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(71) Applicant: **MAN DIESEL & TURBO, FILIAL AF MAN DIESEL & TURBO SE, TYSKLAND**
2450 København SV (DK)

(72) Inventor: **Flarup, Johannes**
2720 Vanløse (DK)

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(74) Representative: **Nordic Patent Service A/S**
Pilestræde 58
1112 Copenhagen K (DK)

(54) **A fuel valve for large stroke diesel engines**

(57) A fuel valve (1) for a large two-stroke diesel engine with a nozzle (30) with conventionally arranged nozzle bores (35) that have a center line (36) substantially coinciding with the center line (34) of the axial bore (33) of the nozzle (30) and a hollow cut-off shaft (40) received in the axial bore (33) in the nozzle (30). The cut-off shaft (40) moves in unison with a valve needle (20) and closes the nozzle holes (35) when the valve needle (20) rests on its seat (22) so that the sac volume is practically zero.

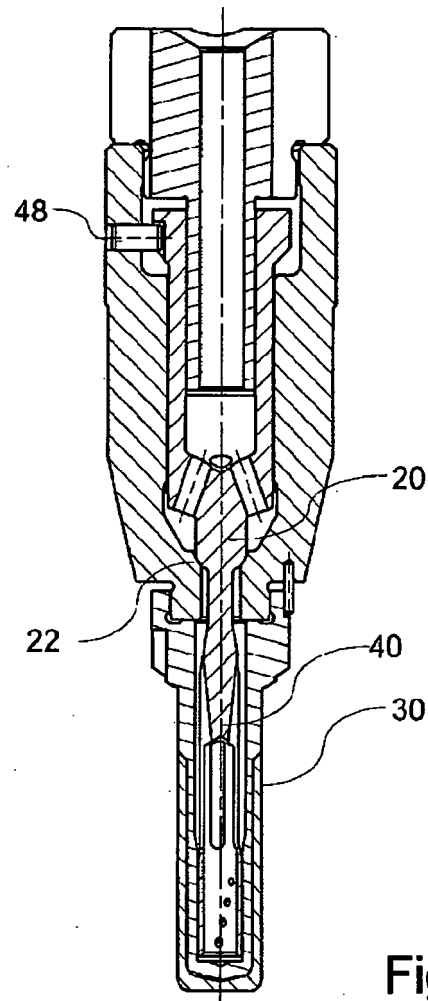


Fig. 2

Description

[0001] The present disclosure relates to a fuel valve for large two-stroke diesel engines.

BACKGROUND OF THE INVENTION

[0002] Large two-stroke diesel engines are typically used as prime movers in large ocean going ships, such as container ships or in power plants.

[0003] These engines are typically provided with two or 3 fuel valves arranged each the cylinder cover. The fuel valve is provided with a spring biased valve needle that acts as a movable valve member. When the pressure of the fuel (typically heavy fuel oil) exceeds a preset pressure (typically 350 Bar) the spindle is lifted from its seat and the fuel is allowed to flow to the combustion chamber via a nozzle at the front of the fuel valve.

[0004] A conventional nozzle has a longitudinal axis that is roughly at an angle of 10 to 15 deg to the direction of the movement of the piston in the cylinder of the engine and the nozzle is provided with central bore and a plurality of nozzle bores that direct the fuel away from the cylinder walls and into the combustion chamber. Typically, there is a swirl in the air in the combustion chamber at the moment of injection and most of the nozzle bores are directed to inject the fuel with the flow of the swirl although some of the bores may be directed to inject the fuel into the flow.

[0005] The volume of the residual fuel e.g. in the longitudinally extending central bore inside the nozzle, the so called sac volume, may leak into the combustion chamber should be as small as possible since this fuel may enter the combustion chamber at a time where temperatures are too low for a proper combustion of the fuel. Thus this discharge may cause an increase of emissions, like increase smoke generation, higher NO_x and VOC emissions and not least deteriorated fuel efficiency.

[0006] An answer to these emission and fuel consumption problems is the MAN Diesel slide fuel valve that has a design with a minimized sac volume of residual fuel.

