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(71) Applicant: **Moussokhranov, Boris**
38001 Santa Cruz de Tenerife (ES)

(72) Inventor: **Moussokhranov, Boris**
38001 Santa Cruz de Tenerife (ES)

(74) Representative: **Carpintero Lopez, Francisco**
HERRERO & ASOCIADOS, S.L.
Alcalá, 35
28014 Madrid (ES)

(54) Method for combustion of liquid fuel and injector for execution thereof

(57) The method is particularly applicable to casting furnaces of the type in which the liquid fuel is mixed with the comburent for its immediate combustion, and consists of heating the fuel/comburent mixture before its ignition, specifically by adding to the injector hot pressurised air that arrives tangentially at the mixing chamber, creating in it a vortex that atomises said mixture. For this purpose, the fuel inlet duct (3) axially accesses a vortex chamber (1), at which arrives radially or tangentially a supersonic pressurised primary air inlet that generates in said chamber (1) the vortex effect for a maximum dispersion or fractioning of the fuel, which can reach a molecular level, the mixture leaving through the outlet duct (4) placed behind the chamber (1) coaxially to the fuel inlet duct (3). The injector itself can be housed in a duct (9) with a larger diameter in which is established a secondary air inlet (6), either forced or by self-absorption.

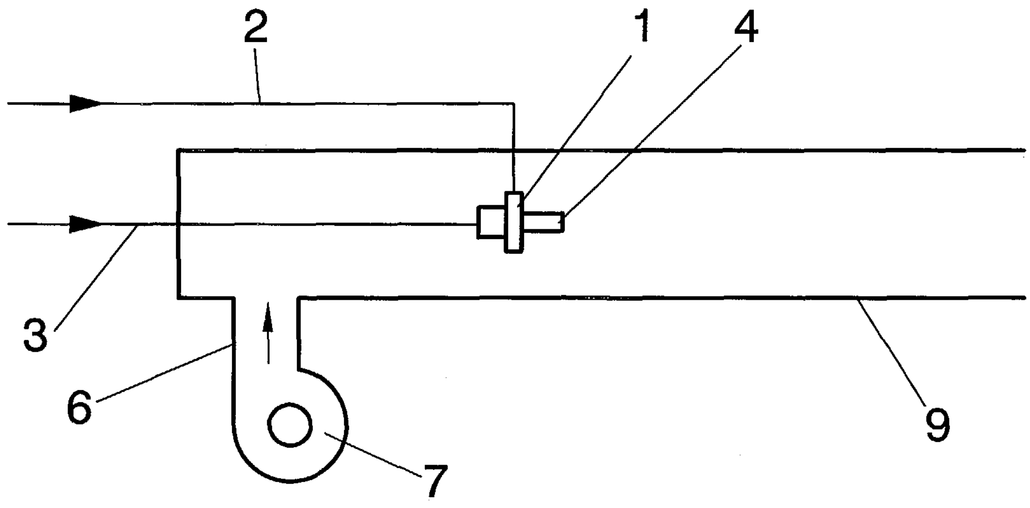

FIG.2

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Description

OBJECT OF THE INVENTION

[0001] The present invention relates to a liquid fuel injector for use in any type of installation wherein the fuel is fed by injection, but particularly suited to the specific case of casting furnaces.

[0002] The object of the invention is to obtain a considerable improvement in the fuel combustion by heating the fuel/comburent mixture immediately prior to its ignition, and by the creation of a vortex that at the same time improves the fuel/comburent mixture, with a greater energy efficiency, an increased flame temperature and a great reduction in the emission of pollutants to the atmosphere such as sulphur dioxide, carbon monoxide, etc., this is, a great reduction of environmental pollution.

[0003] The invention also relates to the injector used to execute this method.

BACKGROUND OF THE INVENTION

[0004] As is known, conventional injectors base their operation on sending the fuel to the mixing chamber at a high pressure for its mixture with the comburent, typically air, and the subsequent combustion of the mixture.

