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(54) **Fuel injector**

(57) The invention relates to a fuel injector 10; 300 comprising an armature 130, a needle 40, a coil 25, a casing 15 and a valve body 20. The coil 25 is arranged in the casing 15. The armature 130 and the needle 40 are at least partially arranged in the valve body 20. The coil 25 is electrically connectable to a control device 30 in order to generate an electromagnetic field 26. The armature 130 is connected with the needle 40 and configured to interact with the electromagnetic field 26 in order to displace the needle 40 from a closed position towards an open position along a longitudinal axis 35 of the valve body 20. The casing 15 is arranged on an outer peripheral surface of a portion of the valve body 20. A separation ring 150 is provided, wherein the separation ring 150 is at least partially arranged between the casing 15 and the armature 130 and configured to lead the electromagnetic field 26 to the armature 130, wherein the separation ring 150 comprises a first section 195 with a first material and at least a second section 230 with a second material, wherein the first material differs from the second material.

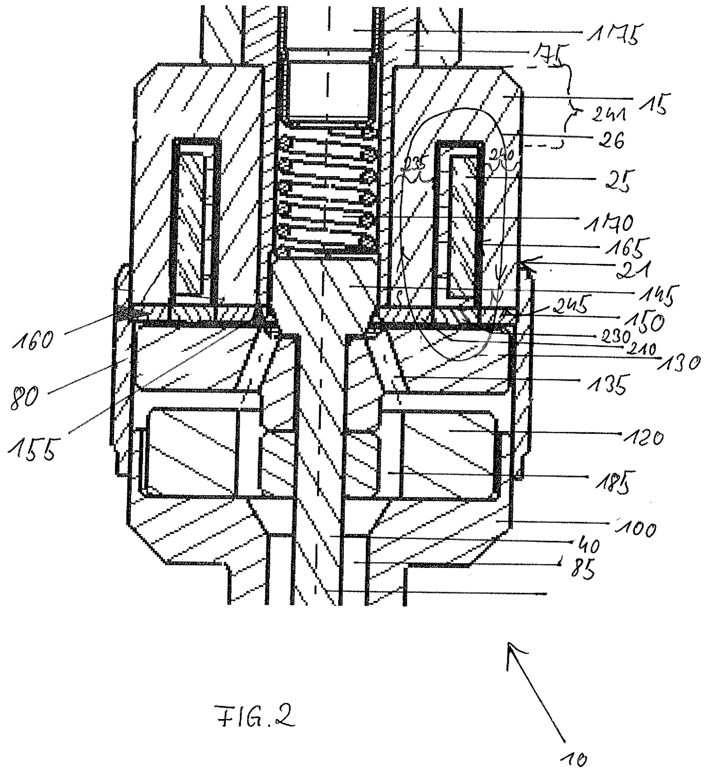

FIG. 2

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Description

[0001] The invention relates to a fuel injector for injecting fuel into a combustion engine, the fuel injector comprising an armature, a needle, a coil, a casing and a valve body, wherein the coil is arranged in a casing, wherein the armature and the needle are at least partially arranged in the valve body, wherein the coil is electrically connectable to a control device in order to generate a magnetic field, wherein the armature is connected to the needle, wherein the armature is configured to interact with the magnetic field in order to move the needle between an open position and a closed position wherein the casing is arranged on an outer peripheral surface of the valve body.

[0002] WO 2012/160100 A1 teaches an injector for injecting fluid comprising a valve needle being axially moveable with respect to a valve body and being operable to prevent a fluid injection in a closed position and to permit the fluid injection in an open position, an armature for moving the valve needle in a first direction from the closed position towards the open position, a needle retainer which is fixed to the valve needle, an armature holder which is fixed to the armature, a needle retainer and the armature holder are releasable compoundable in such way that when the armature moves in the first direction, the needle is moved in the first direction by the movement of the armature holder and the needle retainer.

[0003] It is the object of the present invention to provide an improved fuel injector.

[0004] This object is solved in accordance with claim 1. Advantageous embodiments are indicated in the dependent claims.

[0005] According to the invention, it has been recognized that an improved fuel injector may be provided by a fuel injector comprising an armature, a needle, a coil, a casing and a valve body wherein the coil is arranged in the casing. The armature and the needle are at least partially arranged in the valve body. The coil is electrically connectable to a control device in order to generate a magnetic field.

[0006] The armature is connected to the needle. The armature is configured to interact with the magnetic field in order to displace the needle from a closed position towards an open position along a longitudinal axis of the valve body. In one embodiment, the armature is positionally fixed with respect to the needle. In another embodiment, the armature is axially displaceable with respect to the needle and the relative axial displacement is limited so that the armature is operable to take the needle with it for axially displacing the needle away from the closing position.

[0007] That "the armature is configured to interact with the magnetic field in order to displace the needle" means in particular that the armature is displaceable by the coil by means of the electromagnetic field to travel in axial direction with respect to the valve body, in particular towards the housing and that the armature is further configured for mechanically interacting with the needle for axially displacing the needle away from the closing position.

[0008] The casing is arranged on an outer peripheral surface of a portion of the valve body. For example, the valve body comprises a plurality of separately manufactured parts and the casing surrounds at least one of the parts.

[0009] Furthermore, a separation ring is provided. The separation ring is in particular one of a plurality of parts of the valve body.

[0010] The separation ring is at least partially arranged between the casing and the armature. In particular, it is configured to lead the magnetic field to the armature. That the separation ring is configured to lead the magnetic field to the armature in particular means that the separation ring is in a magnetic path of the injector. The magnetic path is in particular established at least by the coil, the housing, the separation ring and the armature. For example, the magnetic path goes to an interior of the valve body through the separation ring. Preferably, the separation ring contributes to shaping the magnetic field.

[0011] The separation ring comprises a first section with a first material and at least a second section with a second material. The first material differs from the second material. In particular, the first material and the second material have mutually different magnetic properties.

