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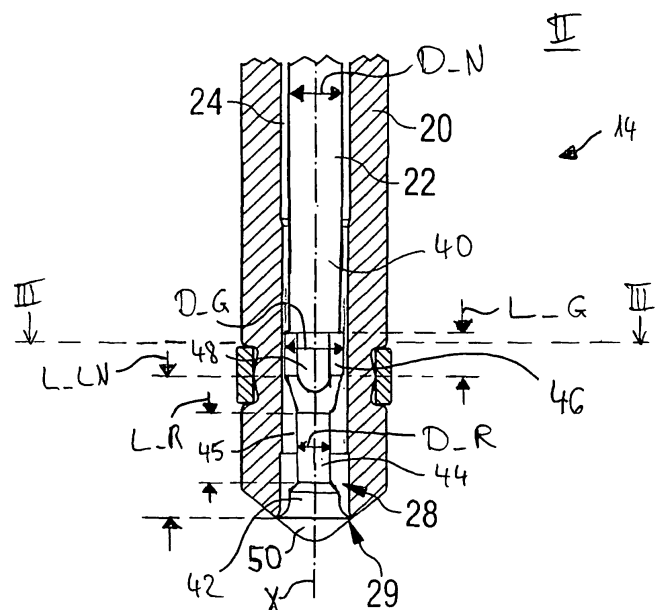
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30165 Hannover (DE)(54) **Valve assembly for an injection valve and injection valve**

(57) Valve assembly (14) of an injection valve (10), the valve assembly (14) comprising a valve body (20) including a central longitudinal axis (X), the valve body (20) comprising a cavity (24) with a fluid outlet portion (28), a valve needle (22) axially movable in the cavity (24), the valve needle (22) preventing a fluid flow through the fluid outlet portion (28) in a closing position and releasing the fluid flow through the fluid outlet portion (28) in further positions. The valve needle (22) has a guide portion (46) being designed to guide the valve needle (22) in the valve body (20) and having fluid channels (48) being designed to enable a fluid flow to the fluid outlet

portion (28), a tip portion (50) being designed to act together with the valve body (20) to prevent the fluid flow through the fluid outlet portion (28), and a lower needle portion (42) being arranged axially between the guide portion (46) and the tip portion (50).

The lower needle portion (42) comprises a recess portion (44) with an annular recess (45). The lower needle portion (42) has an axial length (L_{LN}) of about 7 mm and about 8 mm. The guide portion (46) has an axial length (L_G) of about 2 mm to about 3 mm. The channels (48) in the guide portion (46) have a total cross sectional area (A_{CH}) of about 2 mm². Injection valve (10) with an actuator unit (16) and the valve assembly (14).

FIG 2

Description

[0001] The invention relates to a valve assembly for an injection valve and an injection valve.

[0002] Injection valves are in widespread use, in particular for internal combustion engines where they may be arranged in order to dose the fluid into an intake manifold of the internal combustion engine or directly into the combustion chamber of a cylinder of the internal combustion engine.

[0003] Injection valves are manufactured in various forms in order to satisfy the various needs for the various combustion engines. Therefore, for example, their length, their diameter and all the various elements of the injection valve being responsible for the way the fluid is dosed may vary in a wide range. In addition to that, injection valves may accommodate an actuator for actuating a needle of the injection valve, which may, for example, be an electromagnetic actuator or piezoelectric actuator.

[0004] In order to enhance the combustion process in view of the creation of unwanted emissions, the respective injection valve may be suited to dose fluids under very high pressures. The pressures may be in case of a gasoline engine, for example, in the range of up to 200 bar and in the case of a diesel engine in the range of up to 2000 bar.

[0005] The object of the invention is to create a valve assembly for an injection valve and an injection valve which is simply to be manufactured and which facilitates a reliable and precise function.

[0006] This object is achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0007] According to a first aspect the invention is distinguished by a valve assembly of an injection valve, the valve assembly comprising a valve body including a central longitudinal axis, the valve body comprising a cavity with a fluid outlet portion, a valve needle axially movable in the cavity, the valve needle preventing a fluid flow through the fluid outlet portion in a closing position and releasing the fluid flow through the fluid outlet portion in further positions. The valve needle has a guide portion being designed to guide the valve needle in the valve body and having fluid channels being designed to enable a fluid flow to the fluid outlet portion, a tip portion being designed to act together with the valve body to prevent the fluid flow through the fluid outlet portion, and a lower needle portion being arranged axially between the guide portion and the tip portion. The lower needle portion comprises a recess portion with an annular recess. The lower needle portion has an axial length of about 7 mm to about 8 mm. The guide portion has an axial length of about 2 mm to about 3 mm. The channels in the guide portion have a total cross sectional area of about 2 mm².

