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(54) Electroinjector for fuel feeding to an internal combustion engine, and process for accomplishing it.

(57) In an electroinjector of the type comprising a ferromagnetic core (10) surrounded by an actuator coil (13) and an armature (12) bearing an element (17) for the closure of the injection nozzle (21), as well as an annular shoulder element (24) solid with the core (10) and against which the armature (12) comes to rest in its position of opening of the fuel passage through the injection nozzle (21), the annular element (24) is assembled in position by means of an impulsive action involving a plastic deformation of a portion of the core (10) or of a separated element interposed between the annular element (24) and the core (10). In this way, the core and the annular element can be manufactured by medium-precision machining steps and the end precision of the dimension of the axial clearance between the annular element and the core is established in the assembly step, allowing precise dimensions to be maintained for all the various mass-produced injectors, with limited costs.

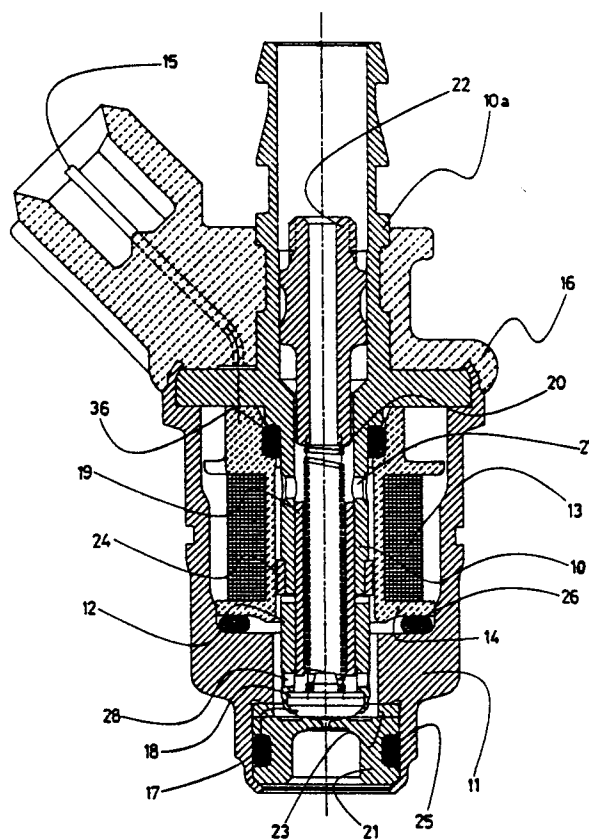


FIG. 1

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"ELECTROINJECTOR FOR FUEL FEEDING TO AN INTERNAL COMBUSTION ENGINE, AND PROCESS FOR ACCOMPLISHING IT"

The present invention relates to an electroinjector for the feed of fuel to an internal combustion engine, and to a process for the manufacturing thereof.

More particularly, the invention relates to an electroinjector of the type comprising an encasing body, inside which a centre core is positioned of ferromagnetic material, at least partly surrounded by an actuator coil; a movable armature of ferromagnetic material, of substantially hollow cylindrical shape, and bearing at one of its ends a closure element suitable to interrupt, in one position of said armature, the passage of fuel through an injection nozzle under the action of a return spring; and an annular shoulder element impact-resistant and at least partly amagnetic, solid with the core and suitable to act as stop shoulder for an opposite end of said armature in another position of said armature in which the closure element leaves open the fuel passage through the injection nozzle, the armature being guided by a small tube inserted in the centre core and protruding therefrom.

Such an electroinjector is known from the European Patent Application Publication Nr. 0172591 to the same Applicant.

The annular shoulder element, coaxially driven on the outer wall or on the inner wall of the centre core and fastened by diametral interference, protrudes axially from the core end, so that in the position of end lift of the armature, when this latter rests against the annular element, a small clearance remains between the armature and the core. This clearance, together with the nature of the material of the annular element, avoids the occurrence of phenomena of magnetic sticking between the armature and the core, phenomena which on the contrary occur in case of direct contact, due to the progressive leveling of the contact surfaces, and hence of the increase of actual contact area, which over time generates considerable adhesion forces.

The same annular element, thanks to its reduced wall thickness, minimises the possibility of hydraulic sticking in the step of resting against the shoulder.

In an electroinjector of this kind, there are hence particularly fast and constant armature closure and opening transients.

