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(12) # EUROPEAN PATENT APPLICATION

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(54) **Improved electroinjector for feeding fuel to an internal combustion engine.**

(57) An electroinjector suitable to supply fuel in internal combustion engines, with intermittent delivery rate, comprising a shoulder element (24), of substantial annular shape and of substantially amagnetic material, said shoulder element being positioned between the armature (12) and the core of (10) said electroinjector.

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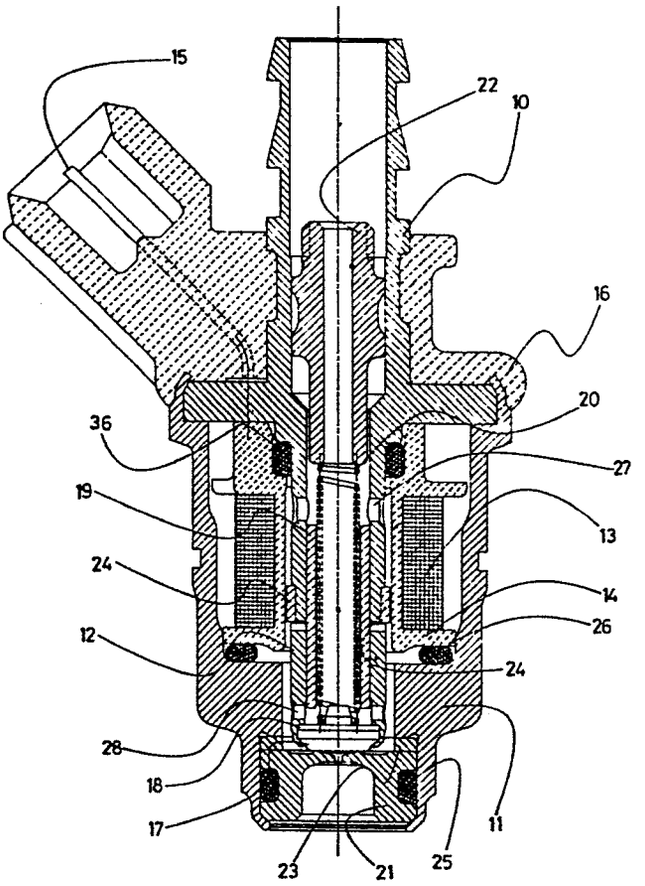

FIG.1

The repeated shoulder knocks tend to annul the micro-unevennesses of working, until the shoulder surfaces become perfectly smooth and coplanar, to that the effective contact area between the surfaces of the armature and of the central core increases with time and a remarkable increase happens of the adhesion forces, of both magnetic and hydraulic characters.

The increase of the effective contact area between the armature and the core involves an increase both of the remanence force, and of the resistance against separation due to the adhesion, also called as attraction force between contacting smooth surfaces.

As a consequence of these phenomenons, the drift appears of electroinjectors, in that their response time at closure increases.

In view of what has been previously exposed, a particular object of the present invention is to realize an electroinjector in which the magnetic and hydraulic sticking effect is eliminated between the shoulder surfaces of the armature and of the core, such object being achieved by resorting to a range of measures consisting of placing a shoulder element in an intermediate position between the armature and the core, in such a way as to leave a gap which prevents the magnetic sticking, of reducing to the minimum the contact area between the armature and the shoulder element, and of hardening at least one of the mating surfaces, so as to reduce the adhesion force, and at the same time to maintain unchanged with time the effective contact area.

More precisely, an electroinjector realized according to the principles of the present invention is charac

Disclosure

The present invention relates to an electroinjector structurally consisting of a central core of ferromagnetic material, of a coil wound on said core, of a movable armature of ferromagnetic material containing at its end an insert of material suitable to build a tight hydraulic seal when the same is pressed by a return spring on an injection nozzle beneath, of a pipe inserted inside said central core, which protrudes inward, penetrating inside a hollow part of the armature, so as to act at the same time as a guide means for the armature itself, and partly as means for feeding the fuel to the nozzle, and finally of an outside body which closes the magnetic loop with the central core and the armature.

General purpose of the invention is of providing an electroinjector designed in such a way as to make the armature opening and closing transients quick and repetitive, the armature being of reduced mass, the friction coefficients between the armature and its relevant guide being low, the gaps being characterized in order to optimising the efficiency both in the opening stage and in the closing stage of the armature, the load of the spring being optimised by intervening from the outside of the injector.