[0008] The annular recess in the recess portion of the lower needle portion has the effect that the diameter of the recess portion is smaller than the diameter of further

sections of the lower needle portion. By this the space between the recess portion and the valve body is larger than the space between the further sections of the lower needle and the valve body.

[0009] Surprisingly it has been found that this configuration of the valve needle has the advantage that an excellent spray structure with a highly axial symmetric spray can be generated. Fluid cavitation effects, in particular sectional fluid cavitation effects in the injection valve can be avoided in a very good manner. Furthermore, the pressure drop in the channels of the guide portion can be kept small. Additionally, turbulence effects can be kept small and zones of turbulence in axial direction can be kept short in particular downstream the guide portion between the valve body and the recess portion. Consequently, a homogeneous fluid flow in the fluid outlet portion between the valve body and the recess portion is available. By this, the angle and the structure of the fluid spray outside the valve assembly can be kept uniform over the time. Consequently, a noise emission of the spray can be kept small.

[0010] A further advantage of this configuration of the valve needle is that a high shot-to-shot stability of the spray can be obtained, even in the case that long pulses of the spray are needed for the injection. Therefore, a very small variation of the spray angle characteristic is available. As the structure of the channels of the guide portion is less important for the characteristic of the fluid flow, the channels can be manufactured in a very simple and easy manner.

[0011] In an advantageous embodiment the recess portion has a diameter of about 2 mm to about 2.2 mm and a length of about 2 mm to about 3 mm.

This allows a good adaptation of the dimensions of the recess portion to the geometry of the guide portion. In particular, sectional fluid cavitation effects in the injection valve can be avoided very effectively.

[0012] In further advantageous embodiments the diameter of the recess portion is about 2.08 mm and the length is about 2.53 mm. These dimensions have the advantage that a very homogeneous fluid flow in the fluid outlet portion between the valve body and the recess portion is available.

[0013] In a further advantageous embodiment the axial length of the lower needle portion is about 7.5 mm. As the turbulence zones in axial direction are short in particular downstream the guide portion between the valve body and the recess portion this has the advantage that cavitation at the tip portion of the valve needle can be prevented to avoid the generation of a spray structure affected by sectional vapor to liquid ratio distributions.

[0014] In a further advantageous embodiment the axial length of the guide portion is about 2.5 mm. This has the advantage that a very small pressure drop in the channels of the guide portion in combination with a secure guiding of the valve needle in the valve body can be obtained.

[0015] In further advantageous embodiments the guide portion has a diameter of about 3.5 mm and the

valve needle outside the guide portion and outside the recess portion has a diameter of about 2.80 mm. These dimensions have the advantage that the disclosed configuration of the valve needle can be applied to a valve assembly of an injection valve of an internal combustion engine.

[0016] According to a second aspect the invention is distinguished by an injection valve comprising an actuator unit and the valve assembly. The valve needle is actuable by the actuator unit.

[0017] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1 an injection valve with a valve assembly in a longitudinal section view,

Figure 2 section II of the valve assembly according to figure 1 in a longitudinal section view, and

Figure 3 the valve assembly in a cross section view along line III-III' of figure 2.

[0018] Elements of the same design and function that appear in different illustrations are identified by the same reference characters.

[0019] An injection valve 10 (figure 1) that is used as a fuel injection valve for an internal combustion engine, comprises a housing 12, a valve assembly 14 and an actuator unit 16.

[0020] The housing 12 has a tubular shape. The actuator unit 16 is inserted into the housing 12 and comprises a piezo actuator, which changes its axial length depending on a control signal applied to it. The actuator unit 16 may, however, also comprise another type of actuator, which is known to a person skilled in the art for that purpose. Such an actuator may be, for example, a solenoid.

[0021] The valve assembly 14 comprises a valve body 20 with a central longitudinal axis X and a cavity 24 which is axially led through the valve body 20. A valve needle 22 which is movable in axial direction is arranged in the cavity 24.

