NOZZLE FOR SPRAYING LIQUID FUEL

Inventors: Markus Neumuller, Hechendorf (DE); Christian Backer, Furstenfeldbruck (DE); Christine Sallinger, Unterschleissheim (DE); Stefan Kunz, Munchen (DE); Florian Metz, Mering (DE)

Correspondence Address:
ROBERTS, MLOTKOWSKI & HOBBES
P. O. BOX 10064
MCLEAN, VA 22102-8064 (US)

Publication Classification
Int. Cl.
F23C 7/00 (2006.01)
F24J 3/00 (2006.01)

U.S. Cl. 239/463: 237/12.3 R; 431/353

ABSTRACT
A nozzle for atomization of liquid fuel by air flowing through the nozzle (20), with an air entry area (50), an air exit area (52) and a flow path (54) which connects the air entry area (50) to the air exit area (52), the nozzle (20) being made of ceramic material, an air guidance device (56) being provided in the air entry area (50) which imparts a swirl to the inflowing air, and the air guidance device (56) being an integral part of the nozzle (20). Furthermore, there is a heater (10) equipped with such a nozzle (20) for mobile applications.
NOZZLE FOR SPRAYING LIQUID FUEL

BACKGROUND OF THE INVENTION

[0001] 1. Field of Invention

[0002] The invention relates to a nozzle for atomization of liquid fuel by means of the air flowing through the nozzle, with an air entry area, an air exit area and a flow path which connects the air entry area to the air exit area.

[0003] 2. Description of Related Art

[0004] Generic nozzles are used, for example, in vehicle heaters. These vehicle heaters can be used, for example, as auxiliary heaters and/or stationary heaters.

[0005] The nozzle is used to supply combustion air, due to the flow of combustion air the liquid fuel, for example, diesel or gasoline, being entrained from a fuel nozzle and atomized. In this way, a mixture of combustion air and fuel is obtained which can be burned, optionally, after mixing with air supplied on other flow paths, by which the heat necessary for heating operation is produced. This heat generated by a burner then heats a heat transfer medium, for example, water or air.

[0006] Nozzles of the prior art often are made of metal, e.g. as cast parts or turned parts. The disadvantage in these components is the comparatively high production cost and the generally high thermal conductivity of the metals. The thermal conductivity can pose problems when the temperature in the area of the fuel nozzle rises unduly as a result of the heat produced in the burner. To solve the problems which are associated with metallic nozzles, it has been proposed that a ceramic nozzle be used.

[0007] The flow behavior of the combustion air is important for the mixing of the combustion air with the fuel on the common path. In order to improve the flow behavior of the combustion air, it was already proposed in DE 100 39 152 A1 and corresponding U.S. Patent Application Publication 2003/0022123 A1 that a swirl be imparted to the combustion air. In this way, it is possible to distinctly improve the atomization quality and thus the efficiency of the burner, since the combustion air speed is increased as a result of the pronounced tangential component of motion. In order to impart this swirl, a carrier with swirl blades is connected upstream of the input area of the nozzle. However, the disadvantage in this carrier with upstream swirl blades is that an additional component is needed, for which reason the tolerances which exist for undisturbed operation of the nozzle can sometimes be exceeded.

[0008] In heaters of the prior art it is, furthermore, problematical to maintain narrow tolerances with respect to positioning of the glow plug with regard to the inflowing fuel/air mixture.

SUMMARY OF THE INVENTION

[0009] The object of the invention is to make available a nozzle which can be economically produced, which has thermal conductivity which is low compared to metal, and which induces advantageous properties with respect to the flow behavior of the combustion air, and calibration problems are to be avoided.

[0010] This object is achieved by the nozzle being made of ceramic material and having an air guidance means formed as an integral part thereof in the air entry area so as to impart a swirl to the inflowing air.