[0007] The nozzle of this known fuel valve is provided with bores from which the fuel spray leave the nozzle that are all at the same longitudinal position near the free tip of the nozzle. The spatial distribution of the nozzle bores is obtained radially and tangentially relative to the longitudinal axis of the fuel injector. Due to space restrictions some of the nozzle bores are substantially radially directed whilst other nozzle bores are mainly tangentially directed. A cut off slide/sleeve inside the central longitudinal bore with holes corresponding the nozzle bores prevent fuel from in the central bore of the nozzle from leaking out after the actual injection step has been performed.

[0008] However, flow conditions, especially from those nozzle bores that are not radially directed mostly tangentially are not optimal.

DISCLOSURE OF THE INVENTION

[0009] On this background, it is an object of the present application to provide a fuel valve that overcomes or at least reduces the drawbacks mentioned above.

[0010] This object is achieved by providing a fuel valve for injecting fuel into the combustion chamber of a large two stroke diesel engine, the fuel valve comprising a fuel valve housing, an elongated nozzle with axial bore and a closed front, a resiliently biased valve needle cooperating with a valve seat and configured to control the flow of fuel to the nozzle, a plurality of nozzle holes distributed over the nozzle with the center lines of the nozzle holes substantially coinciding with the center line of the axial bore of the nozzle, a hollow cut off shaft moving in unison with the valve needle and received axially displaceable in the central bore in the nozzle for opening and closing the nozzle holes, said cut off shaft is provided with a plurality of openings corresponding to the plurality of nozzle holes so as to connect the nozzle holes to the interior of the hollow cut-off shaft in one position of the hollow cut-off shaft and to disconnect the nozzle holes from the interior of the hollow cut-off shaft in another position of the hollow cut-off shaft and the cut-off shaft is prevented from rotating relative to the nozzle and fuel valve housing.

[0011] By providing a cut-off shaft that opens and closes the nozzle holes in unison with the opening and closing of the valve needle the sac volume is reduced to practically zero whilst the nozzle configuration and orientation provides optimal and stable fuel jets.

[0012] The openings in said cut-off shaft may overlap with the nozzle holes when the valve needle is lifted from its seat.

[0013] The openings in said cut-off shaft do may not overlap with the nozzle holes when the valve needle is resting on its seat.

[0014] According to an embodiment the hollow interior of the cut-off shaft is connected to the inlet port of the fuel valve when the valve needle is lifted from its seat.

[0015] Preferably, the valve needle and the cut-off shaft are formed as a single component.

[0016] In an embodiment the nozzle holes are distributed along the length of the nozzle without an overlap of the nozzle holes as seen in direction of the longitudinal extend of the nozzle.

[0017] In another embodiment the nozzle holes are distributed along the length of the nozzle with a substantial overlap of pairs of the nozzle holes as seen in direction of the longitudinal extend of the nozzle.

[0018] It is another object of the invention to provide a use of a fuel valve in a large two stroke diesel engine of the crosshead type for injecting fuel into the combustion chamber of the large two stroke diesel engine, said fuel valve comprising: a fuel valve housing with a head at its rearmost end for mounting the fuel valve in a cylinder cover of a large two stroke diesel engine, an elongated nozzle with axial bore and a closed front, a resiliently biased valve needle cooperating with a valve seat and

configured to control the flow of fuel to the nozzle, a plurality of nozzle holes distributed over the nozzle with the center lines of the nozzle holes substantially coinciding with the center line of an axial bore of the nozzle, a hollow cut-off shaft moving in unison with the valve needle and received axially displaceable in the central bore in the nozzle for opening and closing the nozzle holes, said cut-off shaft is provided with a plurality of openings corresponding to the plurality of nozzle holes so as to connect the nozzle holes to the interior of the hollow cut-off shaft in one position of the hollow cut-off shaft and to disconnect the nozzle holes from the interior of the hollow cut-off shaft in another position of the hollow cut-off shaft, and wherein the cut-off shaft (40) is prevented from rotating relative to the nozzle (30) and fuel valve housing (10).

