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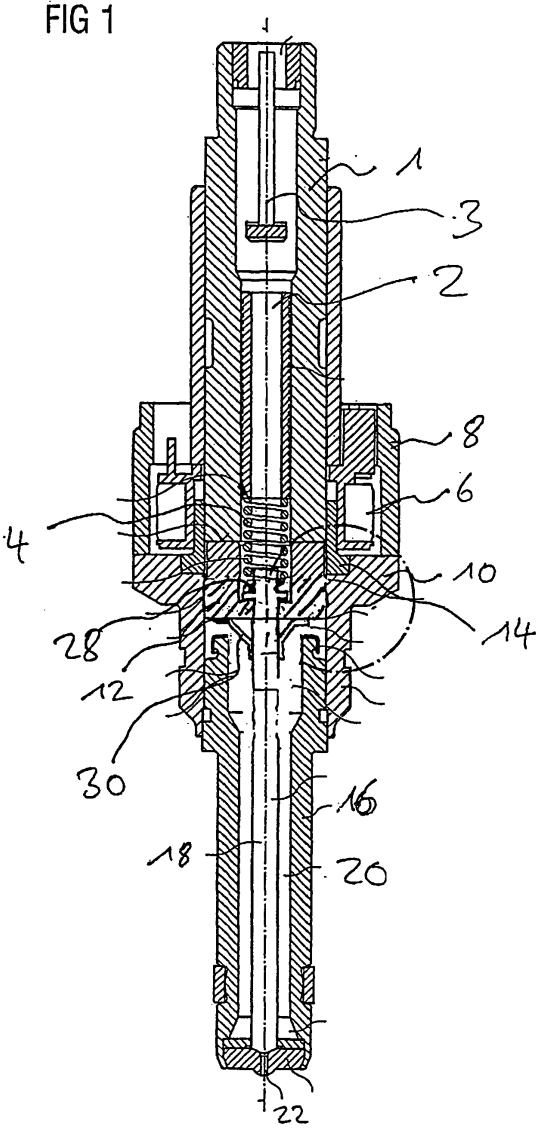
(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

(72) Inventors:
- **Fornaciari, Fabio**
  57124 Livorno (IT)
- **Soriani, Matteo**
  57126 Livorno (IT)

(54) **Valve assembly**

(57) A valve assembly comprises an electro-magnetic circuit operable to actuate a valve needle (18). The electro-magnetic circuit comprises a fluid inlet tube (1) and an armature (12) being arranged axially in proximity to the fluid inlet tube (1). The armature is movably arranged on the valve needle (18). Its axial movement is limited in one direction by a protrusion (28) associated to the valve needle (18). An armature spring (30) is fixed to the valve needle (18) and rests on the armature (12) exerting a force on the armature (12) pushing the armature (12) towards the protrusion (28).

FIG 1



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Description

[0001] The invention relates to a valve assembly, in particular for an injection valve for dosing fluid into a combustion chamber of an internal combustion engine.

[0002] Injection valves are in widespread use, in particular for internal combustion engines, where they may be arranged next to the combustion chamber to dose fluid into the combustion chamber or into the intake manifold. Due to increased requirements in respect to performance and also in respect to the limitation of emissions emitted by a vehicle, in which the injection valve may be arranged, injection valves should be operable to dose also very small amounts of fluid precisely. In addition to that, the injectors should be designed such that their energy consumption is as low as possible.

[0003] It is the object of the invention to create a valve assembly, which enables a very efficient operation.

[0004] The object of the invention is to create a valve assembly which enables a fast and reliable response time and is simple to manufacture.

[0005] The object is achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0006] The invention is distinguished by a valve assembly comprising a electro-magnetic circuit operable to actuate a valve needle. The electro-magnetic circuit comprises a fluid inlet tube and an armature being arranged axially in proximity to the fluid inlet tube. The armature is movably arranged on the valve needle. Its axial movement is limited in one direction by a protrusion associated to the valve needle. An armature spring is fixed to the valve needle and rests on the armature. The armature spring exerts a force on the armature pushing the armature towards the protrusion. In this way, when moving the valve needle towards its closing position, the armature, which has a relatively high inertia compared to the valve needle itself, can dissipate its kinetic energy by making relative movements relative to the valve needle in the closing position of the needle being controlled by the force exerted from the armature spring. This has the effect that bouncing of the valve needle 18 is reduced significantly. Preferably, the spring constant of the armature spring 30 is chosen by way of experiments appropriately in order to ensure the right elastic properties and to ensure an optimum between softness and hardness of the armature spring.

[0007] According to a preferred embodiment of the valve assembly, the armature is made by a sintering process. This is especially cost-effective and is possible due to the possible clearance between the valve needle and the armature.