As it is known to those skilled in the art, the time duration of the closing transient of the armature/stopper can be influenced by the effects of the so-called "hydraulic and magnetic sticking" which is experienced when a direct shoulder of end of stroke between armature and central core exists, due to the relative wear which takes place betweer shoulder surfaces.

terized in that between its armature and its core a shoulder element is interplaced, having a substantially annular shape, at least partly consisting of practically amagnetic material, said shoulder element being provided of a substantially annular end wall suitable to come into contact, at least partly, with a portion of the end wall, the latter too being of substantially annular shape, of one of said armature and core, at least one of said substantially annular wall being formed with a shock resistant material.

The structural and functional characteristics of the invention and its advantages in comparison to the present art will appear still more evident from the following disclosure, referred to the schematic drawings attached, which show examples of embodiments of the invention itself.

In the drawings:

Fig. 1 is a longitudinal section view showing an electroinjector designed according to the invention; and

Figs. from 2 to 9 are enlarged details illustrating components and alternatives of the invention itself.

Referring first to Fig. 1 of the drawings, the electroinjector according to the invention is structurally consisting of a core 10 of ferromagnetic material, an outside shell 11, it too consisting of ferromagnetic material, and of an armature 12, which form altogether a magnetic loop.

By 13 a coil is indicated, wound on a bobbin 14, which surrounds the central core 10 and can be electrically powered with intermittent power by means of the connectors 15 housed within a casing of plastics 16.

The armature 12, which is coupled with a sealing insert 17 of suitable material, with the interplacing of a washer 18, is guided by a small tube 19 inserted with interference on the central core, and is pressed by a spring 20 against the shoulder of a nozzle 21 equipped with a gauged bore for the outlet of fuel.

Said spring 20 interacts with an insert 22 inserted with interference inside the central core 10.

A packing 23 defines the value of the stroke "H" of armature 12, which ends its stroke against a second annular element 24 assembled on core 10 in such a way as to protrude outward by the same value of desired "T" air gap (Fig. 2).

Rings 25, 26 and 36 guarantee the hydraulic tightness, whilst the calkings of the shell 11 on the core 10 and on the nozzle 21 render monolithic the electroinjector.

An electroinjector provided as above described according to the principles of the invention operates as follows.

Fuel is fed through the outer tubular wall of core 10, passes through the central bore of insert 22, then through bores 27 in the core and bores 28 in the armature, it arrives externally to nozzle 21.

Until the electroinjector is not electrically powered, the spring 20 holds the armature 12 with its sealing insert 17 pressed against the sealing flat surface of the nozzle, which is thus closed.

When, by means of the electrical connectors 15, electrical current is fed to the coil 13, a flux is generated in the magnetic loop, which draws back armature

12 from its sealing position to its position of stroke end, defined by the shoulder on the annular element 24 of non magnetic hardened material. This lifting of armature 12, which takes place within a very short time (opening transient) allows the fuel to flow out of the nozzle in a quantity which, at each cycle, for a given gauging of the nozzle, is a function of fuel pressure, and of electrical excitation of the coil.

When the electrical powering is turned off, the armature returns to its shoulder position on the sealing seat of the nozzle, pushed by spring 20 within a time which characterizes the closure transient.

The armature 12 may be manufactured with a harder material than pure iron, such as for instance PERMENORM 5000H3. The annular inserted element 24 (Figs. 2 and 3) can be made of course from AISI 310 or bronze , and it can be assembled both outside and inside of the central core 10 itself.

Moreover, the inserted annular element 24 can be assembled in such a way as to rest against a flat surface 29 of central core 10 (Figs. 1, 6, 7 and 8), or it can be pushed so as to define the desired value of "T" air gap (Figs. 2 and 3), fixing the reached position by dimensional interference, or by other known means, such as by soldering or by glueing means. Another way of fixing the position of element 24 is to provide a longitudinal slot, such as in 30 (Fig. 4) in it, or as in 31 (Fig. 5), along its whole lenght, or along a part of it, then slindingly forcing it on to the central body, exploiting its elasticity within the limits of a given dimensional interference.

Moreover, to the purpose of reducing still more the wear effect of the annular element 24 by the stroke end shoulder surface of the armature 12, a surface layer can be placed of very reduced thickness, of hard material, on the shoulder surface 32 of armature (Fig. 9), said material could be e.g. titanium nitride.