[0012] This configuration provides an improved magnetic performance of the injector with an isolated coil and a high-pressure direct injection application. Moreover, a wet area can easily be separated from the coil in order to avoid external leakage. Furthermore, a force of the coil on the armature can be increased so that the fuel injector can easily be adapted to an increased fuel pressure.

[0013] In a further embodiment, the valve body comprises a tubular inner section and at least a tubular outer section wherein the separation ring is arranged in a radial direction between the inner section and the outer section. In particular, the inner section has an outer diameter which is smaller than an inner diameter of the outer section. The tubular inner section is for example comprised by a first part of the valve body and the tubular outer section is for example comprised by a second part of the valve body, the second part being arranged axially subsequent to the first part.

[0014] This configuration can easily be mounted during the manufacturing process of the fuel injector. Advantageously, the valve body comprising the first part, the separation ring and the second part can be easily assembled.

[0015] In a further embodiment, the separation ring is materially connected to the inner section and/or the outer section of the valve body. For example, the separation ring connects a downstream end of the first part of the valve body with an upstream end of the second part of the valve body in fluid-tight fashion. Particularly a welded connection provides a good sealing of the wet area of the fuel injector and the coil.

[0016] In a further embodiment, the first section of the separation ring comprises at least a separation ring base body, and the second section comprises at least a separation ring insert. In particular, the first section is represented by the separation ring base body and the second section is represented by the separation ring insert. In one embodiment, the separation ring base body comprises at least an opening, the opening being shaped correspondingly to the separation ring insert and configured to at least partly receive the separation ring insert. This configuration can easily be produced in a metal-injecting moulding process so that the separation ring can be produced in a cost-efficient manner. The separation ring insert and the opening of the separation ring base body are at least partly ring-shaped, i.e. in the form of a ring or of a ring-segment. This design allows an advantageous shaping of the magnetic flux through the separation ring.

[0017] In a further embodiment, the separation ring base body comprises the first material and the separation ring insert comprises the second material. In particular, the separation ring base body is made from the first material, i.e. it consists of the first material, and the separation ring insert is made from the second material, i.e. it consists of the second material. This configuration precisely delimits the first material from the second material so that the magnetic flux through the separation ring can easily be defined by the arrangement of the separation ring insert in the separation ring base body.

[0018] In a further embodiment, the opening encloses an angle of approximately 90°.The angle is in particular measured in a radial plane with respect to the longitudinal axis and has its apex on the longitudinal axis. "Approximately 90°" in this context is in particular to be understood that there may be bars for connecting different sections of the separation ring (see below) and the angle differs from 90 ° due to the size of these bars. This configuration is highly symmetric so that non-axial forces acting on the armature can be particularly small. The configuration may also be highly cost-efficient.

[0019] In a further embodiment, the separation ring comprises an inner section and an outer section wherein the outer section is arranged in a radial direction outside of the inner section and is connected to the inner section via at least one bar, wherein the opening is arranged between the inner section and the outer section, wherein the bar is configured to carry the separation ring insert. In particular, the separation ring insert bears on the bar(s). This configuration provides a good mechanical support for the separation ring insert.

[0020] In a further embodiment, the first material is magnetic and the second material is non-magnetic. For example, the first material has a larger magnetic permeability than the second material. The magnetic permeability of the first material may be at least 10 times, preferably at least 100 times, in particular at least 300 times as large as the magnetic permeability of the second material. In one development, the first material is a ferritic steel and the second material is an austenitic steel. Through the difference between the magnetic permeabilities of the two materials, the magnetic flux through the separation ring can be optimized and the magnetic force to raise the needle to open the valve can easily be increased, as well.

[0021] In a further embodiment, the separation ring is manufactured in a metal-injection moulding process. This process is particularly suitable to provide a hermetically sealed-off separation ring.

[0022] In a further embodiment, the fuel injector comprises a dry section and a wet section. The wet section is configured to guide fuel through the fuel injector wherein the needle and the armature are arranged in the wet section. The coil and the casing are arranged in the dry section. The wet section is separated from the dry section at least by the separation ring. In particular, the valve body separates the dry section from the wet section and the separation ring is comprised by the valve body. Due to the separation of the coil from the wet section, a magnetic field is not influenced by the fuel in the wet section.

[0023] In the following, the present invention will be described in more detail with references to the accompanying drawings, in which:

Figure 1 depicts a longitudinal section through a fuel injector according to a first embodiment;

Figure 2 shows a detail of the longitudinal section of the fuel injector shown in Figure 1;

Figure 3 shows a perspective view onto a separation ring of the fuel injector shown in Figure 1 and Figure 2;

Figure 4 shows a perspective view on a top side of the separation ring shown in Figure 3;

Figure 5 shows a perspective view on the bottom side of a separation ring base body shown in Figure 3 and 4;

Figure 6 shows a perspective view onto a top-side of the separation ring base body shown in Figure 5; and

Figure 7 depicts a longitudinal section through a fuel injector according to a second embodiment.

[0024] Figure 1 depicts a longitudinal section through a fuel injector 10 according to a first embodiment and Figure 2 shows a detail of the longitudinal section of the fuel injector 10 shown in Figure 1.

[0025] The fuel injector 10 comprises a casing 15 and a valve body 20. The fuel injector 10 comprises an actuator 21. In the casing 15, a coil 25 of the actuator 21 is arranged. The coil 25 is electrically connected with a control device 30. The control device 30 controls a current through the coil 25 in order to generate an electromagnetic field 26. The actuator 21 is designed to trip a valve unit 45 of the fuel injector.

[0026] The fuel injector 10 comprises a longitudinal axis 35 alongside which a needle 40 of a valve unit 45 of the fuel injector 10 may be moved. The valve unit 45 comprises a valve seat body 50 and a valve closing member 55, as well, the valve closing member 55 being arranged at a first axial end of the fuel injector 10. The first axial end may be configured to protrude into a combustion chamber 60 of an internal combustion engine, for example. Alternatively, it may protrude into an intake manifold of the internal combustion engine, for example. In the valve seat body 50, the valve closing member 55 is received. The valve closing member 55 is ball-shaped and closes a first opening 65 of the valve seat body 50 in a closed position of the valve unit 45. The first opening 65 is located beneath the valve closing member 55. On the opposite side of the first opening 65, the valve closing member 55 is in contact with the needle 40. The valve closing member 55 may expediently be fixed to the needle 40. The needle 40 is solid in the present embodiment. Alternatively, the needle 40 can also be designed as a hollow needle.

