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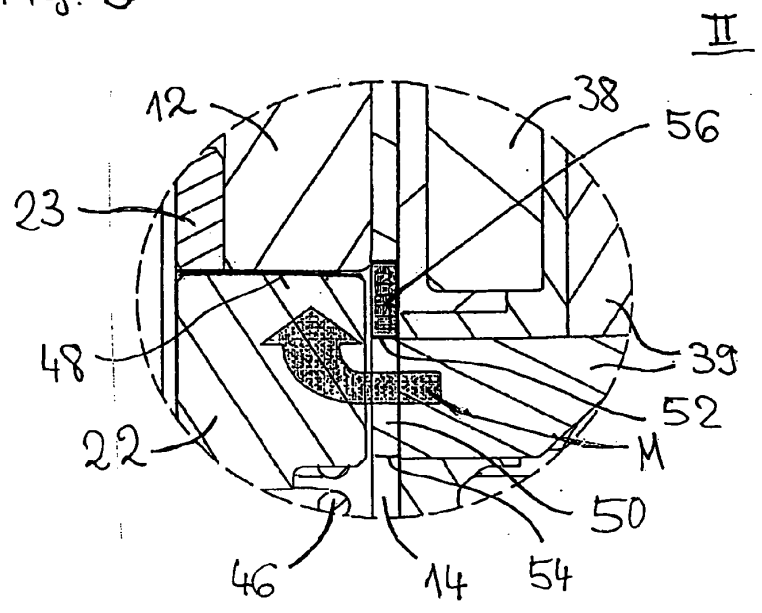
(54) **Valve assembly for an injection valve and injection valve**

(57) Valve assembly (11) for an injection valve (10), comprising a valve body (14) including a central longitudinal axis (L), the valve body (14) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40), a valve needle (20) axially movable in the cavity (18), the valve needle (20) preventing a fluid flow through the fluid outlet portion (40) in a closing position and releasing the fluid flow through the fluid outlet portion (40) in further positions, and an electro-magnetic actuator unit (36) being designed to actuate the valve needle (20), the electro-magnetic actuator unit (36) comprising a solenoid (38) being arranged radially outside the valve body (14), a housing (39) being arranged radially outside the valve body (14) and being in contact with the valve body (14) in a contact section (50) of the valve body (14), the contact section (50) having an upper boundary (52) facing the fluid inlet portion (42), and an armature (22) being axially movable in the cavity (18) of the valve body (14). A stop surface (48) of the valve body (14) facing the fluid outlet portion (40) is designed to limit the axial movement of the armature (22). The valve body (14) has a wall section (55) extending axially from the upper boundary (52) of the contact section (50) to an axial position being equal to an axial position of the stop surface (48). The wall section (55) comprises at least along a part of its axial extension a permanent magnetic wall part (56).

Fig. 3



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Description

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

[0002] Injection valves are in wide spread 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 also 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 piezo electric 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 diesel engines in the range of up to 2000 bar.

[0005] The object of the invention is to create a valve assembly of an injection valve and an injection valve which facilitate a reliable and precise function of the injection valve.

[0006] These objects are 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 for an injection valve, comprising a valve body including a central longitudinal axis, the valve body comprising a cavity with a fluid inlet portion and 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, and an electro-magnetic actuator unit being designed to actuate the valve needle. The electromagnetic actuator unit comprises a solenoid being arranged radially outside the valve body, a housing being arranged radially outside the valve body and being in contact with the valve body in a contact section of the valve body, the contact section having an upper boundary facing the fluid inlet portion, and an armature being axially movable in the cavity of the valve body. A stop surface of the valve body facing the fluid outlet portion is designed to limit the axial movement of the armature. The valve body has a wall section extending axially from the upper boundary of the contact section to an axial position being equal to an axial position of the stop surface. The wall section comprises at least along a part of its axial extension a permanent magnetic wall part.