It is however important, to the purpose of a precise electromagnetic arrangement of the electroinjector, and to keep constant the functional characteristics found on the various electroinjectors from a mass-production, that the dimension of the said clearance be kept as constant as possible

within very narrow tolerance limits, also considering the value of off-plane of the front surface of the shoulder annular element relatively to the front surface of the end of centre core.

5 If one desires to keep the tolerance limits within the maximum value of, e.g., 10 μm , imposing is necessary, for the concerned dimensions of the two components and for the off-normality of the surfaces, tolerance limits lower than 2 μm for each dimension which involves a hardly bearable increase in electroinjector production costs.

10 On the other hand, also an assembly by dimensional sorting of the components, as provided, e.g., by the U.S. patent 4,423,841, does not solve the problem, in that it does not eliminate the need for small tolerances in errors of normality and parallelism between the surfaces concerned by the determination of the dimensional value of the clearance, and is hence burdensome for a mass-production.

20 The purpose of the present invention is now to provide an electroinjector of the type mentioned in the introduction, which can be obtained in a mass-production at competitive costs, while guaranteeing the observance of particularly precise dimensions, but without requiring the observance of severe tolerances for the dimensions of the individual components, but allowing on the contrary medium-precision processes to be adopted for components machining.

30 Within the scope of the invention, also providing a particular electroinjector manufacturing process offering advantages in precision with limited production costs is desired.

35 According to the invention, the above mentioned purpose is achieved in that in an electroinjector of the type mentioned in the introduction, the annular shoulder element fastened by driving on the centre core is affixed in position with deformation or plastic yielding, in an essentially axial direction, of a portion of the centre core or of a component interposed between the annular element and the centre core.

40 Advantageously, said deformation or plastic yielding is accomplished in the step of assembly of the annular element on the centre core, by means of an action of impulsive driving of the annular element previously pressure-slided on the core.

50 The core portion which undergoes the plastic deformation can be a substantially conical portion radiusing the diametrically narrower core portion receiving the annular element, to the subsequent diametrically larger portion provided on fuel feed side.

With such a deformation, the component elements (the core and the annular element) manufactured with medium-precision processes, which would allow a dimensional variability of the clearance of, e.g., 150 μm , are made assume, in the assembly step, mutual positions securing the observance of the dimensions required for the correct operating of the electroinjector.

For the driving of the annular element in its end position a tool is proposed, to exemplifying purposes, of the pendulum type, with a prefixed hammering mass, as it shall be better seen hereinafter.

It has been found indeed that the end positioning of the annular element on the centre core by restriking of the components under a driving impulsive action guarantees the dimensional constancy and the circumferential uniformity of the clearance by causing different local yieldings of the centre body, of material essentially less hard than of the annular element, up to compensate for the widest dimension and shape tolerances applied to the cycle of production of the two components.

The low ratio existing between the fitting length and the diameter of the annular element secures, in the driving step, also the parallelism and the normality of the two elements being assembled.

The portion between the annular element and the core which undergoes the plastic deformation can also be a separate element of high-plasticity material, interposed between the annular element and the core, such as, e.g., advantageously, a copper washer, interposed between the annular element and a flat stop shoulder provided on the core, perpendicular to core axis. The deformation is undergone to exclusively by the washer.

Further details of the invention shall appear more evident from the following disclosure of preferred and not limitative forms of embodiment of an electroinjector according to the invention, illustrated in the attached drawings, wherein:

Fig. 1 is an axial sectional view of an electroinjector accomplished according to the invention;

Fig. 2 is a partial sectional view of the body defining the centre core in a first form of embodiment;

Figs. 3 and 4 are partial sectional view on enlarged scale in correspondence of the area of assembly of the annular element on the core of figs. 1 and 2, respectively before and after the end driving;

Figs. 5 and 6 are partial sectional views on enlarged scale, always in correspondence of the point of assembly of the annular element on the core, in a second form of embodiment, respectively before and after the end driving;

Fig. 7 is a partially sectional view of an exemplifying tool for the assembly of the annular element on the core according to the invention;

Fig. 8 is a detail, on enlarged scale, of fig. 7 in the step immediately prior to the driving.

Referring first to Fig. 1, an electroinjector of the type being the object of the present invention comprises a cylindrical centre core 10 of ferromagnetic material, housed inside an encasing body 11, it too of ferromagnetic material, and extending to the outside of the body 11 to form a fitting 10a to connect the injector to the fuel feed.