[0022] The injection valve 10 has a fluid inlet portion 26 which is arranged in the housing 12 and which is hydraulically coupled to the cavity 24 and a not shown fuel connector. The fuel connector is designed to be connected to a high pressure fuel chamber of an internal combustion engine, the fuel is stored under high pressure, for example, under the pressure of about 200 bar.

[0023] On one of the free ends of the cavity 24, a fluid outlet portion 28 is formed, which is closed or open depending on the axial position of the valve needle 22. Outside of the closing position of the valve needle 22 there is a gap between the valve body 20 and the valve needle 22 at an axial end of the injection valve 10 facing away from the actuator unit 16. The gap forms a valve nozzle 29.

[0024] The valve body 20 has a valve body spring rest

32 and the valve needle 22 comprises a valve needle spring rest 34, both spring rests 32, 34 supporting a spring 30 arranged between the valve body 20 and the valve needle 22.

[0025] The injection valve 10 is of an outward opening type. In an alternative embodiment the injection valve 10 may be of an inward opening type. Between the valve needle 22 and the valve body 20 a bellow 36 is arranged which is sealingly coupling the valve body 20 with the valve needle 22. By this a fluid flow between the cavity 24 and a chamber 38 in which the actuator unit 16 is arranged is prevented. Furthermore, the bellow 36 is formed and arranged in a way that the valve needle 22 is actuable by the actuator unit 16.

[0026] Figure 2 shows an enlarged view of the valve assembly 14 with the valve needle 22. The valve needle 22 has an upper needle portion 40 and a lower needle portion 42.

[0027] The lower needle portion 42 has a recess portion 44 with an annular recess 45.

[0028] Furthermore, the valve needle 22 has a guide portion 46 arranged axially between the upper needle portion 40 and the lower needle portion 42. The guide portion 46 can guide the valve needle 22 in the valve body 20. The guide portion 46 comprises fluid channels 48 which allow a fluid flow from the fluid inlet portion 26 to the fluid outlet portion 28. Preferably, four fluid channels 48 are shaped as grinded flats on the surface of the guide portion 46. The four fluid channels 48 are arranged axial symmetrically on the guide portion 46 so that a good axial symmetry of the fluid can be obtained.

[0029] At an axial end of the lower needle portion 42 facing away from the fluid inlet portion 26 the valve needle 22 has a tip portion 50. Preferably, the tip portion 50 is conical. The tip portion 50 cooperates with the valve body 20 forming a seat to prevent the fluid flow through the fluid outlet portion 28.

[0030] The valve needle 22 outside the guide portion 46 and outside the recess portion 44, in particular the upper needle portion 40, has a diameter D_N of about 3 mm. Preferably, the diameter D_N of the valve needle 22 outside the guide portion 46 and outside the recess portion 44 is about 2.80 mm. This is a typical and reliable value for the diameter of the valve needle 22 of the valve assembly 14 of the injection valve 10 for the internal combustion engine.

[0031] The guide portion 46 has a diameter D_G of about 3.5 mm and an axial length L_G of about 2 mm to about 3 mm. The four channels 48 in the guide portion 46 have together a total cross-sectional area A_{CH} of about 1.85 mm². Preferably, the axial length L_G of the guide portion 46 is about 2.5 mm. These dimensions allow to obtain a secure guiding of the valve needle 22 in the valve body 20 in combination with a very small pressure drop in the channels 48 of the guide portion 46.

[0032] The lower needle portion 42 has an axial length L_{LN} of about 7 mm to about 8 mm. Preferably, the axial length L_{LN} of the lower needle portion 42 is about 7.5

mm. By this, even if swirls are generated at the exit of the channels 48 below the guide portion 46 it can be prevented that they reach the tip portion 50 of the valve needle 22. Consequently, if the fluid leaves the valve nozzle 29 a sectoral cavitation in the spray can be eliminated.

[0033] The recess portion 44 has a diameter D_R of about 2 mm and a length L_R of about 2 mm to about 3 mm. Preferably, the length L_R of the recess portion 44 is about 2.53 mm and the diameter D_R is about 2.08 mm. By this, the fluid outlet portion 28 near the recess portion 44 has a large radial extension and therefore, the fluid flow between the valve body 20 and the recess portion 44 in the fluid outlet portion 28 can be very homogeneous. By this, the formation of swirls in the fluid in this area can be prevented or swirls generated at the exit of the channels 48 below the guide portion 46 can decrease in size and velocity during their axial way through the fluid outlet portion 28.