[0008] The contact between the housing and the contact section of the valve body needs not to be a complete contact over the whole area between the housing and the contact section. Small gaps may exist between the housing and the contact section of the valve body.

[0009] The permanent magnetic wall part has the advantage that a magnetic flux in axial direction through the valve body near the armature may be prevented. Consequently, the magnetic flux through the armature may be kept high. Consequently, the efficiency of the electromagnetic actuator unit may be very high. Furthermore, the dynamic behavior of the valve assembly may be very good.

[0010] In an advantageous embodiment the permanent magnetic wall part of the valve body extends axially from the upper boundary of the contact section at least to the axial position being equal to the axial position of the stop surface. This has the advantage that the magnetic flux in axial direction through the valve body near the armature may be completely prevented. Consequently, the magnetic flux through the armature may be kept very high.

[0011] In a further advantageous embodiment the permanent magnetic wall part is designed in a manner that magnetic dipoles in the permanent magnetic wall part extend in a direction perpendicular to the longitudinal axis. This has the advantage that a magnetic flux in the permanent magnetic wall part in axial direction may be prevented very efficiently.

[0012] In a further advantageous embodiment the permanent magnetic wall part of the valve body is ring-shaped. By this the magnetic flux through the valve body near the armature may be prevented over the whole circumference of the valve body.

[0013] According to a second aspect the invention is distinguished by an injection valve with a valve assembly according to the first aspect of the invention.

[0014] 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, and

Figure 2 an enlarged view of section II of figure 1 in a longitudinal section view for a first embodiment of the valve assembly, and

Figure 3 a further enlarged view of section II of figure 1 in a longitudinal section view for a further embodiment of the valve assembly.

[0015] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0016] An injection valve 10 that is in particular suitable for dosing fuel to an internal combustion engine comprises a valve assembly 11.

[0017] The valve assembly 11 comprises a valve body 14 with an inlet tube 12. The valve body 14 has a central longitudinal axis L. A cavity 18 is arranged in the valve body 14.

[0018] The cavity 18 takes in a valve needle 20 and an armature 22. The armature 22 is axially movable in the cavity 18. The armature 22 is coupled to the valve needle 20 to enable an axial movement of the valve needle 20. At one end of the armature 22 an upper guide 23 is formed as a collar around the valve needle 14. A main spring 24 is arranged in a recess 26 provided in the inlet tube 12. The main spring 24 is mechanically coupled to the upper guide 23. The upper guide 23 is in contact with an inner side of the inlet tube 12 and can guide the valve needle 14 in axial direction inside the inlet tube 12. Alternatively, the upper guide 23 is arranged adjacent to an axial end of the valve needle 20 and is fixedly coupled to the valve needle 20.

[0019] A filter element 30 is arranged in the inlet tube 12 and forms a further seat for the main spring 24. During the manufacturing process of the injection valve 10 the filter element 30 can be axially moved in the inlet tube 12 in order to preload the main spring 24 in a desired manner. By this the main spring 24 exerts a force on the valve needle 20 towards an injection nozzle 34 of the injection valve 10.

[0020] In a closing position of the valve needle 20 it sealingly rests on a seat plate 32 by this preventing a fluid flow through the at least one injection nozzle 34. The injection nozzle 34 may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid. In addition to that a lower guide 35 is provided adjacent to the seat plate 32. The lower guide 35 is adapted to guide the valve needle 20 near the injection nozzle 34. The seat plate 32 may be made in one part with the lower guide 35 or may be a separate part from the lower guide 35.

[0021] The valve assembly 11 is provided with an electro-magnetic actuator unit 36. The electro-magnetic actuator unit 36 comprises the armature 22, a solenoid 38 and a housing 39. The solenoid 38 and the housing 39 are arranged radially outside the valve body 14. The solenoid 38 is arranged in the housing 39.

[0022] The valve body 14, the housing 39 and the armature 22 are forming an electromagnetic circuit.