[0027] The valve body 20 comprises a needle section 70, a first part representing an inner-tubular section 75 and a second part representing an outer tubular section 80. The needle section 70 receives the needle 40 and the forms a first channel 85 between an outer peripheral surface 90 of the needle 40 and an inner peripheral surface 95 of the needle section 70. On a first longitudinal end of the needle section 70, the valve seat body 50 is positioned in the needle section 70 and fixed thereto. On a second longitudinal end of the needle section 70 which is on the opposite side of the first longitudinal end of the needle section 70, the needle section 70 comprises a ledge 100. The first channel 85 ends at the ledge 100. On the peripheral side of the ledge 100, the needle section 70 comprises a first collar 105. The collar 105 is arranged in the second tubular section 80 of the valve body 20. The second tubular section 80, the needle section 70 and the collar 105 seal off a wet section 110 against the environment of the fuel injector 10. In the wet section 110, fuel 115 is transported to the valve seat body 50.

[0028] Above the ledge 100, a guiding disc 120 is in touch with the ledge 100. The first collar 105 is arranged on the outside in a radial manner with regard to the guiding disc 120. The guiding disc receives the needle 40 and comprises a second channel 121. The second channel 121 is hydraulically connected with the first channel 85.

[0029] In a longitudinal direction, the second tubular section 80 is arranged between the casing 15 and the needle section 70.

[0030] Between the casing 15 and the ledge 100, the second tubular section 80 borders on an armature room 125. The armature room 125 is part of the wet section 110. In the armature room 125, an armature 130 is located. The armature 130 comprises a magnetic material such as ferritic steel. The armature 130 also comprises a third channel 135. The armature 130 is connected to the needle 40. The needle 40 extends through a central opening 140 of the armature 130. On the opposite side of the guiding disc 120 relative to the armature 130, the needle 40 comprises a thickening 145 with a diameter which is larger than a diameter of the central opening 140. This configuration provides a good force transfer from the armature 130 to the needle 40 by means of a mechanical coupling, in particular a form-fit coupling.

[0031] Between the armature 130 and the coil 25, a separation ring 150 is located. The separation ring is a portion of the valve body 20.

[0032] The separation ring 150 is arranged in a plane vertical to the longitudinal axis 35. In other words, a central axis of the ring is parallel - in particular coaxial - to the longitudinal axis. The separation ring 150 is arranged between the first tubular section 75 and the second tubular section 80 in radial direction. The separation ring 150 is connected with a first welded connection 155 with the first tubular section 75 and with a second welded connection 160 with the second tubular section 80 in fluid-tight fashion. The separation ring 150 and the first tubular section 75 separate - i.e. hydraulically seal or at least contribute to hydraulically sealing - the wet section 110 of the fuel injector 10 from a dry section 165 of the fuel injector 10.

[0033] The dry section 165 is delimited by the casing 15 and the separation ring 150 on the opposite side of armature 130. The casing 15 has a U-shaped cross-section. The casing 15 surrounds the first tubular section 75. In the casing 15, specifically in the recess of the U-shape, the coil 25 is arranged.

[0034] In the first tubular section 75, the thickening 145 of the needle 40 is arranged. The thickening 145 may cooperate with the first tubular section 75 for axially guiding the needle 40. Upstream of the thickening 145, a spring 170 and a fastening means 175 are located in the first tubular section 75. The fastening means 175 fastens the spring 170 on a first longitudinal end of the spring 170. On a second longitudinal end of the spring 170, the spring 170 is in contact with the needle 40.

[0035] At the second longitudinal end of the fuel injector 10, remote from the valve seat body 50, a fluid inlet tube 180 is arranged adjacent to the upper side of the casing 15 and hydraulically connected to the first tubular section 75 of the valve body 20. Via the fluid inlet tube 180, the fuel injector 10 can be connected to a pipe system and to a high-pressure pump. The high pressure pump is configured to pressurize the fuel 115 and provide it to the fuel injector 10. The fluid inlet tube 180 surrounds the fastening means 175 at a needle 40 averted end of the first tubular section 75.

[0036] Fuel 115 coming from the high-pressure pump is pumped through the fluid inlet tube 180, enters the valve body 20 through the fastening means 175 which may comprise a fluid filter. The fluid flows further through the first tubular section 75 alongside or through the spring to the needle 40 and further alongside the solid needle 40. The fuel 115 flows through the third channel 135 via the armature 130. The guiding disc 120 provides a third channel 135 to connect the second channel 121 via the third channel 135 to the first channel 85. In the first channel 85, the fuel flows along the needle 40 down to the valve seat body 50. When the first opening 65 is opened, the fuel 115 passes the first opening 65 and is injected into the combustion chamber 60.

[0037] The valve unit 45 is controlled by the actuator 21. When the control device 30 provides electric energy to the coil 25, the coil 25 generates the electromagnetic field 26. The electromagnetic field 26 penetrates the separation ring 150 and interacts with the armature 130. In the closed position, the armature 130 is spaced with regard to the separation ring 150 (cf. Figure 1, roughly indicated by the dotted lines representing the respective displacement of the armature 130 in exaggerated fashion).

[0038] The spring 170 is mounted between the needle 40 and the fastening means 175 in a pre-stressed manner. The spring 170 provides a spring force F_S. The spring force F_S has a direction parallel to the longitudinal axis 35 in the direction towards the valve seat body 50. The spring 170 presses the needle 40 and the armature 130 in the direction of the valve seat body 50 with the spring force F_S. The needle 40 presses the valve closing member 55 onto the first opening 65 so that no fuel 115 can be injected into the combustion chamber 60.

