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(54) Electromagnetic injector

(57) Method of manufacturing an electromagnetic injector (1), characterized in that it comprises the following stages:

- inserting a movable element (11) inside a main body (2) and a nozzle (3) provided with a fuel flow distributor (14);
- pushing the nozzle (3) and the movable element (11) along an axis of longitudinal symmetry (C) against a shoulder (7c) inside the main body (2) so as to pre-tension the spring (9);
- checking, by means of suitable devices, whether

the value of the travel of one end of the stem (12) of the movable element (11) complies with the specifications;

- welding the nozzle (3) onto the main body (2) if the preceding check is positive;
- finely calibrating the load on the spring (9) by means of a pusher inserted in the main body (2);
- clamping and locking the calibrating bush (8) inside the main body (2) and finally;
- mounting a coil (15) on the main body (2).

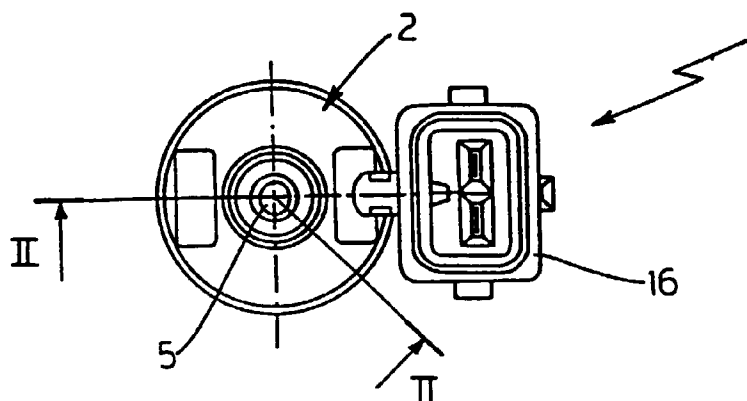


Fig.1

EP 0 905 371 A2

Description

[0001] The present invention relates to an electromagnetic injector.

[0002] As is known, an electromagnetic injector comprises a main body, a sealing seat (nozzle), a passage formed in the main body for channelling the fuel towards the sealing seat (nozzle), a movable element for opening or closing a calibrated hole formed in the sealing seat (nozzle), and a spring which is installed inside the main body and which has the function of opposing the travel of the movable element during opening of the calibrated hole.

[0003] One of the main problems encountered in the injectors described above consists in the complexity of performing the spring calibrating operation during assembly of the injector. A further problem which is encountered in the current injectors consists in the difficulty of calibrating the travel which may be performed by the movable element. These drawbacks also have an effect on the closing efficiency of the nozzle. Moreover, it is practically impossible, during manufacture of the injector, to avoid constructional magnetic dispersion which causes problems with regard to operation of the movable element.

[0004] Among other things, it is very important that injectors to be mounted on the same motor vehicle should have movable elements with the same travel and springs acting on the latter, with the same calibration.

[0005] Taking into account also the fact that the travel in the current electromechanical injectors is equivalent to about 100 μ with tolerances of $\pm 5 \mu$, it can be immediately understood that calibration must be carried out in each case on all the injectors during assembly.

[0006] It is therefore of major importance to devise and provide manufacturing cycles which are reliable as regards the travel of the movable element, calibration of the spring and tolerances in the play.

[0007] Therefore the object of the present invention is to provide a method suitable for the manufacture of electromagnetic injectors which do not possess the aforementioned drawbacks.

[0008] The present invention therefore relates in particular to a method of manufacturing an electromagnetic injector, characterized in that it comprises the following stages:

- (a) arranging a first end of a bush calibrating a resilient element against a shoulder provided inside a main body;
- (b) arranging a first end of the resilient element against a second end of the calibrating bush;
- (c) inserting inside the main body a movable element, the armature of which rests on a second end of the resilient element;
- (d) inserting a stem of the movable element inside the sealing seat provided with a fuel flow distributor;
- (e) pushing the sealing seat and the movable ele-

ment along a longitudinal axis of symmetry so as to pre-tension the resilient element;

(f) checking, by means of suitable electromagnetic devices, whether the value of the travel of one end of the stem complies with the specifications;

(g) welding the sealing seat onto the main body if the check carried out under point (f) is positive;

(h) finely calibrating the load on the resilient element by means of a pusher inserted in the main body so as to obtain the emission of the desired quantity of fuel from an injection hole provided on the sealing seat;

(i) clamping and locking the calibrating bush inside the main body so as to make them rigid with one another;

(l) mounting an electromagnetic coil around the main body; and finally

(m) enclosing the coil inside a casing.