To the core 10 a movable armature 12 of ferromagnetic material is coaxially associated, which, together with the core 10 and the body 11, forms a magnetic circuit.

The core 10 is at least partly surrounded by a coil 13, wound around a bobbin 14, which is electrically fed, in a per se known way, with intermittent drive, by means of conductors 15 partly embedded in a cap of plastics 16.

The movable armature 12, of substantially hollow cylindrical shape, bears a closure element 17 with the interposition of a washer 18, and is guided by a tube 19 inserted in the core 10, but protruding out of it. A spring 20 keeps the closure element 17 normally pressed against the shoulder of an injection nozzle 21, provided, in a per se known way, with a calibrated bore for the outlet of the fuel. The spring 20 reacts against a sleeve 22 inserted with interference inside the core 10 and centrally open to allow the flow of the fuel.

Between the nozzle 21 and the body 11 an annular spacer 23 is placed, substantially defining the stroke of the armature 12, which on its side facing towards the core 10 comes to stop against an annular shoulder element 24, of impact-resistance material, and at least partly amagnetic, mounted on the core 10 so as to axially protrude from the end of core 10, leaving a small clearance T, fig. 2, between the armature 12 and the core 10 in the armature lift end position, in correspondence of which the closure element 17 leaves open the passage through the nozzle 21. The annular shoulder element 24 guarantees that phenomena of magnetic and/or hydraulic sticking, detrimental to the purpose of a quick closure of the injector may not occur.

The hydraulic tightness is secured by seal rings 25, 26 and 36. The fuel, fed through the sleeve 22, arrives, in a per se known way, to the bores 27 of the core 10 and then to the bores 28 of the armature 12, from which the fuel flows to the outside of the nozzle 21.

It shall be understood that when the coil 13 is deenergized, the armature 12 is in its lowermost position wherein the closure element 17 interrupts the fuel flow through the nozzle 21, whilst, when

the coil 13 is energized, the armature 12 is in its uppermost position resting against the annular shoulder element 24 and the closure element 17 leaves open the fuel passage through the injection nozzle 21.

To secure the highest precision in the positioning of the annular element 24 and the maintainment of a clearance T of desired dimension for all the injectors of a mass-production, without the need for respecting too restricted tolerances in the machining of the core 10 and of the annular element 24, and hence without having excessive, unbearable costs, accomplishing the dimensional precision is proposed, according to the invention, when assembling the two components, rather than in the machining step.

The annular element 24, manufactured with medium precision, is driven on the core 10, it too manufactured with medium precision, by diametrical interference up to a certain axial position, and is then fixed in position by plastic deformation of a portion of the core 10 in an essentially axial direction, or by plastic deformation of an element interposed in axial direction between the annular element 24 and the core 10.

To that purpose, according to a first form of practical embodiment illustrated in figs. from 2 to 4, the core 10 is provided, in correspondence of its end portion on which the annular element 24 is to be driven, with an annular groove 29 between a shorter-diameter portion 30 and a longer-diameter portion 31, this latter being radiused to the main cylindrical portion of the core 10. The conical radiused section between the groove 29 and the portion 31 represents in this form of embodiment the portion which on the end assemblage of the annular element 24 undergoes the plastic deformation, as it can be observed by comparing figs 3 and 4.

The affixing in the end position is carried out by means of an impulsive action on the annular element 24 with the interposition of a pusher 32, the stem of which is driven inside the core 10, and the head of which rests against the front end of the annular element 24.

As it can be observed from figs. 3 and 5, the head of the pusher 32 is advantageously provided, on its face facing the stem, with a step 44 of height H and of diameter slightly shorter than the inner diameter of the annular element 24, which step 44, by coming to rest against the front surface of the core 10, determines the end of the axial stroke of pusher 32 and, consequently, the value of the end protrusion, or clearance T of fig. 2, of the annular element 24 from the front surface of said core.

Due to the elastic recovery of the core 10 and of the annular element 24, the dimension H of the step 44 is slightly different from the dimension T of desired clearance. Even in the complete absence of the step 44, a clearance T shall hence be formed, even if of the order of a few hundredths of millimeter only.