[0011] The invention is based on the generic nozzle in that the nozzle is made of ceramic material and the air entry area has air guidance means which impart a swirl to the inflowing air but improves thereof by the air guidance means being made as an integral part of the nozzle. In this way a nozzle is provided which can be economically produced. The ceramic material can be easily worked, numerous versions with respect to shaping being possible. In particular, the air guidance means which delivers a swirl to the combustion air outside of the air entry area can be made integrally with the nozzle. As a result of using a ceramic, there is the additional advantage that the area of the nozzle around the fuel needle which is located in the nozzle does not assume overly high temperatures, so that amounts of fuel which may be emerging from the nozzle cannot ignite. The integral execution of the air guidance means makes it possible to easily adhere to tolerances, since miscalibration of the air guidance means when the burner is being assembled is no longer possible.

[0012] The invention is advantageously developed in that the nozzle has means for holding a glow plug. The positioning of the glow plug with respect to the nozzle is an important parameter with regard to good starting behavior of the burner. In heaters of the prior art, the glow plug was generally held by the burner housing, so that, in this way, fluctuations of the positioning with respect to the nozzle could occur. These tolerances can be precluded by the property of the nozzle of the present invention in that the nozzle itself has means for holding the glow plug so that the glow plug always has the same position with respect to the nozzle.

[0013] Furthermore, the nozzle in accordance with the invention is advantageously developed in that the nozzle has at least in part an essentially cylindrical shape and that the air guidance means forms channels which are offset with respect to the radial directions. The air which is flowing in perpendicular to the axis of the nozzle is therefore not radially supplied, but supplied with an offset. This offset determines the swirl which is delivered to the combustion air, and thus, the flow behavior and ultimately also the properties and quality of combustion.

[0014] It is especially useful for the air guidance means to have essentially triangular base surfaces, the corners being rounded. In this way, the channel offset can be easily implemented. The rounding of the corners is advantageous for uniform flow behavior.

[0015] It can also be useful for the air guidance means to be made as blades. These blades can likewise provide offset channels so that, in this way, the combustion quality is benefited.

[0016] In another preferred embodiment of this invention, it is provided that the means for holding the glow plug are made as a hole which runs obliquely to the cylinder axis. The glow plug must then be simply inserted into the hole for suitable positioning. A stop on the glow plug and/or within the hole provides for the glow plug to be guided into its optimum position with respect to the nozzle.

[0017] The nozzle in accordance with the invention is developed especially advantageously in that an at least essentially cylindrical part of the nozzle has an essentially cylindrical shoulder with an increased diameter and that the means for holding the glow plug are made as a hole which...
penetrates the shoulder which runs obliquely to the cylinder axis. In this way, the glow plug can be held in an area in which it influences the flow behavior of the inflowing fuel/air mixture as little as possible. This can be easily managed by the cylindrical stop which has a greater diameter than the remaining nozzle body.

Likewise, it is especially advantageously provided that an at least essentially cylindrical part of the nozzle has an essentially cylindrical shoulder with an increased diameter and that the cylindrical shoulder has recesses for holding the mounting pins. These mounting pins can be securely attached, for example, to the heat shield of the burner. The relative positioning of the nozzle is fixed in this way by recesses in the shoulder and the position of the mounting pins. Thus, installation is especially simple and is possible with only low tolerances.

In an especially advantageous manner, it can be provided that the nozzle is a Venturi nozzle. The Venturi effect for atomization of the fuel emerging from the fuel needle can be advantageously combined in this way with the swirl delivered to the combustion air. The effects support one another and thus lead to high-quality combustion.

The invention is based on the finding that a nozzle which can be economically produced provided with a shape which can be varied within wide limits using a ceramic material. The shaping of the nozzle can be completed such that the air guidance means which imparts a swirl to the entering combustion air can be made integrally with the nozzle. Furthermore, the ceramic has the advantage that an undesirably high temperature can be avoided in the area of the fuel needle.

Another object consists in devising a heater for mobile applications which can be economically produced.