[0019] Further objects, features, advantages and properties of the fuel valve according to the present disclosure will become apparent from the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the following detailed portion of the present description, the invention will be explained in more detail with reference to the exemplary embodiments shown in the drawings, in which:

Fig. 1 is a longitudinal-section of an exemplary embodiment of a fuel valve,

Fig. 2 is a longitudinal-section on a larger scale through the foremost part of the fuel valve illustrated in Fig. 1, the valve needle being shown in the closed position,

Fig. 3 is an longitudinal-section on a larger scale through the nozzle of the fuel valve shown in Fig. 1, Fig. 4 is an elevated view of the nozzle shown in Fig. 3,

Fig. 5 is an axial section on a larger scale through the valve needle and the cut-off shaft of the fuel valve shown in Fig. 1,

Fig. 6 is an elevated view of the valve needle and the cut-off shaft shown in Fig. 5,

Fig. 7 is an elevated view of an alternative embodiment of the nozzle for the fuel valve shown in Fig. 1, Fig. 8 is an axial section on a larger scale through the nozzle shown in Fig. 7, and

Fig. 9 an elevated view of an alternative embodiment of the valve needle as used in combination with the nozzle shown in Figs. 7 and 8.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] The fuel valve 1 illustrated in Fig. 1 has an elongated external housing 10 which at its rearmost end has a head 14 by which the fuel valve 1 in a known manner may be mounted in the cylinder cover of a large two stroke

diesel engine and be connected with a fuel pump, not shown. The head 14 includes a fuel oil inlet 16 which is in flow connection with a duct 17. The duct extends through a non-return valve 12 to a valve needle 20 axially displaceable in a bore on the valve housing 10. The valve needle 20 is biased to its seat 22 by a closing spring 18. The foremost part of the valve housing 10 holds a nozzle 30 that projects through the valve housing 10 and into the combustion chamber of the engine cylinder, not shown, when the fuel valve 1 is mounted on the cylinder cover.

[0022] Figs. 2 to 6 show the valve needle 20 and the nozzle 30 in greater detail. The closing spring 18 urges the valve needle 20 to its seat 22. Fig. 2 shows the valve needle 20 resting on the valve seat 22. In this position fluid flow of fuel from the fuel oil inlet 16 to the nozzle 30 is blocked.

[0023] The valve needle 20 carries a foremost cut-off shaft 40 that is thinner than the rearmost section of the valve needle 20 and the cut-off shaft 40 projects into a central bore 33 in the nozzle 30.

[0024] The nozzle 30 is provided with a central bore 33 and with a plurality of nozzle holes 35 through which the fuel is injected into the combustion chamber. Thus, during the fuel injection a jet of fuel comes from each of the nozzle holes 35.

[0025] The nozzle bores 35 are distributed over the nozzle 30 so as to distribute them with a space between them along the longitudinal extent of the nozzle. Thus, even with the dimensions of the nozzle bores 35 taken into account there is no overlap of the nozzle bores 35 in the longitudinal extent. Further, the nozzle bores 35 are spread radially and radially directed in different directions so as to cover a wide sector of the combustion chamber with fuel jets coming from the nozzle bores 35.

[0026] In an embodiment the nozzle holes 35 are drilled into the nozzle. The centerline 36 of each nozzle hole 35 coincides roughly with the centerline 34 of the central bore 33, i.e. the centerlines 36 of the nozzle holes 35 are not directed tangentially, instead they are all directed towards the centerline 34 of the central bore 33. The centerlines 36 of the nozzle holes 35 do not have to coincide exactly with the centerline 34 of the central bore 33, but the extent of the nozzle holes 35 should not be substantially tangential relative to the center line 34 of the central bore 33.

[0027] As can be seen in Fig. 3, the centerline 36 of the nozzle holes 35 can be at a non-perpendicular angle with the centerline 34 of the central bore 33.

[0028] The cut-off shaft 40 is in an exemplary embodiment made as one piece of material with the valve needle 20. The cut-off shaft 40 is hollow and the hollow interior of the cut-off shaft 40 connects to the space downstream of the valve seat 22. Thus, when the valve needle 20 is lifted from its seat the flow path 17 extends all the way from the fuel oil inlet 16 to the hollow interior of the cut-off shaft 40.