[0023] The cavity 18 has a fluid outlet portion 40 which is arranged near the seat plate 32. The cavity 18 has a fluid inlet portion 42 which is arranged in the inlet tube 12. The fluid outlet portion 40 is in hydraulic communication with the fluid inlet portion 42.

[0024] A step 44 is arranged in the valve body 14. An armature spring 46 which is preferably a coil spring is fixedly coupled to the step 44 in the valve body 14. The inlet tube 12 has a stop surface 48 which faces the fluid outlet portion 40. The armature 22 is axially movable between the stop surface 48 of the inlet tube 12 and the armature spring 46.

[0025] The housing 39 is in contact with the valve body 14 in a contact section 50 of the valve body 14. The contact section 50 is limited by an upper boundary 52 which faces the fluid inlet portion 42. Furthermore, the contact section 50 is limited by a lower boundary 54 which faces the fluid outlet portion 40.

[0026] The valve body 14 has a wall section 55 which extends in axial direction from the upper boundary 52 of the contact section 50 to an axial position being equal to an axial position of the stop surface 48.

[0027] The valve body 14 has a permanent magnetic wall part 56 which is at least partially arranged inside the wall section 55. In the embodiment shown in Figure 2 the permanent magnetic wall part 56 is completely arranged inside the wall section 55. In a further embodiment shown in Figure 3, the permanent magnetic wall part 56 extends in axial direction from the upper boundary 52 of the contact section 50 beyond an axial position being equal to the axial position of the stop surface 48 of the armature 22. In further embodiments the permanent magnetic wall part 56 may also extend from inside the wall section 55 partially into the contact section 50. The permanent magnetic wall part 56 may extend completely or partially over the radial extension of the wall section 55.

[0028] Preferably, magnetic dipoles in the permanent magnetic wall part 56 extend in a direction perpendicular to the longitudinal axis L.

[0029] In the following, the function of the injection valve 10 is described in detail:

[0030] The fluid is led from the fluid inlet portion 42 towards the fluid outlet portion 40.

[0031] The valve needle 20 prevents a fluid flow through the fluid outlet portion 40 in the valve body 14 in a closing position of the valve needle 20. Outside of the closing position of the valve needle 20, the valve needle 20 enables the fluid flow through the fluid outlet portion 40.

[0032] In the case when the electro-magnetic actuator unit 36 with the solenoid 38 gets energized the actuator unit 36 may effect an electro-magnetic force on the armature 22. The armature 22 is attracted by the electro-magnetic actuator unit 36 with the solenoid 38 and moves in axial direction away from the fluid outlet portion 40. The armature 22 takes the valve needle 20 with it so that the valve needle 20 moves in axial direction out of the closing position. Outside of the closing position of the valve needle 20 the gap between the valve body 14 and the valve needle 20 at the axial end of the injection valve 10 facing away from of the actuator unit 36 forms a fluid path and fluid can pass through the injection nozzle 34.

[0033] In the case when the actuator unit 36 is de-energized the main spring 24 can force the valve needle 20 to move in axial direction in its closing position. It is depending on the force balance between the force on the valve needle 20 caused by the actuator unit 36 with the solenoid 38 and the force on the valve needle 20 caused by the main spring 24 whether the valve needle 20 is in its closing position or not.

[0034] Due to the permanent magnetic wall part 56 of

the valve body 14 a magnetic flux M generated by the actuator unit 36 is prevented to pass through the wall section 55 of the valve body 14 in axial direction parallel to the armature 22. In particular, if the permanent magnetic wall part 56 extends in axial direction from the upper boundary 52 of the contact section 50 beyond an axial position which is equal to the axial position of the stop surface 48 of the armature 22 as shown in Figure 3 the magnetic flux M generated by the actuator unit 36 is completely prevented to pass through the wall section 55 of the valve body 14 in axial direction. In particular, if the magnetic dipoles in the permanent magnetic wall part 56 extend in a direction perpendicular to the longitudinal axis L, the magnetic flux in the wall part 56 in axial direction may be prevented very efficiently. Therefore, a split-up of the magnetic flux M with a fraction of magnetic flux through the permanent magnetic wall part 56 of the valve body 14 can be avoided, and the magnetic flux M which leaves the housing 39 and enters the contact section 50 of the valve body 14 can be completely pass through the armature 22. Consequently, the armature 22 can be moved very fast in axial direction by the actuator unit 36. Thus, the actuator unit 36 can work very efficiently. Consequently, the dynamics of the injection valve 10 and the response time of the valve needle 20 relative to the changes of the input of the actuator unit 36 can be very good.