[0005] As during the combustion itself the fuel must react with the comburent, it is obvious that the dispersion level obtained in the fuel, and thus the degree of mixture with the comburent, is crucial both to obtain optimum results from the standpoint of the combustion or efficient use of the fuel, and to reduce the emission of pollutant gases derived from incomplete combustions.

[0006] The results obtained to date with known injectors are quite unsatisfactory in this sense.

DESCRIPTION OF THE INVENTION

[0007] The method taught by the invention, as mentioned above, is fundamentally based in heating the fuel/comburent mixture immediately before said mixture is ignited.

[0008] The special construction of the injector allows obtaining a fuel "beating" to levels hitherto unknown, practically to the point of fractioning or molecular dispersion, so that the mixture of the aforementioned fuel and air ensures a practically complete combustion of the former, with the resulting benefits derived thereof, specifically an optimum use of the fuel and a lack of emissions of pollutants.

[0009] For this purpose and more specifically, the aforementioned injector generates a vortex in the area of mixture of the fuel and air, said vortex providing the desired effect.

[0010] Specifically, the injector is provided by a fuel inlet that is coaxial with the outlet of the mixture towards the furnace or element involved, with two air inlets cooperating with said fuel inlet, a primary air inlet at a pressure such that the entry speed is supersonic, and a secondary air inlet that may be forced or provided simply by self-absorption, the primary air inlet obviously generating the desired vortex effect and the subsequent fuel dispersion, while the secondary air inlet has an also secondary effect on the operation of the injector, and can be applied by any other means different from those mentioned above or may even not be present.

[0011] According to another characteristic of the invention, the air entering the injector by the main inlet is hot air.

[0012] Specifically, the hot air inlet duct is closed on its proximal end and incorporates a lateral opening through which it is coupled tightly to a chamber housing the injector itself that defines the mixture nozzle, said opening communicating with a tangential orifice established in a washer that can be coupled coaxially to the mixture nozzle outlet, so that the tangential access to the mixing chamber determined by said washer generates both the vortex effect to improve the fuel/comburent mixture and the temperature increase of said mixture to improve the combustion.

DESCRIPTION OF THE DRAWINGS

[0013] As a complement of the description being made and in order to aid a better understanding of the characteristics of the invention, according to an example of a preferred embodiment, a set of drawings is accompanied as an integral part of the description in which, for purposes of illustration and in a non-limiting sense, the following is shown:

Figure 1 shows a schematic representation of an injector for liquid fuel constructed in accordance with the object of the present invention.

Figure 2 shows a schematic representation similar to that of the previous figure, in the specific case in which the secondary air intake is forced.

Figure 3 also shows a representation similar to that of figure 2, corresponding to an alternative embodiment in which the secondary air inlet is caused by self-absorption.

Figure 4 shows another schematic representation of an injector in which the secondary air inlet has been eliminated.

Figure 5 shows an example of an embodiment of the injector of figure 3, in a side elevation and longitudinal section view.

Figure 6 shows an enlarged detail, also in a side elevation and longitudinal section view, of the hot air inlet of the injector of the previous figure.

Figure 7 shows, finally, a plan and profile view of the grooved washer establishing the communication between the tube of the previous figure and the mixing chamber.

PREFERRED EMBODIMENT OF THE INVENTION

[0014] In view of the above-described figures and particularly of figure 1, it can be seen that the injector disclosed comprises a chamber (1) in which the desired vortex effect is achieved, radially or tangentially accessed by an airduct (2), as a primary inlet of air at a high pressure and thus at a high speed, in which chamber (1) enters the liquid fuel axially through the corresponding duct (3); after mixing with the air due to the aforementioned vortex effect said fuel reaches the duct (4) for feeding the fuel/comburent mixture that is coaxial with the fuel inlet duct (3), at the outlet of which is generated the flame (5) that is dispersed inside the furnace.