[0029] The foremost part of the cut-off shaft 40 is cy-

lindrical and fits exactly into the central bore 33. This foremost part of the cut-off shaft 40 is provided with a plurality of openings 45 that correspond to the nozzle holes 35. The angular position of the valve needle 20, and thereby the cut-off shaft 40 is fixed by a pin 48 that prevents the valve needle 20 from rotating relatively to the valve housing 10. This is to ensure that the openings 45 in the cut-off shaft 40 will overlap with the nozzle holes 35 when the valve needle 20 is lifted from its seat 22.

[0030] In operation, the valve needle 20 is lifted from its seat when the pressure of the fuel supplied to the fuel valve 1 exceeds a predetermined threshold. At this moment the fuel can flow into the hollow cut-off shaft 40 and through the openings 45 that are now overlapping with the nozzle holes 35, and through the nozzle holes 35 into the combustion chamber. When the supply of fuel to the fuel valve 1 is discontinued at the end of the fuel injection process the reduced fuel pressure can no longer keep the valve needle 20 from its valve seat 22 and the closing needle 18 urges the valve needle 20 axially forward to its valve seat 22. Since the cut-off shaft 40 moves in unison with the valve needle 20, the cut-off shaft 40 also moves axially towards the front of the fuel valve 1. In the position where the valve needle 20 rests on its seat 22 the openings 45 in the cut-off shaft no longer overlap with the nozzle holes 35. Thus, the fuel in the nozzle (actually in the hollow cut-off shaft 40) is trapped and cannot leak into the combustion chamber.

[0031] Thus, the sac volume (the volume of fuel that can drip out of the nozzle after the fuel injection process has ended) is practically zero in combination with an optimal geometry for the nozzle holes 35.

[0032] Figs. 7 to 9 illustrate another embodiment of the invention that is essentially identical to the embodiments described above, except that the placement of the nozzle bores 35 is slightly different.

[0033] The nozzle bores 35 are placed in pairs of two nozzle bores 35 that are placed at substantially the same longitudinal position along the longitudinal extend of the nozzle 30. As in the embodiment described above, the nozzle bores 35 are radially distributed in the same way and for the same reasons mentioned above. The advantage of the present embodiment is that it allows for the nozzle 30 to have a reduced longitudinal extent, thereby reducing the heat input during the combustion cycle.

[0034] The teaching of this disclosure has numerous advantages. Different embodiments or implementations may yield one or more of the following advantages. It should be noted that this is not an exhaustive list and there may be other advantages which are not described herein. One advantage of the teaching of this disclosure is that it provides for a fuel valve for a large two-stroke diesel engine that combines optimal nozzle bore configuration with a very small sac volume. It is another advantage of the present disclosure that it provides for a fuel valve that combines optimal nozzle bore configuration with a very small sac volume and a reduced nozzle length.

[0035] Although the teaching of this application has been described in detail for purpose of illustration, it is understood that such detail is solely for that purpose, and variations can be made therein by those skilled in the art without departing from the scope of the teaching of this application.

[0036] The term "comprising" as used in the claims does not exclude other elements or steps. The term "a" or "an" as used in the claims does not exclude a plurality. The single processor or other unit may fulfill the functions of several means recited in the claims.

Claims

1. A fuel valve (1) for injecting fuel into the combustion chamber of a large two stroke diesel engine, said fuel valve comprising:

