 2,3 * -----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

C 21 C 7/072
C 22 B 9/05

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	28-05-1990	SUTOR W

CATEGORY OF CITED DOCUMENTS

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