[0009] The present invention also relates to an electromagnetic injector provided in accordance with the above method; this electromagnetic injector comprising:

(a) a ferromagnetic main body, the external surface of which is at least partially surrounded by an electromagnetic coil;

(b) a sealing seat stably joined to the main body;

(c) a resilient element, a bush calibrating the resilient element and a movable element inserted inside the main body and inside the sealing seat.

[0010] This electromagnetic injector according to the invention is characterized by the fact that the main body is provided internally with a shoulder such that the calibrating bush rests with one of its ends thereon so as to be able to perform pre-compression of the resilient element during assembly of the electromagnetic injector.

[0011] The invention will now be described with reference to the accompanying drawings which illustrate a preferred non-limiting example of embodiment in which:

- Figure 1 is a plan view of an electromagnetic injector provided in accordance with the principles of the present invention;
- Figure 2 is a view along the line II-II of Figure 1;
- Figure 3 is a view, in longitudinal cross-section and on a larger scale, of an end portion of the electromagnetic injector shown in Figures 1 and 2;
- Figure 4 is a view, in longitudinal cross-section, of a component of the portion shown in Figure 3; and
- Figure 5 is a plan view of the component according to Figure 4.

[0012] In Figures 1 and 2, 1 denotes in its entirety an electromagnetic injector 1 comprising a substantially cylindrical main body 2 and a sealing seat 3 (injection nozzle) combined with this main body 2, which is also substantially cylindrical. The main body 2 comprises, in

turn, two parts 2a and 2b formed as one piece or, more precisely, made rigid with one another by means of a subsequent laser welding operation. The two parts 2a and 2b are both ferromagnetic. The main body 2 also comprises an entry portion 4 by means of which the fuel is supplied to the sealing seat 3 and hence to the engine (not shown). Immediately after the entry opening 5 there is a filter 6 designed to filter the fuel which flows along the channel 7a. Inside a channel 7b, which is arranged as a continuation of the channel 7a, there is housed a spring calibrating bush 8 which rests against a shoulder 7c which forms a portion joining together the two channels 7a and 7b.

[0013] This spring calibrating bush 8, in a way which will be explained more clearly below, plays an important role during the method of manufacturing the electromagnetic injector 1. This bush 8 has, bearing against it, one end of a helical spring 9, while the other end biases the armature 10, made of ferromagnetic material, of a movable element 11, the obturator stem 12 of which is designed to open and close an injection hole 13 provided on the bottom of the sealing seat 3.

[0014] As shown more clearly in Figure 3, the sealing seat 3 also has, housed inside it, a flow distributor 14 which is preferably inserted by means of forced engagement and is provided with a plurality of longitudinal side passages 14a (Figure 4) and a series of inclined transverse passages 14b so as to impart to the fluid streams of fuel a swirling movement such as to improve atomisation thereof.

[0015] The electromagnetic injector 1 is completed by a coil 15, housed inside a casing 18, arranged outside the main body 2 and supplied by the electric control unit 16 via the cable 17. This coil 15, which is suitably supplied with electric pulses having a duration of the order of 3 ms, subjects the armature 10 of the movable element 11 to a magnetic action which produces raising of the obturator stem 12 with consequent opening of the injection hole 13.

[0016] Basically, the fuel, introduced into the electromagnetic injector 1 through the entry opening 5, first of all travels along the channel 7a and then enters a channel 8a provided in the locked bush 8, in a manner which will be described more clearly below with reference to the manufacturing method, inside the channel 7b. After passing inside the turns of the helical spring 9, the fuel flows towards the through-openings 10a (only one is visible in Figure 1) formed on the armature 10 so as to then flow towards a channel 3a which is situated inside the nozzle 3. As mentioned, the travel path followed by the fuel terminates when the latter passes through the longitudinal side passages 14a, the series of inclined transverse passages 14b and the injection hole 13.

[0017] Calibration of the pre-tensioning force with which the helical spring 9 biases the movable element 11 is of primary importance. In fact, it determines the quantity of fuel which emerges from the injection hole 13. Moreover it is very important that the electromag-

netic injectors 1 which will be mounted on the same engine should have, as far as possible, the same characteristics, so as to ensure uniform operation of the various cylinders.