[0034] In particular, if the diameter D_R of the recess portion 44 is 2.08 mm, the length L_R of the recess portion 44 is 2.53 mm, the axial length L_{LN} is 7.5 mm, the length L_G of the guide portion 46 is 2.5 mm, the diameter D_N of the valve needle 22 outside the guide portion 46 and outside the recess portion 44 is 2.80 mm, and the total cross-sectional area A_{CH} of the channels 48 is 1.85 mm^2 an excellent spray structure with a highly axial symmetric spray is available at the valve nozzle 29.

[0035] In the following, the function of the injection valve 10 will be described in detail:

[0036] Generally, the fluid is led from the fluid inlet portion 26 in the housing 12 to the upper needle portion 40 and to the guide portion 46. Then the fluid passes through the channels 48 of the guide portion 46 and reaches the lower needle portion 42 to be led between the valve body 20 and the recess portion 44 to the fluid outlet portion 28 near the tip portion 50 of the valve needle 22. The valve needle 22 prevents a fluid flow through the fluid outlet portion 28 in the valve body 20 in a closing position of the valve needle 22. Outside of the closing position of the valve needle 22, the valve needle 22 enables the fluid flow through the fluid outlet portion 28.

[0037] In the case that the actuator unit 16 has a piezoelectric actuator, the piezoelectric actuator may change its axial length if it gets energized in an expansion duration of some micro-seconds. By changing its length the actuator unit 16 may effect a force on the valve needle 22. The valve needle 22 can move in axial direction out of the closing position to form the gap between the valve body 20 and the valve needle 22 at the axial end of the injection valve 10 facing away from of the actuator unit 16.

[0038] The spring 30 can force the valve needle 22 via the valve needle spring rest 34 towards the actuator unit 16. In the case when the actuator unit 16 is de-energized the actuator unit 16 shortens its length. The spring 30 can force the valve needle 22 to move in axial direction in its closing position. It is depending on the force balance between the force on the valve needle 22 caused by the

actuator unit 16 and the force on the valve needle 22 caused by the spring 30 whether the valve needle 22 is in its closing position or not.

[0039] The small length L_G of the guide portion 46 allows to have a short length of the channels 48 that combined with the large total cross sectional area A_{CH} lead to minimize the pressure drop across the guide portion 46 as well as the average flow speed. Such an arrangement associated with the annular recess 45 and the lower needle portion 42 contributes to avoid that vortexes detached at the end of the guide portion 46 are transported to the valve nozzle 29. Therefore, the angle and the structure of the fluid spray outside the valve nozzle 29 can be kept very constant in view of the time and a sectoral partition of momentum in the spray can be eliminated.

[0040] Furthermore, the dimensioning of the different parts of the valve needle 22 as described above can result in a high shot-to-shot stable and uniform spray structure, even in the case that the injection process makes long pulses of the spray necessary.

Claims

1. Valve assembly (14) of an injection valve (10), the valve assembly (14) comprising

- a valve body (20) including a central longitudinal axis (X), the valve body (20) comprising a cavity (24) with a fluid outlet portion (28),
- a valve needle (22) axially movable in the cavity (24), the valve needle (22) preventing a fluid flow through the fluid outlet portion (28) in a closing position and releasing the fluid flow through the fluid outlet portion (28) in further positions, the valve needle (22) having
 - a guide portion (46) being designed to guide the valve needle (22) in the valve body (20) and having fluid channels (48) being designed to enable a fluid flow to the fluid outlet portion (28),
 - a tip portion (50) being designed to act together with the valve body (20) to prevent the fluid flow through the fluid outlet portion (28), and
 - a lower needle portion (42) being arranged axially between the guide portion (46) and the tip portion (50), wherein
 - the lower needle portion (42) comprises a recess portion (44) with an annular recess (45),
 - the lower needle portion (42) has an axial length (L_{LN}) of about 7 mm to about 8 mm,
 - the guide portion (46) has an axial length (L_G) of about 2 mm to about 3 mm, and
 - the channels (48) in the guide portion (46) have a total cross sectional area (A_{CH}) of about 2 mm^2 .