[0015] From a practical standpoint, the aforementioned primary air inlet (2) can be assisted by a secondary air inlet (6) as shown in figures 2 and 3, that in the case of figure 2 enters forcedly into the duct (4), such as with the aid of a fan (7), so that this entry of secondary air does not participate in the generation of the vortex effect but simply allows a proper quantification of the fuel to comburent ratios; it is also possible to establish a secondary air inlet (8) by simple self-absorption, as shown in figure 3, in which this secondary air inlet (8), as in the previous case, must be located behind the vortex effect generation chamber (1) so that the mixture stream produced at the outlet (4) generates a depression behind said chamber that in the second case causes the aforementioned self-absorption and in the first case facilitates the transport of secondary air despite it being forcedly applied.

[0016] However, as shown in figure 4, it is possible to eliminate said secondary air inlet (6-8) when the process conditions make it advisable, as the vortex effect is generated by the primary air inlet (2), as mentioned above.

[0017] In the latter case, as in the basic scheme of figure 1, the outlet (4) may constitute the injector mixture outlet, while when there is a secondary air inlet (6-8) there must also be an enveloping tube (9) in which the mixture emerging from the vortex chamber (1) through its outlet (4) and the secondary air are in turn mixed.

[0018] Figure 5 shows a practical solution corresponding to the scheme shown in figure 3, in which is shown the fuel inlet (3) that, with a suitable length, ends at an injection nozzle (10), this assembly being housed inside a tubular casing (9) with a considerably larger diameter that determines an enveloping chamber (11) with a natural atmospheric air inlet (8) that can be replaced by the forced air inlet (6) of figure 2, said casing (9) being fixed to the fuel injector, or example, with the aid of a bolt (12) acting on a neck (13) of the casing (9) that is adapted to the fuel injector tube (14) as clearly shown in figure 5.

[0019] At its internal end, immediately before the injector (10), the fuel inlet tube (14) receives a second neck (15) for attaching the injection chamber (1), in which the injector (10) is axially housed. Said chamber is in turn provided with inlets (8') for atmospheric air from the chamber (11) and with a mixing nozzle (16) through which leave axially the liquid fuel arriving from the injector (10) and the fuel arriving from the orifices (8-8'), absorbed due to the Venturi effect generated by the injector (10); the aforementioned components, the fuel and the comburent, pass into a mixing chamber (17) through the aforementioned nozzle (16), while the aforementioned mixing chamber (17) is defined by a tubular body attached by screws (18) to the casing (9) and that by an internal widening receives the injection chamber (1) with an interposed grooved washer (19), particularly visible in figure 7, secured with the aid of a bolt (20).

[0020] In addition to the described structure, the primary air duct (2) is established laterally in the annular chamber (11) and on its external end finishes at a connector (21) to the corresponding source of hot pressurised air, said tube (2) having its internal end (22) closed and being provided with a lateral opening (23) particularly visible in figure 6, by which it is coupled laterally and radially to the internal end of the cap constituting the mixing chamber (17), specifically to the area of said chamber that receives the injection chamber (1), so that the aforementioned lateral opening (23) is opposite the washer (19), more specifically opposite the tangential groove (24) of said washer, as shown in figure 7, so that the hot air circulating in duct (2) accesses tangentially the mixing chamber (17), where it creates a vortex effect in which, in addition to substantially improving the atomised fuel/comburent mixture, considerably heats said mixture to improve its final ignition, thereby improving the combustion conditions.

[0021] The tests performed show that the use of the injector disclosed by the invention, in order to obtain optimal results from an energetic standpoint compared to a conventional injector, it is possible to obtain fuel savings of up to 50% with a compressed primary air pressure on the order of 2 bars and a flame temperature between 1200 and 1250° C peripherally and 1350° C at the core, also reducing the atmospheric emission of pollutants by a factor of 15 on the average.

[0022] In this sense and more specifically, measurements of pollutants in an uninterrupted regime yielded the following values:

- Nitrogen dioxide: 0.04-1,500 Mg/m^3.
- Sulphur dioxide: 0.005-350 Mg/m^3.
- Nitrogen oxide: 1.2-5,000 Mg/m^3.
- Hydrocarbons: 1.0-500 Mg/m^3.