This object is achieved by a heater for mobile applications, especially motor vehicles which is provided with a burner for combustion of a fuel/air mixture having a nozzle in accordance with the present invention.

The invention is explained in greater detail below with reference to the accompanying drawings which shows a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

**FIG. 1** is a partially cutaway schematic of a heater in which the nozzle of the present invention can be used;

**FIG. 2** cross-sectional side view of one embodiment of a nozzle in accordance with the invention;

**FIG. 3** is a plan view of the air entry area of a nozzle in accordance with the invention; and

**FIG. 4** shows a nozzle in accordance with the invention mounted on a burner.

DETACED DESCRIPTION OF THE INVENTION

In the following description of the drawings, the same reference numbers identify the same or comparable components throughout the various figures.

**FIG. 1** shows a heater 10 for use with the nozzle of the invention which has a burner 12 for combustion of a fuel/air mixture. The heater comprises an annular channel fan 14 with a fan motor 36. Combustion air 42 is taken in through the annular channel fan 14 via an air entry connection 16 and is blown into a combustion air collecting space 18 on the pressure side. The combustion air which is available in the combustion air collecting space 18 is divided into primary air and secondary air. The primary air is conveyed into the combustion chamber 24 by a nozzle 20 which is made as a Venturi nozzle in this example. The secondary air is conveyed through secondary air holes 22 into the combustion chamber 24. The division of the combustion air into primary air and secondary air is useful in order to provide a rich, ignitable mixture at the outlet of the nozzle 20.

The nozzle 20 comprises a settling zone 26 and a diffuser 30 in order to produce the Venturi effect. Within the nozzle 20, there is a fuel needle 28. The fuel needle 28 is supplied with fuel 44 via a fuel line 82. Due to the high flow velocity of the combustion air in the settling zone 26, the fuel which is emerging almost unpressurized from the fuel needle 28 is pulled into filaments which then break down into droplets. The high air speeds which are necessary for good atomization can be achieved by good pressure recovery of the diffuser 30.

Furthermore, over the course of the diffuser 30, the flow velocity of the fuel/air mixture is drastically reduced, by which low flow velocities are accomplished in the area of the glow plug 62 which is indicated in FIG. 2. This supports the formation and propagation of a pilot flame. After the starting process, i.e., ignition of the system by the glow plug 62, the glow plug is turned off. It is used subsequently with the aid of resistance measurement for flame monitoring.

Within the fuel chamber 24, there is a baffle disk 32. The latter constitutes a flow barrier so that the air emerging from the nozzle 20 is forced to the outside. In this way, good mixing of the primary air with the secondary air takes place; this is useful with respect to good final combustion. The area between the nozzle 20 and baffle disk 32 is thus used as a mixing zone 34 and the area on the other side of the baffle disk 32, i.e., the area which is downstream with respect to the baffle disk 32, is used as a reaction zone 38. The mixture produced burns in the further course of the combustion pipe 40 and is routed out of the heater 10 by the parts which carry the exhaust gas. The heat generated heats the entering cold water 46 in heat exchange with the exhaust gas-carrying parts so that hot water 48 emerges from the heater 10. For example, air can also be used as a heat transfer medium instead of water.

**FIG. 2** shows a partially cutaway side view of one embodiment of a nozzle 20. This nozzle 20 can be used, for example, in a heater 10, as is shown in **FIG. 1**. The nozzle 20 is made of a ceramic material; this simplifies the production of the nozzle 20 as compared to metal nozzles. The nozzle 20 has an air entry area 50 and an air exit area 52. The air entry area 50 is connected to the air exit area 52 via the flow path 54. This flow path 54 is divided in this example into a settling zone 26 and a diffuser 30.