[0039] When the electric energy is provided to the coil 25 by the control device 30, a magnetic field 26 is generated by the coil 25. The magnetic field 26 permeates the separation ring 150 and penetrates the armature 130. The armature 130 comprises ferromagnetic material.

[0040] The armature 130 is attracted by the electromagnetic field 26 in the direction towards the coil 25. The electromagnetic field 26 produces a magnetic force F_M by interacting with the armature 130, which has a direction parallel to the longitudinal axis 35 in the direction of the coil 25. The armature 130 presses against the thickening 145 of the needle 40. The thickening 145 presses against the spring 170. When the magnetic force F_M is higher than the spring force F_S, the spring 170 is compressed and needle 40 and the valve closing member 55 which is fixed thereto move towards the fastening element 175. In this way, a gap between the valve closing member 55 and the valve seat body 50 is established and the first opening 65 is unsealed. In this way, fuel 115 can be dispensed from the fuel injector 10 through the first opening 65 and, for example, be injected into the combustion chamber 60.

[0041] The coil 25, the separation ring 150 and the armature 130 are located on the same radial distance to the longitudinal axis 35. To put it in another way, the coil 25, the separation ring 150 and the armature 130 overlap in top view along the longitudinal axis 35. This provides an increased electromagnetic force F_M on the armature. Through the increased electromagnetic force F_M, the spring 170 can be strengthened and can provide a higher spring force F_S. In result the closed position of the valve unit 45 can be secured even by an increase of the pressure of the fuel 115. Also, by means of this arrangement, the magnetic flux through the casing 15 and the armature 130 can be optimized.

[0042] Figure 3 shows a perspective view onto a bottom-side of the separation ring 150. Figure 4 shows a perspective view of the top side of the separation ring 150 shown in Figure 3. Figure 5 depicts a perspective view onto a bottom-side of a separation ring base body 195 of the separation ring 150 shown in Figure 3. Figure 6 shows a top side of the separation ring base body 195 shown in Figure 5.

[0043] The separation ring 150 comprises a third opening 200 through which the needle 40 is guided. At the third opening 200, a second collar 205 is located. On the second collar 205, the first tubular section 75 is welded with the first welded connection 155. The separation ring base body 195 comprises an inner section 210 and an outer section 215. The inner section 210 is radially arranged outside of the second collar 205 and merges with the second collar 205. The outer section 215 is radially arranged on the outside of the inner section 210. Between the inner section 210 and the outer section 215, four partly ring-shaped fourth openings 220 are arranged. The inner section 210 is connected to the outer section 215 with bars 225. The fourth openings 220 each cover an angle of 90° except for the size of the bars 225. Alternatively, every other angle may be covered by the fourth openings 220.

[0044] By means of the bars 225, a mechanical connection can be provided between the inner section 210 and the outer section 215. The bars 225 have a smaller longitudinal extension than each of the inner section 210 and the outer section 215.

[0045] The separation ring base body 195 consists of a first material. The first material is ferromagnetic. For example, the first material could be stainless steel having the SAE steel grade 430. Of course, every other ferromagnetic steel would be also possible.

[0046] In the fourth openings 220, a separation ring insert 230 is arranged. The separation ring insert 230 spans all four fourth openings 22. The separation ring insert 230 comprises the same thickness in longitudinal direction as the inner section 210 or the outer section 215. The thickness of the separation ring insert 230 is only reduced in the area of the bars 225 in order to provide a flat surface on both sides of the separation ring 150.

[0047] The separation ring insert 230 consists of a second material. The second material is non-magnetic. For example, it is an austenitic steel, e.g. stainless steel having the SAE steel grade 304. Of course every other austenitic steel would be also possible. Hence the second material differs from the first material in its magnetically permeability. The first material advantageously comprises a magnetic constant μ_r, which is higher than 10, preferably higher than 100. The magnetic constant μ_r is also known as relative magnetic permeability. The second material comprises a magnetic constant μ_r, which is lower than 10, particularly between 1 and 10. In another embodiment the magnetic constant μ_r of the first material may be higher than 1 and the magnetic constant μ_r of the second material may be lower than 1.

[0048] In a radial direction, the inner section 210 is located directly adjoining an inner section 235 of the casing 15. The casing 15 comprises an outer section 240. The outer section 240 of the casing 15 is spaced with regard to the inner section 235 of the casing in a radial direction and is connected with the inner section 235 on the opposite site of the separation ring by means of a connection section 241, so that the casing 15 has a U-shaped cross-section. The coil 25 is arranged between the inner section 235 and the outer section 240 in radial direction in the recess of the U-shape. The outer section 240 of the casing 15 is located directly adjoining the outer section 215 of the separation ring 150. The inner section 235 and the outer section 240 of the casing 15 have nearly the same radial extension as the inner section 210 and the outer section 215 of the separation ring 150, respectively. The separation ring insert 230 has the radial extension of the recess between the inner and outer sections 235, 240 of the casing 15. The arrangement of the inner sections 210 of the separation ring 150 to the inner section 235 of the casing 15 and the arrangement of the outer section 240 of the separation ring 150 to the outer section 240 of the casing 15 may also be different. Also the arrangement of the coil 25 with regard to the separation ring inlet 230 may be different.

[0049] By means of the non-magnetic material of the separation ring insert 230, the electromagnetic field 26 builds a first magnetic pole (i.e. in Fig. 2 an north pole) on a surface 245 of the outer section 240 of the casing 15 which surface 245 faces towards the armature 130. Due to the direct contact of the outer section 215 of the separation ring 150 to the outer section 240 of the casing 15, the first pole is also located in the outer section 215 of the separation ring 150. A second magnetic pole (i.e. in Fig. 2 a south pole) is located on the surface 245 at the inner section 135 of the casing 15. Hence, the direct contact of the inner section 210 of the separation ring 150 to the inner section 235 of the casing the second pole is also located at the inner section 210 of the separation ring 150. The magnetic material of the armature 130 is designed to close the magnetic path of the electromagnetic field 26, so that the armature 130 is attracted to the magnetic poles and presses the needle 40 against the spring 170 to open the valve unit 45.