[0035] In the following, a method for manufacturing the valve body 14 of the valve assembly 11 is described:

[0036] The valve body 14 is provided. The wall part 56 of the valve body 14 is heated up in a manner that the temperature of the wall part 56 is higher than the Curie temperature of the material of the wall part 56. Preferably, the heating-up of the wall part 56 is carried out by induction heating. In the case of induction heating the area of the valve body 14 which is heated up can be kept very small, and a high heating-up velocity can be obtained. Subsequently, the wall part 56 is cooled down. During the cooling of the wall part 56 a magnetic field is applied to the wall part 56. By this, the permanent magnetic wall part 56 in the valve body 14 may be produced in a simple manner. Preferably, the magnetic field is applied to the wall part 56 of the valve body 14 in a manner that magnetic dipoles in the wall part 56 extend in radial direction. This has the advantage that a magnetic flux in the wall part 56 of the valve body 14 in axial direction may be prevented very efficiently.

Claims

1. Valve assembly (11) for an injection valve (10), comprising

   - a valve body (14) including a central longitudinal axis (L), the valve body (14) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40),
   - a valve needle (20) axially movable in the cavity (18), the valve needle (20) preventing a fluid flow through the fluid outlet portion (40) in a closing position and releasing the fluid flow through the fluid outlet portion (40) in further positions, and
   - an electro-magnetic actuator unit (36) being designed to actuate the valve needle (20), the electro-magnetic actuator unit (36) comprising

     - a solenoid (38) being arranged radially outside the valve body (14),
     - a housing (39) being arranged radially outside the valve body (14) and being in contact with the valve body (14) in a contact section (50) of the valve body (14), the contact section (50) having an upper boundary (52) facing the fluid inlet portion (42), and

   - an armature (22) being axially movable in the cavity (18) of the valve body (14), wherein a stop surface (48) of the valve body (14) facing the fluid outlet portion (40) is designed to limit the axial movement of the armature (22),
     wherein the valve body (14) has a wall section (55) extending axially from the upper boundary (52) of the contact section (50) to an axial position being equal to an axial position of the stop surface (48), and
     the wall section (55) comprising at least along a part of its axial extension a permanent magnetic wall part (56).

2. Valve assembly (11) according to claim 1, wherein the permanent magnetic wall part (56) of the valve body (14) extends axially from the upper boundary (52) of the contact section (50) at least to the axial position being equal to the axial position of the stop surface (48).

3. Valve assembly (11) according to claim 1 or 2, wherein the permanent magnetic wall part (56) is designed in a manner that magnetic dipoles in the wall part (56) extend in a direction perpendicular to the longitudinal axis (L).

4. Valve assembly (11) according to one of the preceding claims, wherein the permanent magnetic wall part (56) is ring-shaped.