[0008] According to a further preferred embodiment, the armature spring has a trumpet-type shape. This has proven to be especially suitable for dampening the bouncing of the needle and in that way dampening the oscillating movement of the armature when reaching the closing position of the valve needle.

[0009] According to a further preferred embodiment, the valve needle is formed in a tubular shape. In this way, the mass of the needle may be reduced resulting in a lower inertia of the valve needle. In this respect, it is in particular advantageous if the valve needle is manufactured by a rotary swaging process.

[0010] According to a further preferred embodiment, a ball is fixed to the valve needle at an axial end of the valve needle facing away from the armature. This permits to choose the material of the ball appropriately in order to ensure a proper sealing of an injection nozzle and on the other hand to minimize wear. In addition, the valve needle itself may be chosen to comprise a material best suitable for the valve needle part itself.

[0011] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

FIG. 1 an injection valve with a valve assembly and

FIG. 2 a part of the valve assembly according to FIG. 1.

[0012] Elements of the same design and function that appear in different illustrations are identified with the same reference characters.

[0013] An injection valve (FIG. 1) comprises a housing, which may be manufactured by an overmolding process, a fluid connector and a connector for the electrical connection of the injection valve and the valve assembly. The fluid connector, the housing and the electrical connector are not shown in FIG. 1. The valve assembly comprises a fluid inlet tube 1 with an inlet recess 2. A filter 3 is arranged in the inlet recess 2 and filters during operation of the injection valve the fluid flowing through the injection valve. The injection valve is during operation connected to a fluid supply via the fluid connector. The injection valve may be arranged in an internal combustion engine in order to dose fuel into an intake manifold or a combustion chamber. The filter 3 may also serve the purpose of pretensioning a spring 4, which is also arranged in the valve assembly.

[0014] The valve assembly comprises an electro-magnetic circuit. The electro-magnetic circuit comprises a coil 6, a magnetic housing 8, a valve body shell 10 and an armature 12. In addition to that, a non-magnetic shell 14, preferably in an L-shape, is also arranged between the coil 6 and the fluid inlet tube 1 and the armature 12. The fluid inlet tube 1 also forms part of the electro-magnetic circuit. The non-magnetic shell 14 is arranged and formed such that the magnetic flux is directed from the fluid inlet tube 1 to the armature 12 to a high percentage and in that way improving the efficiency of the magnetic circuit. The armature 12 is arranged with one of its axial ends in proximity to an opposing axial end of the fluid inlet tube 1.

[0015] The valve assembly further comprises a valve body 16 having a recess 20 taking in a valve needle 18.

The valve needle 18 prevents a fluid flow through an injection nozzle 22 in a closing position and enables a fluid flow through the injection nozzle 22 apart from the closing position. The position of the valve needle 18 depends on the forces exerted on the valve needle 18. The valve needle 18 comprises a protrusion 28 which serves as a spring rest for the spring 4. The forces acting on the valve needle 18 and in that way determining its position are the force exerted by the spring 4, the weight of the valve needle 18, the pressure of the fluid and an electromagnetic force exerted by the electro-magnetic circuit via the armature on the needle 18.

[0016] The valve needle 18 is preferably formed in a tubular shape. In this way, the mass of the valve needle 18 may be kept very low. Preferably, the valve needle 18 is manufactured by a rotary swaging process.

[0017] A ball 26 is preferably fixed to the valve needle 18 at its axial end facing towards the injection nozzle 22. The ball 26 may comprise a material that is suitable for ensuring a good sealing, when the valve needle 18 rests in its closing position and on the other hand ensures that wear during the lifetime of the injector is minimized. The armature 12 is arranged on the valve needle 18 with a clearance in order to enable a slight axial relative movement to the valve needle 18. The axial movement of the armature 12 is limited in the direction facing away from the ball 26 by the protrusion 28.

[0018] An armature spring 30 is provided, which is fixed to the valve needle 18. It is preferably fixed to the valve needle 18 by welding or brazing. The armature spring 30 is arranged such that it exerts a force on the armature 12 pushing it towards the protrusion 28. The spring constant of the armature spring 30 is chosen appropriately in order to enable a slight movement of the armature 12 relatively to the valve needle 18 when the armature needs to dissipate its kinetic energy when the valve needle 18 reaches its closing position. The armature is preferably manufactured by a sintering process and may be additionally grinded.

[0019] The valve needle 18 further comprises a fluid outlet 24. In that way, the fluid may flow through the filter 3 and in the area of the spring 4 into the valve needle 18 and exit the valve needle 18 at the fluid outlet 24 and then flow towards the injection nozzle 22.

[0020] The valve needle is preferably made out of an austenitic stainless steel, which permits to ensure a high chemical resistance against aggressive fluids, like fuel, and ensures a low inertial force due to the low weight. The ball shaped tip is preferably manufactured from a martensitic stainless steel, which permits to maintain the mechanical characteristics during the lifetime of the injector.