In the air entry area, there is air guidance means formed of air guidance elements 56. These air guidance elements 56 are made integrally with the ceramic nozzle 20. The air guidance elements 56 are aligned such that a swirl is imparted to the supplied air, this is explained below with
reference to FIG. 3. In the settling area 26, there can be a fuel needle 28 (see, FIG. 4) so that a mixture of fuel and air emerges from the nozzle 20. This mixture can be ignited via a glow plug 62 which can be inserted into a hole 58 of the nozzle 20. The positioning of the glow plug 62 is thus fixed with respect to the nozzle 20, since the glow plug 62 is held by a hole 58 of the nozzle 20, i.e., especially not by any other parts. Thus, very low tolerances can be maintained with respect to the installation position of the glow plug 62. The hole 58, advantageously, penetrates a cylindrical shoulder 64 of the nozzle 20, which should have an enlarged radius; this has the advantage that the flow behavior of the nozzle 20 is influenced only slightly by the hole 58 or by the glow plug 62 which is located in the hole 58.

[0035] FIG. 3 shows an overhead view of the air entry area 50 of a nozzle. One possible configuration of the air entry area 50 by air guidance elements 56 is shown. The air guidance elements 56 form channels 60 for the inflowing air. These channels 60 are positioned with respect to the radii of the structure which is located essentially on an axis such that there is an offset. Air flowing in from the outside thus undergoes a swirl; this entails advantageous properties with respect to atomization of the fuel which is emerging from the fuel needle which can be located in the settling area 26. Furthermore, in this representation, the arrangement of the opening 58 for holding the glow plug can be recognized. The opening 58 penetrates the essentially cylindrical shoulder 64. Furthermore, the shoulder 64 is provided with recesses 66. These recesses 66 define the installation position of the nozzle 20; this is explained below with respect to FIG. 4.

[0036] FIG. 4 shows a partially cutaway view of a device in accordance with the invention. One end of the burner 12 facing the nozzle 20 is shown.

[0037] The burner 12 is bordered by a heat shield 78. On this heat shield 78, there are two mounting pins 68 in this particular embodiment. These mounting pins 68 can be welded to the heat shield 78 or to the burner 12. The mounting pins 68 define the positioning of the other components which are described below. First of all, there is a seal 76 which preferably is formed of a mica layer and a graphite layer, the mica layer facing the burner 12 and the graphite layer facing the nozzle 20. The ceramic nozzle 20 follows and is positioned with respect to the mounting pins 68. At its recesses 66 (FIG. 3). A fuel feed 70 is connected to the fuel needle 28 and is seated on the nozzle 20. This fuel feed is positioned, likewise, by mounting pins 68 by means of holes 84 which are provided in the side flange. The fuel feed 70 is supplied with fuel by a fuel line 82 in which there is a fuel sensor 80. The fuel feed 70 is followed by a spring 72 which is also seated on the mounting pins 68. The spring 72 is held by clamping disks 74 which sit immovably on the mounting pins 68. The spring 72 is shown in the tensioned state in which the legs of the spring 72 are, for example, parallel to the interposed disk. In the relieved state of the spring 72, the legs of the spring 72 are bent up in the direction to the interposed disk. The glow plug, which is not shown in FIG. 4, is positioned in accordance with the embodiment of nozzle 20 shown in FIG. 2 by this nozzle and is held by a wire spring (not shown) which is supported on the nozzle 20.

[0038] The fuel feed 70, and thus, the fuel needle 28 are automatically aligned in this way with respect to the nozzle 20. Therefore, only two components are involved which influence the fuel feed and mixing of the fuel with the combustion air, so that very small tolerances can be maintained; this is possible by axial mounting on the same mounting pins 68. Likewise, the glow plug 62 can be positioned exactly with respect to the nozzle 20 and the burner 12. The production of the structure shown in FIG. 4 can be completely automated. In particular, the mounting direction is uniformly axial so that only "threading" of the components 76, 20, 70, 72 and 74 need be performed. The seal 76 makes available heat insulation, coupling of the nozzle ceramic 20 to the metal of the heat shield 78, and tolerance compensation. The structure can be advantageously mounted by power-controlled pressing of the clamping disks 74 onto the mounting pins 68 so that, with respect to the heat and temperature properties of the structure, uniform prerequisites can be created. Impacted by the spring force of the spring 72, tolerances due to the varied heating of the components, different final temperatures of the components and different coefficients of temperature expansion can be compensated.