[0018] Although the main body 2 may be formed as one piece in order to avoid costly machining operations, it is also possible to manufacture it, as already mentioned before, in the form of two parts 2a and 2b made of ferromagnetic material which are welded together by means of a laser weld. A particular feature of the present invention consists in forming the part 2b such that it is provided with a projecting portion 2c also obviously made of ferromagnetic material. It has been experimentally proven by the Applicant that the projecting ferromagnetic portion 2c, in view of its small transverse dimensions, becomes saturated very easily from a magnetic point of view, behaving from a given moment onwards as though it were made of non-magnetic material. For this reason, even though the projecting portion 2c is made of ferromagnetic material, there is no risk of dangerous short-circuits of the magnetic flux adversely affecting the raising action on the armature 10. It is obvious that the existence of the projecting portion 2c formed as one piece with the remainder of the part 2b simplifies considerably the assembly of the various constructional elements and moreover lowers considerably the production costs of the part 2b.

[0019] Another innovation contained in the present invention consists in the forced assembly of the distributor 14 inside the sealing seat 3.

[0020] The method of manufacturing the electromagnetic injector 1, which is performed by means of machines not shown in the accompanying figures, has some interesting special features.

[0021] In fact it consists of the following stages:

- (a) arranging a first end of a bush 8 calibrating a spring 9 against a shoulder 7c provided inside a main body 2;
- (b) arranging a first end of the spring 9 against the other end of the calibrating bush 8;
- (c) inserting inside the main body 2 a movable element 11, the armature 10 of which rests on a second end of the spring 9;
- (d) inserting the stem 12 of the movable element 11 inside a sealing seat 3 (nozzle) provided with a fuel flow distributor 14;
- (e) pushing the sealing seat 3 and the movable element along a longitudinal axis of symmetry C so as to pre-tension the spring 9;
- (f) checking, by means of a testing coil (not shown in the figures) which causes raising of the entire movable element 11 and a measuring transducer (not shown) positioned, for example, in the region of the injection hole 13, whether the value of the travel of one end of the stem 12 complies with the specifications;
- (g) welding the sealing seat 3 to the main body 2 if

the check carried out under point (f) is positive;
 (h) finely calibrating the load on the spring (9) by means of a pusher inserted in the channel 7a of the main body 2 so as to obtain the emission of the desired quantity of fuel from the injection hole 13;
 (i) clamping and locking the calibrating bush 8 inside the main body 2 by means of cold plastic deformation of the latter, so as to make them rigid with one another;
 (l) mounting an electromagnetic coil 15 around the main body 2 such it rests on the part 2b of the main body 2; and finally
 (m) enclosing the coil 15 inside a casing 18.

[0022] As mentioned, the measuring transducer may be situated in the vicinity of the injection hole 13 and hence a free end of the stem 12 designed to close this injection hole 13.

[0023] In a further embodiment, measuring of the travel of the obturator stem 12 may instead be performed with a transducer inserted in the channels 7a, 8a and positioned in the vicinity of the end of the stem 12 rigid with the armature 10.

[0024] Finally it is obvious that the manufacturing method and the injector described and illustrated here may be subject to modifications and variations without thereby departing from the protective scope of the present invention.

Claims

1. Method of manufacturing an electromagnetic injector (1), characterized in that it comprises the following stages:
 - (a) arranging a first end of a bush (8) calibrating a resilient element (9) against a shoulder (7c) provided inside a main body (2);
 - (b) arranging a first end of said resilient element (9) against a second end of said calibrating bush (8);
 - (c) inserting inside said main body (2) a movable element (11), the armature (10) of which rests on a second end of said resilient element (9);
 - (d) inserting a stem (12) of said movable element (11) inside a sealing seat (3) provided with a fuel flow distributor (14);
 - (e) pushing said sealing seat (3) and said movable element (11) along a longitudinal axis of symmetry (C) so as to pre-tension said resilient element (9);
 - (f) checking, by means of suitable devices, whether the value of the travel of one end of said stem (12) complies with the specifications;
 - (g) welding said sealing seat (3) to said main body (2) if the check carried out under point (f) is positive;

(h) finely calibrating the load on the resilient element (9) by means of a pusher inserted in said main body (2) so as to obtain the emission of the desired quantity of fuel from an injection hole (13) provided on said sealing seat (3);
 (i) clamping and locking said calibrating bush (8) inside said main body (2) so as to make them rigid with one another;
 (l) mounting an electromagnetic coil (15) around said main body (2); and finally
 (m) enclosing said coil (15) inside a casing (18).