2. Valve assembly (14) in accordance with claim 1,

wherein the recess portion (44) has a diameter (D_R) of about 2 mm to about 2.2 mm and a length (L_R) of about 2 mm to about 3 mm.

3. Valve assembly (14) in accordance with claim 2, wherein the diameter (D_R) of the recess portion (44) is about 2.08 mm. 5
4. Valve assembly (14) in accordance with claim 2 or 3, wherein the length (L_R) of the recess portion (44) is about 2.53 mm. 10
5. Valve assembly (14) in accordance with one of the preceding claims, wherein the axial length (L_{LN}) of the lower needle portion (42) is about 7.5 mm. 15
6. Valve assembly (14) in accordance with one of the preceding claims, wherein the axial length (L_G) of the guide portion (46) is about 2.5 mm. 20
7. Valve assembly (14) in accordance with one of the preceding claims, wherein the guide portion (46) has a diameter (O_G) of about 3.5 mm.
8. Valve assembly (14) in accordance with one of the preceding claims, wherein the total cross sectional area (A_{CH}) is about 1.85 mm². 25
9. Valve assembly (14) in accordance with one of the preceding claims, wherein the valve needle (22) outside the guide portion (46) and outside the recess portion (44) has a diameter (D_N) of about 2.80 mm. 30
10. Injection valve (10) comprising an actuator unit (16) and the valve assembly (14) in accordance with one of the preceding claims, wherein the valve needle (22) is actuable by the actuator unit (16). 35