Claims

1. Method for combustion of "aero-centrifugal" liquid

fuel, particularly applicable in the field of casting furnaces, **characterised in that** it consists of heating the fuel/comburent mixture immediately before igniting this mixture.

2. Method for combustion of "aero-centrifugal" liquid fuel, according to claim 1, **characterised in that** the fuel/comburent mixture is heated by adding hot air to the injector.

3. Method for combustion of "aero-centrifugal" liquid fuel, according to previous claims, **characterised in that** the hot air is supplied under pressure tangentially to the mixing chamber, creating in the latter a vortex effect to atomise the fuel/comburent mixture in parallel to its heating.

4. Method for combustion of "aero-centrifugal" liquid fuel, according to claim 3, **characterised in that** the primary air is supplied at a supersonic speed causing the dispersion of the fuel to molecular fractions.

5. Liquid fuel injector for execution of the method of the previous claims, **characterised in that** a vortex chamber is established in the area of confluence of the fuel feeding duct (3) and the air-feeding duct (2).

6. Liquid fuel injector, according to claim 5, **characterised in that** the primary air inlet (2) radially and tangentially enters the vortex chamber (1), in which the fuel inlet (3) and mixture outlet (4) are established coaxially.

7. Liquid fuel injector, according to claims 5 and 6, **characterised in that** the vortex chamber (1), with its primary air inlet (2) and fuel inlet (3), is established inside an enveloping chamber (11) in which the fuel inlet duct (3) is placed axially, such that immediately before the vortex chamber (1) is also placed a secondary air inlet (6), forced by a fan (7) or the like.

8. Liquid fuel injector, according to claims 5 and 6, **characterised in that** the vortex chamber (1), with its primary air inlet (2) and fuel inlet (3), is established inside an enveloping chamber (11) in which the fuel inlet duct (3) is placed axially, such that placed immediately before the vortex chamber (1) is a secondary air inlet (8) by which the secondary air accesses the chamber (11) by self-absorption.

9. Liquid fuel injector, according to claims 5 to 8, **characterised in that** the air accesses the injection chamber (1) in which the fuel injector (10) is established at ambient temperature by a series of openings (8'), with forced ventilation or by the Venturi effect generated by the injector (10), while at the outlet of said injection chamber (1) and surrounding the mixture nozzle (16) is placed a washer (19), provided with a tangential slit or opening (24) to allow air to enter from the complementary duct (2) connected to a source of hot pressurised air, so that the air circulating in said duct (2) generates the vortex effect by the tangential slit (24) of the washer (19), while heating the fuel/comburent mixture.

10. Liquid fuel injector, according to claim 9, **characterised in that** the hot air inlet tube (2) is established laterally on the injector casing (9) and at its internal end has a lateral opening (23) by which it is coupled also laterally to the injection chamber (1), establishing a communication with the mixing chamber (17) through the slit (24) of the washer (19), which is placed coaxially to the mixing chamber (17) and the injection chamber (1).