2. Method as claimed in Claim 1, in which the weld joining said sealing seat (3) to said main body (2) consists of a laser weld.
3. Method as claimed in at least one of the preceding claims, in which the value of the travel of one end of said stem (12) is obtained by means of a measuring transducer.
4. Method as claimed in Claim 3, in which said measuring transducer is positioned in the vicinity of said injection hole (13).
5. Method as claimed in Claim 3, in which said measuring transducer is positioned in the vicinity of the end of said stem (12) rigid with said armature (10).
6. Method as claimed in at least one of the preceding claims, in which said distributor (14) is coupled with said sealing seat (3) by means of forced engagement.
7. Electromagnetic injector (1), characterized in that it is obtained by means of a manufacturing method as claimed in Claims 1 to 6.
8. Electromagnetic injector (1) comprising:
 - (a) a ferromagnetic main body (2), the external surface of which is at least partially surrounded by an electromagnetic coil (15) enclosed in a casing (18);
 - (b) a sealing seat (3) stably joined to said main body (2);
 - (c) a resilient element (9), a bush (8) calibrating said resilient element (9) and a movable element (11) inserted inside said main body (2) and inside said sealing seat (3);

said electromagnetic injector (1) being characterized in that:

said main body (2) is provided internally with a shoulder (7c) such that said calibrating bush (8) rests with one of its ends on said shoulder (7c) so as to be able to per-

form pre-compression of said resilient element (9) during the assembly stage.

9. Electromagnetic injector (1) as claimed in Claim 8, in which said main body (2) comprises at least two parts (2a, 2b) welded to one another, and in which said main body (2) is made of ferromagnetic material. 5
10. Electromagnetic injector (1) as claimed in Claim 9, in which a first part (2b) of said main body (2) has a projecting portion (2c) welded to a second part (2a) of said main body (2). 10
11. Electromagnetic injector (1) as claimed in at least one of Claims 7 to 10, in which the weld joining said sealing seat (3) to said main body (2) consists of a laser weld, while fixing of said bush (8) calibrating said main body (2) is obtained by means of cold plastic deformation of said main body (2). 15 20