a fuel valve housing (10) with a head (14) at its rearmost end for mounting the fuel valve (1) in a cylinder cover of a large two stroke diesel engine,
an elongated nozzle (30) with axial bore and a closed front,
a resiliently biased valve needle (20) cooperating with a valve seat (22) and configured to control the flow of fuel to the nozzle (30),
a plurality of nozzle holes (35) distributed over the nozzle (30) with the center lines (36) of the nozzle holes (35) substantially coinciding with the center line (34) of an axial bore (33) of the nozzle (30),
a hollow cut-off shaft (40) moving in unison with the valve needle (20) and received axially displaceable in the central bore (33) in the nozzle (30) for opening and closing the nozzle holes (35),
said cut-off shaft (40) is provided with a plurality of openings (45) corresponding to the plurality of nozzle holes (35) so as to connect the nozzle holes (45) to the interior of the hollow cut-off shaft (40) in one position of the hollow cut-off shaft and to disconnect the nozzle (45) holes from the interior of the hollow cut-off shaft (40) in another position of the hollow cut-off shaft, and wherein the cut-off shaft (40) is prevented from rotating relative to the nozzle (30) and fuel valve housing (10).

3. A fuel valve (1) according to claim 1, wherein said openings (45) in said cut-off shaft (40) overlap with the nozzle holes (35) when the valve needle (20) is lifted from its seat (22).

4. A fuel valve (1) according to claim 1, wherein said openings (45) in said cut-off shaft (40) do not overlap with the nozzle holes (35) when the valve needle

(20) is resting on its seat (22).

5. A fuel valve (1) according to claim 1, wherein the hollow interior of the cut-off shaft (40) is connected to the inlet port (16) of the fuel valve (1) when the valve needle (20) is lifted from its seat (22). 5

6. A fuel valve (1) according to claim 1, wherein the valve needle (20) and the cut-off shaft (40) are formed as a single component. 10

7. A fuel valve (1) according to claim 1, wherein the nozzle holes (35) are distributed along the length of the nozzle without an overlap of the nozzle holes (35) as seen in direction of the longitudinal extend of the nozzle (30). 15

8. A fuel valve (1) according to claim 1, wherein the nozzle holes (35) are distributed along the length of the nozzle (30) with a substantial overlap of pairs of the nozzle holes (35) as seen in direction of the longitudinal extend of the nozzle (30). 20

9. Use of a fuel valve (1) in a large two stroke diesel engine of the crosshead type (1) for injecting fuel into the combustion chamber of the large two stroke diesel engine, said fuel valve comprising: 25

a fuel valve housing (10) with a head (14) at its rearmost end for mounting the fuel valve (1) in a cylinder cover of a large two stroke diesel engine, 30

an elongated nozzle (30) with axial bore and a closed front,

a resiliently biased valve needle (20) cooperating with a valve seat (22) and configured to control the flow of fuel to the nozzle (30), 35

a plurality of nozzle holes (35) distributed over the nozzle (30) with the center lines (36) of the nozzle holes (35) substantially coinciding with the center line (34) of an axial bore (33) of the nozzle (30), 40

a hollow cut-off shaft (40) moving in unison with the valve needle (20) and received axially displaceable in the central bore (33) in the nozzle (30) for opening and closing the nozzle holes (35), 45

said cut-off shaft (40) is provided with a plurality of openings (45) corresponding to the plurality of nozzle holes (35) so as to connect the nozzle holes (45) to the interior of the hollow cut-off shaft (40) in one position of the hollow cut-off shaft and to disconnect the nozzle (45) holes from the interior of the hollow cut-off shaft (40) in another position of the hollow cut-off shaft, 50
and wherein the cut-off shaft (40) is prevented from rotating relative to the nozzle (30) and fuel valve housing (10). 55