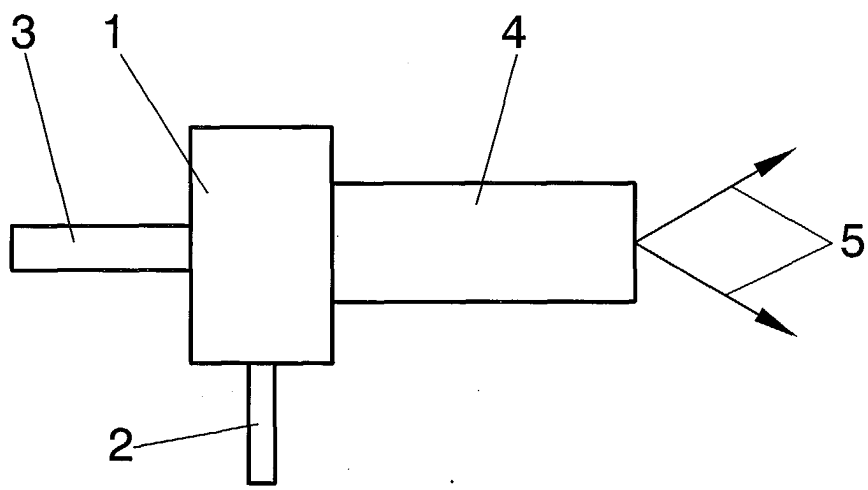

FIG.1

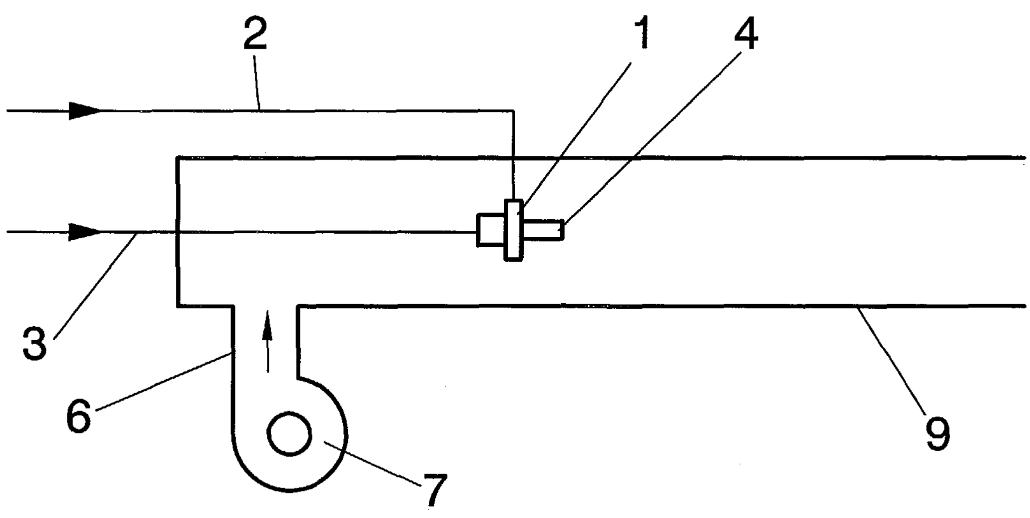