[0021] When the valve needle 18 is moved out of a position apart from the closing position, which may be an opening position, towards its closing position, for example when significantly reducing the magnetic flux in the electro-magnetic circuit, the valve needle 18 reaches the closing position and is then decelerated significantly when the ball 26 rests in its seat closing the injection nozzle 22. The kinetic energy of the armature 12 may then be dissipated by an oscillation of the armature 12 relative to the valve needle 18 enabled by the clearance between the valve needle 18 and the armature 12 and the possible axial movement being dampened by the armature spring 30. This has the effect that a bouncing of the valve needle 18 is minimized, which leads to a very precise closing time of the injection nozzle 22 and therefore enables a very precise dosing of fluid, in particular for small amounts of fluid.

[0022] The armature spring 30 preferably has a trumpet-type shape.

Claims

1. Valve assembly comprising an electro-magnetic circuit operable to actuate a valve needle (18), the electro-magnetic circuit comprising a fluid inlet tube (1) and an armature (12) being arranged axially in proximity to the fluid inlet tube (1), the armature (12) being movably arranged on the valve needle (18) with its axial movement being limited in one direction by a protrusion (28) associated to the valve needle (18), an armature spring (30) being fixed to the valve needle (18) and resting on the armature (12) exerting a force on the armature (12) pushing the armature (12) towards the protrusion (28).

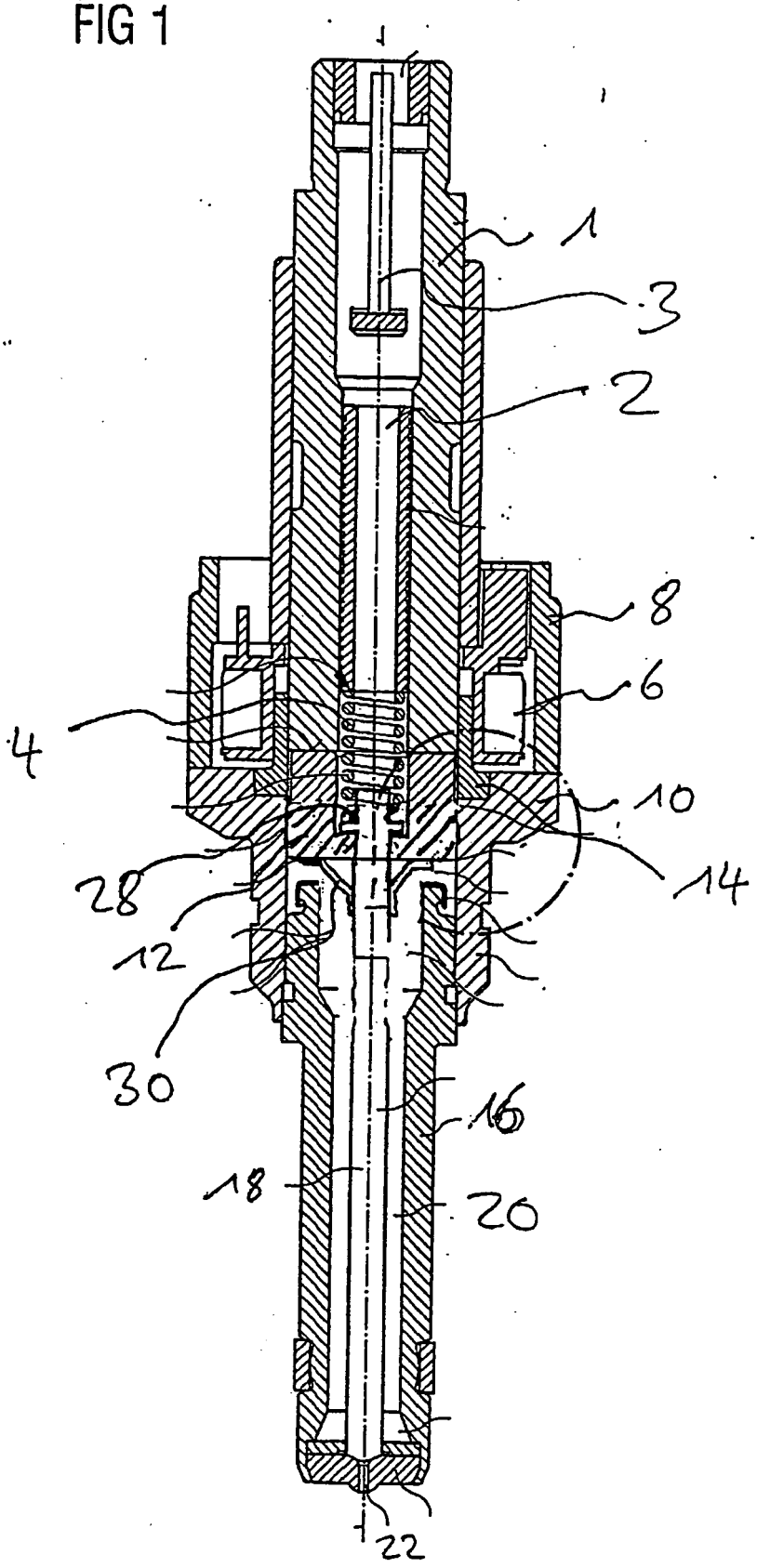
2. Valve assembly according to claim 1, with the armature (12) being made by a sintering process.