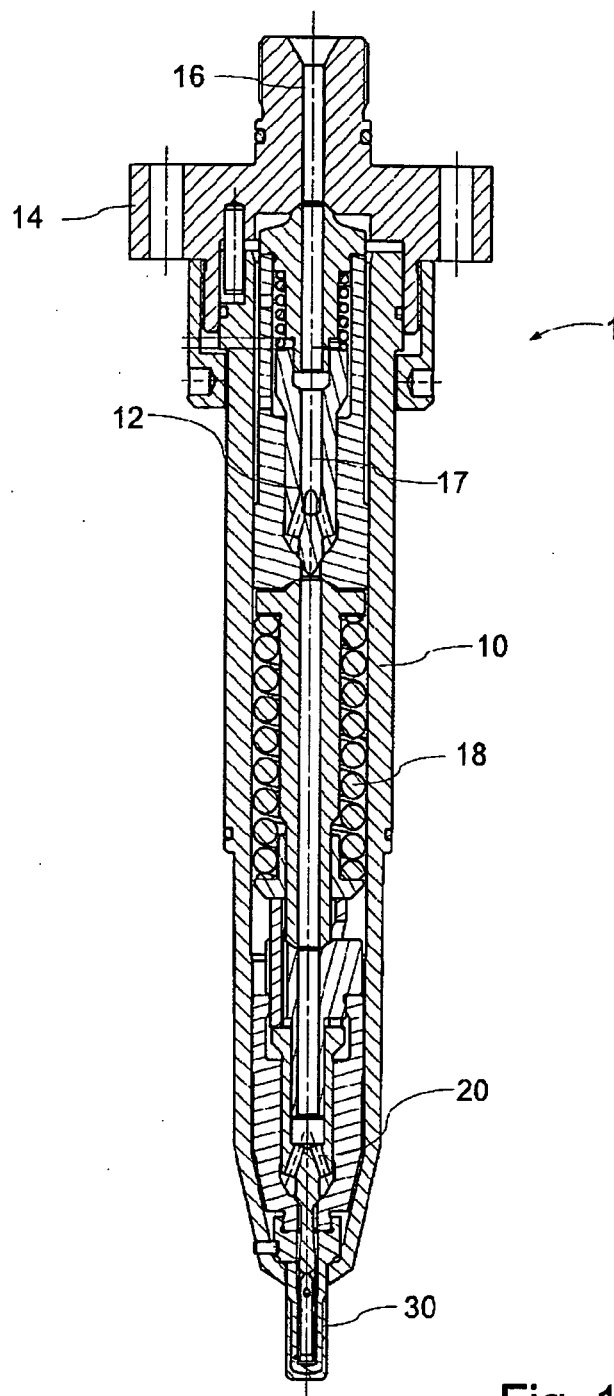


Fig. 1

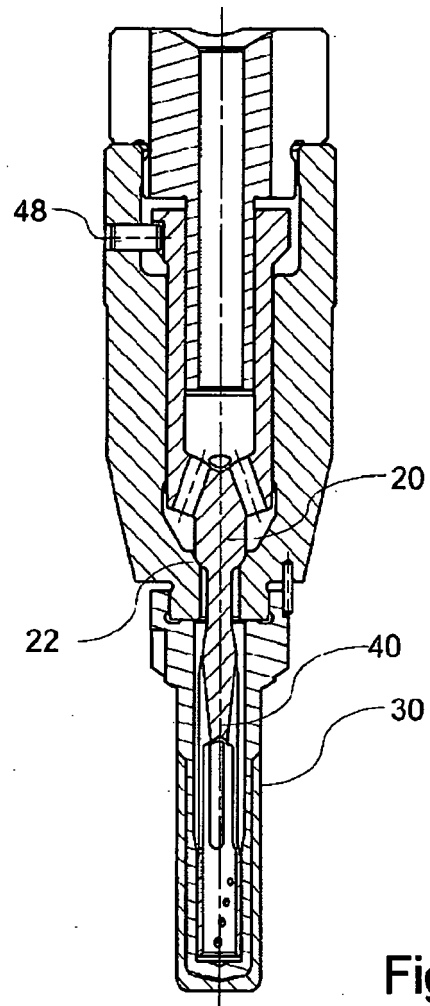


Fig. 2

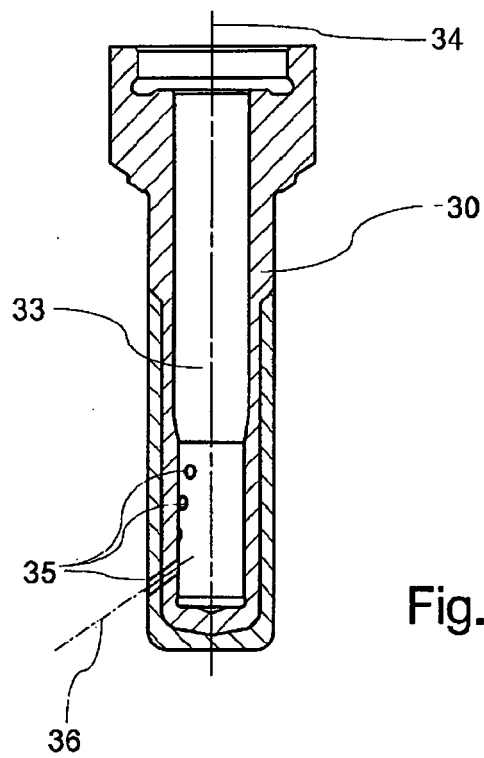


Fig. 3