In addition, by ensuring the hardening of the shoulder surfaces of element 24, as well as of armature 12, the said surfaces can be provided in such a way as to be positioned, instead of parallel, so as to form a given α angle between each other (Fig. 7), of e.g. 1°, or the shoulder surface of the same element 24 can be made radiused, as in 33 (Fig. 6).

By both these solutions, the contact surface between the two components of the shoulder is as reduced as possible.

In any cases, the introduction of the annular element inserted 24, which defines the "T" air gap and the end of the stroke "H" of armature, eliminates the magnetic sticking effect, whilst the hydraulic sticking effect is minimised by the reduced thickness of the wall of element 24 itself and by the hardness of contact surfaces, being it possible to increase such hardness as previously explained.

Moreover, by increasing the hardness of the shoulder surfaces, it becomes possible to further on reduce the contact geometry of said surfaces, by varying the shape of either or of both the surfaces said.

In addition, in order to avoiding a possible pumping effect of the liquid present inside the annular chamber 34 (Fig. 2), which, during the initial stage of downward

motion of armature could give rise to a delay of closure transient, providing id projected of at least a slot 35 on the upper end of armature itself (Fig. 9).

Claims

1. Electroinjector for the feeding of intermittently delivered quantities of fuel to an internal combustion engine, consisting of a core of ferromagnetic material, of a coil surrounding the core, of an injection nozzle, of a movable armature acting as a stopper, positioned between the core and the injection nozzle, coaxial with both, of a return spring which pushes the armature towards the injection nozzle, of a tube partly inserted inside the core, acting as an inside guide for the armature, of a delivery duct of the fuel to the injection nozzle, of an external shell which closes the magnetic loop together with the core and with the armature, said electroinjector being characterized in that between the armature and the core a shoulder element is provided, of essentially annular shape, at least partly consisting of practically amagnetic material, said shoulder element being provided with a substantially annular end portion fitted to come in contact, at least partly, with a portion of the end wall, it too being of substantially annular shape, of either of said armature and core, at least one of substantially annular walls being consisting of shock resistant material.

2. Electroinjector as claimed in claim 1, characterized in that said shoulder element consists of an annular element mounted on an outer cylindrical wall of core.

3. Electroinjector as claimed in claim 1, characterized in that said shoulder element consists of an annular element mounted on the inside cylindrical wall of core.

4. Electroinjector as claimed in claims 2 and 3, cha-

racterized in that said annular element is slidingly forced on the core, with interference.

5. Electroinjector as claimed in claims 2 and 3, characterized in that said annular element is assembled against a shoulder provided on the core.

6. Electroinjector as claimed in claims 2 and 3, characterized in that said annular element is at least partly split in a longitudinal direction, and is elastically slidingly forced on the core.

7. Electroinjector as claimed in claim 1, characterized in that said annular element consists of practically amagnetic shock resistant material.

8. Electroinjector as claimed in claim 1, characterized in that said shoulder element consists of an annular projection provided on the end wall, of practically annular shape, of said core, said annular projection jutting out towards the armature, and its surface being hardened.

9. Electroinjector as claimed in claim 1, characterized in that said shoulder element consists of an annular projection provided on the end wall, practically of annular shape, said annular projectiom jutting out towards the core, and its surface being hardened.

10. Electroinjector as claimed in claim 1, characterized in that the said end annular wall is superficially hardened.

11. Electroinjector as claimed in claim 1, characterized in that the said annular end wall of the armature is coated by means of applied hard material, preferably titanium nitride.

12. Electroinjector as claimed in claims 8 and 9,

characterized in that said annular projection is coated by means of an applied hard material, preferably titanium nitride.

13. Electroinjector as claimed in claim 1, characterized in that one of said annular end walls is radiused.

14. Electroinjectors as claimed in claim 1, characterized in that at least one of said annular end walls is inclined through a certain angle.

15. Electroinjectors as claimed in claim 1, characterized in that said en wall of the armature is provided with at least a notch.