[0050] The non-magnetic material of the separation ring insert 230 provides a flux of the magnetic field 26 through the casing 15 and the armature 130. The electromagnetic field 26 is not short-circuited by the separation ring 150, so that an improved leading of the electromagnetic field by the separation ring 150 can be provided. Parasitic magnetic flux through the separation ring 150 in radial direction is particularly small. Also, the coil 25 is protected against the wet room 110 and chemical attacks. Moreover, the separation ring 150 prevents an external leakage and provides an adequate structural resistance against the forces resulting from the magnetic field and the highly pressurized fuel 115. In order to prevent radial magnetic forces and/or to minimize unintended paths for the magnetic field 26, the first tubular section and/or the second tubular section 80 can be made from non-magnetic materials, e.g. with austenitic material, particularly e.g. with stainless steel having the SAE steel grade 304.

[0051] For easy manufacture of the separation ring 150, the separation ring 150 may be produced by a metal-injection moulding process wherein both the first and the second material may be arranged according to the above-described structure.

[0052] In order to protect the casing 15 against external factors, the casing 15 may be realized e.g. with an overmoulded layer of plastic compound.

[0053] In Figures 1 and 2, the fuel injector 10 comprises an inward opening valve unit 45. The actuator 21 could also be used for an outward opening fuel injector, i.e. a fluid injector that opens by means of displacement of the needle 40 in the direction of the fluid flow.

[0054] Figure 7 shows a longitudinal section through a fuel injector 300 according to a second embodiment. The fuel injector 300 has in general the same design as the fuel injector 10 shown in Figures 1 to 6. Different thereto, the fuel injector 300 according to the present embodiment is an outward opening fuel injector.

[0055] Accordingly, the needle 40 is opened in direction of the fluid flow - out in direction of the combustion chamber 60 for example. Consequently, the casing 15 has its U-shape open side opened in the direction of the fluid inlet tube 180. The separation ring 150 is arranged subsequent to the casing 15 and the armature 130 subsequent to the separation ring 150 in longitudinal direction 35 away from the valve seat body 50 and towards the fluid inlet tube 180. The separation ring 150 has the same design as shown in Figures 3 to 6 and it is connected to an inner tubular section 75 and an outer tubular section 80 of the valve body 20.

[0056] The separation ring 150 of this and other embodiments may have a small longitudinal extension, e.g. starting from 0.5 mm. Alternatively, the separation ring 150 could also have a different longitudinal extension.

[0057] By means of the described fuel injector 10, the casing 15 may be protected from the fuel or other aggressive substances in the fuel injector 10. Moreover, the different materials of the separation ring 150 guarantee an adequate forwarding of the electromagnetic field on the armature 130. In a combination of the design of the casing 15 and the separation ring 150, the radial force on the armature 130 could be minimized.

Claims

1. A fuel injector (10; 300) for injecting fuel (115) into a combustion engine, the fuel injector (10; 300) comprising:

   - an armature (130), a needle (40), a coil (25), a casing (15) and a valve body (20),
   - wherein the coil (25) is arranged in the casing (15),
   - wherein the armature (130) and the needle (40) are at least partially arranged in the valve body (20),
   - wherein the coil (25) is electrically connectable to a control device (30) in order to generate an electromagnetic field (26),
   - wherein the armature (130) is connected with the needle (40),
   - wherein the armature (130) is configured to interact with the electromagnetic field (26) in order to displace the needle (40) from a closed position towards an open position along a longitudinal axis (35) of the valve body (20),
   - wherein the casing (15) is arranged on an outer peripheral surface of a portion of the valve body (20),

   characterized by

   - a separation ring (150),
   - wherein the separation ring (150) is at least partially arranged between the casing (15) and the armature (130) and configured to lead the electromagnetic field (26) to the armature (130),
   - wherein the separation ring (150) comprises a first section (195) with a first material and at least a second section (230) with a second material,
   - wherein the first material differs from the second material.

2. The fuel injector (10; 300) according to claim 1, **characterized in that** the valve body (20) comprises a tubular inner section (75) and at least a tubular outer section (80), wherein the separation ring (150) is arranged in a radial direction between the inner section (75) and the outer section (80).

3. The fuel injector (10; 300) according to claim 1 or 2, **characterized in that** the separation ring (150) is materially connected (155, 160) to the valve body (20).

4. The fuel injector (10; 300) according to any one of claims 1 to 3, **characterized in that** the first section (195) of the separation ring (150) comprises at least a separation ring base body (195), wherein the second section (220) comprises at least a separation ring insert (230), wherein the separation ring base body (195) comprises at least an opening (220), wherein the opening (220) is designed correspondingly to the separation ring insert (230) and configured to at least partly receive the separation ring insert (230).

5. The fuel injector (10; 300) according to claim 4, **characterized in that** the separation ring insert (230) and the opening (230) of the separation ring base body (195) are at least partly ring-shaped.

6. The fuel injector (10; 300) according to claim 4 or 5, **characterized in that** the separation ring base body (195) comprises the first material and the separation ring insert (230) comprises the second material.

7. The fuel injector (10; 300) according to any one of claims 4 to 6, **characterized in that** the opening encloses an angle of approximately 90°.