A tool which can be advantageously used to exert the impulsive action is illustrated in figs. 7 and 8. It comprises a stationary support 33, on the upper part of which a mass 35 is hinged, in the nearby of 34, through a supporting rod 37. To the lower portion of the support 33, the core 10 is fixed in a correspondingly shaped seat 38, in such a way that the front end of the core 10, on which the annular element 24 has to be mounted, protrudes from the side facing towards the mass 35 on the trajectory of the same mass 35. The core 10 is fixed by means of a ring nut 39 screwed down in a sleeve 40 fastened on the support 33.

To the mass 35 a pin 41 is centrally fastened, suitable to act on the pusher 32 inserted in the core 10. The arrangement is such that the axis of the core 10 and of the annular element 24 coincides with the tangent to the trajectory of the centre of the pin 41 in the lowermost point of the same trajectory.

It shall be understood that by letting the mass 35, suitably dimensioned as a function of the dimensions and of the nature of the elements to be fastened to each other, fall down from a pre-established height, on the pusher 32 and hence on the annular element 24, an impulsive action is exerted, which causes the end driving of the annular element 24 on the core 10 with the above said plastic deformation in the section adjacent to the groove 29.

To exemplifying purposes, the annular element 24 can be driven on the core 10 by means of static pre-driving by press with a force of 90 -100 kg, and the dynamic end driving can be obtained with a work of 0.07 kgm.

According to another form of embodiment, illustrated in figs. 5 and 6, the plastic deformation is envisaged to occur on a washer 42, e.g., a copper washer, axially interposed between the annular element 24 and a flat stop shoulder 43 provided on the core 10, extending crosswise relatively to the axis of core 10. The end driving can be carried out in this case in a way analog to that described for the foregoing form of embodiment.

It has been found that an impulsive action as described guarantees not only a constancy of end dimension and a circumferential evenness of the clearance due to different local yieldings of core

10, but also a compensation for the greater tolerances of dimensions and shape adopted in the machining of the core 10 and of the annular element 24.

Of course, within the scope of the invention, numerous changes and variants are possible. So, e.g., the end-driving impulsive action could be achieved by means of a mass made fall down on the annular element 24 kept with its axis in vertical position.

Claims

1. Electroinjector for fuel feeding to an internal combustion engine, comprising an encasing body, inside which a centre core is positioned of ferromagnetic material, at least partly surrounded by an actuator coil; a movable armature of ferromagnetic material, of substantially hollow cylindrical shape, and bearing at one of its ends a closure element suitable to interrupt, in one position of said armature, the passage of fuel through an injection nozzle, under the action of a return spring; and an annular shoulder element impact-resistant and at least partly amagnetic, solid with the core and suitable to act as stop shoulder for an opposite end of said armature in another position of said armature in which the closure element leaves open the fuel passage through the injection nozzle, the armature being guided by a small tube inserted in the centre core, characterized in that the annular shoulder element driven on the centre core is affixed in position with deformation or plastic yielding, in an essentially axial direction, of a portion of the centre core or of a component interposed between the annular element and the centre core.

2. Electroinjector according to claim 1, characterized in that it is provided with a plastically deformed radius zone between a lower-diameter portion on which the annular shoulder element is driven and a greater-diameter portion of the centre core.

3. Electroinjector according to claim 1, characterized in that it is provided with a plastically deformed washer, preferably of copper, interposed between the annular shoulder element and a flat stop shoulder extending crosswise to the axis of the centre core.

4. Process for the accomplishment of an electroinjector according to one of foregoing claims, characterized in that on a centre core of ferromagnetic material an annular shoulder element is driven with interference, of impact-resistant material, and at least partly amagnetic, for a movable armature controlling the opening and the closure of the passage of fuel through the electroinjector, characterized in that the annular shoulder element is fixed in position by means of an impulsive action on the front end of said annular element involving a plastic deformation of a portion of the centre core or of an element interposed in axial direction between the annular element and the centre core.

5. Process according to claim 4, characterized in that the impulsive action on the annular shoulder element is carried out by the interposition of a pusher having its head resting against the front end of the annular element, and its stem inserted in the centre core.

6. Process according to claim 4 or 5, characterized in that the impulsive action on the shoulder element is carried out by making a prefixed mass fall down from a prefixed height against said annular element pre-driven on the centre core.

7. Process according to claim 5, wherein said pusher is provided, on the face of its head facing towards the stem, with a step of dimension substantially corresponding to the desired clearance between the core and the annular element, characterized in that an impulsive action is effected such as to bring said step to rest against the front surface of the core.