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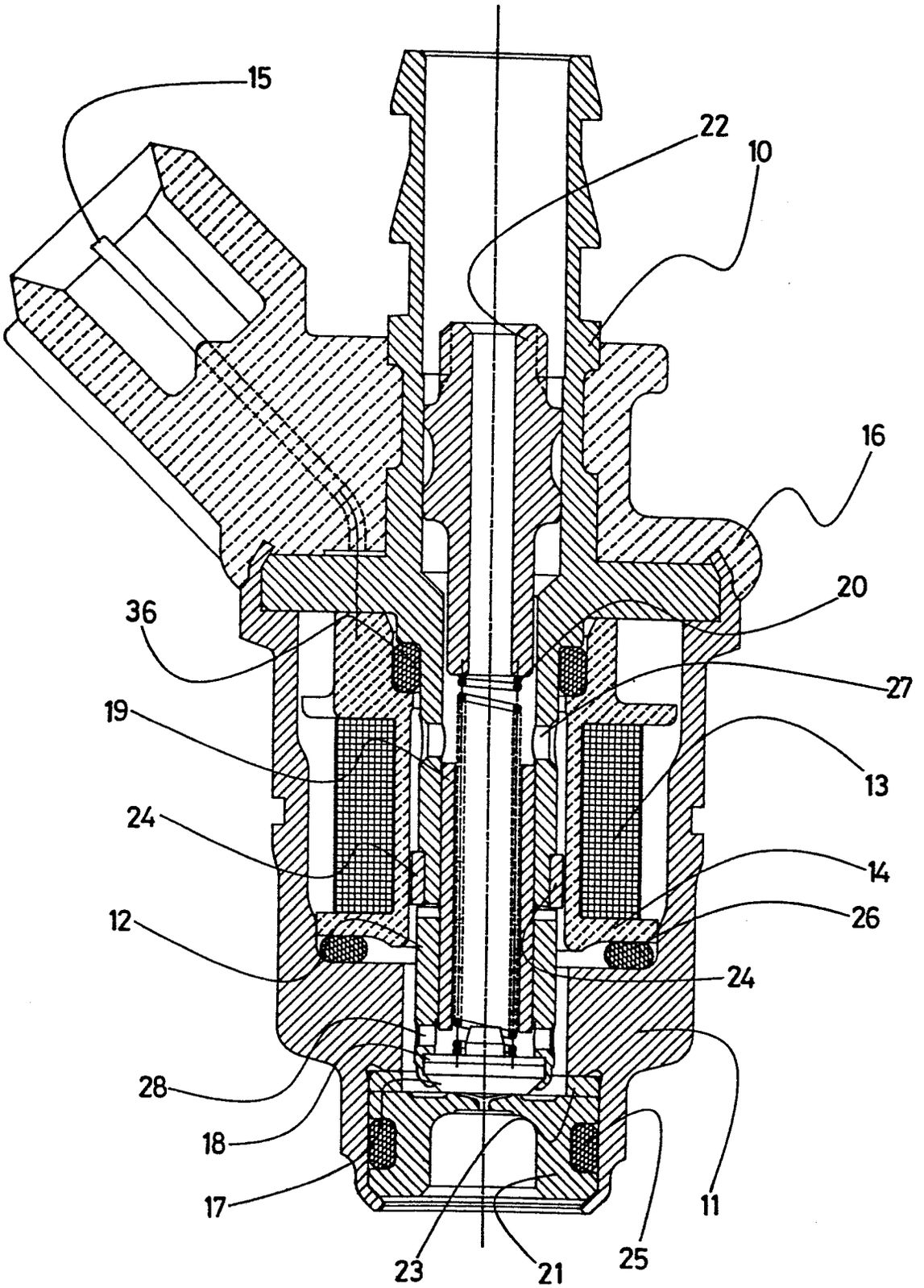