FIG.2

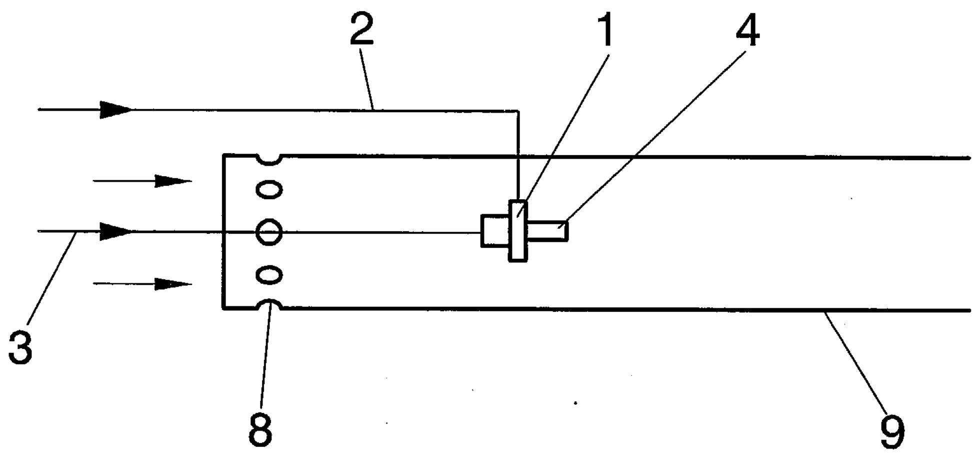

FIG.3

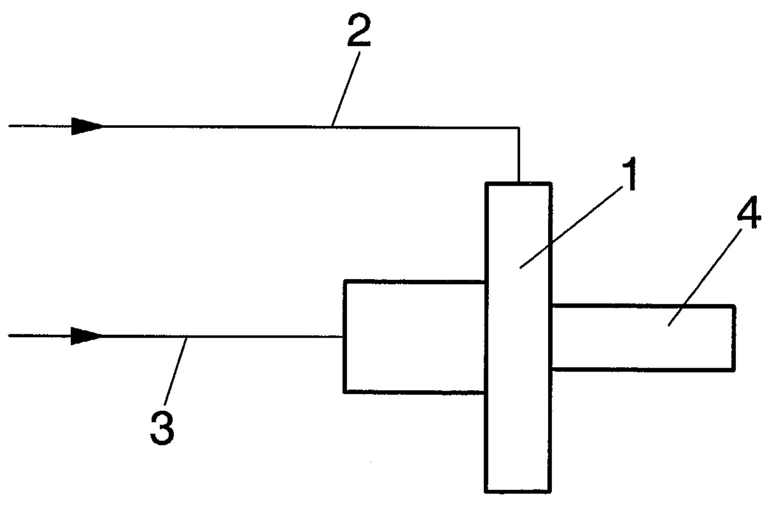