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Fig.2

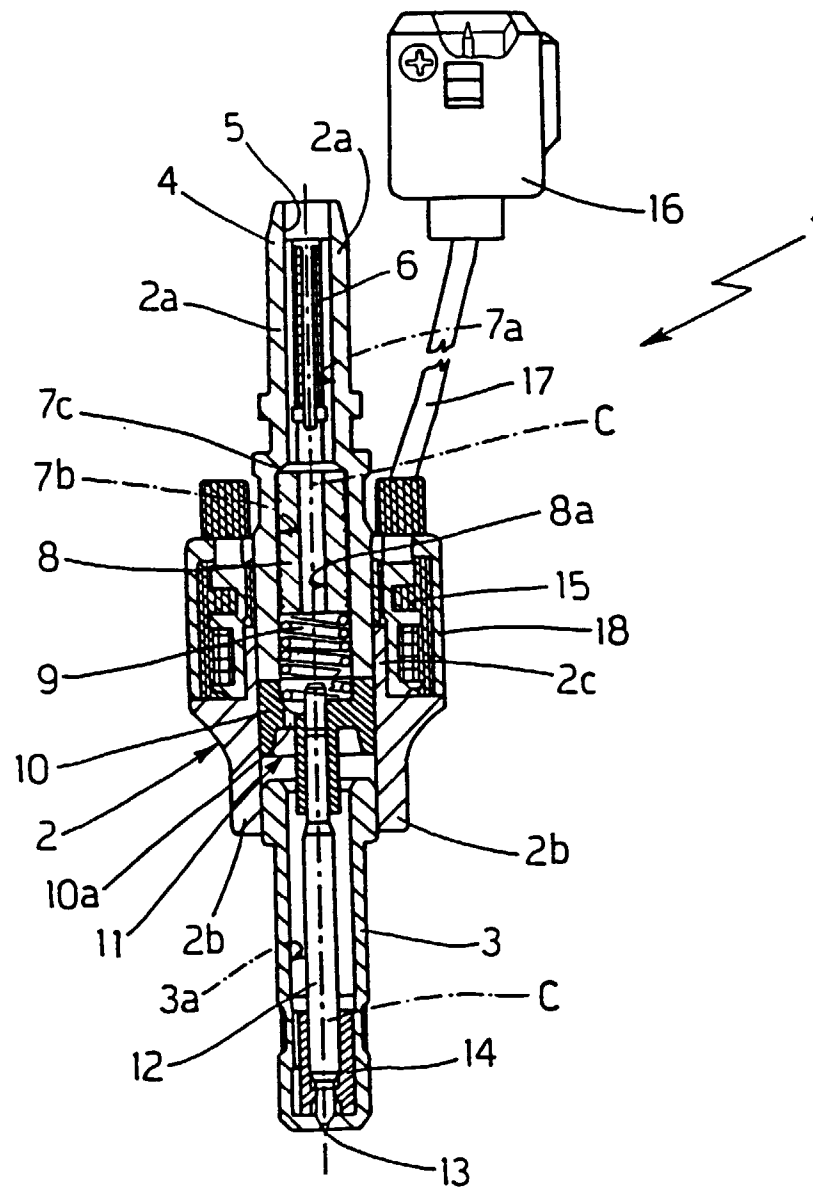


Fig.1

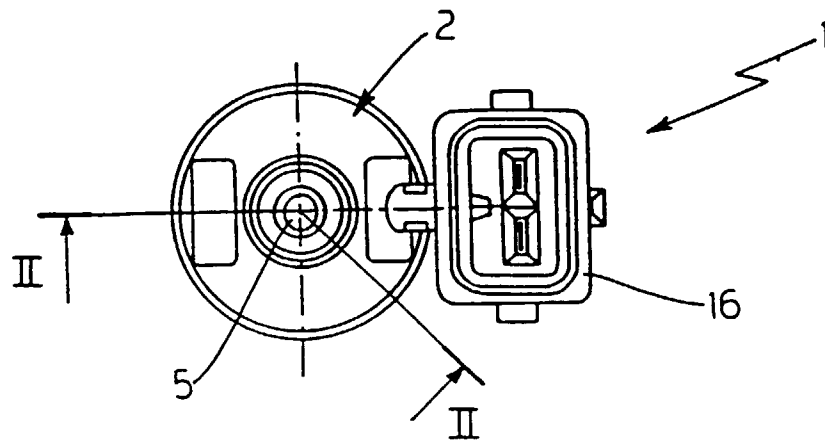


Fig.3

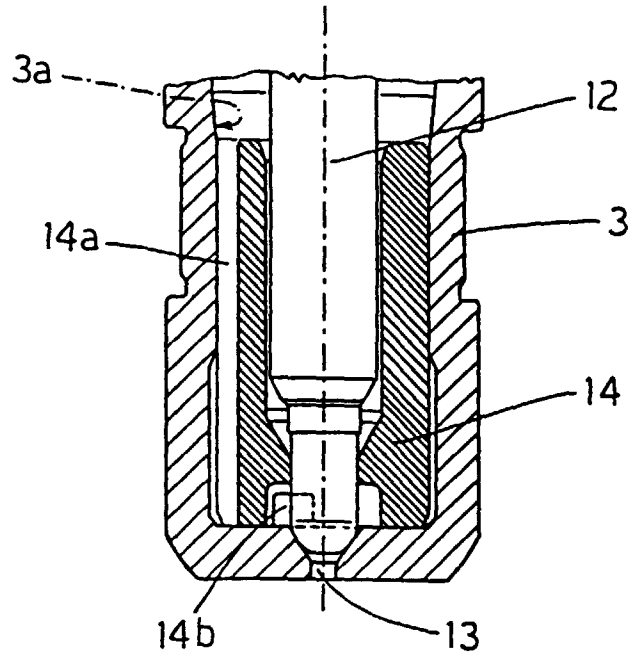


Fig.4

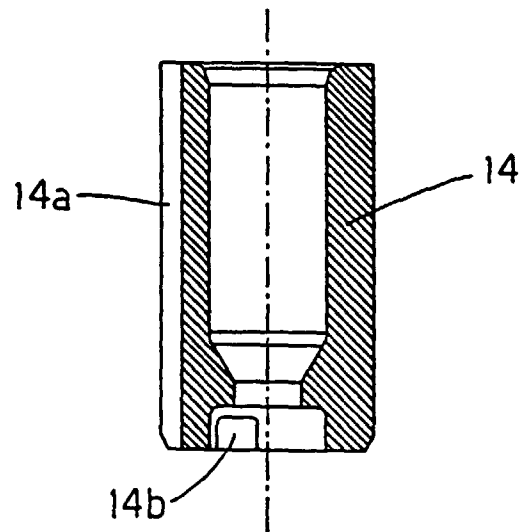


Fig.5