FIG. 1

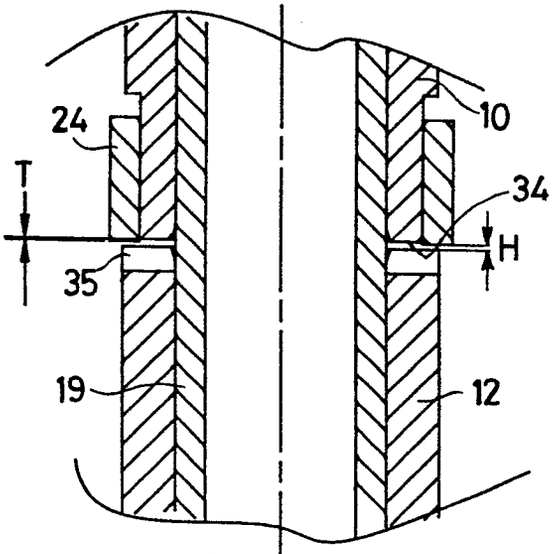

FIG. 2

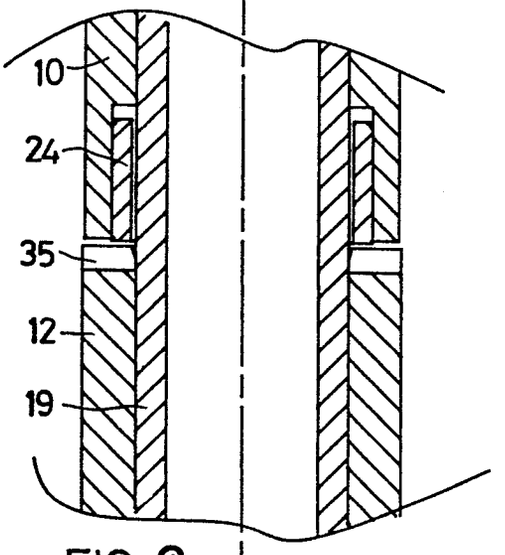

FIG. 3

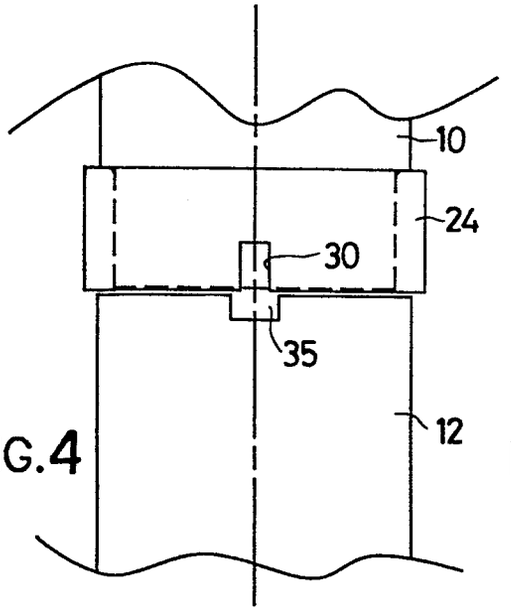

FIG. 4

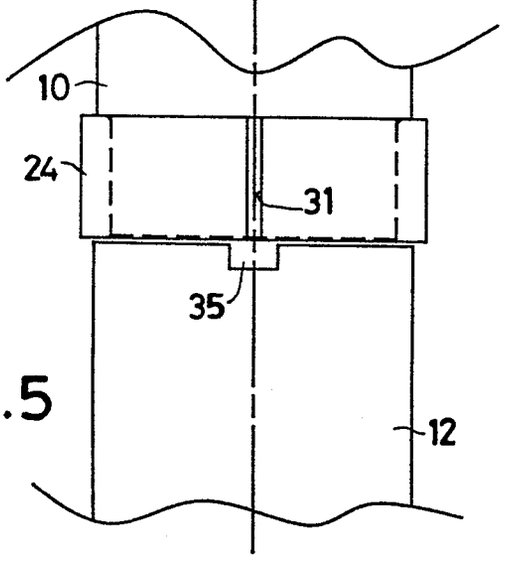

FIG. 5

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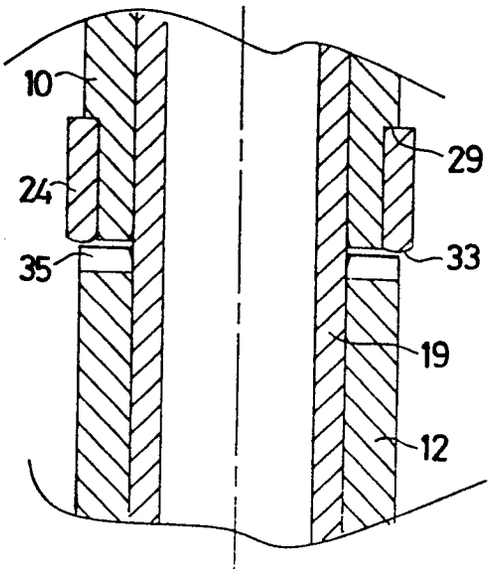