[0039] The features of the invention disclosed in the description above, in the drawings and in the claims can be important to the implementation of the invention both individually and also in any combination.

What is claimed is:

1. Nozzle for atomization of liquid fuel by means of air flowing through a nozzle (20) with
   an air entry area (50),
   an air exit area (52) and
   a flow path (54) which connects the air entry area (50) to the air exit area (52), characterized in that
   the nozzle (20) formed of ceramic material,
   that, in the air entry area (50), there are air guidance elements (56) which are adapted to impart a swirl to the inflowing air, and
   that the air guidance elements (56) are formed as an integral part of the nozzle (20).

2. Nozzle as claimed in claim 1, wherein the nozzle (20) has means (58) for holding a glow plug (62).

3. Nozzle as claimed in claim 1, wherein
   the nozzle (20) has, at least in part, an essentially cylindrical shape and
   wherein the air guidance elements (56) form channels (60) which are offset with respect to radial directions.

4. Nozzle as claimed in claim 1, wherein the air guidance elements (56) have essentially triangular base surfaces and rounded corners.

5. Nozzle as claimed in 1, wherein the air guidance elements (56) are blades.

6. Nozzle as claimed in claim 2, wherein the means for holding the glow plug (62) is a hole (58) which runs obliquely to a center axis of the nozzle.

7. Nozzle as claimed in claim 2, wherein
   an at least essentially cylindrical part of the nozzle (20) has an essentially cylindrical shoulder (64) with an increased diameter and
wherein the means for holding the glow plug (62) is a hole (58) which penetrates the shoulder (64) and which runs obliquely to a center axis of the cylindrical part.

8. Nozzle as claimed in 1, wherein

an at least essentially cylindrical part of the nozzle (20) has an essentially cylindrical shoulder (64) with an increased diameter and

wherein the cylindrical shoulder (64) has recesses (66) for holding mounting pins (68).

9. Nozzle as claimed in claim 1, wherein the nozzle (20) is a Venturi nozzle.

10. Heater (10) for mobile applications, especially motor vehicles, with a burner (12) for combustion of a fuel/air mixture, the burner (12) having a nozzle comprising:

an air entry area,

an air exit area and

a flow path which connects the air entry area to the air exit area, wherein

the nozzle is formed of ceramic material,

in the air entry area, there are air guidance elements which are adapted to impart a swirl to the inflowing air, and

the air guidance elements are formed as an integral part of the nozzle.

11. Heater as claimed in claim 10, wherein the nozzle has means for holding a glow plug.

12. Heater as claimed in claim 10, wherein

the nozzle has, at least in part, an essentially cylindrical shape and

wherein the air guidance elements form channels which are offset with respect to radial directions.

13. Heater as claimed in claim 10, wherein the air guidance elements have essentially triangular base surfaces and rounded corners.

14. Heater as claimed in claim 10, wherein the air guidance elements are blades.

15. Heater as claimed in claim 11, wherein the means for holding the glow plug is a hole which runs obliquely to a center axis of the nozzle.

16. Heater as claimed in claim 11, wherein

an at least essentially cylindrical part of the nozzle has an essentially cylindrical shoulder with an increased diameter and

wherein the means for holding the glow plug is a hole which penetrates the shoulder and which runs obliquely to a center axis of the cylindrical part.

17. Heater as claimed in claim 10, wherein

an at least essentially cylindrical part of the nozzle has an essentially cylindrical shoulder with an increased diameter and

wherein the cylindrical shoulder has recesses holding mounting pins.

18. Heater as claimed in claim 10, wherein the nozzle is a Venturi nozzle.

* * * * *