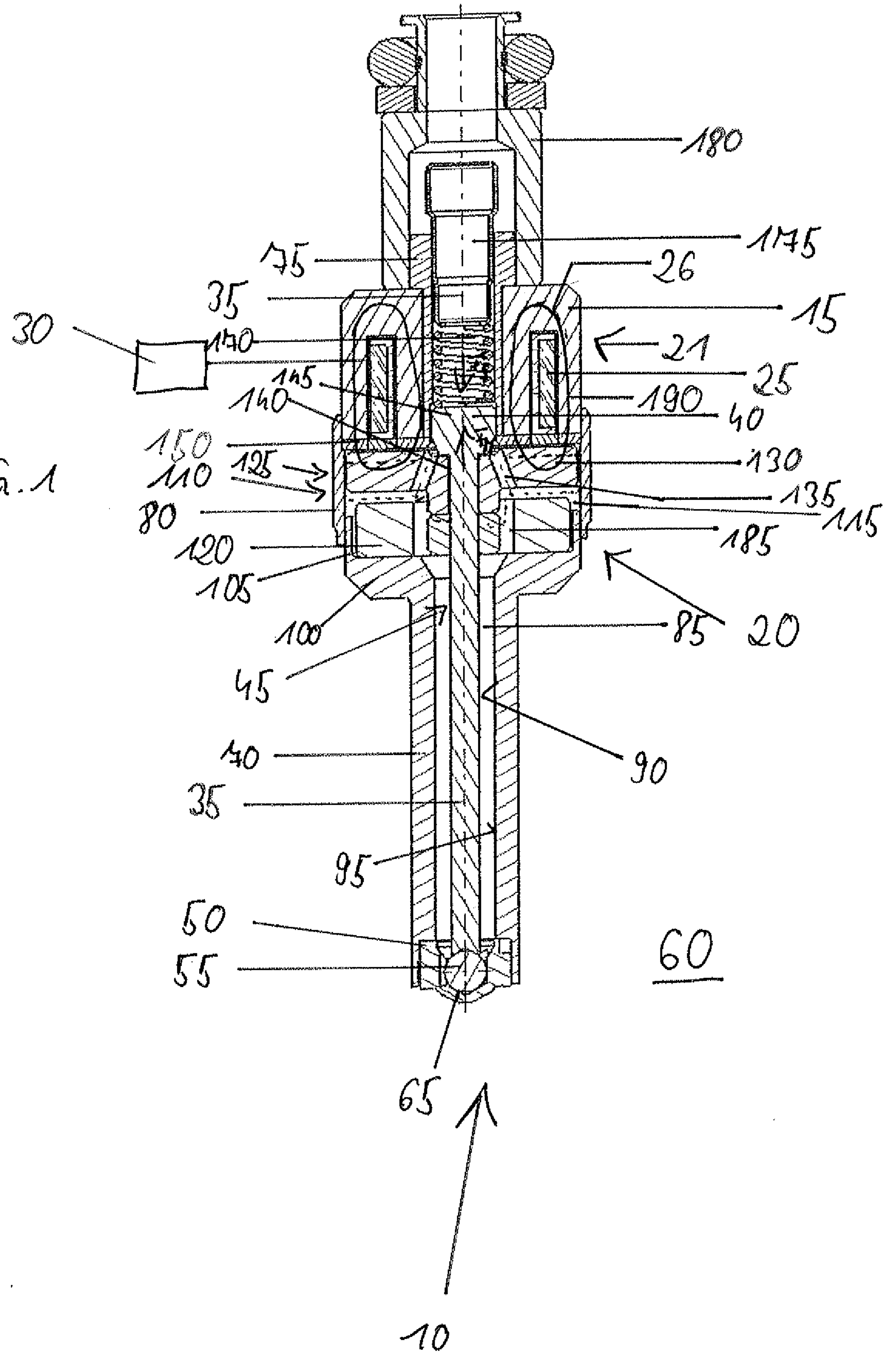
8. The fuel injector (10; 300) according to any one of claims 4 to 7, **characterized in that** the first section (195) of the separation ring (150) comprises an inner section (210) and an outer section (215), wherein the outer section (215) is arranged in a radial direction outside of the inner section (210), wherein the inner section (210) is connected to the outer section (215) via at least a bar (225), wherein the opening (220) is arranged between the inner section (210) and the outer section (215), wherein the bar (225) is configured to carry the second section (230).

9. The fuel injector (10; 300) according to any one of claims 1 to 8, **characterized in that** the first material is magnetic and the second material is non-magnetic.

10. The fuel injector (10; 300) according to claim 9, wherein the magnetic first material is a ferritic steel and the non-magnetic second material is an austenitic steel.

11. The fuel injector (10; 300) according to any one of claims 1 to 10, **characterized in that** the separation ring (150) is produced by means of a metal injection moulding process.