FIG. 6

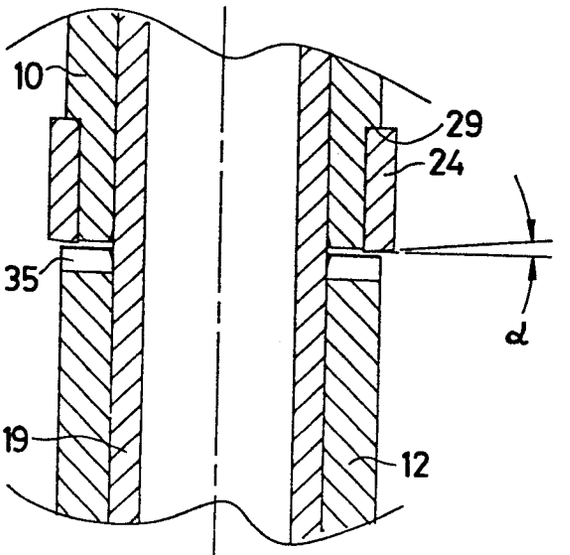

FIG. 7

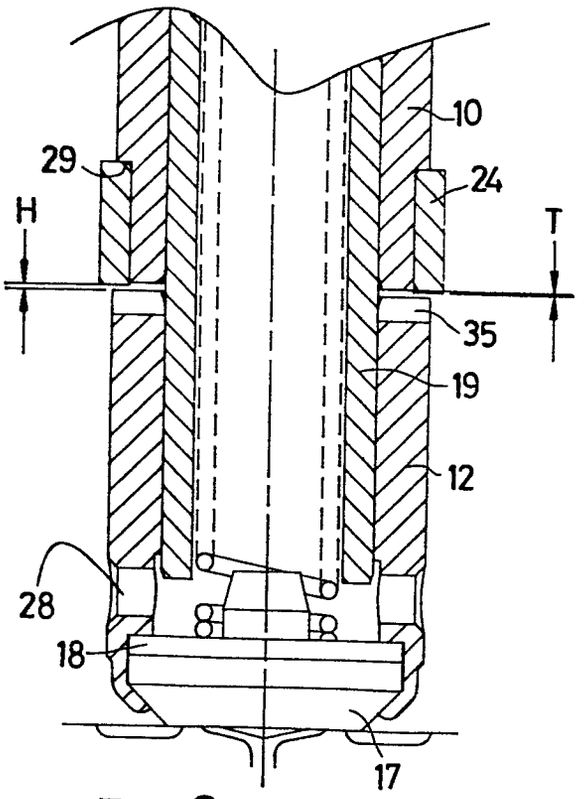

FIG. 8

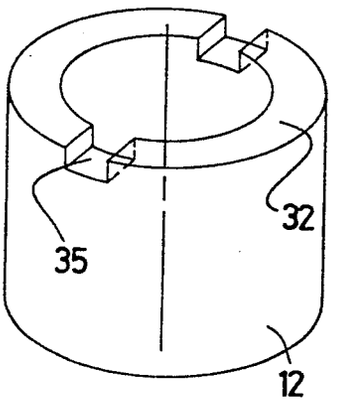

FIG. 9

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EUROPEAN SEARCH REPORT

0172591
Application number

EP 85 20 1124

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)
Y	FR-A-2 241 008 (TECHNIQUES DE HAUTE PRECISION) * Page 7, last paragraph; page 8, lines 1-9; figure 1 *	1,3,7	F 02 U 51/08 H 01 F 7/08
A		8	

Y	DE-A-3 015 192 (INNOVATION TECHNIQUES AVANCES -INNOTA) * Page 9, first paragraph; figure 1 *	1,3,7	
A		5,8	

Y	US-A-4 311 280 (KNAPE) * Column 7, line 48 - column 8, line 12; figures *	1,3,7	TECHNICAL FIELDS SEARCHED (Int Cl 4)
A		9,10	F 02 U H 01 F F 16 K

Y	DE-A-2 123 145 (VYZKUMNY USTAV AUTOMATIZACZNICH PROSTRZEDKU) * Page 10, lines 6-10; figure 4; page 11, lines 11-17 *	1-7	
A		2,4,5,8	
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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	06-11-1985	KAPOULAS T.

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

0172591
Application number

EP 85 20 1124

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)
Y	US-A-2 988 675 (BANCROFT) * Column 2, lines 62-65; figure 2 * ---	1	
A	PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 106 (M-213)[1251], 10th May 1983; & JP - A - 58 27876 (AISAN KOGYO K.K.) 18-02-1983 ---	3	
A	DE-A-2 639 274 (BINDER MAGNETE) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

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