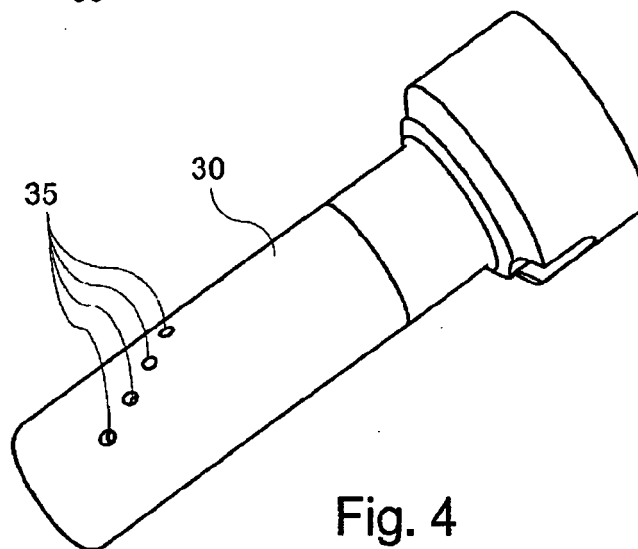


Fig. 4

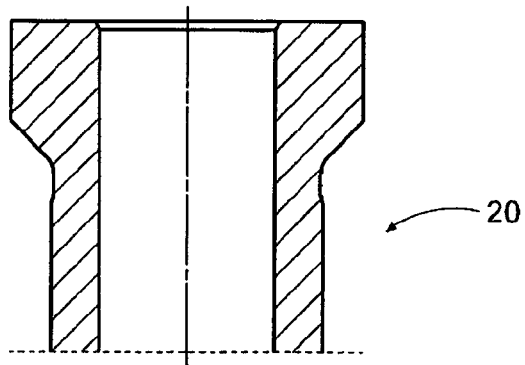


Fig. 5

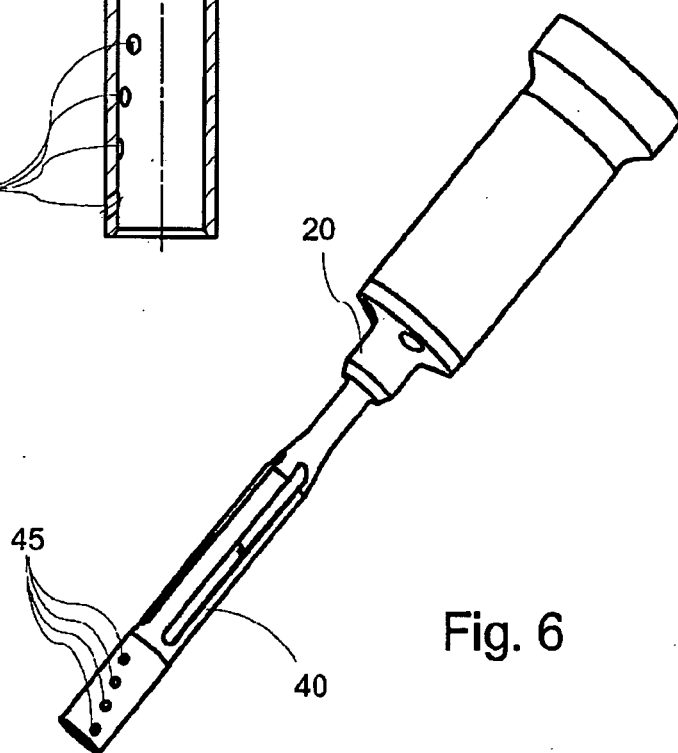
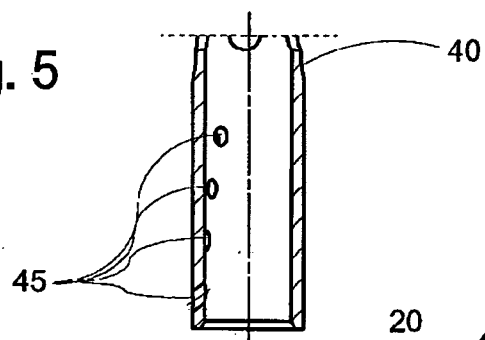