FIG.4

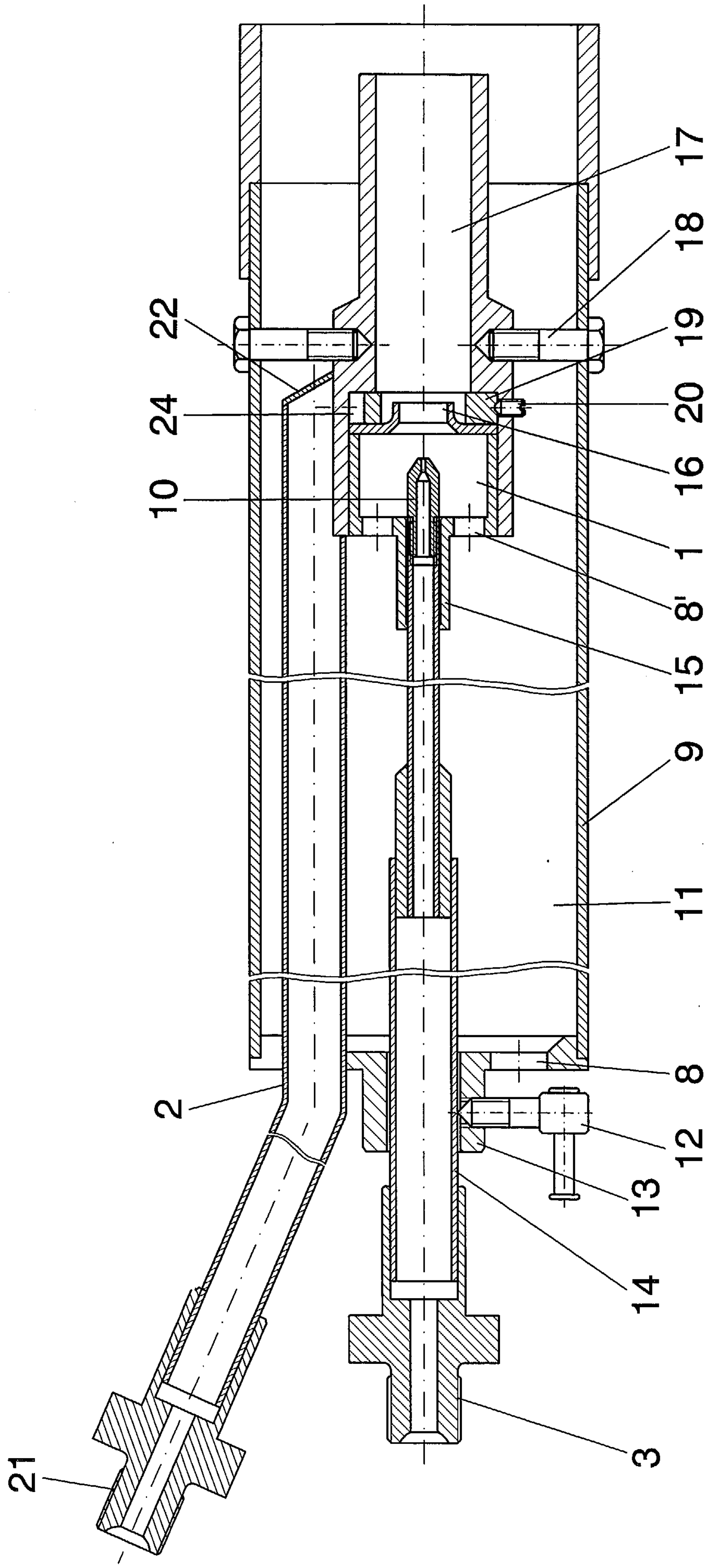

FIG.5