8. Tool for the implementing of the process according to one of the claims from 4 to 7, characterized in that it comprises a mass movable relatively to a stationary support, and suitable to fall down from a prefixed position against said annular element pre-mounted on the core; and a pusher having a head resting against said annular element, and a stem inserted inside the core.

9. Tool according to claim 8, characterized in that the face of the head of said pusher facing towards the stem is provided with a step of height substantially equal to the dimension of the desired clearance between the core and the annular element, and of diameter slightly lower than the inner diameter of the annular element.

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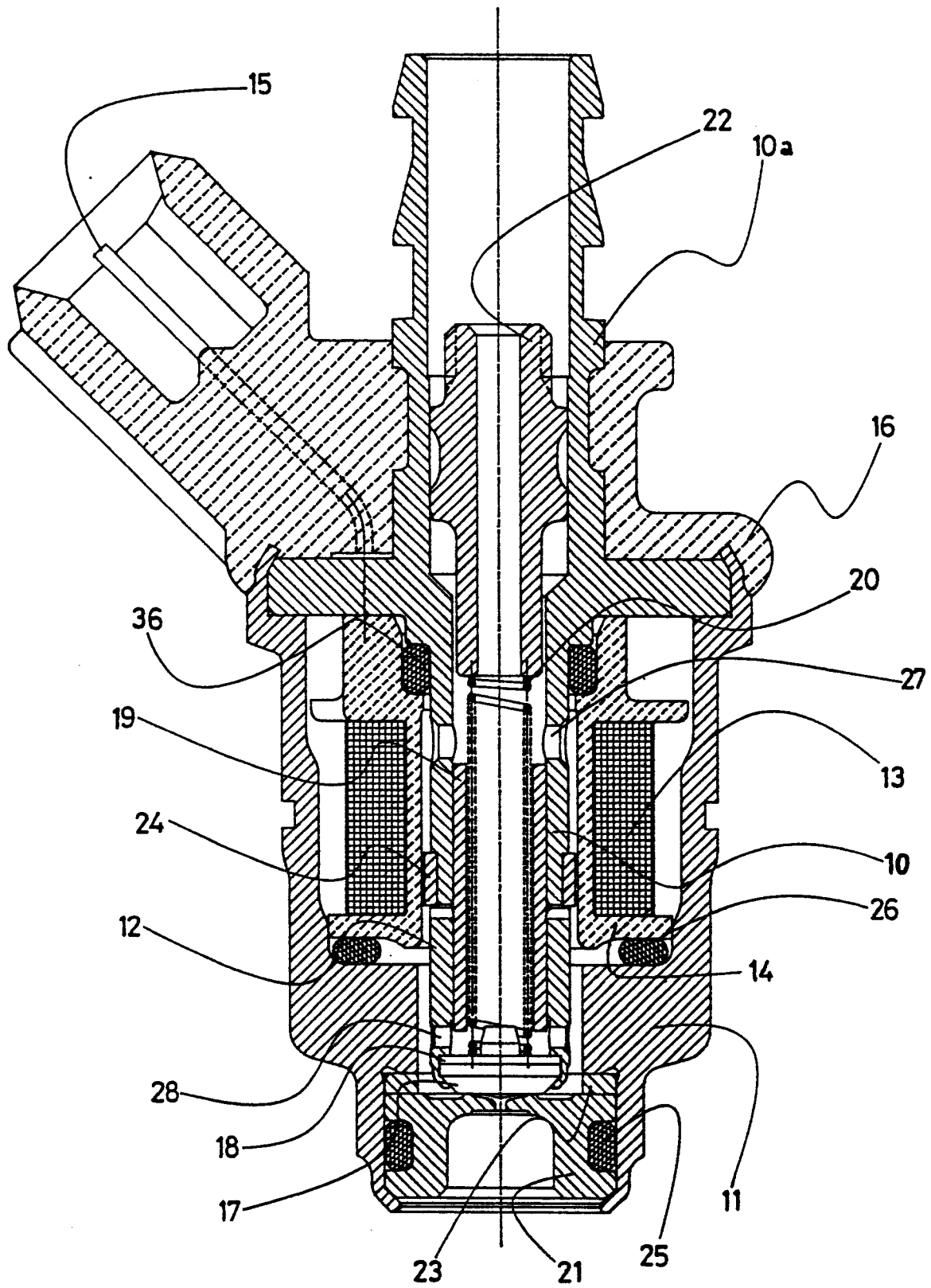