12. The fuel injector (10; 300) according to any one of claims 1 to 11, **characterized by** a dry section (165) and a wet section (110), wherein the wet section (110) is configured to guide the fuel (115) through the injector (10; 300), wherein the needle (40) and the armature (130) are arranged in the wet section (110), wherein the coil (25) and the casing (15) are arranged in the dry section, wherein the wet section (110) is delimited from the dry section (165) at least by the separation ring (150).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150
130
125
110
135
115
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185
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105
100
85
20
45
90
70
35
95
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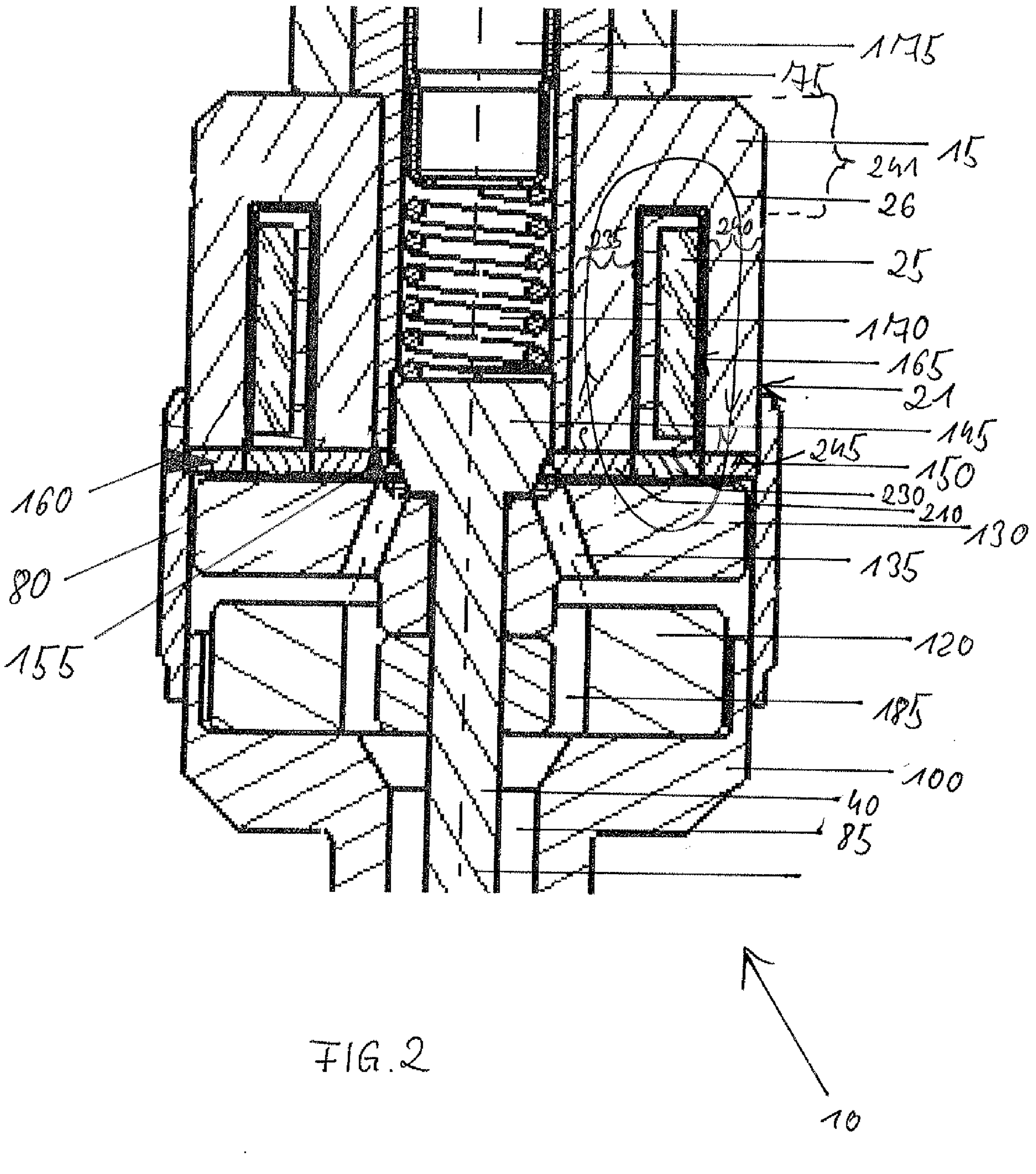
60
65
10

FIG.1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175
15
241
26
25
1170
165
21
145
245
150
230
210
130
135
120
185
100
40
85
160
80
155
235
240
10