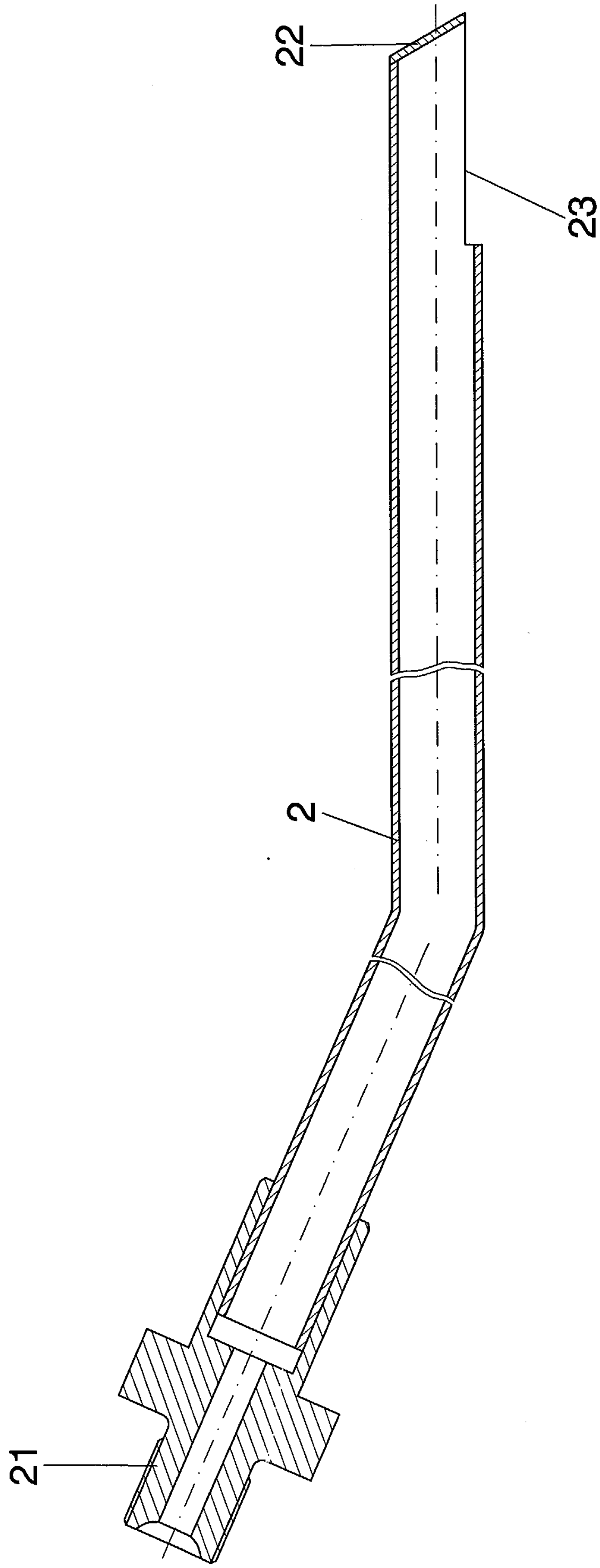

FIG.6

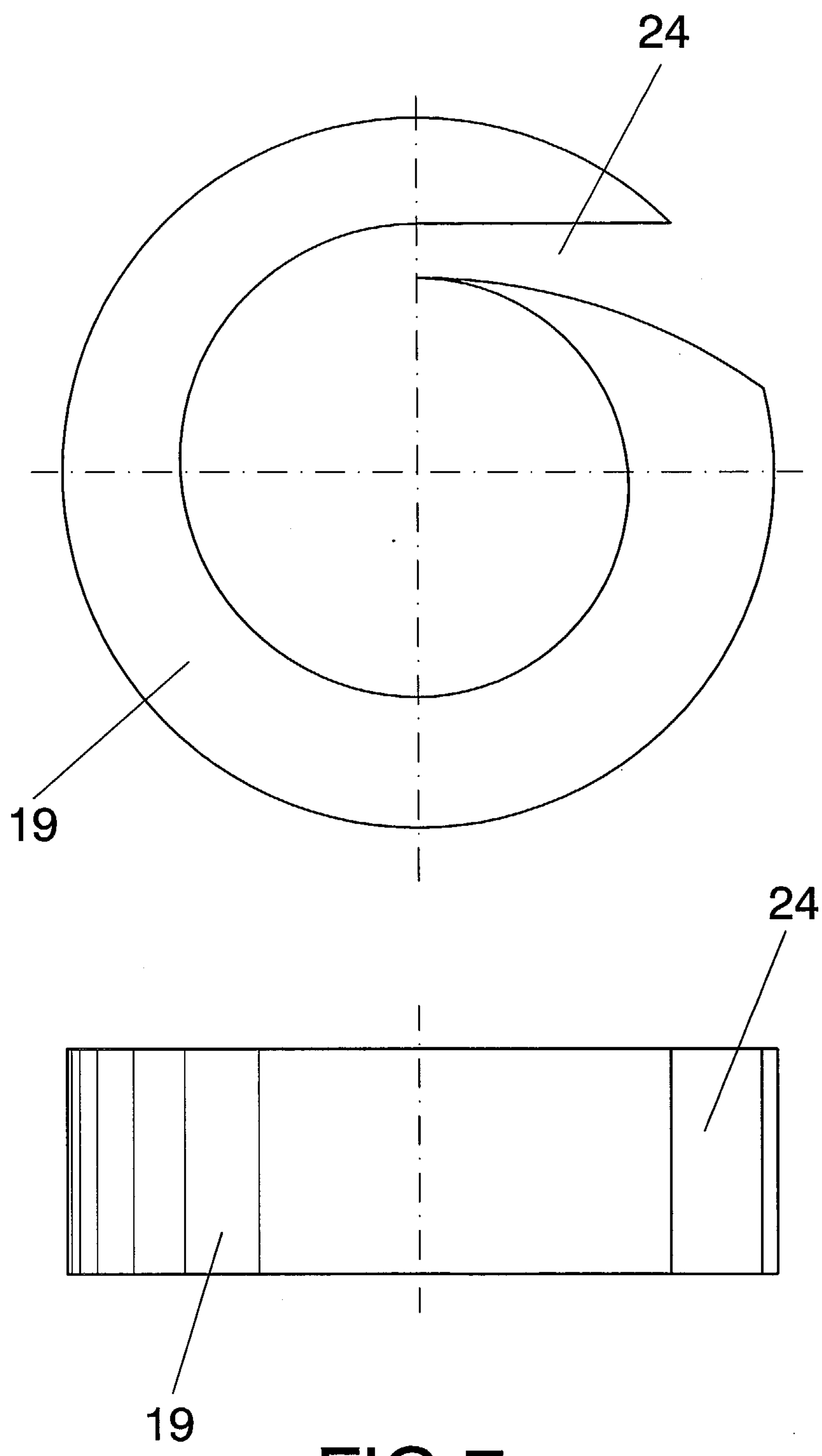

FIG.7