5. Injection valve (10) with a valve assembly (11) according to one of the preceding claims.

Fig. 1

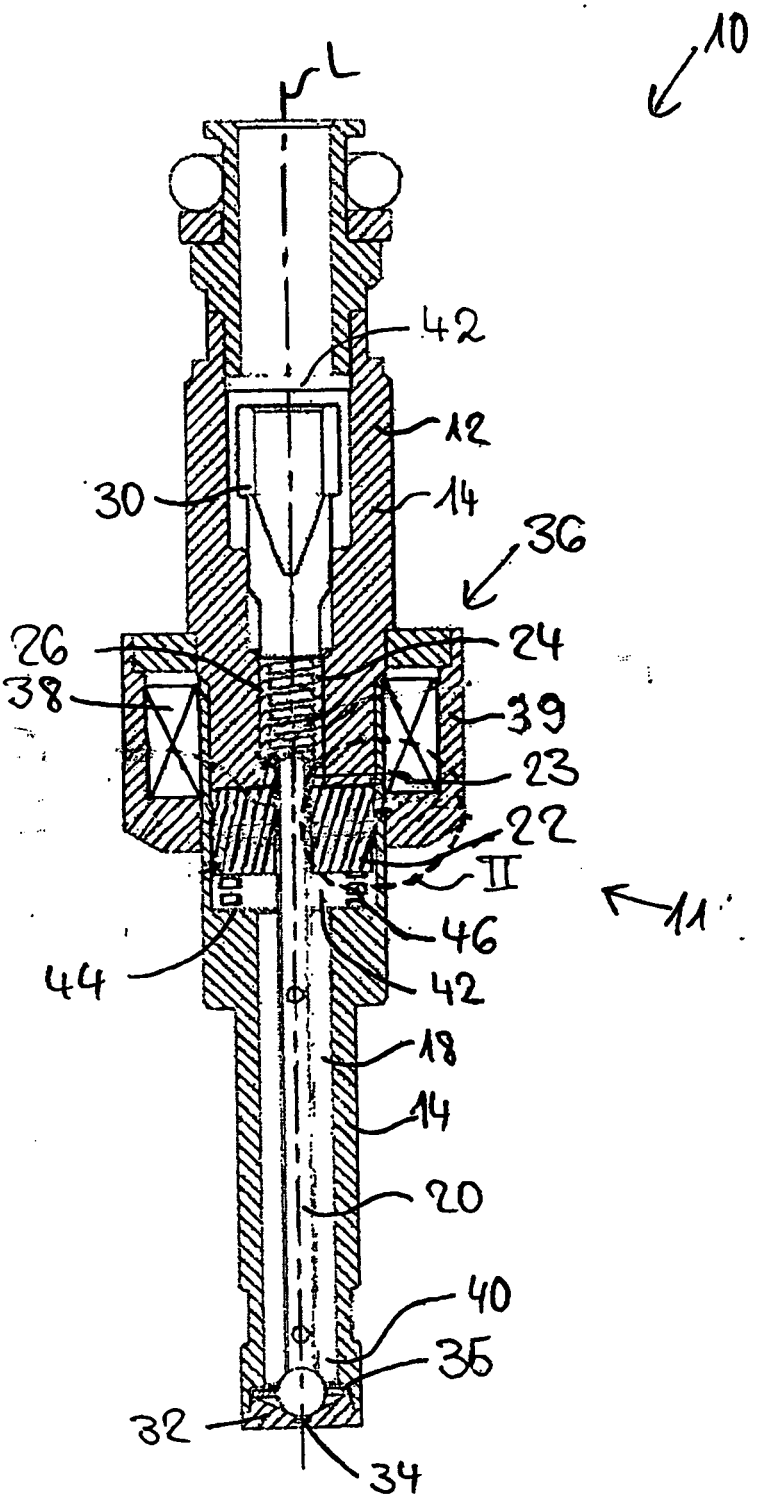

Fig. 2

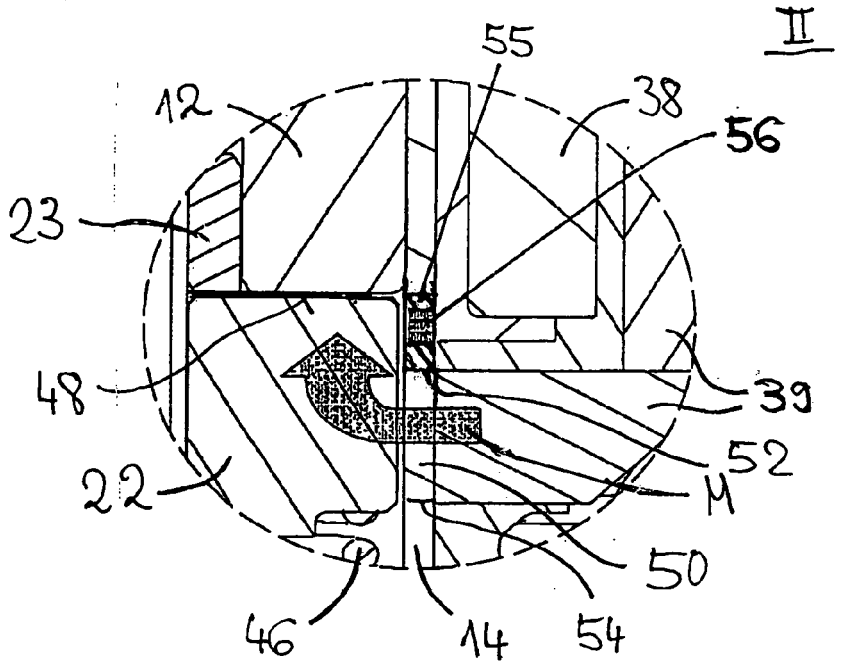
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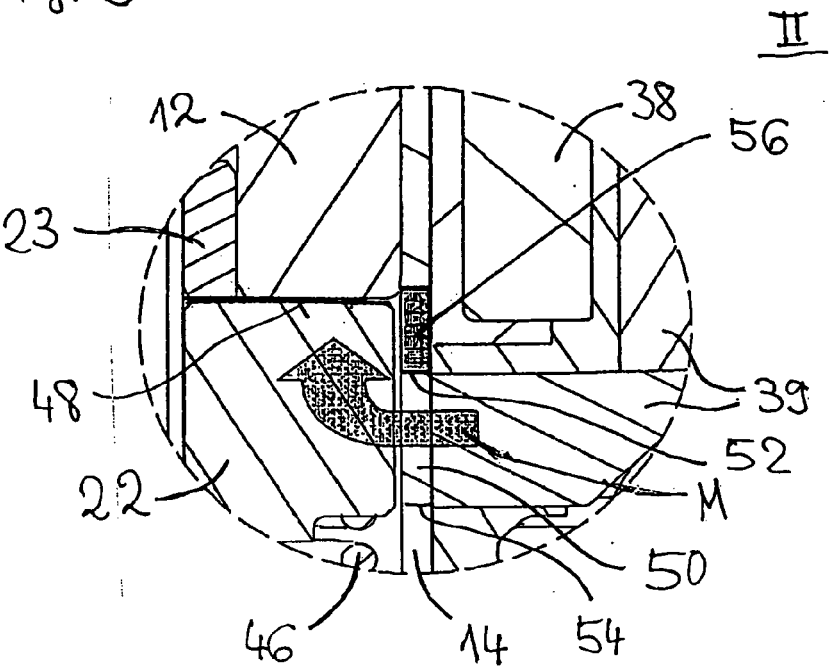
Fig. 3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EUROPEAN SEARCH REPORT

Application Number
EP 10 00 4808

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X	WO 02/12713 A1 (BOSCH GMBH ROBERT [DE]; REITER FERDINAND [DE]) 14 February 2002 (2002-02-14) * page 7, line 16 - page 9, line 25; figures 1,2 * * abstract *	1-5	INV. F02M51/06
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A	US 2003/178510 A1 (KATO YUKINORI [JP] ET AL) 25 September 2003 (2003-09-25) * paragraph [0010] - paragraph [0011]; figures 2a,2b * * abstract *	1-5	
A	US 5 769 391 A (NOLLER KLAUS [DE] ET AL) 23 June 1998 (1998-06-23) * the whole document *	1-5	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	13 August 2010	Hermens, Sjoerd

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