Fig. 6

Fig. 7

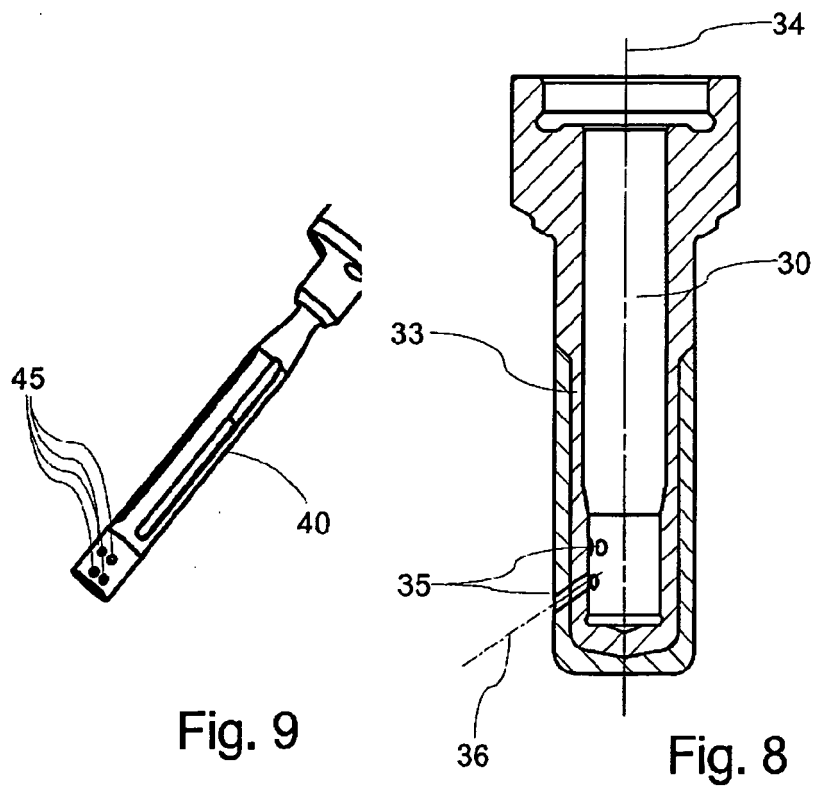
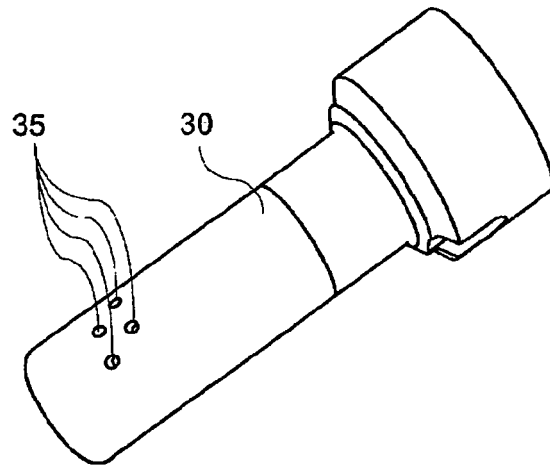


Fig. 9

Fig. 8



EUROPEAN SEARCH REPORT

Application Number
EP 11 00 1060

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Place of search		Date of completion of the search	Examiner
Munich		27 July 2011	Landriscina, V
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 11 00 1060

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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