FIG. 1

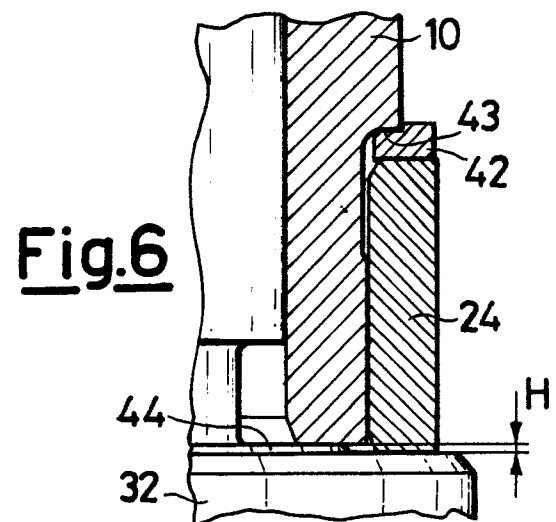
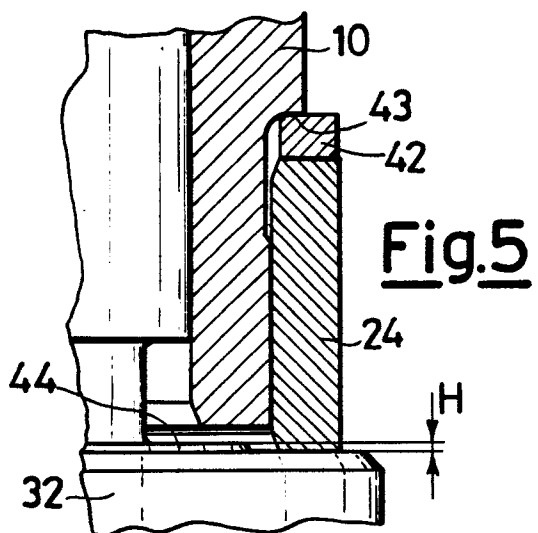
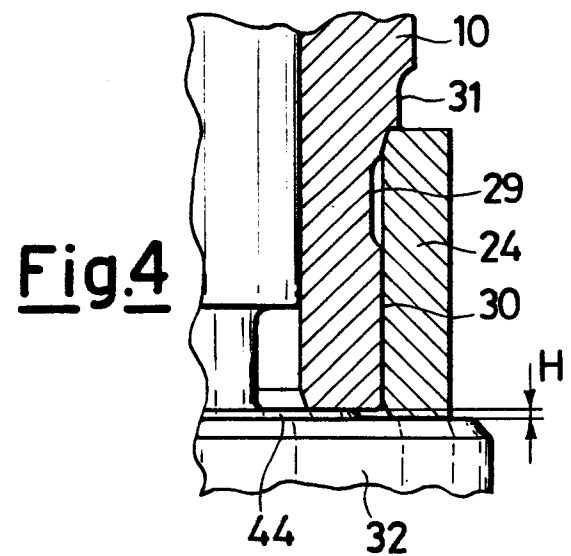
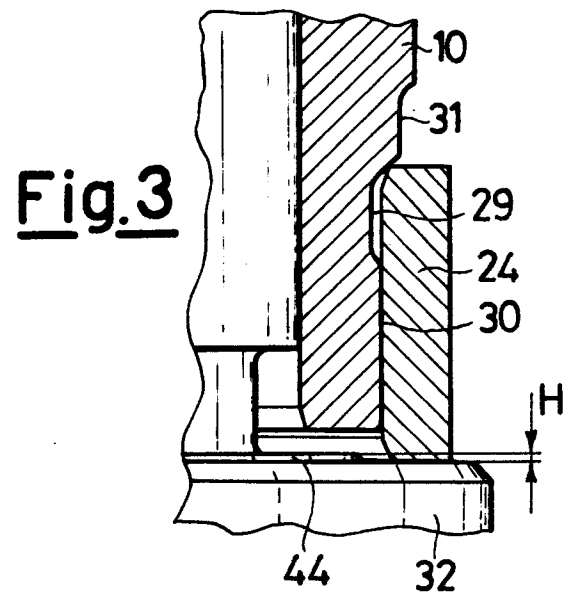
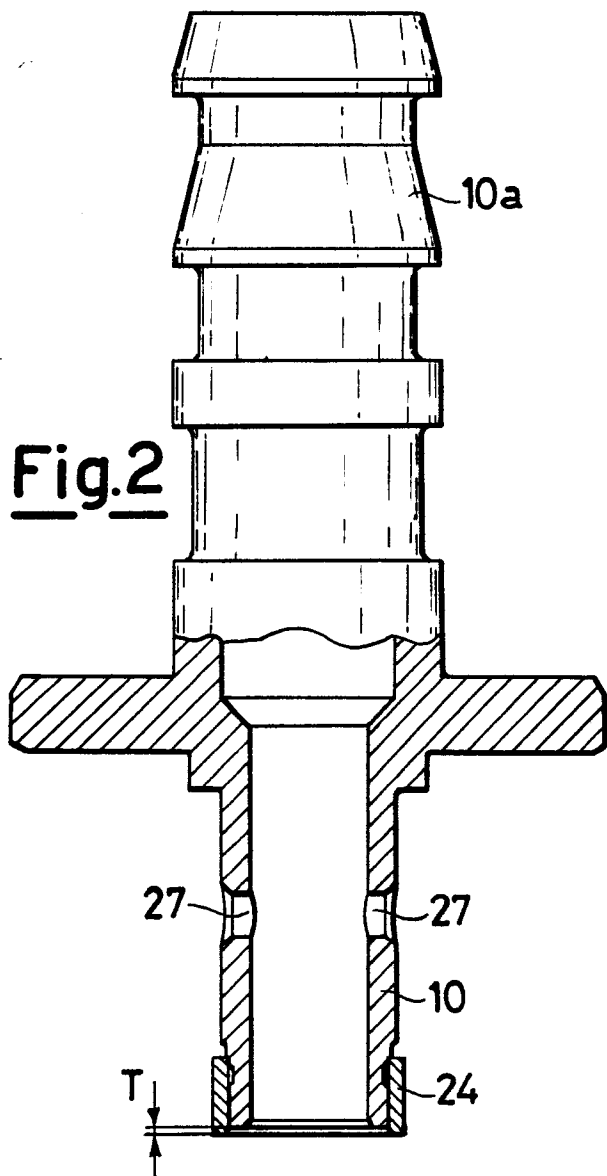
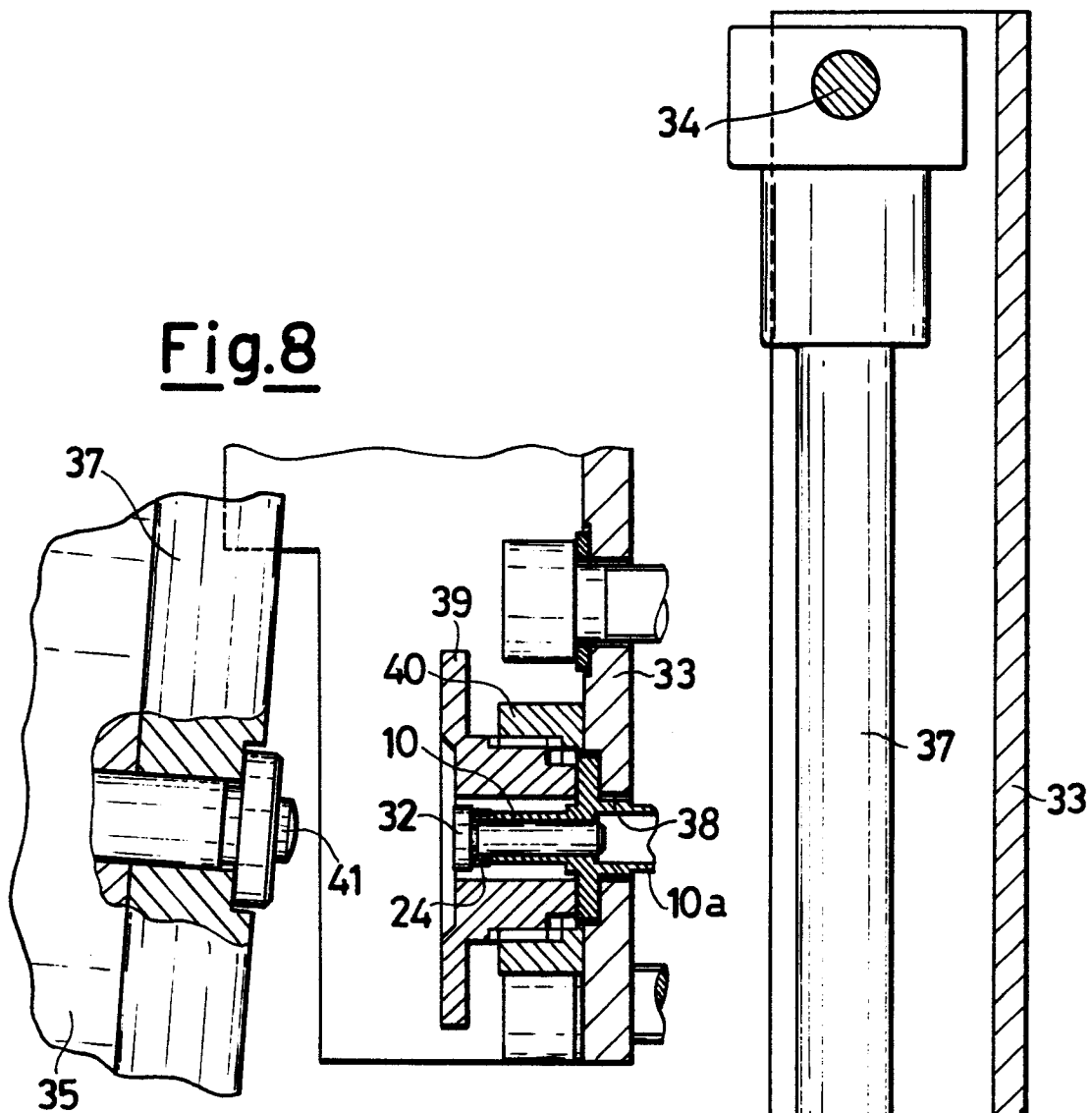
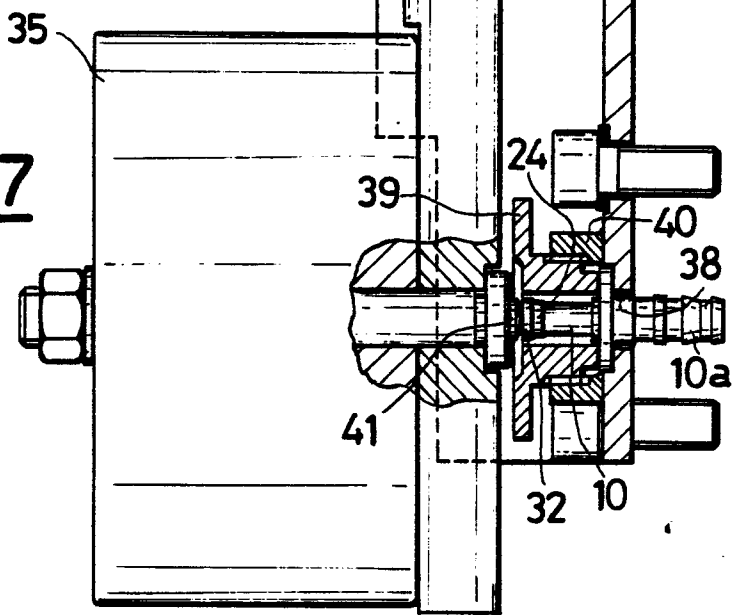


Fig.8Fig.7



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X,P	EP-A-0 172 591 (SPICA S.p.A.) * Page 3, line 23 - page 5, line 24; figure 1 *	1	F 02 M 51/06
A	DE-A-2 123 145 (VYZKUMNY USTAV AUTOMATIZACZNICH PROSTRZEDKU) * Page 10, lines 6-10; page 11, lines 11-17; figure 4 *	1	
A	FR-A-2 532 005 (ALFA ROMEO AUTO S.p.A.) * Page 3, line 23 - page 5, line 8; figure 1 *	1	
A	FR-A-2 241 008 (LES TECHNIQUES DE HAUTE PRECISION) * Page 7, last paragraph; page 8, lines 1-9; figure 1 *	1	
A	US-A-4 311 280 (KNAPE) * Column 7, line 48 - column 8, line 12; figures *	1	
A	FR-A-2 409 818 (ITT INDUSTRIES INC.) * Page 1, lines 1-5,30-35; page 2, lines 3-17; figures 1-10 *	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17-11-1986	Examiner FRIDEN C.M.
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			