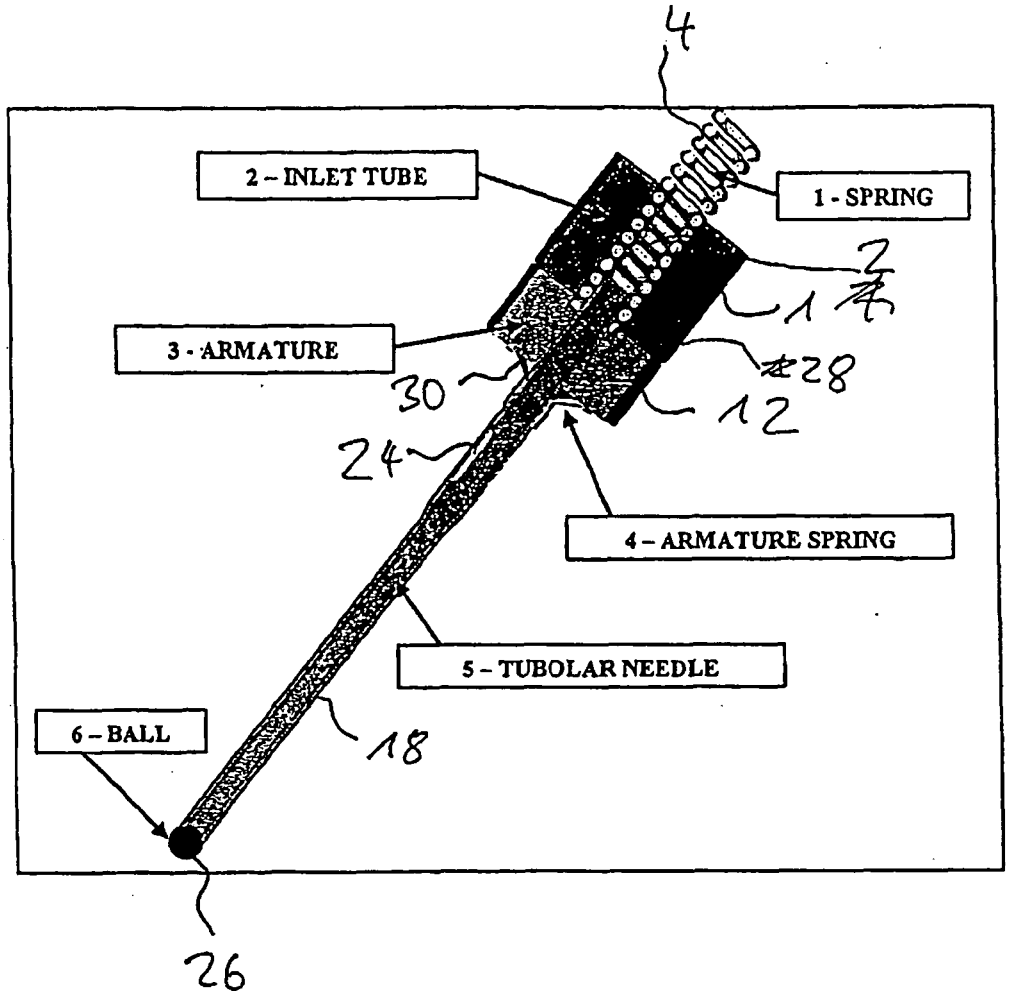
3. Valve assembly according to one of the previous claims, with the armature spring (30) having a trumpet-type shape.

4. Valve assembly with the valve needle (18) being formed in a tubular shape.

5. Valve assembly according to one of the previous claims, with a ball (26) being fixed to the valve needle (18) at an axial end of the valve needle (18) facing away from the armature (12) .

FIG 1




4
2 – INLET TUBE
1 - SPRING
3 - ARMATURE
30
28
12
24
4 – ARMATURE SPRING
5 – TUBOLAR NEEDLE
6 – BALL
18
26

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 00 7615

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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			TECHNICAL FIELDS SEARCHED (IPC) F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 September 2006	Morales, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 00 7615

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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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82