FIG.2

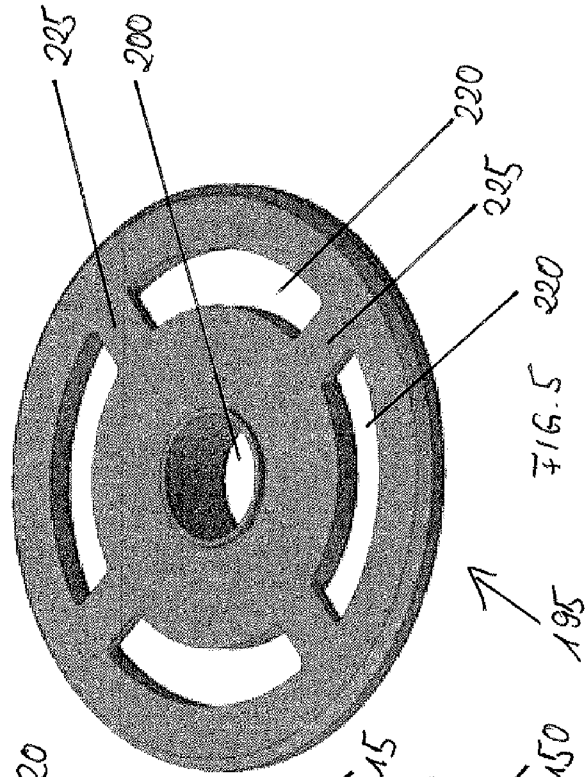

FIG. 5

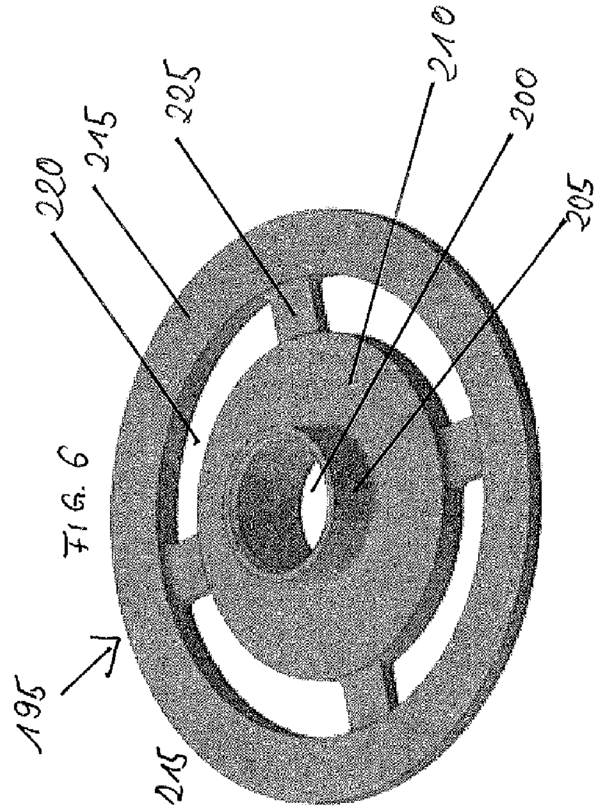

FIG. 6

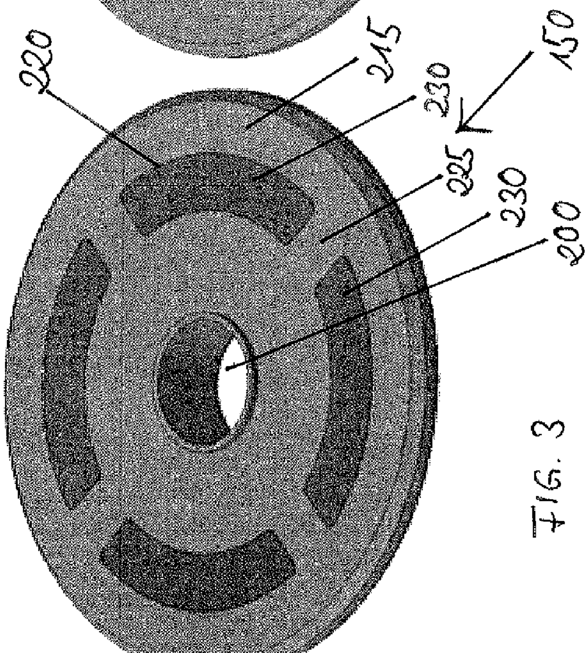

FIG. 3

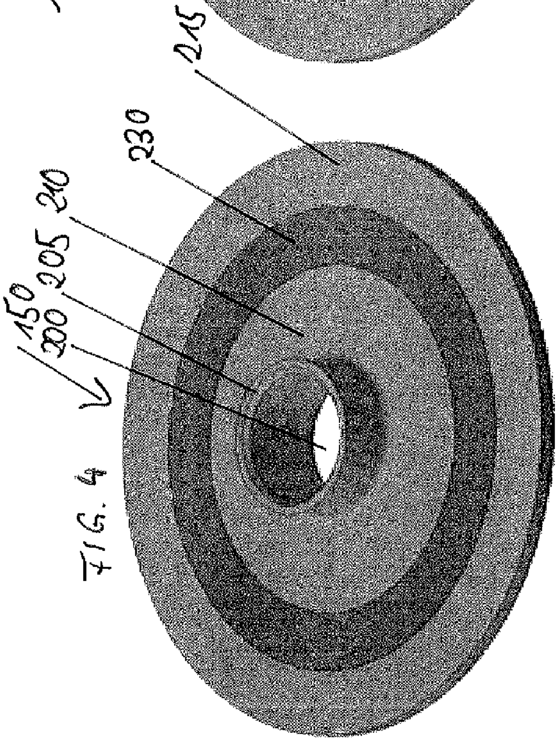

FIG. 4

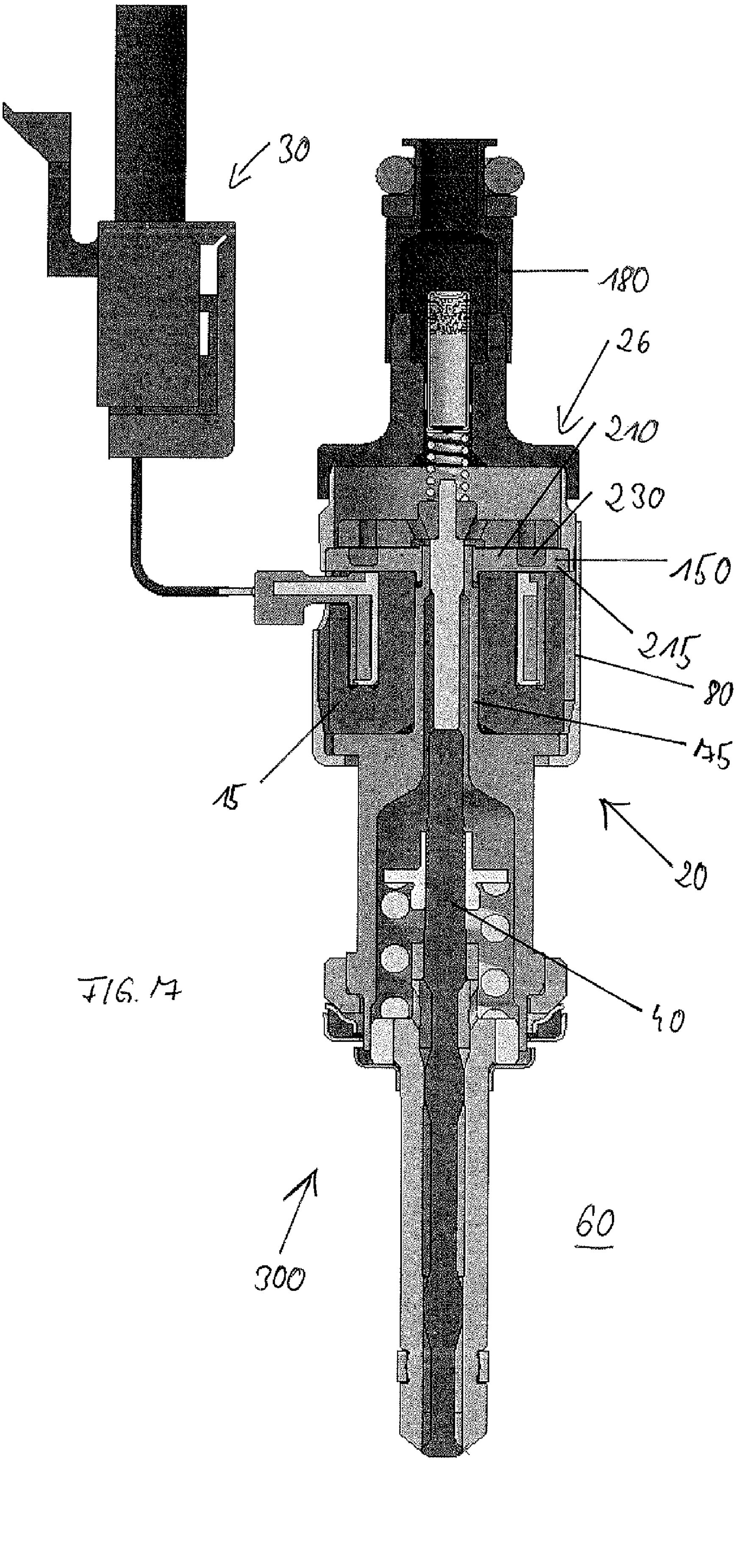

FIG. 17

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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 January 2014	Barunovic, Robert

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