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FIG 1

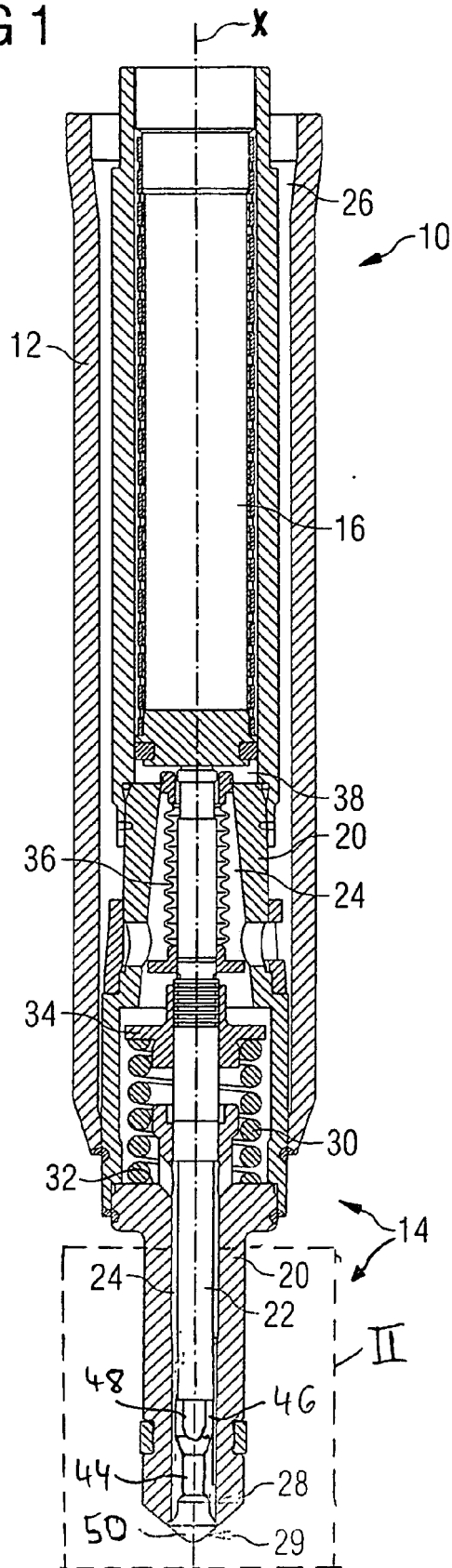


FIG 2

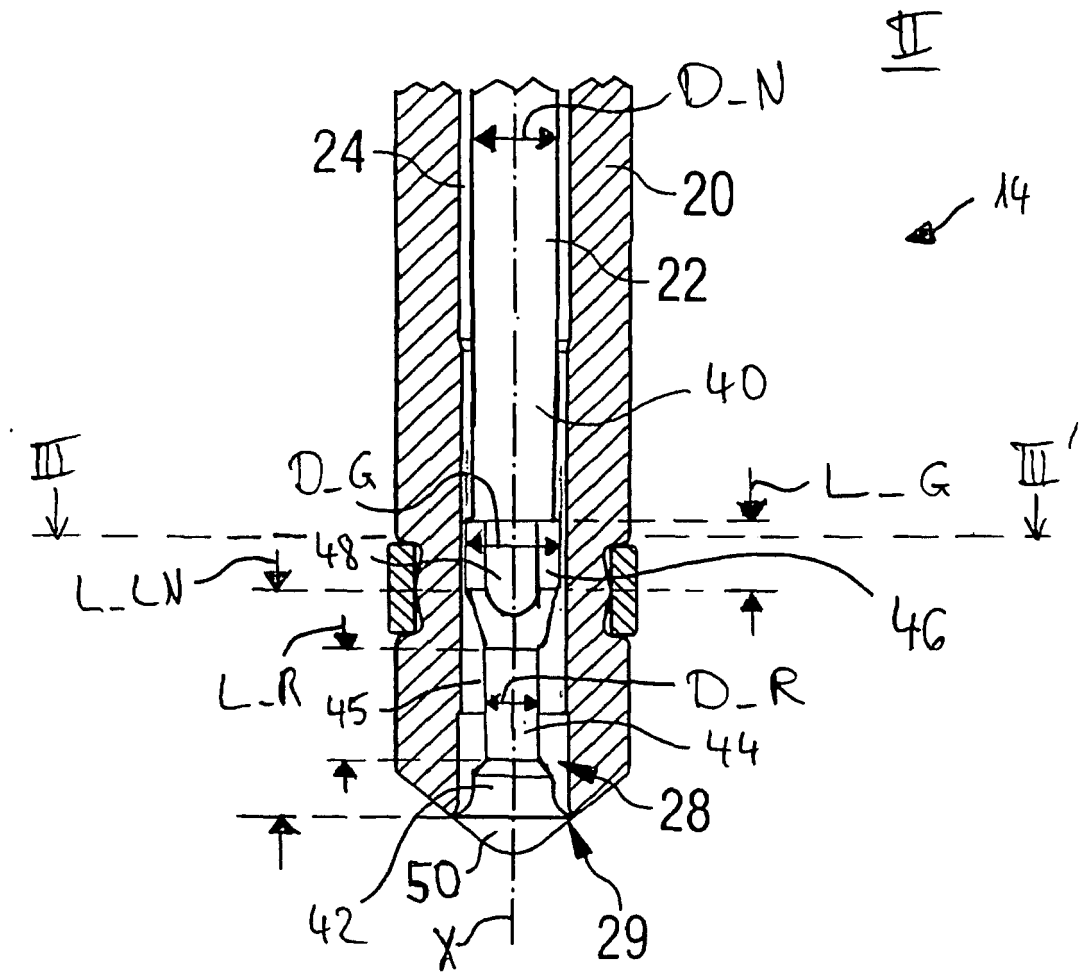
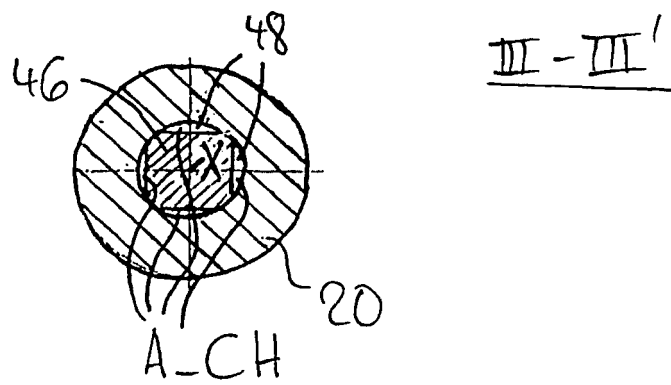


FIG 3





EUROPEAN SEARCH REPORT

Application Number
EP 09 00 2146

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
Place of search Munich		Date of completion of the search 9 July 2009	Examiner Etschmann, Georg
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03-82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 00 2146

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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09-07-2009

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